Bridgend BSP and Associated 33 kV Network

Network Development Report – South Wales

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Electricity Distribution

nationalgrid

Contents

Bridgend BSP and Associated 33 kV Network

1. Network Overview

Bridgend Bulk Supply Point (BSP) supplies a mostly urban area of 33 kV network, with the bulk of the demand centred around the town of Bridgend. The BSP is fed by two 132/33 kV grid transformers, with the 132 kV infeed coming from Pyle GSP. There are four 33/11 kV primary substations supplied by the network: Schwyll, Bridgend Trading Estate, Llangewydd and Litchard.

Bridgend BSP supplies approximately 27,000 customers and currently has a maximum demand of 37 MVA and under NGEDs DFES Best View scenario this is projected to rise over 53 MVA by the year 2034.

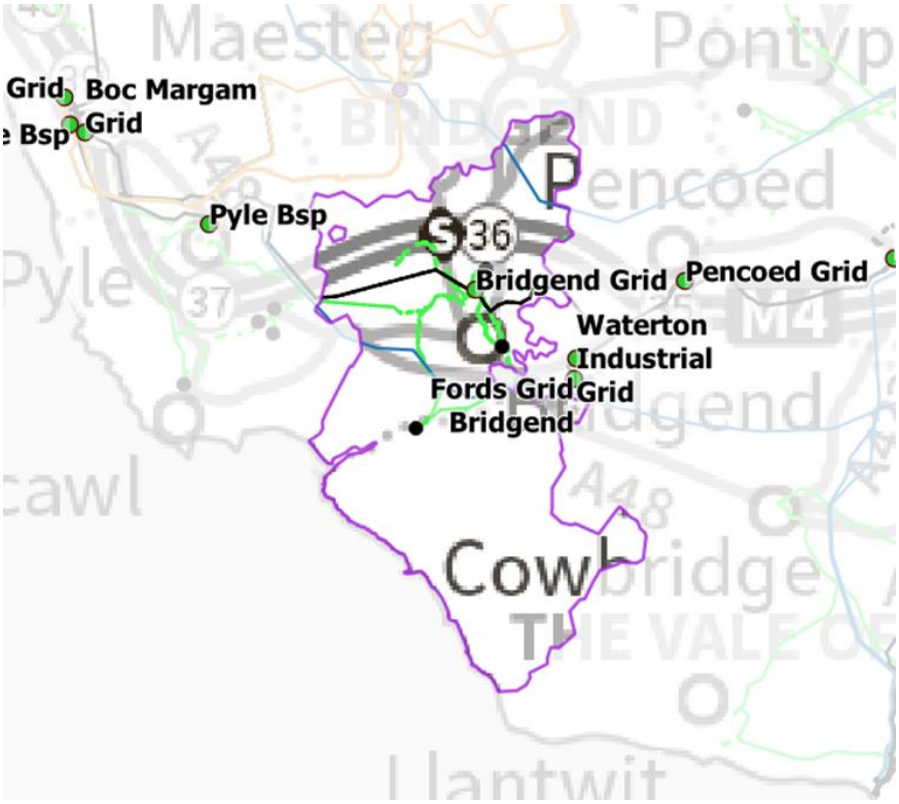

Figure 1.1 – Bridgend BSP geographic network coverage

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 which supply and are supplied by Bridgend 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 Bridgend BSP network is arranged as follows:

- 132/33 kV GT1 and GT2 currently run in parallel supplying Bridgend BSP. GT1 is rated at 22.5/45 MVA and GT2 is rated at 30/60 MVA.
- Schwyll 33/11 kV primary is supplied by a 33 kV circuit from Bridgend BSP, as well as a 33 kV circuit that is run normally open from Llangewydd.
- Llangewydd 33/11 kV primary is supplied by a 33 kV circuit from Bridgend BSP. Furthermore, this site has an interconnection with Pyle BSP that is run normally open. There is also the aforementioned circuit to Schwyll that is run normally open. Lastly, this site has 11 kV interconnection from Litchard.
- Bridgend Trading Estate is a two 33/11 kV transformer primary run on its own 33 kV ring from Bridgend BSP.
- Litchard 33/11 kV primary is supplied by its own 33 kV ring from Bridgend BSP.

