Bicker Fen GSP

Network Development Report – East Midlands

May 2024

Electricity Distribution

nationalgrid

Contents

Bicker Fen 132 kV

1. Network Overview

Bicker Fen Grid Supply Point (GSP) supplies four Bulk Supply Points (BSPs) in National Grid Electricity Distribution's (NGED's) East Midlands licence area around Sleaford and Grantham in Lincolnshire. These four BSPs are: Grantham, Grantham North 25 kV, Skegness and Sleaford.

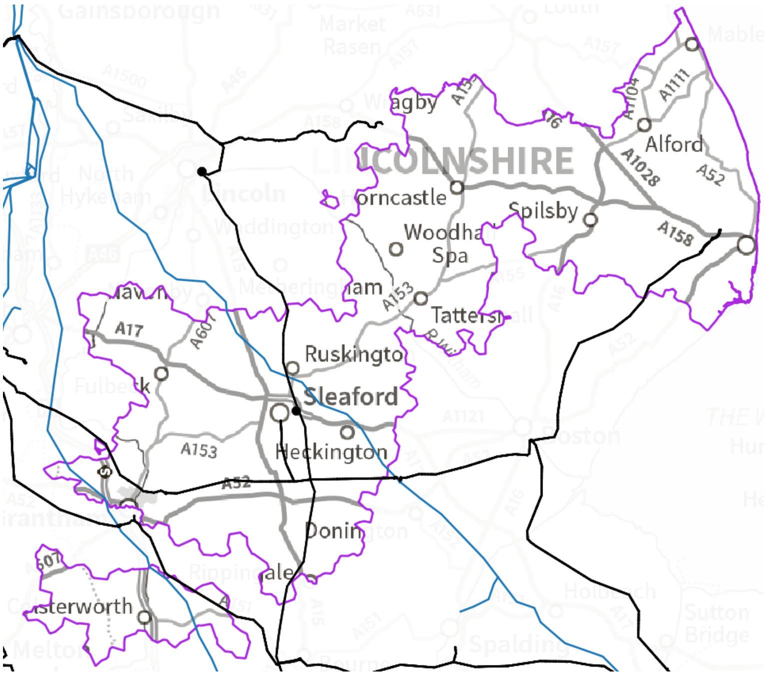

Figure 1.1 Bicker Fen GSP geographic network coverage

This report discusses all existing and future network constraints over a 0-10 year horizon identified on the 132 kV network fed from Bicker Fen 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 Bicker Fen GSP, one of which supplies Skegness BSP via Boston BSP, and the other of which supplies Sleaford, Grantham and Grantham North BSPs. Skegness, Sleaford and Grantham BSPs all have two 132/33 kV Grid Transformers (GTs) each, with Grantham North having two 132/25 kV GTs fed from Bicker Fen.

Bicker Fen is interconnected at 132 kV with two other GSPs: Staythorpe and Walpole. The interconnection with Staythorpe GSP is via normal open points at Grantham North BSP (which has two 132/11 kV GTs fed from Staythorpe). The interconnection with Walpole is via normal open points at Boston BSP (which is fed fully from Walpole under normal running arrangements).

Bicker Fen itself has two 400/132 kV Super Grid Transformers (SGTs) feeding onto a 132 kV double busbar arrangement. The site is run in parallel under normal running arrangements.

