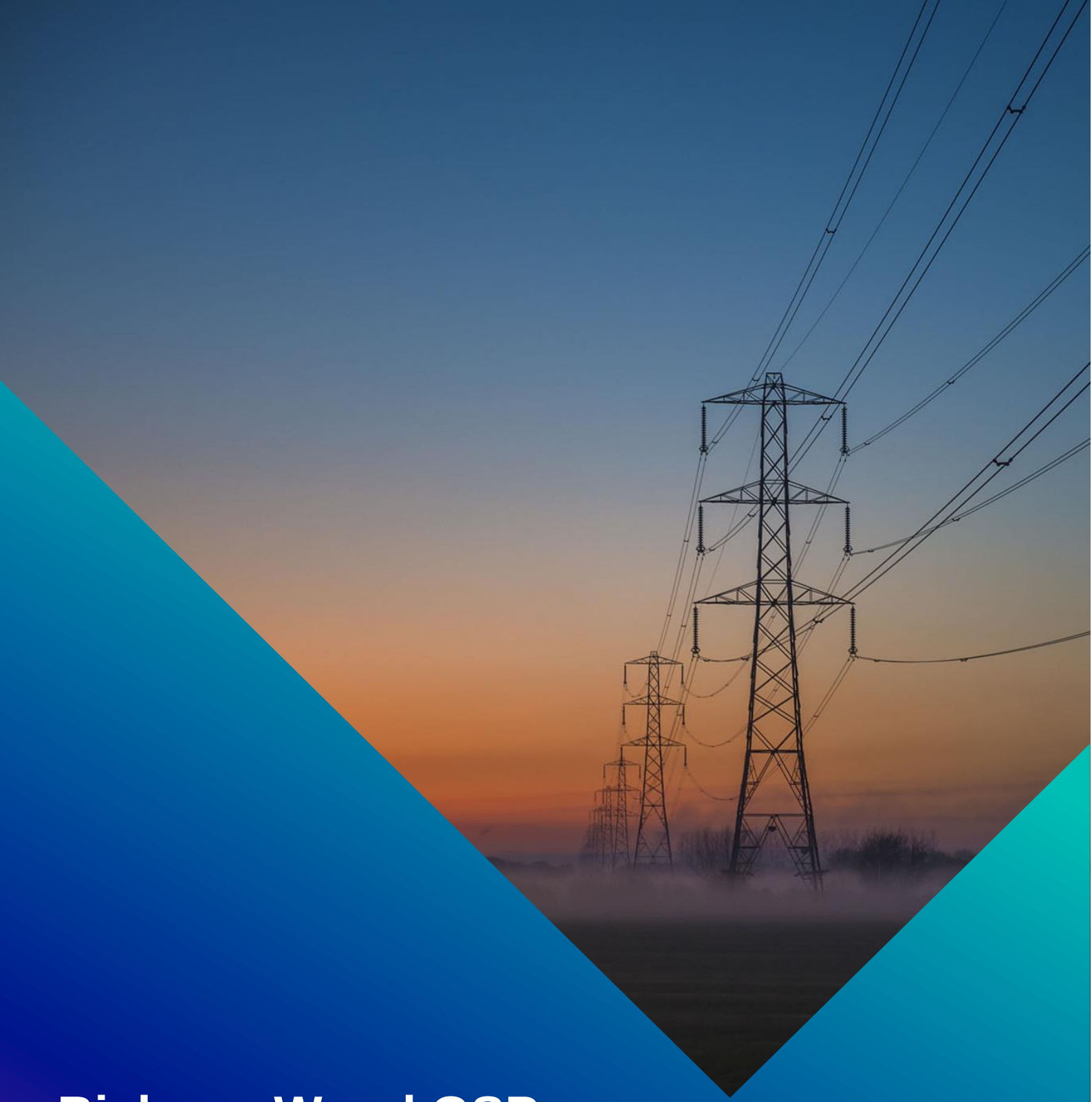

Bishops Wood GSP Network

Network Development Report – West Midlands

May 2024

Electricity Distribution

nationalgrid

Contents

Bishops Wood GSP Network

1. Network Overview

Bishops Wood is a 132 kV Grid Supply Point (GSP) that supplies a relatively large area covering the majority of Herefordshire and parts of Shropshire, Worcestershire and Gloucestershire, connecting over 250,000 customers. The network comprises several 132 kV circuits supplying nine Bulk Supply Points (BSPs) in total; covering 132/66 kV, 132/33 kV and 132/11 kV sites.

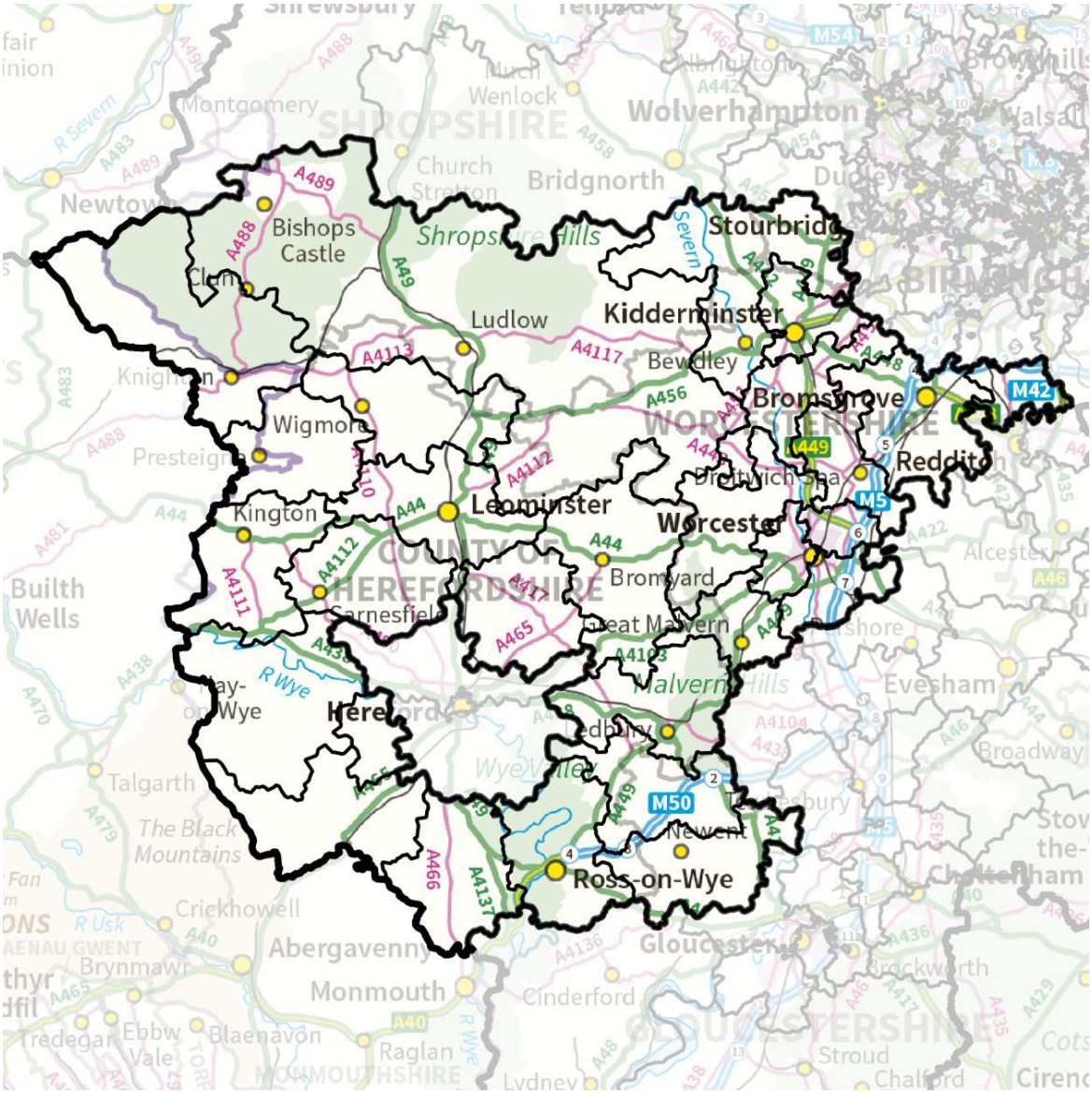

Figure 1.1 Bishops Wood GSP geographic network coverage

This report discusses existing and future network constraints over a 0-10 year horizon associated with Bishops Wood 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

Bishops Wood GSP is a 275/132 kV site fed via four 240 MVA Super Grid Transformers (SGTs), three of which normally run solid and one on hot-standby. They are connected to a 132 kV double busbar configuration with two mains and two reserves.

The 132 kV network consists of a few radial feeders (double circuits to Ludlow BSP, and double circuits to Stourport and Kidderminster BSPs); but also includes 132 kV circuits normally run as a closed ring connecting Upton Warren, Warndon, Timberdine, Malvern, Worcester, and Hereford BSPs.

