ED2 Engineering Justification Paper

SP ENERGY NETWORKS

ED2-LRE-SPM-008-CV1-EJP

Issue	Date	Comments
Issue 0.1	January 2021	Issue to internal governance and external assurance
Issue 0.2	April 2021	Reflecting comments from internal governance
Issue 0.3	May 2021	Reflecting assurance feedback
Issue 1.0	June 2021	Issue for inclusion into Draft Business Plan submission
Issue 1.1	October 2021	Reflecting updated DFES forecasts
Issue 1.2	November 2021	Reflecting updated CBA results
Issue 2.0	November 2021	Issue for inclusion into Final Business Plan submission

Scheme Name	Acer Avenue Primary Reinforcement		
PCFM Cost Type	Load Related Expenditure		
Activity	Primary reinforcement		
Primary Investment Driver	Thermal constraints		
Reference	ED2-LRE-SPM-008-CV1		
Output Type	Load Index		
Cost	**SPM -** £2.543m		
Delivery Year	2026-2027		
Reporting Table	CV1		
Outputs included in ED1	~~Yes~~/No		
Business Plan Section	Develop the Network of the Future.		
Primary Annex	Annex 4A.2: Load Related Expenditure Strategy: Engineering Net Zero Annex 4A.6: DFES		
Spend Apportionment	**ED1**	**ED2**	**ED3**
	£m	**£2.543m**	**£m**

Technical Governance Process

Project Scope Development

IP1(S)

To be completed by the Service Provider or Asset Management. The completed form, together with an accompanying report, should be endorsed by the appropriate sponsor and submitted for approval.
IP1 – To request project inclusion in the investment plan and to undertake project design work or request a modification to an existing project
IP1(S) – Confirms project need case and provides an initial view of the Project Scope
IP2 – Technical/Engineering approval for major system projects by the System Review Group (SRG)
IP2(C) – a Codicil or Supplement to a related IP2 paper. Commonly used where approval is required at more than one SRG, typically connection projects which require connection works at differing voltage levels and when those differing voltage levels are governed by two separate System Review Groups.
IP2(R) – Restricted Technical/Engineering approval for projects such as asset refurbishment or replacement projects which are essentially on a like-for-like basis and not requiring a full IP2
IP3 – Financial Authorisation document (for schemes > £100k prime)
IP4 – Application for variation of project due to change in cost or scope

PART A – PROJECT INFORMATION

Project Title:	**Acer Avenue Primary Reinforcement**
Project Reference:	**ED2-LRE-SPM-008-CV1**
Decision Required:	**To give concept approval to install a new 10MVA 33/11kV transformer at Acer Avenue primary substation, replant the 33kV &11kV switchgear, reconfigure 33kV circuit and underlying 11kV network.**

Summary of Business Need:

Acer Avenue primary substation has a single 33/11kV 7.5MVA transformer. The underlying 11kV network supplies to ca. 6469 customers, a mixture of domestic, commercial and light industrial customer and is normally operated open with the neighbouring 11kV groups. The group's existing firm capacity is 7.5MVA, the current load index position is LI4 with no capacity headroom on the primary transformer and limited thermal capacity on the 33kV and 11kV circuits. Currently the network risk is managed by interim flexible tenders within the group through the end of ED1 period.

Further, the Distribution Future Energy Scenarios (DFES) under the Baseline scenario forecast a significant number of LCTs including 1650 Electric Vehicles and 880 Heat Pumps, the total demand of 9MVA by the end of RIIO-ED2 period. There is an additional HS2 demand (temporary supplies) of ca. 1MVA expected to connect at 11kV in the group. Detailed network studies indicate that with the additional demand within RIIO-ED2 period, the thermal loading in the Acer Avenue primary group would exacerbate the existing thermal issues in the group, hence it is proposed to reinforce the group to address the thermal constraints and secure the demand.

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

The primary driver for the proposed reinforcement scheme is to mitigate the thermal constraints within the Acer Avenue primary group Proposed works include:

1. Install additional 10MVA 33/11kV primary transformer at Acer Avenue.
2. Replace existing 33kV RMU with a 5-panel board and at 11kV side replant existing 8 panel SWS C4X/C8X switchboard with modern switchgear.
3. Transferring Acer Avenue primary substation into Coppenhall Grid– Wheelock 33kV circuit and re-routing the existing 33kV Coppenhall Grid – Acer Avenue circuit to Rolls Royce primary substation.
4. Contract flexibility services to manage the network risk through the delivery stage at a cost of £92k.

It is proposed to start the works in 2025/26 and the release capacity of 2.5MVA will be claimed in 2026/27 at the end of the project. The estimated cost for the above is £2.543 (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

Expenditure Forecast (Where available based on Regulatory Allowance – 2020/21)

License Area	Reporting Table	Description	Total (£m)	Incidence (£m)				
				2023/24	2024/25	2025/26	2026/27	2027/28
SPM	CV1	Primary Reinforcement	**2.451**	-	-	1.225	1.225	-
SPM	CV1	Flexible Services	**0.092**	-	-	0.030	0.062	-
		Total Solution Cost	**2.543**	-	-	1.255	1.288	-

PART B – PROJECT SUBMISSION

Proposed by	Kailash Singh	Signature	kp.Singh	Date:	30/11/2021
Endorsed by	Russell Bryans	Signature		Date:	30/11/2021

PART C – PROJECT APPROVAL

Approved by	Malcolm Bebbington	Signature		Date:	30/11/2021

Contents

1 Introduction

Acer Avenue primary substation comprises of single 33/11kV 7.5MVA transformer and supplies over 6469 customers comprising of a mixture of domestic, commercial and light industrial customer and is normally operated split with the adjacent 11kV groups.

The group's existing firm capacity is 7.5MVA, the current load index position is LI4 with no capacity headroom on the primary transformer and limited thermal capacity on the 33kV and 11kV circuits.

The Distribution Future Energy Scenarios (DFES) for this group under the baseline scenario forecast a significant number of LCTs including 1650 Electric Vehicles and 880 Heat Pumps, the total demand of 9MVA by the end of RIIO-ED2 period. An additional HS2 demand (temporary supplies) of ca. 1MVA is expected to connect at 11kV.

Detailed network studies indicate that with the additional demand within RIIO-ED2 period, thermal loading in the Acer Avenue primary group would exceed the firm capacity. In order to secure supplies within the group, as per EREC P2/7, to meet the licence obligation for maintaining economic, efficient and coordinated network, to accommodate future demand growth within the area, it is proposed to mitigate the thermal constraints in the Acer Avenue group by installing a new primary transformer and reinforce the 33kV and 11kV circuits.

Summary of the proposed scheme:

- Install additional 10MVA 33/11kV primary transformer at Acer Avenue.
- Replace existing 33kV RMU with a 5-panel board and at 11kV side replant existing 8 panel SWS C4X/C8X switchboard with modern switchgear.
- Transferring Acer Avenue primary substation into Coppenhall Grid– Wheelock 33kV circuit and re-routing the existing 33kV Coppenhall Grid – Acer Avenue circuit to Rolls Royce primary substation.
- Contract flexibility services to manage the network risk through the project delivery stage at a cost of £92k.

