Colwyn Bay - Dolgarrog 33kV Reinforcement

ED2 Engineering Justification Paper

ED2-LRE-SPM-005-CV1-EJP

Issue	Date	Comments
Issue 0.1	January 2021	Issue to internal governance and external assurance
Issue 0.2	April 2021	Reflecting comments from internal governance
Issue 0.3	May 2021	Reflecting assurance feedback
Issue 1.0	June 2021	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	Final Business Plan Submission

Scheme Name	Colwyn Bay - Dolgarrog 33kV Reinforcement		
Activity	Primary reinforcement		
Primary Investment Driver	Security of supply		
Reference	ED2-LRE-SPM-007-CV1-EJP		
Output Type	Load Index		
Cost	**SPM -** £0.405m		
Delivery Year	2024-2028		
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	**£0.405m**	**£m**

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:	Colwyn Bay – Dolgarrog 33kV Reinforcement
Project Reference:	ED2-LRE-SPM-007-CV1-EJP
Decision Required:	To give concept approval to contract with flexibility services provides and install 25MVA series reactor in 33kV circuit between Colwyn Bay & Dolgarrog.

Summary of Business Need:

The SP Manweb (SPMW) network in North Wales around the Colwyn Bay, Llandudno, Dolgarrog, and Conway is supplied from Connahs Quay / St Asaph's / Pentir GSP group. The 132kV network group secures Colwyn Bay / Dolgarrog 33kV group supplying over 50,121 customers which includes several recreational/tourist destinations spread across the network.

The demand and generation are not uniformly distributed across the group with two of the three 33kV interconnectors between Colwyn Bay grid and Dolgarrog having reasonably long or high impedance 33kV circuits (>28kms length) leading to increased loading on the direct interconnector which is 14.2kms. System studies indicate that with the increased demand from 10115 Electric Vehicles and 6314 Heat Pumps the 33kV circuit between Colwyn Bay – Dolgarrog will be loaded beyond the cyclic ratings and would lead to potential cascade tripping of the group and loss of supplies to over 40000 customers during 132kV N-1-1 outage situations.

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

Proposed works include:

- Contract with flexibility services providers in the group from year 2023/24 through 2027/28 to manage the network constraint.
- Installation of 25MVA X=5% 33kV circuit reactor at Colwyn Bay 33kV grid substation, to be installed in series with the circuit between Colwyn Bay – Dolgarrog.

The estimated cost for the above is £0.405 (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

Expenditure Forecast (Where available based on Regulatory Allowance – 2020/21)

License Area	Reporting Table	Description	Total (£m)	Incidence (£m)				
				2023/24	2024/25	2025/26	2026/27	2027/28
SPM	CV1	Primary Reinforcement	**0.366**	0.018	0.219	0.128	-	-
SPM	CV1	Flexible Services	**0.039**	0.007	0.007	0.008	0.008	0.010
This Proposal			**0.405**	0.025	0.226	0.135	0.008	0.010

PART B – PROJECT SUBMISSION

Proposed by	Kailash Singh	Signature	kp.Singh	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

The SP Manweb (SPM) network in North Wales around the Colwyn Bay, Llandudno, Dolgarrog, and Conway is supplied from Connahs Quay / St Asaph's /Pentir GSP group. The 132kV network group secures Colwyn Bay / Dolgarrog 33kV group supplying over 50,121 customers which includes several recreational/tourist destinations spread across the network. Figure 1 shows the SPM 132kV and 33kV network area fed from Colwyn Bay / Dolgarrog grid network.

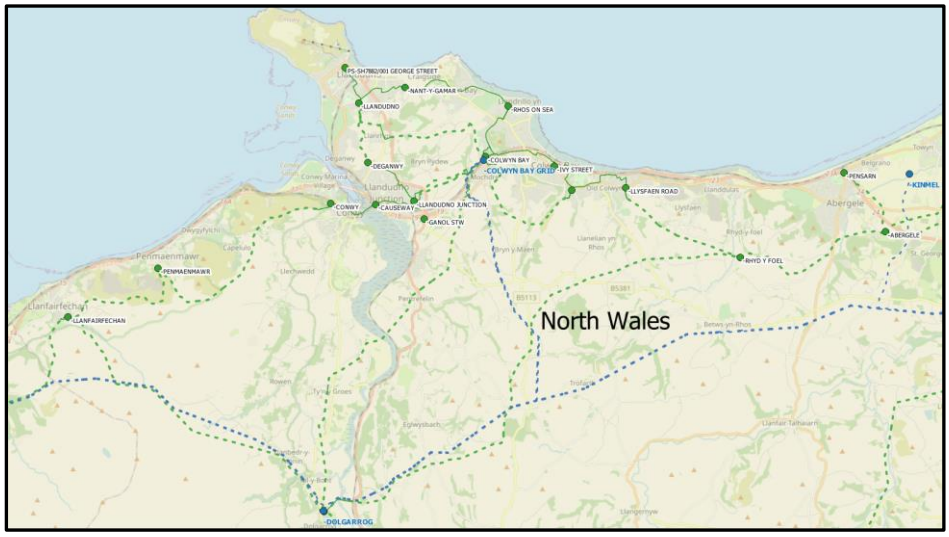

Figure 1. 132kV and 33kV network around Colwyn Bay and Dolgarrog

The existing firm capacity of the Colwyn Bay / Dolgarrog group is 92.5MVA and the present load index position is LI1 with loading at 74% of the group capacity. However, the existing 132kV Connahs Quay/St Asaph/Pentir network is classed as P2/7 Group E (≥300MW) with the network demand of 374.8MVA (winter) and 350MVA (summer). EREC P2/7 states that a class 'E' group, as a minimum must be secured for a Second Circuit Outage (SCO). With the current running arrangement of the GSP group the existing network is adequate to meet the security of supply criteria and secure the customer supplies for N-1-1 outages at 132kV.

system studies indicate that with the additional demand from 10115 Electric Vehicles and 6314 Heat Pumps during maintenance outage of 132kV St. Asaph – Colwyn Bay circuit followed by an outage of 132kV Pentir -Colwyn Bay circuit, the 33kV circuit between Colwyn Bay – Dolgarrog will be thermally overload close the protection settings of the circuit and would lead to potential cascade tripping of the group and loss of supplies to over 40000 customers for during summer maintenance period.

