MSIP Re-opener Application Stage 1: SPT-RI-1797 Strathaven - Elvanfoot OHL Uprating Works (VERE)		
Ofgem Scheme Reference/ Name of Scheme	SPT200474 / SPT-RI-1797 Strathaven - Elvanfoot OHL Uprating Works (VERE)	
Investment Category	Wider Works	
Primary Investment Driver	Thermal Uprating	
Secondary Investment Driver	Asset Health	
Licence Mechanism/ Activity	Special Condition 3.14 Medium Sized Investment Projects Re-opener and Price Control Deliverable/ Clause 3.14.6 (c)	
Materiality Threshold exceeded (£3.5m)	Yes, as a single project due to the threshold for activity 3.14.6 (c)	
PCD primary Output	Replacement of the phase conductor on ZV route between Strathaven and Elvanfoot with a High Temperature Low Sag conductor system, as part of the major refurbishment of this section of 400kV OHL route.	
Total Project Cost (£m)	64.250	
Funding Allowance (£m)	To be confirmed	Requested
Delivery Year	2030/31	
Reporting Table	Annual RRP – PCD Table	
PCD Modification Process	Special Condition 3.14, Appendix 1	

Issue Date	Issue No	Amendment Details
31st January 2024	1	First issue of document.

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Table of Contents

1. Abbreviations / Terminology

Table 1: Table of Abbreviations

Abbreviation	Term
AAAC	All Aluminium Alloy Conductor
ACCR	Aluminium Conductor Composite Reinforced
ACSR	Aluminium Conductor Steel Reinforced
AIS	Air Insulated Switchgear
BEIS	Department for Business, Energy & Industrial Strategy
CEC	Connection Entry Capacity
CfD	Contract for Difference
CION	Connection and Infrastructure Options Note
EISD	Earliest In Service Date
FES	Future Energy Scenario
FNC	Final Needs Case
GIS	Gas Insulated Switchgear
GSP	Grid Supply Point
HND	Holistic Network Design
HTLS	High Temperature Low Sag
HVDC	High Voltage, Direct Current
INC	Initial Needs Case
ITT	Invitation to Tender
Km	Kilometre
kV	Kilovolt
LC	Licence Condition
LOTI	Large Onshore Transmission Investment
LSpC	Licence Special Condition
MSIP	Medium Sized Investment Project
MW	Megawatt
NETS SQSS	National Electricity Transmission System Security and Quality of Supply Standard
NGET	National Grid Electricity Transmission
NGESO	National Grid Electricity System Operator
NOA	Network Options Assessment
OHL	Overhead Line
OTNR	Offshore Transmission Network Review
OFTO	Offshore Transmission Owner
PCD	Price Control Deliverable
OPGW	Optical Ground Wire
RIIO	Revenue = Incentives + Innovation + Outputs
SGT	Supergrid Transformer
SHET	Scottish Hydro Electric Transmission
SPT	SP Transmission
SPEN	SP Energy Networks
STC	System Operator – Transmission Owner Code
UK	United Kingdom
VDUM	Volume Driver Uncertainty Mechanism

2. Reference Documents

Table 2: Table of Reference Documents

Document Reference	Title
SPEN-RIIO-T2_Business_Plan	SP Energy Networks RIIO T2 Business Plan 2021 - 2026
SPNLT20111	XH & XJ Routes 400kV OHL Major Refurbishment

3. Introduction

This MSIP Re-opener application sets out SP Transmission's (SPT) plans to replace the phase conductor and earthwire on ZV route between Strathaven and Elvanfoot 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 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).

In the period since the RIIO-T2 business plan was submitted, expected increases in onshore and offshore wind generation, supported by the 2021, 2022 and 2023 Future Energy Scenarios (FES), confirm the need to deliver significant additional transmission capacity between Scotland and England in the period to the end of the current decade and beyond. This necessitates a significant increase in the thermal rating of the western 400kV double circuit (ZV) OHL route between Scotland and England.

To ensure the electricity transmission system enables a timely transition to Net Zero, in line with United Kingdom (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, 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 Strathaven and Elvanfoot 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 NGESO.

This project will be recommended to proceed by National Grid Electricity System Operator (NGESO) as part of the 2023 Network Options Assessment (NOA) due to be published in March 2024[1] (ref. NOA code VERE). It was identified by NGESO as 'Required for 2030' in the Offshore Transmission Network Review (OTNR) Holistic Network Design (HND)[2] and identified as a 'HND essential option' in the associated NOA Refresh[3] published July 2022.

This MSIP Re-opener application is submitted in accordance with Licence Special Condition (LSpC) 3.14.6 and relates specifically to LSpC 3.14.6 activity (c):

"3.14.6 The licensee may apply to the Authority for a direction amending the outputs, delivery dates or associated allowances in Appendix1 in relation to one or more of the following activities:
(c) a Boundary Reinforcement Project that has received a NOA Proceed Signal in the most recent NOA"

The needs case for intervention on ZV route between Strathaven and Elvanfoot, and the factors that have an impact on the timing and scope of works, are discussed in the following sections. Full

[1] Ahead of publication NGESO confirmed "Proceed" recommendation for VERE at TCSNP Governance meeting 1st Dec 2023.
[2] The Pathway to 2030 Holistic Network Design (ref. Appendix 1).
[3] Network Options Assessment 2021/22 Refresh, July 2022

justification for the preferred investment option is presented, together with a detailed description of the proposed solution.

The estimated total project cost may be subject to change. As agreed with Ofgem, a second stage MSIP submission will be made at the right time relating to the associated amendments outputs, delivery dates and allowances to be detailed as Price Control Deliverables (PCDs) in LSpC 3.14 Appendix 1.

3.1 Structure of Document

This MSIP Re-opener application is structured as follows:

Section 4 – Background and Needs Case
This section outlines the background to the proposed works and details the key project drivers.

Section 5 – Assessment of Options
This section sets out the approach taken to considering the distinct options available to address the needs identified in Section 4. The results of an evaluation of the alternative options are presented and the reasoning behind the selection of the preferred option is summarised.

Section 6 – Proposed Works
This section provides a description of the proposed solution. It sets out the scope and other key supporting information.

