Lister Drive 132kV GSP Reinforcement

ED2 Engineering Justification Paper

ED2-LRE-SPM-003-CV1-EJP

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

Scheme Name	Lister Drive 132kV GSP Reinforcement		
Activity	132kV Network Reinforcement Deferral		
Primary Investment Driver	Thermal Constraints		
Reference	ED2-LRE-SPM-003-CV1-EJP		
Output Type	Load Index		
Cost	£0.778m		
Delivery Year	2024-2028		
Reporting Table	CV1		
Outputs included in ED1	~~Yes~~/No		
Business Plan Section	Develop the Network of the Future		
Primary Annex	Annex 4A.2: Load Related Expenditure Strategy: Engineering Net Zero Annex 4A.6: DFES		
Spend Apportionment	**ED1**	**ED2**	**ED3**
	-	**£0.778m**	**-**

Technical Governance Process

IP1(S)

Project Scope Development

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:	Lister Drive 132kV GSP Reinforcement
Project Reference:	ED2-LRE-SPM-003-CV1-EJP
Decision Required:	To give concept approval for the use of flexibility services in combination with thermal monitoring and network automation to manage a 132kV cable constraint in the Lister Drive GSP.

Summary of Business Need:

The Lister Drive 132kV network group provides supplies to ca 160,000 customers including Liverpool city centre as well as the shipping docks and industries along the Mersey river.

Based on the SPM Distribution Future Energy Scenarios the demand growth in this group is expected to exceed network capacity during the ED2 period due to LCT uptake

Detailed network studies involving all N-1 / N-1-1 outages have identified a thermal constraint on the Lister Drive – Burlington 132kV gas compressed cable circuit. This strategic circuit supplies two 33kV groups in the Liverpool City Centre.

Half-hourly time-profile studies have been undertaken to quantify the hours at risk and to define the flexibility services that would be required to manage the constraint. A total of 22.2MW of Secure product were issued for tender in May 2021. Flexibility tender responses totalling 41.3 MW have been received and technically reviewed. Optioneering and design studies have been undertaken to assess the least cost technically acceptable solution.

The primary driver for the proposed investment is to mitigate the thermal issues in the Lister Drive 132kV group. The proposed solution is to defer conventional reinforcement by managing the 132kV cable constraint through the ED2 period using Flexibility services in combination with thermal monitoring and network automation.

Summary of Project Scope, Change in Scope or Change in Timing:
Proposed works at 132kV:

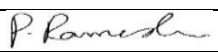
1. Contract ca. **41.3MW flexibility services** using the **Secure** product.
2. Mitigate the risk of thermal loading on Lister Drive – Burlington St circuit through:
   - Install real-time **thermal monitoring equipmen**t at Lister Drive substation on the 132kV circuit to Burlington St.
   - Install a Constraint Management Zone (CMZ) based **automation scheme** to trip the Burlington St. – Bootle 132kV circuit and to close either the line or the bus section breaker at Bootle.
   - Continue annual tendering for flexibility in this area to reduce dependence on automation scheme and higher demand turnout

The estimated cost for the above is **£0.778m** (in 2020/21 prices) with 100% contribution to be included in the ED2 load related expenditure. **This defers a conventional reinforcement of circa £9.0 - 11.5m.**

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	Innovation–Automation scheme	**0.350**	0.350	-	-	-	-
		Innovation – Flexible Services	**0.428**	-	0.019	0.073	0.123	0.213
		Total Expenditure	**0.778**					

PART B – PROJECT SUBMISSION

Proposed by	Ramesh Pampana	Signature		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 Lister Drive 132kV network group provides supplies to 163,700 customers including Liverpool city centre as well as the shipping docks and industries along the Mersey river.

The 132kV network group is an EREC P2/7- Security of Supply Class 'E' group, with a winter peak demand of 323MVA as of 2020/21. Distribution Future Energy Scenarios (DFES), under Baseline scenario, project a peak demand growth of 372MVA, with an expected uptake of up to 10,077 electrical vehicles and 4,995 heat pumps by the end of ED2 period. Additionally, the group also supplies to 130MVA of Agreed Supply Capacity (ASC) demand customers of which 20MW are contracted battery storage customers.

This area of Merseyside experiences high levels of customer connections activity to access the network capacity at lower voltages. In addition to existing developments, there are significant development proposals driven by Liverpool City Council & City Region to meet the Liverpool City Region Combined Authority Net Zero targets by 2040. Additionally, Peel Holdings have proposals for the development residential properties along the Mersey docks which will have an expected total demand of 35MVA over the next 20 years.

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, and to accommodate future demand growth within the area, it is proposed to manage the thermal constraints in the 132kV network group. This will use a combination of innovation and flexibility services to defer reinforcement beyond the ED2 period.

The primary driver for the proposed investment is to mitigate the thermal issues in the Lister Drive 132kV group. Summary of the proposed scheme:

1. Contract ca. **41.3 MW flexibility services** using the **Secure** product.
2. Mitigate the risk of thermal loading on Lister Drive – Burlington St circuit through:
   - Install real-time **thermal monitoring equipmen**t at Lister Drive substation on the 132kV circuit to Burlington St.
   - Install a Constraint Management Zone based **automation scheme** to trip the Burlington St. – Bootle 132kV circuit and to close either the line or the bus section breaker at Bootle.
   - Continue annual tendering for flexibility in this area to reduce dependence on automation scheme and in the case of higher demand turnout

The estimated cost for the above is **£0.778m** (in 2020/21 prices) with 100% contribution to be included in the ED2 load related expenditure. It is proposed to install the thermal monitoring and automation scheme in 2024 and utilise flexible services for the rest of ED2 period. **This defers a conventional reinforcement of circa £9.0 - 11.5m.**

2 Background Information

2.1 Existing / Authorised Network

The 132kV network group is supplied from National Grid Transmission System at Lister Drive by 4 x 275/132kV 240MVA Super Grid Transformers (SGTs) as shown in Figure 2-1 and supplies to other Bulk Supply Point (BSP) sites namely Bootle, Burlington St, Garston, Speke and Wavertree. The underlying EHV (33kV) network is split into four grid groups, each group supplied by 3 x 132/33kV 60MVA grid transformers.

The 132kV network group is normally operated split from the adjacent Kirkby 132kV group at Bootle. Under abnormal operating conditions including during maintenance outages in the Lister Drive group, Bootle GT2A is transferred to Kirkby 132kV group by opening the Bootle - Burlington St cable circuit and closing either the line or the bus section breaker at Bootle.

