COWLEY LOCAL MAIN & ROSE HILL NETWORK REINFORCEMENT ENGINEERING JUSTIFICATION PAPER

Scottish & Southern Electricity Networks

CONTENTS

1 Executive Summary

1.1 Summary

Our proposed investment in the Cowley Local Main and Cowley BSP 132kV network will deliver P2/8 compliance [redacted] during RIIO-ED2 and the start of ED3.

[redacted] The issues occur under Consumer Transformation (CT) of the Distributed Future Energy Scenarios (DFES) published in 2022. Multiple investigations already showed a need for reinforcements in Cowley BSP, in particular the technical report (TR) EXM622-3, which was accepted and then cancelled by the customer.

This Engineering Justification Paper (EJP) considers a range of options to address the P2/8 compliance issues, setting out the options that have been considered and rejected prior to the Cost Benefit Analysis (CBA), and the short-list of those options included within the analysis, with a rationale for including or excluding each option.

An overview of the considered options, the main drivers for the decision to progress or not, and the results of considered options in the CBA are provided in Table 1.

Table 1 – Executive Options Summary

Option	Description	CBA Consideration and Result
1. Do nothing	[redacted]	Not progressed to CBA, [redacted]
2. Load Transfer followed by 132 kV enhancements	This option addresses load-related overloading issues by transferring demand to another BSP.	Not progressed to CBA. This option costs more and does not create additional capacity in the wider networks.
3. 132 kV enhancements	Add a third transformer at Cowley Local Main Busbar. Add a 3rd 132 kV circuit from Cowley BSP to Cowley GSP.	**Progressed to CBA** [redacted]
4. Flexibility followed by 132 kV enhancements **Preferred Option**	Flexible service contracts to reduce peak demand and defer capital investment.	Progressed to CBA. [redacted]

The recommended option is Option 4. This delivers an uplift in network capacity providing 90MVA to Cowley Local Main and additional reinforcement in Rose Hill Primary which meets the needs of our

customers. The capacity of the Cowley Local BSP is increased by 201MVA by a 3rd 132kV circuit between Cowley Local BSP and Cowley GSP.

The asset and cost breakdown of this solution is shown in Table 2.

Table 2 – Project Scope Breakdown

Assets	Volume / unit	Cost
132kV 201/161/161MVA cable	[redacted]	
132/33kV 90MVA Transformer		
132kV CB (Gas Insulated Busbars) (ID) (GM)		
33kV CB (Gas Insulated Busbars) (ID) (GM)		
11kV CB		
33kV Cable 53MVA		
33/11 kV 40MVA Transformer		
Land purchase		
Flexibility		
Total		

The investments are planned for different points in time, with deferral.

- Rose Hill:
  - 11x 11kV circuit breakers; works starting 2025, finishing 2027;
  - 2x 20/40MVA transformer upgrades; works starting 2027, finishing 2029. Includes 2 years deferral;
  - Rose Hill – Cowley Local 33kV dual circuit 3.15km upgrade to a rating of 53/46.9/46.9MVA (winter/spring and autumn/summer seasonal ratings); works starting 2028. Includes 2 years deferral;
- Cowley Local Main:
  - 1x 90MVA transformer,1x 33kV CB, land purchase; works starting 2025, finishing 2028. No deferral;
- Cowley Local GSP;
  - Cowley BSP – Cowley Local 132kV single-circuit 2.5 km installation; works starting 2025, finishing 2028. 1 year deferral;
  - Cowley Local 13x 132kV circuit breakers; works starting 2025, finishing 2028. No deferral;

All price bases are 20/21, and the discount rate for the 45-year Net Present Value (NPV) is 3%. [redacted]

2 Investment Summary Table

Table 3 provides a high level summary of the key investment information relevant to this Engineering Justification Paper (EJP).

All price bases are 20/21, and the discount rate for the 45-year Net Present Value (NPV) is 3%. [redacted]

Table 3 Investment Summary Table

Name of Scheme/Programme	Cowley Local Main and Cowley BSP 132kV network	
Primary Investment Driver	P2/8 Compliance Load-related	
Scheme reference/ mechanism or category	EJP/SEPD/COWL/COLO/001	
Output reference/type	**2027** 11 kV CB Gas insulated Busbar; Land purchase Flexibility **2028** 132 kV UG Cable (Non Pressurised); 132 kV CB Gas insulated Busbar 33 kV CB Gas insulated Circuit Breaker 132/33 kV 90 MVA Transformer Flexibility **2029** 33/11 kV 40 MVA Transformer Flexibility **2030** Flexibility **2031** 33 kV UG Cable (Non Pressurised);	
Cost	[redacted]	
Delivery Year	Assets in 2027, 2028, 2029, 2031	
Reporting Table(s)	CV1: Primary reinforcement	
Outputs in RIIO ED2 Business Plan		
Spend Apportionment	**ED2**	**ED3+**
	[redacted]	[redacted]

MVA released	MVA released by assets: (winter capacities shown) additional 90MVA TX at Cowley Local Main; releases 90MVA. 3rd 132kV Cowley-Cowley Local circuit, releases 201MVA.	; 2x 20MVA TXs at ROSH to be replaced with 2x 40MVA units. N-1 capacity released 20MVA. : 50MVA cable to be installed, replacing 28.7MVA capacity; releases 21.3MVA.

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	Appendix A contains an overview of all used abbreviations and their definitions.

4 Introduction

[redacted]

The Cowley Local BSP feeds seven primaries: Cowley Local, Pressed Steel Cowley, Rose Hill, Union Street, Wallingford, Kennington and Berinsfield. Cowley Local BSP itself is fed by Cowley GSP in the Southern Electric Power Distribution (SEPD) license area.

The proposed upgrades are based on the results of the PSSe based power system analysis and a CBA that is carried out on the progressed options.

Section 5 of this EJP describes our proposed load related investment plan for the reinforcement in the Cowley Local Main network in RIIO-ED2. The primary driver considered within this EJP is circuit thermal overloading triggered by the demand forecasts. This EJP provides background information for the proposed scheme explaining the existing network arrangements, the load growth forecasts through the DFES and setting out the need for this project. This section of the EJP additionally describes the network studies undertaken, detailing the results which justify the need for the proposed investment.

Section 6 provides an overview of the options and identifies the most appropriate option as the proposed solution to address the network issues. 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 summarises the results detailed in section 7 on the optioneering process and section 8 on the cost-benefit analysis of each option.

Section 7 provides a list of the options considered through the optioneering process to establish the most economical and efficient solution. Each option is described in detail, with the EJP setting out the justification for the viable options taken forward to the Cost Benefit Analysis.

