Warwick and Harbury BSPs

Network Development Report – East Midlands

May 2024

Electricity Distribution

nationalgrid

Contents

Warwick and Harbury 33 kV

1. Network Overview

Warwick Bulk Supply Point (BSP) and Harbury BSP is supplied from Berkswell Grid Supply Point (GSP) in National Grid Electricity Distribution's (NGED's) East Midlands licence area.

Figure 1.1 Warwick BSP and Harbury BSP geographic network coverage

This report discusses all existing and future network constraints over a 0-10 year horizon identified on the 33 kV network supplied from Warwick BSP and Harbury BSP. 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

Warwick BSP is fed from Berkswell GSP via 132 kV dual circuits (the CX route). The site has five 33 kV busbars fed by three 132/33 kV Grid Transformers (GTs). Two transformers are rated to 60/78 MVA, and the remaining transformer is rated to 90/117 MVA. Warwick BSP feeds eight primary substations: Banbury Road, Campion Hills, Claverdon, Kenilworth, Lockheed, Princethorpe, Tournament Fields, and Wise Street. All of the primaries fed from Warwick BSP have two 33/11 kV transformers, apart from Princethorpe, which is a single transformer primary.

Reinforcement works for replacing the 33/11 kV transformers at Wise Street with 20/40 MVA units are being progressed. The 33 kV circuits supplying Wise Street are also being reinforced as part of the project. The new ratings have been used in the analysis.

Warwick BSP is interconnected with Coventry West BSP, Whitley BSP and Harbury BSP. Interconnection with Coventry West BSP is via Kenilworth primary and a direct 33 kV circuit. Interconnection with Whitley BSP is via Princethorpe primary. Interconnection with Harbury BSP is via a normally open point at Wise Street primary.

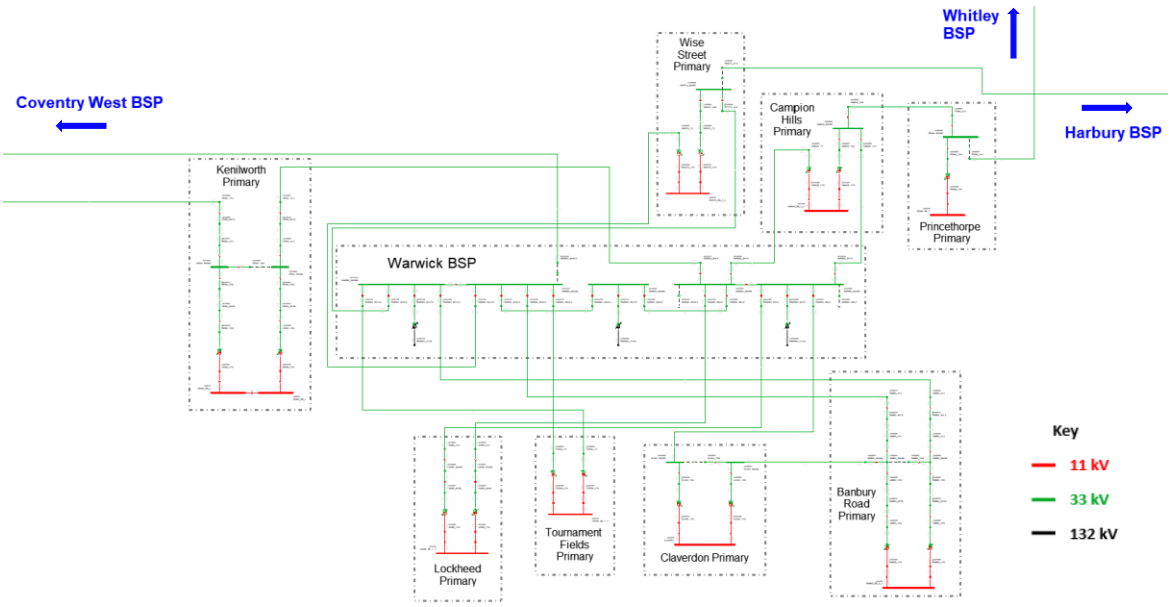

Figure 1.1.1 Warwick BSP 33 kV network single line diagram

Harbury BSP is fed from Berkswell GSP via 132 kV dual circuits (CX and DK route). The site has two 33 kV busbars fed by two 132/33 kV GTs. Both GTs are rated to 90/114 MVA. Harbury BSP feeds five primary substations: Gaydon, Harbury, Southam, Welsh Road Bascote and a dedicated customer site. The only BSP Harbury is interconnected with at 33 kV is Warwick (via Wise Street primary as noted above).

