CHAPTER 4 – THE ROUTEING PROCESS AND ALTERNATIVES

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There are no appendices associated with this chapter.

4 THE ROUTEING PROCESS AND ALTERNATIVES

4.1 Introduction

4.1.1 The need for the Proposed Development and the work undertaken by the Applicant to assess the strategic electricity transmission infrastructure requirements to identify a viable and enduring technical design solution is explained in Chapter 2: Project Need.

4.1.2 In accordance with Regulation 5(2)(d) and Schedule 4, paragraph 2 of the EIA Regulations, this Chapter describes the reasonable alternatives studied by the Applicant which are relevant to the Proposed Development and sets out the main reasons for the options which have been selected, taking account of the potential effects on the environment of the alternatives considered. This Chapter describes the consideration of alternatives that has been undertaken for the Proposed Development following the need identification, including both: (i) the alternative types of technology considered to address that need; and (ii) the routeing process for the selected technology type, being OHL, comprising of the corridor, route and alignment selection stages. The approach has followed SSEN Transmission's Routeing Procedure which provides a systematic framework for the identification and appraisal of alternatives for OHL projects. The Routeing Procedure is explained further in Section 4.4.

4.1.3 An iterative approach has been taken to the identification, appraisal and selection of OHL alternatives through the corridor, route and alignment stages of the process. The routeing process and the final configuration of the Proposed Development has been informed at each stage through consideration of environmental, technical (engineering feasibility) and economic (cost) criteria. It has also been informed by an ongoing process of consultation with statutory and non-statutory consultees, local communities and landowners.

4.1.4 The initial sections of this Chapter (Sections 4.2 to 4.3) outline the relevant statutory framework, and the strategic alternatives considered by the Applicant in defining the nature of the project and its technology in response to the needs case identified and established by the relevant UK Government agencies and as set out in Chapter 2: Project Need. The principal stages which were subsequently followed in the development of the new OHL transmission infrastructure are described in this Chapter, along with their respective outcomes:

- the approach to the corridor, routeing and alignment selection stages of the project (Section 4.4);
- the corridor selection stage process (Section 4.5);
- the route selection stage process (Section 4.6);
- the alignment selection stage process, and (Section 4.7); and
- further consideration of alternatives during the EIA process (Section 4.8).

4.2 Alternatives Considered

Statutory and Licence Framework

4.2.1 It is important to set out the statutory and licence framework that informs the practice of the Applicant when determining: (i) the type of infrastructure technology; and (ii) the route for that infrastructure.

4.2.2 First, SSEN Transmission, as a transmission licence holder, has a statutory duty under section 9(2)(a) of the Electricity Act 1989 to '*develop and maintain an efficient, coordinated and economical system of electricity transmission*'.

4.2.3 Secondly, SSEN Transmission has a statutory duty under Schedule 9 (para. 3) of the Electricity Act 1989, '*when formulating proposals to generate, transmit, distribute or supply electricity*' to:

- "*have regard to the desirability of preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest*"; and

- "*do what [it] reasonably can to mitigate any effect which the proposals would have on the natural beauty of the countryside or on any such flora, fauna, features, sites, buildings or objects*".

4.2.4 Thirdly, under the terms of the transmission licence, SSEN Transmission is obliged to comply with the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS)[1], which provides the criteria for the planning and design of the transmission system. The NETS SQSS requires SSEN Transmission to provide a transmission connection capable of withstanding single circuit faults without loss of supply and without disconnection of generation stations.

4.2.5 Fourthly, the requirements of the Construction (Design and Management) Regulations 2015[2] (CDM Regulations) require that the design aims to minimise hazards and reduces risks during construction, operation and maintenance of assets.

4.2.6 Taking account of these obligations, SSEN Transmission has considered the technical, economic and environmental factors in identifying and evaluating the reasonable alternatives for the Proposed Development.

Scope of Alternatives Study

4.2.7 The EIA Regulations require the Applicant to report upon the reasonable alternatives that were studied and the main reasons for the choice of the development, taking into account the environmental effects. Section 4.3 describes the strategic and technological alternatives that have been considered by SSEN Transmission in taking forward the Proposed Development in response to the need case which has been set out in Chapter 2: Project Need. In summary, those alternatives were:

- Do nothing: the "do-nothing" scenario; and
- Alternative technology types: UGC and subsea cable options.

4.2.8 Section 4.4 summarises the routeing process then undertaken by the Applicant for the selected technology type, describing the approach to the corridor, routeing and alignment selection stages of the project.

4.2.9 Sections 4.5 to 4.8 describe in more detail the alternatives considered for the selected technology with the objective of identifying a Proposed Alignment and associated Limit of Deviation (LoD) for the OHL which is technically feasible, economically viable and, wherever possible, minimises disturbance to the environment and to the people who live, work, visit and enjoy recreation within it.

4.3 Strategic Alternatives: Do Nothing Scenario / Technology Types

"Do-Nothing" Scenario

4.3.1 As established in Chapter 2: Project Need, the Proposed Development is of national importance, contributing significantly towards the delivery of the UK's and Scottish Government's Net Zero Targets and helping to reduce the UK's dependence on imported oil and gas. In a "do-nothing" scenario, the current electricity transmission network would not have capacity to support the transfer of power from both onshore and offshore renewable generation in the north of Scotland to key centres of demand across the country, and therefore the UK Government's targets of 50 GW of offshore wind generation by 2030 and delivery of Net Zero targets could not be met. This Strategic Option would not meet the requirements of the network and was discounted from further consideration given it did not represent a reasonable alternative. Accordingly, it was necessary to consider the available options for new infrastructure, during the holistic network design ('HND') and network options assessment (NOA) processes.

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[1] National Energy System Operator, 2024. National Electricity Transmission System Security and Quality of Supply Standard, Version 2.8, (2024). Available at: https://www.neso.energy/industry-information/codes/security-and-quality-supply-standard-sqss/sqss-code-documents
[2] UK Government (2015). The Construction (Design and Management) Regulations 2015. Available at: http://www.legislation.gov.uk/uksi/2015/51/contents/made

Alternative Technology Types: HND and NOA Process

Primary solution: OHL or UGC

4.3.2 When undertaking the initial assessment of the technology options to reinforce the transmission network (as set out in **Chapter 2: Project Need**) SSEN Transmission's System Planning and Network Investment team assessed the potential technical options against its statutory and licence framework described at **Section 4.2**. As noted in Chapter 2, this consisted of both onshore and offshore options. In this case, an onshore option was selected, which meant that there was an initial strategic choice to make between underground cable (UGC) or OHL technology for the entire length of the route. At that time, the key factor distinguishing these two technology types was their relative cost. In summary:

4.3.3 **Institution of Engineering and Technology (IET) endorsed Costing Study**: at the time the technology options were being considered, the Applicant was mindful of the study titled 'Electricity Transmission Costing Study: An Independent Report Endorsed by the Institution of Engineering & Technology', authored by Parsons Brinkerhoff in April 2012[3] (the Parsons Brinckerhoff Report). The report concluded that an UGC had a build cost rate of 6.9-17.2 times greater than OHL, with a lifetime cost of 4.9-10.5 times greater (please see the cost comparison charts and tables in Section 8 of the Parsons Brinckerhoff Report[3]). The Parsons Brinckerhoff Report was a general (rather than project-specific) study which does not seek to establish a cost ratio that can be applied to all projects (see page vii). Nonetheless, the purpose of the report was to assist in determining the acceptability of a project in planning terms, *'based on an accredited view of the relative costs'* (Foreword). The report sets out the key reasons why UGC is significantly more expensive than an OHL over an equivalent distance.

4.3.4 **Draft UK Government Policy**: The Draft Overarching National Policy Statement of Energy dated 2021 (EN-1)[4] and its supporting Draft National Policy Statement for Electricity Networks Infrastructure dated 2021 (EN-5),[5] had also been published at the time the options were being considered. EN-5, in particular, introduced the UK Government's *'strong starting presumption'* in favour of an OHL (para. 2.9.21) on the basis of, among other factors, the '*additional cost of the proposed underground... alternatives, including their significantly higher lifetime cost of repair and later uprating'* (para. 2.9.26).

