Woodside Grid 33kV Fault Level Mitigation

ED2 Engineering Justification Paper

ED2-LRE-SPM-004-CV3-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	Woodside Grid 33kV Fault Level Mitigation		
Activity	33kV Grid Switchboard Replacement		
Primary Investment Driver	Fault Level Mitigation		
Reference	ED2-LRE-SPM-004-CV3-EJP		
Output	Fault Level Reinforcement		
Cost	£1.926m		
Delivery Year	2024-2026		
Reporting Table	CV3		
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**
	-	**£1.926m**	**-**

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:	Woodside Grid 33kV Fault Level Mitigation
Project Reference:	ED2-LRE-SPM-004-CV3-EJP
Decision Required:	To give concept approval for the replacement of the existing 9-panel 33kV switchboard at Woodside, and the associated remote end protection modifications.

Summary of Business Need:

Wallasey - Woodside 33kV grid group is located within the Birkenhead 132kV GSP group and supplies 42,365 customers in the north-eastern corner of the Wirral Peninsula.

At Woodside Grid substation the make duty fault level is in excess of the rating, and break duty is at 100% of the rating of the existing legacy switchgear on the 33kV side. The site is operationally managed requiring switching actions to temporarily reduce the fault levels prior to certain switching actions on the Woodside switchgear. The high fault levels at this site present a barrier to low-cost timely connection of generation.

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 requirements and accommodate future growth and this proposal will meet that requirement.

The primary driver for the investment at Woodside Grid substation is the fault level exceedances (both Peak Make and RMS Break duties) on the 33kV switchboard. The proposal is to replace the existing 9-panel 33kV switchboard and undertake associated remote end protection modifications. This would create additional fault level headroom of 4.4kA / 250MVA at Woodside Grid substation.

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

- Replace existing 9-panel 33kV switchboard and undertake associated remote end protection modifications.
- Carry out the remote end protection changes and relay upgrades

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	CV3	Fault Level Reinforcement	1.926	1.155	0.385	0.385	-	-
Total Expenditure within RIIO-ED2			**1.926**					

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

Wallasey - Woodside 33kV grid group is located within the Birkenhead 132kV GSP group and supplies the north-eastern corner of the Wirral Peninsula including areas of Birkenhead, Wallasey, and Woodside. This group supplies 42,365 customers and operates split with Prenton – Rock Ferry 33kV group, at Woodside; the bus section circuit breaker runs 'normally open' to reduce the fault levels to within plant rating.

The fault level make duty at Woodside Grid is in excess of the rating of the installed switchgear and the break duty is at its rating. The site is operationally managed requiring switching actions to temporarily reduce the fault levels prior to certain switching actions on the Woodside switchgear. The high fault levels at this site present a barrier to low-cost timely connection of generation.

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 requirements and accommodate future growth and this proposal will meet that requirement.

The primary driver for the investment at Woodside Grid substation is the fault level exceedances (both Peak Make and RMS Break duties) on the 33kV switchboard. The proposal is to replace the existing 9-panel 33kV switchboard and undertake associated remote end protection modifications at a total cost of £1.926m with 100% contribution included in the RIIO-ED2 period under Fault Level Reinforcement / CV3 category. This would create additional fault level (RMS Break) headroom of 4.4kA / 250MVA at Woodside Grid substation. The works are proposed to start in 2023/24 and finish in 20252/26.

2 Background Information

2.1 Existing / Authorised Network

The Wallasey - Woodside 33kV grid group is operated fully interconnected and is supplied from the Birkenhead 132kV GSP using 2 x 60MVA grid transformers at Wallasey and 1 x 45 MVA grid transformer at Woodside as shown in Figure 2-1.

