West Burton GSP

Network Development Report – East Midlands

May 2024

Electricity Distribution

nationalgrid

Contents

West Burton 132 kV

1. Network Overview

West Burton Grid Supply Point (GSP) supplies four Bulk Supply Points (BSPs) in National Grid Electricity Distribution's (NGED's) East Midlands licence area in and around Lincoln and Worksop. These four BSPs are: Lincoln Main, Lincoln Local, Retford and Worksop.

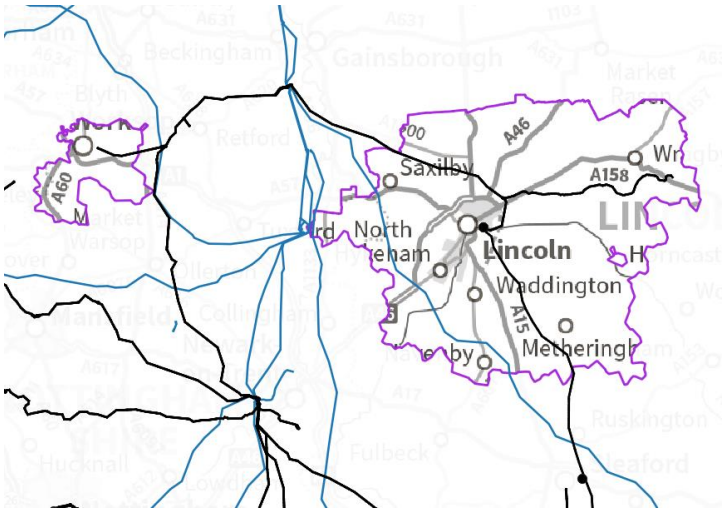

Figure 1.1 West Burton GSP geographic network coverage

This report discusses all existing and future network constraints over a 0-10 year horizon identified on the 132 kV network fed from West Burton GSP. 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

There are two 132 kV dual circuits out of West Burton GSP, one of which supplies Lincoln Main and Lincoln Local BSPs, and the other of which supplies Worksop and Retford BSPs. Worksop and Retford both have two Grid Transformers (GTs) (132/33 kV in the case of Worksop and 132/25 kV for Retford). Lincoln Main and Lincoln Local are located adjacent to one another, with Lincoln Main having three 132/33 kV GTs and one 132/11 kV GT, and Lincoln Local having two 132/11 kV GTs supplied by a short section of 132 kV dual circuit from Lincoln Main.

West Burton is interconnected at 132 kV with two other GSPs: Staythorpe and Walpole. The interconnection with Staythorpe GSP is via normal open points at Checkerhouse BSP (which the 132 kV dual circuit to Worksop and Retford continues on to). The interconnection with Walpole is via a single 132 kV circuit from Lincoln Main BSP. This circuit is run open under normal running arrangements.

West Burton itself has three 400/132 kV super grid transformers (SGTs). Two of these SGTs feed onto the reserve 1 and reserve 2 132 kV busbars respectively. These busbars are run split under normal running arrangements. The third SGT is connected to the main 2 busbar, which is normally run in parallel with the main 1 busbar. The outgoing 132 kV feeders are all selected to the reserve busbars under normal running arrangements, with an autoclose scheme set up to parallel with the main busbars for the loss of an SGT, as described in the network operability modelling section below. There are also two 132/11 kV GTs at West Burton itself.

