# Kirknewton Primary Reinforcement

## ED2 Engineering Justification Paper

**ED2-LRE-SPD-018-CV1-EJP**

| Issue | Date | Comments |
|---|---|---|
| Issue 0.1 | Jan 2021 | Issue to internal governance and external assurance |
| Issue 0.2 | Apr 2021 | Reflecting comments from internal governance |
| Issue 0.3 | May 2021 | Reflecting external assurance feedback |
| Issue 1.0 | Jun 2021 | Issue for inclusion in 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 | Issue for inclusion in Final Business Plan submission |

| | | | |
|---|---|---|---|
| **Scheme Name** | Kirknewton Primary Reinforcement | | |
| **Activity** | Primary Reinforcement | | |
| **Primary Investment Driver** | Thermal Constraints | | |
| **Reference** | ED2-LRE-SPD-018-CV1 | | |
| **Output** | Load Index | | |
| **Cost** | £2.937m | | |
| **Delivery Year** | 2023-2025 | | |
| **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<br>Annex 4A.6: DFES | | |
| **Spend Apportionment** | **ED1** | **ED2** | **ED3** |
| | **£m** | **£2.937m** | **£m** |

# Technical Governance Process

Project Scope Development

# IP1(S)

To be completed by the Service Provider or Asset Management. The completed form, together with an accompanying report, should be endorsed by the appropriate sponsor and submitted for approval.
IP1 – To request project inclusion in the investment plan and to undertake project design work or request a modification to an existing project
**IP1(S) – Confirms project need case and provides an initial view of the Project Scope**
IP2 – Technical/Engineering approval for major system projects by the System Review Group (SRG)
IP2(C) – a Codicil or Supplement to a related IP2 paper. Commonly used where approval is required at more than one SRG, typically connection projects which require connection works at differing voltage levels and when those differing voltage levels are governed by two separate System Review Groups.
IP2(R) – Restricted Technical/Engineering approval for projects such as asset refurbishment or replacement projects which are essentially on a like-for-like basis and not requiring a full IP2
IP3 – Financial Authorisation document (for schemes > £100k prime)
IP4 – Application for variation of project due to change in cost or scope

## PART A – PROJECT INFORMATION

| | |
|---|---|
| Project Title: | **Kirknewton Primary Reinforcement** |
| Project Reference: | **ED2-LRE-SPD-018-CV1** |
| Decision Required: | **To give concept approval uprate Kirknewton primary transformers and unbank the demand group from the Livingston East GSP to Bathgate GSP interconnector circuits.** |

**Summary of Business Need:**

The Kirknewton 33/11kV primary group supplies 2,712 customers in the Central & Fife region of SP Distribution. With the forecast uptake of Low Carbon Technologies (LCT), the group demand at Kirknewton primary is forecast to exceed its firm capacity by the end of RIIO-ED2 period with risk of thermal loading on Kirknewton 33/11kV transformers and the 33kV circuits supplying the site.

In order to secure supplies within the group, meet the licence obligations under EREC P2/7 – Security of Supply; and to accommodate future demand growth within the area, it is proposed to carry out system reinforcement in the RIIO-ED2 price control period. Further, in order to comply with section 9 of the Electricity Act and Condition 21 of our licence 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.

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

It is proposed to:

1. Provide a dedicated connection to Kirknewton 33/11kV substation by installing two new 33kV cable circuits and associated comms infrastructure from the Livingstone East GSP to the tee off points at Oakbank.
2. Replace two 10MVA transformers with 20MVA units at Kirknewton primary.
3. Procure flexibility services to manage the network risk through the delivery stage at a cost of £6k.

The estimated cost for the above is £2.937m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

**Expenditure Forecast (in 2020/21)**

| Licence Area | Reporting Table | Description | Total (£m) | Incidence (£m) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 |
| SPD | CV1 | Primary Reinforcement | **2.931** | 1.466 | 1.466 | - | - | - |
| SPD | CV1 | Flexible Services | **0.006** | 0.001 | 0.005 | | | |
| SPD | **Total** | | **2.937** | **1.466** | **1.471** | **-** | **-** | **-** |

## PART B – PROJECT SUBMISSION

| | | | | | |
|---|---|---|---|---|---|
| Proposed by | Mark Friese | 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 Kirknewton 33/11kV primary group is located in the Central & Fife region of SP Distribution (SPD) licence area. Kirknewton serves ca. 2,712 customers with high economic activity in the area. Authorised development plans from 2014, confirm an additional 1,676 residential units, ten commercial units, two primary schools and a secondary school which will be developed over the next six years.

Kirknewton primary has firm capacity of 10MVA. Our Baseline View projects a peak demand of 12.7MVA by 2028, including an expected uptake of up to 1,022 electric vehicles and 511 heat pumps. By the end of RIIO-ED2 Kirknewton demand group will move to class 'C' of supply as per ENA Engineering Recommendation (EREC) P2/7.

Additionally, Kirknewton, West Calder, and Blackburn primary demand groups are all banked onto the Grid Supply Point (GSP) interconnector circuits between Livingston East GSP and Bathgate GSP. Kirknewton and West Calder are normally fed from Livingston East. Blackburn is normally fed from Bathgate GSP.

The Kirknewton and West Calder primary groups have a combined firm capacity of 20.06MVA. The Baseline View forecasts a peak demand of 22.0MVA for these two groups by 2028.

In order to secure supplies within the group, meet the licence obligations under EREC P2/7 – Security of Supply and to accommodate future demand growth within the area, it is proposed to:

1. Provide a dedicated connection to Kirknewton 33/11kV substation by installing two new 33kV cable circuits and associated comms infrastructure from the Livingstone East GSP to the tee off points at Oakbank.
2. Replace two 10MVA transformers with 20MVA units at Kirknewton primary.
3. Procure flexibility services to manage the network risk through the delivery stage at a cost of £6k.

