New Lesmahagow GSP

ED2 Engineering Justification Paper

ED2-LRE-SPD-020-CV3-EJP

Issue	Date	Comments
Issue 0.1	Jan 2021	Issue to internal governance and external assurance
Issue 0.2	Mar 2021	Reflecting comments from internal governance
Issue 0.3	May 2021	Reflecting external assurance feedback
Issue 1.0	Jun 2021	Issue for inclusion in Draft Business Plan submission
Issue 1.1	Oct 2021	Reflecting updated DFES forecasts
Issue 1.2	Nov 2021	Reflecting updated CBA results
Issue 2.0	Dec 2021	Issue for inclusion in Final Business Plan submission

Scheme Name	New Lesmahagow GSP		
Activity	Fault Level Reinforcement		
Primary Investment Driver	Fault Level Mitigation		
Reference	ED2-LRE-SPD-020-CV3		
Output	Fault Level Reinforcement		
Cost	£2.621m		
Delivery Year	2023-2025		
Reporting Table	CV3/CV4		
Outputs included in ED1	~~Yes~~/No		
Business Plan Section	Develop the Network of the Future		
Primary Annex	Annex 4A.2: Load Related Expenditure Strategy: Engineering Net Zero Annex 4A.6: DFES		
Spend Apportionment	**ED1**	**ED2**	**ED3**
	£m	**£2.621m**	**£2.815m**

Technical Governance Process

Project Scope Development

IP1(S)

To be completed by the Service Provider or Asset Management. The completed form, together with an accompanying report, should be endorsed by the appropriate sponsor and submitted for approval.
IP1 – To request project inclusion in the investment plan and to undertake project design work or request a modification to an existing project
IP1(S) – Confirms project need case and provides an initial view of the Project Scope
IP2 – Technical/Engineering approval for major system projects by the System Review Group (SRG)
IP2(C) – a Codicil or Supplement to a related IP2 paper. Commonly used where approval is required at more than one SRG, typically connection projects which require connection works at differing voltage levels and when those differing voltage levels are governed by two separate System Review Groups.
IP2(R) – Restricted Technical/Engineering approval for projects such as asset refurbishment or replacement projects which are essentially on a like-for-like basis and not requiring a full IP2
IP3 – Financial Authorisation document (for schemes > £100k prime)
IP4 – Application for variation of project due to change in cost or scope

PART A – PROJECT INFORMATION

Project Title:	**New Lesmahagow GSP**
Project Reference:	**ED2-LRE-SPD-020-CV3**
Decision Required:	**To give concept approval to establish a new grid supply point near Lesmahagow.**

Summary of Business Need:

The primary driver for investment at Lesmahagow substation is to alleviate fault level constraints on the 33kV network at Linnmill grid supply point (GSP). Based on the current connected and contracted generation at Linnmill GSP, the fault levels for the switchboard currently exceed their equipment ratings. There is also no capacity on the grid transformers to allow for any new generation connections, 187.6MW of connected generation against a non-firm Grid Transformer capacity of 180MVA. Distribution Future Energy Scenarios data predicts a large increase in distributed generation connecting at Linnmill GSP, with a range of 79-103MW of new generation potentially connected by the end of the RIIO-ED2 price control period. This volume of new connections would result in significant thermal issues at the Linnmill GSP grid transformers requiring substantial reinforcement work.

Summary of Project Scope, Change in Scope or Change in Timing:

It is proposed to establish a new 132/33 kV GSP substation connecting into Coalburn 132kV transmission network. Two new 132/33kV 60MVA rated grid transformers will be installed by SP Transmission as part of the scheme. Eight 33kV circuit breakers (CB) will be installed in a new prefabricated housing that provides space for up to 15 CB panels, leaving room for three additional circuit breakers on one side of the switchboard and four on the other. The Lesmahagow and Douglas West primary substations will be connected to the new Lesmahagow GSP switchboard which is in closer proximity to the demand centre. 72.6MW of generation will all be transferred to the new Lesmahagow GSP network, creating both thermal and fault level headroom at Linnmill GSP.

A Modification Application was submitted to National Grid Electricity System Operator (NGESO) in January 2020; an NGESO offer was received in April 2020; IP2 was approved by the DSRG & TSRG in September 2020; IP3 advisory paper was approved and the NGESO offer was accepted in November 2020.

The estimated cost for the above is £2.621m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure. The associated transmission works are included in the RIIO-T2 investment plan. The full cost of transmission works will be charged to SP Distribution under New Transmission Capacity Charges (NTCC), over a 40-year payback period starting from 2027/28 with one-off costs charged in 2025/26 and 2026/27.

Expenditure Forecast (in 2020/21)

Licence Area	Reporting Table	Description	Total (£m)	Incidence (£m)				
				2023/24	2024/25	2025/26	2026/27	2027/28
SPD	CV3	Fault Level Reinforcement	**1.821**	0.910	0.910	-	-	-
SPD	CV4	New Transmission Capacity Charges	**0.800**	-	-	0.058	0.159	0.583
SPD	**Total**		**2.621**	**0.910**	**0.910**	**0.058**	**0.159**	**0.583**

PART B – PROJECT SUBMISSION

Proposed by	Mark Friese	Signature		Date:	30/11/2021
Endorsed by	Russell Bryans	Signature		Date:	30/11/2021

PART C – PROJECT APPROVAL

Approved by	Malcolm Bebbington	Signature		Date:	30/11/2021

Contents

1 Introduction

Linnmill 132/33 kV Grid Supply Point (GSP) is in Lanarkshire District of the SP Distribution (SPD) licence area. The primary driver for investment at Lesmahagow substation is to alleviate fault level constraints on the 33kV network at Linnmill GSP. Based on the current connected generation at Linnmill GSP, the fault levels at the 33kV switchboard currently exceed their design ratings.

There is also no capacity on the grid transformers to allow for any new generation connections, 187.6MW of connected generation against a non-firm GSP capacity of 180MVA. DFES data predicts a large increase in distributed generation connecting at Linnmill GSP, with a range of 79-103MW of new generation potentially connected by the end of the RIIO-ED2 price control period. This volume of new connections would result in significant thermal issues at the Linnmill GSP grid transformers requiring substantial reinforcement work.

In order to alleviate fault level constraints on the 33kV network, secure supplies within the group and accommodate future low carbon technology uptake within the area, it is proposed to establish a new 132/33kV 60MVA GSP within the Lesmahagow region connecting into Coalburn 132kV transmission network. This will provide SPD the capacity to connect the future distribution generation predicted under the DFES and remove the need for significant fault level mitigation works at Linnmill GSP.

The SP Distribution works for this solution involves the installation of a new indoor 33kV switchboard and 33kV circuits to connect to the new board. The costs of SPD works are included within the CV3 expenditure. The SP Transmission (SPT) works for this solution involves the installation of installation of two 60MVA transformers, two 33kV incomer circuit breakers and associated cables. The full cost of transmission works will be charged to SP Distribution under New Transmission Capacity Charges (NTCC), over a 40-year payback period starting in 2027/28 upon GSP energisation with one-off costs charged in 2025/26 and 2026/27 based on the accepted Modification Application (ModApp) offer.

