Coalville BSP

Network Development Report – East Midlands

May 2024

Electricity Distribution

nationalgrid

Contents

Coalville 33 kV

1. Network Overview

Coalville Bulk Supply Point (BSP) is fed from Enderby Grid Supply Point (GSP) in National Grid Electricity Distribution's (NGED's) East Midlands licence area. Coalville BSP is fed from Enderby via a dual 132 kV circuit with a tee off to Hinckley BSP.

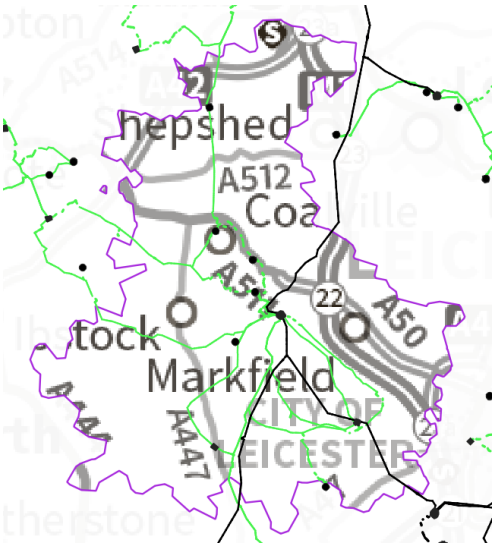

Figure 1.1 Coalville geographic network coverage

This report discusses all existing and future network constraints over a 0-10 year horizon identified on the 33 kV network fed from Coalville 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

Coalville BSP has five 33 kV busbars fed by three 132/33 kV Grid Transformers (GTs), two of which are rated at 60/90/117 MVA (GT1/3) and one of which is rated at 45/90/117 MVA (GT2). The three GTs are normally run in parallel. Coalville BSP feeds nine primary substations: Bardon, Coalville, Desford, Interlink Park, Mantle Lane, Nailstone, Osbaston, Worthington and a dedicated customer site. Coalville primary is located at the same site as Coalville BSP. Seven of the primaries fed from Coalville have two 33/11 kV transformers each, with the remaining two being the dedicated customer site and Worthington which are both single transformer primaries. All of the primaries are supplied directly from Coalville BSP, with the exception of Worthington (which is fed via Mantle Lane primary).

Coalville is interconnected at 33 kV with three other BSPs: Spondon, Gresley and Hinckley. The interconnection with Spondon is via a single 33 kV circuit from Worthington primary to Castle Donington primary (which has a normal open point at the Worthington end). The interconnection with Gresley is via two 33 kV circuits to Willesley primary which are both run open at Willesley. The interconnection with Hinckley is via two 33 kV circuits to Barwell primary which are also run open under normal running arrangements.