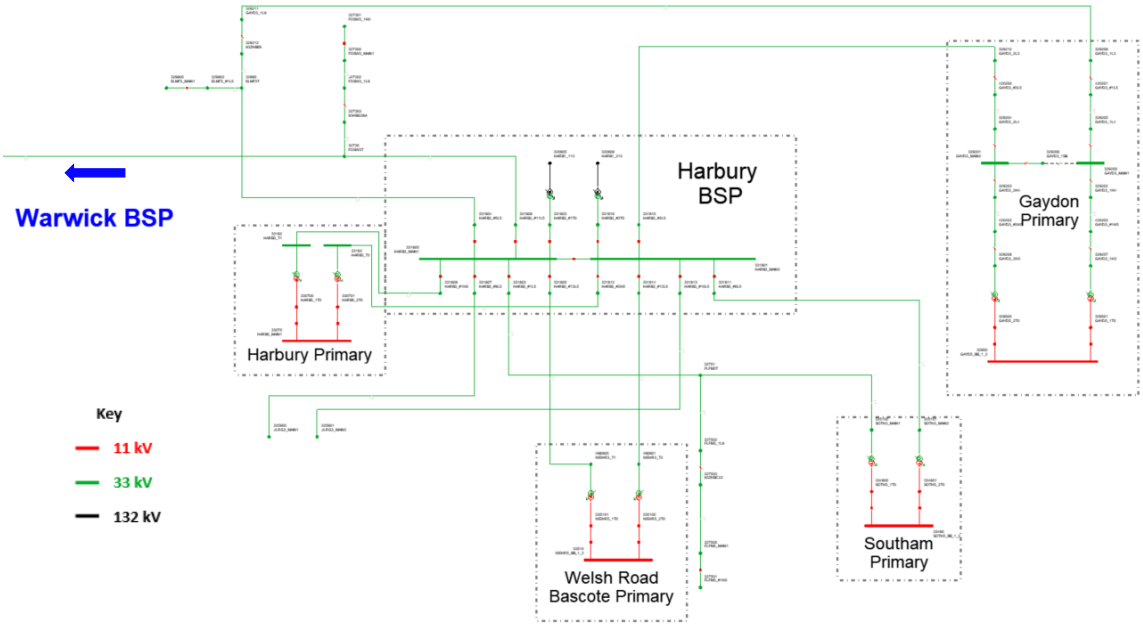

Figure 1.1.2 Harbury BSP 33 kV network single line diagram

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 any arranged outage affecting infeed in to any GT at Warwick BSP or Coventry West BSP, the loose couple at Kenilworth primary is split by opening the 11 kV bus section circuit breaker.
- For arranged outages on any GT at Warwick BSP, 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 Warwick BSP, or their associated 132 kV infeeds, Claverdon primary is split at 11 kV to prevent loose couples.
- For an arranged outage on an infeed to, or a transformer at any of the primaries, the lower voltage side circuit breaker is opened to prevent back-energisation.

2. Network Constraint Details 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 and 33 kV circuits to at Kenilworth primary are projected to overload by 2028, following a planned or unplanned outage on the other transformer or its associated 33 kV infeed.
- Both transformers and 33 kV circuits to at Gaydon primary are projected to overload by 2028, following a planned or unplanned outage on the other transformer or its associated 33 kV infeed.
- Demand growth at Princethorpe primary is expected to take the site beyond the capacity of its 11 kV backfeeds to Southam primary by 2028.
- Forecast demand growth at Princethorpe and Campion Hills primaries results in overloads of the Warwick to Campion Hills 33 kV circuit by 2034.
- Transformers and 33 kV circuits in the 33 kV ring supplying Banbury Road and Claverdon primaries overload from 2028, following planned or unplanned outages on the other transformers or associated 33 kV infeeds.

2.2 Kenilworth primary transformer and 33 kV circuit overloads

Constraint Overview

Generation **Demand**

Kenilworth primary is a 33/11 kV site fed via one circuit from Warwick BSP and another from Coventry West BSP. It runs with the 33 kV isolators between transformers normally open but with the 11 kV bus section breaker closed to form a loose couple between Coventry West and Warwick BSPs. The site and consists of two primary transformers each rated 15/21 MVA and commissioned in 1962.

