Connahs Quay 132kV Reinforcement

ED2 Engineering Justification Paper

ED2-LRE-SPM-001-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	Issue for inclusion into Draft Business Plan submission
Issue 1.1	Oct-21	Reflecting updated DFES forecasts
Issue 1.2	Nov-21	Reflecting updated CBA results
Issue 2.0	December 2021	Issue for inclusion into Final Business Plan submission

Scheme Name	Connahs Quay 132kV Reinforcement		
Activity	Primary reinforcement		
Primary Investment Driver	Thermal constraints		
Reference	ED2-LRE-SPM-001-CV1-EJP		
Output Type	Load Index		
Cost	**SPM -** £8.855m		
Delivery Year	2026-2028		
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	**£8.855m**	**£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:	**Connahs Quay 132kV Reinforcement**
Project Reference:	**ED2-LRE-SPM-001-CV1-EJP**
Decision Required:	**To give concept approval for establishment of new 132/33kV 60MVA transformer at Deeside Park and installation of 132kV circuit breakers at Connahs Quay substation.**

Summary of Business Need:

The SP Manweb (SPM) network surrounding Flintshire, Deeside, Deeside industrial area, Connahs Quay, Prestatyn, Rhyl, Bangor, Caernarfon and St Asaph area are supplied from Connahs Quay/St Asaph/Pentir GSP group. The group supplies 202,227 customers.

The network around Deeside and North Wales will see a significant demand increase including 30MVA demand connection that has already been contracted for the Northern Gateway and Deeside Airfields which would comprise of commercial and residential development projects.

The primary drivers for this investment are insufficient thermal headroom and security of supply risk. 132kV Connahs Quay / St Asaph / Pentir GSP is forecast to exceed its firm capacity of 420MVA (Winter period) and 380MVA (Summer maintenance period), by 2027 under all Distribution Future Energy Scenarios (DFES) and Climate Change Committee (CCC) scenarios. Our Baseline View forecasts a peak demand of 464MVA by 2028, with an expected uptake of up to 47,174 Electric Vehicles and 28,724 Heat Pumps by the end of the RIIO-ED2 period.

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

Proposed works include:

- Install new 132/33kV 60MVA GT at Deeside Park to support 30MVA demand around Deeside Industrial area.
- Installation of new 132kV Bus-Section circuit breaker at Connahs Quay to enable reconfiguration of Connahs Quay GSP to 2+2 SGT operational arrangement.
- Swap the Sixth-Avenue GT with RAF Sealand circuit which will enable to transfer the Sixth Avenue GT onto busbar section "C" and "Normal Open" bus-section reactor at Sixth-Avenue grid to reduce the fault levels.
- "Normal Open" the bus-section reactor at Hawarden to reduce the fault levels.
- Contract flexibility services to support the network during the project delivery.

It is proposed to start the works in 2025/26 and the capacity release of 100MVA at 132kV and 30MVA at 33kV will be claimed in 2027/28 at the end of the project. Additionally, 107MVA of fault level headroom will be created by the proposed scheme.

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	**8.800**	-	-	0.880	3.520	4.400
SPM	CV1	Flexible Services	**0.055**	-	-	-	0.055	-
This Proposal			**8.855**	-	-	0.880	3.575	4.400

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 surrounding Flintshire, Deeside, Deeside industrial area, Connahs Quay, Prestatyn, Rhyl, Bangor, Caernarfon and St Asaph area are supplied from Connahs Quay/St Asaph /Pentir GSP group. The group supplies 202,227 customers.

Deeside industrial area is a major manufacturing location with considerable strengths in the aerospace, automotive, construction, food, paper and packaging, electronics and sustainable energy sectors. Deeside is being continually developed and experiences significant customer connection activity in the form of either enquiries or applications to access the network capacity as part of which 30MVA is already secured by various developers for the development of industrial and residential sites along the Deeside Industrial Park. In addition to existing developments, there are significant development proposals driven by Welsh Government & regional development plans to meet the Net Zero targets by 2040 by decarbonising the heat and transport sectors

The primary drivers for this investment are insufficient thermal headroom and security of supply risk. 132kV Connahs Quay / St Asaph / Pentir GSP is forecast to exceed its firm capacity of 420MVA (Winter period) and 380MVA (Summer maintenance period), by 2027 under all Distribution Future Energy Scenarios (DFES) and Climate Change Committee (CCC) scenarios. Our Baseline View forecasts a peak demand of 464MVA by 2028, with an expected uptake of up to 47,174 Electric Vehicles and 28,724 Heat Pumps by the end of the RIIO-ED2 period.

In order, to secure supplies within the group as per Engineering Recommendation (EREC) P2/7, to meet the licence obligation for maintaining economic, efficient and coordinated network, to accommodate future demand growth within the area and to mitigate the thermal and security of supply constraints in the 132kV GSP group, it is proposed to:

- Install new 132/33kV 60MVA GT at Deeside Park to support 30MVA demand around Deeside Industrial area.
- Installation of new 132kV Bus-Section circuit breaker at Connahs Quay to enable reconfiguration of Connahs Quay GSP to 2+2 SGT operational arrangement.
- Swap the Sixth-Avenue GT with RAF Sealand circuit which will enable to transfer the Sixth Avenue GT onto busbar section "C" and “Normal Open” bus-section reactor at Sixth-Avenue grid to reduce the fault levels.
- "Normal Open" the bus-section reactor at Hawarden to reduce the fault levels.
- Contract flexibility services to support the network during the project delivery.

It is proposed to start the works in 2025/26 and the capacity release of 100MVA at 132kV and 30MVA at 33kV will be claimed in 2027/28 at the end of the project. Additionally, 107MVA of fault level headroom will be created by the proposed scheme.

The timing of the project is based on delivering the highest NPV, while maintaining security of supply. Detailed analysis indicates that with tendered flexibility service costs the proposed scheme can be deferred by 1 year (2026/27) as the flexibility service bids received for 2027/28 is ~ £2.7m which is considerably above the annual ceiling cost for reinforcement deferral. It is recommended to continue annual tendering for flexibility in this area to procure enough capacity and review the scheme depending on future tenders resulting competitive bids enabling to defer the proposed reinforcements.

The estimated cost for the above is £8.855 (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

2 Background Information

2.1 Existing/Authorised Network

Connahs Quay GSP site runs solid with 4x240MVA SGTs, all generally on load; two are isolated from the SPMW Connahs Quay 132kV site and directly connected to Shotton 132kV site. The other two SGTs serve group demand. At Pentir GSP site there are two 240MVA SGTs (SGT1 and 2) and both the SGTs runs split with SGT1 being currently run on open standby to accommodate a contracted generation project (Glyn Rhonwy pump storage plant) and SGT2 will supply the wider network load in the group. At St Asaph GSP site run solid with the group supplied via 1x240MVA SGT.

The 132kV Connahs Quay/St Asaph/Pentir GSP group supplies to 6 x 33kV groups comprising of 16 grid transformers with a total transformation capacity of 1035MVA and these 33kV groups feeds to 110 x 11kV groups supplying 202,227 customers.

The authorised 132kV group networks supplied from Connahs Quay/St Asaph/Pentir GSP group are shown in Figure 1 and the authorised network configuration of 33kV groups supplied from 132kV GSP group is presented in Appendix-1.

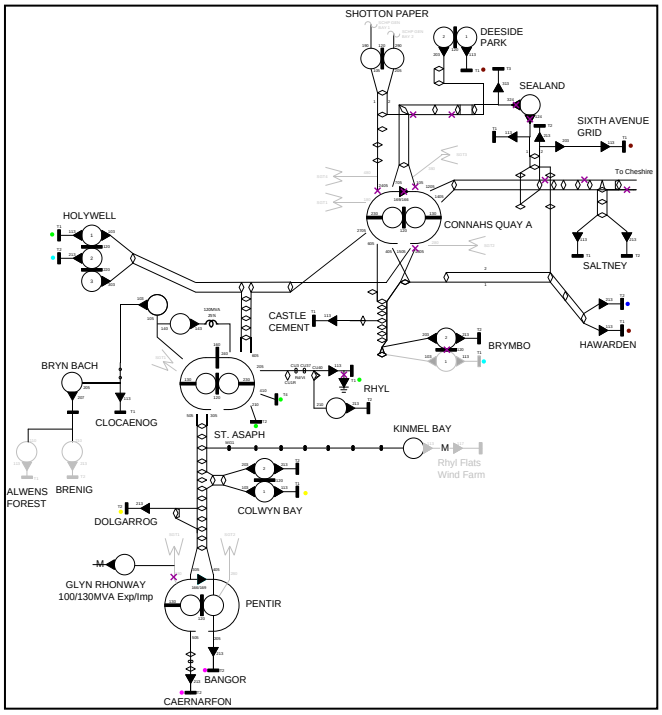


Figure 1. Authorised 132kV Connahs Quay /St Asaph / Pentir GSP group network

2.2 Network supply / circuit capacity

The existing 132kV Connahs Quay/St Asaph/Pentir network is classed as P2/7 Group E (≥300MW) with the network demand of 375MVA (winter) and 360MVA (summer) against firm capacity of 420MVA (N-1) and 380MVA (N-1-1). EREC P2/7 states that a class 'E' group, as a minimum must be secured for a Second Circuit Outage (SCO). The current running arrangement of the GSP group network is adequate to meet the security of supply criteria.

Table 2.1 shows the existing network supply position of the 132kV and 33kV groups.

