Checkerhouse BSP

Network Development Report – East Midlands

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Electricity Distribution

nationalgrid

Contents

Checkerhouse 33 kV

1. Network Overview

Checkerhouse Bulk Supply Point (BSP) is fed from Staythorpe Grid Supply Point (GSP) in National Grid Electricity Distribution's (NGED's) East Midlands licence area. Checkerhouse BSP is fed from Staythorpe via a dual 132 kV circuit from the Staythorpe B switching station.

Figure 1.1 Checkerhouse 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 Checkerhouse 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

Checkerhouse BSP has two 33 kV busbars fed by two 132/33 kV Grid Transformers (GTs) both rated to 45/90/117 MVA. Checkerhouse BSP feeds ten primary substations: Bevercotes, Checkerhouse, Hallcroft Road, Misson, Misterton, North Wheatley, Ordsall Road, Tuxford, Woodbeck and Carlton-on-Trent T2. Checkerhouse primary is located at the same site as Checkerhouse BSP. Five of the primaries fed from Checkerhouse are single transformer primaries (Checkerhouse, Misterton, North Wheatley, Tuxford and Woodbeck). The other five primaries all have two 33/11 kV transformers each. Misterton, North Wheatley and Misson T2 are all fed via Hallcroft Road primary. Woodbeck is fed via Ordsall Road primary. Carlton-on-Trent T2 is fed via Tuxford primary, which in turn is fed via Bevercotes primary.

Checkerhouse BSP is interconnected with three other BSPs: Worksop, Clipstone and Hawton. The interconnection with Worksop is via a normal open point at 33 kV at Manton primary. The interconnection with Clipstone is also via a normal open point at 33 kV (in this case at Ollerton primary). The interconnection with Hawton BSP is via Carlton-on-Trent primary, which is normally run open at both 33 kV and 11 kV.

