RIIO-ED2 Engineering Justification Paper (EJP)

Salisbury-Amesbury 132 kV Network Reinforcement

Investment Reference No: 57/SEPD/LRE/AMESBURY

Contents

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 within the Amesbury/Salisbury 132kV network will deliver P2/7 compliance for investment of £1.899m during RIIO-ED2.

The primary investment driver for this scheme is load related P2/7 compliance issue within the Amesbury/Salisbury 132kV network. The P2/7 compliance issue are apparent under four scenarios (System Transformation, Consumer Transformation, Leading the way, and Steady Progression) for investment in ED2 due to forecast demand growth from our Stakeholder supported Distribution Future Energy Scenario (DFES). This project is required under our accelerating progress towards net zero priority, to aid both Swindon and Wiltshire councils achieve their net zero ambitions by increasing clean renewable energy generation and supporting the uptake of low carbon technologies such as electric vehicles, heat pumps and LED lighting.

Accelerating progress towards a net zero world

The EJP considers a range of options to address the P2/7 compliance issue, 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 Cost Benefit Analysis results shown below in Table 1 demonstrates that the most cost-effective solution, that delivers the best value for consumers in terms of the 45 year Net Present Value (£m), is option 4 which will utilise flexibility followed by delivering additional assets onto the network.

Options	NPV After 45 Years (£k)	Total Investment Cost (£k)
Option 2 – Asset Replacement	-3,683	9,390
Option 3 – Add New Asset	-1,809	1,896
Option 4 – Flexible Solution	-1,745	1,899

Table 1: CBA Summary

Following the optioneering and detailed analysis, as set out in this paper, the proposed scope of works for Option 4 is:

Asset	Volume	Costs
132kV isolator	4	[redacted]
132kV busbar extension	2	[redacted]
Installation of down droppers	1	[redacted]
132kV cable terminations	1	[redacted]
132kV CB (Air Insulated Busbars)(OD) (GM)	1	[redacted]
Flexible Service	-	[redacted]
Total		[redacted]

Table 2: Cost Breakdown

This scheme delivers the following outputs and benefits:

- The uplift in network capacity, under N-2, from 145MVA to 370MVA to meet the needs of our customers.
- Facilitates the efficient, economic, and co-ordinated development of our Distribution Network for Net Zero.

The cost to deliver the preferred solution is £1.899m and the works are planned to be completed in 2026. This EJP investment sits within our Net Zero Totex ask.

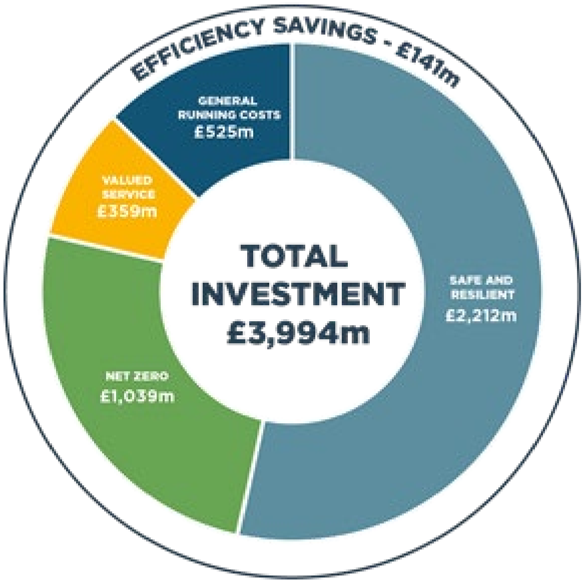


Figure 1: SSEN total investment cost within RIIO ED2

2 Investment Summary Table

Table 3 provides a high level summary of the key information relevant to this Engineering Justification Paper (EJP) and installation of new assets on the Salisbury-Amesbury 132 kV network.

<table>
<tr><th colspan="5">Engineering Justification Paper Investment Summary</th></tr>
<tr><td>Name of Scheme/Programme</td><td colspan="4">Salisbury-Amesbury 132 kV network reinforcement</td></tr>
<tr><td>Primary Investment Driver</td><td colspan="4">Load - thermal overloading under SCO conditions</td></tr>
<tr><td>Scheme reference/ mechanism or category</td><td colspan="4">57/SEPD/LRE/AMESBURY</td></tr>
<tr><td>Output reference/type</td><td colspan="4">132kV Circuits</td></tr>
<tr><td>Cost</td><td colspan="4">£1.9m</td></tr>
<tr><td>Delivery Year</td><td colspan="4">2025/2026</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>-</td><td>1.9</td><td>-</td></tr>
</table>

Table 3: 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 the Amesbury/Salisbury 132kV network 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

In February 2019, a formal offer for a temporary supply of 30 MVA for a customer project was issued, triggering the need for reinforcement of the Salisbury-Amesbury 132kV network to provide the minimum scheme for this customer connection (see section 5.2 for further details). After delays on the customer's side, this temporary supply is expected to be required between winter 2022 and winter 2026 and is planned to be supplied from Salisbury 132/33 kV BSP. Following the five years period of the temporary supply, the permanent supply to that load is forecasted to be 10 MVA.

Salisbury and Amesbury BSPs are 132/33 kV substations which are supplied, under normal operating conditions, by Mannington and Melksham GSP, respectively. Mannington GSP has four SGTs (plus one standby) which are rated at 240 MVA each but can be operated at a winter rating of 288 MVA. From there, two 132 kV circuits feed Salisbury BSP.

Amesbury BSP can be connected to Salisbury BSP via a 132 kV tee-off from one circuit of the Mannington/Salisbury 132 kV double circuit line. Although the tee-off to Amesbury is constructed as a double circuit line itself, only circuit 1 is presently energised, and the network is operated with a normally open point at Amesbury BSP.

