Trostre BSP incl. associated 33 kV network

Network Development Report – South Wales

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Electricity Distribution

nationalgrid

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Trostre BSP & Associated Network

1. Network Overview

Trostre Bulk Supply Point (BSP) supplies an area of 33 kV network within the Swansea region. It is supplied by two 132/33 kV 75 MVA Grid Transformers (GTs) and fed via two 132 kV circuits from Swansea North GSP. The associated 33 kV network feeds a mostly urban area supplying over 20,000 customers that includes the following 33/11 kV Primary substations:

- Kidwelly, Maes Ar Dafen, Meinciau, New Lodge, Pontyates and Westfa.

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 BESS and PV.

Trostre BSP currently has a maximum demand of 67.39 MVA and under NGEDs DFES Best View scenario this is projected to rise to 75.69 MVA by the year 2034.

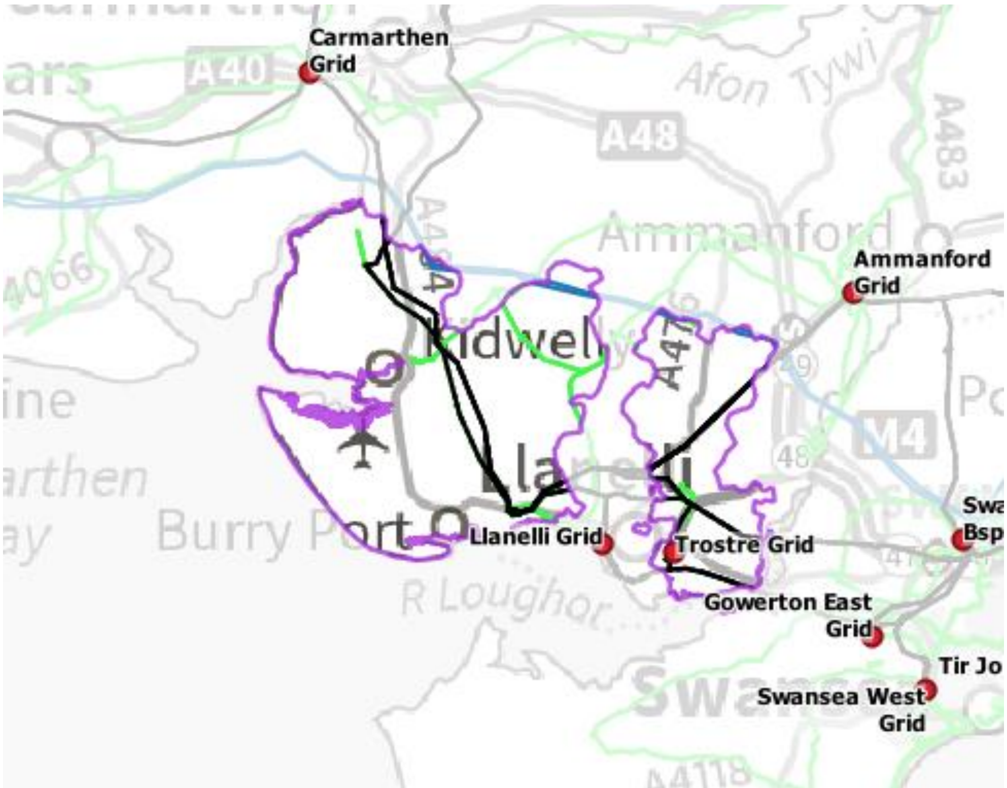

Figure 1.1 - Trostre BSP geographic network coverage

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, 132/33 kV transformers and 132 kV circuits which supply and are supplied by Trostre 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 Trostre 33 kV network is arranged as follows:

- Trostre BSP has two 132/33 kV GTs (GT1 and GT2) both rated at 37.5/75 MVA and is currently run in parallel supplying a two-section outdoor 33 kV busbar arrangement. The outgoing 132 kV circuits are supplied from Swansea North GSP.