In order to secure supplies within the group, meet the licence obligations under EREC P2/7 – Security of Supply and to accommodate future demand growth within the area, it is proposed to carry out system reinforcement in the RIIO-ED2 price control period. The proposed scheme includes:

- Contract with flexibility services providers in the group from year 2023/24 through 2027/28 to manage the network constraint.
- Installation of 25MVA X=5% 33kV circuit reactor at Colwyn Bay 33kV grid substation, to be installed in series with the circuit between Colwyn Bay – Dolgarrog.

Total scheme cost – £0.405m (2020/21 prices), with 100% contribution to be included in the RIIO-ED2 load related expenditure.

2 Background Information

2.1 Network supply / circuit capacity

The existing 33kV Colwyn Bay/Dolgarrog network is classed as P2/7 Group D (≥60MW up to 300MW) Table 2.1 shows the existing network supply position of the 33kV groups.

Table 2.1. Summary of Colwyn Bay / Dolgarrog 33kV grid group

Substation	No. of customers	Scenario	LI firm capacity	Maximum demand	Load Index	Group P2/7 Class
33kV						
Colwyn Bay GT1/ Colwyn Bay GT2 / Dolgarrog GT2	50121	N-1	92.5	68.8	LI1	D

2.2 Existing/Authorised Network

The existing 33kV network comprises a long overhead line circuits and is supplied by 2 x 45MVA grid transformers located Colwyn Bay and 1 x 60MVA grid transformer at Dolgarrog. The 33kV group is supplied from the Connahs Quay / St Asaph / Pentir GSP group. The 33kV network group secures HV network comprising of 20 primary transformers and these primary transformers supply 50,121 customers. The authorised 33kV Colwyn Bay/Dolgarrog grid group network is shown in Figure 2.

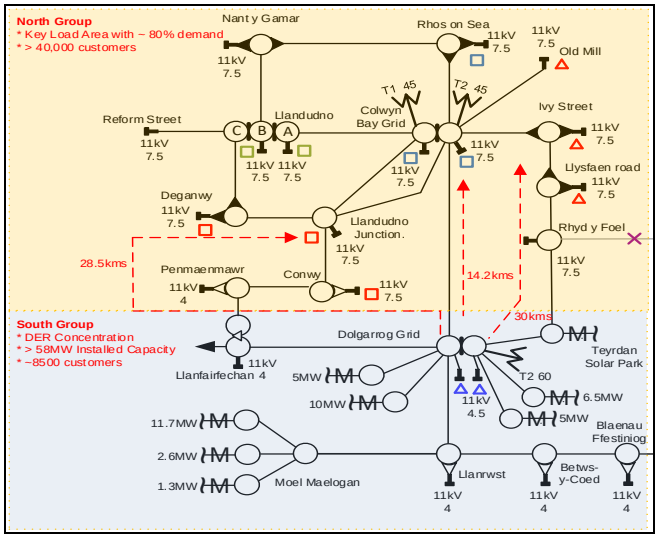

Figure 2. 33kV network around Colwyn Bay and Dolgarrog

2.3 Fault levels

There are no fault level related constraints in the 33kV group network.

2.4 Embedded Generation and Demand connections

The 33kV group network has significant penetration of distributed generation with 58.9MW generation as shown in Table 2.2.

Table 2.2. Connected/Contracted generation

Site	Status	Type	Registered capacity(MW)
Dolgarrog Power Station	Connected	Hydro	12
Teyrdan Solar Park	Connected	Solar	4.51
Moel Maelogan	Connected	Onshore wind	29.6
Total			**58.9**

3 Needs Case

The 33kV Colwyn Bay / Dolgarrog network supplies 50,121 customers cover widespread supply area (>300km²) which is part of the North Wales. The load and generation are not uniformly distributed across the group and the demand is supplied via long overhead line circuits. The generation connections are concentrated in southern part around Dolgarrog grid substation and key load centre with over 40,000 customers is in northern part around Colwyn Bay grid substation.

The existing 132kV Connahs Quay/St Asaph's/Pentir network is classed as P2/7 Group E (≥300MW) and EREC P2/7 states that a class 'E' group, as a minimum must be secured for a Second Circuit Outage (SCO). However, system studies indicate that with the additional demand from 10115 Electric Vehicles and 6314 Heat Pumps during maintenance outage of 132kV St. Asaph – Colwyn Bay circuit followed by an outage of 132kV Pentir -Colwyn Bay circuit, the 33kV circuit between Colwyn Bay – Dolgarrog will be thermally overload to **137%** which is close the protection settings of the circuit and would lead to potential cascade tripping of the group and loss of supplies to over 40000 customers for during summer maintenance period.

The 132kV Connahs Quay/St Asaph' s/Pentir GSP network group will be "Non-Compliant" and it is proposed to carry out system reinforcement in the RIIO-ED2 price control period in order to accommodate future demand growth within the area, secure supplies within the group, meet the licence obligations under EREC P2/7 – Security of Supply.

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 Local Considerations and stake holder feedback

As part of DFES scenario development SPEN held stakeholder engagement sessions with councils to continue to refine the understanding of their economic growth plans and other drivers. This helps determine the resultant demand increase and impact on our network.

