Winster BSP

Network Development Report – East Midlands

May 2024

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Winster 33 kV

1. Network Overview

Winster Bulk Supply Point (BSP) is fed from Willington Grid Supply Point (GSP) in National Grid Electricity Distribution's (NGED's) East Midlands licence area. Winster BSP is fed from Willington via a dual 132 kV circuit with a tee off to Burnaston and Uttoxeter BSPs.

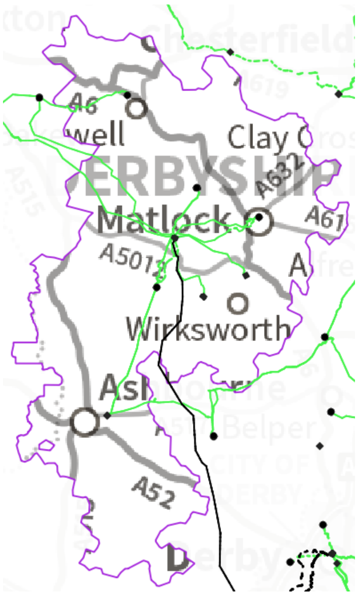

Figure 1.1 Winster geographic network coverage

This report discusses all existing and future network constraints over a 0-10 year horizon identified on the 33 kV network fed from Winster BSP (as well as some 11 kV network relevant to the development of the 33 kV network). 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

Winster BSP has two 33 kV busbars fed by two 132/33 kV Grid Transformers (GTs) both rated to 30/60/78 MVA. Winster BSP feeds seven primary substations: Ashbourne, Bakewell, Cromford, Hopton, Longcliffe, Matlock and Millclose.

Hopton, Cromford and Bakewell primaries each have a single 33/11 kV transformer, with the remaining primaries all having two. All of the primaries listed above are supplied directly from Winster BSP, with the exception of Ashbourne T2 which is supplied via Longcliffe primary.

Winster BSP is interconnected at 33 kV with Buxton BSP via Flagg and Hindlow primaries, and with Alfreton BSP via Ashbourne primary (the interconnection to both BSPs is normally run open).

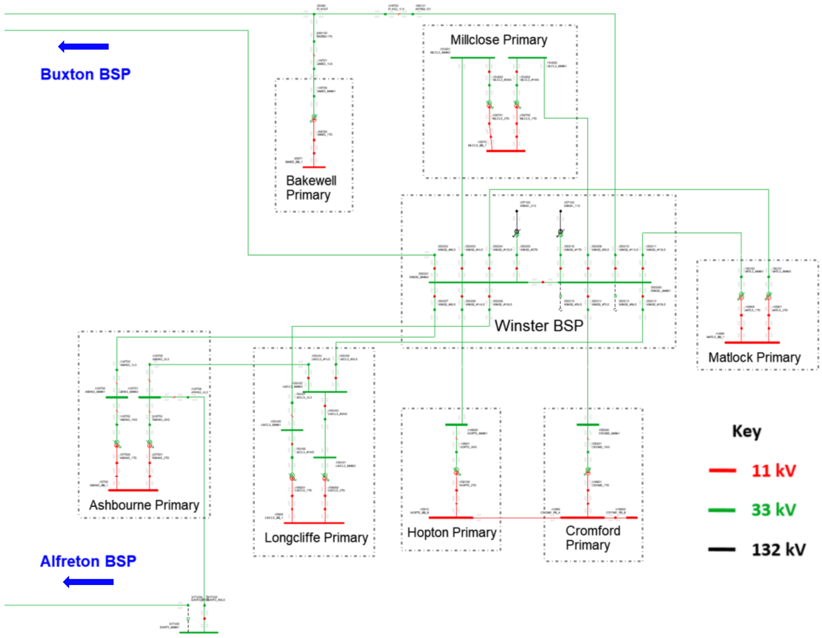

Figure 1.1.1 Winster 33 kV network single line diagram

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 Winster BSP under arranged outages, the lower voltage side circuit breaker is opened to prevent back-energisation.
- The 33 kV network downstream of Winster BSP is split for arranged outages on its 33 kV bus section breaker to prevent loose couples. This involves splitting Matlock, Millclose, Longcliffe and Ashbourne primaries at 11 kV, and opening the 11 kV interconnection between Hopton and Cromford primaries.
- For an arranged outage on the 33 kV infeed to Bakewell, the primary is transferred into Buxton BSP via Flagg primary.
- 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 Bakewell primary the load is backfed on the 11 kV network to Millclose primary (which is then split at 11 kV if required to prevent overloads).
- For arranged or fault outages on the infeeds to Hopton or Cromford primaries the load is backfed at 11 kV to the other primary, with the primaries being run parallel under normal running arrangements.