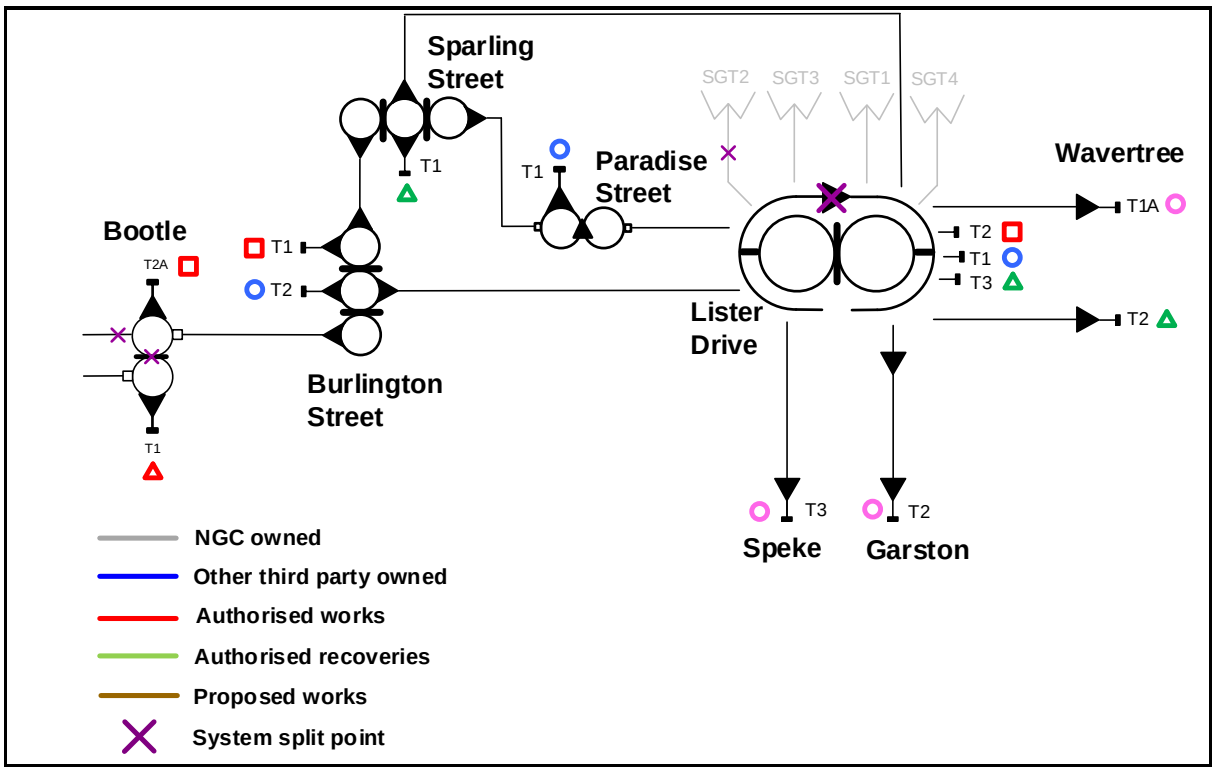


Figure 2-1: Lister Drive 132kV group

2.2 Group Demand & Security of Supply

The current maximum group demand is 323MVA(Winter) and 272MVA(Summer); which places the group in class of supply 'E' as per EREC P2/7(≥300MW) and must be secured for a Second Circuit Outage (SCO). The current running arrangement with 3 SGTs solid, one SGT on open standby is sufficient to meet the security of supply criteria.

The below shows the connected and contracted demand capacities in the group; the firm capacities and existing load indices of the 132kV & EHV grid groups are presented in Table 2-2.

Table 2-1: Connected/Contracted demand and generation

Customer	Import capacity (MVA)	Export capacity (MW)	POC Volts (kV)	Status
BR Bankhall	12.5	-	33	Connected
Canada Docks	6	-	33	Connected
Liverpool Int. Business park	16	7.5	33	Connected
Mannis Island	3.5	1.0	33	Connected
Norton Scrap	5.2	0.8	33	Connected
Paddington Place	10	1.2	33	Connected
Royal Liverpool Hospital	10	5	33	Connected
Trafalgar Docks	20	-	33	Connected
Wavertree Boulevard	6.75	-	33	Connected
Carnegie Road BESS	20	20	33	Connected
Hawthorne Road BESS	20	20	33	Contracted
Total	**129.95**	**45.5**		

Table 2-2: Lister Drive GSP & EHV Group Load Indices

Grid groups	Customers (#)	Outage Scenario	Firm Capacity (MVA)	Max demand (MVA)	Load Index	P2/7 Class of Supply
Lister Drive 132kV	159,743	N-1	360	323	LI2	D
		N-1-1	300	272	LI2	
Bootle - Burlington St - Lister Drive 33kV	48,131	N-1	138	84.8	LI1	D
Burlington St - Lister Drive - Paradise St 33kV	13,133	N-1	139	68.7	LI1	D
Garston - Speke - Wavertree 33kV	33,658	N-1	108	55.9	LI1	C
Lister Drive - Sparling St - Wavertree 33kV	64,821	N-1	138	77.4	LI1	D

2.3 Fault levels

The Lister Drive 272/132kV Super Grid substation is run solid on the 132kV side; however due to fault level constraints at Lister Drive, SGT2 is on open standby under normal running and can be brought into service through an auto-close scheme for the loss of any other SGT.

Table 2-3 below shows, the current and future fault level utilisations as a percentage of switchgear rating in the 132kV group are shown in. As observed, the fault levels in Lister Drive site are currently approaching the switchgear ratings. However, with the ongoing works to replant the AIS switchgear with GIS at Lister Drive, the prospective fault levels will be within the switchgear ratings.

Table 2-3: Max Fault Levels

132kV site	Existing (AIS Switchgear)		Future (GIS Switchgear)	
	Peak Make	RMS Break	Peak Make	RMS Break
Bootle	57%	70%	59%	72%
Burlington St	70%	79%	73%	81%
Lister Drive	**99%**	**95%**	77%	74%
Sparling St	78%	83%	81%	85%

3 Needs Case

The Lister Drive 132kV network group supplies ca 160,000 customers including Liverpool city centre. The customer base is a mix of industrial, commercial and domestic customers, the peak demand observed in the group is 323 MW (Winter) / 272 MVA (Summer) and the total connected /contracted ASC demands in the group is 130MVA import and 45.5MW export capacity.

All of the 132kV circuits in this group are underground cables, with a mix of XLPE, oil filled, and gas compressed types. The limiting circuit is Lister Drive – Burlington St. 7.45 km cable circuit and is the only remaining gas compressed type in this group. The circuit data is provided in Table 3-1 below and the geographic route map is shown in Figure 3-1. This circuit is a strategic asset in the group as it affects the security of two grid groups in Liverpool city centre viz., Bootle T2A/Burlington St T1/Lister Drive T2 and Burlington St T2/Lister Drive T1 /Paradise St T1.

Table 3-1: Lister Drive – Burlington St. cable data

Section (#)	Construction details	Winter Rating (continuous/cyclic)	Summer Rating (continuous/cyclic)	Length (km)
1	0.5 sq.in, 3Core, Cu, Gas comp.	132/153 MVA	113/134 MVA	1.14
2	0.5 sq.in, 1Core, Cu, Gas comp.	138/160 MVA	118/140 MVA	5.85
3	0.65 sq.in, 1Core, Cu, Gas comp.	149/174 MVA	127/151 MVA	0.46

Network studies highlight the following issues under outages scenarios:

1. For the planned/ unplanned loss of either Lister Drive – Sparling St or Lister Drive – Paradise St circuits, under summer max demand conditions, Lister Drive – Burlington St circuit overloads, exceeding the continuous rating of 113MVA.
2. For a planned/maintenance outage of Lister Drive – Sparling St, followed by a forced outage of Lister Drive – Paradise St. circuit, under summer max demand conditions, the Lister Drive – Burlington St circuit overloads, exceeding the cyclic rating of 134MVA.