Kidderminster, Warndon, Timberdine, Malvern, and Worcester are all 11 kV BSPs supplying local demands.

The other BSPs within the group also have 66 kV and 33 kV downstream networks:

- Hereford BSP consists of 3x 132/66 kV Grid Transformers (GTs) that run in parallel with a 132/66 kV GT at Ludlow, suppling 17x primary substations in total, most of which are connected to 66 kV rings that are interconnected and run in parallel.
- Ludlow BSP consists of a single 132/66 kV GT that runs in parallel with Hereford BSP (as mentioned above), and two 132/33 kV GTs supplying 5x primary substations split into two independent 33 kV rings.
- Stourport BSP consists of a single 132/33 kV GT that supplies a local primary and three others via a single 33 kV circuit, with interconnection to Hinksford BSP (fed out of Penn GSP), normally run split.

  The BSP also includes a single 132/66 kV GT which also supplies a local 66 kV primary and a couple of circuits that interconnect with Hereford BSP and Upton Warren BSP, both feeders normally run split.
- Upton Warren BSP consists of a single three-winding 132/11/11 kV GT supplying local demand, and a 132/66 kV GT interconnected with Stourport BSP but not normally running in parallel with it.

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.

Bishops Wood 132 kV:

- Automation scheme that closes in SGT1 (normally on hot-standby) following a fault of one of the other three SGTs.
- Arranged outages of any SGT results in SGT1 (normally on hot-standby) to be closed in.
- Arranged or fault outages leading to loss of a grid transformer at Upton Warren, Warndon, Timberdine, Malvern, and Worcester BSPs results in the 11 kV at these sites being closed in to backfeed from the other transformer(s).

Hereford BSP:

- Arranged outages of any of the three GTs results in the network between the remaining two GTs in-service being run split, with Bromyard and Kenswick primaries being transferred to Stourport.
- Arranged outages of any of the main feeders into the Hereford-Ludlow 66 kV interconnected network results in split arrangements, typically through Kington and Presteigne.
- Arranged outages of either of the main feeders into the Hereford-Ledbury-Dymock-Ross 66 kV ring results in a split configuration through Hereford South 66 kV, to split out this ring from the Hereford-Madley-Peterchurch-Pontrilas ring.
- Similarly to the above, arranged outages of any of the main feeders into Hereford-Madley-Peterchucrh-Pontrilas 66 kV ring results in a split configuration at Hereford South 66 kV, to split out this ring from the Hereford-Ledbury-Dymock-Ross ring.

- Arranged or fault outages leading to loss of a primary transformer at Leominster, Bromyard, Kenswick, Woofferton, Presteigne, Newent, and Ledbury results in the 11 kV at these sites being closed in to backfeed from the other transformer(s).

[There are ongoing works to install a Statcom at Dymock primary substation in order to mitigate 66 kV voltage constraints around the Hereford-Ledbury-Dymock-Ross ring.]

Ludlow BSP (33 kV side):

- Arranged outages that split up the 33 kV busbars at Ludlow BSP results in the other side (normally run open) to be closed in to maintain parallels.
- Arranged outages of the infeed to Leebotwood (via Craven Arms) results in the site being picked up from Ironbridge BSP.
- Arranged outages of the infeed to Bishops Castle (via Craven Arms) results in the site being picked up from Shrewsbury BSP.
- Arranged or fault outages leading to loss of a primary transformer at Ludlow 11 kV, Cleobury Mortimer, Craven Arms, Leebotwood, and Bishops Castle results in the 11 kV at these sites being closed in to backfeed from the other transformer(s).

Stourport BSP:

- Arranged outages of the 132/66 kV GT results in:
    - Stourport 66/11 kV transformer being picked up from Upton Warren BSP
    - Droitwich primary being picked up from Feckenham GSP
    - Kenswick T2 being picked up from Hereford BSP
- Arranged outages of the 132/33 kV GT at Stourport results in:
    - Stourport 33/11 kV demand being picked up from the 66/11 kV transformers
    - Wribbenhall primary and Kinver T1 being picked up from Hinksford BSP (fed out of Penn GSP)
    - Quatt T1 being picked up from Ironbridge BSP (fed out of Ironbridge GSP)
- Arranged or fault outages leading to loss of a primary transformer at Stourport, Kinver, Quatt, Kenswick, and Droitwich, results in the 11 kV at these sites being closed in (reconfigured in some cases) to backfeed from the other transformer(s).

Upton Warren BSP:

- Arranged outages of the 132/66 kV GT results in :
    - Stourport T4 being pick up by Stourport BSP
    - Redditch North T3 being picked up by Feckenham GSP

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:

- Bishops Wood to Worcester-Hereford-Malvern 132 kV ring
    - Bishops Wood to Worcester 132 kV circuit overload
    - Bishops Wood to Upton Warren/Timberdine Tee 132 kV circuit overload
    - Bishops Wood to Hereford_103 132 kV circuit overload
- Hereford and Ludlow 66 kV network
    - Hereford to Bodenham 66 kV circuit overload
    - Bodenham to Leominster 66 kV circuit overload
    - Ludlow to Woofferton 66 kV circuit overload
    - Hereford and Ludlow 66 kV voltage restrictions
- Knighton primary backfeed capacity
- Dymock primary backfeed capacity
- St Weonards primary backfeed capacity
- Newent transformer T2 overload
- Ross transformer overload
- Ledbury transformer overload
- Bromyard transformer overload
- Hereford grid transformer GT1 and GT2 overload
- Hereford_8L5 to Hereford South_1L9B 66 kV circuit overload
- Ludlow to Craven Arms_4L3 33 kV circuit overload
- Stockton primary backfeed capacity
- Craven Arms transformer T4 overload
- Ludlow primary transformer overload
- Stourport primary transformer overload
- Stourport to Wribbenhall 33 kV network
    - Stourport to Wribbenhall 33 kV circuit overload
    - Wribbenhall 33 kV low volts

Transmission-Distribution interface

Bishops Wood GSP is a 275/132 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, have triggered constraints at the transmission network with regards to SGT capacity and 275 kV circuit ratings. Proposals to mitigate are being considered including uprating the existing assets at the GSP or establishing another GSP at a location suitable for the region.

3. Network Constraints and Solution Options

3.1 Bishops Wood to Worcester-Hereford-Malvern 132 kV ring

Constraint Overview

Generation Demand

Bishops Wood has several 132 kV circuits, a few of which are configured in a ring arrangement supplying Upton Warren, Warndon, Timberdine, Malvern, and Hereford BSPs.

There are two circuits either side feeding the ring,

- A pair to Malvern BSP, with a double tee'd connection to Upton Warren, a loop via Timberdine on the one circuit, and another loop via Warndon on the other;
- A pair to Worcester BSP, with one of the circuits looping via Hereford BSP;
- The ring is then completed by a circuit between Malvern and Worcester BSPs.

All four circuits into the ring come from Main 1 and Reserve 1 double busbars at Bishops Wood, run in parallel via the other side of the double busbar arrangement because of the absence of a bus-coupler between Main 1 and Reserve 1.

The group is currently Class D under Engineering Recommendation P2, with the maximum demand exceeding 240 MW, requiring the need for N-2 requirements of restoring, within 3 hours, the smaller of: group demand minus 100 MW or a third of group demand.

The table below outlines the constraints identified for Best View, the conditions they occur 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
Bishops Wood to Worcester 132 kV circuit overload	N-1: Fault outage of Bishops Wood busbar Main 1 taking out a 132 kV circuit to Hereford, and another to Upton Warren/Timberdine	2025	2025	2025	2032
Bishops Wood to Upton Warren/Timberdine Tee 132 kV circuit overload	N-1: Fault outage of Bishops Wood reserve busbars taking out a 132 kV circuit to Worcester, and another to Upton Warren/Warndon	2031	2032	2033	-
Bishops Wood to Hereford_103 132 kV circuit overload	N-1: Fault outage of Bishops Wood reserve busbars taking out a 132 kV circuit to Worcester, and another to Upton Warren/Warndon	2031	2032	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	Reinforcing the existing 132 kV circuits	✓	×	×	Discounted
3	Establishing a 132 kV switching site and a new circuit to the group	✓	✓	✓	Viable
Operational mitigation					
5	Network reconfiguration	✓	✓	×	Viable
Load Management Schemes					
6	Post-fault inter-trips	✓	✓	×	Viable
Flexibility services					
7	Flexibility service procurement	×	✓	×	Discounted

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 2025 with the demand projected to continue increasing thereafter. Doing nothing could therefore lead to thermal overloads, as described above, which could subsequently have health and safety implications.