SPD submitted a ModApp for this works to National Grid Electricity System Operator (NGESO) in January 2020; an NGESO offer was received in April 2020 and the NGESO offer was accepted in November 2020. The associated transmission works are included in the RIIO-T2 investment plan. The associated transmission works are included in the RIIO-T2 investment plan. In addition, there is also a generation customer Little Gala windfarm which is contracted with both SPD and SPT to the new Lesmahagow GSP (see section 5.1).

The estimated cost for the above is £1.821m under the CV3 expenditure and £0.800m (in 2020/21 prices) under the CV4 expenditure with 100% contribution to be included in the RIIO-ED2 load related expenditure.

Due to the proposed connection date in October 2027 driven by SP Transmission works, it is proposed to start the distribution works in 2023/24 and the fault level scheme output will be claimed in 2027/28 upon GSP energisation based on the accepted ModApp offer. The proposed option provides an additional 347MVA (peak make)/113MVA (RMS break) fault level headroom, on design rating.

2 Background Information

2.1 Existing / Authorised Network

The existing distribution system at Linnmill Grid Supply Point (GSP) substation is fed from two 132/33kV 90 MVA rated grid transformers which serve an indoor 33kV switchboard. The board then feeds seven 11kV primary substations, Biggar, Braidwood, Corra Linn, Douglas West, Lanark, Lesmahagow and Symington. There are also interconnections with both the Wishaw and Newarthill GSP's. A network diagram for the Linnmill 33kV distribution network is shown Figure 1.

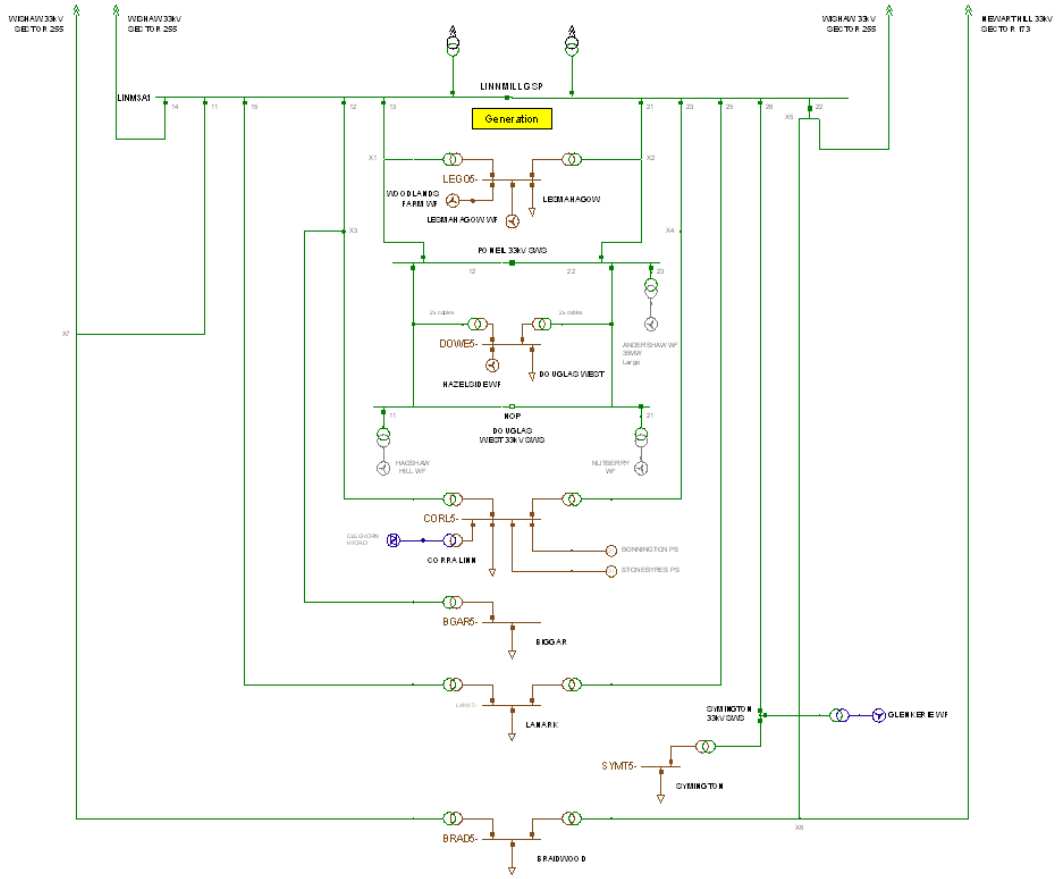

Figure 1. Linnmill GSP 33kV Network

2.2 Network Supply / Circuit Capacity

Currently there is no demand connected at Lesmahagow 132kV network as no distribution network exists. Following the construction of Lesmahagow GSP, the adjacent Lesmahagow primary and Douglas West primary will be transferred to the new GSP. The current demand groups supplied from Linnmill GSP are shown in in Table 2.1.

The existing Linnmill GSP peak demand is around 45MW which is a class 'C' of supply as per ENA Engineering Recommendation (EREC) P2/7. The firm capacity (N-1) of Linnmill GSP is 90MVA.
Linnmill GSP has the following interconnectors for supporting N-1 and N-2 contingencies:

- three 33kV interconnectors to Wishaw GSP (Normally Open Points at Whishaw GSP)
- one 33kV interconnector to Newarthill GSP (Normally Open Points at Newarthill GSP)

Table 2.1. Linnmill GSP demand groups (LTDS 2020)

Demand Group	Customers (#)	Firm Capacity (MVA)	Max Demand (MVA)	Load Index	P2/7 Class of Supply
Biggar	3,084	10	4.17	LI1	B
Braidwood	7,293	23	10.21	LI1	B
Corra Linn	3,586	20	7.27	LI1	B
Douglas West	2,073	24	7.47	LI1	B
Lanark	5,143	24	7.97	LI1	B
Lesmahagow	5,439	24	10.85	LI1	B
Symington	1,343	10	6.47	LI1	B

2.3 Embedded Generation

A list of all connected distributed generation, at Linnmill GSP, is shown in Table 2.2 and contracted distributed generation, at Lesmahagow GSP, is shown in Table 2.3 (see section 5.1).