Section 7 – Project Cost Estimate
This section summarises the estimated cost of the selected option.

Section 8 – Project Delivery
This section outlines the approach which will be taken to deliver the project.

3.2 Requirements Mapping Table

Table 3 maps the requirements set out within Chapter 3 of the RIIO-T2 Re-opener Guidance and Application Requirements Document[4] against specific sections within this document.

Table 3: Requirements Mapping Table

Section	Description	Relevant Section(s) in RIIO-T2 Re-opener Guidance and Application Requirements Document
3	Introduction	3.3, 3.4
4	Background and Needs Case	3.8, 3.9, 3.10, 3.11
5	Assessment of Options	3.13, 3.14, 3.21, 3.22
6	Proposed Works	3.14, 3.16
7	Project Cost Estimate	3.12, 3.19, 3.20
8	Project Delivery	3.15, 3.17

[4] RIIO-2 Re-opener Guidance and Application Requirements Document: Version 2

4. Background and Needs Case

4.1 Statutory and Licence Obligations on SP Transmission plc

SP Transmission plc (SPT) is licenced under section 6(1)(b) of the Electricity Act 1989 ("the 1989 Act") to transmit electricity. The licence is granted subject to certain standard and special conditions. Under section 9(2) of the 1989 Act, SPT is required to fulfil the following duty: -

- *To develop and maintain an efficient, co-ordinated and economical system of electricity transmission; and*
- *To facilitate competition in the supply and generation of electricity.*

This statutory duty is reflected in SPT's transmission licence. In addition, SPT has the following obligations pursuant to its licence conditions (LCs): -

- To at all times have in force a System Operator-Transmission Owner Code (STC) which, amongst other things, provides for the co-ordination of the planning of the transmission system (LC B12);
- To at all times plan and develop its transmission system in accordance with the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS) and in so doing take account of National Grid Electricity System Operator's (NGESO's) obligations to co-ordinate and direct the flow of electricity on, to and over the GB transmission system (LC D3);
- To make available those parts of its transmission system which are intended for the purposes of conveying, or affecting the flow of, electricity so that such parts are capable of doing so and are fit for those purposes (LC D2); and
- To offer to enter into an agreement with the system operator on notification of receipt of an application for connection, or for modification to an existing connection (LC D4A).

Section 38 and Schedule 9 of the 1989 Act also impose duties on SPT when formulating any relevant proposals. In response to statutory and licence obligations upon it, SPT therefore requires to ensure that the transmission system is developed and maintained in an economic, co-ordinated and efficient manner, in the interests of existing and future electricity consumers, balancing technical, economic and environmental factors.

4.2 ZV Route - Background

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.

A wider geographic overview of the existing SPT system is provided in Appendix A.

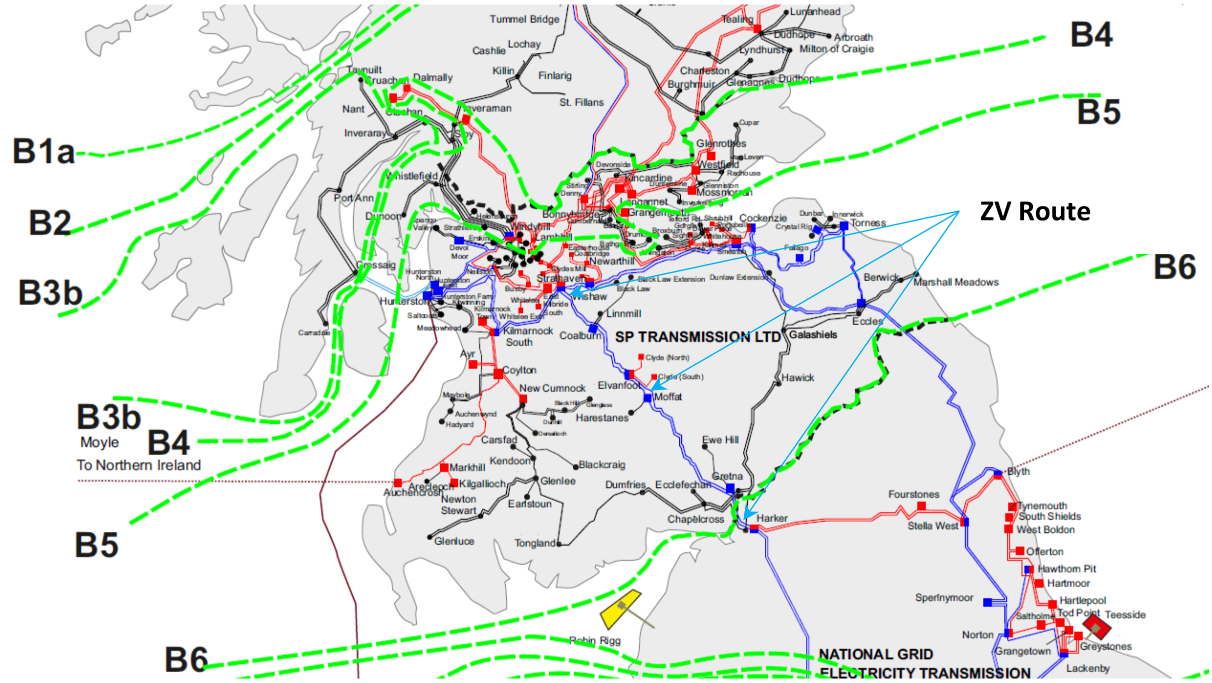

Figure 1 – Main Network Boundaries Across SP Transmission Area and ZV Route

4.3 Key Project Drivers - Load Related

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 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[5] 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[6] 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[7]. The results of the CfD Allocation Round 5 were announced on 8th September 2023, with annual auction rounds expected thereafter.

[5] British energy security strategy - GOV.UK (www.gov.uk)
[6] Biggest ever renewable energy support scheme backed by additional £265 million - GOV.UK (www.gov.uk)
[7] BEIS - Electricity Generation Costs (2020)

4.3.1 Offshore Wind Connections - ScotWind

The results 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, were announced on the 17th January 2022[8]. 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, 6 are in the ScotWind East region[9] with a combined capacity of 10.5GW and option fees totalling £324.5m, of which 3 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[10] (OTNR) Generation Map[11].

