Landulph St Germans BSP Group

Network Development Report – South West

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Electricity Distribution

nationalgrid

Contents

Landulph BSP and St Germans BSP

1. Network Overview

Landulph Bulk Supply Point (BSP) and St Germans BSP supply 33 kV network. Landulph BSP has one 132/33 kV Grid Transformer (GT) which is fed from Landulph Grid Supply Point (GSP). St Germans BSP consists of two Grid Transformers, with the BSP fed from Indian Queens GSP and Landulph GSP. The two BSPs are run in parallel and the group supplies approximately 52,000 customers.

Figure 1.1.1 Landulph – St Germans 33 kV network geographic network coverage

This report discusses all existing and future network constraints over a 0-10 year horizon identified on the Grid Transformers (GTs) and the 33 kV network fed from Landulph BSP and St Germans 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. Five representative days have been studied across the four seasons: Winter Peak Demand, Intermediate Warm Peak Demand, Intermediate Cool Peak Demand, Summer Peak Demand and Summer Peak Generation.

1.1 Network Topology

The Landulph – St Germans 33 kV network is arranged as follows:

- Two Grid Transformers (GT1 and GT2) at St Germans BSP run in parallel at 33 kV with a single Grid Transformer (GT2) at Landulph BSP. An additional Grid Transformer (GT1) is due to be commissioned at Landulph BSP in 2024 and has been included in analysis of the network.
- Looe, Lanreath, Lostwithiel, St Neot, Liskeard Primary substations and three single customers are fed via a 33 kV ring connected to St Germans BSP. An interconnection to St Austell BSP is available at Lostwithiel Primary substation.
- Callington Primary substation is connected to both St Germans BSP and Landulph BSP. From Callington, a 33 kV ring feeds Gunnislake and Lifton Primary substations as well as three 33 kV connected customers. There is a normal open point between Lifton Primary substation and Gunnislake Primary substation which splits the 33 kV ring at Tavistock Primary substation. Interconnection is available to Ernesettle BSP at Tavistock Primary substation and to Pyworthy BSP at Launceston Primary substation.
- Torpoint Antony, Saltash Whity Cross, Torpoint Town, Saltash Dunheved Road Primary substations and a 33 kV customer are supplied via a ring between Landulph BSP and St Germans BSP.
- Pensilva Primary substation and two 33 kV customers are connected on a ring between Callington and Liskeard Primary substations.
- Various single customers are connected to St Germans BSP at 33 kV and various single customers are connected to Landulph BSP at 33 kV.

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.

- For the loss of an infeed to the 33/11 kV transformer and 132/33 kV transformers, the lower voltage side circuit breaker is opened to prevent back-energisation.
- For a range of arranged outages, some generators connected at 33 kV are curtailed.
- Network reconfiguration for various arranged outages has been modelled to prevent Second Circuit Outage (SCO) overloads.
- Directional overcurrent schemes are modelled for the 33/11 kV transformers at Lanreath Primary substation.

When considering different reinforcement options, different manual switching schemes were modelled.

2. Summary of Network Constraints

The following constraints were identified for the Best View Scenario, for which mitigation options will be discussed:

- Grid Transformer (GT) capacity at St Germans BSP.
- Thermal overloads on Callington- Landulph- St Germans 33 kV ring.
- Lost load at Gunnislake and Lifton Primary substations.
- Low Volts on 33 kV network near Launceston Primary substation.
- Circuit overloads on 33 kV ring fed from St Germans BSP.
- Landulph Grid Transformer capacity.
- Lost load at Liskeard Primary substation.
- Low volts on 33 kV ring fed from St Germans BSP.
- High volts on 33 kV ring fed from St Germans BSP.
- Gunnislake transformer capacity.
- Saltash Whity Cross transformer capacity.
- Liskeard transformer capacity
- Callington transformer capacity.
- Looe transformer capacity.

For some constraints, an overall solution is proposed to resolve multiple constraints.

3. Network Constraint Details and Solution Options

3.1 St Germans Grid Transformer Capacity

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 studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
St Germans GT2 demand driven thermal overload	Arranged or fault outage of St Germans GT1.	None	2034	2034	2034	-
St Germans GT2 generation driven thermal overload	Arranged or fault outage of St Germans GT1.	None	-	-	-	2028
St Germans GT1 demand driven thermal overload	Arranged or fault outage of St Germans GT2.	None	2034	2034	2034	-
St Germans GT1 generation driven thermal overload	Arranged or fault outage of St Germans GT2.	None	-	-	-	2028

Uncertainty under other Distribution Future Energy Scenarios: The demand-driven constraint is expected to occur in 2032 under the Leading the Way scenario and later than 2035 according to the Falling Short scenario.

