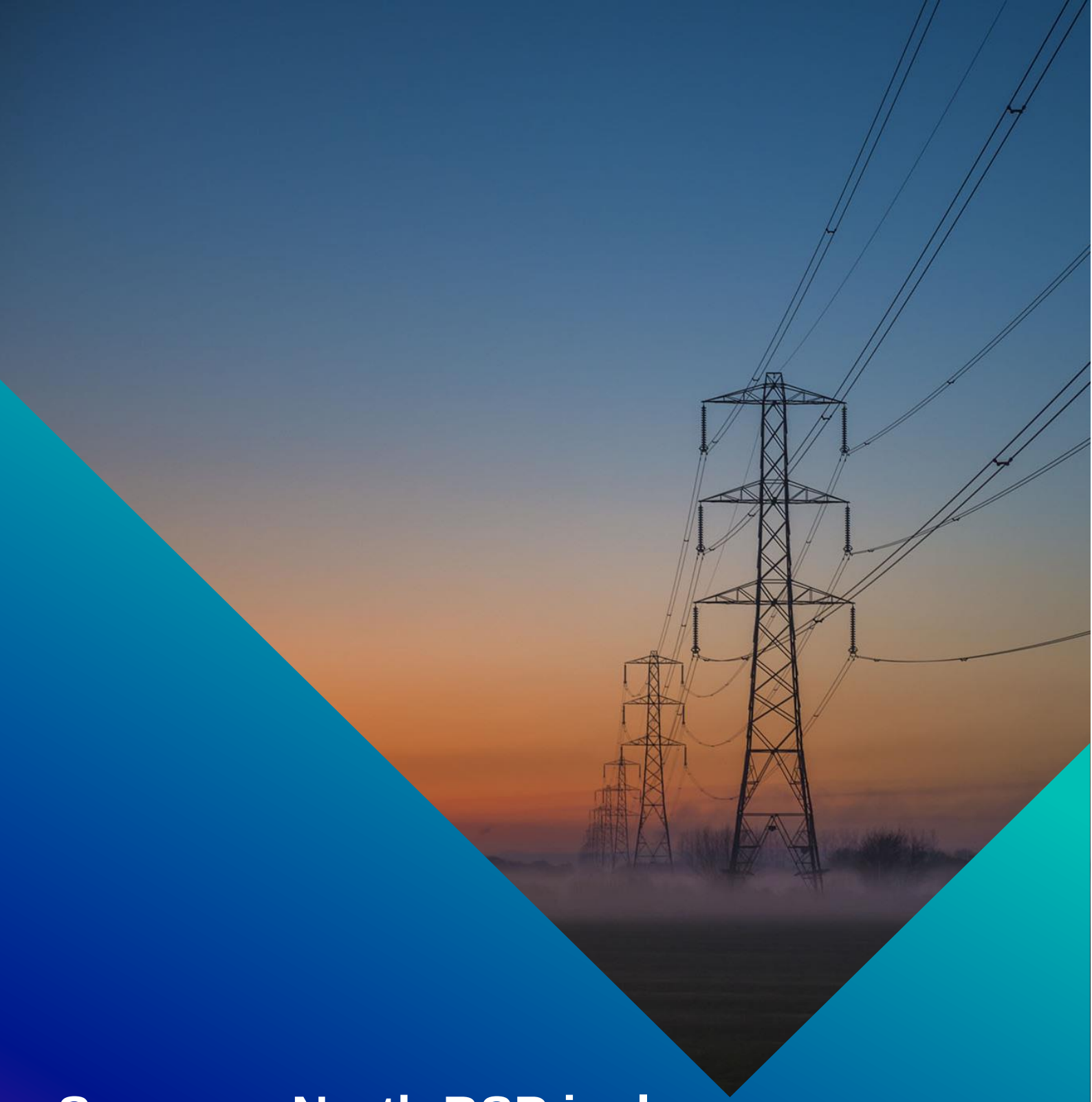

Swansea North BSP incl. associated 33 kV network

Network Development Report – South Wales

May 2024

Electricity Distribution

nationalgrid

Contents

Swansea North BSP & Associated Network

1. Network Overview

Swansea North Bulk Supply Point (BSP) supplies an area of 33 kV network. It is supplied by two in-service 132/33 kV 90 MVA Grid Transformers (GTs) and is located within the Swansea North Grid Supply Point (GSP) substation compound. The associated 33 kV network feeds a combination of rural and urban areas supplying close to 20,000 customers that includes the following 33/11 kV Primary substations:

- Clase, Swansea North Local, Garngoch and Lime Street.