New limiting factor: Rating of existing 132 kV circuits

Option 2 – Reinforcing existing 132 kV circuits

Estimated capacity released: 100 MVA

Discounted

Detailed description: Uprating the existing 132 kV circuits, these include:

- Bishops Wood to Worcester 132 kV circuit, comprising of:
  - 1 km of 0.5 in copper oil filled cable, and
  - 14 km of 300 mm All Aluminium Alloy conductor (AAAC) on PL1 towers
- Bishops Wood to Upton Warren/Timberdine Tee 132 kV circuit, comprising of:
  - 1.2 km of 1.5 in copper oil filled cable, and
  - 4.5 km of 0.175 in twin conductor on L7 towers
- Bishops Wood to Hereford 132 kV circuit, comprising of:
  - 1.1 km of 0.5 in copper oil filled cable, and
  - 10 km of 300 mm AAAC on PL1 towers
  - 32 km of 300 mm AAAC on PL16 towers

Uprating these circuits would require a rebuild of the tower lines to achieve the desired ratings, and this would mean a significant amount of reinforcement considering the total lengths involved with the circuits in question.

New limiting factor: Rating of the circuits within the ring

Option 3 – Establishing a 132 kV switching site and a new circuit to the group

Estimated capacity released: 150 MVA+ **Viable**

Detailed description: Adding a new circuit to the group, the works include:

- Establishing a new 132 kV bay at Bishops Wood GSP, or where there are space restrictions, consideration to be given to establishing a switching site to the South or to the East of the existing GSP. The switching station would include:
    - A two-section double busbar 132 kV, and sufficient room for additional bays and future extensions.
    - Two suitably rated incomers (minimum of 250 MVA summer sustained rating, anticipated to be 1200 mm copper or 1600 mm copper cable laid flat) from Bishops Wood GSP.
    - The interconnectors would utilise two of the four bays that are currently used for the circuits feeding the 132 kV ring (these two circuits would be re-located to the new switching site).
- Installing a 10 km 132 kV circuit from the new switching site to a new tower teeing onto the existing Hereford-Worcester 132 kV; with consideration for an open point at Malvern or Worcester (interchangeable depending on new connection activity and how the load materialises over time).

New limiting factor: Ratings of the 132 kV circuits within the group

Option 4 – Operational mitigation: Network reconfiguration

Estimated capacity released: 0 MVA **Viable**

Detailed description: Reconfiguring the network to avoid thermal overload, this includes:

- Selecting all four circuits feeding the group (under normal running) to connect out of Bishops Wood Main 1
- Splitting the 66 kV network between Hereford and Ludlow; this may be dependent on the existing reinforcement works in that area that would enable a split configuration
- Under arranged outage conditions affecting any of the 132 kV infeeds to the ring, split the network to avoid an overload for a subsequent fault

This option would put the entire group on a single circuit busbar fault risk, which keeps the network compliant and avoids safety risks from overloading assets, but it does have a Customer Interruption (CI) and Customer Minutes Loss (CML) impact which will need to be considered.

New limiting factor: Security of supply, including CIs and CMLs

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

Estimated capacity released: 0 MVA **Viable**

Detailed description: Implementing an overload protection scheme across the 132 kV circuits feeding the ring such that any circuit overload would result in the tripping of its incoming circuit breaker. For reliability and speed of operation, the proposal would be to use hard wired schemes for these intertrips.

This option could trip the entire group demand following a busbar fault outage, which keeps the network compliant and avoids safety risks from overloading assets, but it does have a CI and CML impact, which will need to be considered.

New limiting factor: Security of supply, including CIs and CMLs

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 43 MW+ **Discounted**

Detailed description: Flexibility services through generation turn up and/or demand turn down may be of some benefit in specific outage conditions; however due to the ring arrangement dispatching flexibility services to mitigate for a particular outage could cause an overload elsewhere under a different fault outage scenario. The sensitivity would also vary between one BSP and another, adding an extra layer of complexity for the current flexibility process which could subsequently increase network risk.

New limiting factor: Rating of the existing 132 kV circuits

Solution Recommendation

In terms of reinforcement build options, it would be recommended to pursue Option 3 above (establishing a switching site and a new circuit) as it secures the network for the long term and provides a wider benefit of creating space for additional future bays. It also creates the possibility of establishing a Bishops Wood 2 GSP considering the New Connection activity triggering SGT constraints.

It is acknowledged however that the reinforcement option above, or a version of it, could be hard to justify and even so, it would be very lengthy to construct and therefore Option 4 (reconfiguring the network) or Option 5 (load management/overload protection scheme) could be utilised instead.

3.2 Hereford to Ludlow 66 kV network

Constraint Overview

Generation Demand

Hereford BSP (Bishops Wood side) is 132/66 kV site consisting of 3x GTs (1x 90 MVA and 2x 60 MVA units) fed out of two 132 kV circuits as part of the Bishops Wood 132 kV ring. The transformers connect onto one side of a 66 kV ring busbar that runs split with the other half of the busbars which are fed out of three other GTs from Port Ham GSP.

The 66 kV network within Hereford (Bishops Wood side) supplies several primary substations, and is operated in parallel, (via a heavily interconnected network) with the 132/66 kV GT at Ludlow.

The group is currently Class D 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
Hereford to Bodenham 66 kV circuit overload	N-1: Outage of the 66 kV infeed from Ludlow BSP	2027	2028	2030	-
Bodenham to Leominster 66 kV circuit overload	N-1: Outage of the 66 kV infeed from Ludlow BSP	2028	2029	2030	-
Ludlow to Woofferton 66 kV circuit overload	N-1: Outage of the 66 kV infeed via the Madley ring	2028	2031	-	-
Hereford and Ludlow 66 kV voltage restrictions	N-1: Various outages, the worst being loss of the Ludlow infeed resulting in low volts (at peak demand) and high volts (at peak generation). Some of the worst areas include Kington and Knighton.	Baseline	Baseline	Baseline	Baseline

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 circuits	×	✓	×	Discounted
3	Installing a Ludlow-Presteigne 66 kV circuit	✓	✓	×	Viable
4	Installing a Ludlow-Knighton 66 kV circuit	✓	✓	✓	Viable
Operational mitigation					
5	Load transfers	×	✓	×	Discounted
Load Management Schemes					
6	Post-fault inter-trips	×	✓	×	Discounted
Flexibility services					
7	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: The constraint is imminent with the demand projected to continue increasing. Doing nothing could therefore lead to thermal overloads, voltages dropping below statutory limits, and the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Low volts and rating of the existing circuits

Option 2 – Uprating the existing circuits

Estimated capacity released: 10-20 MVA

Discounted

Detailed description: Uprating the existing 66 kV circuits within the group, the works include:

- Hereford to Bodenham: 12.2 km circuit
- Bodenham to Leominster: 13.7 km circuit
- Ludlow to Woofferton: 7.8 km circuit

The circuit above are predominantly overhead lines and uprating to resolve the thermal issue is feasible but leaves little headroom capacity before the rest of the circuits within the 66 kV mesh trigger additional works.

The voltage constraint however remain, and to have a material impact, the circuits above would need to be undergrounded. This would still not fully resolve the voltage constraints within the network, potentially leading to breach of statutory limits due to 66 kV connected customers.

New limiting factor: Low volts at 66 kV

Option 3 – Installing a Ludlow-Presteigne 66 kV circuit

Estimated capacity released: 60 MVA

Viable

Detailed description: Installing a Ludlow-Presteigne circuit, the works include:

- Installing a second 132/66 kV GT (45/90 MVA unit) at Ludlow BSP, banked with 132/33 kV GT3.
- Extending the 66 kV busbars at Ludlow to include a bus-section circuit breaker and a 66 kV bay for the new GT, and operating both 132/66 kV GTs in parallel.
- Space limitations at Ludlow BSP may trigger the need to replace the existing 33 kV busbars with an indoor board to create room for the 66 kV works.
- Extending the 66 kV busbars at Presteigne to make provisions for a new circuit.
- Installing a new 66 kV circuit from Ludlow to Presteigne, rated at least 90 MVA winter cyclic, anticipated to be a mixture of 630 mm copper cable and 300 mm All Aluminium Alloy conductor (AAAC) overhead line circuit.
- Splitting the Ludlow and Hereford 66 kV networks via open points at Kington 2S0 and at Leominster 1S0.

New limiting factor: Rating of the other 66 kV circuits within the group

Option 4 – Installing a Ludlow-Knighton 66 kV circuit

Estimated capacity released: 60 MVA

Viable

Detailed description: Installing a Ludlow-Knighton circuit, the works include:

- Installing a second 132/66 kV GT (45/90 MVA unit) at Ludlow BSP, banked with 132/33 kV GT3.
- Extending the 66 kV busbars at Ludlow to include a bus-section circuit breaker and a 66 kV bay for the new GT, and operating both 132/66 kV GTs in parallel.
- Space limitations at the BSP may trigger the need to replace the existing 33 kV busbars with an indoor board to create room for the 66 kV works.
- Extending the 66 kV busbars at Knighton to make provisions for a new circuit, reconfiguring it such that the 66 kV generator out of Knighton is on the same section of busbar as the new circuit from Ludlow; alternatively, an intertrip scheme may need to be implemented.
- Installing a new 66 kV circuit from Ludlow to Knighton, rated at least 90 MVA winter cyclic, anticipated to be a mixture of 630 mm copper cable and 300 mm AAAC overhead line circuit.
- Uprating the existing 8.9 km of 66 kV circuit between Knighton and Presteigne; rebuilding it from 0.1 in Aluminium Conductor Steel Reinforced (ACSR) overhead line to a 300 mm AAAC circuit; any necessary cable sections are anticipated to be of 630 mm copper conductor.
- Splitting the Ludlow and Hereford 66 kV networks via open points at Kington 2S0 and at Leominster 1S0.

