RIIO-ED2 Engineering Justification Paper (EJP)

Loudwater Bulk Supply Point (BSP)

Investment Reference No: 107/SEPD/LRE/LOUDWATER

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Definitions and Abbreviations

Acronym	Definition
AIS	Air-insulated Switchgear
ASCR	Aluminium Conductor Steel Reinforced
BSP	Bulk Supply Point
CBA	Cost Benefit Analysis
CBRM	Condition Based Risk Management
CEM	Common Evaluation Methodology
CI	Customer Interruptions
CML	Customer Minutes Lost
CT	Consumer Transformation
DFES	Distribution Future Energy Scenarios
DNO	Distribution Network Operator
EJP	Engineering Justification Paper
ESA	Electricity Supply Area
EV	Electric Vehicle
FCO	First Circuit Outage
FES	Future Energy Scenarios
GIS	Geographic Information System
GM	Ground Mounted
GSP	Grid Supply Point
HI	Health Index
IDP	Investment Decision Pack
LCT	Low Carbon Technology
LEP	Local Enterprise Partnership
LI	Load Index
LRE	Load Related Expenditure
LW	Leading the Way
NPV	Net Present Value
OHL	Overhead Line
PM	Pole Mounted
PV	Photovoltaics
RSN	Relevant Section of Network
SCO	Second Circuit Outage
SSEN	Scottish and Southern Electricity Network
SP	Steady Progression
ST	System Transformation
XLPE	Cross-linked Polyethylene

1 Executive Summary

Our proposed investment at Loudwater substation will deliver P2/7 compliance for an expenditure of £9.02m during RIIO-ED2.

The primary investment driver for this scheme is load related P2/7 compliance issue at Loudwater 132/33 kV substation. The P2/7 compliance issue is apparent under four scenarios (System Transformation, Consumer Transformation, Leading the way, and Steady Progression) requiring investment in ED2 due to forecast demand growth from our Stakeholder supported Distribution Future Energy Scenario (DFES).

This Engineering Justification Paper (EJP) considers a range of options to address the P2/7 compliance issues, setting out the options that have been considered and rejected prior to the CBA analysis, and the short list of those options included within the analysis, with a clear rationale for including or excluding each option.

The only technically feasiable option for this scheme is Option 3 with the cost breakdown shown in Table 1.

Asset	Volume	Costs
132kV CB (Air Insulated Busbars)(OD) (GM)	1	[redacted]
33kV CB (Air Insulated Busbars)(OD) (GM)	1	[redacted]
132kV Transformer (GM)	1	[redacted]
132kV UG Cable (Non Pressurised)	7	[redacted]
Total		[redacted]

Table 1 Project Scope Breakdown

This scheme delivers the following outputs and benefits:

- The uplift in network capacity of 117MVA to meet the needs of our customers.
- Improves the Load Index from LI5 to LI1.
- Facilitates the efficient, economic, and co-ordinated development of our Distribution Network for Net Zero.

The cost to deliver the preferred solution is £9.02m and the works are planned to be completed in 2026. This investment sits within our Net Zero Totex ask.

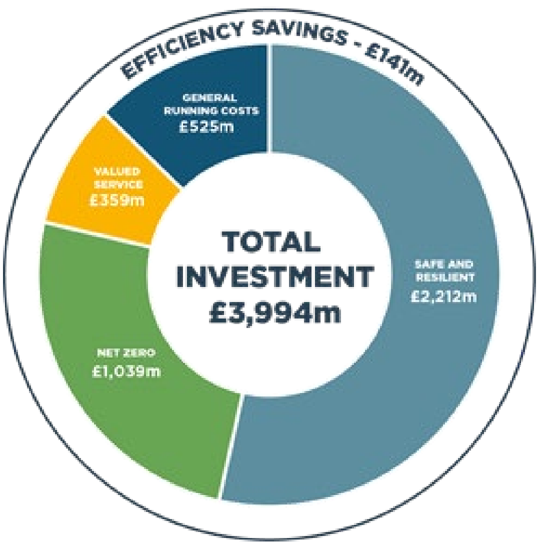


Figure 1: SSEN total investment cost within RIIO ED2

2 Investment Summary Table

Table 2 below provides a high level summary of the key information relevant to this Engineering Justification Paper (EJP) and the installation of 132/33kV transformer and 132kV circuits at Loudwater BSP.

<table>
<tr><th colspan="5">Engineering Justification Paper Investment Summary</th></tr>
<tr><td>Name of Scheme/Programme</td><td colspan="4">Loudwater BSP 132/33kV Transformer and 132kV circuits</td></tr>
<tr><td>Primary Investment Driver</td><td colspan="4">Load – P2/7 (thermal overloading)</td></tr>
<tr><td>Scheme reference/ mechanism or category</td><td colspan="4">107/SEPD/LRE/LOUDWATER</td></tr>
<tr><td>Output reference/type</td><td colspan="4">132/33 kV transformer
132kV Circuits</td></tr>
<tr><td>Cost</td><td colspan="4">£9.02m</td></tr>
<tr><td>Delivery Year</td><td colspan="4">2025/26</td></tr>
<tr><td>Reporting Table</td><td colspan="4">CV1: Primary Reinforcement</td></tr>
<tr><td>Outputs in RIIO ED1 Business Plan?</td><td colspan="4">No</td></tr>
<tr><td rowspan="2">Spend Apportionment</td><td>(£m)</td><td>ED1</td><td>ED2</td><td>ED3+</td></tr>
<tr><td>SEPD</td><td>0</td><td>9.02</td><td>0</td></tr>
</table>

Table 2: Investment Summary

3 Introduction

Our ***Load Related Plan Build and Strategy (Annex 10.1)***[1] sets out our methodology for assessing load-related expenditure and describes how we use the Distribution Future Energy Scenarios (DFES) 2020 as the basis for our proposals. We have established a baseline view of demand, providing a robust projection of the drivers of load-related expenditure for the ED2 period. Our ex-ante baseline funding request is based on the minimum investment required under all credible scenarios and is strongly supported by our stakeholders. Our plan will create smart, flexible, local energy networks that facilitate the accelerated progress towards net zero – with an increased focus on collaboration and whole-systems approaches.

This investment is a component of our strategic goal of 'Accelerating progress towards a net zero world'.

Section 4 of this Engineering Justification Paper (EJP) describes our proposed load related investment plan for the reinforcement of Loudwater substation in RIIO-ED2. The primary driver considered within this paper is load related P2/7 compliance issue due to forecast demand growth from our Stakeholder supported Distribution Future Energy Scenario (DFES).

This EJP provides high-level background information for this proposed scheme explaining the existing network arrangement the load growth forecasts through the Distribution Future Energy Scenarios (DFES) and setting out the need for this project. The Detailed Analysis section of the EJP describes the network studies undertaken, detailing the results which further justify the need of the proposed investment.

Section 5 provides an exhaustive list of the options considered through the optioneering process to establish the most economic and efficient solution. Each option is described in detail, with the EJP setting out the justification for those options which are deemed unviable solutions, and therefore not taken forward to the Cost Benefit Analysis.

Section 6, Cost Benefit Analysis (CBA) Summary, provides the comparative results of all the options considered within the CBA and sets out the rationale and justification for the preferred solution. This section also describes how we have established the cost efficiency of the plan with reference to the unit costs that have been chosen.

Finally, **Section 7** of this EJP also sets out the deliverability of the plan for RIIO-ED2 and this proposed investment.

[1] ***SECTION D: (Chapter 10), Responding to the net zero Opportunity, (Annex 10.1), Load Related Plan Build and Strategy***

4 Background Information and Analysis

4.1 Existing Network Arrangement

Loudwater BSP is located within the Iver Amersham region of the SEPD licence area. This substation is supplied from the Amersham GSP. Loudwater BSP currently supplies 35,398 customers via 33kV circuits, and the 2019/20 peak demand was 53MW. However, the demand at Loudwater BSP is expected to increase during ED2 due to the connection of a 40 MW battery storage to the BSP in 2023/24 and the re-routing of 6,836 customers from Beaconsfield to be supplied from Loudwater BSP (peak demand of 15.4MW). The re-routing of Beaconsfield primary is another proposed ED2 project which aims to address EREC P2/7 non-compliance experienced on this part of the network. As a result, the Beaconsfield project is dependent on the proposed work set out in this EJP.

