Daventry, Rugby and Pailton BSPs

Network Development Report – East Midlands

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Electricity Distribution

nationalgrid

Contents

Daventry / Rugby / Pailton 33 kV

1. Network Overview

Daventry, Rugby and Pailton Bulk Supply Points (BSPs) are fed from Coventry Grid Supply Point (GSP) in National Grid Electricity Distribution's (NGED's) East Midlands licence area. All three BSPs are supplied through the Coventry – Hinckley – Pailton – Daventry – Rugby 132 kV ring circuits, and run with the 132 kV side normally closed.

Figure 1.1 Daventry and Rugby geographic network coverage

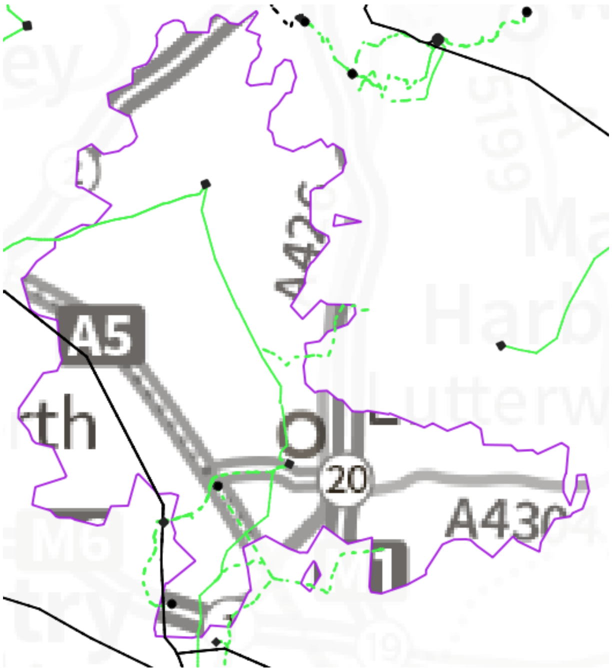

Figure 1.2 Pailton geographic network coverage

This report discusses all existing and future network constraints over a 0-10 year horizon identified on the Grid Transformers (GTs) at, and the 33 kV network supplied from Daventry, Rugby and Pailton BSPs. 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

Daventry BSP is a two 90 MVA, 132/33 kV GT substation. The 33 kV busbar comprises two sections. Daventry BSP supplies seven primary substations: Daventry, Braunston Road, Weedon, Welton, West Haddon, Woodford Halse T2, and Crick T1. Daventry primary is located at the same site as the BSP and comprises two 33/11 kV transformers.

Braunston Road primary is supplied from Daventry BSP via two dedicated 33 kV circuits and comprises 33/11 kV transformers. Weedon is a single transformer primary supplied though a single 33 kV circuit from Daventry BSP. Woodford Halse T2 is supplied through a 33 kV circuit from Daventry BSP, whereas T1 is normally fed from Brackley BSP. The site runs normally open on the 11 kV bus section circuit breaker.

Welton and West Haddon primaries each have a dedicated 33 kV circuit from Daventry BSP, and a shared second 33 kV circuit, which also supplies Crick T1. The remaining transformers at Crick primary are supplied from Rugby BSP, and the site runs normally closed on the 11 kV side. Daventry BSP is interconnected at 33 kV with Rugby BSP through Crick primary, and with Brackley BSP through Woodford Halse primary.

