Sandbach Primary Reinforcement

ED2 Engineering Justification Paper

ED2-LRE-SPM-009-CV1-EJP

Issue	Date	Comments
Issue 0.1	Jan 2021	Issue to internal governance and external assurance
Issue 0.2	Apr 2021	Reflecting comments from internal governance
Issue 0.3	May 2021	Reflecting assurance feedback
Issue 1.0	Jun 2021	Draft Business Plan Submission
Issue 1.1	Oct 2021	Reflecting updated DFES forecasts
Issue 1.2	Nov 2021	Reflecting updated CBA results
Issue 2.0	Dec 2021	Final Business Plan Submission

Scheme Name	Sandbach Primary Reinforcement		
Activity	Primary reinforcement		
Primary Investment Driver	Thermal constraints		
Reference	ED2-LRE-SPM-009-CV1		
Output Type	Load Index		
Cost	**SPM -** £2.501m		
Delivery Year	2023-2028		
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	**£2.501m**	**£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:	**Sandbach Primary Reinforcement**
Project Reference:	**ED2-LRE-SPM-009-CV1**
Decision Required:	**To give concept approval to install a new 10MVA 33/11kV transformer at Sandbach primary substation and establish new 11kV interconnector between Sandbach and Fodens.**

Summary of Business Need:

The Sandbach primary substation comprises of 1 x 7.5MVA 33/11kV transformer which is supplied from the 4 x 33kV circuits and is part of the 33kV Crewe/Coppenhall/Radway Green/Whitchurch grid supply group. The 11kV group network is normally operated split from the adjacent primary network groups.

The existing firm capacity of the Sandbach primary group is 7.5MVA and operating at 90% of the group capacity. As part of the customer driven reinforcements it is planned to install a second 7.5/10MVA transformer at Sandbach to accommodate the authorised demand within RIIO-ED1. Within in RIIO-ED2, DFES forecasts over 1135 Electric Vehicles and 480 Heat Pumps. There will be significant demand growth around Sandbach, Fodens and Smallwood conurbations with large numbers of housing development applications and ongoing stakeholder engagement suggests many more are in the pipeline. Detailed network assessments indicate that with the additional demand within RIIO-ED2, the loading on the Sandbach primary group network would exceed the firm capacity.

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

Proposed works include:

- Install additional 10MVA 33/11kV primary transformer at Fodens.
- Extend the existing 33kV indoor board to accommodate 2 breakers at Fodens.
- Replant existing 8 panel SWS C4X/C8X switchboard with 12 panel modern switchgear.
- Extend existing 11kV switchboard at Sandbach to accommodate 1 breaker.
- Establish new 11kV interconnector between Sandbach and Fodens.
- Contract flexibility services to support during project delivery.

It is proposed to start the works in 2023/24 and the release capacity of 7.5MVA will be claimed in 2024/25 at the end of the project. The estimated cost for the above is £2.501 (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	**2.388**	1.194	1.194	-	-	-
SPM	CV1	Flexible Services	**0.113**	0.030	0.083	-	-	-
This Proposal			**2.501**	1.224	1.277	-	-	-

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

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1 Introduction

The Sandbach primary substation comprises of 1 x 7.5MVA 33/11kV transformer which is supplied from the 4 x 33kV circuits and is part of the 33kV Crewe/Coppenhall/Radway Green/Whitchurch grid supply group. The Sandbach primary network group supplies over 3359 customers with a mix of domestic customers, industrial and commercial customer. The 11kV group network is normally operated split from the adjacent primary group network.

The existing firm capacity of the Sandbach primary group is 7.5MVA and the present load index position is LI2 with loading at 90% of the group capacity. As part of the customer driven reinforcements it is planned to install a second 7.5MVA transformer at Sandbach to accommodate the authorised demand within RIIO-ED1. The existing primary substation also supplies M6 Sandbach services which is planned to have rapid EV charging stations with a combined (North and South bound) demand requirement of 6MVA by end of RIIO-ED2. The Sandbach 33kV network group is shown in Figure 1.

