Legacy 132kV Reinforcement

ED2 Engineering Justification Paper

ED2-LRE-SPM-030-CV1-EJP

Issue	Date	Comments
Issue 0.1	Jan 2021	Issue to SRG and external assurance
Issue 0.2	May 2021	Reflecting comments from SRG
Issue 0.3	Jun 2021	Reflecting assurance feedback
Issue 1.0	Jun 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	Legacy 132kV Reinforcement		
Activity	132kV Network Reinforcement		
Primary Investment Driver	Security of Supply		
Reference	ED2-LRE-SPM-030-CV1-EJP		
Output	Load Index		
Cost	£1.841m		
Delivery Year	2025/26		
Reporting Table	CV1/CV4		
Outputs included in ED1	~~Yes~~/No		
Business Plan Section	Develop the Network of the Future		
Primary Annex	Annex 4A.2: Load Related Expenditure Strategy: Engineering Net Zero Annex 4A.6: DFES		
Spend Apportionment	ED1	ED2	ED3
	-	**£1.841m**	**0.043m**

SP ENERGY NETWORKS

SP ENERGY NETWORKS

Technical Governance Process

Project Scope Development

IP1(S)

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

PART A – PROJECT INFORMATION

Project Title:	Legacy 132kV Reinforcement
Project Reference:	ED2-LRE-SPM-030-CV1-EJP
Decision Required:	To give concept approval for installation of an additional bus-section breaker and swapping SGT tails at Legacy 132kV GSP along with auto-close scheme.

Summary of Business Need:

Legacy 400/132kV GSP is a key substation in the SP Manweb (SPM) Distribution network supporting a major part of North Wales and feeding into Mid Wales and North Shropshire, supplying to ca. 143,600 customers in total.

This 132kV network group has experienced high levels of generation connections activity and has significant penetration of embedded generation with ca. 248MW of connected generation and an additional 130MW expected to connect within the RIIO-ED1 price control period. With growth of both demand and generation in this group and the adjacent Connah's Quay GSP group there is a requirement for increased operational flexibility within ED2. This requires modifications to the layout of the Legacy GSP substation to provide additional security to the group in the event of outages on the Transmission network, and to provide additional operational flexibility to enable improved coupling with the adjacent Connah's Quay GSP.

The primary driver for the proposed scheme is security of supply and increased flexibility in the operation of Legacy 132kV group. The works include installation of an additional outdoor 132kV breaker along with automation and reconfiguration of132kV cables connecting two NGET Supergrid Transformers (SGTs).

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

- Swap SGT2 and SGT4 tails across the 132kV busbars to include security of supply at of £1.576m under CV4 (NTCC)
- Install a new bus-section circuit breaker CB260 between the reserve busbars at £0.265m under CV1(Primary Reinforcement).

The total cost of the scheme is £1.841m fully funded by SPEN in the RIIO- ED2 period. An additional cost of £343k will be paid to NGESO as maintenance charges for the additional 132kV cabling (Transmission Connection Point Charges) beyond RIIO-ED2 period

Expenditure Forecast (in 2020/21 Prices)

Licence Area	Reporting Table	Description	Total (£m)	Incidence (£m)				
				2023/24	2024/25	2025/26	2026/27	2027/28
SPM	CV1	Primary Reinforcement	0.265	0.159	0.053	0.053	-	-
SPM	CV4	New Transmission Capacity Charges	1.576	-	1.549	0.009	0.009	0.009
Total Expenditure within RIIO-ED2			1.841	0.159	1.602	0.062	0.009	0.009

PART B – PROJECT SUBMISSION

Proposed by	Ramesh Pampana	Signature	P. Ramesh	Date:	30/11/2021
Endorsed by	Russell Bryans	Signature		Date:	30/11/2021

PART C – PROJECT APPROVAL

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

Contents

1 Introduction

Legacy 400/132kV GSP is a key site in the SP Manweb (SPMW) Distribution network supporting a major part of North Wales and feeding into Mid Wales and North Shropshire, supplying to ca. 143,600 customers in total.

This 132kV network group has experienced high levels of generation connections activity and has significant penetration of embedded generation with ca. 248MW of connected generation and an additional 130MW expected to connect within the RIIO-ED1 price control period.

With growth of both demand and generation in this group and the adjacent Connah's Quay GSP group there is a requirement for increased operational flexibility within ED2. This requires minor modifications to the layout of the Legacy GSP substation to provide additional security to the group in the event of outages on the Transmission network, and to provide additional operational flexibility to enable improved coupling with the adjacent Connah's Quay GSP.

The summary of the proposed reinforcement include:

- Swap SGT2 and SGT4 tails across the 132kV busbars to include security of supply at a cost of £1.576m along with automation under CV4 (New Transmission Capacity Charges)
- New bus-section circuit breaker CB260 between the reserve busbars to increase operational flexibility at a cost of £0.265m under CV1(Primary Reinforcement).

The total cost of the scheme is £1.841m, to be spent in RIIO-ED2 period. The scheme is primarily aimed to enhance operational flexibility and as such does not contribute to the group's firm capacity.

2 Background Information

2.1 Existing/Authorised Network

Legacy GSP has 4 x 400/132kV SGTs, all rated at 240MVA. Figure 2-2Figure 2-1 shows the substation layout and geographic location.

