Kitwell GSP Network

Network Development Report – West Midlands

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Electricity Distribution

nationalgrid

Contents

Kitwell GSP Network

1. Network Overview

Kitwell is a 132 kV Grid Supply Point (GSP) that feeds a significant part of the central and southern parts of Birmingham connecting over 261,000 customers. The network comprises of several 132 kV circuits distributed across the region, connecting ten 132/11 kV Bulk Supply Points (BSPs) that feed the local demands.

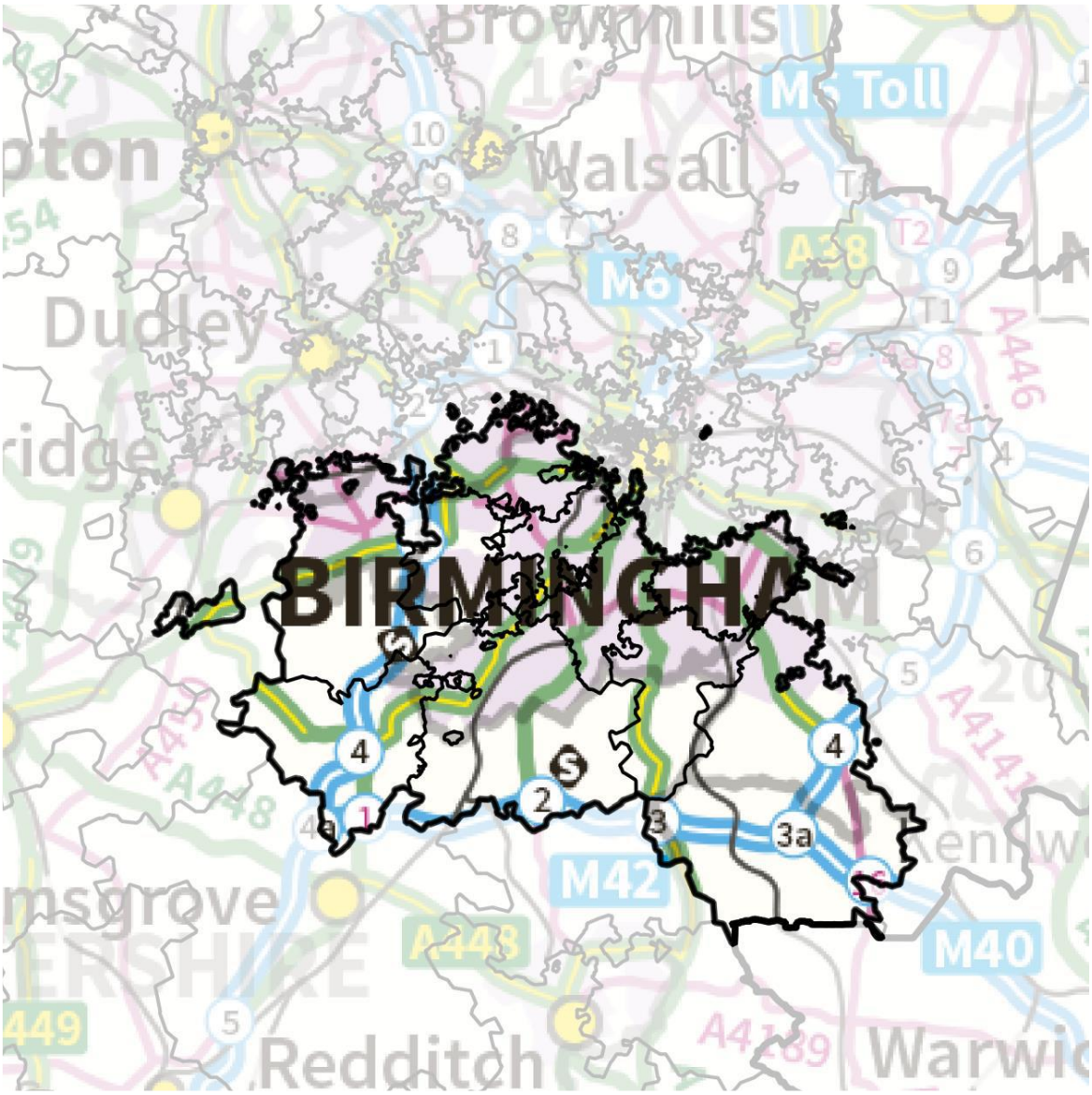

Figure 1.1 Kitwell GSP geographic network coverage

This report discusses existing and future network constraints over a 0-10 year horizon associated with Kitwell GSP and its downstream network that falls in the West Midlands area. 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