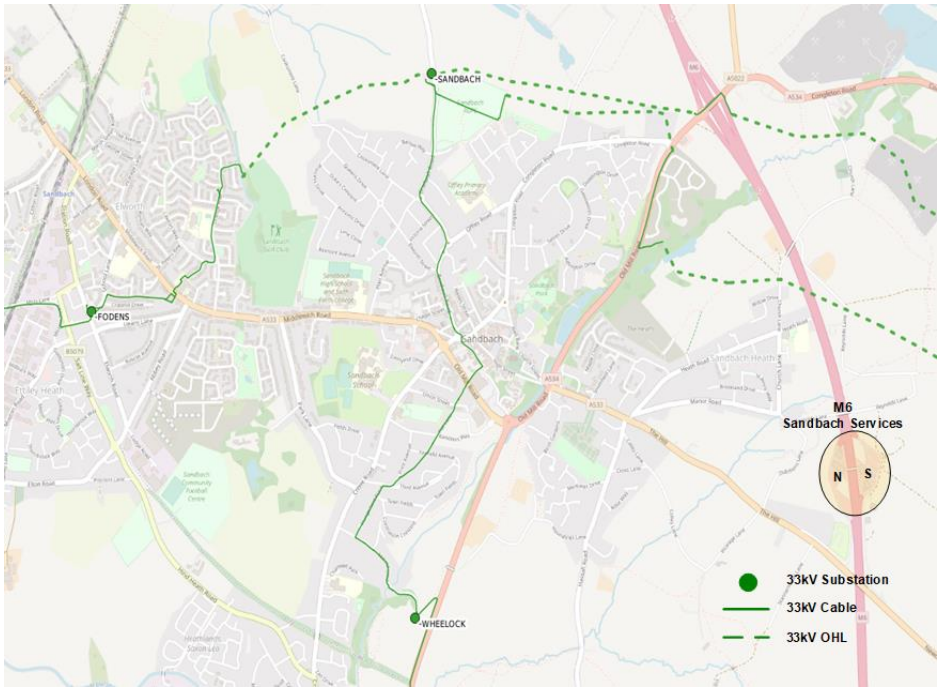

Figure 1. SPM network area around Sandbach

The Distribution Future Energy Scenarios (DFES) for this group under the baseline scenario forecast a significant number of LCTs including 1135 Electric Vehicles and 480 Heat Pumps, additional demand of 7MVA by the end of RIIO-ED2 period.

Detailed network studies indicate that with the additional demand within RIIO-ED2 period, thermal loading in the Sandbach 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 Sandbach group by installing a new primary transformer at Fodens and establishing new 11kV interconnector between Sandbach and Fodens.

Summary of the proposed scheme:

- Install additional 10MVA 33/11kV primary transformer at Fodens.

- Extend the existing 33kV indoor board to accommodate 2 breakers at Fodens.
- Replant existing 8 panel SWS C4X/C8X switchboard with 12 panel modern switchgear.
- Extend existing 11kV switchboard at Sandbach to accommodate 1 breaker.
- Establish new 11kV interconnector between Sandbach and Fodens.
- Contract flexibility services to support the network during the project delivery from year 2023/24 through 2024/25.

It is proposed to start the works in 2023/24 and the release capacity of 10MVA will be claimed in 2024/25 at the end of the project. The estimated cost for the above is £2.501 (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure. The timing of the project is based on delivering the highest NPV, while managing the network risk via operational management through flexibility services during project delivery.

It is recommended to continue annual tendering for flexibility in this area to procure enough capacity and review the scheme depending on future tenders resulting competitive bids enabling to defer the proposed reinforcements.

2 Background Information

2.1 Existing/Authorised Network

The existing 33/11kV Sandbach substation is equipped with 1x7.5MVA transformer with 4 x 33kV infeed's. The existing 11kV site is equipped with 10 panel board with 8 circuits supplying over 70 secondary substations with total 3359 customers across the Sandbach town. The 11kV network is operated radially and is split from adjacent primary substation 11kV networks supplied from Fodens, Wheelock, Smallwoods, Fisons and RHM Foods. RHM Foods and Fisons primary substations are fed from Carrington Fiddlers Ferry GSP.

As part of customer driven connection within RIIO-ED1, it is planned to install second 33/11kV 7.5MVA primary transformer at Sandbach, this would create a capacity headroom of 2.5MVA in the Sandbach primary group and increasing the firm capacity from 7.5MVA to 10MVA.The authorised 33kV and 11kV network around Sandbach primary group is shown in Figure 2.