It is proposed to start the works in 2025/26 and the release capacity of 2.5MVA will be claimed in 2026/27 at the end of the project. The estimated cost for the above is £2.543 (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

It is also recommended to continue annual tendering for flexibility in this area to procure enough capacity and review the proposed conventional/build solutions or in the likely case of additional demand uptake in the group.

2 Background Information

2.1 Existing/Authorised Network

The Acer Avenue primary substation lies within the Crewe/Coppenhall/Whitchurch/Radway Green 33kV group and is supplied from a single 7.5MVA primary transformer. The 11kV substation comprises of 8 panel board, with 5 circuits feeding the underlying network comprising 54 secondary substations and supplies over 6469 customers. The single primary group is operated as standalone and split from the adjacent 11kV groups namely, Leighton Hospital and Rolls-Royce. The Acer Avenue11kV network group is shown in Figure 1.

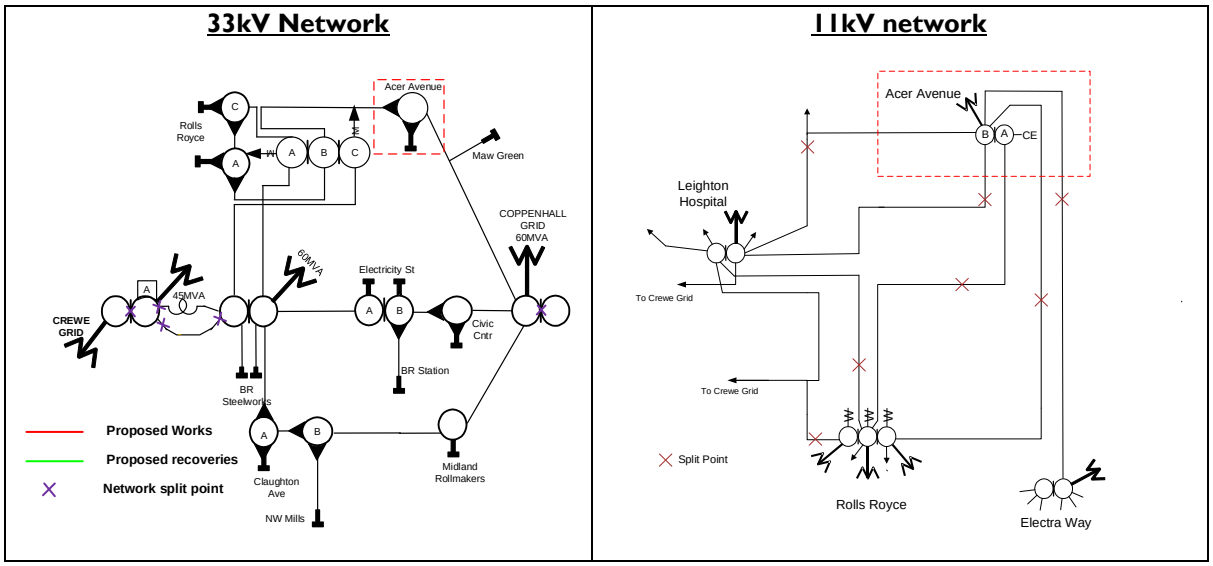

Figure 1. Acer Avenue 33kV and 11kV network group

2.2 Network supply / circuit capacity

The existing 11kV network group is classed as EREC P2/7 Group B (>1MW and ≤12MW) with the network demand of 7.6MVA against firm capacity of 7.5MVA.

The 11kV network primarily consists of 95 sq. mm AL and mix of 0.1/0.15 sq. in CU underground cable (UGC) sections. The networks secondary substations supply a mixture of domestic, commercial and light industrial customers. The neighbouring Leighton Hospital and Rolls Royce 11kV groups are currently utilisation is 46% and 77% correspondingly.

Table *2.1. Summary of Acer Avenue primary group network* shows the existing network supply position of the group.

Table 2.1. Summary of Acer Avenue primary group network

Substation	Customers	Scenario	LI firm capacity (MVA)	Maximum demand (MVA)	Load Index	Class of Supply(P2/7)
Acer Avenue	6469	N-1	7.5	7.6	LI4*	B

*Hours above 100% loading during the year 2022/21 is ≤4 hours

3 Needs Case

The single primary transformer at Acer Avenue is rated for 7.5MVA (continuous) and 10MVA (Cyclic). The group's existing firm capacity is 7.5MVA under the loss of the primary transformer (N-1 condition); the limitation is due to the thermal capacity of the underlying 11kV network.

The existing 11kV cable network is well interconnected, as shown in Figure 1, it is secure for the primary transformer outages, as the load is transferred to the adjacent 11kV groups. However, several cable sections are approaching cyclic thermal capacity under the primary transformer outages. The SPM DFES projections for the Acer Avenue 11kV group forecast a sizeable number of LCTs including 1650 Electric Vehicles and 880 Heat Pumps. Further an additional 1MVA of HS2 temporary supplies is expected to be supplied from this group within the RIIO-ED2 period.

With the forecast demand, the group is expected to exceed the firm capacity within the RIIO-ED2 period, and the primary transformer is likely to exceed the cyclic rating under intact condition and the 11kV network too exceeding the circuit cyclic ratings under the primary transformer outage conditions. Additionally, the group is required to support the adjacent 11kV groups Leighton Hospital and Rolls Royce during outages by picking up additional demand. With Acer Avenue group being constrained to meet its own forecast demand, the thermal constraint will aggravate with Acer Avenue group being required to support the adjacent group demand. Further, the 33kV circuit between Coppenhall grid to Acer Avenue primary substation will be thermally constrained.

To meet the forecasted demand and in order to comply with section 9 of the Electricity Act and Condition 21 of our license obligation "to develop and maintain an efficient, coordinated and economical system for the distribution of electricity" an enduring design solution is required in order to satisfy the existing demand requirements by creating additional thermal headroom in the group and accommodate future load growth.

3.1 Forecast Demand

The system is forecast to grow and exceed firm capacity within the RIIO-ED2 period. This forecast is based on actual system measurement data from the Process Instrumentation (PI) system and stakeholder endorsed Distribution Future Energy Scenarios (DFES) and considers our pipeline of known developments.

3.1.1 Distribution Future Energy Scenarios

Distribution Future Energy Scenarios (DFES) includes granular forecasts to 2050 for demand, generation and Low Carbon Technologies. They assess credible future scenarios covering a range of uncertainties, including differing levels of consumer ambition, policy support, economic growth and technology development and the forecasts are underpinned by extensive stakeholder engagement.

The peak demand forecast based on DFES, including authorised connections are depicted in Figure 2. The anticipated total electric vehicle and heat pump uptakes based on the future energy scenarios is depicted in Figure 3.

The scenario range considers the range of Net Zero compliant scenarios developed by us, the Electricity System Operator (ESO), and the Climate Change Committee (CCC). These are the five scenarios from the CCC 6th carbon budget, and the Leading the Way and Consumer Transformation scenarios from our DFES and the ESO Future Energy Scenarios (FES). We haven't included the System Transformation (ST) scenario as it is an outlier against the other Net Zero compliant scenarios and does not achieve interim carbon targets.