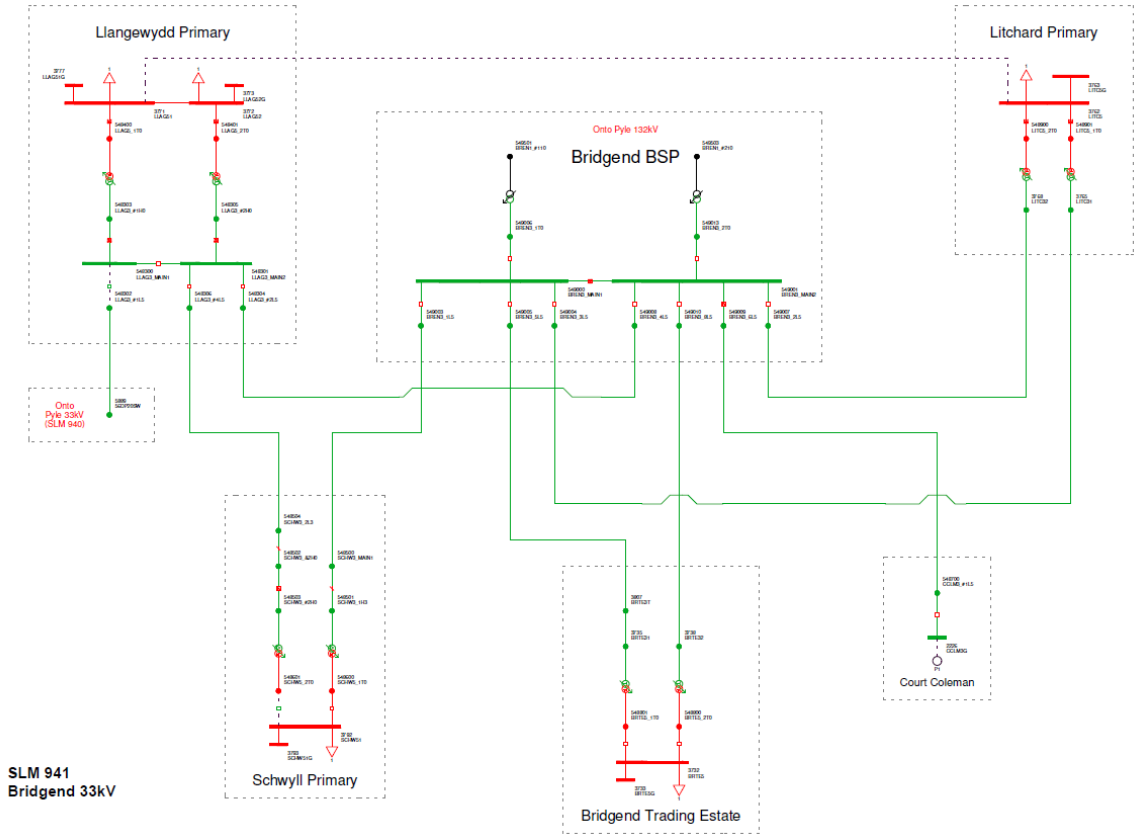

Figure 1.1 Bridgend 33 kV network single line diagram

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, as well as proposed actions, to manage some constraints identified operationally.

- Under intact network conditions, the Bridgend BSP group operates in parallel via several 33 kV circuits.
- For the loss of an infeed to a transformer at any of the primaries fed from within the Bridgend 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:

- Bridgend Trading Estate constraints
- Litchard Transformer constraints

3. Network Constraint Details and Solution Options

3.1 Bridgend Trading Estate constraints

Constraint Overview

Generation Demand

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

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
Bridgend Trading Estate T1 and T2	Loss of Bridgend Trading Estate T1 or T2	None	2034	2034	2034	2034
Bridgend to Bridgend Trading Estate circuit constraints	Loss of either circuit from Bridgend to Bridgend trading Estate.	None	2034	2034	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 3.1.2 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	✓	×	✓	**Viable**
2	Install additional 33 kV circuits to new primary	✓	✓	✓	**Viable**
3	Reinforce 11 kV circuits to transfer demand to other Primaries	✓	✓	✓	**Viable**
4	Reinforce existing CER transformers to CMR 12/24 units	✓	✓	✓	**Viable**
Flexibility services					
6	Procure flexibility at Bridgend Trading Estate primary	✓	×	×	**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 Bridgend Trading Estate primary.