Kitwell GSP is a 275/132 kV site fed via three 240 MVA Super Grid Transformers (SGTs), normally running solid through a two section 132 kV double busbar configuration, and a fourth SGT normally on hot-standby. The GSP supplies ten 132/11 kV BSPs, listed below:

- Halesowen BSP consisting of three 132/11 kV Grid Transformers (GTs), fed via two 132 kV circuits from the GSP. The transformers are connected to three 11 kV double busbars, and normally run split with each other.
- Longbridge BSP consisting of three 132/11 kV transformers fed via three 132 kV circuits from the GSP network. The transformers are connected to six sections of 11 kV busbars, and normally run split with each other.
- Rednal BSP consisting of two 132/11 kV transformers fed via two 132 kV circuits from the GSP network (via Longbridge). The transformers are connected to three 11 kV double busbars, and normally run split with each other.
- Bartley Green BSP consisting of two 132/11 kV transformers fed via two 132 kV circuits from the GSP. The transformers are connected to four sections of 11 kV busbars, and normally run split with each other.
- Chad Valley BSP consisting of two three-winding 132/11/11 kV transformers fed via two 132 kV circuits from the GSP (via Bartley Green). The transformers are connected to four sections of 11 kV double busbars, and normally run split with each other.
- Selly Oak BSP consisting of three 132/11 kV transformers fed via three 132 kV circuits from the Selly Oak switching station which forms part of a closed ring with Bournville BSP. The transformers are connected to six sections of 11 kV busbars, and normally run split with each other.
- Bournville BSP consisting of four 132/11 kV transformers fed via two 132 kV circuits from the Kitwell and interconnected with two others via Selly Oak switching station. The transformers are connected to eight sections of 11 kV busbars, and normally run split with each other.
- Highters Heath BSP consisting of two three-winding 132/11/11 kV transformers fed via two 132 kV circuits. The transformers are connected to four sections of 11 kV busbars, and normally run split with each other.
- Hall Green BSP consisting of two three-winding 132/11/11 kV transformers fed via two 132 kV circuits. The transformers are connected to four sections of 11 kV double busbars, and normally run split with each other.
- Shirley BSP consisting of three 132/11 kV transformers, GT1, GT2, and GT3. GT1 is normally fed from Lea Marston GSP via a 132 kV circuit from the Elmdon-Copt Heath-Solihull ring, while GT2 and GT3 are on Kitwell's network via two 132 kV circuits. The 132 kV busbars are split at Shirley between both GSPs, and the transformers (which are connected to six sections of 11 kV busbars) normally run split at 11 kV.

1.2 Network Operability Modelling

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

Kitwell 132 kV:

- Arranged outages of any of the three SGTs results in the fourth (normally on hot-standby) being closed in.
- Arranged outages at the GSP busbars causing a split configuration results in the reserve busbars being closed in to maintain parallels; this may often include re-selecting SGTs and feeders to avoid constraints following a second outage.
- Arranged or fault outages leading to loss of a GT at any of the 132/11 kV BSPs results in the 11 kV being closed in (and reconfigured in some cases) to backfeed the demand.

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:

- Shirley grid transformer overload
- Bartley Green transformer overload
- Bartley Green and Chad Valley N-2 group compliance
- Kitwell-Bournville-Shirley-Longbridge network constraints
    - Kitwell_205 to Bournville_403 132 kV circuit overload
    - Kitwell_805 to Longbridge_303 132 kV circuit overload
    - Shirley tee to Shirley 132 kV circuit overload (N-1)
    - Shirley tee to Shirley 132 kV circuit overload (N-2)
    - Bournville to Hall Green 132 kV circuit overload
    - Longbridge to Shirley tee 132 kV circuit overload
    - Kitwell_1205 to Longbridge_103 132 kV circuit overload
    - Selly Oak to Highters Heath 132 kV circuit overload

Transmission-Distribution interface

Kitwell GSP is a 400/132 kV site and forms one of the boundaries between the transmission and distribution networks in the central and southern areas within Birmingham. New Connection activity at the distribution network, both demand and generation, have triggered constraint at the transmission network with regards to SGT capacity and 400 kV circuit ratings. Proposals to mitigate are being considered including the addition of more SGTs at Kitwell.