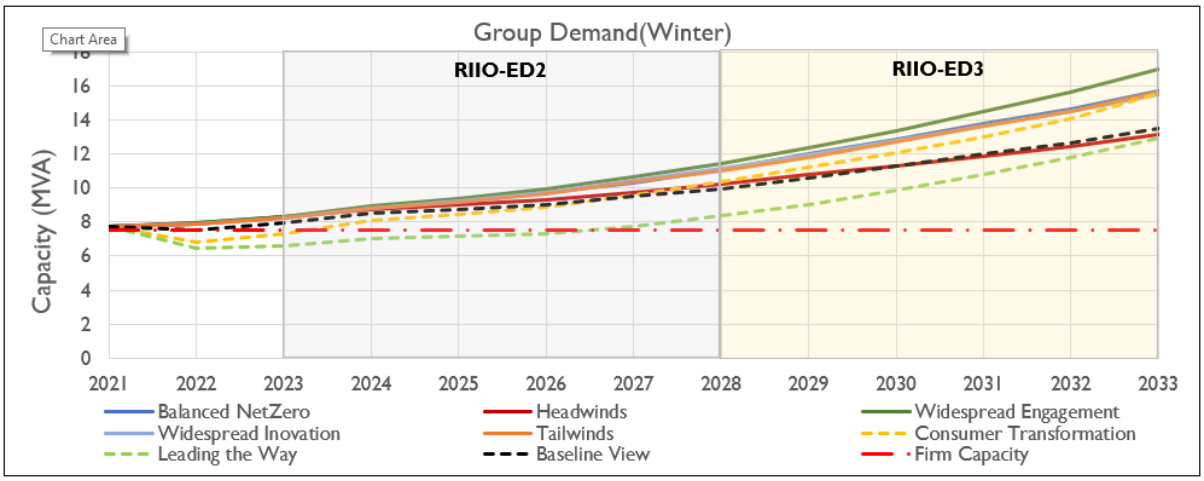

Figure 2. Demand (MVA) forecast for Acer Avenue primary substation

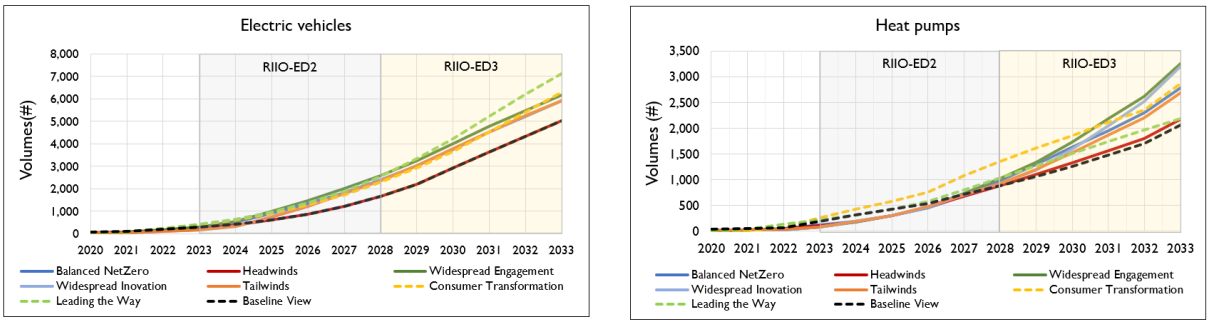

Figure 3. Forecast Electric Vehicle and Heat Pump uptakes for Acer Avenue primary substation group

3.1.2 Baseline View

For the Acer Avenue group demand, the forecast demand growth under our Baseline scenario, along with the firm capacity and utilisation through to RIIO-ED3 period is shown in Table 3.1.

Table 3.1. Baseline View forecast

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Forecast Demand (MVA)	7.7	7.5	8.0	8.5	8.7	9.0	9.5	10.0	10.6	11.3	12.0	12.6	13.5
Firm Capacity (MVA)	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Utilisation (%)	103	100	106	114	117	120	126	133	141	150	160	168	180
Load Index	LI4	LI4	LI5	LI5	LI5	LI5	LI5	LI5	LI5	LI5	LI5	LI5	LI5

3.2 Network Impact Assessment

Detailed network studies covering network intact and outage (N-1) conditions and fault level assessments were carried out for the upstream 33kV network and 11kV network fed from the Acer Avenue primary substation considering the different demand forecast scenarios.

The network thermal constraint during the most onerous outage was identified and time profile-based simulations (17,520 half-hourly simulations/year) were performed considering the historical half hourly measured Supervisory control and data acquisition (SCADA) data at primary substation overlaid with the DFES demand forecasts for each year through the RIIO-ED2 price control period. These studies identify the risk in terms of the thermal capacity exceedances with the forecast demand, the anticipated annual hours at risk and risk window of the constraint. The half-hourly studies performed for years

starting from 2023 through 2028 determined the risk hours and the capacity required to overcome the constraint by using flexibility services. The key results from the half hourly profile-based simulations are furnished in Appendix 1.

System studies indicate that with the forecasted additional demand from HS2 and LCT uptake across the network thermal loading on the primary transformer at Acer Avenue, 33kV circuit between Coppenhall Grid – Acer Avenue will exceed the cyclic rating. Further the underlying 11kV network is thermally constrained by the lower rated circuit sections.

3.2.1 Thermal Constraints

Table 3.2 shows the identified thermal and voltage constraints on the 33/11kV network level.

Table 3.2. Thermal and voltage constraints at 33/11kV level

Network Item	Voltage	Outage
Acer Avenue Transformer T1	33/11 kV	N-1
Coppenhall Grid to Acer Avenue Primary circuit	33 kV	N-1
Acer Venue to Barn Meadow Way circuit	11 kV	N-1
Acer Avenue to Anzac Drive circuit	11 kV	N-1

3.2.2 EREC P2/7 – Security of Supply

The forecast demand is 10MVA by the end of RIIO-ED2 and 13.5 MVA by the end of RIIO-ED3. The group will remain as Class B by the end RIIO-ED3. The forecasted demand will exceed the groups firm capacity as well as the primary transformer cyclic rating of 10MVA during outage scenario. The neighbouring Leighton Hospital and Rolls Royce group's utilisation is forecast be 47% and 87% by the end of RIIO-ED2 and these groups will be thermally constrained in picking up the demand from Acer Avenue under primary transfer outages.

3.2.3 Flexibility services

Under the Baseline View network risk starts from 2023/24 throughout to the year 2028, in order to manage the network risk and security of supply constraint a total capacity of capacity of maximum 2.17MW capacity is required to alleviate the constraints through the delivery period. Based on these requirements, flexibility services were tendered in September 2020 to provide services between 2023-28 period. Table 3.3 below shows flexibility services in terms of the network risk hours and tendered capacity.

