Weston - Basford Sidings 33kV Reinforcement

ED2 Engineering Justification Paper

ED2-LRE-SPM-016-CV1-EJP

Issue	Date	Comments
Issue 0.1	January 2021	Issue to SRG and external assurance
Issue 0.2	May 2021	Reflecting comments from SRG
Issue 0.3	June 2021	Reflecting assurance feedback
Issue 1.0	June 2021	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	Final Business Plan submission

Scheme Name	Weston - Basford Sidings 33kV Reinforcement		
Activity	33kV Circuit Reinforcement		
Primary Investment Driver	Thermal Constraints		
Reference	ED2-LRE-SPM-016-CV1-EJP		
Output	Load Index		
Cost	£1.267m		
Delivery Year	2026-28		
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
	-	**£1.267m**	-

SP ENERGY NETWORKS

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:	Weston - Basford Sidings 33kV Reinforcements
Project Reference:	ED2-LRE-SPM-016-CV1-EJP
Decision Required:	To give concept approval to reinforce existing 33kV OHL and cable section between Weston – Basford.

Summary of Business Need:

The Crewe and surrounding areas of the SP Manweb (SPM) network will see significant demand increase over the next decade and beyond. The 33kV network group supplies over 78,263 customers including 8 major industrial customers and Sandbach motorway services. The demand growth in this group is expected to exceed network capacity during the ED2 period.

The HS2 rail infrastructure project has indicated a requirement for 97MW of demand for initial construction and rail supplies within the SPM network, of which 29.2MVA will be in the Crewe and Weston area. HS2 has already secured a connection for 7.2MW demand in Weston area. In addition, HS2 is expected to stimulate economic growth in this area.

The SPM DFES forecasts a significant number of LCTs including 20k Electric Vehicles and 9.5k Heat Pumps. There will also be high propensity for growth in rapid charging at Sandbach motorway services.

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

The proposed solution is to reinforce the OHL and cable between Weston – HS2 Hough section of the Weston – Basford 33kV circuit. The proposed solution includes:

- Replacing the 1.213km of overhead line in the section between Weston – HS2 Hough with 400Sqmm XLPE Al underground cable.
- Overlay 0.827km UG cable section between Weston – HS2 Hough with 400 sq. mm XLPE Al underground cable.
- Contract flexibility services for 2026/27 during the scheme delivery to manage the network risk during project delivery.

The estimated cost of the above is £1.267m (2020/21 prices), which will be fully funded by SPEN in the ED2 period.

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

Licence Area	Reporting Table	Description	Total (£m)	Incidence (£m)				
				2023/24	2024/25	2025/26	2026/27	2027/28
SPM	CV1	Primary Reinforcement	1.254	-	-	0.063	0.752	0.439
SPM	CV1	Flexible Services	0.013	-	-	-	0.013	-
Total Expenditure within RIIO-ED2			**1.267**	-	-	0.063	0.765	0.439

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

The SP Manweb (SPM) network in the Crewe, Weston, Alsager, Sandbach, Radway Green, Nantwich and Coppenhall areas of Mid Cheshire is supplied from Cellarhead GSP. The 33kV network group (Crewe/Coppenhall/Whitchurch/Radway Green) supplies over 78,263 customers which includes 8 major industrial customers and Sandbach M6 motorway services.

The Mid Cheshire area is of strategic importance through ED2 period as there will be significant increase in electrical demand due to the HS2 project. This demand increase consists of the demand associated with HS2 (the construction works to deliver the project and the enduring load of the project), and the regional economic growth directly resulting from improved transport links created by the project. SPM will need to create additional network capacity to accommodate this demand.

Part of the HS2 route will pass through SPM's licence area is shown in Figure 1-1; the SPM districts are shown by the highlighted regions. In the Weston area HS2 has already secured 7.2MW demand connection for the HS2 Phase 2A construction and site supplies, this will be delivered by a new primary substation named HS2 Hough. The details of the authorised 7.2MW demand to HS2 is furnished in Appendix-8.1.

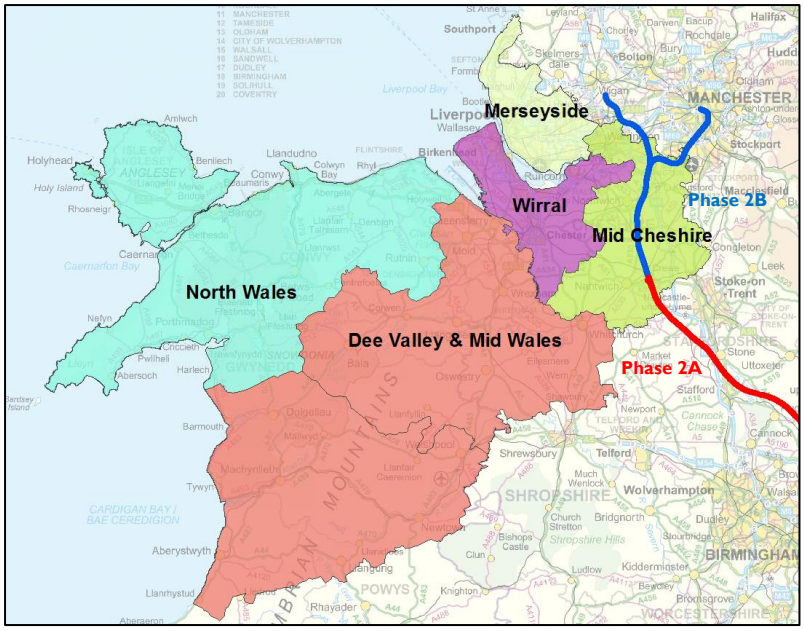

Figure 1-1: HS2 rail project and SPM license area

In addition to above within in RIIO-ED2, DFES forecasts a significant number of LCTs including 20,056 Electric Vehicles and 9,457 Heat Pumps. There will also be high propensity for growth in rapid charging at Sandbach motorway services.

System studies indicate that with the forecasted demand in RIIO-ED2 the thermal overloading on the Weston – HS2 Hough section of the Weston – Basford Sidings 33kV circuit would exceed its cyclic rating during N-1 loss of Crewe GT1A. Further the overloading aggravates when the Weston Power Generation is in operation and it may lead to the thermal overload beyond the protection settings of the circuit and would lead to loss of supplies to HS2 and over 5000 customers.

