Loughborough BSP

Network Development Report – East Midlands

May 2024

Electricity Distribution

nationalgrid

Contents

Loughborough 33 kV

1. Network Overview

Loughborough Bulk Supply Point (BSP) is fed from Ratcliffe Grid Supply Point (GSP) in National Grid Electricity Distribution’s (NGED’s) East Midlands licence area. Loughborough BSP is fed directly from Ratcliffe via a dual 132 kV circuit which continues on to Coalville BSP.

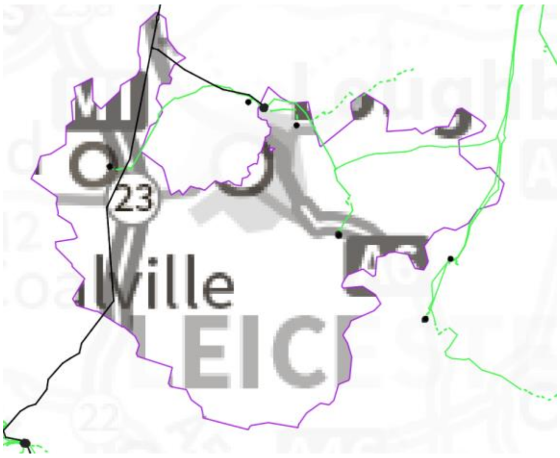

Figure 1.1 Loughborough geographic network coverage

This report discusses all existing and future network constraints over a 0-10 year horizon identified on the 33 kV network fed from Loughborough BSP. This uses the methodology outlined in the Network Development Plan Methodology Report with Network Operability Modelling applied as outlined below.

For the purposes of this analysis the NGED Best View Distribution Future Energy Scenario (DFES) has been used to study the years 2022 (baseline), 2028 and 2034, with consideration given to how proposals could change under the other scenarios. Five representative days have been studied across the four seasons: Winter Peak Demand, Intermediate Warm Peak Demand, Intermediate Cool Peak Demand, Summer Peak Demand and Summer Peak Generation.

1.1 Network Topology

Loughborough BSP has two 33 kV busbars fed by two 132/33 kV Grid Transformers (GTs) both rated to 60/90/117 MVA. Loughborough BSP feeds four primary substations: Shepshed, Quorn and two dedicated customer sites.

All of the primaries listed above are supplied directly from Loughborough BSP and have two 33/11 kV transformers each. Loughborough is interconnected with Willoughby BSP via a single 33 kV circuit which is teed off the circuit to Quorn T2. There is a normal open point at a disconnector located on this circuit.

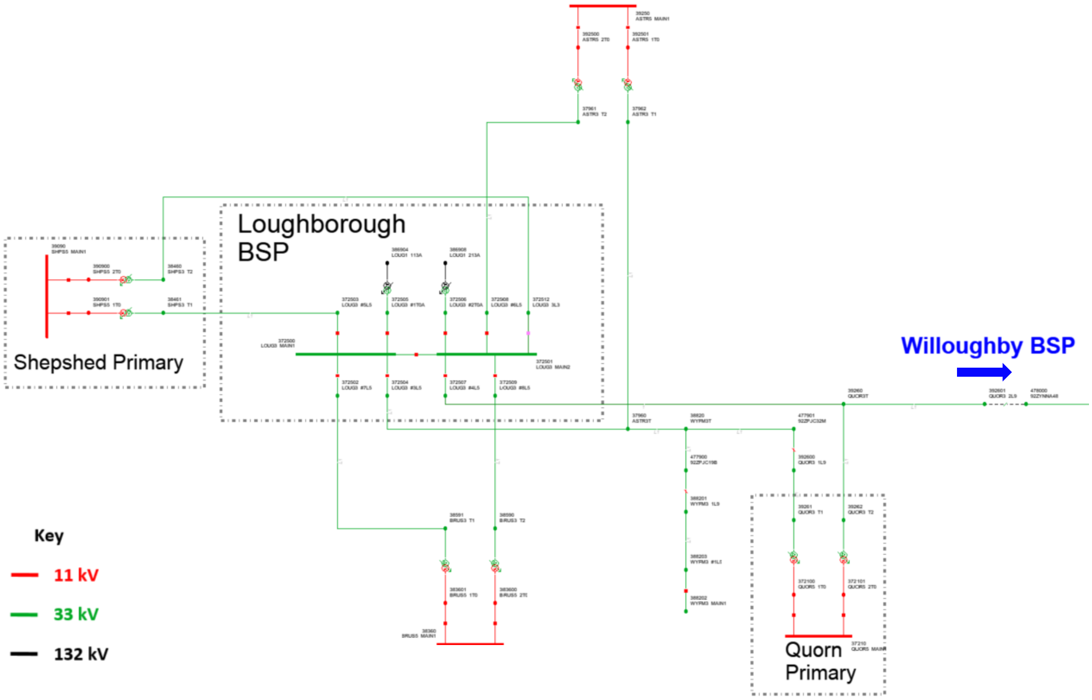

Figure 1.1.1 Loughborough 33 kV network single line diagram

1.2 Network Operability Modelling

The following network automation and manual switching schemes have been modelled in the analysis of this area, aligning to how the network is currently operated.