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.

Swansea North BSP currently has a maximum demand of 62.60 MVA and under NGEDs DFES Best View scenario this is projected to rise to 70.31 MVA by the year 2034.

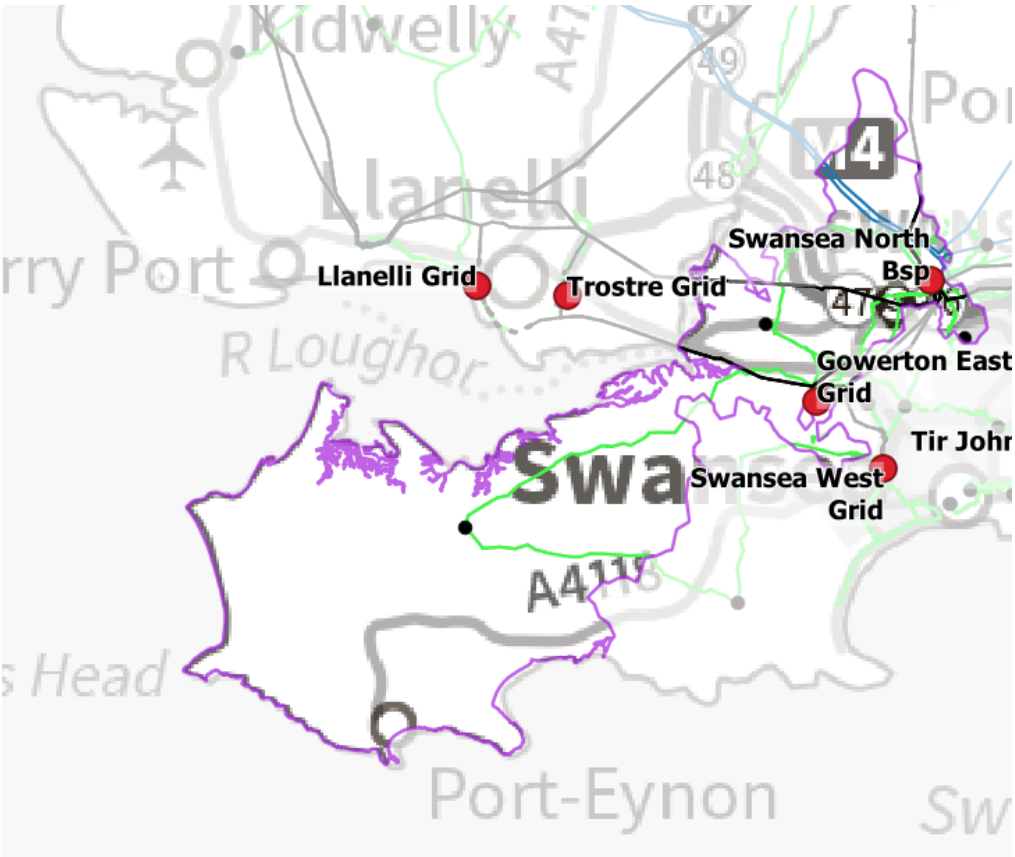

Figure 1.1 Swansea North BSP geographic network coverage

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 Swansea North 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 Swansea North 33 kV network is arranged as follows:

- Swansea North BSP has three 132/33 kV GTs (GT1, GT2 and GT3) all rated at 60/90 MVA and is currently run in parallel supplying a three-section outdoor 33 kV busbar arrangement. GT2 and GT3 operate in-service under intact running conditions. GT1 can be brought into service following an arranged outage to either GT2 or GT3. Each GT is supplied directly from the 132 kV double busbar arrangement within the compound of Swansea North GSP.

- Outgoing 33 kV circuits from Swansea North BSP supply the following four 33/11 kV primary substations:
    - Clase: Single 10/14 MVA primary transformer substation (T1)
    - Garngoch: Two 12/24 MVA primary transformer substation (T1 & T2)
    - Lime Street: Single 12/24 MVA primary transformer substation (T2)
    - Swansea North Local: Two 7.5/15 MVA primary transformer substation (T1 & T2)

- Swansea North BSP also provides connection to a number of 33 kV connected customers and a 33 kV switching site at Waunarlwydd.