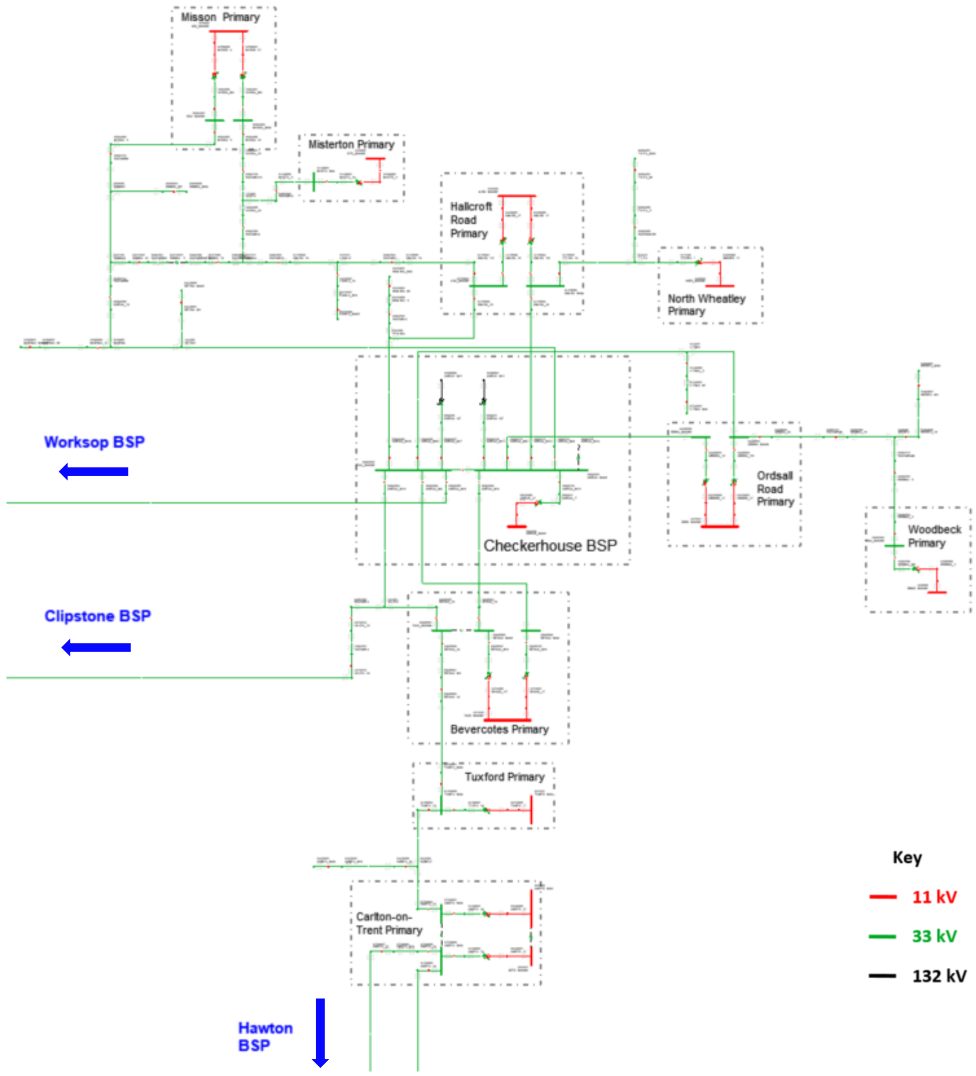

Figure 1.1.1 Checkerhouse 33 kV network single line diagram

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, as well as proposed actions to manage some constraints identified operationally.

- For the loss of an infeed to a transformer at any of the two transformer primaries fed from Checkerhouse BSP under arranged outages, the lower voltage side circuit breaker is opened to prevent back-energisation.
- The 33 kV network downstream of Checkerhouse BSP is split for arranged outages on its 33 kV bus section breaker to prevent loose couples. This involves splitting Bevercotes, Ordsall Road, Hallcroft Road and Misson primaries at 11 kV.
- For an arranged outage on the 33 kV infeed to or the 33/11 kV transformer at North Wheatley primary the load is backfed on the 11 kV network to Misterton primary.
- For an arranged outage on the 33 kV infeed to or the 33/11 kV transformer at Woodbeck primary the load is backfed on the 11 kV network to Tuxford primary.
- For an arranged outage on the 33 kV main 1 busbar at Checkerhouse BSP or the 33/11 kV transformer at Checkerhouse primary the primary's load is backfed on the 11 kV network to Manton and Bevercotes primaries.
- If there is an arranged outage on infeed to Hallcroft Road T2, or on the circuit from Hallcroft Road to the tee point towards Misterton primary then supply can be maintained to Misterton at 33 kV by closing the normal open point on the circuit back towards Checkerhouse main 1.
- For arranged outages on the 33 kV circuit past the tee or on the 33/11 kV transformer at Misterton primary its load is backfed on the 11 kV network to North Wheatley primary. For faults on the transformer or the 33 kV infeed the load is also transferred to North Wheatley via an Automatic Changeover (ACO).
- For arranged outages on the 33 kV infeed to Tuxford primary, Carlton-on-Trent primary can be paralleled at 33 kV to allow Tuxford to be transferred into Hawton BSP.
- For outages on the 33 kV busbar or 33/11 kV transformer at Tuxford primary its load is backfed at 11 kV to Ollerton, Woodbeck and Bevercotes primaries. In future studies the possibility of backfeeding Tuxford at 11 kV for any outages on its 33 kV infeed is also modelled.
- For an outage on the infeed from Checkerhouse or Hawton BSP, Carlton-on-Trent primary is paralleled at 11 kV and 33 kV and fed fully from the other BSP (i.e. for an outage on the circuit from Checkerhouse BSP the site is fed fully from Hawton BSP and vice versa).

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:

- Both of the transformers and the two 33 kV circuits to Hallcroft Road primary are forecast to be overloaded during N-1 outages on the other infeed. Transformer overloads are seen in 2028 and by 2034 circuit overloads are also projected to occur.
- Both generation and demand constraints are projected for the transformer at North Wheatley primary under normal running arrangements by 2034.
- By 2034, an intact demand constraint is projected on the single transformer at Checkerhouse primary.
- The 11 kV backfeed capacity of Woodbeck primary is expected to be insufficient based on demand growth forecasts by 2034.
- Overloads are projected to occur on the transformer at and the 33 kV infeed to Tuxford primary under normal running arrangements. This is expected to occur for demand by 2028, and for generation by 2034.
- Both high and low voltage constraints are observed on the 33 kV network between Tuxford and Carlton-on-Trent primaries.

