Hirwaun & Ystradgynlais BSPs incl. associated 33 kV network

Network Development Report – South Wales

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Electricity Distribution

nationalgrid

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Hirwaun & Ystradgynlais BSPs incl. associated 33 kV network

1. Network Overview

Hirwaun and Ystradgynlais Bulk Supply Points (BSPs) supply a mostly rural network situated in the South Wales licence area. The associated 33 kV network supplies close to 55,000 customers and includes the following 33/11 kV primary substations:

- Abercrave, Aberdare, Aberpergwm, Gwaun Cae Gurwen, Hirwaun Primary, Maerdy, Middle Fan, Pontardawe, Travellers Rest Primary, Western Coal and Ynysfeio

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.

Hirwaun and Ystradgynlais BSPs currently have a maximum demand of 66.3 MVA and under NGEDs DFES Best View scenario this is projected to rise to 109.2 MVA by the year 2034.

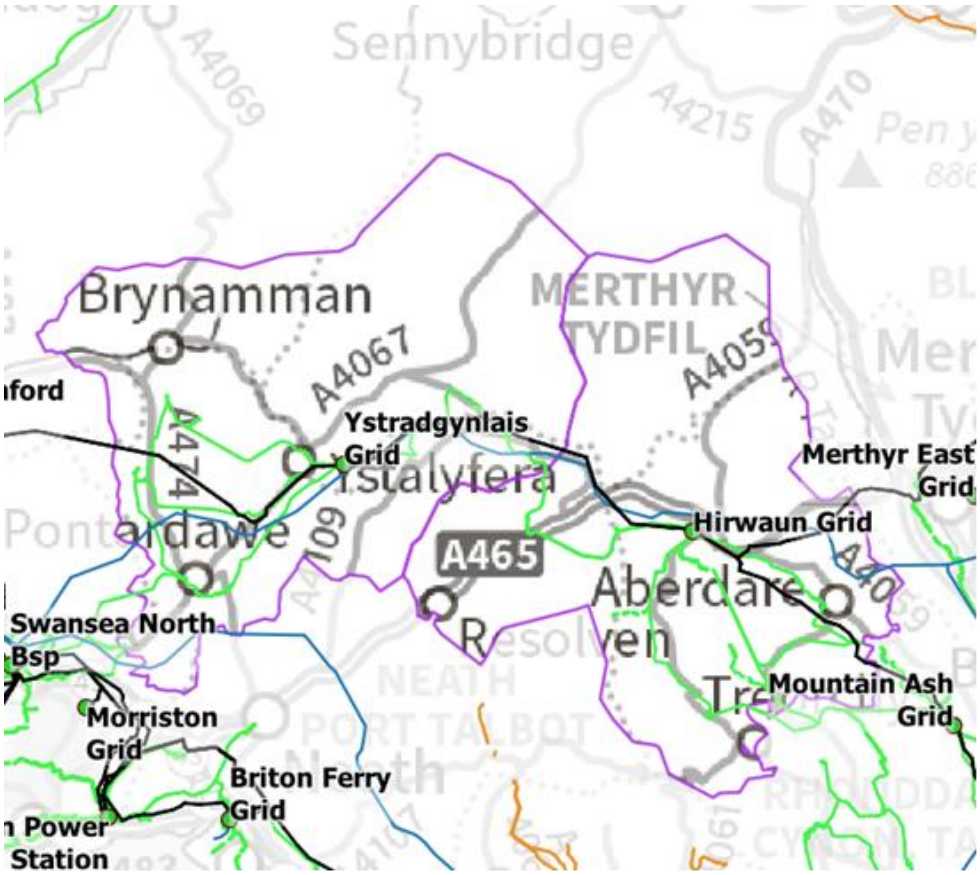

Figure 1.1 Hirwaun & Ystradgynlais BSPs geographic network coverage

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 which supply and are supplied by Hirwaun and Ystradgynlais 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 Travellers Rest & Hirwaun BSP network is arranged as follows:

