PS007695

HARVARD LANE 22/11KV PRIMARY SUBSTATION ENGINEERING JUSTIFICATION PAPER

Scottish & Southern Electricity Networks

CONTENTS

1 Executive Summary

1.1 Summary

Our proposed investment at Harvard Lane 22/11 kV primary substation will deliver a long-term security of supply compliant network arrangement [redacted] during RIIO-ED2 and early RIIO-ED3.

Harvard Lane Primary Substation firm capacity has already been investigated and assessed in a previous Engineering Justification Papers (EJP), which is document 50/SEPD/LRE/HARL. While the last assessment already draws the conclusion that reinforcements and replacements of existing assets will be necessary in order to fulfil the requirements, adjusted input data such as costs and load forecasts call for a review and a re-assessment of the situation at this primary substation. In addition to the previous EJP for Harvard Lane, this EJP will deliver a solution which is designed to be compliant in the long-term until 2050. Therefore, the purpose of this EJP is to re-assess the previous EJP while simultaneously looking ahead to 2050.

Similarly, to the previous EJP, the primary investment driver for this scheme is load related P2 compliance issue under N-1 outage conditions for supply to Harvard Lane 22/11 kV primary substation in RIIO-ED2. [redacted] This will significantly impact our ability to meet the minimum level of security of supply to consumers, as we move towards a net zero network in RIIO-ED2.

To address the overloading issues, multiple options have been considered. The advantages and disadvantages of all options are extensively described and assessed. The most cost-effective and strategic options have been progressed to the cost benefit analysis (CBA) and every single rejection is thoroughly justified. Table 1 displays the options that are progressed to the CBA assessment and the results of this assessment. Option 6 focuses on rearranging the current grid topology. The load growth at Harvard Lane and neighbouring primaries is expected to an extend that Harvard Lane Primary cannot be assessed on its own, to create a sustainable and long-term compliant solution. Consequently, the Harvard Lane Primary will be directly connected to the upstream Grid Supply Point (GSP) and some of the existing assets will be replaced. Therefore, the firm capacity of Harvard Lane increases from 25 MVA to 76 MVA and additionally, the created target grid releases additional capacity for the supply of neighbouring primaries and solves thermal overloading issues on a Bulk Supply Point (BSP) level. Option 6 combines the described option with the use of flexibility to defer the investment into the assets by two years. The results from the cost benefit analysis are shown in Table 1.

Table 1: CBA and investment results for viable options

Options	Net Present Value in £m (after 45 years)
Option 6 - Flexible solution followed by network rearrangement	[redacted]

Following the optioneering and detailed analysis, as set out in this paper, the proposed scope of works for the preferred Option 6 is detailed in Table 2:

Table 2 – Preferred Option Cost Breakdown

Assets & Services	Unit	Cost per unit (£k/unit)	Amount of unit	Sum (£m)
1st circuit: 66kV UG Cable (Non-Pressurised)	km	[redacted]		
2nd circuit: 66kV UG Cable (Non-Pressurised)	km			
66kV – transformer - 80MVA CMR	each			
66kV – transformer - 80MVA CMR	each			
132kV CB (Air Insulated Busbars) (OD) (GM) – operated at 66 kV	each			
Flexibility solution	years			
Total				

This scheme delivers the following outputs and benefits:

- [redacted]
- Facilitates the continued uptake of low carbon technologies (LCT) in Greater London and helps support the climate change targets of Ealing Council.
- Upgrade the firm capacity of Harvard Lane Primary Substation from 25 MVA to 76 MVA. Increasing capacity by 51 MVA to meet the needs of our customers at Harvard Lane Primary.
- Releases capacity at the BSP level for the supply of neighbouring primaries (Dean Gardens, Brentford).
- [redacted]
- Decreases the fault levels in the whole part of the network.
- Aligns with the long-term SSE strategy to steadily phase-out the whole 22 kV network.
- Facilitates the efficient, economic, and co-ordinated development of our Distribution Networks for Net Zero.

The cost to deliver the preferred solution is illustrated in Table 2. [redacted]

2 Investment Summary Table

Table 3 summarises the needed investments.

Table 3: Investment summary table

Name of Scheme/Programme	Harvard Lane Reinforcement	
Primary Investment Driver	Load	
Scheme reference/ mechanism or category	PS007695 / Substation upgrade	
Output reference/type	66kV UG Cable (Non-Pressurised) 66kV Transformer (80MVA, CMR) 132kV CB (Air Insulated Busbars) (OD) (GM) – operated at 66 kV	
Cost	[redacted]	
Delivery Year	From 2025 to 2028	
Reporting Table(s)	CV1: Primary Reinforcement	
Outputs in RIIO ED1 Business Plan	No	
Spend Apportionment	**ED2** [redacted]	**ED3+** [redacted]
MVA released	Temporary by flexibility: 0.79 MVA in 2025 1.33 MVA in 2026 2.21 MVA in 2027	By assets: 51 MVA

3 Appendices Summary

This EJP contains detailed information that is gathered throughout the analyses and assessments. For better readability, the detailed information is included as appendices. The table below depicts an overview of the appendices of this EJP.

Table 4: Overview of appendices

Appendices	Description
Appendix A – Definitions and Abbreviations	Contains an overview of all used abbreviations and their definitions.
Appendix B – Operational Planning Engineers	Contains an overview of the operational planning engineers and their assigned grid area.
Appendix C – Network Assessments	Contains the data and results of the carried-out network assessment.
Appendix D – Relevant Policy, Standards, and Operation Restrictions	Contains the relevant policy guidelines, underlying standards, and current operation restrictions.
Appendix E – Whole Systems Considerations	Contains the results of the assessment of the whole system considerations.