Table 2.2. Embedded generation at Linnmill GSP

GSP	Voltage (kV)	Site	Export capacity (MW)	Type	Status
Linnmill	33	Andershaw Windfarm	36	Onshore Wind	Connected
	33	Auchrobert Windfarm	36	Onshore Wind	Connected
	11	Bonnington PS	11	Hydro	Connected
	11	Cleghorn Hydro	0.75	Hydro	Connected
	33	Glenkerie Windfarm	18.4	Onshore Wind	Connected
	33	Hagshaw Hill WF	15.6	Onshore Wind	Connected
	33	Hagshaw Hill Ext WF	26	Onshore Wind	Connected
	11	Hazelside Windfarm	2.4	Onshore Wind	Connected
	11	Lesmahagow WF	2.25	Onshore Wind	Connected
	33	Nutberry Wind Farm	15	Onshore Wind	Connected
	11	Stonebyres PS	6	Hydro	Connected
	11	Woodlands Farm WF	1.35	Onshore Wind	Connected
	11/LV	Embedded generation (<1MW)	16.85	Onshore Wind/solar	Connected
	Total		187.6		

Table 2.3. SPD and SPT contracted embedded generation at Lesmahagow GSP

GSP	Voltage (kV)	Site	Export capacity (MW)	Type	Status
Lesmahagow	33	Little Gala	29.9	Onshore Wind	Contracted

2.4 Fault Levels / Design Limits

Switchgear is required to have the capability of "making" fault current i.e. closing onto an existing fault and "breaking" fault current i.e. opening and so disconnecting a fault from the system, these duties are defined in terms of Peak Make and RMS Break. Typical planning limits for fault level duties on the SPD network are shown in Table 2.4. These are the design limits for the 33kV network.

Table 2.4. Fault level design limits

Switchgear Type	System Voltage (kV)	3-phase Fault Level Limits (kA)	
		Peak Make	RMS Break
IEC 62271-100; Rating >= 20kA (Installed after 2010)	EHV	50.00	17.50

The switchgear fault level duty assessments are based on the SP Energy Networks (SPEN) design policies ESDD-02-006[1], under which the design principles effectively ensure with regards to the equipment duty, the prospective network fault levels shall never be more than 100% of the plant capability. However, to reflect the potential for under-estimation due to generic assumptions and modelling errors, sites exceeding 95% of design rating are considered for mitigation.

Table 2.5 shows the current 33kV 3-phase fault levels as a percentage of the design limits at the Linnmill GSP substation.

Table 2.5. Linnmill GSP fault level (LTDS 2020)

Substation Name	Design Rating (kA)		3-phase Fault Levels (kA)		Duty (%)	
	Make	Break	Make	Break	Make	Break
Linnmill GSP	50.00	17.50	50.38	16.9	**100.76**	**96.57**

3 Needs Case

Switchgear are network assets which keep the higher voltage network safe in the event of a fault. They safely isolate the faulted section of the network. Switchgear is rated to safely operate with a certain level of fault current. Fault level constraints limit the safe operation of this group.

The primary driver for investment at Lesmahagow substation is to alleviate fault level constraints on the 33kV network at Linnmill GSP. The peak make fault level at Linnmill GSP 33kV switchboard exceed the network design limit and the RMS Break is above 95% of the design limit which would prevent connection of future generation, even small embedded 11kV generation as it would require a high-level cost for the fault level mitigation. Under design policy, the fault level mitigation is deemed necessary above 95% threshold.

There is also no capacity on the grid transformers to allow for any new generation connections, 187.6MW of connected generation against a non-firm grid transformer capacity of 180MVA. Distribution Future Energy Scenarios (DFES) data predicts a large increase in distributed generation connecting at Linnmill GSP, with a range of 79-103MW of new generation potentially connected by the end of the RIIO-ED2 price control period. This volume of new connections would result in significant thermal issues at the Linnmill GSP grid transformers requiring substantial reinforcement work.

Further in order to comply with section 9 of the Electricity Act and Condition 21 of our licence obligation "to develop and maintain an efficient, coordinated and economical system for the distribution of electricity" an enduring design solution is required in order to satisfy the existing demand requirements and accommodate future load growth.

3.1 Forecast Demand

The system is forecast to grow within the RIIO-ED2 period. This forecast is based on actual system measurement data from the Process Instrumentation (PI) system and stakeholder endorsed DFES and considers our pipeline of known developments.

[1] ESDD-02-006 – Calculation of System Fault Levels

DFES includes granular forecasts to 2050 for demand, generation and Low Carbon Technologies. They assess credible future scenarios covering a range of uncertainties, including differing levels of consumer ambition, policy support, economic growth and technology development and the forecasts are underpinned by extensive stakeholder engagement.

The peak demand forecast based on the SPD Distribution Future Energy Scenarios is depicted in Figure 2.

The scenario range considers the range of Net Zero compliant scenarios developed by us, the Electricity System Operator (ESO), and the Climate Change Committee (CCC). These are the five scenarios from the CCC 6th carbon budget, and the Leading the Way and Consumer Transformation scenarios from our DFES and the ESO Future Energy Scenarios (FES). We haven't included the System Transformation (ST) scenario as it is an outlier against the other Net Zero compliant scenarios and does not achieve interim carbon targets.

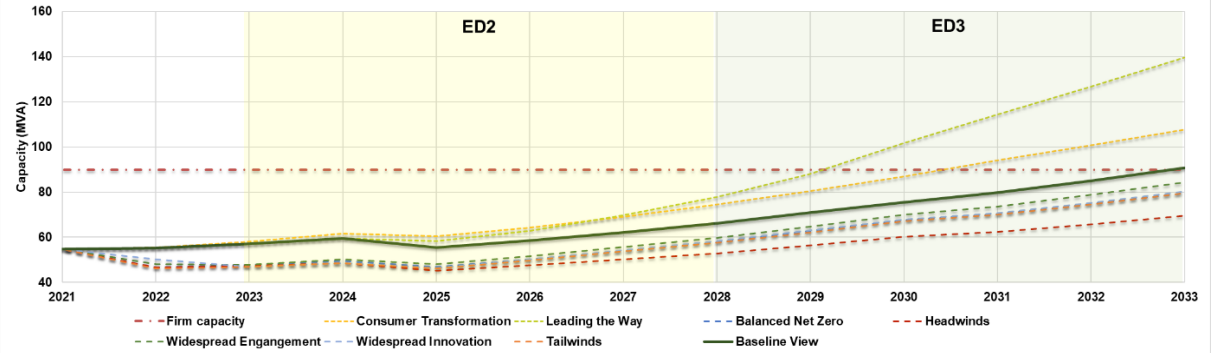

Figure 2. Demand (MVA) forecast for Linmill demand group

3.2 Forecast Generation

As shown in Table 2.2 there is already 187.6MW of connected generation against a firm/non-firm capacity of 90/180MVA. Based on DFES, there is around 79-103MW generation forecasted to be connected to Linnmill GSP by the end of RIIO-ED2.

3.3 Network Impact Assessment

The Linnmill GSP group have been assessed with the forecast demand growth, covering thermal and fault level constraints while considering the different demand forecast scenarios.

3.3.1 Thermal Constraints

No additional thermal constraints have been identified in the group under intact and outage conditions with the forecast demand growth.

3.3.2 Fault Level Constraints

The existing fault level issues at Linnmill GSP will persist and continue into RIIO-ED2. This is expected to increase further by the end of RIIO-ED2 price control period. Currently there is no headroom for the future generation and capacity is limited for the connection of the small embedded generation.

4 Optioneering

Table 4.1 shows a summary of the options considered for this reinforcement. The baseline option represents the lowest cost conventional option, i.e. the minimum level of intervention without application of innovation.