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 Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Run GTs to full cyclic rating following ST: SD8C checks	×	✓	✓	Viable
2	Replace existing 40/60 MVA Grid Transformers with 60/90 MVA units	✓	✓	✓	Viable
Operational Mitigation					
3	Transfer load onto neighbouring BSPs under normal running conditions	✓	×	✓	Viable
Load Management Schemes					
4	Active Network Management	×	✓	✓	Viable
5	Post-fault transfers	×	×	×	Discounted
Flexibility services					
6	Procure flexibility at St Germans BSP	×	✓	✓	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.

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

Option 1 – Run Grid Transformers to full cyclic rating following ST: SD8C checks

Capacity released for constraint(s) considered: 6 MVA (in summer) Viable

Detailed description: The GTs at St Germans BSP are currently assumed to be limited to their nameplate rating (60 MVA). For a transformer to carry a load greater than its nameplate rating, the ancillaries of the transformer must also be able to carry the load.

Before running the Grid Transformers to their full cyclic rating, checks should be carried out on the transformer ancillaries in accordance with ST: SD8C. This is a viable short-term option however this will not relieve the 2034 constraint.

New limiting factor for constraint(s) considered: GTs at St Germans BSP.

Option 2 – Replace 40/60 MVA Grid Transformers with 60/90 MVA units

Capacity Released for constraint(s) considered: 33 MVA Viable

Detailed description: By replacing both the Grid Transformers at St Germans BSP with higher rated assets and running them at their cyclic ratings where required, overloads are forecasted to be avoided out to 2034.

New limiting factor for constraint(s) considered: 33 kV circuits fed from St Germans BSP.

Option 3 – Transfer load onto neighbouring BSPs under normal running conditions

Capacity Released for constraint(s) considered: None Viable

Detailed description: Lostwithiel Primary substation could be transferred onto St Austell BSP however this would not relieve the constraint caused by Generation. Generation connected on the same ring as Lostwithiel could also be transferred onto St Austell BSP however this is not considered a valid long-term solution given that the GTs St Austell BSP are forecasted to be constrained in 2034.

When the second GT at Landulph BSP is commissioned, there will be more capacity available at Landulph BSP however the firm capacity at Landulph BSP would be limited to the existing GT capacity (45 MVA) under N-1 conditions. In addition, circuits between Landulph BSP and St Germans BSP would require reinforcement.

New limiting factor for constraint(s) considered: Spare capacity at St Austell BSP and Landulph BSP.

Option 4 – Active Network Management

Capacity Released for constraint(s) considered: Dependent on curtailment Viable

Detailed description: Active Network Management (ANM) can be used to manage the export of generators onto the network such that a generation driven overload of the Grid Transformers can be avoided. ANM would not prevent demand-driven thermal overloads of the GTs that are forecasted at St Germans for winter 2028.

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

Option 5 – Post-fault transfers

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

Detailed description: Post-fault transfers cannot be utilised as the overload is beyond post-fault ratings meaning there is no window to reduce the load on the 33 kV circuits through load management.

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

Option 6 – Procure flexibility at St Germans BSP

Estimated Flexibility Required (MVA):

Viable

12 MVA (2034 Winter Constraint) under current running arrangement.

Detailed description: Flexibility services could be procured to alleviate projected thermal overloads caused by demand. Generation-driven thermal overloads cannot be resolved by existing flexibility services.

Solution Recommendation

It is recommended that the Grid Transformers are replaced with 60/90 MVA units. This would facilitate future load growth on the St Germans 33 kV network and potentially enable demand to be transferred from St Austell BSP onto St Germans BSP in the future.

3.2 Combined Reinforcement Strategy

Significant demand growth is expected within the Landulph – St Germans BSP group. The network is normally configured such that Landulph BSP and St Germans BSP are run in parallel at 33 kV.

The demand of the group is projected to rise above 100 MW, putting the group into Engineering Recommendation P2 Class of Supply D, which introduces a Second Circuit Outage (SCO) security of supply requirement. By splitting the Landulph – St Germans 33 kV network such that the two BSPs are no longer run in parallel, two smaller groups are created and demand in each smaller group does not exceed 100 MW.

Table 3.2.1 Maximum demand growth on Landulph – St Germans 33 kV network according to DFES 2022 Best View

DFES Scenario	Demand (MW)			
	Baseline	**2025**	**2028**	**2034**
Best View	77.74	79.15	91.57	151.47

The table below summarises the generation forecasted to be connected to the group.

Table 3.2.2 Maximum generation growth on Landulph – St Germans 33 kV network according to DFES 2022 Best View

DFES Scenario	Generation (MW)			
	Baseline	**2025**	**2028**	**2034**
Best View	117.35	121.84	128.65	163.52

In addition, some projected constraints can be relieved by splitting the group. These constraints are covered in Section 3.3 and Section 3.4.

To split the group, a change in running arrangement and installation of circuit breakers is recommended at Callington, Liskeard and Saltash Whity Cross Primary substations. This is proposed in Option 1 of Section 3.3.

