Iron Acton (West Midlands) GSP Network

Network Development Report – West Midlands

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Electricity Distribution

nationalgrid

Contents

Iron Acton (West Midlands) GSP Network

1. Network Overview

Iron Acton is a 132 kV Grid Supply Point (GSP) that supplies parts of Gloucestershire and Bristol areas connecting over 269,000 customers. The GSP is shared between the West Midlands network (with over 115,000 customers) and the South West network (with over 154,000 customers). Within the West Midlands network, the GSP comprises of radial 132 kV circuits supplying two 132/33 kV Bulk Supply Points (BSPs).

Figure 1.1 Iron Acton GSP geographic network coverage

This report discusses existing and future network constraints over a 0-10 year horizon associated with Iron Acton and its downstream network within the West Midlands only. 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

Iron Acton GSP is 275/132 kV site fed via six 240 MVA Super Grid Transformers (SGTs), that normally run 3+3 split through a 2-section 132 kV double busbar configuration. It supplies seven BSPs, two of which fall within the West Midlands network:

- Chipping Sodbury BSP consisting of two 132/33 kV Grid Transformers (GTs), each banked with a 132/11 kV transformer, with all four GTs supplied via two 132 kV circuits from the GSP.
    - The two 132/11 kV transformers run split at 11 kV, and have an interconnection with the 33 kV side via a 33/11 kV transformer, also run split.
    - The two 132/33 kV GTs run closed at 33 kV and supply five other primary substations through the downstream network. It also has a 33 kV interconnection to Ryeford BSP via the transfer of Hammerley Down primary.
    - The 33 kV network consists mainly of two interconnected rings; one connects Hammerley Down, Alveston, and Oxbridge primary substations, and the other connects (via Wapley switching station) Cowhorn, Naishcombe, and direct 33 kV customers.
- Ryeford BSP consisting of four 132/33 kV transformers fed via two circuits from the GSP (via Cambridge Arms switching station). The network is configured such that:
    - The GTs are banked together with each pair supplied via one circuit, but all normally run solid at 33 kV.
    - The downstream 33 kV network feeding a local primary and six other 33/11 kV primary substations and several 33 kV connected customers.
    - The 33 kV network being interconnected to Lydney BSP via the transfer of Netherhills primary.
    - Dursley, Netherhills, Berkeley, Hammerley Down (normally on Chipping Sodbury) and several 33 kV customers forming a ring via Coaley switching station.

Iron Acton GSP also has 132 kV interconnection to Port Ham GSP via Cambridge Arms switching station, allowing Ryeford to be transferred across.

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.

Iron Acton 132 kV:

- Arranged outages affecting the infeeds to Ryeford BSP results in the BSP being transferred to Port Ham network via Cambridge Arms switching station.
- Arranged or fault outages leading to loss of a 132/11 kV grid transformer at Chipping Sodbury BSP results in the 11 kV being closed in to backfeed from the other transformer(s).

Chipping Sodbury BSP:

- Arranged outages that split up the 33 kV network at Chipping Sodbury results in the downstream 33 kV and 11 kV networks being split to avoid loose couples and back energisation.
- Arranged outages affecting the infeeds to either of the 33 kV interconnected rings results in the two ringed networks being split to avoid a thermal overload following a subsequent fault outage.
- Arranged or fault outages leading to loss of a primary transformer at Chipping Sodbury or Naishcombe results in the 11 kV at these sites being closed in to backfeed from the other transformer(s).

Ryeford BSP:

- Arranged outages that split up the 33 kV network at Ryeford results in the downstream 33 kV and 11 kV networks being split to avoid loose couples and back energisation.
- Arranged outages affecting the infeeds via any GT results in the 33 kV busbars (and network is some instances) being run split to avoid an overload for a subsequent fault outage.
- Arranged or fault outages leading to loss of a primary transformer at Ryeford, Dudbridge, or Netherhills results in the 11 kV at these sites being closed in to backfeed from the other transformer(s).

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:

- Hammerley Down primary transformer overload
- Cowhorn primary transformer overload
- Chipping Sodbury BSP constraints
    - Chipping Sodbury N-2 compliance
    - Chipping Sodbury to Hammerley Down 33 kV circuit overload
    - Alveston to Oxbridge 33 kV circuit overload
    - Chipping Sodbury to Oxbridge 33 kV circuit overload
    - Chipping Sodbury to Wapley_1L5 33 kV circuit overload
    - Chipping Sodbury to Wapley_6L5 33 kV circuit overload
- Camp primary transformer overload
- Cherrington primary transformer overload
- Dudbridge primary transformer overload
- Dursley primary transformer overload
- Netherhills primary transformer overload
- Coaley to Berkeley no2 33 kV circuit overload
- Ryeford BSP constraints
    - Ryeford N-2 compliance
    - Ryeford grid transformer overload
    - Coaley to Netherhills 33 kV circuit overload
    - Ryeford to Netherhills 33 kV circuit overload
    - Ryeford to Coaley tee 33 kV circuit overload

Transmission-Distribution interface

Iron Acton GSP is a 400/132 kV site and the boundary between the transmission and distribution network for that area. New Connection activity at the distribution network, both demand and generation across the West Midlands and South West DNO areas, have triggered constraints at the transmission network with regards to SGT capacity and 400 kV circuit ratings. Proposals to mitigate are being considered and include the establishment of a new GSP to offload the existing demand, and pick up some the proposed new connection schemes.