Section 8 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.

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

Section 10 addresses the strategic aspect of the investments and further needed actions for operating a congestion free grid until at least 2050.

Section 11 concludes the EJP and provides a summary of the 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 risks and delivering options.

5 Background Information

The Cowley Local BSP consists of two supply groups. The first group, Cowley Main, consists of four primaries (Cowley Local, Pressed Steel Cowley, Rose Hill, Union Street) and is supplied by the Cowley Local Main 33kV Busbar (COLO-CM). The other supply group, Cowley Reserve, consists of the remaining three primaries (Wallingford, Kennington, Berinsfield) and is supplied by the 33kV reserve Busbar (COLO-CR). Both busbars are connected via two 132/33kV 90MVA transformers which are directly connected to the Cowley GSP via two 132kV Overhead Line (OHL) circuits.

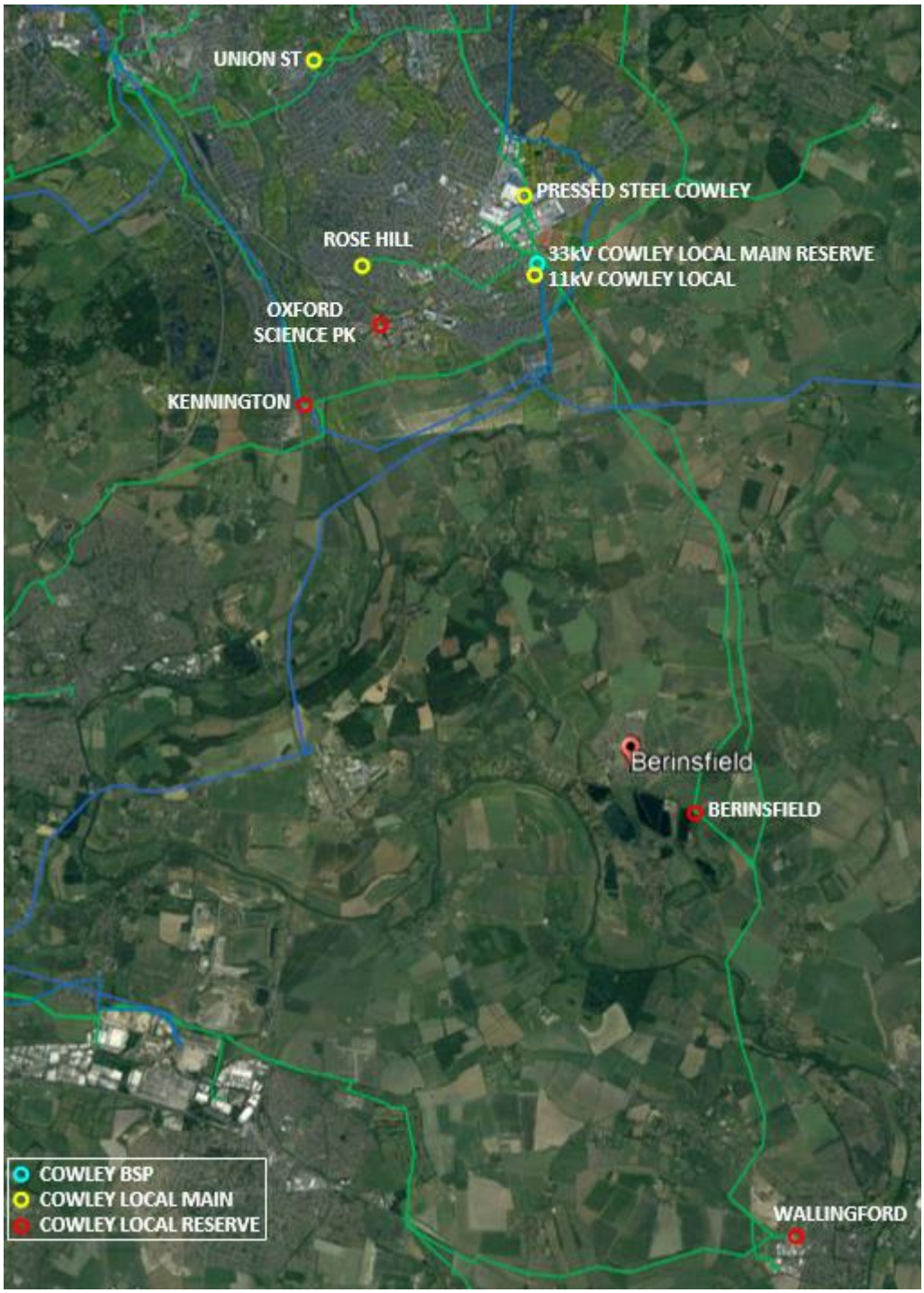


Figure 1: Geographic view at the Cowley BSP (green 33kV circuits, blue 132kV circuits)

5.1 Existing Network Arrangements

Figure 2 shows the schematic of the current Cowley Local BSP network. Cowley Local BSP is connected to Cowley GSP via a dual 132kV circuit with a winter rating of 201MVA and a summer rating of 161MVA. Four 90MVA 132/33kV transformers feed two 33kV busbars (COLO-CM, COLO-CR).

The Cowley Local BSP has two 33kV interconnections to Headington BSP and one 33kV connection to Drayton BSP and Oxford BSP.

Cowley Local Primary is supplied by 3 transformers with a rating of 7.5/15MVA. These have been triggered to change due to a customer connection and the full scope of these works is defined within the technical report (TR) EVV862 and will be replace the 7.5/15MVA transformers with 20/40MVA rated transformers, they are not in the scope of this EJP.

Union Street is connected via a dual cable circuit (7.34km, 28.7MVA winter cyclic rating) to COLO-CM and with a single circuit to Oxford BSP. Each transformer has a capacity of 14.1MVA.

Rose Hill is connected via a dual cable circuit (3.15km, 28.7MVA winter cyclic rating) to COLO-CM. Each transformer has a capacity of 20MVA.

In 2024/2025 Oxford Science Park Primary will be commissioned based on accepted connection project EYT747. This primary is directly connected to COLO-CR and offers another connection to Osney BSP.

The Primaries which are connected to COLO-CR are not in the scope of this EJP, as the Cowley Local Reserve 132/33kV transformers do not exceed capacity in ED2, and the primary locations are not predicted to have significant growth. However, these were considered in the optioneering (load shift scenarios in 7.2) as well as in the demand forecast.