- 33 kV interconnections are provided to the following neighbouring groups under select operating conditions:
    - Swansea West and Tir John via a tee into the Waunarlwydd to Clase 33 kV circuit. This interconnection, which is normally run open at Ravenhill, can provide 33 kV interconnection between Swansea West, Swansea North and Tir John BSPs.
    - Swansea West via the Waunarlwydd 33 kV switching site. This interconnection, which is normally run open at Waunarlwydd, can provide 33 kV interconnection between Swansea West and Swansea North BSPs.
    - Travellers Rest via a tee into an outgoing 33 kV circuit from Swansea North. This interconnection, which is normally run open at Pontardawe, can provide 33 kV interconnection between Swansea North and Travellers Rest BSPs.

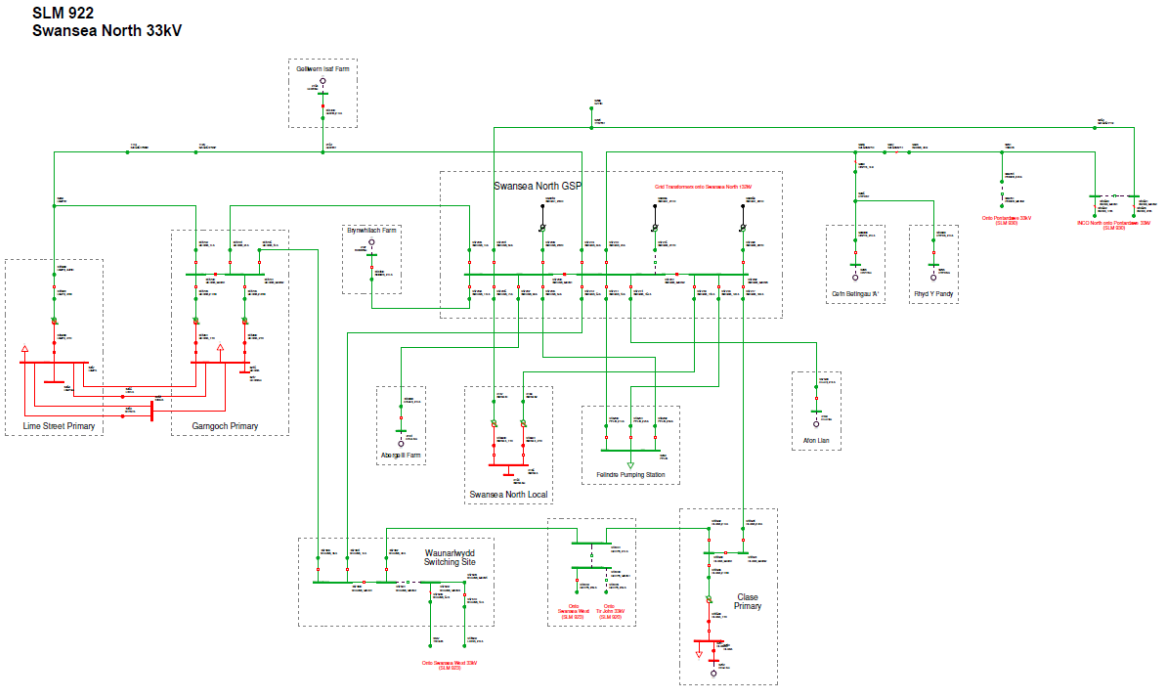

Figure 1.1.1 Swansea North 33 kV network single line diagram

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 of either GT2 or GT3 at Swansea North, GT1 can be brought into service to support the remaining GT.
- The 33 kV circuit from Waunarlwydd to Clase Primary that can provide interconnection between Swansea West, Swansea North and Tir John BSPs is primarily utilised to support either BSP following Second Circuit Outage (SCO) outage conditions.
- The 33 kV interconnection from Waunarlwydd switching site that can parallel Swansea West and Swansea North BSPs is also utilised to support either BSP following SCO outage conditions, in a similar manner as above.
- The 33 kV outgoing circuit from Swansea North that can provide interconnection between Swansea North and Travellers Rest BSPs via Pontardawe is primarily utilised to support the Travellers Rest 33 kV group following an outage to either Pontardawe to Travellers Rest 33 kV circuit.
- Lime Street has an 11 kV interconnection with Garngoch which is typically run solid under intact network conditions.
- For the loss of an infeed to a transformer at any of the primaries fed from within the Swansea North 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. In addition to such sites that are required to participate in a Swansea North BSP Distribution Active Network Management (DANM) scheme to manage the reverse power flow through the associated GTs, as well as controlling the power flow on constrained 33 kV circuits.
- 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:

- Swansea North 33 kV Constraints:
    - Swansea North BSP Grid Transformer Capacity
    - Lime Street & Garngoch 33 kV Group Capacity

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 16 outdoor 33 kV circuit breakers at Swansea North BSP to higher rated 2000 A units to cater for the increase in the three-phase break fault level.