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 33kV group, through network reinforcement schemes. Summary of the proposed scheme:

- Replacing the 1.213km of overhead line in the section between Weston – HS2 Hough with 400Sqmm XLPE Al underground cable.
- Overlay 0.827km UG cable section between Weston – HS2 Hough with 400Sqmm XLPE Al underground cable.
- Procure flexibility services for 2026/27 during the scheme delivery to manage the network risk.

Total scheme cost – £1.267m (2020/21 prices), of which will be fully funded by SPEN in the ED2 period.

It is proposed to start the works in 2025/26 and the capacity release of 8MVA will be claimed in 2027/28 at the end of the project. The estimated cost for the above is £1.267m (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 33kV Crewe/Coppenhall/Whitchurch/Radway Green group supplied from Cellarhead GSP comprises of total 7 x 132/33kV grid transformers with 3x60MVA at Crewe, 1x60MVA and 1x45MVA at Radway Green and 1x60MVA at Coppenhall and 1x45MVA at Whitchurch.

The 33kV network group secures HV network comprising of 32 primary transformers and these primary transformers supply 78,263 customers. The authorised 33kV Crewe / Coppenhall / Whitchurch/Radway Green group network is shown in Figure 2-1.

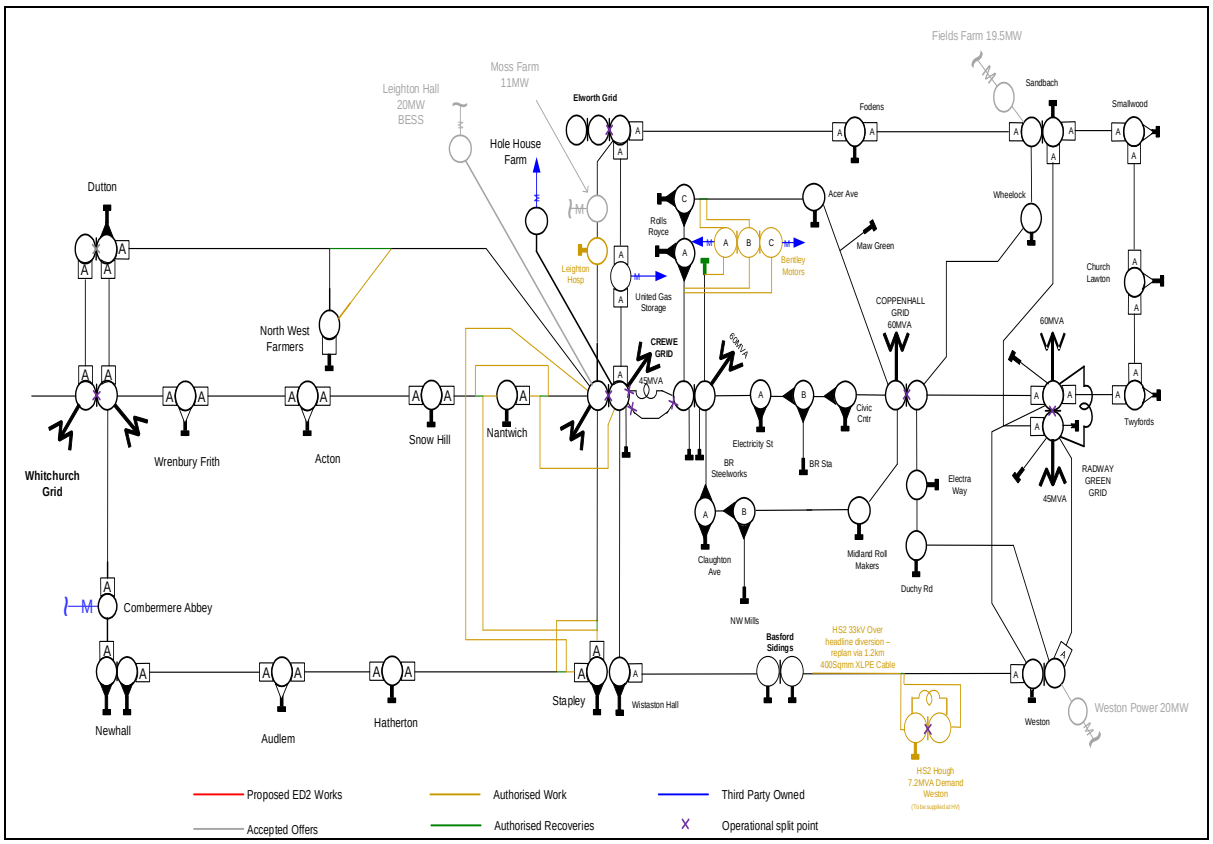

Figure 2-1: Authorised 33kV Crewe/Coppenhall/Whitchurch/Radway Green group network

2.2 Network supply / circuit capacity

The existing 33kV group network is classed as P2/7 Group D (≥60MW and <300MW) with the network demand of 145MVA against firm capacity of 197MVA (N-1).

Table 2-1 shows the existing network supply position and Table 2-2 shows the connected/contracted demand and generation in the group:

Table 2-1: Summary of EHV group network

Substation	No. of customers	Scenario	LI firm capacity	Maximum demand	Load Index	Group P2/7 Class
EHV						
Coppenhall GT1 / Crewe GT1 / Crewe GT2A / Crewe GT4A / Radway Green GT1 / Radway Green GT2 / Whitchurch GT2	78236	N-1	197	145	LI1	D

Table 2-2: Connected/Contracted demand and generation

Customer	Import capacity (MVA)	Export capacity (MW)	POC Volts (kV)	Status
BR Steels	1.9	-	33	Connected
BAE Radway Green	2.8	-	33	Connected
United Gas	11.0	-	33	Connected
Hole Hose Farm	14.0	-	33	Connected
Rolls Royce/ Bentley Motors	16.0	-	33	Connected
Basford Sidings	9.0	-	33	Connected
Leighton Hospital	3.0	-	11	Connected
Maw Green	-	6.0	33	Connected
Combermere Abbey	-	12.0	33	Connected
Leighton BESS	20.0	20.0	33	Contracted
Fields Farm	-	20.0	33	Contracted
Weston Power	-	20.0	33	Contracted
Drury Lane Farm	-	25.0	33	Contracted
HS2	7.2	-	33	Contracted
Total	**84.9**	**103.0**		

Detailed system studies including Intact and N-1 contingencies were performed for the existing 33kV group and there were no thermal or voltage related issues.

2.3 Fault levels

Studies indicate that with the authorised network configuration and customer connections there are no fault level issues.