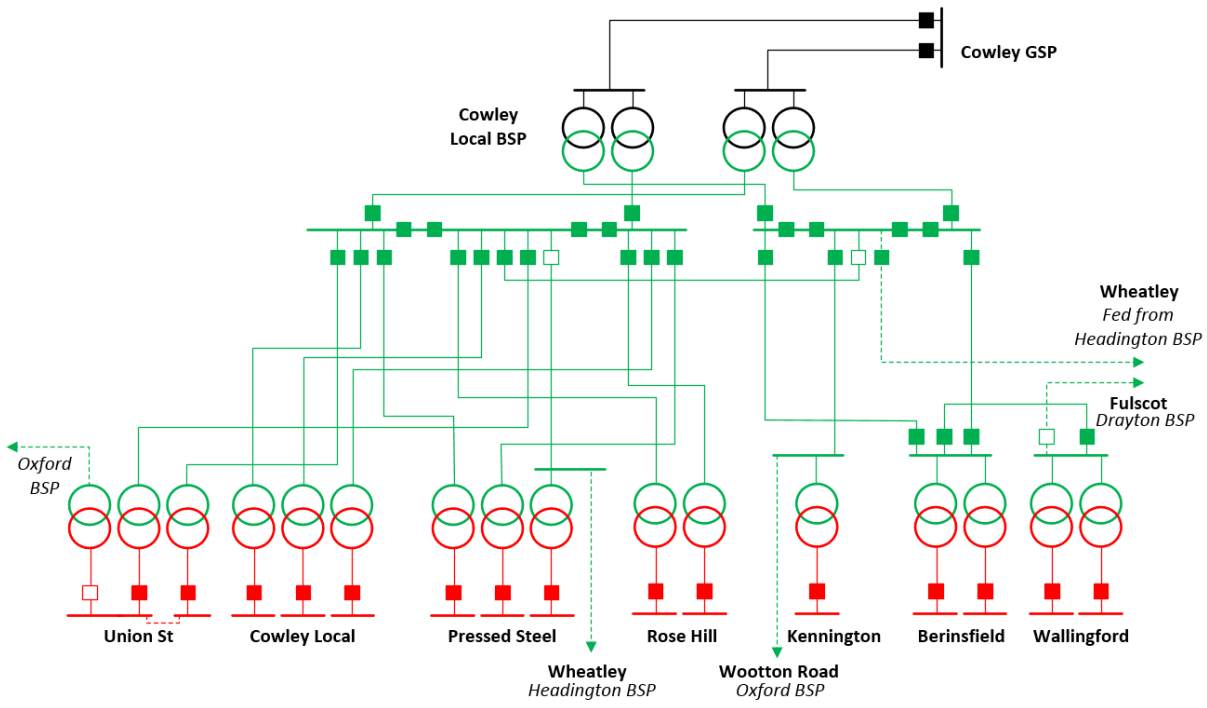


Figure 2: Schematic of the Cowley BSP network.

5.2 Load Forecast for Cowley BSP

To understand future pathways for demand and generation, we have carried out scenario studies – the Distribution future energy scenario, DFES. The basis for this work is National Grid's Future Energy Scenarios (FES) 2022. 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 2023 and 2050 through engagement with the local authorities, local enterprise partnerships (LEPs), devolved governments, community energy groups and other stakeholders.

Based on the stakeholder engagement feedback, we have chosen Consumer Transformation (CT) 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.

Cowley Local Main (COLO-CM)

Figure 3 shows the demand growth up to 2050 at the Cowley Local Main busbar that supplies Cowley Local, Rose Hill, Union Street and Pressed Steel Cowley. Two 90MVA transformers supply the busbar. The worst case is an outage of one transformer. Therefore, the nameplate FCO capacity is 90MVA, though these transformers are non-CER transformers and can be overloaded to up to 117MVA. [redacted]

This is triggered by additional customer demand as shown in the below table. Note that the below graph includes accepted projects in addition to the DFES.

[redacted]

The proposed reinforcement on Option 3 will increase the available capacity at Cowley Main to 180MVA FCO capacity (nameplate rating), and as such the firm capacity at Cowley Main GSP will not be exceeded until 2045, as shown in figure 4.

Cowley Local Reserve (COLO-R)

Figure 5 shows the demand growth up to 2050 at the Cowley Local Reserve busbar that supplies Berinsfield, Kennington, Wallingford and the proposed Oxford Science Park. Two 90MVA transformers supply the busbar. The worst case is an outage of one transformer. Therefore, the FCO nameplate capacity is 90MVA, though these transformers can be overloaded to 117MVA. Through the demand growth, the rating is first exceeded in 2038 in the Winter CT scenario. This is triggered by additional customer demand. Note that the below graph includes accepted projects in addition to the DFES. A 50MVA Battery energy storage system (BESS) connection, has been added to the below numbers with 85% diversity. The likely impact of this BESS is likely to be much reduced; and if we consider the emergency rating of the transformer, will not exceed during ED2.

[redacted]

Cowley Local Primary

Figure 4 shows the demand growth of Cowley Local. [redacted] As shown, the capacity is sufficient for 2050 and no longer needs to be addressed.

[redacted]

Rose Hill Primary

Figure 5 shows the demand growth of Rose Hill. Rose Hill is supplied by two transformers with a nameplate rating of 20MVA, though an overload rating of 26MVA is available. [redacted] The cable circuits from Rose Hill to Cowley Local Main have a winter

rating of 28.7MVA, and spring/autumn rating of 25.4MVA. [redacted]

[redacted]

The proposed reinforcement on Option 3 will increase the available capacity on the Rose Hill primary transformers to 40MVA FCO capacity, and as such the rating at Rose Hill would not be exceeded until 2035, as shown in figure 6.

[redacted]

132 kV Circuits Cowley BSP – Cowley GSP

Figure 7 shows the demand growth for the Cowley BSP that is supplied by two 132kV circuits with a winter cyclic rating of 201MVA.

[redacted]

Figure 8 shows the above forecast data in Figure 7 against the proposed new capacity, considering the installation of a 3rd 132kV circuit between Cowley and Cowley Local. Note that there is no FCO requirement for a 4th circuit until beyond 2050; this may change should there be additional large customer requests.

5.2.1 Thermal Load Analysis

[redacted]

[redacted]

High demand – low generation CT scenarios:

The analysis shows that within the ED2 period, there is an overload of the 33/11kV transformer in Rose Hill as well as with the 132/33kV transformer in Cowley Local Main in the event of an FCO.

[redacted]

Not in the scope of this EJP but needs to be addressed in ED3:

[redacted] This is to be investigated in a separate EJP.

[redacted] The single transformer must be replaced. This is resolved in a separate EJP.