2.2 Hallcroft Road primary 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
Hallcroft Road primary T1 overloads	Arranged or fault outage on T2 or its 33 kV feeder circuit	None	2028	2028	2028	2034
Hallcroft Road primary T2 overloads	Arranged or fault outage on T1 or its 33 kV feeder circuit	None	2028	2028	2028	2028
Checkerhouse to Hallcroft Road T1 33 kV circuit overloads	Arranged or fault outage on the 33 kV circuit to T2	None	-	2034	-	-
Checkerhouse to Hallcroft Road T2 33 kV circuit overloads	Arranged outage on the Checkerhouse to Hallcroft Road T1 circuit	Fault on the 33 kV circuit from Checkerhouse to Misson	2034	2034	2034	-

Uncertainty under other Distribution Future Energy Scenarios: Similar overloads are observed by 2028 in the higher growth scenarios (Consumer Transformation and Leading the Way). Even under the lower growth scenarios (System Transformation and Falling Short), overloads are observed on the transformers at Hallcroft Road by 2034 (but not on the 33 kV circuits).

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 both transformers and circuits to Hallcroft Road primary.
2	Uprate both transformers at Hallcroft Road and install two new 33 kV circuits.
Operational Mitigation	
3	Alternative running arrangements.
Flexibility Services	
4	Procure flexibility under Hallcroft Road primary.

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 both transformers and circuits to Hallcroft Road primary

Discounted

Capacity released for constraint(s) considered: 26 MVA

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

Detailed description: Uprating both of the transformers at Hallcroft Road primary and both of the 33 kV circuits from Checkerhouse BSP would alleviate this constraint. 20/40 MVA transformers would be required to support the long term demand growth projected for the area (installing smaller units such as 12/24 MVA would not be an enduring solution). Replacing the transformers at Hallcroft Road would also confer an asset condition benefit as the existing units are over 55 years old.

In order to free up the capacity created by installing 20/40 MVA transformers, 33 kV circuit works would also be required. This could involve uprating both of the existing circuits. While the circuit to Hallcroft Road T1 could be uprated somewhat without having to replace the entire length, freeing up capacity on the 33 kV circuit to T2 would require replacing virtually the entire distance. It may therefore be preferable to install new 33 kV circuits as discussed in option 2.

Option 2 – Uprate both transformers at Hallcroft Road and install two new 33 kV circuits

Viable

Capacity released for constraint(s) considered: 26 MVA

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

Detailed description: As in option 1, both transformers at Hallcroft Road primary would be uprated to 20/40 MVA. Instead of uprating the existing 33 kV circuits to then free up full capacity of these new transformers, two new circuits could be built. This would have a number of significant benefits compared with option 1:

- It would allow Hallcroft Road to be unstitched from Misterton and Misson primaries on the T2 side and North Wheatley primary on the T1 side. This would reduce network complexity and improve operability, allowing Hallcroft Road to be supplied by two dedicated feeders.
- It would facilitate the creation of a second 33 kV infeed to North Wheatley primary (which may be required as discussed in Section 2.3 of this report). This could be achieved by oversizing one of the new 33 kV circuits such that it could supply both Hallcroft Road T1 and North Wheatley T2.
- Circuit capacity (both thermally and in terms of addresses under Engineering Recommendation P18) would also be freed up for generation connections, which are common on the network supplied from Checkerhouse BSP.

This reinforcement would require around 8 km of 33 kV circuit works (subject to detailed route investigation and land rights) and would require two new 33 kV breakers at Checkerhouse BSP. Installing 20/40 MVA transformers at Hallcroft Road would be subject to a voltage step change study, as well as further optioneering and detailed network design.