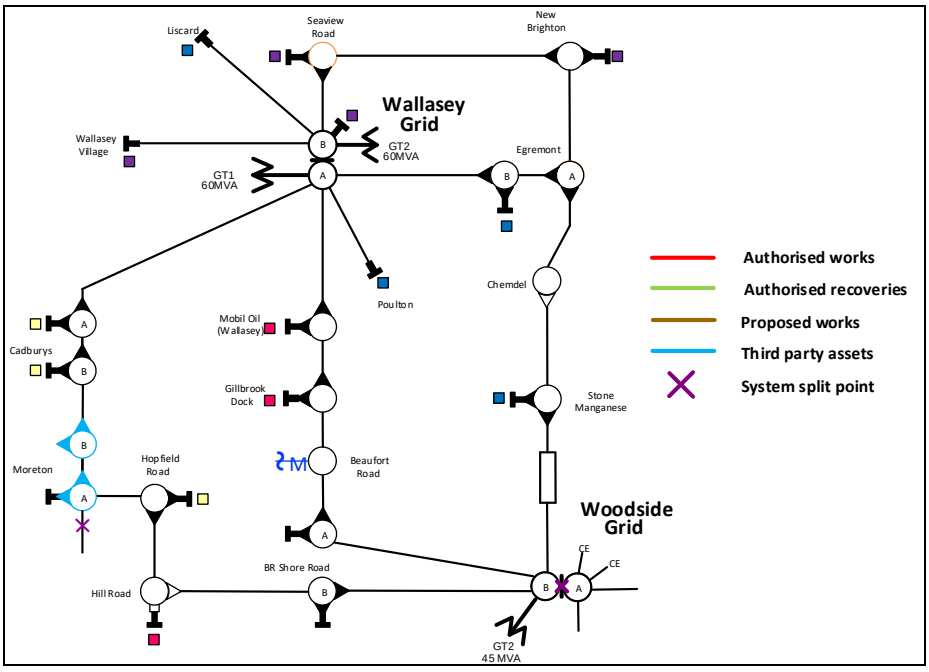

Figure 2-1: Authorised Wallasey -Woodside 33kV group

Under normal running arrangements, Wallasey Grid substation is run solid on the 33kV side and Woodside 33kV board is run split, with the 'B' board feeding Wallasey - Woodside group and the 'A' board connected to Prenton – Rock Ferry 33kV group. With the board run split, the fault level exceedances are on the 'B' side.

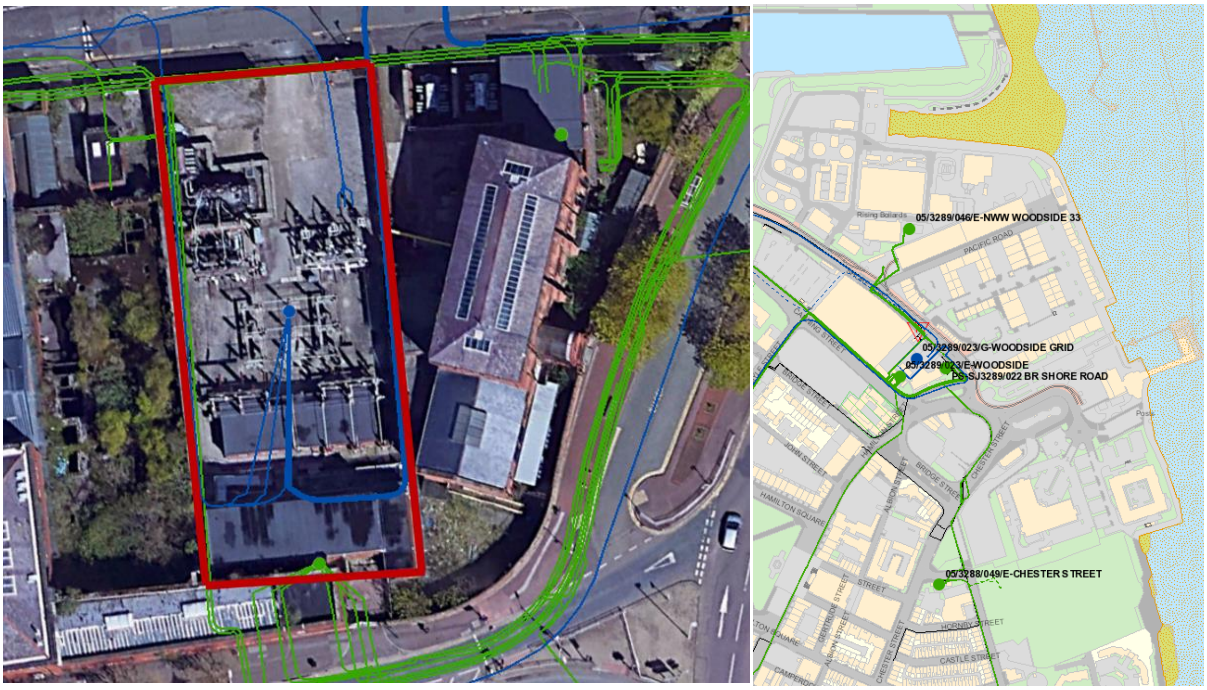

Figure 2-2: Woodside 33kV Grid substation

2.2 Network supply / circuit capacity

The current group demand is 72.8MVA, against the group firm capacity of 95 MVA, the load index group is LI1. The group is EREC P2/7 Class 'D' and requires N-2 redundancy at 132kV level to meet the security of supply requirements.