- Outgoing 33 kV circuits from Trostre BSP supply the following eight 33/11 kV primary substations:

- Kidwelly, Maes Ar Dafen, Meinciau, New Lodge, Pontyates and Westfa.

  - Kidwelly: Two primary transformer substation

    T1 (7.5/15 MVA) and T2 (5/6.25 MVA)
  - Maes Ar Dafen: Two 7.5/15 MVA primary transformer substation (T1 & T2)
  - Meinciau: Single 5/6.25 MVA primary transformer substation (T2)
  - New Lodge: Two 7.5/15 MVA primary transformer substation (T1 & T2)
  - Pontyates: Two 5/6.25 MVA primary transformer substation (T1 & T2)
  - Westfa: Two 12/24 MVA primary transformer substation (T1 & T2)

- Trostre BSP also provides connection to a 33 kV connected customer.

- A 33 kV interconnection to Ammanford is provided at Tumble Primary. This interconnection which is normally run open at Tumble, can provide a 33 kV parallel between Trostre and Ammanford BSPs under select operating conditions.

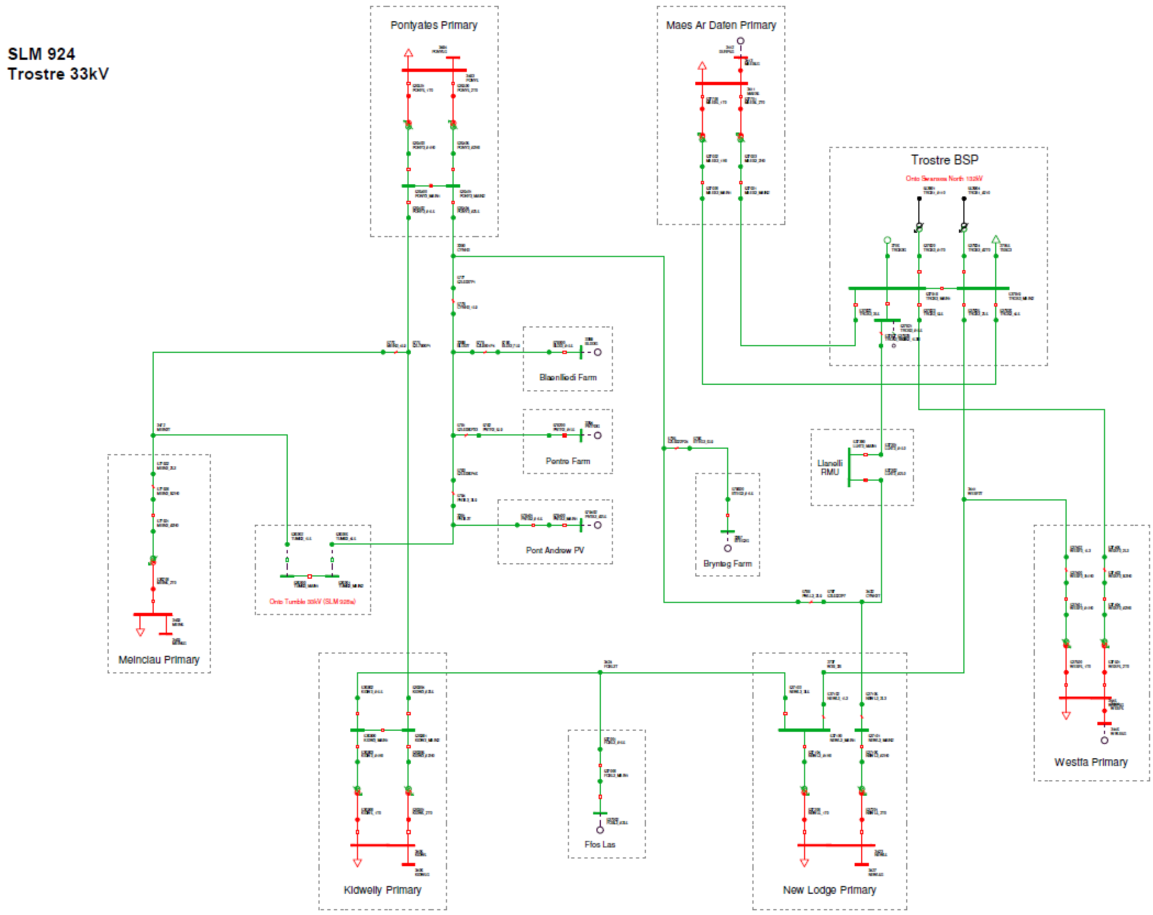

Figure 1.1.1 Trostre 33 kV network single line diagram

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.

- The 33 kV interconnection from Tumble Primary that can parallel Trostre and Ammanford BSPs is primarily utilised to support Ammanford during grid transformer outages.
- For the loss of an infeed to a transformer at any of the primaries fed from within the Trostre 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:

- Trostre 33 kV circuit overloads
- Kidwelly 33/11 kV primary transformer overloads

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:

- Replacement of the existing two-section outdoor 33 kV busbar arrangement with an indoor Gas-Insulated Switchgear (GIS) 33 kV switchboard, as there are currently no options for additional circuit breaker bays within the existing design.
- Replacement of both 132/33 kV GTs (GT1 and GT2) to higher rated 60/90 MVA units.

4. Network Constraint Details and Solution Options

4.1 Trostre 33 kV Group

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

Table 4.1.1 Maximum demand forecast to connect to the Trostre 33 kV network

DFES Scenario	Demand		
	Baseline	2028	2034
Best View	67.39 MW	69.29 MW	75.69 MW

Table 4.1.2 Maximum generation forecast to connect to the Trostre 33 kV network