4.3.5 With consideration of these factors, the Applicant's submission to the National Energy System Operator (NESO) (previously National Grid ESO) to inform the onshore options was based upon costs for OHL as the use of UGC did not meet the requirements for an economical network when a suitable alternative comprising OHL was available to perform the required network function.

4.3.6 After the NESO recommendations to proceed with the reinforcements, the development of the Proposed Development commenced based on using OHL technology for its entire length.

4.3.7 During project development, the final published versions of the Overarching National Policy Statement for Energy (EN-1)[6] and its supporting National Policy Statement for Electricity Networks Infrastructure (EN-5) reinforced that decision. In particular, section 2.9.20 of EN-5, affirmed the UK government's *"strong starting presumption"*[7] for OHL. In addition to the cost of undergrounding, there are further technological challenges that were explained to consultees during the project development phase (as noted below).

[3] Institute of Engineering and Technology (IET) Electricity Transmission Costing Study - An Independent Report (2012) report by Parsons Brinkerhoff. Available at: https://www.theiet.org/media/9376/electricity-transmission-costing-study.pdf
[4] Department of Energy Security and Net Zero (2021) Draft Overarching National Policy Statement (EN-1). Available at: https://assets.publishing.service.gov.uk/media/6132402cd3bf7f05b2ac1f4b/en-1-draft-for-consultation.pdf
[5] Department of Energy Security and Net Zero (2021) Draft Overarching National Policy Statement of Energy (EN-5): https://assets.publishing.service.gov.uk/media/613240ee8fa8f503bd4589a0/en-5-draft-for-consultation.pdf
[6] Department of Energy Security and Net Zero (2023) Overarching National Policy Statement for Energy (EN-1). Available at: https://www.gov.uk/government/publications/overarching-national-policy-statement-for-energy-en-1
[7] Department for Energy Security and Net Zero (2023) National Policy Statement for Electricity Networks Infrastructure (EN-5). Available at: https://www.gov.uk/government/publications/national-policy-statement-for-electricity-networks-infrastructure-en-5

Combined Solutions: Partial Underground Cable Options

4.3.8 Through the development stages (refer to Section 4.4), where challenges to the consenting, construction or operation of an OHL are identified, the potential use of shorter sections of UGC are borne in mind by the project team. However, with the 400 kV Proposed OHL Alignment, there were no challenges that could not be overcome through re-routeing the OHL to minimise impacts on sensitive areas such as those of national significance. This meant that, in turn, it was possible to avoid through other means both (i) the technical engineering challenges; and (ii) system limitations that would be inherent in the partial use of UGCs on a 400 kV line.

Technical challenges of undergrounding

4.3.9 As part of the consultation phase (during project development), the Applicant explained the technical challenges involved in undergrounding to consultees. These challenges were presented within "The challenges with undergrounding at 400kV" document[8], which explains, in general terms, the rationale behind the Applicant's decision to adopt a continuous OHL. These challenges are explained in more detail at in Section 4.8.

System Limitations of Short Sections of Underground Cable

4.3.10 A key technical consideration when assessing UGC sections is the impact to the wider transmission network. High voltage UGC causes the network to operate less efficiently and generates constraint issues. UGC does not transport electricity as efficiently as OHL and requires new or upgraded substation sites to house reactive compensation equipment. This equipment is essential to manage the flow of electricity through the network when using UGCs. It would increase the size of existing substation footprints or require new sites to be constructed. Reactive compensation equipment is not relied upon to the same extent when using OHL and is part of the reason why UGC is more expensive than OHL. Fundamental to the use of short sections of UGC is the availability of suitable sites to extend or build new substations whilst minimising technical challenges and environmental impacts.

4.3.11 SSEN Transmission undertook studies in 2023 to ascertain the impact of introducing UGC onto the 400 kV network. It was determined that the estimated length at which reactive compensation infrastructure would be required would be between 1-2 km of 400 kV UGC installed across the entirety of the over 500 km of new 400 kV OHL infrastructure. Notwithstanding the environmental, technical and cost considerations, introducing UGC sections presents challenges to achieve a functionally operable and compliant circuit on a comparable basis with 400 kV OHL.

4.3.12 The system limitations, technical, environmental and cost challenges described above meant a 400 kV UGC was not considered at any stage to be a reasonable alternative technology. Therefore, the Proposed Development has been progressed as a high voltage OHL in accordance with the process described in the section below. Moreover, as noted below, the Applicant's decision during the project development / consultation phases to adopt a continuous OHL is further supported by factors that have been considered in further detail (or which have emerged) during the EIA study, as noted below at Section 4.8.

4.4 Summary of Routeing Process

4.4.1 Guidelines for the routeing of new high voltage OHLs are established within the electricity supply industry. These guidelines are known as the 'Holford Rules'[9] and have been widely used throughout the UK since the 1960s. The Holford Rules set out a hierarchical approach to routeing which advocates avoiding areas of high amenity value, minimises changes in direction, takes advantage of topography and minimises visual interaction with other transmission infrastructure.

[8] SSEN Transmission (2024). The challenges with Undergrounding at 400kV. Available at: https://www.ssen-transmission.co.uk/globalassets/projects/2030-projects/2030-project-documents/the-challenges-with-undergrounding-at-400kv.pdf
[9] Scottish Hydro Electric Transmission Limited (SHETL) (2004). The Holford Rules: Guidelines for the Routeing of New High Voltage Overhead Transmission Lines with NGC 1992 and SHETL 2003 Notes; Revision 1.01. Available at: https://www.nationalgrid.com/sites/default/files/documents/13795-The%20Holford%20Rules.pdf

4.4.2 SSEN Transmission has developed its own guidance[10], based on the principles set out in the Holford Rules, but broadening the basis for routeing decisions to reflect contemporary practice. It also provides a framework to ensure environmental, technical and economic considerations are identified and appraised at each stage of the routeing process.

4.4.3 The approach to corridor, route and alignment selection has therefore been informed by SSEN Transmission's guidance. The guidance splits the routeing stage of a project into four principal stages, as follows:

- Stage 0: Routeing Strategy Development[11];
- Stage 1: Corridor Selection;
- Stage 2: Route Selection; and
- Stage 3: Alignment Selection.

4.4.4 Each stage is an iterative process and involves an increasing level of detail and resolution, bringing cost, technical and environmental considerations together in a way which seeks to achieve the best balance at each stage. Consultation with stakeholders and the public is carried out at stages 1-3 of the process.

4.4.5 In accordance with the steps outlined in the Holford Rules and SSEN Transmission guidance, the following principles were taken into account during the corridor, route and alignment stages of the Proposed Development:

- avoid, if possible, major areas of highest amenity value (including those covered by national and international designations and other sensitive landscapes);
- avoid by deviation, smaller areas of high amenity value;
- try to avoid sharp changes of direction and reduce the number of larger angle towers required;
- avoid skylining the route in key views and where necessary, cross ridges obliquely where a dip in the ridge provides an opportunity;
- target the route towards open valleys and woods where the scale of poles or towers will be reduced and views broken by trees (avoid slicing through landscape types and try to keep to edges and landscape transitions);
- consider the appearance of other lines in the landscape to avoid a dominating or confusing wirescape effect; arrange wherever practicable that parallel or closely related routes are planned with tower types, spans and conductors forming a coherent appearance; and
- approach urban areas through industrial zones and consider the use of undergrounding in residential and valued recreational areas.

4.4.6 Further detail of routeing stages 1-3 can be found in the following documents:

- Corridor Selection Consultation Document[12];
- Corridor Report on Consultation[13];
- Route Selection Consultation Document[14];
- Route Report on Consultation[15];

[10] SSEN Transmission (2018). Procedures for Routeing Overhead Lines of 132kV and above (updated in 2020 to include underground cables of 132 kV and above)
[11] Setting out the proposed strategy for the routeing stage of a particular project. Available at: https://www.ssen-transmission.co.uk/globalassets/projects/2030-projects/2030-project-documents/routeing-overhead-lines.pdf
[12] SSEN Transmission (2022). Corridor Stage Consultation Document. Available at: https://www.ssen-transmission.co.uk/projects/project-map/beauly-blackhillock-new-deer-peterhead-400kv/
[13] SSEN Transmission (2023). Report on Consultation – Corridor. Available at: https://www.ssen-transmission.co.uk/projects/project-map/beauly-blackhillock-new-deer-peterhead-400kv/
[14] SSEN Transmission (2023). Route Stage Consultation Document. Available at: https://www.ssen-transmission.co.uk/projects/project-map/beauly-blackhillock-new-deer-peterhead-400kv/
[15] SSEN Transmission (2024). Report on Consultation – Route. Available at: https://www.ssen-transmission.co.uk/projects/project-map/beauly-blackhillock-new-deer-peterhead-400kv/

- Alignment Selection Consultation Document[16]; and
- Alignment Report on Consultation[17].