Table 2 shows the EHV connected and contracted demand/generation capacities in the group. Recent connections activity has offered an additional 24.2MVA of demand capacity to two prospective customers.

Table 2-1: Demand and generation data

Customer	Import capacity (MVA)	Export capacity (MW)	Voltage (kV)	Status
Beaufort Road STOR	0.3	20	33	Connected
BR Shore Road	8.5	-	33	Connected
MerseyRail Bidston	6	-	33	Contracted
Wirral Waters	15.2	-	33	Contracted
Total	**30.0**	**20**		

3 Needs Case

Switchgear are network assets which keep the higher voltage network safe in the event of a fault. They safely isolate the faulted section of the network. Switchgear is rated to cope with a certain level of fault current. Increasing volumes of distributed generation will increase the level of network fault current. Fault level constraints limit the low-cost timely connection of future generation in this group.

3.1 Fault levels and switchgear

Table 3 below shows the current 33kV fault levels as a percentage of the lowest of switchgear ratings / design limits at the grid and primary substations in the Wallasey – Woodside group. The fault level issue and the switchgear details are discussed below.

The 33kV fault level design limit for RMS break duty is 17.5 kA. The usual design practice is to limit the network fault levels to 95% of the lowest of design fault levels and switchgear ratings, above this threshold fault level mitigations are deemed necessary.

Woodside board is a 9-panel AEI / Metrovicks / GEC make, VLP9 type oil medium circuit breakers, rated for 13.12kA installed in 1961, 4 of these were replanted 2003. The switchgear is an outdated type and procuring spares for retrofit / refurbishment is challenging. This make and model of switchgear is classified for replanting as per SPEN's policy "SWG-02-007 - SWITCHGEAR ASSESSMENT"

Fault level type 1 assessments identify both make and break duties in excess of switchgear rating on the 'A' side of the board under normal running arrangements. At present the make duty is operationally managed with Technical Limitation Record (TLR) flags on the Network Manage System (NMS) requiring operational switching actions to temporarily reduce the fault levels prior to certain switching actions on the Woodside substation switchgear.

Table 3-1 - Woodside Grid Fault Level

Substation Name	Switchgear Rating (kA)		Fault Levels (kA)		Duty[1] (%)	
	Make	Break	Make	Break	Make	Break
Woodside Grid	33.46	13.12	35.23	13.16	105.3%	100.0%

Detailed Type-2 fault level assessments have been undertaken to risk assess and manage the most onerous fault current seen by each individual circuit breaker.

For these reasons, it is necessary to mitigate the existing fault levels, to continue to maintain a safe and secure network and to provide additional fault level headroom to accommodate the decentralisation and decarbonisation of generation.

3.2 Forecast Demand

The peak group demand observed in the group is 72.8MVA (Winter) / 43.6 MVA (Summer). The group demand is forecast to grow but remain within the firm capacity during the RIIO-ED2 period. This 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 in the group.

No other thermal or voltage constraints were identified in the group during the ED2 period with the forecast demand growth. With the forecast demand growth, group still operates within the limits of the requirements of EREC P2/7 'Class of Supply D' and is compliant through the RIIO-ED2 period.

3.3 Forecast Generation

This group has 20MW of generation connected at EHV. The SPEN DFES indicates across the Birkenhead GSP, generation could increase by up 28.5MW by 2028 under the highest forecast scenario.

[1] The calculated duty is based on the lowest of either the switchgear rating or the 33kV design limits (for 43.75kA Peak Make / 17.5kA RMS Break)

4 Optioneering

Table 4-1 below shows the long list of options considered for the scheme. 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. Among the options taken forward, the **Baseline** option comprising the switchboard replacement is the 'do minimum' intervention without application of innovation to mitigate the fault level issues at Woodside Grid substation.