Table 4.1. Longlist of solution options

#	Options	Status	Reason for rejection
(a)	Do nothing	Rejected	Rejected as it does not address the network fault level issues.
(b)	Intervention plan using only Energy Efficiency	Rejected	Rejected as it does not address the network fault level issues.
(c)	Establish a new GSP near Lesmahagow primary	Shortlisted as **Baseline** option in Detailed Analysis	
(d)	Install Active Network Management (ANM) scheme and a bus section reactor and defer the new GSP until RIIO-ED3	Shortlisted as **Option 1** in Detailed Analysis	
(e)	New Linnmill 'B' board with two new grid transformers	Rejected	Rejected as there are thermal constraints on the 132kV circuits.
(f)	Replace existing grid transformers with higher thermal capacity units	Rejected	Rejected as it does not provide sufficient headroom to accommodate predicted distributed generation growth. There are currently no SPT assets of similar specifications (132/33kV 120MVA rated).
(g)	Installation of an Active Fault Level Management (AFLM) scheme at Linnmill	Rejected	Rejected as AFLM does not reduce the fault level infeed into the requested site. Fault level mitigation will still be required.

5 Detailed Analysis & Costs

5.1 Proposed Option (Baseline) – New Lesmahagow GSP

The proposed option for this scheme is to establish a new 132/33kV 60MVA GSP within the Lesmahagow region connecting into Coalburn 132kV transmission network.

SPD submitted a Modification application for this works to National Grid Electricity System Operator (NGESO) in January 2020; an NGESO offer was received in April 2020 and the NGESO offer was accepted in November 2020. The associated transmission works are included in the RIIO-T2 investment plan.

Table 5.1 shows the scheme summary.

Table 5.1. Proposed option summary

Category	Scheme Name	Scheme Summary	Reporting Table	RIIO-ED2 Contribution (£m)	Post RIIO-ED2 (£m)	Customer Contribution (£m)
Conventional	New Lesmahagow GSP	Establish a new 132/33kV 60MVA GSP in within the Lesmahagow region	CV3 Expenditure	1.821	-	-
			CV4 Expenditure	0.800	17.613	-

The new Lesmahagow 33kV GSP will utilise the existing spare bay (No. 9) at Coalburn 132kV switchboard, as well as a future bay once the switchboard has been extended to ensure a firm connection. the proposed Lesmahagow GSP setup at the Coalburn 132kV substation is shown in Figure 3.

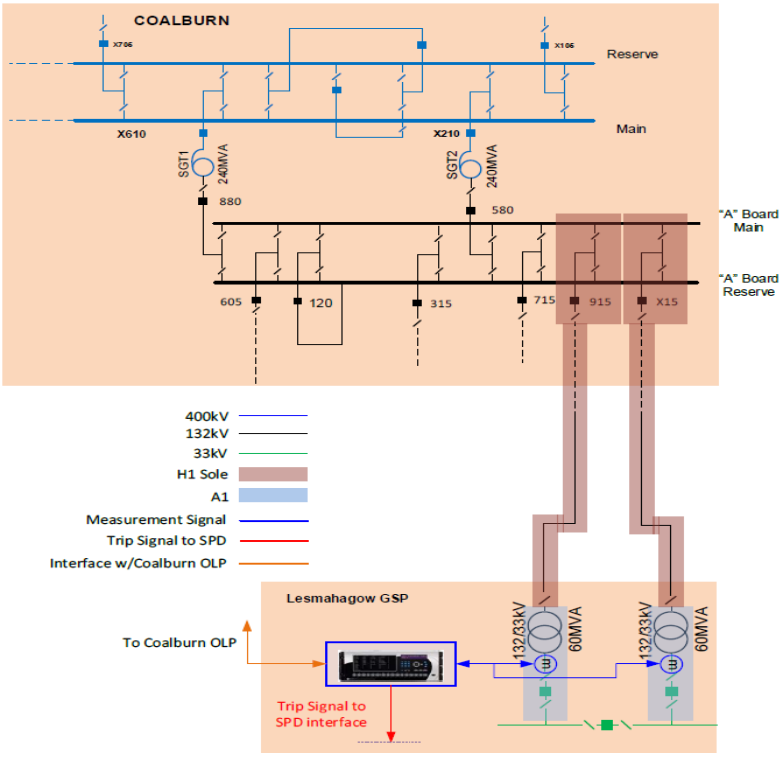

Figure 3. Proposed Lesmahagow GSP layout

The SP Distribution works for this solution involves the installation of a new indoor 33kV switchboard and 33kV circuits to connect to the new board. The costs of SPD works are included within the CV3 expenditure.

The SP Transmission works for this solution the installation of two 60MVA transformers, two 33kV incomer circuit breakers and associated cables. The full cost of transmission works will be charged to SP Distribution under New Transmission Capacity Charges (NTCC), over a 40-year payback period starting in 2027/28 upon GSP energisation with one-off costs charged in 2025/26 and 2026/27 based on the accepted ModApp offer. The associated transmission works are included in the RIIO-T2 investment plan. In addition, there is also a generation customer Little Gala windfarm which is contracted with both SPD and SPT to the new Lesmahagow GSP.

The new Lesmahagow GSP 33kV switchboard will be installed at the GSP compound providing space for up to 15 panels. Initially, nine circuit breakers will be installed as part of the proposed. These include a bus section, five feeder circuit breakers, a customer funded circuit breaker (Little Gala windfarm) and two 33kV incomer circuit breakers installed by SPT. The existing Lesmahagow and Douglas west demand primary substations will be transferred to the new Lesmahagow GSP which is in closer proximity to the demand centres. The Andershaw Windfarm, Hagshaw Hill Windfarm, Nutberry Windfarm, Hazelside Windfarm, Lesmahagow Windfarm and Woodlands Farm Windfarm will all be transferred to the new Lesmahagow GSP network, creating both thermal and fault level headroom at Linnmill GSP. Table 5.2 shows the proposed configuration at the new Lesmahagow GSP.

Table 5.2. Lesmahagow GSP 33kV Switchboard

Panel No	Panel Name
1	Space for future extension
2	Space for future extension
3	Space for future extension
4	Little Gala Windfarm (customer funded)
5	Lesmahagow Primary T2/Linnmill Interconnector 2
6	Poneil SWS No. 2
7	GT1
8	Bus Section
9	GT2
10	Poneil SWS No. 1
11	Lesmahagow Primary T1/Linnmill Interconnector 1
12	Andershaw Wind Farm
13	Space for future extension
14	Space for future extension
15	Space for future extension

Table 5.3 and Table 5.4 show the generation to be connected at each of the Linnmill and Lesmahagow GSPs once the Lesmahagow GSP is energised.