Table 2.1. Summary of existing 132kV GSP group and 33kV grid groups

Substation	No. of customers	Scenario	LI firm capacity	Maximum demand	Load Index	Group P2/7 Class
132kV						
Connahs Quay/St Asaph/Pentir	202227	N-1	420.0	374.7	LI2	E
		N-1-1	380.0	359.5	LI2	
33						
Brymbo GT2 / Hawarden GT2 / Holywell GT2	26729	N-1	82.0	67.7	LI2	D
Castle Cement GT1 / Hawarden GT1 / Saltney GT1 / Saltney G2B	35897	N-1	119.8	81.0	LI1	D
Colwyn Bay GT1 / Colwyn Bay GT2 / Dolgarrog GT2	50121	N-1	92.5	64.1	LI1	D
Deeside Park GT1 / Sixth Ave GT1	1603	N-1	51.7	43.6	LI2	D
Holywell GT1 / Rhyl GT1 / St Asaph GT2 / St Asaph GT4	60209	N-1	112.9	101.2	LI2	D
Bangor GT2 / Caernarfon GT2	27668	N-1	82.1	46.2	LI1	D

System studies covering N-1/N-1-1 contingencies and short circuit calculations for the authorised 132kV network and 33kV groups fed from Connahs Quay/St Asaph/Pentir GSP group indicate that with the contracted demand and generation connections:

- capacity at 132kV Connahs Quay GSP feeding the 33-group network is close to thermal limits with the loading on the two SGT marginally exceeding 100% of rating during outage of either of the two SGTs. However, during N-1-1 outage of the SGTs, the thermal overload situation is operationally managed via transfer capacity from Legacy GSP group and capacity sharing from SGTs feeding Shotton paper.
- an N-1-1 outage at 132kV network will result in loss of both GT's in the 33kV Deeside Park/Sixth Avenue group and during this even customer supplies in the group can be secured via transfer capacity from adjacent group in line with second circuit outage demand requirements of P2/7. The 45MVA GT at Hawarden and 33kV circuits in the Hawarden/Castle Cement/Saltney group are loaded marginally below the cyclic ratings.
- there will be under voltage excursions around the Flint area during key n-1 outage conditions, which is mainly due to geographical configuration of grid transformer in Brymbo/Hawarden/Holywell 33kV group and circuit capacity in relation to the distribution of group load. The demand is not uniformly distributed across the group with several point loads supplied by reasonably long or high impedance 33kV circuits. A reinforcement scheme was planned as part of RIIO-ED1 which is reviewed against network flexibility. The constraint is being managed via flexibility services within RIIO-ED1.

2.3 Embedded Generation and Demand connections

Table 2.2 shows the connected/contracted demand and generation in the GSP group:

Table 2.2. Connected/Contracted demand and generation

Customer	Import capacity (MVA)	Export capacity (MW)	POC Volts (kV)	Status
Shotton Paper	70.0	77.0	132	Connected
Tata Steel	30.0	-	132	Connected
Rhyl Flats Windfarm	-	87.4	132	Connected
Clocaenog Windfarm	-	96.0	132	Connected
Brenig Windfarm	-	37.6	132	Connected
Castle Cement	25.0	-	33	Connected
Airbus	20.0	-	33	Connected

Customer	Import capacity (MVA)	Export capacity (MW)	POC Volts (kV)	Status
Toyota	10.0	5.0	33	Connected
Hamilton Oil	5.0	4.8	33	Connected
Kimberley Clark	13.0	-	33	Connected
North Hoyle	4.3	57.0	33	Connected
Pilkington's STOR	0.6	15.2	33	Connected
Parc Adfer	2.3	18.1	33	Connected
Tir Mostyn Windfarm	1.4	21.4	33	Connected
Dolgarrog Power Station	-	37.1	33	Connected
Teyrdan Solar Park	-	5.7	33	Connected
Moel Maelogan	0.25	16.1	33	Connected
Wern Ddu Windfarm	0.2	9.2	33	Connected
Ynni Cymru ALF	-	16.0	33	Connected
Culvery PS – Queensferry	-	14.0	33	Connected
Various HV/LV Gen Connections	-	59.2	HV/LV	Connected
Alwens Forest	-	32.5	132	Contracted
Glyn Rhonwy	130.0	100.0	132	Contracted
Pant Y Maen	-	20.0	33	Contracted
Ty Coch	-	20.0	33	Contracted
Northern Gateway	30.0	-	33	Contracted
Various HV/LV Connections	24.8	22.8	HV/LV	Contracted
Total	**366.9**	**772.1**		

2.4 Fault levels

Short circuit studies indicate that with the authorised customer connections there are no fault level issues on 132kV GSP group with normal operational configuration. However, during abnormal operational scenario at 132kV Connahs Quay GSP the 3-PH and 1-PH fault levels would exceed the design limits. These fault level constraint limits the extent of thermal support from Legacy GSP, and Shotton Paper SGTs and vice versa during maintenance outages or N-1-1 outage scenarios.

Fault level at 33kV St Asaph grid substation are marginally exceeding the design limits. These make duty exceedance is presently operationally managed considering the maximum through fault current infeed into the breaker. Further there are separate 33kV fault level constraints as shown in Table 2.3 at 33kV level. The mitigation of these fault level constraints is separately addressed in document no. ED2-LRE-SPEN-001-CV3-EJP (Fault Level Monitoring and Management) and ED2-LRE-SPM-011-CV3-EJP (SPM 33kV RMUs Fault Level Mitigation).

Table 2.3. 33kV fault levels within recommended solution within RIIO-ED2

Substation Name	3-PH Duty	% Rating	Asset condition
St Asaph grid	Make	100.52	HI1
Sixth Avenue grid	Make	98.98	HI1
Hawarden grid	Break	96.58	HI1
Deeside Park grid	Make	96.19	HI1
Deeside Ind Pk 6th Ave	Make	97.99	HI1
Queensferry	Break	95.33	HI5
St Asaph business park	Make	95.42	HI1

3 Needs Case

Connahs Quay/St Asaph/Pentir GSP group supplies over 202,227 customers which is >50% of the overall customer base in the North Wales with a wide spread network supply area (>1500km²) as shown below in Figure 2. The demand and generation in the GSP group is not uniformly distributed across the group with network fed from Connahs Quay GSP accounts for over 70% of the authorised group demand and St Asaph/Pentir GSP combinedly accounts for over 80% of the authorised generation capacity.

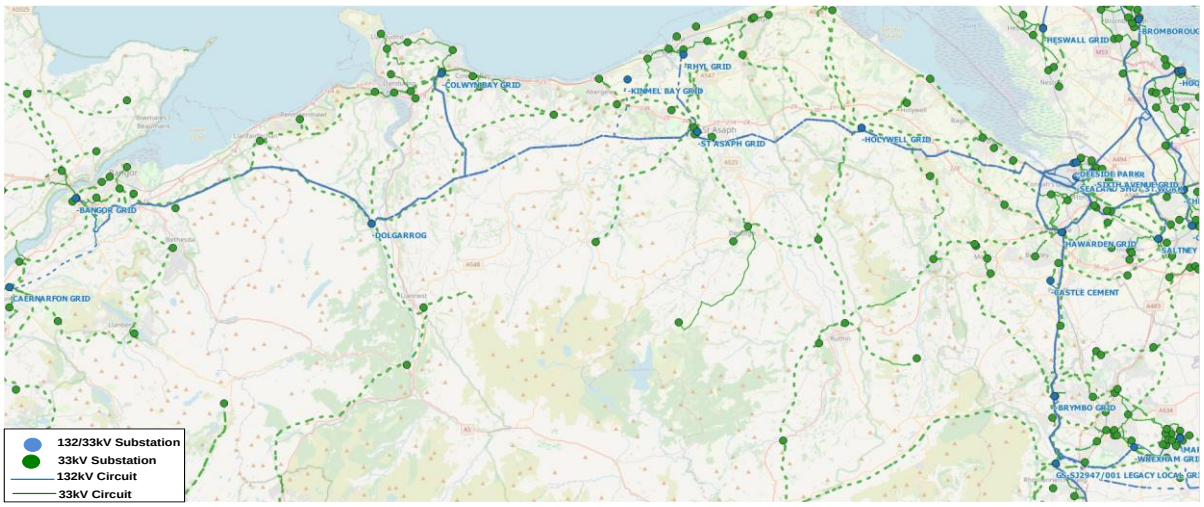


Figure 2. 132kV and 33kV Connahs Quay /St Asaph / Pentir GSP group network

Considering the fast-changing energy landscape to deliver Net Zero carbon targets, a significant proportion of transport and building heating will need to be electrified. There will be further leap in renewable generation capacity as fossil fuel power stations close. This new demand and generation will push the distribution network beyond what it is designed for, meaning that the networks will need to evolve to enable our customers' Net Zero transition.

The SPM network around Deeside and North Wales will see a significant demand increase including 30MVA demand connection that has already been contracted for the Northern Gateway and Deeside Airfields which would comprise of commercial and residential development projects. These known developments/customer connections were added on top of the DFES and CCC scenario projections.

Considering the demand and generation spread in the GSP group with demand concentration across the network fed from Connahs Quay GSP there will be insufficient network capacity (thermal) on 400/132kV SGTs at Connahs Quay GSP, 132kV circuits and 33kV circuits within the group network. The needs case for reinforcement is determined by the magnitude and location new demand which is the sum of the industrial growth in the GSP group especially the growth around Deeside industrial area and demand from LCT uptake.