The primary is currently Class C under Engineering Recommendation P2, expected to become Class D by 2033 following a steep increase in demand, mostly due to significant developments around the south of Kenilworth. The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season, although this would be heavily dependent on the new developments in the area.

Table 2.2.1 constraint(s) and condition under which constraint occurs

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
Kenilworth primary transformer overloads	Arranged or fault outage on the other infeed or transformer	None	2028	2028	2028	2028
Kenilworth – Warwick and Kenilworth – Coventry West 33 kV circuit overloads	Arranged or fault outage on the other infeed	None	2028	2028	2028	2028

Uncertainty under other Distribution Future Energy Scenarios: The constraint is present under all scenarios between 2026 and 2028.

Solution Options

A list of each of the options considered for this constraint is given in the table 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 existing 33 kV transformers and circuits	✓	×	✓	**Viable**
2	Establish new primary substation	✓	✓	✓	**Viable**
Operational Mitigation					
3	Transfer demand to other primaries	✓	×	✓	**Viable**
Flexibility services					
4	Procure flexibility at Kenilworth 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 existing 33 kV transformers and circuits

Capacity Released for constraint(s) considered: 19 MVA

Viable

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

Detailed description: Reinforcing the existing 33/11 kV transformers to 20/40 MVA units would alleviate the constraint in the short to medium term. However; it is projected that the group demand of Kenilworth will exceed 40 MVA by 2035, so even once this solution is implemented additional interventions could be required.

In addition to the transformer works, the 11 kV board would need to be uprated, along with extensive 33 kV circuit works. This includes 7.2 km on the Warwick side (the entire circuit) and 7.1 km on the Coventry West side (entire circuit less a 400 m section of cable that is currently rated adequately).

Option 2 – Establish new primary substation

Capacity released for constraint(s) considered: Up to 38 MVA

Viable

New limiting factor for constraint(s) considered: Capacity of two circuits and transformers for N-2 outages (subject to suitable load split between the two primaries)

Detailed description: There is a 33 kV circuit that interconnects Warwick and Coventry West BSPs (rated at approximately 44 MVA winter) which is currently used for demand restoration following a second circuit outage resulting in the total loss of Warwick and Harbury. This circuit passes close to the town of Kenilworth on the eastern side.

Due to the proposed works to establish a 132 kV interconnecting circuit between Harbury and Banbury BSPs (to provide longer-term demand restoration once the existing circuit is insufficient to support the group demand less 100 MW as set out in Engineering Recommendation P2), there may be an opportunity to utilise the 33 kV interconnecting circuit to alleviate the projected constraints on both transformers at and both circuits to Kenilworth. This solution would be reliant on the Harbury-Banbury interconnector being available before commencing works (as discussed in the Berkswell 132 kV report), due to the works limiting the backfeed capacity of the Warwick and Harbury group.

The new primary would be in addition to the current primary substation in Kenilworth, and would remove the need to upgrade the existing 33 kV circuits and transformers (as the existing transformers are around 60 years old, their replacement may also be triggered based on their condition).

If a suitable plot of land were available, a pair of 20/40 MVA transformers could be installed (along with a 33 kV bus section circuit breaker) to provide an additional 40 MVA of capacity and deload the existing demand at Kenilworth. The running arrangements for the new primary would have to be considered, either split on the 33 kV and 11 kV (with the demand split equally between Warwick and Coventry West), or mimicking the existing loose couple arrangement.

This solution also provides benefit for the Warwick 132/33 kV GT overloads discussed in the Berkswell 132 kV report, as the current circuit connects to the main 4 busbar at Warwick BSP, which could improve the load share.

This option is subject to a suitable location being identified for a new primary substation. A full 11 kV study would also be required to determine how the new primary could be integrated into the existing network (and how much demand could be transferred away from the existing Kenilworth primary).

Option 3 – Transfer demand to other primaries

Capacity Released for constraint(s) considered: Up to 3 MVA (dependent on 11 kV circuit capacity)

Viable

New limiting factor for constraint(s) considered: 11 kV circuit capacity

Detailed description: Transferring approximately 3 MVA demand to neighbouring primaries could alleviate constraints in the short term (up to around 2029). However, further reinforcement will be required for longer term growth in Kenilworth. This solution may be implemented for a limited time to defer reinforcement if proven cost-effective.