Option 3 – Alternative running arrangements

Discounted

Capacity released for constraint(s) considered: Resolves N-2 constraint

New limiting factor for constraint(s) considered: Transformer and circuit ratings for N-1 outages

Detailed description: A number of operational mitigations could potentially be employed to manage the N-2 constraint described above, which is projected to lead to overloads on the 33 kV circuit to Hallcroft Road T2. As this circuit also supplies Misterton primary and half of Misson primary, the demand at Misterton could be backfed at 11 kV and/or Misson could be split at 11 kV. This would prevent overloads for a subsequent fault. Outages could also be restricted to summer to prevent N-2 overloads.

This option has been discounted as it would not alleviate the projected N-1 constraints on the two transformers and the other circuit. N-1 overloads would be observed on the circuit to Hallcroft Road T2 as well, not far beyond 2034, based on current forecasts. Having to utilise these running arrangements would also reduce network operability and security of supply.

Option 4 – Procure flexibility under Hallcroft Road primary

Viable

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

Detailed description: Flexibility services could be procured to alleviate the projected overloads on the transformers at Hallcroft Road primary, and on the two 33 kV circuits from Checkerhouse. Flexibility will not however benefit the condition of the transformers at the primary. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The optimal reinforcement strategy identified is to uprate both transformers at Hallcroft Road primary to 20/40 MVA units (subject to detailed network design), and to build two new 33 kV circuits from Checkerhouse BSP. This solution will fully resolve the constraints identified and confers a number of other network benefits which are discussed above.

2.3 North Wheatley primary transformer and circuit overloads

Constraint Overview

Generation | Demand

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

Table 2.3.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First year constraint is observed in each season under Best View			
Demand			**Winter**	**Int Cool**	**Int Warm**	**Summer**
North Wheatley transformer overload	None	None	2034	2034	2034	2034
North Wheatley transformer overload	Outage on T1 at Misterton primary	None	2034	2034	2034	2034
Generation			**Summer**			
North Wheatley primary transformer reverse power flow overload	None	None	2034			
Hallcroft Road to North Wheatley 33 kV circuit overload	None	None	2034			

Uncertainty under other Distribution Future Energy Scenarios: Similar demand and generation growth is forecast under the Leading the Way and Consumer Transformation scenarios. The only scenario under which intervention may not be required by 2034 is 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	Install a second transformer and 33 kV circuit to North Wheatley primary.
Operational Mitigation	
2	Active Network Management.
Flexibility Services	
3	Procure flexibility under North Wheatley 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 DNOA process.

Option 1 – Install a second transformer and 33 kV circuit to North Wheatley primary

Viable

Capacity released for constraint(s) considered: 11 MVA

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

Detailed description: Installing two 12/24 MVA transformers at North Wheatley primary (one to replace the existing transformer and one to become T2) would resolve the constraint seen on the existing transformer. A new 33 kV circuit would also be required to feed this transformer.
Generation connected at 33 kV could also be transferred to this new circuit to resolve the projected circuit constraint. If the works discussed in Section 2.2 of this report pertaining to Hallcroft Road primary are carried out this new circuit would only have to be back to that site rather than all the way back to Checkerhouse BSP. This would require around 7 km of circuit works (subject to detailed route investigation and land rights).

This solution would free up significant demand and generation headroom at the primary, and the existing 33 kV circuit would be uprated as required further into the future. 20/40 MVA units have been considered but the additional expenditure required is not justified based on current demand projections. This reinforcement would also ensure security of supply is maintained for Misterton primary (which is backfed to North Wheatley at 11 kV during outages).

Option 2 – Active Network Management

Viable

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

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

Detailed description: Any additional connections at North Wheatley 11 kV could be included in an ANM scheme. ANM schemes are used to manage constraints on over-committed networks. This option could help manage the projected generation constraint at North Wheatley, but not the projected demand constraint.

Option 3 – Procure flexibility under North Wheatley primary

Viable

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

Detailed description: Flexibility services could be procured on the network supplied from North Wheatley primary to alleviate the projected demand overloads seen on the transformer. Flexibility could also be procured on the network supplied from Misterton primary to support it during outages where it is backfed to North Wheatley. Flexibility would not be suitable for managing the reverse power flow constraint projected at North Wheatley. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The optimal long term reinforcement solution to cater for demand growth at North Wheatley is to install two 12/24 MVA transformers at the site and a new 33 kV infeed from Checkerhouse BSP via Hallcroft Road primary. The high generation growth forecast for the area may necessitate enhancing this reinforcement proposal, the justification for which would be assessed as load develops in the area. Reinforcement may be deferred in the first instance by a combination of ANM and flexibility procurement to manage the projected generation and demand constraints respectively.

