Carrington Fiddlers Ferry 132kV Reinforcement

ED2 Engineering Justification Paper

ED2-LRE-SPM-002-CV1-EJP

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

Scheme Name	Carrington Fiddlers Ferry 132kV Reinforcement		
Activity	Primary reinforcement / Connections		
Primary Investment Driver	Thermal constraints		
Reference	ED2-LRE-SPM-002-CV1		
Output Type	Load Index		
Cost	**SPM -** £3.351m (CV1 - £0.690m and C2 - £2.661m)		
Delivery Year	2023-2028		
Reporting Table	CV1 / C2		
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	**£3.351m**	**£m**

SP ENERGY NETWORKS

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:	**132kV Carrington Fiddlers Ferry Reinforcements**
Project Reference:	**ED2-LRE-SPM-002-CV1**
Decision Required:	**To give concept approval to establish a new 132/33/11kV substation at Hulseheath and management of 132kV network constraints using automation and flexibility services.**

Summary of Business Need:
The Mid Cheshire and Crewe areas of the SP Manweb network will see significant demand increase over the next decade and beyond. The Carrington / Fiddlers Ferry 132kV network group supplies 4x 33kV groups, over 153,677 customers including 10 major industrial customers and 2 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 97MW of demand requirement for construction and rail supplies within the SPM network, of which 68MW will be supplied via the Carrington/Fiddlers Ferry 132kV network group with 48MW 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 38,644 Electric Vehicles and 17,636 Heat Pumps. There will also be high propensity for growth in rapid charging at motorway services. Additionally, 50MW demand has been authorised for Residential and Commercial development planned at the erstwhile Fiddlers Ferry Power Station area.

There will be insufficient 132kV network capacity (thermal) in Carrington / Fiddlers Ferry GSP group and the needs case for reinforcement is determined by the magnitude and location of the new demand.

Summary of Project Scope, Change in Scope or Change in Timing:
The overall scheme comprises of three elements as detailed below:

- Construction of a new 132/33kV substation near Hulseheath. It will be equipped with 1x60MVA 132/33kV and 2x10MVA 33/11kV transformers. The substation will support the HS2 connections around Manchester International Airport, Ringway and Knutsford and will provide security to the Elworth-Hartford-Lostock-Winsford-Knutsford 33kV group.
- Dedicated monitoring and automation scheme at Cuerdley 132kV substation to manage constraints on the 132kV Cuerdley-Warrington and Cuerdley-Sankey Bridges circuit.
- Contract flexibility services to manage the 132kV circuit constraints and defer reinforcement of 132kV Sankey Bridges- Hartford circuit.
- The estimated cost of the proposed solution is **£14.809m**, with **£3.351m** contribution to be included in the ED2 Primary Reinforcements, split between CV1 – Load Related Reinforcement **(£0.690m)**, and C2 – Connections **(£2.661m)**.

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
C2 - Connections	C2	Connections	**2.661**	0.532	1.064	1.064	-	-
CV1 – Primary Reinforcement	CV1	Primary Reinforcement	**0.690**	0.200	-	-	0.187	0.303
This Proposal			**3.351**					

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 Ringway, Knutsford, Hartford, Lostock, Elworth, Warrington, Sankey Bridges, Dallam, and Winsford areas of Mid Cheshire is supplied from Carrington and Fiddlers Ferry GSPs. The 132kV network group secures 4x 33kV groups supplying 153,677 customers which includes 10 major industrial customers and 2 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; the SPM districts are shown by the highlighted regions.

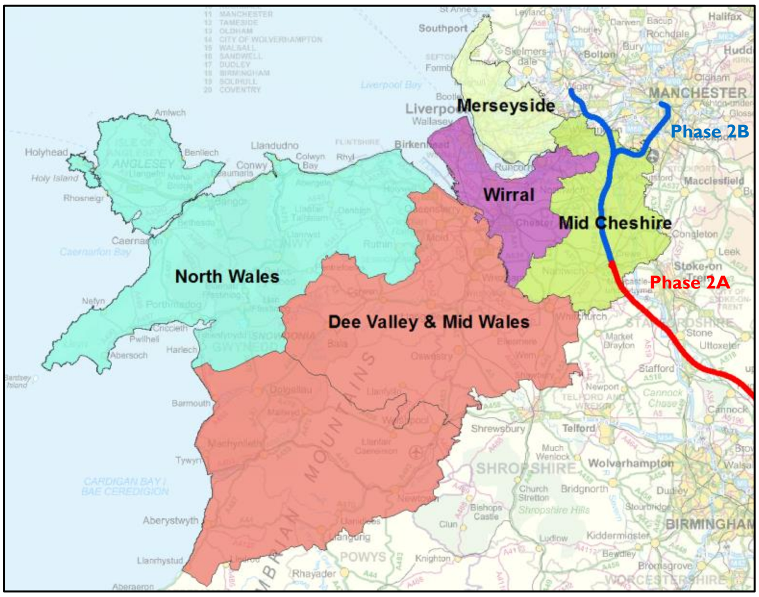

Figure 1. HS2 rail project and SPM license area

Studies indicate that with the additional demand from HS2 and LCT uptake there will be insufficient 132kV network capacity (thermal) in Carrington / Fiddlers Ferry GSP group and the needs case for reinforcement is determined by the magnitude and location of the new demand.

In order, to secure supplies within the group as per Engineering Recommendation (EREC) P2/7, to meet the licence obligation for maintaining economic, efficient and coordinated network, to accommodate future demand growth within the area and to mitigate the thermal and security of supply constraints in the 132kV group, a strategic solution needs to be considered. The proposed solution relies on Flexibility and Automation to defer **£10.5m** network upgrades. The overall scheme comprises of three elements as detailed below.

- **Flexibility services:** Manage the 132kV circuit constraint through ED2 using flexibility services. Contract **8.4MW** of services using the 'Dynamic' product, based on tender responses received to-date. Circa **£0.5m** of flexibility services would defer **£6.5m** of 132kV circuit uprating (Sankey Bridges -Hartford) by delaying the need for reinforcement into RIIO-

ED3. It is planned to place the contracts for the complete service period in ED2 with an option to review the flexible capacity needs based on annual review as demand grows.

- **Network Automation**: monitoring and automation scheme at Cuerdley 132kV substation to manage constraints on the Cuerdley-Sankey Bridges 132kV circuit, deferring **£4m** of circuit upgrades.
- **New 132kV/33kV 60MVA Grid substation to facilitate HS2 connections:** Construction of a new 132/33kV substation near Hulseheath with funding apportioned 80% to HS2. It will be equipped with 1x60MVA 132/33kV and 1x10MVA 33/11kV transformers. The substation will support the HS2 connections around Manchester International Airport, Ringway and Knutsford and will provide security to the Elworth-Hartford-Lostock-Winsford-Knutsford 33kV group.

The estimated cost of the proposed solution is £14.809m, with £3.351m contribution to be included in the ED2 Primary Reinforcements, split between CV1 – Load Related Reinforcement (£0.690m), and C2 – Connections (£2.661m).

2 Background Information

2.1 Existing/Authorised Network

Carrington 132kV substation is a shared site with ENWL. The site normally runs split separating the two DNOs. Traditionally SGT1A (120MVA) and SGT2A (120MVA) supplied the SPM load while SGT1B (180MVA), SGT2B (180MVA), SGT4 (180MVA) and SGT7 (240MVA) supplied the ENWL load at the site. SGT1A failed in 2014 and NGET transferred SGT1B to SPM side.

Fiddler's Ferry SGT3 and 4 both rated at 240MVA are interconnected to Carrington (via Warrington) at 132kV however the SGT capacity at Fiddlers Ferry is restricted by the 180 MVA series reactors. The supply capacity available to the SPM Fiddlers Ferry-Carrington access groups is managed based on 4 SGTs on load. When an outage is planned on any of the Carrington SGTs supplying the SPM side, SGT7 is transferred across from ENWL side to support group demand.

NGET has indicated that for an outage of circuit breaker H20 at Carrington 275kV will result in both SGT2A and SGT2B being unavailable, as both SGT's are banked with his circuit breaker. During this outage, SGT1B can be moved to the ENWL side while SGT7 is switched to the SPEN side, in addition, one of the Sale/Altrincham circuits is transferred to the SP Energy Network side of the split.

The 132kV network group secures 4x 33kV groups comprising of 13 grid transformers with a total transformation capacity of 810MVA and these EHV groups supply 153,677 customers.

The authorised 132kV is shown in Figure 2 and 33kV group networks supplied from 132kV Carrington/Fiddlers Ferry network group are shown in Appendix-A.

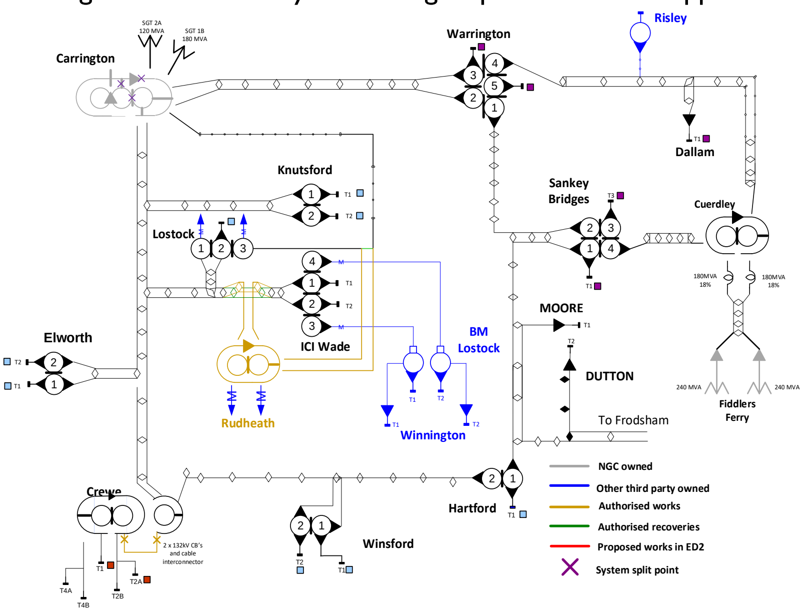

Figure 2. Authorised 132kV system (Crewe and Carrington/Fiddlers Ferry)

2.2 Network supply / circuit capacity

The existing 132kV Carrington/Fiddlers Ferry network is classed as P2/7 Group E (≥300MW) with the network demand of 307MVA (winter) and 276MVA (summer) against firm capacity of 412MVA (N-1) and 310MVA (N-1-1). As a class 'E' group, it must be secured for Second Circuit Outages (SCO). The current running arrangement of the 132kV network group is adequate to meet the security of supply criteria. Table 2.1 lists the existing network supply capacities of the 132kV and 33kV groups.