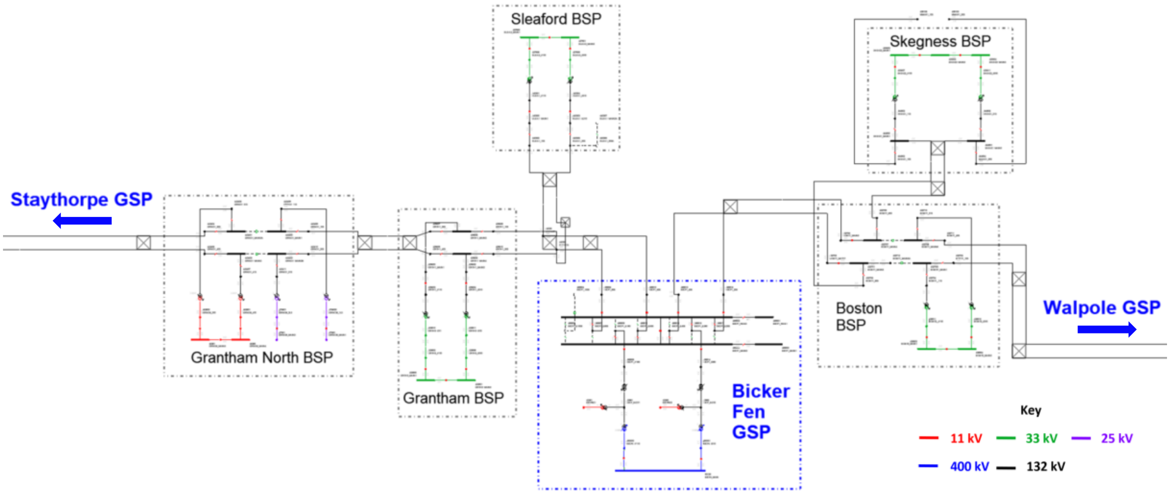

Figure 1.1.1 Bicker Fen 132 kV network single line diagram

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.

- Arranged outages on the 132 kV busbars at Bicker Fen GSP are modelled such that circuits are secured onto in service busbars.
- For arranged outages on either SGT, the 132 kV main 2 or reserve 2 busbars or the bus section breaker at Bicker Fen, or on the 132 kV circuits to Boston BSP, Skegness BSP can be transferred into Walpole by closing the normal open points at Boston. Upon transferring Skegness into Walpole the loose couple at Horncastle primary, between Skegness and Sleaford BSPs, is broken by splitting the site at 11 kV (this loose couple is also split for outages on either GT or infeed to Skegness and Sleaford BSPs).
- For arranged outages on either 132 kV circuit to Grantham BSP, it is transferred along with Grantham North 25 kV into Staythorpe GSP by closing the 132 kV normal open points at Grantham North BSP. For arranged outages on either 132 kV circuit from Grantham to Grantham North, only Grantham North 25 kV is transferred.
- For arranged outages on the 132 kV bus section breaker at Bicker Fen, the 33 kV networks downstream of Sleaford and Grantham BSPs are split.
- For an outage on either 132 kV infeed to (or either GT at) Grantham and Sleaford BSPs, the loose couple between the two sites is broken by splitting Billingborough primary at 11 kV.
- The 33 kV and 11 kV networks downstream of the BSPs fed from Bicker Fen GSP are split for arranged outages on the 33 kV bus section couplers (see relevant 33 kV network reports for more details).
- For the loss of an infeed to a transformer at any of the BSPs fed from Bicker Fen 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:

- The SGTs at Bicker Fen are constrained on generation under N-1 outage conditions (the loss of either SGT). By 2034 demand constraints and intact generation constraints are also projected to arise.
- For a fault or arranged outage on either 132 kV circuit from Bicker Fen GSP to Boston BSP, or from Boston BSP to Skegness BSP, the remaining circuit is projected to overload at times of peak generation by 2028. For the Bicker Fen to Boston circuits overloads are also forecast under intact network conditions.
- By 2034, demand and generation overloads are projected for the 132 kV circuits between Bicker Fen GSP and Sleaford BSP during N-1 outage conditions (the loss of either circuit).
- Overloads identified on the GTs at Skegness and Sleaford BSPs are outlined in the Skegness 33 kV and Grantham and Sleaford 33 kV reports respectively.

2.2 Bicker Fen SGT overloads

Constraint Overview

Generation | Demand

The table below outlines the nature of the network constraints identified in the network analysis. The optioneering for Bicker Fen is focused more on the generation constraint, which is far more onerous (with only slight demand overloads projected in 2034).

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			
Demand			**Winter**	**Int Cool**	**Int Warm**	**Summer**
Bicker Fen SGT1 or SGT2 overload	Arranged or fault outage on either SGT or 132 kV busbar	None	2034	2034	-	-
Generation			**Summer**			
Bicker Fen SGT1 or SGT2 reverse power flow overload	Arranged or fault outage on either SGT or 132 kV busbar	None	Baseline			
Bicker Fen SGT1 or SGT2 reverse power flow overload	None	None	2034			

Uncertainty under other Distribution Future Energy Scenarios: Generation growth within Bicker Fen GSP is driven mainly by a number of large accepted generators.