4.5 Corridor Selection (Stage 1)

4.5.1 A digital toolkit was used to help identify corridor options to connect the four substations at Beauly (Fanellan), Blackhillock (Coachford)[18], New Deer (Greens) and Peterhead (Netherton Hub). The steps to the digital approach were as follows:

- Confirm Study Area – the study area was primarily influenced by the topography of the coastal areas, as well as the need to avoid the Cairngorms National Park and crossing Loch Ness, through the preliminary application of the Holford Rule 1:

  "*Avoid altogether if possible, major areas of highest amenity value, by so planning the general route of the line in the first place, even if the total mileage is somewhat increased in consequence.*"
- Initial Data Gathering – constraints data sets were gathered, reviewed and assessed, and initial sensitivity weightings were applied to each data set by the specialists in the different disciplines. The sensitivity weightings reflect how each constraint affects the project specifically.
- Development of a heat map – the constraints were layered onto a map so they could be viewed as a composite 'heat map' and weightings and buffers applied depending on the sensitivity of the constraint, or opportunity. In addition to constraints, some data sets provide opportunities to OHL routeing in line with the Holford Rules, such as running parallel to existing OHLs or roads; these are also built into the heat-map. The weightings and parameters were refined following site visits and sensitivity analysis to verify the outputs.
- Potential Corridor Development - A 'Least Impact Path' analysis was run to determine potential corridors across the constraints surface, identifying ways to route the OHL to have the least 'environmental impact' and interaction with environmental constraints. This information was provided to the topic environment leads and professional judgement was applied in developing preliminary corridors, taking into account less tangible aspects of the Holford Rules which cannot be digitised. At corridor stage, emphasis for corridor development was focused around avoiding areas of high density residential development, internationally and nationally designated sites, areas of high or steep terrain etc.

4.5.2 Due to the length of the OHL, it was split into five sections as shown on **Figure 4.1: Corridor Options**. Sections 1 to 4 had two corridor options established for comparative appraisal across a range of environmental, technical, and cost parameters. Section 5 had one corridor option due to its short length and therefore limited potential for a second corridor[19]. The outcome of the corridor stage comparative appraisal was a Preferred Corridor, comprised of the preferred corridor option in each section, which was then taken forward to consultation. The comparative appraisal took account of environmental engineering and cost elements as is detailed in the Corridor Selection Consultation Document.

4.5.3 Following feedback received at consultation from stakeholders and the public, amendments were made to the Preferred Corridor to reflect the issues and concerns raised during the consultation period.

4.5.4 The main reasons for the selection of the preferred corridors and key changes following stakeholder consultation are detailed in **Table 4.1**. In addition to those detailed in **Table 4.1**, a number of small corridor deviations were also made in all of the five sections to ensure there was suitable opportunity to identify viable route options at the next stage when taking account of the numerous constraints which needed consideration; including scattered residential properties.

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[16] SSEN Transmission (2024). Alignment Stage Consultation Document. Available at: https://www.ssen-transmission.co.uk/projects/project-map/beauly-blackhillock-new-deer-peterhead-400kv/
[17] SSEN Transmission (2025). Report on Consultation – Alignment. Available at: https://www.ssen-transmission.co.uk/projects/project-map/beauly-blackhillock-new-deer-peterhead-400kv/
[18] Since removed from Scope
[19] Section 5 had one corridor option as it was not as constrained as other sections and therefore had capability to support multiple route options within this corridor at the following stage.

4.5.5 The resultant Proposed Corridor is shown in **Figure 4.2: Proposed Corridor.** Further detail on this can be found in the Corridor Stage Report on Consultation[20], which details the consultation process for corridor stage, consultation feedback received, and clearly outlines the changes that were made to the corridors as a result of the consultation feedback.

Table 4.1: Proposed Corridor Selection Rationale

Section	Preferred Corridor	Proposed Corridor	Main Reason for Decision
1	1A	1A	Avoidance of the Drynachan, Lochindorb and Dava Moors Special Landscape Area (SLA), which cannot be avoided in Corridor 1B, as well as the possibility to avoid peatland habitats. The elevation and terrain of Corridor 1B is likely to be challenging from an engineering perspective. Corridor 1A also contains existing steel lattice tower OHLs and presents the opportunity to keep such infrastructure together if aligned appropriately. Following consultation Corridor 1A was extended slightly at the most western extent to allow additional space to develop route options to the preferred site for the proposed Fanellan substation.
2	2B	2B	Avoidance of high densities of residential dwellings, and less constrained by SLAs and Gardens and Designed Landscapes (GDL)s. It also avoids the possibility of a railway crossing which is not desirable from an engineering perspective. Following consultation Corridor 2B was extended slightly to the north of Romach Hill to ensure there was suitable space to develop viable route options around the northern side of the hill at the next stage.
3	3A	3A	Taking the least environmentally sensitive crossing of the Spey Valley SLA and River Spey Special Area of Conservation (SAC) / Site of Special Scientific Interest (SSSI); which is also less challenging from an engineering perspective. Following consultation the western part of Corridor 3A was extended to the south, near Moss of Bednawinny. This was to widen the corridor in an area that is constrained by residential dwellings, to ensure there was suitable space to develop viable route options at the next stage.
4	4A	4A and 4B	The differences between the two options were marginal, with the Deveron Valley SLA being a key consideration and Corridor 4A marginally preferred from a landscape and visual perspective. Following consultation it was decided to take both corridor options (4A and 4B) forward to the route selection stage. This was largely due to feedback highlighting the use of Crombie Moss by common crane, and proximity to settlements in Corridor 4A. By taking both corridor options forward to the route selection stage, potential route options were explored within both corridor options to ensure the optimum Preferred Route could be established. Corridor 4A was also widened to the north of Aberchirder, to the north of New Deer; and Corridor 4B widened to the West of Marnoch to ensure suitable space to develop route options at the next stage.
5	5	5	Only Corridor 5 is present in Section 5, therefore there is no comparative appraisal. There are some settlements and scattered dwellings throughout the corridor; however there is potential to develop alignments that would minimise visual effects.

[20] SSEN Transmission (2023). Report on Consultation – Corridor. Available at: https://www.ssen-transmission.co.uk/projects/project-map/beauly-blackhillock-new-deer-peterhead-400kv/

Section	Preferred Corridor	Proposed Corridor	Main Reason for Decision
			Corridor 5 was widened to the north of New Deer, to the south near Auchngatt and to the north near Longside to ensure suitable space to develop route options at the next stage.

4.6 Route Selection (Stage 2)

4.6.1 Similarly to the corridor stage, the heat map approach outlined above was continued for route stage. The route options established were approximately 1 km wide, but were more constrained in some areas and up to 2 km in other areas where there were more opportunities for finding OHL alignments. Due to the length of the study area, eleven sections were established, shown in Figure 4.3: Route Options. Section breaks were generally at locations where there was an opportunity to switch between route options. However, where there were numerous options at the section break, 'nodes' were used to enable flexibility in connecting two preferred routes. These nodes were often located at substation site locations.

4.6.2 Route development focused on further refining the work carried out at corridor stage and involved further discussion around avoiding designated sites, areas of high amenity value, settlements, and peatland habitats. In every section there were between two and six route options for comparative appraisal across a range of environmental, technical and cost parameters. The outcome of the route stage comparative appraisal was a Preferred Route, comprised of the preferred route option in each of the eleven sections, which was then taken forward to consultation. The comparative appraisal took account of environmental engineering and cost elements as is detailed in the Route Selection Consultation Document.

4.6.3 Following feedback received at consultation from stakeholders and the public, amendments were made to the Preferred Route to reflect the issues and concerns raised during the consultation period.

