Radway Green 33kV Reinforcement

ED2 Engineering Justification Paper

ED2-LRE-SPM-015-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	Radway Green 33kV Reinforcement		
Activity	132/33kV Transformer Replacement		
Primary Investment Driver	Thermal Constraints		
Reference	ED2-LRE-SPM-015-CV1-EJP		
Output	Load Index		
Cost	£1.924m		
Delivery Year	2025-27		
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
	-	**£1.924m**	**-**

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:	Radway Green 33kV Reinforcement
Project Reference:	ED2-LRE-SPM-015-CV1-EJP
Decision Required:	To give concept approval to replace existing 45MVA 132/33kV Grid Transformer at Radway Green.

Summary of Business Need:

The Crewe, Weston, Alsager, Sandbach, Radway Green, Nantwich and Coppenhall areas of the SP Manweb 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 1 motorway services.

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 20,056 Electric Vehicles and 9,457 Heat Pumps. There will also be high propensity for growth in rapid charging at Sandbach motorway services.

Detailed network studies indicate that with the additional demand within RIIO-ED2, the loading on 132/33kV 45MVA GT1 at Radway Green would exceed the cyclic rating of the transformer during outage of 60MVA GT2.

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

The proposed solution is to replace existing 45MVA 132/33kV Radway Green GT1 with 60MVA (synthetic ester) unit along with replacement of 45MVA GT1 transformer tails, existing auxiliary transformer, and neutral earthing resistor. Flexible Services will be procured for 2026/27 year to manage the network risk during the delivery of the proposed scheme.

The estimated cost of the above is £1.924m (2020/21 prices), which will be fully funded by SPEN in the ED2 period.

Expenditure Forecast (in 2020/21 prices)

Licence Area	Reporting Table	Description	Total (£m)	Incidence (£m)				
				2023/24	2024/25	2025/26	2026/27	2027/28
SPM	CV1	Primary Reinforcement	**1.872**	-	0.468	0.749	0.655	-
SPM	CV1	Flexible Services	**0.052**	-	-	-	0.052	-
Total Expenditure within RIIO-ED2			**1.924**	-	0.468	0.749	0.707	-

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.

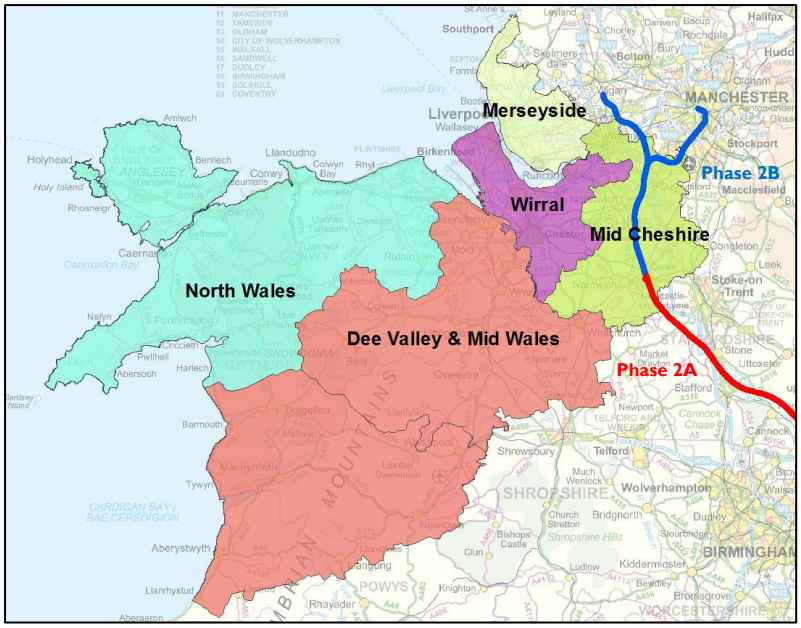

Figure 1-1: HS2 rail project and SPM license area

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.

Detailed network studies indicate that with the additional demand within RIIO-ED2, the loading on 132/33kV 45MVA GT1 at Radway Green would exceed the cyclic rating of the transformer during outage of 60MVA GT2. 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 on the Radway Green GT1 by replacing transformer.

Summary of the proposed scheme:

- Replacement of 45MVA 132/33kV Radway Green GT1 with 60MVA (synthetic ester) unit along with replacement of 45MVA GT1 transformer tails, existing auxiliary transformer, and neutral earthing resistor.