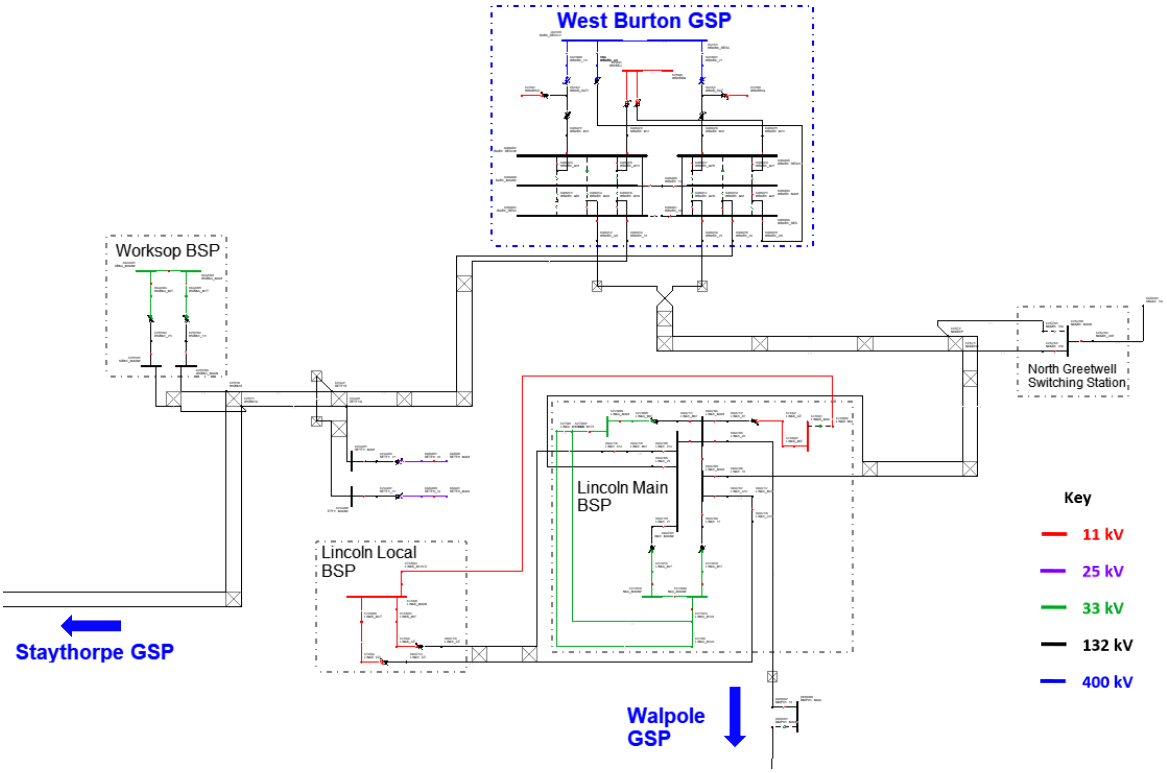

Figure 1.1.1 West Burton 132 kV network single line diagram

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 arranged outages on either 132 kV reserve busbar at West Burton GSP, the feeders are transferred to its partner main busbar. If the reserve bar is on outage and none of the three SGTs are, CB380 (the LV circuit breaker for SGT3) is opened.
- Various splits can be taken for outages on the 132 kV network out of West Burton to prevent overloads for subsequent faults.
- During arranged outages on SGT1, CB130 is closed at West Burton (paralleling the reserve 1 busbar with the main busbars). During arranged outages on SGT2 or SGT3, CB230 is closed (paralleling the reserve 2 busbar with the main busbars).
- For arranged outages on the main 1 busbar, or CB130 at West Burton, a number of actions are taken: the 132 kV feeders on the reserve 2 busbar are transferred to the main 2 busbar and the reserve busbars are paralleled by closing disconnector 166. If SGT1 is not also on outage, SGT3 is disconnected. If SGT1 is also on outage, SGT3 is moved onto the reserve 2 busbar. These actions ensure the 1 + 1 running arrangement is maintained and the autoclose scheme described below can still operate. Similar actions are taken for outages on the main 2 busbar or CB230 (moving feeders to the main 1 busbar, paralleling the reserve busbars and moving SGT3 onto the reserve 2 busbar if SGT2 is in the outage).
- An auto-close scheme is set up to close CB130 for a fault on SGT1 (paralleling the reserve 1 busbar with the main busbars) and closing CB230 for a fault on SGT2 (paralleling the reserve 2 busbar with the main busbars). The auto-close scheme is configured to close CB130 for faults on SGT1/2 during arranged outages on SGT3, main 2 or reserve 2. On the other side, it is configured to close CB230 for faults on SGT2/3 during arranged outages on SGT1. Finally, during arranged outages on main 1, reserve 1 or CB130, faults on SGT1/2 trigger the closing of CB230.

- For arranged outages on CB105 or CB405 at West Burton (the feeder breakers for the 132 kV dual circuit to Worksop and Retford BSPs), Worksop and Retford are transferred into Staythorpe GSP by opening the other circuit breaker (CB105 for CB405 outages and vice versa) and closing the two normal open points at Checkerhouse BSP.
- The 33 kV and 11 kV networks downstream of Worksop and Lincoln Main BSPs are split for arranged outages on the 33 kV bus section couplers (see relevant 33 kV network reports for more details). The 33 kV and 11 kV networks downstream of Lincoln Main BSP are also split for arranged outages on either of its 132 kV bus section couplers (between the main 1 and main 4 132 kV busbars, and between the main 4 and main 2 132 kV busbars).
- For the loss of an infeed to a transformer at any of the BSPs fed from West Burton GSP under arranged outages, the lower voltage side CB is opened to prevent back-energisation.

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:

- Constraints have been identified on the 132/33 kV GTs at Lincoln BSP for N-2 outages (the loss of any two GTs).
- The 132/11 kV GTs at Lincoln Local BSP are projected to overload for an arranged or fault outage on either GT by 2034.
- The group load at Lincoln BSP is high enough that there is significant N-2 restoration requirements for the site (for the loss of the two 132 kV circuits from West Burton GSP). Demand can be restored using the 132 kV circuit from Bourne BSP (a small amount of demand could also be restored on the 33 kV network at Metheringham).
- Any constraints on the 33 kV networks downstream of Worksop BSP and Lincoln BSP are covered in the corresponding NDP reports.