4.6.4 The main reasons for the selection of the preferred corridors and key changes following stakeholder consultation are detailed in Table 4.2. In addition to those detailed in Table 4.1 a number of additional route deviations were also made. Widening of the route corridor in some sections was required, and refinement in others where the Applicant was made aware of additional constraints. Key considerations included minimising woodland loss and impacts on Beaufort Castle GDL; and reducing landscape and visual impacts, notably around the Great Glen and The Aird.

4.6.5 The resultant 'Proposed Route' shown in Figure 4.4: Proposed Route was taken forward to the alignment stage. Further detail can be found in the Route Stage Report on Consultation[21], which details the consultation process for route stage, consultation feedback received, and clearly outlines the changes that were made to the corridors as a result of the consultation feedback.

4.6.6 A further step was included at route stage, which included the development of a 'refined route' as shown in Figure 4.5: Proposed Route and Further Refined Route, that further narrowed the route corridor. The purpose of this stage was to keep stakeholders and the public up to date with route and alignment development, and a suite of information events was carried out across locations close to the refined route study area.

Table 4.2: Proposed Route Selection Rationale

Section	Preferred Route	Proposed Route	Main Reason for Decision
1	1A	1A	Avoidance of the residential receptors in the settlements of Kiltarlity and Culburnie, although noting that this would result in routeing through the

[21] SSEN Transmission (2024) Report on Consultation – Route. Available at: Available at: https://www.ssen-transmission.co.uk/projects/project-map/beauly-blackhillock-new-deer-peterhead-400kv/

Section	Preferred Route	Proposed Route	Main Reason for Decision
			Beaufort Castle GDL and Croiche Wood semi-natural ancient woodland. This also avoided the Belladrum Tartan Heart Festival site. Following consultation, adjustment was made to Route 1A to provide the opportunity to develop alignments which avoid more woodland, whilst also crossing the Beaufort Castle GDL at the least impactful location (subject to other constraints) in this area. A narrow route expansion was also applied to the north of Route 1A to provide opportunity to parallel as close as possible with the existing OHL at the eastern River Beauly crossing.
2	2A2	2A2	On balance this had least constraints when considering the sensitivities in this area, notably the landscape and visual impacts crossing the Great Glen, Caledonian Canal and The Aird; Torvean Landforms SSSI and Geological Conservation Review (GCR) Site; Dochour GDL; semi-natural ancient woodland, scattered residential properties, and engineering challenges crossing the River Ness and with steep terrain. Following consultation, adjustment was made to Route 2A2 to provide opportunity to cross the Aird at a slightly lower elevation, providing opportunity to minimise visual impact and to develop alignment options which run alongside the existing OHL keeping infrastructure together. It also opens up an alternative option for a point for the Proposed OHL to cross the Great Glen.
3	3B	3B	Key constraints were the presence of Culloden Battlefield and Culloden Muir Conservation Area to the north, constraining the northern option and landscape and visual impacts to the south around Daviot constraining the southern option; therefore the middle option was taken which enabled the OHL to run adjacent to an existing OHL, however it is in close proximity to the Scheduled Monument Daviot Ring Cairn. Following consultation, a narrow expansion of the route was applied to the north of Route 3B to provide opportunity to parallel as close as possible with the existing OHL through Daviot Wood.
4	4B	4B	The selected route was located adjacent to the existing OHL (thus keeping infrastructure together from a landscape and visual perspective), maintained a distance from Culloden Battlefield and Culloden Muir Conservation Area (also passing behind Saddle Hill), Dalroy and Clava Landforms SSSI / GCR site and Cawdor Castle GDL to the north; whilst mostly avoiding the peatlands further to the south. Following consultation Route 4B was expanded to the north by a narrow section at the western end, between Saddle Hill (southeast of Culloden Battlefield) up to Mains of Clunas. This expansion provided opportunity to parallel as close as possible with the existing OHL. The eastern end of Route 4B (from Mains of Clunas to Dulsie Wood) was also expanded to allow additional flexibility in developing alignment options at the next stage. The route was expanded at the crossing of the River Findhorn to provide opportunity to parallel as close as possible with the existing OHL.
5	5B	5B	The northern route had landscape and visual and cultural heritage constraints near Edinkillie House and Church, the Dava Way, and the Divie Viaduct making the southern route preferable. There were operational windfarm constraints at both ends making engineering challenging. Following consultation, Route 5B was expanded to the north to provide opportunity for an alignment option to parallel as close as possible with the existing OHL which runs along the northern edge of the route.

Section	Preferred Route	Proposed Route	Main Reason for Decision
6	6C	6C	From a landscape and visual perspective Route 6C ran wide of most sensitive receptors in the area including the settlement of Dallas, with few residential properties and little sign of recreational activity within the route. Although it was noted that avoidance of peatland would be important in choice of alignment selection. Proximity to windfarms was again a challenge in this section. Following consultation, a small route expansion was added at the western end of Route 6C, where it meets Route 5B. This provided improved flexibility at the alignment stage, with more options available to avoid areas of Class 1 peatland and the consented Clash Gour Wind Farm substation location.
7	7B	7B	The southern route was the furthest route from Blackhills House GDL, and Category A and B Listed Buildings; it was also favoured from a landscape and visual perspective as it had the potential to be absorbed into the landscape and be less visible from any highly sensitive receptors. It does however pass through the Glenlatterach Reservoir Drinking Water Protected Area (DWPA) which would need to be carefully considered at the alignment selection stage. Following consultation, Route 7B was expanded to the south, from Glenlatterach to south of Lochbuie to provide opportunity to develop alignments that minimise woodland loss by including a region outwith existing woodland. However, it was noted that there is peatland in this area which would also be a consideration at the alignment assessment stage. The route was also expanded to the north at the eastern end, near Teindland and at the western end near Bodnamoor to provide opportunity to parallel as close as possible with the existing OHL.
8	8A1	8A1	The northern route was the least environmentally sensitive crossing of the Spey Valley SLA and River Spey Special Area of Conservation (SAC) / Site of Special Scientific Interest (SSSI), which was the main criteria for this section. The Spey Valley is wide, open to the west and characterised by intensive agriculture at this location. It does, however, pass through The Spey Boreholes, Dipple and the Ordiequish Collecting Chambers DWPA which would need to be carefully considered at the alignment selection stage. The choice of option at the eastern end was driven by the route choice for Section 9; passing either to the north or south of Keith. At the time, the Proposed Development needed to connect into the proposed Blackhillock 2 (Coachford) substation, which was a separate project. Following public and stakeholder consultation on the location of the proposed substation site, the location was moved from a site to the east of Keith, to an alternative site to the southeast of Keith. Therefore, route options were reviewed and the potential to route the OHL to the south of Keith as well as to the north was identified. Route 8A1 was therefore extended on the approach to and around Keith so that alignments options could be developed to both the north and south of Keith for the upcoming alignment selection stage. Route 8A1 was also extended at the western end, near Altonside, to provide the opportunity to develop more direct, shorter alignments potentially minimising impacts.
9	9C2	9C2	The selected route had both the least landscape and visual effects and the best fit with the landscape; it avoided the settlement of Aberchirder and the more sensitive crossing of the River Deveron to the north; all options being within the Deveron Valley SLA. It was also less visible from the A95 compared to the next similar option.

Section	Preferred Route	Proposed Route	Main Reason for Decision
			Following the change in location to the proposed Blackhillock 2 substation site, the route was extended to provide opportunity for alignment options to be developed to the north and south of Keith for the alignment selection stage. The route was also extended near Cairnie, to the south of Garromuir Wood, and several short, narrow extensions were added at other points along the route to provide more flexibility to develop alignment options where residential properties are scattered.
10	10A	10A	The selected route offered more potential to identify an alignment option that avoid impacting on residential properties than the other options. Following a review of the proposed Greens substation site and consideration of flexibility to develop alignment options into it, it was considered that a small extended area would be beneficial, extending the route to the north near to Castlehill.
11	11A	11A	Whilst this route option was least preferred from a landscape perspective, it was preferred from an engineering perspective as it avoided the requirement to cross the existing 400 kV OHL. The environmentally favoured Route 11B was not considered feasible from an engineering perspective, due to the high number of residential properties that it would pass directly over or in close proximity to. Public consultation feedback raised concerns about the proximity of the OHL to the settlements of Maud and Stuartfield and also to the Hill of Dens in relation to the presence of geese. A number of respondents also proposed that Route 11B would be more appropriate to keep the new infrastructure together with the existing OHL. Route 11B in its entirety was not a viable option due to the proximity of properties in clusters along the existing OHL. Route 11A was extended to the south where feasible to do so, to enable alignment options to be developed further to the south and alongside the existing OHL where feasible.