3. Network Constraints and Solution Options

3.1 Shirley grid transformer overload

Constraint Overview

Generation **Demand**

Shirley BSP consists of three 132/11 kV transformers where GT1 and GT2 (commissioned in 1955) are more heavily loaded than GT3 (commissioned in 2004). As a result, an outage on either GT1 or GT2 could cause the other to overload.

The site is Class C under Engineering Recommendation P2.

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

Table 3.1.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Shirley GT1 or GT2 overload	N-1: Outage of either GT1 or GT2	2027	2027	2029	2033

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

Solution Options

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

Table 3.1.2 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	Replacing GT1 and GT2	✓	✓	×	Viable
3	Adding a fourth transformer	✓	✓	✓	Viable
4	Upgrading the 11 kV backfeed	✓	✓	×	Viable
Operational Mitigation					
5	Load transfers	✓	✓	×	Viable
Load Management Schemes					
6	Post-fault inter-trips	×	✓	×	Discounted
Flexibility services					
7	Flexibility service procurement	✓	✓	×	Viable

Solution Development

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

Option 1 – No Intervention

Estimated capacity released: 0 MVA

Discounted

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

New limiting factor: Rating of the transformers

Option 2 – Replacing GT1 and GT2

Estimated capacity released: 38 MVA

Viable

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

- Replacing GT1 and GT2, which are currently 132/11 kV transformers rated 15/30 MVA each, with 30/60 MVA three-winding 132/11/11 kV transformers.
- Maintaining the split configuration between transformers, but running the two low voltage (LV) windings per transformer in parallel with each other if possible; where there may be fault level restrictions, then the following are to be considered, in the order listed below:
    - Uprating the impacted assets (11 kV circuits and/or downstream 11 kV switchgear);
    - Running split the two LV windings per transformer
- Replacing the 11 kV switchgear board allowing for:
    - additional transformer circuit breakers
    - increased fault level headroom at 11 kV
- Carrying out a fault level assessment of the 11 kV network to determine the circuits that would need to be upgraded

New limiting factor: Rating of the transformers

Option 3 – Adding a fourth transformer

Estimated capacity released: 38 MVA

Viable

Detailed description: Adding a fourth 132/11 kV transformer at Shirley BSP, the works include:

- Establishing a 132 kV transformer bay at Shirley between CB320 and disconnector 403, allowing room for a future feeder bay on that same section.
- Installing a fourth 132/11 kV 15/30 MVA transformer;

  [Subject to survey, it is anticipated this would fit within the existing substation boundary on the western side of the compound.]
- Installing an additional two section 11 kV board suitably interconnected with the existing
- Carrying out site checks allowing the existing transformers to utilise their cyclic ratings

New limiting factor: Rating of the transformers

Option 4 – Upgrading the 11 kV backfeed

Estimated capacity released: 10 MVA

Viable

Detailed description: Upgrading the 11 kV interconnections to neighbouring substations which include Solihull (approximately 4 km away) and Highters Heath (approximately 5 km away). This would allow for excess demand to be transferred over, under outage conditions.

In addition to the above, it would necessary to carry out site checks at Shirley, Solihull, and Highters Heath BSPs allowing their existing transformers to utilise their cyclic ratings.

New limiting factor: Rating of the transformers

Option 5 – Operational mitigation: Load Transfer

Estimated capacity released: 15 MVA

Viable

Detailed description: The site currently runs split at 11 kV with GT1 and GT2 picking up majority of the site's demand. The solution is to better utilise the existing transformers, and is in two-fold:

- Redistributing the demand at 11 kV, during a transformer outage, more evenly between the remaining two in-service transformers.
- Carrying out site checks allowing the existing transformers to utilise their cyclic ratings.