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 SGTs at Bicker Fen GSP.
2	Establish a new GSP.
3	Install a third SGT at Bicker Fen GSP.
Operational Mitigation	
4	Active Network Management.
5	Utilise the short-term ratings of the SGTs at Bicker Fen GSP.
Flexibility Services	
6	Procure flexibility under Bicker Fen GSP.

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.

A number of the options discussed below involve works on the transmission network and will therefore require a modification application and discussions with National Grid Electricity Transmission (NGET) and National Grid ESO (NGESO) to ensure the optimal solution for the whole system (considering both the distribution and transmission systems) is taken forward.

Option 1 – Uprate the SGTs at Bicker Fen GSP

Viable

Capacity released for constraint(s) considered: Up to 60 MVA (for demand)

New limiting factor for constraint(s) considered: N-2 restoration capacity

Detailed description: Uprating the SGTs at Bicker Fen GSP to 460 MVA units would alleviate this constraint and add significant demand and generation capacity to the site. On the demand side, the new limiting factor for the GSP would become the ability to restore demand for N-2 outages via interconnection with Walpole and Staythorpe GSPs (which would limit the site to 299 MW to maintain compliance with the relevant security of supply standards). For both demand and generation, the site would also still be limited by the capacity of the two outgoing 132 kV dual circuits (constraints on which are covered in Section 2.3 and Section 2.4 of this report).

One concern with the 460 MVA units is the increased fault levels introduced to the network. Installing 460 MVA units may still be viable for Bicker Fen, given that only two SGTs run in parallel, and the site's infrastructure is relatively new. A full fault level assessment is required to determine if 460 MVA SGTs at Bicker Fen would overstress any switchgear on the downstream network (and if not how much fault level headroom would be available).

Option 2 – Establish a new GSP

Viable

Capacity released for constraint(s) considered: Up to 240 MVA

New limiting factor for constraint(s) considered: Total SGT capacity between the two GSPs, and 132 kV interconnection capacity

Detailed description: If a new GSP was built in the area, load could be transferred to deload Bicker Fen GSP and alleviate this constraint. The load which could be transferred out of Bicker Fen, and the 132 kV circuits needed to facilitate this, would be dependent on the location of the new GSP. Further optioneering is required to identify the optimal location for both demand and generation in the area.

A new GSP to the east of Bicker Fen could be used to pick up Boston and Skegness BSPs (and associated generation on the 132 kV circuits), deloading both Bicker Fen and Walpole GSPs. It would also help facilitate reinforcement that could be required for these two BSPs (a new 132 kV infeed or BSP near Skegness, and a new BSP near Boston which are discussed as options in the Skegness 33 kV and Boston 33 kV reports respectively). However, there is a lack of existing 400 kV network to the east of Bicker Fen to facilitate this.

A new GSP near Grantham could be used to transfer out Grantham and Sleaford BSPs, and could also support Staythorpe GSP, which is also heavily constrained as outlined in the Staythorpe 132 kV report. A new site at or near the existing GSP itself would provide the easiest way to directly deload Bicker Fen, but would not alleviate any of the constraints on the 132 kV circuits out to each BSP (which are highlighted in the following sections).

Option 3 – Install a third SGT at Bicker Fen GSP

Discounted

Capacity released for constraint(s) considered: 240 MVA

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

Detailed description: Installing a third SGT at Bicker Fen GSP would significantly increase demand and generation capacity at the site. This reinforcement would also allow for demand restoration during N-2 outages without relying on interconnection to other GSPs (making it preferable to uprating the two existing GSPs in that respect). This option may however not be possible at the existing site due to space constraints.

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: Active Network Management (ANM) is currently being used to manage the generation constraint at Bicker Fen GSP. However, the level of accepted generation in the area is high enough that in the long term reinforcement will be required to manage this constraint.