4.7 Alignment Selection (Stage 3)

4.7.1 The alignment stage is the final stage for consideration of the best pathway for the OHL before the Environmental Impact Assessment is undertaken. At the alignment stage, 29 sections were established as shown in **Figure 4.6: Alignment Options**, and similarly to the route stage, section breaks were generally at locations where there was an opportunity to switch between alignment options. To inform the options appraisal, an indicative 100 m LoD (i.e. 100 m micrositing of tower positions) was applied to the alignment options. Apart from Section 9, all sections had between two and seven options for comparative appraisal across a range of environmental, technical, and cost parameters. The outcome of the alignment stage comparative appraisal was a Potential Alignment[22], comprised of the preferred alignment option in each of the 29 sections, which was then taken forward to consultation. The comparative appraisal took account of environmental engineering and cost elements as is detailed in the Alignment Selection Consultation Document.

4.7.2 Following feedback received at consultation from stakeholders and the public, amendments were made to the Potential Alignment to reflect the issues and concerns raised during the consultation period.

[22] The term 'Potential' was used at alignment stage to describe the alignment option considered best on balance following the comparative appraisal ahead of public consultation. For the corridor and route stages, the equivalent term used was 'Preferred'.

4.7.3 The main reasons for the selection of the Potential Alignment and key changes following stakeholder consultation are detailed in **Table 4.3.** Further details can be found in the Alignment Stage Report on Consultation[23]. A summary of the reasons for making the changes is as follows:

- landowner requests to reduce impacts on farming, forestry operations, wetlands, river dredging and future land use;
- engineering considerations such as moving slightly closer to existing OHLs, maintaining offsets from below ground infrastructure and private water supplies, reducing impacts on peat, reducing the number of larger angle towers, and to accommodate telecommunications fixed links and consented residential properties;
- design team refinements resulting from feedback to reduce impacts on landscape, visual amenity, historic settings and assets, and avoid notable trees;
- collaboration with stakeholders to minimise impacts on the Torvean Landforms SSSI and GCR site through careful alignment to reduce impacts on the notable features of this site; and
- collaboration with stakeholders to minimise the potential for impacts on drinking water supplies, notably at the River Spey.

4.7.4 Detailed consideration at alignment selection stage was also given to the diversion of the existing Blackhillock to Rothienorman 400 kV OHL which is associated with the proposed Blackhillock 2 (Coachford) substation development. Alignment options for this diversion were considered alongside options for the proposed 400 kV OHL to ensure potential cumulative effects were considered. Subsequent to completion of the formal alignment selection stage, a decision was taken to no longer proceed with the Blackhillock 2 (Coachford) substation development and therefore the requirement for the Blackhillock to Rothienorman 400 kV OHL diversion was removed. The alignment selection was re-considered in light of the above and three alternative alignment options were identified as illustrated in **Figure 4.7: Coachford Alignment Options**. A comparative appraisal was carried out and the key conclusions are detailed in Section 19 of **Table 4.3**.

4.7.5 The final Proposed Alignment taken forward to EIA stage is shown in **Figure 4.8: Proposed Alignment**.

Table 4.3: Proposed Alignment Selection Rationale

Section	Potential Alignment	Proposed Alignment	Main Reason for Decision
1	1C	1D	Potential Alignment 1C provided the shortest crossing through Beaufort Castle GDL with the potential to avoid placing a tower within the GDL. The tower adjacent to the River Beauly would be at the greatest distance from the Black Bridge and Kiltarlity Old Parish Church Scheduled Monument and unlikely to be a more prominent angle tower. Following consultation Potential Alignment 1C was refined to reduce the impact on farmland (Alignment 1D). This change also sits at a lower elevation in the landscape thus reducing landscape and visual effects
2	2B	2B	This was a balance between the alignment to the north impacting Balblair wood and associated woodland and habitat but with less visible from residents and heritage receptors, versus the southern option being more visible to nearby receptors but impacting less woodland. The middle option (Alignment 2B) was on balance the preferred option. Following consultation Potential Alignment 2B was refined slightly at its eastern end to be as close to the existing OHLs as possible.
3	3A	3A	This option was preferable from virtually all environmental and engineering perspectives.

[23] SSEN Transmission (2025) Report on Consultation – Alignment. Available at: https://www.ssen-transmission.co.uk/projects/project-map/beauly-blackhillock-new-deer-peterhead-400kv/

Section	Potential Alignment	Proposed Alignment	Main Reason for Decision
			Following consultation Potential Alignment 3A was refined slightly at its western end to be as close to the existing OHLs as possible.
4	4A	4A	Marginally favoured as slightly less constrained cultural heritage designations are likely to be more easily avoided through design and it is an increased distance from Listed Buildings in the west. Visually as it is further from a greater number of properties at Easter Moniack and Reelig. Following consultation Potential Alignment 4A was refined slightly to reduce impacts to Cononbank wetland, to increase separate from the A862 at Easter Moniack and to reduce impacts to existing land use.
5	5E	5E	It offers reduced impacts on forestry, ancient woodland and ancient and veteran trees; avoids the requirement for a prominent angle tower on entry into the Great Glen; and provides the opportunity for a straight crossing of the Caledonian Canal and River Ness which would be less intrusive. Following consultation Potential Alignment 5E was refined at Mam Mor to avoid impacts to emergency telecommunications links and to increase separation from residential properties. It was also refined slightly at its eastern end to reduce impacts to Torvean Landforms SSSI.
6	6B	6B	The numerous veteran broadleaved trees present throughout the northern option made this unviable; whilst the southern option passed close to Scaniport, was more widely visible and close to more Scheduled Monuments. The middle option was on balance the one taken forward as it was least constrained. No changes were made to Potential Alignment 6B following consultation.
7	7A	7A	The benefits of maintaining an alignment adjacent to an existing OHL at this location from an ornithology, landscape character, forestry and engineering perspective was the main reason. For other criteria the difference between the two options was marginal. Following consultation Potential Alignment 7A was refined slightly at its eastern end to reduce impacts to the Mains of Daviot Ring Cairn Scheduled Monument.
8	8C	8D	Maintaining a distance from Culloden Battlefield and Culloden Muir Conservation Area and Dalroy and Clava Landforms SSSI / GCR site to the north and using screening from Saddle Hill to further reduce potential visibility. Following consultation Potential Alignment 8C was moved slightly further north to reduce impacts to existing estate activities (Alignment 8D). The Proposed Alignment sits on slightly lower ground, reducing the potential for landscape visual effects slightly. The Proposed Alignment also avoids some areas of deeper peat identified through peat probing surveys in this area.
9	9A	9A	Due to the presence of peatland, elevated terrain and routeing to the south of the existing OHL (away from residential receptors); there is only one option for this section. Following consultation Potential Alignment 9A was refined slightly at its western end to reduce impacts to veteran broadleaved trees. The alignment was also widened slightly near Rehiran, to enable micrositing of tower positions to avoid native woodland once further peat surveys were completed.
10	10B	10B	This option was marginally favoured because visually it runs adjacent to the existing OHL for the longest distance at the western end, then cuts a straight line more distant from Mains of Clunas maintaining a greater distance from properties.