The estimated cost for the above is £2.937m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

It is also recommended to continue annual tendering for flexibility in this area to procure enough capacity and review the proposed conventional/build solutions or in the likely case of additional demand uptake in the group.

The timing of the project is based on delivering the highest NPV savings, while maintaining security of supply. The Baseline View forecasts an operationally manageable level of demand during project delivery; with the level of difficulty, in managing the constraint, increasing throughout RIIO-ED2. For that reason, it is proposed to start the works at the beginning of RIIO-ED2, in 2023/24, with a capacity of 10MVA released in 2024/25, upon completion of the proposed works.

# 2 Background Information

## 2.1 Existing / Authorised Network

The Kirknewton primary substation is served by two 10MVA, Crompton Parkinson 33/11kV transformers (1962) fed from Livingston East GSP via the 33kV network shown in Figure 1. As shown below, Kirknewton is banked with West Calder onto the Livingston East GSP – Bathgate GSP interconnectors.

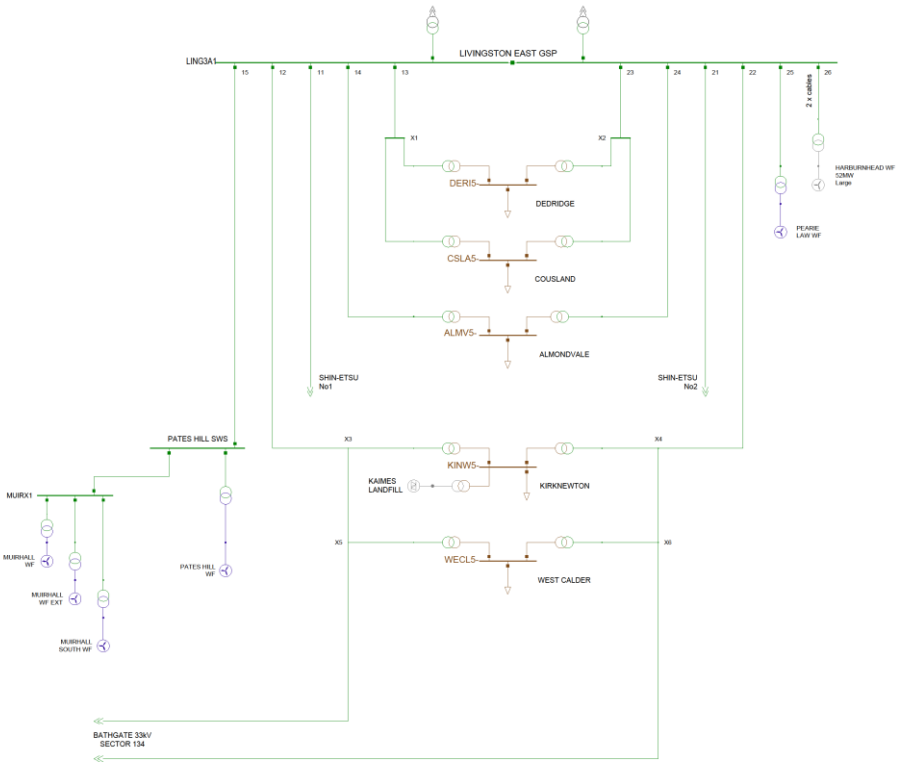


*Figure 1. Existing 33kV Network*

The existing 11kV network comprises a mix of underground cable (UGC) with sections of overhead line (OHL). Kirknewton primary is interconnected at 11kV with Currie, Dedridge, Cousland and West Calder substations.

## 2.2 Group Demand & Security of Supply

The historical maximum demand at Kirknewton primary is 7.24MVA; which places the group in a class 'B' of supply as per EREC P2/7 and must be secured for a first circuit outage (FCO).

The historical maximum demand of the banked Kirknewton/West Calder group is 15.3MVA; which places the group in class 'C' of supply as per EREC P2/7 and must also be secured for an FCO.

Kirknewton Primary is fed via two 33kV OHL circuits. The minimum rated section of the circuit has a summer/winter (multi-circuit) thermal rating of 16.23/20.06MVA. The group is served by two 10MVA, Crompton Parkinson, 33/11kV transformers (1962). A summary of the transformer data is presented in Table 2.1.

*Table 2.1. Kirknewton primary transformer data*

| | T1 | T2 |
|---|---|---|
| **Manufacturer** | Crompton Parkinson | Crompton Parkinson |
| **Manufacturer Year** | 1962 | 1962 |
| **Voltage** | 33/11kV | 33/11kV |
| **Thermal Rating** | 10MVA | 10MVA |
| **Health Index** | 4 | 4 |

Based on measured data above, this area of network would be unable to accommodate any sustained growth without exceeding the 10MVA FCO capacity of the Kirknewton group and 20.06MVA FCO capacity of the banked Kirknewton/West Calder group.

## 2.3 Embedded Generation

Embedded generation connected to the network is shown in Table 2.2.

*Table 2.2. Embedded generation connected to Kirknewton primary*

| Primary | Voltage (kV) | Site | Capacity (MW) | Type | Status |
|---|---|---|---|---|---|
| Kirknewton | 11 | Kaimes Landfill | 2.5 | Waste Incineration | Connected |
| | 11/LV | Embedded generation (<1MW) | 1.57 | Solar/Onshore Wind | Connected |

## 2.4 Fault Levels

Studies indicate that with the authorised customer connections there are no fault level issues at Kirknewton primary.

# 3 Needs Case

Our Baseline View forecasts a peak demand of 12.7MVA by 2028, including an expected uptake of up to 1,022 electric vehicles and 511 heat pumps. This exceeds the 10MVA firm capacity of Kirknewton primary demand group by the end of RIIO-ED2.

Additionally, for the Kirknewton/West Calder demand group, the Baseline View scenario forecasts a peak demand by 2028 of 22.0MVA, with an expected uptake of up to 1,923 electric vehicles and 1,465 heat pumps. This exceeds the groups firm capacity of 20.06MVA within the ED2 period.