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.

4.3.2 Onshore Wind Connections

In December 2022 the Scottish Government published its Onshore Wind Policy Statement[12], setting out its ambition deploy 20GW of onshore wind capacity by 2030. The existing 400kV Substation at Coalburn and the planned Redshaw 400kV Substation support significant existing and planned onshore wind (and Battery Energy Storage System) capacity.

4.3.3 Future Energy Scenarios

Each year, NGESO produces a set of Future Energy Scenarios (FES) for use by the Transmission Owners (TOs) as network investment planning backgrounds. Through application of the criteria set out in the NETS SQSS, the FES provide an indication of the capacity requirements of the system based upon the potential future connection of generation and changing demand profiles.

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).

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

Figure 2 indicates the 2022 FES and 20223 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, with the difference becoming extremely pronounced by the mid to late 2020s in all scenarios.

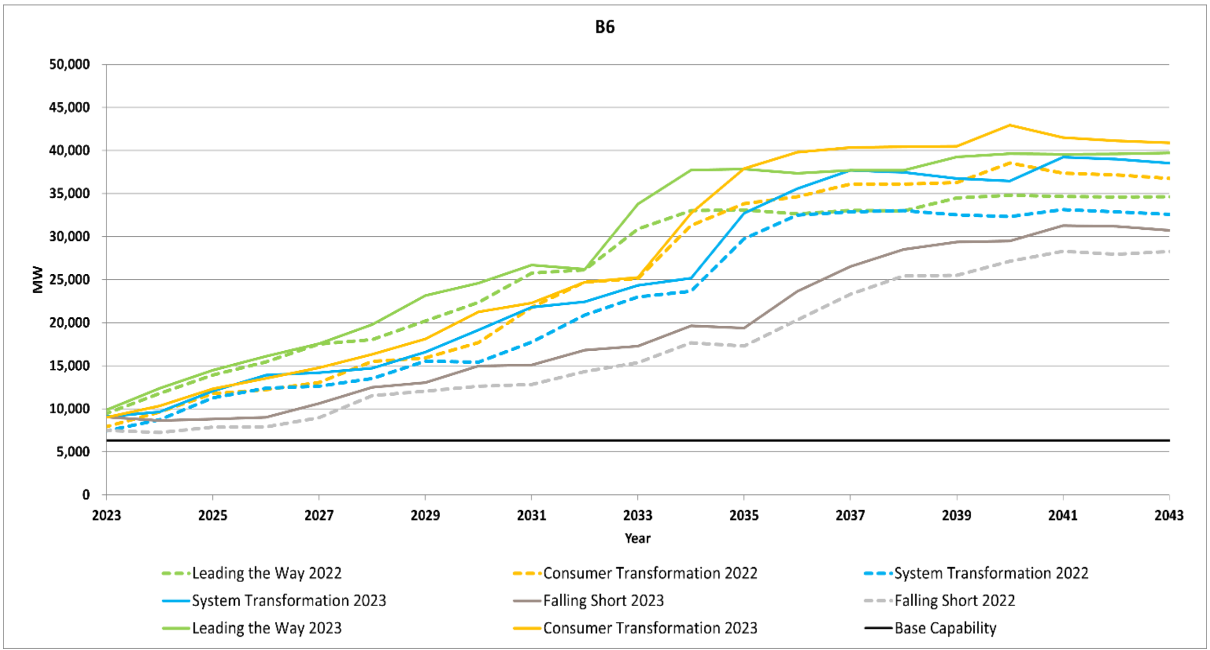

Figure 2: Required Transfers and base capability for boundary B6

The current capability of transmission network boundary B6 is approximately 6,300MW, 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 24.6GW by 2030 and up to approximately 37.9GW by 2035.

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.

4.3.4 Network Options Assessment (NOA)

The Network Options Assessment 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, supports the proposal in this paper to progress the replacement and uprating of the conductor system on ZV route north of Elvanfoot with a HTLS conductor system (ref. NOA7 code VERE), identifying the project as a ‘HND essential option’. This recommendation continues to be supported by the 2023/24 NOA, due to be published in March 2024[13].

[13] NGESO confirmed “Proceed” recommendation for VERE at the NOA 2023 / TCSNP Governance meeting on 1st Dec 2023.

4.4 Key Project Drivers - Non-Load Related

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

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

The 'Fibral' earthwire 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 directing 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 earthwire strands following lightning strikes.

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

4.5 Alignment with RIIO-T2 Strategic Goals

As described in our RIIO-T2 plan[14] for the five-years to the end of March 2026, to mitigate the impacts of climate change and achieve a low-carbon energy system requires a level of focused effort and commitment never seen before. The mass electrification of transport and heat has only started and there is a huge amount required to build on the timely progress already made in the electricity sector.

Energy networks are critical to achieving the wider Net Zero emissions targets and with continued engagement with consumers, network users and our wider stakeholders, we've set a progressive plan in place to facilitate a Net Zero future. Our RIIO-T2 plan sets out four strategic goals – informed by our stakeholder priorities – that will keep us moving towards this sustainable future. These goals and their alignment with the uprating and modernisation of ZV OHL route (Strathaven to Elvanfoot Section), are summarised in Figure 3.

Further detail regarding how this proposal aligns to our four Strategic Goals is outlined below:

Take a leading role in delivering a Net Zero future that is consistent with government objectives.

The uprating of ZV route will enable both increased transmission capacity and the amount of renewable generation connected to the GB electricity network, contributing towards a reduced reliance on fossil fuel electricity generation sources.

Deliver the benefits of increased cost-efficiency to network users and consumers by continually innovating and applying whole system solutions.

Integrating load and non-load related drivers in an economic, efficient and co-ordinated manner, the purpose of this project is to facilitate increased power transfer from Scotland to England and enable the timely modernisation of this strategic 400kV OHL route.

[14] SP Energy Networks RIIO-T2 Business Plan

Maintain world-leading resilience and system operability to ensure security of supplies throughout the energy transition.

The works will help maintain system resilience and operability by modernising existing assets, while enabling additional transmission capacity as well as the capability to connect new sources of renewable generation, with demand for network capacity expected to increase significantly following the ScotWind leasing round announcement.