3 Needs Case

The HS2 rail infrastructure project has indicated 97MW of demand requirement for construction and rail supplies within the SPM network, of which 29.2MVA will be supplied via the 132/33kV network fed from Cellarhead GSP with 9.2MVA including the 7.2MVA demand which is already secured by HS2 and the full capacity expected in this group within the ED2 period. HS2 rail is expected to stimulate economic growth in this area.

The SPM Distribution Future Energy Scenarios forecasts a significant number of LCTs including 20,056 Electric Vehicles and 9,457 Heat Pumps. There will also be high propensity for growth in rapid charging at Sandbach motorway services.

There will be insufficient network capacity (thermal) in the 33kV 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 HS2 demand, rapid charging stations at motorway services, economic growth and demand from LCT uptake. Given this, the fixed HS2 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. This concept paper covers the 33kV Weston – Basford Sidings circuit reinforcements.

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 Local Considerations and stake holder feedback

As part of DFES scenario development SPEN held stakeholder engagement sessions with councils to continue to refine the understanding of their economic growth plans and other drivers. This helps determine the resultant demand increase and impact on our network.

3.1.1.1 East Cheshire region

- In November 2018, the Constellation partnership of seven councils and two local enterprise partnerships published their HS2 Growth Strategy.[1] Within Crewe, the Hub Station 'HS2 campus' is expected to generate 3,750 homes and 20,000 jobs, with a further 3,400 homes and 17,000 jobs across the Crewe Masterplan area.
- In January 2019, Cheshire East council published their 'HS2 Station Hub development strategy'.[2] This outlines the primary, secondary and peripheral development opportunity areas in a 190-hectare zone around the HS2 station. ARUP Group Ltd, on behalf of Cheshire East Council, estimated that across the Crewe Masterplan area, by 2040, the opportunities are likely to be ≥60MVA.
- The Constellation partnership's HS2 Growth Strategy aims to deliver at least 100,000 new homes and 120,000 new jobs by 2040 across the Cheshire, Warrington, Stoke-on-Trent and Staffordshire areas.
- Phase 1 development of new public EV charging stations with a total demand requirement of ~10MW at motorway services stations in Sandbach and Knutsford services

[1] http://constellationpartnership.co.uk/wp-content/uploads/2018/11/hs2-growth-strategy-report-oct-2018.pdf
[2] https://cheshireeast-consult.objective.co.uk/file/5274957

3.1.1.2 HS2

SPEN has engaged extensively with the HS2 to understand the total demand requirements which have been advised as per Table 3-1.

Table 3-1: HS2 Total Capacity requirements (MVA) by year

MVA	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
HS2	-	3.5	7.2	7.2	35	50	72	77	82	82	82	97	97

This demand consists of large supplies for tunnel bore machines (which account for a step increase in demand in early 2025) as well as other construction supplies to be located across the Crewe and Cheshire area of the SPM network. HS2 has already secured connection for the 7.2MVA Phase 2A demand around Weston.

Table 3-2 shows a breakdown of this HS2 demand by voltage level and EHV network group. The HS2 demand requirement will impact the network across Crewe area at all voltage levels.

Table 3-2: HS2 capacity requirements (MVA) by voltage

GSP Group	EHV Network group	Capacity Requirements (MVA)			
		Phase 2A (11kV)	Phase 2B (33kV)	Phase 2B (11kV)	Total
Cellarhead	**Crewe Area** Coppenhall-Crewe-Radway Green-Whitchurch	7.2	20.0	2	29.2
	TOTAL	**7.2**	**20.0**	**2**	**29.2**

3.1.1.3 SPEN's own experience

Around Crewe SPM has experienced an unprecedented level of applications for new connections (demand) and enquiries due to these regional and local growth policies. For example, the Crewe, Nantwich, Weston, Alsager and Sandbach conurbations have all seen large numbers of housing scheme applications; ongoing stakeholder engagement suggests many more are in the pipeline.

3.1.2 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 anticipated residential electric vehicle and heat pump uptake based on the future energy scenarios is depicted in Figure 3-1.

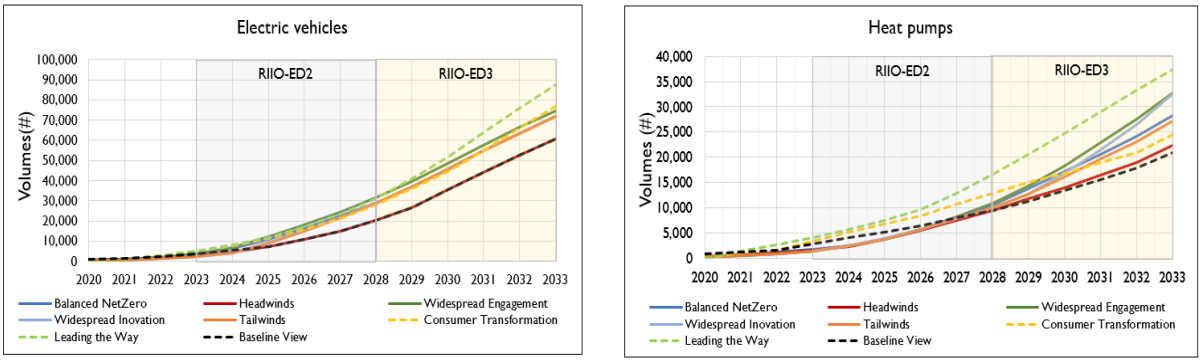

Figure 3-1: LCT uptake profile for the 33kV group

The winter demand forecast based on the future energy scenarios along with the projected demand from authorised connections is shown in Figure 3-2.

