Staythorpe GSP

Network Development Report – East Midlands

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Electricity Distribution

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Staythorpe 132 kV

1. Network Overview

Staythorpe Grid Supply Point (GSP) supplies six Bulk Supply Points (BSPs) in National Grid Electricity Distribution's (NGED's) East Midlands licence area in East Nottinghamshire and West Lincolnshire. These six BSPs are: Asfordby, Bourne West GT2, Checkerhouse, Grantham North 11 kV, Grantham South 11 kV and Hawton.

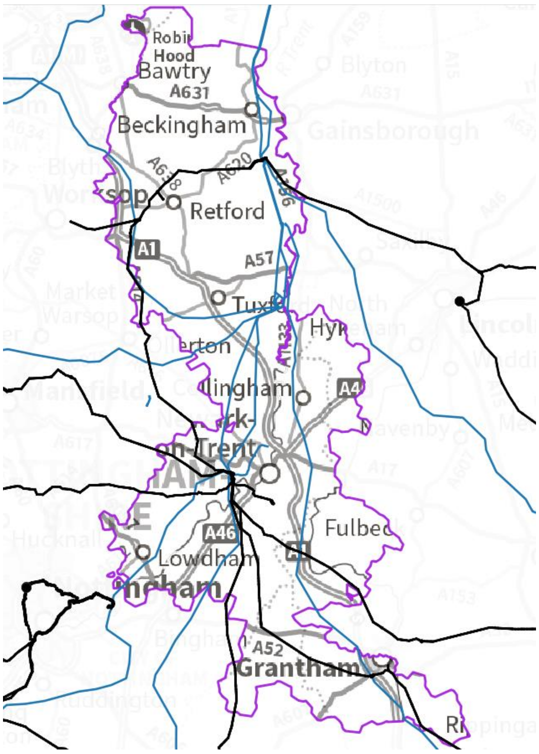

Figure 1.1 Staythorpe GSP geographic network coverage

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

One 132 kV dual circuit directly from Staythorpe C GSP supplies Hawton and Asfordby BSPs, with a second dual circuit going to the Staythorpe B switching station. Checkerhouse BSP, Grantham North 11 kV, Grantham South 11 kV and Bourne West GT2 are all supplied via 132 kV dual circuits from Staythorpe B. Hawton and Checkerhouse BSPs each have two 132/33 kV Grid Transformers (GTs) rated to 45/90/117 MVA. Grantham South and Grantham North BSPs each have two 132/11 kV GTs rated to 15/30/39 MVA.

Staythorpe itself has two 400/132 kV super grid transformers (SGTs) feeding onto four sections of 132 kV busbar. The site is run in parallel under normal running arrangements. Staythorpe B switching station also has four 132 kV busbars, and is similarly run in parallel.

Staythorpe is interconnected with six other GSPs at 132 kV:

- A 132 kV dual circuit from Checkerhouse BSP (which has two normal open points at Checkerhouse) continues on to West Burton GSP (with tees to Worksop and Retford BSPs).
- The other half of Grantham North BSP (the two 132/25 kV GTs) is fed from Bicker Fen GSP via a 132 kV dual circuit (with tees to Sleaford and Grantham BSPs). The two halves of Grantham North are separated by two normal open points.
- The 132 kV dual circuit which feeds Grantham South BSP continues on to Bourne BSP (with a tee off to Bourne West GT2) which is fed from Walpole GSP. There are two normal open points at Bourne BSP preventing a parallel with Walpole.
- The 132 kV dual circuit which feeds Hawton and Asfordby BSPs continues on to Melton Mowbray BSP (where there are two normal open points) which is fed from Grendon GSP.
- A 132 kV dual circuit to Annesley BSP interconnects Staythorpe with both Willington and Chesterfield GSPs (as Annesley is fed from Chesterfield and has a dual circuit to Stanton and Heanor BSPs which are fed from Willington GSP). Another 132 kV dual circuit to Clipstone BSP also interconnects Staythorpe with Chesterfield GSP. Both of these dual circuits have normal open points at Staythorpe itself.