3.1.1.1 Electric Vehicles Charging Strategy

In December 2020, Welsh Government published their electric vehicles charging strategy[1] to facilitate transition of Wales towards Net-Zero in-line with UK Government's targets with a vision that by 2025, all users of electric cars and vans in Wales are confident that they can access electric vehicle charging infrastructure when and where they need it. Welsh Government to invest in public charging infrastructure to at least meet the demand created by 60% of new sales for cars and vans being electric vehicles by 2030. Welsh Government is proposing to invest in the region of £30m over the next five-year period on electric vehicle charging to make this strategy happen.

3.1.2 Distribution Future Energy Scenarios

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.

[1] https://gov.wales/sites/default/files/consultations/2020-12/electric-vehicle-charging-strategy-consultation-document.pdf

The peak demand forecast based on DFES, including authorised connections for the 33kV Colwyn Bay/ Dolgarrog grid group and 132kV Connahs Quay/St Asaph / Pentir group are depicted in Figure 3 and Figure 4. The anticipated total electric vehicle and heat pump uptakes based on the future energy scenarios is depicted in Figure 5.

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.

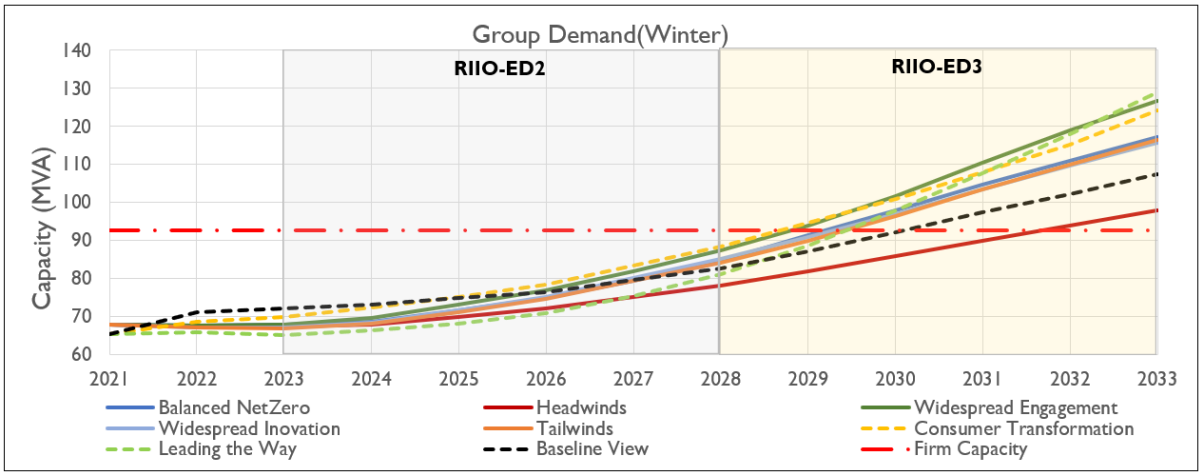

Figure 3. Demand (MVA) forecast for 33kV Colwyn Bay / Dolgarrog grid group

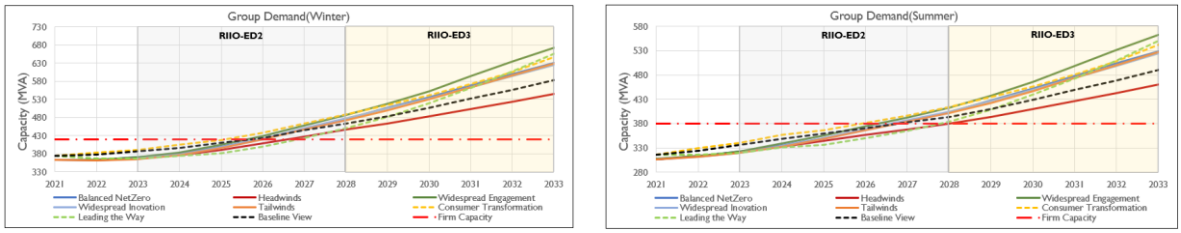

Figure 4. Demand (MVA) forecast for 132kV Connahs Quay / Pentir / St Asaph GSP group

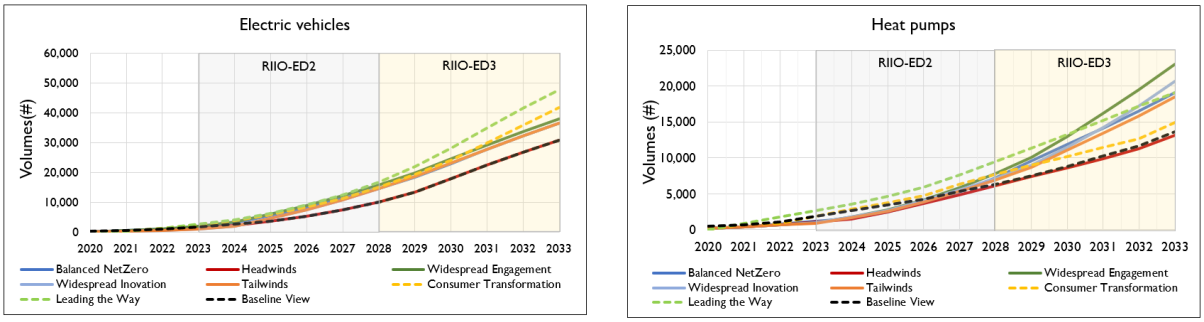

Figure 5. Forecast Electric Vehicle and Heat Pump uptakes for 132kV GSP group

3.1.3 Baseline View

For the 33kV 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
Winter (N-1)													
Forecast Demand (MVA)	65	71	72	73	75	76	80	83	87	92	97	102	107
Firm Capacity (MVA)	93	93	93	93	93	93	93	93	93	93	93	93	93
Utilisation (%)	71	77	78	79	81	82	86	89	94	99	105	110	116
Load Index	LI1	LI1	LI1	LI1	LI2	LI2	LI2	LI2	LI2	LI4	LI5	LI5	LI5

3.2 Network Impact Assessment

Detailed network studies covering network intact, N-1 and N-1-1 outage conditions and fault level assessments were carried out for the 33kV network fed from Colwyn Bay / Dolgarrog grid 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 2024 through 2028 determined the risk hours and the capacity required to overcome the constraint by using flexibility services. The key results from the half hourly profile-based simulations are furnished in Appendix-2.

