Monktonhall-Tranent Primary Reinforcement

ED2 Engineering Justification Paper

ED2-LRE-SPD-010-CV1-EJP

Issue	Date	Comments
Issue 0.1	Jan 2021	Issue to internal governance and external assurance
Issue 0.2	Apr 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	Monktonhall-Tranent Primary Reinforcement		
Activity	Primary Reinforcement		
Primary Investment Driver	Thermal Constraints		
Reference	ED2-LRE-SPD-010-CV1		
Output	Load Index		
Cost	£5.198m		
Delivery Year	2023-2028		
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	**£5.198m**	**£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:	**Monktonhall-Tranent Primary Reinforcement**
Project Reference:	**ED2-LRE-SPD-010-CV1**
Decision Required:	**To give concept approval to commission a new primary substation fed from Cockenzie Grid Supply Point.**

Summary of Business Need:

Monktonhall and Tranent 33/11kV primary demand groups are geographically located in the Edinburgh & Borders region of SP Distribution licence area. Monktonhall serves ca. 9,730 customers and Tranent serves ca. 11,263 customers. With the forecast uptake of Low Carbon Technologies, the group demand at Monktonhall and Tranent primary demand groups are forecast to exceed their firm capacity by the end of RIIO-ED2 period, with risk of thermal overloading on 33/11kV transformers and the 33kV circuits supplying each site.

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

The proposed solution is to establish a new primary substation, "Musselburgh Primary", geographically located between Tranent and Monktonhall substations. The new primary will be connected to the Cockenzie grid 33kV busbar, where two new circuit breakers will be installed on the switchboard to accommodate the new demand group. Musselburgh substation will connect to Cockenzie substation which is approx. 4.6km away. The connection will be made through two 33kV circuits of 400mm2 Al XLPE cable. Optical fibre will be laid with the cables to provide unit protection between Cockenzie Grid and Musselburgh Primary substation. The proposed primary substation will take on standing demand from Montonhall and Tranent primary groups, via interconnectable 11kV circuits.

The estimated cost for the above is £5.198m (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	**4.982**	0.498	1.495	1.495	0.996	0.498
SPD	CV1	Flexible Services	**0.216**	0.001	0.005	0.090	0.120	-
SPD	**Total**		**5.198**	**0.492**	**1.477**	**1.477**	**0.985**	**0.493**

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

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1 Introduction

Monktonhall and Tranent 33/11kV primary groups are geographically located in the Edinburgh region of SP Distribution (SPD) licence area. Monktonhall serves ca. 9,730 customers and Tranent serves ca. 11,263 customers. Figure 1 provides a geographical view of the local area.

Figure 1. Geographical view of the area

Monktonhall primary has firm capacity of 24MVA. Our Baseline View projects a peak demand of 26.5MVA by 2028, including an expected uptake of up to 2,184 electric vehicles and 1,335 heat pumps. By the end of RIIO-ED2, Monktonhall demand group will be class 'C' of supply as per Energy Network Association (ENA) Engineering Recommendation (EREC) P2/7.

Tranent primary has firm capacity of 21.8MVA. Our Baseline View projects a peak demand of 23.0MVA by 2028, including an expected uptake of up to 2,555 electric vehicles and 1,151 heat pumps. By the end of the RIIO-ED2, Tranent demand group will be class 'C' ENA EREC as per P2/7.

In order to secure supplies within the group, meet the licence obligations under EREC P2/7, and to accommodate future demand growth within the area, it is proposed to establish a new 33/11kV primary substation called Musselburgh, geographically located between Monktonhall and Tranent substations. The proposed works are:

1. At Cockenzie Grid Supply Point (GSP) install two new circuit breakers on the existing 33kV switchboard.
2. Provide a dedicated connection from Cockenzie GSP to the new Musselburgh primary substation by installing two new 33kV underground cable circuits with associated communications infrastructure.
3. Establish two 33/11kV primary transformers and a new 7-panel 11kV board at the new Musselburgh Primary substation.

4. Lay 1km of 11kV underground cable, connecting Musselburgh primary into the Tranent 11kV network, allowing the transfer of ca. 5MW ring from St Clement site.
5. Lay 1km of 11kV underground cable, connecting Musselburgh primary into the Monktonhall 11kV network, allowing the transfer of the Tesco and Pinkie Mains IDNO sites.
6. Procure flexibility services to manage the network risk through the delivery stage at a cost of £216k.

The estimated cost for the above is £5.198m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

It is also recommended to continue annual tendering for flexibility in this area to procure enough capacity and review the proposed conventional/build solutions or in the likely case of additional demand uptake in the group.

Due to the complexity of the circuits and the overall project, it is proposed to start the works in 2023/24. A capacity release of 32MVA will be claimed in 2027/28 at the end of the project.

2 Background Information

2.1 Existing / Authorised Network

Monktonhall primary substation is served by two 24MVA, Brush 33/11kV transformers (2008) fed from Portobello GSP. Tranent primary substation is served by two 24MVA, ABB 33/11kV transformers (2012) fed from Cockenzie GSP. The existing 11kV network, fed from both substations, comprises a mix of underground cable (UGC) with sections of overhead line (OHL). Authorised 33kV network for both primary substations is shown in Figure 2.