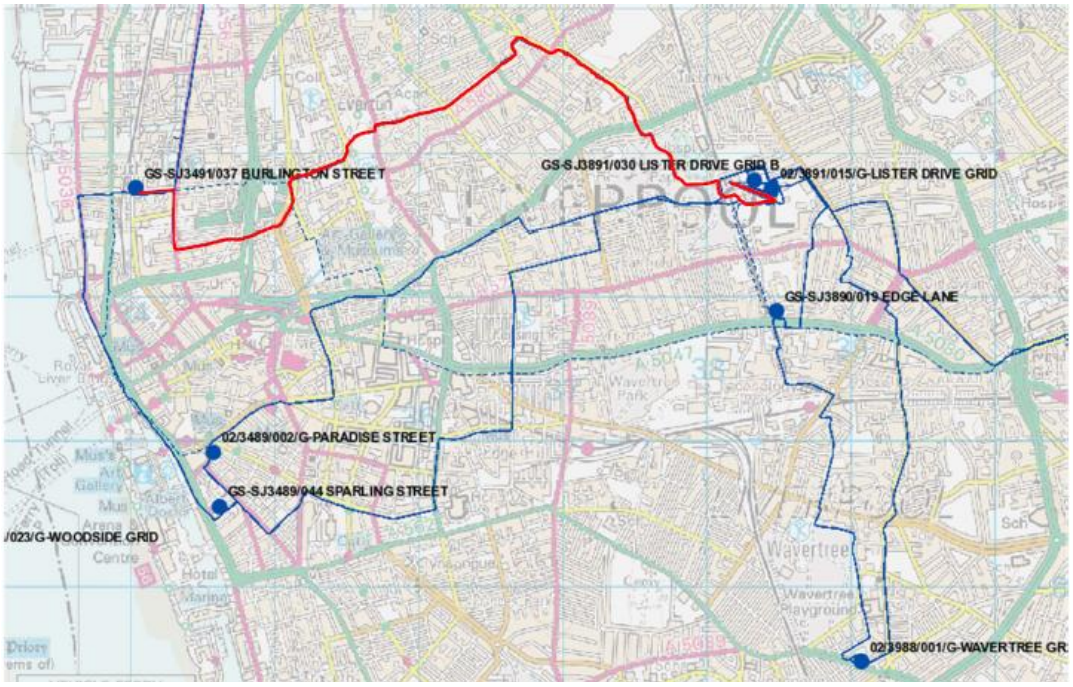


Figure 3-1: Lister Drive – Burlington St 132kV circuit route

3.1 Forecast Demand

The group demand observed in the group is 323 MVA(Winter) / 272 MVA (Summer) in 2020/21. The system is forecast to grow and exceed firm capacity within the ED2 period. This forecast is based on actual system measurement data from the PI system and stakeholder endorsed Distribution Future Energy Scenarios (DFES) and considers our pipeline of known developments.

3.1.1 Distribution Future Energy Scenarios

The DFES includes granular forecasts to 2050 for demand, generation and Low Carbon Technologies. They assess four 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.

3.1.2 Local Considerations

Liverpool City Region Combined Authority (LCRCA) have an ambitious, sustainable strategy to facilitate economic growth in the area over the next 25 years. Within Sefton Council area there is a commitment to the £100 million Regeneration of Bootle Canal Quarter that fulfils LCRCA's plans by providing improved infrastructure, housing, retail, culture, and leisure facilities. At a high level it is predicted this will require around 9-12MVA of additional capacity from the SPM Network.

The proposed development of commercial and residential areas to the south of this regeneration area under Phase 1, will predominately be supplied from 2 separate 6.3kV networks fed from the Bibbys/Regent Road/Inland Revenue and Delamore Street/Kirkdale/Walton primary groups which are part of Bootle / Burlington / Lister Drive 33kV group.

The winter and summer demand forecast based on the SPM Distribution Future Energy Scenarios, including authorised connections are depicted in

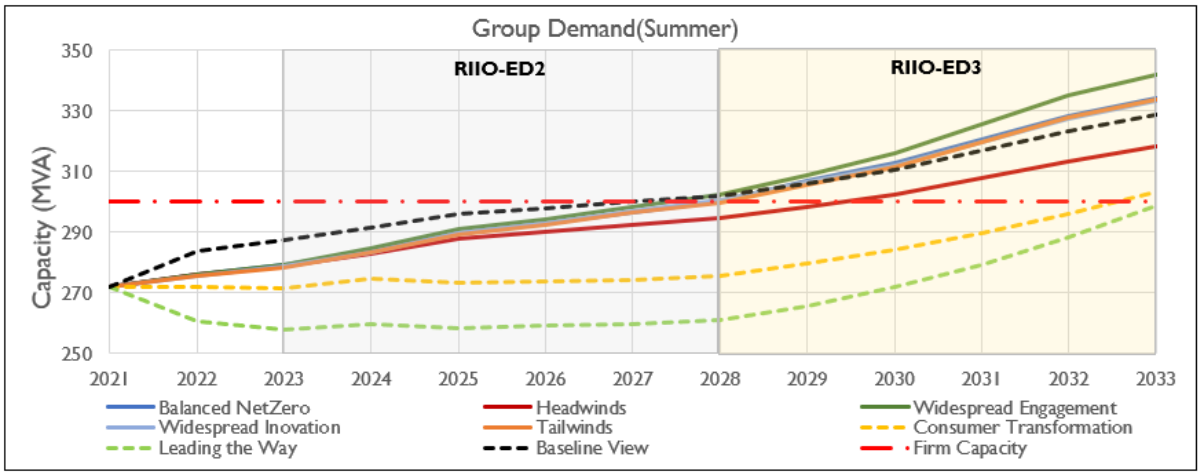
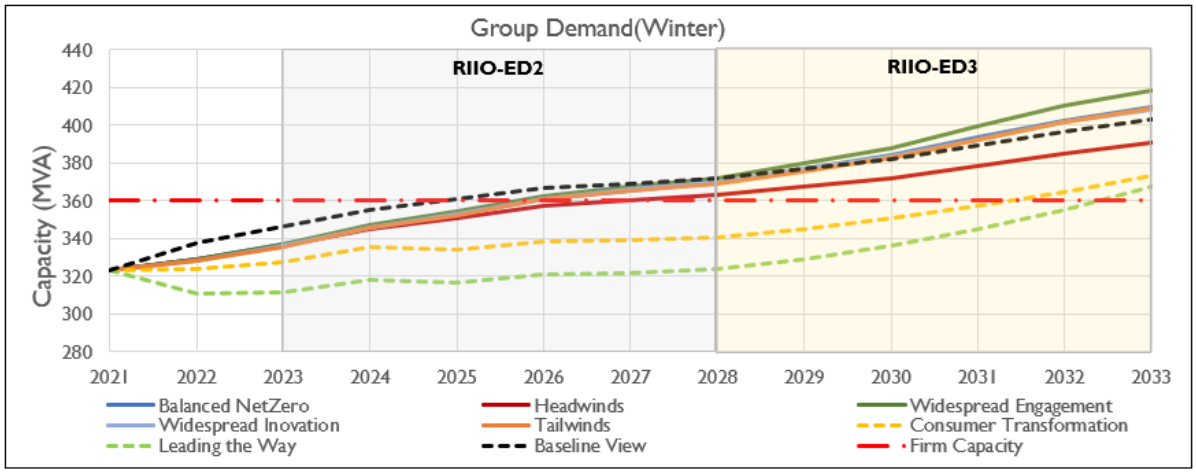


Figure 3-2. The group has a contracted battery storage connection of 20MW, due for connection by the end of ED1. The anticipated total electric vehicle and heat pump uptake based on the future energy scenarios is depicted in Figure 3-3. Based on the DFES forecast, under high uptake scenarios, it expected an uptake of up to 10,077 electrical vehicles and 4,995 heat pumps and the peak group demand is estimated to be 372 MVA by the end of ED2 period in the group. It is expected that majority of the demand appears in the Liverpool City centre, across the Bootle, Burlington St, Lister Drive and Paradise St grid groups.



