Dowlais BSP and Associated 33 kV Network

Network Development Report – South Wales

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Electricity Distribution

nationalgrid

Contents

Dowlais BSP and Associated 33 kV Network

1. Network Overview

Dowlais Bulk Supply Point (BSP) supplies a mostly rural area of 33 kV network, in the Merthyr Tydfil area of South Wales. The BSP is fed from two 22.5/45 MVA 132/33 kV transformers, with the 132 kV infeed coming from Upper Boat GSP. There are four 33/11 kV primary substations on the network in a 33 kV ring arrangement, as well as various distributed generators.

Dowlais BSP supplies approximately 17,000 customers and currently has a maximum demand of 27 MVA and under NGEDs DFES Best View scenario this is projected to rise over 39 MVA by the year 2034.

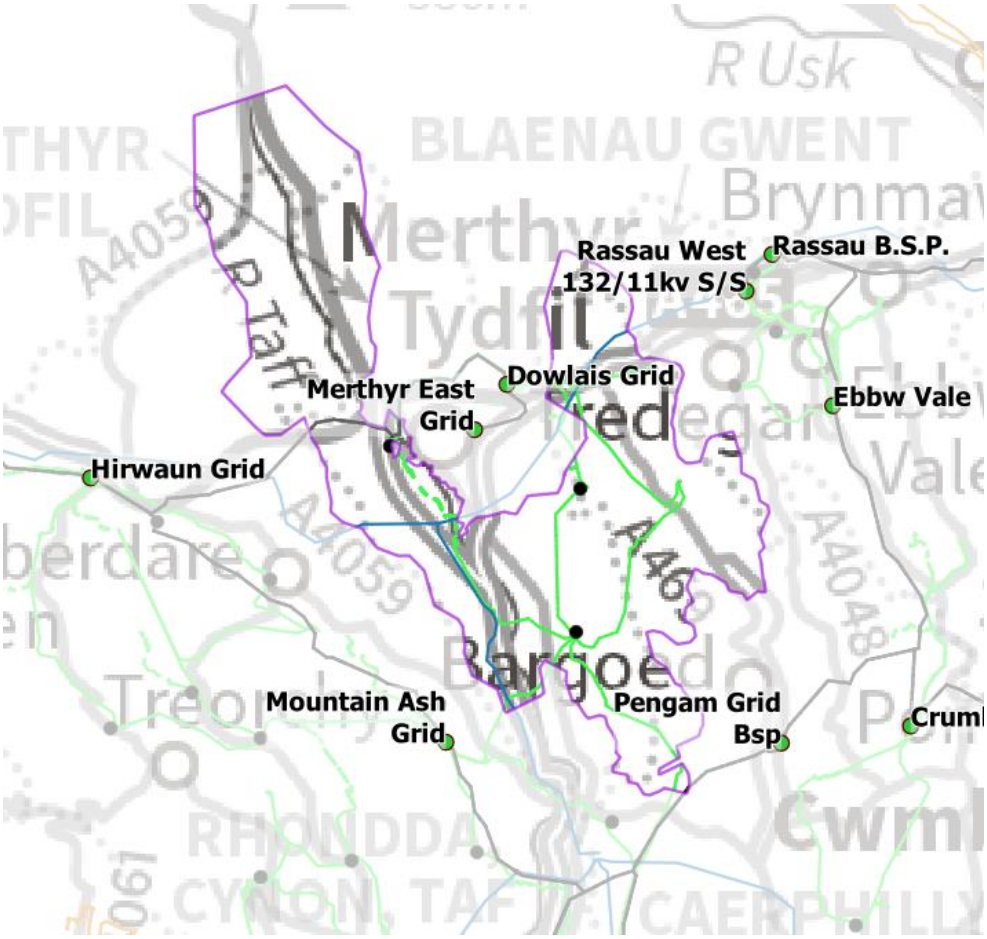

Figure 1.1 Dowlais BSP geographic network coverage

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 and 132/33 kV transformers supply and are supplied by Dowlais BSP. 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 Dowlais BSP network is arranged as follows:

- GT1 and GT2 currently run in parallel supplying Dowlais BSP. Both 132/33 kV transformers are currently rated at 22.5/45 MVA, however due to distributed generation proposals these are earmarked for reinforcement up to 90 MVA under existing plans.
- Abertysswg, Pentrebach and Swansea Road are two 33.11 kV primary transformer substations. These are fed from outgoing 33 kV circuits from Dowlais BSP.
- Nantwen is a single 33/11 kV transformer primary. This is fed from Dowlais BSP and has an interconnector with Mountain Ash BSP (this is run normally open), as well as connecting with the 33 kV ring (via the 33 kV bar) that supplies Abertysswg, Pentrebach and Swansea Road.
- There is a normally open point which connects Upper Boat 33 kV network with Dowlais 33 kV.