Loudwater BSP is currently fed from Amersham GSP via two 132kV circuits as shown in Figure 2 . Both circuits have a winter rating of 138.3MVA and a spring/autumn/summer rating of 126MVA. The two 132/33kV primary transformers are rated at 117/108/108/90MVA in winter/spring/autumn/summer respectively.

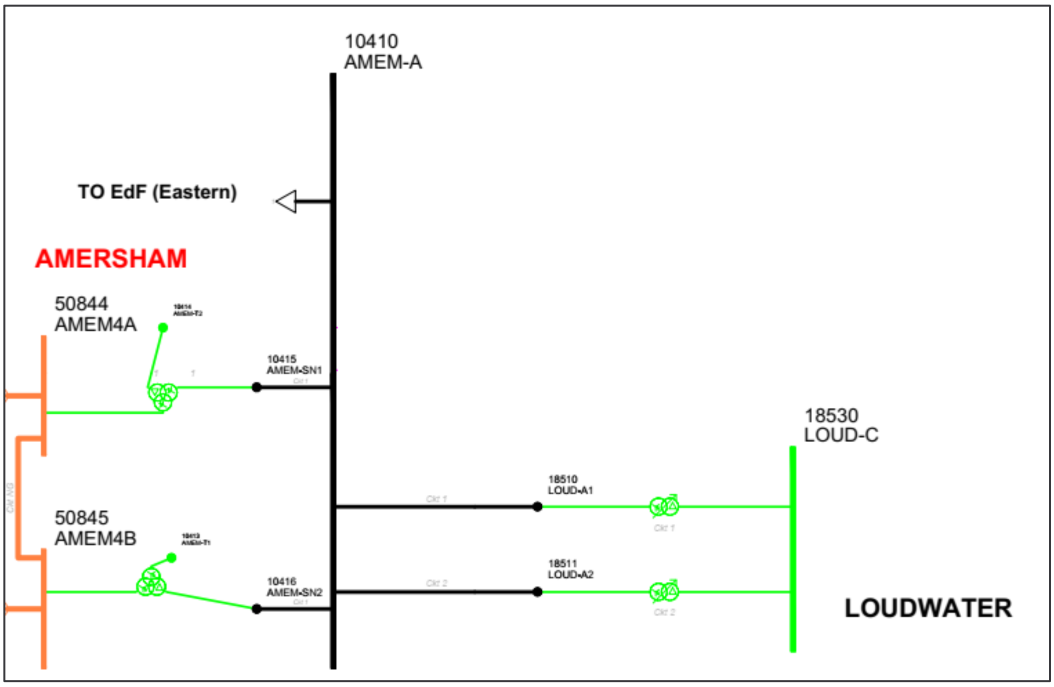


Figure 2: Loudwater BSP 132/33kV Network Arrangement Single Line Diagram.

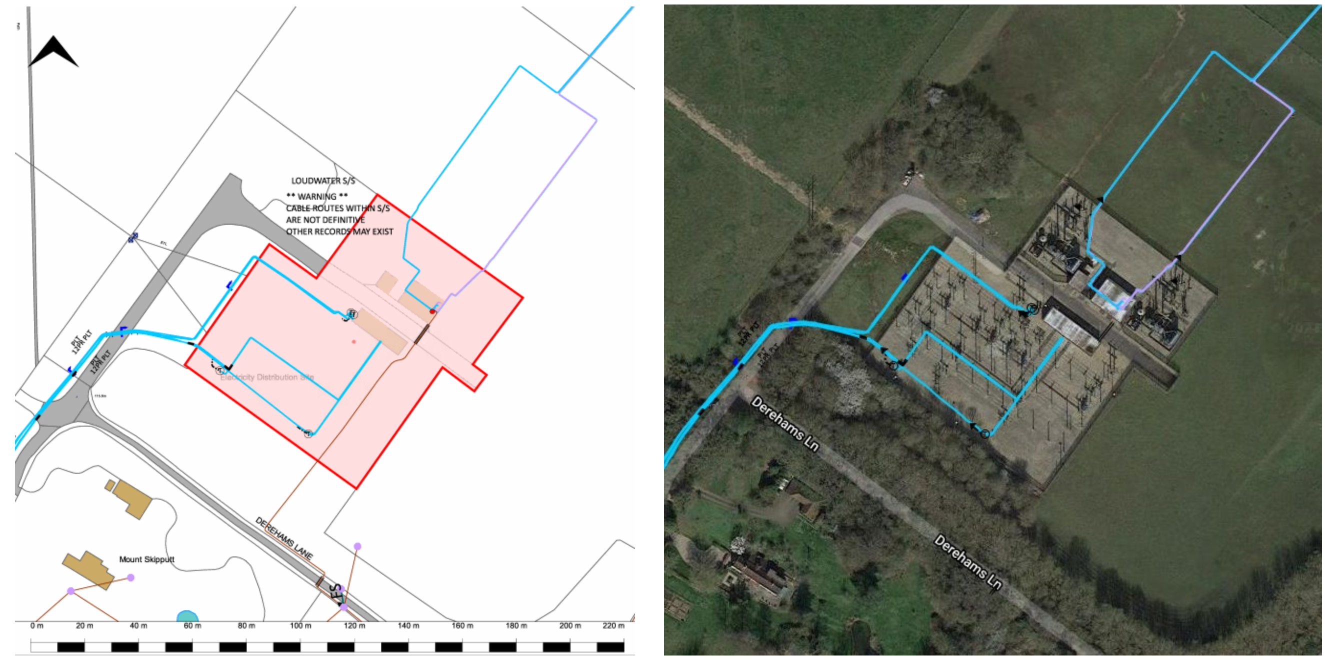


Figure 3: Loudwater BSP Substation geographical layouts

4.2 Local Energy Plan

In 2019, Buckinghamshire council declared a climate emergency and acknowledged the need for Climate Change Strategy. The council has agreed to:

1) Recognise that the rate of climate change is a global emergency.
2) Recognise that, although the UK constitutes 1% of global carbon emissions, it must nevertheless play its part in leading the way in promoting change both in the UK itself and, importantly, globally.
3) Note the significant progress that Buckinghamshire County Council has made to date in addressing climate change.
4) Agree that the new Buckinghamshire Council should consider addressing climate change as a key issue.
5) Acknowledge the net-zero 2050 UK target, as contained in the 2008 Climate Change Act (as amended).
6) Commission a carbon audit pre assessment to gain an insight into the Council's carbon usage.
7) Recommend that Cabinet should further consider this issue, including what proposals, ahead of vesting day, the authority could implement to support this agenda. These proposals to include using the carbon audit gap analysis report to inform the policy decisions of the new Buckinghamshire Council.

4.1 Demand and Generation Forecast for Loudwater BSP

In order to understand the future pathways for demand and generation at Loudwater BSP, we have carried out extensive scenario studies – the Distribution Future Energy Scenarios (DFES). The basis for this work is National Grid's Future Energy Scenarios (FES) 2020. This framework comprises four potential pathways for the future of energy based on how much energy may be needed and where it might come from. The variables for the four scenarios are driven by government policy, economics and consumer attitudes related to the speed of decarbonisation and the level of decentralisation of the energy industry. We have worked closely with our partner Regen to develop the forecasts between 2020 and 2050 through enhanced engagement with the local authorities, local enterprise partnerships (LEPs), devolved governments, community energy groups and other stakeholders.