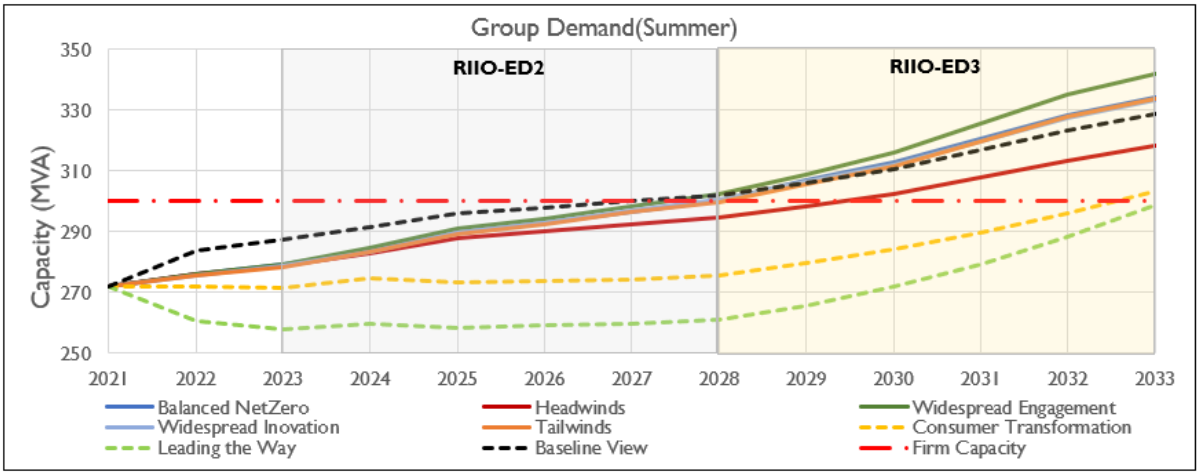


Figure 3-2: Demand (MVA) forecast for Lister Drive GSP group

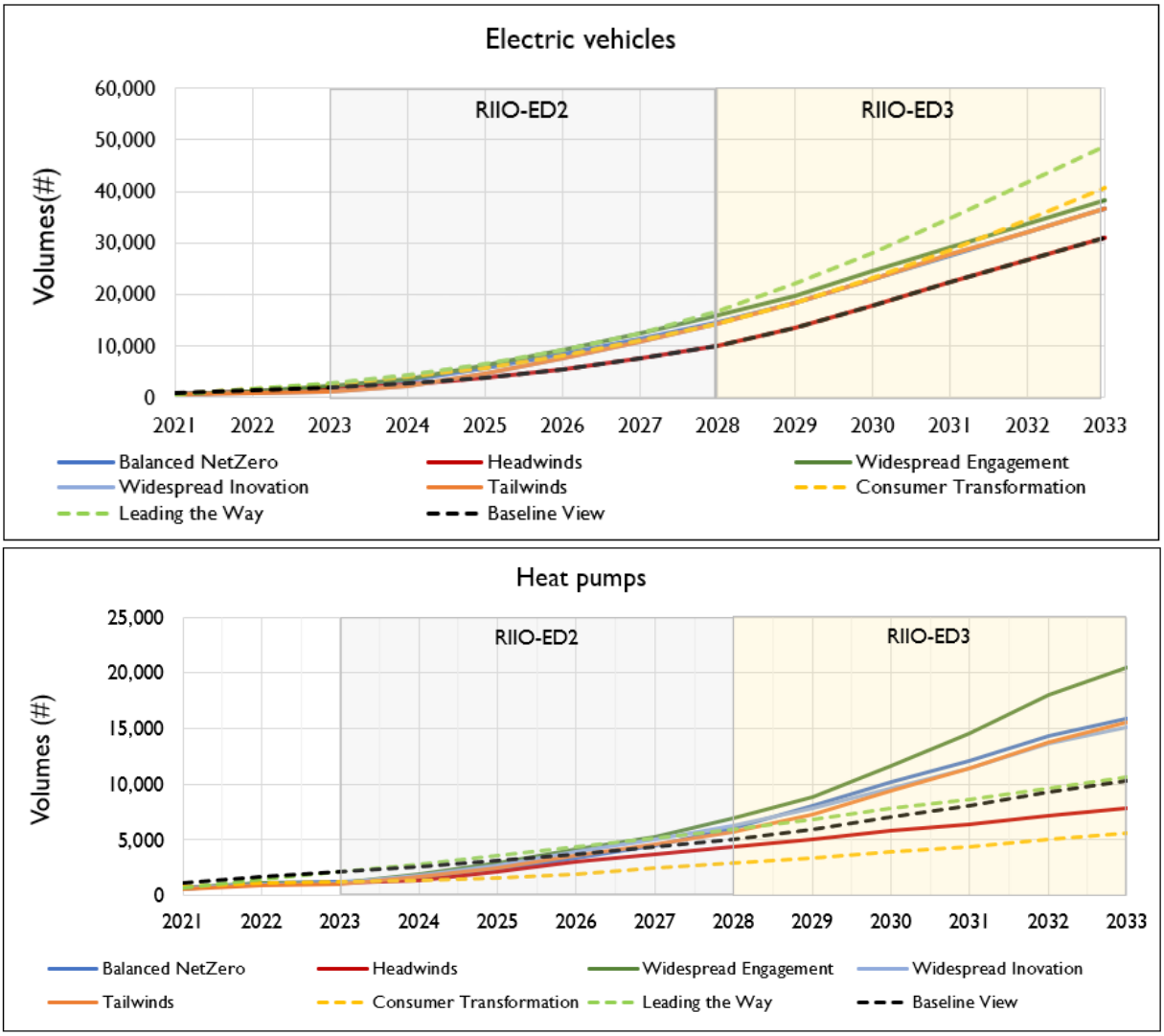


Figure 3-3: Forecasted Electric Vehicle and Heat Pump uptake

3.1.3 Baseline View

For the Lister Drive 132kV GSP, this forecast demand growth under Baseline View, along with the firm capacity and load index position through to ED3 period 2033 and as shown in Table 3-2.

Table 3-2: Baseline View scenario forecast

		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Winter	Forecast Demand (MVA)	323	338	346	355	361	367	369	372	377	382	389	397	403
	Firm Capacity (MVA)	360	360	360	360	360	360	360	360	360	360	360	360	360
	Utilisation (%)	90	94	96	99	100	102	103	103	105	106	108	110	112
	Load Index	LI2	LI2	LI3	LI3	LI4	LI5	LI5	LI5	LI5	LI5	LI5	LI5	LI5
Summer	Forecast Demand (MVA)	272	284	287	292	296	298	300	302	306	311	317	323	329
	Firm Capacity (MVA)	300	300	300	300	300	300	300	300	300	300	300	300	300
	Utilisation (%)	91	95	96	97	99	99	100	101	102	104	106	108	110
	Load Index	LI2	LI2	LI3	LI3	LI3	LI4	LI4	LI4	LI5	LI5	LI5	LI5	LI5

3.2 Network Impact Assessments

Detailed network studies covering network intact and outage (N-1/ N-1-1) conditions and fault level assessments were carried out for the 132kV and 33kV network fed from the Lister Drive 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 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 potential risk duration and risk window of the constraint, help in determine the risk hours and the capacity required to overcome the constraint, using flexible services.

3.2.1 Thermal Constraints

Table 3-3 shows the identified thermal constraints on the 132kV network level. No other thermal constraints were identified on the 33kV groups.

Table 3-3: Thermal constraints

Network Item	Voltage (kV)	Outage
Lister Drive – Burlington St cable ckt	132	N-1 / N-1-1

3.2.2 Voltage Constraints

No other voltage constraints observed in the group under intact or outage conditions on the 132kV and 33kV network groups.

3.2.3 EREC P2/7 – Security of Supply

The current maximum group demand is 323 MVA(Winter) and 272MVA(Summer); which puts the group in class E of supply as per EREC P2/7(≥300MW) and a class 'D' group must be secured as a minimum for a Second Circuit Outage (SCO).

Network studies indicate that Lister Drive GSP is thermally constraint due to the overloads on the Lister-Burlington St cable circuit for both unplanned (N-1) and planned / maintenance (N-1-1) outages in the group.

3.2.4 Fault Level Constraints

No other fault level issues in the group.

3.2.5 Flexibility services

Our assessments indicate that the network constraints in the 132kV group network starts from 2024/25 through to the year 2027/28 for the most onerous scenario. To manage the network risk and

security of supply constraint a max capacity of 7.83MW is required to alleviate the constraints by the end of ED2 period. Table 3.4 below shows flexibility services in terms of the network risk hours and tendered capacity, totalling 22.17MW across RIIO-ED2.

Table 3.4. 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)	-	25	67.5	141	379
Required Flexible Capacity (MW)	-	3.11	5.16	6.07	7.83

4 Optioneering

The following is the longlist of the options considered for this reinforcement. Few of the longlist options are rejected based on the technical and commercial rustications, the reasons are provided in the table. The shortlisted options are taken forward for detailed analysis and included in the cost-benefit analysis. The Baseline option of cable overlay is the "do minimum" scheme required to mitigate the thermal issues in the Lister Drive 132kV group without the use flexibility or innovation.