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 in 2034 on the transformers and infeed circuits to Ashbourne primary for an arranged or fault outage on the other transformer/infeed. Overloads are also seen on the 33 kV circuit from Winster to Longcliffe for arranged or fault outages on the main 2 busbar at Winster.
- The 11 kV backfeed capacity of Hopton and Cromford primaries (which support each other) is forecast to be exceeded by 2028 for Cromford and by 2034 for Hopton.

For the purposes of this network analysis it has been assumed that the GTs at Winster BSP will be uprated to 60/90/117 MVA units and will therefore not become a limiting factor for either of the constraints discussed above. The uprating of the GTs at Winster BSP (which is triggered on both the load at the substation and the condition of the assets) is discussed in depth in the Willington 132 kV report.

2.2 Ashbourne 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
Ashbourne T1 or T2 overload	Arranged or fault outage on either transformer or circuit to Ashbourne primary	None	2034	2034	2034	2034
Winster – Ashbourne T1 circuit overload	Arranged or fault outage on the infeed to Ashbourne T2	None	2034	2034	2034	-
Longcliffe – Ashbourne T2 circuit overload	Arranged or fault outage on the infeed to Ashbourne T1	None	2034	2034	2034	-
Winster – Longcliffe main 3 circuit overload	Arranged or fault outage on Winster main 2	None	-	2034	-	-

Uncertainty under other Distribution Future Energy Scenarios: This constraint not present under any scenario for any season in 2028. In 2034 the constraint is also present in summer for some outage conditions under the Leading the Way and Consumer Transformation scenarios. The only scenario for which intervention is not required by 2034 is Falling Short.

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 Ashbourne primary.
2	Install a third transformer at Ashbourne primary.
3	Build a new primary substation.
Flexibility Services	
4	Procure flexibility under Ashbourne 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 Ashbourne primary

Viable

Capacity released for constraint(s) considered: 12 MVA

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

Detailed description: Overloads are observed on both the transformers and 33 kV feeder circuits to Ashbourne primary by 2034, necessitating intervention for both sets of assets. This could involve uprating both the transformers and 33 kV circuits to Ashbourne, which would fully resolve this constraint in 2034 and provide significant additional capacity for future growth. The new transformers would be rated to 20/40 MVA. This would also benefit the condition of the transformers which are over 60 years old.

For the section of 33 kV circuit from Winster BSP to Longcliffe primary a new 33 kV circuit could be built, allowing Ashbourne and Longcliffe primaries to be unstitched. This would resolve the constraint seen on this section of circuit, create additional circuit capacity to Longcliffe and simplify the network (improving operability). This would require around 4.5 km of circuit works (subject to detailed route investigation and land rights).

Option 2 – Install a third transformer at Ashbourne primary

Discounted

Capacity released for constraint(s) considered: Minimal

New limiting factor for constraint(s) considered: Ratings of the existing transformers

Detailed description: Installing a third transformer at Ashbourne primary rated to 20/40 MVA, with a new 33 kV circuit from Winster BSP would not significantly increase the capacity of the substation. This is because there are only two 33 kV busbars at Winster, with no current plans to add a third, so for the loss of a busbar two transformers would be lost at Ashbourne primary (as two of the circuits to Ashbourne would have to be from the same busbar). There are no other viable BSPs which a third transformer could be fed from, as the nearest 33 kV network outside of the Winster group is Ravensdale Park (fed from Alfreton BSP), which is already a significant distance from where it is fed from and does not have the thermal or voltage capacity to pick up any more demand. The constraints seen at Ravensdale Park are discussed in more detail in the Alfreton 33 kV report.

This option has been discounted, as in addition to the issues discussed above it would also not benefit the condition of the existing transformers as option 1 described above would (so the existing transformers would likely need replacing based on their condition soon regardless).

