



Cardiff East & Cardiff North BSPs incl. associated 33 kV networks

Network Development Report – South Wales

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**Electricity
Distribution**

nationalgrid

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Cardiff East & Cardiff North BSPs incl. associated 33 kV networks

1. Network Overview

Cardiff East and Cardiff North Bulk Supply Points (BSPs) supply an area of 33 kV network within the city of Cardiff and operate in parallel via several 33 kV circuits under intact network conditions. The associated 33 kV network supplies close to 75,000 customers and includes the following 33/11 kV Primary substations:

- Ashgrove, Birchgrove, Crwys Road, Cyncoed, Heath, Heath Hospital, Llanishen, Northcote Street, Park Lane and St Mellons.

Cardiff East and Cardiff North BSPs currently have a maximum demand of 122 MVA and under NGED's DFES Best View scenario this is projected to rise to 128 MVA by the year 2034.



Figure 1.1 Cardiff East & Cardiff North 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, 132/33 kV transformers which supply and are supplied by Cardiff East and Cardiff North 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 Cardiff East and Cardiff North 33 kV network is arranged as follows:

- Cardiff East BSP has two 132/33 kV GTs (GT2 and GT4) both rated at 60/90 MVA.
- Cardiff North BSP has two 132/33 kV GTs: GT1 rated at 60/90 MVA and GT2 rated at 45/90 MVA. GT1 is currently run on hot-standby with GT2 in-service.
- The outgoing 132 kV circuits from each BSP are supplied from the Aberthaw and Cardiff East 132 kV group.
- Outgoing 33 kV circuits from Cardiff East and Cardiff North BSPs supply the following 33/11 kV primary substations:
 - Ashgrove: Two primary transformer substation T1 (7.5/15 MVA) and T2 (7.5/14 MVA)
 - Birchgrove: Two 10/14 MVA primary transformer substation (T1 & T2)
 - Crwys Road: Two 10/14 MVA primary transformer substation (T1 & T2)
 - Cyncoed: Two 20/40 MVA primary transformer substation (T1 & T2)
 - Heath: Two 12/24 MVA primary transformer substation (T1 & T2)
 - Heath Hospital: Two 7.5/15 MVA primary transformer substation (T1 & T2)
 - Llanishen: Single 12/24 MVA primary transformer substation (T1)
 - Northcote Street: Two 12/24 MVA primary transformer substation (T1 & T2)
 - Park Lane: Two 20/40 MVA primary transformer substation (T1 & T2)
 - St Mellons: Two 12/24 MVA primary transformer substation (T1 & T2)
- The 33 kV group also provides connection to a 33 kV connected customer.
- Two 33 kV circuits from Cardiff Central BSP tee into the Park Lane to Cardiff East 33 kV feeders. These circuits, which are normally run open at Cardiff Central, can provide support to the Cardiff East and Cardiff North 33 kV group under select outage conditions.