The 132kV group is normally operated split from the adjacent Connah's Quay GSP via open points on the interconnecting circuits between these two GSPs. Figure 2-1 On the 400kV side, the SGTs supplying each side of the Legacy 132kV busbar originate from the same side of the 400kV busbars i.e. SGT pairs 1&3 and 2&4 supply to the same side of busbars as shown in Figure 2-2.

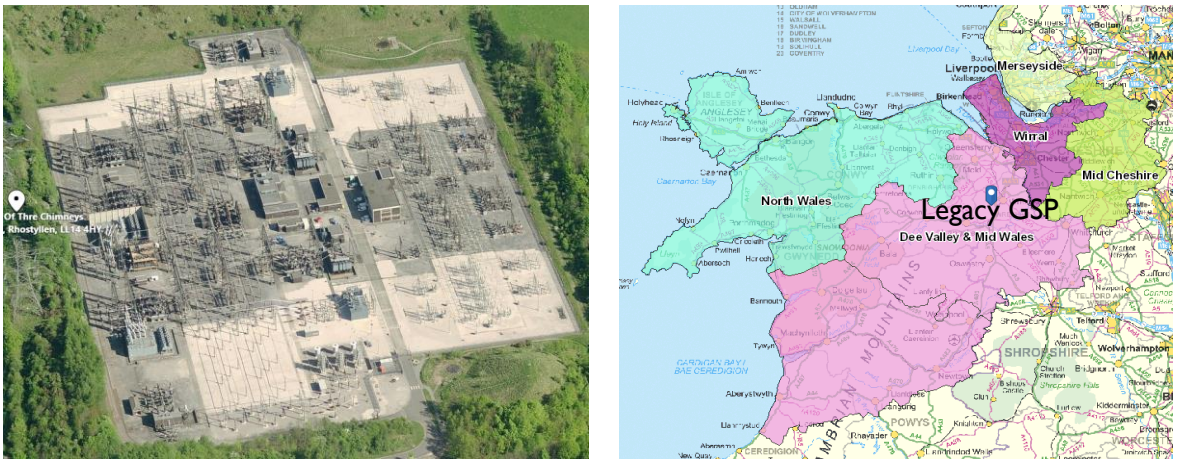

Figure 2-1: Legacy substation layout and location

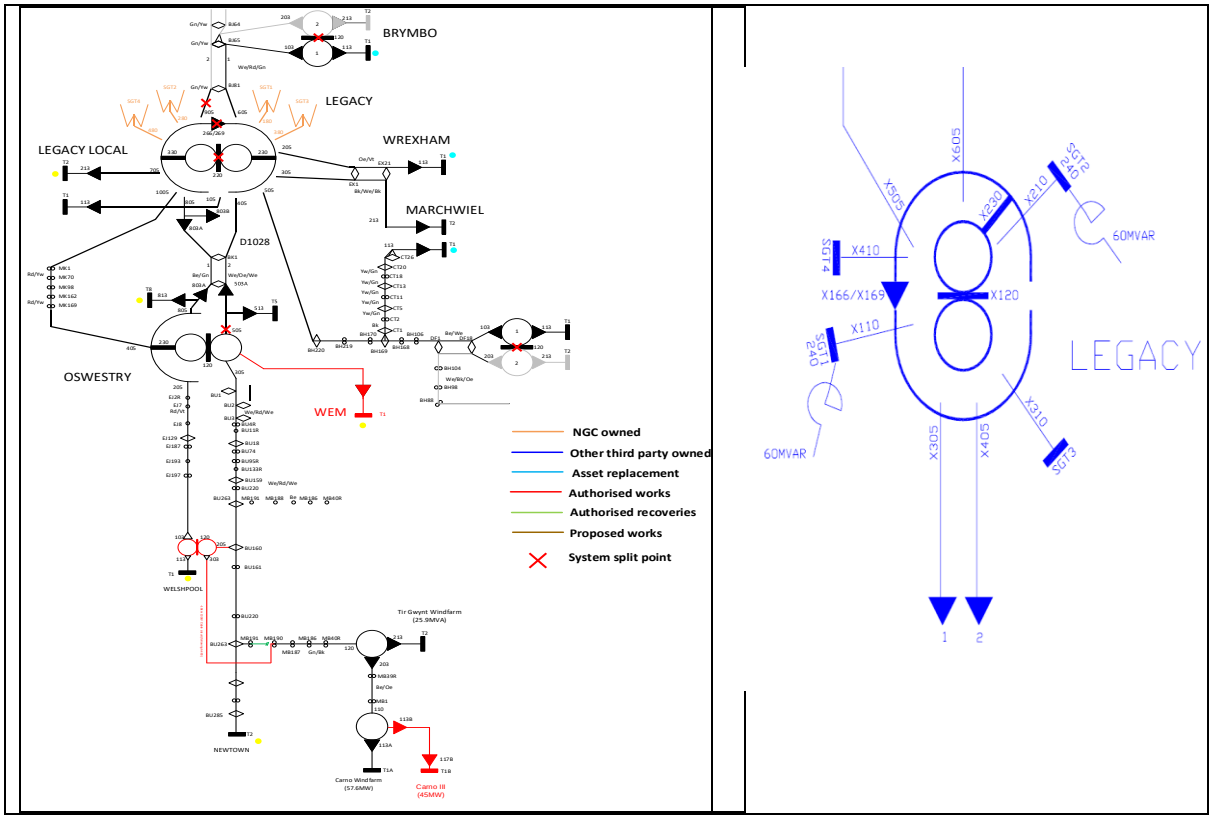

Figure 2-2: Legacy 132kV GSP(left) and 400kV(right) network connectivity

2.2 Group Demand & Security of Supply

The current maximum group demand is 303MVA(Winter) and 287MVA(Summer); which places the group in class of supply 'E' as per EREC P2/7(≥300MW) and must be secured for a Second Circuit Outage (SCO).