3. Network Constraints and Solution Options

3.1 Hammerley Down primary transformer overload

Constraint Overview

Generation | Demand

Hammerley Down primary is a 33/11 kV site consisting of two 12/24 MVA transformers (commissioned in 2013 and 2014), fed from Castle Meads BSP as part of a closed 33 kV ring with Alveston and Oxbridge primary substations. It also has a 33 kV interconnector to Ryeford network normally run open at Hammerley Down.

BSP. The 11 kV switchgear board is 1200 amp rated, commissioned in 1969.

The primary is Class C under Engineering Recommendation P2.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.1.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Hammerley Down primary transformer overload	N-1: Outage of either of the two primary transformers at Hammerley Down	2034	2029	2030	-

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 2029 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: 12 MVA

Viable

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

- Replacing the existing 12/24 MVA rated transformers with 20/40 MVA units
- Replacing the 1200 amp 11 kV board with 2000 amp rated one

New limiting factor: Rating of the 11 kV circuit breakers

Option 3 – Adding a third transformer

Estimated capacity released: 18 MVA

Viable

Detailed description: Adding a third 33/11 kV transformer on site, the works include the following:

- Installing a 33 kV bus-section circuit breaker between disconnectors S506 and S507.
- Installing a third 12/24 MVA transformer, connected to disconnector 3H3.
- Extending the 33 kV busbars at Princess Royal to include an additional bus-section circuit breaker and a transformer bay; the circuit to Bixhead would also need to be relocated to the new section of bar to cover the busbar ends.
- Installing an additional 2-section 11 kV board suitably interconnected with the existing; where space may be restricted in the existing building, consideration to be given to:
    - Utilising/relocating the existing store room; or
    - Diverting the 11 kV terminal wood poles in the northern side of boundary to create additional room for a new building.

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A couple of MVAs

Discounted

Detailed description: Hammerley Down primary is fairly rural and has very limited 11 kV interconnection to other sites such as Alveston (approximately 8 km away) and Dursley (approximately 9 km away); these are therefore not sufficient to mitigate the constraints above.

New limiting factor: Rating of the transformers

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: Hammerley Down primary is Class C under Engineering Recommendation P2 which would require restoration of the demand within 15 minutes for a first 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): 4 MW+

Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could 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 the transformers

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue option 3 above (adding a third transformer) as it is likely to be a more cost-effective and an enduring solution.

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 Cowhorn primary transformer overload

Constraint Overview

Generation | Demand

Cowhorn primary is a 33/11 kV site consisting of two 12/24 MVA transformers (commissioned in 1964), fed from Castle Meads BSP (via Wapley switching station). The 11 kV switchgear board is 1250 amp rated, commissioned in 1981, and currently runs solid.

The primary is Class C under Engineering Recommendation P2.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.2.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Cowhorn primary transformer overload	N-1: Outage of either of the two primary transformers at Cowhorn	Baseline	Baseline	Baseline	2028

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 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 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 imminent and the demand is projected to continue increasing. 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: 12 MVA

Viable

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

- Replacing the existing 12/24 MVA rated transformers with 20/40 MVA units
- Replacing the 1250 amp 11 kV board with 2000 amp rated one

New limiting factor: Rating of the 11 kV circuit breakers

Option 3 – Adding a third transformer

Estimated capacity released: 18 MVA

Viable

Detailed description: Adding a third 33/11 kV transformer on site, the works include the following:

- Installing a 7-panel 33 kV switchgear board to replace the existing air-insulated busbar arrangement. This would help create space in the existing compound and make provision for a third transformer connection
- Installing a third 12/24 MVA transformer on-site
- Extending the 11 kV board to include an additional busbar and section for the third transformer (a 2-section board is not anticipated to fit within the existing boundary)
- Carrying out a fault level assessment with consideration of running the third transformer split from the existing two

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A couple of MVAs

Discounted

Detailed description: Cowhorn primary has limited 11 kV interconnection to other sites such as Naishcombe (approximately 4 km away), and these are not sufficient to mitigate the constraints above.

The option however may be utilised to manage the baseline constraints in the interim, but would not be a viable long term solution.

New limiting factor: Rating of the transformers

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: Cowhorn primary is Class C under Engineering Recommendation P2 which would require restoration of the demand within 15 minutes for a first 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 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 the transformers

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue option 2 above (replacing the existing transformers) as it is likely to be a more deliverable solution and cost-effective especially when considering the age of the existing assets.

As mentioned above, option 4 (operational mitigation) may also be implemented in the interim to manage the baseline constraints but it is not a viable long term solution.

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.

3.3 Chipping Sodbury BSP constraints

Constraint Overview

Generation Demand

Chipping Sodbury BSP is fed from Iron Acton GSP via two 132 kV circuits. The site consists of two 132/11 kV transformers (supplying local demands) and two 132/33 kV transformers supplying five other primary substations and a few 33 kV connected customer. The 33 kV network is effectively operated as two rings, with a normally closed interconnector between them via Oxbridge and Wapley.