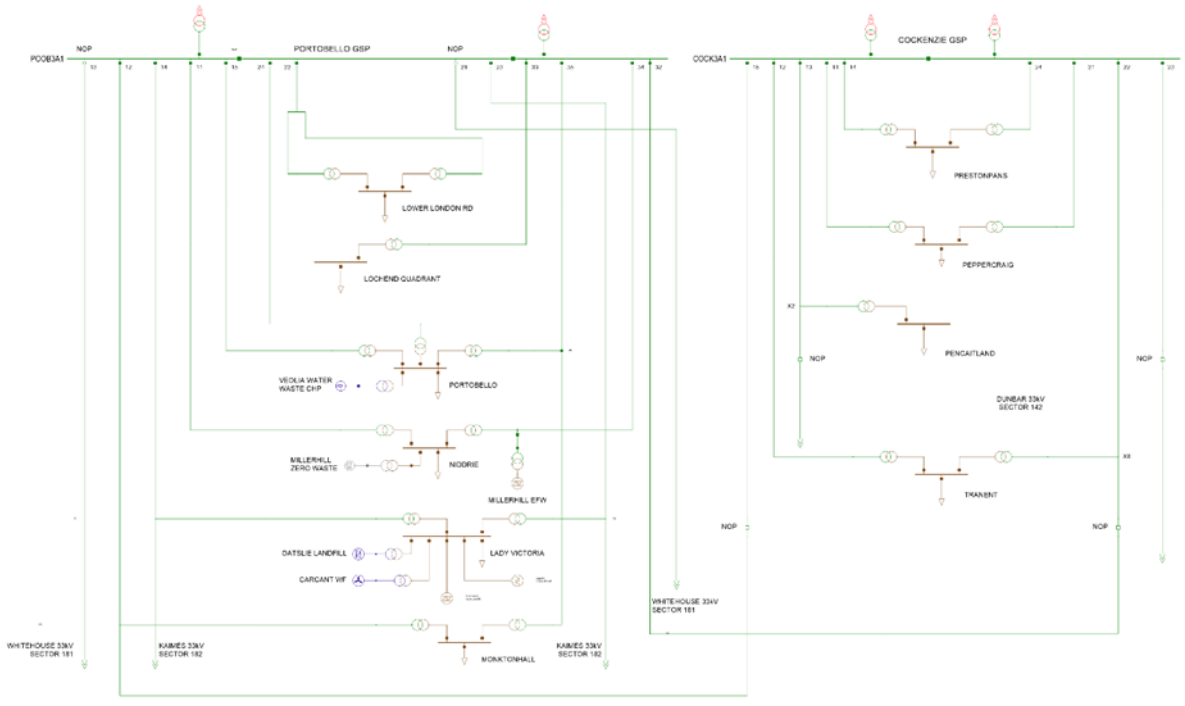

Figure 2. Existing 33kV Network

A summary of the transformer data is presented in Table 2.1.

Table 2.1. Primary Transformer Data

	Tranent		Monktonhall	
	T1	T2	T1	T2
Manufacturer	ABB		Brush	
Manufacturer Year	2012		2008	
Voltage	33/11kV		33/11kV	
Thermal Rating	24MVA		24MVA	
Health Index	1		1	

2.2 Group Demand & Security of Supply

The maximum measure demand at Monktonhall primary is 17.3MVA (2020); which places the group in class 'C' of supply as per EREC P2/7 and must be secured for a first circuit outage (FCO).

The maximum measured demand at Tranent primary is 21.5MVA (2017); which places the group in class 'C' of supply as per EREC P2/7 and must be secured for a first circuit outage (FCO).

Based on measured data, authorised developments and forecast Low Carbon Technologies (LCT) uptake this area of network would be unable to accommodate any sustained growth without exceeding 24MVA FCO capacity of the Monktonhall group and 21.8MVA FCO capacity of the Tranent group.

2.3 Embedded Generation

There is ca. 2.2MW of embedded generation connected at Monktonhall primary and ca. 1.3MW connected at Tranent primary.

2.4 Fault Levels

Studies indicate that with the authorised customer connections there are no fault level issues at Monktonhall and Tranent primary substations.

3 Needs Case

At Monktonhall Primary, our Baseline View projects a peak demand of 26.5MVA by 2028, including an expected uptake of up to 2,184 electric vehicles and 1,335 heat pumps. This exceeds the 24MVA firm capacity of the Monktonhall primary group by the end of RIIO-ED2.

At Tranent Primary, our Baseline View projects a peak demand of 23.0MVA by 2028, including an expected uptake of up to 2,555 electric vehicles and 1,151 heat pumps. This exceeds the 21.8MVA firm capacity of the Tranent primary group by the end of RIIO-ED2.

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 Distribution Future Energy Scenarios (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 forecasts for both primary substations based on the SPD Distribution Future Energy Scenarios, including authorised connections are depicted in Figure 3 and Figure 4. The anticipated total electric vehicle and heat pump uptakes for both primary substations based on the future energy scenarios are depicted in Figure 5 and Figure 6.

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.