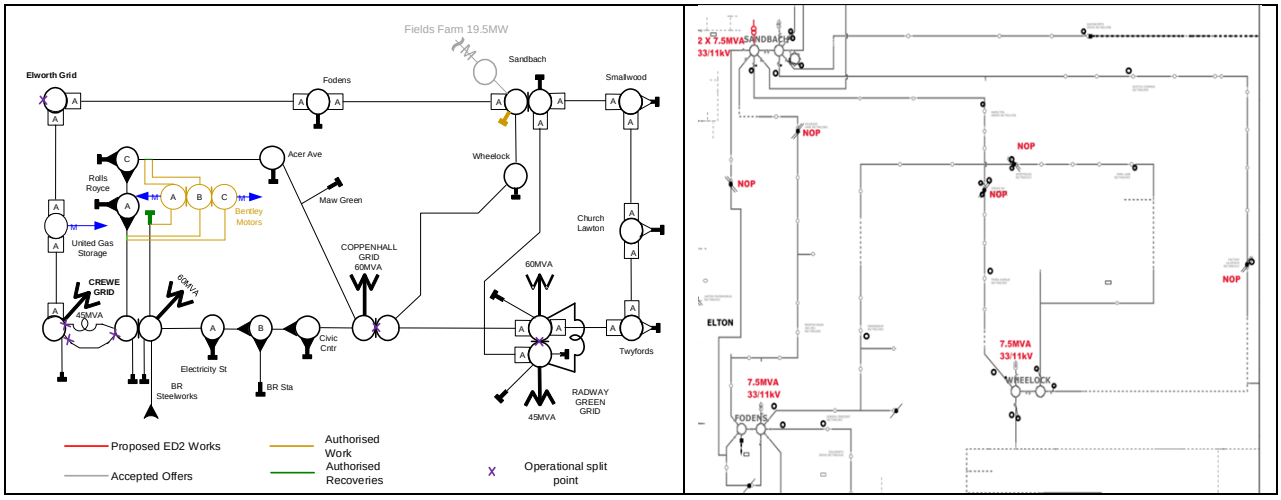

Figure 2. Sandbach 33kV and 11kV network group

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 7.7MVA against firm capacity of 7.5MVA.

The 11kV network primarily consists of 95 sq. mm AL and mix of 0.05/0.1/0.15 ins CU overheard line conductor (OHL) sections. The networks secondary substations supply a mixture of domestic, commercial and industrial customers. The neighbouring Fodens, Wheelock and Smallwood 11kV groups are currently operating at 73%, 76% and 79% utilization correspondingly. Table 2.1 shows the existing network supply position of the group.

Table 2.1. Summary of existing Sandbach primary group network

Substation	Customers	Scenario	LI firm capacity (MVA)	Maximum demand (MVA)	Load Index	Class of Supply(P2/7)
Sandbach	3359	N-1	7.5	6.7	LI2	B

3 Needs Case

The existing firm capacity of the Sandbach primary group is 7.5MVA and the present load index position is LI2 with loading at 90% of the group capacity. As part of the customer driven reinforcements it is planned to install a second 7.5MVA transformer at Sandbach to accommodate the authorised demand within RIIO-ED1.

The authorised 11kV network will be radially operated with split points to the adjacent primary transformer group network. The "Normally Open" points enables to secure the customer supplies during the primary transformer outages, as the load is transferred to the adjacent 11kV groups and vice versa. However, with the authorised demand on the Sandbach and adjacent primary groups several cable sections are approaching cyclic thermal capacity under the outage. The SPM DFES projections for the Sandbach 11kV group forecast a sizeable number of LCTs including 1135 Electric Vehicles and 480 Heat Pumps. The adjacent primary group will have in total of 3100 EVs and 1625 Heat Pumps. Additionally, up to 6MVA of the additional rapid EV charging demand from Sandbach Services is expected to be supported from a new primary substation funded under Green recovery.

There will be insufficient network capacity (thermal) in the 11kV group and the needs case for reinforcement is determined by the magnitude and location of the new demand. This new demand is the sum of the rapid EV charging, economic growth due to HS2 Phase 2A and demand from LCT uptake. Given this, the fixed rapid EV charging demand projection along with the known developments/customer connections was added on top of the SPENs future energy scenario projections.

Further 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 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 3. The anticipated total electric vehicle and heat pump uptakes based on the future energy scenarios is depicted in Figure 4.

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.