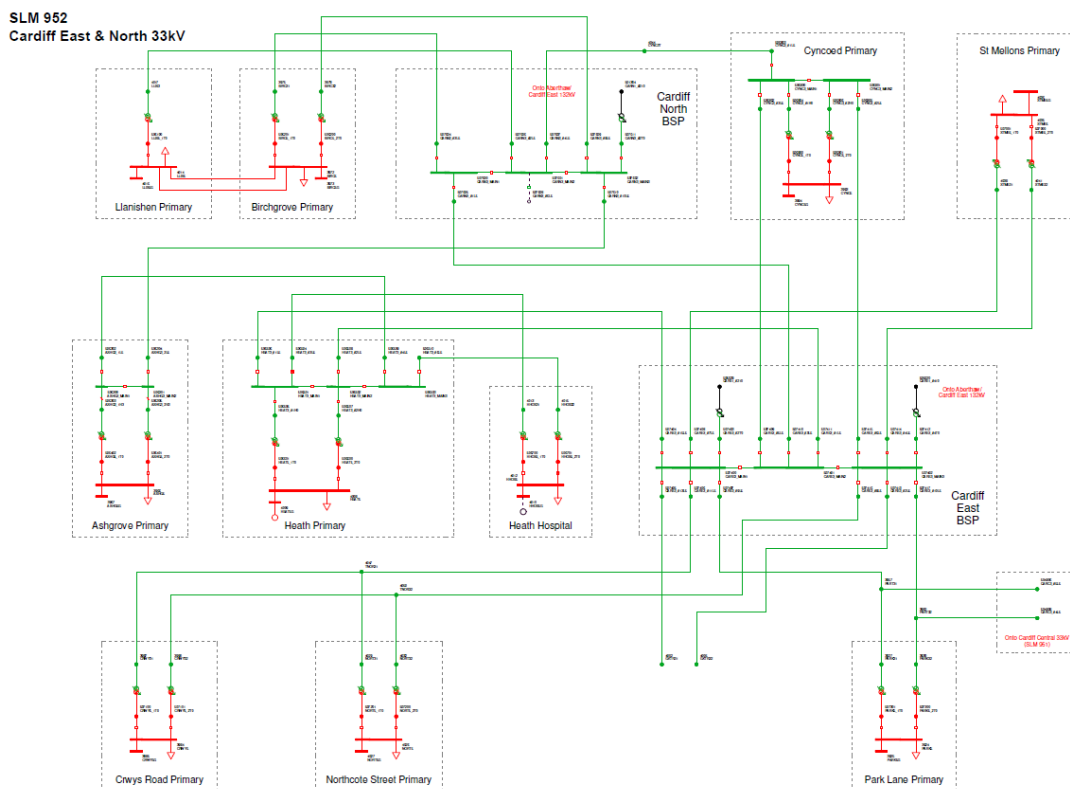


Figure 1.1 Cardiff East & Cardiff North 33 kV network single line diagram

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.

- Under intact network conditions, the Cardiff East & Cardiff North 33 kV group operates in parallel via several 33 kV circuits.
- For an arranged GT outage at either Cardiff East or Cardiff North BSP, the 33 kV normally open points at Cardiff Central can be moved to 9L5 and 10L5 at Cardiff East BSP. This allows Park Lane to be supplied from Cardiff Central, de-loading this group in the process. Due to fault level restrictions, it is not possible to operate the two groups in parallel except for switching time.
- Llanishen single primary transformer substation has 11 kV interconnections to Birchgrove primary which are 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 Cardiff East and Cardiff North 33 kV network under arranged outages, the lower voltage side circuit breaker is opened to prevent back-energisation.
- 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:

- Birchgrove and Llanishen 33/11 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:

- Rationalising the Cardiff East and Cardiff North 33 kV parallel network into two distinct 33 kV BSP groups. The newly established 90 MVA GT1 at Cardiff North BSP is expected to be brought into service alongside GT2 once these 33 kV groups are running independently.

This scheme, alongside the associated works to facilitate this 33 kV network split have been included in all studies from 2028 onwards.

4. Network Constraint Details and Solution Options

4.1 Cardiff East and Cardiff North 33 kV Group

The table below summarises the scale of the background load growth forecast to connect to the Cardiff East and Cardiff North 33 kV network up to 2034 under NGED's DFES Best View scenario.

Table 4.1.1 Maximum demand forecast to the Cardiff East & Cardiff North 33 kV network

DFES Scenario	Demand		
	Baseline	2028	2034
Best View	122 MW	125 MW	128 MW

Table 4.1.2 Maximum generation forecast to the Cardiff East & Cardiff North 33 kV network

DFES Scenario	Generation		
	Baseline	2028	2034
Best View	9 MW	17 MW	33 MW

With new developments proposed to connect within the group at 11 kV and at 33 kV in the near future, the load 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.

Birchgrove & Llanishen 33/11 kV Group Capacity

Constraint Overview

Generation Demand

Llanishen Primary is a single 33/11 kV transformer site which has one 33 kV infeed from Cardiff North BSP. Llanishen relies on an 11 kV interconnection to Birchgrove for the loss of supply to its transformer, which is a 12/24 MVA unit.

The Birchgrove and Llanishen group demand is projected to reach 16 MVA by 2034. In-line with this load growth, SCO combinations can result in transformer overloads where a single Birchgrove 33/11 kV transformer is left to supply the group demand of both Birchgrove and Llanishen.