In order to secure supplies within the group, meet the licence obligations under EREC P2/7 – Security of Supply, maintain the steady state voltage of the 33kV network to within +/- 6% of the declared voltage under the Electricity Safety, Quality and Continuity Regulations (EQSCR), and to accommodate future demand growth within the area, it is proposed to carry out system reinforcement in the RIIO-ED2 price control period.

Further in order to comply with section 9 of the Electricity Act and Condition 21 of our license obligation "to develop and maintain an efficient, coordinated and economical system for the

distribution of electricity" an enduring design solution is required in order to satisfy the existing demand requirements and accommodate future load growth.

This concept paper covers the 132/33kV network capacity constraints and solutions required to accommodate these development plans.

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 Flintshire Development

In September 2019, Flintshire council published their local development plan[1] which aims to create 8,000 jobs with provision of 139.67 hectares of employment land and aims to deliver 7,950 new homes by 2030 of which 1,981 homes are considered under the affordable housing targets. Sites for 3,500 homes have already been allocated of which 1,325 dwellings will be delivered by 2023 as part of Northern Gateway development with a need for dedicated 33kV supply against which 30MW demand has already been contracted by the developers. The Northern Gateway development [2] [3] includes allocation of 72.4 hectares of employment land for commercial hub and district centre development. The overview of Northern Gateway site plan is shown in Figure 3.

Figure 3. Northern Gateway site plan[4]

[1] https://consult.flintshire.gov.uk/file/5491619

[2] https://consult.flintshire.gov.uk/file/5489814

[3] https://consult.flintshire.gov.uk/file/5489819

[4] https://www.flintshire.gov.uk/en/PDFFiles/Planning/LDP-evidence-base/Local/Deeside-Plan.pdf

3.1.1.2 *Electric Vehicles charging*

- In December 2020, Welsh Government published their electric vehicles charging strategy[5] 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. Welsh Government predicts 32,000 EVs by 2025 and 135,000 EVs by 2030 in the SPMW network license area.
- As part of Amazon's "The Climate Pledge" and commitment to be net zero carbon by 2040, Amazon has deployed 30 fully-electric delivery vans at the 99,000 Square feet distribution centre located in the Deeside Northern Gateway development site[6].

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.

The peak demand forecast based on DFES, including authorised connections are depicted in 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.

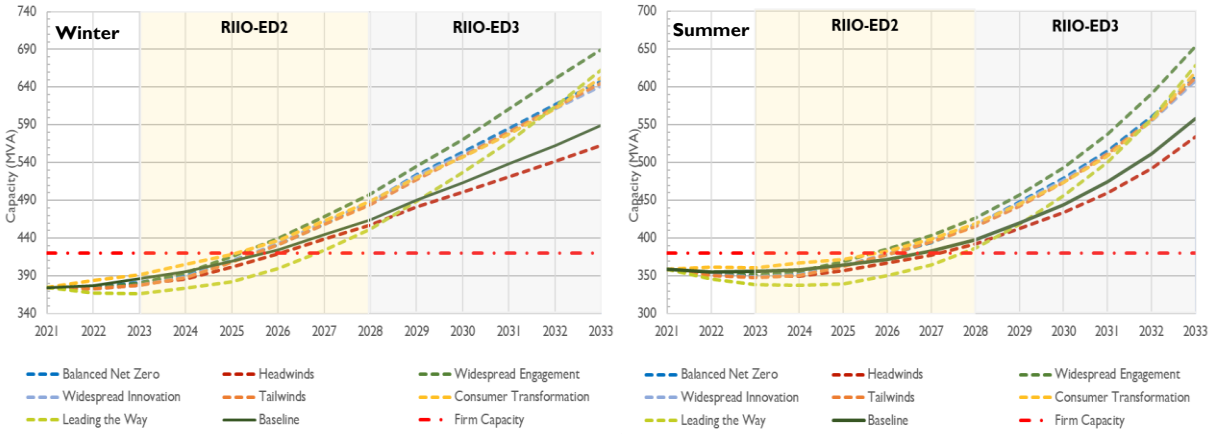


Figure 4. Demand (MVA) forecast for 132kV Connahs Quay / Pentir / St Asaph GSP group

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

[6] http://www.deeside.com/amazon-deploys-30-fully-electric-mercedes-benz-delivery-vans-in-deeside/

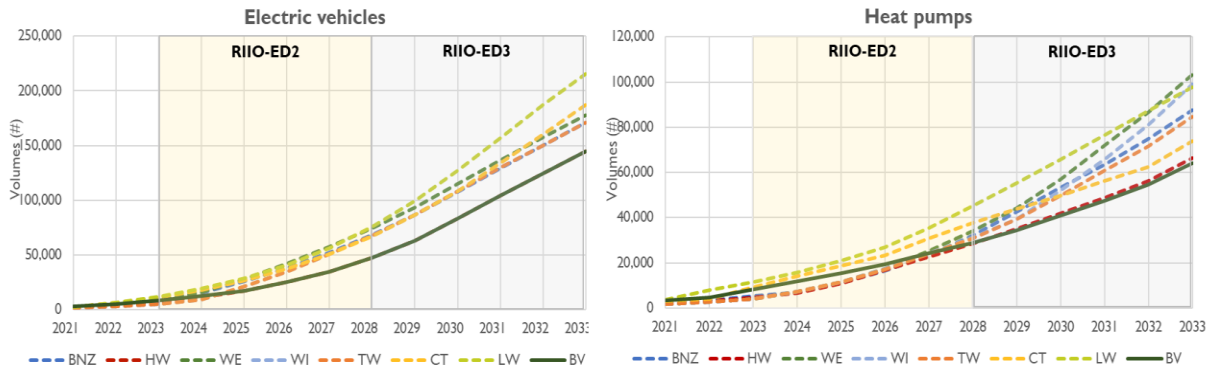


Figure 5. Forecast Electric Vehicle and Heat Pump uptakes for 132kV GSP group

3.1.3 Baseline View

For the 132kV 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)	375	377	386	396	410	424	445	464	490	513	538	563	589
Firm Capacity (MVA)	420	420	420	420	420	420	420	420	420	420	420	420	420
Utilisation (%)	89	90	92	94	98	101	106	110	117	122	128	134	140
Load Index	LI2	LI2	LI2	LI2	LI3	LI4	LI5	LI5	LI5	LI5	LI5	LI5	LI5
Summer (N-1-1)													
Forecast Demand (MVA)	360	355	357	358	364	372	383	398	420	444	475	511	558
Firm Capacity (MVA)	380	380	380	380	380	380	380	380	380	380	380	380	380
Utilisation (%)	95	93	94	94	96	98	101	105	110	117	125	135	147
Load Index	LI2	LI2	LI2	LI2	LI3	LI3	LI4	LI5	LI5	LI5	LI5	LI5	LI5

3.2 Network Impact Assessment

Detailed network studies covering network intact, N-1, N-1-1 outage conditions and fault level assessments were carried out for the 132kV network and 33kV network fed from Connahs Quay / St Asaph/Pentir GSP 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 2027 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 132kV and 33kV voltage level

Network Item	Voltage (kV)	Outage
Connahs Quay SGT1/SGT2	132	N-1
Connahs Quay – Sealand - Hawarden -Sixth Avenue circuit	132	N-1-1
Connahs Quay-Holywell circuit	132	N-1-1
Hawarden Grid Transformer-1	132/33	N-1-1
Castle Cement-Buckley circuit	33	N-1/N-1-1
Hawarden-King George St circuit	33	N-1-1
Hawarden-Queens Ferry circuit	33	N-1-1
Hawarden-Castle Cement circuit	33	N-1-1
NW Paper-Hawarden circuit	33	N-1-1

3.2.1.1 Voltage Constraints

There will be voltage issues at 33kV levels within the Deeside Park/Sixth Avenue grid group during 132kV N-1-1 outage conditions. In addition, the existing under voltage excursions around Flint will aggravate during N-1 and N-1-1 outage.

3.2.2 EREC P2/7 – Security of Supply

Maximum demand on the interconnected Connahs Quay/St Asaph/Pentir group is >300MW (P2/7 Class E) and system studies indicate that there will be security of supply issues in the 33kV network groups fed from the Connahs Quay GSP impacting over 35000 customer supplies during N-1-1 outage conditions at upstream 132kV network. This is mainly due to the combination of additional demand from development around Deeside and LCT uptake.

3.2.3 Flexibility services

Our assessments indicate that the network constraints in the GSP group network starts from 2026/27 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. 31.3MW is required to alleviate the constraints. Based on these requirements, flexibility services were tendered to provide services between 2026/27 – 2027/28 period. 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)	-	-	-	38	416
Required Flexible Capacity (MW)	-	-	-	11.9	31.3

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.