Option 4 – Procure flexibility at Kenilworth primary

Flexibility service type: Generation turn up/demand turn down

Viable

Detailed description: Flexibility services could be procured to alleviate projected overloads. This could defer reinforcement but due to the large quantity of flexibility required this may not be a viable solution in the long term.

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue option 2 above (establishing a new primary substation) as this is an enduring solution that futureproofs the network in Kenilworth at relatively low cost. This solution is dependent on works to increase the backfeed capacity (for demand restoration following a second circuit outage) for Warwick and Harbury being complete first. As a result, it is recommended that flexibility services and load transfers should be used as short term mitigation strategies whilst working towards a longer term reinforcement solution.

2.3 Gaydon primary transformer and 33 kV circuit overloads

Constraint Overview

Generation | Demand

Gaydon primary is a 33/11 kV site fed out of two circuits from the BSP, and consists of two primary transformers that run in parallel, each rated 12/24 MVA and commissioned in 1999.

The primary is currently Class B under Engineering Recommendation P2, expected to become Class D by 2033 following a very steep increase in demand, mostly due to significant developments around the Lighthorne Heath area.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season although this would be heavily dependent on the new developments in the area.

Table 2.3.1 constraint(s) and condition under which constraint occurs

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
Gaydon primary transformer overloads	Arranged or fault outage on the other infeed or transformer	None	2028	2028	2028	2028
Harbury – Gaydon 33 kV circuit overloads	Arranged or fault outage on the other infeed or transformer	None	2028	2028	2028	2028

Uncertainty under other Distribution Future Energy Scenarios: The constraint is present under all scenarios between 2026 and 2028. Excluding the large development proposed, the constraint would materialise between 2040 and 2050.

Solution Options

A list of each of the options considered for this constraint is given in the table 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 existing primary transformers and circuits	✓	×	✓	Viable
2	Establishing a new primary substation	✓	✓	✓	Viable
Operational Mitigation					
3	Transfer demand to other primaries	✓	✓	×	Discounted
Flexibility services					
4	Procure flexibility under Gaydon primary	✓	✓	✓	Viable

Solution Development

These options have been assessed on their technical viability and cost-effectiveness pending a more detailed CBA by the DNO. 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 existing primary transformers and circuits

Estimated capacity released: 15 MVA

Viable

New limiting factor: New transformer ratings

Detailed description: Uprating the existing transformers would release capacity at Gaydon primary. These works would include:

- Replacing both 33/11 kV transformers with 20/40 MVA units.
- Replacing the existing 11 kV switchgear board with a 2000 A rated one.
- Carrying out a fault level assessment of the 11 kV network to identify any potential overstress, where these may be present, consideration to be given to running the new transformers split at 11 kV, with suitable switching schemes put in place.
- Uprating both 33 kV circuits (approximately 11.2 km, predominantly overhead).

Whilst these works will alleviate constraints out to 2030, the solution does not satisfy the long term growth requirements in this area.

Option 2 – Establishing a new primary substation

Estimated capacity released: Up to 38 MVA

Viable

New limiting factor: Total capacity of the two primaries

Detailed description: Establishing a new primary substation is another way of releasing capacity in the area. In order to establish a new substation, the following works would be required:

- Purchasing land in a suitable location and within close proximity to the anticipated significant developments.
- Building two new 33 kV circuits to the site, rated and sized sufficiently for the new developments.
- Installing a minimum of two 20/40 MVA transformers at the new site; where the developments require more capacity, consideration to be given to installing a third transformer via a 33 kV switchboard.
- Installing suitable 11 kV switchboard, with the number of busbar sections, circuit breakers, and 11 kV feeders set to fulfil the size of the developments and allowing the full ratings of the transformers installed to be utilised.

This solution would provide ample capacity for this primary and the proposed development until 2034, but given the steep nature of the growth of new developments further intervention may be required. As a result, consideration could be given to establishing additional 132 kV infeed for the proposed development, which would be more expensive but may be necessary depending on the scale of load required.

Option 3 – Transfer demand to other primaries

Estimated capacity released: A few MVAs

Discounted

New limiting factor: Rating of the transformers

Detailed description: Gaydon primary has limited 11 kV interconnection to other sites and these are not sufficient to mitigate the constraints above.