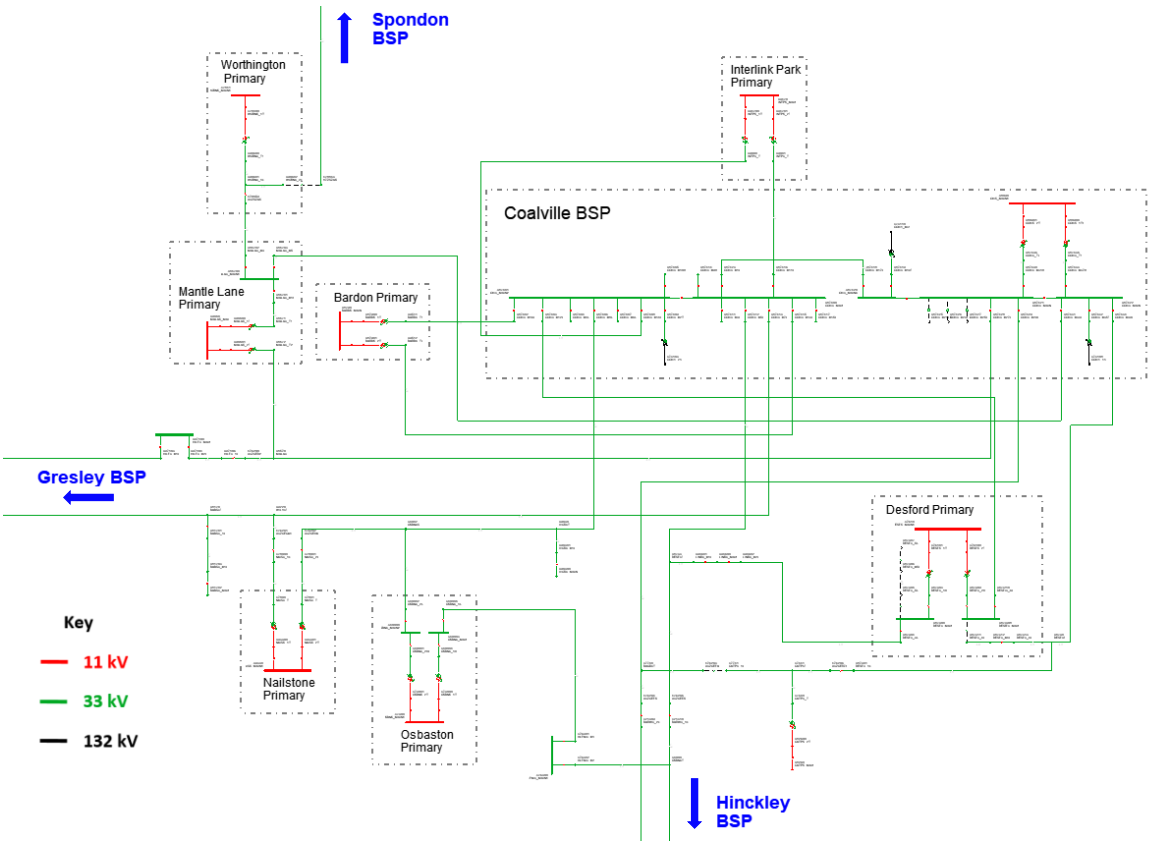

Figure 1.1.1 Coalville 33 kV network single line diagram

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 Coalville BSP under arranged outages, the lower voltage side circuit breaker is opened to prevent back-energisation.
- For an arranged outage on the 33 kV bus section breakers on each side of Coalville, the downstream network is split to prevent loose couples. For the GT1 side this involves splitting Coalville and Mantle Lane primaries at 11 kV. For the GT2 side this involves splitting Bardon, Interlink Park, Nailstone, Osbaston and Desford primaries at 11 kV.
- For an outage on either side of Coalville (on GT1 or GT2), GT3 is used to solely feed that side of Coalville by splitting from the other side. For an outage on GT3, Coalville BSP is also split such that each side is fed by GT1/GT2 respectively.
- For an arranged outage on the 33 kV infeed to the dedicated customer site, the primary is kept on supply at 33 kV by closing the normal open point on the circuit from the main 5 busbar at Coalville BSP 33 kV.
- For an arranged outage on the 33 kV infeed to (past the point at which the primary can be backfed at 33 kV), or the 33/11 kV transformer at the dedicated customer site, the load is backfed on the 11 kV network from Desford primary.
- For an arranged outage on the 33 kV infeed to Worthington, the primary is transferred into Spondon BSP by closing the normal open point on the 33 kV circuit to Castle Donington primary.
- For an arranged outage on the 33/11 kV transformer at Worthington primary, the load is backfed on the 11 kV network from Melbourne primary.

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:

- The 33/11 kV transformer at Worthington is constrained on demand under intact network running (and is projected to also be constrained on generation by 2034).
- The 33 kV circuits to Mantle Lane primary (specifically up to the Mantle Lane tee and on the circuit to main 1) are forecast to overload for the loss of the other circuit by 2028.
- For an arranged or fault outage on the main 2 (33 kV) busbar at Coalville BSP, the 33 kV circuit to the Desford tee is expected to overload at summer peak generation by 2034.

2.2 Worthington primary transformer 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 year constraint is observed in each season under Best View			
Demand			**Winter**	**Int Cool**	**Int Warm**	**Summer**
Worthington primary transformer overloads	None	None	Baseline	Baseline	Baseline	-
Generation			**Summer**			
Worthington reverse power flow transformer overloads	None	None	2034			

Uncertainty under other Distribution Future Energy Scenarios: Relatively low load growth is projected under all five scenarios between now and 2034 at Worthington. As this constraint is present in the baseline, regardless of the scenario, some form of mitigation is required. Under the higher growth scenarios (Leading the Way and Consumer Transformation) ANM and flexibility procurement may not be capable of managing the constraint for as long (which would trigger reinforcement earlier).