Table 2.1. Summary of 33kV grid groups

Substation	No. of customers	Scenario	LI firm capacity	Maximum demand (2021/22)	Load Index	Group P2/7 Class
33kV						
Carrington / Fiddlers Ferry 132kV	153677	N-1	412.0	306.5	LI1	E
		N-1-1	310.0	275.6	LI2	
33kV						
Dallam GT1 / Sankey Bridges GT1 / Warrington GT3	54400	N-1	103.0	81.3	LI1	D
Sankey Bridges GT3 / Warrington GT5	28414	N-1	75.4	70.7	LI2	D
Hartford GT1 / Lostock GT2 / Winsford GT1 / Winsford GT2	45912	N-1	103.8	70.3	LI1	D
Elworth GT1 / Elworth GT2 / Knutsford GT1 / Knutsford GT2	24951	N-1	74.4	52.9	LI1	D

Detailed power flow studies including Intact, N-1 and N-1-1 contingencies were performed for the 132kV and EHV groups fed from Carrington/Fiddlers and there were no voltage related issues.

A thermal overloading issue was observed for the 33kV circuit between Knutsford Grid to Lostock Grid during N-1-1 outage at 132kV. The thermal overload situation is operationally managed via transfer capacity from the adjacent group.

2.3 Embedded Generation and Demand connections

The network fed from the 132kV Carrington/Fiddlers Ferry GSPs has significant penetration of Distributed Generation with 269MW connected generation and an additional 129MW is expected to connect within the RIIO-ED1 price control period. Table 2.2 shows the connected and contracted generation in the GSP group.

Table 2.2. Connected/Contracted generation

Site	Status	Type	Registered capacity (MW)
Winnington	Connected	CHP	125
Elworth	Connected	CHP	50
Arpley	Connected	Gas	18
Griffiths Road	Connected	Gas	20
Slutchers Lane	Connected	Gas	16
Latchford Lane	Connected	Gas	20
Middlewich Power	Connected	Gas	20
Lostock Power	Authorised	Gas	89
Wincham Lane	Authorised	Gas	20
ESF Lostock	Authorised	Diesel	20
Total			**398**

The impact of the existing embedded generation is considered in the power system studies with the respective seasonal P 2/7 contributions included.

2.4 Fault levels

Studies indicate that with the authorised customer connections there are no fault level issues at 132kV except for CB120 circuit breaker at ICI Wade which is presently at asset health index rating of HI5 and included in the non-load programme of works for replanting within the RIIO-ED2 price control period.

3 Needs Case

The HS2 rail infrastructure project has indicated 97MVA of demand requirement for construction and rail supplies within the SPM network, of which 68MVA will be supplied via the Carrington/Fiddlers Ferry 132kV network group with 48MW 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 38,644 Electric Vehicles and 17,636 Heat Pumps. There will also be high propensity for growth in rapid charging at motorway services. Additionally, 50MW demand has been authorised for Residential and Commercial development planned at the erstwhile Fiddlers Ferry Power Station area.

There will be insufficient 132kV network capacity (thermal) in Carrington / Fiddlers Ferry GSP 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, 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 132kV network capacity constraints and solutions required to accommodate these development plans.

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 our DFES scenario development SPEN held stakeholder engagement sessions with councils to continue to refine our 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.

[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

- 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
- In February 2020, Department of Transport launched expression of interest for All-Electric Bus Town[3], in August 2020 Transport for Warrington has secured funding which would need electricity demand of ~7MW for the electric bus depot.
- The erstwhile Fiddlers Ferry power station site[4] is expected to make way for new 1,750 homes, warehouses and low carbon energy production against which 50MVA demand application was submitted and has been authorised in August 2021.

3.1.1.2 Around Manchester Airport

- In January 2019, the Greater Manchester Combined Authority of 10 councils published 'The Greater Manchester Plan for Homes, Jobs and the Environment: the Greater Manchester Spatial Framework' (GMSF)[5]. The GMSF outlines Manchester Airport (and surrounding area) development as a major opportunity to boost the competitiveness and prosperity of Greater Manchester, and to support higher levels of economic growth.
- Manchester Airport is the third busiest passenger airport in the UK, and the largest outside London. It is the only airport in the country other than Heathrow to have two full length runways. A £1bn investment programme is underway to increase passenger capacity from ca. 28 million to over 50 million. The provision of a new HS2 station will make the airport area one of the best-connected locations in the country.
- Policy GM-Strat 10 of the GMSF commits to providing sufficient development opportunities to take full advantage of the introduction of HS2. This includes enhancing local transport links by extending the Metrolink tram, enhancing public transport, and completing the development of 'Airport City' immediately around the airport. This will provide a total of around 500,000m^2 of office, logistics, hotel and advanced manufacturing space around the new HS2 station. This also results in around 2,400 new homes to the west of the M56 at Timperley Wedge.
- Policy GM-Strat 11 of the GMSF allocates land around the former Shell Carrington industrial area to accommodate around 6,100 new homes and 410,000m^2 of employment floor space. Part of this allocation falls within our licence area.

3.1.1.3 HS2

HS2 will be delivered in multiple stages, two of these stages impact the SPM licence:

- HS2 Phase 2A – from the West Midlands to Crewe. Construction is planned to commence in 2022.
- HS2 Phase 2B – from Crewe to Manchester. Construction is planned to start in 2025.

SPEN has engaged extensively with the HS2 project team to understand the total demand requirements which are presented in Table 3.1.

Table 3.1. HS2 total capacity requirements 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

[3]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/923845/Electric-Bus-Town-call-for-expressions-of-interest.pdf

[4]https://www.warrington.gov.uk/sites/default/files/2021-08/fiddlers_ferry_-_masterplan_-_april_2021.pdf

[5]https://www.greatermanchester-ca.gov.uk/what-we-do/housing/greater-manchester-spatial-framework/gmsf-full-plan/

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.

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 Cheshire at all voltage levels. A summary of HS2 demand requirements is within Appendix C.

Table 3.2. HS2 capacity requirements by voltage

GSP Group	EHV Network group		Capacity Requirements (MW)			
		Phase 2A (11kV)	**Phase 2B (33kV)**	**Phase 2B (25kV)**	**Phase 2B (11kV)**	**Total**
Cellarhead	**Crewe Area** Coppenhall-Crewe-Radway Green-Whitchurch 33kV Group	7.2	20.0	-	2.0	29.2
Carrington / Fiddlers Ferry	**Cheshire Plain** Elworth-Hartford-Winsford-Knutsford-Lostock 33kV Group	-	27.2	15.0	25.4	67.6
	TOTAL	**7.2**	**47.2**	**15.0**	**27.4**	**96.8**

3.1.1.4 *SPEN's own experience*

Around Crewe and across Cheshire, SPM has experienced an unprecedented level of demand connection applications and enquiries due to these regional and local growth policies. For example, the Crewe, Nantwich, Alsager, Sandbach, Warrington Town Centre, Warrington electric bus depot, Congleton and Middlewich 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 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.

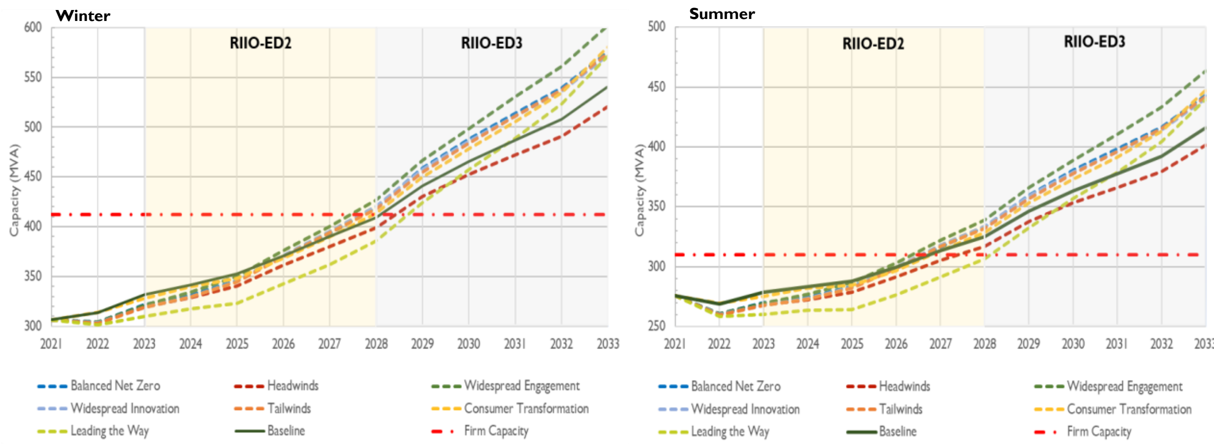

Figure 3. Demand (MVA) forecast for 132kV Carrington Fiddlers Ferry group

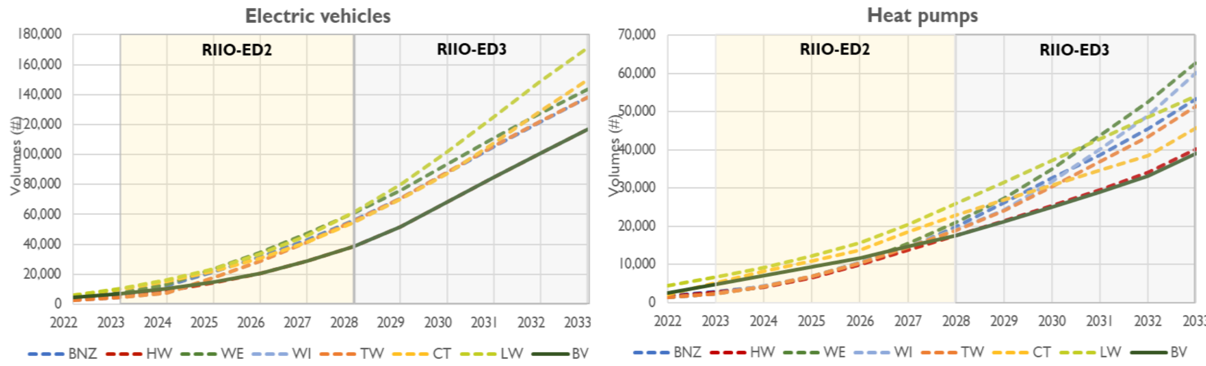

Figure 4. Forecast Electric Vehicle and Heat Pump uptakes for 132kV GSP group

3.1.3 Baseline View

The forecast demand growth under our Baseline Scenario for the 132kV GSP group, along with the firm capacity and utilisation through to RIIO-ED3 period is shown in Table 3.3.