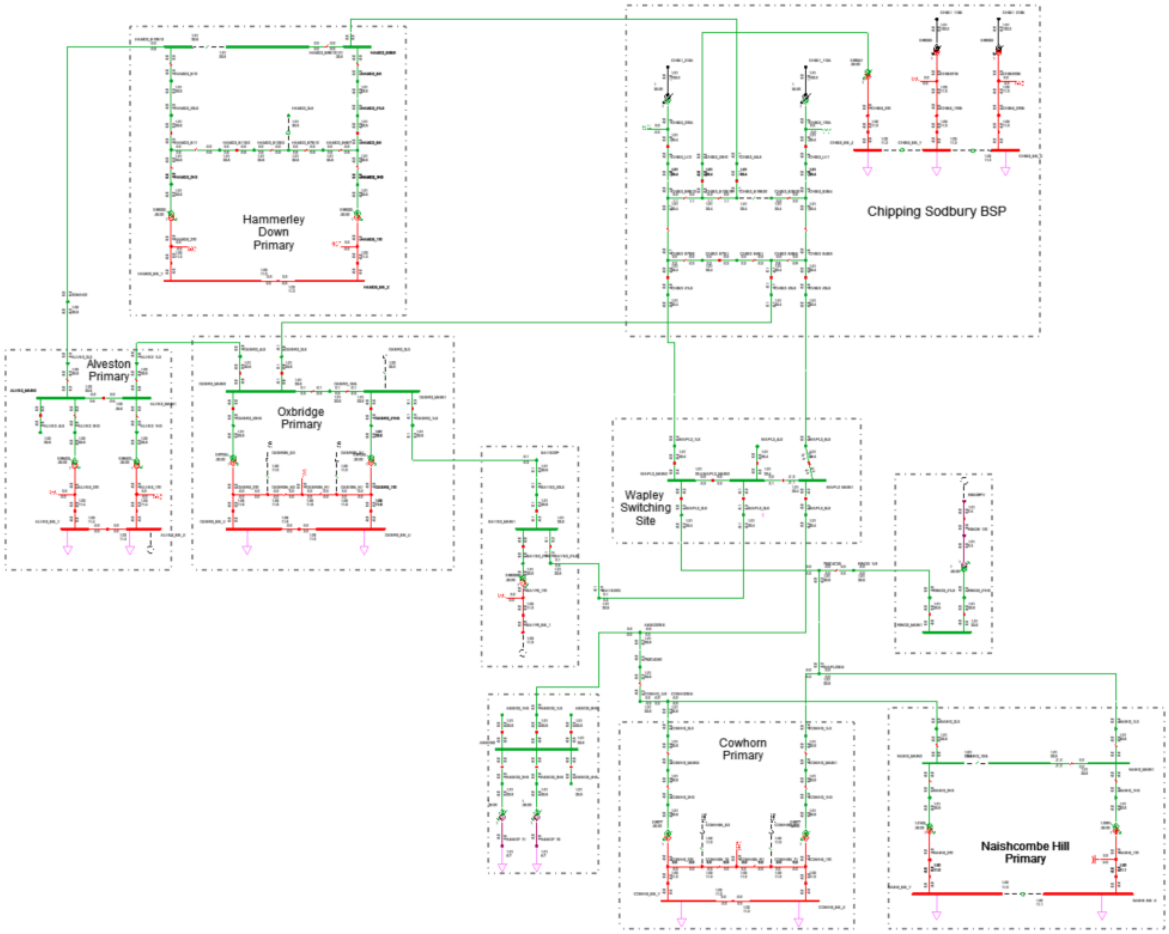

Figure 3.3.1 Chipping Sodbury BSP schematic network diagram

The group is class D under Engineering Recommendation P2, with a group demand expected to exceed 100 MW by 2027.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.3.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Chipping Sodbury N-2 compliance	N-2: Arranged outage of one 132 kV infeed to Chipping Sodbury, followed by a fault of the other; where the group demand exceeds 100 MW	2027	2028	2030	2034
Chipping Sodbury to Hammerley Down 33 kV circuit overload	N-1: Outage of the Chipping Sodbury to Oxbridge 33 kV circuit	Baseline	Baseline	Baseline	2029
Alveston to Oxbridge 33 kV circuit overload	N-1: Outage of the Chipping Sodbury to Hammerley Down 33 kV circuit	2030	2029	2030	-
Chipping Sodbury to Oxbridge 33 kV circuit overload	N-1: Outage of the Chipping Sodbury to Hammerley Down 33 kV circuit	2028	2028	2030	-
Chipping Sodbury to Wapley_1L5 33 kV circuit overload	N-1: Chipping Sodbury 33 kV busbar outage taking the Wapley_6L5 circuit and Oxbridge circuit	Baseline	Baseline	Baseline	2029
Chipping Sodbury to Wapley_6L5 33 kV circuit overload	N-1: Chipping Sodbury 33 kV busbar outage taking the Wapley_1L5 circuit and Hammerley Down circuit	Baseline	Baseline	Baseline	2029

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 3.3.2 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	Upgrading the existing network	✓	✓	×	Viable
3	Establishing a new BSP at Iron Acton	✓	✓	×	Viable
Operational mitigation					
4	Load transfers	×	✓	×	Discounted
Load Management Schemes					
5	Post-fault inter-trips	×	✓	×	Discounted
Flexibility services					
6	Flexibility service procurement	✓	✓	×	Discounted

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: Some of the constraints are imminent and the demand is projected to continue increasing. Doing nothing could therefore lead to thermal overloads, voltages going beyond statutory limits, and the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Rating of existing circuits and P2 compliance

Option 2 – Uprating the existing network

Estimated capacity released: 30 MVA

Viable

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

- Uprating approximately 12 km of 33 kV circuit between Coaley (Ryeford BSP) and Hammerley Down (Chipping Sodbury BSP) to allow sufficient transfer capacity to maintain compliance under Engineering Recommendation P2.