2.4 Checkerhouse primary transformer 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			
			Winter	Int Cool	Int Warm	Summer
Checkerhouse primary transformer overload	None	None	2034	2034	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: Similar growth is forecast under all four of other the scenarios as under Best View. Even under Falling Short (which sees the lowest demand growth) significant overloads are observed 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	Install a 12/24 MVA transformer at Checkerhouse primary.
2	Install two 12/24 MVA transformers at Checkerhouse primary.
Flexibility Services	
3	Procure flexibility under Checkerhouse primary.

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 12/24 MVA transformer at Checkerhouse primary

Discounted

Capacity released for constraint(s) considered: 4 MVA

New limiting factor for constraint(s) considered: Cyclic rating of the existing transformer

Detailed description: If a second transformer were installed at Checkerhouse primary, rated to 12/24 MVA, the existing transformer would not be required to supply the full demand under normal running arrangements. The full cyclic rating of the transformer could then be used, freeing up some capacity (with the new most onerous outage condition being the loss of the new transformer). While this option is technically viable, it may not be prudent given the rapid demand growth projected for Checkerhouse primary.

If this option were implemented, the capacity created would be rapidly depleted and further intervention required. The existing transformer would then need replacing, and carrying this out as a separate project would involve more outages and resource mobilisation.

Option 2 – Install two 12/24 MVA transformers at Checkerhouse primary

Viable

Capacity released for constraint(s) considered: 14 MVA

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

Detailed description: In contrast to option 1, if two 12/24 MVA transformers were installed in the first instance, this constraint would be resolved and the works could be carried out as part of a single project. The 11 kV switchboard would also need to be replaced. Minimal 33 kV circuit works would be required, as Checkerhouse primary is located at the same site as Checkerhouse BSP. 20/40 MVA transformers have been considered, but are not required based on the demand forecasts for the area (12/24 MVA transformers can comfortably accommodate the projected demand up to 2050).

Option 3 – Procure flexibility under Checkerhouse primary

Viable

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

Detailed description: Flexibility services could be procured to alleviate the projected overloads on the primary transformer at Checkerhouse. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

Installing two 12/24 MVA transformers (and a new 11 kV switchboard) at Checkerhouse primary would resolve this constraint and provide ample headroom for future load growth in the area. Carrying out these works in one project rather than one transformer at a time is likely the optimal solution due to the reduced overall resources required.

2.5 Woodbeck 11 kV backfeed 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 studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Woodbeck – Tuxford 11 kV backfeed overload	Transformer or circuit arranged or fault outage to Woodbeck primary	None	2034	2034	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: Under all of the scenarios, demand growth is forecast to be low up to 2030, followed by a period of rapid growth. While notably lower growth is seen for Falling Short compared to the other four scenarios, the 11 kV backfeeds are still expected to be insufficient to support the site's demand 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 second transformer and circuit to Woodbeck primary.
2	Reinforce the 11 kV network between Woodbeck and Tuxford.
Flexibility Services	
3	Procure flexibility under Woodbeck primary.

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. The optimal reinforcement solution identified will be periodically tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Install a second transformer and circuit to Woodbeck primary

Viable

Capacity released for constraint(s) considered: Dependent on growth at Ordsall Road primary

New limiting factor for constraint(s) considered: 33 kV circuits to Ordsall Road primary

Detailed description: Installing a second 33/11 kV transformer at Woodbeck primary would allow the site to be kept on supply for arranged or fault outages at 33 kV, and remove the reliance on the 11 kV interconnection to Tuxford. This reinforcement would resolve this constraint, but would necessitate creating a second 33 kV infeed to feed this new transformer. This could be achieved by building a new 33 kV circuit between Ordsall Road and Woodbeck primaries.