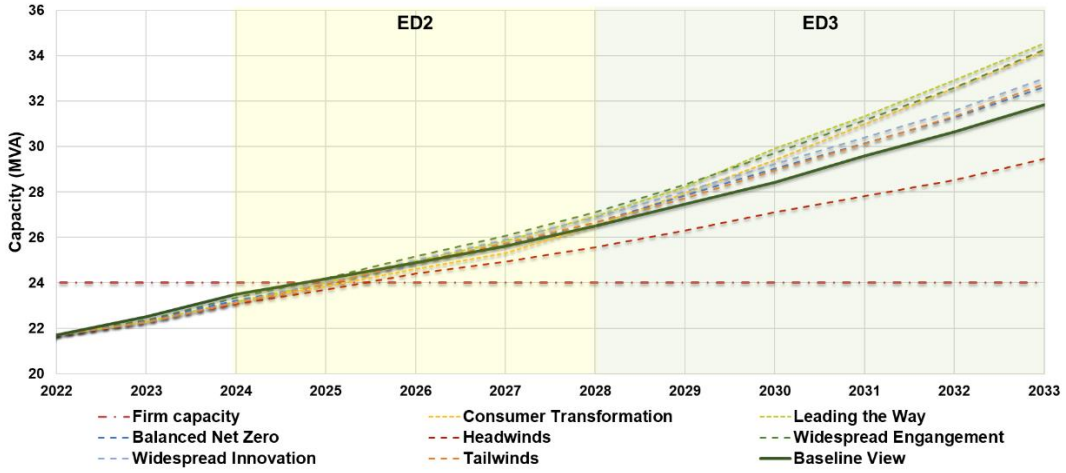

Figure 3. Demand (MVA) forecast for Monktonhall demand group

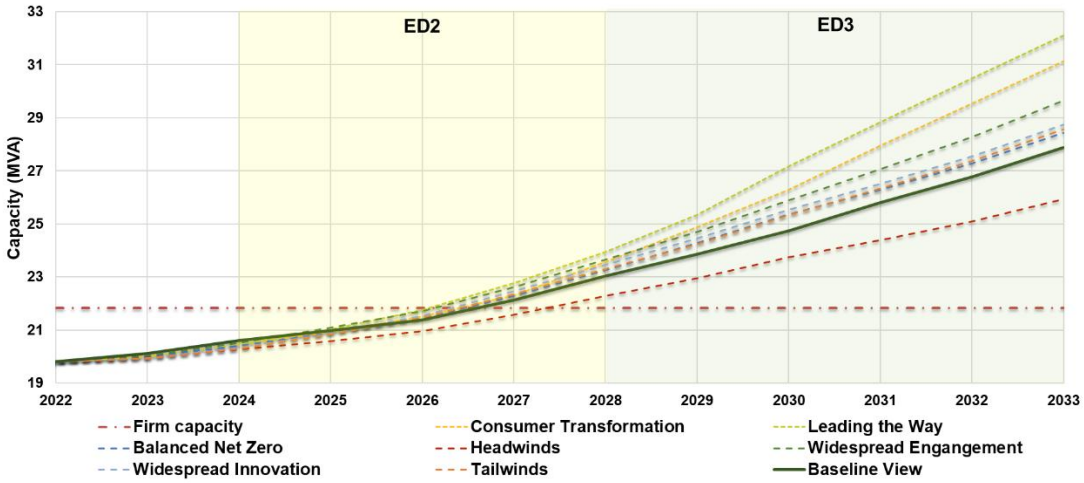

Figure 4. Demand (MVA) forecast for Tranent demand group

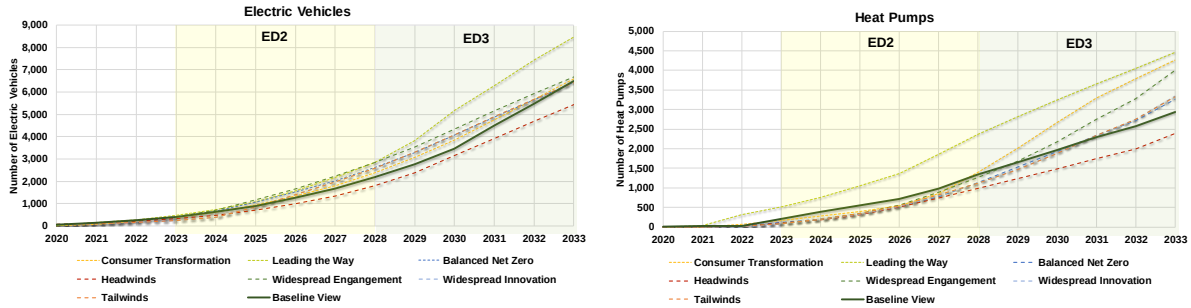

Figure 5. Forecast Electric Vehicle and Heat Pump uptakes for Monktonhall demand group

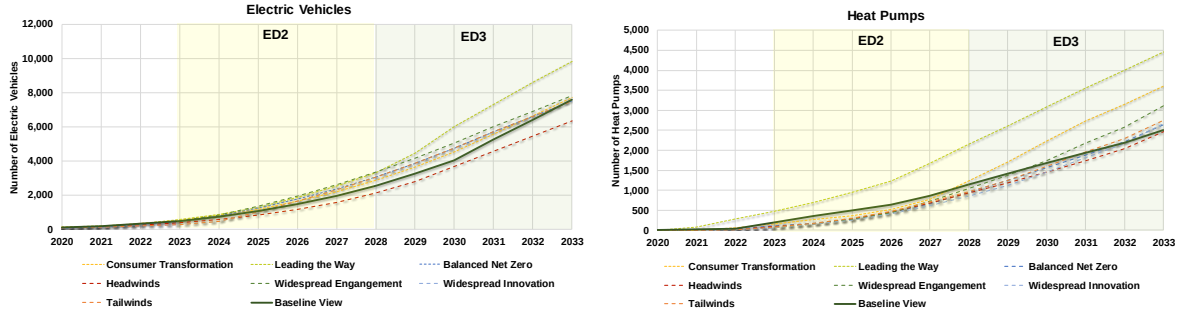

Figure 6. Forecast Electric Vehicle and Heat Pump uptakes for Tranent demand group

3.1.2 Baseline View

For Monktonhall and Tranent group demands, 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 and Table 3.2.

Table 3.1. Baseline View forecast for Monktonhall primary

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Forecast Demand (MVA)	21.7	22.5	23.5	24.2	24.9	25.6	26.5	27.5	28.4	29.6	30.6	31.8
Firm Capacity (MVA)	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Utilisation (%)	90	94	98	101	104	107	110	114	118	123	128	133
Load Index	LI2	LI2	LI3	LI4	LI4	LI4	LI5	LI5	LI5	LI5	LI5	LI5

Table 3.2. Baseline View forecast for Tranent primary

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Forecast Demand (MVA)	19.8	20.1	20.6	21.0	21.4	22.1	23.0	23.9	24.7	25.8	26.8	27.9
Firm Capacity (MVA)	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8
Utilisation (%)	91	92	94	96	98	101	106	109	113	118	123	128
Load Index	LI2	LI2	LI2	LI3	LI3	LI5	LI5	LI5	LI5	LI5	LI5	LI5

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 Monktonhall and Tranent groups 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 3.3 shows the identified thermal constraints on the 33/11kV network level.

Table 3.3. Thermal constraints at 33/11kV level

Network Item	Voltage	Outage
Monktonhall T1	33/11kV	N-1
Monktonhall T2	33/11kV	N-1
Portobello-Monktonhall No.1 Circuit	33kV	N-1
Portobello-Monktonhall No.2 Circuit	33kV	N-1
Tranent T1	33/11kV	N-1
Tranent T2	33/11kV	N-1
Cockenzie-Tranent No.1 Circuit	33kV	N-1
Cockenzie-Tranent No.2 Circuit	33kV	N-1

3.2.2 Voltage Constraints

There were no voltage constraints associated with Tranent or Monktonhall primary demand groups.

3.2.3 EREC P2/7 – Security of Supply

Monktonhall demand group has a forecast peak demand of 25.2MW (26.5MVA) by the end of RIIO-ED2. Tranent Primary substation has a forecast peak demand of 21.9MW (23.0MVA) by the end of RIIO-ED2. EREC P2/7 defines group demands of 12MW-60MW as a class 'C' of supply.