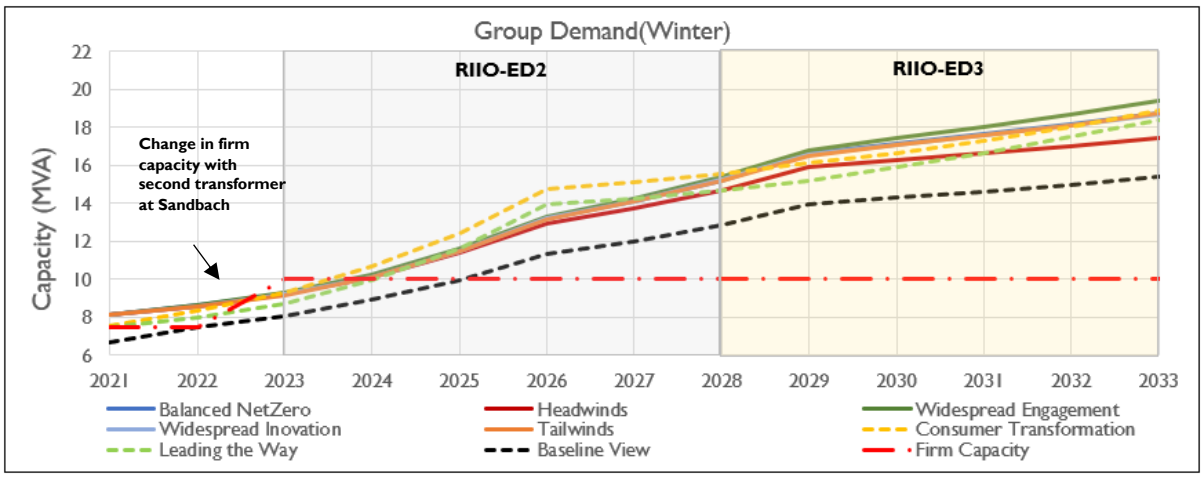

Figure 3. Demand (MVA) forecast for Sandbach primary substation

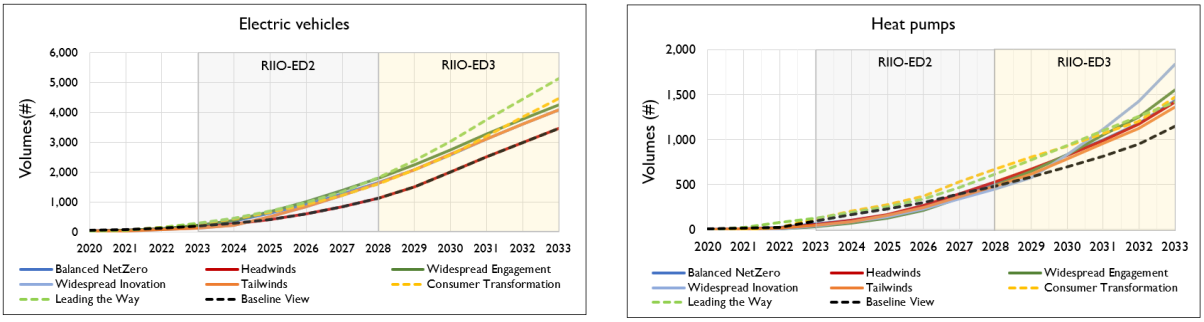

Figure 4. Forecast Electric Vehicle and Heat Pump uptakes for Sandbach primary substation group

3.1.2 Baseline View

For the Sandbach 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	8	8	9	10	11	12	13	14	14	15	15	15
Firm Capacity (MVA)	8	8	10	10	10	10	10	10	10	10	10	10	10
Utilisation (%)	89	100	81	89	100	113	120	128	139	143	146	150	154
Load Index	LI2	LI4	LI2	LI2	LI4	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 Sandbach 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.

The findings from the network impact assessments are detailed in sections below.

3.2.1 Thermal Constraints

Considering the DFES forecast demand and rapid EV charging demand in the group, the thermal constraints that would appear in the RIIO-ED2 period are listed below.

3.2.1.1 Primary Transformer

The primary transformers are rated for 7.5MVA and with the forecast would exceed the group firm capacity of 10MVA within the RIIO-ED2 period without any intervention.

3.2.1.2 11kV network

The 11kV network primarily consists of 95 sq. mm AL UGC and mix of 0.1/0.15 sq. in CU OHL sections. Studies indicate that 11kV OHL sections are approaching cyclic thermal capacity under N-1 conditions, with forecast demand growth and are expected to exceed this rating within the RIIO-ED2 period.

3.2.1.3 Voltage Constraints

There were no voltage constraints identified in the 11kV group network.

3.2.2 EREC P2/7 – Security of Supply

The forecast demand is 14.8MVA by the end of RIIO-ED2 and 17.7MVA by the end of RIIO-ED3. The group will fall into Class C 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 Fodens, Wheelock and Smallwood 11kV groups utilisation is forecast to be 77%, 85% and 99% respectively by the end of RIIO-ED3 and these groups will be thermally constrained in picking up the demand from Sandbach 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 max capacity of ca. 5.3MW is required to alleviate the constraints. Based on these requirements, flexibility services were tendered in September 2020 to provide services between 2023-28 period. Table 3.2 below shows flexibility services in terms of the network risk hours and tendered capacity.

Table 3.2. 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)	804	1699	3247.5	4587	6596.5
Required Flexible Capacity (MW)	1.6	2.2	2.8	3.9	5.3

4 Optioneering

Table 4.1 shows a summary of the options considered for this reinforcement. Option 1 represents the lowest cost solution, 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	The overloading will be over the transformer cyclic ratings and would lead to tripping of the transformer and in turn loss of supplies to rapid EV charging station and over 5000 customers (including largest adjacent single primary group) with a significant CI/CML impact per fault occurrence.
(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 Transformers.	Rejected	Considering the thermal loading during the outage being over the cyclic rating of the transformer, installation of RTTR at primary transformer will not provide any capacity uplift to alleviate the constraint.
(d)	Flexibility Services.	Rejected	Considering the increased risk duration, capacity requirements and cost of flexibility services through RIIO-ED2, reinforcement deferral via flexibility services is not commercially viable. It is proposed to consider flexibility services to manage the risk during project delivery. A combination of flexibility and reinforcement is proposed in Option 1.
(e)	Transfer of demand to Wheelock, Fodens and Smallwood Primary transformer groups.	Rejected	The existing loading on each of the primary transformer group is close to 70% of the firm capacity which includes transfer capacity from adjacent group. With the combined LCT uptake of 4200 EVs and 2100 HPs, transferring demand from Sandbach HV group to these primary group would lead to thermal constraints in these groups.
(f)	New 7.5/10MVA primary transformer substation at Congleton Road and 11kV circuit interconnection to transfer demand from Sandbach.	**Considered (Baseline)**	-
(g)	Install additional 7.5/10MVA primary transformer at Fodens and establish 11kV interconnector between Fodens and Sandbach substation along with flexibility services to manage network risk during project delivery.	**Considered (Option 1)**	-

5 Detailed Analysis & Costs

5.1 Proposed Option 1 – Install additional primary transformer at Fodens

The proposed solution is to alleviate the thermal constraints by installation of additional primary transformer and a new 11kV interconnector. Table 5.1 shows the scheme summary.