- Ystradgynlais BSP has two 132/33 kV GTs (GT1 and GT2) both rated at 22.5/45 MVA. Hirwaun BSP has two 132/33 kV GTs (GT1 and GT2) both rated at 60/90 MVA. The outgoing 132 kV circuits from each BSP are supplied from Swansea North GSP.
- Both BSPs run in parallel and supply a 33 kV group that is coupled on the 33 kV network via Western Coal 33/11 kV primary substation.
- Western Coal 33 kV 2L5 can be opened to split the 33 kV network under select outage conditions.
- Aberdare 33/11 kV primary is fed on its own 33 kV ring from Hirwaun BSP.
- Maerdy and Ynysfeio 33/11 kV primaries are fed via a 33 kV ring from Hirwaun BSP, with a tee off to Middle Fan 33/11 kV primary. Middle Fan is fed primarily from the Upper Boat 33 kV network but can be supplied from Hirwaun BSP if necessary.
- Aberpergwm 33/11 kV primary is fed via a 33 kV ring from Hirwaun BSP. A 33 kV circuit is installed between Aberpergwm and Western Coal.
- There is a 33 kV circuit from Ystradgynlais to Western Coal, with Abercave 33/11 kV primary looped in.
- Pontardawe and Gwaun Cae Gurwen 33/11 kV primaries are fed via a 33 kV ring from Ystradgynlais BSP.
- Travellers Rest 33/11 kV primary substation is an extension of Ystradgynlais BSP and is supplied by a pair of 33 kV interplant cables.
- Hirwaun BSP contains a pair of 33/11 kV transformers that supply an 11 kV switchboard.
- Various distributed generators are connected across both BSPs.