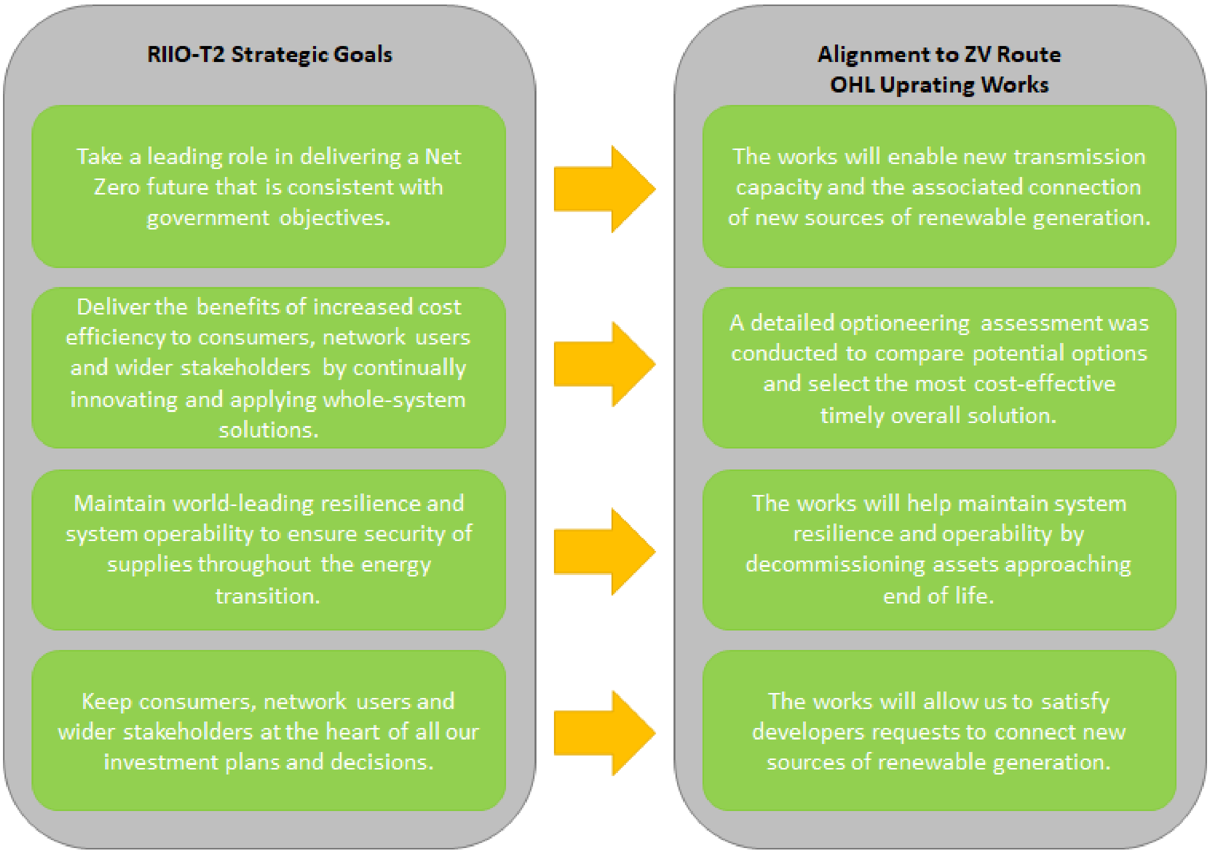

Figure 3: Alignment of the ZV Route OHL Uprating Proposal with SPT RIIO-T2 Strategic Goals

Keep network users and consumers at the heart of all our investment plans and decisions.

The completion of the ZV OHL route uprating and modernisation work is required to maintain and operate an economic, efficient and fit for purpose transmission system, and allow SPT to satisfy network users' requests for connection, consistent with our statutory and licence responsibilities.

Key stakeholders will be consulted during the development of the proposed solution and we will continue to engage with stakeholders throughout the project development and delivery process.

The completion of the ZV OHL route uprating and modernisation works will continue to align with our future strategic ambitions.

5. Assessment of Options

5.1 Existing System Configuration

The existing ZV route is indicated geographically in Figure 4 below.