Forecasts consider the authorised development plans from 2014, which include an additional 1,676 residential units, ten commercial units, two primary schools and a secondary school which will be developed over the next six years.

## 3.1 Forecast Demand

The system is forecast to grow and exceed firm capacity within the RIIO-ED2 period. This forecast is based on actual system measurement data from the Process Instrumentation (PI) system and stakeholder endorsed Distribution Future Energy Scenarios (DFES) and considers our pipeline of known developments.

### 3.1.1 Distribution Future Energy Scenarios

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 for Kirknewton demand group based on the SPD Distribution Future Energy Scenarios including authorised connections is depicted in Figure 2 and the anticipated total electric vehicle and heat pump uptakes based on the future energy scenarios are depicted in Figure 4.

The peak demand forecast for Kirknewton/West Calder demand group based on the SPD Distribution Future Energy Scenarios including authorised connections is depicted in Figure 3 and the anticipated total electric vehicle and heat pump uptakes based on the future energy scenarios are depicted in Figure 5.

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.

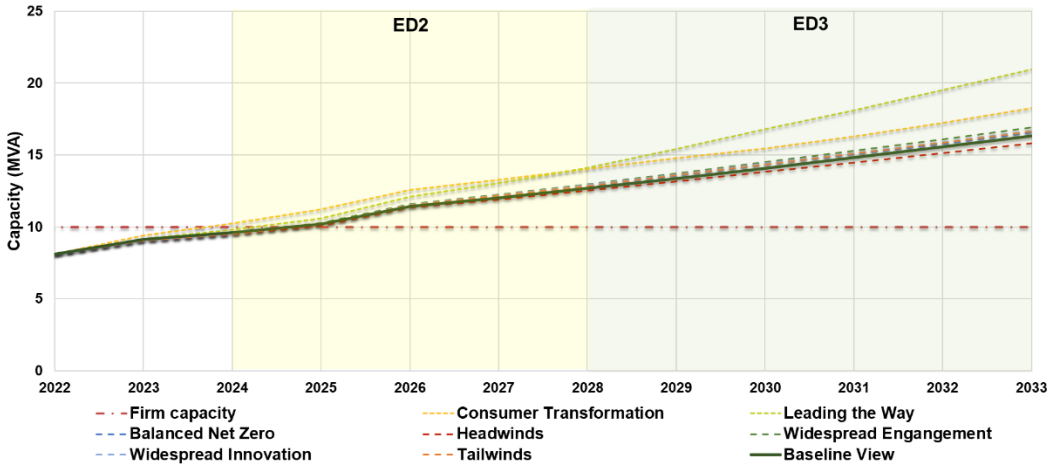


*Figure 2. Demand (MVA) forecast for Kirknewton demand group*

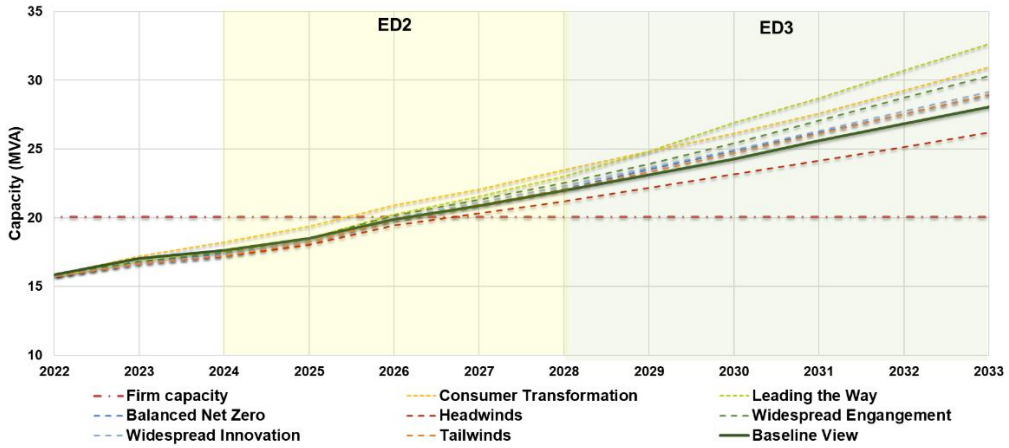


*Figure 3. Demand (MVA) forecast for Kirknewton/West Calder demand group*

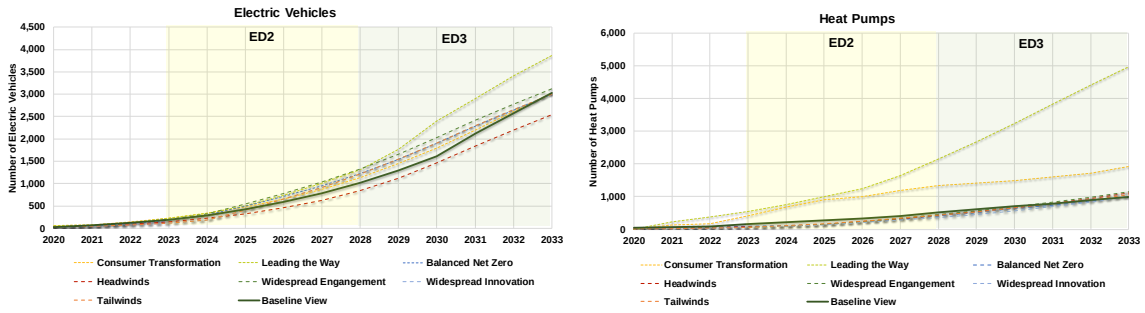


*Figure 4. Forecast Electric Vehicle and Heat Pump uptakes for Kirknewton demand group*