EREC P2/7 states that a group demand with a as a class 'C' of supply must secure the following minimum demand for a first circuit outage:

a) Smaller of group demand minus 12MW; and 2/3 of group demand;
b) Group demand must be met within 3 hours.

Monktonhall group demand has an FCO security of 24MVA and Tranent group demand has an FCO security of 21.8MVA. Therefore, both demand groups are predicted to be non-compliant under EREC P2/7 by the end of the RIIO-ED2 price control period; consequently, mitigating action is required.

3.2.4 Flexibility Services

In order to manage the network risk on the 11kV network, our assessment indicates that the risk of thermal overload on the 33/11kV Monktonhall and Tranent primary transformers, starts from the year 2023/24 throughout to the year 2028 for the most onerous scenario including an additional 5% for the asset protection margin. These risks are shown Table 3.4 and Table 3.5. The detailed results from the half hourly profile-based simulations are furnished in Appendix 1.

Table 3.4. Network annual hours at risk and flexible capacity tendered in Spring 2021 for Monktonhall group

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Annual hours at risk (Hrs)	2	15	44	106	230
Required Flexible Capacity (MW)	0.54	1.46	2.36	3.50	4.92

Table 3.5. Network annual hours at risk and flexible capacity tendered in Spring 2021 for Tranent group

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Annual hours at risk (Hrs)	28	69	122	303	554
Required Flexible Capacity (MW)	0.65	1.20	1.73	2.79	4.13

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.
(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)	BaU reinforcement strategy – Establish a new primary substation "Musselburgh Primary", located between Tranent and Monktonhall primary groups.	Shortlisted as **Baseline** option in Detailed Analysis	
(d)	Replace transformers at Monktonhall and Tranent with higher rated units and replace 33kV OHL and UGC feeding both demand groups with higher rated circuits.	Shortlisted as **Option 1** in Detailed Analysis	
(e)	Utilise flexibility services to defer reinforcement into RIIO-ED3. (Innovation)	Rejected	Discounted due to insufficient flexibility capacity received for Monktonhall and Tranent primary substations to remain EREC P2/7 compliant.
(f)	Real Time Thermal Rating (RTTR). (Innovation)	Rejected	Loading on Tranent and Monktonhall assets is beyond the capacity release realised from RTTR. This option is not technically viable and has been discounted.
(f)	Install active network management on the 11kV network to enable dynamic transfer of demand between substations. (Innovation)	Rejected	Due to increasing demand and projected LCT uptake, neighbouring groups and the local HV network is reaching capacity. Consequently, insufficient transfer capacity is available.

5 Detailed Analysis & Costs

5.1 Proposed Option (Baseline) – Establish a New Primary Substation in Musselburgh

To mitigate the thermal constraints associated with Tranent and Monktonhall, it is proposed to establish a new primary substation, "Musselburgh Primary", in the vicinity of Musselburgh, which lies between Tranent and Monktonhall. 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	Monktonhall-Tranent Primary Reinforcement	Establish a new primary substation in the vicinity of Musselburgh with 11kV interconnectable circuits to Monktonhall and Tranent primary substations	5.198	-

The proposed location of the site is adjacent to Musselburgh East Community Learning Centre. The identified site provides a strategic location for forecast LCT growth and known future development plans in the area. The new primary will be supplied from Cockenzie GSP as the closest GSP by installing two new circuit breakers on the 33kV switchboard at Cockenzie GSP and two new 33kV underground cable circuits with associated comms infrastructure from Cockenzie GSP to the Musselburgh site. An aerial view of the site and the proposed route, highlighted in green, are shown in Figure 7.

Figure 7. Aerial view of the site and 33kV UGC route (green)

The thermal constraints identified on Tranent and Monktonhall 33/11kV network will be mitigated by the transfer of standing demand from the existing sites. To achieve this, four circuit breakers will be

made available on the new primary switchboard and four 11kV interconnectable circuits will be established from the new primary to interconnect into the adjacent 11kV network. The proposed 11kV and 33kV network configurations are shown in Figure 8 and Figure 9.

The proposed solution includes:

1. Installation of two new circuit breakers on the 33kV switchboard at Cockenzie Grid Supply Point (GSP)
2. Provision of a dedicated connection to a new 33/11kV substation by installing two new 33kV underground cable circuits with associated comms infrastructure from the Cockenzie GSP to the new substation site, located to the west of Cockenzie.
3. Commission two 33/11kV 32MVA primary transformers.
4. Installation of a 7-panel 11kV switchboard.
5. Lay 1km of 11kV underground cable, connecting into the Tranent 11kV network, taking on ca. 5MW ring from St Clement site.
6. Lay 1km of 11kV underground cable, connecting into the Monktonhall 11kV network, taking on Tesco and Pinkie Mains IDNO sites.
7. Procure flexibility services to manage the network risk through the delivery stage at a cost of £216k.

Following the proposed investment, Tranent & Monktonhall demand groups would be EREC P2/7 compliant under all DFES scenarios.

