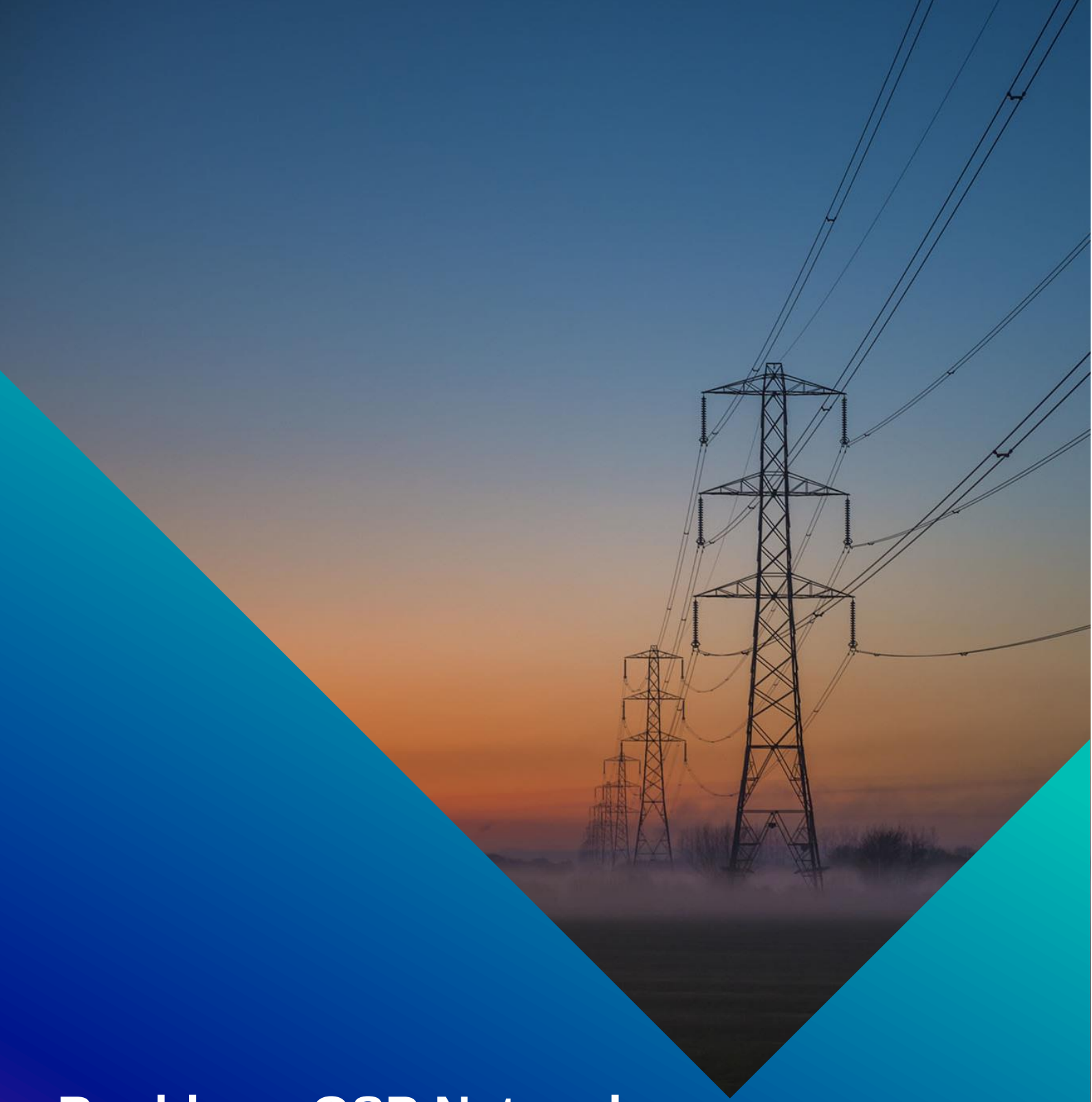

Bushbury GSP Network

Network Development Report – West MIdlands

May 2024

Electricity Distribution

nationalgrid

Contents

Bushbury GSP Network

1. Network Overview

Bushbury Grid Supply Point (GSP) is a relatively small GSP located in the West Midlands in the city of Wolverhampton. It supplies over 91,400 customers, and has 132 kV interconnections, normally run open, with Bustleholm, Willenhall, and Rugeley GSPs.