The current running arrangement with 2 SGTs on each side of busbars with the bus section breaker CB220 open. The group is currently secure for the loss of two SGTs, the site is run solid with CB20 closed. However, as mentioned above the SGT pairs emanate and terminate on the same side of the 400kV and 132kVbusbars, hence for loss of SGTs on the same side(SGT pats 1&3 / 2&4), there is inherent risk that the corresponding 132kV busbars will lose the supply completely.

2.3 Fault levels

The 132kV fault levels at Legacy are currently approaching the switch ratings, however the switchgear is being replace in ED1 period (non-load / condition driven reinforcement) and due to be complete by the 2023. Post the switchgear replacement, the fault levels would be well within both the design and as well as the switchgear ratings.

2.4 Existing Generation

Table 2-1 shows the technology wise split of the connected and contracted generation in the Legacy 132kV group.

Table 2-1: Connected / Contracted Generation

Generation Technology	Capacity (MW)	
	Connected	Contracted
Biomass	5.4	-
Fossil gas	17	82.5
Fossil oil	21.88	36
Solar	64.7	11
Waste	3.33	-
Wind Onshore	126.1	-
Other	9.85	-
Total	**248.3**	**129.5**
	377.8	

3 Needs Case

The DFES Baseline view forecasts additional demand growth of ca. 40MW, the group demand reaching 388MVA by the end of RIIO-ED2 period. There an additional contracted generation of 130MW taking the total generation in the group to 378MW (see Table 2-1).

Network assessments have indicated that with this level of demand / generation growth there will be increased reliance upon the mutual support provided under abnormal running conditions, between the Connah's Quay and Legacy GSPs. The Legacy substation only has a single bus-section breaker, and operationally supporting the Connah's Quay group can place the Legacy busbar at increased operational risk. The existing busbar arrangements are shown in Figure 3-1.

Certain running arrangements on the 400kV transmission network place the Legacy 132kV switchboard at risk of the loss of two of the four SGTs. The Supergrid transformers supplying each side of the 132kV busbar originate from the same side of the 400kV busbars. To ensure that demand can be secured in the event of either 132kV or 400kV busbar outages, the Legacy 132kV substation requires minor modifications to the busbar arrangements.

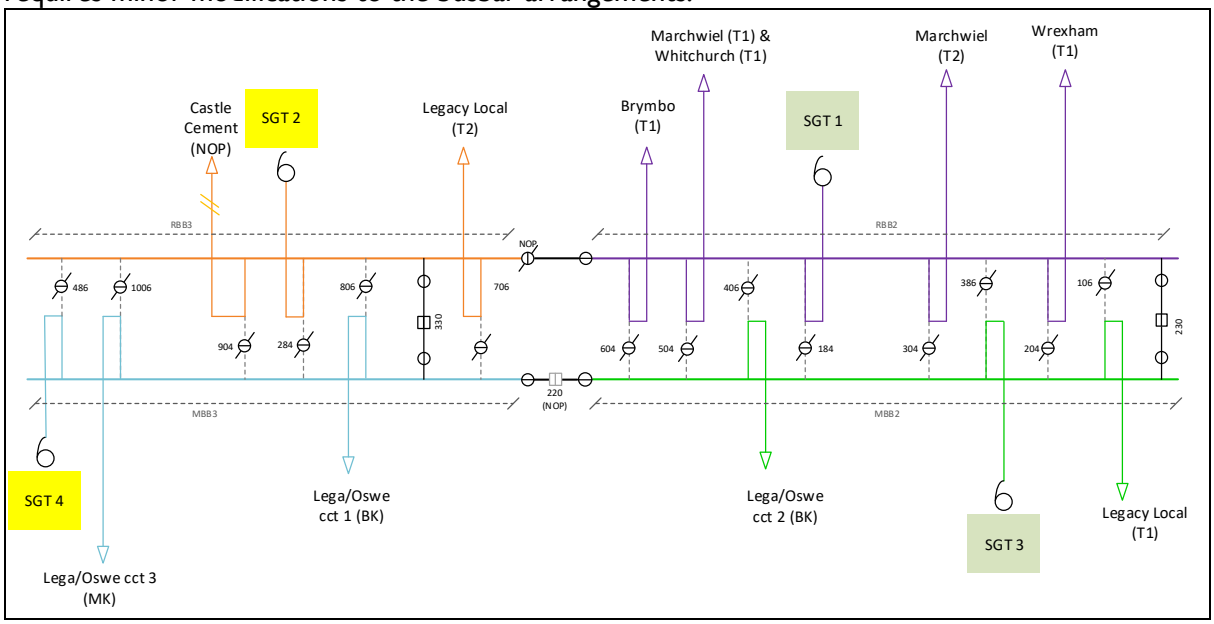

Figure 3-1: Legacy 132kV substation current operational arrangement

3.1 Forecast Demand and Generation

The demand forecast is based on actual system measurement data from the PI system and stakeholder endorsed Distribution Future Energy Scenarios (DFES) and considers our pipeline of known developments. Within the ED2 period the group demand is forecast to grow to ca. 359MVA in the Baseline scenario by end of 2028. The Baseline scenario also considers connection of ca. 32,726 electric vehicles, and ca 23,017 heat pumps in this group by 2028.