Option 3 – 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 Ashbourne and the new substation

Detailed description: This constraint could be resolved by building a new primary substation and transferring some of the demand from Ashbourne to the new substation. The level of demand growth projected at Ashbourne does not necessitate this level of investment, and there are no primaries in close enough proximity that could also benefit from a new primary to shift load to (the closest other primaries are Longcliffe, which is around 10 km away and Ravensdale Park, which is around 7 km away, neither of which are projected to see much demand growth).

This option has therefore been discounted as it would be prohibitively expensive for the limited network benefit it would provide.

Option 4 – Procure flexibility under Ashbourne 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 Ashbourne. Flexibility at Longcliffe primary could be procured to manage the constraint on the Winster – Longcliffe primary, but this would be of limited benefit as the more onerous constraints observed are on the transformers and circuits to Ashbourne primary. Flexibility would also provide no benefit for the condition of the transformers at Ashbourne, so flexibility could not be used to defer the reinforcement of the transformers once their replacement is triggered based on their condition. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The only viable reinforcement solution identified is to uprate the existing transformers and 33 kV circuits to Ashbourne primary, with a third transformer being deemed unfeasible and a new primary being unnecessary and prohibitively expensive.

2.3 Hopton and Cromford 11 kV backfeed overload

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
Hopton – Cromford 11 kV backfeed overload	Transformer or circuit arranged or fault outage to Cromford primary	None	2028	2028	2028	2034
Hopton – Cromford 11 kV backfeed overload	Transformer or circuit arranged or fault outage to Hopton primary	None	2034	2034		

Uncertainty under other Distribution Future Energy Scenarios: For an outage on the infeed to Hopton primary this constraint is not seen in any season under the System Transformation or Falling Short scenarios even in 2034. For an outage on the infeed to Cromford primary this constraint is present by 2028 for every scenario. For both outages the constraint is more severe under the Leading the Way and Consumer Transformation scenarios.

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	Install a second transformer at both sites and a circuit to Cromford primary.
2	Install a second transformer at both sites and a circuit to Hopton primary.
3	Install second transformers and individual circuits to both primaries.
4	Uprate the 11 kV circuit between the two primaries.
Flexibility Services	
5	Procure flexibility under Hopton and Cromford 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 – Install a second transformer at both sites and a circuit to Cromford primary

Discounted

Capacity released for constraint(s) considered: 17 MVA for Cromford primary

New limiting factor for constraint(s) considered: Existing 33 kV circuit to Hopton primary and new transformer rating at Cromford primary

Detailed description: Installing a second transformer and 33 kV circuit to Cromford primary would mean that for arranged or fault outages at Cromford supply could be maintained without having to rely on the 11 kV interconnection with Hopton primary. This would require around 6.5 km of circuit works (subject to detailed route investigation and land rights).

To free up the full capacity at Cromford primary, the existing 33/11 kV transformer would also need uprating. As the existing transformer is already over 60 years old and is due for asset replacement based on its condition, this will provide an economic opportunity to replace it with a 12/24 MVA unit (which the new transformer would be rated to match). The new 20/40 MVA units could be used, but this would not be economical as it would only free up an extra 1 MVA of capacity (with the 33 kV circuit to the site becoming the limiting factor) and demand forecasts indicate this extra capacity will not be required.

Installing a second 33 kV circuit to Cromford primary would also provide the opportunity to create a second 33 kV infeed for Hopton primary. This would be achieved by switching the circuit which currently operates as the 11 kV interconnector between the two primaries (which is 33 kV construction) to 33 kV. There are, however, a number of sections of 11 kV cable along this circuit which would need upgrading to 33 kV (but this is only around 400 m in total). The new 33 kV circuit to Cromford primary would then supply both its second transformer, and a second transformer at Hopton primary (and would be sized accordingly). A new three panel 33 kV board would be required at Cromford to facilitate this, and the existing 33 kV circuit to Hopton would need to be moved to main 1 at Winster BSP (such that both its infeeds are not from the same busbar).

The installation of second transformers at Hopton and Cromford would need to be carried out simultaneously, as analysis indicates that the intermediate stage of Cromford having two transformers and Hopton having one is not viable due to protection and power quality issues. Once these works are carried out the firm capacity of Cromford primary would be 23 MVA and the firm capacity of Hopton primary would be 18 MVA (now limited by the primary transformers and the existing 33 kV infeed respectively).