In the first instance, the new 33 kV construction circuit between Ordsall Road and Woodbeck could be run at 11 kV. This would increase the 11 kV backfeed capabilities of the site and allow extra demand to be accommodated at Woodbeck, without needing to install a second primary transformer straight away. This option, while technically viable, has been discounted, as demand at Woodbeck is projected to increase quickly beyond 2030, so the capacity created by this option would not last long. Installing a second transformer and 33 kV circuit as a single project is likely the most strategic option, but this interim solution could be utilised if demand growth at Woodbeck is slower than anticipated.

The new transformer at Woodbeck would be rated at 7.5/15 MVA to match the existing unit. Increasing the capacity of the site further (such as using 12/24 MVA units) would require replacing the existing transformer as well, and carrying out significant 33 kV works to uprate the circuits from Checkerhouse to Ordsall Road and the existing Ordsall Road to Woodbeck circuit. This additional investment is not justified, as 7.5/15 MVA transformers are sufficient to accommodate demand growth up to 2050 based on current forecasts.

Option 2 – Reinforce the 11 kV network between Woodbeck and Tuxford

Discounted

Capacity released for constraint(s) considered: Up to 3 MVA

New limiting factor for constraint(s) considered: Transformer ratings at Woodbeck and Tuxford primaries

Detailed description: Building more 11 kV circuits between Woodbeck and Tuxford primaries (or uprating the existing ones) would help support both primaries for outage conditions. However, significant capacity would not be released as the transformers at both Woodbeck and Tuxford would limit growth (unless Tuxford is reinforced by the time this constraint arises, as discussed in Section 2.6 of this report). The 11 kV interconnection to other primaries (such as Ordsall Road) could be enhanced, but this would still leave Woodbeck constrained under intact running on its transformer.

This option could be considered to defer the more costly full reinforcement outlined in option 1, but is not an enduring solution and any capacity created would be very quickly used up based on the rapid demand growth forecast beyond 2030 (similarly to the interim solution discussed in option 1).

Option 3 – Procure flexibility under Woodbeck primary

Viable

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

Detailed description: Flexibility services could be procured on the network fed from Woodbeck to alleviate the projected overloads seen on the 11 kV network between Woodbeck and Tuxford primaries during outages. Flexibility could also be procured at Tuxford to help reduce demand on its transformer while it is supplying the demand of Woodbeck if required. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

Installing a second transformer (rated to match the existing unit) at Woodbeck primary, and building a new 33 kV circuit between Ordsall Road and Woodbeck to feed it, is the most strategic and enduring reinforcement solution identified. This will provide sufficient headroom for the demand growth forecast up to 2050 in the area.

2.6 Tuxford primary transformer and circuit overloads

Constraint Overview

Generation | Demand

The table below outlines the nature of the network constraints identified in the network analysis. One of the primaries Tuxford is backfed to under outages is Carlton-on-Trent. This transfer puts the demand at the primary close to its transformer rating.

Table 2.6.1 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**
Tuxford transformer overload	None	None	2028	2028	2034	-
Tuxford transformer overload	Outage on T1 at Woodbeck primary	None	2028	2028	2028	2028
Generation			**Summer**			
Tuxford primary transformer reverse power flow overload	None	None	2034			
Ollerton tee to Bevercotes 33 kV circuit overload	None	None	2034			
Bevercotes to Tuxford primary 33 kV circuit overload	None	None	2034			

Uncertainty under other Distribution Future Energy Scenarios: Higher demand is forecast under the Leading the Way and Consumer Transformation scenarios than under Best View, but not high enough to trigger overloads in any other seasons in 2028. Falling Short is the only scenario under which no demand overloads are forecast to occur by 2028, but overloads are still triggered by 2034. Similarly, on the generation side the lowest growth is forecast under Falling Short, but reverse power flow constraints are still projected to occur by 2034.

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	Install two 12/24 MVA transformers and a new 33 kV circuit from Bevercotes.
2	Alternative 33 kV infeeds.
Operational Mitigation	
3	Active Network Management.
Flexibility Services	
4	Procure flexibility under Tuxford primary.

