Elvanfoot – Harker Uprating Works

NESO Driven EJP

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11/12/2024

SP Energy Networks

RIIO-T3 Business Plan

SP Energy Networks

Elvanfoot - Harker 400kV OHL Uprating Works (EHRE)			
Name of Scheme	SPT-RI-231 Elvanfoot - Harker OHL Uprating Works (EHRE)		
Investment Driver	Wider Works		
NESO Review	NESO Comment: *no review*		
BPDT / Scheme Reference Number	SPT200475		
Outputs	• 400kV OHL (Tower Line) HTLS Conductor – 135.2km Addition • 400kV OHL (Tower Line) Conductor <=2550MVA – 135.2km Disposal • 400kV Overhead Line Fittings – 445 Addition • 400kV Overhead Line Fittings – 445 Disposal • 400kV OHL (Tower Line) Earth Wire – 67.6km Addition • 400kV OHL (Tower Line) Earth Wire – 67.6km Disposal		
Cost	£122.22m (23/24)		
Delivery Year	2030/31		
Applicable Reporting Tables	BPDT (Section 5.1 Project Meta Data, Section 6.1 Scheme C&V Load Actuals and Section 11.10 Contractor Indirects)		
Historic Funding Interactions	None		
Interactive Projects	N/A		
Spend Apportionment	**ET2**	**ET3**	**ET4**
	£0.73m	£121.48m	£0.00m

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1. Executive Summary

This engineering justification paper (EJP) sets out the needs case for the replacement of the phase conductor and earthwire on ZV route between Elvanfoot and the SPT/NGET border north of Harker with a High Temperature Low Sag (HTLS) conductor system, as part of a major refurbishment and uprating of this 400kV overhead line (OHL) route. The purpose of this project is to thermally uprate of this strategic 400kV OHL route to:

- Facilitate the connection of new renewable generation in the area (up to 5.78GW)
- Increase the transfer capability across the B6 boundary to NGET
- Replace the existing earthwire fittings to prevent the need for future double circuit outages

This scheme will enable SP Transmission (SPT) to increase the existing thermal capability of the 400kV Overhead Line (OHL) denoted as part of ZV Route, between the strategic Strathaven 400kV and Elvanfoot 400kV substations. The scheme will replace the existing twin 'Rubus' All Aluminium Alloy Conductor (AAAC) phase conductors that are limited to a maximum operating temperature of 90^{o}C with a High Temperature Low Sag (HTLS) Conductor System that can operate at or above approximately 170^{o}C. This maximise the thermal capability of the existing overhead line routes in anticipation of the future commissioning of new OHL routes and HVDC links between Scotland and England.

This engineering justification paper (EJP) sets out the needs case for the following scope of work:

- Re-conductor both sides of ZV route with a twin HTLS conductor system.
- Replace earthwire with a single "Keziah" 160mm^2 AACSR equivalent OPGW.
- Replace all tension and suspension insulators and conductor end fittings.
- Replace earthwire fittings.
- Replace tower muff foundations as required per condition.
- Upgrade foundations as required per condition.
- Replace downleads and fittings at all substation line entries.

The expected project delivery date is October 2030 and the estimated project cost is £122.22m.

This EJP is submitted for Ofgem's assessment of the need case for the project and the selection of the preferred option in order to provide sufficient funding for pre-construction and early construction activities. A cost assessment under the Load Related Reopener will be submitted to Ofgem for approval at an appropriate time.

2. Introduction

This Engineering Justification Paper supports the proposal as set out under SPT-RI-231 to replace the phase conductor and earthwire on ZV route between Elvanfoot and the SPT/NGET border north of Harker with a HTLS conductor system, as part of a major refurbishment and uprating of this 400kV OHL route. The purpose of this project is to facilitate increased power transfer from Scotland to England via the thermal uprating of this strategic 400kV OHL route. The works are programmed to commence in the RIIO-T2 period and complete in 2030/31 (RIIO-T3).

The expected increase in the volume of onshore wind connections, as forecasted in the Future Energy Scenario (FES) will require SPT to deliver a significant capacity increase between Scotland and England over the RIIO-T3 period and beyond. Further government commitments set by the UK and Scottish governments, 40GW for offshore wind by 2030 set by the UK government and 20GW of onshore and 11GW of offshore set by the Scottish government, provide further indication for the requirement for investment into the electricity transmission network to ensure the timely connection of these future projects. To deliver the necessary capacity increase to accommodate this, the 400kV double circuit corridor between SPT and NGET is required to be subject to a significant thermal uprating.

To ensure the electricity transmission system enables a timely transition to Net Zero, in line with United Kingdom (UK) and Scottish Government targets to reach net zero by 2050 and 2045 respectively, asset intervention must be considered in the context of both current and future system requirements. It is vital that the risk of repeated intervention on strategic routes and assets (and therefore repeated system access for construction purposes) is minimised, in particular, where the need for such intervention within the operational lifetime of the replacement asset may reasonably be foreseen.

As part of a major refurbishment project, integrating load and non-load related drivers in an economic, efficient and co-ordinated manner, it is proposed to replace the existing phase conductor and earthwire on ZV route between Elvanfoot and the SPT/NGET border north of Harker with a HTLS conductor system, significantly increasing the thermal capability of this route. The proposed HTLS conductor system will help to ensure the network is ready for the changes required by Net Zero targets. Project timing is dictated by the need for significant additional transfer capability between Scotland and England by the end of the current decade. The timing of outage work, and therefore final project programme, will be subject to detailed review with the National Energy System Operator (NESO).

This project was recommended to proceed by the NESO as part of the 2023 Network Options Assessment (NOA) published in March 2024 (ref. NOA code VERE). It was identified by the NESO as 'Required for 2030' in the Offshore Transmission Network Review (OTNR) Holistic Network Design (HND)[1] and identified as a 'HND essential option' in the associated NOA Refresh[2] published July 2022. The NESO's advice to the UK government in its Clean Power 2030 plan, published on 5th November 2024 confirmed the ongoing need for this project.

[1] The Pathway to 2030 Holistic Network Design (ref. Appendix 1).
[2] Network Options Assessment 2021/22 Refresh, July 2022

This EJP is submitted for Ofgem's assessment of the Needs Case for the project and the selection of the preferred option in order to provide sufficient funding for the pre-construction and early construction activities. A full cost submission will be made at the appropriate time.