4 Introduction

The reinforcement of the Harvard Lane Primary substation has already been investigated in the previous EJP (50/SEPD/LRE/HARL) using the DFES 2020 values. However, due to the change of the DFES values, change of the scope - regarding an outlook until at least 2035 - and costs, the network arrangement of the Harvard Lane Primary is investigated once again. Similarly to the previous EJP, SSEN's Load Related Plan Build and Strategy sets out the methodology for assessing load-related expenditure and describes how we use the Distribution Future Energy Scenarios (DFES) 2022 as the basis for our proposals. A baseline view of demand has been established which provides a robust projection of the drivers of load-related expenditure for the RIIO-ED2 price control period. The ex-ante baseline funding request is based on the minimum investment required under all credible scenarios and is strongly supported by our stakeholders. The 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.

Section 5 of this Engineering Justification Paper (EJP) describes our proposed load related investment plan for the reinforcement of the Harvard Lane Primary Substation within the RIIO-ED2 period. The primary driver considered within this paper is load related P2 compliance issues due to forecast demand growth triggered by the Distribution Future Energy Scenario (DFES).

This section also provides high-level background information for this proposed scheme explaining the existing network arrangements, the load growth forecasts through the 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 6 provides an overview of the considered options and identifies the most appropriate one as proposed solution to address the network congestion. This section includes a table that summarises the net present value of all the options included in the Cost Benefit Analysis, the year in which each cost is incurred and the year in which each option would need to be triggered. Section 6 therefore summarizes the results detailed in section 7 on the optioneering process and section 8 on the cost-benefit analysis of each option.

Section 7 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 8 details the Cost Benefit Analysis (CBA) and provides comparative results of all the options considered within the CBA. It 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.

Section 9 describes the deliverability of the plan for RIIO-ED2 and this proposed investment. It also addresses possible risks based on the required works, the proposed assts and other surrounding factors, such as the procurement of additional construction space.

Section 10 provides an overview of the Outlook to 2050.

Section 11 provides a summary of main conclusions and recommendations contained within this document. This includes the recommended preferred option, a summary of the costs and timeline of this option, a reasoning on the use of flexibility as well as key risk and delivering options.

5 Background Information

Harvard Lane is a Primary Substation located at Ealing within the SEPD licence area. The substation is fed from Ealing BSP and currently supplies 12,953 customers.

5.1 Existing Network Arrangements

Harvard Lane primary substation is fed from Ealing BSP Substation, which in turn is fed from Ealing GSP Substation. It is operated at 11 kV and is connected to the 22 kV level via 3 transformers. Of the three 22/11 kV transformers, two transformers have a rating of 12.5 MVA and the third transformer has a rating of 12/24 MVA. Three 22kV circuits of lengths 4.72 km, 4.79 km and 4.82 km run from the three transformers and terminate at Ealing BSP on the 22 kV busbar. In addition to the primary station Harvard Lane, the primary stations Dean Gardens and Brentford are also supplied via the 22 kV busbar at Ealing BSP. The 22 kV busbar is connected via 3 66/22 kV transformers to the 66 kV station in Ealing, which in turn is fed via Ealing GSP. The current network configuration is depicted in Figure 1.

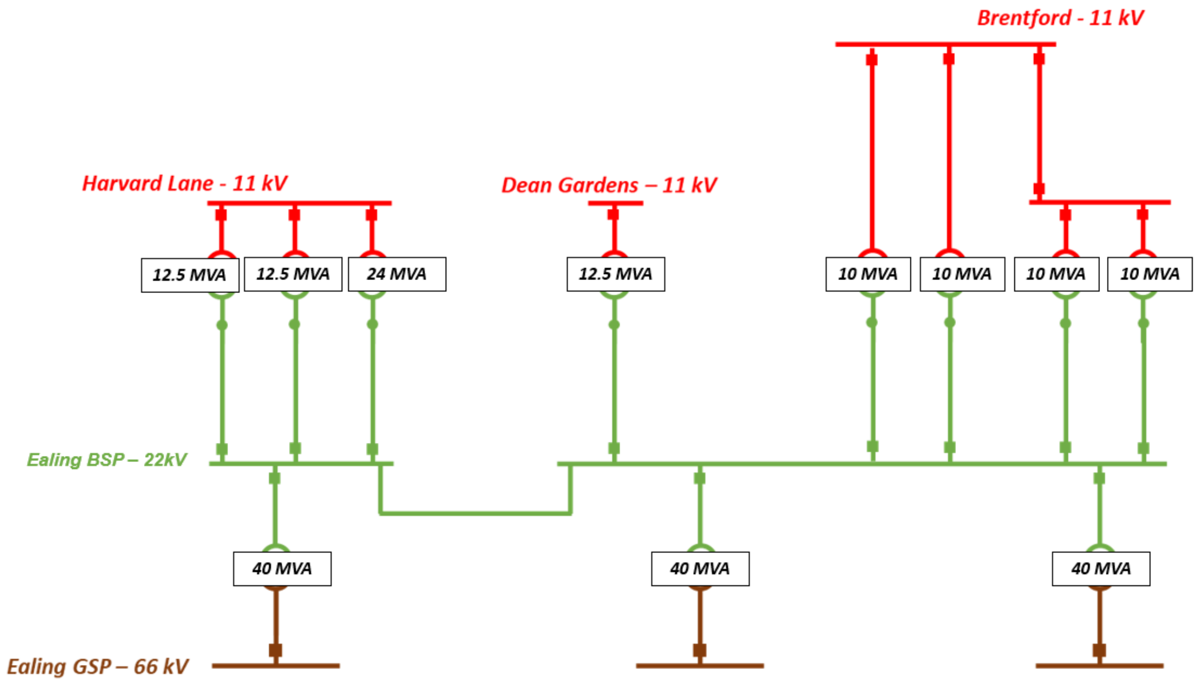

Figure 1: Current Network Configuration of Harvard Lane Primary Station

Harvard Lane Primary Substation is in the middle of a commercial/residential area. Houses and streets border up close to the sub-station. Figure 2 illustrates the geographical location in and around the site.