Table 4-1: Longlist of options considered

Options	Description	Status	Reason for rejection
(a)	No Intervention	Rejected	Not compliant with security of supply requirements as per EREC P2/7.
(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)	Overlay constrained sections of cable	Considered as **Baseline** option	-
(d)	Install New 132kV Cable Circuit	Considered as **Option 1**	-
(e)	Real-time monitoring and network automation	Considered as **Option 2**	-
(f)	Contract with Flexibility services alone	Considered as **Option 3**	-
(g)	Combination of Flexibility Services with real-time monitoring and automation	Considered as **Option 4**	-
(h)	In-line Power flow controller	Rejected	A phase shifting transformer, or power-electronics based power-flow controller placed in series with the constrained circuit would be unable to divert power-flows under the most onerous contingency.
(i)	Power flow controller with adjacent group	Rejected	Rejected due to cost and limited substation footprint at Bootle.
(j)	Split Lister Drive 132kV group	Rejected	This would install an additional transmission infeed and is rejected based on cost, timescales and whole system impacts.
(k)	Reconfiguration to move demand between 33kV groups	Rejected	This would require significant modifications to EHV groups and underlying HV groups. It is rejected based on cost, timescales and whole system impacts.

5 Detailed Analysis

Detailed system studies with the additional demand from LCT uptake indicate that there will be insufficient 132kV network capacity (thermal) in Lister Drive GSP group and security of supply issues in the 33kV network groups during N-1 / 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 Solution – CMZ based automation scheme and Flexibility

5.1.1 Overview

The proposed option for this scheme is to defer the reinforcement with the combination of:

- Utilising Flexibility Services and
- Thermal monitoring and based on CMZ automatic load transfer scheme

Table 5-1 shows proposed solution summary.

Table 5-1. Proposed solution scheme summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Innovation / Smart	Lister Drive 132kV Reinforcement	Deferral of reinforcement through flexibility services.	**0.778**	-
		Dedicated thermal monitoring for the Lister Drive - Burlington St cable circuit.		
		CMZ based automation to transfer Bootle GT2A into Kirkby group.		

5.1.2 Network Risk Duration and Reinforcement deferral via Flexibility Services

Network studies identified the risk in terms of the thermal capacity exceedances with the forecast demand and the anticipated duration of the risk. Time profile-based simulations (17,520 simulations/year) were performed considering the historical half hourly measured SCADA data combined with the DFES demand projections. These considered each year through the RIIO-ED2 price control period to identify the potential risk duration and risk window. The half-hourly studies performed for years starting from 2023 through 2028 helped identify the anticipated time of risk on the network as well as the flexible capacity required to alleviate the constraints on the network.

The studies indicate that the thermal overloads on the Lister Drive – Burlington St 132kV cable circuit, the risk of potential overload starts from the year 2025 throughout to the year 2028 and required a max capacity of ca. 8MW by 2028. Based on these requirements flexibility services, using a Secure[1] product, were tendered in May 2021 to provide services between 2023-28 period. The tenders returned after pre-qualifications bids have shown three qualified bidders, the combined capacity from all the bidders is 41.3MW for all the years between 2023-28.

Table 5-2 below shows the network risk hours, the requested (tendered) capacity and the tender out-turns from the connected/future customers in the group.

Table 5-2: Network risk hours & flexible capacity

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Risk Duration (Hrs)	-	25	67.5	141	379
Required Flexible Capacity (MW)	-	3.11	5.16	6.07	7.83
Received Flexible capacity (MW)	-	9.3	13.4	10.4	8.2
Flexible Capacity met (%)	-	300	259	171	105
Cost of Flexible services(£m)	-	0.019	0.073	0.123	0.213

The flexibility tender returns are sufficient for the entirety of the requested period with higher procurement in the early years helps reduce dependence on the proposed automation scheme.

5.1.3 Reinforcement deferral via Flexibility Service

Network studies indicate risk of thermal overloading of the 132kV Lister Drive – Burlington Street cable due to smaller sized cable sections in the circuit. This overload could be managed, and the need

[1] Under Secure product the DNO procures the services ahead time to prevent the network going beyond its firm capacity.

for cable reinforcement deferred beyond the ED2 period by contracting with a total capacity 41.3MW of flexible services. These services control the demand down (or generation increase) in the relevant timeframes to avoid risk of overload. The flexibility tender returns to date have been unable to meet the entirety of the requested capacity; flexibility tenders will continue in this area to procure the required capacity.

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 required reinforcement works when efficient to do so. The annual reinforcement deferral ceiling cost was calculated to be £0.361m per year to manage the constraint via flexibility. Summary of anticipated cost of flexibility services from recent round of tenders along with annual ceiling cost is shown in Table 5.3.

Table 5.3. Summary of flexibility service costs

Year	2023/24	2024/25	2025/26	2026/27	2027/28
Annual Reinforcement Deferral Ceiling Cost	-	£0.361m	£0.361m	£0.361m	£0.361m
Cost of Flexibility Services	-	£0.019m	£0.073m	£0.123m	£0.213m
Flexibility Outlook	-	●	●	●	●
● - *Accept bids and defer reinforcements*					
● - *Reject bids and deliver reinforcements*					

5.1.4 Thermal monitoring and automatic load transfer scheme

Network studies indicate that the thermal overloading of 132kV Lister Drive – Burlington St cable circuit can be also mitigated by transferring up to ca. 42 MVA into adjacent Kirkby group, as indicated in Figure 5-1. As the Lister Drive – Burlington St circuit feeds the two 33kV groups viz. Bootle-Burlington-Lister Drive and Burlington St- Lister Drive – Paradise St., under conditions where the circuit loading approaches its continuous/cyclic ratings, transferring the Bootle GT2A to Kirkby group will offset the cable loading. However, this results in the cross-coupling of the 132kV groups and can cause fault level exceedances in both the 132kV groups, hence it is recommended to open the Burlington St. – Bootle 132kV circuit.

The full description of the scheme is as described below,

- Install a real time thermal monitoring device (RTTR) at Lister Drive substation on the 132kV, 7.45km, gas compressed circuit to Burlington St and provide alarms into the operational control room.
- Establish a Constraint Management Zone at Lister Drive and implement an automation scheme to trip the Burlington St. – Bootle 132kV circuit and close the either the line or bus section breaker at Bootle. This automation scheme should consider the status of breakers at Bootle and the relevant SGT in-feeds and circuits in the Kirby 132kV into which the demand is transferred.

The proposed scheme can reduce the risk of insufficient flexibility services or if the requested flexible service provider does not turn up. Together, this proposed option will defer the need for reinforcing the Lister Drive – Burlington St. 132kV circuit to beyond ED2. Based on the demand uptake, it is likely the thermal constraints become unmanageable and reinforcement is required in the RIIO-ED3 period.

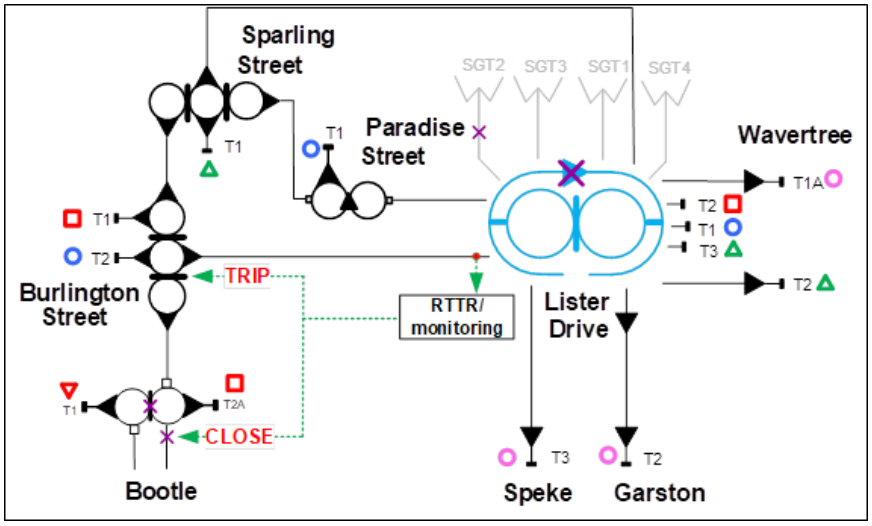


Figure 5-1: Proposed thermal monitoring and load transfer scheme

5.2 Baseline Option – Cable Overlay Lister Drive to Burlington Street.

Overlay the Lister Drive – Burlington St. ca 7.5km of gas compressed cable ckt with a min 630 sq. mm XLPE AL cable. This option would enable 31MVA additional capacity headroom during the summer N-1 outage scenario.