The findings from the network impact assessments are detailed in sections below.

3.2.1 Thermal Constraints

Considering the DFES forecast demand in the group, the thermal constraints that would appear in the RIIO-ED2 period are listed in Table 3.2.

Table 3.2. Thermal constraint at 33kV voltage level

Section	Length (km)	MVA Rating (Cont. / Cyclic)		Winter Loading (MVA)	Summer Loading (MVA)	Outage Scenario
		Winter	Summer			
Colwyn Bay to Dolgarrog	14.2km	16.92 / 19.2	13.55 / 15.38	**9.1**	**18.6**	**Summer (N-1-1):** Pentir-Colwyn Bay Circuit + St Asaph Colwyn Bay Circuit

3.2.2 Flexibility services

Our assessments indicate that the network constraints in the 33kV group network starts from 2024 throughout to the year 2028 for the most onerous scenario. In order to manage the network risk and security of supply constraint a max capacity of ca. 3.2MW is required to alleviate the constraints. Table 3.3 below shows flexibility services in terms of the network risk hours and tendered capacity.

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

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Annual hours at risk (Hrs)	118	147.5	174	225.5	335
Required Flexible Capacity (MW)	2.2	2.3	2.5	2.7	3.2

4 Optioneering

Table 4.1 shows a summary of the options considered for this reinforcement. The Option 2 represents the lowest cost solution, i.e. the minimum level of intervention.

Table 4.1. Longlist of solution options

#	Options	Status	Reason for rejection
(a)	No Intervention	Rejected	Not compliant with ESQCR, Distribution code limits and security of supply requirements as per 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)	Uprating 33kV 13.56km OHL section of the circuit between Colwyn Bay - Dolgarrog.	Considered (**Baseline**)	-
(d)	New 2 x 33kV Circuit to Old Mill by Loop into existing 33kV circuit between Dolgarrog – Teyrdan.	Considered **(Option 1)**	-
(e)	New 33kV 25MVA series reactor between existing Colwyn Bay - Dolgarrog circuit and operational management via flexibility services.	Considered (**Option 2**)	-
(g)	New 33kV circuit between Dolgarrog – Colwyn Bay.	Considered (**Option 3**)	-
(h)	New 132/33kV grid infeed at Colwyn Bay.	Rejected	The overall scheme cost for new 132kV grid infeed along with 12 kms 132kV cable circuit will be significantly higher and will have a long lead time due to environmental planning and clearances required for the circuit.

5 Detailed Analysis & Costs

Demand and generation are not uniformly distributed across the group with two of the three 33kV interconnectors between Colwyn Bay grid and Dolgarrog having reasonably long or high impedance 33kV circuits (>28kms length) leading to increased loading on the direct interconnector which is 14.2kms.

System studies indicate that these imbalance in 33kV circuit loading leads to **137%** loading on the Colwyn Bay -Dolgarrog circuit during N-1-1 during maintenance outage of 132kV St Asaph – Colwyn Bay circuit followed by an outage of 132kV Pentir -Colwyn Bay circuit and these overloading issues cannot be operationally managed and an appropriate mitigation measure would be required within RIIO-ED2 price control period.

5.1 Proposed Option (Option 2) – Series reactor and flexibility services

The proposed solution is to alleviate network constraints by combination of conventional meshed network load balancing solution via series reactor and flexibility services. The proposed solution includes:

Table 5.1. Proposed option summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Flexibility services and Conventional Circuit	Colwyn Bay - Dolgarrog 33kV reinforcements	• Contract with flexibility services providers in the group from year 2023/24 through 2027/28 to manage the network constraint. • Installation of 25MVA X=5% 33kV circuit reactor at Colwyn Bay 33kV grid substation, to be installed in series with the circuit between Colwyn Bay – Dolgarrog.	0.405	-

Considering the circuit length of the Colwyn Bay – Dolgarrog (14.2kms) circuit being 50% lower than other two interconnectors (28.5kms and 30kms), it is proposed to install reactor in series with the Colwyn Bay – Dolgarrog 33kV circuit which will reduce the power flow from the circuit and enable balance of flow between the three interconnectors. System studies indicate that balance of power flow between the interconnectors will reduce the intact network losses by 70.08 MWh annually.

In addition to the series reactor, flexibility services will support during project delivery period and support operational management of the network enabling transfer capacity from Rhyl/St Asaph/Holywell 33kV group network. The increase in capacity and cost of flexibility, due to demand growth, was considered against the benefit of deferral in each year of RIIO-ED2. This is assessed using flexibility to manage the constraint while the level and number of risk hours is relatively low, to commission the above proposed works when efficient to do so. The annual reinforcement deferral ceiling cost was calculated to be £55k per year to manage the constraint via flexibility. Summary of anticipated cost of flexibility services from recent round of tenders along with annual ceiling cost is shown in Table 5.2. This includes a total of 1.6MW of flexibility in the RIIO-ED2 period.

Table 5.2. Summary of flexibility service costs

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Qualified capacity (MW)	2.2	2.3	2.5	2.7	3.2
Reinforcement Deferral Ceiling Cost - per year	£0.055m	£0.055m	£0.055m	£0.055m	£0.055m
Cost of Flexibility Services (Qualified Capacity)	£0.007m	£0.007m	£0.008m	£0.008m	£0.010m
Flexibility Outlook	●	●	●	●	●

● *Accept bids to support operational management of the network constraint. Future tendering to secure full capacity.*

● *Reject bids and deliver reinforcements*

It is recommended to continue annual tendering for flexibility in this area to procure enough capacity and review the need for reactor installation depending on future tenders resulting competitive bids enabling to defer the reinforcement.

