Volume 2: Chapter 4 – Consideration of Alternatives

VOLUME 2, CHAPTER 4: CONSIDERATION OF ALTERNATIVES

Appendices (Volume 4 of this EIAR)

There are no appendices associated with this Chapter.

Figures (Volume 3 of this EIAR)

There are no appendices associated with this Chapter.

4. CONSIDERATION OF ALTERNATIVES

4.1 Introduction

4.1.1 The need for the Emmock and Tealing Section 37 Tie-Ins and the work undertaken to assess the strategic electricity transmission infrastructure requirements to identify a viable and enduring technical design solution is explained in **Volume 2, Chapter 2: Established Need for the Proposed Development**.

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. The Chapter describes the consideration of alternatives that has been undertaken for the Proposed Development following the need identification.

4.1.3 A core factor in establishing the design of the Proposed Development is the locational requirements to connect existing and proposed OHL infrastructure with the Emmock substation (24/00699/FULN) within a relatively limited geographical area. The remit within that is to achieve the most appropriate technical solution.

4.1.4 The Proposed Development has been informed through consideration of technical (engineering feasibility), economic and environmental criteria. It has also been informed by an ongoing process of consultation with statutory and non-statutory consultees, local communities and landowners.

4.2 Alternatives Considered

4.2.1 SSEN Transmission has a statutory duty under Section 9 of the *Electricity Act 1989* to "*develop and maintain an efficient, co-ordinated and economical system of electricity transmission*".

4.2.2 SSEN Transmission *'when formulating proposals to generate, transmit, distribute or supply electricity*' is also required, under Schedule 9 to the *Electricity Act 1989* 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."

4.2.3 Under the terms of the transmission license, 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.

4.2.4 Furthermore, the requirements of the *Construction (Design and Management) Regulations 2015* (CDM Regulations)[2] require that the design aims to minimise hazards and reduce risks during construction.

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

4.2.6 The following alternatives have been considered during project development:

- the "do-nothing" scenario;
- reduced build alternatives;

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[1] National Energy System Operator (NESO), 2024. National Electricity Transmission System Security and Quality of Supply Standard, Version 2.8, (2024). [Online] 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, UK Statutory Instrument 2015 No. 51 Health and Safety. [Online] Available at: https://www.legislation.gov.uk/uksi/2015/51/contents.

- technology options including underground cable (UGC) options; and
- alternative connections layouts.

4.2.7 **Section 4.3** describes the strategic and technological alternatives that have been considered by SSEN Transmission, during the project development and consultation stages, in taking forward the Proposed Development in response to the need case which has been set out in **Volume 2, Chapter 2: Established Need for the Proposed Development**. **Section 4.4** describes the further considerations by SSEN Transmission during the EIA process. Following selection of the technology choice as an OHL transmission project, Sections 4.3 and 4..4 describes in more detail the alternatives considered with the objective of identifying a Proposed Development which is technically feasible and 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 and Technology Types

"Do Nothing" Scenario

4.3.1 The do-nothing scenario specific to the Proposed Development would involve the Emmock and Tealing substations remaining disconnected, and the required re-routeing of existing OHLs would not take place, and with the Kintore to Tealing 400 kV OHL intersecting with the existing Alyth to Tealing OHL.

4.3.2 As established in **Volume 2, Chapter 2: Established Need for the Proposed Development**, the Proposed Development is of national importance, contributing significantly towards the delivery of UK and Scottish Government's Net Zero Targets and helping reduce the UK's dependence on imported oil and gas. In a "do-nothing" scenario, the current electricity network would not have capacity to support the transfer of power from both onshore and offshore renewable generation to key centres of demand across the country, and therefore the UK Government's targets of 50 gigawatts (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.

Alternative technology types: HND and NOA process

Primary solution: OHL or UGC

4.3.3 When undertaking the initial assessment of the technology options to reinforce the transmission network (as set out in **Volume 2, Chapter 2: Established Need for the Proposed Development**) 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**. In this case, there was an initial strategic choice to make between UGC or OHL technology for each of the Tie-Ins. At that time, the key factor distinguishing these two technology types was their relative cost although policy strongly favours OHL over UGC in the following:

- **IET endorsed Costing Study[3]**: 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 ("the Parsons Brinckerhoff Report"). The report concluded that an underground cable 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). The Parsons Brinckerhoff Report was a general (rather than project-specific) study and 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.