Table 4-1 – Long list of options considered

Option	Description	Status	Reason for rejection
(a)	Do Nothing	Rejected	Rejected, as this leads to perpetuation of fault level issues on the grid board and present a barrier to low-cost timely connection of generation in the group.
(b)	Intervention plan using only Energy Efficiency	Rejected	Rejected as it does not address the network fault level issues.
(c)	Replace the 9 panel Woodside Grid switchboard with higher rated switchgear	Shortlisted as **Baseline**	
(d)	Replace only 'A' side of Woodside Grid switchboard (4 panels) with higher rated switchgear	Rejected	Rejected as operationally limits the ability to couple with Prenton-Rock Ferry group.
(e)	Install a 60MVA, 8% impedance series reactor in the tails of Woodside GT	Shortlisted as **Option 1**	
(f)	Replace the Woodside 45MVA GT2 with high impedance 60MVA	Shortlisted as **Option 2**	
(g)	Split the 33kV group into two groups.	Rejected	Considers splitting the group into two groups of two transformers by establishing a grid transformer site at BR Shore Road. To enable this regrouping will also require the installation of 8.7 km 33kV cable and an 11kV group would need to be separated. This was rejected based on cost.
(h)	Operate the group with Wallasey Grid bus section breaker open.	Rejected	Studies indicated the fault level reduction at Woodside is very limited.
(i)	Install Active Fault Level Management (AFLM) with Real-Time Fault Level Monitoring (RTFLM) scheme.	Rejected	This considered Active Network Management to operate the group with Wallasey GT2 on open-standby. This was unable to sufficiently mitigate the risk of already high fault levels.
(j)	Install a Fault Current Limiting (FCL) device in the Woodside GT tails	Rejected	Due to the usage of explosive fuse element, which can be a safety issue and requires maintenance & operational costs
(k)	Install a Superconducting Fault Current Limiter (SFCL) in the Woodside GT tails	Rejected	The technology is not ready for BaU and present experience from SPEN trials indicate that maintenance requirements for the cryogenic systems are prohibitive

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. This section details the recommended scheme and shortlisted options.

5.1 Baseline (Proposed) – Replace Woodside 33kV switchboard

The **proposed solution** is to replace the existing 9 panel switchboard and the associated remote end protection modifications. As shown in Figure 2-2, the substation is space constrained for expansion. An offline build is infeasible; hence this solution considers an inline build using half-board outages. The switchboard replacement creates additional fault level headroom of 4.4kA / 250MVA at Woodside Grid considering the design level fault limit of 17.5kA (RMS Break).

Table 5.1 shows the scheme summary and Table 5.2 shows a summary of reinforcement costs and volumes for the proposed scheme under RIIO-ED2. Figure 5-1 shows the schematic of the works carried at Woodside Grid under the proposed option.

Table 5.1. Proposed option summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution £m)	Customer Contribution (£m)
Fault Level	Woodside 33kV Fault Level Mitigation	Replace Woodside 33kV 9 panel switchboards with higher rated switchgear and associated remote end protection modifications.	1.926	-

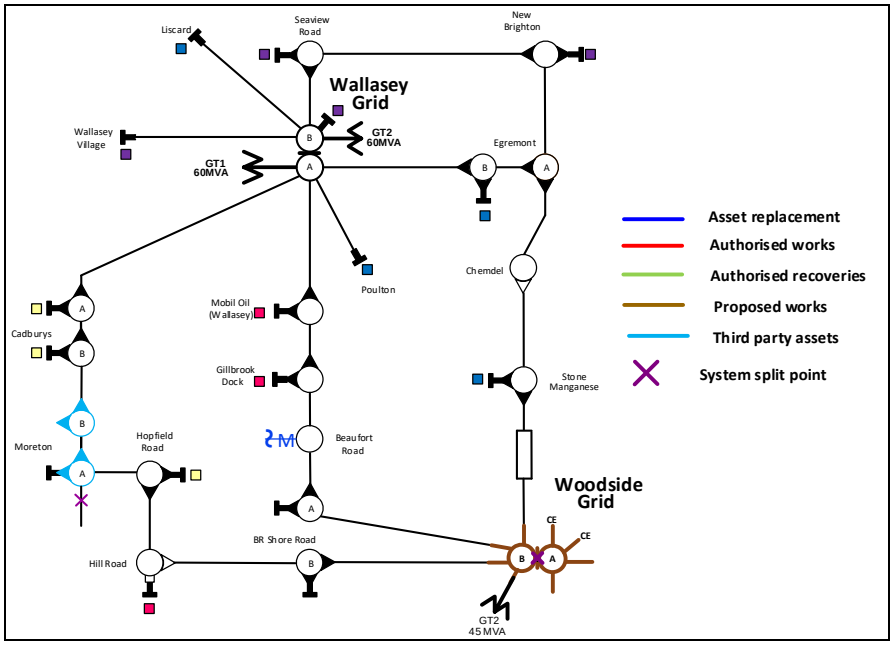

Figure 5-1: Proposed works for replacing the grid switchboard

Table 5.2. Proposed option summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
33kV CB (Gas Insulated Busbars) (ID) (GM)	9	1.534	1.534	-
Civil Works at 33 kV & 66 kV Substations	-	0.108	0.108	-
Protection changes, SCADA / RTU	9	0.234	0.234	-
Other Costs (Identify Below)		0.050	0.050	-
Total Costs		**1.926**	**1.926**	**-**
£50k for engineering time and environmental considerations				