Based on the enhanced stakeholder engagement feedback, we have chosen Consumer Transformation as the baseline scenario for our investment. In order to protect consumer's bill against forecasting uncertainties, our baseline funding only includes load related investment required in the first two years in the RIIO-ED2 period unless it is also required by other net zero scenarios. Full details on our DFES methodology, stakeholder input and regulatory treatments of load related investment can be found in the ***Load-Related Plan Build and Strategy (Annex 10.1)[2].***

As the 132/33kV transformers and 132kV circuits have seasonal ratings, these must be compared with the seasonal demands in order to ensure that no thermal limits are exceeded annually. Table 2, Table 3, and Table 4 show the demand projections in MW of Loudwater BSP for Winter, Spring/Autumn, and Winter respectively for all forecast scenarios. In all cases and all seasons, Figure 4, Figure 5, and Figure 6 demonstrate that the demand growth will exceed the 132/33kV transformer first circuit outage (FCO) limit in 2025/26. This is due to 40 MW of battery storage connecting at Loudwater BSP in 2023/24 and the connection of the Beaconsfield Middle and Beaconsfield End demand to Loudwater BSP in 2025/26. The inclusion of the Beaconsfield primary substation within the Loudwater BSP group is a different proposal (reference ***47/SEPD/LRE/BEAC***) set out in the SEPD RIIO ED2 business plan. It is expected that this primary substation will experience EREC P2/7 non-compliance during the RIIO ED2 price control period. This project, reference ***47/SEPD/LRE/BEAC,*** aims to resolve the overloading issues and to reduce the complexity of the site by transferring Beaconsfields primary susbtation demand into the Loudwater BSP demand group. As a result of this, and with the connection of the 40MW battery storage, overloading will be experienced at Loudwater BSP. Also, the 132kV circuits thermal limit will be exceeded in 2026/27 in Winter and Spring/Autumn, under all scenarios.

It can be observed in Table 3, that under the CT scenario, the Loudwater BSP must be able to restore 3.6MW, 6.7MW, 29.9MW, 34.5MW, and 39.1 MW across the five years of ED2.

Scenario	ED1 (last 3 years)			ED2					Future		
	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
CT	54.8	56.9	59.1	103.6	106.7	129.9	134.5	139.1	143.9	149.0	156.0
LW	54.8	56.9	59.3	104.3	107.4	130.9	135.8	140.9	146.3	153.7	160.6
SP	53.4	54.2	55.1	98.2	99.1	117.0	118.2	119.4	120.9	122.5	124.5
ST	53.8	54.8	55.9	99.1	100.3	119.4	121.5	123.7	125.9	128.1	130.7

Table 3: Loudwater BSP demand projection for winter peak (MW)

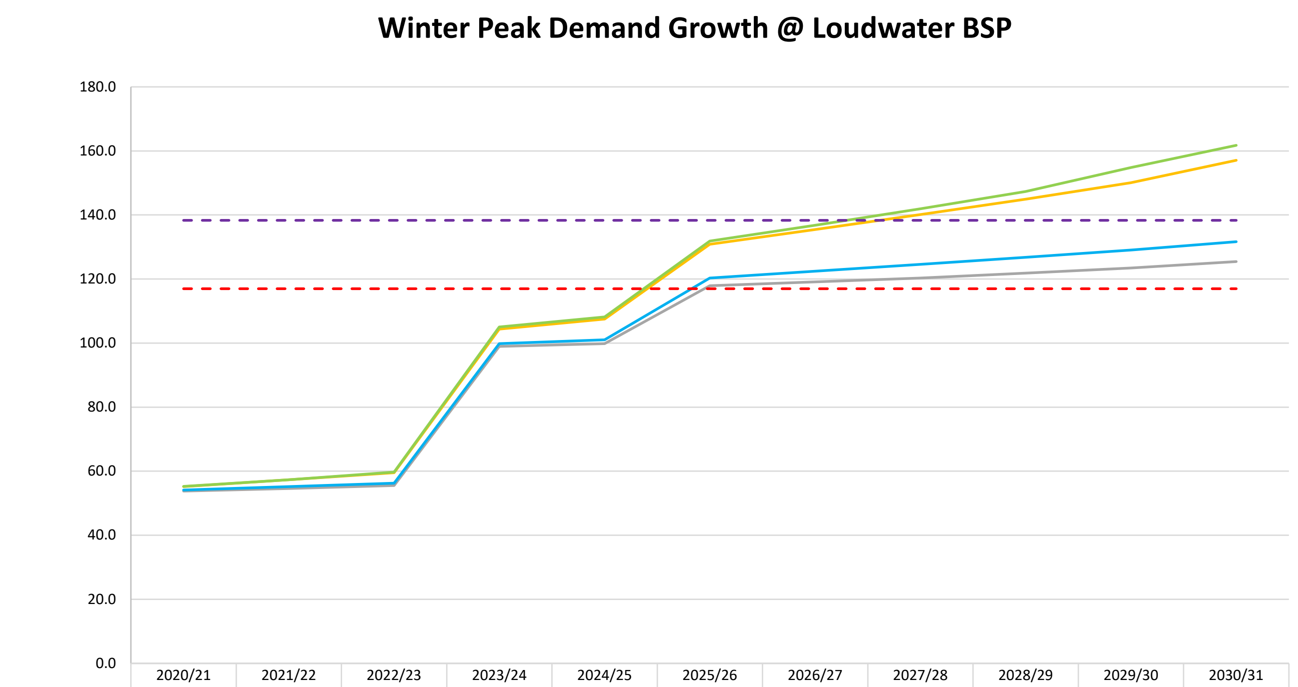
Scenario	ED1 (last 3 years)			ED2					Future		
	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
CT	49.9	51.9	53.8	98.1	101.0	121.7	125.8	130.1	134.5	139.3	145.9
LW	50.0	51.9	53.9	98.7	101.6	122.5	127.0	131.7	136.6	143.6	150.2
SP	48.8	49.4	50.3	93.3	94.1	109.9	111.0	112.1	113.5	115.0	116.9
ST	49.1	49.9	50.9	94.0	95.1	112.0	113.9	115.9	117.9	120.0	122.4

Table 4: Loudwater BSP demand projection for spring/autumn peak (MW)

[2] ***SECTION D: (Chapter 10), Responding to the net zero Opportunity, (Annex 10.1), Load Related Plan Build and Strategy***

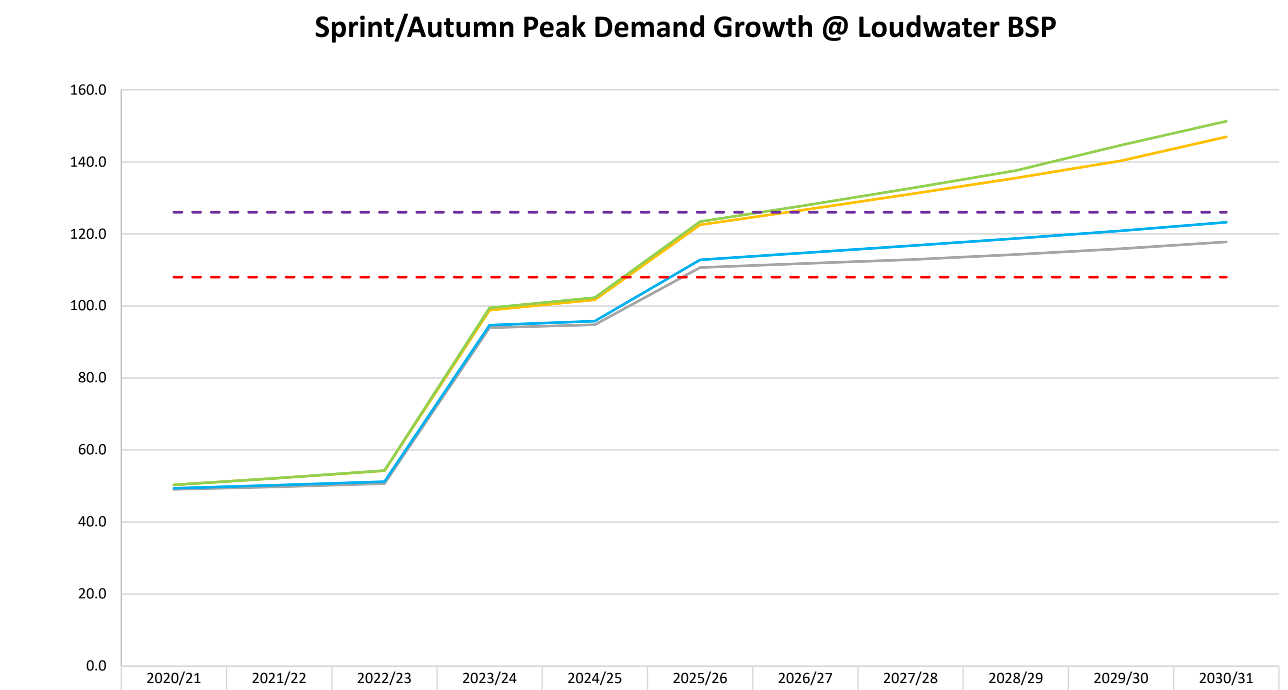
Table 5: Loudwater BSP demand projection for summer peak (MW)