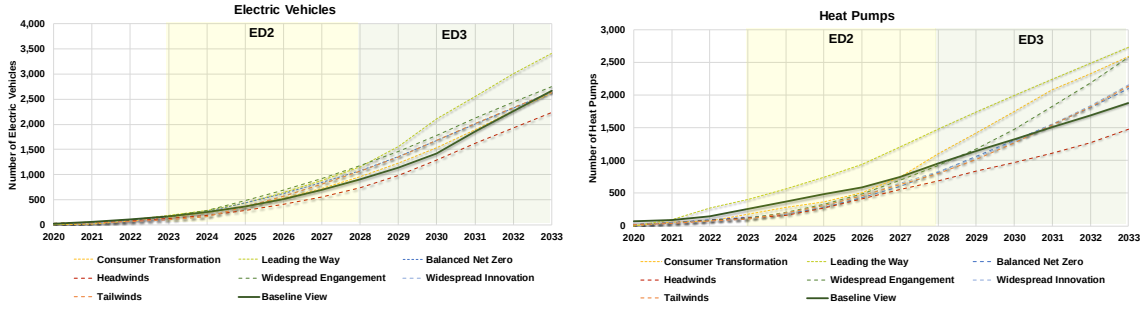


*Figure 5. Forecast Electric Vehicle and Heat Pump uptakes for West Calder demand group*

### 3.1.2 Baseline View

For the Kirknewton group demand, the forecast demand growth under our Baseline scenario, along with the firm capacity and utilisation through to RIIO-ED3 period is shown in Table 3.1.

*Table 3.1. Baseline View forecast for Kirknewton demand group*

| Year | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Forecast Demand (MVA) | 8.1 | 9.1 | 9.6 | 10.2 | 11.4 | 12.0 | 12.7 | 13.4 | 14.1 | 14.8 | 15.6 | 16.3 |
| Firm Capacity (MVA) | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Utilisation (%) | 81 | 91 | 96 | 102 | 114 | 120 | 127 | 134 | 141 | 148 | 156 | 163 |
| Load Index | LI2 | LI2 | LI3 | LI4 | LI5 | LI5 | LI5 | LI5 | LI5 | LI5 | LI5 | LI5 |

For the Kirknewton/West Calder group demand, the forecast demand growth under our Baseline scenario, along with the firm capacity and utilisation through to RIIO-ED3 period is shown in Table 3.2.

*Table 3.2. Baseline View forecast for Kirknewton/West Calder demand group*

| Year | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Forecast Demand (MVA) | 15.9 | 17.0 | 17.7 | 18.5 | 19.9 | 20.9 | 22.0 | 23.1 | 24.3 | 25.6 | 26.8 | 28.1 |
| Firm Capacity (MVA) | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 |
| Utilisation (%) | 79 | 85 | 88 | 92 | 99 | 104 | 110 | 115 | 121 | 128 | 134 | 140 |
| Load Index | LI1 | LI2 | LI2 | LI2 | LI4 | LI5 | LI5 | LI5 | LI5 | LI5 | LI5 | LI5 |

## 3.2 Network Impact Assessment

Detailed network studies covering network intact and outage (N-1) conditions and fault level assessments were carried out for the Kirknewton demand 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 2023 through 2028 determined the risk hours and the capacity required to overcome the constraint by using flexibility services.

### 3.2.1 Thermal Constraints

Table 3.3 shows the identified thermal constraints on the 33/11kV network level.

*Table 3.3. Thermal constraints at 33/11kV level*

| Network Item | Voltage | Outage |
|---|---|---|
| Kirknewton T1 | 33/11kV | N-1 |
| Kirknewton T2 | 33/11kV | N-1 |
| Livingston East to Oakfield No1 ABS | 33kV | N-1 |
| Livingston East to Oakfield No2 ABS | 33kV | N-1 |

### 3.2.2 Voltage Constraints

There were no voltage constraints associated with Kirknewton or West Calder primary demand groups.

### 3.2.3 EREC P2/7 – Security of Supply

Kirknewton Primary substation has a forecast peak demand of 12.7MVA by the end of RIIO-ED2. Kirknewton/West Calder demand group has a forecast peak demand of 22.0MVA by the end of RIIO-ED2. Engineering Recommendation (EREC) P2/7 defines group demands of 12MW-60MW as a class 'C' of supply.

EREC P2/7 states that a group demand, with a class 'C' of supply, must secure the following minimum demand for a first circuit outage:

- Smaller of group demand minus 12MW; and 2/3 of group demand;
- Group demand must be met within 3 hours.

Kirknewton group demand has an FCO security of 10MVA & Kirknewton/West Calder has an FCO security of 20MVA. Therefore, both demand groups are predicted to be non-compliant under EREC P2/7 by the end of the RIIO-ED2 price control period; consequently, investment is required.

### 3.2.4 Flexibility Services

In order to manage the network risk on the 11kV network, our assessment indicates that the risk of thermal overload on the 33/11kV Kirknewton primary transformers and Kirknewton/West Calder 33kV circuits starts from the year 2023/24 throughout to the year 2028 for the most onerous scenario including an additional 5% for the asset protection margin. For Kirknewton/West Calder demand group the risk of thermal overload on 33kV circuits starts from the year 2026/27 throughout to the year 2028. These risks are shown Table 3.4. The detailed results from the half hourly profile-based simulations are furnished in Appendix 1.