An additional 98MW generation is forecast to connect in the RIIO-ED2 period, much of the generation in the form of wind and solar generation. Figure 3-2 and Figure 3-3 show the forecast demand and LCT uptake in the Legacy 132kV group.

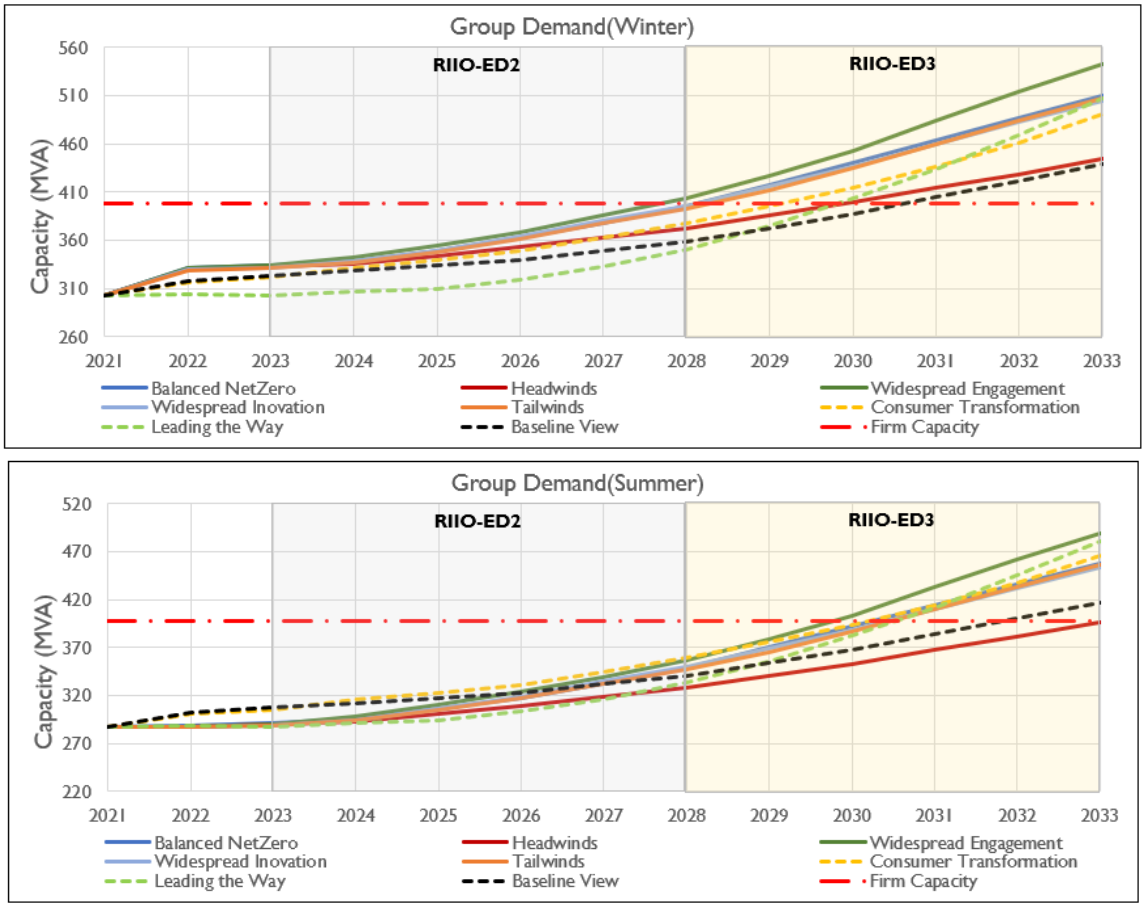

Figure 3-2: Legacy 132kV group demand forecast

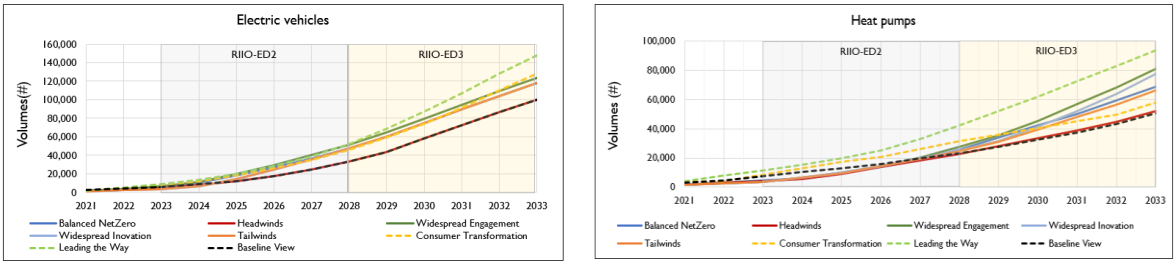

Figure 3-3: Legacy 132kV LCT uptake forecast

3.2 Network Impact Assessments

Detailed network studies covering Intact, N-1, N-1-1 and fault level assessments were conducted for the 132kV and 33kV network fed from the Legacy considering the different demand forecast scenarios. The findings from the network impact assessments are detailed in sections below.