Scenario	ED1 (last 3 years)			ED2					Future		
	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
CT	37.3	38.7	40.1	83.9	86.0	100.7	103.6	106.6	109.8	113.3	118.0
LW	37.2	38.4	39.7	83.7	85.7	100.2	103.0	106.0	109.2	114.2	118.9
SP	36.6	37.3	38.1	81.0	81.8	93.5	94.5	95.6	96.9	98.4	100.8
ST	36.8	37.5	38.3	81.2	82.1	94.7	96.3	97.9	99.6	101.4	103.2



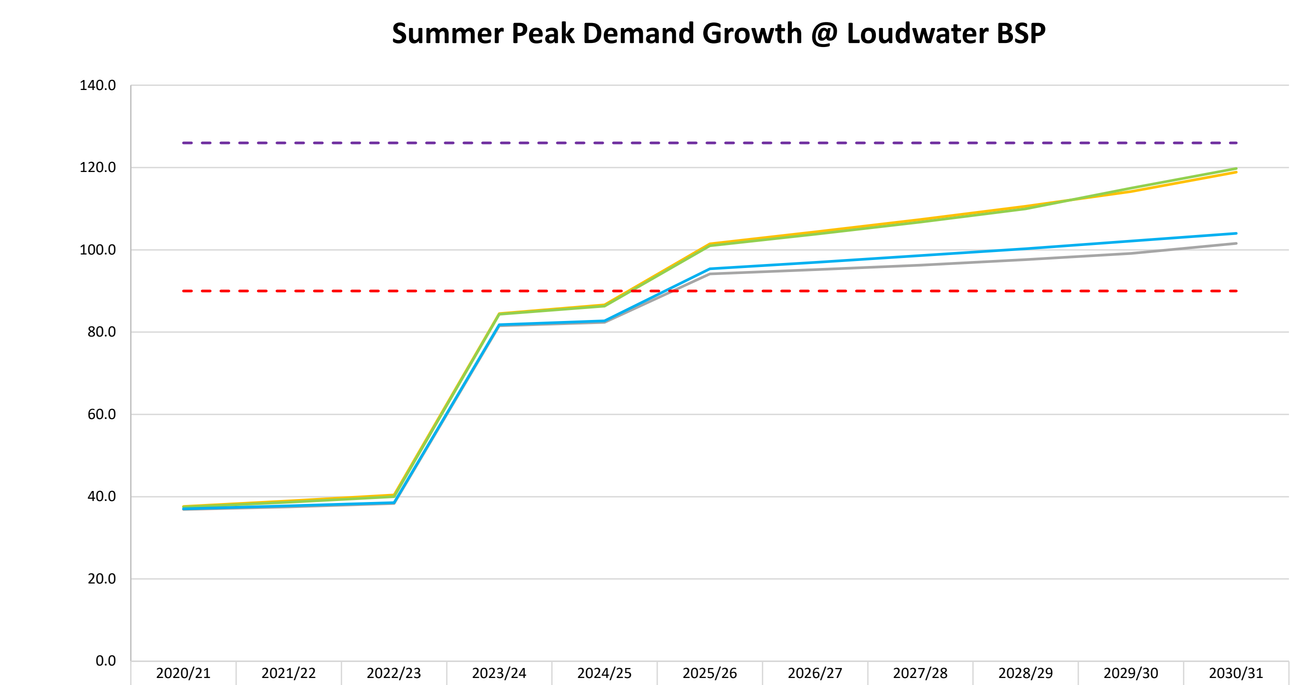
	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
SP	53.8	54.6	55.6	98.9	99.8	117.9	119.1	120.3	121.8	123.4	125.4
CT	55.2	57.3	59.5	104.4	107.5	130.9	135.5	140.1	144.9	150.1	157.1
LW	55.2	57.4	59.7	105.1	108.2	131.9	136.8	142.0	147.3	154.8	161.7
ST	54.2	55.2	56.3	99.9	101.0	120.3	122.4	124.6	126.8	129.1	131.6
FCO TX	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0	117.0
FCO CIR	138.3	138.3	138.3	138.3	138.3	138.3	138.3	138.3	138.3	138.3	138.3

Figure 4: Loudwater BSP winter peak demand growth (MVA with power factor 0.992)



	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
SP	49.1	49.8	50.7	94.0	94.8	110.7	111.8	112.9	114.3	115.9	117.8
CT	50.3	52.3	54.2	98.8	101.7	122.6	126.8	131.1	135.5	140.3	146.9
LW	50.3	52.2	54.3	99.5	102.3	123.4	127.9	132.6	137.6	144.7	151.3
ST	49.4	50.3	51.2	94.7	95.8	112.8	114.7	116.7	118.7	120.9	123.3
FCO TX	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0
FCO CIR	126	126	126	126	126	126	126	126	126	126	126

Figure 5: Loudwater BSP Spring / Autumn peak demand growth (MVA with power factor 0.992)



	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
SP	36.9	37.5	38.3	81.6	82.4	94.2	95.2	96.3	97.6	99.1	101.5
CT	37.6	39.0	40.4	84.5	86.6	101.5	104.4	107.4	110.6	114.1	118.9
LW	37.5	38.7	40.0	84.3	86.3	101.0	103.8	106.8	110.0	115.0	119.8
ST	37.0	37.8	38.5	81.8	82.7	95.4	97.0	98.6	100.3	102.1	104.0
FCO TX	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
FCO CIR	126	126	126	126	126	126	126	126	126	126	126

Figure 6: Loudwater BSP summer peak demand growth (MVA with power factor 0.992)

Peak demand is expected to increase at Loudwater BSP by approximately 68.4MW from 2020/2021 to 2027/28 when following the CT scenario. The projected increase in demand of 68.4MW is split by the demand type as shown in Figure 7. The chart shows the largest impact on demand in the area is from Storage, equating to 36% of the overall projected demand.

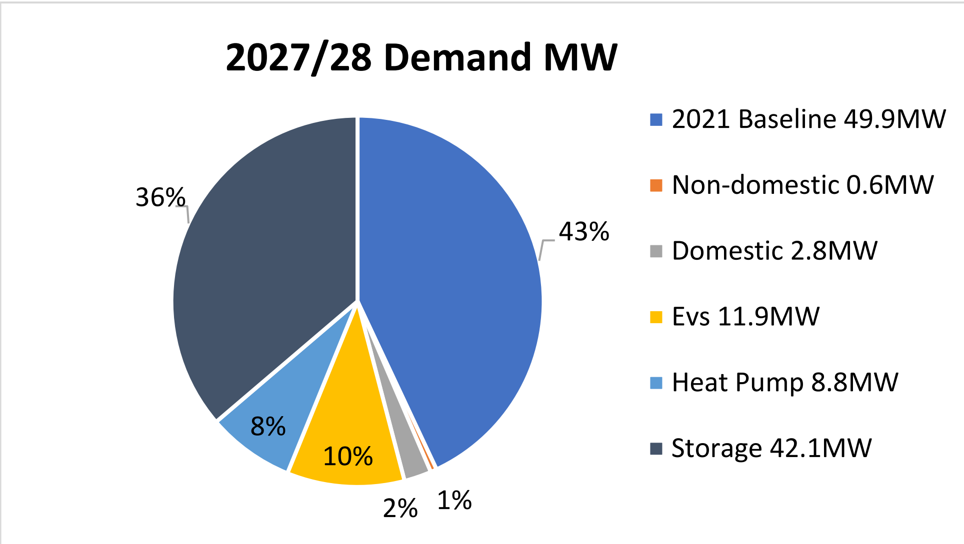


Figure 7: Increase in Demand by Type for CT Scenario in 2027/28

There are currently no connected or planned generators at Loudwater substation.