Table 5.1. Proposed Option 1 summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)
Conventional	Sandbach Primary Reinforcement	• Install additional 10MVA 33/11kV primary transformer at Fodens. • Extend the existing 33kV indoor board to accommodate 2 breakers at Fodens. • Replant existing 8 panel SWS C4X/C8X switchboard with 12 panel modern switchgear. • Extend existing 11kV switchboard at Sandbach to accommodate 1 breaker. • Establish new 11kV interconnector between Sandbach and Fodens. • Contract flexibility services to manage the network risk during project delivery.	2.501

With the new primary transformer and 11kV interconnector, the proposed scheme will increase the group's firm capacity from 10MVA to 20MVA 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 30MVA.

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 £101k 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 5.2.

Table 5.2. Summary of flexibility service costs

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Reinforcement Deferral Ceiling Cost per year	£0.23m	£0.23m	£0.23m	£0.23m	£0.23m
Cost of Flexibility Services (100% Capacity)	£0.10m	£0.28m	£0.69m	£1.34m	£2.63m
Flexibility Outlook	🟢	🔴	🔴	🔴	🔴

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

🔴 *Reject bids and deliver reinforcements*

It can be noted from above that with the increased risk duration, capacity requirements and cost of flexibility services through RIIO-ED2, reinforcement deferral via flexibility services is not commercially viable. It is proposed to consider flexibility services to manage the risk during project delivery. The cost of flexibility for 2023/24 to 2024/25 assuming 30% utilization during project delivery is shown in Table 5.3.

Table 5.3. Flexibility consideration in Baseline plan

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Flexible Capacity (MW)	1.635	2.19	-	-	-
Project delivery utilization period assumption (%)	30%	30%	-	-	-
RIIO-ED2 Cost (£m)	0.030	0.084	-	-	-

Considering above it is proposed to start the works in 2023/24 and the capacity release of 10MVA will be claimed in 2024/25 at the end of the project. The timing of the project is based on delivering the highest NPV, while managing the network risk via operational management through flexibility services during project delivery.

It is recommended to continue annual tendering for flexibility in this area to procure enough capacity and review the scheme depending on future tenders resulting competitive bids enabling to defer the proposed reinforcements.

Figure 5. and Figure 6. show the aerial view of the existing 33/11kV Sandbach primary substation and the proposed works respectively.