  The interconnection would be required to achieve a minimum winter cyclic rating of 36 MVA, anticipated to be 400 mm copper cable (for underground sections) and 200 mm All Aluminium Alloy conductor (AAAC) designed to 75 degrees (for overhead line sections).

- Uprating approximately 10.5 km of 33 kV circuit between Chipping Sodbury and Hammerley Down to achieve a minimum winter cyclic rating of 53 MVA. This would likely require undergrounding the entire circuit using a minimum of 630 mm copper or 800 mm copper cable.

- Uprating approximately 7 km of overhead line to achieve a minimum winter cyclic rating of 42 MVA; this would require the overhead sections to be undergrounded using a minimum of 400 mm copper or 630 mm copper cable.

  [Alternatively to this, installing a second 10 km 33 kV circuit between Alveston and Oxbridge may be an option, with 33 kV busbar extension works either end.]

- Uprating approximately 5.5 km of 33 kV circuit between Chipping Sodbury and Oxbridge to achieve a minimum winter cyclic rating of 53 MVA. This would likely require undergrounding the entire circuit using a minimum of 630 mm copper or 800 mm copper cable.

- Reconfiguring Chipping Sodbury 33 kV busbars to avoid losing two circuits into the network for a single busbar outage, The works would include:
  - Installing two 33 kV bus-section circuits breakers
  - Relocating the two grid transformer bays
  - Relocating the Wapley no1 circuit (towards Wapley_6L5)
  - Relocating the circuit to Hammerley Down

New limiting factor: Rating of the circuits and P2 compliance

Option 3 – Establishing a new BSP near Bilson

Estimated capacity released: 90 MVA

Viable

Detailed description: Establishing a new BSP at Iron Acton consisting of a single GT (initially), and run in parallel with the 132/33 kV GTs at Chipping Sodbury effectively operating the network as a three transformer group. The works would include:

- Establishing a new 132 kV bay at Iron Acton GSP
- Establishing a new BSP at (or near) Iron Acton BSP, consisting of a 132/33 kV GTand 33 kV switchgear board
- Looping in the Alveston to Oxbridge 33 kV circuit via the new GT (the circuit runs through Iron Acton and therefore minimum 33 kV circuit works would be required)

  Carrying out fault level assessment to identify any potential overstress form the additional third infeed into the group
- Carrying out site checks allowing the existing transformers at Chipping Sodbury BSP to utilise their cyclic ratings

New limiting factor: Rating of the circuits

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: 10 MVA+

Discounted

Detailed description: Chipping Sodbury has limited 11 kV interconnection to other BSP, but has a 33 kV interconnection to Ryeford BSP via the transfer of Hammerley Down primary. This would be able to manage the baseline constraints in the interim but would not be sufficient as a long term solution.

New limiting factor: Rating of existing circuits and P2 compliance

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: Chipping Sodbury BSP is Class D under Engineering Recommendation P2 which would require the immediate restoration of the group demand minus 20 MW following a first circuit outage, with restoration of the full demand within 3 hours; therefore demand disconnection schemes (or similar) would make the site non-compliant.

As the group demand exceeds 100 MW, a third infeed would become necessary making this option less viable.

New limiting factor: Rating of existing circuits and P2 compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 0 MW

Discounted

Detailed description: Flexibility services through generation turn up and/or demand turn down could help alleviate some thermal constraints for specific outage conditions but it could become more detrimental to the network if different fault outages occur, considering the parallel ring configuration of the network. It would also not resolve the N-2 group compliance constraints, nor the voltage issues without hindering the Power Quality of the network.

New limiting factor: Rating of existing circuits, Power Quality, and P2 compliance

Solution Recommendation

It would be recommended to pursue option 3 above (establishing a new BSP) as it will likely be a more enduring solution, and more cost-effective in the long run.

As mentioned above, option 4 (operational mitigation) may also be implemented in the interim to manage the baseline constraints but it would not be a viable long term solution.

The significant load growth observed within the BSP is related to these observed for Bilson primary substation and can be traced to a few large developments; as a result, the timing and trigger of any works would be heavily reliant on these new developments materialising, and in some cases, contributing to the works.

3.4 Camp primary transformer overload

Constraint Overview

Generation Demand

Camp primary is a 33/11 kV site consisting of two 7.5/9.75 MVA rated transformers (summer/winter), one commissioned in 1959 and the other in 1964. The site is fed from Ryeford BSP via a 33 kV closed ring with Cherrington primary.

The 11 kV switchgear board is 1250 amp rated, commissioned in 1986, and currently runs solid.

The primary is Class B under Engineering Recommendation P2.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.4.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Camp primary transformer overload	N-1: Outage of either of the two primary transformers at Camp	2028	2029	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 3.4.2 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 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 2028 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: 10 MVA

Viable

Detailed description: Replacing the existing 7.5 MVA transformers with 12/24 MVA units.