5.2 Option 1 – New 60MVA, 8% series reactor in Woodside GT2 tails

This option limits the fault infeed into the group from the 132kV network by installing a series reactor into the Woodside Grid transformer tails. With the proposed 8% impedance series reactor, the fault levels on the Woodside Grid board reduce to ca. 11kA, thus creating a 2.1kA headroom. However, there is limited space available for a reactor requiring adjacent land to be purchased. The switchgear is an outdated type and procuring spares for retrofit/refurbishment is challenging. This option carries an increased risk of asset stranding of the series reactor upon replacement of the legacy switchgear. The increased impedance of the reactor increases network losses by 384MWh/year (considered under societal benefits in CBA). This option considers the legacy switchgear at Woodside to approach end-of-life and require replacement within the RIIO-ED3 period.

Table 5.3 shows the scheme summary and Table 5.4 shows a summary of reinforcement costs and volumes for the proposed scheme under RIIO-ED2. Figure 5-2 shows the schematic of the works carried at Woodside Grid under the proposed option.

Table 5.3. Option 1 summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution £m)	Customer Contribution (£m)
Fault Level	Woodside 33kV Fault Level Mitigation	New 60MVA, 33kV, 8% impedance series reactor in the tails of Woodside GT2.	**1.103**	**-**

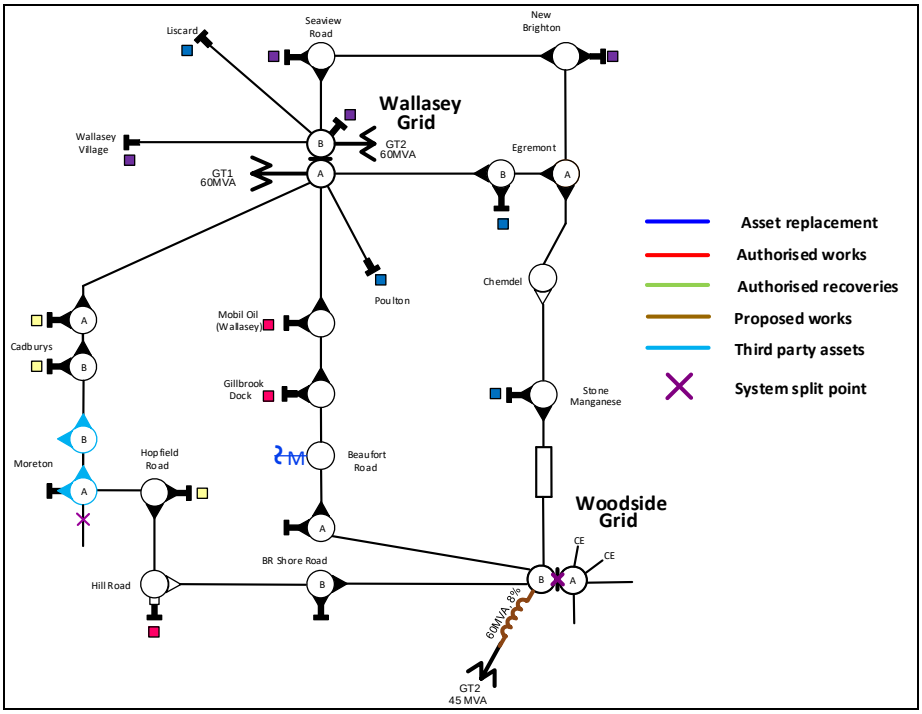

Figure 5-2: Proposed works for installing a series reactor

Table 5.4. 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)	0.30	0.073	0.073	-
Civil Works at 33 kV & 66 kV Substations	-	0.200	0.200	-
Wayleaves/Easements/Land Purchase	-	0.330	0.330	-
Other Costs (Identify Below)	-	0.500	0.500	-
Total Costs		**1.103**	**1.103**	**-**
£100k for updating relay/protection changes				
£350k for outdoor Series reactor, 60MVA and 8% impedance.				
£50k pre-engineering				