The estimated cost for the above is £0.405 (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

Table 5.3 shows a summary of reinforcement costs and volumes for the proposed option within RIIO-ED2. Figure 6 shows proposed 33kV works.

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)	0.10	0.024	0.024	-
Civil Works at 33 kV & 66 kV Substations		0.060	0.060	-
Other Costs (Identify Below)		0.281	0.281	-
Cost of Flexibility for the year 2023/24 – 2027/28		0.039	0.039	-
Total Costs		**0.405**	**0.405**	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
Associated protection, control and SCADA equipment located at a site and remote ends (£40k)				
33kV 25MVA X=5% Series Reactor (£225k)				
Design Studies (£15k)				

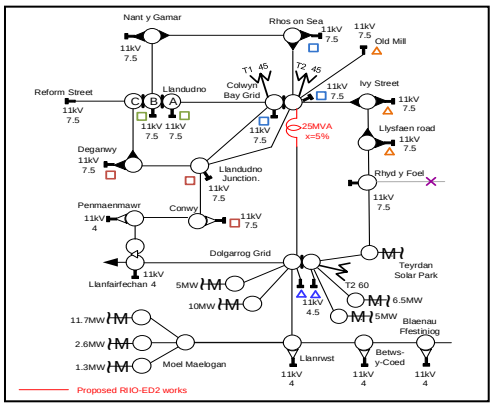

Figure 6. Proposed works in the 33kV group

5.2 Baseline – Uprating 33kV circuit between Colwyn Bay to Dolgarrog

The baseline option is to uprate the existing 33kV 13.56kms 0.1cu section between Colwyn Bay – Dolgarrog 33kV circuit with 150mm² ACSR. System studies indicate that this option will reduce the intact network losses by 131.4 MWh annually. Table 5.4 shows baseline option scheme summary.

Table 5.4. Baseline option summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Conventional Circuit	Colwyn Bay - Dolgarrog 33kV reinforcements	• Uprating 13.56kms 0.1cu section between Colwyn Bay - Dolgarrog by 150mm2 AAAC Poplar with OPPC.	1.373	-

Under this option it is proposed to start the reinforcement works from year 2023/24 and deliver the project in 2025/26. However, this option is rejected as the option does not represent the minimum level of intervention and has lower NPV against proposed option.

Table 5.5 shows a summary of reinforcement costs and volumes for the baseline option within RIIO-ED2. Figure 7 shows proposed 33kV works.

Table 5.5. Baseline option summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
33kV OHL (Pole Line) Conductor	13.56	0.354	0.354	-
33kV Pole	10.00	0.030	0.030	-
33kV UG Cable (Non-Pressurised)	0.20	0.049	0.049	-
Pilot Wire Overhead	13.56	0.366	0.366	-
Pilot Wire Underground	1.00	0.111	0.111	-
Wayleaves/Easements/Land Purchase		0.247	0.247	-
Other Costs (Identify Below)		0.217	0.217	
Total Costs		**1.373**	**1.373**	**-**
Identify activities included within other costs (please provide high-level detail of cost areas)				
Associated protection, control and SCADA equipment located at a site and remote ends (£75k)				
Environmental survey and studies (£32k)				
River Crossing, Railway Crossing and Traffic Management (£75k)				
Planning and Design Studies (£35k)				

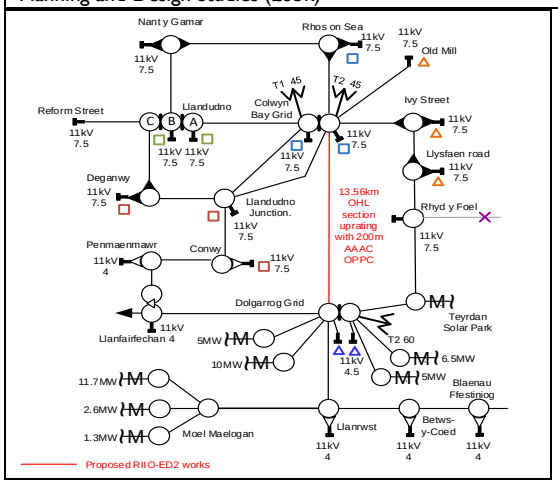

Figure 7. Works under Baseline option in the 33kV group

5.3 Option 1 – New 33kV circuit to Old Mill

This option considers establishing a new 33kV circuit between Dolgarrog to Old Mill and Old Mill to Teyrddan Solar Park by loop into existing circuit between Dolgarrog to Teyrddan Solar Park. The proposed works under this option also includes installation of a new 33kV 5-Panel switchboard at Old Mill. System studies indicate that this option will increase the intact network losses by 70.08 MWh annually.

This option is rejected due its relatively high cost and does not represent minimum level of intervention required. Table 5.6 shows the scheme summary.

Table 5.6. Option 1 scheme summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)
Conventional Substation	Colwyn Bay - Dolgarrog 33kV reinforcements	• Installation of 5-Panel 33kV Switchboard at Old Mill. • New 2 x 33kV circuit to Old Mill by loop into existing 33kV OHL between Dolgarrog - Teyrddan Solar Park.	4.444

Table 5.7 shows a summary of reinforcement costs and volumes for Option 1 within RIIO-ED2. Figure 8 shows proposed 33kV works.