The 11 kV board is 1250 amp rated and would not need to be replaced yet.

New limiting factor: Rating of the 11 kV circuit breakers

Option 3 – Adding a third transformer

Estimated capacity released: 15 MVA

Viable

Detailed description: Adding a third 33/11 kV transformer on site, the works include the following:

- Extending the 33 kV busbar to include another bus-section circuit breaker and a transformer bay
- Relocating the circuit from Ryeford to the end section of the newly extended busbar
- Installing a third 33/11 kV transformer rated 7.5/15 MVA
- Installing a 2-section 11 kV board suitably interconnected with the existing
- Carrying out a fault level assessment with consideration of running the third transformer split from the existing two

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: Very limited

Discounted

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

New limiting factor: Rating of the transformers

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: Camp primary is Class B under Engineering Recommendation P2 which would require restoration of the demand minus 1 MW within 3 hours following a first circuit outage; therefore demand disconnection schemes (or similar) could make the site non-compliant.

New limiting factor: Engineering Recommendation P2 non-compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 3.5 MW+ Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could 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 the transformers

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue option 2 above (replacing the existing transformers) as it is likely to be more cost-effective than the alternative build option, especially when considering the age of the existing assets.

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.

3.5 Cherrington primary transformer overload

Constraint Overview

Generation Demand

Cherrington primary is a 33/11 kV site consisting of two 7.5/9.75 MVA rated transformers (summer/winter), one commissioned in 1958 and the other in 1960. The site is fed from Ryeford BSP via a 33 kV closed ring with Camp primary.

The 11 kV switchgear board is 2000 amp rated, commissioned in 2014, and currently runs solid.

The primary is Class B under Engineering Recommendation P2.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.5.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Cherrington primary transformer overload	N-1: Outage of either of the two primary transformers at Cherrington	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 3.5.2 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 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 2034 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: 10 MVA

Viable

Detailed description: Replacing the existing 7.5 MVA transformers with 12/24 MVA units.

The 11 kV board is 2000 amp rated and would not need to be replaced yet.

New limiting factor: Rating of the 11 kV circuit breakers

Option 3 – Adding a third transformer

Estimated capacity released: 15 MVA

Viable

Detailed description: Adding a third 33/11 kV transformer on site, the works include the following:

- Extending the 33 kV busbar to include another bus-section circuit breaker and a transformer bay.
- Relocating the circuit from Ryeford to the end section of the newly extended busbar.
- Installing a third 33/11 kV transformer rated 7.5/15 MVA.
- Installing a 2-section 11 kV board suitably interconnected with the existing.
- Carrying out a fault level assessment with consideration of running the third transformer split from the existing two.
- Purchasing additional land in the south western area of the substation to enable the extensions above. Alternatively, replacing the existing air-insulated busbars with a 7-panel 33 kV indoor board to create space on site.

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: Very limited

Discounted

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

New limiting factor: Rating of the transformers

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: Cherrington primary is Class B under Engineering Recommendation P2 which would require restoration of the demand minus 1 MW within 3 hours following a first circuit outage; therefore demand disconnection schemes (or similar) could make the site non-compliant.

New limiting factor: Engineering Recommendation P2 non-compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 1 MW+

Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could 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 the transformers

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue option 2 above (replacing the existing transformers) as it is likely to be more cost-effective than the alternative build option, especially when considering the age of the existing assets.

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.

3.6 Dudbridge transformer overload

Constraint Overview

Generation Demand

Dudbridge is a 33/11 kV primary substation fed out of Ryeford BSP via three circuits. The site has three transformers that normally run 2+1, where:

- T2 and T3 (each being a 15/18.75 MVA transformer, commissioned in 1962) run in parallel and thus backfeed each other under an outage of one another
- T1 (rated 15 MVA, commissioned in 1960) runs split from the other two and is backfed via T2 only due to limited 11 kV busbars sections
- The 11 kV board is 1250 amp rated, commissioned in 2001.

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 per season.

Table 3.6.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Dudbridge T2/T3 overload	N-1: Outage of one of the primary transformers on site	2028	2029	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 3.6.2 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	Adding a fourth transformer	✓	✓	×	Viable
3	Uprating the existing transformers	✓	✓	×	Viable
4	Installing additional 11 kV busbar sections	✓	✓	×	Viable
Operational mitigation					
5	Load transfers and split schemes	✓	✓	×	Viable
Load Management Schemes					
6	Post-fault inter-trips	×	✓	×	Discounted
Flexibility services					
7	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 2028 with the demand projected to continue increasing thereafter. Doing nothing could therefore lead to thermal overloads and safety implications.