3.2.1 Network Constraints

There are no thermal/voltage/fault Level constraints on the 132kV networks within the RIIO-ED2 period due to the forecast demand.

4 Optioneering

Table 4-1 shows the list of options considered to increase the operational flexibility and increase security of supply at Legacy 132kV GSP. Few of the options are rejected based on technical / commercial rustications, the rest of the options are taken forward for detail analysis and included in the cost benefit analysis. The shortlisted options are taken forward for detailed analysis and considered for cost benefit analysis.

Among the options taken forward, the Baseline option comprising SGT tail swap over and new bus section circuit breaker is the minimum required works for the scheme.

Table 4-1: Long list of options considered for the scheme

Option	Description	Status	Reason for rejection
(a)	No Intervention	Rejected	This would perpetuate the risk of losing whole bar for busbars faults. Also, would miss the opportunity to facilitate additional operational flexibility.
(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)	SGT tail swap over and new bus section breaker	Considered (**Baseline**)	
(d)	SGT tail swap over and 2 x hybrid breaker/ disconnectors + 2 x disconnectors	Considered (**Option 1**)	
(e)	New PST on the Connah's Quay – Legacy Ckt at Brymbo	Rejected	This option is considerably more expensive than an individual breaker.
(f)	New Back-to-Back DC converter on the Connah's Quay – Legacy Ckt at Brymbo	Rejected	This option is considerably more expensive than an individual breaker.

5 Detailed Analysis

The detailed network fault levels and power flow studies considering the connected and contracted customers and the forecast demand / generation in the group. Both the options taken forward for detailed analysis aims to improve the operational flexibility and increased security of supply.

5.1 Baseline - SGT tail swap over and new bus section breaker

The prosed works at Legacy include

- Swap SGT2 and SGT4 tails across the 132kV busbars to include security of supply
- New bus-section circuit breaker CB260 (along with automation) between the reserve busbars to increase operational flexibility

5.1.1 SGT3 and SGT4 tail swap

Legacy SGT configuration on the 400kV busbars (NGET side) is same as that of the 132kV SGT arrangement. A 400kV busbar fault this can result in the loss of 2 SGTs simultaneously, thus the transmission grid infeeds to either the MBB2/RBB2 or MBB3/RBB3 132kV bus sections will be lost. In addition, the SGT 2 & 4 are always a single 400kV CB apart, i.e. they are always on a X230 risk(see Figure 2-2) , and there is presently no arrangement that avoids this.

To overcome this, SGT tail swap over is proposed i.e., the 132kV connections on SGT3&4 need to be swapped across the busbar split. This would provide 2 SGTs on either side of the split on sourced from different sides of the 400kV bars. Further to this, the auto-close scheme on the bus section CB220 (auto-closing CB220 for the loss of SGT1/SGT2) was disabled after the CB replaced following a failure. The auto-close scheme will be beneficial with the current 2+2 running arrangement, as it can couple the bus sections in switching time scales compared to the manual switching.

The cost of this works will be claimed under CV4 (New Transmission Capacity Charges). The capital contribution towards the SGT tail swap will be paid in full upfront(pre-commissioning), there after these transmission assets carry the non-capital cost component (Maintenance and Transmission Running Costs) over their lifetime (45 years).

5.1.2 New bus section breaker 'CB260' between reserve busbars (RBB2 & RBB3)

Currently, with 2+2 split arrangement, the 132kV busbar is run split with an Oswestry side (MBB4/RBB4) and Wrexham / Marchwiel side (MBB3/RBB3). For 132kV busbar outages, depending on which side of the split, all the circuits would be either on the Main or Reserve busbar. In such cases the circuits feeding the underlying demand groups are at the risk of another busbar trip. With the provision of the bus section breaker 'CB260' the risk of losing the whole reserve bar will be eliminated, thus reducing the risk of losing supply to the demand groups.

It is proposed to install a new bus section circuit breaker 'CB260' between the reserve busbars, the cost of the new breaker will be claimed under CV1(Primary Reinforcement) category in the RIIO-ED2 period. Figure 5-1 shows the works and final 2+2 reconfiguration of Legacy 132kV substation as part of the proposed solution. It is recommended that this work be carried out under an NGET Modification Application and a fee of £30k is allocated for this.