New limiting factor: Rating of the other 66 kV circuits within the group

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: Very limited

Discounted

Detailed description: The group already runs interconnected at 66 kV with other rings within Hereford BSP, and as a result 11 kV interconnections out of the group are very limited and insufficient to mitigate the constraints.

For certain outages, there are running arrangement that could be implemented to minimise network risk but this is not enough to secure the network longer term.

New limiting factor: Low volts and rating of existing circuits

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: The group is Class D under Engineering Recommendation P2 which, for a first circuit outage, would require immediate restoration of the demand minus 20 MW and full group demand within 3 hours; 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): 20 MW+ (for thermal constraints)

Discounted

Detailed description: Flexibility services through generation turn up and/or demand turn down may reduce some risk on specific thermal overload scenarios, but it could be more detrimental to the network if different fault outages occur, considering the parallel meshed configuration of the network. It is also not effective for the voltage constraints, nor for the generation triggered ones.

New limiting factor: Power Quality, low volts, and rating of existing circuits

Solution Recommendation

Both Option 3 (a Ludlow-Presteigne circuit) and Option 4 (a Ludlow-Knighton circuit) have merit and are closely matched.

Option 3 resolves the network constraints and allows for a split configuration between Hereford and Ludlow which simplifies the network and enables better 132 kV configurations.

Option 4 also resolves the network constraints and allows for a split configuration between Hereford and Ludlow (similar to Option 3), but in addition to that, this option facilitates reinforcement of Knighton primary by creating a second 66 kV supply to the site negating the need for another Knighton to Presteigne circuit and avoiding 66 kV busbar extensions at two primaries instead of one.

The final reinforcement solution would remain subject to a more detailed cost benefit analysis.

3.3 Knighton primary backfeed capacity

Constraint Overview

Generation Demand

Knighton is a single 66/11 kV transformer site that relies on 11 kV interconnection to other primary substations for security of supply. The site 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 3.3.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Knighton primary backfeed capacity	N-1: Outage of the primary transformer at Knighton	Baseline	Baseline	Baseline	-

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 11 kV backfeed capacity	✓	✓	×	Viable
3	Adding a second circuit and 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: 11 kV backfeed capacity

Option 2 – Upgrading the 11 kV backfeed capacity

Estimated capacity released: 5 MVA+ **Viable**

Detailed description: Upgrading the 11 kV interconnections to other primary substations such as Presteigne (approximately 9 km away), could mitigate the constraint for the foreseeable future.

[The current capacity is assumed to be approximately 5.5 MVA, it would be worth carrying out a re-assessment of this existing capacity before commencing any physical works.]

New limiting factor: 11 kV backfeed capacity

Option 3 – Adding a second circuit and transformer

Estimated capacity released: 11 MVA **Viable**

Detailed description: Installing a second circuit and transformer at Knighton, the works are split into two parts:

Circuit works:

- Option a: modifying the existing Ludlow-Presteigne scheme to become a Ludlow-Knighton scheme, creating a second 66 kV infeed into Knighton. Details of the works are covered under Option 4 in the section 3.2 above.
- Option b: Extending the 66 kV busbars at Knighton and at Presteigne, and installing a 9 km 66 kV circuit between Presteigne and Knighton.

Substation works:

- Installing a second 7.5/15 MVA 66/11 kV transformer at Knighton primary.
- Extending the 11 kV board or installing an additional section interconnected with the existing, to allow for a transformer circuit breaker and sufficient transfers from the existing board.

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: Very limited **Discounted**

Detailed description: The substation already relies on 11 kV backfeed for security of supply, and has very limited other 11 kV backfeed.

These interconnections however could help manage the Baseline constraints in the interim, but would not be a viable long term solution.

New limiting factor: 11 kV backfeed capacity

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

Estimated capacity released: 0 MW **Discounted**

Detailed description: The primary is Class B under Engineering Recommendation P2 which would require restoration of the group demand minus 1 MW within 3 hours for a circuit outage; therefore demand disconnection schemes (or similar) would make the site non-compliant in the foreseeable future as the shortfall exceeds 1 MW.

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: 11 kV backfeed capacity

Solution Recommendation

With regards to reinforcement build options, both Option 2 (upgrading the 11 kV backfeed) and Option 3 (adding a second circuit and transformer) have merit and would therefore be subject to a more detailed assessment.

However given that the trigger is fairly imminent, it would be worth pursuing a detailed 11 kV backfeed assessment in the first instance, to assert the existing capacity before carrying out physical 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 Distribution Network Options Assessment (DNOA) process.

3.4 Dymock primary backfeed capacity

Constraint Overview

Generation Demand

Dymock is a single 66/11 kV transformer site that relies on 11 kV interconnection to other primary substations for security of supply. The site 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
Dymock primary backfeed capacity	N-1: Outage of the primary transformer at Dymock	2030	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	Upgrading the 11 kV backfeed capacity	✓	✓	×	Viable
3	Adding a second 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 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: 11 kV backfeed capacity

Option 2 – Upgrading the 11 kV backfeed capacity

Estimated capacity released: 5 MVA+

Viable

Detailed description: Upgrading the 11 kV interconnections to other primary substations such as Ledbury (13 km away), Newent (7 km away), and Ross (11 km away), could resolve the constraint especially since the shortfall is relatively small.

[The current capacity is assumed to be approximately 5 MVA, it would be worth carrying out a re-assessment of this existing capacity before commencing any physical works.]

New limiting factor: 11 kV backfeed capacity

Option 3 – Adding a second transformer

Estimated capacity released: 10 MVA

Viable

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

- Extending the 66 kV busbars to include a 66 kV transformer bay.
- Installing a second 66/11 kV transformer rated 7.5/15 MVA, connected to the other section of the existing 11 kV board

[There are ongoing works at Dymock to purchase additional land and install a Statcom, therefore space for an additional transformer may be limited and further land purchase may be required; this adds risk to the deliverability of the scheme.]

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: 0 MW

Discounted

Detailed description: The substation already relies on 11 kV backfeed for security of supply, which is the existing limiting factor.

New limiting factor: 11 kV backfeed capacity

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

Estimated capacity released: 0 MW

Discounted

Detailed description: The primary is Class B under Engineering Recommendation P2 which would require restoration of the group demand minus 1 MW within 3 hours for a circuit outage; therefore demand disconnection schemes (or similar) would make the site non-compliant in the foreseeable future as the shortfall exceeds 1 MW.

New limiting factor: Engineering Recommendation P2 non-compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 0.5 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: 11 kV backfeed capacity

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue Option 2 above (upgrading the 11 kV interconnection) as this is likely to be the most cost-effective and deliverable solution. The site is also not expected to become Class C under Engineering Recommendation P2 (for the foreseeable future), making this option long-lasting.

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 St Weonards primary backfeed capacity

Constraint Overview

Generation Demand

St Weonards is a single 66/11 kV transformer site that relies on 11 kV interconnection to other primary substations for security of supply. The site 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
St Weonards primary backfeed capacity	N-1: Outage of the primary transformer at St Weonards	2025	2027	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 3.5.2 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	Upgrading the 11 kV backfeed capacity	✓	✓	✓	Viable
3	Adding a second circuit and 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 2025 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: 11 kV backfeed capacity

Option 2 – Upgrading the 11 kV backfeed capacity

Estimated capacity released: 5-7 MVA

Viable

Detailed description: Upgrading the 11 kV interconnections to other primary substations, mainly Stowfield (10 km away) could alleviate the constraints especially since the shortfall is relatively small.

[The current capacity is assumed to be approximately 3.5 MVA, it would be worth carrying out a re-assessment of this existing capacity before commencing any physical works.]

New limiting factor: 11 kV backfeed capacity

Option 3 – Adding a second circuit and transformer

Estimated capacity released: 11 MVA

Viable

Detailed description: Adding a second circuit and transformer on site, the works include:

- Establishing a 66 kV switching site, to include a 2-section busbar with a bus-section circuit breaker, at the existing St Weonards tee point location
- Installing a 6 km 66 kV circuit from this new switching station to St Weonards primary (effectively creating two radial feeders from the existing tee point to avoid looping and adding impedance to a ring already having low volts)
- Installing a second 66/11 kV transformer at St Weonards, rated 7.5/15 MVA
- Extending the 11 kV busbars to include a transformer incomer and additional feeder circuit breakers to pick up demand from the existing transformer

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: 0 MW

Discounted

Detailed description: The substation already relies on 11 kV backfeed for security of supply, which is the existing limiting factor.