Table 3.3. Network annual hours at risk and flexible capacity tendered in September 2020

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Annual hours at risk (Hrs)	2	3	137	250	434
Required Flexible Capacity (MW)	0.28	0.36	1.35	1.69	2.17

4 Optioneering

Table 4.1 shows a summary of the options considered for this reinforcement. Few of the longlist options are rejected based on the technical and commercial rustications and the reasons are provided in the table, the rest of the options are taken forward for detail analysis and included in the cost benefit analysis. The Baseline option involving an additional primary transformer at Acer Avenue represents the lowest cost conventional option, i.e. the minimum level of intervention without application of innovation.

Table 4.1. Longlist of solution options

#	Options	Status	Reason for rejection
(a)	No Intervention	Rejected	This option is rejected as without intervention, the thermal overloads will exceed the primary transformer, 33kV circuit and 11kV circuit's cyclic ratings which would lead to security of supply risk to over 6469 customers.
(b)	Intervention plan using only Energy Efficiency	Rejected	Discounted due to lower cost effectiveness (peak MW reduction per £) and the number of individual interventions required across the wide area supplied by this network.
(c)	Real Time Thermal Rating (RTTR) of the 33/11kV 7.5MVA Grid Transformer.	Rejected	Considering the thermal loading during the outage being over the cyclic rating of the transformer, installation of RTTR on the primary transformer will not provide any capacity uplift to alleviate the constraint.
(d)	Demand transfer to Leighton Hospital or Rolls Royce primary groups.	Rejected	The existing utilisation on Rolls Royce and Leighton Hospital groups is 87% and 47% correspondingly. The forecast demand growth in Acer Avenue would certainly exceed the firm capacities of these groups under outage conditions.
(e)	Install additional 7.5/10MVA primary transformer at Acer Avenue, 11kV network reinforcement and 33kV circuit reconfiguration and contract flexibility services to manage the network risk through the delivery stage	Considered as **Baseline**	-
(f)	New primary substation at Gorby Lane and 11kV interconnection with Acer Avenue and Leighton Hospital.	Considered as **Option 1**	-
(g)	Install additional 7.5/10MVA primary transformer at Flowers Lane and 11kV interconnectors to transfer from Acer Avenue to Leighton Hospital.	Considered as **Option 2**	-
(h)	Reinforcement deferral using flexible services	Rejected	Rejected considering the recent round of tender submissions, the tendered capacity falls short of the required capacity.

The considered Baseline option considers the mitigation within the Acer Avenue primary group while the other two considered options involve interconnection with Acer Avenue, as such the alternate option may be costlier and require longer lead times for delivery.

5 Detailed Analysis & Costs

With the initial flexibility tender rounds indicating not enough response to provide with flexible capacity in the group to defer the any reinforcement scheme, hence, to address the thermal constraints in the group, a conventional build solution is proposed.

5.1 Proposed Option (Baseline) – Install additional primary transformer at Acer Avenue

The proposed solution is to alleviate the thermal constraints by installation of additional primary transformer, reconfiguration 33kV circuit and reinforcing the 11kV circuits. Table 5.1 shows the scheme summary.

Table 5.1. Proposed option summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)
Conventional / Innovation	Acer Avenue Primary Reinforcement	• Install additional 10MVA 33/11kV transformer at Acer Avenue. • Replace the existing 33kV RMU with a 5-panel board or equivalent switchgear. On the 11kV side, replant the 8 panel SWS C4X/C8X switchgear with modern switchgear. • Reinforce the underlying 11kV network by overlaying the thermally limiting circuit sections. • Transferring Acer Avenue primary substation into Coppenhall grid – Wheelock 33kV circuit and re-routing the existing 33kV Coppenhall grid – Acer Avenue circuit to Rolls Royce.	2.543

With the new primary transformer and 11kV circuit reinforcements, the proposed scheme will increase the group's firm capacity from 7.5MVA to 10MVA under the loss of one primary transformer, this would be sufficient to meet the forecast demand within the RIIO-ED2 period. Under intact conditions, the group will be able to support up to maximum of 20MVA.

Figure 4. and Figure 5. show the aerial view of the existing 33/11kV Acer Avenue primary substation and the proposed works respectively. Acer Avenue substation is close to the residential area, hence there could be concerns about noise levels. However, the new primary transformer unit will be Eco Tier-2 type with lower noise levels, as well as coast have been allocated in the scheme for noise level survey and abatement (if required).

The tenders rounds from May 2021 has returned more than enough capacity for initial round of flexibility tenders results as shown in **Error! Reference source not found.** for the ED2 period e xcept for the last year. However, it is recommended to continue annual tendering for flexibility in this area to procure capacity and the proposed conventional/build solutions will be reviewed depending on procuring enough capacity in the future tenders.

Table 5.2. Network annual hours at risk and flexible capacity tendered in May 2021

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Annual hours at risk (Hrs)	2	3	137	250	434
Required Flexible Capacity (MW)	0.28	0.36	1.35	1.69	2.17
Qualified Flexible Capacity (MW)	0.71	0.89	3.99	4.80	3.84
Qualified Flexible Capacity (%)	253%	244%	297%	285%	177%

Figure 4. Acer Avenue aerial view

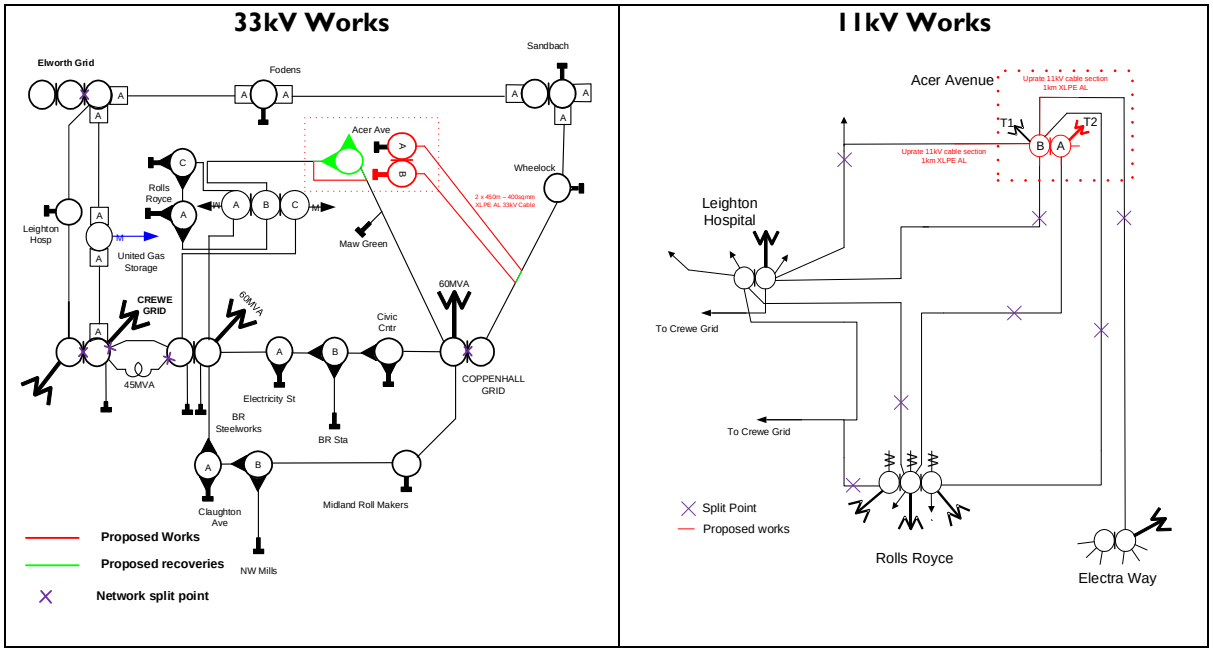

Figure 5. Proposed 33kV and 11kV works

The increase in capacity and cost of flexibility, due to demand growth, was considered against the benefit of deferral in each year of RIIO-ED2. This is assessed using flexibility to manage the constraint while the level and number of risk hours is relatively low, to commission the above proposed works when efficient to do so. The annual reinforcement deferral ceiling cost was calculated to be £0.078m per year to manage the constraint via flexibility. Summary of anticipated cost of flexibility services from recent round of tenders along with annual ceiling cost is shown in Table 5.3