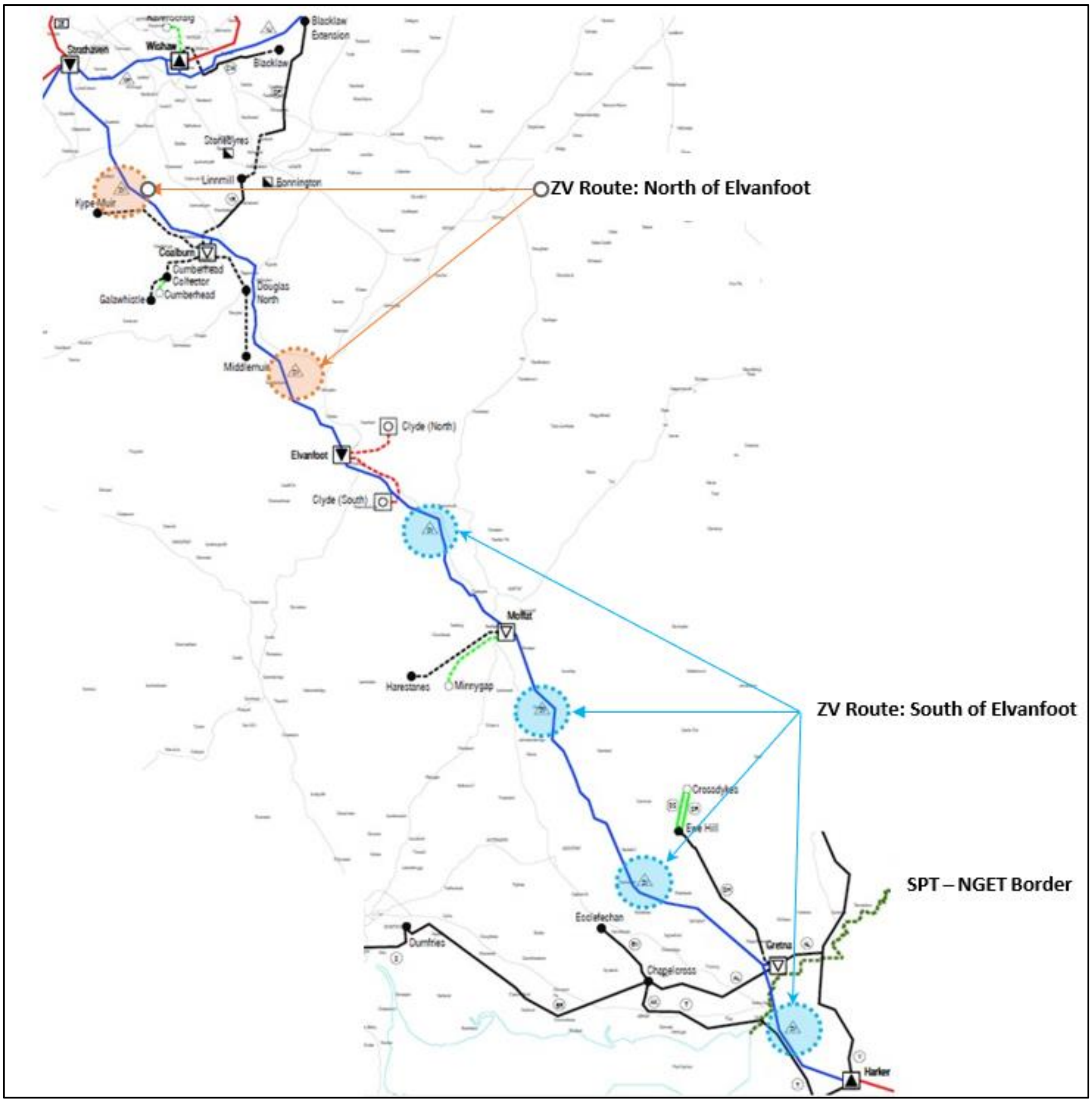

Figure 1: 400kV SPT-NGET Corridor (ZV Route) from Networks Diagram Geographical Layout

3. Background Information

ZV route is a 126km 400kV double circuit OHL route which connects SPT's Strathaven 400kV Substation, southeast of Glasgow, to NGET's Harker 400kV Substation, north of Carlisle.

Constructed in 1993 utilising L8 Type steel lattice towers and comprising a twin All Aluminium Alloy Conductor (AAAC) 500mm^2 'Rubus' phase conductor bundle, ZV route forms a strategic north - south power corridor between the south of Scotland and north of England.

Figure 1 provides a geographic indication of ZV route in the context of key transmission boundaries across the SPT area. ZV route can be seen to cross the B6 boundary north of Harker. Information about the existing ZV route and the proposed options are summarised below.

Table 1: Existing ZV Route Background and Proposed Options

System Design Table	**Circuit / Project**	**Option 1 Baseline:** *Do Nothing / Minimum*	**Option 2:** *Refurbish ZV Route with Twin 560mm2 AAAC Sorbus*	**Option 3:** *Refurbish ZV Route with a Twin HTLS Conductor System*	**Option 4:** Replace ZV Route with new L12 Construction
Thermal and Fault Design	Existing Voltage *(if applicable)*	400kV	400kV	400kV	400kV
	New Voltage	400kV	400kV	400kV	400kV
	Existing Continuous Rating *(if applicable)*	2210MVA @ 90ºC *(Winter Post-fault)*	2210MVA @ 90ºC *(Winter Post-fault)*	2210MVA @ 90ºC *(Winter Post-fault)*	2210MVA @ 90ºC *(Winter Post-fault)*
	New Continuous Rating	N/A	2420MVA @ 90ºC *(Winter Post-fault)*	3100MVA @ 90ºC *(Winter Post-fault)*	2810MVA @ 90ºC *(Winter Post-fault)*
	Existing Fault Rating *(if applicable)*	N/A	N/A	N/A	N/A
	New Fault Rating	N/A	N/A	N/A	N/A
ESO Dispatchable Services	Existing MVAR Rating *(if applicable)*	N/A	N/A	N/A	N/A
	New MVAR Rating *(if applicable)*	N/A	N/A	N/A	N/A
	Existing GVA Rating *(if applicable)*	N/A	N/A	N/A	N/A
	New GVA Rating	N/A	N/A	N/A	N/A
System Requirements	Present Demand *(if applicable)*	N/A	N/A	N/A	N/A
	2050 Future Demand	N/A	N/A	N/A	N/A
	Present Generation *(if applicable)*	N/A	N/A	N/A	N/A
	Future Generation Count	6	6	6	6
	Future Generation Capacity	N/A	N/A	N/A	N/A
Initial Design Consideration	Limiting Factor	Limit on thermal capacity	N/A	N/A	Increase in costs
	AIS/GIS	N/A	N/A	N/A	N/A
	Busbar Design	N/A	N/A	N/A	N/A
	Cable/OHL/Mixed	N/A	OHL	OHL	OHL

	SI	N/A	N/A	Maximise Capacity of existing switchgear therefore no scope for strategic investment	N/A

3.1 System Reinforcement Drivers

In the most recent (2024) Future Energy Scenario (FES) developed by the ESO, the Holistic Transition (HT) pathway, indicates the connection of 13GW of wind (onshore plus offshore) and 3.99GW of battery storage in the SPT area by the end of the RIIO-T3 period. These figures extend to 16.5GW for total wind by 2050, with battery storage remaining at 3.99GW respectively. Based upon the current contracted queue for directly connected transmission connections being significantly greater than the FES requirements, as outlined in the TEC register, it is vital that SPT is proactive in the approach to reinforcement works on the network to ensure that it is adequately prepared to accommodate the connection of this capacity.