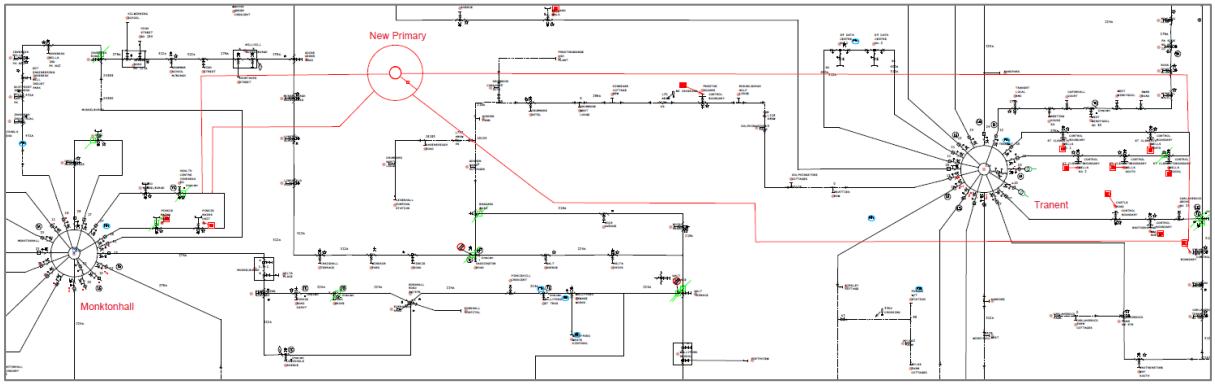

Figure 8. Schematic of the proposed 11kV network

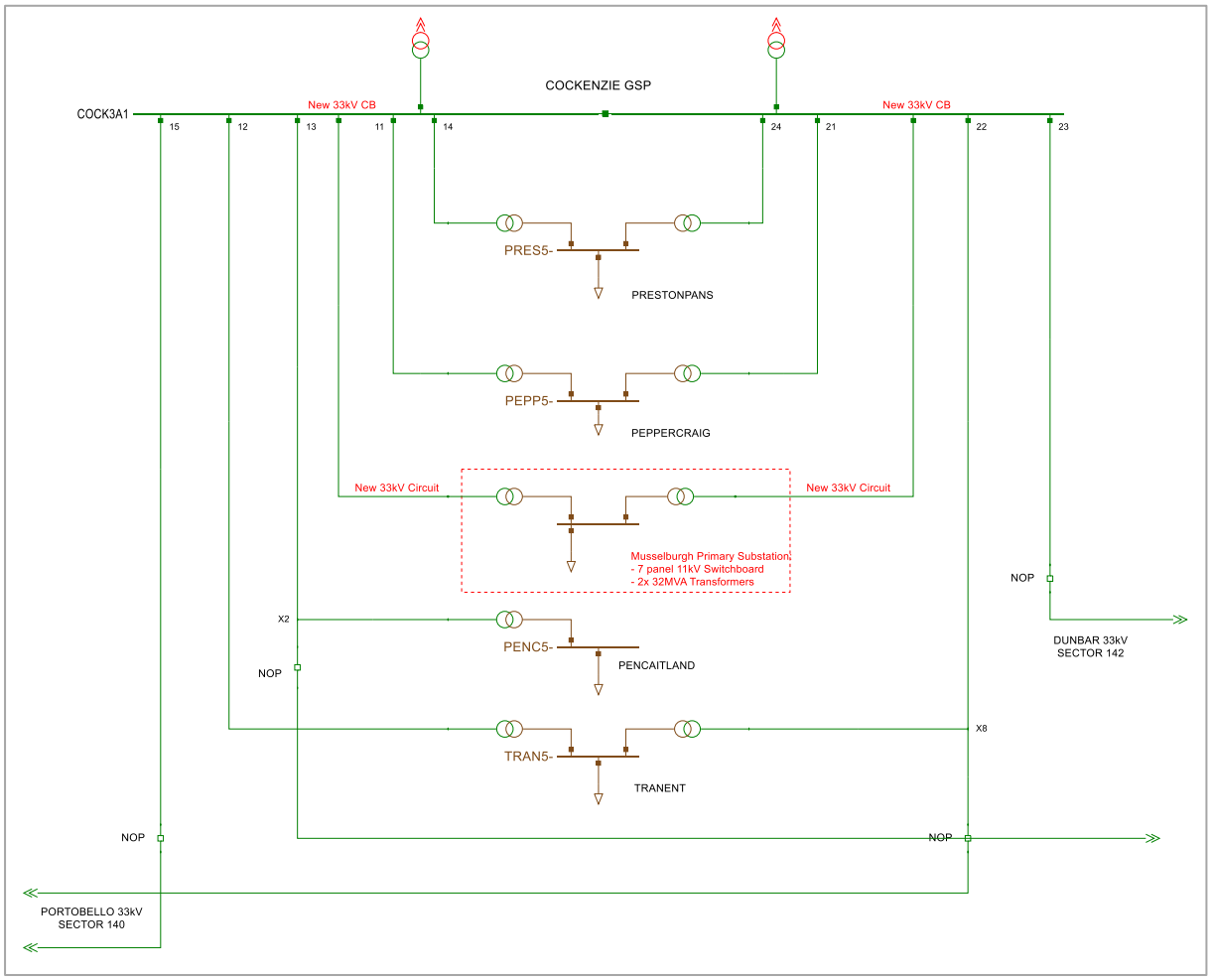

Figure 9. Schematic of the proposed 33kV network

The forecast loading at Musselbugh Primary is shown in *Table 5.2*. DFES scenarios indicate that the peak demand at Musselburgh Primary is forecast to range between 9-37MVA by 2038. The forecast loading is calculated, based on, the DFES demand forecast at Monktonhall and Tranent, that exceeds the firm capacity of the existing groups.

Table 5.2. Musselburgh primary loading

Scenarios	Loading (MVA)	
	2028 Delivery Year	2038 Forecast
Steady Progression	1.74	11.10
Consumer Transformation	7.26	36.74
System Transformation	0.50	8.75
Leading the Way	3.39	25.69
Baseline	4.50	27.02

The SPEN transformer framework provides three transformer ratings, 10, 20 & 32MVA.

- A 10MVA transformer would require additional reinforcement in 4 out of 5 scenarios within 10 years of delivery, including the baseline.
- A 20MVA transformer would require additional reinforcement in 3 out of 5 scenarios within 10 years of delivery, including the baseline.
- A 32MVA transformer would only require additional reinforcement in 1 out of 5 scenarios within 10 years of delivery, with the baseline still within the proposed rating.

Based on the analysis above, a 32MVA transformer is proposed. The proposed rating will ensure suitable capacity is available for forecast demand growth beyond ten years from delivery. Both, 10MVA and 20MVA transformers would require further investment within this period in 80% & 60% of the scenarios, respectively.

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 for Monktonhall and Tranent primary substations to remain EREC P2/7 compliant under the Baseline View. However, in order to facilitate market growth and reduce network risk during delivery, a total of 17MW of capacity has been accepted at Monktonhall and Tranent primary groups between 2023-2028 (see Table 5.3) and the cost of accepted 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 5.3. Accepted flexible capacity from the flexibility tender run in Spring 2021

		2023/24	2024/25	2025/26	2026/27	2027/28
Accepted Capacity (MW)	**Monktonhall**	0.5	1.5	4.7	3.5	-
	Tranent	0.8	1.3	1.8	2.9	-

Table 5.4 shows a summary of reinforcement costs and volumes for the proposed scheme.