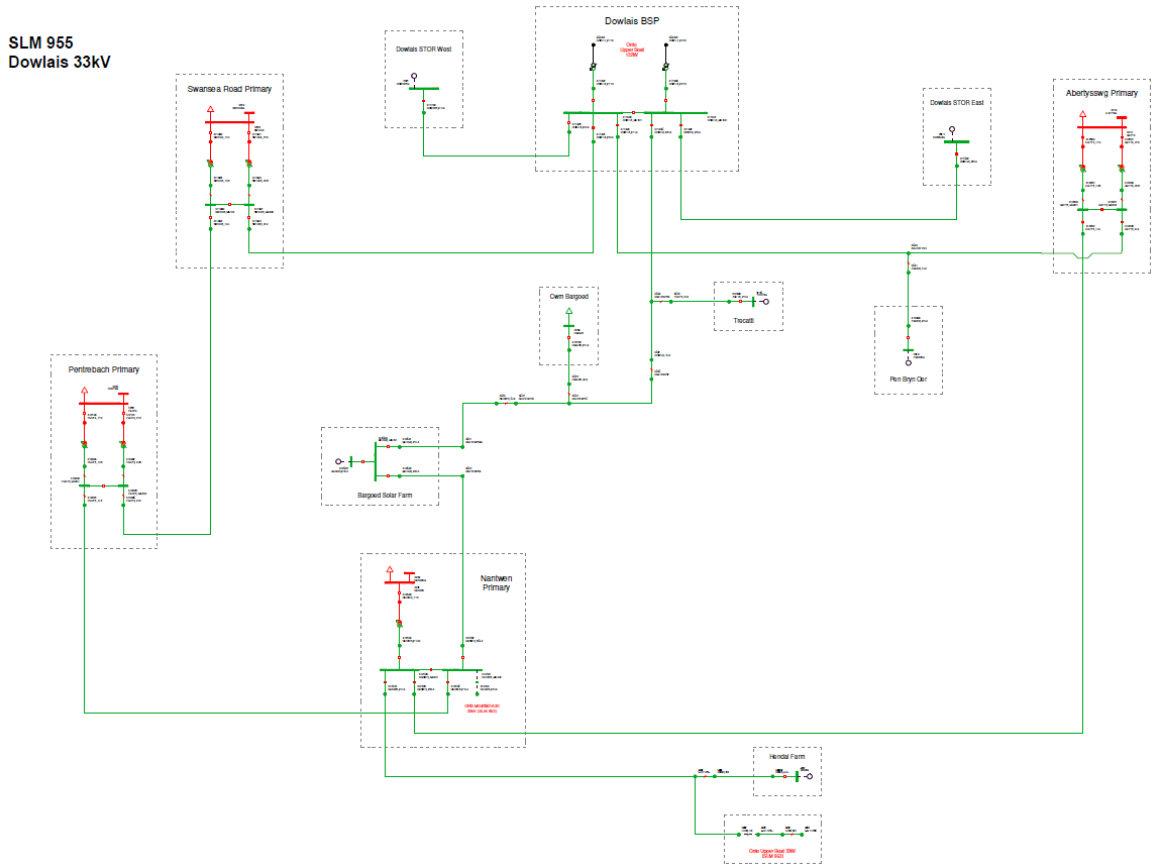

Figure 1.1 Dowlais 33 kV network single line diagram

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.

- Under intact network conditions, the Dowlais BSP group operates in parallel via several 33 kV circuits.
- The interconnectors to Upper Boat via Nantwen and Mountain Ash are primarily used to restore Dowlais BSP in the event of a double GT outage.
- For the loss of an infeed to a transformer at any of the primaries fed from within the Dowlais 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:

- Circuit Overloads on the 33 kV ring from Swansea Road to Abertysswg via Pentrebach and Nantwen under First Circuit Outage (FCO) and Second Circuit Outage (SCO) conditions.
- Pentrebach transformer overloads due to bus section circuit breaker outages followed by circuit faults.
- Abertysswg transformer overloads due to firm capacity constraints.