Table 5.3. Embedded generation at Linnmill GSP once Lesmahagow GSP is energised

GSP	Voltage (kV)	Site	Export capacity (MW)	Type	Status
Linnmill	33	Auchrobert Windfarm	36	Onshore Wind	Connected
	11	Bonnington PS	11	Hydro	Connected
	11	Cleghorn Hydro	0.75	Hydro	Connected
	33	Glenkerie Windfarm	18.4	Onshore Wind	Connected
	33	Hagshaw Hill Ext WF	26	Onshore Wind	Connected
	11	Stonebyres PS	6	Hydro	Connected
	11/LV	Embedded generation (<1MW)	16.85	Wind/solar	Connected
	Total		115		

Table 5.4. Embedded generation at Lesmahagow GSP once Lesmahagow GSP is energised

GSP	Voltage (kV)	Site	Export capacity (MW)	Type	Status
Linnmill	33	Andershaw Windfarm	36	Onshore Wind	Connected
	33	Hagshaw Hill WF	15.6	Onshore Wind	Connected
	11	Hazelside Windfarm	2.4	Onshore Wind	Connected
	11	Lesmahagow WF	2.25	Onshore Wind	Connected
	33	Nutberry Wind Farm	15	Onshore Wind	Connected
	11	Woodlands Farm WF	1.35	Onshore Wind	Connected
	33	Little Gala	29.9	Onshore Wind	Contracted
	Total		102.5		

The proposed layout of the network at Lesmahagow is illustrated in Figure 4. Four circuits with a total length of circa 0.2km will be required to split the existing 33kV circuits, providing a dedicated supply to Lesmahagow primary and interconnection to Linnmill GSP. This will facilitate transferring the demand at Lesmahagow Primary from Linnmill to the new Lesmahagow GSP. Additionally, by looping into the existing circuits, interconnection is established with Linnmill GSP for mutual support.

Poneil switching station is located within a congested corridor for both transmission and distribution circuits, adjacent to the M74 motorway. It is proposed to land Lesmahagow GSP within close proximity of Poneil switching station, which would remove the need for the Poneil switching station and free up valuable land within a constrained area.

Before Poneil switching station is decommissioned, the existing circuits at Poneil switching station need to be relocated. Andershaw Windfarm Point of Connection (POC) would be moved to the new Lesmahagow GSP switchboard, utilising one of the spare bays. The existing circuits connecting Poneil switching station to Linnmill GSP will be disconnected from Poneil switching station and will be terminated onto the new Lesmahagow GSP switchboard, creating two interconnectable circuits between Linnmill GSP and Lesmahagow GSP. Lesmahagow primary will remain banked onto the interconnectable circuits. Douglas West will be unbanked from Poniel switching station. Approx. 50m of 500mm^2 Cu XLPE (two cores per phase) will be installed connecting the existing Douglas West feeders to Lesmahagow GSP. Figure 4 below shows the configuration of the Lesmahagow GSP circuits.

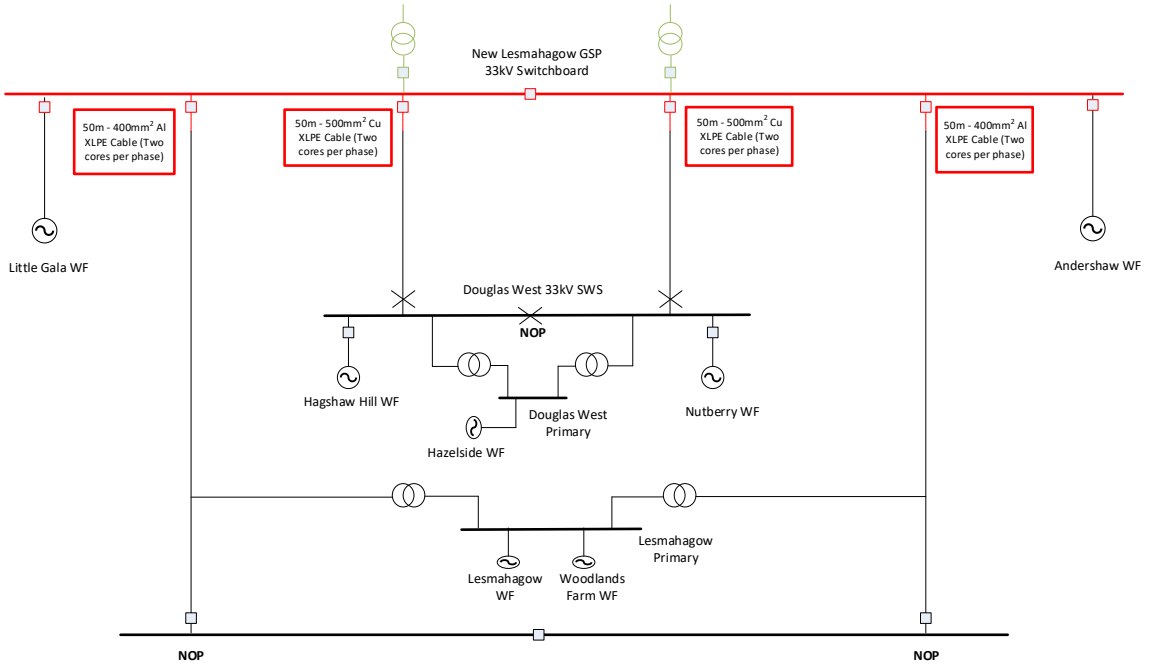

Figure 4. Proposed Lesmahagow GSP 33kV network arrangement

This solution creates additional fault level headroom at Lesmahagow GSP and Linnmill GSP once the new Lesmahagow GSP switchboard has been energised as shown in Table 5.5.

Table 5.5. Proposed option fault levels at Linnmill and Lesmahagow GSP substations

Substation Name	Design Rating (kA)		3-phase Fault Levels (kA)		Duty (%)	
	Make	Break	Make	Break	Make	Break
Linnmill GSP[1]	50.00	17.50	41.86	13.81	**83.72**	**78.91**
Lesmahagow GSP2	50.00	17.50	40.68	14.05	**81.36**	**80.29**

[1]Based on the generation contained in Table 5.3.
[2]Based on the generation contained in Table 5.4.

The existing fault levels associated with Linnmill GSP are resolved with the construction of the new Lesmahagow GSP. The transfer of existing assets also provides both sufficient fault level and thermal headroom for new generators looking to connect within the Linnmill region.

Table 5.6 shows a summary of reinforcement costs and volumes for the proposed scheme under RIIO-ED2.