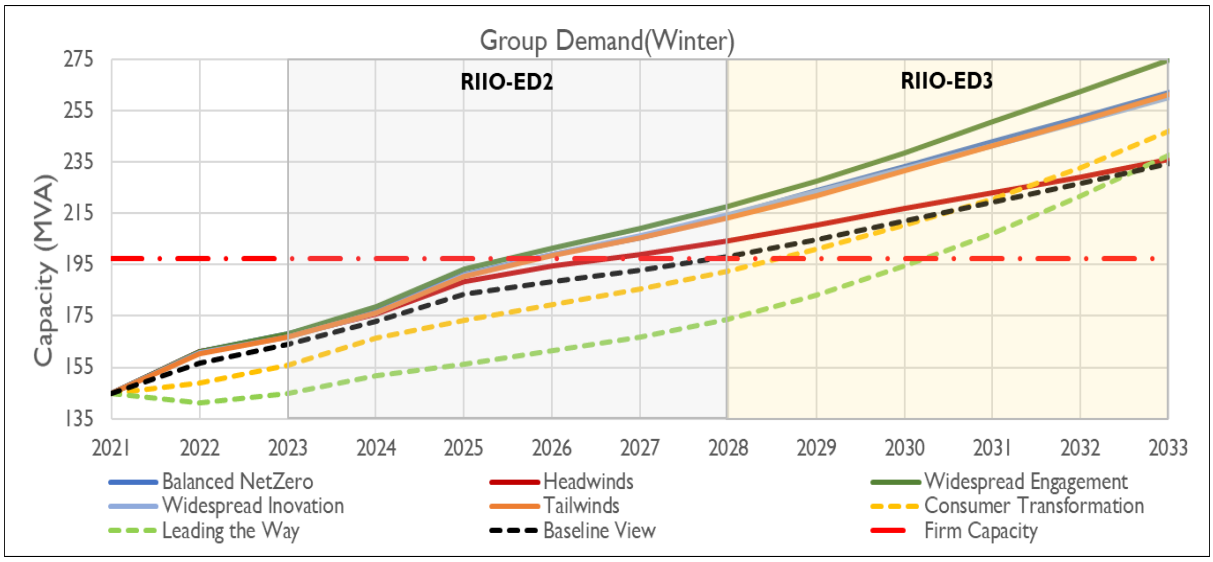

Figure 3-2: Demand forecast for the 33kV group network

3.1.3 Baseline view

For the 33kV 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 3-3.

Table 3-3: Baseline view forecasts

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Forecast Demand (MVA)	145	157	164	173	183	189	193	198	205	212	219	227	235
Firm Capacity (MVA)	221	221	197	197	197	197	197	197	197	197	197	197	197
Utilisation (%)	73	79	83	88	93	95	98	100	104	107	111	115	119
Load Index	LI1	LI1	LI2	LI2	LI2	LI3	LI3	LI4	LI5	LI5	LI5	LI5	LI5

3.2 Network Impact Assessment

Detailed network studies covering Intact, N-1, N-1-1 and fault level assessments were conducted for the 33kV network considering the different demand forecast scenarios. The findings from the network impact assessments are detailed in sections below.

3.2.1 Thermal Constraints

Table 3-4 depicts the thermal constraints at 132/33kV network level:

Table 3-4: Thermal constraints at 132kV and 33kV level

Network Item	Voltage(kV)	Outage
Radway Green GT1	132/33	N-1/N-1-1
Weston-Basford Sidings circuit	33	N-1
Coppenhall – Acer Avenue circuit	33	N-1
Acer Avenue Transformer	33/11	N-1
Sandbach Transformer	33/11	N-1

This concept paper covers the proposed mitigation for the mitigation of thermal constraint on the 132/33kV 45MVA GT1.The mitigation measures for the other three constraints above are covered in separate named scheme justification papers.

3.2.2 Voltage Constraints

There were no voltage constraints identified in the 33kV group network.

3.2.3 Fault Level Constraint

There were no additional fault level related constraints at 33kV.

3.2.4 Network Risk and Flexibility

The profile-based simulation (17520 simulations/year) studies indicate that the risk potential of thermal overload on the 33kV Weston - Basford Sidings circuit starts from the year 2026/27 throughout to the year 2028 and required a max capacity of ca. 5MW by 2028. Based on these requirements, flexible services were tendered to provide services between 2027-28 period. Table 3-5 below shows the network risk hours, tendered capacity and qualified capacity from the connected/future customers in the group.

Table 3-5: Network risk duration and Flexible Capacity (MW)

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Risk Duration (Hrs)	-	-	-	93	6812
Required Flexible Capacity (MW)	-	-	-	1.9	5.00

4 Optioneering

Table 4-1 below shows the long list of options considered for the scheme. Few of the options are rejected based on technical / commercial rustications, the rest of the options are taken forward for detailed analysis and included in the cost benefit analysis.

Among the options taken forward, the **Baseline** option to reinforce the Weston-Basford 33kV circuit is the 'do minimum' option to address the thermal overloads.

Table 4-1: Long list of optioneering solutions

#	Options	Status	Reason for rejection
(a)	No Intervention	Rejected	For an outage of GT2A at Crewe the thermal overload on the circuit between Weston to Basford Sidings will be over the protection setting and would lead to tripping of the circuit and in turn loss of supplies to HS2 and over 5000 customers.
(b)	Reinforcement of Weston – Basford Sidings 33kV OHL and cable section along with flexibility services to manage network risk during project delivery.	Considered (**Baseline**)	-
(c)	Real Time Thermal Rating of the 33kV circuit.	Rejected	Considering the thermal loading during the outage being over the protection settings Real Time Thermal Rating will not provide any capacity uplift to alleviate the constraint.
(d)	Network reconfiguration by transferring Wistaston Hall Primary transformer into Claughton Avenue – Crewe 33kV circuit	Rejected	Considering the limited capacity in the Claughton Avenue – Crewe 33kV circuit, the transfer of Wistaston Hall primary demand would result in thermal issues.
(e)	Re-routing the 33kV circuit between Radway Green – Weston to Basford Sidings.	Rejected	The solution would aggravate the thermal overloading.
(e)	Re-conductor the 33kV OHL section with 200 AAAC OPPC between Radway Green – Weston to Basford Sidings	Rejected	Re-conducting the OHL section will aggravate the thermal constraints on the Weston – HS2 Hough section of the Weston – Basford circuit.
(f)	New 33kV circuit between Weston to HS2 Hough.	Considered (**Option 1**)	-
(g)	New 33kV interconnector between Basford Sidings and Stapely.	Rejected	The new circuit between Basford Sidings and Stapely will not alleviate the thermal constraint.
(h)	Flexibility Services.	Rejected	Rejected considering limited response to flexibility tenders.
(i)	Increase the % impedance of the bus-reactor at HS2 Hough.	Rejected	The increased impedance would lead to voltage issues around Basford and Weston area. Further increasing the % impedance will increase the network losses.

5 Detailed Analysis

Network studies indicate that the thermal loading of the 33kV Weston – Basford Sidings circuit post connection of HS2 Hough and 7.2MVA of demand would exceed its capacity. As part of the HS2 connection it was proposed to install bus-reactor to mitigate the thermal overloading during outage of Crewe GT1. Further the HS2 Hough – Basford Sidings section of the 33kV Weston- Basford Sidings circuit will be reinforced as part of the HS2 diversion works which will be fully funded by HS2.

