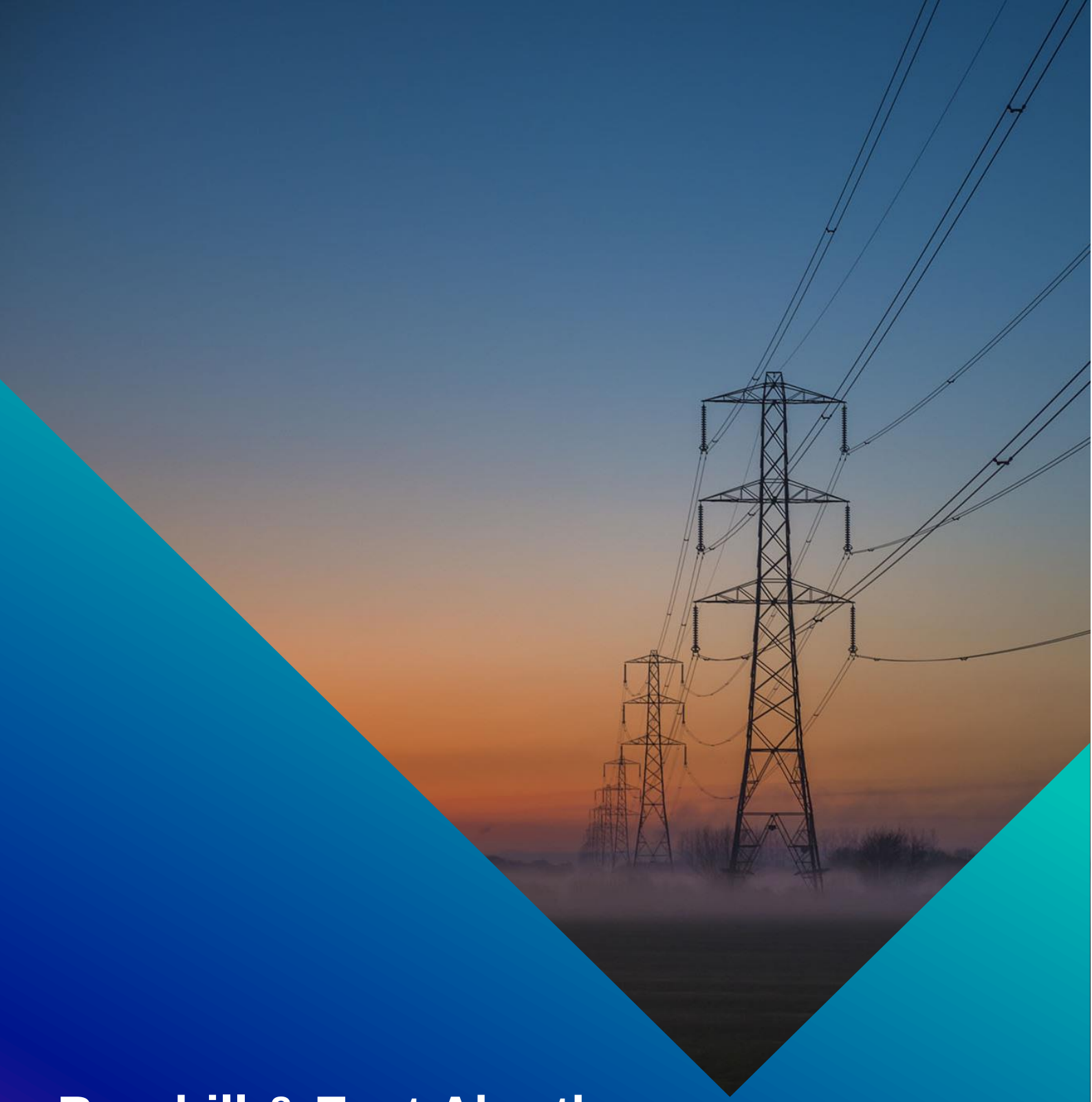

Brynhill & East Aberthaw BSPs incl. associated 33 kV network

Network Development Report – South Wales

May 2024

Electricity Distribution

nationalgrid

Contents

Brynhill & East Aberthaw BSPs incl. associated 33 kV network

1. Network Overview

Brynhill and East Aberthaw Bulk Supply Points (BSPs) supply an area of 33 kV network to the west of Cardiff. The associated 33 kV network supplies over 36,000 customers and includes the following 33/11 kV Primary substations:

- Boverton, Broad Street, Brynhill Primary, East Aberthaw Primary, Court Road, Cowbridge and Ship Hill.