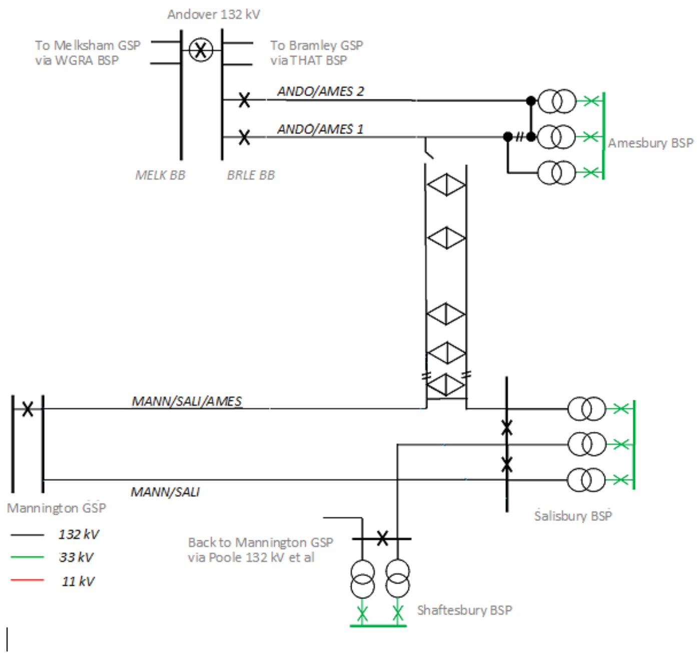


Figure 2: *Existing Mannington-Salisbury-Amesbury 132 kV network SLD (Single Line Diagram)*

4.2 Approved Works Associated with Connection Offer for Customer Supply

As part of the reinforcement scope within the customer quotation, there is a requirement to connect the existing Salisbury/Amesbury 132 kV circuit (which is presently tee'd off the Mannington/Salisbury 132 kV circuit 2) directly to the Salisbury 132 kV busbar. The need for this reinforcement is triggered by second circuit outage (SCO) limitations on the Mannington 132 kV network, which have been brought forward by the additional temporary load. This proposal is the minimum reinforcement required for securing SCO limitations and was included as part of the non-contestable works charged to the customer.

The full scope is listed below and illustrated in Figure 3.

A. Extension of the Salisbury 132 kV busbar to establish a new 132 kV incomer circuit breaker with associated equipment.
B. Installation of 132 kV cable terminations on tower DD1/DD2 on Salisbury/Amesbury tee 132 kV circuit and laying of 0.4 km of 132 kV cable to cable termination structure of new 132 kV incomer circuit breaker bay.
C. Reinforcement of the existing cable section (1.3 km) on the Mannington/Salisbury/Amesbury tee 132 kV circuit with a new 132 kV underground cable (minimum spring/autumn rating of 145 MVA).
D. Reinforcement of the existing cable section (1.3 km) on the Mannington/Salisbury 132 kV circuit with a new 132 kV underground cable, (minimum spring/autumn rating of 145 MVA).

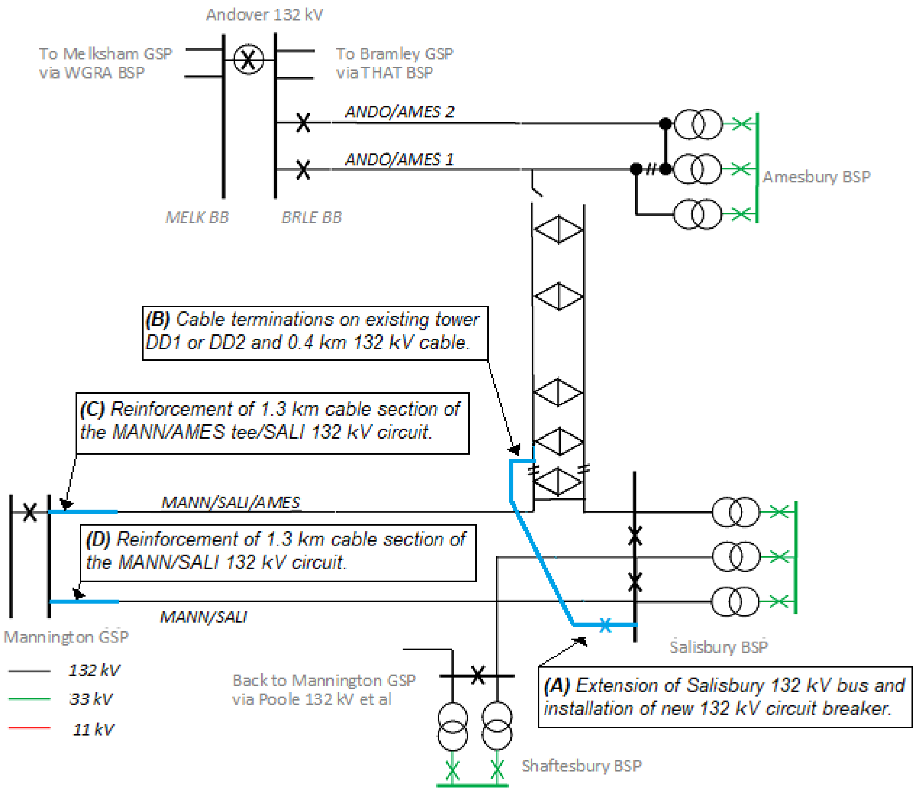


Figure 3: *Annotated SLD of non-contestable works related to customer temporary supply*

For the purposes of this study, it has been assumed that these works would have been completed by the start of the ED2 price control period.

4.3 Local Energy Plan

The Swindon & Wiltshire Local Energy Strategy was published in 2018, detailing four strategic energy priorities for the councils and both councils have pledged to be carbon neutral by 2030. As part of the drive to become carbon neutral by 2030 the councils are taking the following actions:

- Developed parking standards requiring developer to install EV charge points where there is a need for parking for both residential and non-residential development
- Both Councils have received funding to develop additional EV charge points within the local area
- Deployed the use of LED street Lighting

- Constructed renewable energy generation sites, e.g. solar farms, to offset energy needs
- Support the development of community energy projects
- Increase access to public transport including the use if electric buses
- Improve the energy efficiency of homes