*Table 3.4. Network annual hours at risk and flexible capacity tendered in Spring 2021 for Kirknewton demand group*

| Year | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 |
|---|---|---|---|---|---|
| **Annual hours at risk (Hrs)** | 4 | 18 | 250 | 544 | 642 |
| **Required Flexible Capacity (MW)** | 1.53 | 2.18 | 3.47 | 4.18 | 4.77 |

# 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 without application of innovation.

*Table 4.1. Longlist of solution options*

| # | Options | Status | Reason for rejection |
|---|---|---|---|
| (a) | Do nothing | Rejected | Not compliant with security of supply requirements as per 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) | BaU reinforcement strategy - considers the replacement of 10MVA transformers with 20MVA units and unbanking Kirknewton from the 33kV Interconnector using UGC. | Shortlisted as **Baseline** option in Detailed Analysis | |
| (d) | Utilization of flexibility services to defer reinforcement into RIIO-ED3 | Shortlisted as **Option 1** in Detailed Analysis | |
| (e) | BaU reinforcement strategy - considers the replacement of 10MVA transformers with 20MVA units and unbanking of Kirknewton from the 33kV Interconnector using OHL. | Rejected | Overhead line route not viable due to known land ownership issues, ancient woodlands and environmental issues. |
| (f) | Install active network management (ANM) on the 11kV network to enable dynamic transfer of demand between substations. | Rejected | Due to increasing demand and projected LCT uptake, neighbouring groups and the local HV network is reaching capacity. Consequently, insufficient transfer capacity is available. |
| (g) | Real Time Thermal Rating (innovation). | Rejected | Kirknewton transformers are HI4 and therefore cannot be considered for RTTR. This option is not technically viable and has been discounted. |

# 5 Detailed Analysis & Costs

With the initial flexibility tender rounds indicating not enough response to provide with flexible capacity in the group to defer the any reinforcement scheme, hence, to address the thermal constraints in the group, a conventional build solution is proposed.

## 5.1 Proposed Option (Baseline) – Replace Primary Transformers and Unbank Kirknewton

The proposed option for this scheme is to replace the existing 10MVA transformers with new 20MVA units and provide a dedicated connection to Kirknewton 33/11kV substation by installing two new 33kV UGC circuits and associated comms infrastructure from the Livingstone East GSP to the tee off points at Oakbank. Table 5.1 shows the scheme summary.

*Table 5.1. Proposed option summary*

| Category | Scheme Name | Scheme Summary | RIIO-ED2 Contribution (£m) | Customer Contribution (£m) |
|---|---|---|---|---|
| Conventional | Kirknewton Primary Reinforcement | Replace primary transformers and unbank Kirknewton | 2.937 | - |

The proposed solution would remove the existing 10MVA transformers and replace them with new 20MVA units. It is envisaged that an off-line build will be completed on undeveloped land adjacent to the existing compound. However, outages on each transformer will be required to allow for the removal of the existing transformers and to commission the new ones onto the network. An aerial view of the site is shown in Figure 6.

*Figure 6. Aerial view of the site*

As the existing transformers are HI4, the replacement of the existing 10MVA transformer will reduce the risk associated with Kirknewton Primary via the reduction of health index for assets at the site. The proposed works would replace the existing 1960s transformers with modern units.

The lowest rated EHV circuit feeding the group is 0.15ins ACSR OHL with a summer/winter (multi-circuit) rating of 16.23/20.06MVA. Thus, the existing circuits feeding the group cannot provide sufficient thermal headroom to release the full capacity created by the transformers at Kirknewton and cannot supply the Baseline View demand projection of 22.0MVA. It is therefore proposed to provide a dedicated connection to Kirknewton 33/11kV substation by installing two new 33kV UGC circuits and associated comms infrastructure from the Livingstone East GSP to the tee off points at Oakbank. The proposed solution is shown in Figure 7.

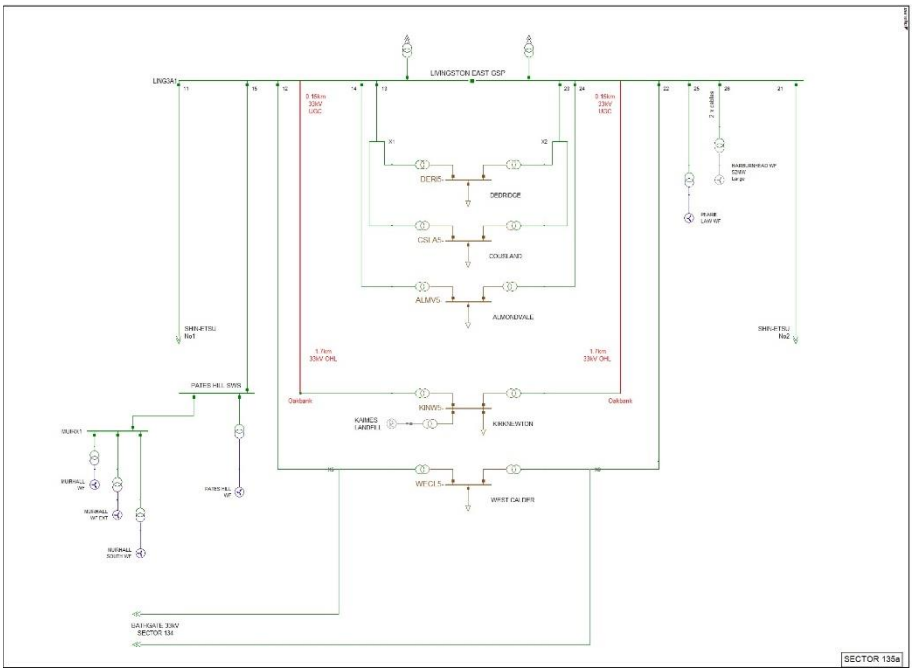


*Figure 7. Proposed 33kV network*

Flexibility services have been procured to manage the network risk through the delivery stage at a cost of £6k. However, it is recommended to continue annual tendering for flexibility in this area and the proposed conventional/build solutions will be reviewed depending on procuring lower cost capacity in the future tenders.

Following the proposed investment solution, Kirknewton & Kirknewton/West Calder demand groups would be EREC P2/7 compliant under all DFES scenarios. Table 5.2 shows a summary of reinforcement costs and volumes for the proposed scheme under RIIO-ED2.