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

Option 1 – Reinforce existing 33 kV circuits

Capacity Released for constraint(s) considered: 5.2 MVA **Viable**

Detailed description: The 33 kV circuits between Bridgend and Bridgend Trading Estate could be uprated to accommodate 30 MVA during summer peak demand periods. This would give more than enough capacity and would enable another 5 MVA of load growth at the time of peak demand on Bridgend Trading Estate.

New limiting factor for constraint(s) considered: Capacity of new 33 kV circuits installed

Option 2 – Install additional 33 kV circuits to a new primary

Capacity released for constraint(s) considered: 23 MVA **Viable**

Detailed description: Installing two new 500m underground 33 kV circuits form Bridgend BSP to a new 33/11 kV primary in the town of Bridgend could be used to permanently de-load both Bridgend Trading Estate as well as Litchard. This would alleviate all the issues associated with Bridgend 33 kV network in a single solution.

New limiting factor for constraint(s) considered: Capacity of new primary, as well as the ability to transfer load off Bridgend trading estate primary permanently.

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

Capacity Released for constraint(s) considered: Up to 30 MVA **Viable**

Detailed description: Nearby 132/11 kV BSPs could be used to transfer demand away from the primary. New 11 kV interconnectors would need to be built in order to transfer the 7 MVA required to alleviate the constraint. Extra 11 kV circuits could be built out of this substation and used to improve the capacity of Bridgend BSP, up to 30 MVA. This would also help with deloading the grid transformers at Bridgend BSP as by 2034 they will be close to their firm capacity.

New limiting factor for constraint(s) considered: 11 kV circuit capacity available

Option 4 – Reinforce 12/24 CER transformers up to 12/24 CMR transformers

Capacity Released for constraint(s) considered: Varies between 1 and 6 MVA **Viable**

Detailed description: The CER transformers could be replaced by CMR units rated at 24 MVA. This however, would not solve the constraint on its own as the highest recorded flow through the transformers was 25 MVA. In addition to reinforcing the transformer, another solution such as a permanent load transfer would be needed in order to solve the constraint.

New limiting factor for constraint(s) considered: 11 kV circuit capacity for permanent load transfer.

Option 6 – Procure flexibility at Bridgend Trading Estate Primary

Estimated Flexibility Required (MVA): 7 MVA+ **Discounted**

Detailed description: It is unlikely that sufficient flexibility could be procured due to the very high amount required on a single 33/11 kV primary. These services would also need to be able to be constantly available as a fault outage could occur at any time.

Solution Recommendation

It is recommended to assess the feasibility of using nearby 132/11 kV BSPs as possible locations in order to de-load Bridgend Trading Estate. This has the dual advantage of deloading Bridgend Trading Estate, as well as deloading Bridgend BSP as a whole.

Alternatively, a new 33/11 kV primary could be built near Bridgend BSP to de-load both Bridgend Trading Estate and Litchard primary. This would alleviate all of the constraints predicted under Best View 2034 for Bridgend BSP.

3.2 Litchard 33/11 kV transformer constraint

Constraint Overview

Generation **Demand**

Due to projected demand growth in line with the DFES scenarios on Litchard 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 3.2.1 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
Litchard 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 3.2.2 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	Uprate existing 33/11 kV Transformers to CMR units	✓	×	×	**Discounted**
Operational Mitigation					
2	Review Seasonal Ratings	×	✓	✓	**Viable**
Flexibility services					
3	Procure flexibility at Litchard 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 Litchard 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 Litchard primary transformer ratings

Option 3 – Procure flexibility at Litchard Primary

Estimated Flexibility Required (MVA): 3 MVA + **Viable**

Detailed description: Flexibility services could be procured at Litchard 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 3 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 Litchard Primary.