Table 5.6. Proposed option summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Post RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
33kV Fittings	4	0.024	0.024	-	-
33kV UG Cable (Non Pressurised)	1.15	0.230	0.230	-	-
33kV CB (Gas Insulated Busbars)(ID) (GM)	6	1.002	1.002	-	-
Batteries at 33kV Substations	1	0.009	0.009	-	-
Pilot Wire Underground	1.15	0.127	0.127	-	-
Civil Works at 33 kV & 66 kV Substations		0.072	0.072	-	-

Wayleaves/Easements/Land Purchase		0.056	0.056	-	-
Other Costs CV3 (Identify Below)		0.301	0.301	-	-
Other Costs CV4 (Identify Below)		18.413	0.800	17.613	-
Total Costs		20.234	2.621	17.613	-
Identify activities included within other costs (please provide high-level detail of cost areas)					
CV3 – Planning and design (£50k)					
CV3 – Remote end protection (£126k)					
CV3 – Telecoms infrastructure (£20k)					
CV3 – RTU/SCADA (£30k)					
CV3 – Decommissioning of Poniel SWS (£50k)					
CV3 – Environmental Consideration (£15k)					
CV3 – Fault Recorder (£10k)					
CV4 – NTCC (New Transmission Capacity Charges) (£800k)					

Due to the proposed connection date in October 2027 driven by SP Transmission works, it is proposed to start the distribution works in 2023/24 and the fault level scheme output will be claimed in 2027/28 upon GSP energisation based on the accepted ModApp offer. The proposed option provides an additional 347MVA (peak make)/113MVA (RMS break) fault level headroom, on design rating.

5.2 Option 1 – Install ANM scheme and a bus section reactor and defer the new GSP until RIIO-ED3

Option 1 considers the installation of a bus section reactor (BSR) at the Linnmill GSP switchboard, coupled with an Active Network management scheme. The aim of the solution is to maintain fault level duty within system design limits, while ensuring that the grid transformers are not thermally overloaded. Table 5.7 shows the scheme summary.

This option requires significant intervention, is not enduring, provides less headroom (thermal/fault level) and has a lower NPV than the baseline. Consequently, this option has been rejected.

Table 5.7. Option 1 summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Innovation/Smart	New Lesmahagow GSP	Install Active Network Management (ANM) scheme and a bus section reactor and defer the new GSP until RIIO-ED3	1.785	-

Figure 5 shows the fault level duty (% of design limit) at Linnmill GSP from 2023 to 2036. The fault level range shown in the graph is based on the DFES credible range of generation growth, with a bus-section reactor installed on the Linnmill GSP 33kV busbar. Study results show, that even after the installation of the BSR, future fault level mitigation works will be required in the forthcoming years, under the full credible range of DFES scenarios. Hence, the option of installing a BSR may prolong the need of further fault level mitigation works by a few years but is not an enduring solution to manage the fault level constraint.

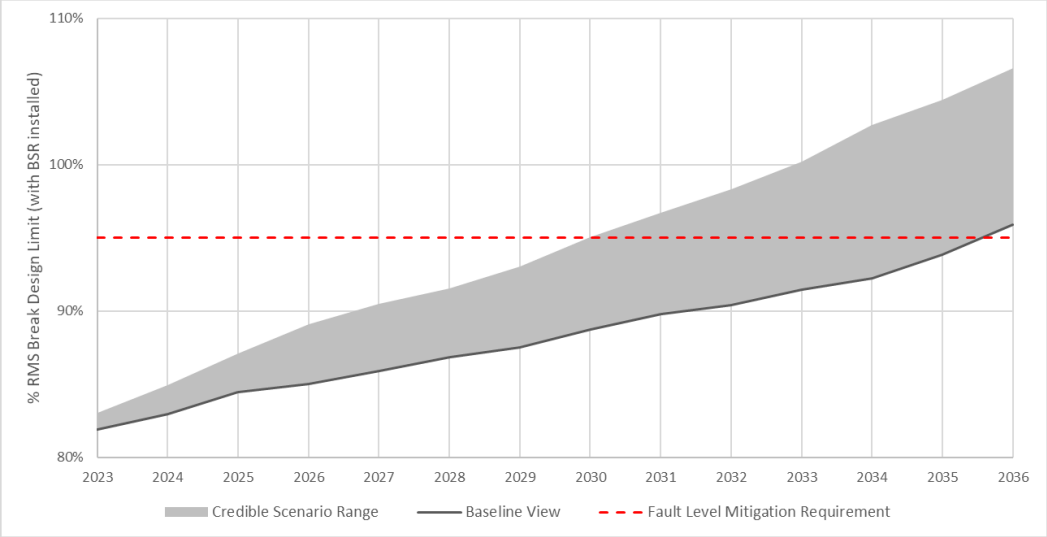

Figure 5. Predicted fault levels at Linnmill GSP with BSR installed at 33kV based on predicted generation growth

Additionally, the significant embedded generation growth at Linnmill GSP, forecast under DFES, will see a large increase in the worst-case reverse power flow on the Linnmill GSP grid transformers. Figure 6 shows the forecast worst-case reverse power flow on the Linnmill grid transformers based on forecast generation growth, including minimum demand. It can be seen that the reverse power flow will range between 169%-192% by the end of RIIO-ED3, under the credible range of DFES scenarios.

Option 1 explores the roll out of an ANM scheme at Linnmill GSP. Installed generation in excess of 140% of non-firm capacity of Linnmill GSP would risk cascade trip of the GSP.

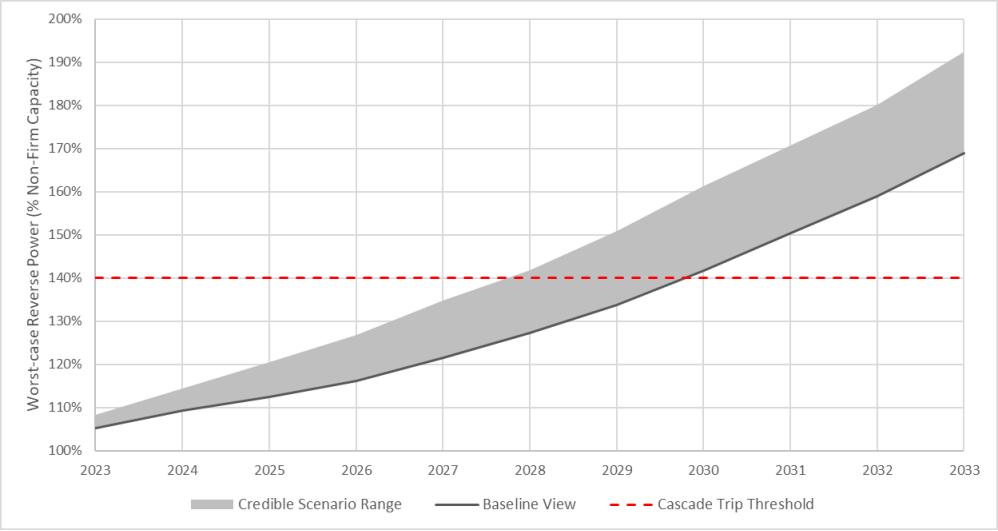

Figure 6. Forecast worst-case reverse power flow on Linnmill grid transformers

Table 5.8 shows a summary of reinforcement costs and volumes for Option 1 under RIIO-ED2.

Table 5.8. Option 1 summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
33kV CB (Gas Insulated Busbars)(ID) (GM)	2	0.334	0.334	-
Civil Works at 33 kV & 66 kV Substations		0.024	0.024	-
Other Costs (Identify Below)		1.052	1.052	-
Other Costs (ANM OPEX)		0.525	0.375	-
Total Costs		1.935	1.785	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
Bus Section Reactor (£580k)				
Planning and Design (£70k)				
Remote End Protection (£42k)				
RTU/SCADA (£10k)				
Protection Modification (£70k)				
ANM Scheme (£220k)				
Telecoms Infrastructure Upgrade (£60k)				

5.3 Options Cost Summary Table

Summary of the costs for each of the evaluated options is presented in Table 5.9.