3. Network Constraint Details and Solution Options

3.1 33 kV circuit overloads from Dowlais BSP

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 3.1.1 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 Dowlais, Abertysswg, Pentrebach and Swansea Road (multiple sections)	Dowlais Busbar main 2 arranged outage.	Swansea Road T2 Fault.	Baseline	Baseline	Baseline	Baseline

Uncertainty under other Distribution Future Energy Scenarios: As this constraint occurs under baseline, there is no uncertainty about future forecasts. There is a risk that demand reduces, however this is not forecast under any scenario so mitigation against this constraint is required

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 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 additional 33 kV circuits	✓	✓	✓	**Viable**
3	Reinforce 11 kV circuits to transfer demand to other Primaries	✓	✓	×	**Viable**
Flexibility services					
4	Procure flexibility at Primaries in Dowlais BSP	✓	✓	✓	**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 primaries in Dowlais BSP.

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 circuits would have to be upgraded to firstly alleviate the constraint, and secondly facilitate load growth. These would need to be uprated to at least 30 MVA to accommodate the constraint. This would require the majority of the circuits out of Dowlais to be replaced, whilst not being massively beneficial regarding future load growth, as the highest rating that could be realistically used is around 35 MVA, only giving 5 MVA of future load growth for the entire group.

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

Option 2 – Install additional 33 kV circuits

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

Detailed description: A new 33 kV circuit could be constructed from Dowlais main busbar 2 to Nantwen primary. From there, a 33 kV connection could be made onto the existing circuit between Nantwen 3L5 and Abertysswg 1L5. This would split the group into two separate rings, with Nantwen, Pentrebach and Swansea Road on one ring, and Abertysswg on a separate ring.

The reason for splitting the group in this way is because of future load growth on the nearby Merthyr East BSP. This results in the BSP exceeding its firm capacity around 2031-2032. A way to deload this BSP would be to put a new 33/11 kV primary substation nearby and use that to deload Merthyr East.

This could be done by adding the new 33/11 kV substation on the ring that Abertysswg is proposed on (utilising the excess capacity of the circuits), which would balance the loads between the two 33 kV rings. Another advantage of using this arrangement would be that generation connected, as well as Nantwen primary, could be switched over to the new ring (by closing 3L5 and opening 1S0). This would allow for greater generation growth on the Nantwen, Pentrebach and Swansea Road ring as a significant amount of the generation would be shifted to a 33 kV ring with excess circuit capacity for generation. Both 33 kV rings could be used to support the other in the event of an SCO for both generation and demand cases.