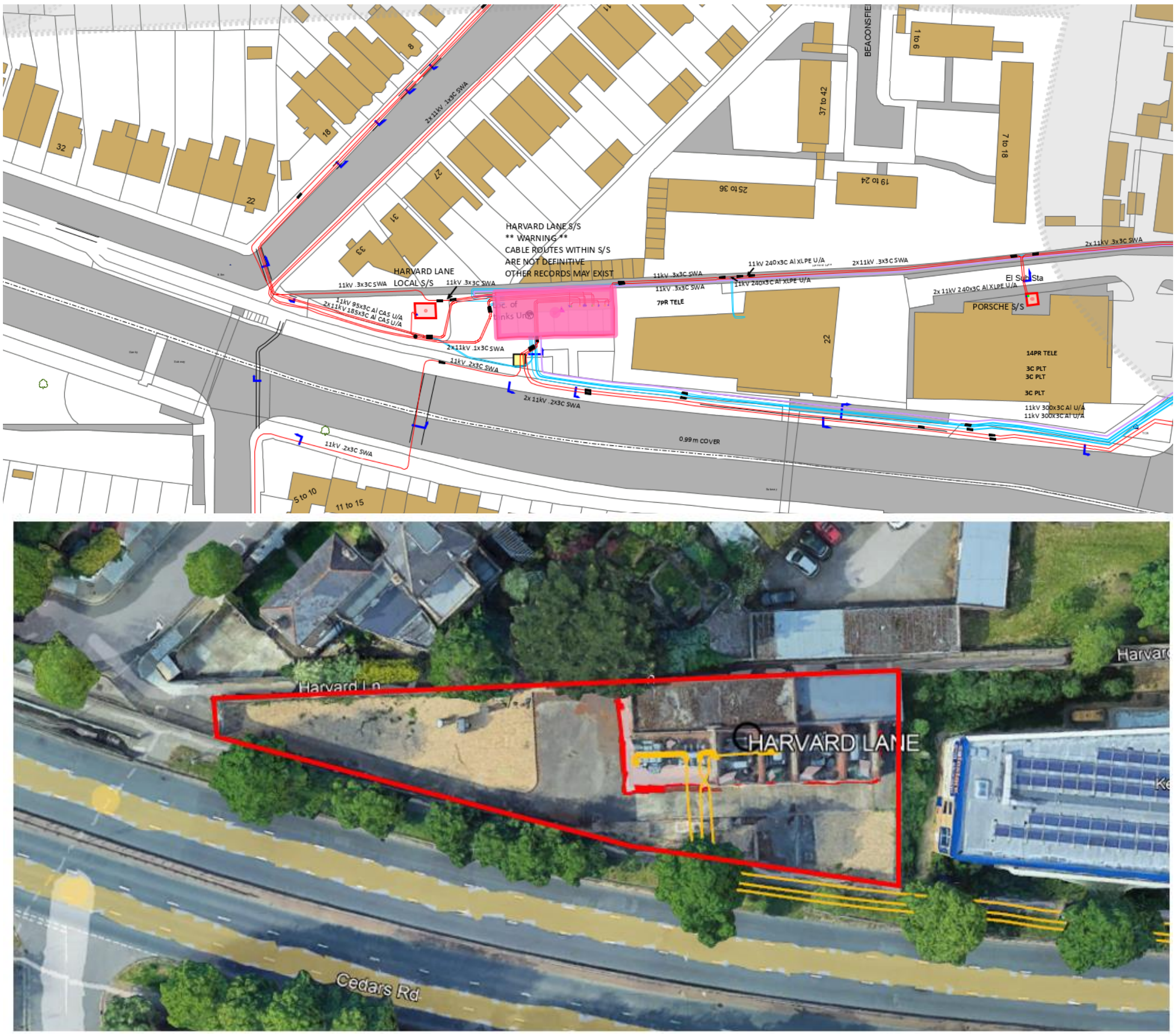

Figure 2: GIS extract of the Primary Station Harvard Lane

5.2 Load Forecast for Harvard Lane Primary

In the following chapter the demand/load growth will be examined against the FCO capacity of Harvard Lane Primary Substation. As explained in the chapter before, this is a Primary Substation operated at 11 kV which is supplied via three 22 kV circuits and three 22/11 kV transformers. When considering the first circuit outage scenario (FCO) capacity, the failure of the strongest network element / network branch is to be considered and accordingly the FCO capacity for the Harvard Lane Primary Substation results from the failure of the greatest 22/11 kV transformer with a rating of 24 MVA. In this case, the two remaining transformers would provide an FCO capacity of 25 MVA. Apart from the DFES demand growth, there are currently no additional connections planned at Harvard Lane. The DFES is depicted for all seasons, winter, summer, and spring/autumn. As can be clearly seen in the next two figures below, this threshold gets exceeded in all scenarios and all seasons. Not only the threshold is exceeded at a particular point in time, but the threshold is already exceeded during the RIIO-ED2 price control period. [redacted] In the CT scenario, the FCO capacity is first exceeded in winter, but the summer scenario

(Figure 4) determines the load increase in the long term. Accordingly, the long-term solution for Harvard Lane should be aligned with the summer peak as well.

[redacted]

[redacted]

Figure 5 illustrates the load growth for Spring/Autumn Season. Similar figures to Winter Season though.