New limiting factor: Rating of existing transformers

Option 2 – Adding a fourth transformer

Estimated capacity released: 18 MVA

Viable

Detailed description: Adding a fourth transformer on site, the works include:

- Extending the 33 kV busbars to include three additional bus-section circuit breaker and a new 33 kV transformer bay
- Install a fourth 33/11 kV 12/24 MVA transformer
- Install an additional 11 kV 2-section board interconnected with the existing but configured such that the site runs 2+2
- Purchasing additional land may be needed to accommodate the new assets above; this would also include substantial 33 kV circuit diversions

New limiting factor: Rating of the 33 kV incoming circuits

Option 3 – Uprating the existing transformers

Estimated capacity released: 26 MVA

Viable

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

- Replacing the three primary transformers with 20/40 MVA units;
- Replacing the 11 kV switchgear board with a 2000 amp rated one

New limiting factor: Rating of the incoming 33 kV circuits

Option 4 – Installing additional 11 kV busbar sections

Estimated capacity released: 9 MVA

Viable

Detailed description: Facilitating better load share between the transformers, the works include:

- Installing an additional 2-section 11 kV board suitably interconnected with the existing
- Transferring enough demand to the new 11 kV busbar sections to allow for an even redistribution of demand (following an outage) between the remaining two transformers in-service

New limiting factor: Rating of the transformer

Option 5 – Operational mitigation: Load transfers and split schemes

Estimated capacity released: Up to 9 MVA

Viable

Detailed description: Utilising the downstream 11 kV network to evenly redistribute the demand between the remaining two transformers in-service following an outage.

New limiting factor: Rating of existing transformers

Option 6 – Load Management Schemes: Post-fault inter-trips

Estimated capacity released: 0 MVA

Discounted

Detailed description: Dudbridge primary 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 7 – Flexibility service procurement

Estimated Flexibility Required (MW): 8.5 MW+

Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could 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 the existing transformers

Solution Recommendation

It would be recommended to pursue option 5 above (operational mitigation) as it is likely to be the most cost-effective solution and would allow for better utilisation of the existing assets.

Where the above gets exhausted, or may no longer be feasible due to 11 kV network limitations, then the next viable reinforcement solution lies between:

- Option 3 (uprating the transformers), especially considering their age; and
- Option 4 (installing additional 11 kV busbar sections) to allow for better utilisation of the existing transformer ratings.

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

3.7 Dursley primary transformer overload

Constraint Overview

Generation Demand

Dursley primary is a 33/11 kV site consisting of two 16.5 MVA transformers (commissioned in 1965), fed from Ryeford BSP via two circuits; one direct and another through Coaley switching station. The 11 kV switchgear board is 1250 amp rated, commissioned in 2015, and currently runs solid.

The primary is Class C under Engineering Recommendation P2.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.7.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Dursley primary transformer overload	N-1: Outage of either of the two primary transformers at Dursley	-	2030	2032	-

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 3.7.2 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 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 by 2030 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: 13 MVA

Viable

Detailed description: Uprating the existing 16.5 MVA rated transformers with 20/40 MVA units (as 12/24 MVA rated ones would likely become overloaded by 2040).

The 11 kV board is currently 1250 amp (commissioned in 2015) but is not anticipated to require replacement yet as it is expected to be sufficient until 2035 at the earliest.

New limiting factor: Rating of the 11 kV circuit breakers

Option 3 – Adding a third transformer

Estimated capacity released: 16.5 MVA

Viable

Detailed description: Adding a third 33/11 kV transformer on site, the works include the following:

- Installing a third 33/11 kV transformer rated 12/24 MVA, utilising the existing bays and space previously occupied by an old transformer
- Carrying out a load assessment to configure the 11 kV network such that the demand can be evenly distributed between two transformers during an outage of the third
- Carrying out a fault level assessment with consideration of operating the third transformer split if necessary

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: Limited

Discounted

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

New limiting factor: Rating of the transformers

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: Dursley primary is Class C under Engineering Recommendation P2 which would require restoration of the demand within 15 minutes for a first 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): 2.5 MW+ Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could 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 the transformers

Solution Recommendation

With regards to reinforcement build options, both option 2 (replacing the existing transformers) and option 3 (adding a third) have merit and the potential to be enduring and cost-effective solutions.

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.

3.8 Netherhills primary transformer overload

Constraint Overview

Generation Demand

Netherhills primary is a 33/11 kV site consisting of two 7.5/15 MVA transformers (commissioned in 2013), fed from Ryeford BSP via two circuits. The 11 kV switchgear board is 1250 amp rated, commissioned in 1985, and currently runs open.

The primary is currently Class B under Engineering Recommendation P2, expected to become Class C by 2030.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.8.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Netherhills primary transformer overload	N-1: Outage of either of the two primary transformers at Netherhills	2031	2029	2030	2031

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 3.8.2 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 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 by 2029 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: 24 MVA

Viable

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

- Replacing the existing 7.5/15 MVA rated transformers with 20/40 MVA units (as 12/24 MVA rated ones would likely become overloaded by 2040).
- Replacing the existing 1250 amp 11 kV board with a 2000 amp one

New limiting factor: Rating of the incoming 33 kV circuits

Option 3 – Adding a third transformer

Estimated capacity released: 14 MVA

Viable

Detailed description: Adding a third 33/11 kV transformer on site, the works include the following:

- Installing a new 10-panel 33 kV indoor switchgear board consisting of five feeder panels, three transformer ones, and two bus-section circuit breakers
- The new 33 kV board above would replace the existing air-insulated busbars; sealing end structures may be required for the tower terminations
- Installing a third 33/11 kV transformer rated 7.5/15 MVA
- Installing an additional 2-section 11 kV switchgear board suitably interconnected with the existing
- Carrying out a fault level assessment with consideration of operating the third transformer split if necessary

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A couple of MVAs

Discounted

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

New limiting factor: Rating of the transformers

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: Netherhills primary is currently Class B under Engineering Recommendation P2, expected to become Class C by 2030 which would require restoration of the demand within 15 minutes for a first 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): 5 MW+

Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could 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 the transformers

Solution Recommendation

With regards to reinforcement build options, both option 2 (replacing the existing transformers) and option 3 (adding a third transformer) have merit and the potential to be enduring and cost-effective solutions.