- Procure flexible services for the year2026/27 during the scheme delivery to manage the network risk.

It is proposed to start the works in 2024/25 and the capacity release of 15MVA will be claimed in 2026/27 at the end of the project. The estimated cost for the above is £1.924m (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.

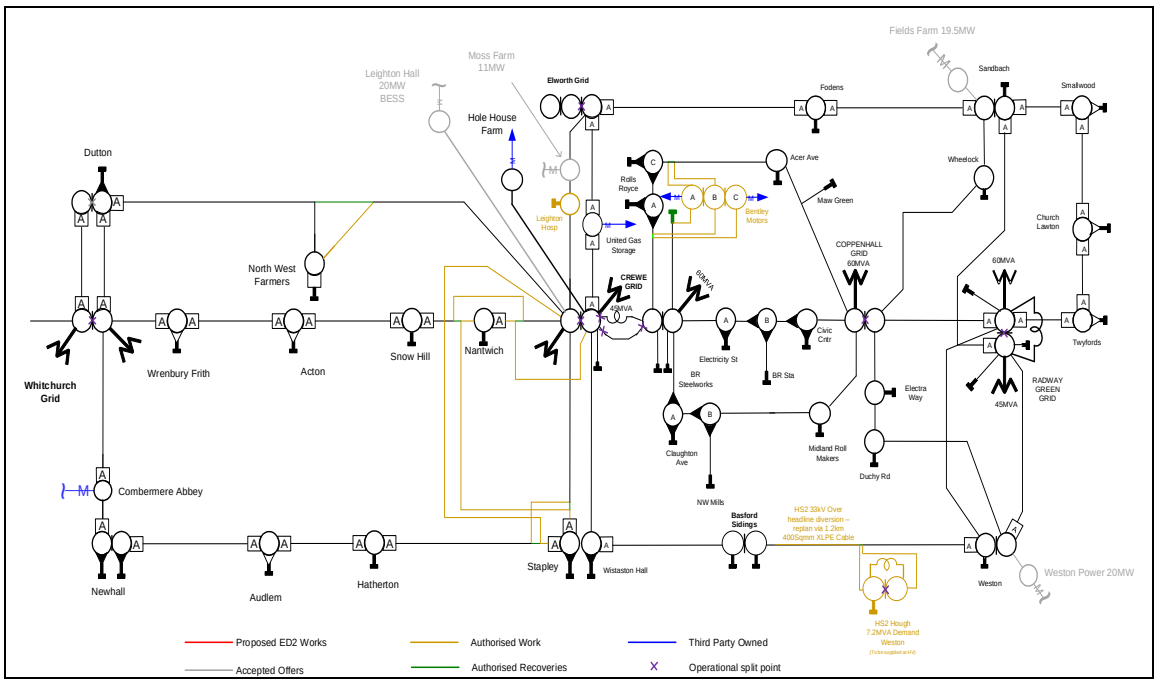

Figure 2.1: Authorised 33kV Crewe/Coppenhall/Whitchurch/Radway Green group network

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	78,263	N-1	197.4	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

Customer	Import capacity (MVA)	Export capacity (MW)	POC Volts (kV)	Status
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 network 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 29.2MW will be supplied via the 132/33kV network fed from Cellarhead GSP with 9.2MW including the 7.2MW 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 reinforcement of 132/33kV 45MVA GT1 at Radway Green.

3.1 Forecast Demand

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

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.

[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

Table 3-1: HS2 Total Capacity requirements (MW) 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 7.2MW 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 (MW) by voltage

GSP Group	EHV Network group	Capacity Requirements (MW)			
		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**	**7.2**	**20.0**	**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.