3.3 Thermal Overloads on Callington - Landulph - St Germans ring, Landulph Grid Transformer Capacity, Lost Load at Gunnislake and Lifton Primary substations, Low Volts on 33 kV network near Launceston Primary substation

Constraint Overview

Generation | Demand

The table below outlines the nature of the network constraints identified in the network analysis. The different constraints may be solved by combining the different solutions given.

Table 3.3.1 constraint(s) and condition under which constraint occurs

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Demand driven overload on 33 kV circuit between St Germans BSP and Callington Primary substation.	Main 1 or Main 2 busbar fault at Callington Primary substation	None	Baseline	Baseline	Baseline	-
Generation driven overload on 33 kV circuit between St Germans BSP and Callington Primary substation	Main 1 busbar fault at Landulph BSP or fault on circuit between Landulph BSP and Callington Primary substation	None	-	-	-	2034
Demand driven thermal overload on circuit between Saltash Whity Cross 5L5 to Landulph BSP 5L5	Arranged or fault outage causing Main 2 busbar at Saltash Dunheved Road Primary substation to be off supply	None	2028	2028	2034	2034
Generation driven thermal overload on circuit between Saltash Whity Cross 5L5 to Landulph BSP 5L5	Arranged or fault outage of GT2 at St Germans BSP	None	-	-	-	2028
Generation driven thermal overload on circuit between Saltash Whity Cross 5L5 to Landulph BSP 5L5	None	None	-	-	-	2034
Demand driven thermal overload between St Germans BSP 2L5 and Saltash Whity Cross 3L5	Main 2 Busbar fault at Landulph BSP	None	2034	2034	-	-
Generation driven thermal overload between St Germans BSP 2L5 and Saltash Whity Cross 3L5	Fault outage of GT2, Main 1 or Main 2 busbar at St Germans BSP	None	-	-	-	2034
Landulph 10L5 to Callington 1L5 demand driven thermal overload	Main busbar fault at St Germans BSP	None	Baseline	Baseline	Baseline	-

Landulph 10L5 to Callington 1L5 generation driven thermal overload	Main busbar fault at St Germans BSP	None	-	-	-	Baseline
Landulph GT2 generation driven thermal overload	Fault on Landulph GT1 or fault or Main busbar fault at St Germans BSP	None	-	-	-	Baseline
Lost load (> 12 MW) at Gunnislake, 33 kV customer and Lifton Primary substations	Arranged or fault outage of Main 3 or Main 4 busbar at Callington	None	Baseline	2028	2034	-
Low volts on 33 kV network near Launceston Primary substation	Main 1 or Main 2 busbar fault at Callington Primary substation.	None	Baseline	Baseline	Baseline	-
Low volts on 33 kV network near Gunnislake	Main 1 or Main 2 busbar fault at Callington Primary substation	None	Baseline	Baseline	Baseline	2034

Uncertainty under other Distribution Future Energy Scenarios: Many of these constraints occur under baseline, so there is no uncertainty about future forecasts. There is a risk that load reduces, however this is not forecast under any scenario so mitigation against this constraint is definitely required.

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 Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Split Landulph BSP and St Gemans BSP at 33 kV	✓	✓	✓	Viable
2	Re-conductor existing 33 kV circuits and maintain running arrangement	✓	✓	×	Viable
Operational Mitigation					
3	Transfer Lifton Primary substations onto neighbouring BSP	×	×	✓	Viable
Load Management Schemes					
4	Active Network Management	×	✓	✓	Viable
Flexibility services					
5	Procure flexibility at various Primary substations	✓	✓	✓	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.

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

Option 1 – Split Landulph BSP and St Gemans BSP at 33 kV

Capacity Released for constraint(s) considered: Up to 40 MVA — Viable

Detailed description:

Adjust running arrangement such that Landulph BSP and St Germans BSP are no longer run in parallel; install new 33 kV circuit and adjust running arrangement to create new ring fed from Landulph BSP.

The following reinforcement is recommended:

- Re-arrange circuit infeeds and switchgear at Callington Primary such that a new ring is created from St Germans BSP with a normally open interconnection to Callington Primary substation. The 33 kV ring fed from St Germans BSP will include Pensilva and Liskeard Primary substations, as well as 33 kV customers. The figure below shows the proposed rearrangement at Callington.