Table 5.9. Cost summary for considered options

Options	Option Summary	RIIO-ED2 Cost (£m)
Baseline	Establish a new GSP near Lesmahagow primary	2.621
Option 1	Install Active Network Management (ANM) scheme and a bus section reactor and defer the new GSP until RIIO-ED3	1.785*

*This option would prolong the need of further fault level mitigation in terms of a new GSP to RIIO-ED3 which has been included in the cost benefit analysis.

Derivation of costs for these options are based on the SPEN RIIO-ED2 Unit Cost Manual for intervention. This is based on bottom up cost assessment of the components of activity detailed within the RIGs Annex A for the above activities, SPEN's contractual rates for delivery, market available rates and historic spend levels.

6 Deliverability & Risk

6.1 Preferred Options & Output Summary

The adopted option is the baseline option to establish a new 132/33kV 60MVA GSP near Lesmahagow primary connecting into Coalburn 132kV transmission network.

6.2 Cost Benefit Analysis Results

A cost benefit analysis (CBA) was carried out to compare the NPV of the options discussed in the previous sections. Considering the lowest forecast capital expenditure, the proposed option has the highest total NPV against other options. The summary of the cost benefit analysis is presented in Table 6.1. The full detailed CBA is provided within 'ED2-LRE-SPD-020-CV3-CBA – New Lesmahagow GSP'.

The proposed option represents the most economic and efficient long-term solution.

Table 6.1. Cost benefit analysis results

Options considered	Decision	Comment	NPVs based on payback periods, £m (2020/21 prices)			
			10 years	20 years	30 years	45 years
Baseline – Establish a new GSP near Lesmahagow primary	**Adopted**					
Option 1 – Install Active Network Management (ANM) scheme and a bus section reactor and defer the new GSP until RIIO-ED3	Rejected	Discounted based on NPV.	-0.07	-0.19	-0.30	-0.44

6.3 Cost & Volumes Profile

Table 6.2 shows the breakdown of expenditure for the proposed scheme (in 2020/21 prices) and the cost incidence (in 2020/21 prices) over the RIIO-ED2 period is shown in Table 6.3. The total cost of the proposed scheme is £2.621m.

Table 6.2: Summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Post RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
33kV Fittings	4	0.024	0.024	-	-
33kV UG Cable (Non Pressurised)	1.15	0.230	0.230	-	-
33kV CB (Gas Insulated Busbars)(ID) (GM)	6	1.002	1.002	-	-
Batteries at 33kV Substations	1	0.009	0.009	-	-
Pilot Wire Underground	1.15	0.127	0.127	-	-
Civil Works at 33 kV & 66 kV Substations		0.072	0.072	-	-
Wayleaves/Easements/Land Purchase		0.056	0.056	-	-
Other Costs CV3 (Identify Below)		0.301	0.301	-	-
Other Costs CV4 (Identify Below)		18.413	0.800	17.613	-
Total Costs		20.234	2.621	17.613	-
Identify activities included within other costs (please provide high-level detail of cost areas)					
CV3 – Planning and design (£50k)					

CV3 – Remote end protection (£126k)
CV3 – Telecoms infrastructure (£20k)
CV3 – RTU/SCADA (£30k)
CV3 – Decommissioning of Poniel SWS (£50k)
CV3 – Environmental Consideration (£15k)
CV3 – Fault Recorder (£10k)
CV4 – NTCC (New Transmission Capacity Charges) (£800k)

Table 6.3: Cost incidence over the RIIO-ED2 period, £m (2020/21 Prices)

Total Investment	Total (£m)	Incidence (£m)				
		2023/24	2024/25	2025/26	2026/27	2027/28
CV3 Expenditure	**1.821**	0.910	0.910	-	-	-
CV4 Expenditure*	**0.800**	-	-	0.058	0.159	0.583

*The full cost of transmission works will be charged to SP Distribution under New Transmission Capacity Charges (NTCC), over a 40-year payback period starting in 2027/28 upon GSP energisation with one-off costs charged in 2025/26 and 2026/27 based on the accepted ModApp offer.

6.4 Risks

All major connections will be secure during the construction period. However, during the changeover from the existing to the proposed system, the demand associated with individual 11kV circuits will be on reduced security of supply. This risk will be minimised by using an offline build approach and having suitable plans for the reconnection of lost supplies in the event of loss of remaining infeed's during construction outages.

Additionally, the delivery of this scheme will be co-ordinated with the delivery of SP Transmission works for operational efficiencies and to minimize the network impact.

6.5 Outputs Included in RIIO-ED1 Plans

There are no outputs expected to be delivered in RIIO-ED1 that are funded within this proposal.

6.6 Future Pathways – Net Zero

6.6.1 Primary Economic Driver

The primary driver for this investment is based on the maximum fault level design limit of the network being exceeded.

6.6.2 Payback Periods

The CBA indicates that for the proposed option demonstrates better NPV results in all assessment periods (10, 20, 30 & 45 years) against other two options. As the intervention is forecast to carry at least a 45-year asset life expectancy, the CBA at this time justifies the intervention. Consumers will also benefit from reduced network risk immediately on completion of the project.

6.6.3 Sensitivity to Future Pathways

The network capacity and capability that result from the proposed option is consistent with the network requirements determined in line with the section 9 of the Electricity Act and Condition 21. Additionally, the proposed option is consistent with the SPEN's Distribution System Operator (DSO) Strategy and Distribution Future Energy Scenarios.

Table 6.4 shows electric vehicle and heat pump uptakes across a range of future pathways and Table 6.5 shows the sensitivity of the proposed solution and Table 6.6 shows the sensitivity of the proposed

RIIO-ED2 expenditure against the full ranges of Net Zero complaint future pathways other Climate Change Committee (CCC) scenarios.

Table 6.4: Electric Vehicle and Heat Pump uptakes for Linnmill GSP demand group across a range of future pathways

End of RIIO-ED2	SPEN	DFES			CCC				
	Baseline	System Transformation*	Consumer Transformation	Leading the Way	Balanced Net Zero Pathway	Headwinds	Widespread Engagement	Widespread Innovation	Tailwinds
EVs	10,125		12,251	13,633	12,146	8,363	13,215	12,035	12,035
HPs	4,823		9,011	14,129	3,949	3,884	4,353	3,605	4,035

*Note: We have excluded System Transformation from our future pathways assessment as it does not meet interim greenhouse gas emission reduction targets.