Table 3.3. Baseline View forecast

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Winter (N-1)													
Forecast Demand (MVA)	307	313	332	342	352	371	390	409	441	465	487	508	540
Firm Capacity (MVA)	412	412	412	412	412	412	412	412	412	412	412	412	412
Utilisation (%)	74	76	81	83	86	90	95	99	107	113	118	123	131
Load Index	LI1	LI1	LI2	LI2	LI2	LI2	LI2	LI4	LI5	LI5	LI5	LI5	LI5
Summer (N-1-1)													
Forecast Demand (MVA)	276	269	279	283	288	299	314	325	346	363	377	392	416
Firm Capacity (MVA)	310	310	310	310	310	310	310	310	310	310	310	310	310
Utilisation (%)	89	87	90	91	93	97	101	105	112	117	122	127	134
Load Index	LI2	LI2	LI2	LI2	LI2	LI3	LI5	LI5	LI5	LI5	LI5	LI5	LI5

3.2 Network Impact Assessment

Detailed network studies covering network intact, N-1 and N-1-1 outage conditions and fault level assessments were carried out for the 132kV and 33kV network fed from GSP group 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 2024 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-D.

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

3.2.1 Thermal Constraints

Considering the DFES forecast demand in the group, the thermal constraints that would appear in the RIIO-ED2 period are listed in Table 3.4.

Table 3.4. Thermal constraint at 132kV and 33kV voltage level

Network Item	Voltage (kV)	Outage
Carrington SGT 2A	275/132	N-1/N-1-1
Cuerdley – Warrington Ckt	132	N-1 / N-1-1
Cuerdley – Sankey Bridges Ckt	132	N-1 / N-1-1
Sankey Bridges – Hartford Ckt	132	N-1-1
Lostock Grid Transformer	132/33	N-1-1
Knutsford Grid Transformer	132/33	N-1-1
Hartford Grid Transformer	132/33	N-1-1

3.2.2 Voltage Constraints

There were no voltage constraints identified on the 132kV or 33kV networks fed from the Carrington / Fiddlers Ferry GSP.

3.2.3 P 2/7 – Security of supply

Maximum demand on the interconnected Carrington Fiddlers Ferry group is >300MW (P2/7 Class E) and system studies indicate that there will be security of supply issues in the 33kV network groups Elworth/Knutsford and Hartford/Winsford/Lostock impacting ca. 50,000 customers during N-1-1 outage conditions on the upstream 132kV network. This is mainly due to the combination of additional demand from LCT uptake and 48MW of demand from HS2. It is to be noted that ~80% of the requested HS2 demand in this group is expected to be connected around Ringway, Mere and Lostock.

3.2.4 Fault Level Constraint

There were no additional fault level related constraints at 132kV.

3.2.5 Flexibility services

Our assessments indicate that the network constraints in the 132kV group network starts from 2027 through to the year 2028 for the most onerous scenario. In order to manage the network risk and security of supply constraint a max capacity of ca. 8.4MW is required to alleviate the constraints. Table 3.5 below shows flexibility services in terms of the network risk hours and tendered capacity.

Table 3.5. Network annual hours at risk and flexible capacity tendered

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Annual hours at risk (Hrs)	-	-	-	587	909
Required Flexible Capacity (MW)	-	-	-	8.0	8.4

4 Optioneering

Table 4.1 shows a summary of the options considered for this reinforcement. The baseline option represents the lowest cost conventional option, i.e. the minimum level of intervention.

Table 4.1. Longlist of solution options

#	Options	Status	Reason for rejection
(a)	No Intervention	Rejected	Non-compliant with security of supply requirements as per P 2/7.
(b)	New 132/33kV substation at Warburton and manage the constraints without any further intervention.	Rejected	This solution would increase the total customer connection costs by £12.5m as a new primary substation needs to be established near Peacocks Lane to supply HS2 and over 12 kms section of the 132kV Carrington-Warrington circuit needs to be updated. Additionally, thermal overload at 132kV will be beyond cyclic rating and cannot be operationally managed. This would potentially risk security of supply for over 50,000 customers.
(c)	New 132/33kV substation at Hulseheath and manage the constraints without any further intervention	Rejected	Thermal overload is beyond cyclic rating and cannot be operationally managed. This would potentially risk security of supply for over 50,000 customers.
(d)	Dedicated supply arrangements at 132kV for HS2 demands via 2x new circuits from Carrington GSP and 2x60MVA Grid transformers at Ringway.	Rejected	The overall scheme cost and impact for the 132kV works would be significantly higher and is not considered as economically viable.
(e)	New 132/33kV substation at Hulseheath, monitoring and automation at Cuerdley and uprating of 132kV circuit between Sankey Bridges to Hartford.	Considered (**Baseline**)	-
(f)	New 132/33kV substation at Hulseheath, monitoring and automation at Cuerdley and new 132kV circuit to Elworth.	Considered (**option 1**)	-
(g)	New 132/33kV substation at Hulseheath, monitoring and automation at Cuerdley and operational mitigate the constraint by closing "Bus-Section" at Crewe to interconnected with Cellarhead GSP	Rejected	Considering the wide phase angle difference between Carrington Fiddlers Ferry and Cellarhead GSP, there would be significant MVAr flow from Carrington side to Cellarhead and would result in aggravation of thermal constraint and significant voltage excursions.
(h)	New 132/33kV substation at Hulseheath, monitoring and automation at Cuerdley and installation of PST at Crewe.	Considered (**option 2**)	-
(i)	New 132/33kV substation at Hulseheath, monitoring and automation at Cuerdley and Flexibility services.	Considered (**option 3**)	-
(j)	New 132/33kV substation at Hulseheath and HVDC back to back convertor at Crewe.	Rejected	High scheme cost and longer lead time.

5 Detailed Analysis & Costs

Detailed system studies with the additional demand from HS2 and LCT uptake indicate that there will be insufficient 132kV network capacity (thermal) in Carrington / Fiddlers Ferry GSP group and security of supply issues in the 33kV network groups Elworth/Knutsford and Hartford/Winsford/Lostock impacting ca. 50,000 customers during N-1-1 outage conditions on the upstream 132kV network.

The following options were shortlisted for detailed analysis and cost benefit analysis to manage the network constraints:

5.1 Proposed Option (Option 3) – HS2 reinforcements, automation and flexibility services

Table 5.1 shows proposed solution summary.

Table 5.1. Proposed option summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Network automation, Flexibility services and Conventional reinforcement	Carrington Fiddlers Ferry 132kV Reinforcements	• Construction of a new 132/33kV substation near Hulseheath. It will be equipped with 1x60MVA 132/33kV and 2x10MVA 33/11kV transformers. The substation will support the HS2 connections around Manchester International Airport, Ringway and Knutsford and will provide security to the Elworth-Hartford-Lostock-Winsford-Knutsford 33kV group. • Dedicated monitoring and automation scheme at Cuerdley 132kV substation to manage constraints on the 132kV Cuerdley-Warrington and Cuerdley-Sankey Bridges circuit. • Contract flexibility services to manage the 132kV circuit constraints and defer reinforcement of 132kV Sankey Bridges-Hartford circuit.	3.351	11.458

5.1.1 HS2 related reinforcements to establish a new 132/33kV substation at Hulseheath

Detailed assessments on behalf of HS2 indicate that in order to accommodate the 38MW demand for HS2 construction and operational supplies around Ringway, Mere, Knutsford and Manchester Airport, a strategic reinforcement scheme is necessary due to the limited network capacity at EHV and HV. These assessments identified Hulseheath as the most efficient location to establish a new substation to support the HS2 demand. Under the recommended strategic reinforcement scheme, a new 132/33kV grid infeed substation with a 60MVA transformer is proposed around the Hulseheath area which will be supplied via a Tee-off arrangement onto the existing 132kV circuit between Carrington – Elworth. This new 132/33kV infeed will be interconnected in the Elworth/Knutsford/Lostock 33kV group, providing support and security to the group. More information on the HS2 driven 33kV network developments around the Lostock/Mere/Ringway area is included in Appendix-B.

5.1.2 Network Automation and Flexibility Services

Based on detailed network assessments thermal overloading on the 132kV circuits between Cuerdley – Sankey Bridges and Cuerdley – Warrington during N-1 outage can be alleviated by monitoring the constraint and automatically tripping the "Bus-Section" breaker at Cuerdley 132kV substation. It is proposed to install a dedicated local monitoring and automation scheme installation at Cuerdley 132kV substation.

Further in order to operationally manage the potential N-1-1 constraints during maintenance outage of either Cuerdley – Sankey Bridges and Cuerdley – Warrington 132kV circuits it is required to request NGET for transferring across SGT7 onto SPM side.

The thermal overloading of the 132kV Sankey Bridges – Hartford circuit would need potential reinforcement by re-stringing the 9.845kms of OHL section and overlaying 1.7kms of cable section. 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 £421k 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	-	-	-	£0.42m	£0.42m
Cost of Flexibility Services (100% Capacity)	-	-	-	£0.19m	£0.30m
Flexibility Outlook	-	-	-	● (green)	● (green)

● (green) *Accept bids and defer reinforcements*
● (red) *Reject bids and deliver reinforcements*

Considering above the proposed solution includes management of thermal constraints on 132kV Cuerdley – Sankey Bridges and Cuerdley – Warrington circuits by installing a dedicated network monitoring and automation at Cuerdley 132kV substation and contract flexibility services to manage the 132kV Sankey Bridges – Hartford circuit constraint. The combination of network automation and flexibility services will enable to defer £10.5m of circuit upgrades.