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 two 12/24 MVA transformers and a new 33 kV circuit from Bevercotes

Viable

Capacity released for constraint(s) considered: 9 MVA

New limiting factor for constraint(s) considered: Existing 33 kV circuit from the Ollerton tee to Bevercotes

Detailed description: Installing two 12/24 MVA transformers at Tuxford primary (one to replace the existing transformer and one to become T2) would resolve the constraint seen on the existing transformer. 12/24 MVA units have been identified as the optimal size to provide the capacity required for long term load growth in the area without being unnecessary and underutilised as 20/40 MVA units would be.

A new 33 kV infeed would also be required to feed a second transformer. This is because, although there are two 33 kV circuits to Tuxford, the circuit from Hawton is unsuitable for this purpose for a number of reasons, including voltage issues (which are discussed in Section 2.7 of this report), thermal constraints which would be created on the 33 kV infeed to Carlton-on-Trent T1 and the fact that it would leave Tuxford straddled across two BSPs.

One way to create a new infeed would be to build a new circuit to Bevercotes primary (which is the closest primary site to Tuxford). This would require around 7 km of circuit works (subject to detailed route investigation and land rights). The 33 kV circuit from Checkerhouse to Bevercotes T1 (which is rated higher than the circuit feeding T2) could then be used to also feed T2 at Tuxford. Although Bevercotes primary is currently not highly loaded, and no constraints have been identified at the site by 2034, long term demand forecasts predict significant growth. Reinforcement of the 33 kV infeeds to Bevercotes may therefore be required in the future. Further capacity could then be released for both primaries quite economically by uprating sections of the circuit to Bevercotes T1 (more than 5 km of which is already rated to over 40 MVA). If the uprating of the 33 kV circuit to T2 were also triggered by demand growth at Bevercotes, a new circuit could be laid, and the existing circuit then used as a dedicated infeed to Tuxford.

A new 33 kV circuit to Tuxford would improve the voltage regulation for this area of network, helping to resolve the voltage constraint discussed in Section 2.7 of this report. It would also stop Tuxford from relying on its 11 kV backfeeds during outages, and could allow it to better support Woodbeck primary (which is also constrained as outlined in Section 2.5 of this report). Despite benefitting Woodbeck, this reinforcement is nevertheless insufficient to prevent the need for reinforcement there (as the limiting factor is the 11 kV interconnection). The possibility of reinforcing only one of the two sites and using it to deload the other has been discounted, as it would require significant 11 kV investment which would be wasted as demand growth in the area will eventually necessitate a second transformer at both sites regardless. Adding significant additional demand to either site would also trigger costly investment on the Checkerhouse to Ordsall Road and the Checkerhouse to Bevercotes 33 kV circuits for Woodbeck and Tuxford respectively.

Another benefit of this reinforcement proposal is that it prevents thermal overloads that could occur on the 33 kV infeed to Carlton-on-Trent T1 (which are briefly mentioned above) for outages at Bevercotes. It would also prevent overloads which are projected to occur on the 33 kV circuit from the Ollerton tee to Bevercotes for outages at Carlton-on-Trent primary. These overloads could be managed operationally by backfeeding Tuxford at 11 kV for any 33 kV outages, but being forced to do so would reduce network operability and security of supply.

Option 2 – Alternative 33 kV infeeds

Discounted

Capacity released for constraint(s) considered: Up to 11 MVA

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

Detailed description: A number of alternative ways of creating a 33 kV infeed to Tuxford have been considered to feed a second transformer. These have all been discounted in favour of a new 33 kV circuit to Bevercotes as proposed in option 1 above (based both on the cost and network impacts):

- A new 33 kV circuit from Hawton BSP would need to be well over 20 km in length, making it both prohibitively expensive and unappealing from a voltage regulation perspective. It would also leave Tuxford primary straddled between Checkerhouse and Hawton, which is suboptimal from a network operability perspective. One possible benefit of this option is that it could be used to create a new infeed to Carlton-on-Trent primary, but this possibility is not sufficient to outweigh the significant disadvantages posed.
- A new 33 kV circuit from Ollerton or Thoresby (which are the closest primary sites outside of the Checkerhouse and Hawton networks) would need to be over 9 km in length. This would also create a loose couple with Chesterfield GSP, and exacerbate the network complexity constraint seen on the Clipstone 33 kV network discussed in the Annesley / Mansfield / Clipstone 33 kV report.