The north to south power transfer requirements on all the northern transmission system boundaries increase significantly over the coming years due to the connection of new renewable generation throughout Scotland as part of the energy transition to meet legislated Net Zero targets. This trend is clearly demonstrated by the transfer requirements on the boundary between the SPT and National Grid Electricity Transmission (NGET) areas (Boundary B6).

Figure 2 indicates the 2023 FES and 2024 FES required transfer capability on the B6 boundary. Existing capability is already exceeded, broadly consistent with all Scotland and North England boundaries, driven by generation developments under the Connect and Manage regime[3], with the capacity shortfall becoming extremely pronounced by the mid to late 2020s in all scenarios.

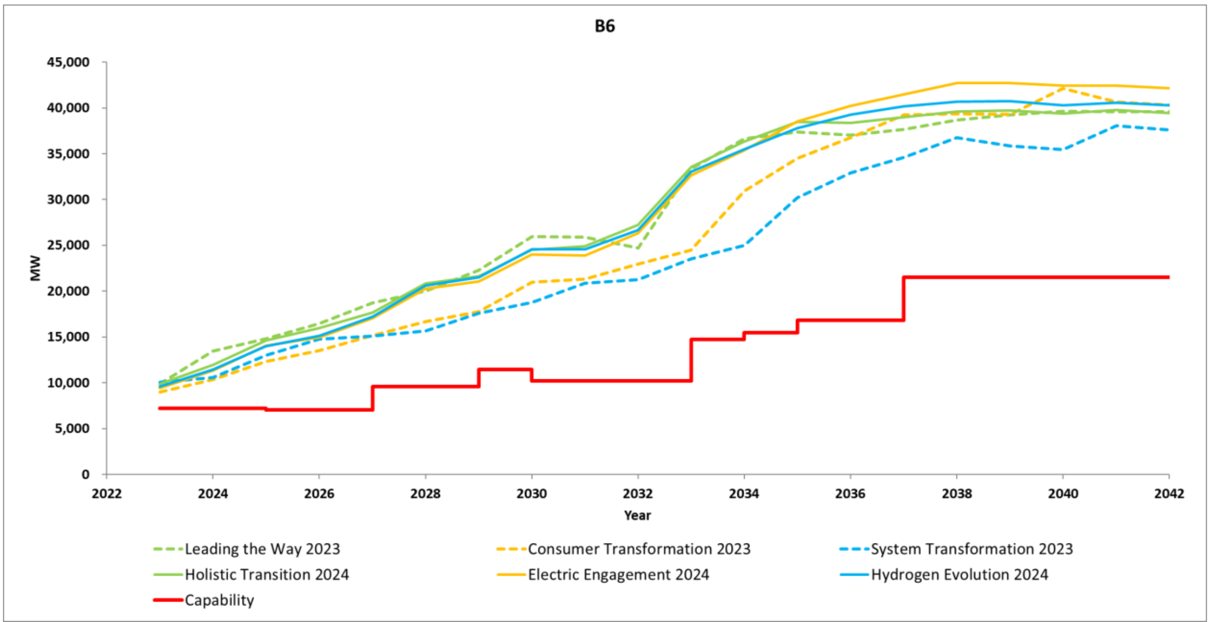

Figure 2: Required Transfers and total base capability for boundary B6

The current total capability of transmission network boundary B6 is approximately 6,700MW, dependent upon the geographic disposition of renewable generation output and based on a thermal limitation on the cross border ZV route, south of Elvanfoot. Figure 2 above shows a required transfer of up to 24.9GW by 2030 and up to approximately 38.5GW by 2035.

[3] The Connect and Manage transmission access regime was introduced by government in August 2010 and implemented on 11 February 2011. Its aim was to improve access to the electricity transmission network for generators by offering generation customers connection dates ahead of the completion of wider transmission system reinforcements. This allows them to connect earlier to the transmission system, but may result in additional constraint costs.

Figure 2 shows that in the coming years the unconstrained boundary flows on B6 are set to increase significantly. In order to maintain an efficient and economic transmission system whilst economically integrating additional renewable generation, significant system reinforcement is required in an unprecedented timeframe.

3.1.1 Offshore Wind Connections

The result of the ScotWind leasing process, a programme managed by Crown Estate Scotland to lease areas of the seabed around Scotland for offshore wind farm development, was announced on the 17th January 2022[4]. In summary:

- 17 projects with a capacity totalling 24.8GW were selected out of a total of 74 applications, and have been offered option agreements which reserve the rights to specific areas of seabed.
- A total of just under £700m will be paid by the successful applicants in option fees and passed to the Scottish Government for public spending.
- Initial indications suggest a multi-billion pound supply chain investment in Scotland.
- Of the 17 projects selected in January 2022, six are in the ScotWind East region[5] with a combined capacity of 10.5GW and option fees totalling £324.5m, of which three are in the East 1 Zone, with a combined capacity of 6.7GW and option fees totalling £199.8m.

Since the announcement of the initial ScotWind leasing results in January 2022, an additional 2.7GW of offshore wind has been leased in an area East of Shetland, taking the total ScotWind generation to 27.6GW. The ScotWind results underline both the scale of development potential off the north and east coasts of Scotland and the commitment from industry to delivering the investments in energy infrastructure necessary to meet Net Zero targets. Off the north and east coasts of Scotland in particular, there is very high potential for offshore wind generation, in areas illustrated by the BEIS/ Ofgem Offshore Transmission Network Review[6] (OTNR) Generation Map[7].

ScotWind offshore developments are expected to contribute towards the Scottish Government ambition of 11GW of offshore wind by 2030 and make a significant contribution towards 2045 and 2050 Net Zero targets. It is vital that the onshore transmission system is developed in a timely manner to enable the benefits of ScotWind to be realised and contribute to the Scottish Government's offshore wind ambition of 11GW by 2030.