Figure 5. Fodens aerial view

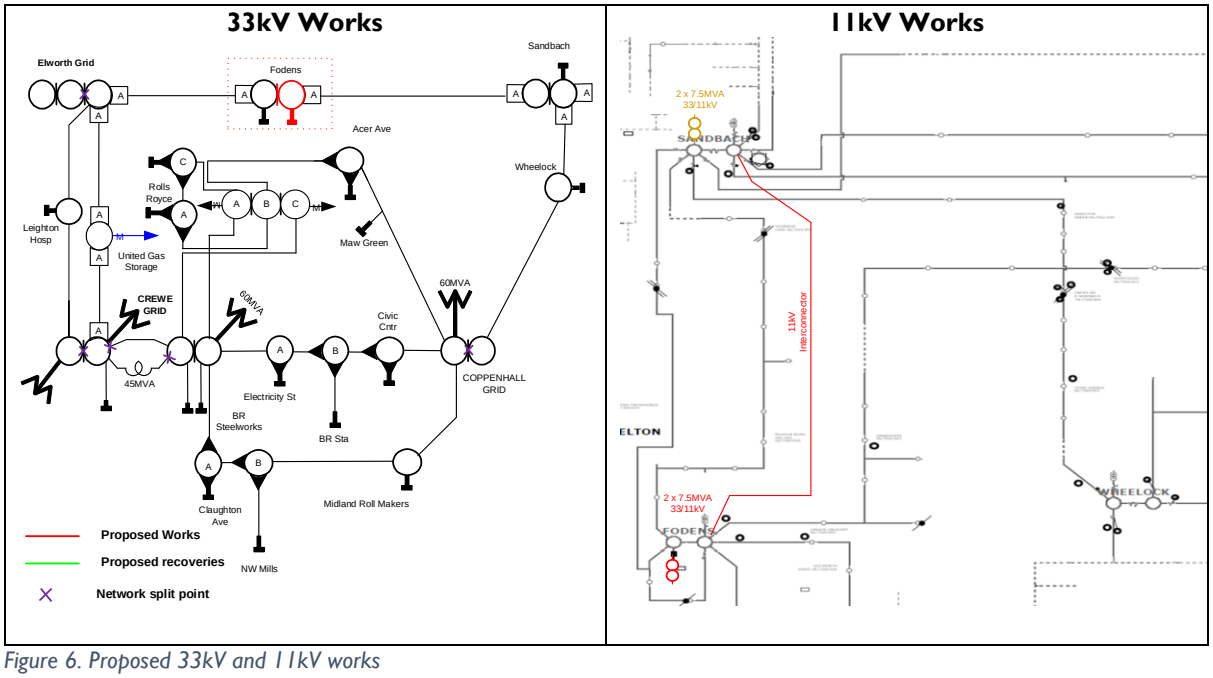

Figure 6. Proposed 33kV and 11kV works

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	4.00	0.470	0.470	-
6.6/11kV CB (GM) Primary	13.00	0.360	0.360	-
33kV UG Cable (Non-Pressurised)	0.10	0.024	0.024	-
33kV CB (Gas Insulated Busbars) (ID) (GM)	2.00	0.341	0.341	-
33kV Transformer (GM)	1.00	0.314	0.314	-
Batteries at 33kV Substations	1.00	0.009	0.009	-
Flexible Services	-	0.113	0.113	-
Civil Works at 33 kV & 66 kV Substations		0.475	0.475	-
Wayleaves/Easements/Land Purchase		0.158	0.158	-
Other Costs (Identify Below)		0.236	0.236	-
Total Costs		**2.501**	**2.501**	-
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 - (£105k)				
Environmental considerations, survey and studies (£50k)				
Planning and design studies (£50k)				
11kV NCP (£22k)				
Noise survey (£9k)				

5.2 Baseline – Establish a New Primary Substation at Congleton Road

This option considers the establishment of a new 33/11kV 10MVA primary substation at a new site preferably at Congleton Road with new 11kV interconnection to Sandbach.

Table 5.5 shows the scheme summary. The option would provide 10MVA additional network capacity and would prevent thermal overloading on Sandbach primary substation group.

This option is rejected due its relatively high cost and gives the similar headroom uplift compared to the Option 1.

Table 5.5. Baseline option summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Conventional	Sandbach Primary Reinforcement	• Establish new 1 x 10MVA 33/11kV primary substation at Gorby Lane • 11kV interconnectors between Congleton Road to Sandbach. • Extend 11kV switchboard at Sandbach.	3.333	-

Table 5.6 shows a summary of reinforcement costs and volumes for Baseline option under RIIO-ED2. The proposed works under this option is shown in Figure 7.

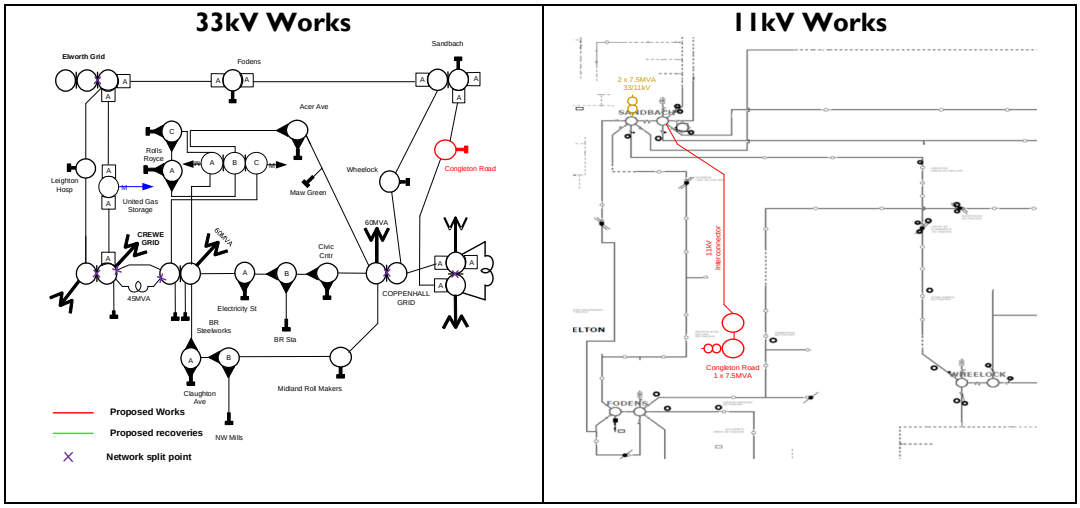

Figure 7. Works proposed under Baseline option

Table 5.6. Baseline 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	3.00	0.352	0.352	-
6.6/11kV CB (GM) Primary	10.00	0.277	0.277	-
33kV UG Cable (Non-Pressurised)	3.00	0.728	0.728	-
33kV CB (Gas Insulated Busbars) (ID) (GM)	3.00	0.511	0.511	-
33kV Transformer (GM)	1.00	0.314	0.314	-
Batteries at 33kV Substations	1.00	0.009	0.009	-
Civil Works at 33 kV & 66 kV Substations		0.425	0.425	-
Wayleaves/Easements/Land Purchase		0.375	0.375	-
Other Costs (Identify Below)		0.362	0.362	-
Total Costs		**3.354**	**3.354**	**-**
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 Options Cost Summary Table

Summary of the costs for each of the evaluated options is presented in Table 5.7.