[redacted]

5.2.2 Fault Level Study

A 3-phase fault analysis was carried out to examine the effects of the expansion activities on the fault currents. The fault currents for the present and future proposed network are shown in Table 6 and Table 7 for the expansion scheme (Option 3).

There is a fault level issue at the 11kV CBs in Rose Hill primary. In the case of a 132kV enhancement, the circuit breakers at Rose Hill must be replaced accordingly. These have a fault rating of 13.1/34.4kA (E1L5, E1S0, E1T0, E2L5, E2T0, E2W0, E3L5, E4L5, E5L5, E6L5, E7L5, E8L5) and must be replaced with a rating of at least 25/62.5kA rated circuit breakers.

[redacted]

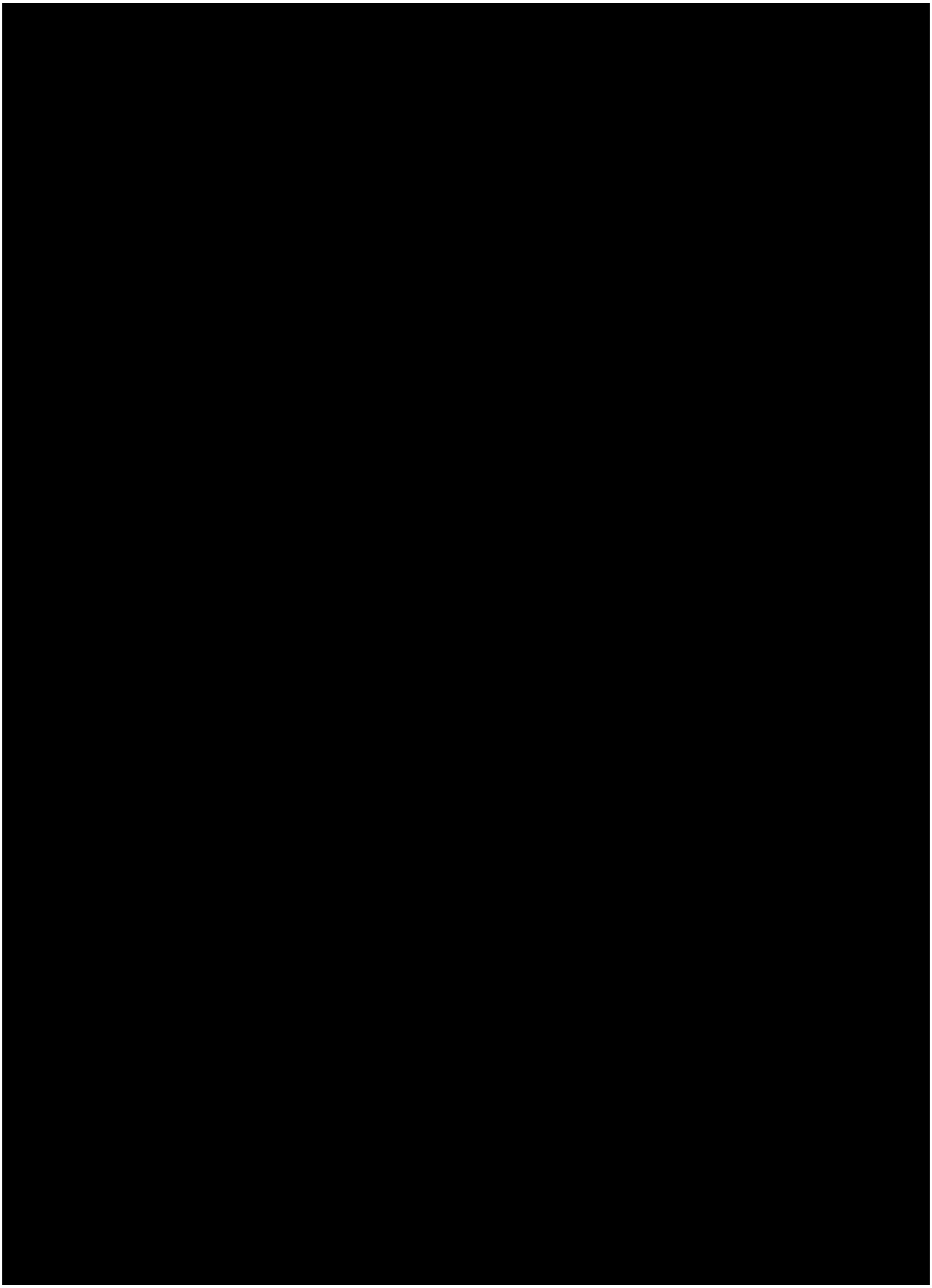
[redacted]

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 period. Accordingly, the target network and its network elements will be studied until 2035.

[redacted] gives an overview of all existing assets that have been considered within the Health Index assessment of the network. In addition to the current HI values, the table also contains the values for the years 2028, the end of the ED2 period, and 2035. The 3x 33/11kV transformers at Cowley Local will be replaced on a separate scheme. [redacted]

[redacted]



[redacted]

5.4 Existing Operational Issues

Cowley Local BSP: [redacted] The CEM tool indicates that a flexibility deferral of one year, with works completing in 2028, is preferred, as this will allow us to remain compliant while reinforcement works complete.

Cowley Local Main transformers: [redacted] Reinforcement of installing 3rd BSP transformer by 2028 is proposed in this work.

Cowley Local Reserve transformers: The 2x 90MVA transformers feeding Cowley Reserve busbars are P2/8 compliant until 2042 when considering overload rating.

Rose Hill Primary transformers: [redacted] The CEM tool indicates that a flexibility deferral of two years, with works completing in 2029, is preferred.

[redacted] The CEM tool indicates that a flexibility deferral of one year, with works completing in 2030, is preferred.

Rose Hill 11kV busbar: [redacted] As current guidance dictates that the full cost of this board replacement goes to the triggering customer, recent applications to connect at Rose Hill have declined the option to bear this significant cost. This will result in the additional capacity being created at Rose Hill being unavailable to customers looking to connect. It is further proposed in Option 3 that we trigger these upgrades in order to facilitate capacity availability.

Additionally, the fault levels identified in 5.2.2. show that the 11kV circuit breakers at Rose Hill will require upgrade as part of the overall Cowley Local reinforcement.

[redacted] Although the availability of flexible solutions provides us with an economic benefit and a more realistic reinforcement timeframe, the required works

are complex. In light of this, it will be advantageous to all concerned parties to begin works as soon as possible.

Cowley Local Primary has already been addressed with a proposed reinforcement of the existing transformers as part of a separate project.

