Kaimes GSP Reinforcement

ED2 Engineering Justification Paper

ED2-LRE-SPD-014-CV1-EJP

Issue	Date	Comments
Issue 0.1	Apr 2021	Issue to internal governance and external assurance
Issue 0.2	May 2021	Reflecting comments from internal governance and 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	Kaimes GSP Reinforcement		
Activity	Primary Reinforcement		
Primary Investment Driver	Thermal Constraints		
Reference	ED2-LRE-SPD-014-CV1		
Output	Load Index		
Cost	£6.094m		
Delivery Year	2024-2027		
Reporting Table	CV1		
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	**£6.094m**	**£m**

SP ENERGY NETWORKS

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:	**Kaimes GSP Reinforcement**
Project Reference:	**ED2-LRE-SPD-014-CV1**
Decision Required:	**To give concept approval to off-load demand from Kaimes GSP by relocating two primary substations to Whitehouse GSP.**

Summary of Business Need:

Kaimes 275/33kV Grid Supply Point (GSP) is located in the Edinburgh and Borders district of SP Distribution (SPD), providing supplies to ca. 53,007 customers.

Kaimes GSP has firm capacity of 120MVA. Our Baseline View forecasts a peak demand of 148MVA by 2028, including an expected uptake of up to 15,516 electrical vehicles and 8,690 heat pumps. By the end of the RIIO-ED2 price control period, Kaimes demand group, will be a class 'D' of supply, as per Energy Network Association (ENA) Engineering Recommendation (EREC) P2/7.

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

To manage the thermal constraint at Kaimes GSP throughout RIIO-ED2, it is proposed to off-load demand by relocating Kings Buildings and Lugton primary substations to the adjacent Whitehouse GSP which involves installation of three new 33kV circuits and utilise flexibility services to facilitate market growth.

The estimated cost for the above is £6.094m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

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	CV1	Primary Reinforcement	**5.867**	-	1.173	2.347	2.347	-
SPD	CV1	Flexible Services	**0.226**	-	0.006	0.220	-	-
SPD	**Total**		**6.094**	**-**	**1.179**	**2.567**	**2.347**	**-**

PART B – PROJECT SUBMISSION

Proposed by	Milana Plecas	Signature	Milana Plecas	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

Kaimes 275/33kV Grid Supply Point (GSP) is located to the south of Kaimes, a suburb of Edinburgh, in the Edinburgh and Borders district of SP Distribution (SPD), providing supplies to 53,007 customers.

The primary drivers for this investment are insufficient thermal headroom and security of supply risk. Kaimes GSP is forecast to exceed its firm capacity of 120MVA, by 2026, under all Distribution Future Energy Scenarios (DFES) and Climate Change Committee (CCC) scenarios. Our Baseline View forecasts a peak demand of 148MVA by 2028, with an expected uptake of up to 15,516 electrical vehicles and 8,690 heat pumps by the end of the RIIO-ED2 period.

In order to secure supplies, meet licence obligations under EREC P2/7 and accommodate future demand growth within the area, it is proposed to off-load demand by relocating two primary substations (Kings Buildings and Lugton) to Whitehouse GSP which involves installation of three new 33kV circuits. The proposed solution would delay installation of a new GSP to the middle of RIIO-ED3. It represents the most economic and efficient long-term solution and enables the load growth in the area by smooth deliverability of the network reinforcement.

The estimated cost for the above is £6.094m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

It is recommended to continue annual tendering for flexibility in this area to procure enough capacity and the proposed solution will be reviewed depending on procuring enough capacity in the future tenders. In order to facilitate market growth, the total of 17.8MW of capacity has been accepted between 2024-2027.

The timing of the project is based on delivering the highest NPV savings, while maintaining security of supply. To achieve this aim, project delivery will comprise two work packages, off-loading of Kings Building Primary (WP1) and off-loading of Lugton Primary (WP2). The baseline view forecasts loading in excess of the firm capacity by 2026. Delivery of WP1 will start in 2023/24, with project completion by 2026. WP1 will be coordinated with the switchboard change at Whitehouse GSP, forecast to be finished by 2026 (see 'ED2-LRE-SPD-015-CV3-EJP - Whitehouse GSP Fault Level Mitigation'). Delivery of WP2 will start in 2025, with project completion by 2027. The proposed schedule of works will maintain demand below the firm capacity of the group throughout RIIO-ED2. A demand transfer of 30.39MVA will be claimed in 2026/27 at the end of the project.

2 Background Information

2.1 Existing / Authorised Network

Kaimes GSP supplies 11 existing primary substations. These are Little France, Poltonhall, Lugton, West Linton, Kingsland, Kings Buildings, Bush Estate, Frogston Road East New, Burghlee, Penicuik and Loanstone. There is also a contracted primary Advanced Computer Center scheduled to be connected in 2023/24. The Kaimes network is a mixture of urban and rural environments, comprising a mix of underground cable (UGC) and overhead line (OHL). Kaimes GSP is interconnectable at 33kV with Portobello GSP and Whitehouse GSP. The authorised network is shown in Figure 1.

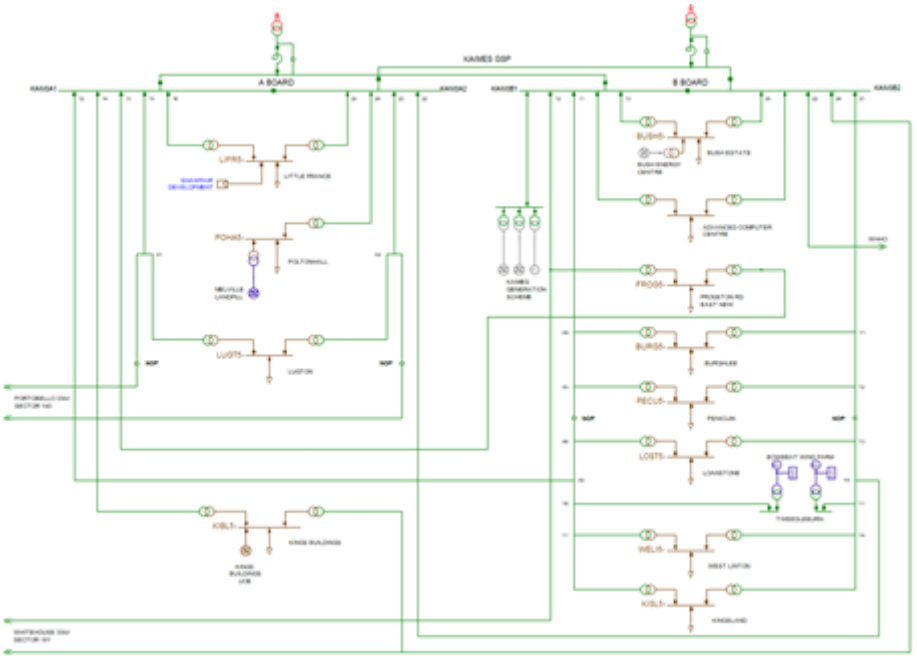

Figure 1. Authorised 33kV Network

Kaimes GSP has two distribution switchboards ('A' board and 'B' board) which are located on the site shared with the 275kV transmission substation as shown in Figure 2. The two-section 'A' and 'B' 33kV busbars have a transmission system infeed onto each half from two 120MVA 132/33kV grid transformers.