However, with the forecasted demand within RIIO-ED2 the thermal overloading on the Weston – HS2 Hough section of the Weston – Basford Sidings 33kV circuit would exceed its cyclic rating, in addition when the Weston Power Generation is operating it may lead to the thermal overload beyond the protection settings of the circuit, and would lead to loss of supplies to HS2 and over 5000 customers.

5.1 Baseline (Proposed) – Reinforcement of Weston – Basford 33kV circuit

To mitigate the thermal issues on the Weston to HS2 Hough section of the Weston – Basford Sidings circuit it is recommended to reinforce the Weston - HS2 Hough section as part of ED2. The proposed solution includes:

- Replacing the 1.213km overhead line section between Weston - HS2 Hough with 400 sq. mm XLPE Al underground cable.
- Overlay 0.827km UG cable section between Weston - HS2 Hough with 400 sq. mm XLPE Al underground cable.
- Contract flexibility services for 2026/27 during the scheme delivery to manage the network risk during project delivery.

Figure 5-1 presents the indicative cable route/site locations and Figure 5-2 shows relevant network single line diagram with the proposed scheme.

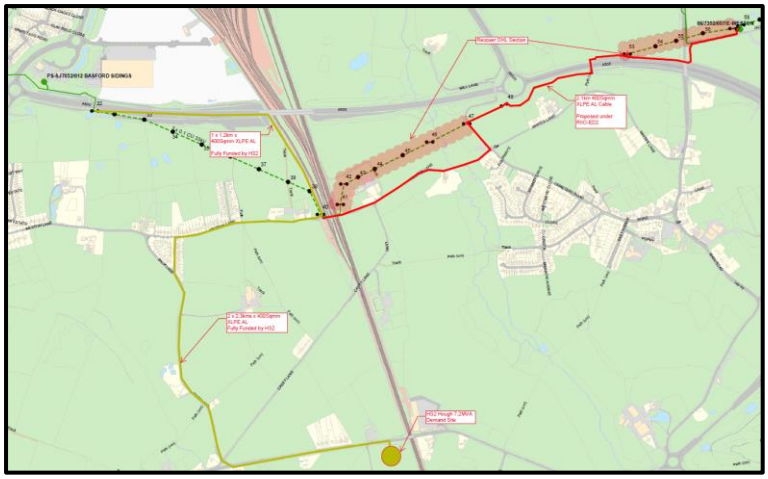

Figure 5-1: Proposed strategic reinforcements locations and indicative cable routes

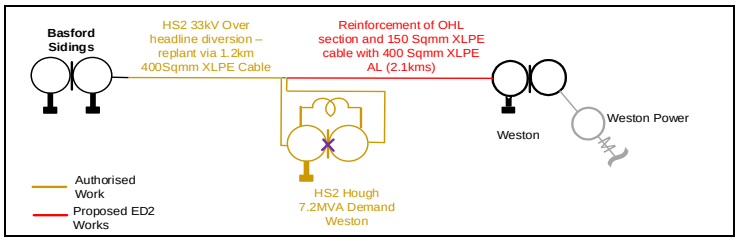

Figure 5-2: Weston – Basford 33kV scheme with HS2 Hough 7.2MVA

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 £52k 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 5.1.

Table 5.1. Summary of flexibility service costs

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Reinforcement Deferral Ceiling Cost - per year	-	-	-	£0.052m	£0.052m
Cost of Flexibility Services (100% Capacity)	-	-	-	£0.013m	£3.4m
Flexibility Outlook					

Accept bids and support the network during reinforcement delivery

Reject bids and deliver reinforcements

The cost of flexibility from 2026/27 to 2027/28 based on the recent tenders is £3.4m for a total of 6.9MW. Thus, it is recommended to accept bids for the year 2026/27 and reject the bids for the year 2027/28.

Considering the above it is proposed to start the reinforcement works in 2025/26 and utilize flexibility services in 2026/27 to manage the network risk during project delivery. The capacity release of 8MVA will be claimed in 2027/28 at the end of the project. The estimated cost for the above is £1.267 (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. The costs for the proposed solution along with flexibility services is presented in Table 5-2.

Table 5-2: Proposed solution costs

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution(£m)	Customer Contribution(£m)
33kV UG Cable (Non-Pressurised)	2.10	0.509	0.509	-
Pilot Wire Underground	2.10	0.244	0.244	-
Flexible Services	-	0.013	0.013	-
Civil Works at 33 kV & 66 kV Substations	-	0.050	0.050	-
Wayleaves/Easements/Land Purchase	-	0.250	0.250	-
Other Costs (Identify Below)	-	0.212	0.212	-
Total Costs		**1.267**	**1.267**	**-**
Associated protection, control and SCADA equipment located at a site and remote ends - (£42k)				
Railway Crossing and Traffic Management- (£120k)				
Environmental considerations and recovery of the OHL section (£50k)				

5.2 Option 1 – New 33kV Weston – HS2 Hough Circuit

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution(£m)
Circuit reinforcement	Weston-Basford 33kV	Extension of switchboard at Weston and HS2 Hough substations. New 33kV circuit between HS2 Hough and Weston 5.5kms XLPE AL Cable	3.279	-

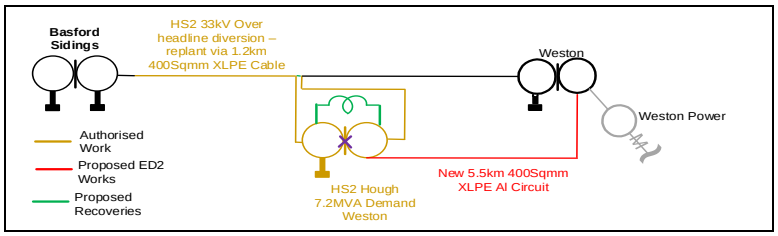

Figure 5-3: New 33kV circuit between Weston – HS2 Hough

Table 5-3: Option -1 cost summary

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution(£m)	Customer Contribution(£m)
33kV UG Cable (Non-Pressurised)	5.50	1.334	1.334	-
33kV CB (Gas Insulated Busbars) (ID) (GM)	2	0.341	0.341	-
33kV Switch (GM)	2	0.095	0.095	-
Pilot Wire Underground	5.50	0.609	0.609	
Civil Works at 33 kV & 66 kV Substations		0.250	0.250	-
Wayleaves/Easements/Land Purchase		0.350	0.350	-
Other Costs (Identify Below)		0.300	0.300	-
Total Costs		**3.279**	**3.279**	**-**
Associated protection, control and SCADA equipment located at a site and remote ends - (£55k)				
Environmental survey and studies (£60k)				
Railway Crossing and Traffic Management (£125k)				
Planning and Design Studies (£60k)				

5.3 Options Cost Summary Table

Based on design studies to determine the costs of the options identified as addressing the network thermal and security of supply issue, the following two options have been considered as shown in Table 5-4.