4.2 Existing Asset Condition

The existing switchgear at Loudwater BSP is in good condition and is HI2 and is expected to progress to HI3 by the end of ED2. The Loudwater BSP transformers were manufactured in 1959 and both are also HI2. It is anticipated that these transformers will progress to HI3 by the end ED2. There are no plans for non-load investment within the ED2 period for these assets.

4.3 Thermal Flow Analysis

The thermal loading for Loudwater BSP has been carried out for both FCO and SCO conditions. Results of the thermal flow analysis are shown in Table 6 and Table 7.

At Loudwater Substation, the demand forecast under all DFES2020 scenarios shows that under a First Circuit Outage (FCO) condition in winter, spring/autumn, and summer seasons, the existing transfomers will be overloaded in 2025/2026 and therefore, considered as EREC P2/7 non-compliant. The current load index (LI) for Loudwater substation is LI1, however, the anticipated load growth within the area is expected to increase this to LI5 if no network reinforcement is carried out.

Similarly the 132kV circuits that connect Loudwater substation to Amersham substation will be non-compliant for all scenarios in Spring/Autumn 2026 Winter 2027. The following sections highlight the results of the newtork analysis conducted at Loudwater BSP.

Demand Group	Scenario	Season	Group Class	Contingency	Loaded Circuit / Transformer	FCO Demand to be Met	FCO Available Capacity	% Loading
Loudwater BSP T1 & T2	CT	Winter	D	Fault on Loudwater BSP T1	Loudwater BSP T2	133.6 MVA	**117 MVA**	**114**
	CT				Loudwater BSP to Amersham GSP 132kV circuit	143.1 MVA	**138 MVA**	**104**
Loudwater BSP T1 & T2	CT	Spring/ Autumn	D	Fault on Loudwater BSP T1	Loudwater BSP T2	123.8 MVA	**108 MVA**	**114**
	CT				Loudwater BSP to Amersham GSP 132kV circuit	130.9 MVA	**126 MVA**	**104**
Loudwater BSP T1 & T2	CT	Summer	D	Fault on Loudwater BSP T1	Loudwater BSP T2	103.2 MVA	**90 MVA**	**114**
	CT				Loudwater BSP to Amersham GSP 132kV circuit	107.8 MVA	126 MVA	86

Table 6: First Circuit Outage (FCO) Thermal Flow Analysis - 2025/2026 Consumer Transformation Scenario

Reinforcement is required due to EREC P2/7 non-compliance, under FCO conditions. Under FCO conditions, the remaining in-service transformer at Loudwater BSP will be loaded, for the worse case, to 114%. A solution is required to prevent this overloading and mitigate the risk of asset failure.

In the first year of ED2 (2023/24), the additional demand from the battery storage connection will change the classification of the demand at Loudwater BSP to Class D, according to EREC P2/7. This classification therefore requires that during double circuit outage, i.e. both 132kV circuits between Amersham GSP and Loudwater BSP, a certain portion of the demand must be restored within three hours. This portion of demand is equal to the peak demand minus one hundred megawatts; it follows that if the peak demand is less than 100MW there is no requirement to restore any demand within this time limit.

Under the existing 33kV network arrangement as shown in Figure 8, Wycombe Marsh primary demand could be temporarily supplied via High Wycombe BSP. In the first two years of RIIO ED2, the existing network will still be EREC P2/7 compliant, under SCO condition.

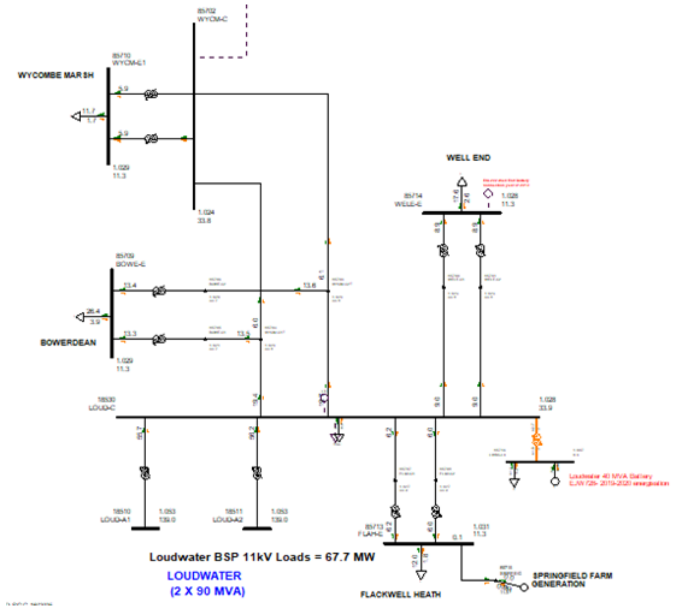


Figure 8: 33kV network arrangement fed from Loudwater BSP

Demand Group	Season	Group Class	Contingency 1st outage	2nd outage	Loaded Circuit / Transformer	SCO Demand to be Met	SCO Available Capacity
Loudwater T1 & T2	Spring/ Autumn	D	Fault on Amersham - Loudwater 1	Fault on Amersham - Loudwater 2	Backfeed from Velmore via 33kV Circuit	121.7 – 100 = 21.7 MVA	**10.8 MVA**

Table 7: Second Circuit Outage (SCO) Thermal Flow Analysis - 2025/2026 Consumer Transformation Scenario

Loudwater BSP is compliant with a second circuit outage until the Beaconsfield load connects in 2025/26, when the amount of demand required to come online within three hours increases from 1MW to 21.7MW. This would be beyond the restorable available capacity at Wycombe Marsh primary, and while it may be possible to feed further load from Loudwater BSP via High Wycombe BSP, it may not be possible to undertake the switching operations within three hours. As the project to re-route Beaconsfield into the Loudwater BSP group will result in this being a permanent supply connection, it is not possible to transfer Beaconsfield back out of this group under emergency conditions. Therefore, reinforcement is required due to EREC P2/7 non-compliance, under SCO conditions.

4.4 Voltage Level Assessment

The voltage level at the 132kV and 33kV bus bars has been assessed. The results of the voltage assessment show (Appendix 1: System Analysis) that the voltage remains within statutory limits and no reinforcement is required due to voltage level limits.

4.5 Fault Level Assessment

The fault level at Loudwater 33kV bus bar has been assessed for three phase and single phase to ground faults, respectively. The results (Appendix 1: System Analysis) show that there are no fault level issues at Loudwater BSP throughout the ED2 price control period.

4.6 Network Analysis Summary

The network analysis has highlighted that Loudwater BSP will experience overloading during ED2 and subsequently will become EREC P2/7 non-compliant. Reinforcement is therefore required to resolve this issue and mitigate the risk of loss of supply to customers. The analysis has also identified that reinforcement is not required based on voltage and fault levels.

5 Summary of Options Considered

This section of the report sets out the investment options that have been considered when resolving overload issues at Loudwater substation. As described below, a holistic approach is taken to ensure investment options represent best value for money for network customers are identified. In addition, as demand is moving into the Loudwater BSP demand group, it is imperative that SEPD works closely with National Grid to maintain the integrity of the network given that another DNO is connected at the GSP.

5.1 Whole System Considerations

We have additionally considered the potential for using Whole System solutions (involving collaboration with third parties) to deliver this investment programme. We set out our assessment in Appendix 2 . This follows our standardised approach for embedding Whole System considerations into our load and non-load investment decisions (in line with Ofgem's ED2 business plan guidance), as described in our ***Whole System (Annex 12.1)***.

Our assessment enables us to take a proportionate consideration of Whole System options, based on the feasibility of such options existing and materiality of the costs involved.

In this case, our Whole Systems assessment finds that this programme is not expected to have any wider Whole System interactions and there are no feasible Whole Systems solutions.