3.1.2 Onshore Wind Connections

In December 2022 the Scottish Government published its Onshore Wind Policy Statement[8], setting out its ambition deploy 20GW of onshore wind capacity by 2030. The existing 400kV Substations at Elvanfoot, Moffat and Gretna all support existing connected onshore wind generation as well as significant planned additional onshore wind (and Battery Energy Storage System) capacity.

3.1.3 New Generation Connections

In June 2019, the UK parliament passed legislation introducing a binding target to reach net zero greenhouse gas emissions by 2050. In Scotland, the Scottish Parliament has committed Scotland to

4 Crown Estate Scotland - ScotWind offshore wind leasing delivers major boost to Scotland's net zero aspirations
5 Sectoral Marine Plan for Offshore Wind Energy
6 Offshore Transmission Network Review
7 OTNR - Generation Map
8 Onshore wind: policy statement 2022 - gov.scot (www.gov.scot)

becoming a net zero society by 2045. The timely connection of low carbon generation, such as onshore and offshore wind, will play a vital role in reaching these legislated net zero targets.

The UK Government announced in October 2020 its commitment to make the UK a world leader in green energy and boosted the UK Government's previous 30GW target for offshore wind to 40GW by 2030. The current Scottish Government ambition is 20GW of onshore wind and 11GW of offshore wind in Scotland by 2030. Further commitments, by the UK Government in October 2021, to decarbonise the power system by 2035, as well as British Energy Security Strategy[9] published April 2022 (which raises the UK Government ambition to 50GW of offshore wind by 2030), further support the requirement for investment in the existing electricity transmission system to enable the timely connection and integration of the required renewable generation sources.

On 9th September 2021, the former Department for Business, Energy & Industrial Strategy (BEIS) announced a £265m[10] budget per year for the Contracts for Difference (CfD) Allocation Round 4, which launched on 13th December 2021 and concluded on 7th July 2022. For the first time since 2015, established technologies, including onshore wind, were able to bid. Given lowering technology costs and a favourable subsidy regime, this will support a considerable number of onshore renewables projects to successfully transition from project inception and development through to energisation[11]. The results of the CfD Allocation Round 6 were announced on 3rd September 2024, with annual auction rounds now expected[12].

Furthermore, on the 4th November 2024, NESO published the 'Clean Power 2030' paper as advice to the UK Government on how to achieve a low-carbon power system by 2030 where demand is met by clean sources (primarily renewables) with gas fired generation only to be used to ensure security of supply (primarily during periods of low wind). While subject to a decision by the UK Government, this publication reaffirmed the need to continue to invest in the wider transmission network to ensure that 2030 and later targets are met.

3.1.4 TECA Scoring

A Bilateral Connection Agreement is in place between NESO and the developers of the generation projects detailed in **Error! Reference source not found.**. In each case, SPT-RI-231 is identified as enabling works corresponding to Transmission Owner Construction Agreements (TOCAs) that are in place between NESO and SP Transmission (SPT).

During the process of identifying and evaluating options for each connection offer, due regard has been given to the development of an efficient, coordinated and economical system of electricity transmission. As well as determining the most appropriate connection location and connection method (e.g. overhead line, underground cable, wood pole vs steel tower, connection voltage etc).

As a part of the RIIO-T3 load planning strategy, SPT has developed a probability scoring system, in order to score directly connected transmission projects based on parameters that will indicate their likelihood to connect to the network by their intended connection date, to inform requirements of network reinforcements. By utilising this tool, a portfolio of generation connections that have a high probability of connecting to the network in the near future can be built, enabling SPT to take a proactive approach when considering future reinforcement works on the network. Areas that have a

9 British energy security strategy - GOV.UK (www.gov.uk)
10 Biggest ever renewable energy support scheme backed by additional £265 million - GOV.UK (www.gov.uk)
11 BEIS - Electricity Generation Costs (2020)
12 Total Capacity of CFD Round 6 across the UK was 9.65GW

significant number of generation connections scheduled to connect to the network, with a corresponding high probability score, has helped to shape the SPT RIIO-T3 plan.

The methodology of the scoring system splits the overall score into four separate categories, each of which carry a different weight regarding the final score and which consider aspects that are specific to individual projects and the technology as a whole. The four categories are as follows:

- Technology
- Technology Maturity
- Developer Track Record
- Planning Status

The data presented indicates that seven of the projects that have SPT-RI-231 as enabling works are likely to connect to the network, based on the medium probability score that they demonstrate as denoted by the orange tag in **Error! Reference source not found.**. This would indicate an increase of 958.8MW of capacity being added to the network in the period of RIIO-T3 and RIIO-T4. If all the listed projects were to connect, this figure would increase to 6.590GW, demonstrating a significant increase to the current generation capacity. This indicates the necessity to increase the current capacity of ZV route to prepare for the accommodation of these connections in the future, in addition to providing additional boundary capacity to the Scotland – England B6 border.

Table 2: Contracted Connection Background & TECA Score Relevant to ZV route

[redacted]

[redacted]

Total Capacity (MW)	-	-	-	**6.59GW**

TECA Legend

TECA Probability	Designated Colour
High	
Medium	
Low	

3.1.5 Network Options Assessment

The Network Options Assessment (NOA) process (ref. Standard Licence Condition C27) demonstrates the need to make significant investment in the capability of the existing transmission system through Scotland and the north of England to accommodate significant growth in renewable generation. This is required to maintain and operate an economic and efficient transmission system. It is critical that the network is ready to accommodate the scale of projected renewable capacity growth, required to support legislated Net Zero targets, whilst also enabling significant constraint savings.

The 2021/22 NOA Refresh Report, published in July 2022[13], supports the proposal in this paper to progress the replacement and uprating of the conductor system on ZV route south of Elvanfoot with a HTLS conductor system (ref. NOA7 code EHRE), identifying the project as a 'Holistic Network Design (HND) essential option'. This recommendation continues to be supported by the Beyond 2030 [14]NOA report and the NESO's advice to the UK Government on its Clean Power 2030 plan.

3.2 Asset Condition

Constructed in 1993 utilising L8 Type steel lattice towers, ZV route comprises a twin AAAC 500mm^2 'Rubus' phase conductor bundle. The earth wire consists of a single AACSR 160mm^2 'Fibral' Optical Ground Wire (OPGW) conductor, similarly installed in 1993.

The need for (non-load) asset condition related intervention at this time relates primarily to the existing earth wire system.