Table 5.3. Summary of flexibility service costs

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Reinforcement Deferral Ceiling Cost - per year(£m)	0.078	0.078	0.078	0.078	0.078
Cost of Flexibility Services (100% Capacity)	0.000	0.000	0.011	0.020	0.264
Flexibility Outlook	●	●	●	●	●

● *Accept bids and support the network during reinforcement delivery*

● *Reject bids and deliver reinforcements*

The cost of flexibility for 2023/24 to 2026/27 based on the recent tenders is £0.031m for a total of 2.8MW.

Considering the above it is proposed to start the reinforcement works in 2025/26 and the capacity release of 2.5MVA will be claimed in 2026/27 at the end of the project. The estimated cost for the above is £2.543m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

We will continue to tender for flexibility in this area before the reinforcement starts to ensure we are using the most efficient intervention. Table 5.4 shows a summary of reinforcement costs and volumes for the proposed scheme under RIIO-ED2.

Table 5.4. Proposed option summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
6.6/11kV UG Cable	2	0.235	0.235	-
6.6/11kV CB (GM) Primary	9	0.250	0.250	-
33kV UG Cable (Non-Pressurised)	1	0.243	0.243	-
33kV CB (Gas Insulated Busbars) (ID) (GM)	5	0.852	0.852	-
33kV Transformer (GM)	1	0.314	0.314	-
Batteries at 33kV Substations	1	0.009	0.009	-
Flexible Services	-	0.092	0.092	-
Civil Works at 33 kV & 66 kV Substations		0.338	0.338	-
Other Costs (Identify Below)		0.210	0.210	-
Total Costs		**2.543**	**2.543**	**-**
Identify activities included within other costs (please provide high-level detail of cost areas)				
Planning and design studies (£29k)				
RTU/SCADA (£25k)				
11kV NCP (£42k)				
Acer Avenue and Remote end protection (£105k)				
Noise survey (£9k)				

5.2 Option 1 – Establish a New Primary Substation at Gorby Lane

This option considers the establishment of a new 33/11kV 10MVA primary substation at a new site preferably at Gorby Lane with 11kV interconnection to Acer Avenue, Leighton Hospital and Electra Way primary. To alleviate the 33kV circuit constraint, it is also proposed to overlay the existing 33kV circuit between Coppenhall grid to Acer Avenue.

Table 5.5 shows the scheme summary. The option would provide 10MVA additional network capacity. It will enable 3MVA of demand to be offloaded from Acer Avenue primary and would prevent thermal overloading. Table 5.5 shows a summary of reinforcement costs and volumes for Option 1 under RIIO-ED2. The proposed works under the Option 1is shown in Figure 6.

This option is rejected due its relatively high cost and gives the similar headroom uplift compared to the baseline solution.

Table 5.5. Option 1 summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Conventional	Acer Avenue Primary Reinforcement	• Establish new 1 x 10MVA 33/11kV primary substation at Gorby Lane • 11kV interconnectors between Gorby Lane to Acer Avenue and Gorby Lane to Leighton Hospital. • 33kV Acer Avenue to Coppenhall grid circuit overlay with 400 Sq. mm XLPE AL Cable.	4.553	-

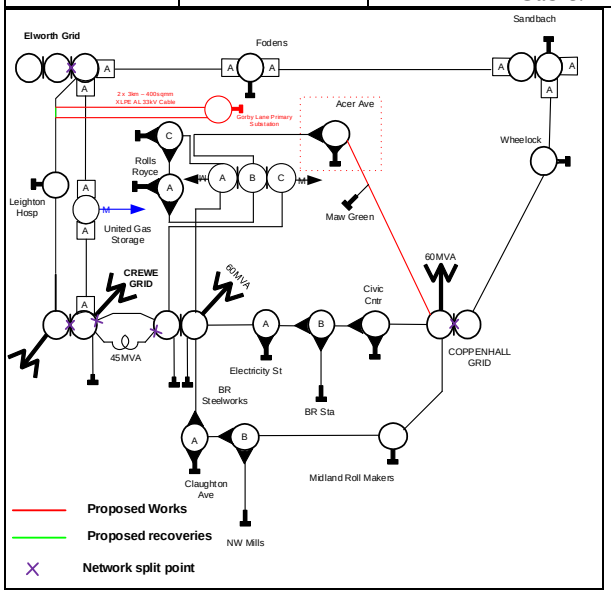

Figure 6. Works proposed under Option 1

Table 5.6. Option 1 summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
6.6/11kV UG Cable	5	0.587	0.587	-
6.6/11kV CB (GM) Primary	9	0.250	0.250	-
33kV UG Cable (Non-Pressurised)	7.5	1.820	1.820	-
33kV CB (Gas Insulated Busbars) (ID) (GM)	3	0.511	0.511	-
33kV Transformer (GM)	1	0.314	0.314	-
Batteries at 33kV Substations	1	0.009	0.009	-
Civil Works at 33 kV & 66 kV Substations		0.500	0.500	-
Wayleaves/Easements/Land Purchase		0.200	0.200	-
Other Costs (Identify Below)		0.362	0.362	-
Total Costs		**4.553**	**4.553**	**-**
Identify activities included within other costs (please provide high-level detail of cost areas)				
Associated protection, control or SCADA equipment located at a site and remote ends - (£145k)				
Environmental considerations, survey and studies (£50k)				
Noise survey and mitigation (£75k)				
Planning and Design Studies (£50k)				
11kV NCP (£42k)				

5.3 Option 2 – Establish a New Primary Substation at Flowers Lane

This option considers the establishment of a new 33/11kV 10MVA primary substation at a new site preferably at Flowers Lane with 11kV interconnection to Acer Avenue, Leighton Hospital and Electra Way primary. To alleviate the 33kV circuit constraint, it is also proposed to overlay the existing 33kV circuit between Coppenhall grid to Acer Avenue. Table 5.7 shows the scheme summary.

The option would provide 10MVA additional network capacity. It will enable 3MVA of demand to be offloaded from Acer Avenue primary and would prevent thermal overloading. Table 5.7 shows a summary of reinforcement costs and volumes for Option 2 under RIIO-ED2. The proposed works under the Option 2 is shown in Figure 7.