Table 5.4. Proposed option summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
6.6/11kV UG Cable	2	0.235	0.235	-
6.6/11kV CB (GM) Primary	7	0.194	0.194	-
33kV UG Cable (Non Pressurised)	9.2	1.836	1.836	-
33kV CB (Gas Insulated Busbars)(ID) (GM)	2	0.334	0.334	-
33kV Transformer (GM)	2	0.790	0.790	-
Batteries at 33kV Substations	1	0.009	0.009	-
Pilot Wire Underground	9.2	1.019	1.019	-
Civil Works at 33 kV & 66 kV Substations		0.318	0.318	-
Wayleaves/Easements/Land Purchase		0.087	0.087	-
Other Costs (Identify Below)		0.159	0.159	-
Flexibility Services		0.216	0.216	-
Total Costs		5.198	5.198	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
Planning and design (£50k)				
RTU/SCADA (£10k)				
33kV telecoms upgrade (£10k)				
Remote end protection (£42k)				
Environmental consideration (£47k)				

Due to the complexity of the circuits and the overall project, it is proposed to start the works in 2023/24. A capacity release of 32MVA will be claimed in 2027/28 at the end of the project.

5.2 Option 1 – Replace Constrained Assets at Monktonhall and Tranent

This option considers replacement of transformers at Monktonhall and Tranent with higher rated units and replacement of 33kV OHL and UGC feeding both demand groups with higher rated circuits. Table 5.5 shows the scheme summary.

The option would enable 8MVA additional network capacity at Monktonhall primary and 10.2MW additional network capacity at Tranent primary. This option is rejected on the basis of no additional capacity uplift compared to the baseline, and higher reinforcement cost.

Table 5.5. Option 1 summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Conventional	Monktonhall-Tranent Primary Reinforcement	Replace transformers at Monktonhall and Tranent with higher rated units and replace 33kV OHL and UGC feeding both demand groups with higher rated circuits.	11.427	-

Table 5.6 shows a summary of reinforcement costs and volumes for Option 1 under RIIO-ED2. In order to facilitate market growth and reduce risk during project delivery, a total of 10.6MW of capacity would been accepted between 2023-2028 and the cost of accepted flexibility services added to this option. Option 1 33kV network configuration in shown Figure 10.

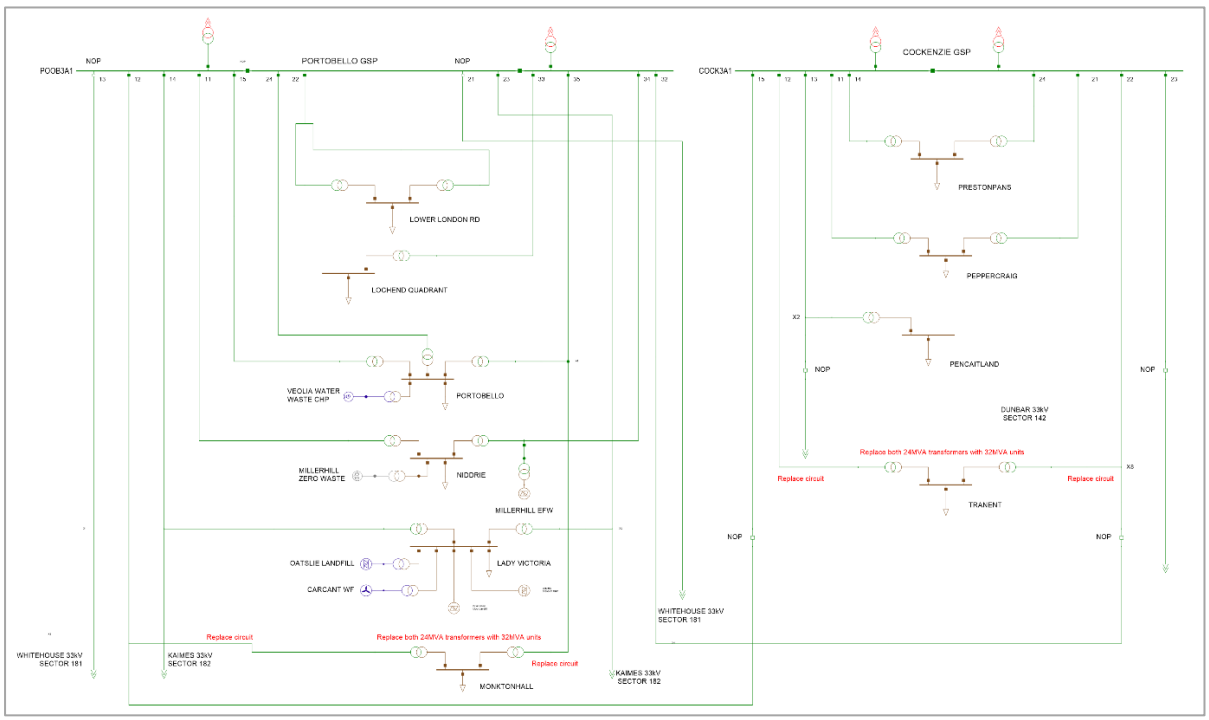

Figure 10. Schematic of Option 1 33kV network

Table 5.6. Option 1 summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
33kV OHL (Pole Line) Conductor	5.2	0.136	0.136	-
33kV Pole	52	0.156	0.156	-
33kV UG Cable (Non Pressurised)	27.6	5.509	5.509	-
33kV Transformer (GM)	4	1.581	1.581	-
Pilot Wire Overhead	5.2	0.140	0.140	-
Pilot Wire Underground	27.6	3.057	3.057	-
Civil Works at 33 kV & 66 kV Substations		0.280	0.280	-
Wayleaves/Easements/Land Purchase		0.208	0.208	-
Other Costs (Identify Below)		0.264	0.264	-
Flexibility Services		0.096	0.096	-
Total Costs		11.427	11.427	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
Planning and design (£100k)				
Environmental consideration (£164k)				

5.3 Options Cost Summary Table

Summary of the costs for each of the evaluated options is presented in Table 5.7.