New limiting factor: Rating of the transformers

Option 6 – 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 7 – Flexibility service procurement

Estimated Flexibility Required (MW): 8 MW +

Viable

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

New limiting factor: Existing transformer ratings

Solution Recommendation

It is recommended to pursue option 5 above (operational mitigation) as it is likely to be the most cost effective solution and could allow for better utilisation of the assets by potentially enabling the cyclic ratings of the transformers.

Longer term, and where the option above has been exhausted, option 3 (adding a fourth transformer) would be the next viable option as it provides wider benefits of:

- keeping fault levels in check
- simplifying the 11 kV backfeed configuration
- allowing for a simpler 132 kV network with better transfer capabilities within Kitwell GSP and also to Lea Marston GSP

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 Distribution Network Options Assessment (DNOA) process.

3.2 Bartley Green transformer overload

Constraint Overview

Generation **Demand**

Bartley Green BSP consists of two 132/11 kV transformers (commissioned in 1964) fed out of two 132 kV circuits from Kitwell GSP that loop in via Bartley Green and continue on to pick up two transformers at Chad Valley.

Bartley Green is Class C under Engineering Recommendation P2; and the group consisting of Bartley Green and Chad Valley is Class D and anticipated to exceed 100 MW between 2034 and 2040 prompting the need for a third infeed in to the group.

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

Table 3.2.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Bartley Green transformer overload	N-1: Outage of either transformer at Bartley Green	2027	2027	2027	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 3.2.2 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	Replacing 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 2027 with the demand projected to continue increasing thereafter. Doing nothing could therefore lead to thermal overloads, as described above, and to the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Rating of the transformers

Option 2 – Replacing the existing transformers

Estimated capacity released: 38 MVA

Viable

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

- Replacing the existing two 132/11 kV 15/30 MVA transformers with two three-winding 132/11/11 kV transformers rated 30/60 MVA each.
- Extending the existing four section 2000 amp 11 kV board (commissioned in 2014) by adding additional 2000 amp circuit breakers and connecting each transformer low voltage (LV) winding to an 11 kV section.
- Running the transformers split at 11 kV, with sequence schemes for restoration of supplies.
- Assessing the fault levels at 11 kV and where possible, running the two LV windings per transformer in parallel with each other; where there may be fault level restrictions, then the following are to be considered, in the order listed below:
    - Uprating the impacted assets (11 kV circuits and/or downstream 11 kV switchgear);
    - Running split the two LV windings per transformer.

New limiting factor: Rating of the transformers

Option 3 – Adding a third transformer

Estimated capacity released: 38 MVA

Viable

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

- Extending the 132 kV busbars at Bartley Green to become a 3-section single busbar arrangement with the two new bus-section circuit breakers.
- Installing a third 132/11 kV transformer rated 15/30 MVA.
- Installing an additional 2-section 11 kV board suitably interconnected with the existing.
- Carrying out site checks allowing the existing transformers to utilise their cyclic ratings.

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load Transfer

Estimated capacity released: A few MVAs

Discounted

Detailed description: Bartley Green has some 11 kV interconnections to neighbouring BSPs but these are not sufficient to secure the site for the foreseeable future and therefore not a viable long term solution.

New limiting factor: Rating of the transformers

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: 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): 10 MW +

Viable

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

New limiting factor: Existing transformer ratings

Solution Recommendation

With regards to reinforcement build options, both options 2 (uprating the transformers) and option 3 (adding a third transformer) have merits, are deliverable, and could be economically viable.

Uprating the transformers avoids the need to replace them on asset condition; whereas adding a third keeps fault levels in check and sets up the site up for a third infeed resolving future N-2 constraint for the Bartley Green and Chad Valley group.

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

3.3 Bartley Green and Chad Valley N-2 group compliance

Constraint Overview

Generation **Demand**

Bartley Green and Chad Valley BSPs are fed via two 132 kV circuits from Kitwell GSP. The group is Class D under Engineering Recommendation P2, anticipated to exceed 100 MW between 2034 and 2040, prompting the need for a third infeed.