Table 5-4: Costs summary for considered options

Options	Total Costs(£m)
Baseline – 33kV Circuit reinforcement	1.267
Option 1- New 33kV circuit	3.279

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 which involves reinforcing the thermally constrained Weston – Basford 33kV circuit. This option will provide an uplift in thermal headroom of ca. 8MVA to the 33kV group to be claimed as output for the scheme upon completion.

6.2 Cost Benefit Analysis

A cost benefit analysis (CBA) was carried out to compare the NPV of the options discussed in the previous sections. Considering the forecast capital expenditure, the proposed option has the highest total NPV against other options. Based on the outcome of the CBA, the proposed option is to reinforce the existing 33kV section between Weston – HS2 Hough of Weston- Basford circuit. The summary of the cost benefit analysis is presented in Table 6-1.

The full detailed CBA is provided within "ED2-LRE-SPM-016-CV1-CBA – Weston-Basford Sidings 33kV Reinforcement".

Table 6-1: Summary of Cost Benefit Analysis

Options considered	Decision	Comment	NPVs based on payback periods from 2023/24 (£m)			
			10 years	20 years	30 years	45 years
Baseline – Existing 33kV circuit reinforcements	Adopted	The proposed scheme is the least cost solution to accommodate HS2 and the future demand growth.	-	-	-	-
Option 1- New 33kV circuit between Weston - HS2 Hough	Rejected	Discounted based on higher scheme cost.	-£1.17	-£1.53	-£1.74	-£1.92

6.3 Cost & Volumes Profile

Table 6-2 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 £1.267m to reinforce the 33kV circuit between Weston and HS2 Hough.

Table 6-2: Summary of reinforcement costs and volume

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution(£m)	Customer Contribution(£m)
33kV UG Cable (Non-Pressurised)	2.10	0.509	0.509	-
Pilot Wire Underground	2.10	0.244	0.244	-
Flexible Services	-	0.013	0.013	-
Civil Works at 33 kV & 66 kV Substations	-	0.050	0.050	-
Wayleaves/Easements/Land Purchase	-	0.250	0.250	-
Other Costs (Identify Below)	-	0.212	0.212	-
Total Costs		**1.267**	**1.267**	**-**
Associated protection, control and SCADA equipment located at a site and remote ends - (£42k)				
Railway Crossing and Traffic Management- (£120k)				
Environmental considerations and recovery of the OHL section (£50k)				

Table 6-3: Cost incidence over the RIIO-ED2 period, £m (2020/21 Prices)

Total Investment	Total (£m)	Cost Incidence (£m)				
		2023/24	2024/25	2025/26	2026/27	2027/28
Primary Reinforcement (CV1)	1.254	-	-	0.063	0.752	0.439
Flexible Services (CV1)	0.013	-	-	-	0.013	-
Total Costs	1.267	-	-	0.063	0.765	0.439

6.4 Risks

Cable overlays/replacements are BaU activity and hence the risks associated with the delivery of the proposed scheme are very minimal. The past track record is detailed in "Annex 4A.11: Cable

Modernisation" of our ED2 business plan. The learnings from the delivery of the previous schemes will be useful in the delivery of the proposed scheme.

The main delivery risks are the necessary approvals and traffic management for the new 33kV circuit route. We intend to mitigate these risks by actively engaging with local authorities.

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 driver for the proposed reinforcement the thermal overload on the circuit between Weston to Basford Sidings, for an outage of GT2A at Crewe, the thermal loading on the Weston – Basford Sidings 33kV circuit will be over the protection setting and would lead to tripping of the circuit and in turn loss of supplies to HS2 and over 5000 customer.

6.6.2 Payback Periods

The CBA indicates that a positive NPV result in all assessment periods (10, 20, 30 & 45 years) which are consistent with the lifetime of the intervention. Consumers 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 has been tested against and has been found to be 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 SPENs DSO vision and future energy strategy.

For the Coppenhall GT1 / Crewe GT1 / Crewe GT2A / Crewe GT4A / Radway Green GT1 / Radway Green GT2 / Whitchurch GT233kV group, Table 6-5 shows electric vehicle and heat pump uptakes across a range of future pathways in the group. Table 6-6 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.

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	20,056	15,154	27,905	31,215	29,001	20,056	31,529	28,751	28,751
HPs	9,457	7,099	12,944	16,592	10,529	9,560	11,019	10,055	10,033

** 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: Electric Vehicle and Heat Pump uptakes across a range of 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									R1				R2	
Leading the Way											R1		R2	
Consumer Transformation										R1			R2	
Balanced Net Zero							R1					R2		
Headwinds								R1					R2	
Widespread Engagement							R1				R2			R3
Widespread Innovation							R1					R2		
Tailwinds							R1					R2		

R1 – Weston – Basford 33kV circuit reinforcements
R2 – Additional 33KV circuit reinforcements
R3 – New 132/33kV grid transformer at Coppenhall

The proposed solution is robust across the range of future pathway scenarios. The proposed intervention is required under all scenarios in RIIO-ED2 or early in RIIO-ED3. The timing of the requirement is sensitive to uptake rates but is found to be required under all scenarios within the RIIO-ED2 period. Additional 33kV circuit works are expected to be required in the group within the RIIO-ED3 timeframe under all except one scenario. The timing of this is sensitive to uptake rates. Under the highest uptake scenario, a new grid infeed may be required to accommodate rapid LCT uptake by end of RIIO-ED3.

Table 6-6: Sensitivity of the proposed RIIO-ED2 expenditure

	Baseline	**Uncertain**
RIIO-ED2 Expenditure (£m)	1.267	-
Comment	Proposed option.	N/A

6.6.4 Asset Stranding Risks & Future Asset Utilisation

Electricity demand and generation uptakes are forecast to increase under all scenarios. The stranding risk is therefore considered to be low and it is predicted asset utilisation will not exceed the design/switchgear ratings in the RIIO-ED2 period.

6.6.5 Losses Sensitivity

Losses have been considered in accordance with License 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.

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 Future Asset Utilisation

It has been assessed that the preferred option is consistent with the future generation and demand scenarios and that the risk of stranding is very low.

6.6.7 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 safe operation of the distribution network and its enduring ability to facilitate wider whole system benefits.