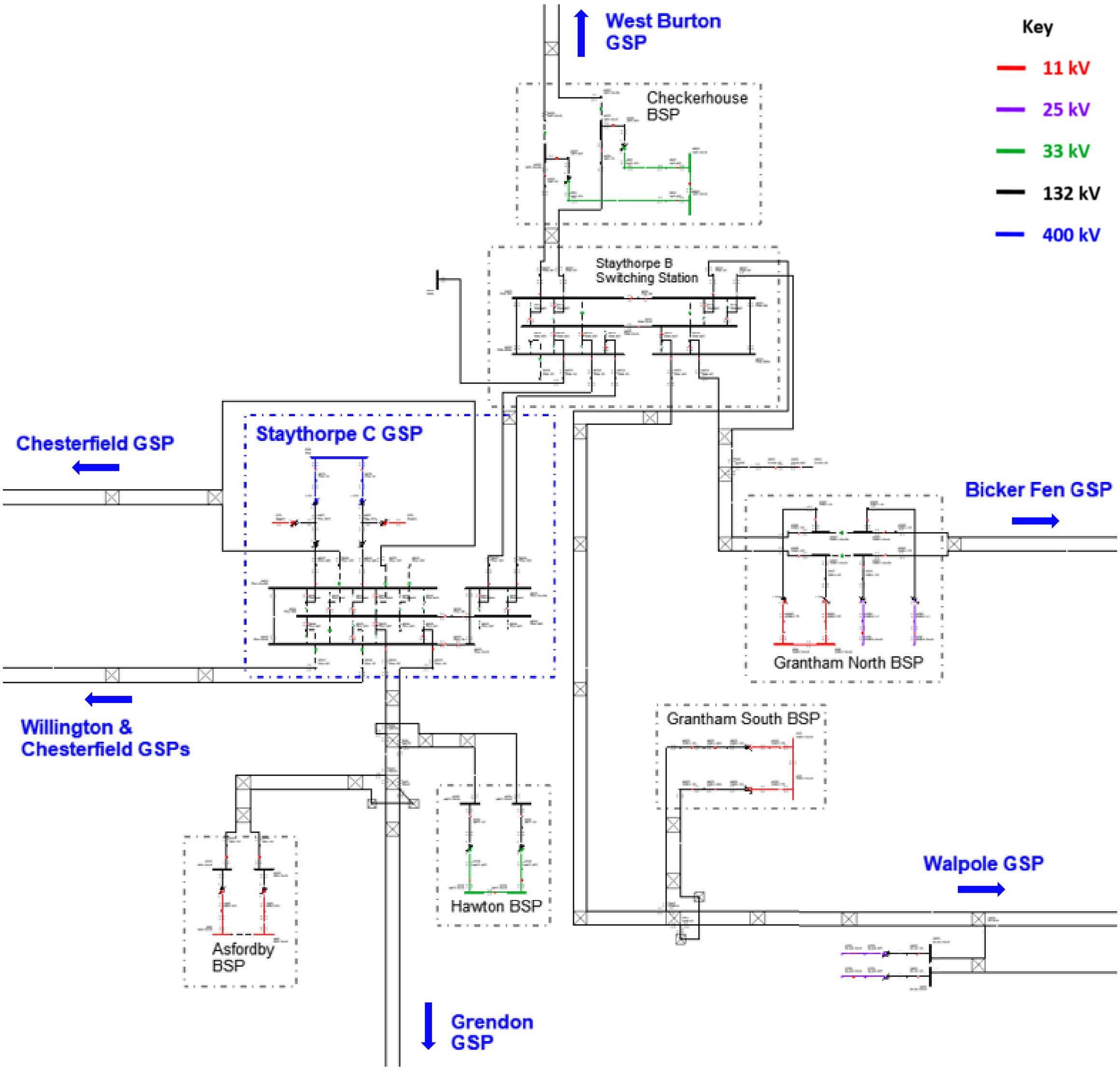

Figure 1.1.1 Staythorpe 132 kV network single line diagram

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 operated now and how it is planned to be operated in the future.

- Arranged outages on the 132 kV busbars at Staythorpe C GSP and the Staythorpe B switching station are modelled such that circuits are secured onto in service busbars.
- For arranged outages on either 132 kV infeed to Grantham North from Staythorpe B, the normal open points at the site are closed and the site is transferred fully into Bicker Fen GSP. Similarly, for outages on either 132 kV infeed to the site from Bicker Fen the normal open points are closed and the site fed fully from Staythorpe.
- For arranged outages on either 132 kV infeed to Grantham South and Bourne West GT2 from Staythorpe B, the normal open points at Bourne BSP are closed to transfer both BSPs fully into Walpole GSP.
- For arranged outages on either 132 kV infeed to Checkerhouse from Staythorpe B, the normal open points at the site are closed and the site is transferred fully into West Burton GSP.
- For an outage on the infeed from Staythorpe or Walpole GSP, Bourne West BSP is fed fully from the other GSP (i.e. for an outage on the circuit from Staythorpe GSP the site is fed fully from Walpole GSP and vice versa).
- The 33 kV and 11 kV networks downstream of Checkerhouse and Hawton BSPs 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 Staythorpe GSP under arranged outages, the lower voltage side circuit breaker 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:

- By 2028, the SGTs at Staythorpe GSP are expected to be constrained for both demand and generation during N-1 outage conditions, for the loss of either SGT. This constraint is exacerbated by the need to transfer Heanor BSP into Staythorpe GSP.
- For the loss of either GT at Hawton BSP, the remaining GT could overload.
- For the loss of either 132 kV circuit to Hawton BSP, the remaining 132 kV circuit from Staythorpe GSP (past the Hawton tee) is forecast to overload by 2028.
- At Checkerhouse BSP, by 2028, overloads are projected to occur on either GT for an arranged or fault outage on the other GT (for both demand and generation).
- The Staythorpe C to Staythorpe B 132 kV circuits are forecast to be constrained for generation under N-1 outages (the loss of either circuit).

2.2 Staythorpe GSP SGT 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			
Demand			**Winter**	**Int Cool**	**Int Warm**	**Summer**
Staythorpe SGT1 or SGT2 overload	Arranged or fault outage on either SGT or 132 kV busbar	None	2028	2028	2028	2028
Staythorpe SGT1 or SGT2 overload (with Heanor BSP transferred)	Arranged or fault outage on either SGT or 132 kV busbar	None	2028	2028	2028	2028
Generation			**Summer**			
Staythorpe SGT1 or SGT2 reverse power flow overload	Arranged or fault outage on either SGT or 132 kV busbar	None	2028			
Staythorpe SGT1 or SGT2 reverse power flow overload	None	None	2028			

Uncertainty under other Distribution Future Energy Scenarios: Similarly high load growth is projected under Consumer Transformation and Leading the Way as under Best View (with both triggering overloads in all seasons by 2028). Even under the lower growth scenarios (System Transformation and Falling Short) significant overloads are projected before 2034 even without the transfer of Heanor into Staythorpe GSP.

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 240 MVA SGTs.
2	Install 460 MVA SGTs.
3	Establish a new GSP.
Operational Mitigation	
4	Utilise the short term ratings of the SGTs at Staythorpe GSP.
5	Transfer load away from Staythorpe GSP.
6	Active Network Management.
Flexibility Services	
7	Procure flexibility under Staythorpe GSP.

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 has been carried out for this constraint as part of the RIIO-ED2 Business Plan (although further optioneering and CBA is required).

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 to ensure the optimal solution for the whole system (considering both the distribution and transmission systems) is taken forward.

Option 1 – Install additional 240 MVA SGTs

Viable

Capacity released for constraint(s) considered: 240 MVA

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

Detailed description: A third SGT could be installed at Staythorpe GSP rated to match the existing two SGTs (240 MVA). This would help alleviate the projected SGT constraint at the site and add significant demand and generation capacity. This new SGT would be installed connected to Staythorpe B, with the site then run with all three SGTs paralleled via the interconnecting 132 kV circuits between Staythorpe B and Staythorpe C.

This reinforcement would facilitate the transfer of Heanor BSP into Staythorpe GSP, which, as discussed in the Willington 132 kV report, would deload the Willington to Derby South and Spondon 132 kV network (resolving constraints on the 132 kV circuits and freeing up capacity at Willington GSP itself).

A third 240 MVA SGT at Staythorpe GSP would resolve the demand and generation constraints projected for the short term. It would not, however, provide sufficient capacity for the site in the longer term. A fourth 240 MVA SGT would likely also need to be installed at some point, which could also be run in parallel. This may however not be possible to achieve within the existing 400 kV site.

Option 2 – Install 460 MVA SGTs

Viable

Capacity released for constraint(s) considered: 60 MVA with two 460 MVA SGTs

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

Detailed description: Replacing the two 240 MVA SGTs at Staythorpe C with 460 MVA units would add significant thermal capacity and resolve this constraint in the short term. The new limiting factor would become the requirement to immediately restore all demand for an N-2 outage for group demands over 300 MW as per Engineering Recommendation P2 and the Security and Quality of Supply Standard (SQSS). Restoring all of the demand at Staythorpe GSP for the loss of both SGTs is likely to be impossible in the long term, given the demand growth forecast for both Hawton and Checkerhouse BSPs and the capacity of the 132 kV interconnection with other GSPs.

Installing three 460 MVA SGTs would resolve the N-2 restoration issue outlined above. However, three 460 MVA SGTs could not be run in parallel based on fault level assessments of the 132 kV network.

Installing four 460 MVA SGTs would allow Staythorpe C and Staythorpe B to be run separately, with normal open points on the interconnecting 132 kV circuits. This would ensure that neither side saw the fault infeed from more than two 460 MVA SGTs, alleviating the fault level constraint noted above. The two sites could then support each other during outages. As with installing a fourth 240 MVA SGT this may not be possible at 400 kV.