Section	Potential Alignment	Proposed Alignment	Main Reason for Decision
			Following consultation Potential Alignment 10B was refined slightly at its eastern end to increase the distance of an angle tower position from a nearby watercourse.
11	11C	11C	The main consideration was the crossing of the River Findhorn to keep the proposed and existing OHLs as close as possible from a landscape and visual and cultural heritage (views from Ardlach bell tower) perspective. Maintaining separation from the recreational fishing lakes at Achagour was also a key consideration. Due to the presence of Cairn Duhie Wind Farm at the eastern end of this section there was not enough space for the Proposed OHL to route adjacent and to the south of the existing OHL. Therefore the existing OHL was proposed to be realigned slightly north for a short section to create enough space for the two lines to run in parallel; this was subsequently referred to as the 'Ferness 275 kV OHL Realignment'. Following consultation Potential Alignment 11C was refined slightly to the east of the River Findhorn to increase separation distance from residential properties.
12	12A	12A	At the eastern end the preference was to keep the proposed and existing OHLs as close as possible and at a lower elevation to minimise landscape and visual effects. For the eastern end the main reason was to prevent significant woodland loss. No changes were made to Potential Alignment 12A following consultation.
13	13C	13C	On balance there was no clear environmentally favoured option. This option was chosen due to it being slightly less constrained from an engineering perspective as it avoids crossing Loch na Speur and requires less angle towers than Alignment 13B. Following consultation Potential Alignment 13B was refined slightly to the south of Mill Buie to reduce impacts to future development potential.
14	14D 14C (Kellas Alternative Alignment)	14G 14F (Kellas Alternative Alignment)	All alignment options are in close proximity to the consented Kellas Wind Farm and the proposed Kellas Drum Wind Farm. Should the proposed Kellas Drum Wind Farm application be refused, the Potential Alignment 14D is the favoured alignment. It passes to the south of Glenlatterach Reservoir and therefore maintains a greater distance from Buinach and Glenlatterach SSSI which it would otherwise be immediately adjacent to. It is also more distant from residential receptors and is back-dropped by the existing windfarm. It does, however, pass through the Glenlatterach Reservoir DWPA which would need careful consideration at the design stage. Potential Alignment 14C was selected as the Kellas Alternative Alignment should the proposed Kellas Drum Wind Farm application be consented as it is the least constrained option which avoids the proposed wind turbine constraint. Although it is,in close proximity to the Buinach and Glenlatterach SSSI it avoids the Glenlatterach Reservoir DWPA. Following consultation the potential alignments 14D and 14C were refined at the western end to increase separation from a residential property, reduce impacts to native woodland, avoid impacting on emergency telecommunications links and crossing a windfarm access route (Alignments 14G and 14F).
15	15C	15C	Section 15 was also influenced by the proposed Kellas Drum Wind Farm application (see Section 14).

Section	Potential Alignment	Proposed Alignment	Main Reason for Decision
	15B (Kellas Alternative Alignment)	15B (Kellas Alternative Alignment)	On balance there was no clear environmentally favoured option. These options were chosen as they maintained greater separation from residential properties and the active quarry to the north of Hart Hill. They do, however, pass through known areas of peatland which would need careful consideration at the design stage. Following consultation Potential Alignment 15B was refined slightly to avoid technical constraints. No changes were made to Potential Alignment 15C.
16	16A	16A	The selected alignment parallels the existing OHL most closely and remains on lower slopes therefore minimising landscape and visual impacts and is downslope of the Coleburn Pasture SSSI. Following consultation Potential Alignment 16A was refined slightly to avoid technical constraints.
17	17B	(17D	On balance this was considered to be the most sensitive alignment through the Spey Valley SLA, noting that all alignment options would intensify the effects of infrastructure and increase the extent of influence on the Spey Valley SLA due to the presence of two existing OHLs. It does, however, pass through the Spey boreholes, Dipple and the Ordiequish Collecting Chambers DWPA which would need to be carefully considered at the design stage. Following consultation, the alignment was deviated to the south, further from Scottish Water infrastructure, to reduce the potential for impacts on the public water supply (Alignment 17D).
18	18A	18J1/18H	The key considerations in this section were the crossing of the River Spey SAC / SSSI; avoidance of areas of peatland (Gow Moss and Douglassheil Moss); interaction with two existing OHLs; and minimising impacts to forestry. This section was also influenced by the decisions in Section 17 relating to the Spey Valley and Section 18 in relation to whether the alignment passes to the north or south of Keith. On balance Potential Alignment 18A was selected taking these considerations into account. Following consultation Potential Alignment 18A was altered at its western end where it crosses the River Spey, to accommodate the changes within Section 17 (Alignment 18J1). Further adjustments were also made to the alignment to accommodate forestry operations and avoid a private water supply (Alignment 18H).
19	19C	19C (amended to Alignment C to the east and southeast of Keith)	The presence of significant engineering constraints to the south and east of Keith relating to existing electricity and gas pipeline infrastructure influenced the decision to route to the north of Keith. Landscape and visual impacts around Newmills were a key factor which pushed the alignment further to the north. To the south of Keith, consideration of the location in relation to properties and agricultural land influenced the alignment choice here. At the alignment selection stage the project also included a diversion of the existing Blackhillock to Rothienorman 400kV OHL into the proposed Coachford substation, resulting in an additional two proposed 400 kV OHLs being located to the south of Keith. The combined impacts of the three OHLs, especially in relation to landscape and visual effects was a factor in the overall decision. Note that this proposal is no longer part of this project. Blackhillock 2 (Coachford) Substation Removed from Project During the EIA stage it was decided not to proceed with the Blackhillock 2 (Coachford) substation development. As such, the additional two OHL diversions and need to connect into this substation location were no longer part of the project. The alignment selection was re-considered in light of the

Section	Potential Alignment	Proposed Alignment	Main Reason for Decision
			above and an alternative alignment selected (Alignment C). The main reason for this choice was the consideration of community and landowner feedback from previous alignment consultation events which indicated that there was a preference to keep infrastructure away from the community of Keith, to reduce effects on residential properties, agricultural land and local people within the area.
20	20D	20G	The key consideration in this section was to minimise the effects on both the settlement of Cairnie and the residential properties scattered throughout the area. Avoidance of Mortlach Moss SAC / SSSI was also a consideration. Following consultation Potential Alignment 20D was altered to the north to move further from the village of Cairnie and to avoid impacting future land use and a pond crossing (Alignment 20G).
21	21D	21D	At the western end the main reason for this choice was to reduce / minimise the effects on Arn Hill stone circle Scheduled Monument and so the southern alignment option was taken. It also results in less 'wirescaping' around White Hill by maintaining a greater distance from the existing 400 kV OHL for a greater distance and it avoids the densest grouping of residential properties. Following consultation Potential Alignment 21D was refined at the western end to avoid a private water supply and reduce visual impacts to nearby properties.
22	22D	22D	This section included alternative crossing locations of an existing 400 kV OHL. The selected alignment avoided Raich stone circle Scheduled Monument to the north with the northern alignment being least favoured. Of the southern alignments there was no clear environmental preference however Alignments 22C and 22D were least constrained from an engineering perspective. The final choice was influenced by the decision in Section 23. No changes were made to Potential Alignment 22D following consultation.
23	23E	23E	There is a number of stone circle Scheduled Monuments in the area with visual inter-relationship; the selected alignment minimised setting impacts on them as well as on Frendraught House listed building. Avoidance of forestry loss was also a factor in this decision. No changes were made to Potential Alignment 23E following consultation.
24	24C	24C	The selected alignment avoided the settlement of Turriff where there is a large number of close residential receptors, and the Deveron Valley SLA thus minimising landscape and visual effects; whilst minimising setting impacts on two stone circle Scheduled Monuments to the south. No changes were made to Potential Alignment 24C following consultation.
25	25C	25D	The selected alignment was favoured for all environmental disciplines and it was one of the least constrained for engineering. Following consultation the alignment was moved slightly further south at the eastern end, to be closer to field margins and to reduce limitations to future land use (Alignment 25D).
26	26A	26E	The selected alignment is favoured as it is located on slightly lower ground and further from the Culsh Monument (Listed Building and a viewpoint) and so is marginally less intrusive in the panoramic views from the monument and has marginally fewer direct views onto the alignment at the western end. Following consultation the alignment was modified slightly to avoid impacts on property, protect future development potential and avoid a private water supply serving several properties (Alignment 26E).