Bushbury GSP is fed by three Super Grid Transformers (SGTs) and feeds four Bulk Supply Points (BSPs): Bushbury BSP, Wednesfield BSP, Stafford BSP and Stafford South BSP.

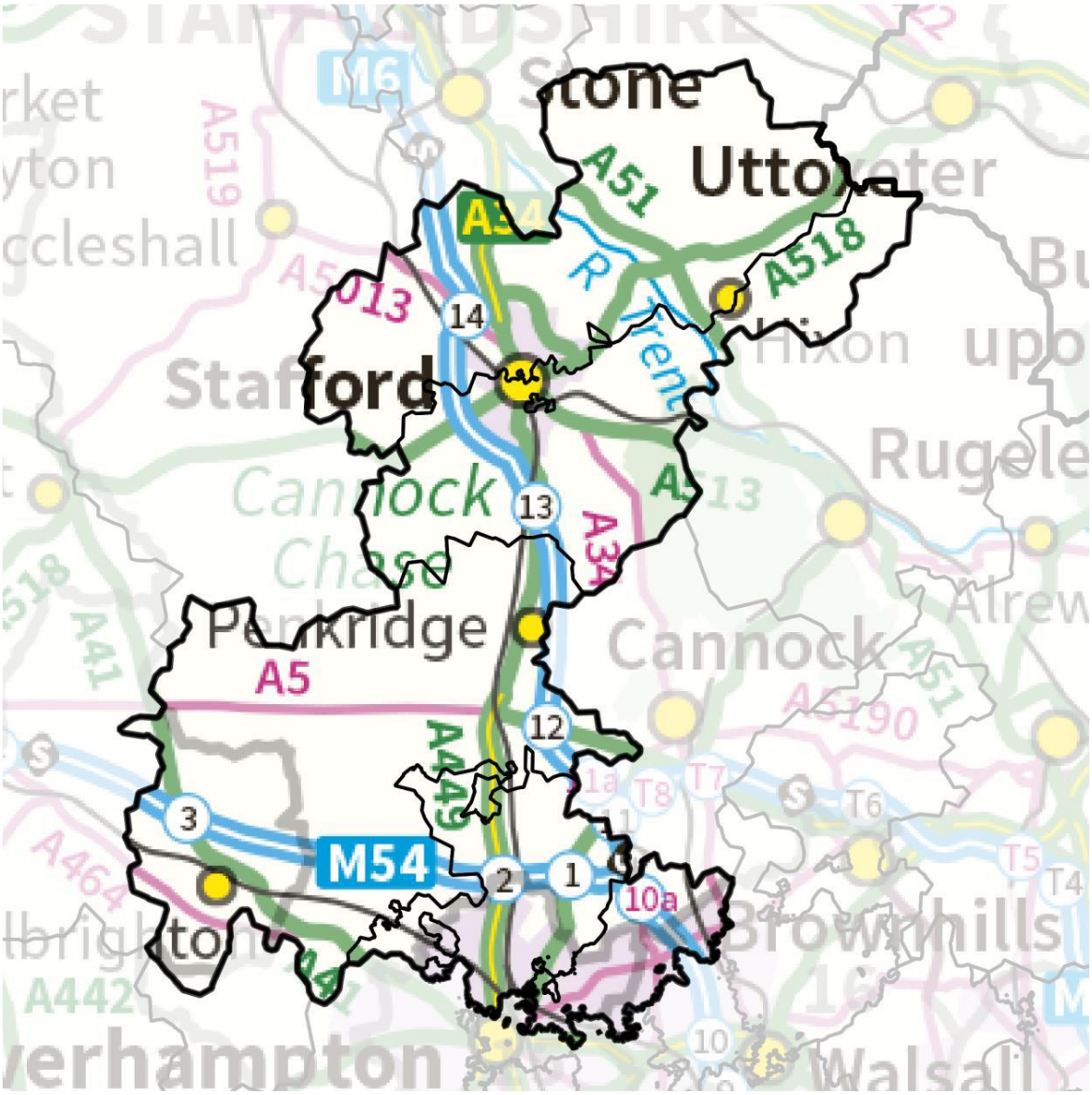

Figure 1.1 Bushbury BSP geographic network coverage

This report discusses existing and future network constraints over a 0-10 year horizon associated with Bushbury GSP and its downstream network. It uses the methodology outlined in the Network Development Plan Methodology Report with Network Operability Modelling applied as outlined further below.