Table 6.5: Sensitivity of the proposed solution against future pathways

	RIIO-ED1				RIIO-ED2					RIIO-ED3				
Solution Requirements	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Baseline							R1							
Consumer Transformation							R1							
Leading the Way							R1							
Balanced Net Zero Pathway							R1							
Headwinds							R1							
Widespread Engagement							R1							
Widespread Innovation							R1							
Tailwinds							R1							

R1 – New Lesmahagow GSP

The proposed solution is robust across all pathways. As this is the minimum requirement to mitigate the fault levels in the group, it is expected that it is insensitive to the future pathways and is expected that proposed solution is required under all the future pathways. In all cases this solution is expected to endure beyond RIIO-ED3.

Table 6.6: Sensitivity of the proposed RIIO-ED2 expenditure

	Baseline	Uncertain
RIIO-ED2 Expenditure (£m)	2.621	N/A
Comment	Proposed option	

6.6.4 Asset Stranding Risks & Future Asset Utilisation

Electricity demand and generation loadings are forecast to increase under all scenarios. The stranding risk is therefore considered to be low.

6.6.5 Losses / Sensitivity to Carbon Prices

Losses have been considered in accordance with Licence Condition SLC49 and the SP Energy Networks Losses Strategy and Vision to "consider all reasonable measures which can be applied to reduce losses and adopt those measures which provide benefit for customers". Reasonable design efforts have been taken to minimise system losses without detriment to system security, performance, flexibility or economic viability of the scheme. This includes minimising conductor lengths/routes, the choice of appropriate conductor sizes, designing connections at appropriate voltage levels and avoiding higher impedance solutions or network configurations leading to higher losses.

Losses have been considered as part of this design solution and it has not been necessary to carry out any losses justified upgrades. MWh losses for each of the options have been included within the cost benefit analysis and solution selection was not found to be sensitive to the impact of the carbon cost of losses.

During the evaluation of the options associated with the proposed scheme, we have embedded within the CBA, where data are available, an assessment of the embodied carbon and the associated carbon cost to inform our NPV evaluation. The mass of carbon dioxide emitted (CO2e) during the manufacture of the main equipment deployed to deliver this scheme is estimated to be 19 tonnes. The monetised embodied carbon value associated with this emission is £0.9k. It should be noted that the embodied carbon evaluation undertaken has only considered the manufacture and supply of materials. Further collaborative industry-wide work is planned for the RIIO-ED2 price review period to better understand the overall embodied carbon values including, for example installation and commissioning services, decommissioning and disposal activities as well as refurbishment opportunities. More information regarding this can be found in Section 3.1.2 of our Environmental Action Plan[2].

6.6.6 Whole Systems Benefits

Whole system solutions have been considered as part of this proposal. The completion of this scheme will maintain the integrity of the distribution network and its enduring ability to facilitate wider whole system benefits.

6.7 Environmental Considerations

6.7.1 Operational and Embodied Carbon Emissions

The New Lesmahagow GSP reinforcement programme has limited potential to impact on SPEN's Business Carbon Footprint (BCF) and on the embodied carbon resulting from the delivery of the programme.

Upfront costs associated with this programme (e.g. embodied carbon from the manufacture and supply of components and associated civil engineering works) should be considered against our ongoing operational need to maintain the resilience of our assets and networks.

6.7.2 Supply Chain Sustainability

For us to take full account of the whole-life carbon impact of our New Lesmahagow GSP reinforcement programme, we need access to reliable data to be provided by our suppliers. The need for carbon and other sustainability credentials to be provided now forms part of our wider sustainable procurement policy.

We believe that such a requirement sends a strong message to our suppliers that we take sustainability seriously, and that such positive engagement is key to improving the overall sustainability of our collective supply chain.

6.7.3 Resource Use and Waste

The New Lesmahagow GSP reinforcement programme will result in the consumption of resources and the generation of waste.

[2] Annex 4C.3: Environmental Action Plan, SP Energy Networks, Issue 2, 2021.

Where waste is produced it will be managed in accordance with the waste hierarchy which ranks waste management options according to what is best for the environment. The waste hierarchy gives top priority to preventing waste in the first instance, then preparing for re-use, recycling, recovery, and last of all disposal (e.g. landfill).

6.7.4 Biodiversity / Natural Capital

The New Lesmahagow GSP reinforcement programme involves development on currently undeveloped land. However, the impact on, and the opportunity to improve biodiversity and natural capital is expected to be minimal.

6.7.5 Preventing Pollution

SPEN will always follow all relevant waste regulations and will make sure that special (hazardous) waste produced or handled by our business is treated in such a way as to minimise any effects on the environment.

6.7.6 Visual Amenity

SPEN continually seeks to reduce the landscape and visual effects of our networks and assets. Our use of underground cables instead of overhead lines helps to minimise our overall visual impact.

6.7.7 Climate Change Resilience

In addition to our efforts to minimise our direct carbon emissions in line with our Net Zero ambitions, we are also conscious of the need to secure the resilience of our assets and networks in the face of a changing climate. We have also modified our policy on vegetation control in the face of higher temperatures and longer growing seasons.

7 Conclusion

Linnmill 132/33kV Grid Supply Point is in Lanarkshire District of the SP Distribution (SPD) licence area. The primary driver for investment at Lesmahagow substation is to alleviate fault level constraints on the 33kV network at Linnmill GSP, as the fault levels currently exceed the network design limit.

In addition, there is also no capacity on the grid transformers to allow for any new generation connections, as there is 187.6MW of connected generation against a non-firm GSP capacity of 180MVA.

It is proposed to establish a new 132/33kV 60MVA GSP within the Lesmahagow region connecting into Coalburn 132kV transmission network. This will provide SPD the capacity to connect the future distribution generation and remove the need for significant fault level mitigation works at Linnmill GSP. The proposed reinforcement represents the most economic and efficient long-term solution.

The SP Distribution works for this solution involves the installation of a new indoor 33kV switchboard and 33kV circuits to connect to the new board. The costs of SPD works are included within the CV3 expenditure.

SPD submitted a Modification application for this works to National Grid Electricity System Operator (NGESO) in January 2020; an NGESO offer was received in April 2020 and the NGESO offer was accepted in November 2020. The associated transmission works are included in the RIIO-T2

investment plan. In addition, there is also a generation customer Little Gala windfarm which is contracted with both SPD and SPT to the new Lesmahagow GSP.

The SP Transmission works for this solution involves the installation of installation of two 60MVA transformers, two 33kV incomer circuit breakers and associated cables. The full cost of transmission works will be charged to SP Distribution under New Transmission Capacity Charges (NTCC), over a 40-year payback period starting in 2027/28 upon GSP energisation with one-off costs charged in 2025/26 and 2026/27 based on the accepted ModApp offer.

The estimated cost for the above, is £1.821m under the CV3 expenditure and £0.800m (in 2020/21 prices) under the CV4 expenditure, with 100% contribution to be included in the RIIO-ED2 load related expenditure.

Due to the proposed connection date in October 2027 driven by SP Transmission works, it is proposed to start the distribution works in 2023/24 and the fault level scheme output will be claimed in 2027/28 upon GSP energisation based on the accepted ModApp offer. The proposed option provides an additional 347MVA (peak make)/113MVA (RMS break) fault level headroom, on design rating.