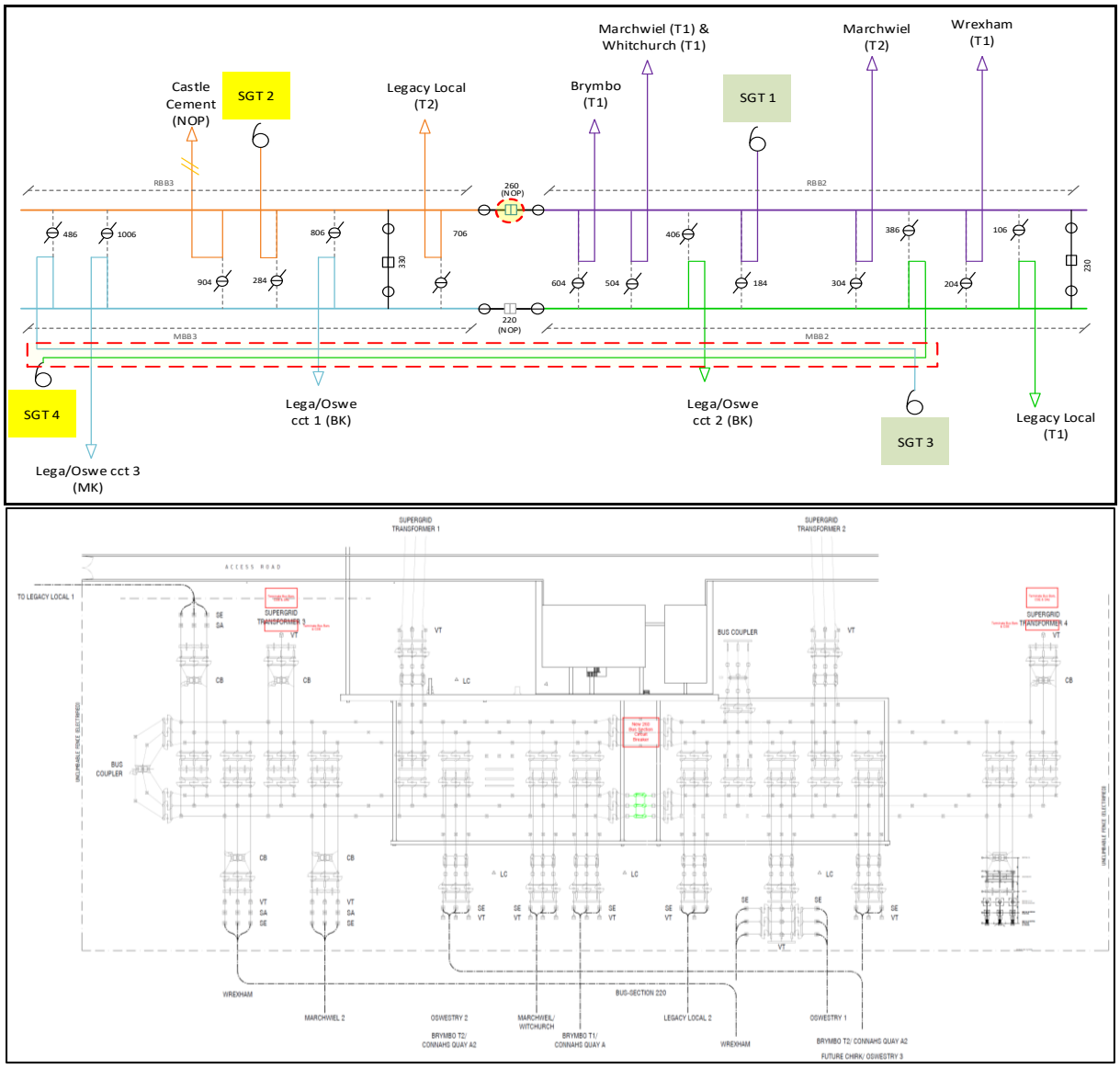

Figure 5-1: Legacy 132kV substation proposed operational arrangement

Table 5-1:Total scheme cost breakdown

Asset Description		Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contributions (£m)
132kV UG Cable (Non-Pressurised)		0.46	0.510	0.510	-
132kV CB (Air Insulated Busbars) (OD) (GM)		1	0.176	0.176	-
Civil Works at 132 kV Substations		-	0.709	0.709	-
Other Costs	Protection & SCiS Changes	-	0.290	0.290	-
	Auto-close scheme	-	0.100	0.100	-
	NGET Modification Application Fee	-	0.030	0.030	-
	Opex Costs (Maintenance Charges)	-	0.352	0.026	-
Total Costs (£m)			**2.167**	**1.841**	-

Table 5-2: Cost and Volumes breakdown

CV Category	Asset Description	Cost(£m)	Total
CV1	132kV CB	0.235	0.265
	NGET Mod app fee	0.030	
CV4	SGT tail swap	1.450	1.576
	Auto-close scheme on 132kV CB	0.100	
	Maintenance charges on 132kV cables	0.026	
		Total	**1.841**

A ModApp will be submitted to NGESO for works involving SGT132kV tail swap in 2023 and it is envisaged that the works will be completed in 2025/26. In addition to this, there are also one-off costs for the 132kV cable laying and associated civil works which will be paid to the NGESO in 2024/25.

5.2 Option 1: SGT tail swap over and 2 x hybrid breakers / disconnectors + 2 x disconnectors

This option is similar to the Baseline option but different in the additional switchgear required to achieve operational flexibility. Due to space limitations on site, an alternative to installation of bus-section breaker 260 is the installation of 2 x 132kV hybrid breaker-disconnectors (into MBB3 and RBB2), 2 x 132kV disconnectors (into RBB3 and MBB2) and the SGT3&4 tail swap as indicated in Figure 5-2.

These additional breakers would enable the 2+2 running arrangement at a cost more than the proposed option. The fault level limitations on the Legacy 132kV switchboard will be resolved in ED1 and therefore a 'CB260' bus-section breaker should be sufficient to provide the security and operational flexibility required.