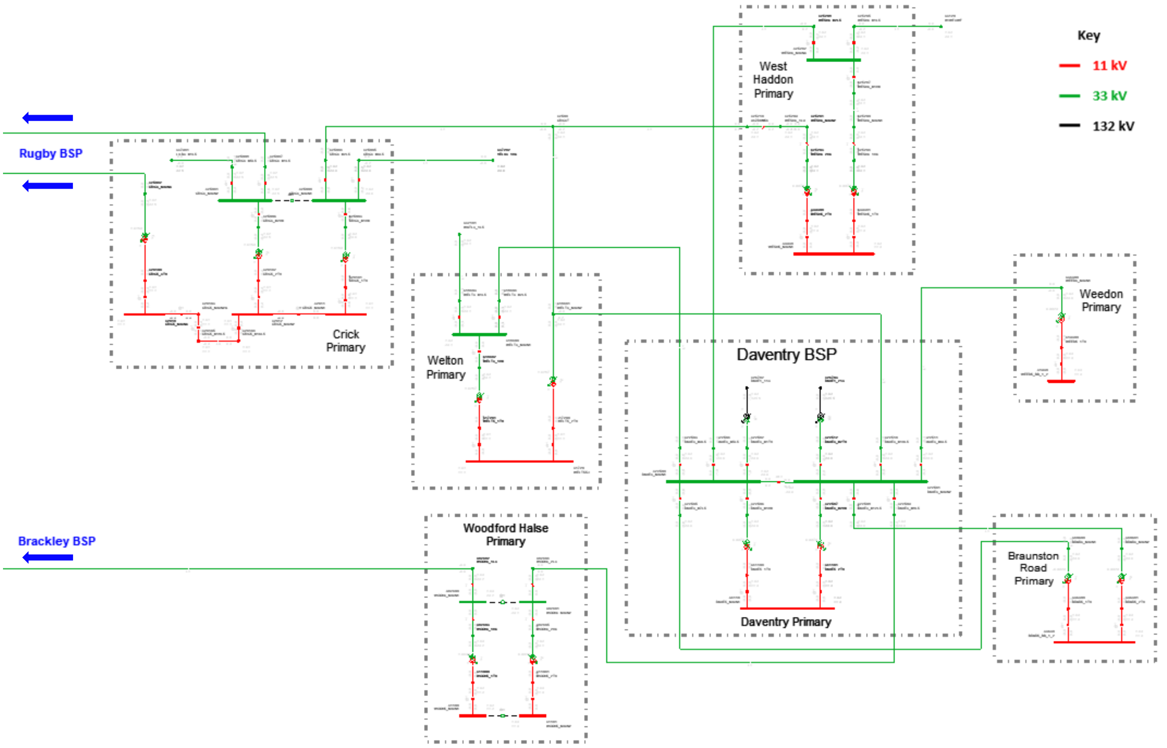

Figure 1.1.1 Daventry 33 kV network single line diagram

Rugby BSP is a two 90 MVA, 132/33 kV GT substation. The 33 kV busbar comprises two sections and is rated at 2000 A. The two sections are connected via a 33 kV bus section circuit breaker, with an alternative cable interconnection as shown in the figure below. Rugby BSP supplies six primary substations: Lawford, Union Street, Brownsover, Hillmorton, Rugby Gateway T1, and Crick T2 and T3.

Brownsover, Union Street, and Lawford primaries are supplied from Rugby BSP via double 33 kV circuits. Lawford and Union Street share their 33 kV circuits with 33 kV connections. Crick (T2/T3) and Hillmorton primaries each have a single 33 kV circuit supplying one of the transformers, and share a 33 kV circuit for the remaining unit.

Rugby Gateway primary T1 is supplied through a dedicated 33 kV circuit from Rugby BSP, whereas T2 is normally fed from Pailton BSP. The site runs normally closed on the 11 kV bus section circuit breaker, and open on the 33 kV side. Rugby BSP is interconnected at 33 kV with Daventry BSP through Crick primary, and with Pailton BSP through Rugby Gateway and Lutterworth primaries.

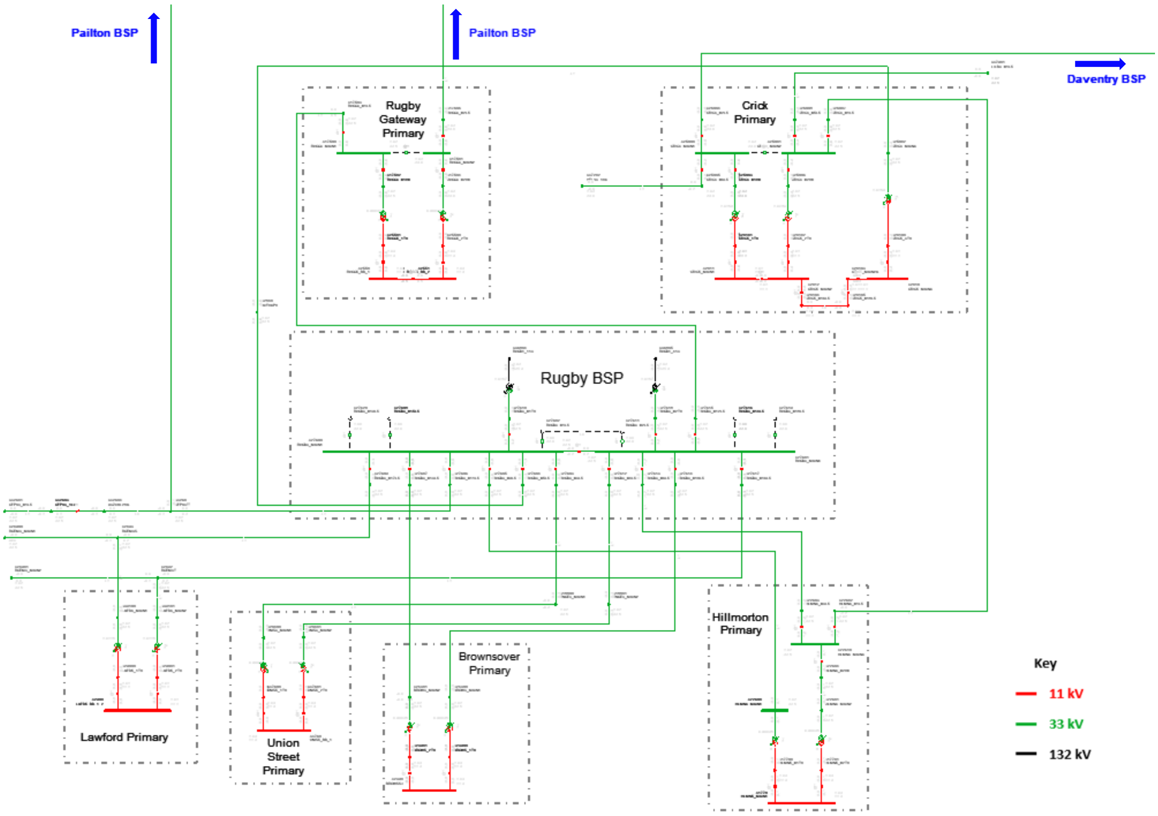

Figure 1.1.2 Rugby 33 kV network single line diagram

Pailton BSP is a two 90 MVA, 132/33 kV GT substation. The 33 kV busbar comprises two sections and is rated at 2000 A. Pailton BSP supplies five primary substations: Churchover, Lutterworth, Magna Park, Sapcote T1, and Rugby Gateway T2. Churchover primary is supplied from Rugby BSP via a pair of 33 kV circuit and 33/11 kV transformers.

Lutterworth primary is supplied via two 33 kV circuits from Pailton BSP, one of which is shared with Sapcote T1. Sapcote primary T2 is supplied from Hinckley BSP, and the site is normally run closed on the 11 kV bus section circuit breaker. The 33 kV circuit supplying Lutterworth T2 can also be used for demand transfers between Pailton BSP and Rugby BSP, since a 33 kV circuit, normally open at Lutterworth, is connecting Lutterworth and Rugby BSPs.