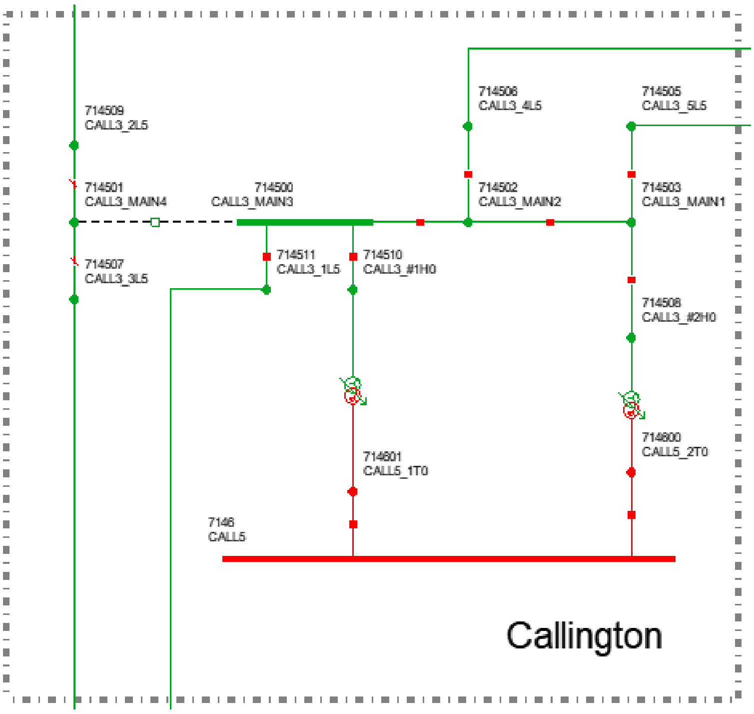

Figure 3.3.1: Proposed rearrangement of Callington Primary substation showing a normal open point between the St Germans 33 kV network and Landulph 33 kV network.

- Re-arrange circuit infeeds and switchgear at Saltash Whity Cross Primary substation such that a ring is created from Landulph BSP that feeds Torpoint Town and Saltash Dunheved Road Primary substations. A normally open interconnection to Saltash Whity Cross Primary is proposed.

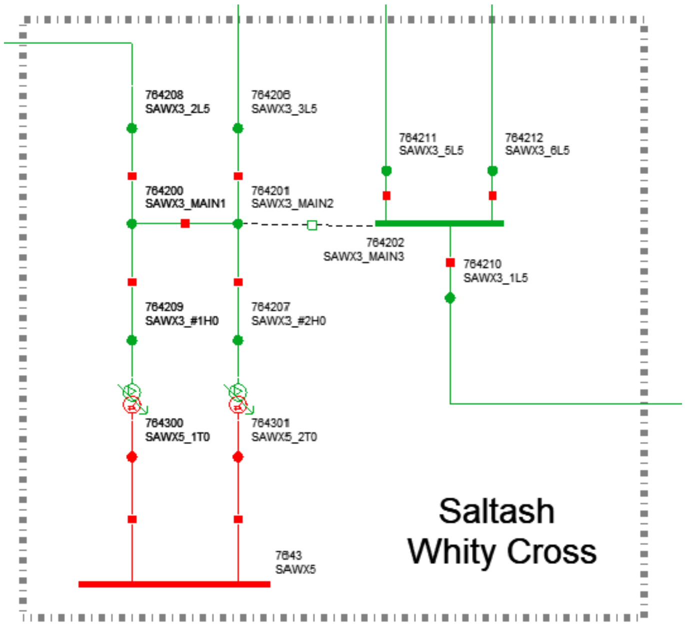

Figure 3.3.2: Proposed arrangement for Saltash Whity Cross Primary substation showing a normal open point between the St Germans 33 kV network and Landulph 33 kV network.

- Carry out line survey to re-profile 0.15 Hard Drawn Copper (HDC) 33 kV circuit between Landulph BSP and Callington Primary substation. This will enable 30.29 MVA capacity post-fault in winter.
- A new 33 kV circuit from Landulph BSP to feed the 33 kV network near Gunnislake. This will help de-load the circuit between Landulph BSP and Callington BSP when Landulph BSP is no longer run in parallel with St Germans BSP. 200 mm^2 All Aluminium Alloy conductor (AAAC) is recommended.
- Install sufficient reactive compensation equipment at Lifton Primary substation to help relieve voltage constraints.
- Apply cyclic ratings to Landulph GT2. With the network split, Landulph GT2, rated at 22.5/45 MVA, is not forecasted to be constrained by generation however 46.63 MVA demand is forecasted for a Main 1 busbar fault at Landulph BSP in winter which can be resolved by applying the cyclic rating of 63 MVA.

Other proposed changes include:

  - Closing the open point between Lifton Primary substation and Main 3 bar at Tavistock Primary substation so that there is an electrical connection between Gunnislake and Lifton Primary substations via Tavistock. This will increase security of supply at Lifton and will ensure that more of the 33 kV network benefits from reactive compensation equipment proposed to be installed at Lifton Primary substation.
  - Moving the circuit directly between Landulph BSP and Saltash Dunheved Road onto Main busbar 1 to increase security of supply for the proposed ring feeding Torpoint Town and Saltash Dunheved Road Primary substations.

New limiting factor for constraint(s) considered: Capacity of GTs at St Germans BSP and GT2 at Landulph BSP.

Option 2 – Re-conductor existing 33 kV circuits and maintain running arrangement

Capacity released for constraint(s) considered: Depends on chosen conductor. **Viable**

Detailed description: This solution requires re-conductoring and/or re-profiling interconnecting circuits between Landulph BSP and St Germans BSP.