4. Network Constraint Details and Solution Options

Swansea North 33 kV Group

The table below summarises the scale of the demand and generation forecast to connect to the Swansea North 33 kV network up to 2034 under NGEDs DFES Best View scenario.

Table 4.1.1 Maximum demand forecast to connect to the Swansea North 33 kV network

DFES Scenario	Demand		
	Baseline	2028	2034
Best View	62.60 MW	66.56 MW	70.31 MW

Table 4.1.2 Maximum generation forecast to connect to the Swansea North 33 kV network

DFES Scenario	Generation		
	Baseline	2028	2034
Best View	43.62 MW	46.89 MW	54.52 MW

With several large 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 significantly 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.

4.1 Swansea North 132/33 kV Grid Transformer Capacity

Due to several large new connections proposing to connect to this network, a Swansea North BSP Distribution Active Network Management (DANM) scheme to manage the power flow through the associated GTs is currently a requirement for proposed load management schemes within the group to participate in.

The solution options below are aimed at releasing additional capacity for the network with the aim to alleviate the constraints that the DANM scheme is projected to manage.

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 and 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
Swansea North GT2 or GT3 overload	Fault to either GT/ 132 kV circuit	None	2028	2028	2028	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	Permanently have 3 GTs in-service at Swansea North under intact conditions	✓	✓	✓	**Viable**
2	Uprate Swansea North GTs by use of cyclic ratings	×	✓	✓	**Viable**
Operational Mitigation					
-	*None Identified*	-	-	-	-
Flexibility services					
3	Procure flexibility at Swansea North BSP	×	✓	✓	**Viable**

Uncertainty under other Distribution Future Energy Scenarios: This constraint is not an issue under the current baseline scenario. Based on the DFES projections and expected energisation dates for several new connections, constraints are observed from 2028 onwards under all scenarios.

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 this constraint would result in an increasing level of curtailment facing new connections that propose to connect within the area.

Existing limiting factor for constraint(s) considered:

Existing Swansea North 90 MVA GT Rating

Option 1 – Permanently have 3 GTs in-service at Swansea North under intact conditions

Capacity Released for constraint(s) considered: 90 MVA ⬆ **Viable**

Detailed description: Reconfiguring the existing arrangement at Swansea North BSP to permanently switch GT1 into service alongside GT2 and GT3 would ensure two transformers remain in-service for any First Circuit Outage (FCO) event, arranged or fault.

GT1 is not a permanent fixture at the substation compound and is viewed as a system spare for the distribution network, ultimately this asset cannot be relied upon at Swansea North indefinitely.

This option has the potential to release a significant level of capacity for the Swansea North 33 kV network area which will also result in connections participating within the DANM system to experience a reduction in curtailment. This would ensure that connections of similar nature can continue to connect to the network with less constraints than currently proposed.

This solution would help improve network security and resilience under SCO conditions.

New limiting factor for constraint(s) considered:

Combination of the remaining Swansea North GTs in-service during FCO conditions

Option 2 – Uprate Swansea North GTs by use of cyclic ratings

Capacity Released for constraint(s) considered: Viable

27 MVA (winter cyclic increase) and 9 MVA (summer cyclic increase)

Detailed description: Uprating the existing GTs by use of cyclic ratings in accordance with British Standard 171/IEC60076 and NGED Standard Technique SD8C will provide additional capacity for the network. This requires a capability assessment of all transformer ancillaries. In addition, an assessment of the cyclic profile of the load will be required to determine if transformer temperature and ageing is within acceptable limits.

These works can increase the winter cyclic rating to 117 MVA and summer cyclic to 99 MVA if the assessment permits the use of cyclic ratings.

However, given the load growth across the area during this 0-10 year horizon, it is unlikely that the use of cyclic ratings could be utilised as a long-term solution, particularly with only a slight increase in the summer cyclic rating, meaning this option would likely only defer a permanent solution.