Table 5.7. Cost summary for considered options

Options	Option Summary	RIIO-ED2 Cost (£m)
Baseline	Establish a new primary substation in the vicinity of Musselburgh with 11kV interconnectable circuits to Monktonhall and Tranent primary substations	5.198
Option 1	Replace transformers at Monktonhall and Tranent with higher rated units and replace 33kV OHL and UGC feeding both demand groups with higher rated circuits.	11.427

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 in the vicinity of Musselburgh with 11kV interconnectable circuits to Monktonhall and Tranent primary substations 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-010-CV1-CBA – Monktonhall-Tranent Primary 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 – Establish a new primary substation "Musselburgh Primary", located between Tranent and Monktonhall primary groups	**Adopted**					
Option 1- Replace transformers at Monktonhall and Tranent with higher rated units and replace 33kV OHL and UGC feeding both demand groups with higher rated circuits	Rejected	Discounted on the basis of no additional capacity uplift compared to the baseline, and higher reinforcement cost.	-2.04	-3.34	-4.11	-4.70

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 £5.198m with £0.216m included 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)
6.6/11kV UG Cable	2	0.235	0.235	-
6.6/11kV CB (GM) Primary	7	0.194	0.194	-
33kV UG Cable (Non Pressurised)	9.2	1.836	1.836	-
33kV CB (Gas Insulated Busbars)(ID) (GM)	2	0.334	0.334	-
33kV Transformer (GM)	2	0.790	0.790	-
Batteries at 33kV Substations	1	0.009	0.009	-
Pilot Wire Underground	9.2	1.019	1.019	-
Civil Works at 33 kV & 66 kV Substations		0.318	0.318	-
Wayleaves/Easements/Land Purchase		0.087	0.087	-
Other Costs (Identify Below)		0.159	0.159	-
Flexibility Services		0.216	0.216	-
Total Costs		5.198	5.198	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
Planning and design (£50k)				
RTU/SCADA (£10k)				
33kV telecoms upgrade (£10k)				
Remote end protection (£42k)				
Environmental consideration (£47k)				

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)	4.982	0.498	1.495	1.495	0.996	0.498
CV1 (Flexible Service)	0.216	0.001	0.005	0.090	0.120	-
Total Cost	5.198	0.492	1.477	1.477	0.985	0.493

6.4 Risks

The main delivery risks are the land for the new primary and cable route. We would mitigate these risks by seeking alternatives for the primary location and engaging with local authorities.

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, security of supply risk and EREC P28 compliance. 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 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 and Table 6.5 show electric vehicle and heat pump uptakes across a range of future pathways for Monktonhall and Tranent demand groups. Table 6.6 shows the sensitivity of the proposed solution and Table 6.7 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 for Monktonhall demand group

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	2,184		2,395	2,844	2,620	1,804	2,851	2,596	2,596
HPs	1,335		1,405	2,367	1,131	991	1,273	1,124	1,122

*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: Electric Vehicle and Heat Pump uptakes across a range of future pathways for Tranent demand group

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	2,555		2,859	3,310	3,065	2,110	3,335	3,037	3,037
HPs	1,151		1,231	2,147	942	928	1,038	860	963

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

Table 6.6: 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	F	R[I]					
Consumer Transformation					F	F	F	F	R[I]					
Leading the Way					F	F	F	F	R[I]					
Balanced Net Zero Pathway					F	F	F	F	R[I]					
Headwinds					F	F	F	F	R[I]					
Widespread Engagement					F	F	F	R[I]						
Widespread Innovation					F	F	F	F	R[I]					
Tailwinds					F	F	F	F	R[I]					

F – Utilise flexibility services

R[I] – Establish a new 32MVA primary substation in the vicinity of Musselburgh with 11kV interconnectable circuits to Monktonhall and Tranent primary substations

The proposed solution is robust across the range of future pathways. The selected solution is required under all scenarios. In all cases this solution is expected to endure beyond RIIO-ED3. The timing of the requirement is only slightly sensitive to uptake rates but is found to be required under all scenarios within the RIIO-ED2 period. Under higher uptake scenarios increased flexibility services may be required in RIIO-ED2 at a cost of £0.180m.

Table 6.7: Sensitivity of the proposed RIIO-ED2 expenditure

	Baseline	**Uncertain**
RIIO-ED2 Expenditure (£m)	5.198	+0.180
Comment	Proposed option	Increased flexibility services

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 402 tonnes. The monetised embodied carbon value associated with this emission is £23k. 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 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 Monktonhall-Tranent Primary Reinforcement programme has the potential to impact on the embodied carbon resulting from the delivery of the programme. There is likely to be little or no impact on SPEN's Business Carbon Footprint (BCF).

6.7.2 Supply Chain Sustainability

For us to take full account of the sustainability impacts associated of the Monktonhall-Tranent Primary Reinforcement programme, we need access to reliable data from our suppliers. The need for carbon and other sustainability credentials to be provided now forms part of our wider sustainable procurement policy.

6.7.3 Resource Use and Waste

The Monktonhall-Tranent Primary Reinforcement programme will result in the consumption of resources and the generation of waste materials from the construction of new assets and 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 Monktonhall-Tranent Primary Reinforcement programme will affect both named sites containing existing assets, an undeveloped site adjacent to Musselburgh East Community Learning Centre for the Musselburgh primary substation 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.

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

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 but recognises that the nature of our substations makes it challenging to minimise their visual impact. 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

In order to secure supplies within the group, meet the licence obligations under EREC P2/7, and to accommodate future demand growth within the area, it is proposed to:

1. Install two new circuit breakers on the 33kV switchboard at Cockenzie GSP
2. Provide a dedicated connection to a new 33/11kV substation by installing two new 33kV underground cable circuits with associated comms infrastructure from the Cockenzie GSP to the new substation site, located to the west of Cockenzie.
3. Commission two 33/11kV primary transformers.
4. Install a 7-panel 11kV switchboard.
5. Lay 1km of 11kV underground cable, connecting into the Tranent 11kV network, taking on ca. 5MW ring from St Clement site.
6. Lay 1km of 11kV underground cable, connecting into the Monktonhall 11kV network, taking on Tesco and Pinkie Mains IDNO sites.
7. Procure flexibility services to manage the network risk through the delivery stage at a cost of £216k.

The proposed solution represents the lowest cost and most efficient engineering solution to meet the forecast demand growth when compared with the alternative schemes identified.