If the network is not split, Landulph GT2 is forecasted to be thermally overloaded by generation in the summer. Applying cyclic ratings would not be sufficient to relieve this constraint out to 2034 as the post-fault cyclic rating would be 51 MVA with 53.03 MVA forecasted. Landulph GT2 would require replacement with a 60/90 MVA transformer.

Installation of reactive compensation equipment to near Lifton is recommended to ensure that voltage remains within statutory limits on the network.

New limiting factor for constraint(s) considered: Depends on chosen conductor.

Option 3 – Transfer Lifton Primary substation onto neighbouring BSP

Capacity Released for constraint(s) considered: 6.56 MVA

Viable

Detailed description:

Lifton Primary substation could be fed from Pyworthy BSP via Launceston Primary substation, or from Ernesettle BSP via Tavistock Primary substation. This will reduce reinforcement requirements however significant reinforcement would still be required alongside this load management scheme.

To enable this solution, it is likely that reinforcement would need to be carried out in adjacent groups. For example, this solution would be more viable if a new BSP was installed near Launceston.

New limiting factor for constraint(s) considered: Spare capacity on 33 kV interconnecting circuits between BSPs.

Option 4 – Active Network Management

Capacity Released for constraint(s) considered: Dependent on curtailment

Viable

Detailed description: Active Network Management (ANM) can be used to manage the export of generators onto the network such that some generation-driven overloads can be avoided. However, ANM would not relieve demand-driven thermal overloads or voltage constraints.

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

Option 5 – Procure flexibility at various Primary substations

Estimated Flexibility Required (MVA): N/A

Viable

Detailed description: Flexibility services could be procured to alleviate projected thermal overloads caused by demand. Voltage constraints and generation-driven thermal overloads cannot be resolved by existing flexibility services.

Solution Recommendation

It is recommended that Callington and Saltash Primary substations are redesigned to enable a future split of the 33 kV network fed from Landulph BSP and St Germans BSP, as discussed in Option 1. Re-profiling of the circuit between Landulph BSP and Callington Primary should be a priority and installation of reactive power compensation at Lifton Primary substation is recommended.

3.4 Circuit Overloads, Lost Load, Low Volts and High Volts on 33 kV ring fed from St Germans

Constraint Overview

Generation | Demand

The table below outlines the nature of the network constraints identified in the network analysis. The different constraints may be solved by combining the different solutions given.

Table 3.4.1 constraint(s) and condition under which constraint occurs

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
St Germans 7L5 to Liskeard 1L5 33 kV circuit thermal overload	Various arranged and fault outages, first occurring for a Reserve busbar fault at St Germans BSP	None	2034	2034	2034	2034
St Germans 6L5 to Liskeard 2L5 33 kV circuit thermal overload 2	Various arranged and fault outages, first occurring for a Main 1 or Main busbar fault as St Germans BSP	None	2028	2028	2028	-
St Germans 6L5 to Liskeard 2L5 33 kV circuit thermal overload 2	Various arranged and fault outages, first occurring for a Main 1 or Main busbar fault as St Germans BSP	None	-	-	-	2034
Lostwithiel 3L5 to Liskeard 4L5 thermal overload	Main 3 busbar fault at Looe Primary substation	None	2034	2034	2034	Baseline
Lanreath 2L3 to Lostwithiel 4L5 thermal overload	Busbar fault at Liskeard Primary substation	None	2028	2028	2028	Baseline
Lanreath to Looe 33 kV circuit thermal overload caused by Demand	Busbar fault at Liskeard Primary substation	None	Baseline	Baseline	Baseline	2034
Lanreath to Looe 33 kV circuit thermal overload caused by Generation	Busbar fault at Liskeard Primary substation	None	N/A	N/A	N/A	Baseline
Lost load at Liskeard (greater than 12 MW)	Busbar fault at Liskeard Primary substation	None	Baseline	2028	2028	2028
Lost load at Lostwithiel (greater than 12 MW)	Busbar fault at Lostwithiel Primary substation	None	2034	2034	-	-
Low Volts on 33 kV ring between Liskeard	Various arranged and fault	None	Baseline	Baseline	Baseline	Baseline

Primary substation and Looe Primary substation	outages, first occurring for a busbar fault at Liskeard Primary substation					
Low Volts on 33 kV ring between Liskeard Primary substation and Looe Primary substation	None	None	2028	2028	2028	2028
High volts on 33 kV ring between Liskeard Primary substation and Looe Primary substation	Various arranged and fault outages	None	-	-	-	2028

Uncertainty under other Distribution Future Energy Scenarios: Some of these constraint occurs under baseline, so there is no uncertainty about future forecasts. There is a risk that load reduces, however this is not forecast under any scenario so mitigation against this constraint is definitely required.