The 'Fibral' earth wire utilised on ZV route represents 'first generation' OPGW technology. The primary role of lightning energy displacement can result in the emergence of 'Fibral' earthwire strands unwinding, emanating in both directions from the lightning strike contact area. The high recoil of the 'Fibral' strands is in comparison to the superior performance of modern AACSR OPGW conductors. The 'Fibral' strands unwind with the assistance of wind to the extent they represent a risk to the adjacent live circuits. Double circuit outages are required to contain and repair the earthwire strands, before a fault outage occurs, with both operational cost and system security considerations, in view of the strategic nature of ZV route. There have been two instances in recent years of double circuit outages being required on ZV route to contain and repair earth wire strands following lightning strikes.

This scheme also provides an opportunity to remove the risks associated with the existing 'Fibral' earth wire system and reduce the requirement for short notice double circuit outages to carry out repairs.

4. Optioneering

This section provides a description of each option for the ZV route uprating and details the key considerations that have been considered in proposing or discounting each proposal. A summary of each option is described at the end of this section, with the selected option and highlighted and an in-depth review provided. At a high level the options considered are:

1. Do Nothing
2. Refurbish ZV Route with Twin 560mm^2 AAAC Sorbus
3. Refurbish ZV Route with a Twin HTLS Conductor System
4. Replace ZV Route with a new Route of L12 Construction

[13] NOA 2021/22 Refresh Report
[14] Beyond 2030 NOA Report

4.1. Option 1: Baseline - Non-Load Intervention Works Only

A 'Non-load intervention works only' option has been considered to represent the ongoing maintenance and repair as part of the business as usual. This option involves the minimum level of intervention that is required to remain compliant with all relevant safety and legal regulations.

This option would not provide the necessary capacity uplift required to accommodate the contracted generation forecast to connect in the area as presented in the load drivers of this paper, it is inconsistent with the transmission requirements identified via the NOA, the Offshore Transmission Network Review (OTNR) HND, Beyond 2030 report and the NESO's advice to government on the Clean Power 2030 plan. This option is not credible in relation to this project and would be inconsistent with SPT's statutory duties and licence obligations, including Licence Conditions D3 and D4A, which require SPT to comply with the NETS (National Electricity Transmission System) SQSS (Security and Quality of Supply Standard) and to offer to enter into an agreement with the system operator upon receipt of an application for connection, such offers being in accordance with the System Operator Transmission Owner Code (STC) and associated Construction Planning Assumptions provided by the NESO.

4.2. Option 2: Refurbish ZV Route with Twin 560mm^2 AAAC Sorbus

This option involves the major refurbishment of ZV route from Elvanfoot to the SPT/ NGET border north of Harker with a twin 560mm^2 AAAC (Sorbus) conductor system. This option is inconsistent with the transmission requirements identified via the NOA, the Offshore Transmission Network Review (OTNR) HND, the Beyond 2030 report and the NESO's advice to government on the Clean Power 2030 plan.

This option involves additional steelwork and foundation reinforcement works to accommodate the larger conductor system on towers of L8 design and therefore leads to increased capital cost for a relatively modest incremental thermal capacity of up to 210MVA per circuit (Winter Post fault).

4.3. Option 3: Refurbish ZV Route with a Twin HTLS Conductor System

This option involves the major refurbishment of ZV route from Elvanfoot to the SPT/ NGET border north of Harker with a twin HTLS conductor system. The current carrying capability of the HTLS conductor system will be specified to be not less than that in Table 3 below.

The major refurbishment of the route with a HTLS conductor system is consistent with the transmission system requirements identified via the NOA and the OTNR HND (Section 3.1.5), delivering a significant incremental thermal capacity of up to 890MVA per circuit (Section 4.5), when accounting for other (4000A continuous) circuit loading limitations. When complete, it will provide the full functionality required to give ZV route a further 40 years of service without further major intervention.

4.4. Option 4: Replace ZV Route with a new Route of L12 Construction

The scope of work associated with this option involves the complete replacement of the existing ZV route from Elvanfoot to the SPT/ NGET border north of Harker with a new route of L12 Type construction, capable of supporting a twin 700mm^2 AAAC (Araucaria) conductor system. It is assumed that the new route would be established alongside the existing ZV OHL, and the existing route removed upon completion.

This option would involve an increase in the required capital cost relative to Options 2 and 3, totalling £227.26m, albeit with reduced system access requirements for construction outages. It is not considered to be efficient given the remaining life of the existing ZV route towers. It would deliver an incremental thermal capacity of up to 600MVA per circuit (ref. Table 3, lower than that delivered by Option 3 above). The use of HTLS conductor would not be necessary as heavier Araucaria conductor, which in more suited to this tower type, can be used on the L12 towers to achieve a similar rating at less cost than using HTLS. The lead time to deliver such a project, inclusive of the requirement to secure new Section 37 consent and land agreements, would be significant.

Additional 400kV double circuit routes between Scotland and England are also being developed alongside the reconductoring of ZV as part of a complementary and coordinated suite of transmission system reinforcements as recommended by NESO (Section 3.1.5).

4.5 400kV OHL Thermal Ratings

Table 3 below provides an indication of the incremental OHL thermal ratings achieved on ZV route, on a per circuit basis, for each of Options 2, 3 and 4, relative to the existing twin Rubus conductor system. Note that the existing substation equipment on ZV route, including switchgear, instrument transformers and series compensation equipment, is specified with a 4000A continuous rating.

Table 3:Incremental 400kV OHL Thermal Ratings, per Circuit, Relative to Existing Conductor System

Incremental 400kV Thermal Ratings per Circuit relative to Option 2	Twin AAAC ‘Sorbus’ (Option 2)		Twin HTLS (Option 3)		Twin Araucaria (Option 4)	
Season / State	**Amps**	**MVA**	**Amps**	**MVA**	**Amps**	**MVA**
Winter Pre-Fault	260	180	1080	750	720	500
Winter Post-Fault	310	210	1290	890	860	600
Spring/Aut. Pre-Fault	240	170	1120	770	690	470
Spring/Aut. Post-Fault	290	200	1330	920	820	570
Summer Pre-Fault	230	160	1190	830	640	450
Summer Post-Fault	270	190	1410	980	760	530