Table 5.7. 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	0.10	0.003	0.003	-
33kV Pole	2.00	0.006	0.006	-
33kV UG Cable (Non Pressurised)	8.00	1.941	1.941	-
33kV CB (Gas Insulated Busbars) (ID) (GM)	5.00	0.852	0.852	-
Pilot Wire Underground	8.00	0.886	0.886	-
Civil Works at 33 kV & 66 kV Substations		0.210	0.210	-
Wayleaves/Easements/Land Purchase		0.266	0.266	-
Other Costs (Identify Below)		0.280	0.280	-
Total Costs		**4.444**	**4.444**	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
Associated protection, control and SCADA equipment located at a site and remote ends (£105k)				
Environmental considerations, survey and studies (£75k)				
Planning and design studies (£50k)				
River Crossing and Traffic Management(£50k)				

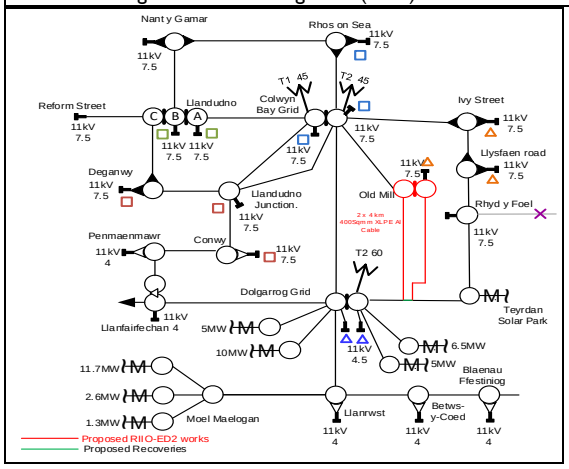

Figure 8. Works under Option 1 in the 33kV group

5.4 Option 3 – New 33kV circuit between Colwyn Bay – Dolgarrog

This option considers establishing a new 33kV circuits between Colwyn Bay to Dolgarrog with 14kms circuit up to Llandudno Junction and will be interconnected with existing Llandudno Junction – Colwyn Bay 33kV circuit which will be re-routed to Dolgarrog. To accommodate the new 33kV circuit this option would require extending the 33kV switchboard at Dolgarrog grid substation. System studies indicate that this option will increase the intact network losses by 604.44 MWh annually.

This option is rejected due its relatively high cost and does not represent minimum level of intervention required. Table 5.8 shows the scheme summary.

Table 5.8. Option 2 scheme summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)
Conventional Circuit	Colwyn Bay - Dolgarrog 33kV reinforcements	• New 33kV 14kms XLPE AL circuit between Dolgarrog-Llandudno. • Re-routing Llandudno Junction - Colwyn Bay circuit. • Extension of 33kV switch board Dolgarrog and installation of 1 outdoor 33kV breaker.	6.109

Table 5.9 shows a summary of reinforcement costs and volumes for Option 3 under RIIO-ED2. Figure 9 shows proposed 33kV works.

Table 5.9. Option 3 summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
33kV UG Cable (Non Pressurised)	0.20	3.397	3.397	-
33kV CB (Air Insulated Busbars)(OD) (GM)	1.00	0.058	0.058	-
Pilot Wire Underground	15.00	1.551	1.551	-
Civil Works at 33 kV & 66 kV Substations		0.096	0.096	-
Wayleaves/Easements/Land Purchase		0.353	0.353	-
Other Costs (Identify Below)		0.654	0.654	-
Total Costs		**6.109**	**6.109**	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
Associated protection, control and SCADA equipment located at a site and remote ends (£125k)				
Environmental survey and studies (£100k)				
River Crossing, 2 x Railway Crossing and Traffic Management (£375k)				
Planning and Planning and Design Studies (£54k)				

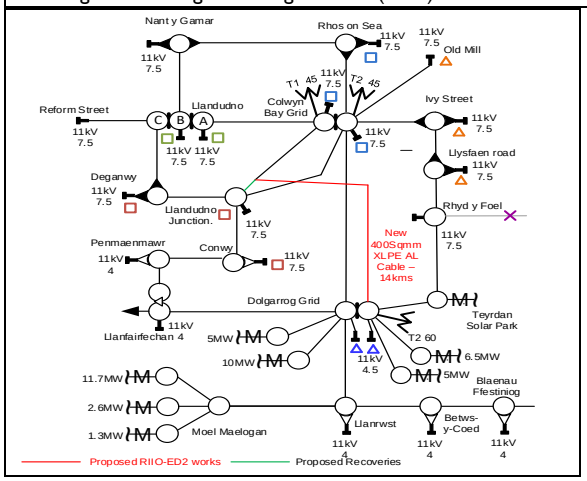

Figure 9. Proposed works under Option 3 at 33kV group network

5.5 Options Cost Summary Table

Summary of the costs for each of the evaluated options is presented in Table 5.10.

Table 5.10. Cost summary for considered options

Options	Option Summary	RIIO-ED2 Cost (£m)
Baseline	Uprating 33kV 13.56km OHL section of the circuit between Colwyn Bay - Dolgarrog.	1.373
Option 1	New 2 x 33kV Circuit to Old Mill by Loop into existing 33kV circuit between Dolgarrog – Teyrddan.	4.444
Option 2	New 33kV 25MVA series reactor between existing Colwyn Bay -Dolgarrog circuit and operational management via flexibility services.	0.405
Option 3 (Proposed)	New 33kV circuit between Dolgarrog – Colwyn Bay.	6.109