A large amount of distributed generation has also been connected to the 33 kV and 11 kV networks in recent times, more of which is proposing to connect in the near future, in a variety of different technology types, including wind and PV.

Brynhill (also known as Barry BSP) and East Aberthaw BSPs currently have a maximum demand of 59.6 MVA and under NGEDs DFES Best View scenario this is projected to rise to 85.7 MVA by the year 2034.

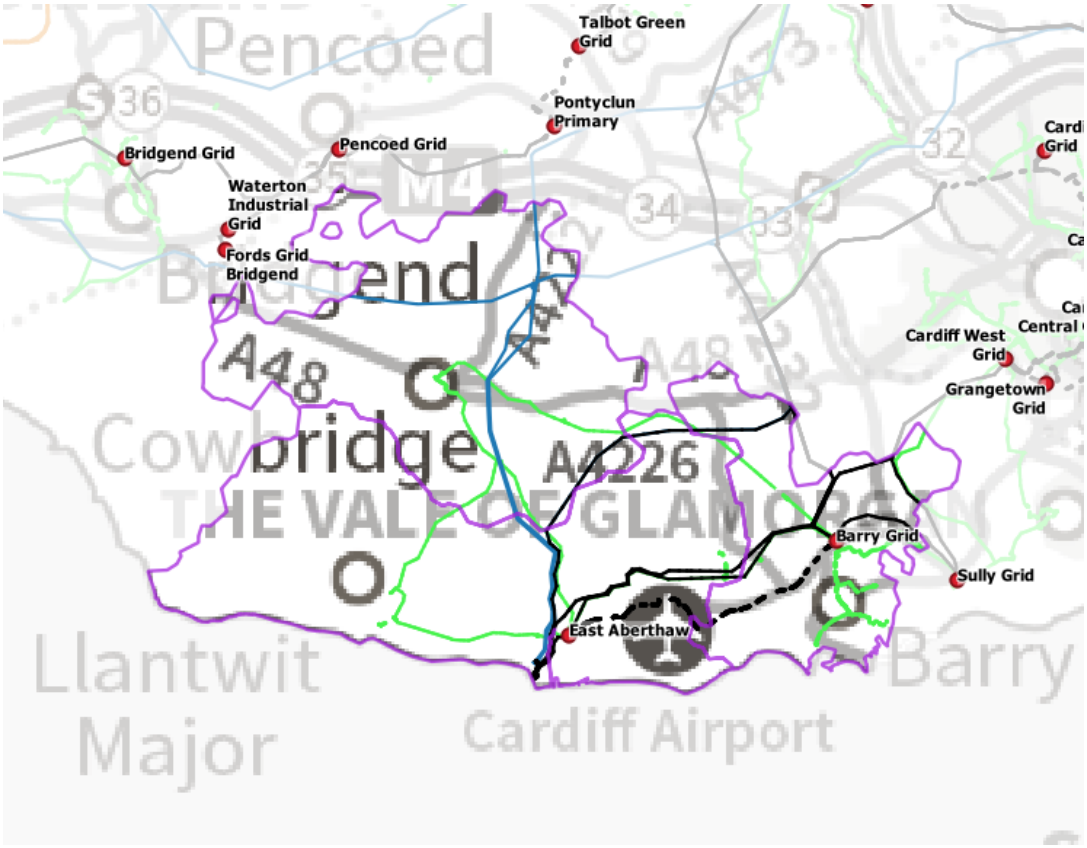

Figure 1.1 Brynhill (Barry) & East Aberthaw BSPs geographic network coverage

This report discusses all existing and future network constraints over a 0-10 year horizon associated with the 33/11 kV transformers, 33 kV circuits, 132/33 kV transformers which supply and are supplied by Brynhill and East Aberthaw BSPs. This uses the methodology outlined in the Network Development Plan Methodology Report with Network Operability Modelling applied as outlined below.

For the purposes of this analysis the NGED Best View Distribution Future Energy Scenario (DFES) has been used to study the years 2022 (baseline), 2028 and 2034, with consideration given to how proposals could change under the other scenarios.