New limiting factor: 11 kV backfeed capacity

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

Estimated capacity released: 0 MW

Discounted

Detailed description: The primary is Class B under Engineering Recommendation P2 which would require restoration of the group demand minus 1 MW within 3 hours for a circuit outage; therefore demand disconnection schemes (or similar) could make the site non-compliant in the foreseeable future as the shortfall exceeds 1 MW.

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: 11 kV backfeed capacity

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue Option 2 above (upgrading the 11 kV interconnection) as it is likely to be the most cost-effective and it provides a wider benefit of increasing the capacity at Stowfield primary which is also a single transformer site.

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 Newent transformer T2 overload

Constraint Overview

Generation Demand

Newent primary is 66/11 kV site consisting of two primary transformer fed from Hereford BSP. It has two 66 kV radial circuits from Dymock primary. The site 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 3.6.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Newent transformer T2 overload	N-1: Outage of Newent transformer T1	Baseline	Baseline	2025	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 3.6.2 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	Uprating the existing transformer	✓	✓	×	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 transformer T2

Option 2 – Uprating the existing transformer

Estimated capacity released: 8 MVA

Viable

Detailed description: Replacing the existing transformer T2 (commissioned in 1966) with a 20/40 MVA unit.

The existing 11 kV board is already 2000 amp rated therefore no upgrade works required.

New limiting factor: Rating of transformer T1 which is 12/24 MVA rated

Option 3 – Adding a third transformer

Estimated capacity released: 18 MVA

Viable

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

- Extending the 66 kV busbars at Newent to create 3x sections with 2x bus-section circuit breakers, 3x transformer bays, and 2x circuit incomers.
- Installing a third 12/24 MVA transformer
- Installing a new 2-section 11 kV board suitably interconnected with the existing
- Additional land may need to be purchased to accommodate the new assets above.

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A few MVAs

Discounted

Detailed description: Newent primary has limited 11 kV interconnection to other primary substations which is insufficient to alleviate all the constraint.

The interconnections however could help manage the Baseline constraints in the interim, but would not be a viable long term solution.

New limiting factor: Rating of transformer T2

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: Newent primary is currently 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): 9 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 transformer T2

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue Option 2 above (replacing the existing transformer) as it will likely be more cost-effective especially when considering its age.

As mentioned above, Option 4 (operational mitigation) can 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.

3.7 Ross transformer overload

Constraint Overview

Generation **Demand**

Ross primary is a 66/11 kV site consisting of two 12/24 MVA transformers (commissioned in 2020) fed from Hereford BSP via the Hereford-Ross-Dymock-Ledbury ring. 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
Ross transformer overload	N-1: Outage of either of the two transformers at Ross	-	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 3.7.2 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 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 transformers (commissioned in 2020) with 20/40 MVA units
- Replacing the existing 1250 amp 11 kV board with a 2000 amp one

New limiting factor: Rating of transformers and circuits

Option 3 – Adding a third transformer

Estimated capacity released: 18 MVA

Viable

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

- Installing a third 12/24 MVA rated 66/11 kV transformer at Ross, connected to the middle section of the existing 66 kV busbars, and utilising the spare transformer bay on site
- Extending the 66 kV busbars where T3 is connected to allow for the circuit to Hereford to be relocated there
- Installing an additional 11 kV 2-section board suitably interconnected with the existing; it is anticipated that this would fit towards the north end corner of the existing substation boundary

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A few MVAs

Discounted

Detailed description: Ross primary has limited 11 kV interconnection to other sites, which is insufficient 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: Ross primary is Class C under Engineering Recommendation P2 which would require restoration of the 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): 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 will likely be more cost-effective and avoid having to decommission relatively new assets that still have many years of service.

Given the constraints are observed in the intermediate cool and intermediate warm seasons only, and that the demand is not dominated by commercial nor industrial load, it will be worth re-assessing the seasonal ratings of these transformers prior to commencing any physical 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.

3.8 Ledbury transformer overload

Constraint Overview

Generation | **Demand**

Ledbury primary is 66/11 kV site consisting of two 12/24 MVA primary transformers (commissioned in 1966) fed from Hereford BSP via the Hereford-Ross-Dymock-Ledbury ring. 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 3.8.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Ledbury transformer overload	N-1: Outage of either of the two transformers at Ledbury	-	2029	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 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 12/24 MVA 66/11 kV transformers (commissioned in 1966) with 20/40 MVA units.

The 11 kV board is already 2000 amp rated (commissioned in 2013) therefore would not require works.

New limiting factor: Rating of transformers

Option 3 – Adding a third transformer

Estimated capacity released: 18 MVA

Viable

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

- Installing a third 66/11 kV transformer, rated 12/24 MVA, at Ledbury
- Installing an additional 11 kV 2-section board suitably interconnected with the existing
- Purchasing additional land may be required to accommodate the new assets above

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A few MVAs

Discounted

Detailed description: Ledbury primary has limited 11 kV interconnection to other sites, which is insufficient 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: Ledbury primary is Class C under Engineering Recommendation P2 which would require restoration of the 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 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 will likely be more cost-effective overall especially when considering the age of the existing transformers.

Given the constraints are observed in the intermediate cool and intermediate warm seasons only, and that the demand is not dominated by commercial nor industrial load, it will be worth re-assessing the seasonal ratings of these transformers prior to commencing any physical 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.

3.9 Bromyard transformer overload

Constraint Overview

Generation Demand

Bromyard primary is 66/11 kV site consisting of two 10/13 MVA primary transformers fed from Hereford BSP. T1 was commissioned in 1959, and T2 in 1993.

The primary is Class B under Engineering Recommendation P2, expected to become Class C by 2031.

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
Bromyard transformer overload	N-1: Outage of either of the two transformers at Bromyard	2032	2026	2027	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 3.9.2 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 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 2026 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: 25 MVA

Viable

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

- Replacing the existing 66/11 kV transformers, rated 10/13 MVA, with 20/40 MVA units (replacing with 12/24 MVA transformers would become insufficient by 2040).
- Replacing the existing 11 kV board with a 2000 amp rated one.

New limiting factor: Rating of transformers

Option 3 – Adding a third transformer

Estimated capacity released: 13 MVA

Viable

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

- Extending the existing 66 kV busbars to allow for two bus-section circuit breakers and a third transformer bay
- Installing a third 66/11 kV transformer, rated 12/24 MVA
- Installing an additional 2-section 11 kV board suitably interconnected with the existing
- Purchasing additional land may be required to accommodate the new assets above

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A few MVAs

Discounted

Detailed description: Bromyard primary has limited 11 kV interconnection to other sites, which is insufficient 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: Bromyard primary is Class B under Engineering Recommendation P2, expected to become Class C by 2031, which would require restoration of the 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): 4.5 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 will be more deliverable and cost-effective overall 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 DNOA process.

3.10 Hereford GT1 and GT2 overload

Constraint Overview

Generation Demand

Hereford BSP (Bishops Wood side) consists of three GTs (GT1 and GT2 being 40/60 MVA transformers, while GT3 is a 45/90 MVA transformer) fed via two 132 kV circuits, and connected to a 66 kV ring busbar configuration that runs solid.

The site is currently Class D 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 3.10.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Hereford grid transformer GT1 and GT2 overload	N-1: Busbar fault at 66 kV taking out GT2 and associated feeders splits the busbars and puts majority of the demand on GT1 causing it to overload; or	Baseline	Baseline	Baseline	2030
Hereford grid transformer GT1 and GT2 overload	N-1: Circuit/transformer fault at GT3 would marginally overload GT1 and GT2	2031	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 3.10.2 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	Uprating the existing transformers	✓	✓	×	Viable
3	Adding a Hereford-Hereford South circuit	✓	✓	✓	Viable
Operational mitigation					
5	Network reconfiguration	✓	✓	×	Discounted
Load Management Schemes					
6	Post-fault inter-trips	✓	✓	×	Discounted
Flexibility services					
7	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: The constraint is imminent and the demand is projected to continue increasing. Doing nothing could therefore lead to thermal overloads, as described above, which could subsequently have health and safety implications. There is also a risk of becoming non-compliant with Engineering Recommendation P2.

New limiting factor: Rating of GT1 and GT2

Option 2 – Reinforcing the existing transformers

Estimated capacity released: 60 MVA

Viable

Detailed description: Uprating the transformers, the works include:

- Replacing GT1, which is a 40/60 MVA 132/66 kV transformer commissioned in 2004, with a 60/90 MVA unit
- Replacing GT2, which is also a 40/60 MVA 132/66 kV transformer commissioned in 2002, with a 60/90 MVA unit

New limiting factor: Rating of the GT3

Option 3 – Adding a Hereford-Hereford South circuit

Estimated capacity released: 30 MVA

Viable

Detailed description: Adding a new Hereford to Hereford South circuit, the works include:

- Establishing a new 66 kV bay on the GT3 side of the existing busbars at Hereford BSP; where space may be restricted, consideration to be given to banking a new feeder with one of the generation schemes connected at Hereford GT3 side.
- Installing a new 66 kV circuit from the new bay at Hereford BSP (or banked with an existing generation scheme as per above) to Hereford South, picking up the circuit to the Ross-Dymock-Ledbury ring. This unstitches the ring from the Madley-Peterchurch-Pontrilas network which would remain supplied via the existing Hereford_8L5 to Hereford South_1L9B circuit.
- The new circuit is anticipated to be approximately 7 km, requiring a minimum of 90 MVA winter cyclic rating, expected to consist of a mixture of 630 mm copper cable and 300 mm AAAC overhead line designed to 75 degrees.
- Carrying out site checks allowing the existing transformers (specifically GT1 and GT2) to utilise their cyclic ratings.