This option is **rejected** based on cost and longer lead times for the RIIO-ED2 period and can be managed by automation along with flexibility.

Table 5-4. Scheme summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Circuit reinforcement	Lister Drive 132kV Reinforcement	Overlay the Lister Drive – Burlington St. ca 7.5km of gas compressed cable ckt with 630 / 800 sq. mm XLPE AL cable	**9.07**	-

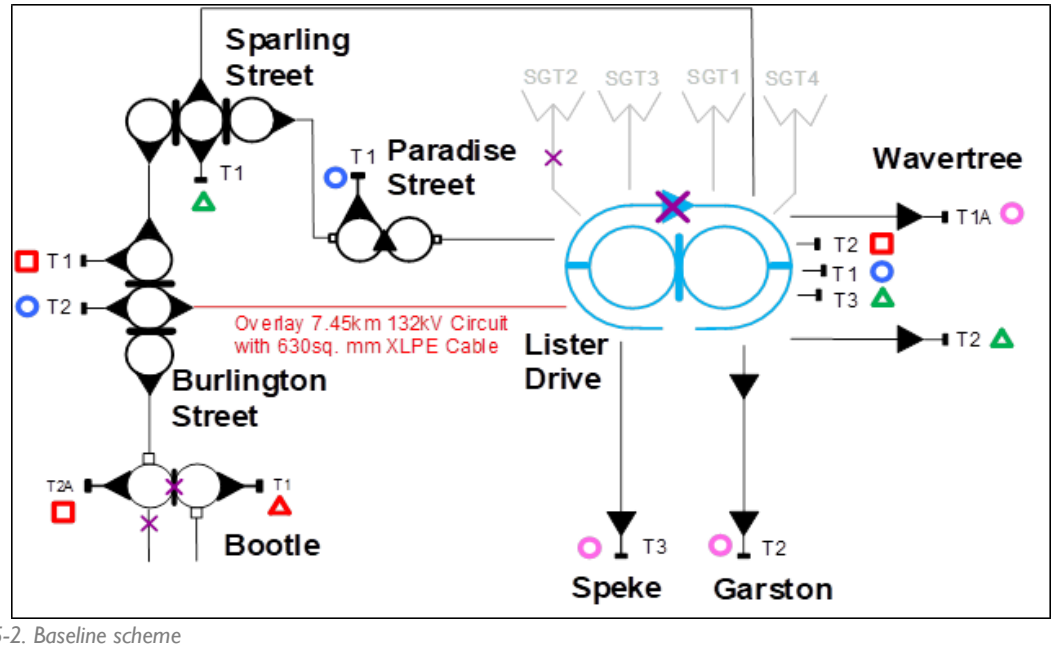


Figure 5-2. Baseline scheme

Table 5-5 Baseline scheme costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
132kV UG Cable (Non-Pressurised)	7.50	8.32	8.32	-
Wayleaves/Easements/Land Purchase		0.50	0.50	-
Other Costs (Identify below)		0.25	0.25	-
Total Costs		9.07	9.07	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
1. £200k for upgrading relays and other protection change cost				
2. £50k for engineering costs				

5.3 Option 1 - Install New 132kV cable circuit

New 132kV cable circuit, 800 sq. mm, 3C, AL XLPE, 7.2km long between Lister Drive to Burlington St. sites (associated comms, ducts and switchgear). This option would enable 90MVA additional capacity headroom during the summer N-1 outage scenario.

This option is rejected based on cost and longer lead times for the RIIO-ED2 period and can be managed by automation along with flexibility.

Table 5-6 - Scheme summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
New Circuit	Lister Drive 132kV Reinforcement	New 132kV cable circuit, 800 sq. mm, 3C, AL XLPE, 7.2km long, between Lister Drive and Burlington St. sites (associated comms, ducts and switchgear)	**11.74**	**-**

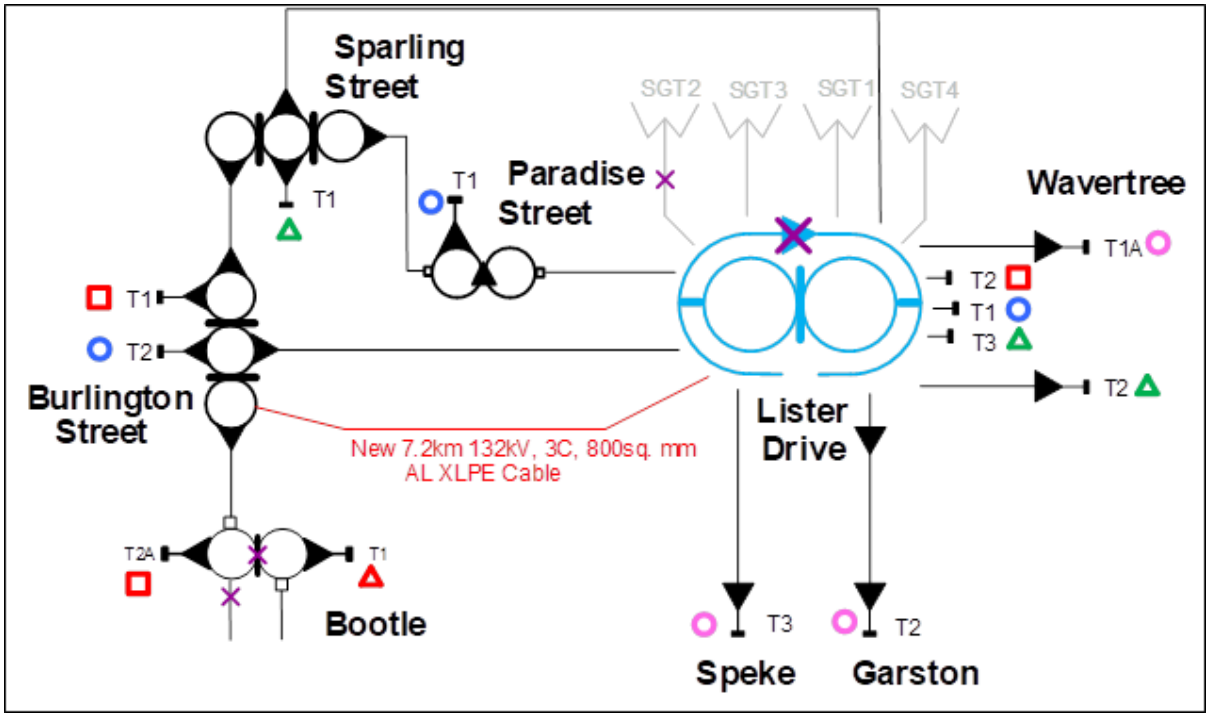


Figure 5-3 - New 132kV cable circuit

Table 5-7 - Option 1 scheme costs and volumes

Asset Description	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
132kV UG Cable (Non-Pressurised)	7.20	7.98	7.98
132kV CB (Air Insulated Busbars) (OD) (GM)	1.00	0.18	0.18
132kV CB (Gas Insulated Busbars) (ID) (GM)	1.00	0.78	0.78
Pilot Wire Underground	7.20	0.80	0.80
Civil Works at 132kV Substations		0.50	0.50
Wayleaves/Easements/Land Purchase		0.50	0.50
Other Costs (Identify below)		0.50	0.50
Total Costs		11.74	11.74
Identify activities included within other costs (please provide high-level detail of cost areas)			
1. Associated protection, control or SCADA equipment located at a site and remote ends			

5.4 Option 2 - Real-time thermal monitoring and inter-tripping scheme

This innovation option considered installing RTTR (Real Time Thermal Rating) monitoring scheme on the Lister Drive – Burlington St.132kV circuit with an automation scheme to transfer load into Kirkby 132kV group. This is as per the proposed option, but without flexibility services.

This option has been **rejected** due to increased network risk and limited capacity release. This option alone cannot mitigate the risk of overload when the adjacent group is run under abnormal conditions.