5.3 Option 2 – Replace Woodside 45MVA GT2 with higher impedance 60MVA unit

This option limits the fault infeed into the group from the 132kV network by replacing the 45MVA unit with higher impedance 60MVA. The existing 45MVA GT2's nominal impedance is 12.6%; considering an additional 8% impedance (same impedance as series reactor impedance in Option 1), the proposed nominal impedance of the new 60MVA impedance is ca. 25% (standard 60MVA unit impedance is ca. 19%) . With the proposed 25% impedance GT, the fault levels on the Woodside Grid board reduce to ca. 11kA, thus creating a 2.1kA headroom.

The increased impedance of the new GT increases network losses by 384 MWh/year (considered under societal benefits in CBA). This option considers the legacy switchgear at Woodside to approach end-of-life and require replacement by the end of RIIO-ED3 period.

Table 5.5 shows the scheme summary and Table 5.6 shows a summary of reinforcement costs and volumes for the proposed scheme under RIIO-ED2. Figure 5-3 shows the schematic of the works carried at Woodside Grid under the proposed option.

Table 5.5. Option 1 summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution £m)	Customer Contribution (£m)
Fault Level	Woodside 33kV Fault Level Mitigation	Replace Woodside 45MVA GT2 with higher impedance 60MVA unit	**2.200**	**-**

Table 5.6. Option 1 summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
33kV UG Cable (Non-Pressurised)	0.05	0.012	0.012	-
132kV UG Cable (Non-Pressurised)	0.05	0.055	0.055	-
132kV Switchgear - Other	1.00	0.018	0.018	-
132kV Transformer	1.00	1.589	1.589	-
Civil Works at 132 kV Substations		0.400	0.400	-
Other Costs (Identify Below)		0.125	0.125	-
Total Costs		**2.200**	**2.200**	**-**
£25k for environmental considerations				
£100k for protection changes and relay upgrades				