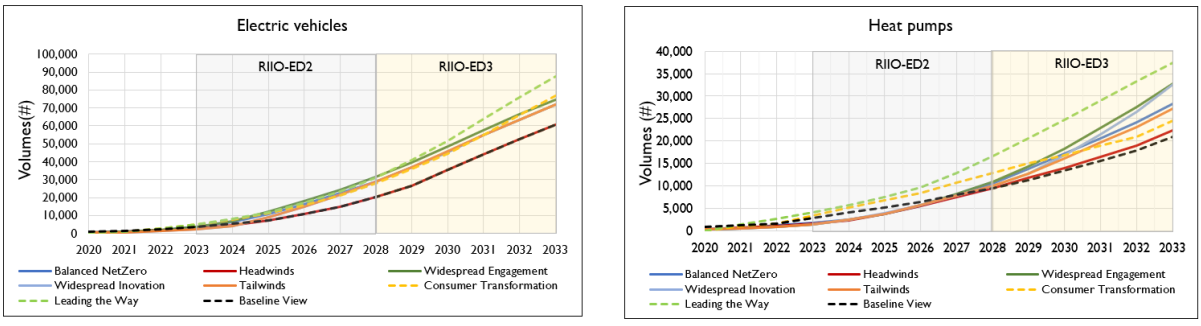

Figure 3.1: LCT uptake profile for the 33kV group

The winter demand forecast based on the future energy scenarios along with the projected demand from authorised connections is shown in Figure 3.2.

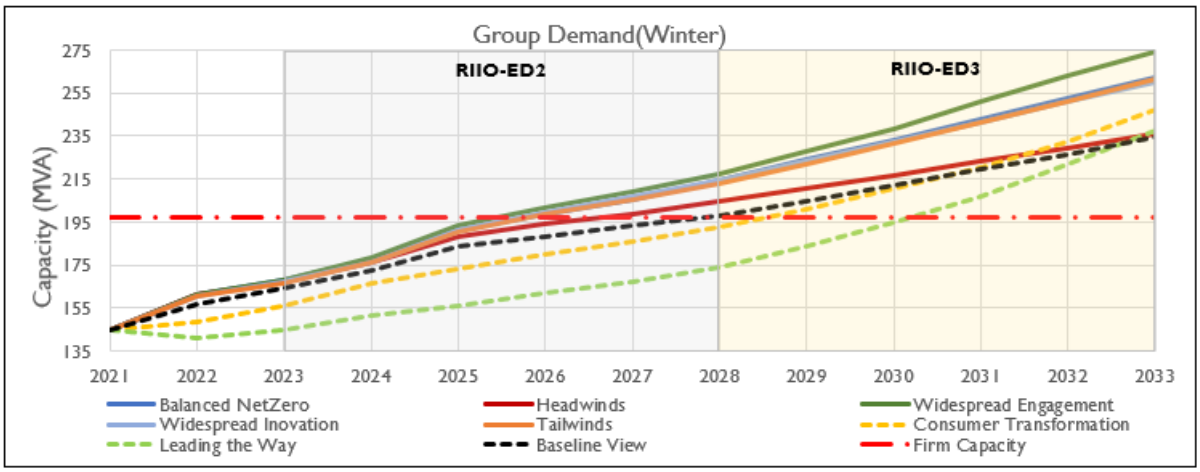

Figure 3.2: Demand forecast for the 33kV group network

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)	197	197	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 132/33kV 45MVA GT1 at Radway Green starts from the year 2026/27 throughout to the year 2028 and required a max capacity of ca. 9.9MW 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)	-	-	-	294.5	1714.5
Required Flexible Capacity (MW)	-	-	-	4.7	9.9
Received Flexible capacity (MW)	-	-	-	4.7	9.9
Flexible capacity met (%)	-	-	-	100%	100%
Cost(£m)	-	-	-	0.052	0.85

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 is to replace existing 45MVA 132/33kV GT1 at Radway Green is the 'do minimum' option to address the thermal overloads.

Table 4-1: Long list of optioneering solutions

Option	Description	Status	Reason for rejection
(a)	No Intervention	Rejected	For an outage of GT2 at Radway Green the thermal overload on 45MVA GT1 will be over the transformer cyclic ratings and would lead to tripping of the transformer and in turn loss of supplies to HS2 and over 35000 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)	Replacement of 132/33kV 45MVA GT1 at Radway Green with 60MVA unit along with flexibility services to manage network risk during project delivery.	Considered (**Baseline**)	-
(d)	Real Time Thermal Rating of the 132/33kV 45MVA Grid Transformer.	Rejected	Considering the thermal loading during the outage being over the cyclic rating of the transformer, installation of RTTR at GT1 will not provide any capacity uplift to alleviate the constraint.
(e)	Network reconfiguration by permanently closing the 33kV bus-section breaker at Coppenhall grid substation.	Rejected	This option alleviates the thermal constraint on the 45MVA Radway Green, however with the bus-section closed at Coppenhall grid substation fault levels at Coppenhall and Crewe grid substation will exceed the design limits.
(f)	Installation of 33kV 60MVA bus-section reactor with X=10% at Coppenhall grid substation. With reactor operating in "Normally Closed".	Rejected	The 33kV fault levels under this option will be within plan ratings. However, this option does not alleviate the thermal overloading constraint on the 132/33kV Radway Green GT1.
(g)	Installation of 132/33kV 60MVA Grid Transformer at Weston.	Considered (**Option1**)	
(h)	Flexibility Services.	Rejected	Rejected considering limited response to flexibility tenders.