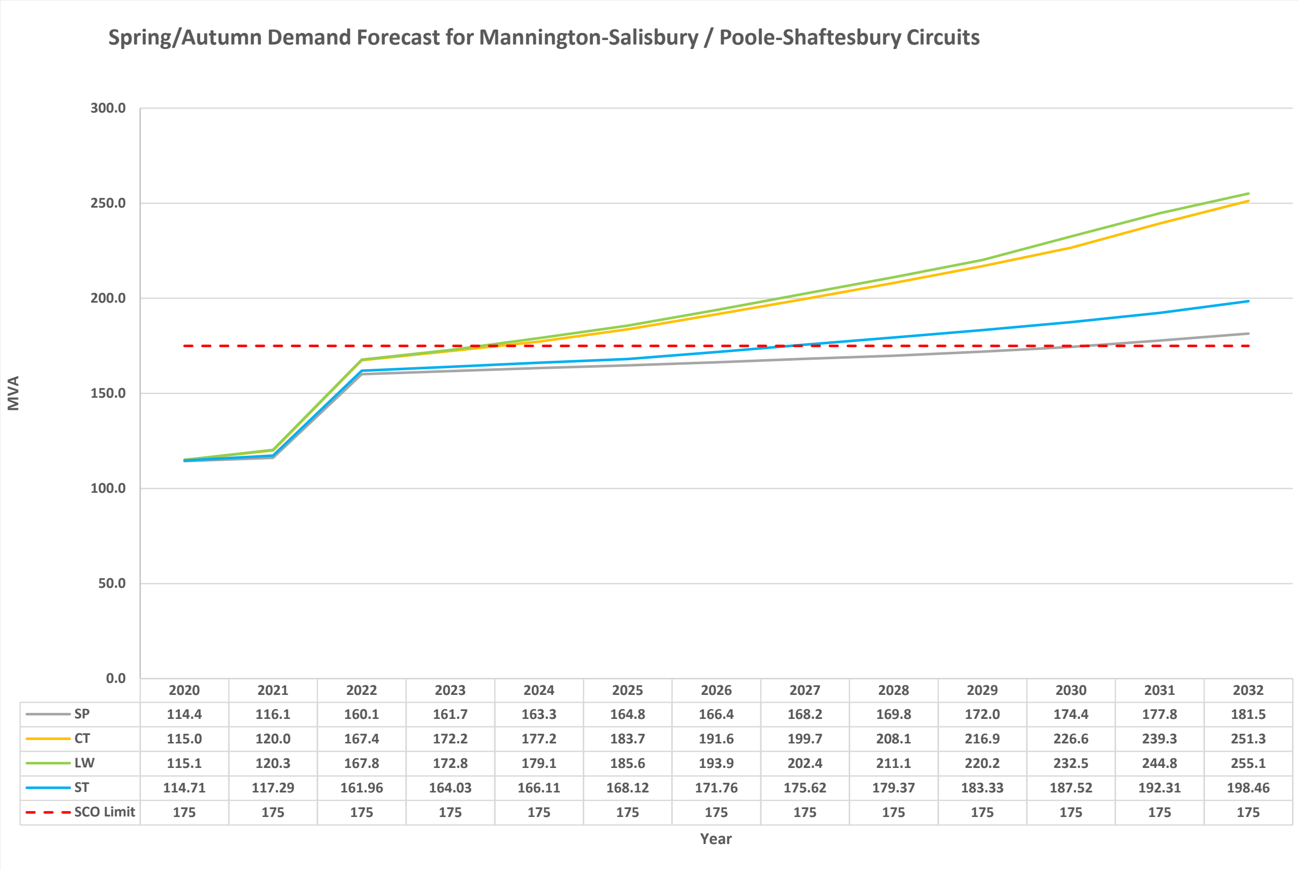
4.4 Demand and Generation Forecast

In order to understand the future pathways for demand and generation, SSEN has 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).***

There is a substantial quantity of existing generation connected to both the 11kV and 33 kV network which exceeds 350 MW, with over 90% of this being solar PV. A further 112 MW of generation and approximately 100 MW of battery storage have been accepted for connection. Generation has not been included in demand adequacy studies to ensure a conservative approach to meeting load requirements.

Figure 4 shows the forecast demand for the RIIO ED2 period against the SCO capacity for the Mannington-Salisbury and Poole-Shaftesbury circuits. Figure 4 shows that under SCO conditions the remaining in service 132kV circuit will become overloaded in 2024/25 for CT and LW scenarios. For the ST scenario overloading will be experienced in 2027/28 and for SP no overloading is expected during RIIO ED2.



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
SP	114.4	116.1	160.1	161.7	163.3	164.8	166.4	168.2	169.8	172.0	174.4	177.8	181.5
CT	115.0	120.0	167.4	172.2	177.2	183.7	191.6	199.7	208.1	216.9	226.6	239.3	251.3
LW	115.1	120.3	167.8	172.8	179.1	185.6	193.9	202.4	211.1	220.2	232.5	244.8	255.1
ST	114.71	117.29	161.96	164.03	166.11	168.12	171.76	175.62	179.37	183.33	187.52	192.31	198.46
SCO Limit	175	175	175	175	175	175	175	175	175	175	175	175	175

Figure 4: Mannington-Salisbury/Poole-Shaftesbury Spring/Autumn Demand

It should be noted that the 42.5MW Salisbury Battery Energy Scheme, scheduled from 2022/2023 onwards, has not been included in the 2020 DFES evaluation and has been manually added to the data to provide the plot below.

The projected primary demand at Salisbury and Amesbury BSPs by the end of ED2 is split as in Figure 5 and Figure 6 below by demand type. The chart shows the largest impact on demand in the area is from EVs and heat pumps, equating to 9.9% and 12% for Salisbury of the overall projected demand increase respectively and 6.5% and 9.8% for Amesbury.