Table 5.7. Cost summary for considered options

Options	Option Summary	RIIO-ED2 Cost (£m)
Baseline	New 7.5/10MVA primary transformer substation at Congleton Road and 11kV circuit interconnection to transfer demand from Sandbach.	3.354
Option 1 (Proposed)	Install additional 7.5/10MVA primary transformer at Fodens and establish 11kV interconnector between Fodens and Sandbach substation.	2.501

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 to install additional primary transformer at Fodens along with a new 11kV interconnector between Fodens and Sandbach primary substation. It is also proposed to contract with flexibility services providers from 2023/24 to 2024/25 which will enable to manage the risk during project delivery. The proposed reinforcement works are to be started in 2023/24 and the capacity release of 10MVA will be claimed in 2024/25 at the end of the project. The timing of the project is based on delivering the highest NPV, while managing the network risk via operational management through flexibility services during project delivery.

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-009-CV1-CBA – Sandbach 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 – New primary substation at Congleton Road	Rejected	Discounted based on higher scheme cost and lower NPV against proposed option.	-	-	-	-
Option1 – Additional Transformer at Fodens	**Adopted**	The proposed scheme is the least cost solution to accommodate forecasted demand from LCT Uptake.	0.42	0.56	0.65	0.72

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 £2.501m.

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	4.00	0.470	0.470	-
6.6/11kV CB (GM) Primary	13.00	0.360	0.360	-
33kV UG Cable (Non-Pressurised)	0.10	0.024	0.024	-
33kV CB (Gas Insulated Busbars) (ID) (GM)	2.00	0.341	0.341	-
33kV Transformer (GM)	1.00	0.314	0.314	-
Batteries at 33kV Substations	1.00	0.009	0.009	-
Flexible Services	-	0.113	0.113	-
Civil Works at 33 kV & 66 kV Substations		0.475	0.475	-
Other Costs (Identify Below)		0.158	0.158	-
Total Costs		**2.501**	**2.501**	-

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
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 - (£105k)				
Environmental considerations, survey and studies (£50k)				
Planning and design studies (£50k)				
11kV NCP (£22k)				
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	**2.388**	1.194	1.194	-	-	-
CV1 – Flexible Services	**0.113**	0.030	0.083	-	-	-
Total Cost(£m)	**2.501**	1.224	1.277	-	-	-

6.4 Risks

The main delivery risks are the land for the new 11kV cable route and necessary approvals especially related to traffic management. We would mitigate these risks by engaging with local authorities.

Considering Fodens 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.

The increased network thermal loading risk will be managed via flexibility services and temporary load transfer at HV level to adjacent groups during project delivery. The cost of flexibility services is considered as part of Baseline expenditure.

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

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 Pathway	Headwinds	Widespread Engagement	Widespread Innovation	Tailwinds
EVs	1,135	878	1,616	1,1820	1,641	1,135	1,785	1,627	1,627
HPs	481	105	672	615	504	526	493	452	481

**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

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

R1 – Install additional primary transformer at Fodens and new 11kV interconnector

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 for network requirements to beyond the end of RIIO-ED3. Under higher uptake scenarios an additional 33/11kV primary substation may be required by mid-late RIIO-ED3.

Table 6.6: Sensitivity of the proposed RIIO-ED2 expenditure

	Baseline	Uncertain
RIIO-ED2 Expenditure (£m)	2.501	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 to Carbon Prices

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 this design solution and it has not been necessary to carry out any losses justified upgrades.

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 Sandbach 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 Sandbach Primary Reinforcement programme, 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.

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

6.7.2 Supply chain sustainability

For us to take full account of the sustainability impacts associated of the Sandbach 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.
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 Sandbach 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 Sandbach 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 Sandbach group network, the proposed solution is to install additional primary transformer at Fodens along new 11kV interconnector between Fodens and Sandbach primary substations.

It is proposed to start the works in 2023/24 and the release capacity of 10MVA will be claimed in 2024/25 at the end of the project. The estimated cost for the above is £2.501m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