New limiting factor: Rating of GT1 and GT2

Option 4 – Operational mitigation: Load Transfer

Estimated capacity released: A few MVAs

Discounted

Detailed description: Load transfers to outside of the Hereford group are fairly limited and would not be sufficient to mitigate the constraints highlighted above.

This option however may be utilised to manage part of the baseline line constraints in the interim, but it is not a long term viable solution.

New limiting factor: Rating of GT1 and GT2

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: Implementing an overload protection scheme, could be set up to trip the overloaded GTs but this could push the constraint onto the Ludlow 66 kV network as it runs in parallel with Hereford.

The overload protection scheme would therefore need to expand to include some of the 66 kV network, resulting in demand disconnection to avoid a thermal overload.

This option however would need to have the following considerations:

- It would only be applicable for busbar fault constraints to avoid the risk of becoming non-complaint under Engineering Recommendation P2. This means it would rely on **GT1 and GT2 passing their site checks to have their cyclic ratings utilised**, thus resolving the circuit outage issue.
- It would have an impact on CIs and CMLs.

In any case, this this option, although may be utilised to manage constraints in the interim, would not be a long term viable solution.

New limiting factor: Security of supply and impact on CIs and CMLs

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 25 MW+ **Discounted**

Detailed description: Flexibility services through generation turn up and/or demand turn down may be of some benefit in specific outage conditions; however due to the interconnected configuration with Hereford and Ludlow 66 kV network, dispatching flexibility services to mitigate for a GT outage could cause a circuit overload under a different fault outage scenario. The sensitivity would also vary, adding an extra layer of complexity for the current flexibility process which could subsequently increase network risk.

New limiting factor: Rating of GT1 and GT2

Solution Recommendation

Both Option 2 (replacing the transformers) and Option 3 (installing a new circuit to unstitch the network) have merit and are closely matched in terms of cost-effectiveness. In addition to that:

- Option 2 is more easily deliverable and provides longevity
- Option 3 simplifies the network and resolves future circuit overloads

The optimal solution would therefore be subject to a more detailed assessment and cost benefit analysis.

It is also acknowledged however that both options above would be lengthy to build and therefore it would be worth considering Option 3 (load transfers) and Option 4 (load management scheme) to manage the constraints in the interim.

3.11 Hereford_8L5 to Hereford South_1L9B 66 kV circuit overload

Constraint Overview

Generation **Demand**

Hereford BSP (Bishops Wood side) supplies the Madley-Peterchurch-Pontrilas ring as well as the Ross-Dymock-Ledbury ring, both of which share a feeder on one side, the Hereford_8L5 to Hereford South_1L9B 66 kV circuit.

The group is Class D 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 3.11.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Hereford_8L5 to Hereford South_1L9B 66 kV circuit overload	N-1: Busbar fault at 66 kV taking out GT1 and associated feeders overloads the circuit; or N-1: Circuit fault on the Hereford-Ledbury 66 kV infeed overloads the circuit, from 2031 onwards	Baseline	Baseline	2025	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 3.11.2 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 Hereford-Hereford South circuit	✓	✓	×	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: The constraint is imminent (for a busbar outage), with the demand projected to continue increasing. Doing nothing could therefore lead to thermal overloads leading to safety implications, and potentially the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Rating of the existing circuit

Option 2 – Upgrading the existing circuit

Estimated capacity released: 34 MVA+

Viable

Detailed description: Uprating the existing circuit, which is limited by a 20 metre section of 0.175 in ACSR overhead line, by installing,

- 300 mm AAAC designed to 75 degrees, or
- 630 mm copper underground cable

New limiting factor: Rating of the circuit

Option 3 – Adding a Hereford-Hereford South circuit

Estimated capacity released: 30 MVA

Viable

Detailed description: Adding a new Hereford to Hereford South circuit, the works include:

- Establishing a new 66 kV bay on the GT3 side of the existing busbars at Hereford BSP; where space may not permit, consideration to be given to banking a new feeder with one of the generation schemes connected at Hereford GT3 side.
- Installing a new 66 kV circuit from the new bay at Hereford BSP (or banked with an existing generation scheme as per above) to Hereford South, picking up the circuit to the Ross-Dymock-Ledbury ring. This unstitches the ring from the Madley-Peterchurch-Pontrilas network which would remain supplied via the existing Hereford_8L5 to Hereford South_1L9B circuit.
- The new circuit is anticipated to be approximately 7 km, requiring a minimum of 90 MVA winter cyclic rating, expected to consist of a mixture of 630 mm copper cable and 300 mm AAAC overhead line designed to 75 degrees.
- Carrying out site checks allowing the existing transformers (specifically GT1 and GT2) to utilise their cyclic ratings.

New limiting factor: Rating of the circuits

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A few MVAs

Discounted

Detailed description: The substations within this group have very limited interconnectivity, and therefore insufficient to mitigate the constraint.

New limiting factor: Rating of the existing circuit

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

Estimated capacity released: 0 MVA

Discounted

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

New limiting factor: Engineering Recommendation P2 non-compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 24 MW+

Discounted

Detailed description: Flexibility services through generation turn up and/or demand turn down may be of some benefit in specific outage conditions; however due to the interconnected configuration of the network, dispatching flexibility services to mitigate for a particular constraint could cause a circuit overload under a different fault outage scenario. The sensitivity would also vary, adding an extra layer of complexity for the current flexibility process which could subsequently increase network risk.

New limiting factor: Rating of existing circuit

Solution Recommendation

It is recommended to pursue Option 2 above (uprating the existing circuit) as it provides the most value for money considering the works involve uprating a 20 metre span of 66 kV OHL circuit.

3.12 Ludlow to Craven Arms_4L3 33 kV circuit overload

Constraint Overview

Generation | Demand

Craven Arms primary, Bishops Castle T1 and Leebotwood T2 are fed via two 33 kV circuits from Ludlow BSP, run solid at Craven Arms 33 kV busbars; one circuit is predominantly overhead line, and the other is an all cable circuit (rated much higher than the overhead line).

The group 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 3.12.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Ludlow to Craven Arms_4L3 33 kV circuit overload	N-1: Outages of the Ludlow-Craven Arms_1L3 33 kV cable circuit	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 3.12.2 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 Ludlow-Craven Arms 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 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 circuit

Option 2 – Uprating the existing circuit

Estimated capacity released: 20 MVA

Viable

Detailed description: Uprating the existing 33 kV overhead line circuit between Ludlow and Craven Arms, the works involve:

- Re-stringing/re-building approximately 13 km of the overhead line circuit between Ludlow and Craven Arms 4L3, from 0.1 in ACSR to 200 mm AAAC designed to 75 degrees, to achieve a near 40 MVA winter cyclic rating.
- Where undergrounding is necessary, minimum of 400 mm copper cable to be installed to match the other circuit between Ludlow and Craven Arms.
- Replacing the 400 amp disconnectors at Cravens Arms with 800 amp ones, especially the line isolators on the circuits from Ludlow BSP and the busbar disconnectors.

New limiting factor: Rating of the circuit

Option 3 – Adding a third Ludlow-Craven Arms circuit

Estimated capacity released: 40 MVA

Viable

Detailed description: Installing an additional Ludlow-Craven Arms circuit, the works include:

- Extending the 33 kV air-insulated busbars at Ludlow to establish a new bay.
- Extending the 33 kV air-insulated busbars at Craven Arms to establish a new bay; this may involve purchasing additional land.
- Installing a 15 km 33 kV circuit between Ludlow and Craven Arms, to achieve a minimum winter cyclic rating of 40 MVA, matching the existing cable circuit between Ludlow and Craven Arms_1L3.
- Reconfiguring Craven Arms 33 kV busbars to have the new circuit and the cable circuit from Ludlow run in parallel picking up Craven Arms and Bishops Caste T1, while the overhead line configured to pick up the feeder to Leebotwood under normal running.

New limiting factor: Rating of the overhead line circuit

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A couple of MVAs

Discounted

Detailed description: There are possible transfers at Leebotwood and Bishops Castle which are often utilised for arranged outages but do not resolve the fault outage constraints.

Other 11 kV interconnections out of the group are limited and insufficient to fully resolve the constraints.