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.

The estimated cost of the proposed solution is £14.809m, with £3.351m contribution to be included in the ED2 Primary Reinforcements, split between CV1 – Load Related Reinforcement (£0.690m), and C2 – Connections (£2.661m).

Table 5.3 shows a summary of reinforcement costs and volumes for the proposed option within RIIO-ED2. Figure 5 shows the strategic reinforcement scheme and Figure 6 shows the site location and new substation layout.

Table 5.3. Proposed option summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
6.6/11kV CB (GM) Primary	7.00	0.194	-	0.194
33kV UG Cable (Non Pressurised)	19.00	4.610	-	4.610
33kV CB (Gas Insulated Busbars)(ID) (GM)	9.00	1.534	0.565	0.969
33kV Transformer (GM)	2.00	0.629		0.629
Batteries at 33kV Substations	2.00	0.018	0.007	0.012
132kV OHL (Tower Line) Conductor	0.06	0.004	0.001	0.002
132kV Tower	1.00	0.114	0.042	0.072
132kV Fittings	1.00	0.003	0.001	0.002
132kV UG Cable (Non Pressurised)	0.50	0.554	0.204	0.350
132kV Transformer	1.00	1.214	0.447	0.767
Pilot Wire Underground	19.50	2.160	0.478	1.682
Civil Works at 33 kV & 66 kV Substations		0.600	0.221	0.379

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Civil Works at 132 kV Substations		0.936	0.345	0.591
Wayleaves/Easements/Land Purchase		0.950	0.350	0.600
Other Costs (Identify Below)		0.800	0.200	0.600
Cost of Flexibility for the year 2026/27 – 2027/28		0.490	0.490	-
Total Costs		**14.809**	**3.351**	**11.458**
Activities included within other costs (high-level detail of cost areas)				
Associated protection, control and SCADA equipment located at a site and remote ends (£140k)				
Environmental survey and studies (£75k)				
River Crossing, Dual carriage way (A556) Crossing, Motorway (M56) Crossing and Railway Crossing (£300k)				
Planning and Design Studies (£85k)				
Bespoke monitoring, automation and intertripping scheme for Cuerdley -Warrington & Cuerdley - Sankey Bridges 132kV Circuits and advanced overcurrent protection unit for Sankey Bridges -Hartford Circuit -£200k				

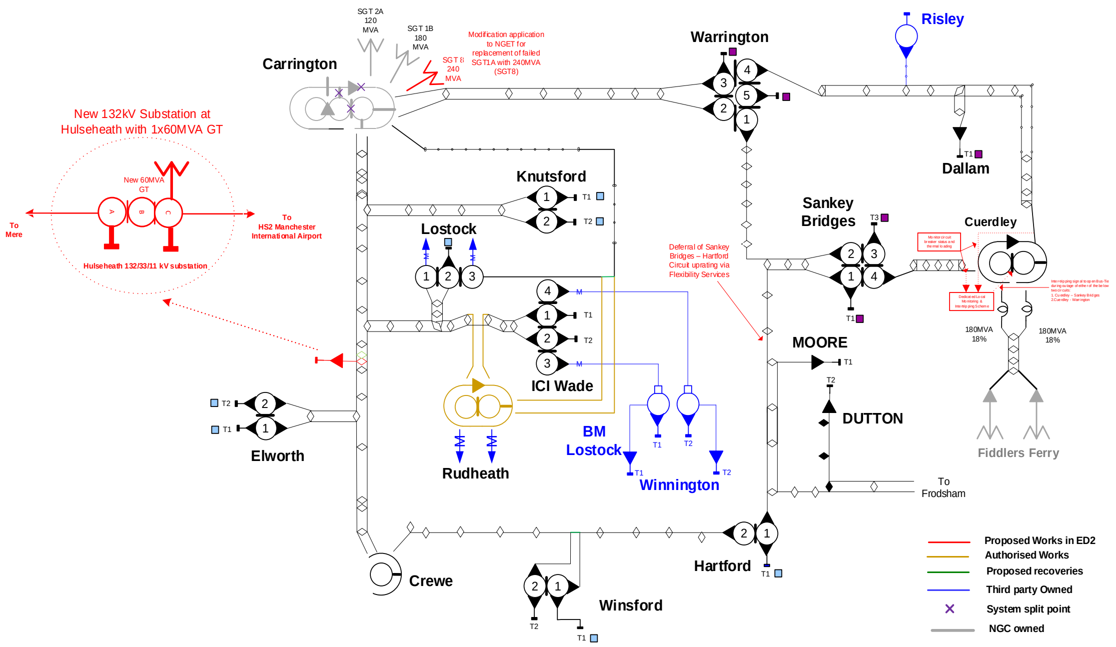

Figure 5. Proposed scheme at 132kV voltage level

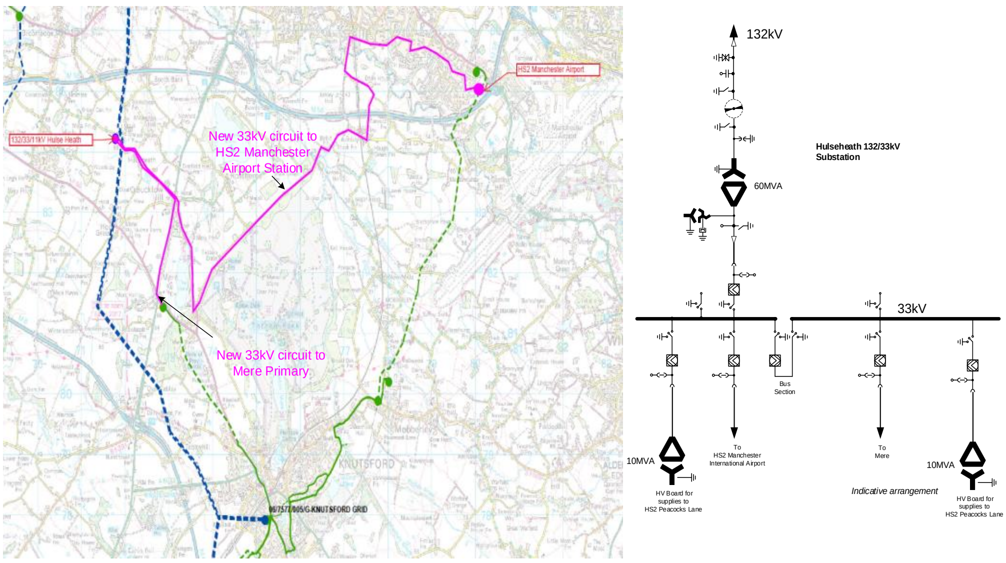

Figure 6. Proposed site location and new substation line diagram

In addition to above it is proposed to submit a modification application to NGET for replacement of the failed SGT1A which will facilitate the securing demand during N-1-1 outages. The associated costs and any allocation will need to be considered in conjunction with NGET.

5.2 Baseline – HS2 reinforcements, automation and uprating 132kV circuit

The baseline option is to establish a new 132kV substation at Hulseheath, installation of monitoring and automation scheme at Cuerdley 132kV substation and re-stringing the 9.845kms of OHL section and overlaying 1.7kms of cable sections of the 132kV circuit between Sankey Bridges – Hartford. Table 5.4 shows baseline option scheme summary.

Table 5.4. Baseline option summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Conventional substation and circuit	Carrington Fiddlers Ferry 132kV Reinforcements	• Construction of a new 132/33kV substation near Hulseheath. It will be equipped with 1x60MVA 132/33kV and 2x10MVA 33/11kV transformers. The substation will support the HS2 connections around Manchester International Airport, Ringway and Knutsford and will provide security to the Elworth-Hartford-Lostock-Winsford-Knutsford 33kV group. • Dedicated monitoring and automation scheme at Cuerdley 132kV substation to manage constraints on the 132kV Cuerdley-Warrington and Cuerdley-Sankey Bridges circuit. • Re-stringing the 9.845kms of OHL section and overlaying 1.7kms of cable sections of the 132kV circuit between Sankey Bridges – Hartford.	9.389	11.458

Under this option it is proposed to start the reinforcement works from year 2023/24 and deliver the project in 2025/26 against which the capacity release of 15.8MVA at 132kV will be claimed. However, this option is rejected based on lower NPV against proposed option.

Table 5.5 shows a summary of reinforcement costs and volumes for the baseline option within RIIO-ED2. Figure 7 shows the baseline reinforcement scheme.

Table 5.5. Baseline option summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
6.6/11kV CB (GM) Primary	7.00	0.194	-	0.194
33kV UG Cable (Non Pressurised)	19.00	4.610	-	4.610
33kV CB (Gas Insulated Busbars)(ID) (GM)	9.00	1.534	0.565	0.969
33kV Transformer (GM)	2.00	0.629	-	0.629
Batteries at 33kV Substations	2.00	0.018	0.007	0.012
132kV OHL (Tower Line) Conductor	9.97	0.598	0.596	0.002
132kV Tower	33.00	3.757	3.685	0.072
132kV Fittings	33.00	0.097	0.095	0.002
132kV UG Cable (Non Pressurised)	2.30	2.551	2.200	0.350
132kV Transformer	1.00	1.214	0.447	0.767
Pilot Wire Underground	21.30	2.360	0.677	1.682
Civil Works at 33 kV & 66 kV Substations		0.600	0.221	0.379
Civil Works at 132 kV Substations		0.936	0.345	0.591
Wayleaves/Easements/Land Purchase		0.950	0.350	0.600
Other Costs (Identify Below)		0.800	0.200	0.600

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Total Costs		**20.847**	**9.389**	**11.458**
Activities included within other costs (high-level detail of cost areas)				
Associated protection, control and SCADA equipment located at a site and remote ends (£140k)				
Environmental survey and studies (£75k)				
River Crossing, Dual Carriage Way (A556) Crossing, Motorway (M56) Crossing and Railway Crossing (£300k)				
Planning and Design Studies (£85k)				
Bespoke monitoring, automation and intertripping scheme for Cuerdley -Warrington & Cuerdley - Sankey Bridges 132kV Circuits and advanced overcurrent protection unit for Sankey Bridges -Hartford Circuit -£200k				