[redacted] The CEM tool indicates that a flexible solution is preferred here.

There is a longer-term requirement for reinforcements in the Cowley Reserve GSP, but this is not required until the ED3 period.

The network analysis has been performed using CT winter scenario loading, as this is assumed to hold the best balance between a conservative network assessment and a realistic loading situation.

5.5 Regional Stakeholder Engagement and Whole systems analysis Summary

(Primaries: Cowley Local, Pressed Steel Cowley, Rose Hill, Union Street, Wheatley Farm Battery Storage, Berinsfield, Kennington, Wallingford, Burcot Farm PV, and Oxford Science Park)

Regional stakeholder engagement and whole systems analysis summary

Cowley Local Main BSP and Reserve BSP cover South Oxford, St Clements, parts of South Oxfordshire and parts of Vale of White Horse. These areas are a mixture of residential housing, agriculture, industry, and business.

SSEN has strong working relationships with stakeholders across Oxfordshire through various innovation projects and trials. Project LEO and TRANSITION where collaborative, cross sector, multi-year projects that involved coordination with local councils, the Low Carbon Hub, University of Oxford, Oxford Brookes University, and commercial partners.

Oxfordshire County Council was also one of three councils with whom SSEN partnered through the RESOP Project to trial LAEP+, an innovative local area energy planning tool created by Advanced Infrastructure. As a co-founder of the International Community for Local Smart Grids, SSEN collaborates with and feeds into research led by the University of Oxford, which is centred on local pathways to net zero. Oxfordshire County Council has also received Zero Emissions Bus Regional Area funding, which funds 159 electric buses in Oxfordshire. It was also awarded LEVI funding of £3.6mil to triple public electric vehicle charging provision by 2025.

Oxford City Council, South Oxfordshire Council and Vale of White Horse District Council have been both onboarded to LENZA, SSEN's GIS tool for local area energy planning – which built on the work of LAEP+. SSEN holds regular meetings with the aforementioned local authorities to discuss their local area energy planning as well as joint meetings with Connections to discuss immediate plans.

We also participate in the ZCOP (Zero Carbon Oxfordshire Partnership) meetings and workshops, where grid constraints are frequently mentioned. The project is a partnership of Oxford City Council, ERM, Oxfordshire Greentech, BMC, ARC Oxford and Unipart Logistics. It aims to increase capacity and capability within local organisations to decarbonise. Oxford City Council has a net zero carbon emissions goal by 2040.

Vale of White Horse District Council has a Climate Action Plan for 2022-2024, in which it sets out how it will achieve its target of becoming carbon neutral by 2030, which is a 75 per cent reduction in emissions by 2025. Actions include installing EV charge points in council depots and other locations to meet the needs of the council's vehicle fleet, as well as a plan to install public EV charging points.

South Oxfordshire District Council has set a target to become carbon neutral by 2030. To achieve this aim, the Council has secured funding for solar PV panels and a heat pump at its art centre. Oxfordshire County Council adopted their Local Transport and Connectivity Plan in 2022, which

states an aim to have a net zero transport network by 2040. In support of this target, the Council's ambitious Electric Vehicle Infrastructure Strategy lays the groundwork to accommodate the projected growth in EVs over the next several years. One of several targets outlined in this strategy is to convert 7.5% of local authority owned car park space to EV charge points by 2025. The Council's Park and Charge project, part of the Oxfordshire Electric Vehicle Infrastructure Strategy, is funding the rollout of charge points across the county to achieve this target

There are significant generation schemes either fed currently through Cowley, or intending to connect in the near future, including:

[redacted]

There is also significant demand intending to connect in the near future, including:

[redacted]

5.6 Flexible Market Viability

Viability of utilising flexibility service to defer the reinforcement is investigated.

It has been concluded that some aspects of the reinforcement will benefit from flexibility services, and the results from the Flexibility Team indicate that flexibility is available.

- Rose Hill primary;
  - 11x 11 kV circuit breakers; no deferral benefit;
  - 2x 20/40 MVA transformer upgrades; benefit of 2 years deferral;
  - Rose Hill – Cowley Local 33kV dual circuit 3.15 km upgrade; benefit of 2 years deferral;
- Cowley Local Main:
  - 1x 90 MVA transformer,1x 33 kV CB, land purchase; no deferral benefit;
- Cowley Local GSP;
  - Cowley BSP – Cowley Local 132 kV single-circuit 2.5 km installation; benefit of 1 year deferral;
  - Cowley Local 13x 132 kV circuit breakers; no deferral benefit;

[redacted]

[redacted]

Additional comments:

[redacted]

5.7 Confidence Table

The confidence we have in the assumptions and input data for this EJP is described in Table 9.

Table 9: Confidence Table

Confidence Factor	Certainty	Comments
Load Forecast	High	[redacted]
Existing Asset Condition	High	Up-to-date asset health of CBs and transformers are available.
[redacted]	[redacted]	[redacted]
Connections Activity	High	New primary substation, Oxford Science Park, is to be built following under acceptance of connection project ETY747. Reinforcements at Osney 132kV - 119-SEPD-LRE-OXFORD
Regional Stakeholder engagement	High	The local authorities have recently updated their commitment to achieve the net zero goals. They have set out goals and funding to reach these goals in the coming years, which is incorporated in the forecast of the local DFES.
Flexible market Viability	High	Flexibility to be used for some aspects of reinforcement, see section 5.6.
Funding Position	High	As described in this EJP, there is high certainty the region will be overloaded within the ED2 and ED3 period. [redacted]

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 10: Summary of considered options

Option	Description	Advantages	Disadvantages	CBA Consideration and Result
1. Do Nothing	Monitoring loading condition circuits in the network.	No capital cost incurred. Small impact on the existing network. Short delivery time.	[redacted]. Large CI/CML penalty.	Considered but not progressed to CBA
2. Load transfer followed by 132kV enhancements	Load transfer of several Primaries to defer the 132 kV reinforcement	Deferral through more FCO Capacity leads to lower NPV.	Higher investment costs. [redacted]	Considered but not progressed to CBA
3. 132kV enhancements	Installing a third 33/132kV Transformer at COLO-M. Add third 132 kV circuit from Cowley BSP to Cowley GSP. Reinforce 33/11kV Assets at Rose Hill	Increasing network capacity.	Land purchase	**Taken forward to CBA**
4. Flexible solution followed by 132kV reinforcements	Flexibility is deemed viable for Rose Hill transformer and circuit upgrades, and Cowley BSP 132kV circuit works	The benefit of deferring investment	Additional flexibility costs	**Taken forward to CBA**

6.2 Options comparison table – C0a

7 Detailed option analysis

7.1 Option 1: Do Nothing

Estimated Cost: N/A

The grid is not capable of FCO compliance during ED2 as the 33 kV and 132 kV assets are heavily overloaded. In the case of an FCO in a high-demand scenario, the 33 kV Transformers at Rose Hill and 132/33 kV transformers at Cowley BSP will be overloaded which cannot be prevented by minor network rearrangements.