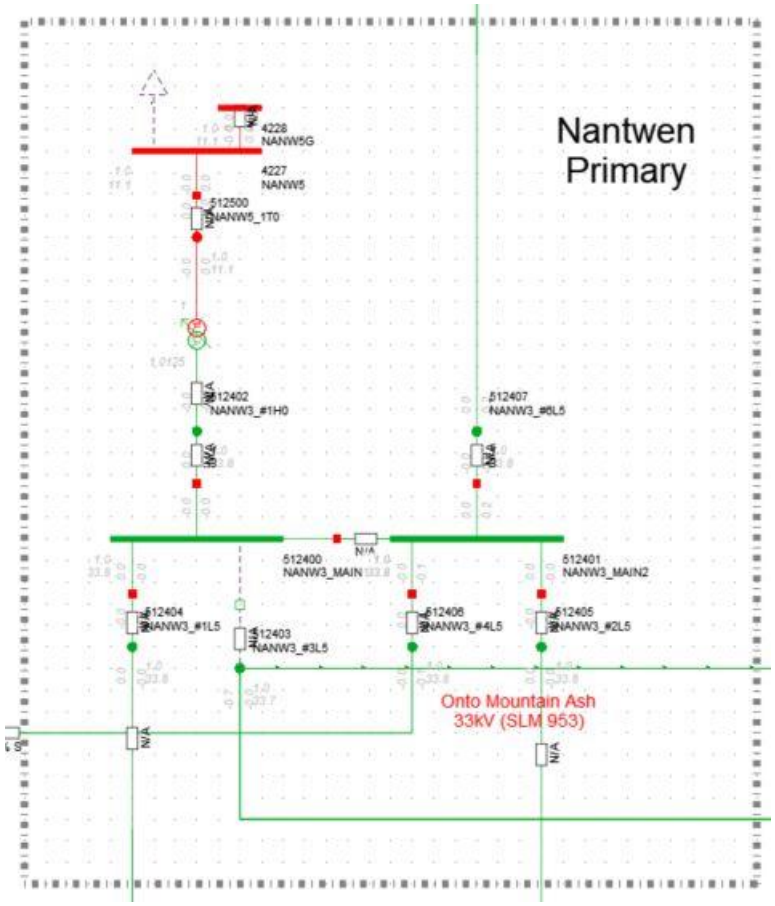

Figure 3.1 Proposed redesign of Nantwen primary

New limiting factor for constraint(s) considered: Circuit capacities of existing 33 kV circuits from Dowlais BSP. Eventually (around 2034) sections of the Dowlais – Abertysswg circuit will need to be reprofiled to operate at 75 degrees in order to accommodate the demand of Nantwen, Abertysswg and the proposed Merthyr South 33/11 kV primary substation (in the event Nantwen is switched over for a fault on the Dowlais bar).

Option 3 – Reinforce 11 kV circuits to transfer demand to other Primaries

Capacity Released for constraint(s) considered: Up to 8 MVA — Viable

Detailed description: Currently, there is around 8 MW of excess capacity at Merthyr East 132 kV/11 kV BSP. As Pentrebach and Swansea Road Primaries are both in the vicinity, new interconnections could be built to de-load Dowlais BSP in the event of an arranged busbar outage or arranged circuit outage from one of the feeds out of Dowlais. This is likely not a long term solution due to high load growth on Merthyr East substation, however this could be used in the interim as an alternative to flexibility or reinforcement.

New limiting factor for constraint(s) considered: Firm capacity of Merthyr East BSP.

Option 4 – Procure flexibility at Dowlais BSP

Estimated Flexibility Required (MVA): 5 MVA + — Viable

Detailed description: Flexibility services could be procured to alleviate projected overloads. This could defer reinforcement but due to the large quantity of flexibility required this may not be a viable solution.

Solution Recommendation

It is recommended to assess the feasibility of conducting load transfer between Pentrebach/Swansea Road primaries and Merthyr East BSP. Reinforcement on the 11 kV circuits may be required in order to accommodate the minimum required load transfer. In the medium term it is recommended that some flexibility services could be procured in order to further deload Dowlais BSP, and hence defer reinforcement.

Longer term it is recommended to build the new 33 kV circuit from Dowlais to Nantwen, build the proposed Merthyr South primary and split the group. This would help with security of supply as well as futureproofing the BSP group for future load growth.

3.2 Pentrebach Transformer T1

Constraint Overview

Generation | Demand

The table below outlines the nature of the network constraints identified in the network analysis.

Table 3.2.1 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
Pentrebach T1	Pentrebach arranged bus section outage	Swansea Road T2 transformer outage	2028	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 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 Transformers	✓	✓	×	**Viable**
2	Build new 33 kV Circuit	✓	✓	×	**Viable**
Operational Mitigation					
3	Transfer demand to Merthyr East BSP	✓	✓	✓	**Viable**
4	Open 1T0 breaker at Pentrebach to prevent through flows	✓	✓	✓	**Viable**
Flexibility services					
5	Procure flexibility at Swansea Road/Pentrebach Primary	✓	✓	✓	**Viable**

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full 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 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 Pentrebach and Swansea Road primary substations.

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

Option 1 – Reinforce existing transformers

Capacity Released for constraint(s) considered: 3 MVA **Viable**

Detailed description: A potential solution to the constraint could be to uprate the existing transformers to 12/24 MVA CMR units. This would alleviate the constraint in the long term, as well as allowing the firm capacity of Pentrebach substation to be significantly increased. This could be of benefit as Pentrebach could be used to de-load Merthyr East in times of high loading, which would allow for some reinforcement to be deferred.

New limiting factor for constraint(s) considered: Rating of new 12/24 MVA transformers.

Option 2 – Construct a new 33 kV circuit to a tee off between Swansea Road and Pentrebach

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

Detailed description: Building a new 33 kV circuit from Dowlais Main busbar 2 to a tee off between Swansea Road and Pentrebach would help alleviate the constraint. Furthermore, it would mean that in the event of a Dowlais Main 1 busbar outage, the power flow would be split through two 33 kV circuits instead of one, helping with a number of overloads observed.