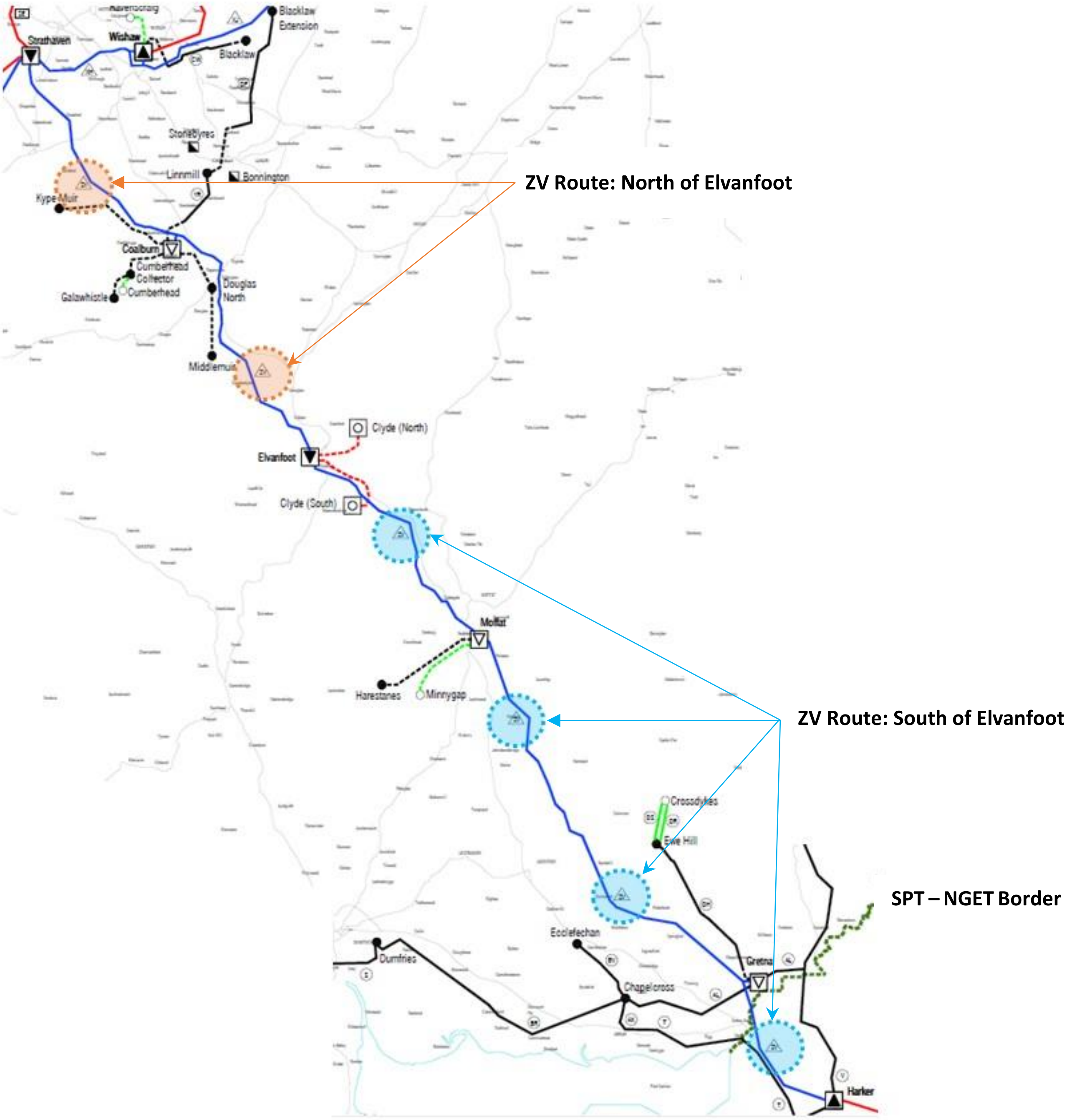

Figure 4 Geographic Indication of ZV OHL Route[15]

[15] ZV Route north of Elvanfoot is indicated by the two shaded orange circles. ZV Route south of Elvanfoot is indicated by the four shaded blue circles.

The 400kV circuits supported by ZV route form part of the Main Interconnected Transmission System (MITS). By virtue of the role of this north - south corridor, following the secured event of a fault outage of the existing east coast 400kV double circuit overhead line route which connect the Scottish electricity transmission system to England, its thermal capability and performance have a significant impact on the ability to transfer power from Scotland to England.

As detailed Figure 5 and Figure 6 below, ZV route supports the following circuits:

Route Section: Strathaven to Elvanfoot, Route Length 48.6km

- Strathaven – Coalburn 400kV (ZV western side) - 21.9km
- Coalburn – Elvanfoot 400kV (ZV western side) - 26.7km
- Strathaven – Elvanfoot 400kV (ZV eastern side) - 48.6km

Route Section: Elvanfoot to Harker, Route Length 77.5km (67.6km SPT owned, 9.9km NGET owned)

- Elvanfoot – Moffat 400kV (ZV western side) - 23.6km
- Moffat – Harker 400kV (ZV western side) - 53.8km (43.9km SPT owned, 9.9km NGET owned)
- Elvanfoot – Gretna 400kV (ZV eastern side) - 65.6km
- Gretna – Harker 400kV (ZV eastern side) - 11.9km (2km SPT owned, 9.9km NGET owned)

Outage access to these circuits has traditionally been challenging [redacted]