2.2 Lincoln Main 132/33 kV Grid 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 studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Lincoln Main GT1, GT2 or GT6 overload	Arranged outage on any GT at Lincoln Main BSP	Fault on a second GT at Lincoln Main BSP	Baseline	Baseline	Baseline	Baseline

Uncertainty under other Distribution Future Energy Scenarios: There are no scenarios under which overloads are seen on any of the GTs at Lincoln Main for N-1 outages. However, significantly higher demand growth is forecast under Leading the Way and Consumer Transformation, which would trigger reinforcement sooner (as operational mitigation would not be able to manage the constraint for as long).

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	Install additional 132/33 kV GTs at Lincoln Main BSP.
2	Rationalise the 33 kV busbars at Lincoln Main BSP.
Operational Mitigation	
3	Transfer demand to the 132/11 kV GTs at Lincoln Local BSP.
4	Split the 33 kV network during arranged outages.
Flexibility Services	
5	Procure flexibility under Lincoln Main BSP.

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 Distribution Network Options Assessment (DNOA) process.

Option 1 – Install additional 132/33 kV GTs at Lincoln Main BSP

Discounted

Capacity released for constraint(s) considered: Up to 114 MVA

New limiting factor for constraint(s) considered: Total GT capacity at Lincoln Main BSP

Detailed description: Adding additional 132/33 kV GTs at Lincoln Main BSP would add capacity and help resolve this constraint. This option may not be feasible due to space limitations at the site, and would not be a strategic choice compared to better utilising the existing GTs as discussed in option 2 below.

Option 2 – Rationalise the 33 kV busbars at Lincoln Main BSP

Viable

Capacity released for constraint(s) considered: Up to a total of 228 MVA

New limiting factor for constraint(s) considered: 132/33 kV GT capacity

Detailed description: The constraint seen at Lincoln Main is for an N-2 loss of two 132/33 kV GTs. As discussed in option 4, the site can be split to mitigate against overloads for subsequent faults. However, the layout of the existing 33 kV busbars does not allow the full capacity of the three GTs to be utilised. By rebuilding the 33 kV switchboard at Lincoln Main, the full capacity of each GT could be unlocked. This would be done by creating two switchboards, each with a GT feeding onto it, and a third GT set up on a three panel board able to feed onto either side of the BSP.

Rebuilding and reconfiguring the 33 kV switchgear at Lincoln Main BSP would free up significant capacity at the site to accommodate future demand growth. It would also improve operability and free up switchboard space to create additional 33 kV feeders.

Option 3 – Transfer demand to the 132/11 kV GTs at Lincoln Local BSP

Discounted

Capacity released for constraint(s) considered: Minimal

New limiting factor for constraint(s) considered: GT capacity at Lincoln Main and Lincoln Local

Detailed description: If demand could be transferred onto the 132/11 kV GTs at Lincoln Local BSP, the 132/33 kV GTs at Lincoln Main BSP would be deloaded, helping to manage this constraint. This option has been discounted for two reasons. Firstly, the 132/11 kV GTs at Lincoln Local BSP are projected to also be constrained as outlined in Section 2.3 of this report. Secondly, it would be difficult to transfer sufficient demand over to the 132/11 kV GTs to materially affect this constraint regardless. This option has been discounted, but options for increasing capacity on the 132/11 kV GTs at Lincoln Local BSP are discussed in Section 2.3.

Option 4 – Split the 33 kV network during arranged outages

Viable

Capacity released for constraint(s) considered: Dependent on splits taken

New limiting factor for constraint(s) considered: Network operability and security of supply

Detailed description: As noted in option 2, for arranged 132/33 kV GT outages at Lincoln Main BSP the downstream 33 kV network can be split to prevent overloads for subsequent faults. These splits include splitting various primaries at 11 kV, and the interconnecting 33 kV circuits between the three busbars as required.

This option is not an adequate long term strategy for managing this constraint, as the existing 33 kV arrangement does not allow the full capacity of the GTs to be utilised (it is not possible to evenly split demand between the remaining GTs for all possible outages). Another significant disadvantage of running the network in this way is that during arranged outages, large amounts of demand would need to be put on single circuit risk (reducing security of supply). While the network can be run safely and securely at present, as demand in the area grows, operational mitigation will become more and more difficult (which at some point will necessitate a more permanent solution).