Table 4: Options Summary

Options	Map	Layout of Substation/Connection	Layout of all Route Works	Relevant Survey Works	Narrative Consenting Risks	Narrative Preferred Option	Narrative Rejection
Rejected – Option 1 (Baseline): Do Minimum / Delay	N/A	N/A	N/A	N/A	N/A	N/A	A 'Do Nothing' or 'Delay' option is not credible in relation to this project and would be inconsistent with SPT's statutory duties and licence obligations: *Load Related Considerations* - Timely progression of the replacement of the conductor system on ZV route is crucial to alleviating enduring constraints on the GB transmission system, enabling growth in renewable electricity and supporting an economic transition to Net Zero emissions. The timing of outage work will be subject to detailed review with the NESO in view of the potential operational impacts.
Rejected – Option 2: Refurbish ZV Route with Twin 560mm^2 AAAC Sorbus Circuits	N/A	N/A	N/A	N/A	N/A	N/A	Inconsistent with the transmission requirements identified via NOA and the OTNR HND. High risk of further intervention being required on this strategic route and assets within the operational lifetime of the replacement conductor system.
Preferred – Option 3: Refurbish ZV Route with a	N/A	N/A	N/A	N/A	N/A	Provides full functionality required to give ZV route a	

Twin HTLS Conductor						further 40 years of service without further major intervention, maximising capacity on existing assets.	
Option 4: Replace ZV Routes with new L12 Construction	N/A	N/A	N/A	N/A	S37 consents and land agreements required for this option.	N/A	Inefficient given the remaining life of the existing towers and higher overall capital cost than other options presented. Reduced incremental thermal capacity per circuit relative to Option 3. Significant project lead time, inclusive of the requirement to secure new Section 37 consent and land agreements.

4.6 Whole Systems Outcomes

It should be noted that our optioneering approach has identified 'Whole System' interactions with other system operators (i.e., NGET) in the development of our proposed solution and has considered the appropriate 'Whole System' outcome. This is with consideration that the proposed solution in this EJP, by enabling connection of new renewable generation to the SPT network and supporting future power transfer between SPT and NGET across the B6 boundary.

4.7 Project Scope

The preferred option to provide the most economical and efficient solution to meet all the system requirements is the solution outlined in Section 4.3 and noted as Option 3. Option 3 presents the solution to reconductor ZV route with twin HTLS conductors.

HTLS conductor systems can deliver significant increases in current carrying capacity by overcoming the characteristic constraints of standard conductors when operating at higher temperatures. The use of substitute cores, made with carbon or composite materials, are not only light but capable of handling both the weight and tension, notably sagging significantly less than standard conductors at operating temperatures between 150°C to 210°C.

A common characteristic of carbon and composite cored conductors is their susceptibility to core failure if the manufacturer's recommended guidance is not followed and the bending radius is exceeded. Installation is the greatest risk of the process to establish an effective HTLS system. This project is therefore being developed informed by SPT's recent experience of installation and operation of the ACCR 'Curlew' HTLS conductor system on the Coylton – Mark Hill (YY) OHL route.

The proposed solution for the ZV OHL routes is the replacement of the 500mm^2 'Rubus' AAAC with a HTLS conductor system (GZTACSR Matthew, ACCR Curlew or similar). The current carrying capability of the HTLS conductor system will be specified to be not less than that summarised in Table 5. The proposed HTLS conductor system shall be capable of achieving or improving upon the thermal ratings above, ensuring the replacement conductor system has a post-fault continuous rating, in all rating seasons, not less than the 4000A continuous rating of the existing 400kV switchgear and primary equipment at Strathaven, Coalburn, Elvanfoot, Moffat and Gretna 400kV Substations. Replacing the existing AAAC phase conductor, which is limited to a maximum operating temperature of 90°C, with a HTLS conductor system that can operate at or above approximately 170°C, will increase transfer capacity to the maximum possible using the existing structures.

It is proposed to replace the existing AACSR 160mm^2 'Fibral' OPGW earth wire with a modern 36 fibre, 160mm^2 'Keziah' equivalent AACSR, with optical fibre incorporated in the earth wire.

Tower foundations will be assessed to identify any structural load considerations and address any repair/ replacement or upgrade as required. The works for SPT-RI-231 are as follows:

- Re-conductor both sides of ZV route with a twin HTLS conductor system.
- Replace earth wire with a single "Keziah" 160mm2 AACSR equivalent OPGW.
- Replace all tension and suspension insulators and conductor end fittings.
- Replace earth wire fittings.
- Replace tower muff foundations as required per condition.
- Upgrade foundations as required per condition.
- Replace downleads and fittings at all substation line entries.
- Replace any heavily corroded or damaged steelwork (above category 4).

- Tower painting.
- Update all OHL records to reflect the works carried out.
- All control and protection works.
- All Environmental and Civil works.
- Miscellaneous works.

The thermal ratings for twin HTLS conductor system thermal ratings* at 75ºC operating temperature:

Table 5: Twin HTLS Conductor Ratings

Season / State	Amps	MVA
Winter Pre Fault	3760	2610
Winter Post Fault	4480	3100
Spring/Autumn Pre Fault	3700	2560
Spring/Autumn Post Fault	4400	3050
Summer Pre Fault	3590	2490
Summer Post Fault	4270	2960

* Based on 170°C Maximum Operating Temperature, GZTACSR Matthew. Note that Option 3 would involve specification of a conductor with thermal rating not less than GZTACSR Matthew.

4.8 Estimated Project Costs

A Business Plan provision and estimated cost of the project is indicated in the following table. Costs below are referred as direct, so no risk and contingency nor indirects have been included in the project cost.

Project costs are summarised in the Cost Breakdown below:

Table 6: Cost Breakdown

[redacted]

Total		122.22

Expenditure incidence is summarised below.

Table 7: CAPEX Value

Estimated capex value per year, £m, 23/24 price base								
Energisation Year	RIIO-T2 Total: capex	Yr. 2027	Yr. 2028	Yr. 2029	Yr. 2030	Yr. 2031	RIIO-T3 Total: capex	Total: capex
2030/31	0.73	2.17	7.33	39.92	39.92	32.14	121.48	122.22

4.9 Regulatory Outputs

The indicative primary asset outputs are identified in table below:

Table 8: Regulatory Outputs

Asset Categories	Asset-Sub Category	Voltage	Intervention	Addition	Disposal
Overhead Tower Line	400kV OHL (Tower Line) HTLS Conductor	400kV	Addition	135.2 km	
Overhead Tower Line	400kV OHL (Tower Line) HTLS Conductor <=2550MVA	400kV	Disposal		135.2km
Overhead Line Fittings	Fittings	400kV	Addition	445	
Overhead Line Fittings	Fittings	400kV	Disposal	-	445
Earth Wire	OHL (Tower Line) Earth Wire	400 kV	Addition	67.6km	
Earth Wire	OHL (Tower Line) Earth Wire	400 kV	Disposal	-	67.6km

4.10 Environmental and Consent Works

The existing ZV route has Section 37 consent to operate at 400kV and no new Section 37 consent will be required. However, any clearance infringement mitigation works, temporary access and working areas required to facilitate physical OHL works may require planning permission from the local planning authority. Landowner agreements will be required to deliver these works. SPT will take a co-ordinated approach to all aspects of these works in view of the need to deliver an overall and integrated solution which recognises potential interaction and cumulative impacts.