New limiting factor for constraint(s) considered:

Swansea North GT1/GT2 with a 117 MVA (winter cyclic) and 99 MVA (summer cyclic) rating.

Option 3 – Procure flexibility across Swansea North 33 kV network

Estimated Flexibility Required: Dependent on the progression of new connections Viable

Detailed description: Flexibility services could be procured throughout the Swansea North 33 kV network to help alleviate the projected overloads in the short term. This could defer reinforcement but due to the large quantity of flexibility required in the long term this may not be a sustainable permanent solution.

The viability of utilising flexibility will be further considered as part of the DNOA process.

Solution Recommendation

Due to the background load growth and several large proposed connections being the foundation for the DANM scheme, it is recommended that a third GT is installed as a permanent fixture at Swansea North (Option 1). This would provide the most network benefit in alleviating the constraints being managed while ensuring that low carbon technologies can continue to connect to the network with less constraints than currently proposed. This solution would help improve network security and resilience under SCO conditions.

It is suggested 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.

Should any of these new connections not proceed then the Swansea North 33 kV group should be reviewed to determine if the reinforcement proposed is to be undertaken based on the capacity of the new connections progressing.

4.2 Lime Street & Garngoch 33/11 kV Primary Substation Group Load

Constraint Overview

Generation Demand

Lime Street Primary is a single 33/11 kV transformer substation which has one 33 kV infeed from Swansea North BSP that includes a tee off towards Garngoch Primary. Lime Street relies on an 11 kV interconnection to Garngoch for the loss of supply to its transformer.

Garngoch Primary is a two 33/11 kV transformer substation which has three 33 kV infeeds from the surrounding 33 kV network. A 33 kV fault to Main Busbar 2 at Garngoch can result in both Garngoch and Lime Street being supplied entirely by a single 33 kV circuit from Swansea North.

The Lime Street and Garngoch group demand is projected to rise over 25 MVA by 2028 and reach 30 MVA by 2034. In-line with this load growth, limiting sections of this 33 kV circuit will soon overload when required to support both primaries.

Furthermore, SCO combinations can result in transformer overloads where a single transformer is left to supply the group demand of both Lime Street and Garngoch. These SCO overloads occur even with operational outage windows restricted to summer demand periods only. In addition, voltages at the remote ends of the circuit can fall below statutory limits.

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

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
Overloaded sections of the Lime Street to Swansea 33 kV circuit	Garngoch 33 kV main 2 busbar fault	None	Baseline	Baseline	2025	2028
Garngoch T1 overload and low voltages observed	Garngoch 33 kV main 2 busbar arranged outage	Lime Street T2 Fault	N/A	N/A	N/A	2028

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	Uprate the existing Lime Street to Swansea North 33 kV circuit	×	✓	✓	**Discounted**
2	Install a second 33/11 kV transformer at Lime Street and install a 33 kV circuit to Swansea North BSP	✓	✓	✓	**Viable**
Operational Mitigation					
3	Transfer load to nearby primaries	×	✓	✓	**Discounted**
4	Reconfigure 33 kV circuits at Garngoch	×	✓	✓	**Discounted**
Load Management Schemes					
-	*None Identified*	-	-	-	-
Flexibility services					
4	Procure flexibility at both primaries	×	✓	✓	**Viable**

Uncertainty under other Distribution Future Energy Scenarios: This constraint appears to be an issue under the current baseline scenario.

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 thermal overloads for the conditions described above. The network would still be susceptible to voltages outside of statutory limits under the same conditions outlined. This would lead to an inability to meet the Security of Supply requirements of Engineering Recommendation P2 for this group.

Existing limiting factor for constraint(s) considered:

21.3 MVA post fault rating of the limiting section of the Lime Street to Swansea North 33 kV circuit

Option 1 – Uprate the existing Lime Street to Swansea North 33 kV circuit

Capacity Released for constraint(s) considered:

Discounted

9 + MVA of additional 33 kV circuit capacity

Detailed description: To overcome the initial overloads observed on the existing Lime Street to Swansea North 33 kV circuit, it is proposed to overlay approximately 0.25 km of the limiting underground cable section to 185 mm^2 copper EPR cable or similar. Further to this, it is proposed to reprofile approximately 5.3 km of limiting 0.15 sq.in. HDC conductor for operation at 75°C.

These works however, would only resolve the constraints on this circuit up until 2028.