Section	Potential Alignment	Proposed Alignment	Main Reason for Decision
27	27G	27H	The most southern alignment was selected to create greater separation from both the visual residential receptors at the settlement of Maud, and at South Ugie Water / Hill of Dens where a large number of overwintering geese are understood to forage and pass over. In general it was the least constrained alignment. Following consultation the alignment was modified to avoid proposed developments, emergency telecommunications links and to accommodate landowner feedback. (Alignment 27H).
28	28G	28H	The most southern alignment was selected to create greater separation from both the visual residential receptors at the settlement of Stuartfield and South Ugie Water / Hill of Dens where a large number of overwintering geese are understood to forage and pass over.It also enables it to run adjacent to the existing OHL. In general it was the least constrained alignment. Following consultation the alignment was modified to accommodate the deviation in Section 27 also allowing field margins to be followed more closely (Alignment 28H).
29	29E	29E	The most southern alignment was selected as it contains OHL infrastructure into the existing OHL corridor which is favoured from a landscape and visual perspective. There is also greater separation from the South Ugie Water where a large number of overwintering geese are understood to forage and pass over. Following consultation Potential Alignment 29E was refined slightly at its western end due to a change in angle tower position to avoid technical constraints.

4.8 Further Considerations of Alternatives During the EIA Process

4.8.1 The earlier sections in this Chapter focus on the consideration of alternatives by the Applicant prior to this EIA stage during the project development and consultation phases. During this EIA process, the Applicant has continued to reflect upon: (i) the use of alternative technology types for the Proposed Development; and (ii) the means by which effects of the selected technology type, OHL, could be further minimised. The considerations that have formed part of this EIA process are summarised in this section.

Alternative technology types: whole / partial use of UGC

4.8.2 As highlighted in the previous sections, the policy support and cost analysis that informs the initial selection of proposed reinforcements provides the strong starting presumption for use of OHL infrastructure. EN-5 also recognises the engineering feasibility and environmental impacts of alternatives influence this policy and any resulting decision on national infrastructure technology selection. In this regard, the following section outlines additional considerations that have influenced the selection of OHL and support why the use of alternative technologies has not been taken further.

Technical and Environmental Considerations of HVDC Subsea Cable

4.8.3 The benefits and limitations of subsea HVDC systems are explored within this section:

- One of the key benefits of HVDC subsea cable is its ability to transmit electricity uninterrupted over large distances of greater than 500 km without the need to construct interim substations to manage the performance of the cable.
- The use of subsea cable can avoid challenges seen onshore, such as avoiding developed areas such as cities and towns, as well as isolated dwellings, which impact on the available routes for OHLs.

- The current capacity of proven HVDC technology at 525 kV is 2 GW, whereas the equivalent High Voltage Alternating Current (HVAC) OHL technology operating at 400 kV is approximately 6 GW, offering approximately three times the capacity. Therefore, to achieve the capacity of one 400 kV OHL, three HVDC systems would be required.
- The use of three HVDC systems to achieve the same capacity as one 400 kV OHL would require more substation infrastructure than the equivalent OHL, with each HVDC system requiring its own Converter Station (footprint of approximately 93,000 m^2 (9.3 hectares)), resulting in the need for, on average, three converter stations at either end of the cable route, as opposed to one substation site required for HVAC technology. This would result in more convertor stations with a number of buildings to house the equipment. The HVDC technology still requires connection to the Alternating Current (AC) network, and so the use of HVDC does not remove the need for AC substations and can lead to larger substations to enable the three HVDC systems to connect to the AC system. The HVDC converter stations would be required in addition to the current proposed AC substations.
- The current cost of HVDC systems is significantly higher than the equivalent HVAC OHL system. Therefore, in addition to having substantially less capacity than HVAC, there would be additional cost to the consumer to install this technology to achieve the same capacity. Recent findings published by the IET[24] found that offshore HVDC subsea cable was 5 times more expensive than an OHL.
- With an HVDC system, additional Converter Stations would be required at any point along the routes not to manage the flow of electricity but to connect the system back to the existing network to either supply the Distribution Network or allow Generators or large Demand users to connect on HVAC. This would be necessary to ensure security of supply. The construction of this additional infrastructure to allow connection to the existing HVAC network drives further costs to the consumer (through increased energy bills), as well as requiring land take with localised impacts.
- HVDC UGC requires a smaller footprint than an equivalent HVAC UGC when considered on an individual basis. However, with three HVDC cables required to achieve the equivalent capacity of one 400kV HVAC system, the construction footprint becomes similar between HVDC and HVAC. This may not represent the best solution for landowners due to the greater footprint and associated impact on agricultural land, and the same issues with regards to operation and maintenance needs apply to the use of HVDC UGC as previously described.
- Similar to onshore infrastructure, subsea cables present technical and environmental challenges and there are significant constraints in the marine environment that can limit the infrastructure that can be placed subsea, such as (but not limited to) existing and planned offshore windfarms, offshore oil and gas infrastructure, designated Marine Protection Areas, crossing existing and planned cables and pipelines, as well as potential impacts to the seabed and marine environment, including protected species.

Technical and Environmental Considerations of HVAC Underground Cable

4.8.4 The benefits and challenges of using HVAC UGC are set out below.

- A key benefit of the use of UGC is it can reduce landscape and visual impacts in certain circumstances by removing the need for OHL infrastructure. However, as noted in paragraph 4.3.10 the requirements for reactive compensation and further substation infrastructure can introduce different localised environmental impacts.
- UGC is present in a limited capacity on the SSEN Transmission network, mainly at 132 kV. However, 132 kV cabling requires reduced width working and Operational Corridors in comparison to 275 kV and 400 kV, being approximately half the width required for these voltages. This provides for a reduced footprint of this infrastructure and can assist with managing the challenges associated with UGC set out in this section. In this context it is important to note that, the 132 kV network is not critical to the operation of the transmission

[24] 100110238_001-rev-j-electricity-transmission-costs-and-characteristics_final-full.pdf

network however the 275 kV and 400 kV network connected to the Main Interconnected Transmission System are. Therefore, issues with operability can be more acceptable on radial 132 kV UGC dependent on the connections it is facilitating.

- In order to deliver the necessary capacity for the Proposed Development, which requires a three phase 400 kV double circuit, up to 30 parallel cables would be required underground. For electrical and thermal reasons, these cables need to be suitably spaced out. To achieve the required spacing, a group of trenches at a combined width of over 40 m wide would need to be excavated, typically between 1 m and 3 m deep. During the construction period, a working corridor of over 70 m wide is required for cable installation to accommodate access tracks, working and storage areas. UGC construction requires a continuous access along the entire length of the UGC cable section.
- UGC construction differs from OHL construction where construction access is generally restricted to the tower locations and does not need to be continuous along the alignment. The specialised equipment for UGC construction and weight of cable drums can require more substantial access infrastructure to accommodate heavier and larger equipment compared to OHL construction. An additional impact is the requirement for cable joint bays. UGC can only be transported in certain lengths ranging from 500 m – 1000 m and therefore cable joints are required at these intervals. These are generally below ground concrete structures where the cable joints are located. For up to 30 cables, these structures are approximately 45m in width and space restrictions may drive cable alignments to where joint bays can suitably be located. In addition, the joint bays require permanent access for operation and maintenance purposes.
- The installation of UGC can have lasting impacts on the surrounding environment. Woodland removal may be required to install transmission circuits within a corridor that has been cleared of trees and other vegetation for installation and operational purposes—this being required for both OHLs and underground cabling. UGC Operational Corridors need to maintain a set width and be clear of trees, to ensure root growth does not damage cables, limiting opportunities for tree retention in design, construction, and operation.
- In an agricultural setting, UGC can offer benefits that, once installed, the ground can be farmed provided the UGC is able to be installed at depth below that at which the field is ploughed. This can allow farmers to utilise the full area of their fields.
- Peat and carbon-rich soils present a significant challenge to underground cabling. The Scottish Government's National Planning Framework 4 (NPF4) clearly sets out that development proposals should seek to avoid or minimise impacts to peatland, carbon-rich soils and priority peatland habitat. Where the development of essential infrastructure will affect peatland, NPF4 clearly sets out that it would only be considered where there is a specific locational need and where it can be clearly demonstrated that no other alternative options are available to avoid excavating peat. Installing cables in peatland presents significant risks of movement as watercourses and ground conditions change over time which can cause cable damage and faults. To mitigate against this, cables need to be installed in solid structures, like ducts and trenches, which can result in additional environmental impacts such as amending ground water flows, damaging the surrounding peatlands. In addition, due to the heat generated by the cables, this can impact reinstated peat via drying and damaging this habitat.
- Excavations involved with underground trenches have a higher likelihood to disrupt shallow groundwater systems which can result in the lowering of groundwater levels in the immediate vicinity of the excavations. In contrast, OHLs are unlikely to alter groundwater flows. Cable trenches can also modify water drainage pathways to groundwater flows, with potential impacts on environmentally sensitive wetland habitats such as marshes, flushes; and heightened risk to groundwater fed Private Water Supplies (PWS).
- Due to UGC being unable to dissipate the heat generated during their operation they are less efficient in terms of their capacity than the equivalent OHL. To overcome this, additional cables would be required in comparison to the number of OHL conductors necessary to achieve the same overall capacity. Recent studies undertaken by the IET found that UGC is estimated to cost a minimum of 4.5 times more than the

equivalent OHL which is driven through items such as increased cable numbers and requirements for large excavations and land take.