New limiting factor for constraint(s) considered: Rating of new 12/24 MVA transformers.

Option 3 – Transfer demand to Merthyr East BSP

Capacity Released for constraint(s) considered: Up to 8 MVA **Viable**

Detailed description: Demand could be moved from Swansea Road to Merthyr East BSP in the event of an arranged busbar outage. This would alleviate the constraint as well as give plenty of headroom for further load growth around Swansea and Pentrebach.

New limiting factor for constraint(s) considered:

Ability of Merthyr East to sustain the load transfer.

Option 4 – Open 1T0 11 kV circuit breaker at Pentrebach

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

Viable

Detailed description: This is done to prevent through flow of demand via the transformers at Pentrebach. This would leave Swansea Road on single circuit risk (under the arranged outage) however this would move the condition resulting in lost load to a SCO condition.

New limiting factor for constraint(s) considered: Load at Swansea Road primary

Option 5– Procure flexibility at Pentrebach and Swansea Road primaries

Estimated Flexibility Required (MVA): 2 MVA+

Viable

Detailed description: Flexibility services could be procured to help alleviate the projected overloads. It is unlikely that sufficient flexibility could be procured as a long-term 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, due to the nature of the overload, allied with the low projected load growth on Swansea Road and Pentrebach, it would be recommended to either transfer demand or consider opening the 1T0 11 kV circuit breaker. Whilst building a new 33 kV circuit would be the best solution regarding security of supply, the overloads only being at 113% in 2028 mean that economically it is not viable when other options such as flexibility and operational mitigation present strong alternatives. This, allied with the low projected load growth on Swansea Road or Pentrebach mean that operational mitigation or flexibility remain the best option. Furthermore, if another substation is built to support the wider Merthyr area then there should be more than enough options for managing the constraint going forward.

3.3 Abertysswg 33/11 kV transformer constraint

Constraint Overview

Generation Demand

Due to projected demand growth in line with the DFES scenarios on Abertysswg Primary, both transformers (T1/T2) experience overloads due an arranged outage or fault on the adjacent unit.

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 3.3.1 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
Abertysswg transformers (T1 and T2)	Loss of an adjacent transformer	-	-	2034	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 3.3.2 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	Uprate existing 33/11 kV Transformers to CMR units	✓	×	×	Discounted
Operational Mitigation					
2	Review Seasonal Ratings	×	✓	✓	Viable
Flexibility services					
3	Procure flexibility at Abertysswg primary	✓	✓	✓	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 thermal overloads for the conditions described above. This would lead to an inability to meet the Security of Supply requirements of Engineering Recommendation P2 for Abertysswg primary.

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

Option 1 – Reinforce the existing CER transformers to CMR units

Capacity released for constraint(s) considered: Between 1 – 6 MVA **Discounted**

Detailed description: As the constraint occurs under intermediate warm/cool demand, the CER units could be changed for CMR units. This gives the advantage of allowing for greater capacity during the summer months, and would secure the site for the medium term future (post 2034). It is worth noting however, that due to forecasted load growth between 2034 and 2040 this solution would likely become obsolete.

New limiting factor for constraint(s) considered: Post 2034 load growth

Option 2 – Review Seasonal Ratings

Capacity Released for constraint(s) considered: Dependent on mitigation **Viable**

Detailed description: Overloads are observed under intermediate cool and intermediate warm demands from 2034 onwards. An internal review of the transformer seasonal ratings may conclude that these constraints are not present as early as estimated. This could be the situation if it is deemed that these seasonal ratings are viewed as overly pessimistic as they align to the summer rating. This could defer the overloads by a number of years.

New limiting factor for constraint(s) considered: Existing Abertysswg primary transformer ratings

Option 3 – Procure flexibility at Abertysswg Primary

Estimated Flexibility Required (MVA): 2 MVA + **Viable**

Detailed description: Flexibility services could be procured at Abertysswg to help alleviate the projected overloads. It is unlikely that sufficient flexibility could be procured as a long-term 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. This could rise over 2 MVA by 2034.

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. An internal review of the transformer seasonal ratings should be carried out to help address the overloads observed at Abertysswg Primary.

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