To fully alleviate the 33 kV circuit constraints up to 2034 and beyond, it would be proposed to reconductor and reprofile approximately 8.1 km of the overhead line sections of this circuit to 175 mm^2 ACSR conductor for operation at 75°C.

However, the 11 kV interconnection to Garngoch that supports Lime Street for the loss of supply to its transformer is forecast to be inadequate from 2030 onwards. SCO combinations where a single transformer is left to supply the group demand of both Lime Street and Garngoch also remain. Transformer overloads are expected from 2028.

New limiting factor for constraint(s) considered:

12 MVA 11 kV backfeed capacity

Option 2 – Install a second 33/11 kV transformer at Lime Street and install a 33 kV circuit to Swansea North BSP

Capacity Released for constraint(s) considered:

Viable

Lime Street T1 with a 23 MVA (winter cyclic) and 18 MVA (summer cyclic) rating.

Detailed description: Installing a second 33/11 kV transformer at Lime Street Primary (including removal of any ancillary rating limitations) alongside the installation of a new 33 kV circuit from Lime Street to Swansea North would alleviate the associated FCO constraints up to 2034 and beyond.

SCO combinations that previously resulted in single transformer overloads and low voltages being observed are also alleviated. The Lime Street and Garngoch summer peak group demand is projected to rise over 19 MVA by 2028 and reach 24 MVA by 2034. Under the existing arrangement, SCO overloads are observed from 2028 even with operational outage windows restricted to summer demand periods only.

A new 33 kV circuit of approximately 6.5 km to Swansea North BSP will be required. Assumed as a combination of both overhead line construction (0.15 sq.in. HDC conductor or similar) with underground cable sections (185 mm^2 copper EPR cable or similar).

It is proposed that T1 will be installed as a 12/24 MVA rated unit to match the existing rating of T2.

The current 33 kV network diagram is shown below in figure 4.3.1. The proposed arrangement based on the reinforcement works recommended in this option is shown in figure 4.3.2:

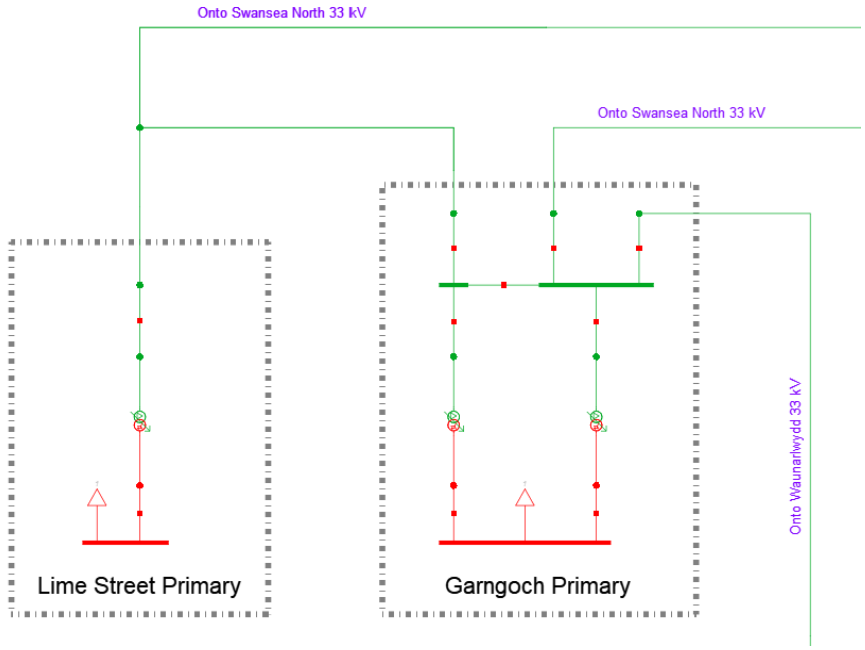

Figure 4.3.1 Existing Lime Street & Garngoch 33 kV network diagram

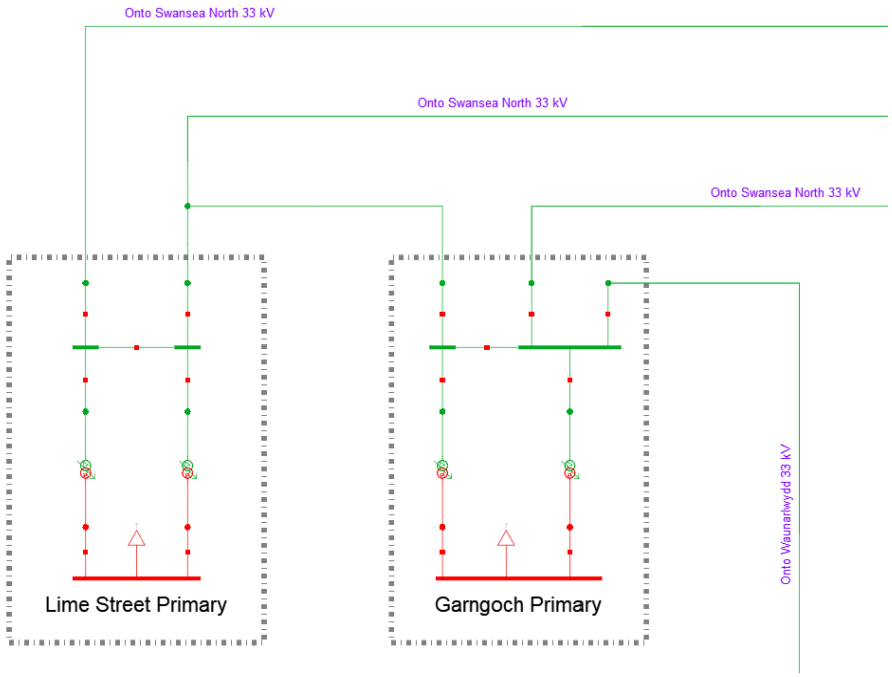

Figure 4.3.2 Proposed Lime Street & Garngoch 33 kV network diagram

These works may prove difficult to achieve due to the existing Lime Street substation footprint and lack of space available that would be required to install T1 alongside the associated 33 kV switchgear and extension of the 11 kV switchboard that would be needed to facilitate this work.

If achievable, this option will release considerable capacity for future growth and will improve network resilience under SCO conditions. Dependency on 11 kV interconnectivity under FCO will also reduce, which is forecast to be inadequate from 2030 onwards.

If there is insufficient space at the existing substation to facilitate this work, given the future load growth, it may be a consideration to acquire a parcel of land nearby in order to establish a larger Lime Street primary substation.

New limiting factor for constraint(s) considered:

FCO at either Lime Street or Garngoch primary, based on this network proposal:

23 MVA (winter cyclic) and 18 MVA (summer cyclic) ratings.

Option 3 – Transfer load to nearby primaries

Capacity Released for constraint(s) considered: 9 MVA by 2034 **Discounted**

Detailed description: Lime Street has an 11 kV interconnection with Garngoch, however any 11 kV demand transfers would have to be made to primaries supplied outside of this group to overcome the 33 kV circuit overloads observed. Due to the location of Lime Street and Garngoch, 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:

21.3 MVA post fault rating of the limiting section of the Lime Street to Swansea North 33 kV circuit

Option 4 – Reconfigure 33 kV circuits at Garngoch

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

Detailed description: A 33 kV fault to Main Busbar 2 at Garngoch can result in both Garngoch and Lime Street being supplied by a single 33 kV circuit from Swansea North, ultimately resulting in the loss of two out of three 33 kV infeeds from Swansea North.

If the 33 kV circuit to Waunarlwydd switching site (Garngoch 4L5) could be transferred across onto Main Busbar 1, then for a FCO impacting either 33 kV busbar at Garngoch, two infeeds to Swansea North will remain to support the group demand of both Lime Street and Garngoch. This proposal would alleviate FCO constraints observed for a Garngoch 33 kV Main 2 bar outage.

However, the 11 kV interconnection to Garngoch that supports Lime Street for the loss of supply to its transformer is forecast to be inadequate from 2030 onwards. SCO combinations where a single transformer is left to supply the group demand of both Lime Street and Garngoch would also remain. Transformer overloads are expected from 2028.

New limiting factor for constraint(s) considered: 12 MVA 11 kV backfeed capacity

Option 5 – Procure flexibility at both primaries

Flexibility service type: Demand turn down or generation turn up **Viable**

Detailed description: Flexibility services could be procured at both Lime Street and Garngoch 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 9 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.

Following this, a technical review of installing a second 33/11 kV transformer and new 33 kV circuit (Option 2) should be made as it is likely to provide the most network benefit in the long term and will release additional capacity for the nearby area.

This option will also ensure compliance with statutory voltage limits and P2/8 throughout the forecasted load growth period and beyond.

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