6.7 Sustainability and Environmental Considerations

6.7.1 Environment and Sustainability

This scheme may be subject to Environmental Impact Assessment and other statutory planning requirements, and the contents of this environmental section are not provided in lieu of any Environmental Statement that may be required.

6.7.2 Operational and embodied carbon emissions

The proposed scheme has limited 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 Weston – Basford 33kV reinforcement 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 28 tonnes. The monetised embodied carbon value associated with this emission is £2k.

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.

6.7.3 Supply chain sustainability

For us to take full account of the whole-life carbon impact of proposed scheme, we need access to reliable data to be provided by 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.

6.7.4 Resource use and waste

The proposed scheme 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).

6.7.5 Biodiversity/ natural capital

The proposed scheme will affect undeveloped sites as well as developed sites containing existing assets. However, the impact on, and the opportunity to improve biodiversity and natural capital is expected to be minimal.

6.7.6 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.

6.7.7 Visual amenity

SPEN continually seeks to reduce the landscape and visual effects of our networks and assets, and our use of underground cables instead of overhead lines helps to minimise our overall visual impact.

6.7.8 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

The Crewe and surrounding areas of the SPM network will see significant demand increase over the next decade and beyond. The 33kV network group supplies over 78,263 customers including 8 major industrial customers and Sandbach motorway services. The demand growth in this group is expected to exceed network capacity during the ED2 period.

In order to accommodate additional demand from HS2, economic growth and LCT uptake and mitigate the thermal overloading issue on the 33kV circuit by reinforcing the Weston – HS2 Hough section of the Weston – Basford Sidings circuit. The recommended solution comprises:

- Replacement of the 1.213km overhead line section between HS2 Hough and Weston with 400Sqmm XLPE Al underground cable.
- Overlay 0.827km UG cable section between HS2 Hough and Weston with 400Sqmm XLPE Al underground cable.
- Contract flexibility services for 2026/27 during the scheme delivery to manage the network risk during project delivery.

Total scheme cost – £1.267m (2020/21 prices), of which will be fully funded by SPEN in the ED2 period.

The proposed solution represents the lowest cost and most efficient engineering solution to meet the forecast demand growth when compared with the alternative schemes identified, provides an additional uplift of 8MVA to groups' firm capacity.

8 Appendices

8.1 HS2 Accepted Demand(7.2MVA)

S No.	Connection Reference	Location	Date Required	Connection Demand KVA	Connection Required For
1	CA5-00-P086	Rail Systems DNO (Intervention A+, Crewe Station)	Q1 2025	247	Network Rail
2	CA5-00-P087	Rail Systems DNO (Intervention A+, Sydney Road)	Q1 2025	58	Network Rail
3	CA5-36-P080	Rail Systems DNO (near Lower Den Farm, Blakenhall Bridleway 8 Accommodation Overbridge)	Q1 2025	226	Network Rail
4	CA5-37-P032	Network Rail Pumping Station 1	Q1 2025	373	Network Rail
5	CA5-37-P081	Potato Fields TSL (Rail Systems DNO near Blakenhall Bridleway 12)	Q1 2025	36	Network Rail
6	CA5-38-P082	Chorlton PSP (Rail Systems DNO near Chorlton Lane)	Q1 2025	100	Network Rail
7	CA5-38-P088	South Crewe Crossovers	Q1 2026	298	Network Rail
8	CA5-39-P083	Rail Systems DNO near Newcastle Road	Q1 2025	250	Network Rail
9	CA5-39-P084	Rail Systems DNO near Casey Lane	Q1 2025	181	Network Rail
10	TBC	Rail Systems DNO near OB 69 Haywood (North of Betley Rd. Jcn)	Q1 2025	105	Network Rail
11	CA5-37-P030	245-S2 South Crewe MPATS	Q1 2025	3000	HS2 Permanent Connection
12	CA5-35-T143	Checkley North Embankment satellite compound	Q1 2021	5	HS2 Temporary Connection
13	CA5-35-T147	Checkley Lane West Railway System Compound	Q1 2025	25	HS2 Temporary Connection
14	CA5-36-T151	Den Lane East rail systems satellite compound	Q2 2024	8	HS2 Temporary Connection
15	CA5-36-T155	Den Lane West rail systems satellite compound	Q2 2024	120	HS2 Temporary Connection
16	CA5-36-T159	Blakenhall Northbound Spur Embankment satellite compound	Q1 2021	190	HS2 Temporary Connection
17	CA5-36-T163	Blakenhall Cutting satellite compound (WCML)	Q4 2021	80	HS2 Temporary Connection
18	CA5-37-T167	Waybutt Lane rail systems satellite compound	Q2 2025	57	HS2 Temporary Connection
19	CA5-37-T171	Delta Junction Railway System Compound	Q2 2025	13	HS2 Temporary Connection
20	CA5-37-T175	Crewe South Cutting satellite compound	Q1 2021	57	HS2 Temporary Connection
21	CA5-37-T179	Swill Brook rail systems satellite compound	Q3 2026	17	HS2 Temporary Connection
22	CA5-38-T183	Heath Farm rail systems satellite compound	Q4 2025	17	HS2 Temporary Connection
23	CA5-39-T187	Chorlton Cutting satellite compound	Q1 2021	67	HS2 Temporary Connection
24	CA5-39-T191	Creamery Bridge rail systems satellite compound	Q2 2024	70	HS2 Temporary Connection
25	CA5-39-T195	Crewe South Portal satellite compound	Q1 2021	40	HS2 Temporary Connection
26	CA5-39-T199	Casey Lane East rail systems satellite compound	Q2 2024	8	HS2 Temporary Connection
27	CA5-39-T203	Basford Hall Southbound rail systems satellite compound	Q2 2024	75	HS2 Temporary Connection
28	CA5-40-T258	Basford Cutting Batching Plant	Q2 2021	300	HS2 Temporary Connection
29	CA5-40-T260	Basford Cutting Main Compound	Q2 2021	550	HS2 Temporary Connection
30	CA5-40-T264	Crewe South Crossovers rail systems satellite compound	Q2 2024	75	HS2 Temporary Connection
31	CA5-40-T297	Basford Cutting Temporary Worker Accommodation	Q2 2024	260	HS2 Temporary Connection
32	CA5-41-T268	Alexandra Stadium rail systems satellite compound	Q1 2021	35	HS2 Temporary Connection
33	CA5-41-T272	Motorail Terminal rail systems satellite compound	Q1 2021	115	HS2 Temporary Connection
34	CA5-41-T276	Tommy's Lane RRAP rail systems satellite compound	-	35	HS2 Temporary Connection
35	CA5-41-T280	Crewe Retail Park (ALDI) rail systems satellite compound	-	120	HS2 Temporary Connection