For the purposes of this analysis the NGED Best View Distribution Future Energy Scenario (DFES) has been used to study each year up to and including 2034. Representative days for each of the four seasons (Winter, Intermediate Cool, Intermediate Warm, and Summer) have been studied to cover the edge case scenarios for the network.

1.1 Network Topology

Bushbury GSP is a 275/132 kV site fed via three 240 MVA SGTs currently running in parallel through a 132 kV double busbar arrangement. It supplies the following four BSPs:

- Bushbury BSP is fed via three dedicated 132 kV circuits from Bushbury GSP. It is comprised of two 132/33 kV transformers and three 132/11 kV transformers. It is located at the same site as the Bushbury GSP.
    - The 33 kV side consists of two 132/33 kV Grid Transformers (GTs) that run in parallel via a 33 kV busbar comprised of four sections. The BSP, in turn, supplies three primary substations; Albrighton, i54 Business Park, and Four Ashes. It also has two 33 kV interconnectors to Wolverhampton BSP (fed out of Willenhall GSP) that normally run open.

      There are ongoing New Connection driven proposals that will likely involve the installation of a third 132/33 kV GT including additional 33 kV network as part of upstream reinforcement to accommodate additional demand.
    - The 132/11 kV side consists of three 132/11 kV transformers, two of which are banked with the 132/33 kV transformers.
- Wednesfield BSP is comprised of two three-winding 132/11/11 kV transformers each supplied via a 132 kV circuit from Bushbury GSP.
- Stafford BSP is comprised of two 132/11 kV transformers, one fed from Bushbury GSP and another from Rugeley GSP, normally run split at 11 kV and 132 kV.
- Stafford South BSP is comprised of two 132/11 kV transformers, one fed from Bushbury GSP and another from Rugeley GSP, normally run split at 11 kV and 132 kV.

1.2 Network Operability Modelling

The analysis modelling covers automation and manual switching schemes that represent how the network is generally operated. Some of the main ones are listed below.

Bushbury 132 kV:

- The GSP busbars run in solid under normal configuration, and for arranged outages that result in a split, disconnector 169 is closed in to re-establish the parallel running, and SGTs are re-selected to minimise losses for the next credible fault.
- Arranged or fault outages leading to loss of a GT at Stafford, Stafford South, Wednesfield, and Bushbury 132/11 kV results in the 11 kV being closed in to backfeed.

Bushbury 132/33 kV BSP:

- Arranged outages that split up the 33 kV network results in the downstream 33 kV and 11 kV networks being split to avoid loose couples and back energisation
- Arranged outages affecting infeeds to Albrighton primary results in the primary site being picked up from Wolverhampton West BSP (fed out of Penn GSP)
- Arranged or fault outages leading to loss of a primary transformer at Albrighton results in the 11 kV at being closed in to backfeed.

2. Summary of Network Constraints

The following constraints were identified for the Best View Scenario, for which mitigation options are covered further down in the report:

- Albrighton transformer overload
- Albrighton 33 kV feeder circuits
    - Bushbury to Albrighton 33 kV circuit overload
    - Pattingham to Albrighton 33 kV circuit overload
    - Wolverhampton West to Pattingham 33 kV circuit overload

3. Network Constraints and Solution Options

3.1 Albrighton transformer overload

Constraint Overview

Generation **Demand**

Albrighton is a 33/11 kV primary substation where T1 is fed out of Bushbury BSP, and T2 out of Wolverhampton West BSP, with the 11 kV and 33 kV normally run open. The transformers back feed each other under arranged and fault outages. The site is Class C under Engineering Recommendation P2.

The table below outlines the constraints identified for Best View, the conditions they occur under, and the triggering year and season.

Table 3.1.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Albrighton transformer overload	N-1: arranged outage of either transformer at Albrighton primary	2032	2027	2028	2033

Uncertainty under other Distribution Future Energy Scenarios: The constraints above are identified under Best View and worsened under some of the other Distribution Future Energy Scenarios. The demand in the region is generally on an upward trend indicating constraints are potentially getting worse if not addressed, but the trigger year may vary depending on how quickly demand and/or generation materialises.