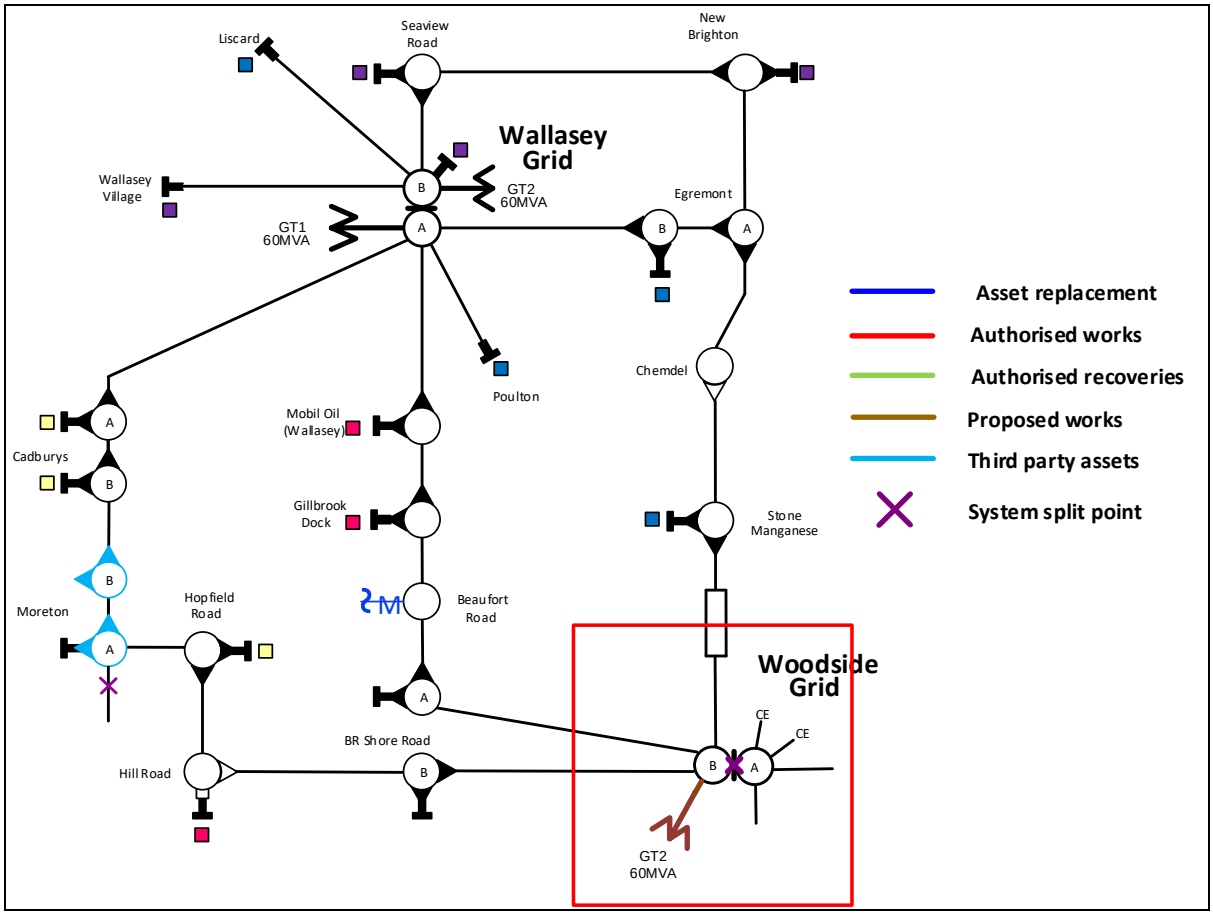

Figure 5-3: Proposed works for installing a 60MVA GT

5.4 Options Summary Table

Summary of the costs for each of the evaluated options is presented in Table 5-7.

Table 5-7: Technical summary for considered options

Options	Option Summary	Total Costs(£m)
Baseline	Replant Woodside 33kV, 9 panel switchboard with higher rated switchgear.	1.926
Option 1	New 60MVA, 33kV, 8% impedance(max) series reactor in the tails of Woodside GT2.	1.103
Option 2	Replace Woodside 45MVA GT2 with higher impedance 60MVA unit	2.200

Derivation of costs for these options are based on the SPEN RIIO-ED2 Unit Cost Manual for intervention. This is based on bottom up cost assessment of the components of activity detailed within the RIGs Annex A for the above activities, SPEN's contractual rates for delivery, market available rates and historic spend levels.

6 Deliverability & Risk

6.1 Preferred Options & Output Summary

The adopted option is the **Baseline** involving replanting the Woodside 33kV grid switchgear with a min of 17.5kA rating. The adopted option increases the fault level (RMS Break) headroom at the grid substation by at least 4.4kA / 250MVA. This uplift in fault level headroom will be claimed as the output in the RIIO-ED2 period upon completion of the project.

6.2 Cost-Benefit Analysis

A cost benefit analysis (CBA) was carried out to compare the NPV of the three options discussed in the previous sections. Considering the lowest forecast capital expenditure, the adopted option has the highest NPV (across the lifetime of the asset) and represents the lowest-cost option, considering this is an enduring solution and gives the highest uplift in fault level headroom at Woodside Grid substation. Table 6-1 shows the results of CBA analysis supporting the adopted option. The full detailed CBA is provided within "ED2-LRE-SPM-004-CV3-CBA–Woodside Grid 33kV Fault Level Mitigation".

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	Switchboard Replacement	**Adopted**					
Option 1	New 60 MVA, 8% Series Reactor	Rejected	Rejected based on NPV	-0.25	-0.69	-0.97	-1.20
Option 2	Higher impedance 60MVA GT at Woodside	Rejected	Rejected based on NPV	-0.91	-1.58	-1.98	-2.32

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 6.2. The total cost of the proposed scheme is £1.926m to replace the 9-panel switchboard at Woodside Grid substation.

Table 6.2: Summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)
33kV CB (Gas Insulated Busbars) (ID) (GM)	9	1.534	1.534
Civil Works at 33 kV & 66 kV Substations	-	0.108	0.108
Protection changes, SCADA / RTU	9	0.234	0.234
Other Costs (Identify Below)		0.050	0.050
Total Costs		**1.926**	**1.926**
£50k for engineering time and environmental considerations			

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

Total Investment	Total	Cost Incidence (£m)				
	(£m)	2023/24	2024/25	2025/26	2026/27	2027/28
Fault Level Reinforcement (CV3)	**1.926**	1.155	0.385	0.385	-	-

6.4 Risks

The switchboard replanting / replacements are a BaU activity and hence the risks associated with the delivery of the proposed scheme are very minimal. Within the RIIO-ED1 period, 5 grid board replacements have been carried out, one of which is the Wallasey Grid substation belonging to this group. The RIIO-ED1 track record is detailed in "Annex 4A.10: Substations & Switchgear; EHV to LV" of our ED2 business plan. The learnings from the delivery of these schemes will be useful in the delivery of the proposed scheme.