The 'A' board is a 12-panel indoor 33kV switchboard configured as two SP Transmission (SPT) incomers, an SPD bus-section and nine SPD feeder circuit breakers.

The 'B' board is a 10-panel outdoor 33kV switchboard configured as two SPT incomers, an SPD bus-section and seven SPD feeder circuit breakers. The 'B' board will be replaced in RIIO-ED1 with a modern indoor equivalent under asset modernisation. The new 'B' Board will be replaced with a 12-panel indoor switchboard configured as two SPT incomers, an SPD bus-section, and nine SPD feeders, to accommodate the new contracted primary.

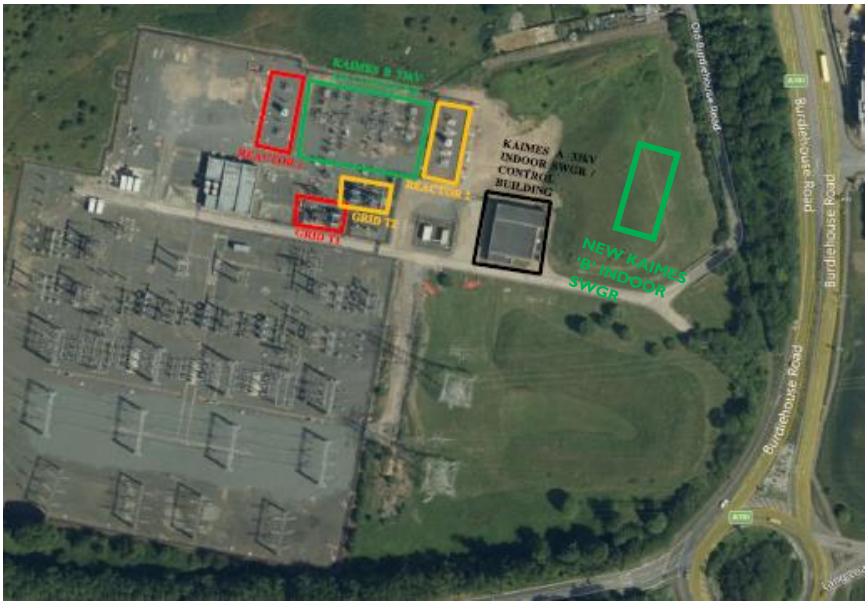

Figure 2. Kaimes GSP layout

2.2 Group Demand & Security of Supply

The existing Kaimes GSP network has a maximum demand ~102MVA is a class 'D' of supply (over 60MW and up to 300MW) as per Engineering Recommendation (EREC) P2/7. The group is served by two 275/33kV super grid transformers (SGTs) of 120MVA. Kaimes GSP has the following interconnectors for supporting N-1 and N-2 contingencies:

- two 33kV interconnectors to Portobello GSP via Lugton and Lady Victoria primary substations (Normally Open Points (NOPs) between primary substations)
- one 33kV interconnector to Whitehouse GSP via Kings Buildings primary (NOP at Whitehouse GSP)
- one 33kV interconnector to Whitehouse GSP via Frogston Rd East primary (NOP at Whitehouse GSP)
- one clean 33kV interconnector to Whitehouse GSP (NOP at Whitehouse GSP)

2.3 Embedded Generation

Embedded generation connected and contracted to the network is shown in Table 2.1.

Table 2.1. Embedded generation at Kaimes GSP

GSP	Voltage (kV)	Site	Export capacity (MW)	Import capacity (MW)	Type	Status
Kaimes	11	Melville Landfill	1.2	-	Waste Incineration (not CHP)	Connected
	33	Bowbeat Windfarm (Emly Bank)	15	-	Onshore Wind	Connected
	33	Bowbeat Windfarm (Roughsidehill)	15	-	Onshore Wind	Connected
	11	Bush Energy Centre	2.5	-	Small CHP	Connected
	11/LV	Embedded generation (<1MW)	2.2	-	Photovoltaic/Hydro/ Onshore Wind	Connected
	11	Shawfair Development	5.0	-	Photovoltaic	Contracted
	33	Kaimes Generation Scheme	50	30 (Non-firm)	Photovoltaic/Gas/ Battery	Contracted
	Total		90.9	30		

2.4 Fault Levels

Studies indicate that with the authorised customer connections there are no fault level issues at Kaimes GSP.

3 Needs Case

Our Baseline View forecasts a peak demand by 2028 of 148MVA, with an expected uptake of up to 15,516 electrical vehicles and 8,690 heat pumps. This exceeds Kaimes GSP firm capacity of 120MVA within the RIIO-ED2 period, which could lead to loss of supplies for over 50,000 customers.

3.1 Forecast Demand

The system is forecast to grow and exceed firm capacity 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.

3.1.1 Distribution Future Energy Scenarios

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, including authorised connections, is depicted in Figure 3. The anticipated total electric vehicle and heat pump uptakes based on the future energy scenarios are depicted in Figure 4.

The scenario range considers the range of Net Zero compliant scenarios developed by us, the Electricity System Operator (ESO), and the Climate Change Committee. 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.