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 transformer at Worthington primary.
2	Install a second transformer at Worthington primary.
Operational Mitigation	
3	Active Network Management.
Flexibility Services	
4	Procure flexibility under Worthington 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 transformer at Worthington primary

Viable

Capacity released for constraint(s) considered: Up to 6 MVA

New limiting factor for constraint(s) considered: 11 kV network capacity

Detailed description: Replacing the transformer at Worthington primary with a 12/24 MVA unit would resolve the existing/projected demand and generation constraints on the transformer. Exactly how much capacity this would add to the site is dependent on the capacity of the existing 11 kV network, specifically the 11 kV backfeed capacity.

A further 11 kV study is required to assess this, and if the 11 kV network is sufficient, a 12/24 MVA transformer at Worthington would add enough capacity for the growth forecast in the are up to 2050.

Option 2 – Install a second transformer at Worthington primary

Discounted

Capacity released for constraint(s) considered: Dependent on load growth at Mantle Lane and Castle Donington primaries

New limiting factor for constraint(s) considered: 33 kV circuit capacity

Detailed description: Installing a second transformer at Worthington primary rated to 12/24 MVA (and uprating the existing transformer to match) would add significant capacity to the site. There are a number of drawbacks for this option which make it unsuitable as the initial reinforcement strategy for the site (but this could be considered further into the future):

- It is significantly more expensive than option 1, requiring two 12/24 MVA transformers as well as all of the associated 33 kV and 11 kV switchgear.
- The site would need to be run split following reinforcement in order to prevent a loose couple being formed between two GSPs (Willington and Enderby).
- Adding load to the 33 kV circuit from Spondon BSP to Castle Donington T2 would exacerbate a constraint there, which is discussed in the Spondon and Heanor 33 kV report. The impact of this would depend on how load develops at Castle Donington primary (reinforcement could be triggered regardless, and it is important to note that a large portion of the growth forecast for Castle Donington is due to hydrogen electrolysis).
- Transferring demand would have implications for both Spondon BSP and Willington GSP (although not a huge impact, and not enough to affect the overall strategy for either site).

If the 11 kV study proposed in option 1 concludes that Worthington primary is very limited by its 11 kV backfeed capacity, this option may need to be progressed (unless economic solutions could be identified at 11 kV).

Option 3 – Active Network Management

Viable

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

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

Detailed description: Any additional connections downstream of Worthington could be included in an Active Network Management (ANM) scheme. ANM schemes are used to manage constraints on over-committed networks. This option could help manage the generation constraint at Worthington, but not the demand constraint.

Option 4 – Procure flexibility under Worthington primary

Viable

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

Detailed description: Flexibility services could be procured on the network supplied from Worthington primary to alleviate the projected demand overloads seen on the transformers. Flexibility would not be suitable for managing the reverse power flow constraint projected at Worthington. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

If ANM and/or the use of flexibility services proves insufficient to manage this constraint the existing transformer at Worthington primary could be uprated to resolve this constraint. Depending on the capacity of the 11 kV interconnection to Worthington primary a second transformer may eventually be required, although demand forecasts for the area are low so this would likely only be triggered well into the future (if at all).

2.3 Coalville to Mantle Lane 33 kV circuit 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 year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Coalville to Mantle Lane main 1 33 kV circuit overload	Arranged or fault outage on the infeed to Mantle Lane T2	None	2034	2028	2034	-
Coalville to the Mantle Lane tee 33 kV circuit overload	Arranged or fault outage on the infeed to Mantle Lane T1	None	2028	2028	2028	-

Uncertainty under other Distribution Future Energy Scenarios: Significantly higher demand growth is forecast for Mantle Lane under Consumer Transformation and Leading the Way. In the long term, similar demand is projected under Falling Short and System Transformation (although up to 2034 growth is higher under Best View). Demand growth at Worthington primary, which will affect loading on the circuit to Mantle Lane main 1, is discussed in Section 2.2 of this report.