This option is rejected due its relatively high cost and gives the similar headroom uplift compared to the baseline solution.

Table 5.7. Option 2 summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Conventional	Acer Avenue Primary Reinforcement	• Establish new 1 x 10MVA 33/11kV primary substation at Flowers Lane • 11kV interconnectors between Flowers Lane to Acer Avenue and Flowers Lane to Leighton Hospital. • 33kV Acer Avenue to Coppenhall grid circuit overlay with 400 Sq.mm XLPE AL Cable.	4.006	-

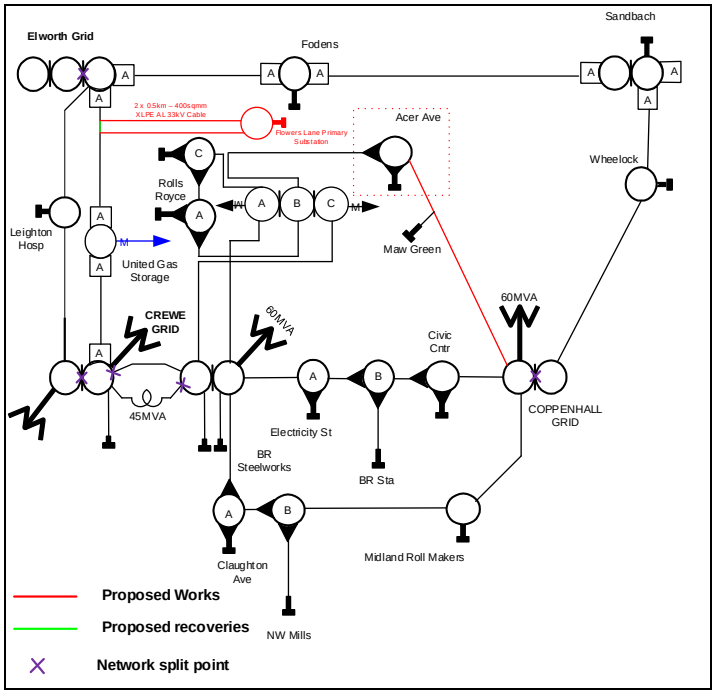

Figure 7. Works proposed under Option 2

Table 5.8. Option 2 summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
6.6/11kV UG Cable	10	1.175	1.175	-
6.6/11kV CB (GM) Primary	9	0.250	0.250	-
33kV UG Cable (Non-Pressurised)	2	0.485	0.485	-
33kV CB (Gas Insulated Busbars) (ID) (GM)	3	0.511	0.511	-
33kV Transformer (GM)	1	0.314	0.314	-
Batteries at 33kV Substations	1	0.009	0.009	-
Civil Works at 33 kV & 66 kV Substations		0.500	0.500	-
Wayleaves/Easements/Land Purchase		0.400	0.400	-
Other Costs (Identify Below)		0.362	0.362	-
Total Costs		**4.006**	**4.006**	**-**
Identify activities included within other costs (please provide high-level detail of cost areas)				
Associated protection, control or SCADA equipment located at a site and remote ends - (£145k)				
Environmental considerations, survey and studies (£50k)				
Noise survey and mitigation (£75k)				
Planning and Design Studies (£50k)				
11kV NCP (£42k)				

5.4 Options Cost Summary Table

Summary of the costs for each of the evaluated options is presented in Table 5.9.

Table 5.9. Cost summary for considered options

Options	Option Summary	RIIO-ED2 Cost (£m)
Baseline	Install additional primary transformer at Acer Avenue along with uprating 11kV circuit and reconfiguration of 33kV circuit.	2.543
Option 1	Establish a new primary substation in Gorby Lane along with HV interconnectors and overlay 33kV cable circuit between Coppenhall grid to Acer Avenue.	4.553
Option 2	Establish a new primary substation in Flowers Lane along with HV interconnectors and overlay 33kV cable circuit between Coppenhall grid to Acer Avenue.	4.006

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

6 Deliverability & Risk

6.1 Preferred Options & Output Summary

The adopted option is the baseline option to install additional primary transformer at Acer Avenue along with uprating 11kV circuits and reconfiguration of 33kV circuit by transferring Acer Avenue primary substation into Coppenhall grid – Wheelock 33kV circuit and re-routing the existing 33kV Coppenhall grid – Acer Avenue circuit to Rolls Royce.

6.2 Cost Benefit Analysis Results

A cost benefit analysis (CBA) was carried out to compare the NPV of the options discussed in the previous sections. Considering the lowest forecast capital expenditure, the proposed option has the highest total NPV against other options. The summary of the cost benefit analysis is presented in Table 6.1. The full detailed CBA is provided within 'ED2-LRE-SPM-008-CV1-CBA – Acer Avenue Primary Reinforcement'.

Table 6.1. Cost benefit analysis results

Options considered	Decision	Comment	NPVs based on payback periods, £m (2020/21 prices)			
			10 years	15 years	30 years	45 years
Baseline - Additional Transformer at Acer Avenue	**Adopted**	The proposed scheme is the least cost solution to accommodate forecasted demand from LCT Uptake and additional demand from HS2.	-	-	-	-
Alternate Option1 -New Primary Substation at Gorby Lane	Rejected	Discounted based on higher scheme cost and lower NPV against proposed option.	-1.23	-1.63	-1.87	-2.04
Alternate Option2 -New Primary Substation at Flowers Lane	Rejected	Discounted based on higher scheme cost and lower NPV against proposed option.	-0.93	-1.22	-1.39	-1.52

6.3 Cost & Volumes Profile

Table 6.2 shows the breakdown of expenditure for the proposed scheme (in 2020/21 prices) and the cost incidence (in 2020/21 prices) over the RIIO-ED2 period is shown in Table 6.3. The total cost of the proposed scheme is £2.543m.

Table 6.2: Summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
6.6/11kV UG Cable	2.0	0.235	0.235	-
6.6/11kV CB (GM) Primary	9	0.250	0.250	-
33kV UG Cable (Non-Pressurised)	1	0.243	0.243	-
33kV CB (Gas Insulated Busbars) (ID) (GM)	5	0.852	0.852	-
33kV Transformer (GM)	1	0.314	0.314	-

Batteries at 33kV Substations	1	0.009	0.009	-
Flexible Services	-	0.092	0.092	-
Civil Works at 33 kV & 66 kV Substations		0.338	0.338	-
Other Costs (Identify Below)		0.210	0.210	-
Total Costs		**2.543**	**2.543**	**-**
Identify activities included within other costs (please provide high-level detail of cost areas)				
Planning and design studies (£50k)				
RTU/SCADA (£25k)				
11kV NCP (£42k)				
Acer Avenue and Remote end protection (£105k)				
Noise survey (£9k)				

Table 6.3: Cost incidence over the RIIO-ED2 period, £m (2020/21 Prices)

Total Investment	Total	Incidence (£m)				
	(£m)	2023/24	2024/25	2025/26	2026/27	2027/28
CV1 – Primary Reinforcement	**2.451**	-	-	1.225	1.225	-
CV1 – Flexible Services	**0.092**	-	-	0.030	0.062	-
Total Cost(£m)	**2.543**	-	-	1.255	1.288	-

6.4 Risks

The main delivery risks are the land for the new 33kV cable route required for network reconfiguration and necessary approvals and traffic management for HV circuit overlays. We would mitigate these risks by engaging with local authorities.