New limiting factor: Rating of the existing circuit, and low volts

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: The group 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): 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 existing circuit

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 the more economical and deliverable option, that also avoids complicating 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.

3.13 Craven Arms transformer T4 overload

Constraint Overview

Generation | Demand

Craven Arms primary is 33/11 kV site consisting of two transformers fed from Ludlow BSP via two 33 kV circuits. The primary is Class B under Engineering Recommendation P2, expected to become Class C by 2032.

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

Table 3.13.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Craven Arms transformer T4 overload	N-1: Outage of Craven Arms transformer T1	2033	2029	2031	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 3.13.2 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 transformer	✓	✓	×	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 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: 5.5 MVA

Viable

Detailed description: Uprating the existing 33/11 kV transformer T4 (commissioned in 2012) from a 6/12 MVA unit to 12/24 MVA.

The 11 kV board is 1200 amp which is currently sufficient for the network needs.

[Transformer T1 is 7.5/15 MVA rated (commissioned in 2016), but this is not anticipated to overload until beyond 2034, at which point it would be proposed to uprate it to 12/24 MVA unit.]

New limiting factor: Rating of transformer T1

Option 3 – Adding a third transformer

Estimated capacity released: 17 MVA

Viable

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

- Installing a third 7.5/15 MVA 33/11 kV transformer at Craven
- Installing a new 2-section 11 kV board suitably interconnected with the existing
- Purchasing additional land to accommodate the assets above

New limiting factor: Rating of transformer T4

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A couple of MVAs — **Discounted**

Detailed description: Craven Arms primary is relatively rural and has limited 11 kV interconnectivity to other primary substations which is insufficient to maintain its compliance under Engineering Recommendation P2.

New limiting factor: Rating of the transformers

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

Estimated capacity released: 0 MVA — **Discounted**

Detailed description: Craven Arms primary is Class B under Engineering Recommendation P2, expected to become Class C by 2032 which would require restoration of the 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): 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, it would be recommended to pursue Option 2 above (replacing the existing transformer) as it will likely be the more cost-effective and deliverable option.

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.

3.14 Ludlow primary transformer overload

Constraint Overview

Generation | **Demand**

Ludlow primary is a 33/11 kV primary substation fed out of two transformers (normally run split) from Ludlow BSP. The existing transformers are 15 MVA units commissioned in 1963, connected to a 1200 amp 11 kV board, also commissioned in 1963.

The site 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 3.14.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Ludlow primary transformer overload	N-1: Outage of either of the two 33/11 kV transformers	-	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 3.14.2 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 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 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 the existing transformers

Option 2 – Uprating existing transformers

Estimated capacity released: 23 MVA

Viable

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

- Uprating the existing 33/11 kV transformers from 15 MVA to 20/40 MVA units
- Replacing the existing 1200 amp 11 kV board with a 2000 amp board

New limiting factor: Rating of the new transformers

Option 3 – Adding a third transformer

Estimated capacity released: 14 MVA

Viable

Detailed description: Adding a third transformer at Ludlow primary, the works include:

- Installing a new 33 kV bay at the existing BSP
- Installing an additional two section 11 kV board suitably interconnected with the existing
- Installing a third 7.5/15 MVA 33/11 kV transformer and transferring sufficient demand to it
- Assessing the fault levels at Ludlow with a possible split configuration at 11 kV

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 constraints longer term.

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): 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 (uprating the existing transformers) as it is likely to be more economical, providing better value for money 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.

3.15 Stockton primary backfeed capacity

Constraint Overview

Generation Demand

Stockton is a single 33/11 kV transformer site, fed out of Ludlow BSP, which relies on 11 kV interconnection to other primary substations for security of supply. The site 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 3.15.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Stockton primary backfeed capacity	N-1: Outage of the primary transformer at Stockton	2029	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 3.15.2 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 11 kV backfeed capacity	✓	✓	×	Viable
3	Adding a second 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 2029 with and 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: 11 kV backfeed capacity

Option 2 – Upgrading the 11 kV backfeed capacity

Estimated capacity released: A few of MVAs

Viable

Detailed description: Upgrading the 11 kV interconnections to other primary substations such as Cleobury Mortimer (10 km away), Tenbury (12 km away) and Kenswick (11 km away).

[The current capacity is assumedd to be approximately 5.5 MVA, it would be worth carrying out a re-assessment of this existing capacity before commencing any physical works.]

New limiting factor: 11 kV backfeed capacity

Option 3 – Adding a second transformer

Estimated capacity released: 7.5 MVA

Viable

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

- Extending the 33 kV busbars to include a bus-section circuit breaker and an additional transformer bay
- Extending the 11 kV busbars to include a bus-section circuit breaker and a transformer incomer (a new 11 kV single section board, interconnected with the existing, may be needed)
- Installing a second 33/11 kV transformer rated 7.5/15 MVA
- Diverting the existing 33 kV tower on-site, or purchasing additional land adjacent to the existing, may be necessary to accommodate the new assets above

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: 0 MW

Discounted

Detailed description: The substation already relies on 11 kV backfeed for security of supply, which is the existing limiting factor.

New limiting factor: 11 kV backfeed capacity

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

Estimated capacity released: 0 MW

Discounted

Detailed description: The primary is Class B under Engineering Recommendation P2 which would require restoration of the group demand minus 1 MW within 3 hours for a circuit outage; therefore demand disconnection schemes (or similar) would make the site non-compliant in the foreseeable future as the shortfall exceeds 1 MW.

New limiting factor: Engineering Recommendation P2 non-compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 0.5 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: 11 kV backfeed capacity

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue Option 3 above (adding a second transformer) as it is the most enduring solution that will secure the site for the foreseeable future.

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.

3.16 Stourport primary transformer overload

Constraint Overview

Generation Demand

Stourport primary consists of three transformers,

- T5: 33/11 kV transformer rated 20 MVA fed out of Stourport 132/33 kV GT
- T3: 66/11 kV transformer rated 20 MVA fed out of Stourport 132/66 kV GT
- T4: 66/11 kV transformer rated 20 MVA fed out of Upton Warren 132/66 kV BSP

T3 and T4 backfeed each other under an outage, and T5 is backfed from T4 during an outage.

The group 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 3.16.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Stourport T5 overload	Intact	-	2029	2033	-
Stourport T5 overload	N-1: arranged busbar outage at Stourport 66 kV taking out normal infeeds to both T3 and T4	Baseline	Baseline	Baseline	Baseline
Stourport T4 overload	N-1: outage of T5 putting its demand on T4 only	Baseline	Baseline	Baseline	Baseline

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 3.16.2 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	✓	×	×	Discounted
3	Uprating the existing transformers	✓	×	×	Discounted
4	Adding a 66 kV isolator, with 11 kV transfers	✓	✓	×	Viable
Operational mitigation					
4	Load transfers and redistribution	✓	✓	×	Viable
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: Some of the constraints are imminent with the demand projected to continue increasing. 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: 9 MVA

Discounted

Detailed description: Adding a fourth transformer on site would only release half the capacity of the smallest transformer as the limitation would become the GT infeeds and 66 kV low volts. The works include:

- Extending the 66 kV busbars to include an additional bus-section circuit breaker and a new 66 kV transformer bay
- Installing a fourth 66/11 kV 12/24 MVA transformer
- Installing an additional 2-section 11 kV board interconnected with the existing but running split to avoid overstressing the 11 kV network
- Additional land may need to be purchased to accommodate the new assets

New limiting factor: GT configuration and 66 kV network volts

Option 3 – Uprating the existing transformers

Estimated capacity released: 20 MVA

Discounted

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

- Replacing the existing 33/11 kV 20 MVA transformer T5 with a 20/40 MVA unit
- Replacing the existing 66/11 kV 20 MVA transformer T4 with a 20/40 MVA unit
- Replacing the existing 66/11 kV 20 MVA transformer T3 with a 20/40 MVA unit
- Adding an additional 11 kV 2-section 11 kV board to full utilisation of the transformer ratings

New limiting factor: Rating of the transformers

Option 4 – Adding a 66 kV isolator, with 11 kV transfers

Estimated capacity released: 20 MVA

Viable

Detailed description: Better utilising the existing assets, the works include:

- Redistributing (at 11 kV) some of the T5 demand, to T3 and T4

  (This will resolve the intact constraints at T5 (anticipated by 2029); as well as the baseline constraints at T4.)

- Installing a 66 kV disconnector between 4H0 and the tee point to 2L3 to avoid taking out the Stourport 132/66 kV GT and the infeed from Upton Warren under a single arranged outage; alternatively, installing a 66 kV disconnector between 4H4 and the tee point to 3H4 would achieve the same result.

  (This would resolve the N-1 baseline constraint at T5.)

New limiting factor: Rating of the transformers

Option 5 – Operational mitigation: Load transfers and redistribution

Estimated capacity released: Up to 10 MVA

Viable

Detailed description: Redistributing the 11 kV demand, specifically from T5 and onto T3 and T4. This would resolve the T4 constraint and intact T5 constraint only.