DFES Scenario	Generation		
	Baseline	2028	2034
Best View	37.54 MW	43.89 MW	71.99 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 Trostre 33 kV Circuit Overloads

Constraint Overview

Generation Demand

Due to the interconnected nature of the Trostre BSP group every primary (expect for Maes Ar Dafen) has some level of connection via the meshed 33 kV circuit topology. This leads to complex constraints for generation that are not trivial to solve. These mostly arise from a 33 kV busbar outage at Trostre BSP.

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

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 (various sections)	Arranged outage to Trostre main busbar 1 or main busbar 2	33 kV circuit fault on one of the remaining feeder circuits	-	-	-	2028

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	Establish a 33 kV RMU and construct a 33 kV circuit from Cynheidre to Trostre BSP	×	✓	✓	Discounted
2	Reinforce circuit sections on the Trostre 33 kV network	×	✓	✓	Discounted
3	Build a new circuit from Kidwelly 33 kV to Trostre BSP	×	✓	✓	Discounted
4	Strategy combining options 1,2 and 3 and splitting the 33 kV network	✓	✓	✓	Viable
Operational Mitigation					
-	*None Identified*	-	-	-	-
Load Management Schemes					
5	Active Network Management schemes	✓	✓	✓	Viable

Uncertainty under other Distribution Future Energy Scenarios: This constraint is not an issue under the current baseline scenario. It first becomes present by 2028 under Best View.

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 33 kV circuit overloads for the sections observed.

Existing limiting factor for constraint(s) considered: Existing 33 kV circuit summer cyclic ratings

Option 1 – Establish a 33 kV RMU and construct a 33 kV circuit from Cynheidre to Trostre

Capacity Released for constraint(s) considered:

Discounted

Up to 30 MVA (dependant on circuit rating)

Detailed description: It is proposed to establish a 33 kV ring main unit (RMU) at the former Cynheidre substation site to accommodate a new 33 kV circuit to be constructed directly from Trostre BSP. This would alleviate some of the generation constraints, however not alleviate all of them, especially if there is a 33 kV busbar outage at Pontyates primary.