As this option is unable to resolve overload and would result in poorer guaranteed standard performance and customer interruptions, it is rejected and is not taken forward into the CBA.

7.2 Option 2: Load Shift followed by 132kV reinforcements

There are several ways to offload the Cowley Local Main busbar and defer the 132 kV investment. The most straightforward approach is to transfer additional loads to the other busbar (COLO-CR). Although the transformers at COLO-CR offer a nameplate FCO capacity of 90 MVA in 2023, multiple new customers and the rising demand prevent any load shifts, it is more likely that reinforcements will be necessary at the COLO-CR busbar in the near future. The available capacity for a load shift is shown in Table 11.

Although a load shift within the BSP is not possible, the load of outer primaries can be moved to other BSPs. A possible solution is a load shift from Rose Hill to Oxford BSP. Table 12 shows the load of Rose Hill. The load shift of Rose Hill would defer the needed enhancements in Cowley Local Main by six years, which can result in a better NPV, therefore it should be investigated.

Table 12: Peak demand [MVA] Rose Hill

Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
DFES Load	17	22	28	28	29	31	32	33	35	37	39	41

The circuits from Rose Hill to Cowley Local Main need to be reinforced (3.15 km) as shown in Section 5.2. Instead of reinforcement, a new circuit to Oxford BSP (approx. 5 km) offers an economical load shift. A route is shown in Figure 6, which crosses a river and a railway.

Figure 6: Load Shift Rose Hill to Osney BSP, new cable route

Although this may result in a better NVP, there are limited capacities at Oxford BSP. The EJP 119-SEPD-LRE-OXFORD investigated a reinforcement of the 132 kV circuits and assets at Oxford. The capacity will be increased in 2031 from 2x90 MVA to 2x90 + 1x 120 MVA, which results in a new FCO capacity of 180 MVA in 2031. Flexibility will be used until 2030 to prevent thermal overloading. Table 13 shows the available capacity at Oxford BSP with the latest DFES. As shown, there is no capacity left for a load transfer. A load shift of Rose Hill is not a suitable option, nor is a transfer of load from Union Street Primary to Oxford BSP.

[redacted]

Another possibility is to transfer load from Union Street primary substation to Headington BSP. Table 14 shows the peak demand of Union Street Primary.

Table 14: Peak demand [MVA] Union Street

Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
DFES Load	15	17	20	20	22	22	23	23	24	25	25	26

A possible route is shown in Figure 7 with a length of approx. 3.3 km. This would defer the 132 kV reinforcement of Cowley Local Main by three years into 2028.

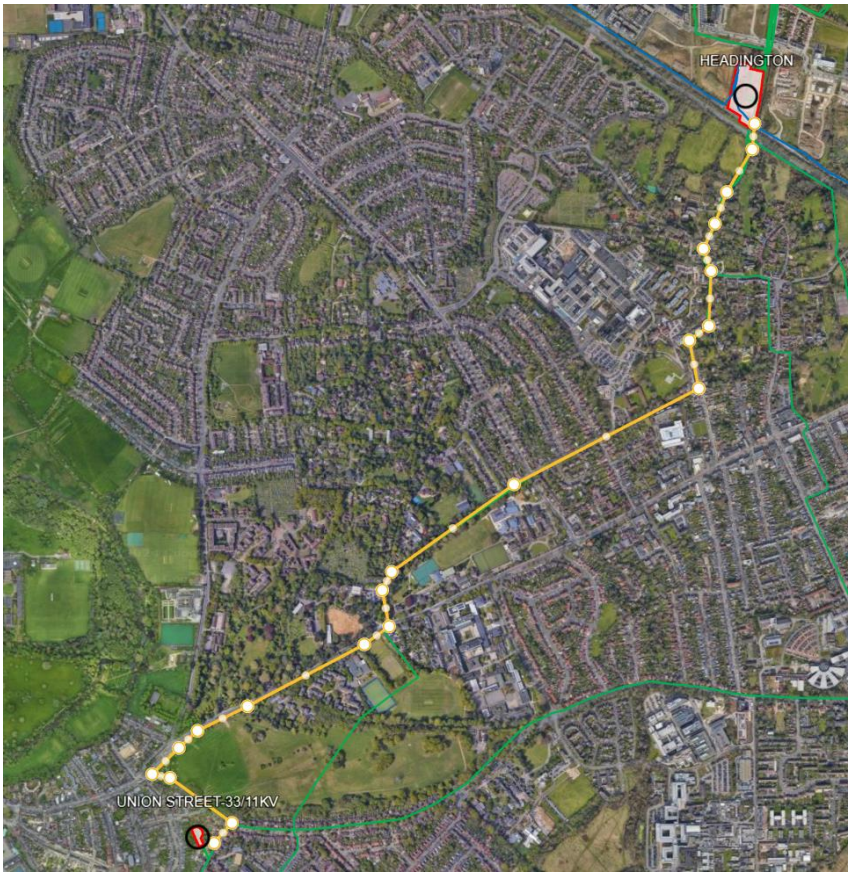


Figure 7: Load Shift Union Street to Headington BSP, new cable route

Table 15 shows the available capacity at Headington. As shown, there is no more available capacity. The demand increase forces an enhancement of the 132 kV capacity and needs to be addressed.

[redacted] A Load shift to Headington is not a feasible option.

[redacted]

A load shift of Berinsfield and Wallingsford is not economical either (nearest BSP: Didcot 11 km, Drayton 15 km).

As this option is technically unfeasible to resolve overload, it is rejected and is not taken forward into the CBA.