5 Detailed Analysis

Network studies indicate that with the additional demand from HS2, rapid charging stations at Sandbach services and LCT uptake across the network thermal loading on the 132/33kV 45MVA GT1 at Radway Green will exceed the cyclic rating during outage of 60MVA GT2. This thermal constraint would lead to loss of supplies to HS2 and over 35000 customers around Weston, Alsager, Sandbach, Radway Green and Congleton with significant CI/CML impact.

5.1 Baseline (Proposed) – Replace the Radway Green 45MVA GT1 with 60MVA unit

To mitigate the thermal issue, it is recommended to replace the existing 45MVA 132/33kV GT1 at Radway Green. The proposed solution includes:

- Replacement of 45MVA 132/33kV Radway Green GT1 with 60MVA (synthetic ester) unit along with replacement of 45MVA GT1 transformer tails, existing auxiliary transformer, and neutral earthing resistor.
- Contract flexibility services to manage network risk during project delivery

Figure 5.1 presents the aerial view of the existing 132/33kV Radway Green grid substation.

Figure 5.1: Aerial view of Radway Green grid substation

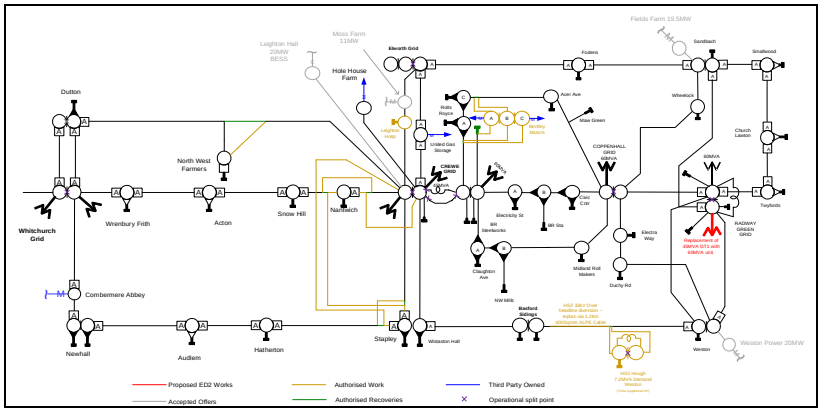

Figure 5.2: 33kV group network with the replacement of GT1 at Radway Green grid substation

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 £0.075m 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	£0.075m	£0.075m	£0.075m	£0.075m	£0.075m
Cost of Flexibility Services (100% Capacity)	-	-	-	£0.052m	£0.850m
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 £0.9m for a total of 15.6MW. Thus, it is recommended to accept bids for the year 2026/27 and reject the bids for the year 2027/28.

Considering above it is proposed to start the reinforcement works in 2024/25 and the capacity release of 15MVA will be claimed in 2026/27 at the end of the project. The estimated cost for the above is £1.924m (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)	0.20	0.049	0.049	-
33kV CB (Air Insulated Busbars) (OD) (GM)	1	0.058	0.058	-
132kV UG Cable (Non-Pressurised)	0.05	0.055	0.055	-
132kV Switchgear - Other	3	0.055	0.055	-
132kV Transformer	1	1.214	1.214	-
Flexible Services	-	0.052	0.052	
Civil Works at 33 kV & 66 kV Substations		0.096	0.096	-
Civil Works at 132 kV Substations		0.240	0.240	-
Other Costs (Identify Below)		0.105	0.105	-
Total Costs		**1.924**	**1.924**	-
Protection changes and relay upgrades - £75k				
Environmental considerations - £30k				

5.2 Option 1 – Install a new 60MVA GT at Weston

Option 1 involves a new 60MVA grid infeed at Weston and ca, 8km long 132kV circuit to Weston Grid by teeing off at tower DG31 on the exiting Crewe – Barlaston 132kV circuit. The total cost of the scheme is £5.810m.

This option is rejected based on the high scheme costs and as well as the longer lead-time associated with installing the new 132kV circuit.