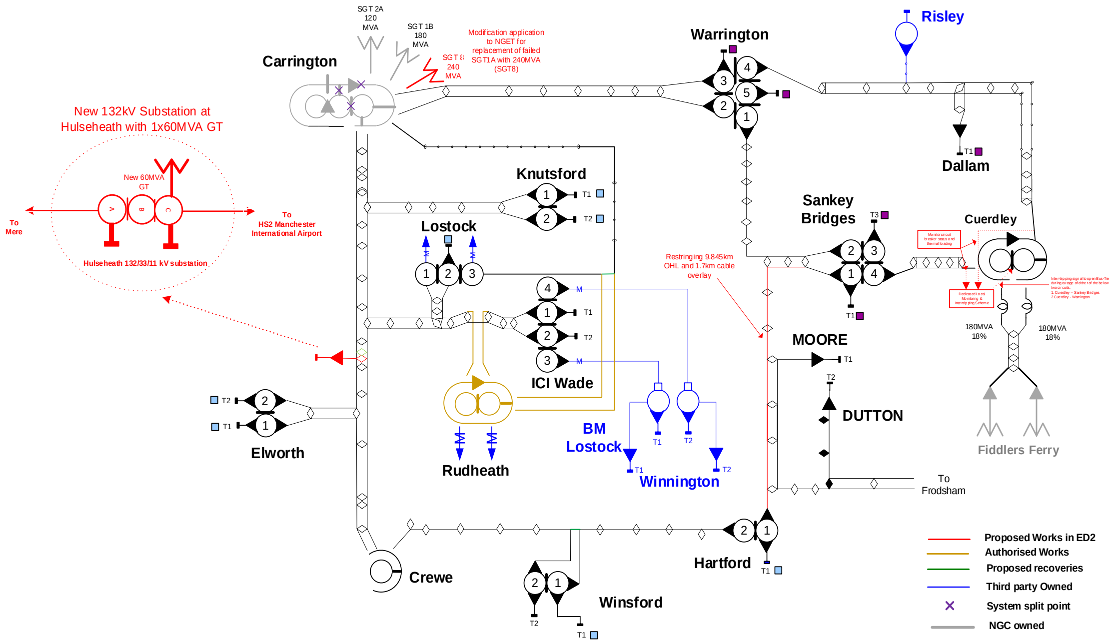

Figure 7. Proposed reinforcements at 132kV as part of Baseline option

5.3 Option 1 – HS2 reinforcements, automation and new 132kV circuit

This option considers establishing a new 132kV substation at Hulseheath, installation of monitoring and automation scheme at Cuerdley 132kV substation. In order alleviate the constraints on 132kV Sankey Bridges – Hartford circuit, under this option it is proposed to establish a new circuit to Elworth grid substation by tee- off from existing circuit between Crewe – ICI Wade which would provide additional capacity headroom 2MVA at 132kV. This option is rejected due its relatively high cost and does not represent optimum level of intervention required as it create limited capacity headroom in the network. Table 5.6 shows baseline option scheme summary.

Table 5.6. Option 1 summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Conventional substation and circuit	Carrington Fiddlers Ferry 132kV Reinforcements	• Construction of a new 132/33kV substation near Hulseheath. It will be equipped with 1x60MVA 132/33kV and 2x10MVA 33/11kV transformers. The substation will support the HS2 connections around Manchester International Airport, Ringway and Knutsford and will provide security to the Elworth-Hartford-Lostock-Winsford-Knutsford 33kV group.	8.256	11.458

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
		• Dedicated monitoring and automation scheme at Cuerdley 132kV substation to manage constraints on the 132kV Cuerdley-Warrington and Cuerdley-Sankey Bridges circuit. • New circuit to Elworth grid substation by tee-off from existing circuit between Crewe – ICI Wade		

Table 5.7 shows a summary of reinforcement costs and volumes for Option 1 within RIIO-ED2. Figure 8 shows the works proposed under Option 1.

Table 5.7. Option 1 summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
6.6/11kV CB (GM) Primary	7.00	0.194	-	0.194
33kV UG Cable (Non Pressurised)	19.00	4.610	-	4.610
33kV CB (Gas Insulated Busbars)(ID) (GM)	9.00	1.534	0.565	0.969
33kV Transformer (GM)	2.00	0.629		0.629
Batteries at 33kV Substations	2.00	0.018	0.007	0.012
132kV OHL (Tower Line) Conductor	0.06	0.004	0.001	0.002
132kV Tower	4.00	0.455	0.384	0.072
132kV Fittings	4.00	0.012	0.010	0.002
132kV UG Cable (Non Pressurised)	4.00	4.436	4.086	0.350
132kV CB (Air Insulated Busbars)(OD) (GM)	1.00	0.176	0.176	-
132kV Transformer	1.00	1.214	0.447	0.767
Pilot Wire Underground	23.00	2.548	0.866	1.682
Civil Works at 33 kV & 66 kV Substations		0.600	0.221	0.379
Civil Works at 132 kV Substations		1.186	0.595	0.591
Wayleaves/Easements/Land Purchase		1.300	0.700	0.600
Other Costs (Identify Below)		0.800	0.200	0.600
Total Costs		**19.715**	**8.256**	**11.458**
Activities included within other costs (high-level detail of cost areas)				
Associated protection, control and SCADA equipment located at a site and remote ends (£140k)				
Environmental survey and studies (£75k)				
River Crossing, Dual Carriage Way (A556) Crossing, Motorway (M56) Crossing and Railway Crossing (£300k)				
Planning and Design Studies (£85k)				
Bespoke monitoring, automation and intertripping scheme for Cuerdley -Warrington & Cuerdley - Sankey Bridges 132kV Circuits and advanced overcurrent protection unit for Sankey Bridges -Hartford Circuit -£200k				

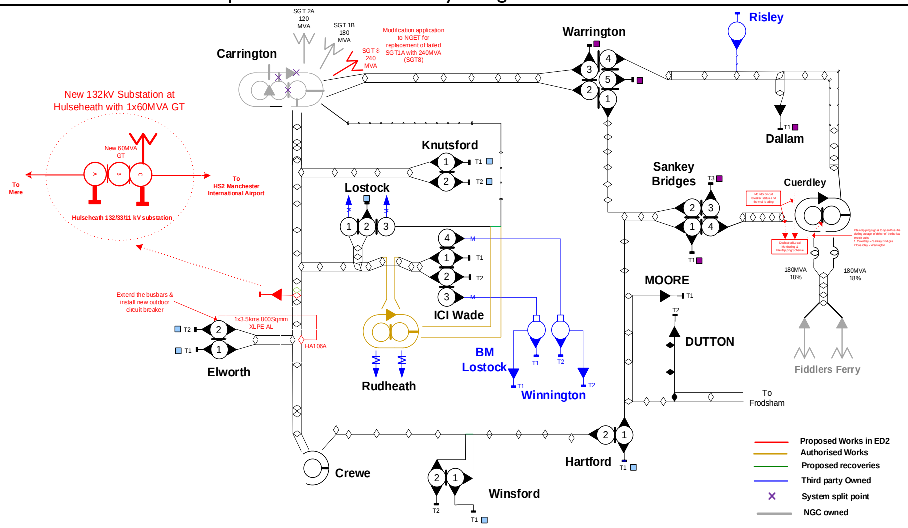

Figure 8 Proposed reinforcements at 132kV as part of Option-1

5.4 Option 2 – HS2 reinforcements, automation, and PST

This option considers establishing a new 132kV substation at Hulseheath, installation of monitoring and automation scheme at Cuerdley 132kV substation. In order alleviate the constraints on 132kV Sankey Bridges – Hartford circuit, under this option it is proposed to install a Phase Shifting Transformer at Crewe which will enable transfer capacity between Cellarhead and Carrington Fiddlers Ferry GSP groups. This option would provide additional capacity headroom of 80MVA at 132kV.

This option is rejected due its relatively lower NPV by end of RIIO-ED4 against the proposed option with reinforcement deferral. Table 5.8 shows the scheme summary.

Table 5.8. Option 2 scheme summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Conventional substation and innovation	Carrington Fiddlers Ferry 132kV Reinforcements	• Construction of a new 132/33kV substation near Hulseheath. It will be equipped with 1x60MVA 132/33kV and 2x10MVA 33/11kV transformers. The substation will support the HS2 connections around Manchester International Airport, Ringway and Lostock and will provide security to the Elworth-Hartford-Lostock-Winsford-Knutsford 33kV group. • Dedicated monitoring and automation scheme at Cuerdley 132kV substation to manage constraints on the 132kV Cuerdley-Warrington and Cuerdley-Sankey Bridges circuit. • Dual Tank 180MVA Phase Shifting Transformer at Crewe 132kV Substation.	8.437	11.458

Table 5.9 shows a summary of reinforcement costs and volumes for Option 2 under RIIO-ED2. Figure 9 shows proposed 33kV works.