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 33 kV circuits to Mantle Lane primary.
2	Build new 33 kV circuits.
Operational Mitigation	
3	Transfer Worthington primary into Spondon BSP.
4	Transfer demand at 11 kV.
Flexibility Services	
5	Procure flexibility under Mantle Lane and Worthington primaries.

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 33 kV circuits to Mantle Lane primary

Viable

Capacity released for constraint(s) considered: Dependent on sections uprated

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

Detailed description: On the 33 kV circuit to the Mantle Lane tee, under 3 km of circuit could be uprated to increase its capacity by 13 MVA. On the 33 kV circuit to Mantle Lane main 1 however, virtually the entire length would need to be uprated to add significant capacity, so building a new circuit could be considered as it would require a similar length of circuit works.

Option 2 – Build new 33 kV circuits

Viable

Capacity released for constraint(s) considered: The demand of Worthington plus additional capacity from the new circuit rating

New limiting factor for constraint(s) considered: Mantle Lane transformer capacity

Detailed description: As noted above, the 33 kV circuit to Mantle Lane main 1 would need replacing almost in its entirety to increase its capacity significantly. One option which should therefore be considered is building a new circuit (or circuits) to Mantle Lane primary. This would not only add capacity at Mantle Lane, it would also allow Worthington primary to be unstitched, reducing network complexity and increasing 33 kV interconnection between Coalville and Spondon BSPs.

The 33/11 kV transformers at Mantle Lane are around 60 years old, and by 2034 are projected to be near their firm capacity. The replacement of the transformers at Mantle Lane with 20/40 MVA units, while not triggered by the load growth seen up to 2034, is likely to be required in the near future (triggered either by demand growth or asset condition). Any 33 kV circuit works should therefore consider this likelihood and facilitate unlocking the full capacity of 20/40 MVA units when they are installed, if possible (or at least begin the process of freeing up this capacity).

Option 3 – Transfer Worthington primary into Spondon BSP

Viable

Capacity released for constraint(s) considered: Demand of Worthington primary

New limiting factor for constraint(s) considered: 33 kV circuits to Mantle Lane T2 and Castle Donington T2

Detailed description: Transferring Worthington primary into Spondon BSP could be utilised to help alleviate this constraint, although there are some drawbacks to this strategy. Firstly, it would only help mitigate the constraint on one of the circuits to Mantle Lane. Secondly, it would exacerbate the projected constraint on the 33 kV circuit between Spondon BSP and Castle Donington T2, which is outlined in the Spondon and Heanor 33 kV report.

This transfer could potentially be utilised in the short term to defer this constraint while there is capacity on the Spondon 33 kV network. It could also be considered in the long term if the Spondon to Castle Donington 33 kV circuits are uprated. This option needs to be considered in conjunction with both the Spondon to Castle Donington 33 kV circuit constraint and the constraint at Worthington itself which, along with potential solutions, is discussed in Section 2.2 of this report.

Option 4 – Transfer demand at 11 kV

Viable

Capacity released for constraint(s) considered: Dependent on 11 kV transfers

New limiting factor for constraint(s) considered: 11 kV transfer capacity

Detailed description: Demand could potentially be transferred at 11 kV to the nearby Bardon primary (which has significant demand headroom available), to deload Mantle Lane and help mitigate this constraint. A full 11 kV study is required to determine what transfers could be achieved. If 11 kV reinforcement is required to facilitate transfers, the cost of this would need to be weighed against the benefit of deferring reinforcement on the 33 kV circuits to Mantle Lane. This option is unlikely to be an enduring solution based on the demand forecasts for the area.

Option 5 – Procure flexibility under Mantle Lane and Worthington primaries

Viable

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

Detailed description: Flexibility services could be procured at Mantle Lane and/or Worthington primaries to alleviate the projected demand overloads on the 33 kV circuits to Mantle Lane. Flexibility procured at Worthington would only impact the constraint on the circuit to Mantle Lane main 1. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

A number of possible short term mitigation options for this constraint have been considered, including demand transfers at 11 kV and moving Worthington primary into Spondon BSP. In the longer term, 33 kV circuit works will be required, which should be aimed at both resolving the projected constraint and futureproofing the area (considering the eventual replacement of the transformers at Mantle Lane primary with 20/40 MVA units). Whether this will involve uprating the existing circuits, or building a new circuit (or circuits), will be subject to CBA and detailed route investigation.