Considering Acer Avenue primary substation being in densely populated residential area, there is a risk of noise complaints. In order to overcome this risk, the scheme includes noise survey and appropriate noise abatement by constructing fire wall between transformers.

6.5 Outputs Included in RIIO-ED1 Plans

There are no outputs expected to be delivered in RIIO-ED1 that are funded within this proposal.

6.6 Future Pathways – Net Zero

6.6.1 Primary Economic Driver

The primary drivers for this investment are insufficient thermal headroom and security of supply risk. The investment does not have a strong reliance on environmental benefits.

6.6.2 Payback Periods

The CBA indicates that for the proposed option demonstrates better NPV results in all assessment periods (10, 15, 30 & 45 years) against other two options. As the intervention is forecast to carry at least a 45-year asset life expectancy, the CBA at this time justifies the intervention. Consumers will also benefit from reduced network risk immediately on completion of the project.

6.6.3 Sensitivity to Future Pathways

The network capacity and capability that result from the proposed option is consistent with the network requirements determined in line with the section 9 of the Electricity Act and Condition 21. Additionally, the proposed option is consistent with the SPEN's Distribution System Operator (DSO) Strategy and Distribution Future Energy Scenarios.

Table 6.4 shows electric vehicle and heat pump uptakes across a range of future pathways and Table 6.5 shows the sensitivity of the proposed solution and Table 6.6 shows the sensitivity of the proposed RIIO-ED2 expenditure against the full ranges of Net Zero complaint future pathways other Climate Change Committee (CCC) scenarios.

Table 6.4: Electric Vehicle and Heat Pump uptakes across a range of future pathways

End of RIIO-ED2	SPEN	DFES			CCC				
	Baseline	System Transformation*	Consumer Transformation	Leading the Way	Balanced Net Zero	Headwinds	Widespread Engagement	Widespread Innovation	Tailwinds
EVs	1,652	1,234	2,284	2,552	2,389	1,652	2,597	2,597	2,368
HPs	880	135	1,359	1,044	978	891	1,021	932	932

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

Table 6.5: Sensitivity of the proposed solution against future pathways

	RIIO-ED1				RIIO-ED2					RIIO-ED3				
Solution Requirements	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Baseline					F	F	F	R1						
Leading the Way					F	F	F	R1						
Consumer Transformation					F	F	F	R1				R2		
Balanced Net Zero Pathway					F	F	R1					R2		
Headwinds					F	F	F	R1						
Widespread Engagement					F	F	R1					R2		
Widespread Innovation					F	F	R1					R2		
Tailwinds					F	F	R1					R2		

F – Flexibility services to manage the network risk
R1 – Install additional primary transformer at Acer Avenue with 33kV network reconfiguration and 11kV circuit upgrades
R2 – New Primary Substation

The proposed solution is robust across a wide range of pathways. In Baseline and Headwinds scenario this solution is expected to provide sufficient capacity to cater beyond the end of RIIO-ED3. The timing of the requirement within RIIO-ED2 is slightly sensitive to uptake rates but is found to be required under all scenarios within the RIIO-ED2 period. Under higher uptake scenarios a 33/11kV primary substation may be required by mid of RIIO-ED3.

Table 6.6: Sensitivity of the proposed RIIO-ED2 expenditure

	Baseline	Uncertain
RIIO-ED2 Expenditure (£m)	2.543	N/A
Comment	Proposed option	Under higher uptake scenarios additional 33/11kV Substation may be required within RIIO-ED3.

6.6.4 Asset Stranding Risks & Future Asset Utilisation

Electricity demand are forecast to increase under all scenarios. The stranding risk is therefore considered to be low.

6.6.5 Losses Sensitivity

Losses have been considered in accordance with Licence Condition SLC49 and the SP Energy Networks Losses Strategy and Vision to "consider all reasonable measures which can be applied to reduce losses and adopt those measures which provide benefit for customers". Reasonable design efforts have been taken to minimise system losses without detriment to system security, performance, flexibility or economic viability of the scheme. This includes minimising conductor lengths/routes, the choice of appropriate conductor sizes, designing connections at appropriate voltage levels and avoiding higher impedance solutions or network configurations leading to higher losses. Solution selection was not found to be sensitive to the impact of the carbon cost of losses.

Losses have been considered as part of the design solution and it has not been necessary to carry out any losses justified upgrades. MWh losses for each of the shortlisted options have been included within the CBA and solution selection was not found to be sensitive to the impact of the carbon cost of losses.

6.6.6 Whole Systems Benefits

Whole system solutions have been considered as part of this proposal. No alternatives have been identified that could be provided through a whole systems solution. The completion of this scheme will maintain the integrity of the distribution network and its enduring ability to facilitate wider whole system benefits.

6.7 Environmental Considerations

6.7.1 Operational and embodied carbon emissions

The Acer Avenue Primary Reinforcement programme has the potential to impact on SPEN's Business Carbon Footprint (BCF) and on the embodied carbon resulting from the delivery of the programme.

During the evaluation of the options associated with the proposed scheme, we have embedded within the CBA, where data are available, an assessment of the embodied carbon and the associated carbon cost to inform our NPV evaluation. The mass of carbon dioxide emitted (CO2e) during the manufacture of the main equipment deployed to deliver this scheme is estimated to be 136 tonnes. The monetised embodied carbon value associated with this emission is £4k. It should be noted that the embodied carbon evaluation undertaken has only considered the manufacture and supply of materials. Further collaborative industry-wide work is planned for the RIIO-ED2 price review period to better understand the overall embodied carbon values including, for example installation and commissioning services, decommissioning and disposal activities as well as refurbishment opportunities. More information regarding this can be found in Section 3.1.2 of our Environmental Action Plan[1].

6.7.2 Supply chain sustainability

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

[1] Annex 4C.3: Environmental Action Plan, SP Energy Networks, Issue 2, 2021.

We believe that such a requirement sends a strong message to our suppliers that we take sustainability seriously, and that such positive engagement is key to improving the overall sustainability of our collective supply chain.

6.7.3 Resource use and waste

The Acer Avenue Primary Reinforcement programme will result in the consumption of resources and the generation of waste materials from end of life assets.

Where waste is produced it will be managed in accordance with the waste hierarchy which ranks waste management options according to what is best for the environment. The waste hierarchy gives top priority to preventing waste in the first instance, then preparing for re-use, recycling, recovery, and last of all disposal (e.g. landfill).

6.7.4 Biodiversity/ natural capital

The Acer Avenue Primary Reinforcement programme will only affect a single named site containing existing assets. Therefore, the impact on, and the opportunity to improve biodiversity and natural capital is expected to be minimal.