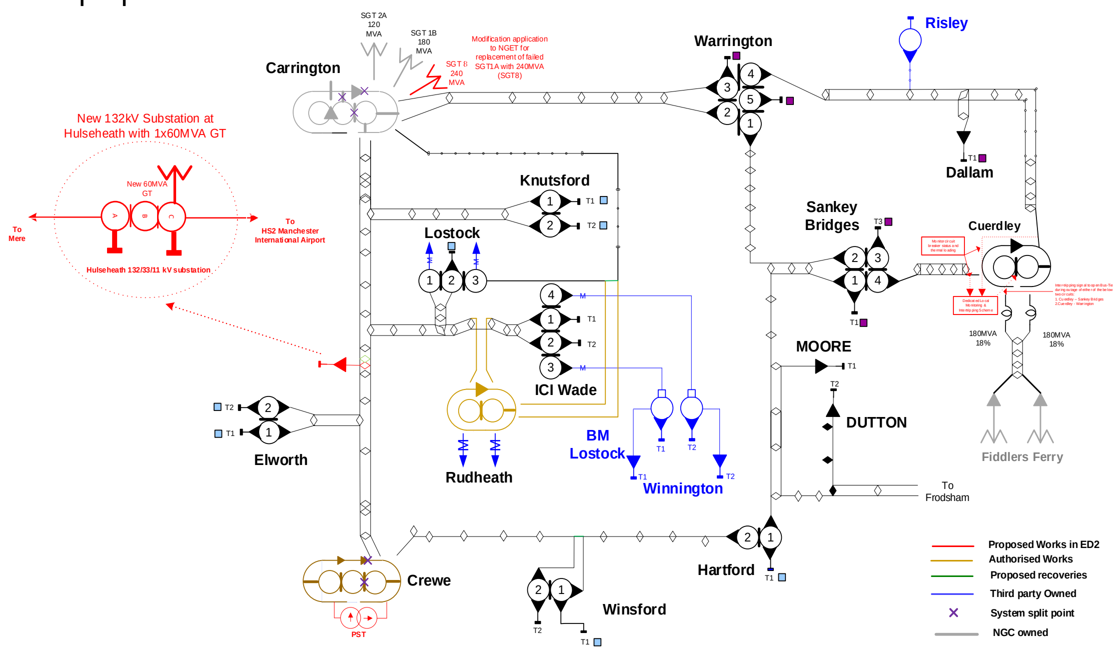

Figure 9. Proposed works under Option 2 at 33kV group network

Table 5.9. Option 2 summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
6.6/11kV CB (GM) Primary	7.000	0.194	-	0.194
33kV UG Cable (Non Pressurised)	19.000	4.610	-	4.610
33kV CB (Gas Insulated Busbars)(ID) (GM)	9.000	1.534	0.565	0.969
33kV Transformer (GM)	2.000	0.629		0.629
Batteries at 33kV Substations	2.000	0.018	0.007	0.012
132kV OHL (Tower Line) Conductor	0.060	0.004	0.001	0.002
132kV Tower	1.000	0.114	0.042	0.072
132kV Fittings	1.000	0.003	0.001	0.002
132kV UG Cable (Non Pressurised)	1.300	1.442	1.091	0.350
132kV Transformer	1.000	1.214	0.447	0.767
Pilot Wire Underground	20.300	2.249	0.567	1.682
Civil Works at 33 kV & 66 kV Substations		0.600	0.221	0.379
Civil Works at 132 kV Substations		1.236	0.645	0.591
Wayleaves/Easements/Land Purchase		0.950	0.350	0.600
Other Costs (Identify Below)		5.100	4.500	0.600
Total Costs		**19.895**	**8.437**	**11.458**
Activities included within other costs (high-level detail of cost areas)				
Associated protection, control and SCADA equipment located at a site and remote ends (£140k)				
Environmental survey and studies (£75k)				
River Crossing, Dual Carriage Way (A556) Crossing, Motorway (M56) Crossing and Railway Crossing (£300k)				
Planning and Design Studies (£85k)				
Bespoke monitoring, automation and intertripping scheme for Cuerdley -Warrington & Cuerdley - Sankey Bridges 132kV Circuits and advanced overcurrent protection unit for Sankey Bridges -Hartford Circuit -£200k				
Dual Tank Power Flow Convertor - 180MVA / ± 25 Degrees and associated works (£4.3m) at Crewe 132kV Substation				

5.5 Options Cost Summary Table

Summary of the costs for each of the evaluated options is presented in Table 5.10.

Table 5.10. Cost summary for considered options

Options	Option Summary	RIIO-ED2 Cost (£m)	Customer contribution (£m)	Total Cost (£m)
Baseline	New 132/33kV substation at Hulseheath, monitoring and automation at Cuerdley and uprating of 132kV circuit between Sankey Bridges to Hartford.	9.389	11.458	20.847
Option 1	New 132/33kV substation at Hulseheath, monitoring and automation at Cuerdley and new 132kV circuit to Elworth.	8.256		19.715
Option 2	New 132/33kV substation at Hulseheath, monitoring and automation at Cuerdley and installation of PST at Crewe.	8.437		19.895
Option 3 (Proposed)	New 132/33kV substation at Hulseheath, monitoring and automation at Cuerdley and Flexibility services.	3.351		14.809

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 establish a new 132/33kV grid infeed substation with a 60MVA transformer is proposed around the Hulseheath area to support the 38MW demand around Manchester International Airport, Ringway and Knutsford. The proposed new substation will also provide security to the Elworth-Hartford-Lostock-Winsford-Knutsford 33kV group.

The proposed solution also includes management of thermal constraints on 132kV Cuerdley – Sankey Bridges and Cuerdley – Warrington circuits by installing a dedicated network monitoring and automation at Cuerdley 132kV substation and contract flexibility services to manage the 132kV Sankey Bridges – Hartford circuit constraint. The combination of network automation and flexibility services will enable to defer £10.5m of circuit upgrades.

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 forecast capital expenditure, the proposed option has the highest total NPV against other options by end of RIIO-ED4 period. The summary of the cost benefit analysis is presented in Table 6.1. The full detailed CBA is provided within 'ED2-LRE-SPM-002-CV1-CBA – Carrington Fiddlers Ferry 132kV Reinforcement'.

Table 6.1. Cost benefit analysis results

Options considered	Decision	Comment	NPVs based on payback periods, £m (2020/21 prices)			
			10 years	20 years	30 years	45 years
Baseline: New 132/33kV substation at Hulseheath, monitoring and automation at Cuerdley and uprating of 132kV circuit between Sankey Bridges to Hartford.	Rejected	Discounted on the basis of limited capacity headroom and high reinforcement cost.	-	-	-	-
Option 1: New 132/33kV substation at Hulseheath, monitoring and automation at Cuerdley and new 132kV circuit to Elworth.	Rejected	Discounted on the basis of marginal capacity uplift and reinforcement cost benefit.	-£1.76	-£2.96	-£3.69	-£4.26
Option 2: New 132/33kV substation at Hulseheath, monitoring and automation at Cuerdley and installation of PST at Crewe.	Rejected	Solution enables adequate capacity headroom and benefits from inter-GSP transfer. However, the solution provides lower NPV at the end of RIIO-ED4.	-£0.23	-£0.00	£0.14	£0.26
Option 3: New 132/33kV substation at Hulseheath, monitoring and automation at Cuerdley and Flexibility services.	**Adopted**	The proposed option enables to manage the network constraints during reinforcement delivery and renders better value to the customers.	£1.06	£0.52	£0.17	-£0.12

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 estimated cost of the proposed solution is £15.796m, with £2.957m contribution to be included in the ED2 Primary Reinforcements, split between CV1 – Load Related Reinforcement (£0.690m), and C2 – Connections (£2.267m).

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 CB (GM) Primary	7.00	0.194	-	0.194
33kV UG Cable (Non Pressurised)	19.00	4.610	-	4.610
33kV CB (Gas Insulated Busbars)(ID) (GM)	9.00	1.534	0.565	0.969
33kV Transformer (GM)	2.00	0.629		0.629
Batteries at 33kV Substations	2.00	0.018	0.007	0.012
132kV OHL (Tower Line) Conductor	0.06	0.004	0.001	0.002
132kV Tower	1.00	0.114	0.042	0.072
132kV Fittings	1.00	0.003	0.001	0.002
132kV UG Cable (Non Pressurised)	0.50	0.554	0.204	0.350
132kV Transformer	1.00	1.214	0.447	0.767
Pilot Wire Underground	19.50	2.160	0.478	1.682
Civil Works at 33 kV & 66 kV Substations		0.600	0.221	0.379
Civil Works at 132 kV Substations		0.936	0.345	0.591
Wayleaves/Easements/Land Purchase		0.950	0.350	0.600
Other Costs (Identify Below)		0.800	0.200	0.600
Cost of Flexibility for the year 2026/27 – 2027/28		0.490	0.490	-
Total Costs		**14.809**	**3.351**	**11.458**
Activities included within other costs (high-level detail of cost areas)				
Associated protection, control and SCADA equipment located at a site and remote ends (£140k)				
Environmental survey and studies (£75k)				
River Crossing, Dual carriage way (A556) Crossing, Motorway (M56) Crossing and Railway Crossing (£300k)				
Planning and Design Studies (£85k)				
Bespoke monitoring, automation and intertripping scheme for Cuerdley -Warrington & Cuerdley - Sankey Bridges 132kV Circuits and advanced overcurrent protection unit for Sankey Bridges -Hartford Circuit -£200k				
Note:				
a. Above costs does not include the additional costs associated to HV connection arrangement, reconfiguration, EIA assessments and any other costs to fulfil the specific requirements of HS2. b. Above costs are only for the works associated with 132/33/11kV Hulseheath Substation and does not include the costs for any other HS2 related reinforcements such as New Manchester Airport Substation, Crewe Hub, Gadbrook, New Lostock Grahlam substation, extension of Mere substation etc.,				

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 – Load Related Reinforcement	**2.661**	0.532	1.064	1.064	-	-
C2 – Connections	**0.690**	0.200	-	-	0.187	0.303

6.4 Risks

The main delivery risks are the necessary approvals and traffic management for the new 132kV substation, 132kV circuit route and 33kV circuit route. We intend to mitigate these risks by actively engaging with local authorities.

We will continue to tender for flexibility services in this area which will enable competitive bids to procure additional capacity and mitigate the risk of shortfall in flexibility services, or flexibility services terminating contracts at short notice.

The delivery phasing implements the automation scheme in early RIIO-ED2 to facilitate and coordinate the flexibility services.

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 to accommodate additional demand from HS2 and LCT uptake and security of supply risk to over 50,000 customers under network outage conditions. The investment does not have a strong reliance on environmental benefits.

6.6.2 Payback Periods

The CBA indicates that proposed option demonstrates better NPV results in assessment periods (10, 20 and 30 years) against other options. As the proposed reinforcement works is forecast to carry at least a 45-year asset life expectancy, the CBA at this time justifies the intervention. Consumers will also benefit from reduced network risk immediately on completion of the project.