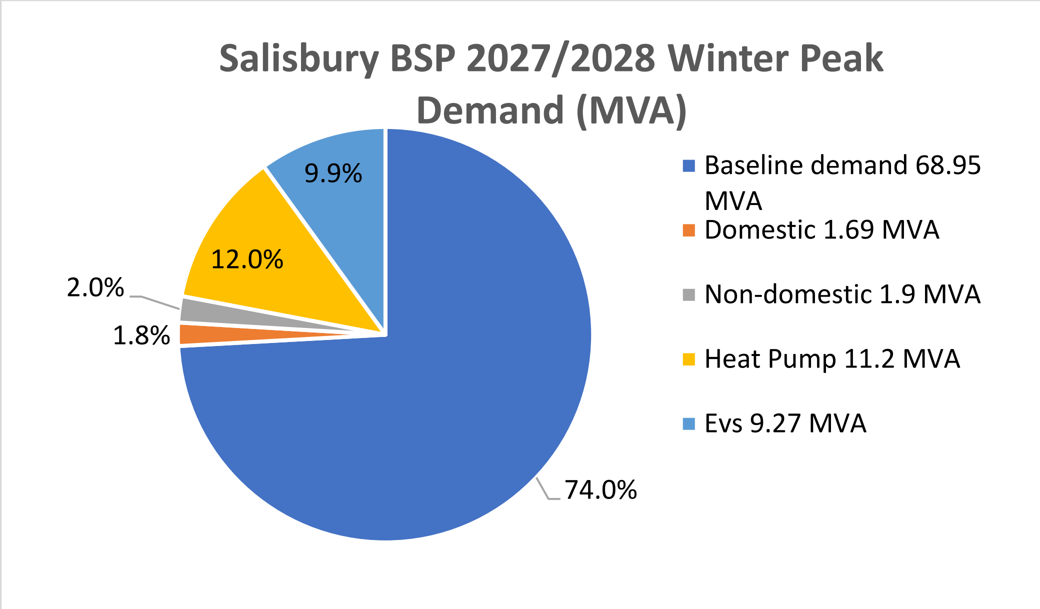


Figure 5: Salisbury 2027/2028 Demand Type

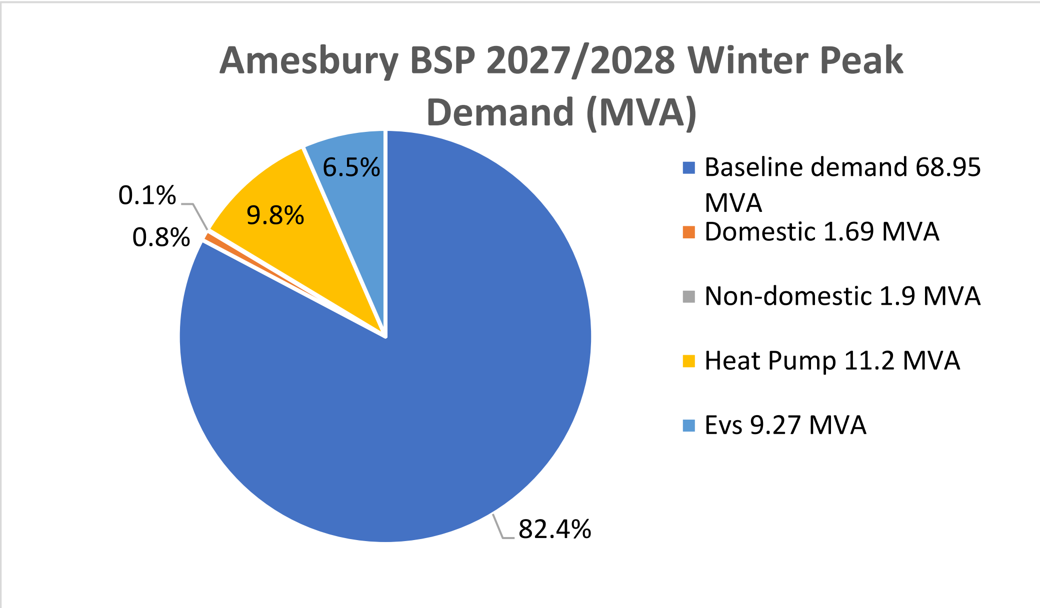


Figure 6: Amesbury BSP Demand Type

4.5 Existing Asset Condition

The Salisbury/Amesbury circuits 1 and 2 are part of Salisbury/Amesbury tee/Andover 132 kV circuits 1 and 2 (DD line) which were assessed under refurbishment scheme PS003626 and found to be in a good condition requiring only tower painting. Although the tower painting is planned for the first part of RIIO-ED2, both circuits are in good condition and can be energised before then – their current and future health index (HI) is HI1. The capital works proposed here compliment these refurbishment works by making use of the Salisbury/Amesbury circuit 2.

The 132 kV circuits from Mannington to Salisbury are also noted to be in good condition, with present and future health index of HI1.

The official health index of the Poole – Shaftesbury 132 kV circuit is noted to be HI5, however, it is understood that this circuit has recently been rebuilt, and it would therefore be expected that the health rating has improved to HI1.

In terms of transformers in the area, Salisbury 132/33 kV Transformer 3 is due to be replaced for health condition reasons. It has a current health index of HI4, and a future health index of HI5. Transformer 1 and Transformer 2 are also noted to be degrading, currently assessed to be HI3, with a future health index of HI4. However, these two are not scheduled for replacement.

4.6 Thermal Flow Analysis

By way of load flow studies, a detailed analysis of FCO and SCO against the requirements of Engineering Recommendation P2/7 has been performed for the area. The reported results correspond with the Consumer Transformation scenario, being the selected SSEN baseline. Results for 2027/28 (last year of ED2 window) are presented below.

In order to understand the progression of the network's adequacy, different case studies were considered as follow:

i. 2027/28 without temporary supply load;
ii. 2027/28 with 42.5 MW battery charging and 30 MW temporary supply added at Salisbury BSP, but with none of the connection scheme's network upgrades implemented;
iii. 2027/28 with 42.5 MW battery charging and 30 MW temporary supply added at Salisbury BSP, and the full scope of the connection scheme's network upgrades implemented;
iv. 2027/28 with 30 MW temporary supply added at Salisbury BSP, and the *full scope* of the connection scheme's network upgrades implemented, but no battery charging load (this is specifically an SCO consideration, assuming that battery charging would be prohibited under maintenance conditions to mitigate the effects of an SCO).

4.7 Thermal Load Flow Analysis

Since the greater Mannington GSP supply area is classified as type E, the network also needs to have the capability of maintaining supply under SCO. The results for SCO studies for case (i) are shown in Table 4. Load flow studies were performed on the Spring-Autumn case file (i.e. loads set to their Maintenance Period values).

Second Circuit Outage (SCO) Analysis – 2027/28 Case (i)						
Demand Group	**Season**	**Group Class**	**Contingency**	**Loaded Circuit / Transformer**	**SCO Demand**	**SCO Capacity**
Mannington GSP	Maintenance period	E	2 x Mannington GSP Transformers	Remaining 2 x Mannington GSP Transformers	905 MVA	1022 MVA[2]
Mannington GSP 132 kV Network	Maintenance period	E	2 x Mannington / Salisbury 132 kV circuits	Poole / Shaftesbury 132 kV circuit	218 MVA	175 MVA[3]
			1 x Mannington / Salisbury 132 kV	Mannington / Salisbury 132 kV circuit	194 MVA	175 MVA

[2] Assuming up to 140 MVA pre-emptively transferred to Melksham and Axminster GSPs.

[3] This figure is made up of the 145 MVA Rate B capacity of the recently upgraded Poole-Shaftesbury 132 kV circuit, plus approximately 30 MVA load which can be transferred away by effecting five load transfers at 11 and 33 kV level.

			circuit and Poole / Shaftesbury 132 kV circuit			

Table 4: Load flow results for SCO analysis – 2027/28 – case (i)

The results indicate that the network will be P2/7 non-compliant if the connection scheme does not go ahead. The date at which these SCO limits are forecast to be exceeded, under case (i) would be 2024/25 for Leading the Way and for Consumer Transformation. Given that case (i) demand exceeds SCO capacity when the connection scheme is not included in the system analysis, it is clear that for case (ii) where the connection scheme does go ahead but with none of the associated network upgrades, this case would also encounter this non-compliance.