[redacted]

[redacted]

Furthermore, in contrast to the original EJP, we are expanding the scope of the investigations, seeking compliance for a longer period. Therefore, Harvard Lane Primary Substation can no longer be investigated on its own but must be looked at in the light of all the primaries supplied by Ealing BSP Group Demand. Thus, we will look at the aggregated load development of Harvard Lane, Deans Gardens and Brentford primary substations, all together. Figure 6 and Figure 7 display the aggregated load forecast for all three substations for Winter and Summer Seasons, respectively. FCO and SCO capacity of the 22 kV Ealing BSP are also illustrated.

As a group demand (GD) - formed by the three primary substations – a load growth above 100 MVA in the upcoming years is noticed. Therefore, according to EREC P2, this GD will transition from category C to category D, which is accompanied by additional requirements, or SCO compliance.

[redacted] While optioneering future network arrangements of Harvard Lane primary substation, this condition needs to be considered.

[redacted]

[redacted]

5.3 Existing Asset Conditions

The methodology of assessing the Health Index (HI) scoring has been considered for all relevant components on the network. As part of setting the methodology, it has been agreed that the study will extend beyond the ED2 price control period. Accordingly, the target network and its network elements will be studied until 2035.

Table 5 gives an overview of all existing assets which have been considered within the Health Index assessment of Harvard Lane Primary Substation. In addition to the current Health Index values, the table also contains the values for the years 2028 - the end of the ED2 period - and 2035. [redacted]

Taking this into account, it can be determined that the transformers will be in a critical condition before 2035 and this should be considered in the planning process.

[redacted]

5.4 Existing Operational Issues

There are currently a few operational issues that need to be considered throughout the whole process. Firstly, the access to one of the existing transformers is difficult as it is positioned between blast and fire walls and hence, the access to the transformer is restricted. Temporary access is permitted under the condition that the tap changer of the transformer is set on a fixed position for the duration of the work required. To be more precise, during maintenance routines, it is not permitted to tap through the positions 10/11.

[redacted]

These operational issues need to be kept in mind while planning the future network arrangement.

5.5 Network Analysis Summary

In the following section the results of the network analysis of the Harvard Lane Primary will be presented. Following Engineering Recommendation P2, the assessment focusses on the First Circuit Outage Study since the group demand of Harvard Lane Primary falls into category C and hence, there are no SCO requirements to consider while analysing the current topology at the Harvard Lane Primary.

The network analysis has been performed using Consumer Transformation scenario loading, as this is assumed to hold best balance between a conservative network assessment and a realistic loading situation. [redacted]

[redacted]

5.6 Regional Stakeholder Engagement and Whole systems analysis Summary

SSEN has strong working relationships with local authorities and other key stakeholders in the region. We have engaged extensively with the Greater London Authority and Old Oak and Park Royal Development Corporation to discuss development plans and local area energy planning. We also engage with the Greater Southeast Net Zero Hub, of which the Greater London Authority is a member. We met with Transport for London in March 2023 to discuss electric vehicles and the connections timeline. This engagement has helped SSEN stay informed about planning and development that will impact communities' use of the network.

In their Climate Emergency Action Plan, the London Borough of Hounslow Council aims to produce a significant proportion of its electricity demand from local renewable generation and have the council's entire vehicle fleet electric or hybrid by 2030. To achieve the former target, they have already installed solar PV at 48 sites across the borough. In late 2022, they also set a target to install more than 2,000 new electric vehicle charge points by 2026.

5.7 Flexible Market Viability

The flexibility market viability has been assessed for the customers supplied from Harvard Lane Primary Substation. It has been found that a maximum of 2.2 MVA of flexibility is available to defer the investment into assets. This is, however, highly dependent on the available flexibility by commercial loads supplied by Harvard Lane Primary Substation. Participation rates in commercial demand turn down are not well documented yet, and consequently, we recommend a deferral of two years using flexibility with a re-assessment based on more up-to-date information closer to the delivery time for the potential use of flexibility in 2028.

The assessment of the flexibility is shown in Table 7.

[redacted]

[redacted]

5.8 Confidence Table

The confidence we have in the assumptions and input data for this EJP are described in Table 8.

Table 8: Confidence table

Confidence Factor	Certainty	Comments
Load Forecast	High	Based on the Distribution Future Energy Scenarios published by the Company.
Existing Asset Condition	High	Based on Asset Management Health Index and Criticality Index.
Existing Operational Issues	Medium	No operational issues are known that endanger the replacement and reinforcement of the Harvard Lane primary.
Connections Activity	High	Based on information received from Connections and Commercial Contracts Management Teams.
Regional Stakeholder engagement	High	The local authorities have recently updated their commitment to achieve the zero net goals. They have set out goals and funding to reach these goals in the next years, which is incorporated in the forecast of the local DFES.
Flexible Market Viability	Medium	Based on Distribution Future Energy Scenarios, Common Evaluation Methodology tool and Flexibility Market Assessment carried out by our dedicated Team.
Funding Position	Medium	The reinforcement fund has been partially approved under the original EJP (50/SEPD/LRE/HARL) with £3.74m (base line submission). Outstanding amount to be funded by Uncertainty Mechanism scheme.

6 Summary of options considered

6.1 Summary of Options

The table below 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 section on the detailed option analysis.