Installing 460 MVA SGTs may not add as much capacity as four 240 MVA SGTs, as each side of Staythorpe would still be limited to under 300 MW to retain SQSS compliance.

Further studies are required to assess the feasibility of the various methods of adding capacity to Staythorpe GSP, as doing so would be very beneficial for the overall 132 kV network. One of these methods could involve setting up an autoclose scheme, but this would need studying to ensure it does not create voltage step change issues and that it retains compliance with all relevant security of supply regulations.

Without the ability to run three SGTs in parallel during outage conditions 460 MVA units do not add as much capacity as four 240 MVA units. Another issue is that (with potential transfers also considered) significantly more demand could be fed from Staythorpe C (limiting capacity, which would not be an issue with four 240 MVA SGTs as those would allow the two halves of Staythorpe to be run in parallel).

Option 3 – Establish a new GSP

Capacity released for constraint(s) considered: The demand of Heanor BSP **Viable**

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

Detailed description: By establishing a new GSP in the geographic area between Willington and Staythorpe, Heanor BSP would not need to be transferred into Staythorpe. This would remove the added demand and generation associated with Heanor BSP, and confers a number of other network benefits for Willington, Chesterfield and Staythorpe GSPs.

The location of a new GSP would be subject further optioneering and a full siting strategy, but is likely to be a good strategic choice for the network if it can be achieved. It would not, however, be sufficient alone to alleviate the constraints projected for Staythorpe GSP, because as shown in the table above, the SGTs at Staythorpe are forecast to be constrained even without the transfer of Heanor BSP.

Option 4 – Utilise the short term ratings of the SGTs at Staythorpe GSP

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

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

Detailed description: The SGTs at Staythorpe 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 Staythorpe.

Option 5 – Transfer load away from Staythorpe GSP

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

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

Detailed description: As noted above, Staythorpe is heavily interconnected at 132 kV with other GSPs which could provide the opportunity to transfer demand and/or generation away to help alleviate this constraint.

A number of transfers have been considered (none of which are suitable to effectively manage this constraint):

- Transferring Hawton BSP into Grendon GSP (or a potential future Grendon North GSP) is not feasible due to both the interconnecting 132 kV circuit capacity being insufficient and the fact that it would leave the network non-compliant with Engineering Recommendation P18 by increasing network complexity.
- As with the transfer of Hawton BSP, transferring Checkerhouse BSP into West Burton GSP under normal running arrangements is not possible due to a lack of both 132 kV circuit capacity and addresses under P18. Options for the reconfiguration of the 132 kV network around Checkerhouse, Retford and Worksop BSPs are discussed in Section 2.5 of this report (but none of these options would facilitate a significant enough deloading of Staythorpe GSP).
- Grantham South BSP could not be transferred into Walpole GSP for the same reasons as the two transfers noted above (thermal and network complexity restrictions). Constraints on the Walpole to Bourne 132 kV network are outlined in the Walpole 132 kV report.
- Grantham North BSP could potentially be transferred into Bicker Fen GSP (further studies would be required to confirm this). This transfer would not have a material impact on the SGT constraint at Staythorpe GSP, as it would only transfer around 10 MVA of demand away from Staythorpe.
- Transferring any large 132 kV generators out of Staythorpe BSP would not be possible without also transferring one of the aforementioned BSPs as well (which is not feasible).

Building new 132 kV circuits to allow transfers to be made out of Staythorpe GSP is not feasible or economical due to the distances involved. Some of the transfers listed above may be of use in supporting the network for certain outage conditions, but none (with the possible exception of Grantham North) are possible under normal running arrangements and are therefore of no value in alleviating the SGT overloads highlighted (which occur for N-1 faults).

Option 6 – Active Network Management

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

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

Detailed description: Active Network Management (ANM) schemes are used to manage constraints on over-committed networks such as Staythorpe GSP. ANM is planned to be utilised to manage the generation constraint on the SGTs at Staythorpe, and could potentially also be used to manage the demand constraint. The use of ANM would not be a long term solution for this constraint, but may be essential in managing the network in the short term.

Option 7 – Procure flexibility under Staythorpe GSP

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

Detailed description: Flexibility services could be used to help manage the constraint on the SGTs at Staythorpe GSP. Over a number of flexibility procurement rounds flexibility has been sought in the area, as outlined in the last few DNOA reports. Insufficient flexibility has been procured to fully manage this constraint and defer reinforcement, but ongoing flexibility procurement will be carried out to help meet the needs of the network before one of the reinforcement proposals discussed above can be carried out.