With the inclusion of the connection scheme scope of works, that non-compliance with P2/7 under SCO conditions is not expected.

While the greatest risk is presented in those cases where the connection scheme does not proceed or the associated works are delayed, there are other factors to consider in the event the scheme does progress in its full capacity.

The results between the cases (ii) to (iv) highlight careful consideration must be taken against the scenarios to adopt an approach that will mitigate the risk to overloading and enable the network to be operated in a safe and reliable manner. The summary below highlights key factors which should be considered when assessing the need for network reinforcement within the Salisbury-Amesbury area. These are:

- A greater demand growth, compared to the CT base case, will exacerbate the issue and potentially create risk of overloading in case (ii)
- Extensive switching is required in case (iii) to create more capacity and maintain P2/7 compliance which operationally is a sub-optimal strategy
- Demand at Shaftesbury BSP has decreased over the past 1-2 years. There is a risk that if the load increases to its previous levels then the results of case (iii) and (iv) could be impacted
- Once the network upgrades have been implemented for the connection scheme, the network will be operating in an asymmetrical configuration, with uneven load sharing on the Andover – Amesbury 132 kV circuits, and very high bus-section load transfer across the 132 kV busbar at Salisbury (assuming the busbar does, in fact, remain coupled during such an SCO event).

Since, for a Class E network of this size, under SCO, the full group demand requires to be supplied immediately, the network is not P2/7 compliant for case (i). Additionally, given the points noted above it is proposed to adopt a solution in addition of the scope of works proposed for the customer connection to:

- Mitigate the risk of SCO overloading in the cases described in section 6
- Mitigate the risk of overloading should the demand growth follow a trend that is not the baseline (CT scenario)
- Enable the operation of a robust and reliable network

4.8 Voltage Level Analysis

The voltages at the 132kV bus bars were also studied. The result of the study show that reinforcement is not required based on voltage as the voltages remain within statutory limits.

4.9 Fault Level Analysis

The fault level at the 132kV bus were studied for both three phase and single phase to ground faults. No fault level issues were identified and reinforcement is not required based on fault level.

4.10 Network Analysis Summary

The Network analysis shows that during the RIIO ED2 price control period, under SCO conditions the remaining in service 132kV circuits will become overloaded and therefore non-compliant with P2/7. This issue will become apparent from 2024. Reinforcement is therefore required to mitigate this issue and minimise the risk of loss of supply to customers.

5 Summary of Options Considered

This section of the report sets out the investment options that are considered when resolving overload issues. As described below a holistic approach is taken to ensure investment options which are both least regrets and represents best value for money for network customers are identified.

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 3. 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

The table below provides a high-level summary of the four 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 subsequent sub-sections.

Option	Description	Advantages	Disadvantages	Result
1. Do Minimum	Carried out via demand transfer from the overloaded demand group to the Bramley-Thatcham side of the network.	Minimum cost and workload; Small impact to existing network; Short delivery time.	Does not increase network capacity; Does not capitalise on the opportunity created by the connection project for temporary supply, to enhance network operational flexibility; Leaves network in non-standard arrangement of only one circuit being energised on the Salisbury-Amesbury tee.	Not Progressed to CBA
2. Asset Replacement	The replacement of the full overloaded equipment including the following line sections between Poole and Shaftesbury BSPs:	Increases normal and contingency capacity of these circuits	New servitudes or long outages required (the latter leaving the network very vulnerable to faults);	Progressed to CBA

	• 120 m 132 kV cable • 38.67 km 132 kV overhead line The following line sections between Mannington GSP and Salisbury BSP: • 1.24 km 132 kV cable • 26.94 km 132 kV overhead line	Avoids the need for complex medium voltage load shifting under contingency	In the case of Mannington to Salisbury, the two circuits are built on the same set of structures, and so replacing just one circuit with a larger conductor would not be possible; Two separate, significant asset replacements are required to address two SCO limitations, as a single asset replacement cannot cover both.	
3. Add New Assets	Adding the following new assets: • 132 kV isolator at Amesbury Substation for second Salisbury – Amesbury circuit • Cable terminations on the Salisbury-Amesbury tee 132 kV circuit at the tee-off point. • Extension of Salisbury 132 kV busbar and new 132 kV bay • 132 kV cable between cable terminations and Salisbury 132 kV busbar.	Increases transfer capacity between Mannington and Bramley GSPs under contingency; Relatively small scope and quick works for the quantity of additional network operational flexibility this creates; Normalises an unusual network arrangement due to the scope of the connection project only addressing one circuit of the tee, and resulting uneven loading of Andover-Amesbury circuits; Allows for planned maintenance on both of the Mannington-Salisbury circuits (one at a time) without risking unserved load should a fault occur; Avoids the need for complex medium voltage load shifting under contingency; Creates the option to move Amesbury onto Mannington GSP should Bramley GSP experience thermal constraints in the future.		Progressed to CBA
4. Flexibility Solution followed by Add New Assets	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. Flexibility would only be required under planned outage conditions,	Progressed to CBA

			potentially resulting in an unattractive business case for flexibility providers.	

Table 5: Summary of 132 kV circuit reinforcement investment options

5.3 Detailed Option Analysis

5.3.1 Option 1: Do-Minimum

Estimated Cost: N/A

In this case, the minimum option would be to transfer load out of the Salisbury/Amesbury demand group. Since no P2/7 violations would be noted if the connection scheme goes ahead, this is a technically viable option for the cases where the connection scheme progresses. It is not, however advisable, as it leaves the network in a less than optimal, non-standard state and requires several switching actions to occur consecutively to enable this option. There is also a risk that if the connection scheme were to be delayed or cancelled, this option would not enable suitable volumes of load transfer to maintain P2/7 compliance at Salisbury/Amesbury. As this option is operationally sub-optimal and does not technically mitigate the risks of overloading under SCO conditions, this option has been rejected and not assessed in the OFGEM CBA.