Table 9: Summary of considered options

Option	Description	Advantages	Disadvantages	CBA Consideration and Result
1. Do Nothing	[redacted]	No cost	[redacted]	Not progressed to CBA
2. Load Transfer	Transferring Load from Harvard Lane to other geographically close Primary Substations	Minimum investment costs	[redacted]	Not progressed to CBA

3. Flexible Solution	Volume of flexibility needed in years 2026 and 2027 appears to be procurable based on the analysis.	Beneficial if used as an alternative to maintain security of supply whilst reinforcement works are ongoing.	Volume of flexibility needed beyond 2027 not sufficient to avoid reinforcement works.	Not progressed to CBA
4. Asset Replacement	Replacement of the three 22 kV circuits from Ealing 22 kV to the three 22/11 kV transformers plus replacement of the two of the three existing transformers	Increase in capacity to meet load growth forecast to 2045.	No voltage rationalisation. This solution does not meet load growth forecast until 2050. Ealing BSP Substation needs upgrade to meet load growth forecast to 2045.	Not progressed to CBA
5. Networks Reconfiguration	Harvard Lane to have 2x 80MVA 66/11kV transformers to replace the existing ones. Circuits upstream to be replaced as well, operating at 66kV.	Increase in capacity to meet load growth forecast to 2050. Voltage Rationalisation.	Timescales to implement the project do not meet the load growth in the short term (RIIO-ED2 price control period).	Not progressed to CBA
6. Networks Reconfiguration Combined with Flexibility **Preferred Option**	The scheme is the same as Option 5 with Flexibility procured until 2027 added to the scope of works.	Advantages listed in Option 5. Disadvantage mentioned in Option 5 is removed.	Expensive.	**Taken forward to CBA** Starting Year: 2025

7 Detailed option analysis

7.1 Option 1: Do Nothing

Estimated Cost: N/A

The Consumer Transformation scenario in 2040, the load at Harvard Lane Primary will be more than double compared to 2023 and the current network arrangement is not designed for such an increase. [redacted]

[redacted]

The combination of poor asset health and overloading leads to an increased risk in outages. This does translate into more customer minutes lost and therefore customer interruption costs. It also leads to an economic value loss of load and potentially reputational loss for SSEN.

As doing nothing does not resolve the overloading or asset health issues regarding the supply of Harvard Lane Primary, this option is rejected and has not progressed to the CBA.

7.2 Option 2: Load Transfer

Estimated Cost: N/A

As indicated in chapter 5.2, not only the load at Harvard Lane increases significantly but the load of all primary substation downstream Ealing BSP Substation. As can be seen in Figure 8, Harvard Lane, Dean Gardens and Brentford are supplied via Ealing 22 kV. [redacted] As the winter of the CT scenario is decisive in the short term and the summer in the long term, these two representative values are taken up again below. In the Consumer Transformation winter scenario in 2023 the aggregated group demand of the three primaries is roughly 50 MW. This summer group demand is forecasted to be 169 MW in 2050. Consequently, the group demand of Harvard Lane, Dean Gardens and Brentford will transition from category C to category D over the next decades and hence, it must adhere to stricter SCO guidelines. However, Figure 8 already indicates that the security of supply of the three primaries via the existing 40 MVA transformers will be endangered in an SCO case as the remaining capacity would only be 40 MVA.

It can be concluded that the current network arrangement and capacity at Primary as well as at BSP level does not allow for a feasible load transfer as this might trigger other or even more reinforcements and other locations.

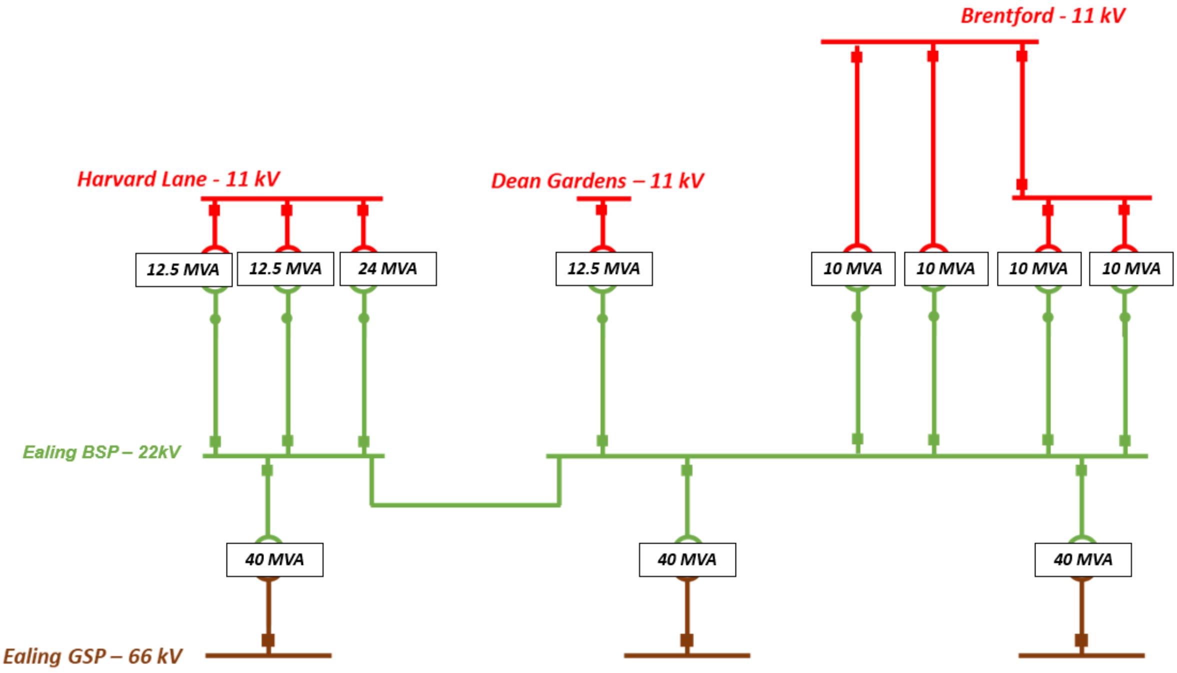

Figure 8: Current network arrangement – Harvard Lane, Dean Gardens and Brentford are all being supplied via Ealing 66 kV

As the proposal will not resolve the overloading [redacted] without further network reinforcement, this option has been rejected and has not progressed to CBA.