The estimated cost for the above is £5.198m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

It is also recommended to continue annual tendering for flexibility in this area to procure enough capacity and review the proposed conventional/build solutions or in the likely case of additional demand uptake in the group.

Due to the complexity of the circuits and the overall project, it is proposed to start the works in 2023/24 and the release capacity of 32MVA will be claimed in 2027/28 at the end of the project.

8 Appendices

Appendix 1. System Study Results

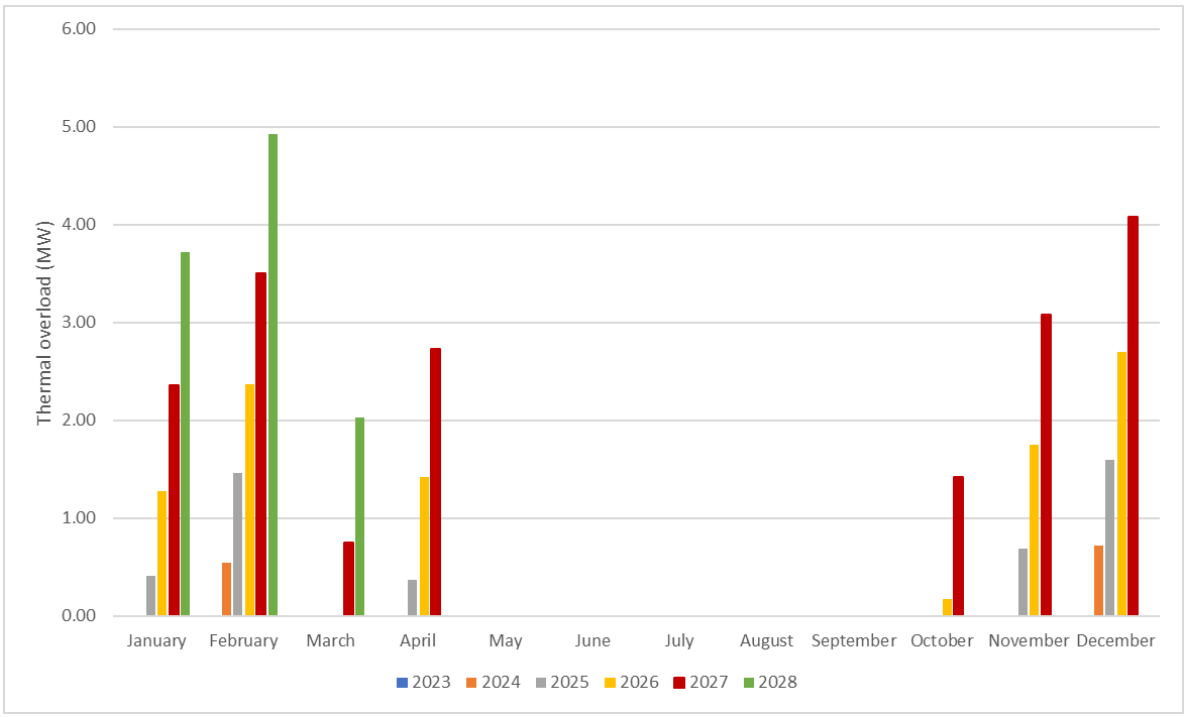

Figure 11. Monthly maximum overload on 33/11kV Monktonhall transformer

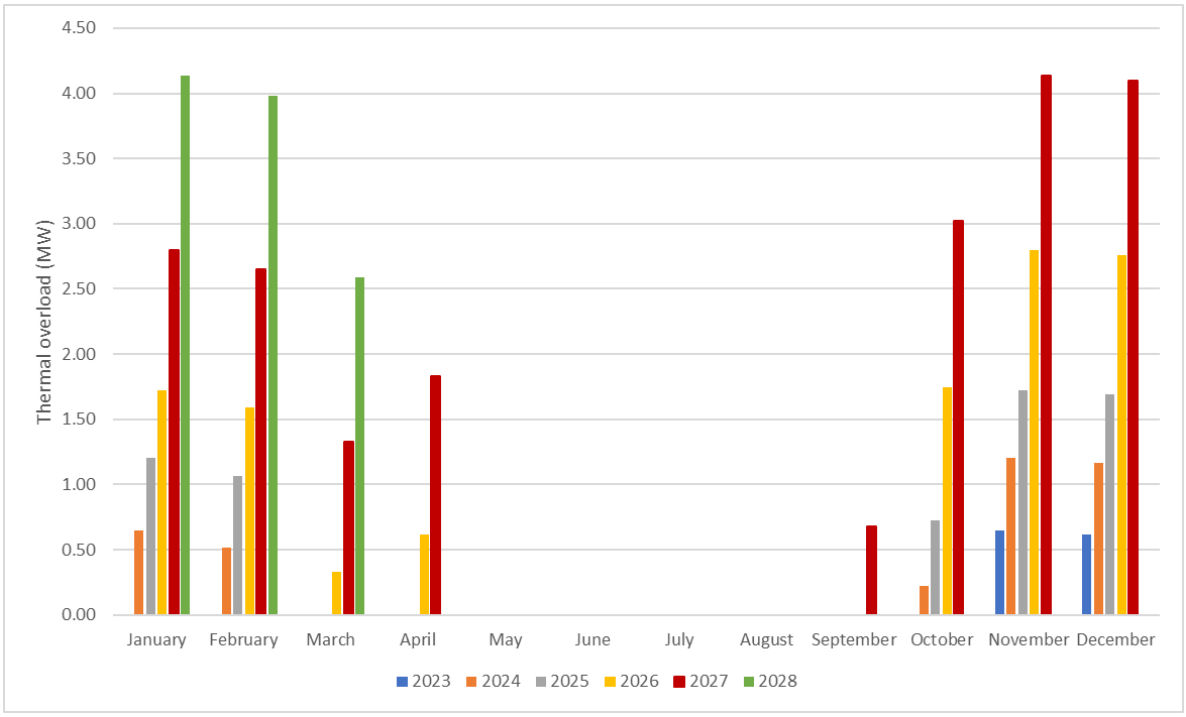

Figure 12. Monthly maximum overload on 33/11kV Tranent transformer