Solution Recommendation

There are a number of options that have been considered to add SGT capacity at Staythorpe GSP. These involve installing either 240 MVA or 460 MVA SGTs at the site, the advantages and disadvantages of which are highlighted in the descriptions above. In summary, while 460 MVA SGTs would provide more thermal headroom, there are a number of associated drawbacks (including increased fault levels).

As noted in option 2, the benefits of increasing the capacity at Staythorpe GSP as much as is practical are clear, warranting further analysis to determine the feasibility of the various potential methods of doing so. More in depth studies, as well as engagement with NGET and NGESO are required (especially given the potential implications for a number of other GSPs aside from Staythorpe itself, such as Chesterfield, Willington, West Burton, Bicker Fen and Walpole GSPs).

In the shorter term a number of options for managing the network before reinforcement can be carried out have been considered. This includes potential load transfers (of which the options are very limited), the use of ANM and the use of flexibility services.

Adding significant capacity to Staythorpe could also free up a number of other options (as the site is very well interconnected at 132 kV with other GSPs):

- The possibility of transferring Bourne BSP into Staythorpe. This option is discussed in the Walpole 132 kV report. This would deload Walpole GSP (or a potential future GSP in the area) and free up 132 kV circuit capacity.
- Transferring BSPs to deload Chesterfield GSP (such as Clipstone BSP and potentially portions of Annesley and/or Mansfield BSPs). These options and their associated benefits are outlined in the Chesterfield 132 kV and Annesley / Mansfield / Clipstone 33 kV reports.
- Being able to better support West Burton and Bicker Fen GSPs during outages. This benefit is of particular importance for Bicker Fen GSP, which only has two SGTs.
- Transferring Heanor BSP from Willington GSP, as already highlighted in option 1 above.

2.3 Hawton BSP GT overloads

Constraint Overview

Generation | **Demand**

The table below outlines the nature of the network constraints identified in the network analysis. N-2 constraints were also identified for arranged outages on the main 2 33 kV busbar at Checkerhouse BSP, which causes additional demand to be transferred into Hawton BSP. These N-2 constraint have been omitted as they could be managed operationally, and N-1 overloads are observed in the baseline regardless so the overall reinforcement strategy is unaffected.

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
Hawton BSP GT overloads	Arranged or fault outage on the other GT or 132 kV infeed	None	2028	Baseline	2028	2028

Uncertainty under other Distribution Future Energy Scenarios: High growth is forecast under every scenario at Hawton BSP between now and 2034. This constraint is exacerbated most significantly under the higher growth scenarios (Leading the Way and Consumer Transformation), and as this constraint is present in the baseline intervention is required regardless of scenario.

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 GTs at Hawton BSP.
2	Install a third 132/33 kV GT at Hawton BSP.
3	Establish a new BSP.
Operational Mitigation	
4	Review seasonal ratings.
Flexibility Services	
5	Procure flexibility under Hawton 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 – Uprate the GTs at Hawton BSP

Discounted

Capacity released for constraint(s) considered: N/A

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

Detailed description: Uprating the 132/33 kV GTs at Hawton BSP would alleviate this constraint. This option is not viable as the GTs are already the highest rating NGED uses on the network as standard. Utilising non-standard equipment creates a number of issues, such as finding replacements if serious faults occur.

Option 2 – Install a third 132/33 kV GT at Hawton BSP

Viable

Capacity released for constraint(s) considered: Dependent on circuit works carried out

New limiting factor for constraint(s) considered: 132 kV circuit capacity (or N-2 restoration capacity once the existing circuits are uprated)

Detailed description: A third GT could be installed at Hawton to resolve this constraint. To allow the capacity of the new GT to be fully utilised, it would be set up such that it can feed onto either of two 33 kV boards (with an existing GT feeding onto each of those boards). This would allow each side to be loaded up to the full capacity of a GT, and the site to be easily split in half for arranged outages on any GT.

The new limiting factor for the site would become the 132 kV circuits to Hawton BSP. As these are similarly rated to the GTs, their uprating will likely be carried out at a similar time. The next limiting factor for the site would become the ability to restore demand for N-2 outage conditions, which will necessitate creating a new 132 kV infeed. These circuit works are discussed in more detail in Section 2.4 of this report.

Option 3 – Establish a new BSP

Discounted

Capacity released for constraint(s) considered: 114 MVA (if the new BSP could be fully utilised)

New limiting factor for constraint(s) considered: Total capacity of both BSPs

Detailed description: Building a new BSP in the area could be used to transfer demand away from Hawton BSP and alleviate this constraint. This option has been discounted, as it would require extensive works at both 132 kV and 33 kV irrespective of where the new BSP is located. This makes this reinforcement prohibitively expensive in comparison to option 2 which, once all required circuit works are complete, would create a similar amount of additional capacity.