6.6.3 Sensitivity to Future Pathways

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

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

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

End of RIIO-ED2	SPEN	DFES			CCC				
	Baseline	System Transformation*	Consumer Transformation	Leading the Way	Balanced Net Zero Pathway	Headwinds	Widespread Engagement	Widespread Innovation	Tailwinds
EVs	38,644	29,922	54,706	61,315	55,877	38,644	60,748	55,396	55,396
HPs	17,636	11,118	22,998	25,980	19,833	17,526	21,005	19,152	18,894

*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					A		R^1	F	F	F	R^2			F
Leading the Way					A		R^1	F	F	F	R^2	F	F	R^3
Consumer Transformation					A		R^1	F	F	R^2		F	F	R^3
Balanced Net Zero Pathway					A		R^1	F	F	R^2		F	F	R^3
Headwinds					A		R^1	F	F	F	F	F	R^2	
Widespread Engagement					A		R^1	F	F	R^2		F	R^3	
Widespread Innovation					A		R^1	F	F	R^2		F	F	R^3
Tailwinds					A		R^1	F	F	F	R^2		F	R^3

F – Flexibility Services
A – Network Automation at Cuerdley 132kV Substation
R^1 – New 132/33kV Substation Hulseheath
R^2 – 132kV circuit upgrade works
R^3 – New 132kV interconnector

The proposed solution caters for the range of Net Zero compliant scenarios. The monitoring and automation scheme at Cuerdley 132kV substation should be delivered in early RIIO-ED2 to manage the constraints on the Cuerdley - Sankey Bridges 132kV circuit as demand increases. The new 132/33kV substation at Hulseheath is required by 2026 to facilitate HS2 requirements and secure the network. Flexibility, in combination with the automation scheme, can manage the 132kV constraints through the remaining ED2 years across all scenarios. Under higher uptake scenarios, additional flexibility capacity may be required within the RIIO-ED2 period beyond the level included in the baseline. The RIIO-ED2 regulatory framework will need to allow DNOs' allowances to flex in response to higher uptakes.

Table 6.6: Sensitivity of the proposed RIIO-ED2 expenditure

	Baseline	Uncertain
RIIO-ED2 Expenditure (£m)	3.351	0.600
Comment	Proposed option	Additional flexibility capacity within RIIO-ED2 period

We will continue to tender for flexibility to ensure the most efficient solutions are progressed in both RIIO-ED2 and RIIO-ED3 timescales. Demand growth in RIIO-ED3 has the potential to significantly increase loadings such that 132kV circuit upgrade works will be required across all scenarios. The timing of these is expected to be sensitive to uptake. In some of the highest uptake scenarios an additional 132kV circuit may be required in RIIO-ED3.

6.6.4 Asset Stranding Risks & Future Asset Utilisation

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

6.6.5 Losses Sensitivity

Losses have been considered in accordance with Licence Condition SLC49 and the SP Energy Networks Losses Strategy and Vision to "consider all reasonable measures which can be applied to reduce losses and adopt those measures which provide benefit for customers". Reasonable design efforts have been taken to minimise system losses without detriment to system security, performance, flexibility or economic viability of the scheme. This includes minimising conductor lengths/routes, the choice of appropriate conductor sizes, designing connections at appropriate voltage levels and avoiding higher impedance solutions or network configurations leading to higher losses.

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

6.6.6 Whole Systems Benefits

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

6.7 Environmental Considerations

6.7.1 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 Carrington Fiddlers Ferry 132kV Reinforcement programme 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 proposed scheme, we have embedded within the CBA, where data are available, an assessment of the embodied carbon and the associated carbon cost to inform our NPV evaluation. The mass of carbon dioxide emitted (CO2e) during the manufacture of the main equipment deployed to deliver this scheme is estimated to be 825 tonnes. The monetised embodied carbon value associated with this emission is £43k. 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[6].

6.7.3 Supply chain sustainability

For us to take full account of the whole-life carbon impact of our Carrington Fiddlers Ferry 132kV Reinforcement programme, 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 Carrington Fiddlers Ferry 132kV 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] Annex 4C.3: Environmental Action Plan, SP Energy Networks, Issue 2, 2021.

6.7.5 Biodiversity/ natural capital

Some aspects of the Carrington Fiddlers Ferry 132kV Reinforcement programme will only affect developed sites containing existing assets, so the impact on, and the opportunity to improve biodiversity and natural capital is expected to be limited.

For the construction of a new 132kV substation at Hulseheath, however, SPEN will seek to reduce impacts on the natural environment.

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.

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 adopted option is to establish a new 132/33kV grid infeed substation with a 60MVA transformer is proposed around the Hulseheath area and management of thermal constraints on 132kV Cuerdley – Sankey Bridges and Cuerdley – Warrington circuits by installing a dedicated network monitoring and automation at Cuerdley 132kV substation and contract flexibility services to manage the 132kV Sankey Bridges – Hartford circuit constraint. The combination of network automation and flexibility services will enable to defer £10.5m of circuit upgrades.

The estimated cost of the proposed solution is £14.809m, with £3.351m contribution to be included in the ED2 Primary Reinforcements, split between CV1 – Load Related Reinforcement (£0.690m), and C2 – Connections (£2.661m).

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.

8 Appendices

Appendix A. 33kV Authorised Networks

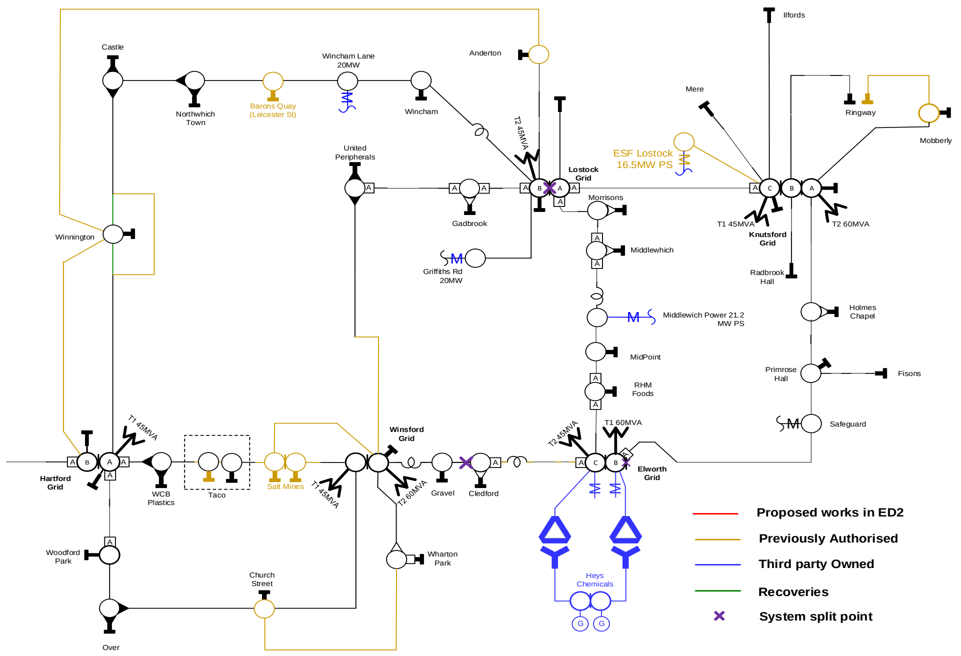

Figure 10. Authorised 33kV Elworth -Hartford-Lostock-Winsford-Knutsford grid group network