[3] Institute of Engineering and Technology (IET) Electricity Transmission Costing Study - An Independent Report (2012) report by Parsons Brinkerhoff

- 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 overhead line (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).

4.3.4 It is also important to note that both the Alyth to Tealing and Tealing to Westfield 275 kV OHLs (see Paragraph 1.1.3 of **Volume 2: Chapter 1: Introduction and Background**) will be OHLs given that existing towers are to be retained with the higher operating voltage accommodated through reconductoring.

System Limitations of Short Sections of Underground Cable

4.3.5 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 UGC. 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 UGC are more expensive than OHL technology. 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.

4.3.6 During 2023, studies were conducted by SSEN Transmission on 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.

4.4 Further Consideration of Alternatives during the EIA Process

4.4.1 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. However, 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

4.4.2 As highlighted previously, the policy support and cost analysis that informs the initial selection of proposed reinforcements provides the strong starting presumption for use of OHL infrastructure. The published final version of EN-5[6] 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.

Environmental and Technical Considerations of HVAC Underground Cable

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

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[4] Department of Energy Security and Net Zero (2021) Draft Overarching National Policy Statement EN-1 Overarching National Policy Statement for Energy.
[5] Department of Energy Security and Net Zero (2021) Draft Overarching National Policy Statement of Energy: EN-5 Electricity Networks National Policy Statement - final word version
[6] National Policy Statement for Electricity Networks Infrastructure (EN-5), March 2023, UK Government.

4.4.4 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 **Section 4.3** the requirements for reactive compensation and further substation infrastructure can introduce different localised environmental impacts.

4.4.5 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 circa 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 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.

4.4.6 When comparing 400 kV UGC and 275 kV, it is acknowledged that 275 kV is not as technically challenging as 400 kV UGC, the same challenges exist, albeit at a lesser scale.

4.4.7 In order to deliver the necessary capacity for the Proposed Development, which requires a three phase 275 kV single circuit, up to 12 parallel cables would be required underground. For electrical and thermal reasons, these cables need to be suitably spaced out. To accommodate this arrangement, a minimum working area of approximately 40 m – 60 m would be required for cable installation, to accommodate access tracks, working and storage areas with this reduced 30 m – 50 m sterilised operational corridor. UGC construction requires a continuous access along the entire length of the UGC section.

4.4.8 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 12 cables, these structures are approximately 20 m in width and space restrictions may drive cable alignments to where joint bays can be suitably located. In addition, the joint bays require permanent access for operation and maintenance purposes.

4.4.9 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 depths below that at which the field is ploughed. This can allow farmers to utilise the full area of their fields.

4.4.10 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 PWS.

4.4.11 Due to UGC being unable to dissipate the heat generated during 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.

4.4.12 It is noted that minor faults occur with less frequency with UGC in comparison to OHL. However, restoring power in the event of an underground cable 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 400 kV network this could impact a significant number of customers due to the critical nature of these circuits.

4.4.13 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.

4.4.14 UGC 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.

4.4.15 UGCs 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 UGC, when they occur, they result in major disruption to the electricity network and take significantly longer to resolve, often requiring extensive works. UGCs 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

4.4.16 A recent study by the IET[7] 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[8] 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 1 km. The indicative costs are necessarily based upon assumptions as recorded in the report (eg 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: IET Indicative Cost Comparison** below summarises the IET report table 5.3 and as illustrated within the supporting Flyer[9]. 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 - £/MW km
OHL	£1190/MW km
UGC	£5350/MW km
Subsea Cable	£6400/MW km

[7] 100110238_001-rev-j-electricity-transmission-costs-and-characteristics_final-full.pdf

[8] 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

[9] Institute of Engineering and Technology (2025) Electricity technologies Flyer: electricity-transmission-technologies-flyer-2pp-v9_print-ready.pdf

4.4.17 The cost of investing in the electricity transmission network is paid for by electricity consumers. As noted above in **Section 4.2** 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.

4.4.18 Balancing the potential benefits of UGC against its significant disbenefits, all as set out in detail above, the Applicant is clear in its view that an OHL solution is the most appropriate one to meet the need for new infrastructure and did not in the Applicant's view overcome the strong starting presumption in EN-5 for OHL, and that UGC is not a potential alternative amenable to further detailed study.