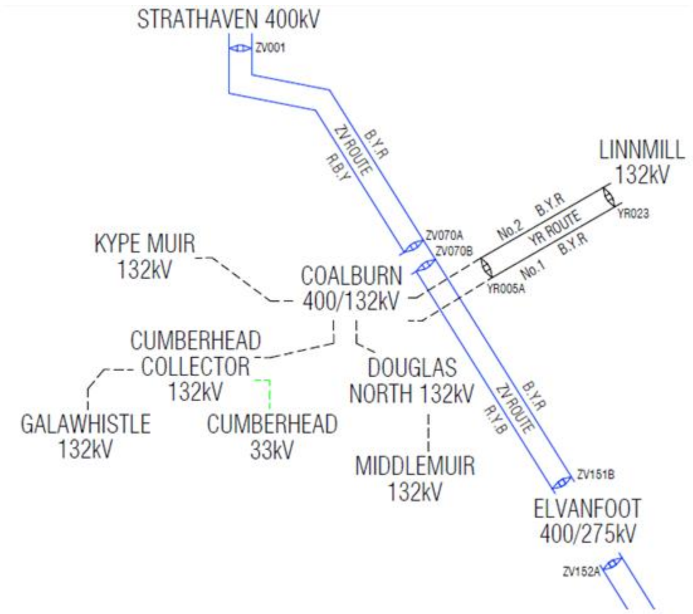

Figure 5 Existing Configuration and Phasing – ZV OHL Route, North of Elvanfoot

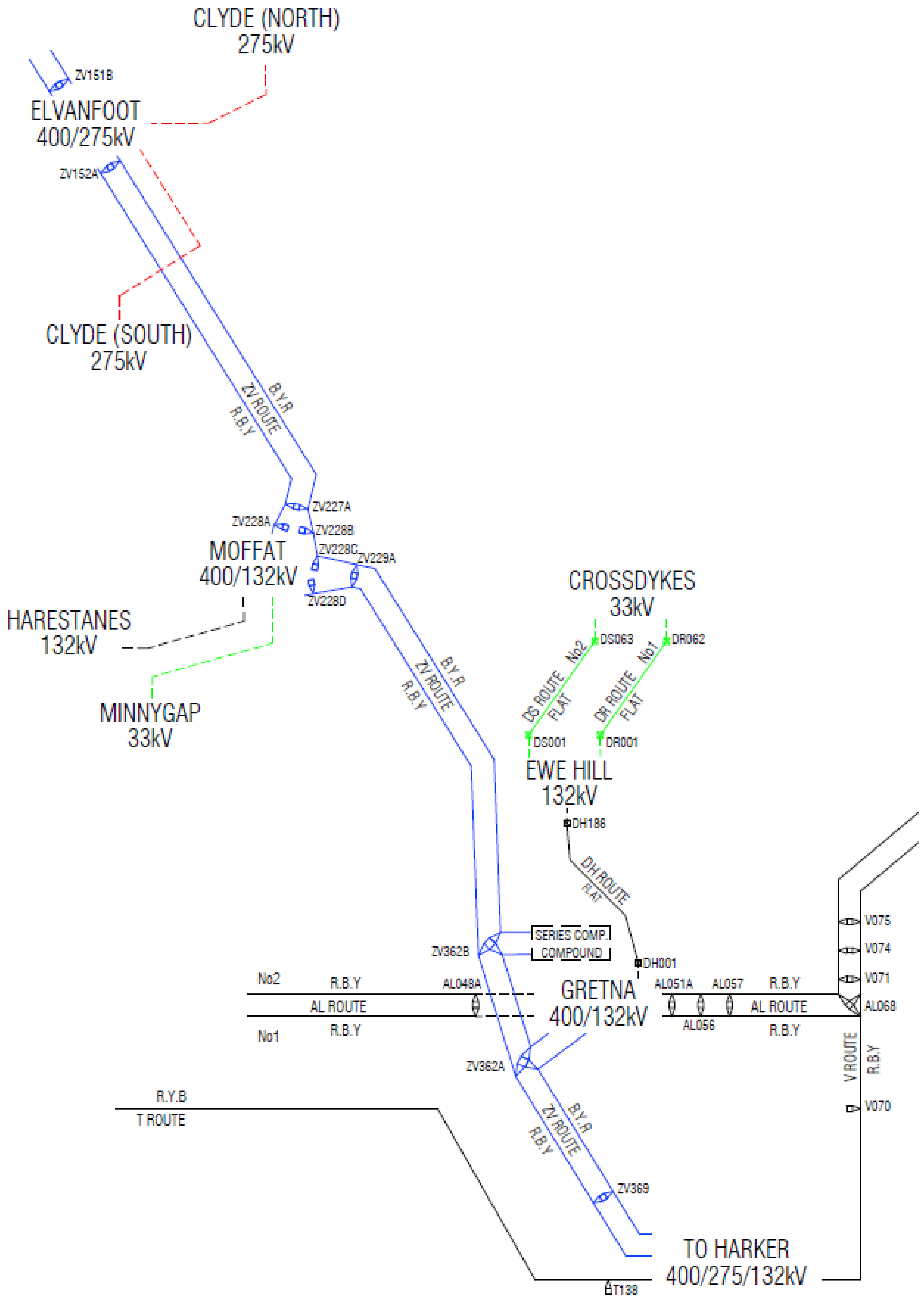

Figure 6 Existing Configuration and Phasing – ZVOHL Route, South of Elvanfoot

5.2 Planned System Configuration – HND/ NOA Projects

Following the ESO's publication of the HND and NOA 7 Refresh on 7th July 2022, the following projects were highlighted for progression within SPT's network area.

Table 4: Status within HND – Required for 2030 Targets

NOA7R Code	Description	NOA7 EISD
DNEU	Installation of a new 400/275kV 1000MVA Supergrid transformer (SGT2) at Denny North 400kV substation.	**2025**
DWUP	Establish a 400kV single circuit corridor south from Kincardine North, on existing overhead line (OHL) routes, to Wishaw substation or Clyde's Mill substation.	**2026**
E2DC	Establish a High Voltage Direct Current (HVDC) subsea link from a new Branxton 400kV Substation (near Torness) to Hawthorn Pit in the northeast of England. Branxton will facilitate the connection of offshore renewable developments as well as the reinforcement of capacity between Scotland and England.	**2027**
LWUP	Establish a new 400kV substation north of Kincardine and connect to Denny North at 400kV, integrating load and non-load related investment drivers and enabling significant reinforcement of transfer capacity through central Scotland.	**2027**
VSRE	Replace existing OHL conductor on the strategic east-west Strathaven - Smeaton (XH/XJ route) corridor with modern high temperature low sag (HTLS) conductor.	***2027***
DWNO	Establish a new 400kV OHL from Bonnybridge substation to an existing OHL north of Glenmavis, together with associated substation works, conductor replacement and voltage uprating on existing OHL routes.	**2028**
EHRE	Replace existing OHL conductor on the southern (Elvanfoot - Harker) section of the strategic north-south Strathaven - Harker (ZV route) corridor with modern high temperature low sag (HTLS) conductor.	**2028**
BDUP	Uprate the Beauly - Denny OHL route to double circuit 400kV operation.	**2029**
DLUP	Establish a new 400kV substation at Windyhill and a 400kV single circuit corridor, on existing overhead line routes, between Windyhill, Lambhill and Denny North.	**2029**
VERE[16]	***Replace existing OHL conductor on the northern (Strathaven - Elvanfoot) section of the strategic north-south Strathaven - Harker (ZV route) corridor with high temperature low sag (HTLS) conductor.***	**2030**
TGDC	Creation of a second new High Voltage Direct Current (HVDC) Eastern subsea link from the SPT area, to south of the Humber estuary, in the northeast of England, together with associated onshore works.	**2031**
TKUP	Establish new 400kV substations at Mossmorran, Westfield and Glenrothes to establish a 400kV double circuit corridor, on existing overhead line routes, between Kincardine North and the SSEN Transmission Tealing substation. Scope includes further works within the SSEN-T area.	**2032**

Table 5: Status within NOA7 – Proceed

NOA7R Code	Description	NOA7 EISD
CMNC	Creation of a new 400kV double circuit OHL route and associated substation infrastructure from southeast Scotland to the northwest of England.	**2033**
WCNC	Creation of a new 400kV double circuit OHL route and associated substation infrastructure from southwest Scotland to the northwest of England.	**2036**
TLNO	Creation of a new 400kV double circuit OHL route and associated substation infrastructure from east central Scotland to the northeast of England.	**2037**

16 This project – SPT-RI-1797 Strathaven to Elvanfoot OHL Uprating

5.3 Overview of Options

This section provides a description of the options considered to integrate load and non-load related drivers in an economic, efficient and co-ordinated manner, facilitating increased power transfer from Scotland to England and the timely uprating of this strategic 400kV OHL route north of Elvanfoot, and details the key considerations.

Table 6 below presents a summary of the options considered.