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 demand 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
Birchgrove 33/11 kV transformer overloads	Arranged outage of Llanishen T1	Fault to either Birchgrove T1 or T2	Baseline	Baseline	2032	N/A

Solution Options

A list of each of the options considered for these constraints are 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	x	x	x	Discounted
Reinforcement					
1	Install a second 33/11 kV transformer at Llanishen and a second 33 kV circuit to Cardiff North BSP	✓	✓	✓	Viable
2	Replace Birchgrove T1/T2 with higher rated units	✓	x	✓	Viable
3	Transfer demand to nearby primaries	✓	x	x	Discounted
Operational Mitigation					
4	Sufficiency of the available access window	✓	✓	✓	Viable
Load Management Schemes					
-	None Identified	-	-	-	-
Flexibility services					
5	Procure flexibility within the group	✓	✓	✓	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 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 this group.

Existing limiting factor for constraint(s) considered:

Birchgrove T1/T2 with a CMR value of 14 MVA

Option 1 – Install a second 33/11 kV transformer and a second 33 kV circuit

Capacity Released for constraint(s) considered:

 **Viabile**

Llanishen T2 with a 23 MVA (winter cyclic) and 18 MVA (summer cyclic) rating.

Detailed description: Installing a second 33/11 kV transformer at Llanishen (T2) and a new 33 kV circuit to Cardiff East BSP would alleviate this constraint and will release capacity for future growth. This option will improve network resilience and reduces the dependency on 11 kV interconnectivity under outage conditions.

A new 33 kV circuit of approximately 1.8 km to Cardiff East BSP will be required with an assumed underground cable construction (185 mm² copper EPR cable or similar). It is proposed that T2 will be installed as a 12/24 MVA rated unit to match the rating of T1.

Following these works, the normally closed 11 kV interconnectors between Birchgrove and Llanishen are expected to be opened.

New limiting factor for constraint(s) considered:

Llanishen T1/T2 with a 23 MVA (winter cyclic) and 18 MVA (summer cyclic) rating.

Option 2 – Replace Birchgrove T1/T2 with higher rated units

Capacity Released for constraint(s) considered:

 **Viabile**

Birchgrove T1/T2 with a 23 MVA (winter cyclic) and 18 MVA (summer cyclic) rating.

Detailed description: Replacing the 33/11 kV transformers at Birchgrove Primary to 12/24 MVA units will alleviate the constraints observed at the primary across this period of assessment.

However, given that the projected group demand of Birchgrove and Llanishen will reach 16 MVA by 2034, this will likely also necessitate 11 kV network reinforcement to upgrade the 11 kV backfeed capacity required under outage conditions.

New limiting factor for constraint(s) considered:

11 kV backfeed capacity

Option 3 – Transfer demand to nearby primaries

Capacity Released for constraint(s) considered: 3 MVA + by 2034

 **Discounted**

Detailed description: Any 11 kV demand transfers would have to be made to primaries supplied outside of Birchgrove and Llanishen to overcome the overloads observed.

This may only offer marginal benefit in the short term and will limit potential future growth as additional reinforcement may still be required at a later date to release additional capacity in the long-term.

New limiting factor for constraint(s) considered:

Birchgrove T1/T2 with a CMR value of 14 MVA

Option 4 – Sufficiency of the available access window

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

 **Viable**

Detailed description: Currently, 2034 studies do not indicate overloads under summer peak demand conditions. It is recommended that the adequacy of the available access window for the arranged outage is assessed as a summer access window could be available to mitigate this overload.

It may be possible to defer this reinforcement through access scheduling.

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

Option 5 – Procure flexibility within the group

Estimated Flexibility Required (MVA): 3 MVA + by 2034

 **Viable**

Detailed description: Flexibility services could be procured at both Birchgrove and Llanishen to help alleviate the projected overloads. 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.

Following this, a technical review of installing a second 33/11 kV transformer and new 33 kV circuit (Option 1) 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 P2/8 throughout the forecasted load growth period and beyond.



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