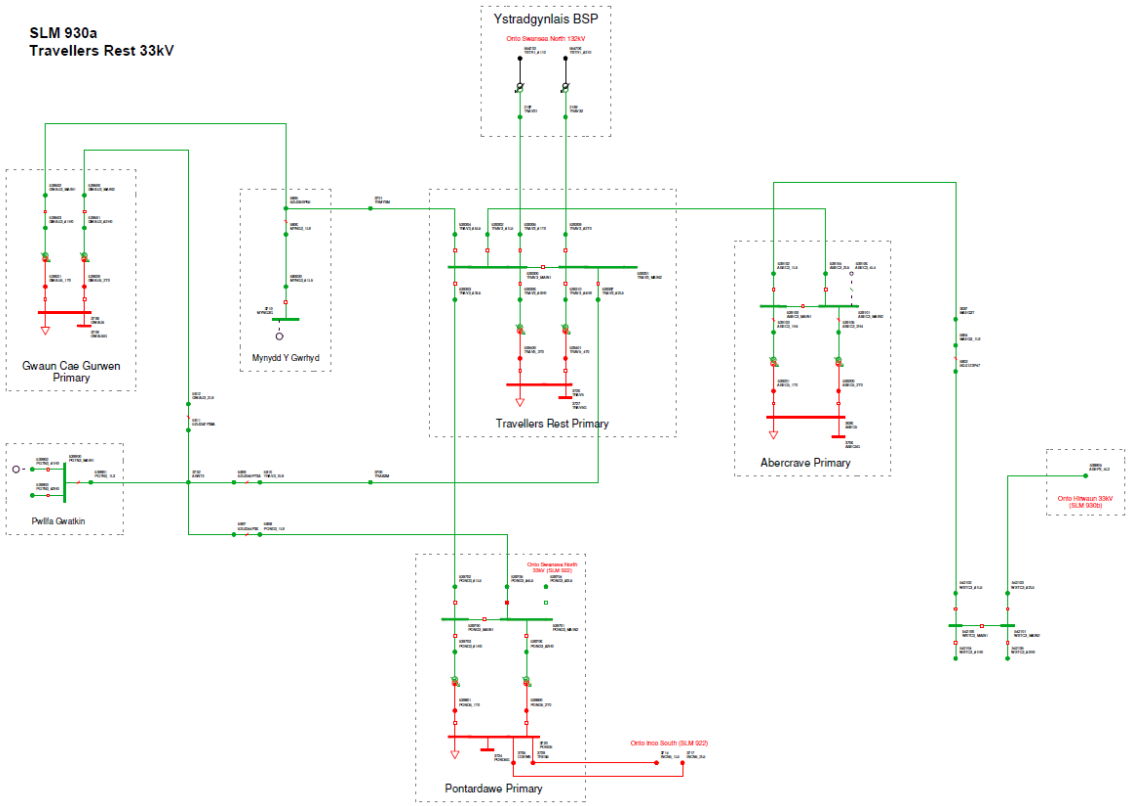

Figure 1.2 Ystradgynlais BSP 33 kV network single line diagram

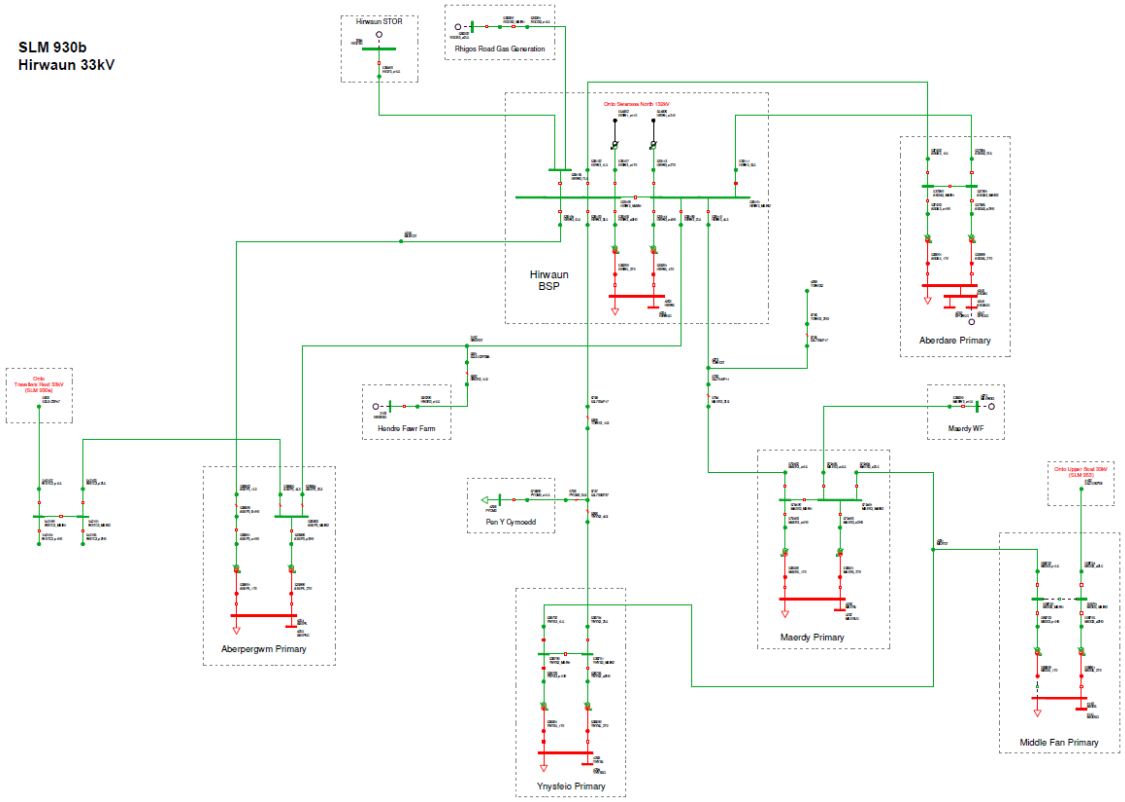

Figure 1.3 Hirwaun BSP 33 kV network single line diagram

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.

- For an arranged outage impacting either Swansea North / Ammanford / Ystradgynlais 132 kV circuit (PP/C route), Hirwaun BSP can be transferred across to the Upper Boat 132 kV group. The 33 kV network is split between Hirwaun and Ystradgynlais at Western Coal 2L5.
- Ystradgynlais BSP can be restored from the Upper Boat 132 kV group should the remaining 132 kV circuit fault.
- The 33 kV outgoing circuit from Pontardawe that can provide interconnection between Swansea North and Ystradgynlais BSPs is primarily utilised to support the Travellers Rest 33 kV group following an outage to either Pontardawe to Travellers Rest 33 kV circuit.
- For the loss of an infeed to a transformer at any of the primaries fed from within the Hirwaun and Ystradgynlais 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 Second Circuit Outage (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:

- Aberdare 33/11 kV transformer constraints
- Gwaun Cae Gurwen & Travellers Rest primary transformer constraints

3. Network Constraint Details and Solution Options

3.1 Hirwaun and Ystradgynlais 33 kV Group

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

Table 3.1.1 Maximum demand forecast to the Hirwaun and Ystradgynlais 33 kV network

DFES Scenario	Demand		
	Baseline	2028	2034
Best View	66.3 MW	95.1 MW	109.2 MW

Table 3.1.2 Maximum generation forecast to the Hirwaun and Ystradgynlais 33 kV network

DFES Scenario	Generation		
	Baseline	2028	2034
Best View	70.9 MW	161.5 MW	207.9 MW

Several large new connections are also proposed to connect within the group in the near future which further increase these figures. 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.

3.2 Aberdare Primary Transformer 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 Intermediate cool and warm demands.

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
Aberdare T1 and T2	Loss of Aberdare T1 or T2	-	-	2034	2034	-

Uncertainty under other Distribution Future Energy Scenarios: This constraint occurs under Best View by 2034. Hence, there is uncertainty over whether the load will actually grow in this way.

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	Install additional 33 kV circuits to a new primary substation	✓	✓	✓	**Viable**
2	Uprate existing 33/11 kV Transformers to CMR units	✓	×	×	**Discounted**
3	Reinforce 11 kV circuits and transfer demand to Mountain Ash	✓	✓	✓	**Viable**
Operational Mitigation					
4	Review Seasonal Ratings	×	✓	✓	**Viable**
5	Construct a new 132/11 kV BSP	✓	✓	✓	**Viable**
Flexibility services					
6	Procure flexibility at Aberdare 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 overloads for the conditions described above. This would lead to an inability to meet the Security of Supply requirements of Engineering Recommendation P2 for Aberdare Primary.

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

Option 1 – Install additional 33 kV circuits to a new primary substation

Capacity Released for constraint(s) considered: 23 MVA

Viable

Detailed description: Since Aberdare has a peak demand of around 20 MW under the 2034 Best View scenario, a new primary from Hirwaun BSP consisting of 2 x 12/24 MVA transformers fed from approximately 9 km of overhead line construction would be the best way to futureproof the network, as this would allow for a further 23 MW of load growth.

This substation would ideally be established halfway between Aberdare and Mountain Ash primaries. This would give the dual advantage of allowing load to be potentially transferred out of both Aberdare and Mountain Ash and into the new primary.

New limiting factor for constraint(s) considered: Capacity of the new primary substation.

Option 2 – Reinforce the existing CER transformers for 12/24 MVA CMR units

Capacity released for constraint(s) considered: Between 4 - 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 3 – Reinforce 11 kV circuits to transfer demand to Mountain Ash

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

Viable

Detailed description: Mountain Ash has multiple 11 kV interconnections with Aberdare. Some demand could be switched over permanently to alleviate the constraints. This could be effective as Mountain Ash has a winter peak loading of 13.15 MW in 2034 under the Best View scenario.

This would be a strong solution as there is plenty of excess capacity that could be used to alleviate the constraint, although reinforcement of the 11 kV network would likely be needed in order to make the switchover permanent.

New limiting factor for constraint(s) considered: Mountain Ash primary substation capacity.

Option 4 – 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 Aberdare primary transformer ratings

Option 5 – New 132/11 kV BSP near Hirwaun

Capacity Released for constraint(s) considered: 30 MVA

Viable

Detailed description: A new 132/11 kV BSP could be constructed between Hirwaun and the Dowlais/Merthyr East tee off. This would likely be built as a 132 kV tee off and could be fed from the proposed new Grid Supply Point within the Hirwaun area. This would have a large benefit for the Hirwaun group, as it could be used to significantly deload Aberdare, as well as Hirwaun primary.

New limiting factor for constraint(s) considered: Firm capacity of new BSP

Option 6 – Procure flexibility at Aberdare Primary

Estimated Flexibility Required (MVA): 3 MVA +

Viable

Detailed description: Flexibility services could be procured at Aberdare 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 Aberdare Primary.