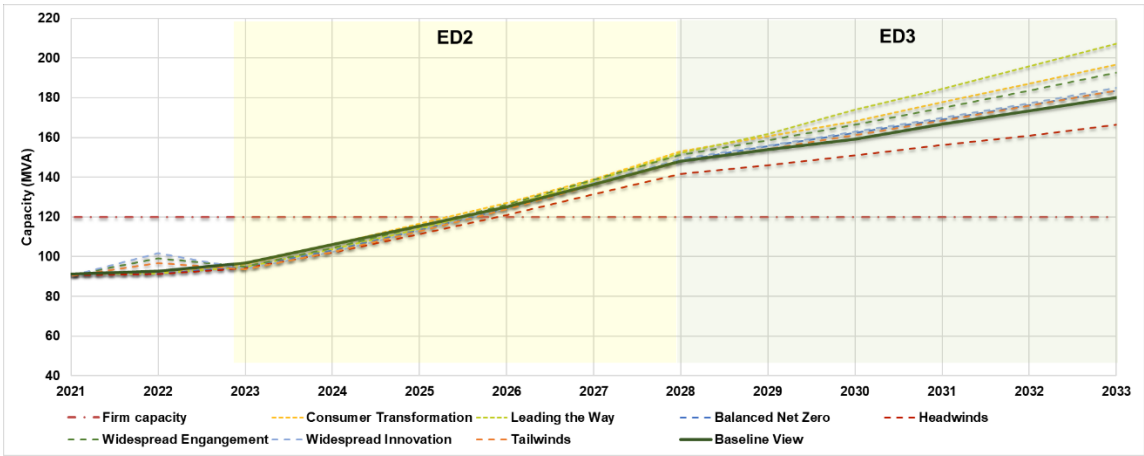

Figure 3. Demand (MVA) forecast for Kaimes GSP demand group

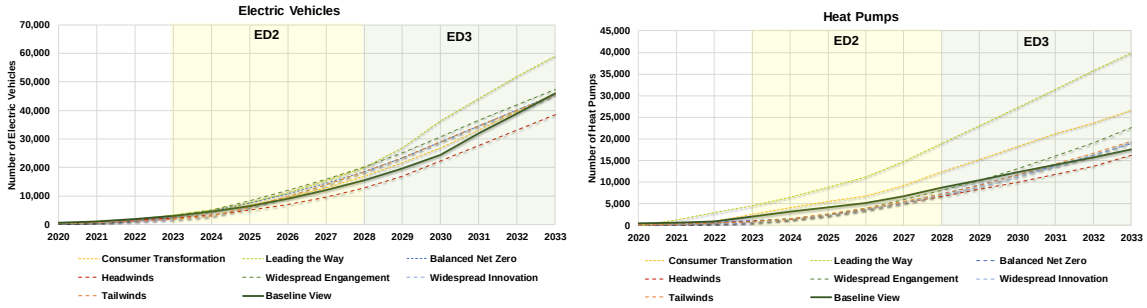

Figure 4. Forecast Electric Vehicle and Heat Pump uptakes for Kaimes GSP demand group

3.1.2 Baseline View

For the Kaimes GSP group demand, the forecast demand growth under our Baseline scenario, along with the firm capacity and utilisation through to RIIO-ED3 period is shown in Table 3.1.

Table 3.1. Baseline View forecast

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Forecast Demand (MVA)	91.3	92.6	96.8	106	115	125	136	148	154	159	167	173	180
Firm Capacity (MVA)	120	120	120	120	120	120	120	120	120	120	120	120	120
Utilisation (%)	76	77	81	88	96	104	114	123	128	133	139	144	150

3.2 Network Impact Assessment

Detailed network studies covering network intact and outage (N-1) conditions and fault level assessments were carried out for the 33kV network fed from the Kaimes group considering the different demand forecast scenarios.

The network thermal constraint during the most onerous outage was identified and time profile-based simulations (17,520 half-hourly simulations/year) were performed considering the historical half hourly measured Supervisory control and data acquisition (SCADA) data at primary substation overlaid with the DFES demand forecasts for each year through the RIIO-ED2 price control period. These studies identify the risk in terms of the thermal capacity exceedances with the forecast demand, the anticipated annual hours at risk and risk window of the constraint. The half-hourly studies performed for years starting from 2023 through 2028 determined the risk hours and the capacity required to overcome the constraint by using flexibility services.

3.2.1 Thermal Constraints

Table 3.2 shows the identified thermal constraints on the 275/33kV network level. No other thermal constraints were identified on the 33kV groups.

Table 3.2. Thermal constraints at 275/33kV level

Network Item	Voltage	Outage
Kaimes SGT	275/33kV	N-1

3.2.2 Voltage Constraints

No other voltage constraints observed in the group under intact or outage conditions on the 33kV network groups.

3.2.3 EREC P2/7 – Security of Supply

Kaimes GSP substation has a forecast peak demand of 148MVA by the end of RIIO-ED2 which puts the group in class 'D' of supply as per EREC P2/7.

Kaimes GSP group demand has a first circuit outage security of 120MVA which is insufficient to secure the forecast demand. Without mitigation this site is predicted to become non-compliant with EREC P2/7 during the RIIO-ED2 price control period.

3.2.4 Flexibility Services

In order to manage the network risk and security of supply, our assessment indicates that the risk of thermal overload on the 275/33kV Kaimes grid transformers and security of supply constraints in the group starts from the year 2024/25 throughout to the year 2028 for the most onerous scenario including an additional 5% for the asset protection margin. This is shown in Table 3.3. The detailed results from the half hourly profile-based simulations are furnished in Appendix 1.

Table 3.3. Network annual hours at risk and flexible capacity tendered in Spring 2021

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Annual hours at risk (Hrs)	-	30	277	742	1,808
Required Flexible Capacity (MW)	-	3.63	14.17	26.99	41.36

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	Not compliant with security of supply requirements as per EREC P2/7 and could lead to loss of supplies for over 50,000 customers.
(b)	Intervention plan using only Energy Efficiency	Rejected	Discounted due to lower cost effectiveness (peak MW reduction per £) and the number of individual interventions required across the wide area supplied by this network.
(c)	Off-loading of Kings Buildings and Lugton primary substations to the adjacent Whitehouse GSP	Shortlisted as **Baseline** option in Detailed Analysis	
(d)	Establishment of a new Kaimes 'C' GSP	Shortlisted as **Option 1** in Detailed Analysis	
(e)	Off-loading of Frogston Road East and Lugton primary substations to the adjacent Whitehouse GSP	Shortlisted as **Option 2** in Detailed Analysis	
(f)	Utilise flexibility services to defer reinforcement into RIIO-ED3	Rejected	Discounted due to insufficient flexibility capacity received for Kaimes GSP to remain EREC P2/7 compliant.
(g)	Utilise interconnection with adjacent groups	Rejected	Closing an interconnector in N-1 situation at Kaimes GSP would introduce fault level issues at the interconnected GSPs.

5 Detailed Analysis & Costs

5.1 Proposed Option (Baseline) – Reconfiguration of the 33kV Network

The proposed option for this scheme is to off-load two primary substations, Kings Buildings and Lugton, to the adjacent Whitehouse GSP by installing three new 33kV circuits. Table 5.1 shows the scheme summary.

Table 5.1. Proposed option summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Conventional	Kaimes GSP Reinforcement	Reconfiguration of the 33kV network (off-loading of Kings Buildings and Lugton to Whitehouse GSP)	6.094	-

Kings Buildings primary would be supplied from Whitehouse GSP by relocating Normally Open Points (NOP) at Kings Buildings T2 circuit to Kaimes GSP side and installing a new 33kV 3.2km circuit from Kings Buildings primary to Whitehouse GSP to connect Kings Buildings T1 side to Whitehouse GSP. The route for this circuit is shown in Figure 5.

Lugton primary would be supplied from Whitehouse GSP by extending each of Lugton primary 33kV circuits by 6.5km from Kaimes GSP to Whitehouse GSP. The route for these two circuits is shown in Figure 6. Three new circuit breakers at Whitehouse GSP will be installed during a replacement of Whitehouse 33kV switchboard which is detailed in the paper 'ED2-LRE-SPD-015-CV3-EJP - Whitehouse GSP Fault Level Mitigation'.