There are also no other BSPs in close enough proximity to Hawton to also benefit from a new BSP, with the closest being Grantham BSP at over 20 km away (with no existing 33 kV network to facilitate any transfers). Checkerhouse BSP which is also supplied from Staythorpe GSP and is also projected to be constrained (as discussed in Section 2.5 of this report) would be equally ill served by a new BSP used to deload Hawton, being over 30 km away.

Option 4 – 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 the baseline 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 (as by 2028 overloads are projected for all four seasons).

Option 5 – Procure flexibility under Hawton BSP

Viable

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

Detailed description: Flexibility services could be procured on the network supplied from Hawton BSP to alleviate the projected demand overloads seen on the GTs. This flexibility could potentially also overlap with any procured to manage the constraint on the 132 kV circuits to Hawton BSP outlined in Section 2.4 of this report. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The optimal reinforcement strategy identified to resolve the GT constraint at Hawton BSP is to install a third GT (rated to match the existing two). To be able to utilise the full capacity of this new GT, additional 33 kV busbars will be required. 132 kV circuit works will also be required, the options for which are outlined in Section 2.4 of this report. In the short term, a review of seasonal transformer ratings and/or the use of flexibility services could potentially be used to manage this constraint and defer the need for reinforcement.

2.4 Staythorpe to Hawton 132 kV circuit overloads

Constraint Overview

Generation | Demand

The table below outlines the nature of the network constraints identified in the network analysis. The N-2 condition starting with an arranged outage at Checkerhouse BSP noted in Section 2.3 of this report also causes constraints on the Staythorpe to Hawton 132 kV circuits. As with the GTs these have been omitted as it can be managed operationally and has limited bearing on the overall reinforcement strategy.

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			
			Winter	Int Cool	Int Warm	Summer
Hawton tee to Hawton BSP 132 kV circuit overloads	Arranged or fault outage on the other 132 kV circuit	None	2028	2028	2028	2028

Uncertainty under other Distribution Future Energy Scenarios: The demand growth at Hawton BSP is described in Section 2.3 of this report, and as with the GTs, 132 kV circuit constraints are projected to occur under every scenario.

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 to Hawton BSP.
2	Install a third 132 kV circuit to Hawton BSP.
Flexibility Services	
3	Procure flexibility under Hawton BSP.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA has been carried out for this constraint as part of the RIIO-ED2 Business Plan. This reinforcement will be tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Uprate the 132 kV circuits to Hawton BSP

Viable

Capacity released for constraint(s) considered: Up to 41 MVA

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

Detailed description: Reconductoring the 132 kV circuits from the Hawton tee to Hawton BSP (and uprating the cable sections at the tee tower close to Staythorpe GSP) would resolve this constraint and free up significant circuit capacity for Hawton. This would need to be carried out at a similar time to installing a third GT at the BSP (as described in Section 2.3 of this report), as the existing GTs have a similar rating to the 132 kV circuits (so neither works alone would free up much capacity).

The new limiting factor for the site would become the ability to restore demand for an N-2 outage (the loss of both 132 kV circuits to Hawton). Studies indicate that around 42 MW of demand can be restored via interconnection at 33 kV to other BSPs following such an N-2 event. Any growth above around 140 MW at Hawton BSP could potentially therefore lead to non-compliance with Engineering Recommendation P2 (regarding security of supply). Further reinforcement will therefore be needed to support the long term growth forecast for the area, one option for which is described below.

Option 2 – Install a third 132 kV circuit to Hawton BSP

Viable

Capacity released for constraint(s) considered: A further 86 MVA (assuming the existing circuits have already been uprated, a third GT has been installed and demand is split evenly between the two halves of Hawton)

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

Detailed description: As noted in option 1 above, with a third GT at Hawton BSP and the existing 132 kV circuits form Staythorpe uprated, the new limiting factor for the site would be the ability to restore demand for an N-2 outage. This could be resolved by adding a third 132 kV infeed to the site. The most economical way of achieving this would be to tee a new circuit off one of the existing 132 kV circuits from Staythorpe B to Grantham North BSP (an address has been reserved on this circuit for this purpose).