For the medium term, the most optimal solution would be to reinforce the 11 kV network between Mountain Ash and Aberdare. This would allow the excess capacity from Mountain Ash to be utilised.

Longer term, either a new primary substation being constructed, or similarly a new BSP would be the most optimal solution. Both options will ensure compliance with P2/8 throughout the forecasted load growth period and beyond. A new substation in the nearby area will have the added benefit of being able to de-load nearby primaries, whilst also providing additional capacity for the area.

3.3 Gwaun Cae Gurwen & Travellers Rest 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 intermediate warm/cool 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
Gwaun Cae Gurwen T1/T2	Loss of Gwaun Cae T1/T2	None	-	2034	2034	-
Travellers Rest T1/T2	Loss of Travellers Rest T1/T2	None	-	2034	2034	-

Uncertainty under other Distribution Future Energy Scenarios: This constraint occurs under best view conditions in 2034. Hence, there is uncertainty over whether the load will actually grow in this way.

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	Reinforce existing transformers	✓	×	✓	Viable
2	Install additional 33 kV circuits to a new primary	✓	✓	✓	Viable
3	Reinforce 11 kV circuits to transfer demand to other Primaries	×	×	×	Discounted
Operational Mitigation					
4	Review Seasonal Ratings	×	✓	✓	Viable
Flexibility services					
5	Procure flexibility at both primaries	✓	✓	✓	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 Travellers Rest and Gwaun Cae Gurwen primary substations.

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

Option 1 – Uprate the 33/11 kV transformers

Capacity Released for constraint(s) considered: 9 - 15 MVA ⬆ **Viable**

Detailed description: The following transformers are currently installed at each primary:

- Gwaun Cae Gurwen: Two 5/6.25 MVA 33/11 kV CMR transformers
- Travellers Rest: Two 7.5/15 MVA 33/11 kV CER transformers

Transformer overloads are observed from 2034 under intermediate cool/warm conditions. Installing new 12/24 MVA transformers at both substations would alleviate the constraints observed and will secure the long term load growth projected across the area.

New limiting factor for constraint(s) considered:

33 kV circuit sections between Travellers Rest and Pontardawe/Gwaun Cae Gurwen tee-off.

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

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

Detailed description: In order to alleviate all three transformer constraints, whilst simultaneously deloading the 33 kV circuits between Travellers Rest, Pontardawe and Gwaun Cae Gurwen, a new 33/11 kV primary substation on a dedicated 33 kV ring could be established.

Two new dedicated 33 kV circuit breaker bays will be required at Travellers Rest to supply the new primary. Constructed approximately halfway between Gwaun Cae Gurwen and Pontardawe, both primaries could be de-loaded sufficiently. This will secure the Pontardawe and Gwaun Cae Gurwen group from future load growth.

Furthermore, this new primary could be used to deload Travellers Rest if 11 kV circuits are established between both substations.

New limiting factor for constraint(s) considered: Capacity of the new primary substation.

Option 3 – Transfer demand to other Primaries

Capacity Released for constraint(s) considered: 0 MVA ⬇ **Discounted**

Detailed description: Any 11 kV demand transfers would have to be made to primaries supplied outside of Travellers Rest or Gwaun Cae Gurwen. Unfortunately, no primary is in close enough proximity to be able to transfer the sufficient level of demand required in order to alleviate this constraint.

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

Option 4 – 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 primary transformer ratings

Option 5 – Procure flexibility at both Primary Substations

Estimated Flexibility Required (MVA): 3 MVA +

Viable

Detailed description: Flexibility services could be procured at both primaries 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 Gwaun Cae Gurwen and Travellers Rest Primary.

Following this, a technical comparison should be made between replacing the existing 33/11 kV primary transformers (Option 1) against establishing a new 33/11 kV primary substation (Option 2).

Option 1 is likely to prove the most cost effective solution and will ensure compliance with P2/8 throughout the forecasted load growth period and beyond.

A new substation in the nearby area will have the benefit of being able to de-load nearby primaries sufficiently whilst providing additional capacity for the area. However, it may be deemed that the load growth forecast in this area is not of sufficient magnitude to warrant the establishment of a new 33/11 kV primary substation.

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