Solution Options

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

Table 3.4.2 solution options to solve constraint(s)

Solution Options	Description	Solves Constraint	Wider Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	✗	✗	✗	**Discounted**
Reinforcement					
1	Install new 33 kV circuits and de-load ring	✓	✓	✗	**Viable**
2	Re-conductor existing 33 kV circuits in ring and maintain running arrangement	✗	✗	✗	**Discounted**
3	Install new BSP near Lostwithiel	✓	✓	✓	**Viable**
4	Transfer load onto St Austell BSP under normal running conditions	✗	✗	✓	**Viable**
Operational Mitigation					
-	*None identified*	-	-	-	
Load Management Schemes					
5	Active Network Management	✗	✓	✓	**Viable**
Flexibility services					
6	Procure flexibility at Looe, Lanreath, Lostwithiel, St Neot and Liskeard Primary substations	✗	✓	✓	**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.

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

Option 1 – Install new 33 kV circuits and de-load ring

Capacity Released for constraint(s) considered: Up to 30.11 MVA **Viable**

Detailed description: Take Liskeard and Looe Primary substations out of ring and install two 33 kV circuits from St Germans BSP.

Significant reinforcement is recommended for the ring, regardless of the preferred option. This includes:

- Installation of circuit breaker 1S0 at Liskeard Primary substation to remove Lost Load constraint.
- Replace CTs to enable removal of the current transformer (CT) limitations of 200 A on circuits between Lostwithiel and Lanreath, Lostwithiel and Liskeard, Lanreath and Looe to help prevent thermal overloads on the ring.
- Re-building the 0.1 in^2 HDC 33 kV circuit between Lostwithiel and Liskeard with 200 mm^2 AAAC conductor to help prevent both Generation and Demand driven thermal overloads.
- Install 1S0 breaker at Lostwithiel to prevent lost load at Lostwithiel following a busbar fault of Main 1 or Main 2 busbars. In 2034, 13.18 MVA demand is projected which places Lostwithiel in Class C of supply according to EREC P2.

In Option 1, additional reinforcement is suggested:

- The circuit between Lostwithiel and Liskeard will be extended from Liskeard Primary substation to St Germans BSP. This solution requires building a new bay at St Germans BSP and approximately 7.70 km of 200 mm^2 AAAC conductor. It is proposed that the circuit runs electrically separate to Liskeard Primary substation such that Liskeard is not part of the ring. This will reduce the loading on the ring, as Liskeard is forecasted to have approximately 12 MW growth of generation and 16 MW growth of demand by 2034 compared to the DFES 2022 baseline figures.
- A new 33 kV circuit from St Germans BSP to Lanreath Primary substation. 200 mm^2 AAAC conductor is recommended to prevent projected thermal overloads and help prevent voltage constraints. A normal open point and auto-changeover scheme at Lanreath is recommended such that the circuit between Lanreath and Looe is normally open but will close following a voltage drop on the new circuit supplying Lanreath from St Germans BSP. This means that the 33 kV circuits between St Germans BSP and Looe Primary substation are normally only feeding Looe Primary substation.
- Install reactive compensation at the 11 kV bar at Lostwithiel Primary substation to help alleviate voltage constraints on the 33 kV network near Lostwithiel.

New limiting factor for constraint(s) considered: 33 kV circuits supplied by St Germans BSP into the ring.

Option 2 – Re-conductor existing 33 kV circuits in ring and maintain running arrangement

Capacity released for constraint(s) considered: Up to 18.09 MVA **Discounted**

Detailed description: This solution requires the recommended reinforcement covered in Option 1 as well as the following reinforcement.

- Re-build 33 kV circuits between Liskeard and St Germans with 150 mm^2 AAAC.
- Re-conductor 33 kV circuit between Lanreath and Lostwithiel with 150 mm^2 AAAC.
- Re-build the 33 kV circuit between Looe and Lanreath with 150 mm^2 AAAC.
- It is likely that reactive compensation will still be required at Lostwithiel to ensure that voltage stays within the statutory limits specified in the ESQCRs.

This solution is not expected to be viable as the forecasted load growth for the ring including Liskeard will exceed 40 MVA and the two 33 kV circuits cannot be re-conductored to achieve the necessary capacity.

New limiting factor for constraint(s) considered: 33 kV circuits between St Germans BSP and Liskeard Primary substation.

Option 3 – Install new BSP near Lostwithiel

Capacity Released for constraint(s) considered: 60 MVA **Viable**

Detailed description: A new BSP would help relieve the thermal and voltage constraints predicted for this 33 kV ring. Lostwithiel Primary substation is positioned geographically over 20 km away from St Germans BSP. A tee-off from the 'B' route 132 kV circuit is a possible option for an infeed into a new BSP. The BSP would initially consist of one Grid Transformer.

This option would have a wider benefit to the network as some load could be transferred away from St Austell BSP and St Germans BSP.