Table 5-3: Option 1 scheme summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Substation reinforcement	New 132/33kV Grid Transformer at Weston	1. Install 132kV OHL conductor on the second circuit from the existing Tee-Off point (at tower DG31) on the Barlaston - Crewe 132kV Circuit. 2.Install new 132kV 3-Panel outdoor switchboard. 3.Install New 132/33kV 60MVA grid transformer at existing Weston 33kV substation. 4.Extend the existing 33kV switchboard at Weston.	5.810	-

Figure 5.3: Aerial view of existing Weston substation

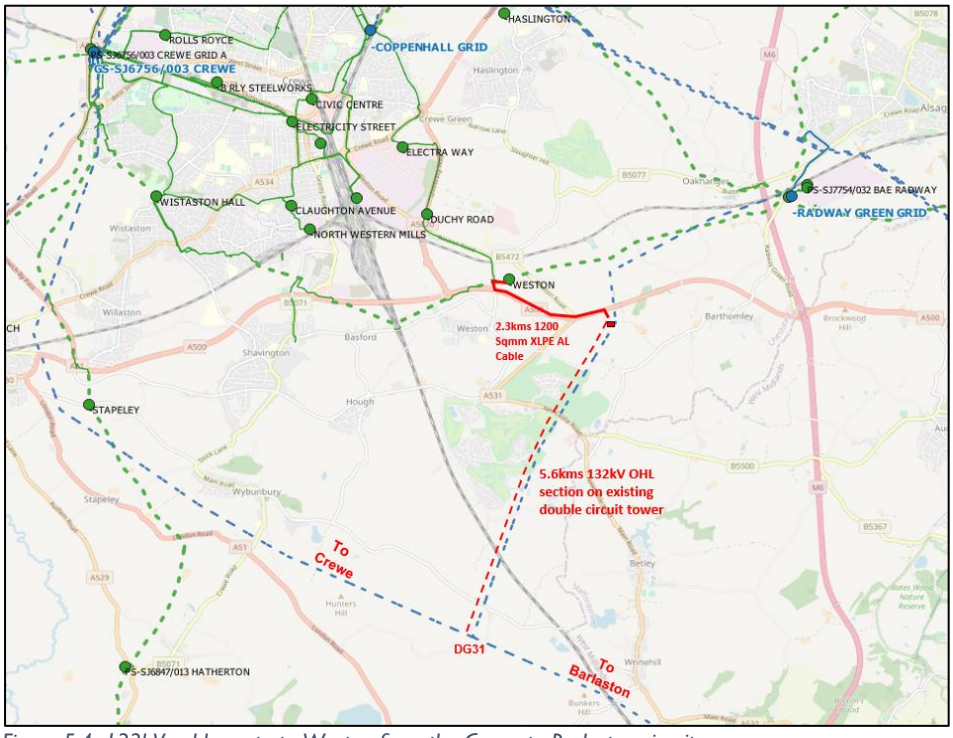

Figure 5.4: 132kV cable route to Weston from the Crewe to Barlaston circuit.

Table 5-4: Option 1 costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
33kV CB (Air Insulated Busbars) (OD) (GM)	1	0.051	0.051	-
33kV Switchgear - Other	1	0.075	0.075	-
132kV OHL (Tower Line) Conductor	5.60	0.336	0.336	-

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
132kV UG Cable (Non-Pressurised)	2.30	2.551	2.551	-
132kV CB (Air Insulated Busbars) (OD) (GM)	3	0.529	0.529	-
132kV Switchgear - Other	3	0.055	0.055	-
132kV Transformer	1	1.214	1.214	-
Civil Works at 33 kV & 66 kV Substations		0.150	0.150	-
Civil Works at 132 kV Substations		0.450	0.450	-
Wayleaves/Easements/Land Purchase		0.200	0.200	-
Other Costs (Identify Below)		0.200	0.200	-
	Total Costs	**5.810**	**5.810**	**-**

5.3 Options Technical 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:

Table 5-5: Technical summary for considered options

Options	Option Summary	Total Cost(£m)
Baseline	Replace existing 45MVA 132/33kV GT1 with 60MVA unit.	1.924
Option 1	Install a new 60MVA 132/33kV GT at Weston.	5.810

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 comprises replacing the existing 45MVA Radway GreenGT1 with 60MVA unit to mitigate the thermal overloads on the grid transformer. The new 60MVA GT will balance the power flows in to the 33kV group at Radway and the new GT being Tier 2 Eco unit, the group will benefit from reduction in network losses.