Table 4.1. Longlist of solution options

#	Options	Status	Reason for rejection
(a)	No intervention	Rejected	For an N-1 outage of SGT at Connahs Quay or N-1-1 outage within the 132kV group network would result in potential security of supply issue for over 35000 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)	"Normally Closing" the circuit breaker of the feeders with SGT feeding Shotton Paper to establish permanent interconnection with all 4 SGTs in service. At 33kV the constrained circuits to be uprated.	Rejected	This option would result in fault levels raise beyond design limits at 132kV and 33kV network and would not provide the flexibility in operation. Uprating of constrained circuits does not enable any capacity headroom as the thermal constraints are close to protection settings of the circuit and would result in cascade tripping and loss of supplies.
(d)	"Normally Closing" the circuit breaker of the 132kV feeders to Castle Cement and Brymbo to establish permanent interconnection with Legacy GSP. At 33kV the constrained circuits to be uprated.	Rejected	This option would result in fault levels raise beyond design limits at 132kV and 33kV network both at Connahs Quay and Legacy. Further permanent interconnection between GSPs may result in cross flows beyond thermal ratings during outages on NGET network. Uprating of constrained circuits does not enable any capacity headroom as the thermal constraints are close to protection settings of the circuit and would result in cascade tripping and loss of supplies.
(e)	Reconfiguration of Connahs Quay GSP with 2+2 running arrangement and New GT at Deeside Park grid.	Considered (**Baseline**)	
(f)	Reconfiguration of Connahs Quay GSP with 2+2 running arrangement and New 33kV circuit between Saltney grid and Deeside Park grid.	Considered (**Option 1**)	
(g)	Reconfiguration of Connahs Quay GSP with 2+2 running arrangement and interconnection of Deeside Park grid Chester Main via 30MVA PST.	Considered (**Option 2**)	
(h)	Back to Back HVDC convertor at Brymbo to interconnect Connahs Quay and Legacy GSP with transfer of Castle Cement and Brymbo into Legacy group network.	Rejected	This option is discounted considering higher cost and lead time.
(i)	Operational management via Flexibility services.	Rejected	This option is discounted considering flexibility service bids received for 2027/28 being significantly above the reinforcement deferral ceiling cost.
(j)	Combination of flexibility services and baseline reinforcements.	Considered **(Option 3) Proposed**	

5 Detailed Analysis & Costs

Network studies indicate that with the additional demand across the network, thermal loading on the 132kV and 132/33kV network will exceed the cyclic ratings. These thermal constraints would lead to loss of supplies to over 35000 customers around Flintshire, Deeside, Deeside industrial area and Connahs Quay with potential IIS (CI/CML) related penalties.

Considering the scale of the impact on the network, as strategic intervention is required to mitigate the network constraint.

5.1 Proposed Option (Option 3) – Flexibility Services and Baseline reinforcements

The proposed solution is to alleviate network constraints by installation of new 132/33kV 60MVA grid transformer at existing Deeside Park grid substation and extension of 132kV switchboard at Connahs Quay to accommodate Bus-section breaker and 132kV feeder to new grid transformer at Deeside Park grid substation. The Bus-section breaker at Connahs Quay provides flexibility to operate the substation with 2+2 SGT configuration and manage the fault levels within the plant ratings. Table 5.1 shows proposed option scheme summary.

Table 5.1. Proposed option summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Flexibility services and Conventional solution	Connahs Quay 132kV reinforcements	• Install new 132/33kV 60MVA GT at Deeside Park to support 30MVA demand around Deeside Industrial area. • Installation of new 132kV Bus-Section circuit breaker at Connahs Quay to enable reconfiguration of Connahs Quay GSP to 2+2 SGT operational arrangement. • Swap the Sixth-Avenue GT with RAF Sealand circuit which will enable to transfer the Sixth Avenue GT onto busbar section "C" and "Normal Open" bus-section reactor at Sixth-Avenue grid to reduce the fault levels. • "Normal Open" the bus-section reactor at Hawarden to reduce the fault levels. • Contract flexibility services for the year 2026/27 to support the network during the project delivery.	8.855	-

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 £348k 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.

Table 5.2. Summary of flexibility service costs

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Reinforcement Deferral Ceiling Cost - per year	-	-	-	£0.348m	£0.348m
Cost of Flexibility Services (100% Capacity)	-	-	-	£0.055m	£2.72m
Flexibility Outlook	-	-	-	🟢	🔴

🟢 *Accept bids and defer reinforcement delivery*

🔴 *Reject bids and deliver reinforcements*

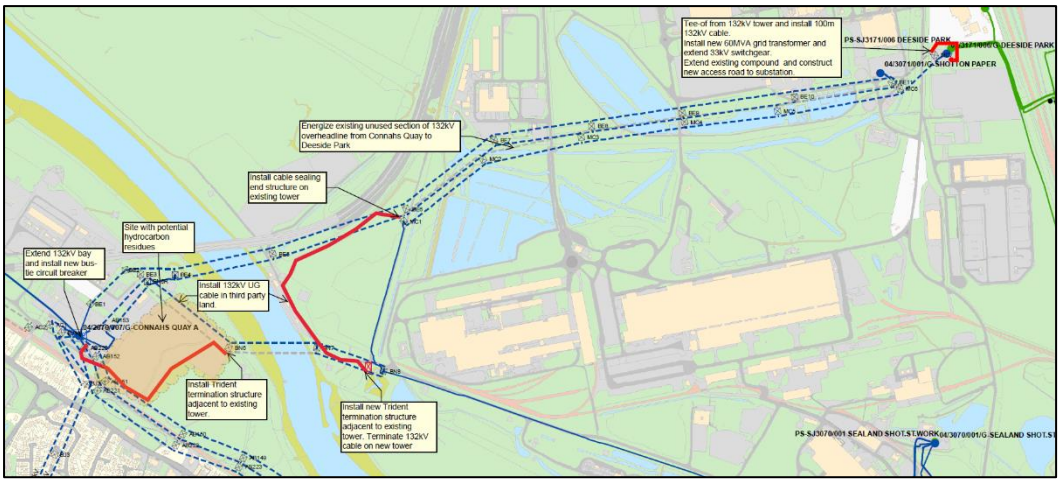
Considering above it is proposed to defer the reinforcement delivery by 1 year and start the works in 2025/26 and deliver the project in 2027/28 against which the capacity release of 100MVA at 132kV and 30MVA at 33kV will be claimed. Additionally, 107MVA of fault level headroom will be created by the proposed scheme.

It is also recommended to continue annual tendering for flexibility in this area to procure enough capacity and review the scheme depending on future tenders resulting competitive bids enabling to defer the proposed reinforcements.

Table 5.3 shows a summary of reinforcement costs and volumes for the proposed option within RIIO-ED2. Figure 6 shows the 132kV cable route and site location, Figure 7 and Figure 8 shows proposed 132kV works and Figure 9 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)	0.30	0.073	0.073	-
33kV CB (Gas Insulated Busbars) (ID) (GM)	3.00	0.511	0.511	-
132kV Tower	7.00	0.797	0.797	-
132kV Fittings	7.00	0.021	0.021	-
132kV UG Cable (Non-Pressurised)	1.65	1.830	1.830	-
132kV CB (Air Insulated Busbars) (ID) (GM)	2.00	0.748	0.748	-
132kV CB (Air Insulated Busbars) (OD) (GM)	3.00	0.529	0.529	-
132kV Switchgear - Other	3.00	0.055	0.055	-
132kV Transformer	1.00	1.214	1.214	-
Pilot Wire Underground	1.50	0.166	0.166	-
Civil Works at 33 kV & 66 kV Substations		0.196	0.196	-
Civil Works at 132 kV Substations		1.236	1.236	-
Wayleaves/Easements/Land Purchase		0.475	0.475	-
Other Costs (Identify Below)		0.950	0.950	-
Cost of Flexibility for the year 2026/27		0.055	0.055	-
Total Costs		**8.855**	**8.855**	**-**
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 (Connahs Quay, Deeside Park, Shotton Paper, Sixth Avenue and RAF Sealand) - (£200k)				
Environmental survey and studies (£75k)				
Environmental conservation for birds around Deeside area (£265k)				
Planning and Design Studies (£75k)				
Remediate hydrocarbon contamination at site around Connahs Quay 132kV substation (£325k)				
33kV VT at Sixth Avenue and RAF Sealand (£10k)				



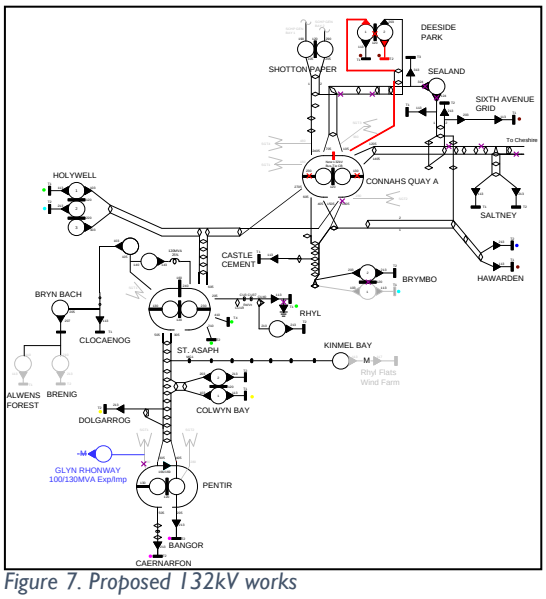


Figure 7. Proposed 132kV works

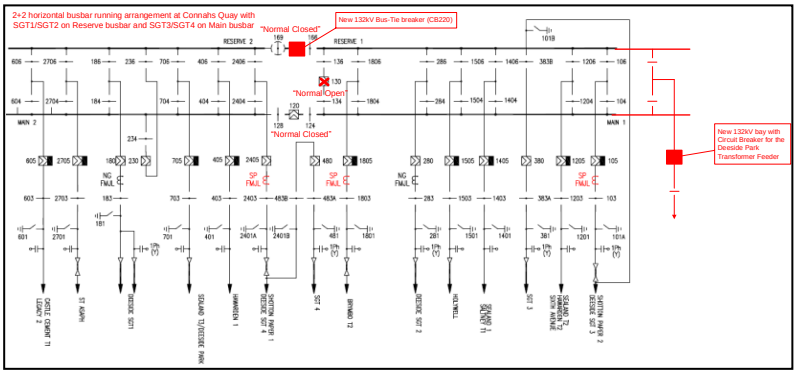


Figure 8. Proposed works at Connahs Quay 132kV substation

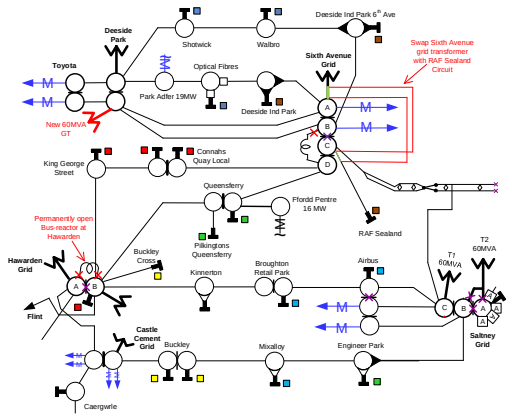


Figure 9. Proposed works in the 33kV group

5.2 Baseline – New 132/33kV GT at Deeside Park and reconfiguration at Connahs Quay 132kV substation

The baseline option is to install new 132/33kV 60MVA grid transformer at existing Deeside Park grid substation and extension of 132kV switchboard at Connahs Quay to accommodate Bus-section breaker and 132kV feeder to new grid transformer at Deeside Park grid substation. The Bus-section