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

Table 3.3.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Bartley Green and Chad Valley N-2 compliance	N-2: Arranged outage on one circuit from Kitwell followed by a fault outage of the other leaves the entire group off supply.	2034-2040	2034-2040	2034-2040	2034-2040

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	Installing a new circuit from Kitwell	✓	✓	×	Viable
3	Tee connection to the Selly Oak circuit	✓	✓	×	Viable
Operational Mitigation					
4	Load transfers	×	✓	×	Discounted
Load Management Schemes					
5	Intertrips	×	✓	×	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 anticipated to trigger between 2034 and 2040, with the demand projected to continue increasing thereafter. Doing nothing could therefore lead to the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Engineering Recommendation P2 compliance

Option 2 – Installing a new circuit from Kitwell

Estimated capacity released: 182 MVA

Viable

Detailed description: Adding a 132 kV circuit from Kitwell, the works include:

- Establishing a new 132 kV bay at Kitwell GSP
- Laying approximately 2.5 km of 132 kV circuit between Kitwell and Bartley Green
- Extending the 132 kV busbars at Bartley Green to become a 3-section single busbar arrangement with the two new bus-section circuit breakers normally run open.
- Configuring the 132 kV connections at Bartley Green such that:
    - The existing circuits from Kitwell connect to the end busbars
    - The two transformers connect to the end busbars
    - The feeders towards Chad Valley connect to the end busbars
    - The new cable circuit connects to the middle busbar for backfeed purposes

New limiting factor: Rating of the 132 kV circuits

Option 3 – Tee connection to the Selly Oak circuit

Estimated capacity released: 110 MVA

Viable

Detailed description: The two 132 kV tower line circuits between Kitwell and Selly Oak pass through Bartley Green's 132 kV substation compound, with tower 15 positioned within a suitable distance for a drop down arrangement. The works include:

- Extending the 132 kV busbars at Bartley Green to become a 3-section single busbar arrangement with the two new bus-section circuit breakers normally run open.
- Dropping down from the existing tower line between Kitwell and Selly Oak (via tower 15, and on the 47PZY circuit) on to the new busbar extension at Bartley Green.
- Connecting the new tee'd 132 kV circuit onto the end busbar at Bartley Green (normally run open via the bus-section circuit breaker, to be closed in for N-2 compliance only.

New limiting factor: Rating of the 132 kV circuits

Option 4 – Operational mitigation: Load Transfer

Estimated capacity released: A few MVAs

Discounted

Detailed description: The group (Bartley Green and Chad Valley) have 11 kV interconnections to neighbouring BSPs which could push the need a few years but the available interconnections would not be sufficient to maintain long term compliance of the group.

New limiting factor: Engineering Recommendation P2 compliance

Option 5 – Load Management Schemes: Intertrips

Estimated capacity released: 0 MVA

Discounted

Detailed description: The constraint is driven by N-2 security of supply limitation for a Class D group (greater than 100 MW demand) and therefore there is no viable intertrip scheme that would mitigate it.

New limiting factor: Engineering Recommendation P2 non-compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 0 MW

Discounted

Detailed description: Flexibility services through generation turn up and/or demand turn down could be procured to help alleviate thermal constraints, but as the constraint above is driven by an N-2 loss of supply compliance issue, flexibility would not be feasible here.

New limiting factor: Engineering Recommendation P2 non-compliance

Solution Recommendation

It is recommended to pursue option 3 above (Tee connection to the Selly Oak circuit) as this is likely to be the most deliverable and cost-effective solution that better utilises the existing assets.

3.4 Kitwell-Bournville-Shirley-Longbridge network constraints

Constraint Overview

Generation Demand

The group of BSPs consisting of Selly Oak, Bournville, Longbridge, Rednal, Highters Heath, Hall Green, and Shirley are fed via interconnected 132 kV rings supplied through the following main circuits from Kitwell GSP:

- Two circuits to Selly Oak switching station
- Two circuits to Bournville
- Three circuits to Longbridge

The group is currently Class D under Engineering Recommendation P2, expected to become Class E by 2032.

The table below outlines the constraints identified for Best View, the conditions they occur under, and the triggering year per season. These are only some of the main overloads, but various other N-2 conditions also lead to a number of other circuit overloads.