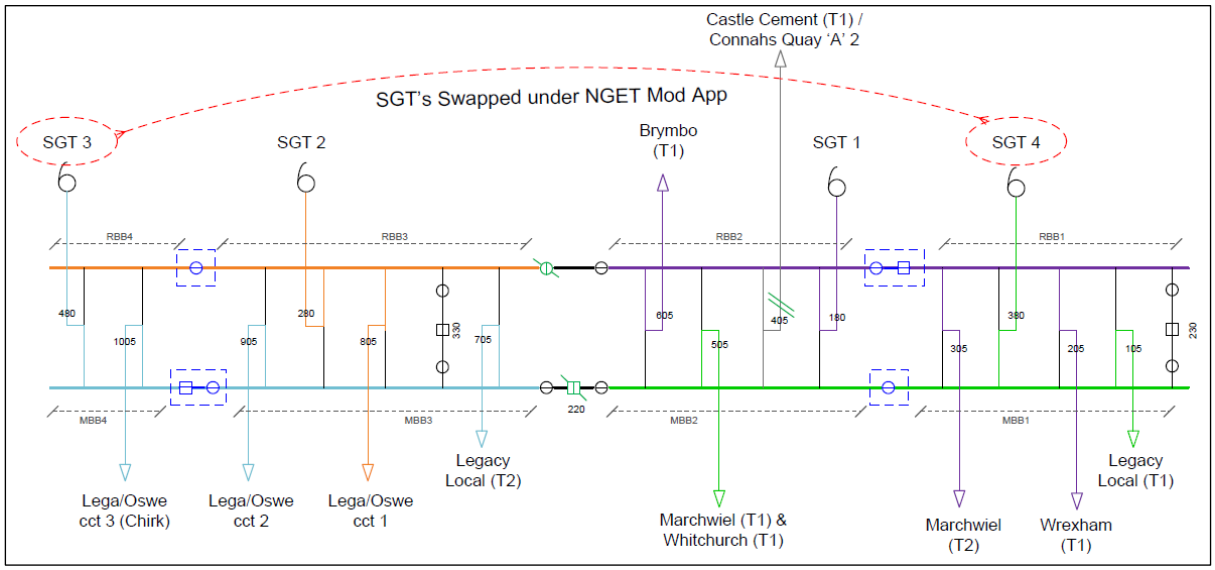

Figure 5-2: Legacy 132kV substation proposed alternate arrangement

Table 5-3: Cost and Volumes breakdown

Asset Description		Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contributions (£m)
132kV UG Cable (Non-Pressurised)		0.86	0.954	0.954	-
132kV CB (Air Insulated Busbars) (OD) (GM)		4	0.705	0.705	-
132kV Switchgear - Other		4	0.073	0.073	-
Civil Works at 132 kV Substations		-	0.790	0.790	-
Other Costs	Protection & SCiS Changes	-	0.400	0.400	-
	Auto-close scheme	-	0.100	0.100	-
	NGET Modification Application Fee	-	0.030	0.030	-
	Opex Costs (Maintenance Charges)	-	0.352	0.026	-
Total Costs (£m)			**3.405**	**3.077**	-

5.3 Options Summary Table

Summary of the costs for each of the evaluated options is presented in Figure 5-1.

Table 5-4 –Technical summary for considered options

Options	Option Summary	Total Costs(£m)
Baseline	SGT tail swap over and new bus section breaker	1.841
Option 1	SGT tail swap over and 2 x hybrid breaker/ disconnectors + 2 x disconnectors	3.077

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 **Baseline** comprising of SGT tail swap over and additional bus section circuit breaker to increase operational flexibility and security of supply. The scheme does not add to the existing thermal headroom as it is primarily aimed at improving operational network flexibility.

6.2 Cost-Benefit Analysis

A cost benefit analysis (CBA) was carried out to compare the NPV of the two options discussed in the previous sections. Considering the lowest forecast capital expenditure, the adopted Baseline option has the highest NPV (across the lifetime of the asset) and represents the lowest-cost option. Table 6-1 shows the results of CBA analysis supporting the adopted option. The full detailed CBA is provided within "ED2-LRE-SPM-030-CV1-CBA – Legacy 132kV Reinforcement".

Table 6-1: Summary of Cost Benefit Analysis

Options	Description	Decision	Comment	NPVs based on payback periods from 2023/24 (£m)			
				10 years	20 years	30 years	45 years
Baseline	SGT tail swap over and new bus section breaker	Rejected	Rejected based on NPV				
Option 1	SGT tail swap over and 2 x hybrid breaker/ disconnectors + 2 x disconnectors	**Proposed**		-1.22	-1.65	-1.91	-2.10

6.3 Cost & Volumes Profile

Table 6.2 shows the breakdown of expenditure for the proposed scheme and the cost over the RIIO-ED2 period is shown in Table 6-3. The total cost of the proposed scheme is £1.841m to carry out the proposed works at Legacy.

Table 6.2: Summary of reinforcement costs and volumes

Asset Description		Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)
132kV UG Cable (Non-Pressurised)		0.46	0.510	0.510
132kV CB (Air Insulated Busbars) (OD) (GM)		1	0.176	0.176
Civil Works at 132 kV Substations		-	0.709	0.709
Other Costs	Protection & SCiS Changes	-	0.290	0.290
	Auto-close scheme	-	0.100	0.100
	NGET Modification Application Fee	-	0.030	0.030
	Opex Costs (Maintenance Charges)	-	0.352	0.026
Total Costs (£m)			**2.167**	**1.841**

Table 6-3: Cost incidence over the RIIO-ED2 period, £m (2020/21 Prices)

Investment category	Total (£m)	Cost Incidence (£m)				
		2023/24	2024/25	2025/26	2026/27	2027/28
Primary Reinforcement (CV1)	0.265	0.159	0.053	0.053	-	-
New Transmission Capacity Charges (CV4)	1.576	-	1.549	0.009	0.009	0.009
Total Costs (£m)	**1.841**	**0.159**	**1.602**	**0.062**	**0.009**	**0.009**

6.4 Risks

The proposed option is a combination of works under two expenditure categories Primary Reinforcement (CV1) and the New Transmission Capacity Charges (CV4).