New limiting factor for constraint(s) considered: 33 kV circuits connected to new BSP.

Option 4 – Transfer load onto St Austell BSP under normal running conditions

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

Detailed description:

Recommended reinforcement as specified in Option 1 would be a pre-requisite for this solution.

Lostwithiel Primary substation could be transferred onto St Austell BSP however this would not relieve the constraint caused by Generation. Generation connected on the same ring as Lostwithiel could also be transferred onto St Austell BSP however this is not considered a valid long-term solution given that the GTs at St Austell BSP are forecasted to be constrained in 2034.

When the second GT at Landulph BSP is commissioned, there will be more capacity available at Landulph BSP however the firm capacity at Landulph BSP would be limited to the existing GT capacity (45 MVA). In addition, circuits between Landulph BSP and St Germans BSP would require reinforcement.

Installation of reactive compensation at Lostwithiel to ensure that voltage stays within the statutory limits specified in the Electricity Safety Quality and Continuity Regulations 2002 (ESQCRs) is recommended.

New limiting factor for constraint(s) considered: Spare capacity at St Austell BSP.

Option 5 – Active Network Management

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

Detailed description: Active Network Management (ANM) can be used to manage the export of generators onto the network such that some generation-driven overloads can be avoided. However, ANM would not relieve demand-driven thermal overloads or voltage constraints on the ring.

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

Option 6 – Procure flexibility at Looe, Lanreath, Lostwithiel, St Neot and Liskeard Primary substations

Estimated Flexibility Required (MVA): N/A **Viable**

Detailed description: Flexibility services could be procured to alleviate projected thermal overloads caused by demand. Voltage constraints and generation-driven thermal overloads cannot be resolved by existing flexibility services.

Solution Recommendation

It is recommended that Liskeard is taken off the ring by installing a 33 kV circuit that physically goes between St Germans and Liskeard, but is connected between St Neot and St Germans, as specified in Option 1. Removal of 200 A limitations should also be a priority as discussed in Option 1. Reactive compensation at Lostwithiel is also recommended. If projected load growth materialises, further reinforcement should be carried out, either as specified in Option 1 or Option 3.

3.5 Gunnislake Transformer Capacity

Constraint Overview

Generation | **Demand**

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

Table 3.5.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Warm	Int Cool	Summer
T1 thermal overload at Gunnislake Primary substation.	Arranged or fault outage causing T2 to be off supply.	None	Baseline	Baseline	Baseline	-
T2 thermal overload at Gunnislake Primary substation	Arranged outage of Gunnislake Main 2 busbar.	None	Baseline	Baseline	Baseline	-
T2 thermal overload at Gunnislake Primary substation	Arranged outages causing Gunnislake T1 to be off supply.	None	2028	2028	2028	-

Uncertainty under other Distribution Future Energy Scenarios: As this constraint occurs under baseline, there is no uncertainty about future forecasts. There is a risk that demand reduces, however this is not forecast under any scenario so mitigation against this constraint is definitely required.

Solution Options

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

Table 3.5.2 solution options to solve constraint(s)

Solution Options	Description	Solves Constraint	Wider Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Replace 5 MVA transformers with 7.5/15 MVA transformers	✓	✓	✓	Viable
Operational Mitigation					
2	Transfer demand to neighbouring Primary substations	×	×	×	Discounted
Load Management Schemes					
	None identified	-	-	-	-
Flexibility services					
3	Procure flexibility at Gunnislake Primary substation	✓	✓	✓	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.

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

Option 1 – Replace 5 MVA transformers with 7.5/15 MVA transformers

Capacity Released for constraint(s) considered: 10 MVA
Viable

Detailed description: Replace transformers at Gunnislake with 7.5/15 MVA transformers.

New limiting factor for constraint(s) considered: 7.5/15 MVA transformers at Gunnislake Primary substation.

Option 2 – Transfer demand to neighbouring Primary substations

Capacity Released for constraint(s) considered: None
Discounted

Detailed description: Demand would need to be fed from neighbouring Primary substations under intact network conditions as overloads are forecast for first circuit fault conditions. By transferring demand to nearby Primary substations, overloads on the transformers could be avoided however demand growth is expected at nearby Primary substations and therefore there is unlikely to be capacity at them to enable this to be a long term solution.

New limiting factor for constraint(s) considered: 5 MVA transformers at Gunnislake Primary substation.

Option 3 – Procure flexibility at Gunnislake Primary substation

Estimated Flexibility Required (MVA): 1.75 MVA +
Viable

Detailed description: Flexibility services could be procured to alleviate projected thermal overloads caused by demand. As demand increases, more flexibility services will be required. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

If unable to procure sufficient flexibility, replace existing transformers with 7.5/15 MVA transformers at Gunnislake Primary substation.