5.2 Summary of Options

Table 8 provides a summary of the investment options under consideration along with the advantages and disadvantages associated with each. A more detailed description of each option is then provided within the proceeding section.

Option	Description	Advantages	Disadvantages	Result
1. Do Minimum: Load Transfer	It is normally done by carrying out demand transfer from the overloaded demand group to another.	Minimum cost and workload; Minor impact to existing network; Short delivery time.	Does not increase network capacity, further reinforcement may still be required.	Not Progressed to CBA
2. Asset Replacement	The replacement of the full overloaded equipment including:	Allow latest and most efficient technology to be installed e.g. oil	Can incur long outages if	Not Progressed to CBA

	• 2 x 132kV Transformers • 2 x 7.4km of 132kV Circuits	filled cable replaced with XLPE cable. Increase network capacity Reduce environmental impact.	replacement cannot be built offline; Requires additional planning for second circuit outage limitations.	
3. Add New Assets	New equipment will be added into existing network. This involves: • a new 132kV transformer at Loudwater BSP • a new 7.4km 132kV circuit between Amersham GSP and Loudwater BSP • new switchgear at Amersham GSP and Loudwater BSP	Increase network resilience, Resolves second circuit outage issues; Limited outage time; Long term benefit.	Additional land purchase will be required at Loudwater BSP and Amersham GSP; Can incur significant civil costs; Required new control strategy.	Progressed to CBA
4. Flexibility Solution	Flexible service contracts to reduce peak demand and defer capital investment	Relatively low cost Defers need for network reinforcement	Amount of flexibility depends on location-specific resources and interests. CAPEX may still be required.	Progressed to CEM CBA

Table 8: Summary of Primary Investment Options

5.3 Detailed Option Analysis

5.3.1 Option 1: Do-Minimum (Load Transfer)

Estimated Cost: £0k

The only option to do minimum is to load transfer from Loudwater BSP to another circuit/substation. However, as the load growth at Loudwater BSP is driven by storage connecting local to this busbar and, in addition the re-routing of power from the 6.6kV Beaconsfield middle and end loads to Loudwater BSP. It is not possible to re-route power, as power is being routed to Loudwater to address issues in other areas of the network.

Given that the demand forecast shows that the transformers and circuits at Loudwater will be overloaded in 2023/24, under almost all scenarios, this option is not considered viable. As a result, this option has been rejected and not taken forward to the Ofgem CBA analysis.

5.3.2 Option 2: Asset Replacement

Estimated Cost: N/A.

The overloaded equipment for Loudwater BSP is the 132kV Transformers which are currently rated at 117/108/90 MVA, and the 132kV circuits between Loudwater BSP and Amersham GSP which are currently rated at 138/126/126 MVA.

It is possible to replace the transformers with two units that are rated at 120MVA from SSEN existing suppliers. However, even if the transformer and circuits were upgraded the power would then be limited by the 33kV circuit breakers. These circuit brakers will require to be uprated from 2,000A to 3,000A outdoor AIS units to fully utilise the full 120MVA of the new transformers. However, this option will not address the SCO non-compliance mentioned in Section 4.3. Therefore, this solution has been rejected and not taken forward to the Ofgem CBA analysis.

5.3.3 Option 3: Add New Assets

Estimated Cost: £9,020k.

To increase capacity at this site an additional 90MVA 132kV transformer could be installed, a new 132kV 400mm^2 XLPE cable of rating 165/136/136 MVA, and new 2500A switchgear at both the 132kV, and 33kV busbars. The capacity increase for this case would be limited to 117MVA which is based on the winter rating of the 132/33kV transformer. Figure 9 shows the existing network configuration between Amersham GSP and Loudwater BSP, and the proposed configuration for the new connection. The implementation of this solution would result in the Load Index improving from LI5 to LI1, by the end of ED2.

At both Loudwater substation and Amersham substation, there appears to be space available for addition of extra assets and increasing substation footprint. There would be additional costs for the purchase of extra land, which have been estimated in the costs. See Figure 9 for the layout of Loudwater substation, and Figure 10 for the layout of Amersham substation.

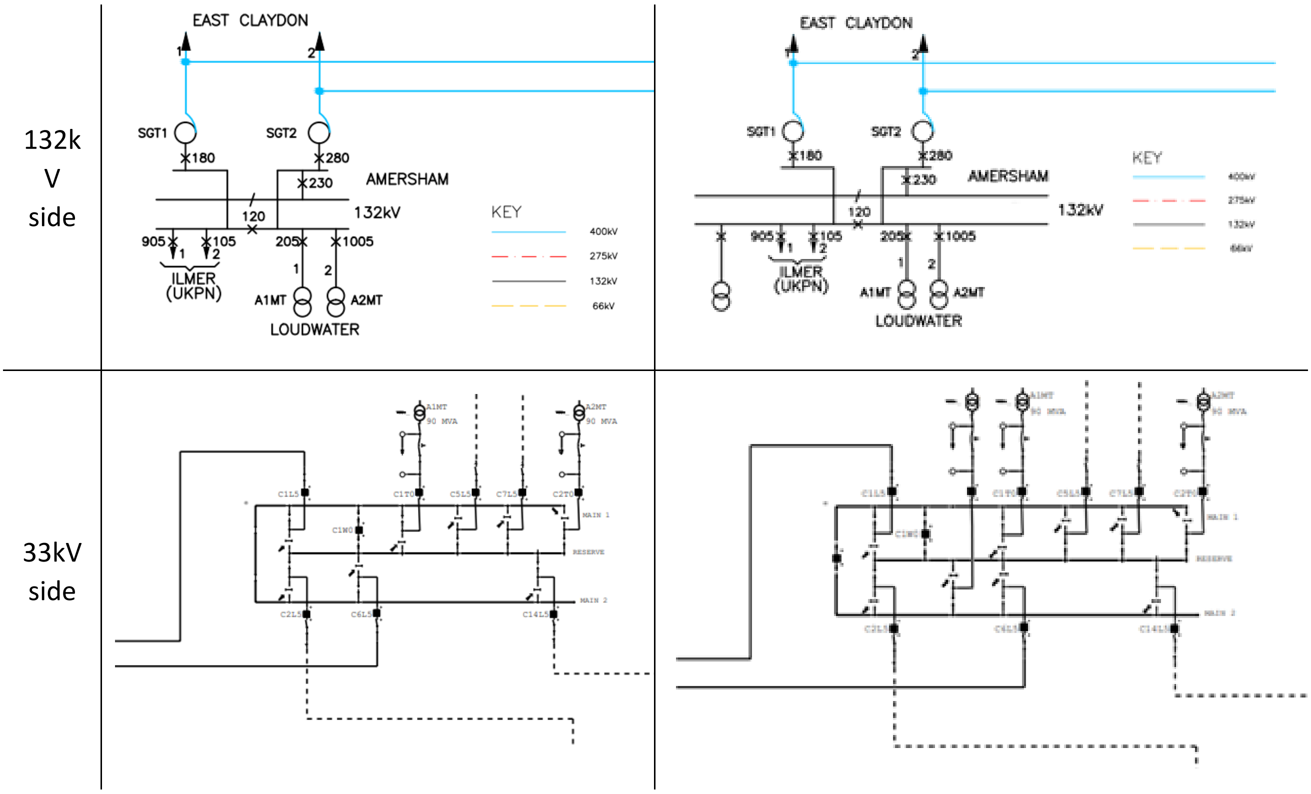


Figure 9: Loudwater BSP Existing Network Arrangement SLDs (left), and Proposed Network Arrangement SLDs (right)

Figure 10: Amersham GSP Substation

As this solution will resolve both the FCO and SCO overloading issues, this solution is the preferred option for reinforcement at Loudwater BSP.

5.3.4 Option 4: Flexible Solution

Estimated Cost: £N/A

Option 3 being the only technically feasible option was fed into the Common Evaluation Methodology (CEM) tool to assess whether there are benefits in deferring the capital investment. This framework would evaluate options around timing of network investments, in particular taking into account:

- the range of different options available (e.g., reinforcing the network, using flexibility, or doing nothing);
- the time periods in which actions can be taken; and
- the existence of uncertainty, and the impact of incremental information which becomes available over time.