*Table 5.2. Proposed option summary of reinforcement costs and volumes*

| Asset Description | Volumes | Prime Costs (£m) | RIIO-ED2 Contribution (£m) | Customer Contribution (£m) |
|---|---|---|---|---|
| 33kV Pole | 12 | 0.036 | 0.036 | - |
| 33kV UG Cable (Non Pressurised) | 6 | 1.198 | 1.198 | - |
| 33kV Transformer (GM) | 2 | 0.738 | 0.738 | - |
| Pilot Wire Underground | 6 | 0.665 | 0.665 | - |
| Civil Works at 33 kV & 66 kV Substations | | 0.140 | 0.140 | - |
| Wayleaves/Easements/Land Purchase | | 0.047 | 0.047 | - |
| Other Costs (Identify Below) | | 0.108 | 0.108 | - |

| | | | | |
|---|---|---|---|---|
| Flexibility Services | | 0.006 | 0.006 | |
| Total Costs | | 2.937 | 2.937 | - |
| Identify activities included within other costs (please provide high-level detail of cost areas) | | | | |
| Planning and design (£50k) | | | | |
| Environmental assessments and consideration (£27.5k) | | | | |
| Railway possessions (£30k) | | | | |

The timing of the project is based on delivering the highest NPV savings, while maintaining security of supply. The Baseline View forecasts an operationally manageable level of demand during project delivery; with the level of difficulty, in managing the constraint, increasing throughout RIIO-ED2. For that reason, it is proposed to start the works at the beginning of RIIO-ED2, in 2023/24, with a capacity of 10MVA released in 2024/25, upon completion of the proposed works.

## 5.2 Option 1 – Flexibility Services

This option considers the feasibility of managing the overload for the constraint by contracting with up to 14.1MW of flexibility services which is shown in **Error! Reference source not found.**. These services would contract with third parties to control the down demand (or increase generation) in the relevant timeframes to avoid risk of overload. Based on these requirements, flexibility services will be tendered in 2021, to test the market for provision of services between 2023-28 period. Table 5.3 shows the scheme summary.

*Table 5.3. Option 1 summary*

| Category | Scheme Name | Scheme Summary | RIIO-ED2 Contribution (£m) | Customer Contribution (£m) |
|---|---|---|---|---|
| Conventional | Kirknewton Primary Reinforcement | Utilise flexibility services to defer a new primary into RIIO-ED3 | 2.032* | - |

*This option would defer a requirement for a new primary to RIIO-ED3 of £2.937m which has been included in the cost benefit analysis.

The tenders rounds from May 2021 returned more than enough capacity for all years of the RIIO-ED2 price control period, as shown in Table 5-4. However, due to high bid costs provided by the market, it is recommended to continue annual tendering for flexibility in this area and the proposed conventional/build solutions will be reviewed depending on procuring lower cost capacity in the future tenders.

*Table 5-4: Network annual hours at risk and flexible capacity tendered in May 2021*

| Year | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 |
|---|---|---|---|---|---|
| Annual hours at risk (Hrs) | 4 | 18 | 250 | 544 | 642 |
| Required Flexible Capacity (MW) | 1.53 | 2.18 | 3.47 | 4.18 | 4.77 |
| Secured Flexible Capacity (MW) | 1.53 | 2.18 | 3.47 | 4.69 | 9.06 |
| Secured Flexible Capacity (%) | 100% | 100% | 100% | 112% | 190% |
| Cost (£m) | 0.001 | 0.005 | 0.108 | 7.838* | 1.291 |

* The bid price received in the May 2021 tender for 2026/27 was £7.838m (£3,125/MWh). In the CBA it has been assumed that future tenders would produce lower values and a cost of £0.627m (£250/MWh) was assumed.

## 5.3 Options Cost Summary Table

Summary of the costs for each of the evaluated options is presented in Table 5.5.

*Table 5.5. Cost summary for considered options*

| Options | Option Summary | RIIO-ED2 Cost (£m) |
|---|---|---|
| Baseline | Replace primary transformers and unbank Kirknewton | 2.937 |
| Option 1 | Utilise flexibility services to defer a new primary into RIIO-ED3 | 2.032* |

*This option would defer a requirement for a new primary to RIIO-ED3 of £2.931m which has been included in the cost benefit analysis.

Derivation of costs for these options are based on the SPEN RIIO-ED2 Unit Cost Manual for intervention. This is based on bottom up cost assessment of the components of activity detailed within the RIGs Annex A for the above activities, SPEN's contractual rates for delivery, market available rates and historic spend levels.

# 6 Deliverability & Risk

## 6.1 Preferred Options & Output Summary

The adopted option is the baseline option to replace the existing 10MVA transformers with new 20MVA units and provide a dedicated connection to Kirknewton 33/11kV substation.

## 6.2 Cost Benefit Analysis Results

A cost benefit analysis (CBA) was carried out to compare the NPV of the options discussed in the previous sections. Considering the lowest forecast capital expenditure, the proposed option has the highest total NPV against other options. The summary of the cost benefit analysis is presented in Table 6.1. The full detailed CBA is provided within 'ED2-LRE-SPD-018-CV1-CBA – Kirknewton Primary 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 – Replace 2 x 10MVA transformers with 20MVA units and unbank Kirknewton | **Adopted** | | | | | |
| Option 1- Utilise flexibility services to defer a new primary into RIIO-ED3 | Rejected | Discounted on NPV | -0.24 | -0.88 | -1.26 | -1.57 |

## 6.3 Cost & Volumes Profile

Table 6.2 shows the breakdown of expenditure for the proposed scheme (in 2020/21 prices) and the cost incidence (in 2020/21 prices) over the RIIO-ED2 period is shown in Table 6.3. The total cost of the proposed scheme is £2.937m.