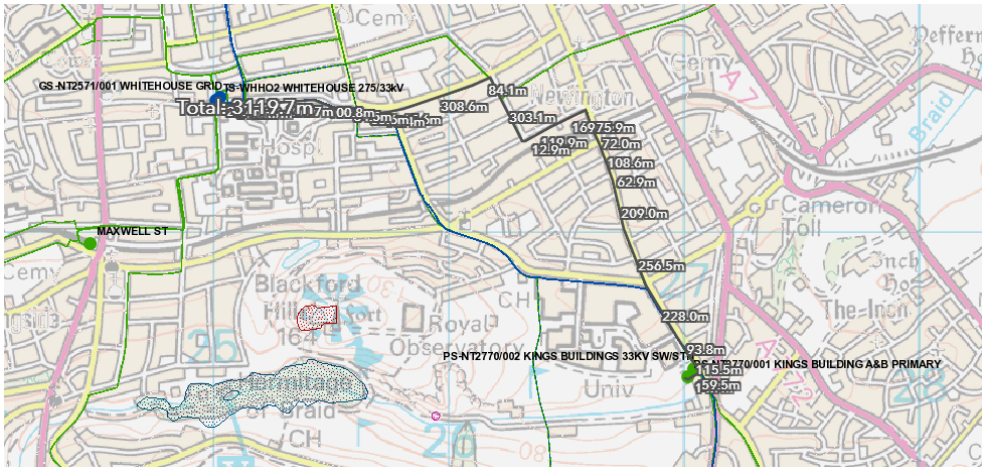

Figure 5. 33kV circuit route for Kings Buildings T1 circuit to Whitehouse GSP

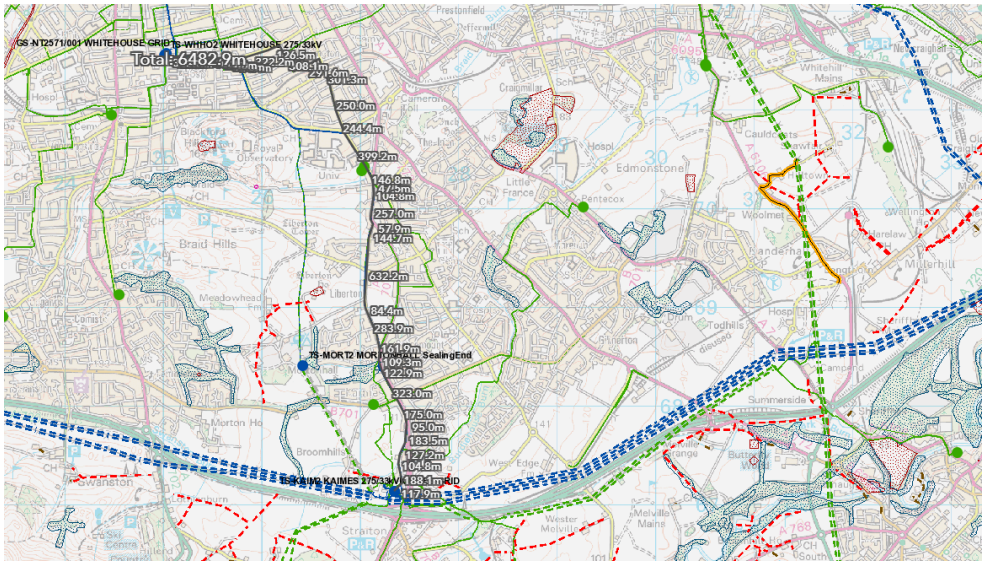

Figure 6. 33kV circuit route for extension of Lugton primary circuits to Whitehouse GSP

33kV network configuration at Whitehouse GSP after relocations of Kings Buildings and Lugton primary substations to Whitehouse GSP is shown in Figure 7.

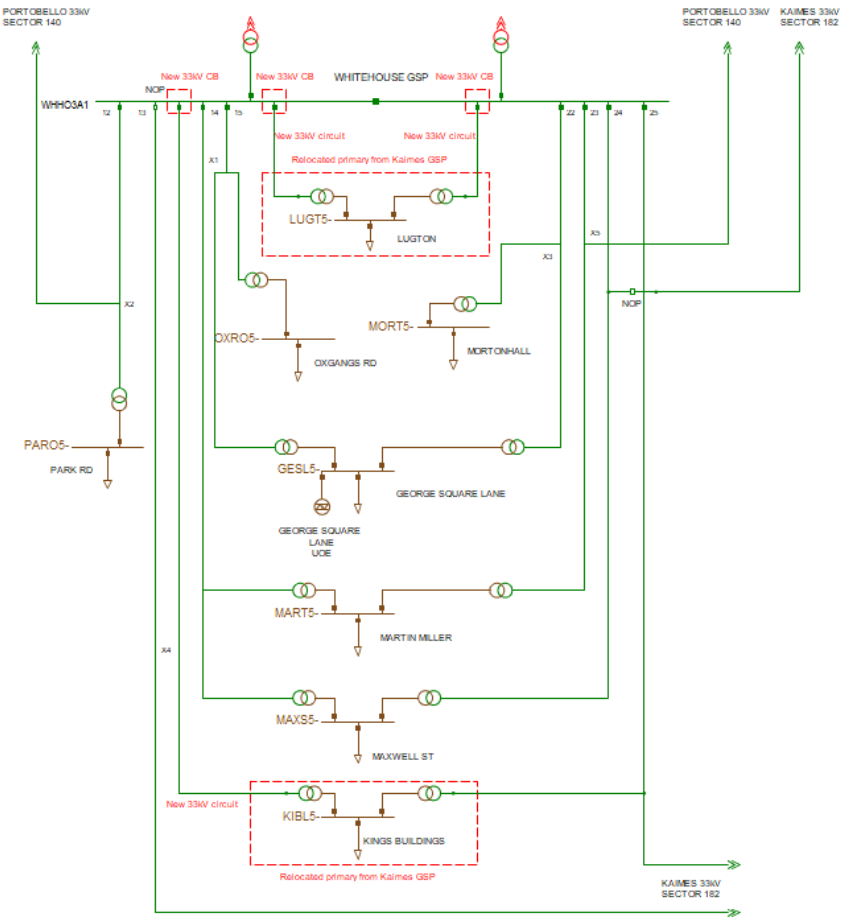

Figure 7. Schematic of Whitehouse GSP 33kV network

Based on the response to the flexibility tender run in Spring 2021, flexibility as a viable option to delay reinforcement has been discounted as insufficient flexibility capacity was received below the annual ceiling cost for Kaimes GSP to remain EREC P2/7 compliant under the Baseline View. However, in order to facilitate market growth, the total of 17.8MW of capacity has been accepted between 2024-2027 which is shown in Table 5.2. The cost of flexibility services has been added to the proposed solution. It is recommended to continue annual tendering for flexibility in this area to procure enough capacity and the proposed solution will be reviewed depending on procuring enough capacity in the future tenders.