This solution is effective and needed in reducing the amount of overloads, however, due to the limiting 33 kV circuit sections allied with the complex topology this solution should not be used in isolation.

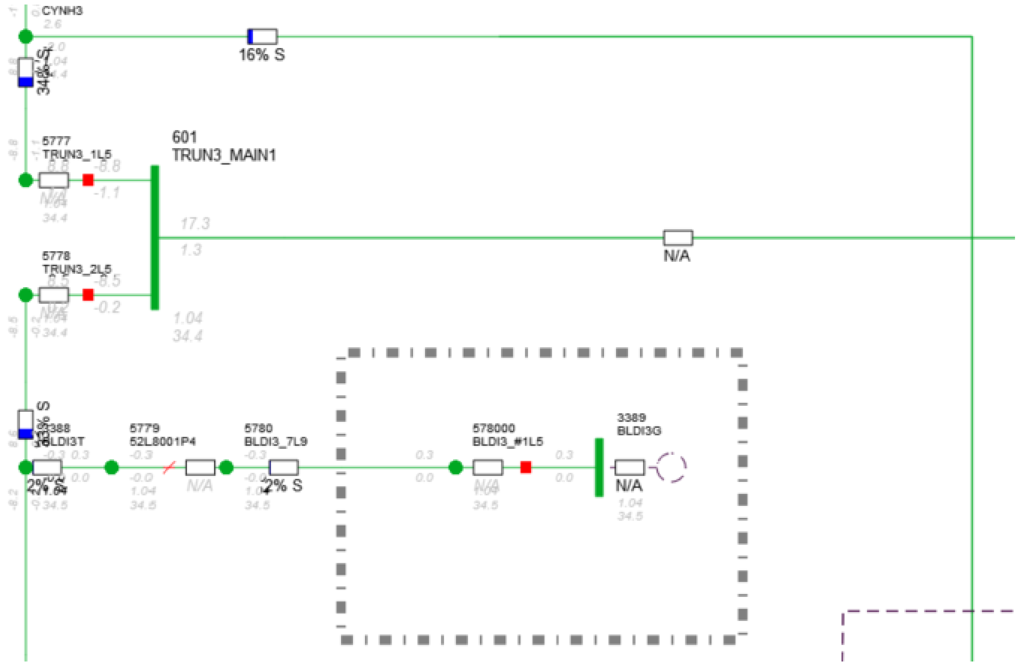

Figure 4.2.1 Proposed design of Cynheidre RMU 33 kV single line diagram

New limiting factor for constraint(s) considered: 33 kV limiting circuit sections

Option 2 – Reinforce limiting 33 kV sections within the Trostre network

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

Discounted

Detailed description: There are several limiting sections that need to be upgraded due to the high predicted generation growth by 2034 on Trostre BSP. Firstly, approximately 800 m section of 33 kV overhead line circuit either side of the previously proposed RMU will require reprofiling from 50 degrees to 75 degrees. This adds sufficient capacity to avoid thermal overloads. Currently these 33 kV overhead line sections have a summer sustained rating of 18 MVA.

Secondly, the 33 kV circuit from Llanelli RMU to Cynheidre tee-off requires the 200 mm of ducted sections to be overlaid with a larger conductor, subject to duct size in order to solve the de-rating issues. This would increase the rating of the circuit to 28.8 MVA, comfortably enough to accommodate the 2034 generation growth predictions.

Lastly, two sections of 33 kV 185 Cu cable (of 25 m and 27 m length) as well as a 17 m section of XLPE should be overlaid with a conductor of approx. 35 MVA on the Westfa tee off to Llanelli 33 kV circuit section. This would increase the summer cyclic rating to approximately 32 MVA.

New limiting factor for constraint(s) considered:

Summer cyclic ratings of the new 33 kV circuit sections.