Magna Park primary is supplied via two 33 kV circuits from Pailton BSP, one of which is shared with Rugby Gateway T2. Rugby Gateway primary T1 is supplied from Rugby BSP, and the site is normally run closed on the 11 kV bus section circuit breaker. Pailton BSP is interconnected at 33 kV with Hinckley BSP through Sapcote primary, and with Rugby BSP through Rugby Gateway and Lutterworth primaries.

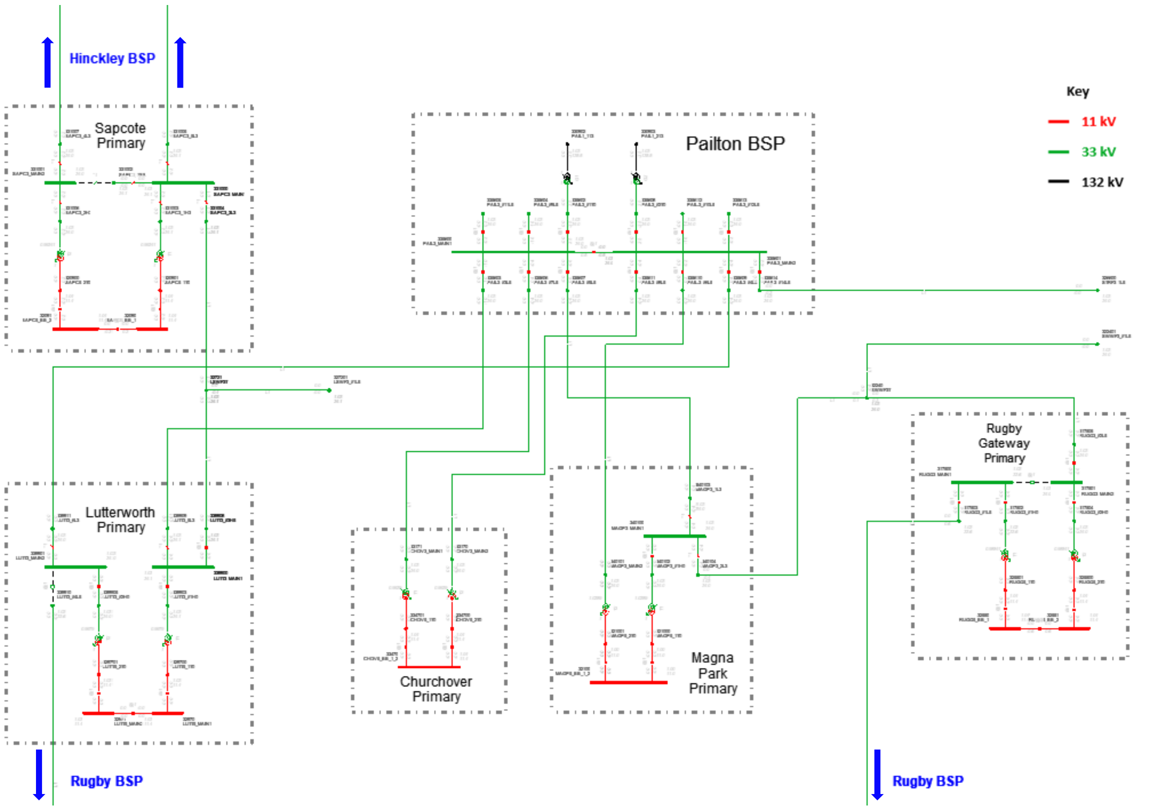

Figure 1.1.3 Pailton 33 kV network single line diagram

1.2 Network Operability Modelling

The following network automation and manual switching schemes have been modelled in the analysis of this area, aligning to how the network is currently operated.

- For arranged outages on any GT at Daventry, Rugby, or Pailton BSPs, or their associated 132 kV infeeds, the lower voltage side circuit breaker is opened to prevent back-energisation.
- For arranged outages on any GT at Daventry, Rugby, or Pailton BSPs, or their associated 132 kV infeeds, the 11 kV bus section circuit breakers at Sapcote, Rugby Gateway, and/or Crick primaries are opened to prevent loose couples.
- For arranged outages on the 33 kV bus section circuit breaker at Daventry BSP, the downstream network is split at 11 kV to prevent loose couples. This involves splitting Daventry, Braunston Road, Welton, West Haddon, and Crick primaries.
- For arranged outages on the 33 kV bus section circuit breaker at Pailton BSP, the downstream network is split at 11 kV to prevent loose couples. This involves splitting Churchover, Lutterworth, Magna Park, Sapcote, and Rugby Gateway primaries.
- For arranged outages on the 33 kV bus section circuit breaker at Rugby BSP, the alternative 33 kV bus section interconnector is used.
- For an arranged outage on a transformer at Daventry, Braunston Road, Welton, West Haddon, Crick, Lawford, Union Street, Brownsover, Hillmorton, Rugby Gateway, Churchover, Lutterworth, Magna Park, and Sapcote primaries, or their associated 33 kV infeed, the lower voltage side circuit breaker is opened to prevent back-energisation.
- For arranged outages on one of the transformers at Crick primary, the site is split at 11 kV to prevent overloading under the next credible fault.
- For an arranged outage on the infeed to, or the transformer at Weedon primary, the demand at Weedon is transferred to Bugbrook and Daventry primaries on the 11 kV network.
- Following the loss of a transformer at Woodford Halse, or the infeed to one of the transformers, the 11 kV bus section circuit breaker is closed to maintain security of supply.