breaker at Connahs Quay provides flexibility to operate the substation with 2+2 SGT configuration and manage the fault levels within the plant ratings. 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 solution	Connahs Quay 132kV reinforcements	• Install new 132/33kV 60MVA GT at Deeside Park to support 30MVA demand around Deeside Industrial area. • Installation of new 132kV Bus-Section circuit breaker at Connahs Quay to enable reconfiguration of Connahs Quay GSP to 2+2 SGT operational arrangement. • Swap the Sixth-Avenue GT with RAF Sealand circuit which will enable to transfer the Sixth Avenue GT onto busbar section "C" and "Normal Open" bus-section reactor at Sixth-Avenue grid to reduce the fault levels. • "Normal Open" the bus-section reactor at Hawarden to reduce the fault levels.	8.800	-

Under this option it is proposed to start the works in 2023/24 and the capacity release of 100MVA at 132kV and 30MVA at 33kV will be claimed in 2025/26 at the end of the project. Additionally, 107MVA of fault level headroom will be created by the proposed scheme. However, this option is rejected based on lower NPV against proposed option.

Table 5.5 shows a summary of reinforcement costs and volumes for the baseline option within RIIO-ED2. Figure 6 shows the 132kV cable route and site location, Figure 7 and Figure 8 shows proposed 132kV works and Figure 9 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 UG Cable (Non-Pressurised)	0.30	0.073	0.073	-
33kV CB (Gas Insulated Busbars) (ID) (GM)	3.00	0.511	0.511	-
132kV Tower	7.00	0.797	0.797	-
132kV Fittings	7.00	0.021	0.021	-
132kV UG Cable (Non-Pressurised)	1.65	1.830	1.830	-
132kV CB (Air Insulated Busbars) (ID) (GM)	2.00	0.748	0.748	-
132kV CB (Air Insulated Busbars) (OD) (GM)	3.00	0.529	0.529	-
132kV Switchgear - Other	3.00	0.055	0.055	-
132kV Transformer	1.00	1.214	1.214	-
Pilot Wire Underground	1.50	0.166	0.166	-
Civil Works at 33 kV & 66 kV Substations		0.196	0.196	-
Civil Works at 132 kV Substations		1.236	1.236	-
Wayleaves/Easements/Land Purchase		0.475	0.475	-
Other Costs (Identify Below)		0.950	0.950	-
Total Costs		**8.800**	**8.800**	**-**
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 (Connahs Quay, Deeside Park, Shotton Paper, Sixth Avenue and RAF Sealand) - (£200k)				
Environmental survey and studies (£75k)				
Environmental conservation for birds around Deeside area (£265k)				
Planning and Design Studies (£75k)				
Remediate hydrocarbons at site around Connahs Quay 132kV substation (£325k)				
33kV VT at Sixth Avenue and RAF Sealand (£10k)				

5.3 Option 1 – New 33kV interconnector and reconfiguration at Connahs Quay 132kV substation

This option considers establishing a new 33kV interconnector between Saltney grid substation along with uprating of existing 33kV circuits between Hawarden – King George St and Hawarden – Queensferry. At 132kV this option considers extension of 132kV switchboard at Connahs Quay to accommodate Bus-section breaker and 132kV feeder to new grid transformer at Deeside Park grid substation. The Bus-section breaker at Connahs Quay provides flexibility to operate the substation with 2+2 SGT configuration and manage the fault levels within the plant ratings.

This option would provide the capacity release of 100MVA at 132kV and 30MVA at 33kV. There will be no fault level headroom created by this option.

This option is rejected due its relatively high cost and does not represent optimum level of intervention required as it does not create any fault level headroom in the network. Table 5.6 shows the scheme summary.

Table 5.6. Option 1 scheme summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)
Conventional solution	Connahs Quay 132kV reinforcements	• New 33kV circuit between Saltney grid and Deeside Park grid - 12kms 400 Sqmm XLPE AL cable • Extending the existing 33kV switchboard at Deeside Park grid and Saltney grid substations to accommodate 33kV breaker for the new circuit. • Installation of new 132kV Bus-Tie circuit breaker at Connahs Quay to enable reconfiguration of Connahs Quay GSP to 2+2 SGT operational arrangement. • Uprating Hawarden to King George St 33kV circuit by 4.5kms 400Sqmm XLPE Al cable. • Uprating Hawarden to Queensferry 33kV circuit by 4.5kms 400Sqmm XLPE Al cable. • Swap the Sixth-Avenue GT with RAF Sealand circuit which will enable to transfer the Sixth Avenue GT onto busbar section "C" and "Normal Open" bus-section reactor at Sixth-Avenue grid to reduce the fault levels. • "Normal Open" the bus-section reactor at Hawarden to reduce the fault levels.	10.421

Table 5.7 shows a summary of reinforcement costs and volumes for Option 1 within RIIO-ED2. Figure 10 shows the 33kV cable route and site location and Figure 11 shows proposed 132kV and 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 UG Cable (Non Pressurised)	21.50	5.216	5.216	-
33kV CB (Gas Insulated Busbars)(ID) (GM)	4.00	0.682	0.682	-
132kV CB (Air Insulated Busbars)(OD) (GM)	1.00	0.176	0.176	-
Pilot Wire Underground	21.00	2.326	2.326	-
Civil Works at 33 kV & 66 kV Substations		0.198	0.198	-
Civil Works at 132 kV Substations		0.250	0.250	
Wayleaves/Easements/Land Purchase		0.756	0.756	-

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Other Costs (Identify Below)		0.817	0.817	-
Total Costs		**10.421**	**10.421**	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
Associated protection, control or SCADA equipment located at Connahs Quay, Deeside Park, Shotton Paper, Sixth Avenue, King Geroge St and RAF Sealand - (£267k)				
Environmental considerations, survey and studies (£75k)				
Planning and design studies (£50k)				
Deeside River Crossing (£250k)				
33kV VT at Sixth Avenue and RAF Sealand (£10k)				
Recovery of 33kV Poles and Conductors from 2 x 33kV circuits (£165k)				

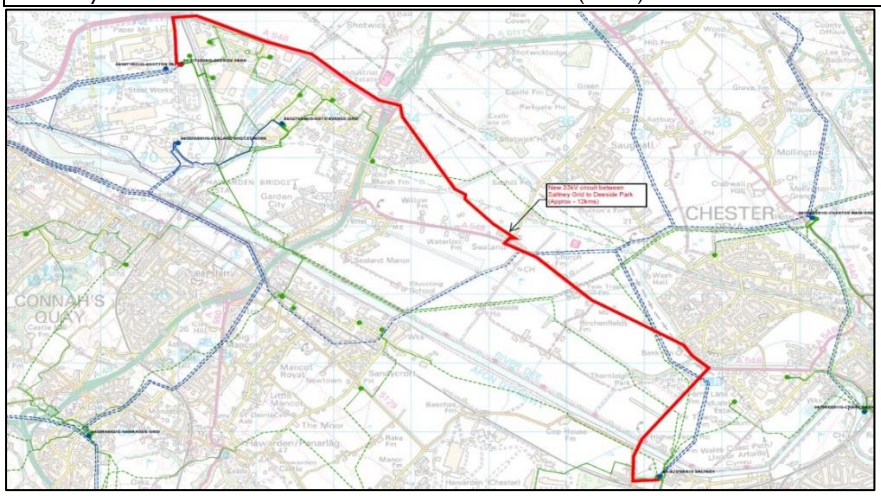


Figure 10 Route for 33kV circuit between Saltney grid to Deeside Park grid substation