Table 5.2. Accepted flexible capacity from the flexibility tender run in Spring 2021

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Accepted Flexible Capacity (MW)	-	3.6	14.2		-

Table 5.3 shows a summary of reinforcement costs and volumes for the proposed scheme under RIIO-ED2.

Table 5.3. Proposed option summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
33kV UG Cable (Non Pressurised)	16.2	3.234	3.234	-
33kV CB (Gas Insulated Busbars)(ID) (GM)	3	0.501	0.501	-
Pilot Wire Underground	16.2	1.795	1.795	-
Civil Works at 33 kV & 66 kV Substations		0.036	0.036	-
Wayleaves/Easements/Land Purchase		0.073	0.073	-
Other Costs (Identify Below)		0.229	0.229	-
Flexibility Services		0.226	0.226	-
Total Costs		6.094	6.094	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
Planning and design (£50k)				
Remote end protection (£63k)				
RTU/SCADA (£15k)				
Environmental Assessments & Considerations (£81k)				
Telecoms costs – modern intertripping (£20k)				

The relocation of Kings Buildings and Lugton primary substations would release 30.39MVA from Kaimes GSP in 2026/27 with a peak demand of 105.4MVA. A peak demand at Whitehouse GSP with Kings Buildings and Lugton primary substation will be 90.3MVA. This solution would delay installation of a new GSP to the middle of RIIO-ED3 which is considered in the CBA. It enables the load growth in the area by smooth deliverability of the network reinforcement.

The timing of the project is based on delivering the highest NPV savings, while maintaining security of supply. To achieve this aim, project delivery will comprise two work packages, off-loading of Kings Building Primary (WP1) and off-loading of Lugton Primary (WP2). The baseline view forecasts loading in excess of the firm capacity by 2026. Delivery of WP1 will start in 2023/24, with project completion by 2026. WP1 will be coordinated with the switchboard change at Whitehouse GSP, forecast to be finished by 2026 (see 'ED2-LRE-SPD-015-CV3-EJP - Whitehouse GSP Fault Level Mitigation'). Delivery of WP2 will start in 2025, with project completion by 2027. The proposed schedule of works will

maintain demand below the firm capacity of the group throughout RIIO-ED2. A demand transfer of 30.39MVA will be claimed in 2026/27 at the end of the project.

5.2 Option 1 – Establish a New Kaimes 'C' GSP

This option considers the installation of a new 275/33kV 2 x 90MVA Kaimes 'C' GSP next to the existing Kaimes GSP in 2026. SP Distribution would submit a Modification Application (£35.8k) to NGESO for a new GSP. Table 5.4 shows the scheme summary. This option would enable 90MVA of additional network capacity.

This option is rejected based on cost and the risk of deliverability of a new GSP in RIIO-ED2.

Table 5.4. Option 1 summary

Category	Scheme Name	Scheme Summary	Reporting Table	RIIO-ED2 Contribution (£m)	Post RIIO-ED2 (£m)	Customer Contribution (£m)
Conventional	Kaimes GSP Reinforcement	Establish a new Kaimes 'C' GSP	CV1 Expenditure	3.926	-	-
			CV4 Expenditure	2.738	26.076	-

The SP Distribution works for this solution involves the installation of a new 10-panel indoor 33kV switchboard with space for additional two panels on each side. The new 10-panel board will comprise seven feeder breakers, a bus section and two transmission incomer breakers, with the facility for additional two circuit breakers on each side for future connections. Little France, Poltonhall, Lugton and Bush Estate primary substation would be moved to the new Kaimes 'C' GSP. The costs of SPD works are included within the CV1 expenditure.

The SP Transmission works for this solution involves the installation of 2 x 90MVA 275/33kV grid transformers, associated cable works, two transmission incomer breakers and 275kV 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 2025/26 upon GSP energisation.

In addition to this to manage the risk in the earlier years, Kings Buildings primary would be off-loaded to the adjacent Whitehouse GSP by relocating Normally Open Points (NOP) at Kings Buildings T2 circuit to Kaimes GSP side and installing a new 33kV 3.2km circuit from Kings Buildings primary to Whitehouse GSP to connect Kings Buildings T1 side to Whitehouse GSP. A new circuit breaker at Whitehouse GSP will be installed during a replacement of Whitehouse 33kV switchboard which is detailed in the paper 'ED2-LRE-SPD-015-CV3-EJP - Whitehouse GSP Fault Level Mitigation'.

A peak demand at new Kaimes 'C' GSP is forecast to be 52.5MVA against the firm capacity of 90MVA and the existing Kaimes GSP would be 81.6MVA against the firm capacity of 120MVA by the end of RIIO-ED2. The configuration of Kaimes 'C' GSP is shown in Figure 8.

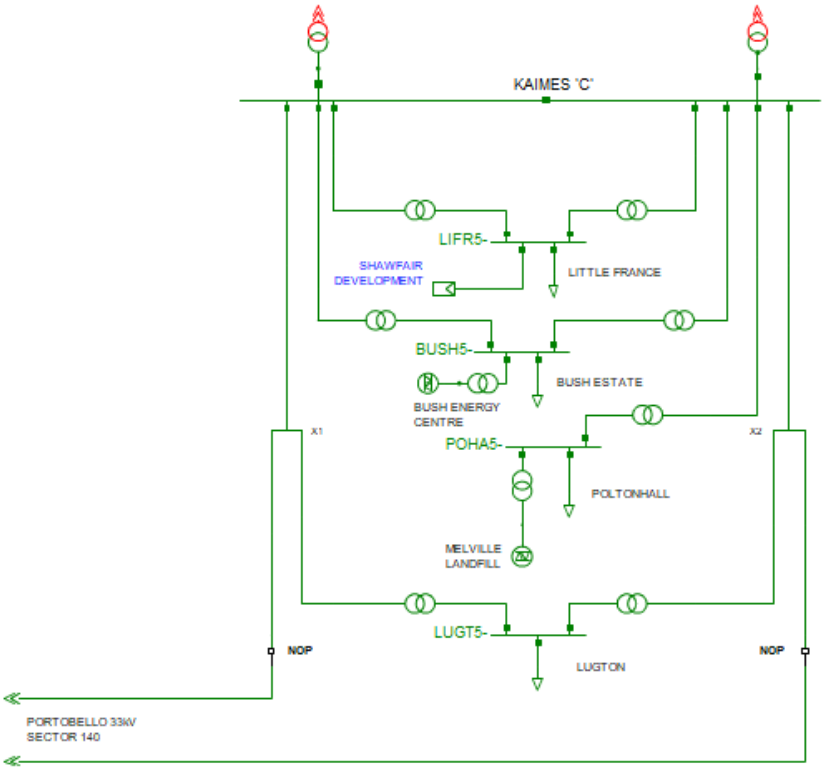

Figure 8. Schematic of Option 1 33kV network

Table 5.5 shows a summary of reinforcement costs and volumes for Option 1 under RIIO-ED2.