7.3 Option 3: Flexible Solution

Estimated Cost: N/A

According to Flexibility Viability Assessment, the volume of flexibility needed in years 2026 and 2027 appears to be procurable based on the analysis. However, flexible service requirements on current forecast of requirement and potential to procure is not recommended for 2028 due to uncertainty and not feasible in 2029. Flexibility offerings should be re-assessed closer to delivery date.

As flexibility availability is not certain beyond 2027, this will not improve security of supply in the short term, this option alone has been rejected and has not progressed to CBA.

7.4 Option 4: Existing Assets Replacement

Estimated Cost: N/A

Replacing the existing 22/11kV transformers at Harvard Lane Primary Substation and three 22kV circuits upstream to Ealing BSP Substation will increase the capacity of that substation only, meeting its load growth forecast until approximately 2045 (Figure 3, Figure 4 and Figure 5). However, this solution would only move the networks constraint upstream and shall not release capacity to the end users. This means Ealing BSP Substation transformers must be replaced as well due to the load growth expected for this group demand (Figure 9).

Nevertheless, this solution is not in line with the voltage rationalisation to be gradually implemented, eliminating the 22kV voltage level from our networks.

Therefore, this option has been rejected and has not progressed to CBA.

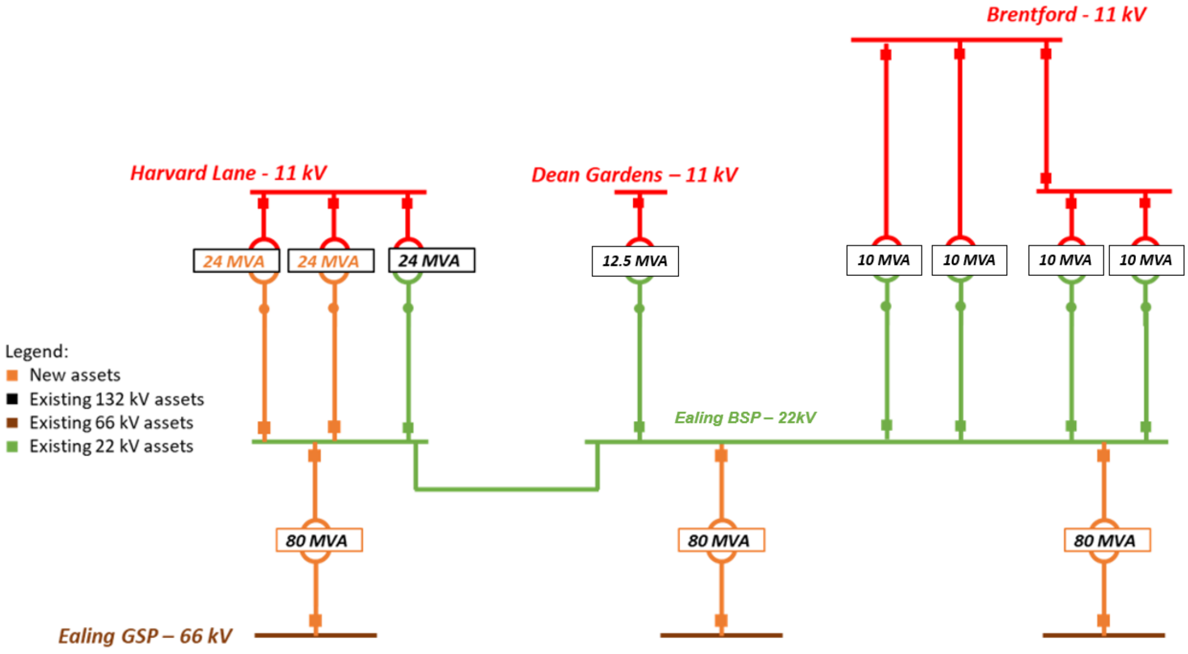

Figure 9: Option 4 – Existing Assets Replacement

7.5 Option 5: Networks Reconfiguration

[redacted]

Throughout this document, we emphasised the importance of assessing Harvard Lane Primary Substation in a holistic way. As such this option considers a network reconfiguration by disconnecting Harvard Lane Primary Substation from the 22 kV Ealing BSP and directly connect it to Ealing 66 kV GSP Substation, as shown in Figure 10.

Through by-passing the 22 kV busbar at Ealing BSP, the firm capacity at Harvard Lane will be increased from 25 MVA to 76 MVA, by 51 MVA and we will temporarily release capacity to Ealing 22 kV BSP Substation, since Harvard Lane will be diverted from it. [redacted] In addition to the network capacity increase, the solution also reduces the fault level in the whole area.

Furthermore, this option is an important milestone in the decommissioning of the whole 22 kV network below the Ealing GSP, towards voltage rationalisation of the networks.