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 transformers at Lutterworth primary overload by 2034, following a planned or unplanned outage on the other transformer or its associated 33 kV infeed.
- Both transformers at Braunston Road primary overload by 2028, following a planned or unplanned outage on the other transformer or its associated 33 kV infeed.
- Both transformers at Lawford primary overload by 2028, following a planned or unplanned outage on the other transformer or its associated 33 kV infeed.
- Both transformers at Daventry primary overload by 2034, following a planned or unplanned outage on the other transformer or its associated 33 kV infeed.
- The 11 kV back-feeding capacity for Weedon primary is projected to be exceeded by 2034.
- The 33 kV circuit between Daventry BSP and Welton primary T2 overloads by 2034 following an N-1 or N-2 event, when required to support demand from Welton, West Haddon, and Crick primaries.
- Both 33 kV circuits between Rugby BSP and Lawford primary overload by 2034 under N-1 conditions, following a planned or unplanned outage on the other.
- Both 132/33 kV transformers at Rugby BSP overload by 2028 for the loss of the other. Under certain N-2 conditions, this is of concern before 2028.

2.2 Lutterworth primary transformer overloads

Constraint Overview

Generation | **Demand**

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

Table 2.2.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Lutterworth primary transformer overloads	Arranged or fault outage on the other infeed or transformer	None	-	2034	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: Under high growth scenarios, Leading the Way and Consumer Transformation, overloads are expected before 2034. Overloads are observed under System Transformation and Falling Short as well, between 2034 and 2050.

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)

Solution Options	Description	Solves Constraint	Wider Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	**Discounted**
Reinforcement					
1	Reinforce both transformers with 20/40 MVA units	✓	×	✓	**Viable**
2	Install third transformer on site	✓	×	×	**Viable**
Operational Mitigation					
3	Transfer demand to other primaries	✓	×	✓	**Viable**
Flexibility services					
4	Procure flexibility under Lutterworth primary	✓	×	✓	**Viable**

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full Cost Benefit Analysis (CBA). This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the Distribution Network Options Assessment (DNOA) process.

Option 1 – Reinforce both transformers with 20/40 MVA units

Viable

Capacity released for constraint(s) considered: up to 5 MVA (winter) / 7 MVA (summer) before circuit works; 15 MVA (winter) / 12 MVA (summer) after 33 kV circuit works

New limiting factor for constraint(s) considered: 33 kV circuits supplying Lutterworth primary

Detailed description: Uprating both primary transformers at Lutterworth to 20/40 MVA units will increase capacity across all seasons from the current 18/23 MVA. The 11 kV switchboard is rated at 1200 A and will therefore also require replacement.

Following transformer and 11 kV switchboard replacement, the primary substation's firm capacity will be approximately 25 MVA summer and 28 MVA winter, limited by approximately 5 km of 33 kV cables from Pailton BSP to Lutterworth T2. This will require reinforcement in order to release more capacity. Additionally, in order to release capacity on the 33 kV circuit that is shared with Sapcote primary, Sapcote would need to be moved into Hinckley on a permanent basis.

Option 2 – Install a third transformer on site

Capacity released for constraint(s) considered: approximately 11 MVA (winter) / 9 MVA (summer), depending on 11 kV arrangement

Viable

New limiting factor for constraint(s) considered: 33 kV circuits supplying Lutterworth primary

Detailed description: Installing a third 33/11 kV transformer at Lutterworth could increase capacity; however, it will require additional works such as a third section of 11 kV switchboard, transferring of 11 kV feeders, and additional 33 kV switching equipment.

There are only two 33 kV circuits feeding Lutterworth from Pailton BSP, and with no third 33 kV section at Pailton, the third transformer at Lutterworth would be supplied from Rugby BSP. This will mean a proportion of the demand at Lutterworth will be transferred into Rugby BSP, where the 132/33 kV transformers are already constrained, as described in Section 2.9.

The capacity released will depend on the 11 kV configuration, and may not be sufficient for long term demand growth. Creating a three transformer primary would also present additional network operability complexity (such as needing to split the 11 kV network for an arranged outage on any transformer).

Given the location of Lutterworth primary substations, space for additional 33 kV switching equipment and an additional transformer will likely be a limiting factor for this solution, subject to a full survey and detailed design.

Option 3 – Transfer demand to other primaries

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

Viable

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

Detailed description: Transferring demand out of Lutterworth primary to adjacent primary substations through the 11 kV network will be assessed as part of a full 11 kV study. This may not be a viable long term solution for constraint management.

Option 4 – Procure flexibility under Lutterworth primary

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

Viable

Detailed description: Flexibility services could be procured to alleviate the projected overloads on the 33/11 kV transformers at Lutterworth primary. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

Installing 20/40 MVA transformers on site would be the optimal long term solution that reduces future expenditure at Lutterworth primary. To release the full capacity of the new transformers, the 11 kV switchboard will require replacement, alongside the reinforcement of approximately 5 km of 33 kV cables and the transfer of Sapcote primary into Hinckley BSP. The works could be undertaken in stages, with the transformers and 11 kV switchboard being the first one. The second stage would involve 33 kV circuit works and the transfer of Sapcote primary.

2.3 Braunston Road primary transformer overloads

Constraint Overview

Generation | Demand

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

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

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Braunston Road primary transformer overloads	Arranged or fault outage on the other infeed or transformer	None	2034	2028	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: Under high growth scenarios, Leading the Way and Consumer Transformation, overloads are expected before 2034. Overloads are observed under System Transformation and Falling Short as well, by or shortly after 2034.