Table 6: Options Summary

	Option	Outcome of Initial Review	Reason for Rejection
1	Do Nothing or Delay	Rejected	A 'Do Nothing' or 'Delay' option is not credible in relation to this project and would be inconsistent with SPT's various 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 NGESO in view of the potential operational impacts.
2	Refurbish ZV Route with Twin 560mm^2 AAAC Sorbus	Proposed for Further Consideration	-
3	Refurbish ZV Route with a Twin HTLS Conductor	Proposed for Further Consideration	-
4	Replace ZV Routes with new L12 Construction	Proposed for Further Consideration	-
5	Underground ZV Route	Rejected	This option involves the replacement of ZV OHL route with 400kV underground cable circuits. This option was considered previously in respect of the SPT-RI-130 XH and XJ Route OHL Uprating Works[17], involving a 73.7km 400kV double circuit route length, which is 25.1km longer than the 77.5km 400kV double circuit route between Strathaven and Elvanfoot 400kV Substations. As part of the SPT-RI-130 XH and XJ Route OHL Uprating project, a like for like comparison of the cable purchase cost for the circuit length was estimated to be approximately £400m, and potentially £600m best case for delivery (without any variation in length relative to the existing OHL routes, consideration of technical feasibility, engineering difficulties or system operability/ reactive compensation requirements). This option was considered uneconomic and was not progressed for further engineering consideration.

Options 2 and 3 provide feasible timely solutions. These options, together with Option 4, are discussed in further detail in the following sections.

[17] XH-XJ MSIP Reopener - For Publication.pdf (spenergynetworks.co.uk)

Table 7 below provides an overview of the OHL thermal ratings achieved on ZV route, on a per circuit basis, for each of Options 2, 3 and 4. Table 7 provides detail of the capability of the existing twin AAAC 'Rubus' conductor system for comparison purposes.

Table 7: 400kV Thermal Ratings, per Circuit

400kV Thermal Ratings per Circuit [18]	Twin AAAC 'Rubus' (Existing)[19]		Twin AAAC 'Sorbus' (Option 2)		Twin HTLS (Option 3)[20]		Twin Araucaria (Option 4) [21]	
Season / State	**Amps**	**MVA**	**Amps**	**MVA**	**Amps**	**MVA**	**Amps**	**MVA**
Winter Pre-Fault	2680	1860	2940	2040	3760	2610	3400	2360
Winter Post-Fault	3190	2210	3500	2420	4480	3100	4050	2810
Spring/Aut. Pre-Fault	2580	1790	2820	1960	3700	2560	3270	2260
Spring/Aut. Post-Fault	3070	2130	3360	2330	4400	3050	3890	2700
Summer Pre-Fault	2400	1660	2630	1820	3590	2490	3040	2110
Summer Post-Fault	2860	1980	3130	2170	4270	2960	3620	2510

Table 8 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 8: 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

5.3.1 Option 2 - Refurbish ZV Route with Twin 560mm^2 AAAC Sorbus

This option involves the major refurbishment of ZV route from Strathaven to Elvanfoot with a twin 560mm^2 AAAC (Sorbus) conductor system. This option is inconsistent with the transmission requirements identified via the NOA and the OTNR HND (reference Section 4.3 and 5.2).

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 (ref. Table 8).

[18] 90°C Maximum Operating Temperature for AAAC Options 2 and 5 (Resistivity 30.5 nΩ.m).

[19] 90°C Maximum Operating Temperature for existing AAAC 'Rubus' (Resistivity 31.2 nΩ.m).

[20] 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.

[21] Note that Option 4 relates to the establishment of a new overhead line route utilising L12 type towers, and does not relate to the replacement of the conductor system on the existing Strathaven – Harker route.

5.3.2 Option 3 - Refurbish ZV Route with a Twin HTLS Conductor System

This option involves the major refurbishment of ZV route from Strathaven to Elvanfoot 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 7 above.

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 (reference Section 4.3 and 5.2), delivering a significant incremental thermal capacity of up to 830MVA per circuit (ref. Table 8), 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.

5.3.3 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 Strathaven to Elvanfoot 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 a significantly higher capital cost relative to Options 2 and 3, 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 8), lower than that delivered by Option 3 above. 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 complimentary and coordinated suite of transmission system reinforcements as recommended by NGESO (reference Section 4.3 and 5.2).

5.4 Option Assessment

As described in our RIIO-T2 Business Plan Annex 8[22], while most engineering justification papers have a CBA aligned with the RIIO-T2 CBA model, projects in the following categories do not:

- Live projects rolling over from RIIO-T1, since they have already initiated, with decisions made during the previous price control.
- Customer connection projects, as the proposed approach is based on agreement with the connecting party as they will bear a sizeable proportion of the costs incurred.
- TO Reinforcements associated with new connections, where the options considered are evaluated purely based on the lowest cost solution, which meets the project objectives, as the benefits are all comparable.
- Projects justified through the Network Options Assessment Process as these are subject to an extensive and rigorous CBA process by the Electricity System Operator who can consider market options, and different options which may be offered by Transmission Owners.

Projects in the four categories above have an associated document (this MSIP Re-Opener application in respect of the ZV route OHL uprating) explaining the feasible options and the reasoning behind the selection of the preferred investment option.

[22] Annex 8 - Cost Benefit Analysis Methodology (spenergynetworks.co.uk)

The short-listed options relating to the economic, efficient and co-ordinated development of the transmission system to facilitate increased power transfer from Scotland to England and enable the modernisation of this strategic 400kV OHL route are described in Section 5.3 while Table 9 summarises the key benefits and disadvantage of each option.

In general terms, to achieve an increased thermal capacity, exceeding the value of an existing conductor, replacement with a larger conductor is required. The largest conventional (AAAC) conductor suitable for the L8 tower design on ZV route does not however meet the projected load growth for these circuits (Option 2). Traditionally, this would result with the circuits having to be rebuilt with the larger conductor system (Option 4). The use of HTLS conductor systems however, enables the reuse of the existing OHL towers and removes the need to build approximately 48.5km of new overhead line (Option 3).