Table 5.5. Option 1 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 UG Cable (Non Pressurised)	5.6	1.118	1.118	-	-
33kV CB (Gas Insulated Busbars)(ID) (GM)	9	1.503	1.503	-	-
Batteries at 33kV Substations	1	0.009	0.009	-	-
Pilot Wire Underground	5.6	0.620	0.620	-	-
Civil Works at 33 kV & 66 kV Substations		0.156	0.156	-	-
Wayleaves/Easements/Land Purchase		0.014	0.014	-	-
Other Costs CV1 (Identify Below)		0.506	0.506	-	-
Other Costs CV4 (Identify Below)		28.814	2.738	26.076	-
Total Costs		32.741	6.665	26.076	-
Identify activities included within other costs (please provide high-level detail of cost areas)					
CV1 – Planning and design (£100k)					
CV1 – Remote end protection (£189k)					
CV1 – RTU/SCADA (£45k)					
CV1 – Telecoms infrastructure upgrade to modern intertripping (£120k)					
CV1 – Environmental Assessments & Considerations (£16k)					
CV1 – NGESO ModApp fee (£35.8k based on NGESO charges from 1st April 2021)					
CV4 – NTCC (New Transmission Capacity Charges) (£2.74m)					

5.3 Option 2 – 33kV network reconfiguration

This option considers off-loading of two primary substations, Frogston Road East and Lugton, to the adjacent Whitehouse GSP. This solution would delay installation of a new GSP to the last year of RIIO-ED2 which is considered in the CBA. Table 5.6 shows the scheme summary. This option is rejected based on cost and the risk of deliverability of a new GSP by the end of RIIO-ED2.

Table 5.6. Option 2 summary

Category	Scheme Name	Scheme Summary	Reporting Table	RIIO-ED2 Contribution (£m)	Post RIIO-ED2 (£m)	Customer Contribution (£m)
Conventional	Kaimes GSP Reinforcement	Reconfiguration of the 33kV network (off-loading of Frogston Road East and Lugton to Whitehouse GSP)	CV1 Expenditure	9.294	-	-
			CV4 Expenditure	0.923	27.891	-

Frogston Road East primary would be supplied from Whitehouse GSP by relocating Normally Open Points (NOP) at Frogston Road East T1 circuit to Kaimes GSP side and installing a new 33kV 5.7km circuit from Frogston Road East primary to Whitehouse GSP to connect Frogston Road East T2 side to Whitehouse GSP. The route for this circuit is shown in Figure 9. Lugton primary would be supplied from Whitehouse GSP by extending each of Lugton primary 33kV circuits by 6.5km from Kaimes GSP to Whitehouse GSP. The route for these two circuits is shown in Figure 6. Three new circuit breakers at Whitehouse GSP will be installed during a replacement of Whitehouse 33kV switchboard which is detailed in the paper 'ED2-LRE-SPD-015-CV3-EJP - Whitehouse GSP Fault Level Mitigation'.

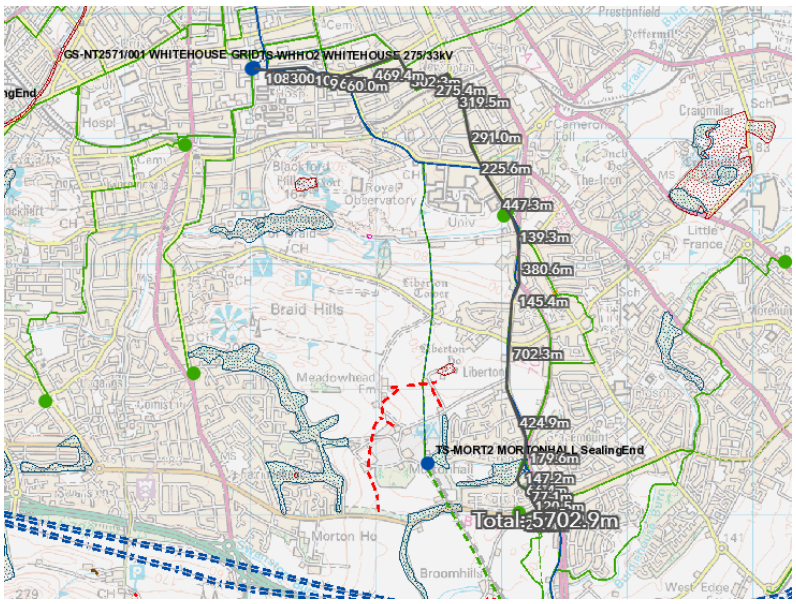

Figure 9. 33kV circuit route for Frogston Road East T2 circuit to Whitehouse GSP

33kV network configuration at Whitehouse GSP after relocations of Frogston Road East and Lugton primary substations to Whitehouse GSP is shown in Figure 10.