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)

Solution Options	Description	Solves Constraint	Wider Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Reinforce both transformers with 20/40 MVA units	✓	×	✓	Viable
2	Install third transformer on site	✓	×	×	Discounted
Operational Mitigation					
3	Review seasonal ratings	✓	×	✓	Viable
4	Transfer demand to other primaries	×	×	✓	Viable
Flexibility services					
5	Procure flexibility under Braunston Road primary	✓	×	✓	Viable

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 – Reinforce both transformers with 20/40 MVA units

Viable

Capacity released for constraint(s) considered: approximately 15 MVA (winter) / 12 MVA (summer)

New limiting factor for constraint(s) considered: The new transformers and existing 11 kV switchboard at Braunston Road primary

Detailed description: Uprating both primary transformers at Braunston Road to 20/40 MVA units will increase capacity across all seasons from the current 18/23 MVA. The 11 kV switchboard is rated at 1200 A and will therefore also require replacement. The primary substation's new firm capacity will be approximately 30 MVA summer and 38 MVA winter. The existing 33 kV circuits have sufficient capacity to accommodate the entire capacity of the new transformers.

Option 2 – Install a third transformer on site

Capacity released for constraint(s) considered: approximately 11 MVA (winter) / 9 MVA (summer), depending on 11 kV arrangement

Discounted

New limiting factor for constraint(s) considered: Transformer ratings for a planned or unplanned outage at Daventry BSP

Detailed description: Installing a third 33/11 kV transformer at Braunston Road would not materially increase the site's capacity as there are only two 33 kV busbars at Daventry BSP, thus two transformers would need to be fed from a single busbar at Daventry BSP (which would both be lost for a busbar outage).

If a third GT were required at Daventry BSP, then this option could potentially become viable. Either another 33 kV circuit, or additional 33 kV switching equipment and re-configuration will be required at Braunston Road. Creating a three transformer primary would also present additional network operability complexity (such as needing to split the 11 kV network for an arranged outage on any transformer).

Due to all of the above, this option has been discounted.

Option 3 – 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 2028 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 2034 overloads are projected for all seasons).

Option 4 – Transfer demand to other primaries

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

Viable

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

Detailed description: Transferring demand out of Braunston Road primary to adjacent primary substations through the 11 kV network will be assessed as part of a full 11 kV study. This may not be a viable long term solution for constraint management.

Option 5 – Procure flexibility under Braunston Road primary

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

Viable

Detailed description: Flexibility services could be procured to alleviate the projected overloads on the 33/11 kV transformers at Braunston Road primary. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The optimal, long term reinforcement solution recommendation for Braunston Road primary is to install 20/40 MVA transformers and replace the 11 kV switchboard.

2.4 Lawford 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
Lawford primary transformer overloads	Arranged or fault outage on the other infeed or transformer	None	2034	2028	2028	2028

Uncertainty under other Distribution Future Energy Scenarios: Under high growth scenarios, Leading the Way and Consumer Transformation, overloads are expected across three seasons by 2028. Overloads are observed under all scenarios 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)

Solution Options	Description	Solves Constraint	Wider Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	**Discounted**
Reinforcement					
1	Reinforce both transformers with 12/24 MVA units	✓	×	✓	**Discounted**
2	Reinforce both transformers with 20/40 MVA units	✓	×	✓	**Viable**
3	Install third transformer on site	✓	×	×	**Discounted**
Operational Mitigation					
4	Transfer demand to other primaries	✓	×	✓	**Viable**
Flexibility services					
5	Procure flexibility under Lawford primary	✓	×	✓	**Viable**

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 – Reinforce both transformers with 12/24 MVA units

Discounted

Capacity released for constraint(s) considered: up to 1.2 MVA

New limiting factor for constraint(s) considered: The new transformers and existing 11 kV switchboard

Detailed description: Uprating both primary transformers at Lawford to 12/24 MVA units will only marginally increase capacity across all seasons from the current 15/21.8 MVA. However, the new capacity will shortly be exceeded, which means this is not a suitable long term solution. For this reason, this solution has been discounted.

Option 2 – Reinforce both transformers with 20/40 MVA units

Viable

Capacity released for constraint(s) considered: none by 2034 without 33 kV circuit works / up to 11 MVA after Section 2.8 works / up to 16 MVA after additional 33 kV circuit works

New limiting factor for constraint(s) considered: 33 kV circuits supplying Lawford primary

Detailed description: Uprating both primary transformers at Lawford to 20/40 MVA units and replacing the 11 kV switchboard will increase capacity on the transformers significantly. This replacement would also confer an asset condition benefit as the existing transformers are over 60 years old.

In order to release the full capacity of the new transformers, the 33 kV circuits supplying Lawford primary will require reinforcement. These have also been observed as being constrained, and are discussed in more detail further down in Section 2.8, alongside the reinforcement solution which will benefit this constraint.

Following the proposed reinforcement works in Section 2.8, which releases capacity over the section of 33 kV circuit which is shared with a 33 kV connection, the next limiting factor will be the remaining 33 kV circuit to Lawford primary. These reinforcement work can be undertaken at a later stage, as required by additional demand growth in the area.

Option 3 – Install a third transformer on site

Discounted

Capacity released for constraint(s) considered: None

New limiting factor for constraint(s) considered: Transformer ratings for a busbar outage at Rugby BSP

Detailed description: Installing a third 33/11 kV transformer at Lawford primary would not materially increase the site's capacity as there are only two 33 kV busbars at Rugby BSP, thus two transformers would need to be fed from a single busbar at the BSP (which would both be lost for a busbar outage).

If a third GT were required at Rugby BSP, as discussed as an option in Section 2.9, then this option could potentially become viable. Either another 33 kV circuit, or additional 33 kV switching equipment and re-configuration will be required at Lawford primary. However, installing the same size transformers will not provide sufficient capacity for the forecasted loads in 2034, which means that three 20/40 MVA units will be required. This will result in even more expenditure and works than Option 2, which isn't required in the medium term at least. Should demand grow beyond the capacity of two 20/40 MVA transformers, further expansion will be considered at that stage.

Due to all of the above, this option has been discounted for now, but will be considered again at a later stage as required. In the design of Option 2, consideration will be given for this potential future enhancement.