The Woodside Grid substation will be replaced through online build due space constraints and requires half bar outages to build the whole board. As such, the scheme requires a minimum of two outage seasons for delivery. However, to accommodate the overall SPM ED2 delivery plan and co-ordinate the network outage requirement, the scheme delivery could stretch to three outage seasons, the cost incidence is reflective of this. The switchboard replacement is planned to begin in 2023/24. The risk of missing outage season is minimal and can be provisionally managed through planned switching.

Further to this, at the same Woodside Grid substation, additional works are proposed under ED2 CV7 (non-load) plans to replant the existing 45MVA grid transformer with a 60MVA unit, the scheme is scheduled to be delivered in the later years of ED2 2026-28. The needs case for this scheme is detailed in the engineering justification paper, "ED2-NLR(A)-SPM-005-TX-EJP Woodside 132kV Grid Transformer T2 Replacement WDC".

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 proposed reinforcement is to address the fault level exceedances at the Woodside Grid substation, both Peak Make and RMS Break duties are in exceeding the switchgear ratings.

6.6.2 Payback Periods

The CBA indicates that a positive NPV result in all assessment periods (10, 20, 30 & 45 years) which are consistent with the lifetime of the intervention. Consumers 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 Wallasey-Woodside 33kV 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	5,167	4,150	7,427	8,544	7,472	5,167	8,123	7,408	7,408
HPs	146	196	85	186	178	129	203	184	169

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

Table 6.5: Sensitivity of the proposed solution against future pathways

Solution Requirements	RIIO-ED1				RIIO-ED2					RIIO-ED3				
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Baseline							R1							
Consumer Transformation							R1							
Leading the Way							R1							
Balanced Net Zero							R1							
Headwinds							R1							
Widespread Engagement							R1							
Widespread Innovation							R1							
Tailwinds							R1							

R1 – Replace the 33kV switchboard

The proposed solution is robust across all pathways. As this is the minimum requirement to mitigate the fault levels in the group, it is not sensitive to the future pathways and is expected that proposed solution is required under all the future pathways. In all cases this solution is expected to endure beyond RIIO-ED3.

Table 6.6: Sensitivity of the proposed RIIO-ED2 expenditure

	Baseline	Uncertain
RIIO-ED2 Expenditure(£m)	1.926	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 avoiding higher impedance solutions or network configurations leading to higher losses.

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

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

6.6.6 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 in terms of accommodating more distributed generation.

6.7 Environment and Sustainability Considerations

6.7.1 Operational and embodied carbon emissions

The scheme has the potential to impact on the embodied carbon resulting from the delivery of the programme. There is likely to be little or no impact on SPEN's Business Carbon Footprint (BCF).

During the evaluation of the options associated with Woodside Grid fault level mitigation, we have embedded within the CBA, where data are available, an assessment of the embodied carbon and the associated carbon cost to inform our NPV evaluation.

It should be noted that the embodied carbon evaluation undertaken has only considered the manufacture and supply of materials. Further collaborative industry-wide work is planned for the RIIO-ED2 price review period to better understand the overall embodied carbon values including, for example installation and commissioning services, decommissioning and disposal activities as well as refurbishment opportunities. More information regarding this can be found in Section 3.1.2 of our Environmental Action Plan, Annex 4C.3: Environmental Action Plan, SP Energy Networks, Issue 2, 2021.

6.7.2 Supply chain sustainability

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

6.7.3 Resource use and waste

The 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 fault level make duty at Woodside Grid is in excess of the rating of the installed switchgear and the break duty is at its rating. The site is operationally managed requiring switching actions to temporarily reduce the fault levels prior to certain switching actions on the Woodside switchgear. The high fault levels at this site present a barrier to low-cost timely connection of generation

The proposed scheme is the baseline option of replacement of the Woodside 33kV panel board. It is an enduring solution to mitigate the existing fault levels at Woodside and provides the highest fault level headroom compared to other options considered. The total cost of the scheme is £1.926m to spend entirely within the RIIO-ED2 period.

The works for the proposed schemed are to commence in 2023/24 and expected to be delivered in 2025/26, an increment in the fault level headroom of 4.4kA / 250MVA(RMS Break) to be claimed as output for the scheme upon completion.