Option 3 – Construct a new 33 kV circuit from Kidwelly Primary to Trostre BSP

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

Detailed description: In order to alleviate generation constraints caused by a Trostre 33 kV main busbar 2 outage, a new 33 kV circuit should be constructed from Kidwelly primary to Trostre BSP.

This prevents generation to flow towards the Llanelli RMU 33 kV circuit in the event of the previously mentioned outages. This would require a 33 kV busbar extension at Kidwelly primary.

New limiting factor for constraint(s) considered:

Summer cyclic ratings of the new 33 kV circuit sections

Option 4 – A strategy to combine options 1, 2 and 3 as well as split the 33 kV network with the introduction of normally open points.

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

Detailed description: In order to allow for maximum growth of both demand and generation, options 1, 2 and 3 could be combined as this would allow for the 33 kV network at Trostre BSP to be run split into smaller radial feeds and groups that can mutually support each other.

Once the proposed 33 kV circuits have been constructed, as well as limiting sections removed, it is proposed that the split points can be introduced at:

- New Lodge 2L3
- Kidwelly 2L5
- Cynheidre RMU 1L5
    - Open point to be the Pontyates side of the proposed RMU
    - Existing generation, Tumble side of the RMU, to be provided by an independent 33 kV circuit to Trostre

This strategy splits the network into the following two groups:

- A 33 kV ring arrangement with Westfa, New Lodge and Kidwelly primaries.
- A 33 kV group consisting of a radial feed with Pontyates and Meinciau primaries.

Whilst the radial feed with Pontyates and Meinciau is technically at single circuit risk. By 2034, the group demand of the two primaries is expected to reach 4.1 MW.

If demand growth reaches a point whereby this may no longer be compliant under P2, then an additional 33 kV bus section circuit breaker could be installed at Tumble primary, shown below:

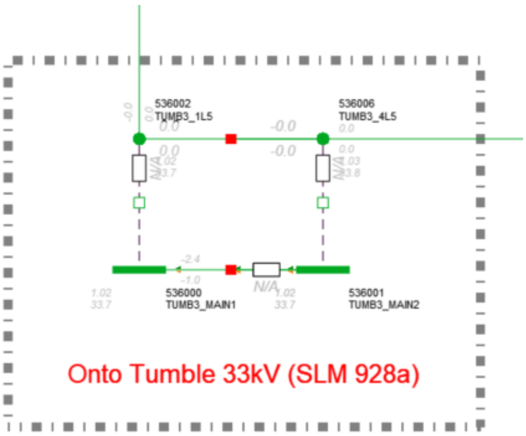

Figure 4.2.2 Proposed Tumble 33 kV bus section circuit breaker

This would make create a closed ring between Pontyates, Meinciau and the 33 kV connected distributed generation, ensuring sufficient demand resilience throughout the forecasted load growth period and beyond.

An alternative proposal to the Tumble 33 kV bus section would be to install an intertrip that closes in the normally open point at Kidwelly 2L5 in the event of a 33 kV circuit fault on the feeder between Trostre and Pontyates.

New limiting factor for constraint(s) considered:

Summer cyclic ratings of the new 33 kV circuit sections

Option 5 – Active Network Management schemes

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

Detailed description: Any additional connections into this group may be included in an Active Network Management (ANM) scheme, which could also be utilised to manage constraints on over-committed networks.

New limiting factor for constraint(s) considered: Existing 33 kV circuit summer cyclic ratings

Solution Recommendation

It is recommended that a technical review of the strategy proposed in option 4 is carried out. This option allows for future load growth within the Trostre area whilst providing a reduction in network complexity.

4.3 Kidwelly 33/11 kV Primary Substation

Constraint Overview

Generation | Demand

Kidwelly Primary Substation is a two 33/11 kV transformer site and is supplied by two 33 kV circuits from the surrounding 33 kV network. The primary currently has a pair of transformers of different ratings and the firm capacity of the substation is limited by the smaller of the two transformers, T2 which is rated at 5/6.25 MVA.