Option 4 – Procure flexibility under Gaydon primary

Estimated Flexibility Required (MW): Generation turn up/demand turn down

Viable

New limiting factor: Rating of the transformers

Detailed description: Flexibility services could help alleviate the constraint and defer reinforcement. This option would be subject to a CBA closer to the time, including all necessary sufficiency checks, and would not be a long term solution given the scale of projected load growth.

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue option 2 above (establishing a new primary substation for the future developments) as this is an enduring solution that avoid complicating the existing 33 kV network configuration.

The timing and trigger of such works would be heavily reliant on the new developments materialising, and in some cases, contributing to the works.

Any reinforcement solution however would be subject to a CBA by the DNO, and in this case, it would then be tested against the flexibility market as part of the DNOA process.

2.4 Princethorpe 11 kV backfeed overload

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 condition under which constraint occurs

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
Princethorpe – Southam 11 kV backfeed overload	Transformer or circuit arranged or fault outage to Princethorpe primary	None	2034	2034	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: Similar overloads are projected under the Leading the Way and Consumer Transformation scenarios as under Best View. While lower growth is observed under System Transformation and Falling Short, overloads are still observed across multiple seasons by 2040 in both of these scenarios.

Solution Options

A list of each of the options considered for this constraint is given in the table 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	Install a second transformer at Princethorpe primary	✓	×	✓	**Viable**
2	Uprate the 11 kV backfeeds	✓	×	✓	**Discounted**
Flexibility services					
3	Procure flexibility under Princethorpe 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 Princethorpe primary

Capacity Released for constraint(s) considered: Up to 15 MVA

Viable

New limiting factor for constraint(s) considered: Existing transformer rating of 12 MVA

Detailed description: Installing a second transformer at Princethorpe primary would mean that, for arranged or fault outages at Princethorpe, supply could be maintained without having to rely on the 11 kV interconnection with Southam primary. The new transformer would be rated to closely match the existing transformer (suggested 7.5/15 MVA unit).

Princethorpe primary has two 33 kV circuits, one from Warwick BSP and another from Whitley BSP (with a normally open isolator at Princethorpe). The additional transformer could be installed on the Whitley circuit, and the 11 kV run normally open between the two transformers.

This approach would also defer the need for uprating 33 kV circuits between Warwick and Campion Hills, as outlined in the Section 2.5 of this report. Moving demand onto the Whitley network would be dependent on 132 kV reinforcement works as outlined in the Coventry 132 kV report.

Option 3 – Uprate the 11 kV backfeeds

Capacity Released for constraint(s) considered: Dependent on 11 kV works carried out

Discounted

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

Detailed description: Carrying out reinforcement at 11 kV could increase the backfeed capacity of Princethorpe primary, helping to alleviate this constraint. This option has been discounted as the load growth forecast for Princethorpe is high enough between now and 2050 that this would not be an enduring solution. 11 kV reinforcement could potentially be used to defer more permanent reinforcement, but this is likely not economical either, due to the distances to nearby primaries and the limited benefit of transfers to Campion Hills (as outlined in Section 2.5 of this report).

Option 3 – Procure flexibility under Princethorpe primary

Flexibility service type: Generation turn up/demand turn down

Viable

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

Solution Recommendation

It is recommended that option 1 (adding a second transformer at Princethorpe primary) would resolve this constraint and create sufficient capacity for the demand growth forecast for the area up to 2050. In the short term, flexibility services and load transfers to other primaries could be considered, but these do not offer the long term benefits associated with a second transformer.

2.5 Warwick to Campion Hills 33 kV circuit overloads

Constraint Overview

Generation **Demand**

Campion Hills primary substation is supplied via two 33 kV circuits from Warwick BSP, with two 33/11 kV primary transformers. Princethorpe primary is also supplied via a single 33 kV circuit, which is teed onto the Campion Hills T2 circuit. A fault which leaves the group demand of Campion Hills and Princethorpe supplied via a single circuit from Warwick BSP results in overloads by 2034. The table below outlines the nature of the network constraints identified in the network analysis.

Table 2.5.1 constraint(s) and condition under which constraint occurs

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
Warwick to Campion Hills T2 33 kV circuit overload	Busbar fault of main 1 busbar at Warwick BSP	None	2034	2034	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: Similar overloads are projected under the Leading the Way and Consumer Transformation scenarios as under Best View. While lower growth is observed under System Transformation and Falling Short, overloads are still observed across multiple seasons by 2045 in both of these scenarios.