Solution Options

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

Table 3.1.2 solution options to identified constraint(s)

Option	Description	Solves constraint	Potentially economic	Wider benefit	Viable or Discounted
1	No Intervention	×	✓	×	Discounted
Reinforcement (build) options					
2	Uprating the existing transformers	✓	✓	×	Viable
3	Adding a third transformer	✓	✓	×	Viable
Operational Mitigation					
4	Load transfers	×	✓	×	Discounted
Load Management Schemes					
5	Post-fault inter-trips	×	✓	×	Discounted
Flexibility services					
6	Flexibility service procurement	✓	✓	×	Viable

Solution Development

These options have been assessed on their technical viability and cost-effectiveness pending a more detailed cost benefit analysis (CBA) by the DNO. The section below covers more detail on these options.

Option 1 – No Intervention

Estimated capacity released: 0 MVA

Discounted

Detailed description: The constraint is anticipated to trigger by 2027, with the demand projected to continue increasing thereafter. Doing nothing could therefore lead to thermal overloads and the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Rating of existing transformers

Option 2 – Uprating the existing transformers

Estimated capacity released: 15 MVA

Viable

Detailed description: Uprating the existing assets, the works include:

- Replacing the existing 12/24 MVA transformers (commissioned in 1967) with 20/40 MVA units
- Replacing the 1250 amp 11 kV board with a 2000 amp rated switchboard

New limiting factor: Rating of the 33 kV feeder circuits

Option 3 – Adding a third transformer

Estimated capacity released: 23 MVA

Viable

Detailed description: Adding a third transformer, the works include:

- Extending the 33 kV busbars at Albrighton, including the addition of a second bus-section circuit breaker and a new transformer bay; if space is restricted, consider establishing a new 3-section 33 kV indoor switchboard and decommissioning the existing air-insulated busbars
- Installing a third 12/24 MVA transformer
- Installing and additional 2-section 11 kV board suitably interconnected with the existing
- Assessing the fault levels at Albrighton, with a possible split configuration

New limiting factor: Rating of the 33 kV feeder circuits

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A few MVAs

Discounted

Detailed description: The solution involves transferring 11 kV demand to other neighbouring substations but these interconnections are limited and insufficient to mitigate the constraint.

New limiting factor: Rating of the exiting transformers

Option 5 – Load Management Schemes: Post-fault inter-trips

Estimated capacity released: 0 MVA

Discounted

Detailed description: The site is Class C under Engineering Recommendation P2 which would require restoration of the group demand within 15 minutes for a circuit outage; therefore demand disconnection schemes (or similar) would make the site non-compliant.

New limiting factor: Engineering Recommendation P2 non-compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 7 MW+

Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could be procured to help alleviate the constraint and defer reinforcement. This option would be subject to a cost benefit analysis closer to the time, including all necessary sufficiency checks.

New limiting factor: Rating of existing transformers

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue option 2 above (uprating the existing transformers) as it is a more deliverable scheme, avoids complicating the network, and is likely to be more economical and provide better value for money especially when considering the age of the existing transformers.

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 Distribution Network Options Assessment (DNOA) process.

3.2 Albrighton 33 kV feeder circuits

Constraint Overview

Generation Demand

Albrighton is a 33/11 kV primary substation fed from two 33 kV sources, one directly from Bushbury BSP, and the other from Wolverhampton BSP via Pattingham primary. Under outage conditions of either infeed, the site is picked up on the other circuit.

Albrighton is Class C under Engineering Recommendation P2.

The table below outlines the constraints identified for Best View, the conditions they occur under, and the triggering year and season.

Table 3.2.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Bushbury to Albrighton 33 kV circuit overload	N-1: outage of the 33 kV infeed to Albrighton, from Wolverhampton West	2032	2033	2034	-
Pattingham to Albrighton 33 kV circuit overload	N-1: outage of the 33 kV infeed to Albrighton, from Bushbury	2032	2033	2034	-
Wolverhampton West to Pattingham 33 kV circuit overload	N-1: outage of the 33 kV infeed to Albrighton, from Bushbury	2032	2033	2034	-

Uncertainty under other Distribution Future Energy Scenarios: The constraints above are identified under Best View and worsened under some of the other Distribution Future Energy Scenarios. The demand in the region is generally on an upward trend indicating constraints are potentially getting worse if not addressed, but the trigger year may vary depending on how quickly demand and/or generation materialises.