The busbar outage constraint could be partially mitigated by relying on the 66 kV infeed from Hereford (via Kenswick) to pick up transformer T3. This however would not be an enduring long term solution due to low 66 kV voltages.

New limiting factor: Low volts at 66 kV

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: The group 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): 17 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 is recommended to pursue Option 4 above (adding a 66 kV isolator with 11 kV transfers) as it is likely to be the most cost-effective solution in the long run, and would allow for better utilisation of the existing assets.

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. The flexibility option however, although may be technically viable, is not likely to be as cost-effective as the alternative viable options above.

3.17 Stourport to Wribbenhall 33 kV network

Constraint Overview

Generation Demand

Stourport BSP, fed out of Bishops Wood GSP, consists of a 132/66 kV transformer (GT1) and a 132/33 kV transformer (GT2).

- GT1 normally feeds Stourport T3, Droitwich primary, and Kenswick T2, and has 66 kV interconnection to Upton Warren BSP which normally feeds Stourport T4.
- GT2 normally feeds Stourport T5, Kidderminster T3 (normally on hot-standby), Wribbenhall primary, Quatt T1, Kinver T1, and 33 kV connected customers.

Hinksford BSP, fed out of Penn GSP, consists to two 132/11 kV transformers that feed local supplies, and a single 132/33 kV transformer (GT3) that normally feeds Hinksford T5 (normally on hot-standby) and Kinver T2.

Stourport and Hinksford 33 kV networks back feed each other under various outage conditions, via Kinver's 33 kV bus-section circuit breaker, with an additional interconnection to Ironbridge 33 kV network via Quatt primary.

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

Table 3.17.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
33 kV network voltages	N-1: Outage of the 132/33 kV at Stourport BSP or the Stourport-Wribbenhall 33 kV circuit	Baseline	Baseline	Baseline	Baseline
Wribbenhall 33/11 kV transformers running out of taps to control the 11 kV voltages	N-1: Outage of the 132/33 kV at Stourport BSP or the Stourport-Wribbenhall 33 kV circuit	2025	2025	2025	2025
Hinksford to Kinver 33 kV circuit overload	N-1: Outage of the 132/33 kV at Stourport BSP or the Stourport-Wribbenhall 33 kV circuit	2027	2027	2027	-
Stourport to Wribbenhall 33 kV circuit overload	N-1: Outage of the 132/33 kV infeed from Hinksford BSP or the Hinksford-Kinver 33 kV circuit	2027	2027	2027	-

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 3.17.2 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	Reinforcing the existing 33 kV network	×	✓	×	Discounted
3	Installing a Hinksford-Wribbenhall circuit	✓	✓	×	Viable
4	Installing 33 kV circuits and reconfiguring	✓	✓	✓	Viable
Operational Mitigation					
5	Load transfers	×	✓	×	Discounted
Load Management Schemes					
6	Post-fault inter-trips	×	✓	×	Discounted
Flexibility services					
7	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 with the demand projected to continue increasing. Doing nothing could therefore lead to thermal overloads, voltages outside of statutory limits, and to the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Low volts and rating of existing circuits

Option 2 – Reinforcing the existing 33 kV network

Estimated capacity released: 10 MVA

Discounted

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

- Uprating the 33 kV tower line circuit from Hinksford to Kinver to Wribbenhall; the total length of these circuits is over 26 km, most of which is a double circuit tower line that would need to be rebuilt.
- Uprating sections (approximately 2 km in total) of the Stourport to Wribbenhall 33 kV circuit, including 600 amp rated current transformers (CTs);

The works above would resolve the thermal constraints but would have limited benefit on the voltage restrictions.

New limiting factor: Low voltages at 33 kV

Option 3 – Installing a Hinksford-Wribbenhall circuit

Estimated capacity released: 40 MVA

Viable

Detailed description: Installing a 33 kV circuit from Hinksford to Wribbenhall, the works include:

- Extending the 33 kV indoor board at Hinksford to add a new feeder circuit breaker.
- Extending the 33 kV air-insulated busbars at Wribbenhall to allow for a new feeder.
- Installing additional disconnectors at Arley switching station, including a circuit breaker on the circuit from Kinver.
- Installing approximately 22 km of 33 kV cable between Hinksford and Wribbenhall to achieve a 40 MVA winter cyclic rating (anticipated to be 400 mm copper cable).

  [A switching site may need to be established approximately mid-way along the route to break the circuit via circuit breakers, limiting the cable charging currents.]

New limiting factor: Rating of the exiting tower line circuits

Option 4 – Installing 33 kV circuits and reconfiguring

Estimated capacity released: 20 MVA+

Viable

Detailed description: Installing additional 33 kV circuits and reconfiguring the network. The works are split into the following phases:

Phase 1:

- Extending the 33 kV indoor board at Hinksford to add a new feeder circuit breaker.
- Extending the 33 kV air-insulated busbars at Wribbenhall to allow for a new feeder.
- Installing additional disconnectors at Arley switching station, including a circuit breaker on the circuit from Kinver.
- Installing approximately 2 km of 33 kV 630 mm copper cable from the new circuit breaker at Hinksford BSP to tower 76ZHKC1 (along the Hinksford - Kinver 33 kV circuit). The tower 76ZHKC1 will require additional sealing ends to connect the new cable; alternatively it may be possible to drop down on to a terminal pole.
- Removing the bonding along the Hinksford-Kinver 33 kV double circuit tower line between towers 76ZHKC1 and 76ZHKC22, such that the two sets of conductors become independent circuits. Then uprating these conductors to 200 mm AAAC poplar (designed to 50 degrees); a tower line survey will be needed to determine feasibility and to establish the level of tower works required.
- Removing the bonding along the Kinver-Arley 33 kV double circuit tower line between towers 76ZHKC22 and 76ZWLFB1.
- Reconfiguring the connections at tower 76ZHKC22 such that Kinver becomes a double tee'd substation (one from each side of the tower) instead of a loop; tower 76ZHKC22 may require mods to allow for this. Kinver's 33 kV bus-section circuit breaker is to then run normally 'open'.
- Installing approximately 1.8 km of 33 kV 630 mm copper cable from tower 76ZWLFB1 to tower 76ZWLF21. Both of these towers will require sealing ends on one side to connect the new cable; alternatively it may possible to drop down to terminal poles.
- Removing the bonding along the Arley-Wribbenhall 33 kV double circuit tower line between towers 76ZWLF21 and 76ZWLF1, such that the two sets of conductors become independent circuits.
- Raising the 33 kV target volts at Hinksford BSP to 1.02 per unit and amending the Load Drop Compensation 'firm capacity' setting to 682 amps (39 MVA).
- Running the 11 kV bus-section circuit breaker at Wribbenhall normally 'open', with a new sequence scheme put in place.

Phase 2: Anticipated to be needed from 2033 onwards

- Uprating the 33 kV double circuit tower line (approximately 7.2 km) between Kinver and Arley to 200 mm AAAC designed to 50 degrees.
- Uprating the 33 kV double circuit tower line (approximately 4 km) between Arley and Wribbenhall to 200 mm AAAC designed to 50 degrees.

Phase 3: Anticipated to be needed from 2035 onwards

- Installing a Statcom (or a form of voltage compensation) at Wribbenhall 33 kV busbars, with additional CBs to allow for a swing arrangement.
- Uprating Stourport-Wribbenhall Tee 33 kV circuit, which includes:
    - Replacing a short 300 mm copper EPR cable section through a bridge, with 630 mm copper, via directional drilling
    - Replacing the 600 amp CTs to at least 800 amp or 1200 amp rated ones
- Uprating the 33 kV circuit between Wribbenhall Tee and Wribbenhall primary, which includes:
    - Restringing approximately 3 km of overhead line, and
    - Replacing approximately 1.3 km of underground cable.

New limiting factor: 33 kV voltages

Option 5 – Operational mitigation: Load transfers

Estimated capacity released: A few MVAs

Discounted

Detailed description: There are some transfers within the group, at 33 kV (via Quatt) and at 11 kV within Wribbenhall and Kinver, which can be utilised to manage some of the baseline constraints, but these are not long term viable solutions.

New limiting factor: Rating of circuits and maintaining statutory volts

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

Estimated capacity released: 0 MVA

Discounted

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

New limiting factor: Engineering Recommendation P2 non-compliance

Option 7 – Flexibility service procurement

Estimated Flexibility Required (MW): 10 MW+

Discounted

Detailed description: Flexibility services through generation turn up and/or demand turn down may be beneficial for a few select outages triggering thermal constraints, but it would not mitigate for some of the more complicated scenarios nor the voltage constraints.

New limiting factor: Low volts and rating of existing circuits

Solution Recommendation

It is recommended to pursue Option 4 above (installing additional 33 kV circuits and reconfiguring) as it is likely to be more cost-effective and better utilises the existing network.

As mentioned above, Option 5 (operational mitigation) can also be implemented in the interim to manage some of the baseline constraints but it is not a viable long term solution.

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