Option 5 – Procure flexibility under Lincoln Main BSP

Viable

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

Detailed description: Flexibility services could be procured to alleviate the projected overloads on the GTs at Lincoln Main BSP. This could be carried out alongside the operational mitigations discussed in option 4 above. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

Reconfiguring the 33 kV network at Lincoln Main BSP would confer a number of significant network benefits. It would alleviate this constraint by allowing the full capacity of the three 132/33 kV GTs to be utilised. Network operability and security of supply would also be improved. By creating the switchboard space to add new 33 kV feeders, options for resolving the constraint on the 132/11 kV GTs at the nearby Lincoln Local BSP (highlighted in Section 2.3 of this report) would be opened up. This would also facilitate future development of the 33 kV network fed from Lincoln Main BSP (which is discussed in the Lincoln 33 kV report). In the short term, the network can be managed operationally, but this is not a long term solution.

2.3 Lincoln Local 132/11 kV Grid 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
Lincoln Main GT3 or GT4 overload	Arranged or fault outage on GT4 or GT3 at Lincoln Local	None	2034	2034	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: Slight overloads at intermediate cool could be seen under Leading the Way in 2028, but overloads are not projected for any other scenario or season by 2028. Overloads are projected for at least some seasons by 2034 under the lower growth scenarios (System Transformation and 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 the 132/11 kV GTs at Lincoln Local BSP.
2	Build a new 33/11 kV primary.
Operational Mitigation	
3	Utilise the 132/11 kV GT5.
Flexibility Services	
4	Procure flexibility under Lincoln Local BSP.

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 the 132/11 kV GTs at Lincoln Local BSP

Discounted

Capacity released for constraint(s) considered: Minimal

New limiting factor for constraint(s) considered: 11 kV circuit capacity out of Lincoln Local

Detailed description: Uprating the 132/11 kV GTs at Lincoln Local BSP to 30/60/78 MVA 132/11/11 kV units (along with the associated 11 kV busbars required) would alleviate this constraint. Significant capacity would not however be released, as the site would still be limited by the ability to build new 11 kV circuits out to the network. This option has therefore been discounted.

Option 2 – Build a new 33/11 kV primary

Viable

Capacity released for constraint(s) considered: 38 MVA

New limiting factor for constraint(s) considered: Total capacity between the 132/11 kV GTs and the primaries within Lincoln

Detailed description: Building a new 33/11 kV primary (either at Lincoln Main BSP or nearby) with two 20/40 MVA transformers would allow Lincoln Local BSP to be deloaded, alleviating this constraint. This would also bypass the restriction discussed in option 1 of getting new 11 kV circuits out of Lincoln Local BSP. In order to supply a new primary from Lincoln Main BSP, the works discussed in Section 2.2 of this report would need to be carried out first (rationalising the 33 kV switchgear at Lincoln Main). This would be required both to create capacity for transferring load from Lincoln Local, and to allow the required two new 33 kV feeders to be created.

An appropriately located new primary could be used to pick up a significant amount of demand within Lincoln, and could also be used to deload Anderson Lane primary (which is also projected to be constrained as discussed in the Lincoln 33 kV report). This would be subject to an 11 kV study to determine what demand could be transferred over (which would also help inform the optimal location for a new primary).

Option 3 – Utilise the 132/11 kV GT5

Discounted

Capacity released for constraint(s) considered: Minimal

New limiting factor for constraint(s) considered: 11 kV circuit capacity out of Lincoln Local

Detailed description: There is a third 132/11 kV GT (GT5 located at Lincoln Main BSP) which could be utilised to add capacity to Lincoln Local, but doing so would require a new 33/11 kV transformer at Lincoln Main to pick up the dedicated demand which GT5 currently supplies (which in turn would require the rationalisation of Lincoln Main 33 kV as discussed in Section 2.2 of this report). This option has been discounted, because as with option 1, the BSP would still be restricted by the ability to create new 11 kV circuits out of the site.

Option 4 – Procure flexibility under Lincoln Local BSP

Viable

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

Detailed description: Flexibility services could be procured to manage the projected overloads on the 132/11 kV GTs at Lincoln Local BSP. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

Building a new primary substation in the area to deload Lincoln Local BSP has been identified as the optimal reinforcement solution to manage this constraint. The location of this new primary would be determined by what can be achieved at the existing Lincoln Main BSP site, and what other nearby sites could be used (but would need to be relatively close to Lincoln Local / Lincoln Main to effectively transfer demand away without triggering extensive 11 kV works).

This reinforcement would need to be considered in conjunction with the constraint and solutions discussed for Lincoln Main BSP in Section 2.2 of this report, with the aim of creating an effective overall reinforcement strategy to meet the needs of the network in and around Lincoln on an enduring basis. This includes the possibility of deloading Anderson Lane primary (which is also projected to be constrained as discussed in the Lincoln 33 kV report).

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Registered Office: Avonbank, Feeder Road, Bristol BS2 0TB
nationalgrid.co.uk