Solution Options

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

Table 3.2.2 solution options to identified constraint(s)

Option	Description	Solves constraint	Potentially economic	Wider benefit	Viable or Discounted
1	No Intervention	×	✓	×	Discounted
Reinforcement (build) options					
2	Uprating existing circuits	✓	✓	×	Viable
3	Adding a Bushbury-Albrighton 33 kV circuit	✓	✓	×	Viable
Operational Mitigation					
4	Load transfers	×	✓	×	Discounted
Load Management Schemes					
5	Post-fault inter-trips	×	✓	×	Discounted
Flexibility services					
6	Flexibility service procurement	✓	✓	×	Viable

Solution Development

These options have been assessed on their technical viability and cost-effectiveness pending a more detailed CBA by the DNO. The section below covers more detail on these options.

Option 1 – No Intervention

Estimated capacity released: 0 MVA

Discounted

Detailed description: The constraint is anticipated to trigger by 2032, with the demand projected to continue increasing thereafter. Doing nothing could therefore lead to thermal overloads and the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Rating of existing circuits

Option 2 – Uprating the existing circuits

Estimated capacity released: 17 MVA

Viable

Detailed description: The works include uprating the following existing circuits:

- Bushbury to Albrighton 33 kV circuit, mainly:
  - Re-stringing approximately 1.1 km of 0.15 in Aluminium Conductor Steel Reinforced (ACSR) OHL with 200 mm All Aluminium Alloy (AAAC) designed to 75 degrees
  - Replacing approximately 2 km of underground cable (mixture of 240 mm copper, 300 mm copper, and 0.3 in copper) with 400 mm copper cable
- Wolverhampton to Pattingham 33 kV circuit, mainly:
  - Re-stringing approximately 5.2 km of 0.175 in ACSR OHL with 200 mm AAAC designed to 75 degrees
  - Replacing approximately 500 metres of 260 mm copper underground cable with 400 mm copper cable
- Pattingham to Albrighton 33 kV circuit, mainly:
  - Re-stringing approximately 5.3 km of OHL (mixture of 0.15 in and 0.175 in ACSR) with 200 mm AAAC designed to 75 degrees

New limiting factor: Rating of the remaining circuit sections

Option 3 – Adding a Bushbury-Albrighton 33 kV circuit

Estimated capacity released: 40 MVA

Viable

Detailed description: Adding a third 33 kV circuit from Bushbury, the works include:

- Extending the 33 kV switchgear board at Bushbury (on the GT3B side) to allow for a new circuit breaker; where there is no room to extend, consideration is to be given to installing a 3-panel board on site and using this to reconfigure and make provision for a new panel.
- Extending the 33 kV busbars at Albrighton, including the addition of a second bus-section circuit breaker and a new feeder bay; if space is restricted, consider establishing a new 3-section 33 kV indoor switchboard and decommissioning the existing air-insulated busbars.
- Installing a new 10 km 33 kV circuit between Bushbury and Albrighton; achieving a minimum winter cyclin rating of 40 MVA, anticipated to be a mixture of 400 mm copper cable and 200 mm AAAC OHL designed to 75 degrees.

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: Limited

Discounted

Detailed description: The solution involves transferring 11 kV demand to other neighbouring substations but these interconnections are limited and insufficient to mitigate the constraint.

New limiting factor: Rating of the exiting circuits

Option 5 – Load Management Schemes: Post-fault inter-trips

Estimated capacity released: 0 MVA

Discounted

Detailed description: The site is Class C under Engineering Recommendation P2 which would require restoration of the group demand within 15 minutes for a circuit outage; therefore demand disconnection schemes (or similar) would make the site non-compliant.

New limiting factor: Engineering Recommendation P2 non-compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 3 MW+

Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could be procured to help alleviate the constraint and defer reinforcement. This option would be subject to a cost benefit analysis closer to the time, including all necessary sufficiency checks.

New limiting factor: Rating of existing transformers

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue option 2 above (uprating the existing circuits) as it is a more deliverable scheme, avoids complicating the network, and is likely to be more cost-effective.

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.

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