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 to install 25MVA X=5% reactor at Colwyn Bay in series with the existing 33kV circuit between Colwyn Bay to Dolgarrog. It is also proposed to contract flexibility services from 2023/24 to 2027/28 which will support during project delivery period and support operational management of the network enabling transfer capacity from Rhyl/St Asaph/Holywell 33kV group 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 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-SPM-007-CV1-CBA –Colwyn Bay-Dolgarrog 33kV 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: Uprating 33kV 13.56km OHL section of the circuit between Colwyn Bay - Dolgarrog.	Rejected	Discounted based on higher scheme cost and lower NPV against proposed option.	-	-	-	-
Option 1: New 2 x 33kV Circuit to Old Mill by Loop into existing 33kV circuit between Dolgarrog – Teyrddan.	Rejected	Discounted based on higher scheme cost and lower NPV against proposed option.	-£4.93	-£7.54	-£9.10	-£10.32
Option 2: New 33kV 25MVA series reactor between existing Colwyn Bay -Dolgarrog circuit and operational management via flexibility services.	**Adopted**	The proposed option is the minimum cost solution within RIIO-ED2 and enables to manage the network constraints demonstrating better value to the customers.	£0.54	£0.73	£0.85	£0.94
Option 3: New 33kV circuit between Dolgarrog – Colwyn Bay.	Rejected	Discounted based on higher scheme cost and lower NPV against proposed option.	-£3.02	-£3.97	-£4.54	-£4.97

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 £0.405m.

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)	0.10	0.024	.024	-
Civil Works at 33 kV & 66 kV Substations		0.060	0.060	-
Other Costs (Identify Below)		0.281	0.281	-
Cost of Flexibility for the year 2023/24 – 2027/28		0.057	0.057	-
Total Costs		**0.405**	**0.405**	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
Associated protection, control and SCADA equipment located at a site and remote ends (£40k)				
33kV 25MVA X=5% Series Reactor (£225k)				
Design Studies (£15k)				

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

Total Investment	Total	Incidence (£m)				
	(£m)	2023/24	2024/25	2025/26	2026/27	2027/28
CV1 – Primary Reinforcement	0.366	0.018	0.219	0.128	-	-
CV1 – Flexible Services	0.039	0.007	0.007	0.008	0.008	0.010
Total Cost	0.405	0.025	0.226	0.135	0.008	0.010

6.4 Risks

The network risk of transferring demand into the 33kV Rhyl / St Asaph /Holywell grid group at a time when it is operating abnormally is managed through using flexibility services to reduce the hours at risk.

The combination of reactor and flexibility services mitigates the risk of shortfall in flexibility services, or flexibility services terminating contracts at short notice. Further we will continue to tender for flexibility services in this area which will enable competitive bids to procure additional capacity.

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 security of supply risk. The investment does not have a strong reliance on environmental benefits.

6.6.2 Payback Periods

The CBA indicates that proposed option demonstrates better NPV results in assessment periods (10, 20, 30 and 45 year) 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 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	10,115	8,076	14,988	16,842	14,626	10,115	15,901	14,500	14,500
HPs	6,314	4,944	7,710	9,493	7,238	6,090	7,823	7,123	6,892

*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

Solution Requirements	RIIO-ED1				RIIO-ED2					RIIO-ED3				
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Baseline					F	F	R[1]	F	F	F	F	F	F	F
Leading the Way					F	F	R[1]	F	F	F	F	F	F	R[2]
Consumer Transformation					F	R[1]	F	F	F	F	F	F	F	R[2]
Balanced Net Zero Pathway					F	R[1]	F	F	F	F	F	F	F	R[2]
Headwinds					F	F	R[1]	F	F	F	F	F	F	F
Widespread Engagement					F	R[1]	F	F	F	F	F	R[2]		
Widespread Innovation					F	R[1]	F	F	F	F	F	F	F	R[2]
Tailwinds					F	R[1]	F	F	F	F	F	F	F	R[2]

F – Utilise flexibility services to support network during reinforcement delivery
R[1] – 33kV series reactor
R[2] – Uprating 33kV circuit

The proposed solution is robust across a wide range of pathways. In Baseline and Headwinds scenario this solution is expected to endure by end of RIIO-ED3. 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. Under higher uptake scenarios some additional flexibility may be required during the RIIO-ED2 period, thereafter the 33kV circuit between Colwyn Bay to Dolgarrog is likely to require uprating by end of RIIO-ED3.

Table 6.6: Sensitivity of the proposed RIIO-ED2 expenditure

	Baseline	Uncertain
RIIO-ED2 Expenditure (£m)	0.405	0.007
Comment	Proposed option	-

6.6.4 Asset Stranding Risks & Future Asset Utilisation

Electricity demand 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. Solution selection was not found to be sensitive to the impact of the carbon cost of losses.

Losses have been considered as part of this design solution and it has not been necessary to carry out any losses justified upgrades.

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 Colwyn Bay – Dolgarrog 33kV Reinforcement programme will result in the emissions of embodied carbon arising from the manufacture and supply of components associated with delivery of the programme. The installation of a new series reactor has the potential to increase network losses, with an impact on SPEN's Business Carbon Footprint (BCF).

During the evaluation of the options associated with the Colwyn Bay-Dolgarrog 33kV reinforcement 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.

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

6.7.2 Supply chain sustainability

For us to take full account of the whole-life carbon impact of our Colwyn Bay – Dolgarrog 33kV 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.

6.7.3 Resource use and waste

The Colwyn Bay – Dolgarrog 33kV 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 Colwyn Bay – Dolgarrog 33kV Reinforcement programme will affect named sites containing existing assets, therefore 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. However, as the Colwyn Bay – Dolgarrog 33kV Reinforcement programme consists of relatively minor works to sites containing existing assets, there will not be visual impact for us to mitigate in this instance.

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

The proposed option is to install 25MVA X=5% reactor at Colwyn Bay in series with the existing 33kV circuit between Colwyn Bay to Dolgarrog. It is also proposed to contract flexibility services from 2023/24 to 2027/28 which will support during project delivery period and support operational management of the network enabling transfer capacity from Rhyl/St Asaph/Holywell 33kV group network. The proposed solution represents the minimum level of intervention required to mitigate the security of supply risk within the 33kV group network.