3.3 Llangewydd Primary Lost load

Constraint Overview

Generation **Demand**

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

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
Loss of load at Llangewydd primary	33 kV busbar fault at Llangewydd primary	None	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 3.3.2 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	Install a new circuit from Bridgend 33 kV to Llangewydd main busbar 1	✓	✓	✓	**Viable**
2	Install a bus section breaker at Schwyll primary and reconfigure Llangewydd 4L5 to main busbar 1	✓	✓	✓	**Viable**
3	Run Pyle and Bridgend in parallel via Llangewydd 1L5	×	×	✓	**Viable**
4	Reinforce 11 kV interconnection and run Llangewydd and Litchard solid	×	×	✓	**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 lost load of Llangewydd substation. Whilst this only occurs under a busbar fault, technically not a P2 violation as the group load is at 11.3MW by 2034 under best view scenario, this will enter P2 category B under best view projections in 2035. This means that either a circuit that has automatic switching would be needed, or another circuit that can supply Llangewydd under the SCO. By 2034, the group load of Llangewydd has grown to the point where Pyle BSP will have its firm capacity exceeded if Llangewydd is switched onto Pyle. As a result of this, doing nothing is a viable option in the short/medium term, however by 2030 Pyle BSP has its firm capacity exceeded when Llangewydd is automatically transferred over.

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

Option 1 – Install a new 33 kV circuit from Bridgend 33 kV to Llangewydd main busbar 1

Capacity Released for constraint(s) considered: 1 to 6 MVA ↑ **Viable**

Detailed description: Installing a new 33 kV circuit at Llangewydd main busbar 1 back to Bridgend BSP, where a new 33 kV circuit breaker bay would be installed. This would allow for load to be sustained at Llangewydd in the event of a main busbar 2 fault, hence solving the lost load issues at the primary, whilst also futureproofing the group against potential future demand growth.

New limiting factor for constraint(s) considered: New firm capacity of Llangewydd primary

Option 2 – Install a 33 kV bus section breaker at Schwyll primary and reconfigure Llangewydd 4L5 to main busbar 1

Capacity released for constraint(s) considered: 24 MVA ↑ **Viable**

Detailed description: This solution involves reconfiguring the 33 kV busbar so that the Llangewydd 4L5 circuit breaker and associated 33 kV circuit to Schwyll primary would run off main busbar 1 instead of main busbar 2 at Llangewydd. This allows for load to be sustained under FCO as all another 33 kV circuits can supply the primary in the event of a busbar fault. In addition to this, a 33 kV bus section breaker could be installed at Schwyll primary to prevent through flows on the primary transformers as a result of demand from Llangewydd.

By 2034 however, the Schwyll 33 kV circuit to Bridgend becomes overloaded due to demand growth on both primaries, under the FCO of the circuit from Llangewydd to Bridgend under an intermediate warm peak demand case. As a result of this, approximately 200m of 33 kV circuit (in two separate sections) will need to be reconductored to circuit of a higher rating.

New limiting factor for constraint(s) considered:

Firm capacity of the 33 kV circuits between Bridgend and Llangewydd-Schwyll group.

Option 3 – Run Pyle and Bridgend in parallel under intact network conditions

Capacity Released for constraint(s) considered: up to 7 MVA ↓ **Discounted**

Detailed description: This solution entails running Pyle BSP and Bridgend BSP in parallel. This would mean two 33 kV circuits will be feeding Llangewydd substation, however the parallel BSPs could result in a number of issues including fault level as well as loose couples. This solution should therefore be discounted.

New limiting factor for constraint(s) considered: Fault level and loose coupling issues

Option 4 – Reinforce 11 kV circuits and run Litchard and Llangewydd solid

Capacity Released for constraint(s) considered: up to 7 MVA + ↑ **Viable**

Detailed description: Currently, the 11 kV back feeds can restore up to 6.9 MVA under winter ratings at Llangewydd. It is proposed to increase the size of the 11 kV interconnectors by building new circuits between the primary substations, up to a rating around 12 MVA. This would allow Llangewydd to be supported from Litchard, however due to demand growth on Litchard 20/40 MVA transformers would be required in order to accommodate all the demand from Llangewydd as well as Litchard.

Solution Recommendation

It is recommended to install a 33 kV bus section breaker at Schwyll primary, and reconfigure the 33 kV circuits at Llangewydd main 2 busbar, to have the circuit to Schwyll running from main busbar 1. This is a highly cost effective way to ensure that demand security requirements are met regarding lost load at Llangewydd. Even though the Schwyll circuits need to be reinforced, it is only a short section (200m) to ensure security of supply long term for Llangewydd Primary. As a result, this is the most optimal solution to the lost load issues.

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