Option 3 is the preferred investment option, integrating load and non-load related drivers in an economic, efficient and co-ordinated manner. It delivers additional incremental capacity relative to Option 4 at significantly lower capital cost, facilitating increased power transfer from Scotland to England and enabling modernisation of the strategic ZV 400kV OHL route north of Elvanfoot.

There is no market based alternative to the preferred investment option.

Table 9: Option Benefits, Drawbacks and Selection Outcome

	Option	Estimated Capital Cost (2018/19)	Key Advantages	Key Disadvantages	Option Outcome
2	Refurbish ZV Route north of Elvanfoot with Twin 560mm^2 AAAC Sorbus	£48.68m	- Lowest overall capital cost.	- 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.	Rejected
3	Refurbish ZV Route north of Elvanfoot with a Twin HTLS Conductor System	£64.25m	- Consistent with the transmission requirements identified via NOA and the OTNR HND, delivers a significant incremental thermal capacity up to 930MVA/ circuit. - Provides full functionality required to give ZV route a further 40 years of service without further major intervention.	- Higher overall capital cost relative to Option 2 reflective of conductor system technology and installation methods.	**Proposed**

4	Replace ZV Route north of Elvanfoot with a new Route of L12 Construction	£108.94m	- Anticipated reduction in system access requirements for construction outages.	- Highest overall capital cost. - Inefficient given the remaining life of the existing towers. - 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.	Rejected

6. Proposed Works

6.1 Summary

HTLS conductors 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 SPTs 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 7 above. 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 earthwire 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.

6.1.1 Proposed Works on ZV Route, Strathaven 400kV Substation to Elvanfoot 400kV Substation

The proposed works are summarised as follows:

- 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.
- Replace any heavily corroded or damaged steelwork (above category 4).
- Tower painting.
- Update all OHL records to reflect the works carried out.

6.2 Environmental and Consent Related 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.

6.3 Stakeholder Engagement

SPT's Stakeholder Engagement Plan for the ZV route works will be closely aligned to our wider Stakeholder Engagement commitments as outlined in our RIIO-T2 business plan. It will centre around timely engagement with key stakeholders, including those involved in land and planning consents, to achieve mutually acceptable outcomes. We recognise that stakeholders' influence and interest in the project will vary as the project develops and that stakeholders' opinions may change over time. As well as affected landowners, SPT will engage with:

- NGESO in relation to system access for construction outages - Detailed outage requirements and sequences will be developed as part of the detailed project design. Delivery of the construction works will be carefully co-ordinated and integrated with the system access requirements of the projects identified in Table 4. Detailed consideration will be given to the stage by stage sequencing of works e.g. completion of works on a circuit by circuit basis, such that the operational impact of later outages in sequence is mitigated by increased circuit thermal rating(s) delivered during outages earlier in the sequence. This may have a bearing on project delivery methods, programme and capital cost.
- NGET in relation to the co-ordination of all works on ZV route, north and south of the SPT/NGET border.

7. Project Cost Estimate

As agreed with Ofgem, a further (Stage 2) MSIP submission will be made at the right time relating to the associated amendments to the outputs, delivery date and allowances to be detailed in LSpC 3.14 Appendix 1. The detail in this section is therefore indicative pending that further submission.

7.1 Estimate Total Project Costs

Aligned with the format of the Re-Opener Pipeline Log, Table 10 details the expected energisation year and the current view of potential direct capital expenditure. The (RIIO-T2) allowances will be subject to the Opex escalator mechanism:

Table 10: Estimated Incidence of Expenditure

	Potential direct capex value per year, £m, 18/19 price base								
Energisation Year	Yr. 24/25: direct capex	Yr. 25/26: direct capex	Yr. 26/27 (T3): direct capex	Yr. 27/28 (T3): direct capex	Yr. 28/29 (T3): direct capex	Yr. 29/30 (T3): direct capex	Yr. 30/31 (T3): direct capex	RIIO-T2 Total: direct capex	Total: direct capex
2030/31	0.321	1.606	6.425	7.710	16.063	16.063	16.063	1.928	64.250

Current estimates for the capital cost of this project have been developed using experience of the successful Innovation Roll-out Mechanism project to install HTLS conductor systems in South West Scotland.

7.2 Regulatory Outputs

The indicative primary asset outputs are identified in Table 11 below. They relate to works on SPT assets between Strathaven 400kV Substation and Elvanfoot 400kV Substation.

Table 11: Regulatory Outputs Table (Volumes)

Asset Category	Asset Sub-Category Primary	Voltage	Forecast Additions/ Activity	Forecast Disposals
Overhead Tower Line	OHL (Tower Line) HTLS Conductor	400 kV	97.31km	97.31km
Overhead Line Fittings	Fittings	400 kV	306 each	306 each
Earth Wire	OHL (Tower Line) Earth Wire	400 kV	48.6km	48.6km
Overhead Tower Line	Tower	400 kV	153 each	

8. Delivery

We have applied our project management approach to ensure that this project work is delivered safely, and in line with the agreed time, cost and quality commitments. We have 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 have assigned a dedicated Project Manager 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.

8.1 Delivery Schedule

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 12 summarises the key milestones within the delivery schedule.

Table 12: Key Milestones

Milestone	Phase	Estimated Completion Date
1	Issue ITT (Service Partnership)	February 2024
2	Issue OHL Contract to framework partner	September 2026
3	Commence Site Works	March 2028
4	Complete Site Works	October 2030

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.

8.2 Risk and Mitigation

A Risk Register has been generated collaboratively during the initial design stages to identify any risks, which if realised, could result in deviation from the delivery plan. Mitigation strategies have also been 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:

[redacted]

8.3 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:

8.3.1 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.

8.3.2 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.

8.3.3 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.

8.3.4 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.

9. Conclusion and Recommendations

This MSIP Re-opener application demonstrates the need to facilitate increased power transfer from Scotland to England and enable the timely and coordinated modernisation of the strategic ZV 400kV OHL route north 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, 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, will play a vital role in reaching legislated net zero targets, and is aligned with SPT's RIIO-T2 strategic goals.
- 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.
- An MSIP Re-opener application is required in respect of these works.

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

- The option being progressed addresses a clear customer need and represents value to UK consumers, 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 second stage MSIP submission and assessment.

Appendix A - SP Transmission System, Geographic Overview