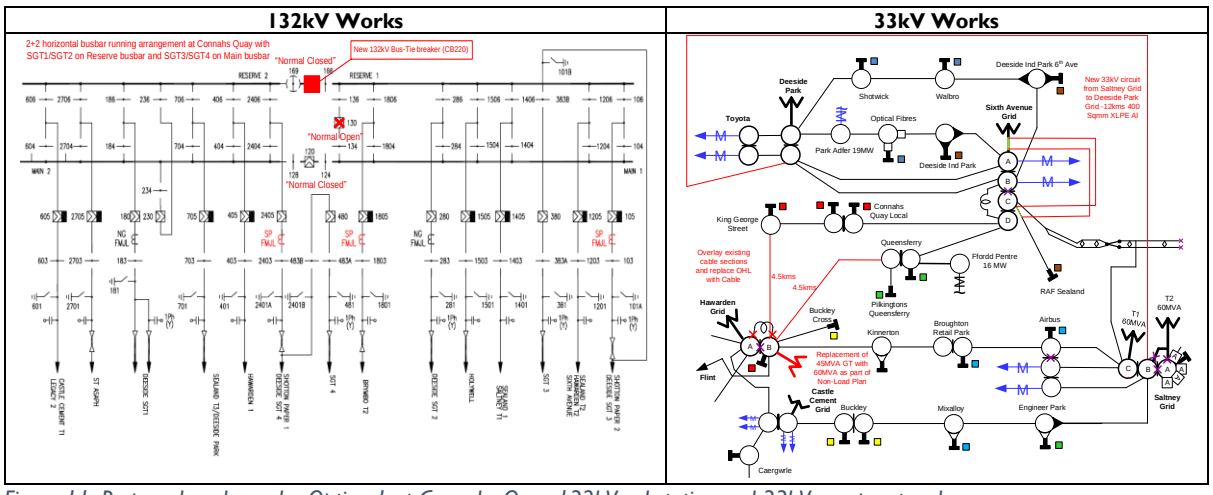


Figure 11. Proposed works under Option 1 at Connahs Quay 132kV substation and 33kV group network

5.4 Option 2 – 33kV PST at Deeside Park and reconfiguration at Connahs Quay 132kV substation

This option considers establishing a new 33kV interconnector between Chester Main grid substation and Deeside Park grid substation along with installation of 33kV 30MVA Phase Shifting Transformer (PST) at Deeside Park grid substation which will enable to couple the GSP groups. At 132kV this option considers extension of 132kV switchboard at Connahs Quay to accommodate Bus-section breaker and 132kV feeder to new grid transformer at Deeside Park grid substation. The Bus-section

breaker at Connahs Quay provides flexibility to operate the substation with 2+2 SGT configuration and manage the fault levels within the plant ratings.

This option would provide the capacity release of 100MVA at 132kV and 25MVA at 33kV. There will be no fault level headroom created by this option.

This option is rejected due its relatively high cost and does not represent optimum level of intervention required as it does not create any fault level headroom in the network. Table 5.8 shows the scheme summary.

Table 5.8. Option 2 scheme summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)
Innovation	Connahs Quay 132kV reinforcements	• New 33kV circuit between Chester Main grid and Deeside Park grid - 13kms 400 Sqmm XLPE AL cable • Extending the existing 33kV switchboard at Deeside Park grid and Chester Main grid substations to accommodate 33kV breaker for the new circuit. • Installation of new 132kV Bus-Tie circuit breaker at Connahs Quay to enable reconfiguration of Connahs Quay GSP to 2+2 SGT operational arrangement. • Installation of new 30MVA PST at Deeside Park grid substation. • Swap the Sixth-Avenue GT with RAF sealand circuit which will enable to transfer the Sixth Avenue GT onto busbar section "C" and "Normal Open" bus-section reactor at Sixth-Avenue grid to reduce the fault levels. • "Normal Open" the bus-section reactor at Hawarden to reduce the fault levels.	9.211

Table 5.9 shows a summary of reinforcement costs and volumes for Option 2 under RIIO-ED2. Figure 12 shows proposed 132kV and 33kV works.

Table 5.9. Option 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)	13.00	3.154	3.154	-
33kV CB (Gas Insulated Busbars) (ID) (GM)	4.00	0.682	0.682	-
Batteries at 33kV Substations	1.00	0.009	0.009	-
132kV CB (Air Insulated Busbars) (OD) (GM)	1.00	0.176	0.176	-
Pilot Wire Underground	13.00	1.440	1.440	-
Civil Works at 33 kV & 66 kV Substations		0.300	0.300	-
Civil Works at 132 kV Substations		0.250	0.250	-
Wayleaves/Easements/Land Purchase		0.500	0.500	-
Other Costs (Identify Below)		2.700	2.700	-
Total Costs		**9.211**	**9.211**	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
Associated protection, control or SCADA equipment located at Connahs Quay, Deeside Park, Chester Main, Sixth Avenue and RAF Sealand - (£225k)				
Phase Shifting Transformer – 30MVA 33kV (£2m)				
Environmental considerations, survey and studies (£75k)				
Planning and design studies including detailed system studies to determine PST operational range and set points (£125k)				
Railway and Canal Crossing (£265k)				
33kV VT at Sixth Avenue and RAF Sealand (£10k)				

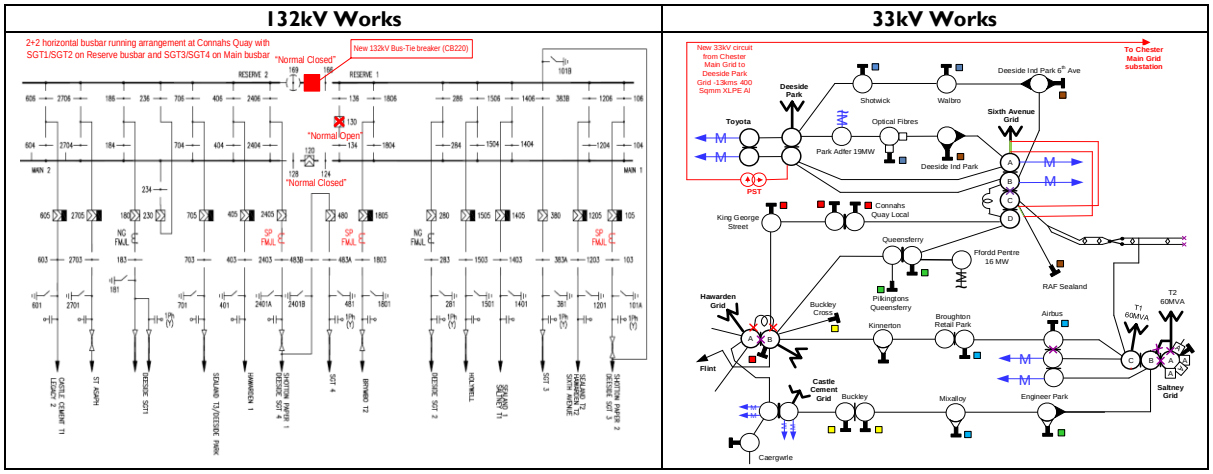


Figure 12. Proposed works under Option 2 at Connahs Quay 132kV substation and 33kV group network

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	Reconfiguration of Connahs Quay GSP with 2+2 running arrangement and New GT at Deeside Park grid.	8.800
Option 1	Reconfiguration of Connahs Quay GSP with 2+2 running arrangement and New 33kV circuit between Saltney grid and Deeside Park grid.	10.421
Option 2	Reconfiguration of Connahs Quay GSP with 2+2 running arrangement and interconnection of Deeside Park grid Chester Main via 30MVA PST.	9.211
Option 3 (Proposed)	Combination of flexibility services and baseline reinforcements.	8.855

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 new 132/33kV 60MVA grid transformer at existing Deeside Park grid substation and extension of 132kV switchboard at Connahs Quay to accommodate Bus-section breaker and 132kV feeder to new grid transformer at Deeside Park grid substation and contract flexibility services for the year 2026/27 to support the network during the project delivery. It is proposed to start the works in 2025/26 and the capacity release of 100MVA at 132kV and 30MVA at 33kV will be claimed in 2027/28 at the end of the project.

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-001-CV1-CBA –Connahs Quay 132kV Reinforcement'.

Table 6.1. Cost benefit analysis results

Options considered	Decision	Comment	NPVs based on payback periods, £m (2020/21 prices)			
			10 years	15 years	30 years	45 years
Baseline - Reconfiguration of Connahs Quay GSP and New GT at Deeside Park grid.	Rejected	Discounted based on lower NPV against proposed option.	-	-	-	-
Option 1 - Reconfiguration of Connahs Quay GSP and New 33kV circuit between Saltney grid and Deeside Park grid.	Rejected	Discounted based on higher scheme cost and lower NPV against proposed option.	-£1.19	-£1.52	-£1.72	-£1.87
Option 2 - Reconfiguration of Connahs Quay GSP and interconnection of Deeside Park grid Chester Main via 30MVA PST.	Rejected	Discounted based on higher scheme cost and lower NPV against proposed option.	-£0.66	-£0.74	-£0.79	-£0.82
Option 3 - Combination of flexibility services and baseline reinforcements.	**Adopted**	The proposed option enables to defer the reinforcement by 1 year and renders better value to the customers.	£0.69	£0.62	£0.57	£0.52

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 £8.855m.

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)	0.30	0.073	0.073	-
33kV CB (Gas Insulated Busbars)(ID) (GM)	3.00	0.511	0.511	-
132kV Tower	7.00	0.797	0.797	-
132kV Fittings	7.00	0.021	0.021	-
132kV UG Cable (Non Pressurised)	1.65	1.830	1.830	-
132kV CB (Air Insulated Busbars)(ID) (GM)	2.00	0.748	0.748	-
132kV CB (Air Insulated Busbars)(OD) (GM)	3.00	0.529	0.529	-
132kV Switchgear - Other	3.00	0.055	0.055	-

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
132kV Transformer	1.00	1.214	1.214	-
Pilot Wire Underground	1.50	0.166	0.166	-
Civil Works at 33 kV & 66 kV Substations		0.196	0.196	-
Civil Works at 132 kV Substations		1.236	1.236	-
Wayleaves/Easements/Land Purchase		0.475	0.475	-
Other Costs (Identify Below)		0.950	0.950	-
Cost of Flexibility for the year 2026/27		0.055	0.055	-
Total Costs		**8.855**	**8.855**	**-**
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 (Connahs Quay, Deeside Park, Shotton Paper, Sixth Avenue and RAF Sealand) - (£200k)				
Environmental survey and studies (£75k)				
Environmental conservation for birds around Deeside area (£265k)				
Planning and Design Studies (£75k)				
Remediate hydrocarbons at site around Connahs Quay 132kV substation (£325k)				
33kV VT at Sixth Avenue and RAF Sealand (£10k)				

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	8.800	-	-	0.880	3.520	4.400
CV1 – Flexible Services	0.055	-	-	-	0.055	-
Total Cost	**8.855**	**-**	**-**	**0.880**	**3.575**	**4.400**

6.4 Risks

The main delivery risks include:

- contamination of site from hydrocarbon residue around Connahs Quay 132kV substation due to the demolished power plant and,
- necessary approvals related to environmental clearances for conservation of bird's area around banks of river Dee.