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.

3.9 Coaley to Berkeley no2 33 kV circuit overload

Constraint Overview

Generation Demand

Berkeley primary is a 33/11 kV site consisting of two 20/40 MVA transformers than are supplied from Ryeford BSP via Coaley switching station. The 33 kV circuits from Coaley are the current limiting factors to the primary:

- Coaley-Ryeford no1 circuit is rated up to 28.1 MVA winter cyclic
- Coaley-Ryeford no2 circuit is rated up to 18.8 MVA winter cyclic

The primary is Class B under Engineering Recommendation P2, expected to become class C by 2027.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.9.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Coaley-Berkeley no2 33 kV circuit overload	N-1: Outage of the Coaley-Berkeley no1 circuit	2033	2033	2033	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 3.9.2 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 circuit	✓	✓	×	Viable
3	Adding a third circuit to Berkeley	✓	✓	×	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 2033 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 circuit

Estimated capacity released: 10 MVA

Viable

Detailed description: Uprating the existing 33 kV circuit, the works include the following:

- Restringing / rebuilding approximately 2.5 km of 0.1 in Aluminium Conductor Steel Reinforced (ACSR) overhead tower line sections
- Restringing / rebuilding approximately 5 km of 0.1 in ACSR overhead wood pole line sections
- Replacing the 400 amp current transformers (CTs) along the circuit

For the circuit works, a minimum winter cyclic rating of 37 MVA (matching the transformers at Berkeley primary) is to be achieved; this is anticipated to require:

  - 200 mm AAAC designed to 75 degrees (for overhead line sections)
  - 400 mm copper cable (for any underground sections)

New limiting factor: Rating of the other 33 kV circuit to Berkeley

Option 3 – Adding a third circuit to Berkeley

Estimated capacity released: 18 MVA

Viable

Detailed description: Adding a third 33 kV circuit to Berkeley primary, the works include:

- Extending the 33 kV busbars at Coaley switching station to include a new feeder bay.
- Extending the 33 kV busbars at Berkeley primary to include two bus-section circuit breakers and a new feeder bay.
- Installing approximately 9 km of 33 kV circuit between the bays at Coaley and at Berkley. The circuit is to achieve a minimum winter cyclic rating of 37 MVA, anticipated to require 400 mm copper cable (for underground sections) and 200 mm AAAC designed to 75 degrees (for overhead sections).

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: Limited

Discounted

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

New limiting factor: Rating of the circuits

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: Berkeley primary is Class B under Engineering Recommendation P2, expected to become Class C by 2027 which would require restoration of the demand within 15 minutes for a first 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): 2.2 MW+

Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could 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 the circuits

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue option 2 above (uprating the existing circuit) as it is likely to be a more deliverable and cost-effective solution, without complicating the configuration of the network.

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.

3.10 Ryeford BSP constraints

Generation | Demand

Constraint Overview

Ryeford BSP is fed from two 132 kV circuit from Iron Acton GSP (via Cambridge Arms switching station). The site consists of four 132/33 kV transformers banked together such that each pair is supplied via a 132 kV circuit. The transformers run closed at 33 kV, and supply several primary substations:

- Dudbridge is fed via three direct circuits.
- Camp and Cherrington are fed via a closed 33 kV ring.
- Dursley, Berkeley, Netherhills, and four 33 kV connected customers are fed via three 33 kV circuits an interconnected with each other via Coaley switching station.
    - Dursley is looped in to one of the Ryeford-Coaley circuits.
    - Netherhills is looped in to the other Ryeford-Coaley circuit (on one side), and tee'd on to the third Ryeford-Coaley circuit (on the other side). Netherhills also has two circuits to Lydney BSP network, normally run open.
    - Berkeley has two dedicated circuits from Coaley.
    - Hammerley Down also has a dedicated circuit from Coaley but is normally fed from Chipping Sodbury BSP.

The group is class D under Engineering Recommendation P2, with a group demand expected to exceed 100 MW by 2027. There is about 15 MW of interconnection to Lydney BSP that allows Ryeford to remain P2 compliant but only until 2030 when the group demand is expected to exceed 115 MW.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.10.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Ryeford N-2 compliance	N-2: Arranged outage of one 132 kV infeeds to Ryeford, followed by a fault of the other; where the group demand exceeds 100 MW	2030	2031	2033	2034
Ryeford grid transformer overload	N-1: Outage of either 132 kV circuit to Ryeford taking out two GTs	Baseline	2025	2029	2031
Coaley to Netherhills 33 kV circuit overload	N-1: Outage of the direct 33 kV circuit to Netherhills from Ryeford [Generation constraint only]	-	-	-	Baseline
Ryeford to Netherhills 33 kV circuit overload	N-1: Busbar outage at Ryeford 33 kV taking out the circuits to Dursley and to Coaley/Netherhills tee	2029	2029	2029	2030
Ryeford to Coaley tee 33 kV circuit overload	N-1: Busbar outage at Ryeford 33 kV taking out the direct circuit to Coaley, and the direct circuit to Netherhills	2029	2029	2029	2030