- It is more challenging to find a suitable route and install UGC on undulating terrain and steep slopes such as those associated with upland areas. Where there is rock near to the surface this can require significant rock breaking activities. This can permanently alter the landscape setting removing the natural appearance and creating hard edges, where a cable trench is positioned.
- It is noted that minor faults occur with less frequency with UGC in comparison to OHL. However, restoring power in the event of an UGC fault can take significantly longer than for an OHL. Underground cable faults often require extensive works, specialist resource, tools and equipment to locate the fault, followed by significant civils work to expose the damage, replace the damaged section and carry out the repairs. This presents significant risks to security of supply and network reliability. It also impacts on SSEN Transmission's ability to meet its licence obligations of maintaining an efficient transmission network. Undergrounding cables over a significant length can have additional risk to the electricity transmission network in the event of cable failure and consequent outages; on the 400kV network this could impact a significant number of customers due to the critical nature of these circuits.
- The installation of UGC can often require crossing of infrastructure such as public roads or railways. These cannot be excavated in the same manner as other areas therefore Horizontal Directional Drilling (HDD) is often used. The use of this method leaves the cable section within the drill section inaccessible for repair and maintenance due to the installation method "sealing" behind it. In the specific areas where HDD installation is deployed it also results in the cable operating closer to cable ratings due to the depth at which it is installed. This can reduce the operational life of the cable.
- Underground cable can present risks of environmental pollution to watercourses due to cable surround material being washed out during flood events. In addition, joint boxes/bays (where cable sections are jointed) need to be raised substantially to avoid all flooding as water ingress to these installations affects the operation of the cable and reduces its operational life. Moreover, the link boxes/bays will need to be kept clear of vegetation. Permanent vehicular access is required to all link boxes/bays.
- Underground cables pose more challenges from an operational perspective than OHLs. The ongoing maintenance and inspection of UGC is significantly more difficult due to them being buried and therefore less accessible to both locate and subsequently fix the faults. Although minor faults are less common in UGCs, when they occur they result in major disruption to the electricity network and take significantly longer to resolve, often requiring extensive works. Underground cables have an operational life of approximately 40 years, similar to an OHL conductor, whereas steel lattice towers and conductors have an operational life of approximately 50-70 years. When the Proposed Development's OHL conductor reaches the end of its design life, it can be replaced with limited impact to landowners, whereas the replacement of an UGC would be significantly more disruptive to both landowners, the local community, and the environment.

Further Economic Considerations

4.8.5 A recent study by the IET[25], released in 2025, ("the 2025 IET Report") provides a further source of guidance on the indicative costs of different transmission technologies (as an update to the 2012 Parsons Brinckerhoff Report). The 2025 IET Report found that OHL was the most economic form of electricity transmission in comparison to onshore UGC and subsea cables. The 2025 IET Report[25] includes, (within Section 5,) a cost comparison based on the parameter of the lifetime cost to transmit one Mega Watt (MW) by a distance of one kilometre (km). The indicative costs are necessarily based upon assumptions as recorded in the report (e.g. typical circuit lengths, operational voltages and configurations across the National Grid), but nonetheless offer a useful guide to the factors that generally make OHL the most cost-effective technology. **Table 4.1** below summarises the IET report Table 5.3 and as illustrated within the supporting Flyer[26]. For present purposes, the lifetime cost of UGC was estimated to be 4-5 times greater than OHL (page 8).

Table 4.1: IET Indicative Cost Comparison

Technology	Cost - £/MWkm
OHL	1,190
UGC	5,350
Subsea Cable	6,400

4.8.6 The cost of investing in the electricity transmission network is paid for by electricity consumers. As noted above at **paragraph 4.2.2** of this Chapter, Section 9(2) of the Electricity Act 1989 places a duty on the Applicant to develop and maintain an efficient, coordinated and economical system of electricity transmission. As noted in the 2025 IET Report, UGC is currently/at the date of the 2025 Report estimated to be at least 4.5 times more expensive than OHL, and therefore in line with the Applicant's electricity transmission licence obligation, cost is a key consideration directing the use of OHL technology.

4.8.7 Balancing the potential benefits of partial UGC against its significant disbenefits, all as set out in detail above, the Applicant is clear in its view that, having conducted the careful routeing exercise identified in this Chapter, a continuous OHL solution is the most appropriate one to meet the need for new infrastructure, and that UGC (whole or partial) is not a potential alternative amenable to further detailed study.

4.9 Design Solutions

Design of the Proposed Development

4.9.1 Following the alignment selection stage, the type and location of infrastructure was designed, including tower types and positions, temporary and permanent access tracks; working areas and other temporary infrastructure. Environmental constraints were considered during this phase to minimise potential impacts to the environment; such as the presence of landscape and visual receptors, peat presence / depth; presence of heritage assets; and ecological and ornithological features. Discussions were held with landowners to seek to minimise impact on agricultural and forestry management practices and further discussions were also held with NatureScot to ensure that the design minimised impacts on the sensitive features of the Torvean Landforms and Dalroy and Clava Landforms SSSI / GCR sites.

4.9.2 Further design solutions have been considered that could mitigate likely significant environmental effects or provide another benefit. These are described in detail in **Chapter 3: Project Description**, but a summary has been provided below.

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[25] Institute of Engineering and Technology (2025) A comparison of electricity transmission technologies: Costs and characteristics: 100110238_001-rev-j-electricity-transmission-costs-and-characteristics_final-full.pdf
[26] Institute of Engineering and Technology (2025) Electricity technologies Flyer : electricity-transmission-technologies-flyer-2pp-v9_print-ready.pdf

Existing Transmission OHL Crossings

4.9.3 The Proposed Development will cross a number of existing OHLs and there are a variety of different technologies that can be used to facilitate this. For the Proposed Development 'diamond crossing' or 'duck-under' tower arrangements are proposed (see **Chapter 3: Project Description** for details), which enable the existing OHL to pass underneath the Proposed Development. This avoids the need to underground the existing OHL at the crossing which requires the construction of Cable Sealing End compounds which are visually obtrusive.

Floating Tracks

4.9.4 Where there is peatland, floating tracks will be constructed to minimise impacts to the peatland. Floating access tracks require the placement of a geotextile membrane on existing topsoil and vegetation followed by aggregate layers. This is an alternative to excavating or displacing peat, which is an irreplaceable habitat, integral to the survival of groundwater dependent terrestrial ecosystems (GWDTE).

Piled Foundations

4.9.5 Where ground conditions indicate deep peat (>1.5 m / 2.0 m) piling is an alternative method for installing the foundations of the towers. Piling is preferred in areas with deep peat as it only displaces peat, rather than requiring peat to be excavated, which would cause a greater degree of irreversible damage to these irreplaceable habitats that GWDTE species depend on.

4.10 Kellas Alternative Alignment

4.10.1 As discussed in **Chapter 1: Introduction and Background**, the application also seeks consent under section 37 of the 1989 Act for the Kellas Alternative Alignment. The Kellas Alternative Alignment will be assessed as part of the EIA, but will only be constructed if Kellas Drum Wind Farm application is consented. Should the windfarm application be refused by the Scottish Government, the Proposed OHL Alignment would be constructed. The Proposed OHL Alignment is preferred as it takes a more direct and shorter route which is preferable from a technical and cost perspective. It is also preferable from an environmental perspective as it is in close proximity to Cairn Uish so that the windfarm acts as a backdrop to contain infrastructure in this area and reduce landscape and visual impacts. It is also further from Buinach and Glenlatterach SSSI.