2.4 Coalville to the Desford tee 33 kV circuit overloads

Constraint Overview

Generation Demand

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

Table 2.4.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed under Best View
			Summer (generation)
Coalville to the Desford tee 33 kV circuit overload	Coalville main 2 33 kV busbar arranged or fault outage	None	2034

Uncertainty under other Distribution Future Energy Scenarios: Generation growth at Desford and Osbaston primaries is highest under Consumer Transformation (slightly higher than under Best View) and lowest under Falling Short. Growth at both sites is notably higher beyond 2034 for all three net zero compliant scenarios.

Solution Options

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

Table 2.4.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Uprate the 33 kV circuit between Coalville and the Desford tee.
2	Build new 33 kV circuits.
Operational Mitigation	
3	
4	Active Network Management.
Flexibility Services	
5	Procure flexibility under Desford and Osbaston primaries.

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.

Option 1 – Uprate the 33 kV circuit between Coalville and the Desford tee

Viable

Capacity released for constraint(s) considered: 13 MVA

New limiting factor for constraint(s) considered: 33 kV cable section rating

Detailed description: The majority of the 33 kV circuit to the Desford tee (just under 3 km) is consists of half of a dual 33 kV overhead line route. The cost to uprate this, and resolve this constraint, would be dependent on what conductor size could be accommodated on the existing structures. If the 33 kV cable section also ever needed uprating, this would only require overlaying a short section of cable out of Coalville BSP. This option may not preferable compared to building new circuits as per option 2 (which would remove the dual overhead line).

Option 2 – Build new 33 kV circuits

Viable

Capacity released for constraint(s) considered: Dependent on new configuration

New limiting factor for constraint(s) considered: Total 33 kV circuit capacity

Detailed description: New 33 kV circuits could be built south from Coalville BSP to add generation capacity to the area. A number of options could be explored to unstitch Osbaston, Desford and Nailstone primaries, and generation connected at 33 kV. Highly rated circuits down towards Osbaston and Desford could provide the capacity required for the long term generation growth forecast for area, but would be significantly more expensive than option 1. Rebuilding the dual overhead line with two single circuits would also be beneficial but could be a high cost scheme.

Option 3 – Alternative running arrangements

Discounted

Capacity released for constraint(s) considered: None

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

Detailed description: A number of alternative running arrangements have been considered to help alleviate this constraint (none of which are deemed viable):

- Circuits could be moved at Coalville BSP to prevent infeeds to both Osbaston and Desford primaries being lost for a busbar outage (which is the most onerous constraint identified). This would however be difficult to achieve without either loose coupling the two halves of Coalville, or compromising the load balance of the site.
- Transferring load via Barwell primary into Hinckley BSP to alleviate this constraint is not possible, as it would increase network complexity and lead to non-compliance with Engineering Recommendation P18 (as the circuits to Barwell primary would end up with too many addresses).

Option 4 – Active Network Management

Viable

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

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

Detailed description: Any additional connections at Desford 11 kV or Osbaston 11 kV could be included in an Active Network Management (ANM) scheme. ANM schemes are used to manage constraints on over-committed networks.

Option 5 – Procure flexibility under Desford and Osbaston primaries

Discounted

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

Detailed description: Flexibility is not suitable to manage this constraint as it is generation driven. Managing generation constraints using flexibility procurement is technically feasible, but NGED's internal tools and processes for calculating flexibility requirements for generation constraints are still in development.

Solution Recommendation

The optimal initial reinforcement solution (if ANM is no longer suitable to manage the constraint) would likely be to reinforce the 33 kV circuit to the Desford tee. This could involve reconductoring, rebuilding or undergrounding the overhead line (detailed surveys would be required to determine what can be achieved on the existing structures). In the long term, new 33 kV circuits could be required (generation growth in the area will be monitored to assess the need for this as load materialises).

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