7.3 Option 3: 132kV enhancements

[redacted]

In this Option, the thermal overload at Rose Hill will be prevented by replacing the dual cable circuit (53MVA) to match the demand of 48.5MVA in 2050. The transformer will be replaced as well by two 40 MVA transformers. This replacement forces an enhancement of the CBs at Rose Hill. A new Busbar will be installed at 11kV with the following equipment:

- 2x 20/40MVA 33/11kV Transformer
- 11x new CB will be added/replaced at 11kV level caused by fault level issues (Section 5.2.1):
    - 2x Tx CB
    - 1 Section Breaker
    - 8 Feeder
- 2x 3.15km 33kV Cable (53MVA) Circuit (dual circuit)

In addition, the 132kV network needs enhancements. To match the increasing demand in Cowley Local Main, the following Assets will be installed/changed:

- 1x new 90MVA 132/33kV Transformer
- 1x 2.5km single-circuit from Cowley to Cowley Local; rated 201MVA;
- 1x new 132kV CB at Cowley GSP
- 1x 132kV Busbar at Cowley Local
    - 12x new 132 kV CB
        - 3x CBs for 132 kV incomers
        - 4x CBs for existing 132/33 kV Tx
        - 2x CB for section breaker
        - 1x CB for new Tx
        - 2x CB for bus coupler
- 1 new 33kV CB for new Tx
- Land purchase

Figure 8 shows the new network arrangement.

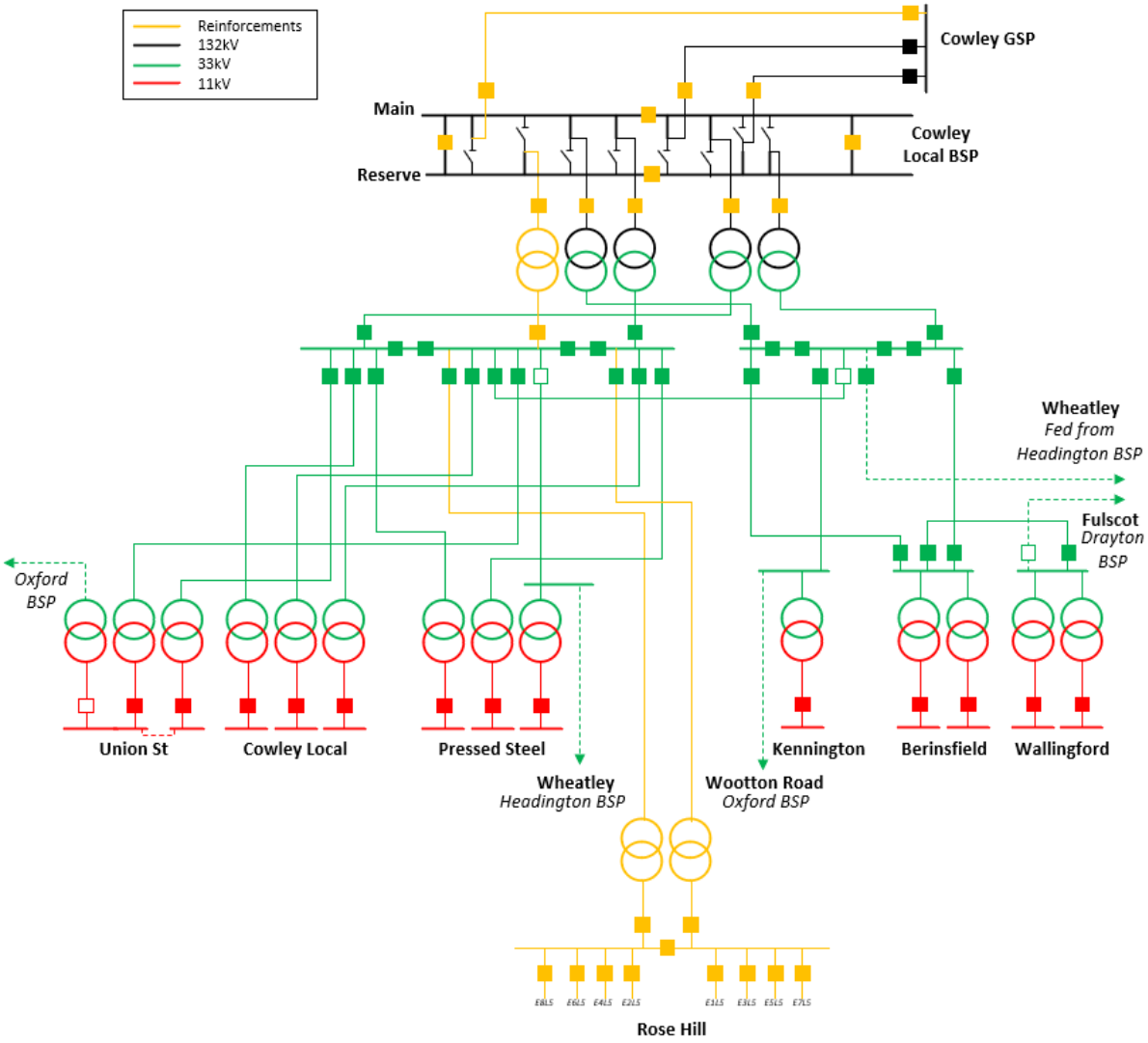


Figure 8: Schematic of the new network arrangement

[redacted]

As this [redacted] is in line with the overall SSE strategy, this option is progressed to the Ofgem CBA.

7.4 Option 4: Flexible solution followed by 132kV reinforcements

[redacted]

This option has the same reinforcements as option 3, but flexibility is used to defer reinforcements as per below;

- Rose Hill primary;
  - 11x 11kV circuit breakers; no deferral;
  - 2x 20/40MVA transformer upgrades; 2 years deferral;
  - Rose Hill – Cowley Local 33kV dual circuit 3.15 km upgrade; 2 years deferral;
- Cowley Local Main:
  - 1x 90MVA transformer,1x 33kV CB, land purchase; no deferral;
- Cowley Local GSP;
  - Cowley BSP – Cowley Local 132kV single-circuit 2.5 km installation; 1 year deferral;
  - Cowley Local 13x 132kV circuit breakers; no deferral;

In case no flexibility is used, Option 3 is the preferred one from a technical, regulatory, and strategical point of view as it increases the network capacity significantly, enables more operational flexibility and

[redacted]. In the following, the benefit and possibility of deferring the needed investment by using flexibility will be assessed. For this assessment, the Common Evaluation Methodology (CEM) is used.

Firstly, the level to which the capacity of the network capacity is exceeded at peak load will be assessed. This is calculated based on the FCO requirements.

Flexibility investigations for Rose Hill Primary

The amount by which the required FCO demand exceeds the current network capacity is displayed in Table 16 for the 33/11kV reinforcement at Rose Hill Primary, using the CER rating of the transformers.

[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. The price of flexibility has two components. [redacted]

Deferral is only economical for a maximum of two years.

[redacted]

Table 17 shows the level the capacity is exceeded if the reinforcement of the transformers has taken place.[redacted]

[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. The price of flexibility has two components. [redacted]

Figure 11 shows that there is an optimal deferral period of 2 years.