5 Deliverability

SPT project management approach has been applied to this project to ensure that this work is delivered safely, and in line with the agreed time, cost and quality commitments. SPT has a proven track record of delivering essential transmission network upgrade projects and will draw upon this knowledge and experience to effectively manage these works. We work closely with our supply chain partners and this relationship is critical to the successful delivery of our plans. Our supply chain provides the support and agility to respond to changes in workload over the course of a price review. Further information Is contained within our Workforce & Supply Chain Resilience Annex. A dedicated Project Manager has been assigned to the works at every stage who is responsible for overall delivery of the scope and is the primary point of contact for all stakeholders. The project manager responsibilities include but are not limited to:

- Handing over the project from development phase and ensuring minimum requirements of the SPT project handover are met
- System and customer updates to reflect transfer of ownership
- Leading tender activities during development phase
- Provision of a comprehensive resource plan to encompass all contractor and SPT operational activities
- Booking outages and risks of trip with operational planning
- Ensure all offline works are completed prior to any outage being taken to reduce system risk
- Co-ordinate all site commissioning issues
- Chair commissioning panel meetings
- Chair progress meetings
- Maintain the site quality plans

Some further responsibilities of the project manager are discussed in the following sub-sections.

5.1 Delivery Schedule (Level 1 Programme)

A standard approach has been applied to the planning phase of these works and that will continue for the reporting and the application of processes and controls throughout the lifecycle. Table 9 below summarises the key milestones within the delivery schedule. [redacted]

Table 9: High Level Project Milestones

Item	Project Milestone	Estimated Completion Date
1	Technical Approval	Oct 2024
2	Detailed Design	Mar 2026
3	Final Financial Authorisation	May 2026
4	Commence Site Works	Mar 2029
5	Complete Site Works	Oct 2030

SP Energy Networks (SPEN) for its procurement process follows a generic global process (INS 00.08.04) for supplier pre-qualification, product technical assessment, manufacturing factory capability assessment and quality audit. The SPEN's equipment approval procedure is to:

- Identify and select candidate equipment
- Ensuring the candidate equipment is assessed to meet the specific requirements of SPEN
- Ensuring a structured and consistent approach is adopted for the approval of candidate equipment prior to energisation
- Ensuring no equipment is installed on SPEN's network without first having been examined in accordance with the procedure and issued a formal internal approval

ASSET-02-002 specifies the SPEN's approval process inclusive of assessment scope and business processes for various equipment.

Regular meetings with the Project and Construction Management Teams shall be undertaken to assess the ongoing effectiveness of the Project Management interfaces.

The Project Manager will facilitate internal Project Team Meetings, in which project progress and deliverables will be reviewed and any arising risks or issues will be discussed and addressed.

5.2 Risk and Mitigation

A Risk Register is generated collaboratively during the initial design stages to identify any risks, which if realised, could result in deviation from the delivery plan. Mitigation strategies are developed to manage the risks identified and these will be implemented by the Project Manager. The risk register shall remain a live document and will be updated regularly. Currently, the top scheme risks are:

- Working over existing distribution overhead lines to be addressed by diverting or undergrounding on a temporary basis.
- Railway and road crossings to be mitigated through scaffolding and traffic management systems or deployment of a catenary support system.
- Utilities within working areas to be addressed through procurement of records for duration of the project.
- Access routes to be addressed through early engagement with landowners, employing low bearing pressure ground vehicles and trackway where possible to minimise extents of stone tracks.
- Network operability/wayleave/environmental restrictions which impact on the progression of works as planned.
- Supply chain for materials and resources.
- Ensure bending radius of HTLS conductor is not exceeded by complying with manufacturers recommended guidance is followed and using competent and trained operatives
- Mitigate the risk of core failure of HTLS conductor is not exceeded by complying with manufacturers recommended guidance is followed and using competent and trained operatives

5.3 Quality Management

SPT adopts a “life cycle” approach to Quality Management in major project delivery. Our Management Systems are certified to ISO 9001, ISO 14001 and ISO 45001. Various areas applicable to these standards ensure a quality product is delivered. The significant areas detailed below:

5.3.1 Quality Requirements During Project Development

Any risk or opportunity that may affect the quality of the product are detailed in the Project Risk Register.

The suppliers of main equipment may also receive a Factory Acceptance Test Inspection when the asset is being built.

5.3.2 Quality Requirements in Tenders

Each contract that SPT issues has a standard format. Specifically in relation to quality, this will include a Contractors’ Quality Performance Requirement (CQPR). This CQPR represents a specification that details roles and responsibilities for all parties during the works, frequency and format of reporting. It will also specify the document management process to be adhered to during the delivery of the project. In addition to the CQPR, each project has a contract specific Quality Management Plan, detailing the inspection and testing regime for works as well as the records to be maintained.

5.3.3 Monitoring and Measuring During Project Delivery

SPT Projects undertake regular inspections on projects and contractors to monitor and measure compliance with SPT Environmental, Quality and Health and Safety requirements, as detailed in the contract specifications for the work. All inspections are visual, with the person undertaking the inspection ensuring that evidence of the inspection and any actions raised are documented.

The following inspections are completed:

- Quality Inspections (monthly)
- Environmental Inspections (monthly, with weekly review by third party Environmental Clerk of Works)
- Safety Assessments & Contractor Safety Inspection (daily, with full time Site Manager)
- Project Management Tours (monthly)

The scope of audits and Inspections is to determine compliance with:

- Procedures & Guides
- Planned arrangements for ISO 9001, 14001 & 18001
- Legal and other requirements.

5.3.4 Post Energisation

SPT Projects and SPT Operations carry out a Defect Liability Period Inspection within the Contract Defect Liability Period with the aim of identifying any defects and rectifying them with the contractors.

5.4 Environmental and Wayleave Considerations

5.4.1 Environmental Planning

The following environmental surveys will require to be carried out prior to any work commencing on site:

- Ecology: Phase 1 habitat survey
- Ecology: Protected species survey
- Archaeology: Desktop based survey
- Archaeology: Field evaluation*
- Archaeology: Watching brief for any ground-breaking works within identified areas*

**may only be required if any proposed ground-breaking works encroach on areas of interest*

The intention should be to use low bearing pressure vehicles where possible. Access routes and formation may be supplementary to existing roads and tracks and should use sustainable materials which can be reutilised where possible. Any compaction of ground should be rectified.