Option 4 – Transfer demand to other primaries

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

Viable

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

Detailed description: Transferring demand out of Lawford primary to adjacent primary substations through the 11 kV network will be assessed as part of a full 11 kV study. This may not be a viable long term solution for constraint management.

Option 5 – Procure flexibility under Lawford primary

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

Viable

Detailed description: Flexibility services could be procured to alleviate the projected overloads on the 33/11 kV transformers at Lawford primary. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The optimal long term reinforcement solution for the constraint at Lawford primary is installing 20/40 MVA transformers, replacing the 11 kV switchboard, and reinforcing the 33 kV circuits as described in Section 2.8. In designing these works, consideration will be given to the future expansion of the substation with an additional 20/40 MVA transformer, if possible.

2.5 Daventry primary transformer 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
Daventry primary transformer overloads	Arranged or fault outage on the other infeed or transformer	None	2034	2034	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: The constraint is observed under all growth scenarios by 2034, across all seasons.

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)

Solution Options	Description	Solves Constraint	Wider Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Reinforce both transformers with 20/40 MVA units	✓	×	✓	Viable
2	Install third transformer on site	×	×	×	Discounted
3	Establish a new primary substation	✓	✓	×	Viable
Operational Mitigation					
3	Transfer demand to other primaries	✓	×	✓	Viable
Flexibility services					
4	Procure flexibility under Daventry primary	✓	×	✓	Viable

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 – Reinforce both transformers with 20/40 MVA units

Capacity released for constraint(s) considered: approximately 11.6 MVA (winter) / 10 MVA (summer)

Viable

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

Detailed description: Uprating both primary transformers at Daventry to 20/40 MVA units and will increase capacity on the transformers from the current 20/26.4 MVA. The 11 kV switchboard will also require reinforcement. The replacement of the transformers at Daventry primary would also confer an asset condition benefit, as the existing units are over 60 years old.

Option 2 – Install a third transformer on site

Discounted

Capacity released for constraint(s) considered: None

New limiting factor for constraint(s) considered: Transformer ratings for a busbar outage at Daventry BSP

Detailed description: Installing a third 33/11 kV transformer at Daventry primary would not materially increase the site's capacity as there are only two 33 kV busbars at Daventry BSP, thus two transformers would need to be fed from a single busbar at the BSP (which would both be lost for a busbar outage).

If a third GT were required at Daventry BSP, then this option could potentially become viable. Either another 33 kV circuit, or additional 33 kV switching equipment and re-configuration will be required at Lawford primary. However, installing the same size transformers will not provide sufficient capacity for the forecasted loads in 2034, which means that three 20/40 MVA units will be required. This will result in even more expenditure and works than Option 1, which isn't required in the medium term at least. Should demand grow beyond the capacity of two 20/40 MVA transformers, further expansion will be considered at that stage.

Due to the above, this option has been discounted for now, but may be considered again at a later stage as required.

Option 3 – Establish a new primary substation

Viable

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

New limiting factor for constraint(s) considered: depending on transfers

Detailed description: A new 20/40 MVA primary substation could be established near Daventry primary, which will enable 11 kV demand transfers from Daventry primary, but also from Braunston Road, which is situated only a few kilometres away. Another factor in determining the new location will be related to the location of the forecasted demand growth area, to ensure the optimal location is secured. Two new 33 kV circuit breakers and 33 kV circuits will be required to the new site

The location of the new primary substation, as well as any new 33 kV circuits, are subject to land purchase and consents. This will also impact costs, making this option more costly than Option 1.

Option 4 – Transfer demand to other primaries

Viable

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

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

Detailed description: Transferring demand out of Daventry primary to adjacent primary substations through the 11 kV network will be assessed as part of a full 11 kV study. This may not be a viable long term solution for constraint management.

Option 5 – Procure flexibility under Daventry 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 33/11 kV transformers at Daventry primary. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The recommended reinforcement solution for the constraint at Daventry primary is installing 20/40 MVA transformers and replacing the 11 kV switchboard. In designing these works, consideration will be given to the future expansion of the substation with an additional 20/40 MVA transformer, if possible.

2.6 Weedon primary 11 kV backfeed overloads

Constraint Overview

Generation | **Demand**

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

Table 2.6.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Insufficient 11 kV backfeed capacity at Weedon primary	Arranged or fault outage on the other infeed or transformer	None	2034	2034	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: The constraint is observed under all growth scenarios by 2034 for the winter season. By 2050, overloads are expected across all seasons even under the lower growth 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)

Solution Options	Description	Solves Constraint	Wider Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Install a second transformer at, and 33 kV circuit to Weedon primary	✓	×	✓	Viable
2	Install additional 11 kV transfer capacity	✓	×	✓	Viable
Operational Mitigation					
3	Transfer demand to other primaries	✓	×	✓	Viable
Flexibility services					
4	Procure flexibility under Weedon primary	✓	×	✓	Viable

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Install a second transformer at, and 33 kV circuit to Weedon primary

Viable

Capacity released for constraint(s) considered: approximately 16 MVA (winter) / 11 MVA (summer)

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

Detailed description: Installing a second transformer at Weedon primary and a new 33 kV circuit from Daventry BSP, which is approximately 6 km away, will significantly increase the substation's firm capacity. A new 33 kV circuit breaker will be required at Daventry BSP to connect the new 33 kV circuit. The length of the new 33 kV circuit is subject to a full route survey and land rights.

Option 2 – Install additional 11 kV transfer capacity

Viable

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

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

Detailed description: Reinforcement of the existing 11 kV network to support additional demand transfers out of Weedon primary under single circuit outage conditions will be assessed as part of a full 11 kV study. This may not be a viable long term solution for the site, especially since some of the nearby substations are also constrained.