Table 5-8- Scheme summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Innovation/ Smart	Lister Drive 132kV Reinforcement	Dedicated thermal monitoring for the Lister Drive - Burlington St cable circuit. CMZ based automation to transfer Bootle GT2A into Kirkby group.	**0.35**	**-**

5.5 Option 3 - Flexibility services

The overload could be managed by contracting with tendered(qualified) capacity 41.3 MW of flexible services from May 2021 round of tenders. These services control the demand down (or generation increase) in the relevant timeframes to avoid risk of overload.

This option has been **rejected**. Although the flexibility tender returns from May 2021 provided sufficient to more than the required capacity, there is an inherent risk of managing the network constraint using flexible services alone owing to the size and prominence of the customer base.

Table 5-9 - Scheme summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Flexibility	Lister Drive 132kV Reinforcement	Flexibility services from connected/future customers in the GSP group	**0.428**	**£0.00**

5.6 Options Cost Summary Table

Summary of the costs for each of the evaluated options is presented in Table 5-10.

Table 5-10: Costs summary for considered options

Option	RIIO – ED2 Cost (£m)
Baseline – Cable Overlay	9.07
Option 1 - New cable circuit	11.74
Option 2 - Real-time thermal monitoring and network automation	0.350
Option 3 - Flexibility services	0.428
Option 4 (Proposed)- Flexibility Services with real time thermal monitoring and network automation	0.778

6 Deliverability and Risk

6.1 Preferred Options & Output Summary

The adopted option is the option 4 to procure flexibility services throughout RIIO-ED2 period and also install a CMZ based automated load transfer scheme. The combination of flexibility services and automation scheme will help manage the thermal overloads on the Lister Drive – Burlington St 132kV circuit, thereby deferring the need for reinforcement into RIIO-ED3 period.

6.2 Cost Benefit Analysis

A cost-benefit analysis was carried out to compare the NPV of the five options discussed in the previous sections. Considering the lowest forecast capital expenditure, the proposed option has the lowest total NPV and represents the lowest-cost option when losses and other operational costs are included in the analysis. Based on the outcome of the CBA, the proposed option is to defer the build options by means of flexibility services and monitoring scheme is selected. The summary of the cost benefit analysis is presented in Table 6-1.

Table 6-1: Cost Benefit Analysis results

Options	Decision	Comment	NPVs based on payback periods, £m (2020 / 21 prices)			
			10 years	20 years	30 years	45 years
Baseline Overlay Cable	Rejected	Discounted on cost.	0.00	0.00	0.00	0.00
Option 1 Install new cable circuit	Rejected	Discounted on cost.	-1.32	-1.86	-2.18	-2.43
Option 2 Real-time monitoring and intertripping scheme	Rejected	Discounted due to network risk. Cannot mitigate the risk of overload when the adjacent group is run under abnormal conditions.	1.68	1.46	1.31	1.17
Option 3 Flexibility services	Rejected	Discounted due to network risk associated with the contracted flexible services terminating.	1.40	0.97	0.70	0.46
Option 4 Flexibility with real time monitoring & automation	**Adopted**	Manages risk of thermal overload using innovation and defers the need for replanting a new cable beyond ED2.	1.18	0.69	0.37	0.10

6.3 Summary of Costs and Volumes

Table 6-2 shows the breakdown of expenditure for the proposed scheme (2020/21 prices). The total cost of the thermal monitoring scheme and automation scheme is £0.35m and further £0.428m to procure future flexibility services in the group.

Table 6-2: Summary of reinforcement Costs and Volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Constraint Management Zone based automation scheme	-	0.130	0.130	-
Thermal monitoring	-	0.120	0.120	-
Communications and protection modifications	-	0.100	0.100	-
Flexibility service costs	-	0.428	0.428	-
Total Cost(£m)		**0.778**	**0.778**	**-**

6.4 Expenditure Profile

Table 6-3: Cost Incidence over the ED2 period

Total Investment	Total	Cost Incidence (£m)				
	(£m)	2023/24	2024/25	2025/26	2026/27	2027/28
Primary Reinforcement (CV1)	0.778	0.350	0.019	0.073	0.123	0.213

6.5 Risks

The network risk of transferring demand into the 132kV Kirby group at a time when it is operating abnormally is managed through using flexibility services to reduce the hours at risk. There is inherent risk of fault level increase in the Lister Drive group due to cross-coupling with Kirkby 132kV group. Which would be will be managed operationally.

The risk of shortfall in contracted flexibility services, or flexibility services terminating contracts at short notice is managed through the provision of the automation scheme. If the forecast demand uptake is higher, when required, we will continue to tender for flexibility services in this area to give the market opportunity to service the additional capacity requirement.

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

The use of real-time thermal monitoring equipment on this type of 132kV cable has not been trialled in SPEN. The risk of this not operating sufficiently could be reduced by triggering the automation at a lower set-point using current measurements.

6.6 Future Pathways – Net Zero

6.6.1 Primary Economic Driver

The primary driver for this investment is insufficient thermal headroom to accommodate the forecast demand and security of supply risk to over 160,000 customers under network outage conditions.

6.6.2 Payback Periods

The CBA indicates that a positive NPV result in all assessment periods (10, 20, 30 & 45 years) which are consistent with the lifetime of the intervention. Consumers 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 License Condition 21. Additionally, the proposed option is consistent with the SPENs DSO vision and future network strategy.

For the Lister Drive 132kV group, Table 6-4 shows electric vehicle and heat pump uptakes across a range of future pathways, 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 Climate Change Committee (CCC) scenarios for the Lister Drive 132kV GSP by the end of RIIO-ED2 period.

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	10,077	8,065	14,404	16,777	14,570	10,077	15,841	14,445	14,445
HPs	4,995	6,285	2,912	5,935	6,052	4,378	6,907	6,268	5,754

**System Transformation scenario is excluded from future pathways assessment as it does not meet interim greenhouse gas emission reduction targets.*

Table 6-5: Sensitivity of the proposed solution against future pathways

Solution Requirements	RIIO-ED1			RIIO-ED2					RIIO-ED3				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Baseline					F1						R1		
Consumer Transformation													R1
Leading the Way													R1
Balanced Net Zero					F2						R1		
Headwinds					F2						R1		
Widespread Engagement					F2						R1		
Widespread Innovation					F2						R1		
Tailwinds					F2						R1		

List of solutions:
F1 – Flexibility services and load automation scheme
F2 – Increased flexible capacity requirement
R1 – 132kV circuit overlay

The proposed solution is robust across a wide range of pathways. The adopted solution would defer the need for reinforcement into RIIO-ED3 in all scenarios. The flexibility capacity requirement in RIIO-ED2 is sensitive to uptake volumes under each pathway. Under the higher uptake scenarios, the flexibility capacity requirement would be an additional ca. 4MW.

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

	Baseline	Uncertain
RIIO-ED2 Expenditure (£m)	0.778	0.044
Comment	Proposed option.	Additional flexible capacity under high uptake scenarios

6.6.4 Asset Stranding Risks

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

6.6.5 Losses / Sensitivity to Carbon Prices

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".

Losses have been considered as part of this design solution and it has not been necessary to carry out any Losses justified upgrades. 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 benefits have been considered as part of this proposal as the recommended solution enables to defer additional reinforcement into RIIO-ED3 price control period.

Lister Drive GSP is part of the MerseyRing transmission network. The NG ESO's Voltage pathfinder project for Mersey region[2] has been identified to potentially experience high voltages (due to high reactive power gains from cable networks) under minimum demand conditions. By deferring this reinforcement, the additional reactive power gains from the bigger-cross section cable is deferred, therefore not compounding the existing high voltages issue on the Mersey ring transmission and presenting a whole system benefit.

6.7 Environmental Considerations

6.7.1 Operational and embodied carbon emissions

The proposed scheme has limited potential to impact on SPEN's Business Carbon Footprint (BCF) and on the embodied carbon resulting from the delivery of the programme.