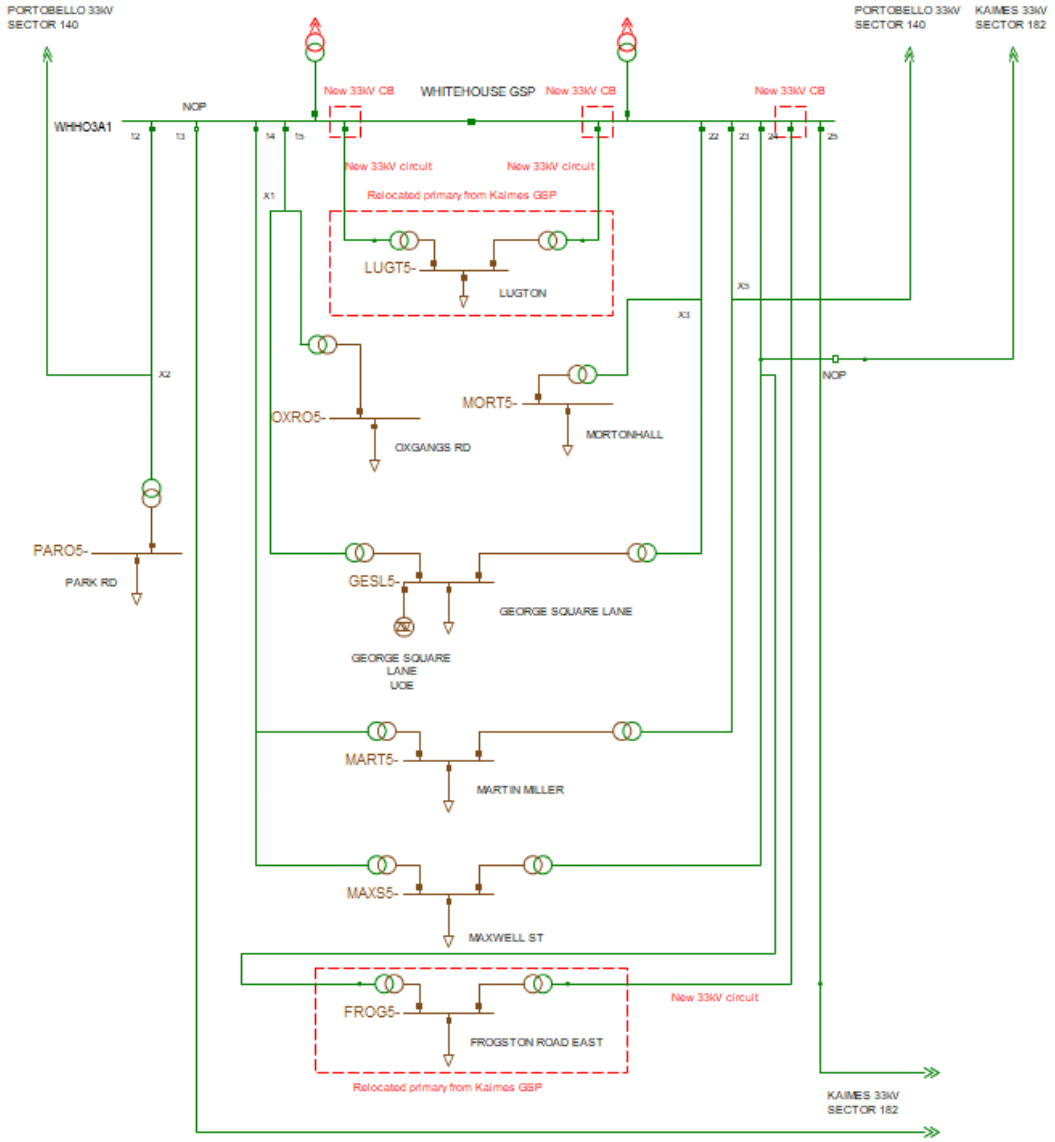

Figure 10. Schematic of Whitehouse GSP 33kV network

The relocation of Frogston Road East and Lugton primary substations would release 24.8MVA from Kaimes GSP in 2025/26 with a peak demand of 116.8MVA. A peak demand at Whitehouse GSP with Frogston Road East and Lugton primary substation will be 66.7MVA. This solution would delay installation of a new GSP to the last year of RIIO-ED2 which is considered in the CBA. SP Distribution would submit a Modification Application (£35.8) to NGESO for a new GSP. 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.

Table 5.7 shows a summary of reinforcement costs and volumes for Option 2 under RIIO-ED2.

Table 5.7. Option 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 UG Cable (Non Pressurised)	21.1	4.212	4.212	-	-
33kV CB (Gas Insulated Busbars)(ID) (GM)	11	1.837	1.837	-	-
Batteries at 33kV Substations	1	0.009	0.009	-	-
Pilot Wire Underground	21.1	2.337	2.337	-	-
Civil Works at 33 kV & 66 kV Substations		0.180	0.180	-	-
Wayleaves/Easements/Land Purchase		0.084	0.084	-	-
Other Costs CV1 (Identify Below)		0.635	0.635	-	-
Other Costs CV4 (Identify Below)		28.814	0.923	27.891	-
Total Costs		38.109	10.218	27.891	-
Identify activities included within other costs (please provide high-level detail of cost areas)					
CV1 – Planning and design (£100k)					
CV1 – Remote end protection (£231k)					
CV1 – RTU/SCADA (£55k)					
CV1 – Telecoms infrastructure upgrade to modern intertripping (£120k)					
CV1 – Environmental Assessments & Considerations (£94k)					
CV1 – NGESO ModApp fee (£35.8k based on NGESO charges from 1st April 2021)					
CV4 – NTCC (New Transmission Capacity Charges) (£923k)					

5.4 Options Cost Summary Table

Summary of the costs for each of the evaluated options is presented in Table 5.8.

Table 5.8. Cost summary for considered options

Options	Option Summary	RIIO-ED2 Cost (£m)
Baseline	Off-load Kings Buildings and Lugton primary substations	6.094
Option 1	Establish a new Kaimes 'C' GSP	6.665
Option 2	Off-load Frogston Road East and Lugton primary substations	10.218

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 off-load two primary substations, Kings Buildings and Lugton, to the adjacent Whitehouse GSP and utilise flexibility services to facilitate market growth.

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-014-CV1-CBA – Kaimes GSP Reinforcement'.

The proposed option represents the most economic and efficient long-term solution and enables the load growth in the area by smooth deliverability of the network reinforcement.

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 – Off-load Kings Buildings and Lugton primary substations	**Adopted**					
Option 1- Establish a new Kaimes 'C' GSP	Rejected	Discounted based on NPV and the risk of deliverability.	-1.28	-1.17	-0.98	-0.60
Option 2 – Off-load Frogston Road East and Lugton primary substations	Rejected	Discounted based on NPV.	-2.66	-3.41	-3.76	-3.93

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 £5.807m and further £0.226m to procure future flexibility services in the group.

Table 6.2: Summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
33kV UG Cable (Non Pressurised)	16.2	3.234	3.234	-
33kV CB (Gas Insulated Busbars)(ID) (GM)	3	0.501	0.501	-
Pilot Wire Underground	16.2	1.795	1.795	-
Civil Works at 33 kV & 66 kV Substations		0.036	0.036	-
Wayleaves/Easements/Land Purchase		0.073	0.073	-
Other Costs (Identify Below)		0.229	0.229	-
Flexibility Services		0.226	0.226	-
Total Costs		6.094	6.094	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
Planning and design (£50k)				
Remote end protection (£63k)				
RTU/SCADA (£15k)				
Environmental Assessments & Considerations (£81k)				
Telecoms costs – modern intertripping (£20k)				

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
CV1 (Primary Reinforcement)	**5.867**	-	1.173	2.347	2.347	-
CV1 (Flexible Service)	**0.226**	-	0.006	0.220	-	-
Total Cost	**6.094**	**-**	**1.179**	**2.567**	**2.347**	**-**

6.4 Risks

The main delivery risks are the interaction with the project to change the Whitehouse 33kV switchboard (ED2-LRE-SPD-015-CV3-EJP - Whitehouse GSP Fault Level Mitigation) and land for the new cable route.

To mitigate risks associated with the Whitehouse project, we would ensure early and efficient planning of resources and early engagement with suppliers.

We would mitigate the risks associated with laying underground cables by engaging early, with local authorities and landowners.

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 drivers for this investment are insufficient thermal headroom and security of supply risk. The investment does not have a strong reliance on environmental benefits.

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 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	15,516		16,912	19,957	18,613	12,816	20,251	18,444	18,444
HPs	8,690		12,406	18,920	7,240	6,725	8,067	6,908	7,289

*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					F	F	F	R1					R2	
Consumer Transformation					F	F	F	R1				R2		
Leading the Way					F	F	R1	R1			R2			
Balanced Net Zero Pathway					F	F	F	R1					R2	
Headwinds					F	F	F	F	R1					R2
Widespread Engagement					F	F	F	R1				R2		
Widespread Innovation					F	F	F	R1					R2	
Tailwinds					F	F	F	R1					R2	

F – Utilise flexibility services
R1 – Off-load Kings Buildings and Lugton primary substations
R2 – New GSP (reinforcement costs included in CBA as explained in section 5.1)

The proposed solution is robust across a wide range of pathways. The timing of the requirement is slightly sensitive to uptake rates but is found to be required under all scenarios within the RIIO-ED2 period. In addition, increased flexibility services might be required under higher uptake scenarios during the RIIO-ED2 period. Under all scenarios, a new GSP is required in the RIIO-ED3 period, with timing within the period dependant on scenario.