- For the loss of an infeed to a transformer at any of the primaries fed from Loughborough BSP under arranged outages, the lower voltage side circuit breaker is opened to prevent back-energisation.
- The 33 kV network downstream of Loughborough BSP is split for arranged outages on its 33 kV bus section breaker to prevent loose couples. This involves splitting Shepshed, Quorn and the two dedicated customer primaries at 11 kV.

2. Network Constraints and Solution Options

2.1 Summary of Network Constraints

The following constraints were identified for the Best View Scenario, for which mitigation options will be discussed:

- Overloads are seen by 2028 on the transformers and infeed circuits to Shepshed primary for an arranged or fault outage on the other transformer/infeed in any season.
- For arranged or fault outages on either transformer or circuit at Quorn primary, the remaining transformer is projected to overload at intermediate cool peak demand by 2028 (and for other seasons by 2034).

2.2 Shepshed transformer and circuit overloads

Constraint Overview

Generation | **Demand**

The table below outlines the nature of the network constraints identified in the network analysis.

Table 2.2.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Shepshed T1 or T2 overload	Arranged or fault outage on either transformer or circuit to Shepshed primary	None	2028	2028	2028	2028
Loughborough – Shepshed 33 kV circuit overloads	Arranged or fault outage on either infeed	None	2028	2028	2028	2028
Shepshed 33 kV and 11 kV low volts	33 kV busbar outage at Loughborough BSP	None	2028	2028	2028	2028

Uncertainty under other Distribution Future Energy Scenarios: Although higher or lower demand growth is forecast under the other four scenarios, there are none under which overloads are not observed by 2028. Even under Falling Short where the lowest growth is forecast overloads are projected on both transformers and both circuits by 2034.

Solution Options

A list of each of the options considered for this constraint is given below.

Table 2.2.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Uprate the transformers and circuits to Shepshed primary.
2	Build a new 132/11 kV BSP.
3	Build a new primary substation.
Flexibility Services	
4	Procure flexibility under Shepshed primary.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full Cost Benefit Analysis (CBA). This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the Distribution Network Options Assessment (DNOA) process.

Option 1 – Uprate the transformers and circuits to Shepshed primary

Viable

Capacity released for constraint(s) considered: 15 MVA

New limiting factor for constraint(s) considered: New transformer ratings

Detailed description: Overloads are observed on both the transformers and 33 kV feeder circuits to Shepshed primary by 2028, necessitating intervention for both sets of assets. The transformers at Shepshed would be replaced with 20/40 MVA units. In order to free up this capacity 33 kV circuit works will also be required. One of the circuits to Shepshed is already rated high enough except for under 1 km of cable which would need to be uprated. The other circuit is mostly made up of a dual 33 kV circuit, one side of which is currently used to feed T2 at Shepshed. This dual circuit is not rated high enough and is also in a poor condition so would need replacing with either a 33 kV single circuit overhead line or a new 33 kV cable.

This option would add significant capacity to Shepshed primary but may not be sufficient alone to accommodate long term demand growth forecast for the area. By 2034 the capacity of the new 20/40 MVA transformers are projected to be exceeded, necessitating further intervention.

Option 2 – Build a new 132/11 kV BSP

Discounted

Capacity released for constraint(s) considered: 38 MVA

New limiting factor for constraint(s) considered: Network complexity

Detailed description: The 132 kV dual circuit between Ratcliffe GSP and Coalville BSP passes within 500 m of Shepshed primary. A new 132/11 kV site could therefore be built to deload the primary and resolve this constraint. This would also reduce loading on the GTs at Loughborough BSP. This option has been discounted for two main reasons:

- The growth forecast at Shepshed, while high, is not of sufficient magnitude to warrant this level of investment.
- Building a new site fed from these 132 kV circuits would lead to them becoming non-compliant with Engineering Recommendation P18 regarding network complexity.

Option 3 – Build a new primary substation

Viable

Capacity released for constraint(s) considered: 38 MVA or 23 MVA

New limiting factor for constraint(s) considered: Total primary capacity of Shepshed and the new substation

Detailed description: As noted in option 1, growth at Shepshed is expected to exceed the new firm capacity of the site with 20/40 MVA units by 2034. As 20/40 MVA primary transformers are the highest rated units utilised by NGED as standard on the network, and installing a third transformer would not be optimal from a network operability perspective (and would regardless not free up more capacity without installing a third 33 kV busbar at Loughborough BSP), further reinforcement of Shepshed is not practical. A new primary substation could instead be built to deload Shepshed.

If this new primary were built between Shepshed and Quorn primaries, it could be used to deload both sites (Quorn primary is also projected to be constrained as discussed in Section 2.3 of this report). Given the fact that reinforcing Quorn primary could be carried out quite economically as discussed below, it may be prudent to instead locate the new primary near Shepshed itself to more easily deload it. Forecasts indicate that a new 12/24 MVA site picking up demand from only Shepshed itself would still not be underutilised, and the 33 kV circuit works in option 1 could potentially be enhanced to facilitate this.