Initial route investigations indicate a new 33 kV circuit to Cromford primary from Winster BSP may not be possible. This option has therefore been discounted in favour of option 2 which is described below.

Option 2 – Install a second transformer at both sites and a circuit to Hopton primary

Viable

Capacity released for constraint(s) considered: 12 MVA for Hopton primary

New limiting factor for constraint(s) considered: Existing 33 kV circuit to Hopton primary and new transformer rating at Cromford primary

Detailed description: The 33 kV network supplying Hopton and Cromford primaries is largely symmetrical, so the solution discussed in option 1 would be equally technically viable mirrored. This would involve building a new 33 kV circuit to Hopton primary to feed a new primary transformer there, with a 33 kV three panel board being used to feed a second transformer at Cromford primary via the 33 kV construction circuit between the primaries (which is currently being used as 11 kV interconnection as discussed above). This would require around 6.5 km of 33 kV circuit works (subject to detailed route investigation and land rights) plus the 400 m of overlay on the interconnector as mentioned in option 1. This solution would synergise well with the asset replacement of Hopton's existing transformer (which, similarly to Cromford primary's transformer, is over 60 years old and due for replacement based on its condition).

As with option 1, the new limiting factor for the primaries is the existing 33 kV infeed or the new transformer rating, so the same firm capacity would be achieved at the sites regardless. As the works are required to be carried out in one phase (the same protection and power quality limitations prevent an intermediate step being utilised as in option 1) it is also largely irrelevant which primary reaches its existing firm capacity first.

The deciding factor for which primary a second 33 kV circuit is taken to is therefore based solely on the viability of the two routes. As noted above installing a new circuit to Cromford primary may not be possible. In contrast, a new circuit to Hopton primary is viable, making this the preferred option.

Option 3 – Install second transformers and individual circuits to both primaries

Discounted

Capacity released for constraint(s) considered: 18 MVA for Cromford primary and 12 MVA for Hopton primary

New limiting factor for constraint(s) considered: Existing 33 kV circuit to Hopton primary and new transformer rating at Cromford primary

Detailed description: This constraint could be resolved by installing new 33 kV circuits to both primaries and installing two 33/11 kV 12/24 MVA transformers at each site. This option has been discounted as it would require significantly more 33 kV circuit works (around double) than the solutions discussed in options 1 and 2 above. This makes this option prohibitively expensive when considering similar capacity could be released by the cheaper options discussed which utilise the existing 33 kV construction circuit between the two primaries.

This proposal would also run into the aforementioned difficulties with building a new circuit between Winster and Cromford. Having a single 33 kV circuit which splits off to both primaries would reduce the circuit works required, but has been discounted as an option as it would leave one of the primaries fed entirely by a single busbar at Winster BSP (and regardless creates no additional network benefits compared with options 1 and 2).

Option 4 – Uprate the 11 kV circuit between the two primaries

Viable

Capacity released for constraint(s) considered: Dependent on which sections of the circuit are uprated

New limiting factor for constraint(s) considered: As before (unless the entire circuit is rebuilt)

Detailed description: Uprating sections of the 11 kV interconnector between the two primaries would increase the capacity of both substations, deferring this constraint. Capacity could be added without uprating the entire circuit as there are various sections at present with various ratings between around 6 MVA and 8 MVA when run at 11 kV).

The 11 kV boards at both primaries would need to be replaced as well, as the circuit would otherwise still be limited by the 11 kV circuit breakers at each end. This option is technically viable and would be significantly cheaper than options 1 and 2, but would not provide the capacity required for long term growth of the network (even if the circuit were fully rebuilt the transformers and circuits to each primary would limit the firm capacity as for outages the demand of both primaries would be supplied from one infeed). The costs of this option need to be weighed against the deferral of the more permanent solutions discussed above.

Option 5 – Procure flexibility under Hopton and Cromford primaries

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 11 kV circuit between Hopton and Cromford primaries. Flexibility would however provide no benefit for the condition of the transformers at Hopton and Cromford primaries, so flexibility could not be used to defer the reinforcement of the transformers once their replacement is triggered based on their condition. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The optimal long term reinforcement strategy to resolve this constraint is to install a second transformer and 33 kV circuit to Hopton primary, creating the option to then feed a second transformer at Cromford via the 33 kV construction circuit between the primaries. In the short term uprating the 11 kV circuit and/or procuring flexibility services could be used to defer this constraint.

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