Our proposal includes costs for decontamination of necessary site, detailed environmental survey to assess the potential impacts on bird's and building appropriate mitigation measure to avoid risk of collision with power lines. Further we intend to mitigate these risks by actively 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 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 proposed option demonstrates better NPV results in all assessment periods (10, 15, 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	47,174	36,393	67,200	75,901	68,212	47,174	74,158	67,624	67,624
HPs	28,724	19,963	37,666	45,113	32,257	28,631	34,098	31,093	30,730

*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	R^1					
Leading the Way								F	R^1					R^2
Consumer Transformation							F	R^1						R^2
Balanced Net Zero Pathway							F	R^1						R^2
Headwinds								F	R^1					
Widespread Engagement							F	R^1					R^2	
Widespread Innovation							F	R^1						R^2
Tailwinds							F	R^1						R^2

F – Utilise accepted flexibility services
R^1 – Reconfiguration of Connahs Quay GSP with 2+2 running arrangement and New GT at Deeside Park grid.
R^2 – EHV circuit reinforcements and STATCOM at 33kV voltage level

The proposed solution is robust across the range of future pathways. The selected solution is required under all scenarios. This proposed solution is expected to cater for network capacity requirements beyond RIIO-ED3 and provides significant capacity and security to this group.

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 EHV circuit reinforcements and installation of STATCOM to alleviate the voltage constraints may be required by end of RIIO-ED3.

Table 6.6: Sensitivity of the proposed RIIO-ED2 expenditure

	Baseline	Uncertain
RIIO-ED2 Expenditure (£m)	8.855	N/A
Comment	Proposed option	Under higher uptake scenarios EHV circuit reinforcements along with STATCOM at 33kV may be required by end of RIIO-ED3.

6.6.4 Asset Stranding Risks & Future Asset Utilisation

Electricity demands are forecast to increase under all scenarios. The stranding risk is therefore considered to be low.

6.6.5 Losses Sensitivity

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 the design solution and it has not been necessary to carry out any losses justified upgrades. MWh losses for each of the shortlisted options have been included within the CBA and solution selection was not found to be sensitive to the impact of the carbon cost of losses.

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 Environment and Sustainability

This scheme may be subject to Environmental Impact Assessment and other statutory planning requirements, and the contents of this environmental section are not provided in lieu of any Environmental Statement that may be required.

6.7.2 Operational and embodied carbon emissions

The Connahs Quay 132kV Reinforcement programme has limited potential to impact on SPEN's Business Carbon Footprint (BCF) and on the embodied carbon resulting from the delivery of the programme.

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 706 tonnes. The monetised embodied carbon value associated with this emission is £48k. 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[7].

Further SPEN are committed to making a positive impact on the natural environment in which we operate, and where feasible will seek to adopt clean alternatives greenhouse gasses (F-Gas), such as SF6. The proposed solution for this project requires the installation of a new 132kV circuit breaker at Connahs Quay substation, traditionally this will have required a new circuit breaker using SF6 as its insulating medium, by selecting clean SF6 free circuit breakers, the potential to increase SPEN SF6 footprint by 36kg will be eliminated. (36kg of SF6 equates to 820,800kg of CO2).

6.7.3 Supply chain sustainability

For us to take full account of the whole-life carbon impact of our Connahs Quay 132kV 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.

6.7.4 Resource use and waste

The Connahs Quay 132kV 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).

6.7.5 Biodiversity/ natural capital

The Connahs Quay 132kV Reinforcement programme will only affect developed sites containing existing assets, so the impact on, and the opportunity to improve biodiversity and natural capital is expected to be minimal.

6.7.6 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.

6.7.7 Visual amenity

SPEN continually seeks to reduce the landscape and visual effects of our networks and assets. However, as the Connahs Quay 132kV Reinforcement programme only consists of relatively minor works to sites containing existing assets, there is little visual impact for us to mitigate in this instance.

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

6.7.8 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

Proposed option is to install new 132/33kV 60MVA grid transformer at existing Deeside Park grid substation and extension of 132kV switchboard at Connahs Quay to accommodate Bus-section breaker and 132kV feeder to new grid transformer at Deeside Park grid substation and contract flexibility services for the year 2026/27 to support the network during the project delivery.

It is proposed to start the works in 2025/26 and the capacity release of 100MVA at 132kV and 30MVA at 33kV will be claimed in 2027/28 at the end of the project. The estimated cost for the above is £8.855m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