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 3.10.2 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	Upgrading the existing network	✓	✓	×	Viable
3	Establishing a new BSP at Cambridge Arms	✓	✓	×	Viable
Operational mitigation					
4	Load transfers	×	✓	×	Discounted
Load Management Schemes					
5	Post-fault inter-trips	×	✓	×	Discounted
Flexibility services					
6	Flexibility service procurement	✓	✓	×	Discounted

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: Some of the constraints are imminent and the demand is projected to continue increasing. Doing nothing could therefore lead to thermal overloads, voltages going beyond statutory limits, and the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Rating of existing circuits and P2 compliance

Option 2 – Uprating the existing network

Estimated capacity released: 60 MVA

Viable

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

- Extending the 132 kV busbars at Cambridge Arms (on the Port Ham side) to establish a new feeder bay.
- Installing approximately 10 km of 132 kV circuit from Cambridge Arms to Ryeford BSP
- At Ryeford BSP:
    - Taking back the existing 132 kV tower line connections to create space around the 132 kV busbars, and reconnecting through short cable lengths and sealing ends
    - Extending these busbars to include three bus-section circuit breakers, such that the GTs are effectively unbanked
    - Creating an additional bay for the new 132 kV circuit from Cambridge Arms
    - Operating the 132 kV busbars solid
- Uprating approximately 1.4 km of 0.15 in Cadmium Copper (CadCu) 33 kV overhead tower line circuit between Coaley/Netherhills tee and Netherhills primary to achieve a minimum summer cyclic rating of 30 MVA anticipated to require 200 mm AAAC designed to 75 degrees.
- Uprating approximately 5.8 km of 0.15 in CadCu 33 kV overhead tower line circuit between Ryeford and Netherhills (direct feeder), to achieve a minimum winter cyclic rating of 37 MVA, anticipated to require 200 mm AAAC designed to 75 degrees (for overhead sections) and 400 mm copper cable (for any underground sections).
- Uprating approximately 4.5 km of 0.15 in CadCu 33 kV overhead tower line circuit between Ryeford and Coaley/Netherhills tee, to achieve a minimum winter cyclic rating of 37 MVA, anticipated to require 200 mm AAAC designed to 75 degrees (for overhead sections) and 400 mm copper cable (for any underground sections).
- Carrying out site checks allowing the existing transformers at Ryeford BSP to utilise their cyclic ratings; this will mitigate the observed GT overload until 2029.

New limiting factor: Rating of the circuits and GTs

Option 3 – Establishing a new BSP at Cambridge Arms

Estimated capacity released: 60 MVA

Viable

Detailed description: Establishing a new BSP at Cambridge Arms, the works would include:

- Extending the 132 kV busbars at Cambridge Arms (on the Port Ham side) to establish two new feeder bays (one effectively banked with the Lydney circuit).
- Installing two 132/33 kV GTs at Cambridge Arms, rated 90 MVA each; their connectivity onto the 132 kV busbars may need to be via short cable sections and sealing ends due to space restrictions.
- Installing a 2-section 33 kV indoor board at Cambridge Arms.
- Splitting the 33 kV busbars at Netherhills and installing 3.5 km of 33 kV circuit from the new BSP to Netherhills to pick up T2 only; the circuit is anticipated to be 400 mm copper cable.
- Installing two 3.5 km 33 kV circuits (anticipated to be 630 copper cable each) from the new BSP to Coaley switching station to pick up Berkeley primary under normal running, with the option of transferring in Dursley during certain outages. [Additional bays and bus-section circuit breakers may be required at Coaley to facilitate this configuration.]
- Carrying out site checks allowing the existing transformers at Ryeford BSP to utilise their cyclic ratings; this will mitigate the observed GT overload until 2029.

New limiting factor: Rating of the circuits

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: 10 MVA+

Discounted

Detailed description: Ryeford has limited 11 kV interconnection to other BSPs, but has a 33 kV interconnection to Lydney BSP via the transfer of Netherhills primary. This may be able to manage the baseline constraints in the interim but would not be sufficient as a long term solution.

In addition to this, some of the generation constraints may also be managed using Active Network Management (ANM) schemes (or similar) but this would not be able to resolve the demand overloads nor the P2 compliance constraints.

New limiting factor: Rating of existing circuits and P2 compliance

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: Ryeford BSP is Class D under Engineering Recommendation P2 which would require the immediate restoration of the group demand minus 20 MW following a first circuit outage, with restoration of the full demand within 3 hours; therefore demand disconnection schemes (or similar) would make the site non-compliant.

As the group demand exceeds 100 MW, a third infeed would become necessary making this option less viable.

New limiting factor: Rating of existing circuits and P2 compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 0 MW

Discounted

Detailed description: Flexibility services through generation turn up and/or demand turn down could help alleviate some thermal constraints for specific outage conditions but it could become more detrimental to the network if different fault outages occur, considering the parallel ring configuration of the network. It would also not resolve the N-2 group compliance constraints, nor the generation driven ones.

New limiting factor: Rating of existing circuits, and P2 compliance

Solution Recommendation

It would be recommended to pursue option 3 above (establishing a new BSP) as it will likely be a more enduring solution, and more cost-effective in the long run.

As mentioned above, option 4 (operational mitigation) may also be implemented in the interim to manage the baseline constraints but it is not a viable long term solution.

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