Solution Options

A list of each of the options considered for this constraint is given in the table 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 the existing 33 kV circuits	✓	×	✓	Viable
2	Install second transformer at Princethorpe to transfer demand	✓	✓	✓	Viable
Operational Mitigation					
4	Transfer demand to other primaries	✓	×	✓	Viable
Flexibility services					
5	Procure flexibility under Campion Hills and Princethorpe 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 circuits

Capacity Released for constraint(s) considered: Up to 8 MVA

Viable

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

Detailed description: Uprating sections of the existing Warwick 7L5 to Campion Hills T2 circuit would help alleviate this constraint and facilitate load growth. For 2034, this could be limited to 3.2 km of 0.15 in^2 underground cable; however beyond 2034 further load growth may require additional sections of underground cable to be uprated to achieve a rating of approximately 30 MVA to accommodate the projected load growth up to 2050.

Option 2 – Install second transformer at Princethorpe to transfer demand

Capacity released for constraint(s) considered: Half the demand of Princethorpe

Viable

New limiting factor for constraint(s) considered: Existing circuit capacity

Detailed description: Installing a second transformer at Princethorpe primary as outlined in Section 2.4 of this report would allow for half of the demand at Princethorpe to be transferred onto the Whitley network. This would reduce the effect of the projected load increases at Princethorpe on the Warwick to Campion Hills circuit, which could defer the need to reinforce existing circuits as in option 1 until post 2034.

This option is dependent on the suitability of load transfers from Princethorpe into Whitley, which would be dependent on reinforcement works outlined in the Whitley 33 kV and Coventry 132 kV reports.

Option 3 – Transfer demand to other primaries

Capacity Released for constraint(s) considered: Up to 5 MVA (dependent on 11 kV circuit capacity)

Viable

New limiting factor for constraint(s) considered: 11 kV circuit capacity

Detailed description: Transferring approximately 5 MVA of demand to neighbouring primaries (particularly Wise Street) will alleviate constraints in the short term, but may be subject to 11 kV circuit works to facilitate load transfers. This solution may be implemented for a limited time to defer further reinforcement if proven cost-effective.

Option 4 – Procure flexibility under Campion Hills and Princethorpe primaries

Flexibility service type: Generation turn up/demand turn down

Viable

Detailed description: Flexibility services could be procured to alleviate projected overloads. This could defer reinforcement but due to the constraint occurring under a first circuit fault under all representative days, flexibility would be expected to be dispatched for extended periods of time.

Solution Recommendation

The short term recommendation is to assess the feasibility of load transfers and flexibility services to manage circuit loading. If insufficient in the longer term, consideration should first be given to option 2 (installing a second transformer at Princethorpe primary) to facilitate load transfers out of the group. Longer term, the recommendation is to uprate the existing 33 kV circuit.

2.6 Banbury Road and Claverdon primary transformer and 33 kV circuit overloads

Constraint Overview

Generation | **Demand**

Banbury Road primary is a 33/11 kV site fed via two circuits from Warwick BSP. It runs with a 33 kV isolator between transformers, normally open, but with the 11 kV bus section breaker closed. The site consists of two primary transformers, each rated 12/24 MVA and commissioned in 2013.

Claverdon primary is a 33/11 kV site fed via one circuit directly from Warwick BSP, with another circuit to Banbury Road. As a result, Claverdon and Banbury Road form a group with three incoming circuits from Warwick BSP. The site consists of two primary transformers, each rated 15 MVA and commissioned in 1964. The geographic area supplied by Claverdon covers a rural area to the west of Warwick.

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

Table 2.6.1 constraint(s) and condition under which constraint occurs

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
Claverdon primary transformer overloads	Arranged or fault outage on the other infeed or transformer	None	2028	2034	2034	2034
Banbury Road primary transformer overloads	Arranged or fault outage on the other infeed or transformer	None	2034	2034	2034	2034
Warwick to Banbury Road 33 kV circuit overloads	Fault outage resulting in the loss of one of the two Warwick – Banbury Road circuits	None	2028	2034	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: Similar overloads are projected under the Leading the Way and Consumer Transformation scenarios as under Best View. While lower growth is observed under System Transformation and Falling Short, overloads are still observed across multiple seasons by 2040 in both of these scenarios for all of the outage conditions listed above.