5.3.2 Option 2: Asset Replacement

Estimated Cost: £ 9,390k

This option proposed the replacement of the existing circuits with higher rated conductors. This option would see the replacement of:

- 132kV circuit between Poole and Shaftsbury
  - 120 m 132 kV cable
  - 38.67 km 132 kV overhead line
- 132kV circuit between Mannington GSP and Salisbury BSP:
  - 1.24 km 132 kV cable
  - 26.94 km 132 kV overhead line
- 132kV circuit between Mannington GSP and Poole BSP
  - 20.62km 132 kV overhead line

The SCO condition which proved to be problematic in the base study (i.e. case (i), Maintenance period loading) has been tested with the scope of Option 2 implemented. For the purposes of the simulation a twin Lynx overhead conductor and a 1000 mm^2 Cu cable were used for the overhead and underground section of the upgrade, respectively.

In this proposed option, the replacement of the 132kV circuits will resolve the SCO overloading issue.

5.3.3 Option 3: Add New Assets

Estimated Cost: £1,896k

The scope for this solution has been investigated in detail and marked up in Figure 7 below, with items **(A)-(D)** indicating the scope to be completed within the connection project for temporary supply, and items **(E)-(H)** required within this option.

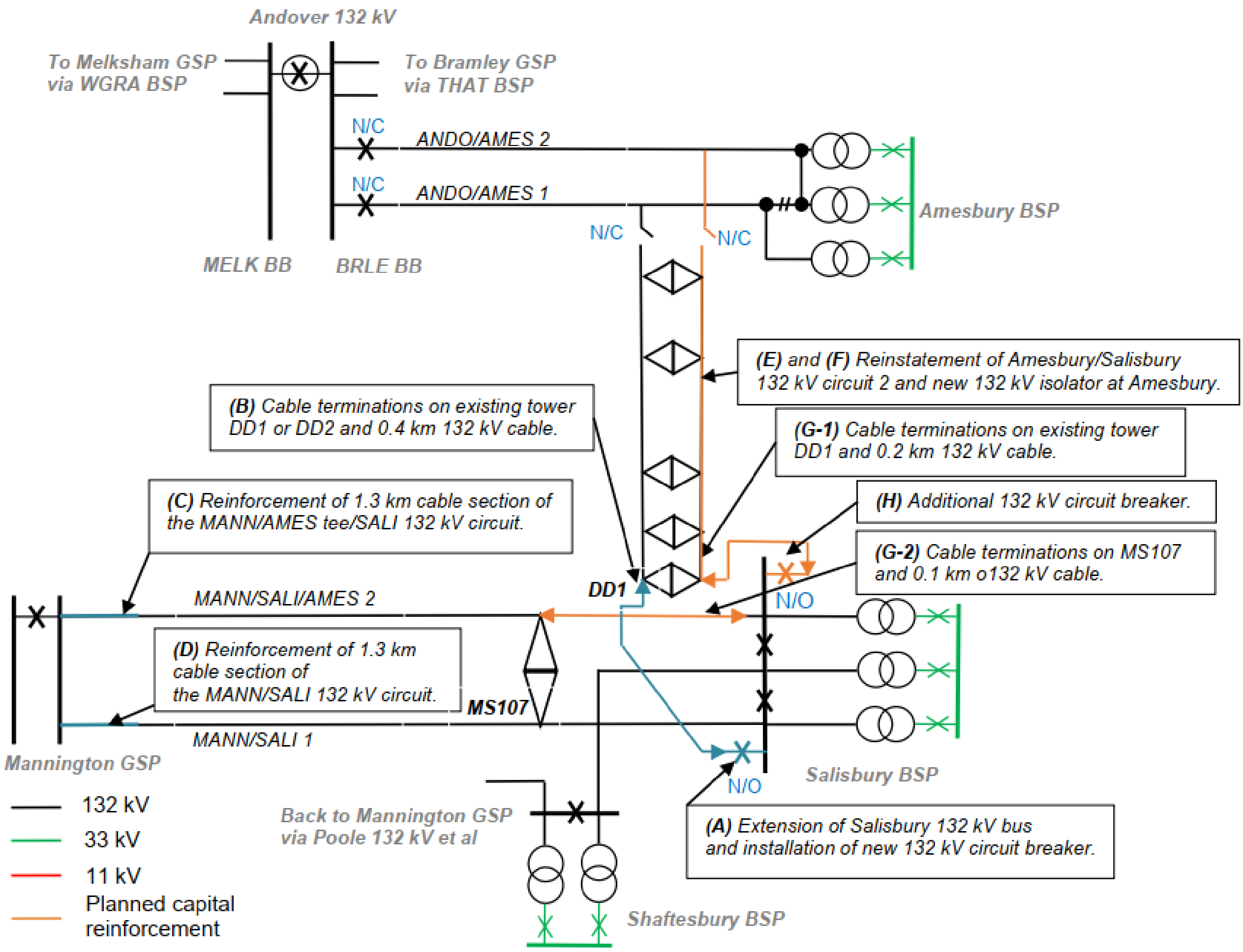


Figure 7: Salisbury-Amesbury tee: addition of new assets

Item (E): Reinstatement of the de-energised Salisbury/Amesbury tee 132 kV circuit 2.

The Salisbury/Amesbury circuits 1 and 2 are part of Salisbury/Amesbury tee/Andover 132 kV circuits 1 and 2 (DD line) which were assessed under refurbishment scheme PS003626 and found to be in a good condition requiring only tower painting. Tower painting is planned for the first part of RIIO-ED2, and as such, capital works proposed here complement these refurbishment works by making use of the Salisbury/Amesbury circuit 2.

Item (F): Installation of a 132 kV isolator at Amesbury 132 kV substation and connection on to Salisbury/Amesbury tee 132 kV circuit 2.

These works at Amesbury 132 kV substation involve:

- Installation of down-droppers to incoming termination structures and 132 kV isolator just below tower DD51 on the western end of Amesbury 132 kV substation.
- Disconnection of risers from low-level 132 kV busbar to high-level 132 kV strain busbar just before Amesbury A1MTB.
- Extension of high-level 132 kV strain busbar from A2MT on the eastern end of Amesbury 132 kV substation to the new 132 kV isolator on the western end of the substation.

Item (G): Installation of 132 kV cable terminations on tower DD1 or DD2 on the Salisbury/Amesbury tee 132 kV circuit 2 and laying of 132 kV cable to cable termination structure of Amesbury circuit 2 132 kV incomer circuit breaker bay.