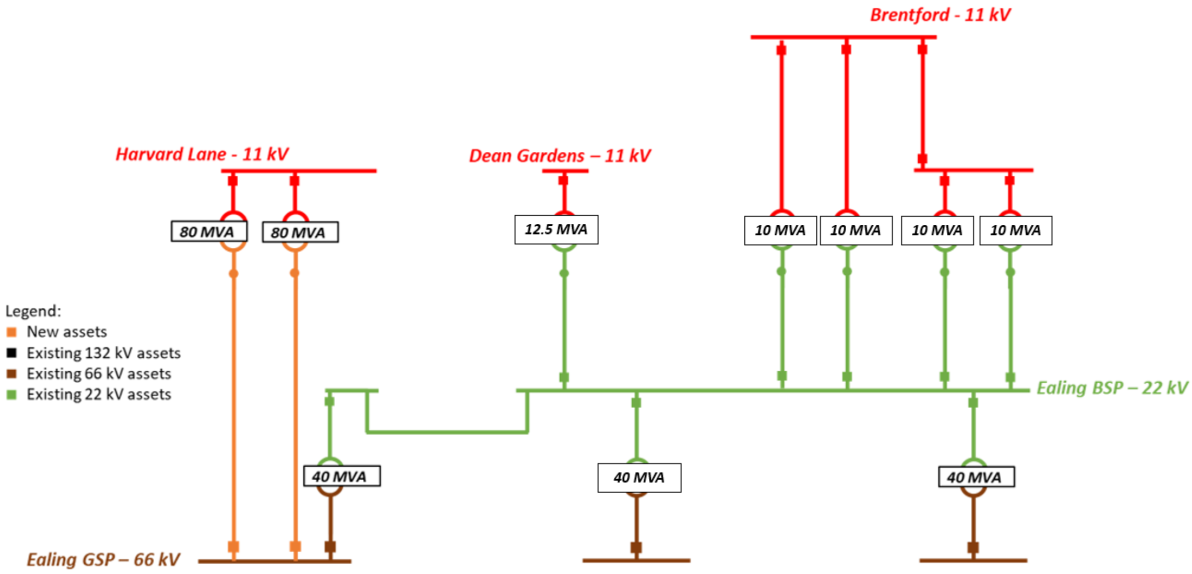

Figure 10: Option 5 - Direct Connection between Harvard Lane and Ealing GSP bypassing the 22 kV Ealing bus bar

The proposed solution will be achieved by bypassing the 22 kV Ealing BSP and directly connecting Harvard Lane to Ealing 66 kV GSP Substation. This option is realised through multiple replacements of assets. Firstly, three existing transformers in Harvard Lane will be decommissioned and instead, two new 66/11 kV transformers with a rating of 80 MVA will be installed. Like the transformers, the existing 22 kV cables between Harvard Lane and 22 kV Ealing BSP will be replaced by 132kV (operated at 66 kV) cables which will run from Harvard Lane to 66 kV Ealing GSP Substation. The suggested route for the 132kV (operated at 66kV) cables is depicted in Figure 11. To connect them to Ealing 66 kV GSP busbar, we need to install two new circuit breakers at the 66 kV Ealing GSP. However, within another parallel working scheme (PS006736), the existing switchboard at Ealing 66kV GSP Substation will be replaced through installation of new units and extended under this project. Refer to Table 10 for cost breakdown for this option.

Table 10 – Option 5 Cost Breakdown

Assets & Services	Unit	Cost per unit (£k/unit)	Amount of unit	Sum (£m)
1st circuit: 66kV UG Cable (Non-Pressurised)	km	[redacted]		
2nd circuit: 66kV UG Cable (Non-Pressurised)	km			
66kV – transformer - 80MVA CMR	each			
66kV – transformer - 80MVA CMR	each			
132kV CB (Air Insulated Busbars) (OD) (GM) – operated at 66 kV	each			
Total				

Harvard Lane 11kV busbar does not need to be replaced as it is already configured to connect the new proposed 80MVA 66/11kV three-winding transformers. The firm capacity of this substation shall be 76MVA, limited by the rating of the 11kV circuit breakers.

This option is a P2 compliant solution in the long-term, in line with the overall strategy and creates operational flexibility. However, it is not deliverable in the time scale by which the exceedance occurs i.e. 2025, as seen in Figure 3, Figure 4 and Figure 5.

Therefore, this option has not progressed to the CBA. Deferral using flexibility is discussed for this scope of works under the next proposed offer following this report.

Figure 11: Suggested Cable Route Between Ealing GSP and Harvard Lane Primary Substation

7.6 Option 6: Networks Reconfiguration Combined with Flexibility

Estimated Cost: Refer to Table 2

Under this option flexibility is used to defer Option 5 to make its delivery feasible since it is the preferred one from a technical, regulatory, and strategical point of view. This increases the network capacity significantly, enables more operational flexibility and it is an important milestone towards voltage rationalisation for the entire Ealing group demand. For this assessment the Common Evaluation Methodology (CEM) is used. The cost breakdown for this option can be seen in Table 2.

Firstly, the exceedance of the network capacity will be assessed. The exceedance of the network capacity describes the power delta with which the network capacity is exceeded at peak load. In this case, the exceedance is calculated based on the FCO requirements since it was established in section 5.2 that the group demand of Harvard Lane is subcategorised into group C. The amount by which the required FCO demand exceeds the current network capacity is displayed in Table 11. The table below indicates that [redacted] the magnitude of the exceedance will grow over time.

[redacted]

[redacted]. The calculated necessary flexibility in scope and time for the Consumer Transformation (CT) scenario is shown in Table 12.

[redacted]

The tables above provide the necessary input data for the CEM tool to calculate the benefit and possibility of using flexibility to defer investments. [redacted]

Under consideration of all the input data, the optimal deferral period is shown in Figure 12. The results of the CEM-tool indicate that the optimal solution would be to defer the investment by six years into 2031 in the Consumer Transformation scenario, in case that this flexibility would be available in all five years.

[redacted]

The assessment of the flexibility market viability in section 5.7 describes that a maximum of 2.2 MW of flexibility is available. [redacted] A re-assessment of the flexibility amount will be executed closer to delivery date.

As the flexibility option provides a benefit compared to the grid reinforcement in 2025, this option has progressed to CBA, which would allow for an investment deferral of three years.

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8 Cost Benefit Analysis (CBA)

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 paper.