For a first circuit outage (arranged or fault) which results in the loss of Kidwelly T1, the lower rated transformer T2 in service begins to overload in-line with future generation growth forecasts.

Kidwelly is projecting 2.06 MVA of generation to be installed by 2028 and 7.56 MVA by 2034.

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

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
Kidwelly T2 remaining in-service	Outage to Kidwelly T1 (arranged or fault)	None	N/A	N/A	N/A	2034

Solution Options

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

Table 3.2.1 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 transformer T2 at Kidwelly	✓	✓	✓	Viable
2	Reinforce 11 kV circuits to transfer generation to other Primaries	✓	×	×	Discounted
Operational Mitigation					
-	*None Identified*	-	-	-	-
Load Management Schemes					
3	Active Network Management schemes	×	✓	✓	Viable

Uncertainty under other Distribution Future Energy Scenarios: This constraint is not an issue under the current baseline scenario. It first becomes present by 2034 under Best View and Consumer Transformation. This constraint is not observed under any other scenario before the end of this assessed period.

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 transformer overloads for the conditions described above.

Existing limiting factor for constraint(s) considered:

Kidwelly T2 with a 7.7 MVA (winter cyclic) and 6.2 MVA (summer cyclic) rating

Option 1 – Uprate transformer T2 at Kidwelly

Capacity Released for constraint(s) considered: Between 6.3 and 5 MVA — Viable

Detailed description: Uprating the T2 transformer at Kidwelly to a 7.5/15 MVA unit to match T1 (including works to remove associated ancillary rating limitations) would alleviate all the overloads observed at the primary up to 2034 and beyond the period covered by this analysis.

New limiting factor for constraint(s) considered:

Kidwelly T1/T2 with a 14 MVA (winter cyclic) and 11.2 MVA (summer cyclic) rating.

Option 2 – Reinforce 11 kV circuits to transfer generation to other primaries

Capacity Released for constraint(s) considered: 2 MVA by 2034 **Discounted**

Detailed description: New 11 kV circuits may be installed (or existing circuits reinforced) to provide greater interconnectivity towards nearby primaries in order to transfer generation capacity away from Kidwelly. Meinciau and Pontyates are both located approximately 4.5 km from Kidwelly and are the only realistic options for support. Approximately 2 MVA would need to be transferred away to alleviate the overloads observed up to 2034.

The 11 kV interconnection has not been studied in detail, further analysis of the 11 kV network surrounding Kidwelly would be required to fully analyse any potential transfer capability. However, considerable 11 kV circuit lengths would be needed to reach these supporting primaries. Reinforcing this 11 kV network sufficiently to meet a transfer capacity in the order of 2 MVA may result in voltage / power quality issues, restricting the level of capacity that could be released.

New limiting factor for constraint(s) considered:

Existing Kidwelly T2 with a 7.7 MVA (winter cyclic) and 6.2 MVA (summer cyclic) rating

Option 3 – Active Network Management schemes

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

Detailed description: Any additional connections into this group may be included in an Active Network Management (ANM) scheme, which could also be utilised to manage constraints on over-committed networks.

New limiting factor for constraint(s) considered:

Existing Kidwelly T2 with a 7.7 MVA (winter cyclic) and 6.2 MVA (summer cyclic) rating

Solution Recommendation

It is recommended that the existing 33/11 kV transformer T2 at Kidwelly (Option 1) is uprated to a 7.5/15 MVA unit to match T1. This option may prove to be the most cost-effective long term solution and would also be compatible with the existing site layout at Kidwelly Primary. Furthermore, this option allows for future load growth within the Kidwelly area.

Generation projects would connect through NGED's application process and be assessed on an individual basis. Dependent on size and voltage level of the connection, customers may be subject to cost apportionment of the required reinforcement based on voltage level of connection in accordance with relevant rules at the time of application.

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