This option will provide an uplift in thermal headroom of ca. 15MVA to the 33kV group to be claimed as output for the scheme upon completion.

6.2 Cost Benefit Analysis

A cost-benefit analysis was carried out to compare the NPV of the two options discussed in the previous sections. Considering the lowest forecast capital expenditure, the proposed option has the highest total NPV and represents the lowest-cost option when losses and other operational costs are included in the analysis. The summary of the cost benefit analysis is presented in Table 6-1.

The full detailed CBA is provided within "ED2-LRE-SPM-015-CV1-CBA – Radway Green 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– Replacement of GT1 at Radway Green	Proposed	The proposed scheme is the least cost solution to accommodate HS2, rapid charging stations at Sandbach services and the future demand growth.	-	-	-	-
Option 1- New 60MVA 132/33kV GT at Weston	Rejected	Discounted based on higher scheme cost.	-3.09	-4.76	-5.77	-6.64

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 £1.924m to install a replace the 45MVA Radway Green GT1 with 60MVA unit.

Table 6-2: Summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)
33kV UG Cable (Non-Pressurised)	0.20	0.049	0.049
33kV CB (Air Insulated Busbars) (OD) (GM)	1	0.058	0.058
132kV UG Cable (Non-Pressurised)	0.05	0.055	0.055
132kV Switchgear - Other	3	0.055	0.055
132kV Transformer	1	1.214	1.214
Civil Works at 33 kV & 66 kV Substations		0.052	0.052
Civil Works at 132 kV Substations		0.096	0.096
Other Costs (Identify Below)		0.240	0.240
Total Costs		**1.924**	**1.924**
Protection changes and relay upgrades - £75k			
Environmental considerations - £30k			

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)	1.872	-	0.468	0.749	0.655	-
Flexible Services (CV1)	0.052	-	-	-	0.052	-
Total Cost	1.924	-	0.468	0.749	0.707	-

6.4 Risks

Grid Transformer 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.14: 132kV Plants and Circuits" 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 Radway grid substation is outdoor type and there is enough space to do an 'inline' transformer replacement. Three outage seasons are considered for delivery, owing to size of the 33kV group required; this will be co-ordinated with SPM ED2 delivery plan and the network outage requirement, the cost incidence is reflective of this.

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 is to address the thermal overloads on the Radway 45MVA GT1 unit due to the forecast LCT growth and HS2 demand uptake in this 33kV group.

6.6.2 Payback Periods

The CBA indicates that proposed option demonstrates better NPV results in assessment periods (10, 20, 30 years) against other 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 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 6-4 shows electric vehicle and heat pump uptakes across a range of future pathways in the group. 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.

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: 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									R^1				R^2	
Leading the Way											R^1		R^2	
Consumer Transformation										R^1			R^2	
Balanced Net Zero							R^1					R^2		
Headwinds								R^1					R^2	
Widespread Engagement							R^1				R^2			R^3
Widespread Innovation							R^1					R^2		
Tailwinds							R^1					R^2		

R^1 – Radway Green GT replacement
R^2 – Additional 33KV circuit reinforcements
R^3 – 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. 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 two uptake scenarios 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)	1.924	-
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 Operational and embodied carbon emissions

The proposed scheme 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 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 345 tonnes. The monetised embodied carbon value associated with this emission is £20k.

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 whole-life carbon impact of our 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.

6.7.3 Resource use and waste

The proposed scheme 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 proposed scheme will only affect a single named site containing existing assets, so 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. However, as the proposed scheme only consists of relatively minor works to sites containing existing assets, there is little visual impact for us to mitigate in this instance.

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

The Crewe, Weston, Alsager, Sandbach, Radway Green, Nantwich and Coppenhall areas of the SP Manweb network will see significant demand increase over the next decade and beyond. The 33kV network group supplies over 78,263 customers.

In order to accommodate additional demand from HS2, rapid charging stations at Sandbach services, economic growth and LCT uptake and mitigate the thermal overloading issue on the 45MVA 132/33kV GT1. The recommended solution comprises:

- Replacement of 45MVA 132/33kV Radway Green GT1 with 60MVA (synthetic ester) unit along with replacement of 45MVA GT1 transformer tails, existing auxiliary transformer and neutral earthing resistor.
- Procure flexible services for the year2026/27 during the scheme delivery to manage the network risk.

Total scheme cost – £1.924m (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. A thermal uplift of 15MVA will be claimed as the scheme output after the completion.

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	Motorall 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