Ofgem's RIIO-ED2 standard CBA template was used to assess costs and benefits of the conventional options for each circuit individually.

Table 13 provides an overview of the net present value of the only viable option, i.e. Option 6 that was considered during the CBA assessment.

[redacted]

9 Deliverability and Risk

The specific considerations for deliverability based on the scope of this EJP are detailed below:

- Low risk on cable route - The proposed new 66 kV cable route from Ealing GSP Substation to Harvard Lane Primary Substation follows the existing cable route of the 22 kV cables. Therefore, the three existing 22 kV cables need to be decommissioned and two new 66 kV cables need to be commissioned.
- In ED1, we have delivered several EHV cable projects and transformer installation projects in house. The experience and skills acquired from these projects lay the foundation for the delivery of the cable installation and transformer replacement.
- Some sections of the existing 22 kV cables are oil-filled. Oil management is required which poses a low risk for this investment.
- High risk on switchgear installations – The current EJP has high dependencies with other EJPs and working schemes. Currently, it is planned that the whole switch board at the Ealing 66 kV bus bar will be replaced. All old oil circuit breakers will be replaced by newer GIS installations. Therefore, the realisation of this EJP may depends on the reinforcement and renewal of the existing 66 kV Ealing switching board.
- Medium to high risk regarding installation of additional 66/132 kV circuit breakers - There is limited space at Ealing 66 kV substation. There are currently renewal plans for Ealing 66 kV substation in place.
- Using flexibility services can potentially defer the reinforcement for three years based on the output of the CEM CBA model under the CT scenario. However, the amount of flexibility depends on location-specific resources and market interests. Uncertainties associated with the flexibility market can be addressed through market testing nearer the time and via relevant uncertainty mechanisms.

10 Outlook to 2050

While assessing the situation at Harvard Lane Primary Substation, the whole grid topology from the GSP level downwards to the primary substations has been considered. By choosing a holistic approach, we were able to design an option which will be compliant until 2050 and beyond. The preferred solution delivers the best economic outcome for the customers while ensuring a long-term compliant solution as well as a congestion free operation. Additionally, the option increases the supply capacity at Harvard Lane while it simultaneously releases capacity for increasing the security of supply at the neighbouring primaries. Furthermore, the option is aligned with the overall strategy of steadily phase out the 22 kV assets from our networks.

To summarise, the preferred option ensures a long-term compliant solution which ensures security of supply for our customers and helps to deliver on the net-zero mission.

11 Conclusion and Recommendation

For the planning and realisation of a demand-oriented power grid, a continuously updated network plan is required, adapting to changing conditions. In the previous EJP, it was already determined that the network capacity at the Harvard Lane Primary is insufficient for the upcoming load increase. Within the framework of this EJP, the scope of the previous EJP for Harvard Lane is re-evaluated, and the scope of investigation is extended until 2050. The aim of this EJP is, firstly, to determine the required investment volume for the RIIO-ED2 period, and secondly, to design a demand-oriented target power grid until at least 2035.

Consequently, a range of options for the design Harvard Lane are examined. The most promising, strategical, economically sustainable, and technically superior option that emerged is Option 6 – Networks Reconfiguration Combiner with Flexibility. The main driver of the option is thermal overloading. However, throughout the EJP we emphasise the need to challenge not only the thermal overloading issues at Harvard Lane but also the upstream thermal overloading issues since a sole reinforcement of the primary without reinforcement of the BSP or respectively GSP would not provide any additional headroom. Therefore, an option is created which tackles issues at the primary as well as at the BSP level. Option 6 combines using flexibility as well as rearranging the network. While the capacity increase is already needed as early as 2025, the utilisation of flexibility allows us to defer the needed investment into 2028 which simultaneously creates a societal benefit. Once the project is complete, Harvard Lane will no longer be supplied via the Ealing 22 kV BSP but directly from the 66 kV GSP. The network re-arrangement increases the firm capacity of Harvard Lane to 76 MVA.

12 References

The documents detailed in Table 12.1 - Scottish and Southern Electricity Networks Documents, Table 12.2 – External Documents, and Table 12.3 – Miscellaneous Documents, should be used in conjunction with this document.

Table 12.1 - Scottish and Southern Electricity Networks Documents

Reference	Title

Table 12.2 – External Documents

Reference	Title

Table 12.3 – Miscellaneous Documents

Title

13 Revision History

No	Overview of Amendments	Previous Document	Revision	Authorisation
01				
02				

Appendix A Definitions and Abbreviations

Table 0.1 – 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

Appendix B Sensitivity Analysis

For each investment proposed in this EJP, we have reviewed the annual maximum demand figures under all DFES scenarios out to 2050. Based on this assessment, we will place this investment into one of the categories from Table 2.

Table 2

Category	Description	Applies to this EJP?
A	Schemes where the chosen investment size is large enough to meet peak demand/generation under all net zero compliant scenarios to 2050	✓
B	Schemes where we would require further future reinforcement of the particular asset(s) being proposed under a more aggressive scenario to 2050	
C	Schemes where the proposed investment is not required under any scenario to 2050 (if any)	
D	Schemes where investment can be deferred until a later date under some scenarios i.e. ST scenario indicates no investment needed until 2030	

Justification for Categorisation:

The demand load growth at Harvard Lane for all Distribution Future Energy Scenarios and seasons is illustrated in Figure 3, Figure 4 and Figure 5. The current firm capacity of this Primary Substation will be exceeded during RIIO-ED2 price control period as a worst-case scenario, during Winter Season (Figure 3), with flexibility procured while the reinforcement works are undertaken. Once the proposed works are complete, Harvard Lane Primary Substation shall have a firm capacity of 76MVA, sufficient to meet peak demand beyond 2050, for all scenarios and seasons.