8 Appendices

Appendix 1. Authorised 33kV Networks

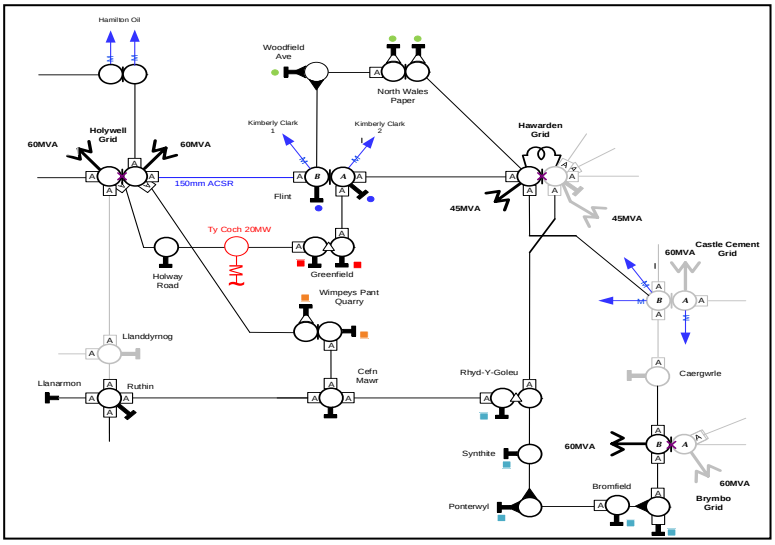


Figure 13. 33kV Brymbo-Hawarden-Holywell Group

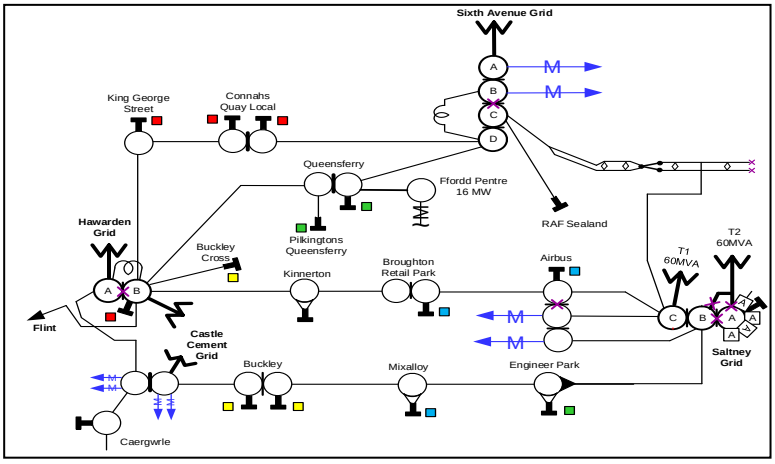


Figure 14. 33kV Hawarden-Saltney-Castle Cement-Sixth Avenue Group

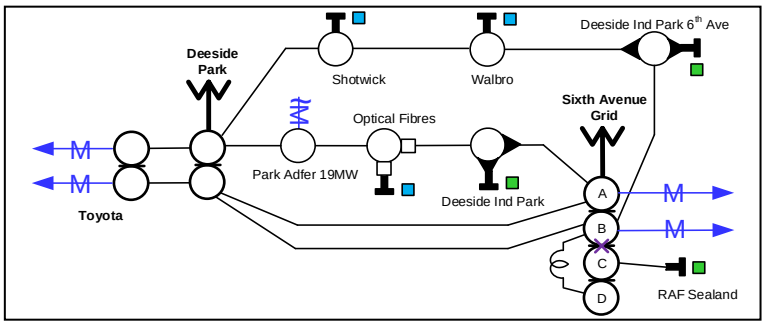


Figure 15. 33kV Deeside Park-Sixth Avenue Group

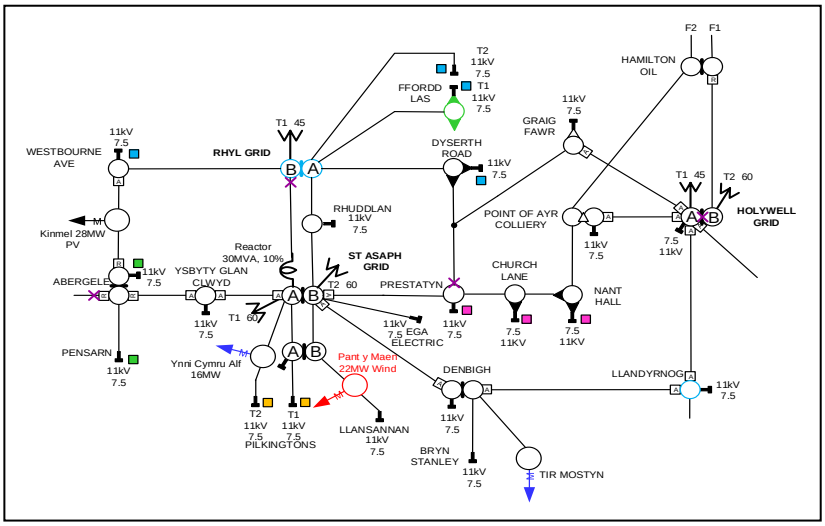


Figure 16. 33kV Rhyl-St Asaph-Holywell Group

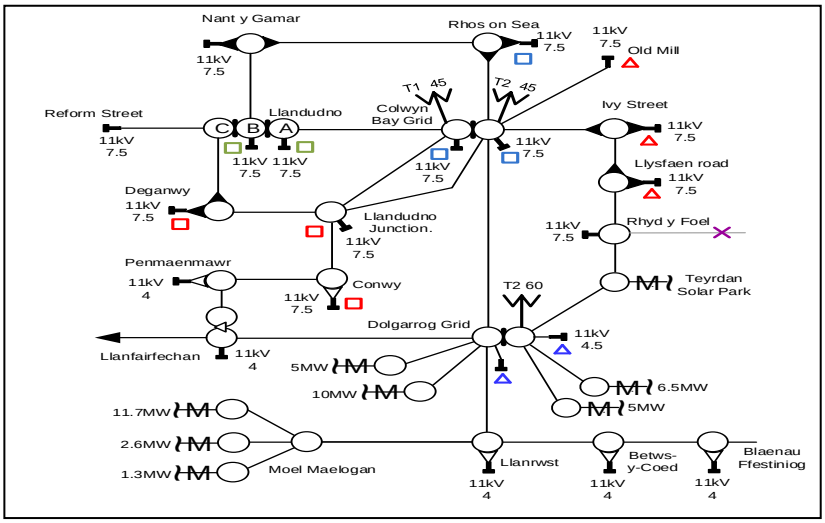


Figure 17. 33kV Colwyn Bay-Dolgarrog Group

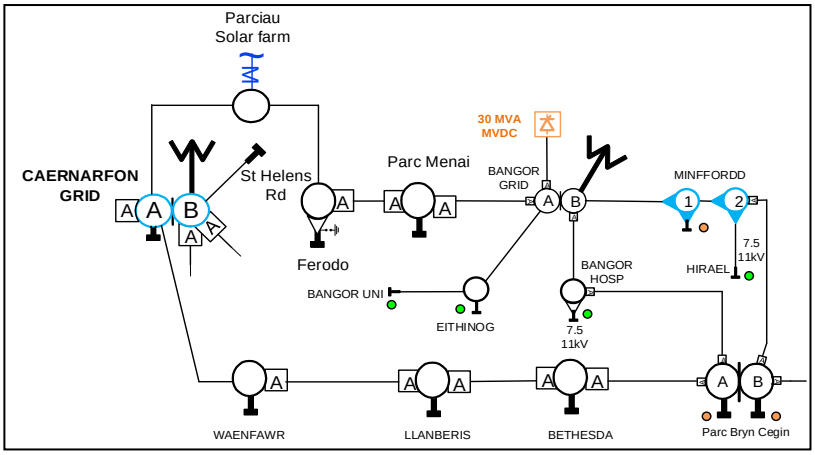


Figure 18. 33kV Bangor-Caernarfon Group

Appendix 2. Key Study Results

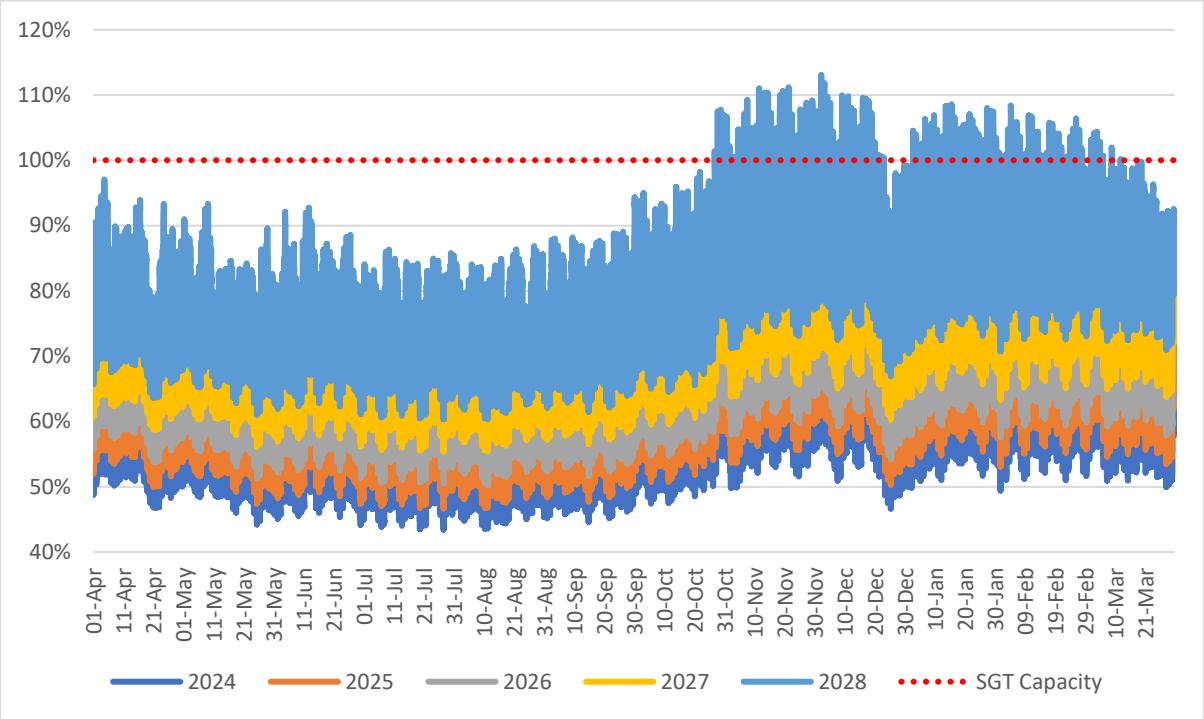


Figure 19. Connahs Quay 400/132kV Supergrid transformer loading profile during N-1 outage

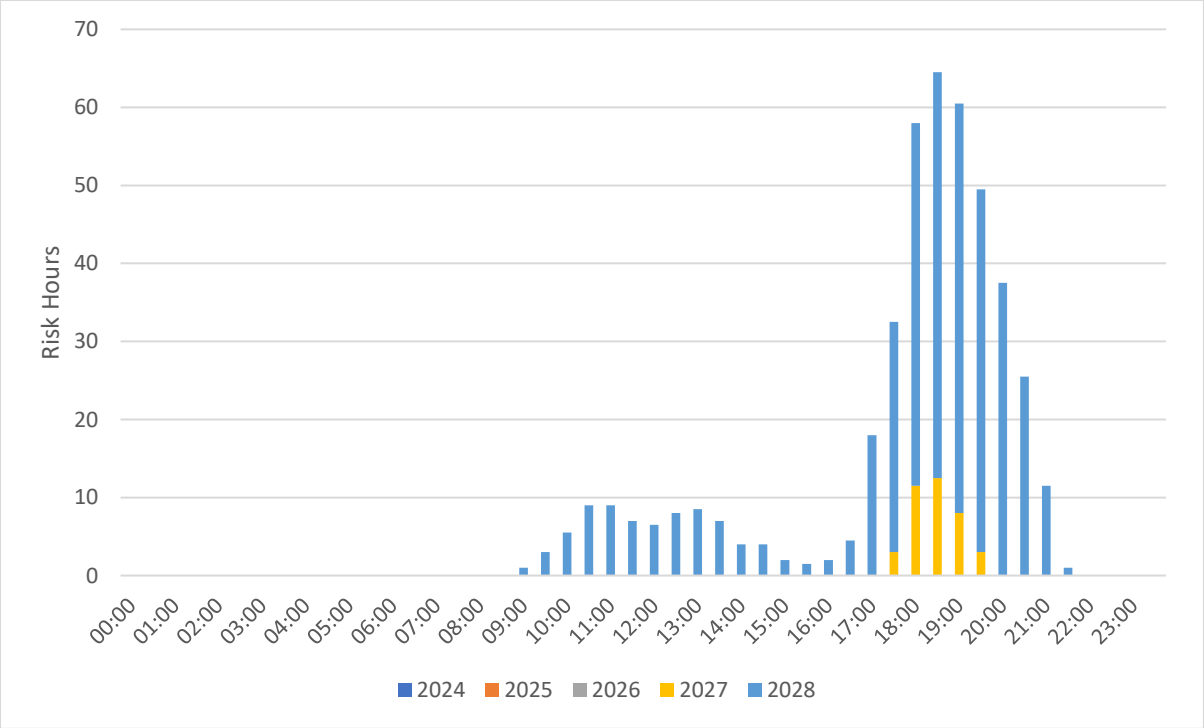


Figure 20. Calculated daily network risk hour window