The two most onerous half-hours have been studied for each of the five representative days considered: Winter Peak Demand, Intermediate Warm Peak Demand, Intermediate Cool Peak Demand, Summer Peak Demand and Summer Peak Generation.

1.1 Network Topology

The Brynhill and East Aberthaw 33 kV network is arranged as follows:

- Brynhill BSP has two 132/33 kV GTs (GT1 and GT2) both rated at 30/60 MVA. A pair of 33/11 kV primary transformers (12/24 MVA) are also installed that supply an 11 kV switchboard.
- East Aberthaw BSP has two 132/33 kV GTs: GT1 rated at 60/90 MVA and GT2 rated at 22.5/45 MVA. GT1 is currently run on hot-standby with GT2 in-service. A pair of 33/11 kV primary transformers (7.5/15 MVA) are also installed that supply an 11 kV switchboard.
- The outgoing 132 kV circuits from each BSP are supplied from the Aberthaw and Cardiff East 132 kV group.
- Outgoing 33 kV circuits from Brynhill an East Aberthaw BSPs supply the following 33/11 kV primary substations:
    - Boverton: Two 12/24 MVA primary transformer substation (T1 & T2)
    - Broad Street: Single 7.5/15 MVA primary transformer substation (T1)
    - Court Road: Single 7.5/15 MVA primary transformer substation (T1)
    - Cowbridge: Two 14 MVA primary transformer substation (T1 & T2)
    - Ship Hill: Single 7.5/15 MVA primary transformer substation (T1)
- The Brynhill and East Aberthaw 33 kV group also provides connection to a 33 kV connected customer.
- A 33 kV interconnection to the Cardiff Central and Cardiff West 33 kV group is available via an outgoing 33 kV circuit at Brynhill BSP. This circuit, which is normally run open, can provide 33 kV interconnection between both 33 kV groups under select operating conditions.

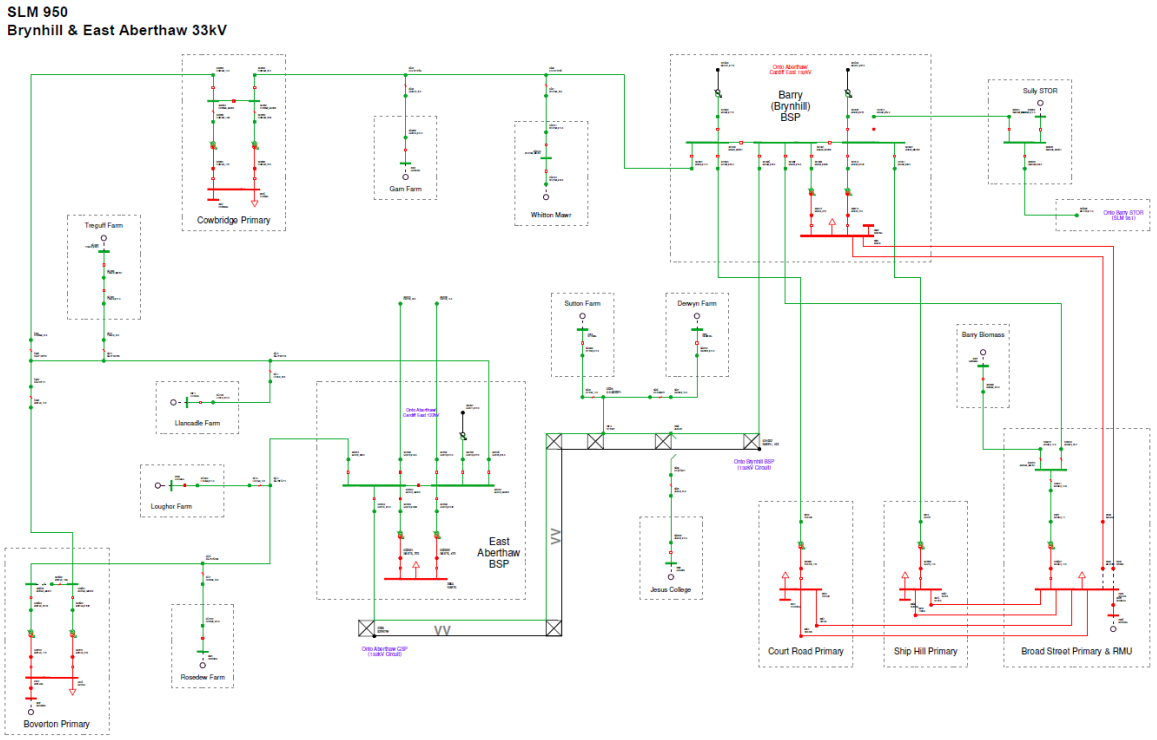

Figure 1.1 Brynhill & East Aberthaw 33 kV network single line diagram

1.2 Network Operability Modelling

The following network automation and manual switching schemes have been modelled in the analysis of this area, aligning to how the network is currently operated.