The Primary Reinforcement (CV1) works include installing a new bus section breaker 'CB260', which is a BaU activity and entails very low risk. The works are proposed to start in the beginning of ED2.

The New Transmission Capacity Charges (CV4) works include the works on the NGET (National Grid Electricity Transmission) assets, like cable overlays, civil works and associated protection changes. These works will require raising a Modification Application with (NGESO), the works and required outages will liaised with National Grid and hence the risk are assumed to be low to medium.

SPM's past track record of 132kV works is presented in "Annex 4A.14: 132kV Plants and Circuits" our RIIO-ED2 business plan.

6.5 Outputs Included in RIIO-ED1 Plans

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

6.6 Future Pathways – Net Zero

6.6.1 Primary Economic Driver

The primary driver for the Legacy 132kV reinforcement is to facilitate greater operational flexibility in terms of circuit transfer and outages and minimises the risk of losing whole bar for busbars faults.

6.6.2 Payback Periods

The CBA indicates that a positive NPV result in all assessment periods (10, 20, 30 & 45 years). As the intervention is forecast to carry at least a 45-year asset life expectancy, the positive 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 has been tested against and has been found to be 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 SPENs DSO vision and future energy strategy.

For the Legacy 132kV group, Table 6.4 shows electric vehicle and heat pump uptakes across a range of future pathways, the G74 fault contributions from the forecast uptakes along with the generation will exacerbate the existing fault levels in the group. 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	Headwinds	Widespread Engagement	Widespread Innovation	Tailwinds
EVs	32,726	25,057	46,078	52,077	47,320	32,726	51,446	46,913	46,913
HPs	23,017	19,932	31,283	42,258	25,870	22,936	27,359	24,947	28,849

** Note: System Transformation is excluded 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						R1								
Consumer Transformation						R1								
Leading the Way						R1								
Balanced Net Zero						R1								
Headwinds						R1								
Widespread Engagement						R1								
Widespread Innovation						R1								
Tailwinds						R1								

R1 – SGT tail swap and new bus-section circuit breaker

The proposed solution is robust across a wide range of pathways. This is the minimum requirement to facilitate operational flexibility and is not sensitive to the future pathways. The proposed solution is required under all the future pathway scenarios.

Table 6.6: Sensitivity of the proposed RIIO-ED2 expenditure

	Baseline	Uncertain
RIIO-ED2 Expenditure (£m)	1.841	0.0
Comment	Proposed option.	N/A

6.6.4 Asset Stranding Risks & Future Asset Utilisation

Electricity demand and generation uptakes are forecast to increase under all scenarios. The stranding risk is therefore considered to be low and it is predicted asset utilisation will not exceed the design/switchgear ratings in the RIIO-ED2 period.

6.6.5 Losses / Sensitivity to Carbon Prices

Losses have been considered in accordance with License 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 or high impedance solutions, network configurations leading to higher losses.

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

6.6.6 Future Asset Utilisation

It has been assessed that the preferred option is consistent with the future generation and demand scenarios and that the risk of stranding is very low.

6.6.7 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 safe operation of the distribution network and its enduring ability to facilitate wider whole system benefits.

6.7 Environment and Sustainability Considerations

6.7.1 Operational and embodied carbon emissions

The proposed scheme is likely to result in the emissions of embodied carbon arising from the delivery of the programme. There is likely to be little or no impact on SPEN's Business Carbon Footprint (BCF).

The volumes of carbon emissions are calculated based on the asset category and volumes for each of the options considered and included in the CBA under societal benefits.

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 sustainability impacts associated of our EHV transformer modernisation programme, we need access to reliable data from our suppliers. The need for carbon

and other sustainability credentials to be provided now forms part of our wider sustainable procurement policy.
We believe that such a requirement sends a strong message to our suppliers that we take sustainability seriously, and that such positive engagement is key to improving the overall sustainability of our collective supply chain.

6.7.3 Resource use and waste

The proposed scheme 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 proposed scheme will only affect developed 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 but recognises that the nature of our substations makes it challenging to minimise their visual impact.

6.7.7 Climate change resilience

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

7 Conclusion

The growth of both demand and generation in Legacy 132kV group and the adjacent Connah's Quay GSP group there is a requirement for increased operational flexibility within ED2. This requires minor modifications to the layout of the Legacy GSP substation to provide additional security to the group in the event of outages on the Transmission network, and to provide additional operational flexibility to enable improved coupling with the adjacent Connah's Quay GSP.

The highlighted issues can be resolved, by swapping the 132kV connections to SGT 3 and 4 in order secure the demand for 400kV bar outages and installing a new bus section breaker 'CB260' between the reserve busbars. The provision of a bus section breaker between the reserve busbars, would facilitate greater operational flexibility in terms of circuit transfer and outages and minimises the risk of losing whole bar for busbars faults.

The proposed solution represents the lowest cost and is an efficient solution to meet the forecast demand growth when compared with the identified alternative scheme. The estimated cost for the above is £1.841 m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure. An additional cost of £343k will be paid to NGESO as maintenance charges for the additional 132kV cabling (Transmission Connection Point Charges) beyond RIIO-ED2 period.