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 generation connections at Tuxford 11 kV could be included in an ANM scheme. ANM schemes are used to manage constraints on over-committed networks. This option could help manage the projected thermal generation constraint at Tuxford (and potentially benefit the high voltage constraint discussed in Section 2.7 of this report), but not the projected demand constraint.

Option 4 – Procure flexibility under Tuxford primary

Viable

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

Detailed description: Flexibility services could be procured on the network supplied from Tuxford primary to alleviate the projected demand overloads seen on the transformer. Flexibility would not be suitable for managing the reverse power flow constraint projected at Tuxford. Flexibility may also not be able to meaningfully benefit the low voltage constraint discussed in Section 2.7 of this report. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

Installing two 12/24 MVA transformers at Tuxford would resolve this constraint and provide the demand capacity required for the long term growth forecast in the area. The optimal method of bringing a new 33 kV infeed to the site to feed a second primary transformer is to build a new 33 kV circuit between Bevercotes and Tuxford primaries (with further reinforcement of the Checkerhouse to Bevercotes 33 kV network triggered as required at a later date).

2.7 Tuxford to Carlton-on-Trent 33 kV high and low volts

Constraint Overview

Generation | Demand

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

Table 2.7.1 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**
Low volts on the Tuxford and Carlton-on-Trent network	Outage on the 33 kV circuit from Bevercotes to Tuxford	None	Baseline	Baseline	Baseline	2028
Generation			**Summer**			
High volts on the Tuxford and Carlton-on-Trent network	None	None	Baseline			

Uncertainty under other Distribution Future Energy Scenarios: As described in Section 2.6 of this report, lower demand and generation growth is forecast under Falling Short, and higher load growth is forecast under Leading the Way and Consumer Transformation (which would exacerbate these voltage constraints).

Solution Options

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

Table 2.7.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Build a new 33 kV circuit.
Operational Mitigation	
2	Alternative running arrangements.
Flexibility Services	
3	Procure flexibility under Tuxford and Carlton-on-Trent primaries.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution.

Option 1 – Build a new 33 kV circuit

Viable

Capacity released for constraint(s) considered: Up to 9 MVA

New limiting factor for constraint(s) considered: Voltage constraints under N-1 outage conditions

Detailed description: Building a new 33 kV circuit into this section of network would help improve the voltage regulation and alleviate the high and low voltage constraints seen here. As high volts are an issue on the intact network, this constraint could be present after reinforcement is carried out for N-1 outages. This could potentially be improved if the generation present at 33 kV were transferred over to the new circuit.

A new 33 kV circuit to Tuxford primary would also help resolve the thermal constraint seen there, as discussed in Section 2.6 of this report. A circuit to Bevercotes primary would be sufficient to provide the requisite thermal headroom at Tuxford, but if required to further improve voltage regulation a new circuit could be built directly back to Checkerhouse BSP. This would require additional 33 kV circuit works but would simplify and futureproof the network.

Option 2 – Alternative running arrangements

Discounted

Capacity released for constraint(s) considered: Helps mitigate low voltage constraint only

New limiting factor for constraint(s) considered: High voltage constraint

Detailed description: Backfeeding Tuxford primary at 11 kV during outages on its 33 kV infeed from Checkerhouse could be used to help mitigate the low voltage constraint observed. It would, however, not be suitable for managing the high voltage constraint, which is present under intact network conditions. This constraint could be alleviated by transferring a 33 kV generator into Hawton BSP, but doing so would require Carlton-on-Trent to be paralleled at 33 kV and as such has been discounted. High volts would regardless still be seen for various outages.

Option 3 – Procure flexibility under Tuxford and Carlton-on-Trent primaries

Discounted

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

Detailed description: Flexibility procurement is unsuitable to manage this constraint and defer reinforcement. This is due to the fact that it is voltage driven, and is present for both generation and demand.

Solution Recommendation

Installing a new 33 kV circuit into the area has been identified as the only viable method of improving voltage regulation on this section of network. A new 33 kV circuit to Tuxford (likely from Bevercotes primary) would also serve to increase capacity and resolve the thermal constraints outlined in Section 2.6 of this report.

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