Option 5 – Utilise the short term ratings of the SGTs at Bicker Fen GSP

Viable

Capacity released for constraint(s) considered: Up to 60 MVA

New limiting factor for constraint(s) considered: Short term ratings and/or N-2 restoration capacity

Detailed description: The SGTs at Bicker Fen GSP are equipped with short-term ratings which allow them to run above their nameplate rating for a short period of time. This allows the control engineers to reconfigure the network (which could include transferring load away on the 132 kV network to other GSPs) before the equipment can be damaged.

This may help to mitigate this constraint but is not a long term solution due to the high demand and generation growth forecast for Bicker Fen.

Option 6 – Procure flexibility under Bicker Fen GSP

Viable

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

Detailed description: Flexibility services could be used to help manage the demand constraint on the SGTs at Bicker Fen GSP, but not the more onerous generation constraint. If ANM is used to manage the generation constraint at Bicker Fen in the short to medium term flexibility could be used to manage the demand constraint until reinforcement can be carried out (the feasibility of this will be assessed as part of the DNOA process).

Solution Recommendation

Further optioneering is required to determine the optimal reinforcement strategy to resolve this constraint. Whether a new GSP is built, or Bicker Fen itself is reinforced, it is likely that significant 132 kV circuit works will be required to accommodate the demand and generation growth projected for the area (some of which are discussed in the following sections of this report). Any reinforcement taken forward would also need to be considered in conjunction with Staythorpe and Walpole GSPs (which Bicker Fen is interconnected with at 132 kV and could benefit from a new GSP near Bicker Fen depending on its location).

2.3 Bicker Fen – Boston – Skegness 132 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 studied year constraint is observed under Best View
			Summer (generation)
Bicker Fen GSP to Boston BSP 132 kV circuit overloads	Fault or arranged outage on the other circuit	None	2028
Bicker Fen GSP to Boston BSP 132 kV circuit overloads	None	None	2028
Boston BSP to Skegness BSP 132 kV circuit overloads	Fault or arranged outage on the other circuit	None	2028

Uncertainty under other Distribution Future Energy Scenarios: Generation growth within Bicker Fen GSP is driven mainly by a number of large accepted generators.

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	Reconductor the 132 kV circuits.
2	Rebuild the 132 kV circuits.
Operational Mitigation	
3	Active Network Management.
Flexibility Services	
4	Procure flexibility under Skegness BSP.

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.

Option 1 – Reconductor the 132 kV circuits

Viable

Capacity released for constraint(s) considered: Up to around 80 MVA

New limiting factor for constraint(s) considered: Boston to Skegness 132 kV circuits

Detailed description: Reconductoring the 132 kV overhead lines between Bicker Fen GSP and Boston BSP, and between Boston BSP and Skegness BSP, would free up some capacity to help alleviate these constraints. There are short sections of 132 kV underground cable which also make up sections of these circuits near each site, but these are already rated significantly higher than the overhead line sections.

The Bicker Fen to Boston overhead lines are being reconductored which will increase their capacity, but the Boston to Skegness 132 kV circuits already have the largest conductors which can be accommodated on the existing towers (so further uprating through reconductoring is not possible).

Option 2 – Rebuild the 132 kV circuits

Viable

Capacity released for constraint(s) considered: Over 100 MVA

New limiting factor for constraint(s) considered: SGT capacity at Bicker Fen GSP

Detailed description: As noted above, reconductoring the existing overhead line circuits with larger conductors can only free up so much capacity. To free up further capacity to accommodate the large amount of generation in the area the tower lines would need to be rebuilt completely. This would be extremely expensive given the lengths of the circuits involved:

- The Bicker Fen to Boston 132 kV dual circuit is around 15.6 km in length, of which around 15.3 km is overhead tower circuit.
- The Boston to Skegness 132 kV dual circuit is around 29.5 km in length, of which around 29.2 km is overhead tower circuit.

To free up the capacity required sections of the 132 kV underground cables may also need uprating.

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: ANM is used to manage constraints on over-committed networks such as the Bicker Fen – Boston – Skegness 132 kV circuits. As with the Bicker Fen SGT constraint outlined in Section 2.2 of this report ANM will be essential in managing the network in the short to medium term. In the longer term reinforcement will be required (options for which are discussed in options 1 and 2 above.