6.7.5 Preventing pollution

SPEN will always follow all relevant waste regulations and will make sure that special (hazardous) waste produced or handled by our business is treated in such a way as to minimise any effects on the environment.

6.7.6 Visual amenity

SPEN continually seeks to reduce the landscape and visual effects of our networks and assets but recognises that the nature of our substations makes it challenging to minimise their visual impact.

6.7.7 Climate change resilience

In addition to our efforts to minimise our direct carbon emissions in line with our net-zero ambitions, we are also conscious of the need to secure the resilience of our assets and networks in the face of a changing climate. We have also modified our policy on vegetation control in the face of higher temperatures and longer growing seasons.

7 Conclusion

To accommodate the demand growth, improve security of supply and alleviate thermal constraints in the Acer Avenue group network, the proposed solution is to install additional primary transformer at Acer Avenue along with uprating 11kV circuits and reconfiguration of 33kV circuit by transferring Acer Avenue primary substation into Coppenhall grid – Wheelock 33kV circuit and re-routing the existing 33kV Coppenhall grid – Acer Avenue circuit to Rolls Royce.

It is proposed to start the works in 2025/26 and the release capacity of 2.5MVA will be claimed in 2026/27 at the end of the project. The estimated cost for the proposed scheme is £2.543m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

8 Appendices

Appendix 1. System Study Results

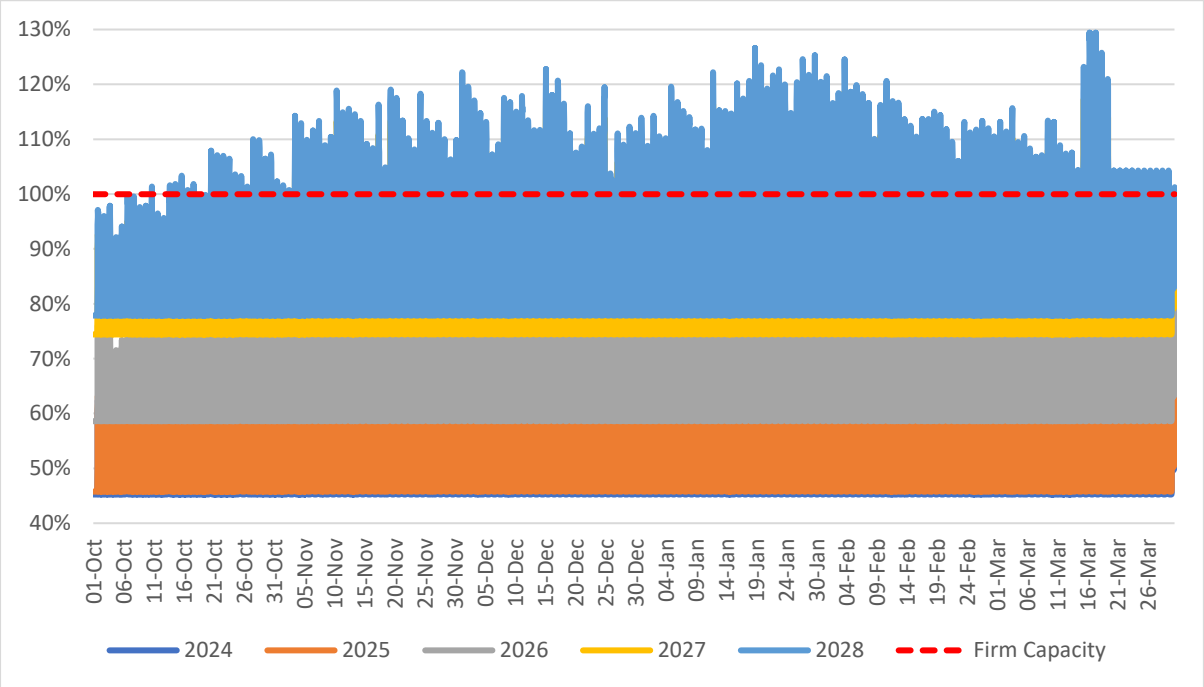

Figure 8. Half-hourly loading on 33/11kV Acer Avenue primary transformer

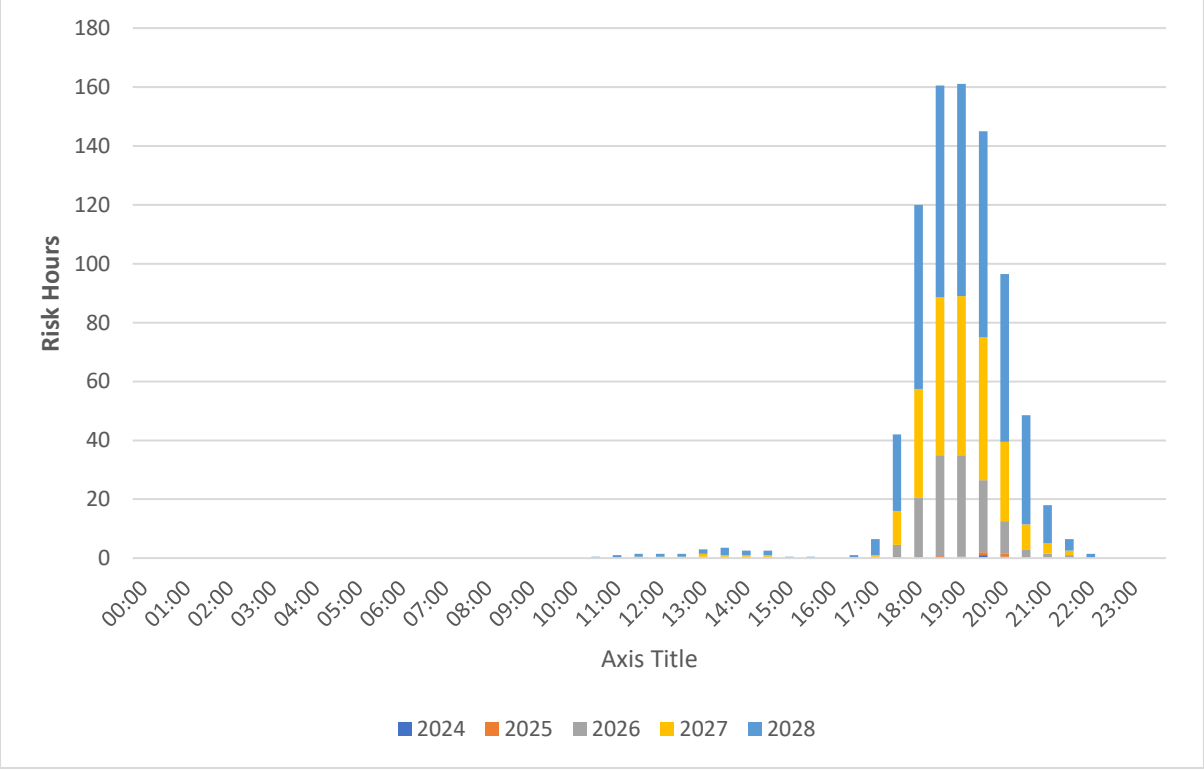

Figure 9. Calculated daily network risk hour window