- Broad Street, Court Road and Ship Hill single primary transformer substations have 11 kV interconnections which are typically run solid under intact network conditions.
- The 33 kV interconnection from the Cardiff Central and Cardiff West 33 kV group is primarily utilised to support either BSP group following SCO outage conditions.
- For the loss of an infeed to a transformer at any of the primaries fed from within the Brynhill and East Aberthaw 33 kV network under arranged outages, the lower voltage side circuit breaker is opened to prevent back-energisation.
- Curtailment of all connected load management schemes within the group are modelled at a variety of outage conditions, as outlined in customer connection agreements.
- Various winter arranged outages not permitted due to SCO overloads.
- Various SCO overloads solved by network reconfiguration for arranged outages.

2. Summary of Network Constraints

The following constraints were identified for the Best View Scenario, for which mitigation options will be discussed:

- Brynhill and East Aberthaw 33 kV Constraints:
    - 33 kV circuit overloads on the East Aberthaw BSP to Boverton and Cowbridge 33 kV ring following the proposed 33 kV network split (see section 3.0 below).
    - Brynhill BSP to Court Road, Ship Hill, Broad Street 33 kV circuit and 33/11 kV primary transformer constraints.

3. EHV Reinforcement Schemes Progressing

The following list contains the EHV reinforcement schemes that are currently in active development in this area to overcome a number of constraints facing the network, these include:

- Rationalising the Brynhill and East Aberthaw 33 kV parallel network into two distinct 33 kV BSP groups. This is to accommodate the newly established 90 MVA GT1 to be in-service alongside the existing GT2 at East Aberthaw BSP.

This scheme, alongside the associated works to facilitate this 33 kV network split have been included in all studies from 2028 onwards.

4. Network Constraint Details and Solution Options

4.1 Brynhill and East Aberthaw 33 kV Group

The table below summarises the scale of the background load growth forecast to connect to the Brynhill and East Aberthaw 33 kV network up to 2034 under NGEDs DFES Best View scenario.

Table 4.1.1 Maximum demand forecast to the Brynhill & East Aberthaw 33 kV network

DFES Scenario	Demand		
	Baseline	2028	2034
Best View	59.6 MW	63.1 MW	85.7 MW

Table 4.1.2 Maximum generation forecast to the Brynhill & East Aberthaw 33 kV network

DFES Scenario	Generation		
	Baseline	2028	2034
Best View	67.7 MW	79.3 MW	107.8 MW

With several new developments proposed to connect within the group at 11 kV and at 33 kV in the near future, the demand and generation forecast is expected to increase. However, this will vary depending if such developments materialise.

This group becomes vulnerable to outage conditions throughout the 0-10 year horizon period as a result of the load growth projections. These limitations are highlighted below.

4.2 East Aberthaw BSP 33 kV Circuit Overloads

Constraint Overview

Generation | Demand

The table below outlines the nature of the network constraints identified in the network analysis, with the worst overloads seen at winter peak demand.

Table 4.2.1 constraint(s) and condition under which constraint occurs

Constraint	N-1 Condition	Subsequent N-2 Condition	First year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
33 kV circuits between Cowbridge, Boverton and East Aberthaw (multiple sections)	Arranged outage of East Aberthaw 33 kV Main 1 busbar	33 kV circuit fault to East Aberthaw 8L5	2034	2034	2034	-

Uncertainty under other Distribution Future Energy Scenarios: This constraint first appears in 2034 and is driven by the background load growth at both Cowbridge and Boverton primaries in combination with future developments proposed within the area.