Table 6.6: Sensitivity of the proposed RIIO-ED2 expenditure

	Baseline	Uncertain
RIIO-ED2 Expenditure (£m)	6.094	+0.032
Comment	Proposed option	Increased flexibility services in RIIO-ED2. New GSP is required in RIIO-ED3.

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 210 tonnes. The monetised embodied carbon value associated with this emission is £12.4k. 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[1].

6.6.6 Whole Systems Benefits

Whole system solutions have been considered as part of this proposal. No alternatives have been identified that could be provided through a whole systems solution. The completion of this scheme

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

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 Kaimes GSP Reinforcement programme has the potential to result in the emissions of embodied carbon arising from the delivery of the programme. There is likely to be little or no impact on SPEN's Business Carbon Footprint (BCF).

Upfront costs associated with replacement assets (e.g. embodied carbon in the materials and emissions associated with civil engineering works) should be considered against the potential operational efficiency improvements associated with replacement assets from a lifetime carbon perspective. For example, with the carbon emissions resulting from the raw materials and manufacture of new assets only contributing around 5-10% of the whole-life carbon impact of a transformer, it is entirely possible that a transformer with a higher embodied carbon footprint may have lower whole-life carbon emissions if it can operate more efficiently with fewer losses.

As network losses currently account for 95% of our BCF, even a marginal improvement in the efficiency of a transformer can bring a significant reduction in lifetime losses and the resulting carbon emissions. Therefore, it is important that efficiency criteria inform the decision-making process.

6.7.2 Supply Chain Sustainability

For us to take full account of the whole-life carbon impact of our Kaimes 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 Kaimes GSP Reinforcement programme will result in the consumption of resources and the generation of waste materials from end of life assets.

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 Kaimes GSP Reinforcement programme will affect Kaimes GSP and Whitehouse GSP sites containing existing assets and on undeveloped sites on the route of new underground cables. We will minimise the area of landtake required and will minimise disturbance to soils and vegetation during construction. We will replace and enhance the existing habitat, working with relevant stakeholders to identify the measures required to achieve a net gain in biodiversity and wider ecosystem services.

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

To manage the thermal constraint on Kaimes transformers throughout RIIO-ED2, it is proposed to off-load demand by relocating two primary substations (Kings Buildings and Lugton) to Whitehouse GSP which involves installation of three new 33kV circuits.

The estimated cost for the above is £6.094m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

The proposed solution would delay installation of a new GSP to the middle of RIIO-ED3. It represents the lowest cost and most economic and efficient engineering long-term solution from the whole system perspective to meet the forecast demand growth when compared with the alternative schemes identified.

It is recommended to continue annual tendering for flexibility in this area to procure enough capacity and the proposed solution will be reviewed depending on procuring enough capacity in the future tenders. In order to facilitate market growth, the total of 17.8MW of capacity has been accepted between 2024-2026.

The timing of the project is based on delivering the highest NPV savings, while maintaining security of supply. To achieve this aim, project delivery will comprise two work packages, off-loading of Kings Building Primary (WP1) and off-loading of Lugton Primary (WP2). The baseline view forecasts loading in excess of the firm capacity by 2026. Delivery of WP1 will start in 2023/24, with project completion by 2026. WP1 will be coordinated with the switchboard change at Whitehouse GSP, forecast to be finished by 2026 (see 'ED2-LRE-SPD-015-CV3-EJP - Whitehouse GSP Fault Level Mitigation'). Delivery of WP2 will start in 2025, with project completion by 2027. The proposed schedule of works will maintain demand below the firm capacity of the group throughout RIIO-ED2. A demand transfer of 30.39MVA will be claimed in 2026/27 at the end of the project.

8 Appendices

Appendix 1. System Study Results

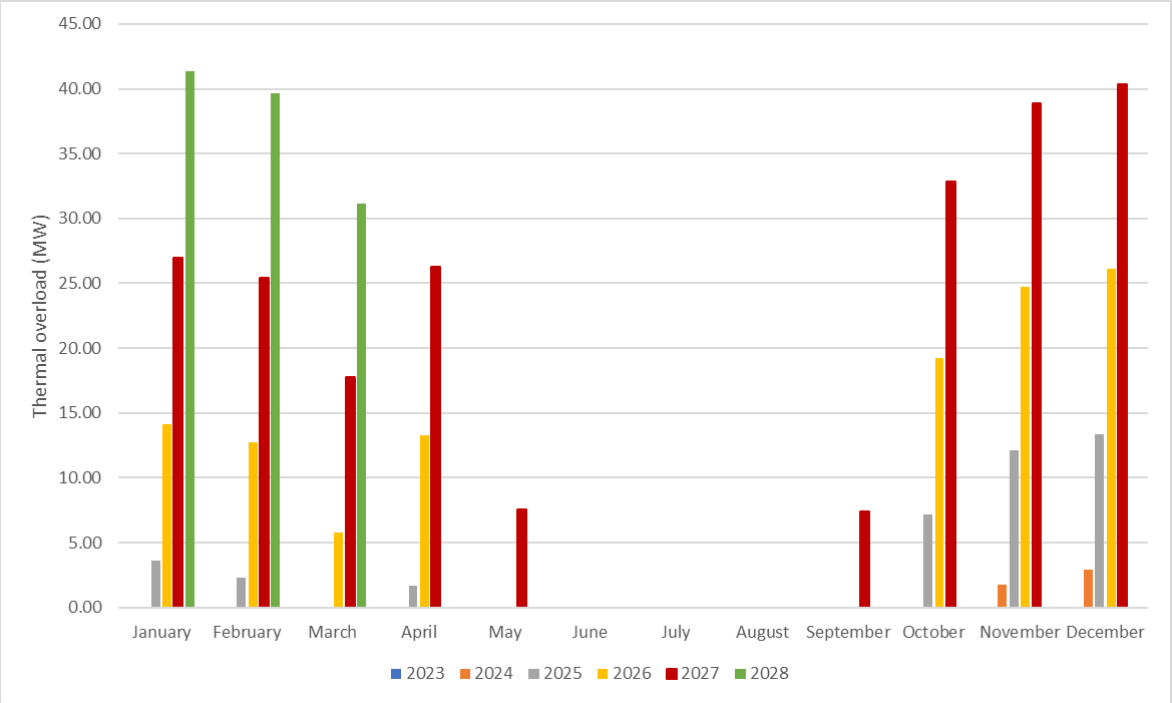

Figure 11. Monthly maximum overload on 275/33kV Kaimes transformer