Option 3 – Transfer demand to other primaries

Viable

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

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

Detailed description: Transferring demand out of Weedon primary to adjacent primary substations through the 11 kV network will be assessed as part of a full 11 kV study. This may not be a viable long term solution for the site, especially since some of the nearby substations are also constrained.

Option 4 – Procure flexibility under Weedon 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 11 kV back-feeds at Weedon primary. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The optimal, long term reinforcement solution for the constraint at Weedon primary is installing a second 12/24 MVA transformer and a new 33 kV circuit from Daventry BSP. This will provide sufficient capacity at Weedon for beyond 2050, and will enable the possibility of demand transfers from nearby substations into Weedon, which could help mitigate the constraints at Daventry primary. This will also have the additional benefit of releasing capacity at Bugbrook and Daventry primaries, since they will no longer be required to support the demand of Weedon under N-1 outages.

2.7 Daventry – Welton T2 33 kV circuit overloads

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 studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Daventry – Welton T2 33 kV circuit overloads	Arranged outage at Daventry or Rugby, where Crick T1 is supplied fully from Daventry BSP	Fault of Daventry main 1	2034	2034	2034	-

Uncertainty under other Distribution Future Energy Scenarios: The constraint is present when the circuit is required to support the entire demand of Welton, West Haddon and Crick T1, under various outage or restoration scenarios where the loose couples between Daventry and Rugby BSPs need to be broken. This is worse under higher growth scenarios.

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)

Solution Options	Description	Solves Constraint	Wider Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Reinforce the existing 33 kV circuit	✓	✓	✓	Viable
2	Install a new 33 kV circuit to Welton primary	✓	✓	×	Viable
Operational Mitigation					
3	Restrict outage windows	✓	×	✓	Discounted
4	Transfer Crick T1 out of Daventry for any relevant planned outage	✓	×	✓	Viable
Flexibility services					
5	Procure flexibility under Welton and West Haddon primaries	✓	×	✓	Viable

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 – Reinforce the existing 33 kV circuit

Viable

Capacity released for constraint(s) considered: around 15 MVA
New limiting factor for constraint(s) considered: Existing 33 kV overhead line circuit rating

Detailed description: Reinforcing part of the existing 33 kV circuit will increase capacity on this section of network. The 33 kV cable sections are the limiting factor, which account for approximately 3 km of the total circuit length. The 33 kV overhead line circuit can remain in place as it already has large conductors installed. Further upgrading can be considered at a later stage, but this is likely to involve the undergrounding of the overhead line in order to achieve a significant capacity increase.

Option 2 – Install a new 33 kV circuit to Welton primary

Capacity released for constraint(s) considered: The demand at Welton on the existing 33 kV circuit

Viable

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

Detailed description: Installing a new 33 kV circuit between Daventry BSP and Welton primary will help resolve the constraint by unstitching the network, and have the added benefit of increasing capacity more than Option 1 by splitting the network.

The new circuit would feed Welton T2, leaving Welton primary on its own dedicated pair of circuits, and the existing circuit would supply West Haddon and Crick T1, which are expected to grow less over time based on the current forecasts.

Option 3 – Restrict outage windows

Capacity released for constraint(s) considered: None

Discounted

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

Detailed description: Constraint are not expected by 2034 in the summer season, hence consideration of restricting outages to the summer season only have been considered. However, given the combination of outages that can lead to this constraint, and the fact that they span across two BSPs, makes this solution unviable for the medium to long term.

Option 4 – Transfer Crick T1 out of Daventry for any relevant planned outage

Capacity released for constraint(s) considered: The demand at Crick T1

Viable

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

Detailed description: Crick T1 is a contributing factor to this constraint, and not transferring it into Rugby BSP during planned outages off-loads the 33 kV circuit between Daventry BSP and Welton primary T2. To prevent loose couples during planned outages at Daventry or Rugby BSP, the 11 kV side of Crick T1 can be opened instead, which results in the full demand at Crick primary to be supplied from Rugby BSP. However, the GTs at Rugby BSP are already constrained, and this will make the constraint worse. Should the reinforcement at Rugby BSP progress, as described in Section 2.9, it will improve the viability of this solution.

Option 5 – Procure flexibility under Welton and West Haddon primaries

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

Viable

Detailed description: Flexibility services could be procured to alleviate the projected overloads on the 33 kV circuit between Daventry BSP and Welton primary T2. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

It is recommended that the approximately 3 km in length 33 kV cable circuit between Daventry BSP and Welton T2 is reinforced, as this will provide more capacity across all three primary substation without operational limitations. If additional capacity is created at Rugby BSP, it could make Option 4 a viable and cost effective solution for managing this N-2 circuit constraint.

2.8 Rugby – Lawford 33 kV circuit overloads

Constraint Overview

Generation | **Demand**

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

Table 2.8.1 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
Rugby – Lawford 33 kV circuit overloads (both)	An arranged or fault outage on the other circuit, or on either busbar at Rugby BSP	None	2034	2034	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: The constraint is also present under the higher growth scenarios Consumer Transformation and Leading the Way by 2034. In the lower growth scenarios, the constraint occurs between 2034 and 2050.

Solution Options

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

Table 2.8.2 solution options to solve constraint(s)

Solution Options	Description	Solves Constraint	Wider Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Reinforce the existing 33 kV circuits	×	×	✓	Discounted
2	Install two new 33 kV circuits	✓	✓	✓	Viable
Flexibility services					
3	Procure flexibility under Lawford primary	✓	×	✓	Viable

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 – Reinforce the existing 33 kV circuit

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

Discounted

New limiting factor for constraint(s) considered: The new 33 kV circuits

Detailed description: Only the first section of the circuits require reinforcement, between Rugby BSP and the 33 kV tee points on the circuit where a 33 kV customer connects. The route from Rugby BSP to the two 33 kV tee points along the circuit is approximately 2 km in length.