[redacted]

Flexibility investigations for Cowley Local BSP

Table 18 shows the level the capacity of the 132/33kV Transformers at Cowley Local Main are exceeded, using the nameplate ratings of the transformers.

[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. The price of flexibility has two components. [redacted]

Figure 12 shows that a postponement does not provide any benefit.

[redacted]

Table 19 shows the level the capacity of the existing 132 kV circuits (Cowley Local BSP – Cowley GSP) are exceeded, using Autumn restrictions.

[redacted]

Figure 13 shows that a postponement of 1 year provides optimum benefit.

[redacted]

There is benefit to deferring some of the above reinforcements;.

As this [redacted] is in line with the overall SSE strategy, this option is progressed to the Ofgem CBA.

8 Cost Benefit Analysis (CBA)

8.1 CBA of investment options

Ofgem's RIIO-ED2 standard CBA template was used to assess the costs and benefits of the conventional options for each circuit individually. An overview of the options that are considered in the CBA is given in Table 20.

Table 20: Summary of options progressed to CBA

Options	Costs
Option 3: 132 kV enhancements	[redacted]
Option 4: 132 kV enhancements with flexibility	

The expenditure plan of the option that progressed to the CBA is displayed in Table 21. The presented numbers reflect the costs used in the CBA analysis.

Table 21: Expenditure plan of options progressed to CBA

Options	2025	2026	2027	2028	2029	2030	2031	total
Option 3: 132 kV enhancements	[redacted]							
Option 4: 132 kV enhancements with flexibility								

8.2 CBA Results

Based on the former chapters, the analysis and the expenditure plans of the options, the cost benefit analysis has been carried out using the OFGEM CBA tool. Table 22 provides an overview of the 45-year net present value (45y NPV) of the options that were considered during the CBA assessment.

Table 22: Net Present Value (NPV) of options calculated with OFGEM CBA Tool

Options	Net Present Value (after 45 years)
Option 3: 132 kV enhancements	[redacted]
Option 4: 132 kV enhancements with flexibility	

[redacted]

9 Deliverability and Risk

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

- Medium risk on transformer replacement in Rose Hill. There is a risk that the delivery of two 40MVA transformers is delayed, as these should be implemented as soon as possible.
- Medium risk on 132/33kV transformer enhancement. There is a risk that the delivery of one 90MVA transformer is delayed, as these should be implemented as soon as possible.
- Low risk on new circuits. The 33kV and 132kV routes go along the existing circuits beside asphalted roads.
- Medium risks on old cables. The cables between Rose Hill and Cowley Local are fluid-filled cables. Therefore, there is a medium risk to environmental safety.
- Medium risk on switchgear installations – replacement is proposed for circuit breakers that will have fault level issues including CBs of the entire 11kV switch-board at Rose Hill primary substation.
- Medium risk on flexibility usage; Flexibility Team to advise on possibility of required procurement.
- [redacted]
- We have chosen the CT scenario as the baseline scenario for our investment optioneering based on the enhanced stakeholder engagement feedback. However, there is a risk that the demand growth in the future doesn't progress as predicted in the CT scenario. Therefore, we will monitor the demand development of the surrounding network and review the reinforcement option annually.

10 Outlook to 2050

With the reinforcement proposed in this paper, Cowley Local 132kV networks will be enhanced to accommodate the forecasted demand growth in the area toward 2050. There are however some remaining risks in the area.

Under Cowley Local Reserve network, Berinsfield and Kennington primary substations may require reinforcement to avoid overloading with demand growing in the area. This has been investigated and resolved in another EJP.

Rose Hill Primary will not exceed the new FCO rating of 40MVA until after 2035. The accuracy of the CT DFES in regard to the load growth at Rose Hill can be re-assessed alongside possible new customer requests closer to this time.

11 Conclusion and Recommendation

Various options for a target network for 2035 were examined. Only one option is technically feasible. The proposed concepts have been examined for the requirements in 2035 and 2050 in a low generation – high demand scenario. The proposed concept is sufficient for 2035.

The investment is distributed in 4 Phases: In 2027 the transformers and the busbar in Rose Hill will be renewed (20MVA to 40MVA, 20MVA released); in 2028 the 132kV Busbar including new CBs and a new transformer will be added (3rd 90MVA transformer, 90MVA released). Additionally the 132kV circuit Cowley-Cowley Local will be reinforced; (3rd circuit, 161MVA released). In 2029 the 33kV circuit Cowley-Rose Hill will be reinforced; (28.7MVA to 53MVA, 24.3MVA released).

[redacted]

Using flexibility provides a more realistic timeframe, with deferral costs that are reasonable. As such, **option 4 is the most promising and preferred option.**

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
EMX662/3	Technical Report Promis/[redacted]
119-SEPD-LRE-OXFORD	Oxford (Osney) BSP 132 kV Circuits ENGINEERING JUSTIFICATION PAPER
EVV862_003	Technical Report Promis/[redacted]

Table 12.2 – External Documents

Reference	Title

Table 12.3 – Miscellaneous Documents

Title

13 Subsequent Sections

14 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	Criticality Index
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 max 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 1. Note that this sensitivity analysis utilises the latest 2023 DFES data.

Table 1

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:

[redacted] To make the justification of the categorisation of this EJP more digestible, the constraints have been split into individual sections accompanied by graphs that aim to show the load growth from the different distribution future energy scenarios for each constraint identified in this EJP (these justifications are summarised in Table 2). This allows us to understand if a different scenario were considered whether the same network intervention would be required. The graphs also show the constraint following the works triggered in this EJP to demonstrate whether it would be suitable for all scenarios.

Table 2

Constraint	Category	Justification
Cowley Local Main BSP transformers	A	Constrained under all scenarios within ED2. Solution proposed meets forecasted demand out to 2050 for all scenarios.
Cowley Local Main and Reserve BSP 132kV circuits	A	Not constrained under all scenarios within ED2 but solution required in order to facilitate SCO compliance, and FCO compliance out to 2050.
Rose Hill PSS	A	Constrained under all scenarios within ED2. Solution proposed meets forecasted demand out to 2050 for all scenarios.

Cowley Local Main BSP Constraint:

[redacted]

[redacted] whilst the triggered works from this EJP facilitate sufficient capacity out to 2050 under all the DFES scenarios.

Rose Hill PSS Constraint:

[redacted] The works triggered at Rose Hill PSS facilitate enough capacity to meet the forecasted demand under all the scenarios out to 2050.

Cowley Local Main and Reserve BSP 132kV Circuit Constraint:

[redacted] The works triggered at Cowley Local facilitate enough capacity to meet the forecasted demand under all the scenarios out to 2050.