Option 3 – Procure flexibility under Hawton BSP

Viable

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

Detailed description: Flexibility services could be procured on the network supplied from Hawton BSP to alleviate the projected demand overloads seen on the 132 kV circuits between Staythorpe GSP and Hawton BSP. This flexibility could also overlap with any procured to manage the constraint on the 132 kV circuits to Hawton BSP outlined in Section 2.3 of this report. Beyond this flexibility could not be used to reduce security of supply requirements at Hawton BSP, but could be used to help facilitate the transfers required at 33 kV for demand restoration. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

In order to fully utilise the capacity of the third GT planned to be installed at Hawton BSP (as per Section 2.3 of this report) and resolve this constraint, significant 132 kV works are required. This is likely to be carried out in two phases, by first restringing the existing circuits from the Hawton tee (and uprating the short section of cable), and then adding a third 132 kV circuit teed off one of the circuits to Grantham North at a later date to support N-2 restoration of the site.

2.5 Checkerhouse BSP GT overloads

Constraint Overview

Generation Demand

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

Table 2.5.1 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**
Checkerhouse GT1 or GT2 overload	Fault or arranged outage on either GT at Checkerhouse	None	2034	2028	2028	2034
Generation			**Summer**			
Checkerhouse reverse power flow GT overload	Fault or arranged outage on either GT at Checkerhouse	None	2028			

Uncertainty under other Distribution Future Energy Scenarios: Similar demand growth is forecast under Consumer Transformation as under Best View, with slightly higher growth forecast under Leading the Way (but not high enough to trigger overloads in any other seasons in 2028). Even under Falling Short (which sees the lowest demand growth) a demand constraint is projected to occur by 2034. On the generation side overloads are also triggered for all scenarios by 2034.

Solution Options

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

Table 2.5.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Install a third 132/33 kV GT at Checkerhouse BSP.
2	Establish a new BSP fed from West Burton GSP.
3	Create a Checkerhouse B BSP.
Operational Mitigation	
4	Transfer load to Worksop BSP.
5	Review seasonal ratings.
6	Active Network Management.
Flexibility Services	
7	Procure flexibility under Checkerhouse 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 – Install a third 132/33 kV GT at Checkerhouse BSP

Discounted

Capacity released for constraint(s) considered: N/A

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

Detailed description: Installing a third 132/33 kV GT at Checkerhouse BSP would add both demand and generation capacity to the site and resolve this constraint. This option has been discounted as due to the layout of the site a 132 kV cross bay (which would be required to feed a third GT) could not be built.

Option 2 – Establish a new BSP fed from West Burton GSP

Viable

Capacity released for constraint(s) considered: 114 MVA

New limiting factor for constraint(s) considered: Total capacity of the two BSPs

Detailed description: If a new BSP were built near Checkerhouse (supplied from West Burton GSP), it could be used to deload Checkerhouse by transferring away both demand and generation. A new BSP to the north of Checkerhouse could also reduce 33 kV works required (the development of the 33 kV network fed from Checkerhouse BSP is discussed in detail in the Checkerhouse 33 kV report*). A significant added benefit of this option is that it would transfer both demand and generation away from Staythorpe GSP, which as highlighted in Section 2.2 of this report is projected to be constrained on both counts on its SGTs.

Adding a new BSP fed from West Burton GSP could trigger uprating the existing 132 kV circuits. Another concern is that there are no available addresses on either circuit, so to create a new BSP it would need to be located within walking distance of an existing site (excluding Checkerhouse BSP as it is not fed from West Burton GSP) in order to satisfy Engineering Recommendation P18. This makes finding a site for a new BSP challenging, so this option is only viable if this hurdle could be overcome. Another way of creating the required address for a new BSP fed from West Burton GSP would be transferring Worksop BSP into Staythorpe GSP, as discussed below.

Building new 132 kV circuits from West Burton GSP to unstitch some of the existing sites and free up addresses for a new BSP would be very expensive. It is also not possible to extend West Burton GSP to create additional bays (as it is in indoor site) so this option is not viable.

Option 3 – Create a Checkerhouse B BSP

Viable

Capacity released for constraint(s) considered: 114 MVA

New limiting factor for constraint(s) considered: Total GT capacity between the two Checkerhouse BSPs

Detailed description: By installing two new 132/33 kV GTs at Checkerhouse BSP, a second BSP could be created. This new BSP would be fed from West Burton GSP. Doing so would run into the network complexity limitation outlined in option 2 above. To allow this new BSP to be created, Worksop BSP would therefore need to be transferred into Staythorpe GSP. This could be achieved with some works at Checkerhouse BSP as the tee off to Worksop is located at Checkerhouse itself.

Transferring Worksop BSP into Staythorpe GSP would necessitate uprating the 132 kV circuits between Staythorpe B and Checkerhouse (but these works have already been triggered by accepted connections regardless). It would also add demand and generation to an already constrained Staythorpe GSP, but this would be outweighed by the load transferred over from Checkerhouse to the new Checkerhouse B fed from West Burton GSP. The extent to which this is the case will be dependent on what is transferred over to Checkerhouse B (there would be a lot of flexibility in what is transferred as the two BSPs would be located at the same site, so if required Checkerhouse B could be heavily loaded to reduce the strain on Staythorpe GSP).