During the evaluation of the options associated Lister Drive 132kV 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. As the adopted option is reinforcement deferral, the deferred mass of carbon dioxide emitted (CO_2e) during the manufacture of the main equipment deployed to deliver this scheme is estimated to be ca. 170 tonnes, the monetised embodied carbon value associated with this emission is £8.4k.
It should be noted that the embodied carbon evaluation undertaken has only considered the manufacture and supply of materials. Further collaborative industry-wide work is planned for the RIIO-ED2 price review period to better understand the overall embodied carbon values including, for example installation and commissioning services, decommissioning and disposal activities as well as refurbishment opportunities. More information regarding this can be found in Section 3.1.2 of our Environmental Action Plan, Annex 4C.3: Environmental Action Plan, SP Energy Networks, Issue 2, 2021.

6.7.2 Supply chain sustainability

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

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

[2] https://www.nationalgrideso.com/document/140821/download

6.7.3 Resource use and waste

The proposed scheme will result in the consumption of resources and the generation of waste materials from end of life assets.

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

6.7.4 Biodiversity/ natural capital

The proposed scheme 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 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 SP Manweb Lister Drive 132kV network group provides supplies to ca 160,000 customers including Liverpool city centre as well as the shipping docks and industries along the Mersey river. This area of Merseyside experiences high levels of customer connections activity to access the network capacity at lower voltages. In addition to existing developments, there are significant development proposals driven by Liverpool City Council & City Region to meet the Liverpool City Region Combined Authority Net Zero targets by 2040. Additionally, Peel Holdings have proposals for the development residential properties along the Mersey docks which will have an expected total demand of 35MVA over the next 20 years.

To accommodate the demand growth in this group, an innovative approach is proposed including:

1. Contract ca. **41.3 MW flexibility services** using the **Secure** product.
2. Mitigate the risk of thermal loading on Lister Drive – Burlington St circuit through:
   - Install real-time **thermal monitoring equipmen**t at Lister Drive substation on the 132kV circuit to Burlington St.
   - Install a Constraint Management Zone based **automation scheme** to trip the Burlington St. – Bootle 132kV circuit and to close either the line or the bus section breaker at Bootle.
   - Continue annual tendering for flexibility in this area to reduce dependence on automation scheme and in the case of higher demand turnout.
   -

The estimated cost for the above is **£0.778m** (in 2020/21 prices) with 100% contribution to be included in the ED2 load related expenditure. **This defers a conventional reinforcement of circa £9.0 - 11.5m.**

8 Appendices

8.1 Network Constraint Study Results

Table 8-1: N-1 / N-1-1 Assessment results

Violation Description	Network Item	Flow (MVA)	Rating (MVA)	Rating (%)	Season	Outage	Contingency ID
Exceeds 100% Standard Rating	PARA C1.PARA E1.Transformer	70	60	117%	SUMMER	N-1	LISTERDRIVE_GT1
Exceeds 100% Standard Rating	LISD C5.LISD E3.GT1	70	60	117%	SUMMER	N-1	LISTERDRIVE_PARADISE ST
Exceeds 100% Standard Rating	PARA C1.PARA E1.Transformer	69	60	115%	SUMMER	N-1	LISTERDRIVE_BURLINGTON ST
Exceeds 100% Standard Rating	LISD C5.LISD E3.GT1	69	60	115%	SUMMER	N-1	LISTERDRIVE_BURLINGTON ST
Exceeds 100% Standard Rating	BURL C2.BURL E2.Transformer	69	60	114%	SUMMER	N-1	LISTERDRIVE_GT1
Exceeds 100% Standard Rating	BURL C2.BURL E2.Transformer	68	60	114%	SUMMER	N-1	LISTERDRIVE_PARADISE ST
Exceeds 100% Summer FCO Rating	BURL MC2.LISD M2.7.45 km	118	113	104%	SUMMER	N-1	LISTERDRIVE_SPARLING ST
Exceeds 100% Standard Rating	BURL C1.BURL E1.Transformer	60	60	101%	SUMMER	N-1	LISTERDRIVE_BURLINGTON ST
Exceeds 100% Standard Rating	BURL C1.BURL E1.Transformer	60	60	100%	SUMMER	N-1	LISTERDRIVE_GT2_GARSTON
Exceeds 100% Summer SCO Rating	BURL MC2.LISD M2.7.45 km	166	134	124%	SUMMER	N-1-1	BURLINGTON ST_SPARLING ST & LISTERDRIVE_GT2_GARSTON
Exceeds 100% Summer SCO Rating	BURL MC2.LISD M2.7.45 km	156	134	117%	SUMMER	N-1-1	LISTERDRIVE_SPARLING ST & LISTERDRIVE_GT2_GARSTON
Exceeds 100% Summer SCO Rating	BURL MC2.LISD M2.7.45 km	155	134	115%	SUMMER	N-1-1	LISTERDRIVE_PARADISE ST & LISTERDRIVE_GT1
Exceeds 100% Summer SCO Rating	BURL MC2.LISD M2.7.45 km	142	134	106%	SUMMER	N-1-1	LISTERDRIVE_PARADISE ST & LISTERDRIVE_SPARLING ST
Exceeds 100% Summer SCO Rating	BURL MC2.LISD M2.7.45 km	141	134	105%	SUMMER	N-1-1	LISTERDRIVE_SPARLING ST & LISTERDRIVE_GT1

8.2 Profile based study results

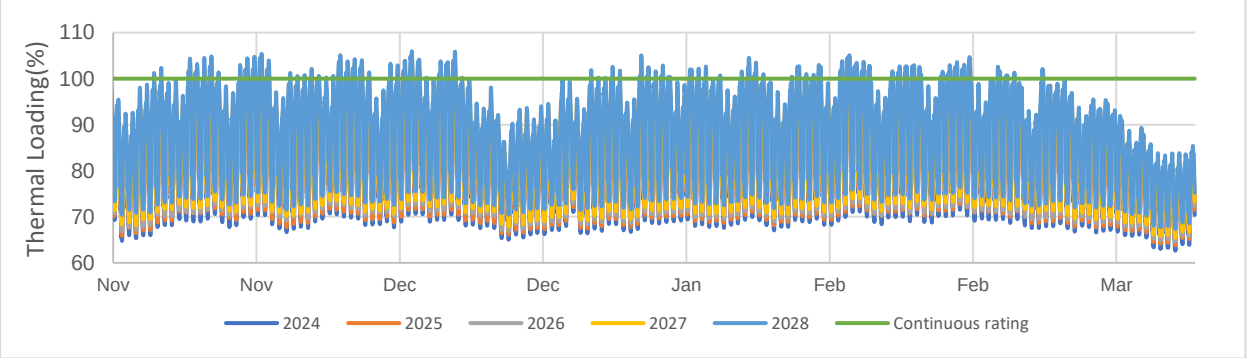


Figure 8-1: Half hourly loading on Lister Drive – Burlington St 132kV Circuit

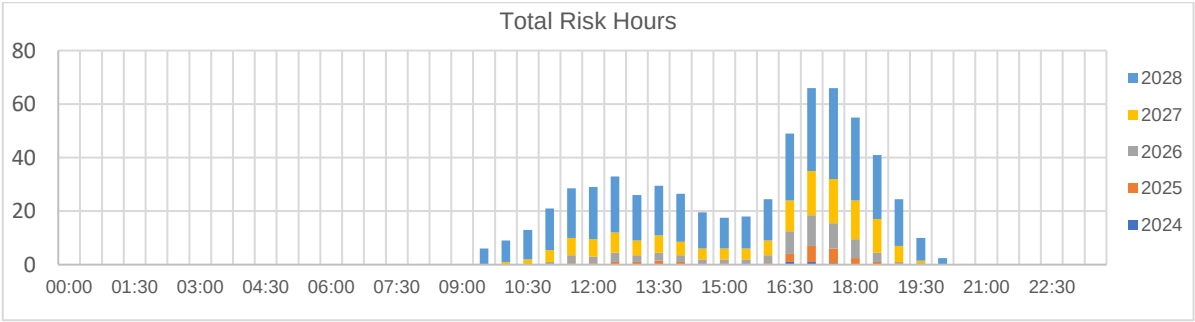


Figure 8-2: Calculated daily network risk hour window