Table 3.4.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Kitwell_205 to Bournville_403 132 kV circuit overload	N-1: Fault outage of Kitwell busbar reserve 2 taking out a 132 kV circuit to Selly Oak and another to Bournville	2033	-	-	-
Kitwell_805 to Longbridge_303 132 kV circuit overload	N-1: Fault outage of Kitwell busbar main 2 taking out 3x 132 kV circuits: to Selly Oak, to Bournville, and to Longbridge	-	2031	-	-
Shirley tee to Shirley 132 kV circuit overload	N-1: Fault outage of the Kitwell_1005 to Bournville_203 132 kV circuit	2030	2031	2033	-
Shirley tee to Shirley 132 kV circuit overload	N-2: Arranged outage of a 132 kV infeed via Bournville followed by a fault outage of the second infeed via Bournville	Baseline	Baseline	2025	2028
Bournville to Hall Green 132 kV circuit overload	N-2: Arranged outage of a 132 kV infeed via Selly Oak followed by a fault outage of the infeed via Longbridge (or vice versa)	2029	2029	2030	-
Longbridge to Shirley tee 132 kV circuit overload	N-2: Arranged outage of a 132 kV infeed via Selly Oak followed by a fault outage of the infeed via Bournville (or vice versa)	Baseline	Baseline	Baseline	2025
Selly Oak to Highters Heath 132 kV circuit overload	N-2: Arranged outage of a 132 kV infeed via Bournville followed by a fault outage of the infeed via Longbridge (or vice versa)	2027	2026	2029	-
Kitwell_1205 to Longbridge_103 132 kV circuit overload	N-2: Arranged outage at Longbridge 132 kV isolating two infeeds from the wider group, followed by a fault outage of an infeed via Bournville	2030	Baseline	2026	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 3.4.2 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	Installing a Kitwell-Bournville circuit	✓	✓	×	Viable
3	Uprating existing 132 kV circuits	✓	✓	×	Viable
4	Reconfiguring and uprating 132 kV circuits	✓	✓	✓	Viable
Operational mitigation					
5	Network Reconfiguration and 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 and the demand is 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 the 132 kV circuits

Option 2 – Adding a Kitwell-Bournville circuit

Estimated capacity released: 100 MVA+

Viable

Detailed description: Adding a third circuit between Kitwell and Bournville, the works include:

- Establishing a new 132 kV bay at Kitwell GSP, on the Main 1 / Reserve 1 side
- Extending the 132 kV busbars at Bournville to include an additional feeder bay
- Installing approximately 7.5 km of 132 kV cable circuit between Kitwell and Bournville with a minimum rating of 200 MVA summer cyclic, anticipated to be 1000 mm copper conductor
- Carrying out a fault level assessment across the BSPs within the group to identify any overstress

New limiting factor: Rating of the 132 kV circuits

Option 3 – Uprating existing 132 kV circuits

Estimated capacity released: 100 MVA+ ↑ Viable

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

- Kitwell to Bournville circuits: Replacing the 600 amp disconnectors and 800 amp circuit breakers at Kitwell, uprating them to 231/213 MVA winter/summer cyclic ratings.
- Selly Oak to Bournville circuit: Replacing approximately 90m of 0.4in Cu gas-filled cable with one rated a minimum of 181 MVA summer cyclic.
- Kitwell_805 to Longbridge_303: Replacing approximately 3.5 km of 0.85Cu oil filled cable sections with one rated a minimum of 200 MVA summer cyclic. The 600 amp disconnectors and 800 amp circuit breaker at Kitwell would also need replacing.
- Highters Heath to Shirley circuit: Restringing/uprating approximately 8.5 km of double circuit tower line between Highters Heath and Shirley BSP. The existing conductor is a mixture of 0.175 in Aluminium Conductor Steel Reinforced (ACSR) and 0.175 in Cadmium Copper (CadCu); the new circuit is anticipated to be 300 mm All Aluminium Alloy conductor (AAAC), subject to a tower line survey.