Initially it was proposed to terminate cables on the Salisbury/Amesbury tee 132 kV circuit 2 at tower DD2 with 0.4 km of 132 kV cable to Salisbury 132 kV substation. This option avoids moving the Mannington/Salisbury 132 kV circuit 2, which is connected onto tower DD1, but requires securing a cable route through a field from tower DD2 to Salisbury 132 kV substation. If the Salisbury/Amesbury tee 132 kV circuit 2 is terminated at DD1 then the Mannington/Salisbury 132 kV circuit 2 will need to be terminated at MS107. The decision for terminating the cables at DD1 or DD2 is subject to more detailed design but initial discussions highlight the need to cater for the cable termination to be made at tower DD1 due to concerns with securing a 132 kV cable route. The following works consider this variation:

- Retrofitting sealing end platform to terminate the Mannington/Salisbury 132 kV circuit 2 onto tower MS107. For these works, there will be a 50:50 split with connection (temporary supply) project. (£ 150k)
- Sealing end structure for Mannington circuit 2 and 100 m cable route connection to MS107. (£ 250k)
- Retrofitting sealing end platform to terminate the Salisbury/Amesbury 132 kV circuit 2 onto tower DD1. For these works, there will be a 50:50 split with the connection project for temporary supply. (£ 150k)
- Sealing end structure for Amesbury circuit 2 and 200m cable route connection to tower DD1. (£ 300k)

Item (H): Extension of the Salisbury 132 kV busbar to establish a second new 132 kV incomer circuit breaker with associated equipment.

These works at Salisbury 132 kV substation involve:

- Elevate and extend the existing 132 kV busbar section 3 from the Mannington circuit 2 132 kV isolator.
- Establish a new 132kV circuit breaker bay onto the extended section of the Salisbury 132 kV busbar section 3.

The SCO condition which proved to be problematic in the base study (i.e. case (i), Maintenance period loading) has been tested with the scope of Option 3 implemented. The thermal analysis results, show that this solution is well with P2/7 compliance limits for thermal loading. The voltages at the 132kV bus were also assessed. The results highlighted that the voltages remain within statutory limits.

5.3.4 Option 4: Flexible Solution

Estimated Cost: £1,899k

An alternative to conventional reinforcement is through the use of flexible service. The CEM 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.

The baseline reinforcement cost used as an input into the CEM framework is the costs associated with Option 3, equating to £1.6m, as this option has the lowest costs of the conventional reinforcement options. Figure 8 shows that the half-hourly forecast 2028 Spring/Autumn demand profile for the combined load on the Mannington 132 kV circuits to Salisbury exceeds the effective SCO capacity (made up of the 145 MVA Rate B capacity of the Poole-Shaftesbury 132 kV circuit, plus approximately 30 MVA load which can be transferred away by effecting five load transfers at 11 and 33 kV level, and accounting for the high losses experienced on the long 132 kV line from Poole to Shaftesbury) during the afternoon/evening peak. The total duration of exceedance for the Consumer Transformation scenario is 7 hours.

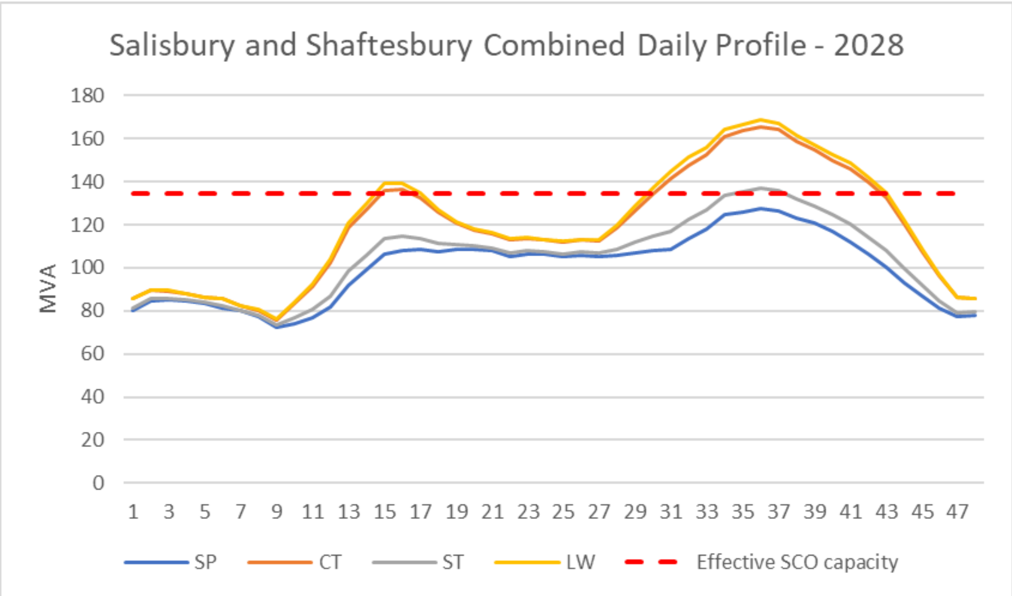


Figure 8: Salisbury and Shaftesbury forecast Spring/Autumn profile for 2028 without flexibility services.

The MW exceedance, the daily and annual overload hours (Table 6) and the flexibility unit costs of £150 per MW per hour and £150 per MWh were used as input parameters in the CEM CBA model.

	2020	2021	2022	2023	2024	2025	2026	2027	2028
Hours/day required	0	0	0	0	0.5	2.5	4.0	5.5	7.0
Days/year required	0	0	0	0	128	128	128	128	128
MWh	0	0	0	0	5.8	1097	37745	7316	14026
Dispatch duration	0	0	0	0	0.5	2.5	4.0	5.5	6.0

Table 6: Estimated Dispatch Requirements for Flexibility Solution.

The CEM CBA model suggests that there is an economic benefit to deferring conventional reinforcement for one year.

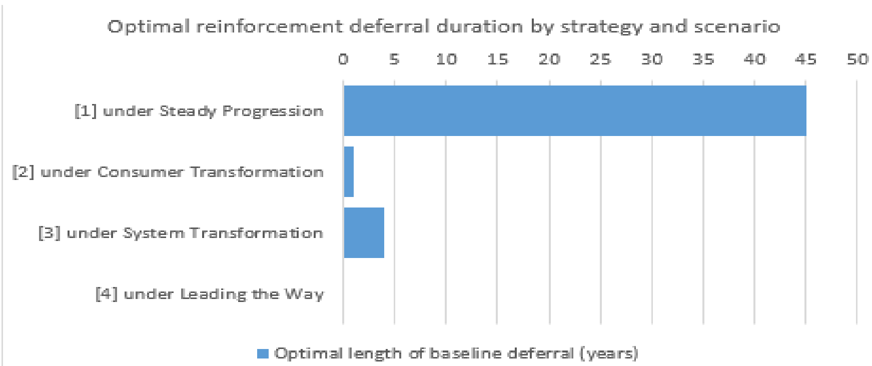


Figure 9: CEM Flexibility CBA Optimal Deferral Results

In line with our Flexibility First Approach, this project is technically compatible with a Flexibility Solution. In this case flexibility will allow us to defer the need for a conventional solution by one year, as such we will carry out Flexibility market tests to establish the cost, location and technical capabilities of the available flexibility.