Figure 11 shows a typical load profile of a winter peak day at Loudwater BSP. It can be seen that the peak demand will exceed the FCO rating in 2026 for approximately five hours. Flexibility services in the form of increasing generation export or decreasing demand import could be used to reduce the peak.

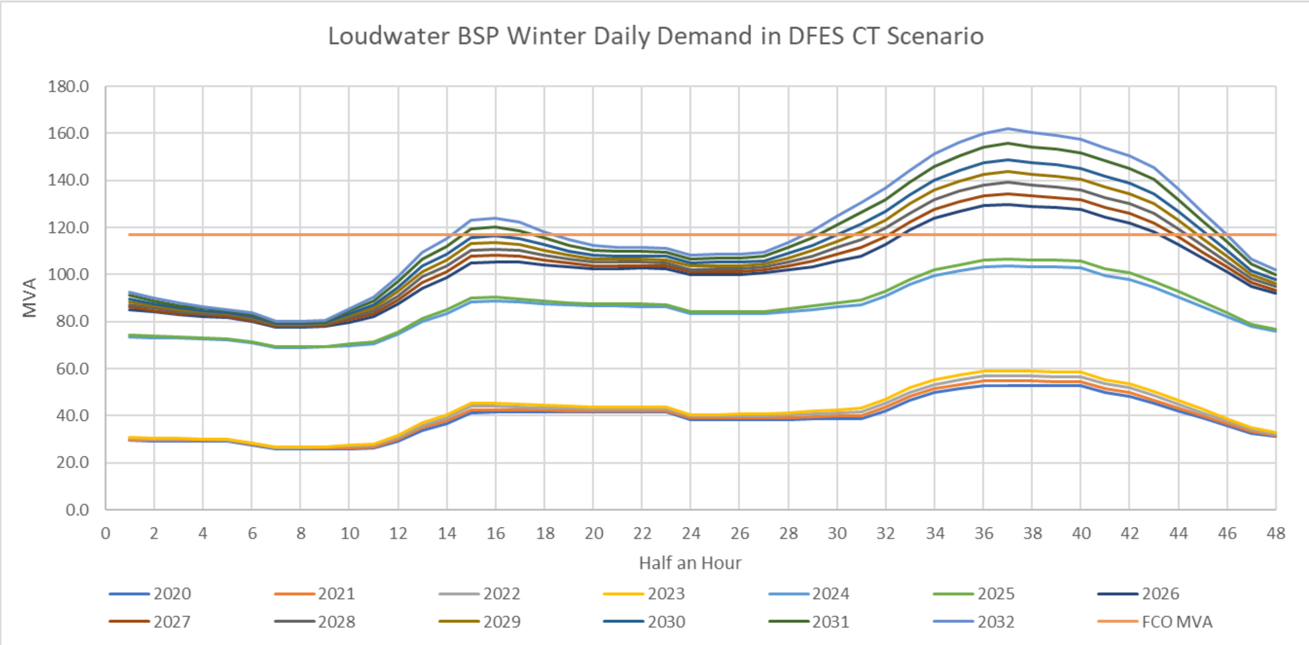


Figure 11: Loudwater BSP Winer Half-Hourly Demand Without Flexibility Services.12

The MW exceedance, the daily and annual overload hours (Table 9) and the flexibility unit costs of £150 per MW and £150 per MWh were used as input parameters in the CEM CBA model (full details of the flexibility methodology can be found in our ***Load-Related Plan Build and Strategy (Annex 10.1).***

	2020	2021	2022	2023	2024	2025	2026	2027	2028
Hrs/day required	0.0	0.0	0.0	0.0	0.0	0.0	5.5	6.4	7.1
Days/yr required	0.0	0.0	0.0	0.0	0.0	0.0	256.0	256.0	256.0
No. Dispatch/yr	0.0	0.0	0.0	0.0	0.0	0.0	128.0	128.0	128.0
Dispatch duration	0.0	0.0	0.0	0.0	0.0	0.0	8934	13567	18846

Table 9: Estimated dispatch requirements for flexibility solution.

The results of the CEM flexibility tool (Figure 12) show that there is no benefit to using flexibility under all four scenarios. Consequently, this option was not carried through to the Ofgem CBA and has been rejected.

Cumulative benefit of deferral (excluding benefit from further deferral, but including multi-year discount)		**Defer by 1 year(s) to 2027**	**Defer by 2 year(s) to 2028**	**Defer by 3 year(s) to 2029**
[1] under Consumer Transformation	*£0*	-£3,693,377	-£9,195,468	-£16,648,254
[2] under Leading the Way	*£0*	-£4,036,139	-£10,146,698	-£18,557,212
[3] under Steady Progression	*£0*	-£105,155	-£438,902	-£1,023,741
[4] under System Transformation	*£0*	-£585,824	-£1,664,466	-£3,217,057

Figure 13: Net Benefit of Deferring Reinforcement.

Despite our commitment to the Flexibility First approach, in this scenario the current assessment has concluded the required Flexibility could not be secured effectively within the allocated investment for the scheme. Flexibility will only be pursued where the economic benefit of deferring the capital investment exceeds the additional cost of the flexibility service, providing an optimised net present value to consumers or potentially delivering additional whole system benefits.

However, flexibility may provide OPEX benefits to SSEN and our customers during scheme delivery by;

a) Avoiding/reducing the risk of outages during planned works through load/generation management
b) Avoiding/reducing the need for Mobile Diesel Generation in planned or unplanned outage scenarios

c) Reducing the scale of the works through the implementation of a ‘Hybrid’ scheme, part reinforcement and part Flexibility.

These opportunities will be reviewed, and Flexibility secured should the CEM Framework CBA prove a positive benefit, with justification of the decisions/reviews presented as required.

Further detail of our Flexibility First approach and assessment methodology can be found in our ***DSO Strategy (Annex 11.1) Appendix F - Delivering Value through Flexibility.***

6 Cost Benefit Analysis (CBA)

In cases where there are different technically viable options, the Ofgem CBA tool is utilised to assess costs and benefits. Capital reinforcement costs, CI/CML penalties, network losses and other societal benefits would be the key parameters used. As there is only one technically viable option in this EJP the use of the Ofgem CBA wasn't required. In addition, the use of the flexibility tool didn't recommend any deferrals for this investment. It is proposed to deliver the capital scheme (Option 3) in 2025/26 as shown in Table 10.

Options	Unit	2024	2025	2026	2027	2028	2029	Total
Option 3 – Add New Asset	£m	0	0	9.02	0	0	0	9.02

Table 10: Cost and phasing of the investment scheme.

Our RIIO ED2 Business Plan costs are derived from our outturn RIIO ED1 expenditure. We have modified costs per activity, capturing and reporting those adjustments in our cost-book. By tying our costs back to reported, outturn, real life data this approach provides multiple data points on which both the Regulator and we can benchmark cost efficiency.

It provides a high level of cost confidence in our Business Plan cost forecast for RIIO ED2. Through our benchmarking analysis, we recognised that not all Non-Load related RIIO-ED1 actual unit costs sit within the upper quartile efficiency band. Where this is the case, we have applied a catch-up efficiency to those cost categories.

Further detail on our unit cost approach, cost efficiency and cost confidence for RIIO-ED2 can be found within our ***Cost Efficiency (Annex 15.1)***[3]. Following our draft Business Plan, we have continued to develop project scopes and costs, utilising valuable stakeholder feedback. We have included developments of our Commercial Strategy within the updated project scope and delivery strategy.

Unlike asset replacement, large load projects will include more unique and site-specific costs for example civils, waterway, road or rail crossings and local planning considerations. Through detailed bottom-up project assessment, we have identified projects that are impacted by Regional and Site factors driving additional costs.