It is anticipated that surveys on ZV Route will identify sites of historical interest and environmental value that will require dialogue with the relevant statutory organisations before work will commence.

5.4.2 Wayleave Issues

The existing ZV route has Section 37 consent to operate at 400kV. Any clearance infringement mitigation works, temporary access and working areas required to facilitate physical OHL works will require planning permission from the local planning authority. Landowner agreements will be required to deliver these works. SPT will take a co-ordinated approach to all aspects of these works in view of the need to deliver an overall and integrated solution which recognises potential interaction and cumulative impacts.

5.4.3 Environmental Sustainability

IMS-01-001 encompasses all activities undertaken within and in support of SP Energy Networks three Licences. This includes operational and business support functions concerned with management of SP Transmission, SP Distribution and associated regulatory and commercial interfaces, products, services and their associated environmental, social and economic impacts. The policy makes the following commitments which shall be respected in any works associated with this scheme.

SP Energy Networks will incorporate environmental, social and economic issues into our business decision-making processes, ensuring compliance with or improvement upon legislative, industry, regulatory and other compliance obligations. We will deliver this by being innovative and demonstrating leadership on the issues which are important to us and our stakeholders, and will:

- Ensure the reliability and availability of our Transmission and Distribution network whilst creating value and delivering competitiveness by increasing efficiency and minimising losses.
- Reduce greenhouse gas emissions in line with our Net Zero Science Based GHG target, which is a target of 90% reduction in GHG emissions by 2035 (TBC) from a 2018/19 baseline.
- Integrate climate change adaptation requirements into our asset management and operations processes to support business resilience and reduce the length and time of service interruptions.
- Consider whole life cycle impacts to reduce our use of resources to sustainable levels, improve the efficiency of our use of energy and water and aim for zero waste.
- Improve land, air and watercourse quality by preventing pollution and contamination and protecting and enhancing biodiversity in our network areas.
- Improve our service to local communities, supporting their economic and social development, protecting vulnerable customers, and respecting human rights.

ENV-04-014 gives specific guidance on the management of incidents with environmental consequence, or potential for environmental consequences, over and above the general requirements for the management of incidents.

The proposed design solution is also resilient to future climate change risks, such as substation flooding or potential faults from vegetation along the route.

In SPEN to reduce the number of vegetation related OHL faults, the route will be surveyed, consented, and cut on a per kilometre basis. The cutting specification entails:

- Falling distance plus 5m (i.e., Vicinity Zone) to the conductor and maintain 5 years clear from that distance.

- Clearance as 5.3m to be achieved from conductor positioned at 45° blowout and maximum sag condition. Maintain 5 years clear from that distance.

- All vegetation directly below the OHL with the potential to breach the Vicinity Zone before the next cut cycle shall be removed.

- Hedgerows shall be maintained. Species identified with no threat to breach the Vicinity Zone at any point in the future shall continue to be managed as part of the 3-year vegetation management programme.

- Tower bases shall be kept free of all scrub to a distance of 5m from the base.

OHL-03-080 gives detailed specification for OHL vegetation management in SPEN.

Additionally, the preferred OHL route for the project needs to be identified after extensive evaluation of the length of route, biodiversity and geological conservation, landscape and visual amenity (including recreation and tourism), cultural heritage, land use, forestry, and flood risk.

If routing the OHLs in areas of forestry the guideline is to -:

- Avoid areas of landscape sensitivity;

- Not follow the line of sight of important views;

- Be kept in valleys and depressions;

- Not divide a hill in two similar parts where it crosses over a summit;

- Cross skylines or ridges where they dip to a low point;

- Follow alignments diagonal to the contour as far as possible, and;

- Vary in the alignment to reflect the landform by rising in hollows and descending on ridges.

The overall project design objective is to minimise the extent of felling required and woodland areas and individual trees are to be avoided where possible during the routeing phase. Where routeing through woodland has been unavoidable, a 'wayleave' corridor is required for safety reasons to ensure that trees do not fall onto the line and for health and safety of forestry operatives. SPEN has statutory powers to control tree clearance within the wayleave corridor. Where possible the design of the new OHLs and associated infrastructure must be sought to avoid/minimise felling where possible, when balancing with other technical and environmental objectives.

6. Eligibility for Competition

Under the RIIO-T3 Business Plan Guidance, Ofgem has requested that projects that are above £50m and £100m should be flagged as being eligible for being suitable for early and late competition respectively. This project is above both thresholds, however, is not suitable due to:

- Being significantly developed, therefore not suitable for early competition.

- This project is not separable as it is the reconductoring of existing circuits, via several substations, all integral to the existing SPT system.
- Several new connections projects are dependent on the completion date, therefore delays through any project tender exercise will delay these projects.

7. Conclusion

This EJP sets out the need to facilitate increased power transfer from Scotland to England to enable the timely and coordinated increase in the thermal rating of the strategic ZV 400kV OHL route south of Elvanfoot. These works are programmed to commence in the RIIO-T2 period and complete in 2030/31, during the RIIO-T3 period.

To ensure the electricity transmission system enables a timely transition to Net Zero, in line with UK and Scottish Government targets of 2050 and 2045 respectively, asset intervention must be considered in the context of both current and future system requirements. It is vital that the risk of repeated intervention on strategic routes and assets (and therefore repeated system access for construction purposes) is minimised, due to the increase in constraints costs that incurred when this circuit is unavailable for any period of time, where the need for such intervention within the operational lifetime of the replacement asset may reasonably be foreseen.

The main conclusions of this submission are:

- The timely connection of low carbon generation, including onshore and offshore wind and will play a vital role in reaching legislated net zero targets
- It is necessary to make significant investment in the capability of the existing transmission system through Scotland and the north of England to accommodate growth in renewable generation. This is required to maintain and operate an economic and efficient transmission system. It is critical to allow the network to keep pace with projected growth to support legislated Net Zero targets whilst also enabling significant constraint savings.

We, respectfully, request Ofgem’s agreement to the following:

- The option being progressed addresses a clear customer need and represents value to UK consumers, due to overall reduction in constraint costs, therefore, the works should proceed based on the preferred solution (Option 3).
- Efficient expenditure is fully funded, as necessary to maintain programme timelines and mitigate project delivery risk e.g., order long-lead equipment, prior to the cost assessment stage of Load Related Reopener.

Appendix A –Maps & Diagrams