*Table 6.2: Summary of reinforcement costs and volumes*

| Asset Description | Volumes | Prime Costs (£m) | RIIO-ED2 Contribution (£m) | Customer Contribution (£m) |
|---|---|---|---|---|
| 33kV Pole | 12 | 0.036 | 0.036 | - |
| 33kV UG Cable (Non Pressurised) | 6 | 1.198 | 1.198 | - |
| 33kV Transformer (GM) | 2 | 0.738 | 0.738 | - |
| Pilot Wire Underground | 6 | 0.665 | 0.665 | - |
| Civil Works at 33 kV & 66 kV Substations | | 0.140 | 0.140 | - |
| Wayleaves/Easements/Land Purchase | | 0.047 | 0.047 | - |
| Other Costs (Identify Below) | | 0.108 | 0.108 | - |
| Flexibility Services | | 0.006 | 0.006 | |
| Total Costs | | 2.937 | 2.937 | - |
| Identify activities included within other costs (please provide high-level detail of cost areas) | | | | |
| Planning and design (£50k) | | | | |
| Environmental assessments and consideration (£27.5k) | | | | |
| Railway possessions (£30k) | | | | |

*Table 6.3: Cost incidence over the RIIO-ED2 period, £m (2020/21 Prices)*

| Total Investment | Total (£m) | Incidence (£m) | | | | |
|---|---|---|---|---|---|---|
| | | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 |
| CV1 (Primary Reinforcement) | **2.937** | 1.466 | 1.466 | - | - | - |
| CV1 (Flexible Service) | **0.006** | 0.001 | 0.005 | - | - | - |
| Total Cost | **2.937** | **1.466** | **1.471** | **-** | **-** | **-** |

## 6.4 Risks

The main delivery risks for the proposed works are, the cable route, and, security of supply during construction outages. Outages will result in load centres associated with Kirknewton primary substation being on single circuit risk.

We would mitigate risks associated with the cable route by engaging with local authorities. To minimise risk associated with construction outages, it is proposed that the transformer replacement be undertaken on an off-line basis. The risk will also be minimised by having suitable contingency plans for the reconnection of lost supplies in the event of loss of remaining infeed's during construction outages.

## 6.5 Outputs Included in RIIO-ED1 Plans

There are no outputs expected to be delivered in RIIO-ED1 that are funded within this proposal.

## 6.6 Future Pathways – Net Zero

### 6.6.1 Primary Economic Driver

The primary drivers for this investment are insufficient thermal headroom and security of supply risk. The investment does not have a strong reliance on environmental benefits.

### 6.6.2 Payback Periods

The CBA indicates that for the proposed option demonstrates better NPV results in all assessment periods (10, 20, 30 & 45 years) against other two options. As the intervention is forecast to carry at

least a 45-year asset life expectancy, the CBA at this time justifies the intervention. Consumers will also benefit from reduced network risk immediately on completion of the project.

### 6.6.3 Sensitivity to Future Pathways

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

Table 6.4 and Table 6.5 show electric vehicle and heat pump uptakes across a range of future pathways for Kirknewton and Kirknewton/West Calder demand groups. Table 6.6 shows the sensitivity of the proposed solution and Table 6.7 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 for Kirknewton demand group*

| End of RIIO-ED2 | SPEN | DFES | | | CCC | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Baseline | System Transformation* | Consumer Transformation | Leading the Way | Balanced Net Zero Pathway | Headwinds | Widespread Engagement | Widespread Innovation | Tailwinds |
| EVs | 1,022 | | 1,140 | 1,316 | 1,226 | 844 | 1,334 | 1,215 | 1,215 |
| HPs | 511 | | 1,332 | 2,150 | 410 | 429 | 446 | 354 | 426 |

*Note: We have excluded System Transformation from our future pathways assessment as it does not meet interim greenhouse gas emission reduction targets.

*Table 6.5: Electric Vehicle and Heat Pump uptakes across a range of future pathways for West Calder demand group*

| 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 | 901 | | 962 | 1,154 | 1,081 | 744 | 1,176 | 1,071 | 1,071 |
| HPs | 954 | | 1,097 | 1,482 | 816 | 691 | 923 | 828 | 803 |

*Note: We have excluded System Transformation from our future pathways assessment as it does not meet interim greenhouse gas emission reduction targets.

*Table 6.6: Sensitivity of the proposed solution against future pathways*

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

R1 – Replacement of 2 x primary transformers and Kirknewton unbanking

The proposed solution is robust across the range of future pathways. The selected solution is required under all scenarios. In all cases this solution is expected to endure beyond RIIO-ED3. The timing of

the requirement is only slightly sensitive to uptake rates but is found to be required under all scenarios within the RIIO-ED2 period.

*Table 6.7: Sensitivity of the proposed RIIO-ED2 expenditure*

| | Baseline | Uncertain |
|---|---|---|
| **RIIO-ED2 Expenditure (£m)** | 2.937 | N/A |
| **Comment** | Proposed option | |

### 6.6.4 Asset Stranding Risks & Future Asset Utilisation

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

### 6.6.5 Losses / Sensitivity to Carbon Prices

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

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

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 337 tonnes. The monetised embodied carbon value associated with this emission is £15.9k. 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[1].

### 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.

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

## 6.7 Environmental Considerations

### 6.7.1 Operational and Embodied Carbon Emissions

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

Upfront costs associated with resized assets used within the reinforcement programme (e.g. embodied carbon in the materials and emissions associated with civil engineering works) will be considered against the potential operational efficiency improvements associated with the new assets from a lifetime carbon perspective. For example, with the carbon emissions resulting from the raw materials and manufacture of a new transformer only contributing around 5-10% of its whole-life carbon impact, it is entirely possible that a transformer with a higher embodied carbon footprint may have lower whole-life carbon emissions if it can operate more efficiently with fewer losses.

As network losses currently account for 95% of our BCF, even a marginal improvement in the efficiency of an EHV transformer can bring a significant reduction in lifetime losses and the resulting carbon emissions. Therefore, it is important that efficiency criteria inform the decision-making process.