Category	Sub-category	Unit Cost (£k)	Unit	Asset Count	Predominant Costing Approach	Cost £k
Switchgear	132kV CB (Air Insulated Busbars)(OD) (GM)	[redacted]	#	1	ED1 6yr average actual unit rates	[redacted]
Switchgear	33kV CB (Air Insulated Busbars)(OD) (GM)	[redacted]	#	1	ED1 6yr average actual unit rates	[redacted]
Transformer	132kV Transformer (GM)	[redacted]	#	1	ED1 6yr average actual unit rates	[redacted]
Cable	132kV UG Cable (Non Pressurised)	[redacted]	km	7	ED1 5yr average actual unit rates	[redacted]
					Project Total	[redacted]

Table 11: Cost and Volumes Breakdown

[3] Link to ***Cost Efficiency Annex 15.1***.

7 Deliverability and Risk

Between our draft and final Business Plans we have carried out a more detailed deliverability assessment of our overall plan as a package and its component investments. Using our draft Business Plan investment and phasing as a baseline we have followed our deliverability assessment methodology. We have assessed any potential delivery constraints to our plan based on:

- In-house workforce capacity and skills constraints based on our planned recruitment and training profile and planned sourcing mix as well as the efficiencies we have built into our Business Plan ***(detailed in our Workforce Resilience Strategy (Annex 16.3)*** and ***Cost Efficiency (Annex 15.1)***
- Assessment of the specific lead and delivery timelines for the asset classes in our planned schemes
- We have evaluated our sourcing mix where there were known delivery constraints to assess opportunities to alleviate any constraints through outsourcing
- We have engaged our supply chain detailed in our ***Supply Chain Strategy (Annex 16.2)*** to explore how the supply chain could support us to efficiently deliver greater volumes of work and how we could implement a range of alternative contracting strategies to deliver this
- We have also engaged with the supply chain on the delivery of work volumes that sit within Uncertainty Mechanisms to ensure we have plans in place to deliver this work if and when the need arises
- Specific to load schemes: We have carried out flexibility assessments at all voltage levels in order to understand when we can defer reinforcement through paying for flexibility services, therefore ensuring our investment profile is deliverable and at the lowest cost to consumers ***see Flexibility within Load Related Plan Build and Strategy (Annex 10.1***)
- We have assessed the synergies between our planned load, non-load and environmental investments to most efficiently plan the scheduling of work and minimise disruption to consumers
- Based on our assessment of delivery constraints and potential solutions to resolve them, we have revised our investment phasing accordingly to ensure our Business Plan is deliverable, meets our consumers' needs and is most cost efficient for our consumers

Table 12 sets out the revised investment phasing based on the outcome of our deliverability assessment:

	2023/24	2024/25	2025/26	2026/27	2027/28
Revised Investment Phasing	0	0	£9,020k	0	0

Table 12 Revised investment phasing

This investment scheme is part of the wider load-related investment portfolio in RIIO-ED2. SSEN have developed a strategy to deliver a much larger volume of work in comparison with the level of investment in ED1. We have engaged with our supply chain to negotiate the most effective unit costs and we have taken measures to ensure we secure a future workforce with the right skills and competencies to deliver capital projects in ED2.

In RIIO-ED1, SEPD have delivered a number of 132 kV and 33kV projects using internal workforce. The experience and skills acquired from these projects lay the foundation for the delivery of the proposed option within this paper.

8 Conclusion

This Engineering Justification Paper (EJP) provides relevant information in relation to the load related investment at Loudwater 132/33kV substation in RIIO-ED2.

The thermal overloading of the two 132/33 kV transformers at Loudwater is triggered by all DFES 2020 scenarios during the ED2 price control. To address EREC P2/7 non-compliance, the following options were considered:

- Option 1: Do minimum
- Option 2: Asset replacement
- Option 3: Add in new assets
- Option 4: Flexible Solution to reduce peak demand

Option 3 is the only technically viable option and is therefore our preferred option. While the optioneering process highlighted that the use of flexible services is not a valid option for this project, it is recommended that this is explored again before the delivery date as it is known that potential flexibility providers will be connected to the network at the beginning of the RIIO ED2 price control period.

Appendix 1: System Analysis

SYSTEM VOLTAGE LEVELS						
Season	Amersham 132kV voltage	Loudwater BSP Demand	Generation	Study Scenario	Loudwater BSP 33kV voltage	Busbar Name
[-]	[p.u.]	[MVA]	[MVA]	[-]	[p.u.]	[-]
Winter	1.049	66.7 MVA	0	Intact	1.033	LOUD-C
Winter	1.034	143.1 MVA	0	Fault on Loudwater BSP T1	1.031	LOUD-C
Spring/Autumn	1.049	66.7 MVA	0	Intact	1.027	LOUD-C
Spring/Autumn	1.0337	143.1 MVA	0	Fault on Loudwater BSP T1	1.031	LOUD-C
Summer	1.068	35.9 MVA	0	Intact	1.035	LOUD-C
Summer	1.060	66.6 MVA	0	Fault on Loudwater BSP T1	1.028	LOUD-C
The Voltage levels are in the limit of ± 10% on 132KV. ± 6% on 33KV or 22 kV under intact condition.						

Table 13: Voltage Level Assessment

Bus Number	Bus Name	Nominal Voltage (kV)	Pre-fault Voltage (p.u)	X/R ratio	Ik''-Initial Sym. (kA)	Ip-Peak Make (kA)	RMS Sym. Break (kA)	DC Component (kA)	RMS Asym. Break (kA)	Circuit Breaker Break Rating (kA)	Circuit Breaker Make Rating (kA)	Circuit Breaker Fault Level Index
3 Phase Fault Level Results												
18530	LOUD-C	33	1.028	16.3	14.52	37.98	11.83	11.11	16.23	17.5	44.6	FLI3
Single Phase to Ground Fault Level Results												
18530	LOUD-C	33	1.028	2.1	2.77	6.93	2.74	3.42	4.38	17.5	44.6	FLI1

Table 14: Fault Level Assessment

Appendix 2: Whole Systems consideration

In augmenting our decision-making processes to consider Whole System solutions, we have introduced an assessment to identify where a Whole Systems CBA would be a useful decision-making tool for ED2 load and non-load schemes. While our work with the ENA to undertake Whole Systems CBAs is ongoing, we have introduced the 'Whole Systems CBA test' to identify where a scheme may be suitable for a Whole Systems CBA to be conducted. Where a Whole Systems CBA is determined to be a useful decision-making tool, these would be conducted in addition to the standard Ofgem CBA and/or SSEN's flexibility CBA. We have introduced this test in line with Ofgem's expectations for "proportionality when submitting a Whole System CBA. For example, smaller or simple projects following the standard CBA template, whereas larger or more complex projects requiring bespoke analytical approaches" (Ofgem BPG, section 4.28, p.34).

The 'Whole Systems CBA test' involves assessing each investment scheme of over £2m (the threshold to develop an EJP for load and non-load investments) against 5 tests. These 5 tests help determine whether a Whole Systems CBA is a useful decision-making tool based on the characteristics of the scheme, including whether it will have wider cross sector or societal impacts.

Details on each of the tests are provided in case study 6 in our ***Whole System (Annex 12.1)***. Tests 1-3 are aligned with the ENA's guidance for Whole System CBA tests. We have added Tests 4 and 5 to clarify whether a Whole Systems CBA is required based on the materiality / proportionality of the investment (Test 4) and whether a flexibility CBA only is sufficient (Test 5). Table 15 below outlines our Whole Systems CBA test for Loudwater BSP.

Scheme	Test 1: Are there Whole Systems interactions, or is there potential for it?	Test 2: Could a Whole Systems CBA drive you to make a different decision?	Test 3: Is a Whole Systems CBA reasonable?	Test 4 - Is the project valued at over £2m?	Test 5 - Is the investment plan related to procuring flexible solutions only?
Loudwater BSP	No – We consider there to be limited potential for Whole Systems interactions with third parties to deliver this investment programme, and accordingly we do not consider there to be potential for Whole Systems solution(s).	No – As noted under Test 1 we do not consider there to be potential for Whole Systems solution(s) in this case.	No – As noted under Test 1 we do not consider there to be potential for Whole Systems solution(s) in this case.	Yes	No

Table 15 Whole Systems CBA test for Loudwater BSP

As the result of tests 1, 2 and 3 above is “No”, a Whole Systems CBA is not required for this investment. It is not expected to have any wider Whole System interactions or potential Whole Systems solutions.