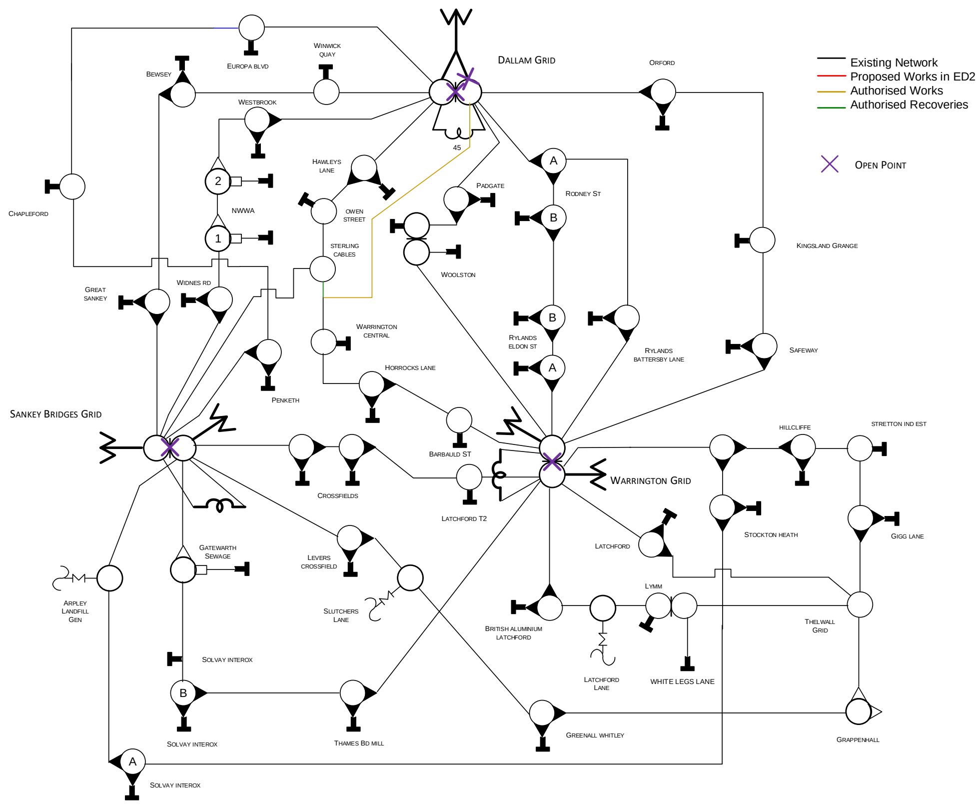

Figure 11. Authorised 33kV Dallam-Sankey Bridges-Warrington grid group network

Appendix B. HS2 demand location and related interventions

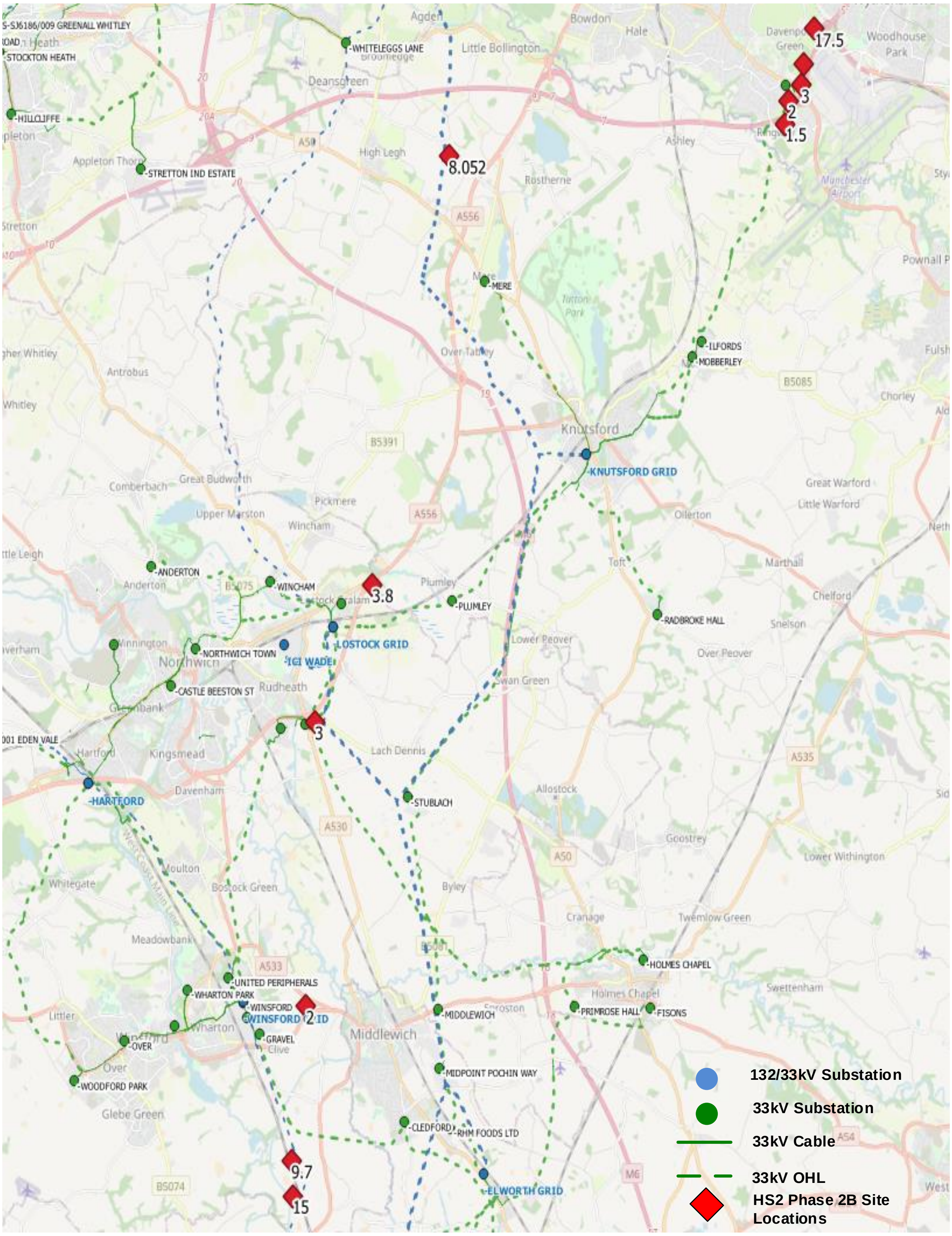

Figure 12. HS2 Phase-2B site locations across SPM Mid-Cheshire network area

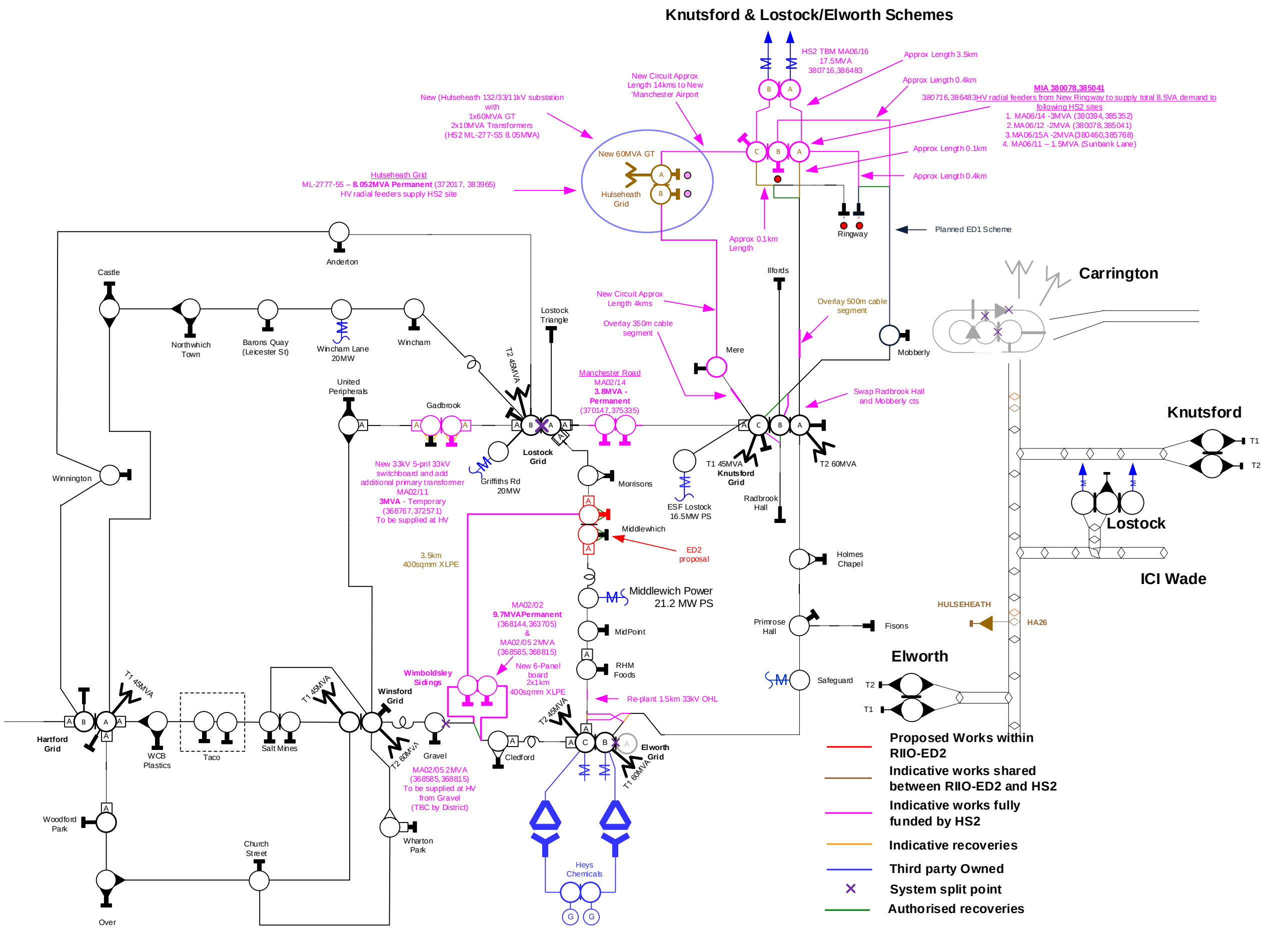

Figure 13. Proposed works around Elworth/Knutsford/Lostock/Mere/Ringway/Manchester International Airport

Appendix C. HS2 Demand Requirements

<table>
<tr><th>HS2 Construction Compound Reference</th><th>POC Voltage (kV)</th><th>Phase</th><th>Temporary Demand (MW)</th><th>Permanent Demand (MW)</th><th>Total Supply (MW)</th></tr>
<tr><td>New Castle Road (245 -S2 South Crewe MPATS)</td><td>33</td><td>2A</td><td>2.3</td><td>4.9</td><td>7.2</td></tr>
<tr><td>MA01/04 (Crewe Tunnel North Main Compound)</td><td>33</td><td>2B</td><td>20.0</td><td>7.3</td><td>20.0</td></tr>
<tr><td>MA02/02 (Crewe Rolling Stock Depot)</td><td>33</td><td>2B</td><td>3.0</td><td>9.7</td><td>9.7</td></tr>
<tr><td>MA02/05 (A54 Middlewich Road)</td><td>11</td><td>2B</td><td>2.0</td><td>-</td><td>2.0</td></tr>
<tr><td>MA02/11 (Gad Brook Viaduct North)</td><td>11</td><td>2B</td><td>3.0</td><td>-</td><td>3.0</td></tr>
<tr><td>MA02/14 (Smoker Brook Viaduct South)</td><td>11</td><td>2B</td><td>3.0</td><td>3.8</td><td>3.8</td></tr>
<tr><td>MA03/06 (Peacock Lane ATFS)</td><td>11</td><td>2B</td><td>-</td><td>8.1</td><td>8.1</td></tr>
<tr><td>MA06/11 (Sunbank Lane)</td><td>11</td><td>2B</td><td>1.5</td><td>-</td><td>1.5</td></tr>
<tr><td>MA06/12 (M56 East)</td><td>11</td><td>2B</td><td>2.0</td><td>-</td><td rowspan="4">24.5</td></tr>
<tr><td>MA06/14 (Manchester Airport Station)</td><td>11</td><td>2B</td><td>3.0</td><td>-</td></tr>
<tr><td>MA06/15 (Manchester Airport Station North)</td><td>11</td><td>2B</td><td>2.0</td><td>-</td></tr>
<tr><td>MA06/16 (Manchester Tunnel South Portal)</td><td>33</td><td>2B</td><td>17.5</td><td>18.1</td></tr>
<tr><td>MA01/02(Shaft No.1)</td><td>11</td><td>2B</td><td>1.0</td><td>-</td><td>1.0</td></tr>
<tr><td>MA01/03(Shaft No.2)</td><td>11</td><td>2B</td><td>1.0</td><td>-</td><td>1.0</td></tr>
<tr><td>Crewe RSD traction supply (132/25kV)</td><td>25</td><td>2B</td><td>-</td><td>15.0</td><td>15.0</td></tr>
<tr><td colspan="3">Total (MW)</td><td>61.3</td><td>66.8</td><td>96.8</td></tr>
</table>

Appendix D. System study results

Results of half hourly profile-based simulations for summer N-1-1 using historical SCADA data