New limiting factor: Rating of the 132 kV circuits

Option 4 – Reconfiguring and uprating 132 kV circuits

Estimated capacity released: 100 MVA+ ↑ Viable

Detailed description: Uprating existing circuits, circuit breakers, and disconnectors, along with network reconfiguration, the works include:

- At Kitwell GSP, replacing the 600 amp disconnectors and 800 amp circuit breakers for the circuits below (uprating them to 231/213 MVA winter/summer cyclic ratings):
    - Kitwell_205 to Bourville_403 circuit, and
    - Kitwell_1005 to Bourville_203 circuit
- Installing approximately 2 km of 132 kV cable between Shirley tee and Shirley BSP to unstitch the existing tee point, effectively creating a Highters Heath to Shirley circuit, and a Longbridge to Shirley circuit. The cable is to have a minimum 200 MVA summer cyclic rating, anticipated to be 1000 mm copper cable.
- Establishing a new feeder bay at Shirley (between CB320 and isolator 403) for the new cable circuit, allowing room for a future transformer bay (as part of a different scheme to increase capacity at Shirley BSP – this is also necessary for this scheme to allow demand transfer, under normal running, to the Longbridge-Shirley circuit).
- Connecting the 132 kV circuit between Selly Oak switching station and Highters Heath BSP into Bournville BSP. The circuit passes through Bournville 132 kV compound, the works therefore include splitting this cable circuit at Bournville by:
    - Connecting the end heading towards Selly Oak switching station to disconnector 428.
    - Connecting the end heading towards Highters Heath BSP to circuit breaker CB420.

  [Alternatively, connecting both ends to circuit breaker CB420, effectively creating a tee point at the 132 kV busbar, could also be considered.]
- Splitting the network by normally operating the 132 kV circuit breakers at Selly Oak switching station, CB220 and CB305, open; and still keeping the circuit breaker at Shirley, CB320, open. This would effectively divide the interconnected network into three smaller groups:
    - Group 1: Selly Oak GT1, Selly Oak GT2, a 132 kV customer BSP, and future interconnection to Bartley Green.
    - Group 2: Bournville, Highters Heath, Hall Green, and Shirley (GT1 and GT2).
    - Group 3: Longbridge, Rednal, future Shirley GT4, and future 132 kV demand connection between Shirley and Copt Heath.

New limiting factor: Rating of the 132 kV circuits

Option 5 – Operational mitigation: Network reconfiguration and load transfers

Estimated capacity released: A few MVAs

Discounted

Detailed description: The group has some 11 kV interconnections to other BSPs, as well as transfers via Shirley, both of which could help reduce some of the N-2 constraints but would be insufficient to fully mitigate, and would not help resolve the N-1 constraints.

In addition to the above, there are options to split the network during the arranged outage to mitigate the N-2 constraints; this includes open points at various BSPs, depending on the arranged outage at the time.

The above would not resolve the N-1 constraints highlighted, nor the N-2 constraints once the group reached Class E under Engineering Recommendation P2, which is anticipated by 2032, due to the requirement to restore the entire group demand during the access period for a second circuit outage; but they can be utilised to manage the baseline constraints and N-2 overloads in the meantime.

New limiting factor: Rating of the 132 kV circuits and P2 compliance

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

Estimated capacity released: 0 MVA

Discounted

Detailed description: The group is Class D under Engineering Recommendation P2, anticipated to become Class E by 2032 which would require full restoration of the group, during the access period, following a second circuit outage; therefore demand disconnection schemes (or similar) would make the group non-compliant.

The requirements become more onerous as the group becomes Class E under P2, solidifying

New limiting factor: Engineering Recommendation P2 compliance

Option 7 – Flexibility service procurement

Estimated Flexibility Required (MW): 40 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 configuration comprising several interconnected rings, 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

It would be recommended to pursue option 4 above (unstitching the Shirley tee and reconfiguring) as it is likely to be more cost-effective than the other viable options and would better utilise the existing network capacity; it also has the wider benefit of simplifying the network (for protection and operability purposes) and would keep fault levels in check.

It is acknowledged however that the reinforcement option above, or a version of it, could be lengthy and therefore option 5 (operational mitigation) could be utilised in the interim to manage the baseline and N-2 constraints.

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