If the market test is successful, a Flexibility Solution will be employed offering value to both, us and our customers in terms of investment deferral and optionality. Should the market test fail or only partially succeed in identifying the required Flexibility, we will utilise the CEM Framework to assess the optimal, secondary solution for this location, be that be a further market test for full Flexibility, accelerating the Conventional solution or a Hybrid Scheme.

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

6 Cost Benefit Analysis

This section provides an overview of the results from the Cost Benefit Analysis (CBA). This detailed exercise has been undertaken to support the investment strategies discussed within this EJP.

6.1 CBA of Investment Options

Ofgem's RIIO-ED2 standard CBA template was used to assess costs and benefits of the conventional options for each circuit individually. Capital reinforcement costs, CI/CML penalties, network losses and other societal benefits are the key parameters used in the CBAs of the three options progressed. The customer interruptions / customer minutes lost (CI/CML) were calculated based on the potential overload and the probability of a failure. Further information on our Cost Benefit Analysis (CBA) approach is set out within our ***Cost Benefit Analysis Process (Annex 15.8)***.

6.2 CBA Results

Table 7 summarises the CBA outcome for all the valid options considered to resolve the thermal constraints at within the Salisbury/Amesbury 132kV network under SCO conditions. The results of the cost benefit analysis show that option 3 is the preferred option. This option has the lowest CAPEX cost and subsequently the lowest NPV value of all the options assessed.

Options	NPV After 45 Years (£k)	Total Investment Cost (£k)
Option 2 – Asset Replacement	-3,683	9,390
Option 3 – Add New Asset	-1,809	1,896
Option 4 – Flexible Solution	-1,745	1,899

Table 7: CBA Results Summary

Summary of Cost

Options	Unit	2024/25	2025/26	2026/27	2027/28	2028/29	Total
Option 2 – Asset Replacement	£m	9.390	0	0	0	0	9.390
Option 3 – Add New Asset	£m	1.896	0	0	0	0	1.896
Option 4 – Flexible Solution	£m	0.003	1.896	0	0	0	1.899

Table 8: Cost Summary Across RIIO ED 2 Period

6.3 Costing Approach

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)***[4]. 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. Cost and volumes breakdown are presented in Table 9.

Category	Sub-category	Unit Cost (£k)	Unit	Asset Count	Predominant Costing Approach	Cost £k
Switchgear	132kV isolator	[redacted]	#	4.00	Finance Advised Ofgem Rate	[redacted]
Substation	132 kV busbar extension	[redacted]	#	2.00	Finance Advised Ofgem Rate	[redacted]
Overhead Line	Installation of down droppers	[redacted]	#	1.00	Finance Advised Ofgem Rate	[redacted]
Cable	132 kV cable terminations	[redacted]	#	1.00	Finance Advised Ofgem Rate	[redacted]
Switchgear	132kV CB (Air Insulated Busbars)(OD) (GM)	[redacted]	#	1.00	ED1 6yr average actual unit rates	[redacted]
Project Sub Total						[redacted]

Table 9: Preferred Solution Cost Breakdown

The costs breakdown above is reflective of the cost of the physical asset and associated works only. The cost for the use of flexible services to defer the reinforcement until 2025 will be in addition to this. Based on the assessment of flexibility it is estimated that cost for procuring flexible services (availability and utilisation) will be £3k. This will bring the total project cost to £1,899k.

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 the 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 in (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

[4] Link to ***Cost Efficiency Annex 15.1***

- 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

The table below sets out the revised investment phasing based on the outcome of our deliverability assessment:

	2023	**2024**	**2025**	**2026**	**2027**
Revised Investment Phasing	0	£2.6k	£1,896k	0	0

Table 10 Revised investment phasing

This investment scheme is part of the wider load-related investment portfolio in RIIO-ED2. We 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 132kV, 33kV and 11kV 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

The purpose of this Engineering Justification Paper (EJP) has been to describe the overarching investment strategy that SSEN intends to take during RIIO ED2 for the load related investment on the Salisbury-Amesbury network. Within the RIIO ED2 price control period, the Salisbury-Amesbury 132kV network will experience network overloading under SCO conditions and subsequently will become non-compliant with P2/7.

The options considered to resolve the thermal overloading under SCO conditions were:

- Option 1: Do Minimum
- Option 2: Asset Replacement
- Option 3: Add New Asset
- Option 4: Flexible Solution

Based on the result of the CBA, the preferred investment for the Salisbury-Amesbury 132kV network in RIIO ED2 is Option 4 – Flexible solution followed by option 3 – Asset replacement, as this option had the lowest NPV across a 45 year period and therefore is the most cost effective.

Appendix 1. Assumptions

CI/CML Table

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
CT	115.0	120.0	124.9	129.7	134.7	141.2	149.1	157.2	165.6	174.4
Firm Capacity	135	135	135	135	135	135	135	135	135	135
Difference	20.0	15.0	10.1	5.3	0.3	-6.2	-14.1	-22.2	-30.6	-39.4
Customer No. 1% Growth	74808	75556	76312	77075	77846	78624	79410	80204	81006	81816
MW per customer	0.0015	0.0016	0.0016	0.0017	0.0017	0.0018	0.0019	0.0020	0.0020	0.0021
No. Faults per Year	0.2265	0.2265	0.2265	0.2265	0.2265	0.2265	0.2265	0.2265	0.2265	0.2265
Final Input										
CI	0.000	0.000	0.000	0.000	0.000	-0.998	-2.139	-3.193	-4.181	-5.121
CML	0.0	0.0	0.0	0.0	0.0	-179.7	-384.9	-574.8	-752.6	-921.9

Table 11: CI/CML for Do Nothing Option.

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 12 outlines our Whole Systems CBA test for Salisbury Amesbury 132 kV System Reinforcement.

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?
Salisbury Amesbury 132 kV System Reinforcement	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.	No	No

Table 12:Whole Systems CBA test for Salisbury Amesbury 132 kV System Reinforcement

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.