Solution Options

A list of each of the options considered for this constraint is given in the table 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	Uprating the existing network	✓	×	✓	**Viable**
2	Installing a new 33 kV circuit between Warwick and Claverdon	✓	✓	✓	**Viable**
Operational Mitigation					
3	Transfer demand to other primaries	✓	×	✓	**Viable**
Flexibility services					
4	Procure flexibility under Claverdon and Banbury Road 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 – Uprating the existing network

Capacity Released for constraint(s) considered: Dependant on works

Viable

New limiting factor for constraint(s) considered: New primary transformer and 33 kV circuit capacity

Detailed description: In order to release capacity across the whole group by upgrading the existing network, the following uprating works would be required:

- Uprating the existing transformers at Claverdon to 12/24 MVA units, along with upgrading the 11 kV board. This would provide ample capacity for Claverdon out to 2045. As the existing transformers are around 60 years old, their replacement may also be triggered based on their condition.
- Uprating the existing transformers at Banbury Road to 20/40 MVA units, along with upgrading the 11 kV board. This would provide ample capacity for Banbury Road to 2050. However, it does involve replacing relatively new assets.
- In order to utilise the capacity created by the new transformers at Claverdon, uprating 5.7 km of 33 kV circuit between Claverdon and Warwick (predominantly overhead sections of 0.1 in^2 ACSR conductor) and 6.4 km of 33 kV circuit between Claverdon and Banbury Road (predominantly overhead sections of 100 mm^2 ACSR conductor).
- Uprating 8 km of 33 kV circuit between Banbury Road and Warwick BSP to facilitate the load growth of both Claverdon and Banbury Road. For 2034 this will require a rating of at least 34 MVA, but the size of the Claverdon and Banbury Road group is forecast to exceed 50 MVA by 2050.

Option 2 – Installing a new 33 kV circuit between Warwick and Claverdon

Capacity released for constraint(s) considered: 37 MVA

Viable

New limiting factor for constraint(s) considered: Capacity of two existing circuits for N-1 outages

Detailed description: As an alternative to option 1, consideration could be given to installing a new 33 kV circuit between Warwick BSP and Claverdon primary. This would result in Claverdon having two direct circuits to Warwick. This option would require approximately 10 km of 33 kV circuit to be built (subject to detailed route investigation and land rights). This is in addition to uprating the transformers at Claverdon, and the existing circuit between Warwick and Claverdon.

The benefit of this option is that it would remove the need for the 5.7 km of circuit uprating between Claverdon and Banbury Road, and the rating required on the Warwick to Banbury Road circuits would only need to cater for the projected demand to 2050 at Banbury Road, which could reduce the amount of circuit requiring uprating to 5.2 km of overhead line circuit.

This option also provide benefits in terms of simplifying the 33 kV topology of Warwick, as currently this circuit couples the GT1A and GT3A bars together, so require splitting under various first circuit outage conditions to avoid through flows for second circuit outage conditions.

Option 3 – Transfer demand to other primaries

Capacity Released for constraint(s) considered: Up to 4 MVA (dependent on 11 kV circuit capacity)

Viable

New limiting factor for constraint(s) considered: 11 kV circuit capacity

Detailed description: Transferring demand to Tournament Fields primary from Banbury Road or Claverdon (which is geographically between the two) could alleviate constraints in the short term. This would be subject to detailed 11 kV assessment to ascertain what additional 11 kV works may be required to facilitate transfers. However, further reinforcement may be required for longer term growth at both Claverdon and Banbury Road. This solution may be implemented for a limited time to defer reinforcement if proven cost-effective.

Option 4 – Procure flexibility under Claverdon and Banbury Road primaries

Flexibility service type: Generation turn up/demand turn down

Viable

Detailed description: Flexibility services could be procured to alleviate projected overloads. This could defer reinforcement but due to the constraint occurring under a first circuit fault flexibility would be expected to be dispatched for extended periods of time.

Solution Recommendation

It is recommended to assess the feasibility of transferring demand from Claverdon and Banbury Road primaries to Tournament Fields primary, which may require 11 kV circuit works. If the 11 kV circuits do not offer sufficient capacity then flexibility could be procured to defer the reinforcement requirements, subject to a CBA confirmation through the DNOA process.

To facilitate longer term growth it is recommended that the transformers at Claverdon are uprated, which could be coordinated with asset replacement works. Additional circuit works will also be required, and depending on the exact location of load growth options to reinforce existing circuits or establish a new circuit to Claverdon should be considered.

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