Option 4 – Procure flexibility under Skegness BSP

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

ANM will be used to manage the projected constraints for the Bicker Fen to Boston and Boston to Skegness 132 kV circuits in the first instance. The level of generation projected to connect in the area is also expected to trigger uprating the 132 kV circuits. Reconductoring the overhead lines would free up some capacity relatively economically (but as noted the Boston to Skegness 132 kV circuits cannot be uprated any further through reconductoring). If a full rebuild of the dual circuits is required this would be extremely expensive given the lengths involved. A new GSP in the area could help deload these circuits depending on its location, but this is very early in the optioneering process as highlighted in Section 2.2 of this report.

2.4 Bicker Fen to Sleaford 132 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 in each season under Best View			
Demand			**Winter**	**Int Cool**	**Int Warm**	**Summer**
Bicker Fen to the Sleaford tee 132 kV circuit overloads	Fault or arranged outage on the other circuit	None	2034	2034	-	-
Generation			**Summer**			
Bicker Fen to the Sleaford tee 132 kV circuit overloads	Fault or arranged outage on the other circuit	None	2034			
Sleaford tee to Sleaford BSP 132 kV circuit overloads	Fault or arranged outage on the other circuit	None	2034			

Uncertainty under other Distribution Future Energy Scenarios: Generation growth within Bicker Fen GSP is driven mainly by a number of large accepted generators. On the demand side, this constraint is seen for other seasons by 2034 under the higher growth scenarios (Leading the Way and Consumer Transformation). Falling Short is the only scenario under which no demand overloads are projected to occur by 2034.

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 132 kV circuits.
2	Build a new GSP.
Operational Mitigation	
3	Active Network Management.
Flexibility Services	
4	Procure flexibility under Grantham and Sleaford BSPs.

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.

A number of the options discussed below involve works on the transmission network and will therefore require a modification application and discussions with NGET and NGESO to ensure the optimal solution for the whole system (considering both the distribution and transmission systems) is taken forward.

Option 1 – Uprate the 132 kV circuits

Viable

Capacity released for constraint(s) considered: Around 80 MVA

New limiting factor for constraint(s) considered: New overhead line ratings

Detailed description: Uprating the 132 kV circuits from Bicker Fen GSP to Sleaford BSP (before and after the Sleaford tee) would alleviate this constraint, adding capacity to the area for the projected demand and generation growth. The largest conductors which could be accommodated on the existing towers would give a winter rating of just over 200 MVA, which is sufficient for most of the demand growth at Grantham and Sleaford BSPs for the foreseeable future.

Rebuilding the tower lines would allow far more capacity to be released, but would be extremely expensive (the Bicker Fen to the Sleaford tee and Sleaford tee to Sleaford 132 kV circuits are around 11.6 km and 6.6 km in length respectively).

Option 2 – Build a new GSP

Viable

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

New limiting factor for constraint(s) considered: Total capacity between the two GSPs

Detailed description: The possibility of building a new GSP to deload Bicker Fen is briefly discussed in Section 2.2 of this report. If this new GSP were located to the west of Bicker Fen (near Grantham) then Grantham, Grantham South and Sleaford BSPs could be transferred into it (deloading the constrained circuits from Bicker Fen). Reinforcement strategies for Bicker Fen GSP are early in the optioneering process, and the extent to which a new GSP would deload these circuits would be dependent on how it is stitched into the existing 132 kV network.

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 on the Grantham / Sleaford network would be included in an ANM scheme. This option could help manage the projected generation constraint, but not the projected demand constraint.

Option 4 – Procure flexibility under Grantham and Sleaford BSPs

Viable

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

Detailed description: Flexibility services could be procured on the network supplied from Grantham and Sleaford BSPs to alleviate the projected demand overloads seen on the 132 kV circuits from Bicker Fen. Flexibility would not however be suitable for managing the corresponding generation constraint. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

This constraint could potentially be managed with a combination of ANM and flexibility procurement (ANM on the generation side and flexibility on the demand side). Reinforcement would likely involve reconductoring the existing 132 kV circuits. The possibility of building a new GSP in the area has been discussed, and needs to be considered in conjunction with the other distribution constraints outlined in this report (as well as other GSPs, and the transmission network through engagement with NGET and NGESO).

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