Although reinforcing the existing 33 kV circuits does release some capacity on the network, it is anticipated that this will not be sufficient to accommodate the 2034 demand forecast in the area. The existing circuits already have a high rating, limiting the amount of capacity achievable with bigger standard conductors. This option has been discounted.

Option 2 – Install two new 33 kV circuits

Capacity released for constraint(s) considered: Up to 50 MVA (on the first section) **Viable**

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

Detailed description: Installing two new 33 kV circuits from Rugby BSP to the 33 kV tee points instead and separating the existing circuit into two individual supplies releases significantly more capacity than Option 1. Two new 33 kV circuit breakers will be required at Rugby BSP to supply the new circuits. Lawford primary will be supplied by the new circuits, and its firm capacity will be limited by the transformers and the remaining 1 km from the former tee point to the primary substation. The 33/11 kV transformers have also been identified as constrained (see Section 2.4) and will require reinforcement. It is not anticipated that the second section of 33 kV cables will require reinforcement by 2034. However, should more capacity be required beyond 2034, this can be reinforced at a later stage.

This solution has the added benefit of removing two 33 kV tee joints from the network, which improves network operation and resilience. Through un-stitching, the security of the network is also improved.

Option 3 – Procure flexibility under Lawford 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 33 kV circuit between Rugby BSP and Lawford primary. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The optional long term solution for the 33 kV circuit overload constraint is to install two new 33 kV circuits from two new 33 kV circuit breakers at Rugby BSP, and un-stitch the 33 kV network as described in Option 2. This has multiple benefits and ensures minimal intervention at a later stage should more capacity be required. This solution also supports to release more capacity alongside the transformer reinforcement works at Lawford primary, as described in Section 2.4.

2.9 Rugby BSP transformer overloads

Constraint Overview

Generation | Demand

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

Table 2.9.1 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
Rugby BSP transformer overloads	Arranged or fault outage on the other infeed or transformer	None	2028	2028	2028	2028
Rugby BSP transformer overloads	Arranged outage on Crick T1 or Rugby Gateway T2, or their infeeds	Fault on a GT at Rugby BSP or its infeed	2028	Baseline	Baseline	2028
Rugby BSP transformer overloads	Arranged outage on a GT at Rugby BSP or its infeed Arranged	Fault on Crick T1 or Rugby Gateway T2, or their infeeds	2028	Baseline	Baseline	2028

Uncertainty under other Distribution Future Energy Scenarios: The N-2 constraint is present in the baseline analysis, when Rugby BSP is supplying the entire demand of either Crick or Rugby Gateway primaries, followed by a fault on either GT. By 2028, the constraint is present under N-1 scenarios as well. This is anticipated to be worse under higher growth scenarios.

Solution Options

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

Table 2.9.2 solution options to solve constraint(s)

Solution Options	Description	Solves Constraint	Wider Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Uprate the GTs at Rugby BSP	×	×	×	Discounted
2	Install a third GT at Rugby BSP	✓	×	✓	Viable
Operational Mitigation					
5	Review seasonal ratings	✓	×	✓	Viable
4	Transfer demand out of Rugby BSP permanently	✓	×	×	Discounted
5	Transfer demand out of Rugby BSP when breaking loose couples	✓	×	✓	Viable
Flexibility services					
6	Procure flexibility under Rugby BSP	✓	×	✓	Viable

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Uprate the GTs at Rugby 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 Rugby 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 GT at Rugby BSP

Viable

Capacity released for constraint(s) considered: approximately 40 MVA

New limiting factor for constraint(s) considered: The 132 kV circuits supplying Rugby BSP

Detailed description: In order to increase the capacity at Rugby BSP, a third 132/33 kV transformer can be installed on site. The 33 kV switchboard is already being replaced as part of a separate project due to safety and fault level constraints, and it is designed to accommodate a three GT arrangement.

Option 3 – 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 and intermediate warm. 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 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 2028 overloads are projected for all seasons).

Option 4 – Transfer demand out of Rugby BSP permanently

Discounted

Capacity released for constraint(s) considered: None

New limiting factor for constraint(s) considered: Transformer ratings for a busbar outage at Daventry BSP

Detailed description: Rugby BSP partially supplies two primary substations: Crick and Rugby Gate. These could be moved into their alternative BSPs to off-load Rugby BSP. However, transferring the demand of these two primaries will not be sufficient to bring the loading of the GTs at Rugby within rating. Additional demand would need to be transferred, which will involve installing additional 33 kV circuits to any appropriate substations.

Given that most demand at Rugby is supplied relatively close to the BSP, and that other BSPs are significantly further away, it is anticipated that this solution will not only cost more than Option 1, but will also take additional time to deliver due to the need for new consents for 33 kV circuits. For these reasons, this option has been discounted.

Option 5 – Transfer demand out of Rugby BSP when breaking loose couples

Capacity released for constraint(s) considered: None by 2028

Viable

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

Detailed description: Transferring demand out of Rugby BSP during outage could enable the management of some of the N-2 constraint observed in our baseline analysis. However, the capacity being transferred out will shortly be insufficient to maintain the GTs at Rugby within rating during outages. The N-1 constraint will not be resolved by this solution. Although potentially viable for the short term management of some N-2 constraints, this option will not be suitable for long term network integrity compliance.

Option 6 – Procure flexibility under Rugby BSP

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

Viable

Detailed description: Flexibility services could be procured to alleviate the projected overloads on the 132/33 kV transformers at Rugby BSP (and could be used in conjunction with the operational mitigation options discussed above). The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The optimal reinforcement solution for the constraint at Rugby BSP is installing and additional 90 MVA transformer. In the short term, the N-2 constraint can be managed with operational mitigations as described in Option 3 and Option 5.

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

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