Solution Options

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

Table 4.2.2 solution options to solve constraint(s)

Solution Options	Description	Solves Constraint	Wider Area Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Reinforce existing 33 kV circuits	✓	×	×	Discounted
2	Install an additional 33 kV circuit to Boverton primary and split Boverton onto a dedicated 33 kV ring	✓	✓	✓	Viable
3	New 33 kV circuit from Cowbridge primary to East Aberthaw BSP	×	✓	×	Discounted
Operational Mitigation					
4	Sufficiency of the available access window	✓	✓	✓	Viable
Flexibility services					
5	Procure flexibility within the East Aberthaw BSP group	✓	×	×	Discounted

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full cost benefit analysis (CBA). This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the Distribution Network Options Assessment (DNOA) process.

Option 0 – No Intervention

Capacity Released for constraint(s) considered: 0 MVA

Discounted

Detailed description: Doing nothing to mitigate the constraint would result in overloads for the conditions described above. This would lead to an inability to meet the Security of Supply requirements of Engineering Recommendation P2 for primaries in the East Aberthaw BSP group.

New limiting factor for constraint(s) considered: N/A

Option 1 – Reinforce existing 33 kV circuits

Capacity Released for constraint(s) considered: 5 MVA

Discounted

Detailed description: Several sections of the existing 33 kV circuits would have to be upgraded to firstly alleviate the constraint, and secondly to facilitate load growth. These circuits would need to be uprated to at least 40 MVA to accommodate the overloads observed.

This would require the majority of the 33 kV circuits supplied by East Aberthaw BSP to be replaced, whilst not being massively beneficial regarding future load growth, as the highest rating that could realistically be used is around 40 MVA, only giving very limited headroom for future load growth for the entire group.

New limiting factor for constraint(s) considered: Limiting rating of 33 kV circuits

Option 2 – Install an additional 33 kV circuit to Boverton primary and split Boverton onto a dedicated 33 kV ring

Capacity released for constraint(s) considered: 25 - 30 MVA

Viable

Detailed description: The following works could be proposed to alleviate the overloads observed:

- Construct a new 33 kV circuit (rated around 35 MVA) from East Aberthaw 33 kV main busbar 2 to Boverton primary, including two 33 kV circuit breaker bays and associated works to facilitate this connection.
- Install an additional 33 kV circuit breaker at Boverton primary (1L5) to the outgoing 33 kV circuit currently supplied by Boverton T2.
- Introduce a new 33 kV split point by opening this proposed 33 kV circuit breaker 1L5. This effectively splits the group by having Cowbridge and the large developments proposed within the area separate from Boverton, which can now be on its own 33 kV ring with two dedicated 33 kV circuits from East Aberthaw BSP.

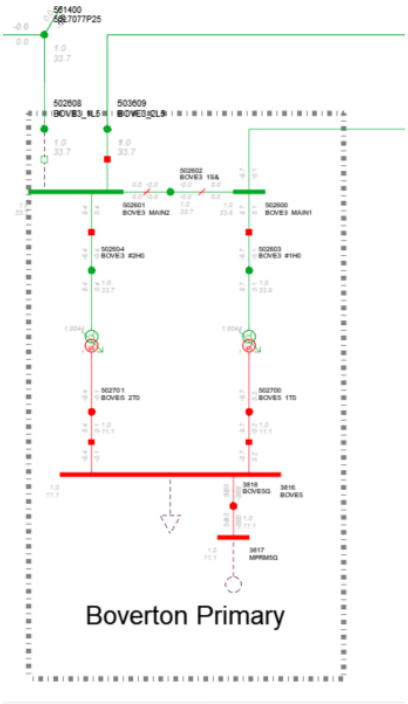

Figure 4.2 Proposed redesign of Boverton 33/11 kV primary substation single line diagram

New limiting factor for constraint(s) considered: Limiting rating of 33 kV circuits

Option 3 – New 33 kV circuit from Cowbridge Primary to East Aberthaw BSP

Capacity Released for constraint(s) considered: Up to 10 MVA

Discounted

Detailed description: Similarly to Boverton, a new 33 kV circuit could be constructed from East Aberthaw BSP to Cowbridge primary, with the existing Cowbridge to Boverton 33 kV circuit run open to split Cowbridge onto its own 33 kV ring.

This however, is ineffective as due to the lower projected loadings on Cowbridge primary, there would still be FCO overloads on one of the 33 kV circuits from Boverton and the developments within the area to East Aberthaw BSP.