### 6.7.2 Supply Chain Sustainability

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

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

### 6.7.3 Resource Use and Waste

The Kirknewton Primary Reinforcement programme will result in the consumption of resources and the generation of waste materials from end of life assets.

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

### 6.7.4 Biodiversity / Natural Capital

The Kirknewton Primary reinforcement programme will affect Kirknewton Primary site, containing existing assets, and on undeveloped sites on the route of new underground cables. We will minimise the area of landtake required and will minimise disturbance to soils and vegetation during construction. We will replace and enhance the existing habitat, working with relevant stakeholders to identify the measures required to achieve a net gain in biodiversity and wider ecosystem services.

### 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. Our use of underground cables instead of overhead lines helps to minimise our overall visual impact.

### 6.7.7 Climate Change Resilience

In addition to our efforts to minimise our direct carbon emissions in line with our Net Zero ambitions, we are also conscious of the need to secure the resilience of our assets and networks in the face of a changing climate. We have also modified our policy on vegetation control in the face of higher temperatures and longer growing seasons.

## 7 Conclusion

The Kirknewton 33/11kV primary group is located in the Central & Fife region of SPD. Kirknewton serves ca. 2,712 customers with high economic activity in the area. Authorised development plans from 2014, confirm an additional 1,676 residential units, ten commercial units, two primary schools and a secondary school which will be developed over the next six years.

Kirknewton primary has firm capacity of 10MVA. The DFES best-view projects a peak demand of 12.7MVA by 2028, including an expected uptake of up to 1,022 electric vehicles and 511 heat pumps. By the end of ED2 Kirknewton demand group will move to class 'C' of supply as per ENA EREC P2/7.

Additionally, Kirknewton, West Calder, and Blackburn primary demand groups are all banked onto the GSP interconnector circuits between Livingston East GSP and Bathgate GSP. Kirknewton and West Calder are normally fed from Livingston East. Blackburn is normally fed from Bathgate GSP.

The Kirknewton and West Calder primary groups have a combined firm capacity of 20.06MVA. DFES best-view forecasts a peak demand of 22.0MVA for these two groups by 2028.

In order to secure supplies within the group, meet the licence obligations under EREC P2/7 – Security of Supply and to accommodate future demand growth within the area, it is proposed to:

1. Provide a dedicated connection to Kirknewton 33/11kV substation by installing two new 33kV cable circuits and associated comms infrastructure from the Livingstone East GSP to the tee off points at Oakbank.
2. Replace two 10MVA transformers with 20MVA units at Kirknewton primary.
3. Procure flexibility services to manage the network risk through the delivery stage at a cost of £6k.

The estimated cost for the above is £2.937m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

It is recommended to tender annually for flexibility services in this area to procure enough capacity. The proposed solution will be reviewed depending on procuring enough capacity in the future tenders.

The timing of the project is based on delivering the highest NPV savings, while maintaining security of supply. The Baseline View forecasts an operationally manageable level of demand during project delivery; with the level of difficulty, in managing the constraint, increasing throughout RIIO-ED2. For that reason, it is proposed to start the works at the beginning of RIIO-ED2, in 2023/24, with a capacity of 10MVA released in 2024/25, upon completion of the proposed works.

# 8 Appendices

## Appendix 1. System Study Results

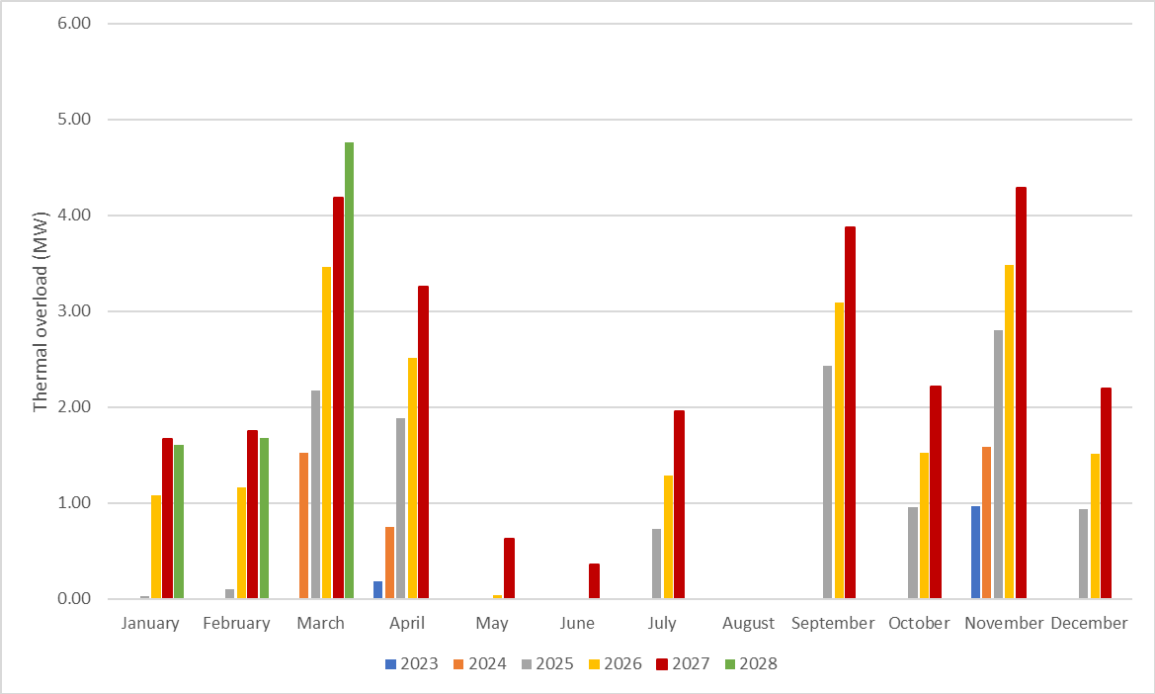


*Figure 8. Monthly maximum overload on 33/11kV Kirknewton transformer*