Option 4 – Transfer load to Worksop BSP

Discounted

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

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

Detailed description: Transferring demand over to Worksop BSP could be used to reduce loading at Checkerhouse BSP, and the GTs at Worksop could be uprated to 60/90/117 MVA units to facilitate this. This option has been discounted for two main reasons:

- The existing 33 kV interconnection between the two BSPs is insufficient to carry out any meaningful load transfers. New 33 kV circuits would need to be built to facilitate these transfers, which would be expensive given the distance between the two sites.
- Utilising Worksop would not create anywhere near as much capacity as a new BSP which is considered in the options above. Long term growth forecasts indicate significant additional capacity is required in the area, so any assets installed (such as new GTs at Worksop and new 33 kV circuits between the BSPs) would become underutilised when further works are inevitably triggered.

Option 5 – Review seasonal ratings

Viable

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

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

Detailed description: Demand overloads are only seen by 2028 for intermediate cool and intermediate warm. It is therefore possible that the demand constraint could be delayed slightly by reviewing NGED's internal policy regarding transformer ratings, which does not currently distinguish between summer and intermediate cool or intermediate warm ratings (which may be overly pessimistic). This solution is dependent on an internal review and would not be a long term solution (as by 2034 overloads are projected for all four seasons).

Option 6 – 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 Checkerhouse BSP would 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 projected generation constraint at Checkerhouse, but not the projected demand constraint.

Option 7 – Procure flexibility under Checkerhouse BSP

Viable

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

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

Solution Recommendation

Building a new BSP fed from West Burton GSP (most likely located at the existing Checkerhouse BSP site) would add the capacity required for the area to support long term growth of demand and generation. In the shorter term, a review of seasonal transformer ratings, the use of ANM and/or flexibility procurement could potentially be used to manage this constraint.

2.6 Staythorpe C to Staythorpe B 132 kV circuit overloads

Constraint Overview

Generation Demand

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

Table 2.6.1 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)
Staythorpe C to Staythorpe B 132 kV circuit overloads	Arranged or fault outage on the other 132 kV circuit	None	2034

Uncertainty under other Distribution Future Energy Scenarios: The majority of the generation growth forecast within Staythorpe GSP is concentrated within a number of large 132 kV generation connections. The projected connection dates for these generators are largely consistent between the various scenarios.

Solution Options

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

Table 2.6.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Uprate the 132 kV circuits between Staythorpe C and Staythorpe B.
2	Install SGTs at Staythorpe B.
Operational Mitigation	
3	Active Network Management.
Flexibility Services	
4	Procure flexibility on the network downstream of Staythorpe B.

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 132 kV circuits between Staythorpe C and Staythorpe B

Viable

Capacity released for constraint(s) considered: Dependent on the new conductor size

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

Detailed description: Further uprating the 132 kV circuits between Staythorpe C and Staythorpe B will likely not be required in the short to medium term, as they are already being uprated as part of an ongoing reinforcement project. In the long term, it may be necessary to uprate these circuits to support the large amounts of generation expected to connect downstream of Staythorpe B. Uprating these circuits could be carried out at a relatively low cost, as they are under 100 m in length.

Option 2 – Install SGTs at Staythorpe B

Viable

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

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

Detailed description: Installing SGTs at Staythorpe B would not be a cost effective way of resolving just this constraint. However, it may be carried out to increase SGT capacity at Staythorpe as outlined in Section 2.2 of this report, which would have the added benefit of creating a new infeed or infeeds at Staythorpe B and alleviating this constraint. Even with an SGT (or SGTs) at Staythorpe B, these circuits will have a vital part to play in operating the network, such as allowing the two halves of Staythorpe to support each other during outages.

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: Active Network Management (ANM) schemes are used to manage constraints on over-committed networks such as Staythorpe GSP. ANM is planned to be utilised to manage the generation constraint on the SGTs at Staythorpe (as discussed in Section 2.2 of this report), and could potentially be used to manage this constraint as well.

Option 4 – Procure flexibility on the network downstream of Staythorpe B

Discounted

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

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

In the short to medium term, the 132 kV circuits between Staythorpe C and Staythorpe B will not need uprating, as their rating is already being increased as part of an ongoing reinforcement project. In the longer term there may be a strategic advantage to further uprating these circuits, to ensure they are not a limiting factor in the operation of the network. This uprating would need to be considered in conjunction with the options for adding SGT capacity to Staythorpe GSP, and could likely be carried out at a relatively low cost due to the short distance of the circuits.

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