New limiting factor for constraint(s) considered: Limiting rating of 33 kV circuits

Option 4 – Sufficiency of the available access window

Capacity Released for constraint(s) considered: N/A

Viable

Detailed description: Currently, 2034 studies do not indicate overloads under summer peak demand conditions. It is recommended that the adequacy of the available access window for the arranged outage is assessed as a summer access window could be available to mitigate this overload.

It may be possible to defer this reinforcement through access scheduling.

New limiting factor for constraint(s) considered: N/A

Option 5 – Procure flexibility at East Aberthaw BSP

Estimated Flexibility Required (MVA): 23 MVA+

Discounted

Detailed description: Flexibility services could be procured throughout the East Aberthaw 33 kV network to help alleviate the projected overloads. It is unlikely that sufficient flexibility could be procured due to the volume required when compared with the group demand.

This, combined with the constraints on the East Aberthaw 33 kV circuits occurring under N-1 for winter peak, intermediate warm and intermediate cool conditions suggest that flexibility may not be an optimal solution. The viability of utilising flexibility will be further considered as part of the DNOA process. The amount required will continue to grow as demand grows meaning this would likely only defer the reinforcement.

Solution Recommendation

It is recommended to firstly consider flexibility as an option to gauge the level of procurement available within the area, subject to a cost benefit analysis and confirmation through the DNOA process. Following this, as it is anticipated that flexibility will be insufficient to solve the constraint, it is recommended that the sufficiency of the available access window for the arranged outage is confirmed as it may be possible to defer this reinforcement through access scheduling.

If the arranged outage window is not sufficient, it is recommended that a technical review of building a new 33 kV circuit from Boverton primary to East Aberthaw BSP and the associated works required to facilitate this connection is carried out (Option 2).

This allows for a reduction in network complexity, whilst ensuring compliance with Engineering Recommendation P2/8 throughout the forecasted load growth period and beyond.

4.3 Brynhill BSP 33 kV Circuit and Primary Transformer Constraints

Constraint Overview

Generation **Demand**

The table below outlines the nature of the network constraints identified in the network analysis, with the worst overloads seen at winter peak demand.

Table 4.3.1 constraint(s) and condition under which constraint occurs

Constraint	N-1 Condition	Subsequent N-2 Condition	First year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
33 kV circuit overloads 33/11 kV primary transformer overloads Undervoltages	Brynhill 33 kV Main 2 arranged busbar outage OR Arranged 33 kV circuit outage to either Court Road, Ship Hill or Broad Street	Brynhill GT1/GT2 fault OR 33 kV circuit fault to either Court Road, Ship Hill or Broad Street	2034	2034	2034	-

Uncertainty under other Distribution Future Energy Scenarios: This constraint first appears in 2034 and is driven by the background load growth within the area.

Solution Options

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

Table 4.3.2 solution options to solve constraint(s)

Solution Options	Description	Solves Constraint	Wider Area Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	**Discounted**
Reinforcement					
1	Reinforce existing primary transformers	✓	✓	✓	**Viable**
2	Construct a new 33 kV circuit to Court Road and install a second primary transformer at Court Road	✓	✓	✓	**Viable**
3	Install a 33 kV bus section coupler at Brynhill BSP	×	✓	✓	**Viable**
Operational Mitigation					
4	Sufficiency of the available access window	✓	✓	✓	**Viable**
Flexibility services					
5	Procure flexibility at Court Road, Ship Hill and Broad Street primaries.	✓	✓	✓	**Viable**

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full cost benefit analysis (CBA). This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the Distribution Network Options Assessment (DNOA) process.

Option 0 – No Intervention

Capacity Released for constraint(s) considered: 0 MVA

Discounted

Detailed description: Doing nothing to mitigate the constraint would result in overloads for the conditions described above. This would lead to an inability to meet the Security of Supply requirements of Engineering Recommendation P2 for Court Road, Ship Hill and Broad Street primary substations.

New limiting factor for constraint(s) considered: N/A

Option 1 – Reinforce existing primary transformers

Capacity Released for constraint(s) considered: Up to 9 MVA per primary

Viable

Detailed description: A potential solution to the constraint could be to uprate the existing transformers at Court Road, Ship Hill and Broad Street to 12/24 MVA units. This would alleviate the constraint from the N-2 loss of two 33 kV feeder circuits to the group, as well as allowing the islanded group demand to be back fed via the 11 kV interconnections available between each primary.