8 Appendices

Appendix 1. System Study Results

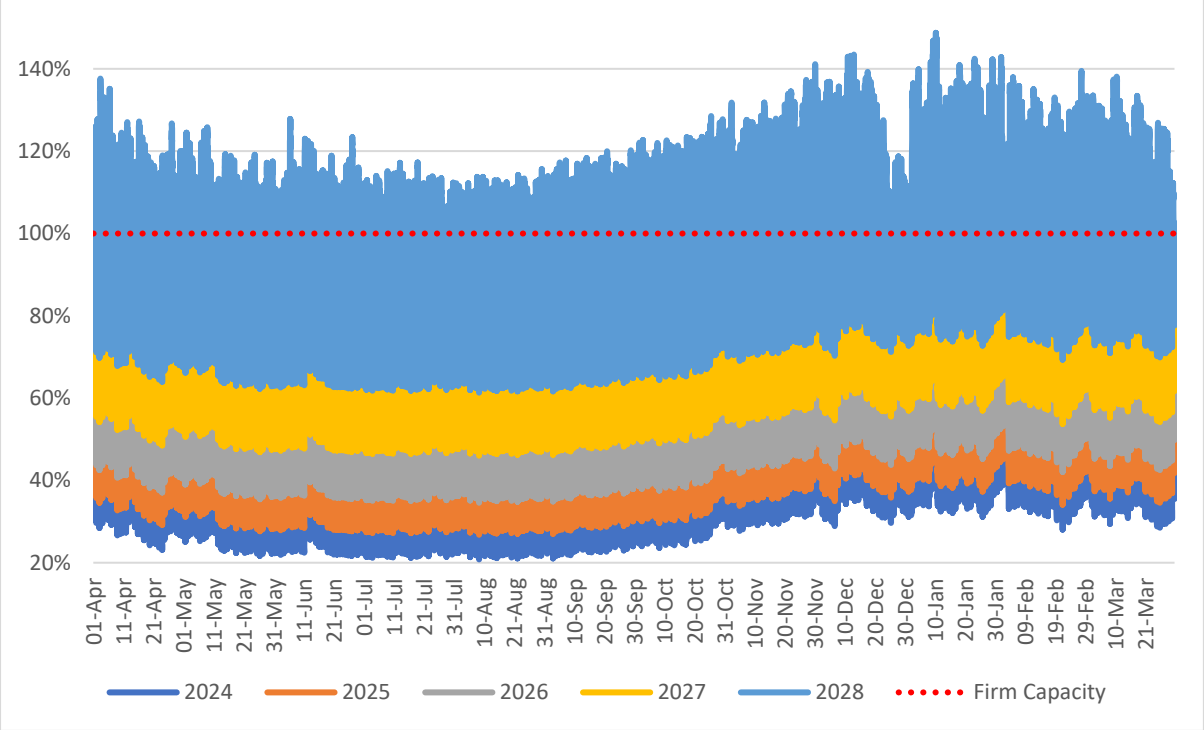

Figure 8. Half-hourly loading on 33/11kV Sandbach primary transformer

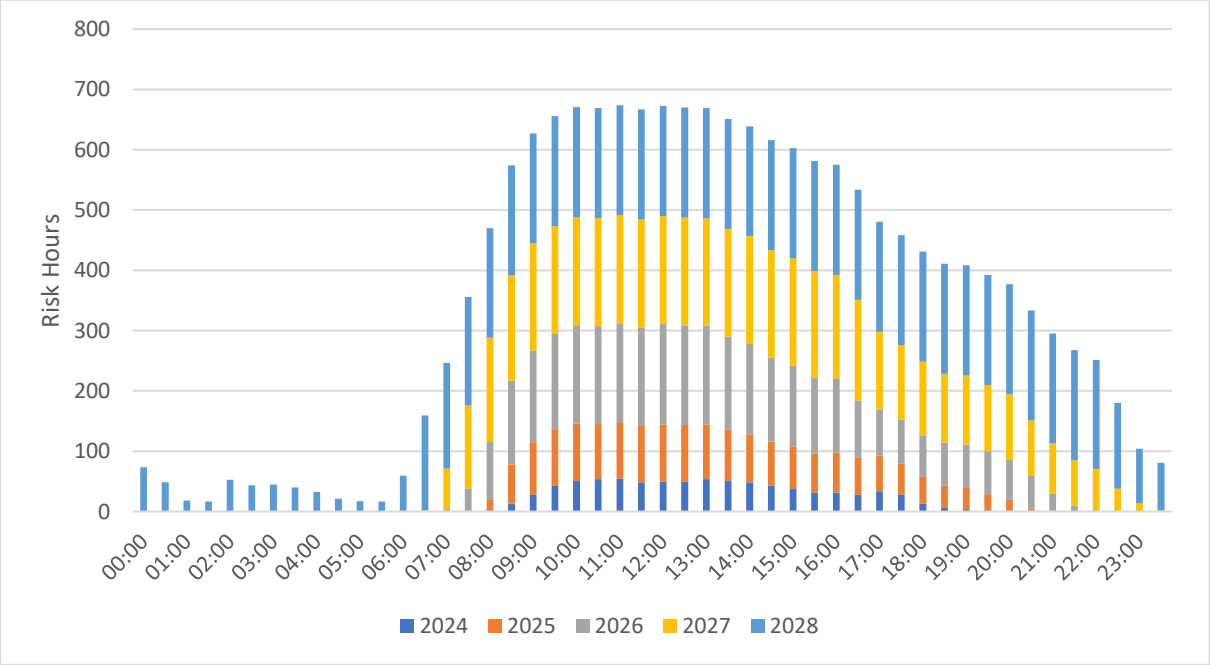

Figure 9. Calculated daily network risk hour window