The estimated cost for the above is £0.405m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

8 Appendices

Appendix 1. Key Study Results

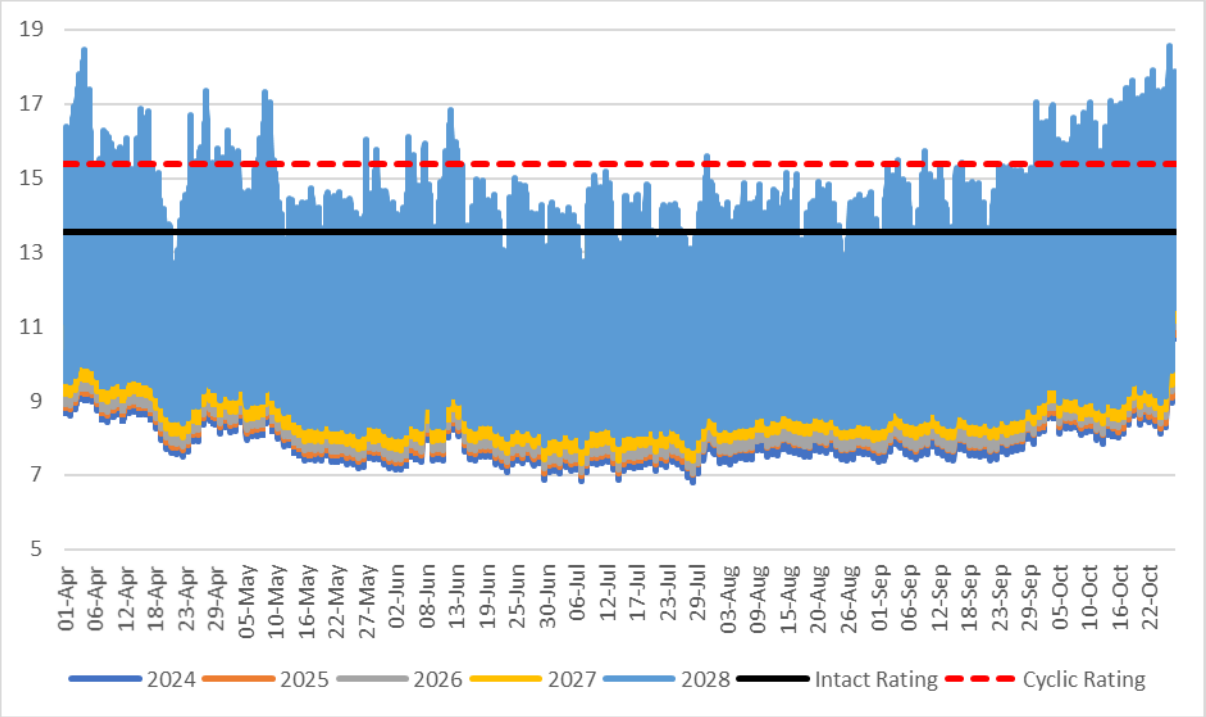

Figure 10. 33kV Colwyn Bay – Dolgarrog circuit loading profile during N-1-1 outage (Summer)

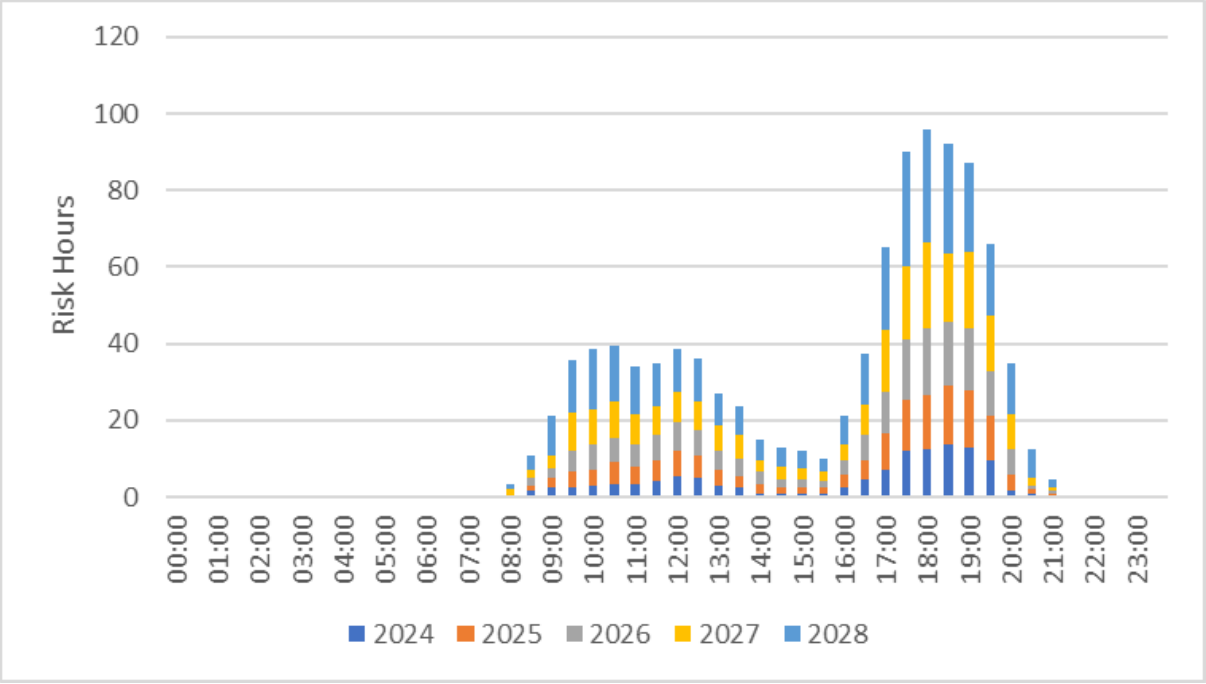

Figure 11. Calculated daily network risk hour window