This solution solves the N-2 issues, however is ineffective under the break parallel event as there are still undervoltages and thermal overloads on 33 kV circuits within this group.

New limiting factor for constraint(s) considered:

11 kV backfeed capacity between the primaries in the Court Road, Ship Hill and Broad Street group

Option 2 – Construct new 33 kV circuit to Court Road and install a second primary transformer at Court Road

Capacity Released for constraint(s) considered: 25 - 30 MVA

Viable

Detailed description: Building a new 33 kV circuit (rated at a minimum of 25 MVA under winter cyclic conditions) to Court Road and installing a second 33/11 kV primary transformer (12/24 MVA) would help alleviate both the N-2 issues observed as well as the break parallel issues.

It is also proposed to install a 33 kV bus section breaker at Court Road, as this allows the islanded section of the 33 kV busbar at Brynhill BSP to be back fed without causing through flows via the 33/11 kV primary transformers.

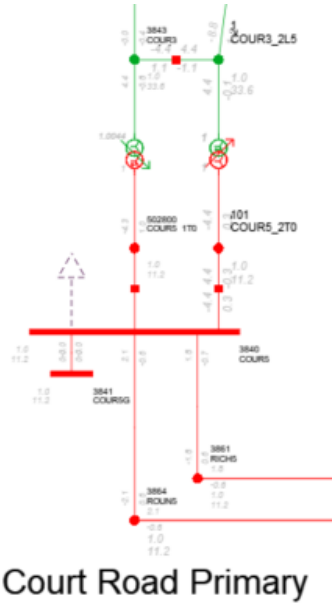

Figure 4.3 Proposed redesign of Court Road 33/11 kV primary substation single line diagram

It is worth noting however, that this proposed scheme does not completely solve the problem as there is still a 33 kV circuit overload present in the SCO event of a Brynhill GT2 fault, whilst Brynhill 33 kV main 2 busbar is out on an arranged outage.

This causes an overload on the existing Court Road to Brynhill BSP 33 kV circuit.

New limiting factor for constraint(s) considered: Rating of the 33 kV circuit capacity available

Option 3 – Install a 33 kV bus section coupler at Brynhill BSP

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

Viable

Detailed description: In order to prevent against a break parallel event, a 33 kV bus section coupler could be installed at Brynhill BSP by extending Main 1 and Main 3 busbars with 1 additional GIS 33 kV breaker at each busbar with a 33 kV interplant cable running between them.

This would then be switched in under the arranged busbar outage of Brynhill 33 kV Main 2 to keep the bus sections in series under the SCO transformer fault.

There would still be a need to include Option 1 (uprate the existing primary transformers) due to this solution being ineffective at dealing with the SCO circuit constraints.

New limiting factor for constraint(s) considered:

11 kV backfeed capacity between the primaries in the Court Road, Ship Hill and Broad Street group

Option 4 – Sufficiency of the available access window

Capacity Released for constraint(s) considered: N/A

Viable

Detailed description: Currently, 2034 studies do not indicate overloads under summer peak demand conditions. It is recommended that the adequacy of the available access window for the arranged outage is assessed as a summer access window could be available to mitigate this overload.

It may be possible to defer this reinforcement through access scheduling.

New limiting factor for constraint(s) considered: N/A

Option 5 – Procure flexibility at primaries at Brynhill BSP

Estimated Flexibility Required (MVA): 20 MVA +

Viable

Detailed description: Flexibility services could be procured across Court Road, Ship Hill and Broad Street primary substations to help alleviate the projected overloads. The viability of utilising flexibility will be further considered as part of the DNOA process. The amount required will continue to grow as demand grows meaning this would likely only defer the reinforcement.

Solution Recommendation

It is recommended to firstly consider flexibility as an option to gauge the level of procurement available within the area, subject to a cost benefit analysis and confirmation through the DNOA process. Following this, it is recommended that the sufficiency of the available access window for the arranged outage is confirmed as it may be possible to defer this reinforcement through access scheduling.

If the arranged outage window is not sufficient, it is recommended that a technical review of adding a 33 kV bus section coupler at Brynhill BSP, as well as uprating the existing 33/11 kV primary transformers at Broad Street, Ship Hill and Court Road primaries, is carried out (Options 1 and 3). Finally installing a new circuit and transformer could be considered if other solutions prove insufficient (Option 2). This will ensure compliance with P2/8 throughout the forecasted load growth period and beyond.

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