Option 4 – Procure flexibility under Shepshed primary

Viable

Flexibility service type: Generation turn up/demand turn down.

Detailed description: Flexibility services could be procured to alleviate the projected overloads seen on the 33 kV circuits to and the primary transformers at Shepshed. While flexibility may be of use in the short term, it is unsuitable for managing the voltage constraint that is forecast to occur by 2028. If the reinforcement works outlined in option 1 were carried out, flexibility could then be used to manage the new constraints forecast to occur by 2034 (deferring the need for further reinforcement). The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The optimal reinforcement strategy identified is to uprate both of the transformers at Shepshed primary to 20/40 MVA units. In the longer term a new primary substation may be required which would likely be located near the existing primary.

2.3 Quorn primary transformer overloads

Constraint Overview

Generation | **Demand**

The table below outlines the nature of the network constraints identified in the network analysis.

Table 2.3.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Quorn primary transformer overloads	Arranged or fault outage on either transformer or 33 kV circuit to Quorn primary	None	2034	2028	2034	-

Uncertainty under other Distribution Future Energy Scenarios: Under the higher growth scenarios (Consumer Transformation and Leading the Way) overloads are also observed in summer in 2034. The only scenario under which overloads are not seen by 2034 for any season is Falling Short.

Solution Options

A list of each of the options considered for this constraint is given below.

Table 2.3.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Uprate both transformers at Quorn primary.
2	Build a new primary substation.
Operational Mitigation	
3	Review seasonal ratings.
Flexibility Services	
4	Procure flexibility under Quorn primary.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Uprate both transformers at Quorn primary

Viable

Capacity released for constraint(s) considered: 2 MVA

New limiting factor for constraint(s) considered: 33 kV circuit to Quorn T1 (before circuit works are carried out)

Detailed description: Uprating both of the transformers at Quorn primary to 20/40 MVA units would help alleviate this constraint. This would also benefit the condition of the transformers, which are almost 55 years old. To free up the full capacity of the new transformers, 33 kV circuit works would also be required at some point. The majority of both 33 kV circuits to Quorn are already rated high enough to accommodate the full demand of 20/40 MVA transformers, so less than 1 km of circuit would need uprating (across both circuits) to increase the capacity of Quorn primary to 38 MVA. This capacity would be sufficient to accommodate the demand growth projected at Quorn up to around 2050.

Option 2 – Build a new primary substation

Discounted

Capacity released for constraint(s) considered: 38 MVA or 23 MVA

New limiting factor for constraint(s) considered: Total primary capacity of Quorn and the new substation

Detailed description: Building a new primary substation would not be justified based on the demand growth projected at Quorn alone. It could however potentially be used to deload other primary sites as well (such as Shepshed or Mountsorrel as discussed below).

Shepshed primary is projected to be heavily constrained as discussed in Section 2.2 of this report (even after the primary itself is reinforced). A new primary between Quorn and Shepshed could be used to deload both sites. Shepshed is located to the west of Quorn (the two primaries are around 8 km apart.

Mountsorrel primary (fed from Willoughby BSP) is also expected to be heavily constrained, with significant overloads projected to occur by 2028 as outlined in the Willoughby 33 kV report. Similarly to Shepshed, a new primary between Mountsorrel and Quorn (which are around 4 km away from each other) could be used to deload both sites. This option would need to be considered in conjunction with the overall development of the Willoughby 33 kV network. It would also have implications for the loading of both Loughborough and Willoughby BSPs (the new primary would likely be fed from Loughborough as it is much closer to the two primaries than Willoughby).

This option has been discounted as the reinforcement of Quorn itself, as discussed in option 1, is far more economical (and also confers an asset condition benefit), and it would likely be difficult to find a viable primary site to deload both Quorn and Shepshed as they are located either side of Loughborough's town centre. Deloading Mountsorrel would likely not be sufficient justification for a new primary either, as 20/40 MVA transformers would be sufficient to accommodate the long term demand growth forecast there.

Option 3 – Review seasonal ratings

Viable

Capacity released for constraint(s) considered: Dependent on review

New limiting factor for constraint(s) considered: As before

Detailed description: Overloads are only seen in 2028 for intermediate cool. It is therefore possible that this constraint could be delayed slightly by reviewing NGED's internal policy regarding transformer ratings, which does not currently distinguish between summer and intermediate cool ratings (which may be overly pessimistic). This solution is dependent on an internal review and would not be a long term solution.

Option 4 – Procure flexibility under Quorn primary

Viable

Flexibility service type: Generation turn up/demand turn down.

Detailed description: Flexibility services could be procured to alleviate the projected overloads on the transformers at Quorn primary. This could be carried out alongside the operational mitigations discussed in option 3 above. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The lowest cost and most strategic method of resolving this constraint is to reinforce Quorn primary itself, by replacing its primary transformers and upgrading the 33 kV infeeds. This reinforcement may potentially be deferred by a review of NGED's seasonal transformer ratings.

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