8.2 System Study Results

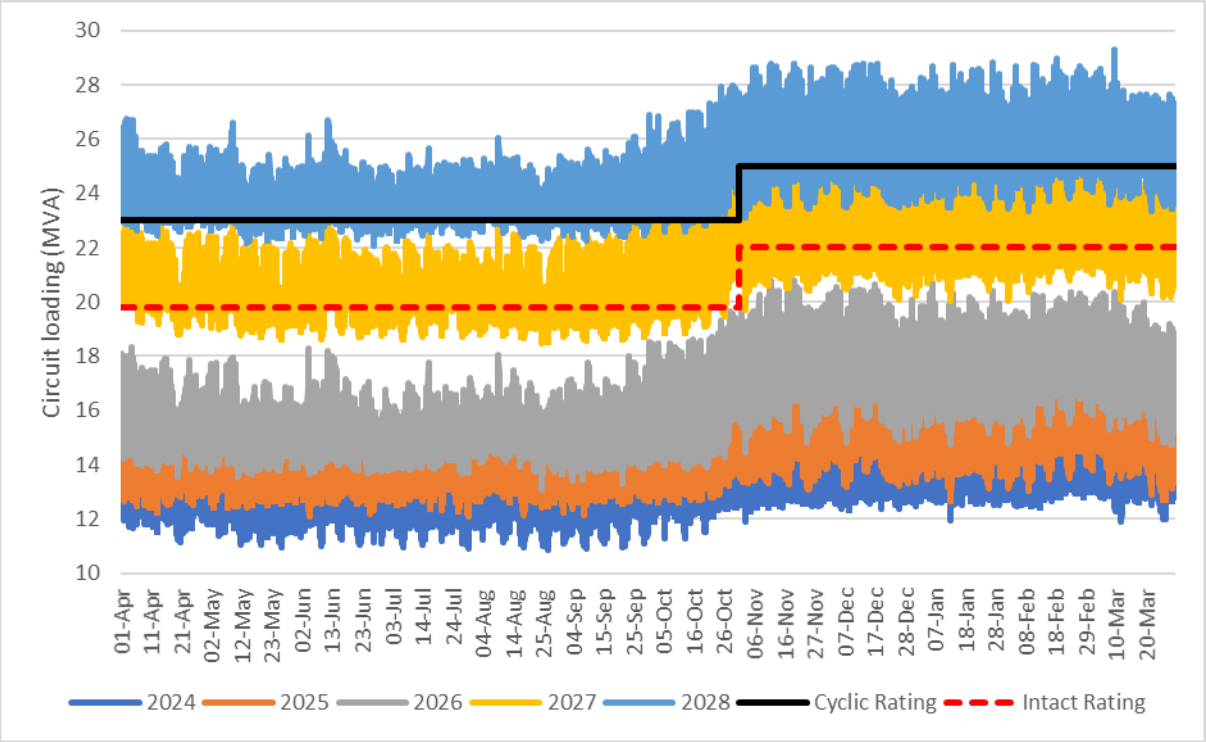

Figure 8-1: Weston – Basford 33kV circuit loading(calculated) in RIIO-ED2

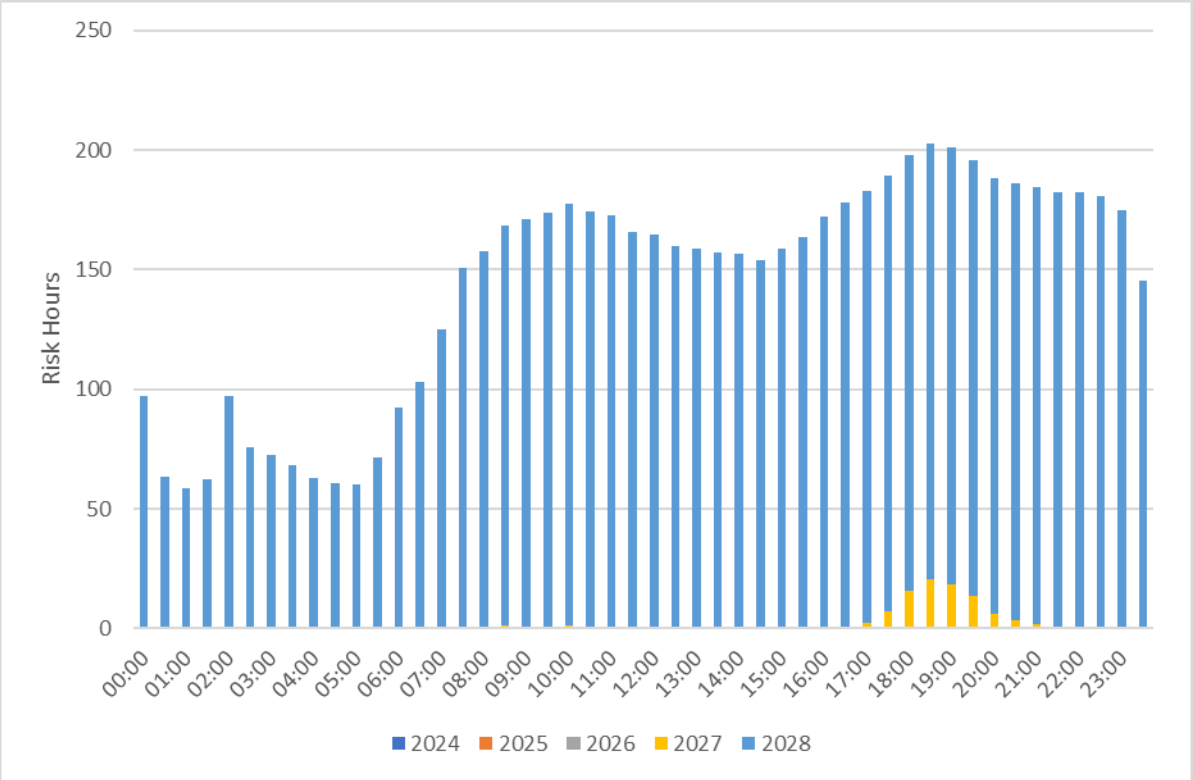

Figure 8-2: Calculated risk hours based on Weston -Basford circuit thermal overloads in RIIO-ED2