3.6 Saltash Whity Cross Transformer Capacity

Constraint Overview

Generation | **Demand**

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

Table 3.6.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Warm	Int Cool	Summer
T1 thermal overload at Saltash Whity Cross Primary substation	Arranged or fault outage causing T2 to be off supply.	None	2034	2034	2034	2034
T2 thermal overload at Saltash Whity Cross Primary substation	Arranged or fault outage causing T1 to be off supply.	None	2034	2034	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: Under the Leading the Way scenario, this constraint is forecasted to occur in 2029. Under the Falling Short scenario, the constraint is forecasted to occur later than 2035.

Solution Options

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

Table 3.6.2 solution options to solve constraint(s)

Solution Options	Description	Solves Constraint	Wider Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Replace 5/6.25 MVA transformers with 12/24 MVA transformers	✓	✓	✓	Viable
Operational Mitigation					
2	Transfer demand to neighbouring Primary substations	×	×	×	Discounted
Load Management Schemes					
	None identified	-	-	-	-
Flexibility services					
3	Procure flexibility at Saltash Whity Cross Primary substation	✓	✓	✓	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.

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

Option 1 – Replace 5/6.25 MVA transformers with 12/24 MVA transformers

Capacity Released for constraint(s) considered: Up to 17.75 MVA — Viable

Detailed description: Replace transformers at Saltash Whity Cross Primary substation with 12/24 MVA units. The recommended size for the new units is recommended due to the DFES 2022 Best View projection of 20.26 MW demand at Saltash Whity Cross Primary substation in 2045.

New limiting factor for constraint(s) considered: 12/24 MVA transformers at Saltash Whity Cross Primary substation.

Option 2 – Transfer demand to neighbouring Primary substations

Capacity Released for constraint(s) considered: None — Discounted

Detailed description: Demand would need to be fed from neighbouring Primary substations under intact network conditions as overloads are forecast for a first circuit fault conditions. By transferring demand to nearby Primary substations, overloads on the transformers could be avoided however demand growth is expected at nearby Primary substations and therefore it is unlikely that there is sufficient capacity at Primary substations to enable this to be a long term solution.

New limiting factor for constraint(s) considered: N/A (still the transformers at the same rating)

Option 3 – Procure flexibility at Saltash Whity Cross Primary substation

Estimated Flexibility Required (MVA): 6.10 MVA + — Viable

Detailed description: Flexibility services could be procured to alleviate projected thermal overloads caused by demand. As demand increases, more flexibility services will be required. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

If unable to procure sufficient flexibility, replace existing transformers with 12/24 MVA transformers at Saltash Whity Cross Primary substation.

3.7 Liskeard Transformer Capacity

Constraint Overview

Generation | **Demand**

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

Table 3.7.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Warm	Int Cool	Summer
T1 thermal overload at Liskeard Primary substation	Arranged or fault outage causing T2 to be off supply.	None	2034	2034	2034	N/A
T2 thermal overload at Liskeard Primary substation	Arranged or fault outage causing T1 to be off supply.	None	2034	2034	2034	N/A

Uncertainty under other Distribution Future Energy Scenarios: Under the Leading the Way scenario, this constraint is forecasted to occur in 2032. Under the Falling Short scenario, the constraint is forecasted to occur later than 2034.

Solution Options

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

Table 3.7.2 solution options to solve constraint(s)

Solution Options	Description	Solves Constraint	Wider Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Replace 12/24 MVA transformers with 20/40 MVA transformers	✓	✓	✓	Viable
Operational Mitigation					
2	Transfer demand to neighbouring Primary substations	×	×	×	Discounted
Load Management Schemes					
	None identified	-	-	-	-
Flexibility services					
3	Procure flexibility at Liskeard Primary substation	✓	✓	✓	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.

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

Option 1 – Replace 12/24 MVA transformers with 20/40 MVA transformers

Capacity Released for constraint(s) considered: 16 MVA **Viable**

Detailed description: Replace transformers at Liskeard Primary substation with 20/40 MVA units.

The 33 kV circuits between St Germans BSP and Liskeard Primary substation should be re-conductored and re-profiled appropriately. The 150 mm^2 33 kV circuit from St Germans 6L5 to Liskeard 2L5 should be re-profiled and the CT limitation of 440 Amps removed. The 0.15 in^2 HDC circuit between St Germans 7L5 and Liskeard 1L5 should be re-conductored with 150 mm^2 AAAC conductor. This will enable the new transformers to be utilised up to their capacity.

New limiting factor for constraint(s) considered: 33 kV circuit infeeds to Liskeard Primary substation

Option 2 – Transfer demand to neighbouring Primary substations

Capacity Released for constraint(s) considered: None **Discounted**

Detailed description: Demand would need to be fed from neighbouring Primary substations under intact network conditions as overloads are forecast for a first circuit fault conditions. However, neighbouring Primary substations are not forecasted to have sufficient capacity to de-load Liskeard to prevent overloads on the transformers.

New limiting factor for constraint(s) considered: 12/24 MVA transformers ta Liskeard Primary substation.

Option 3 – Procure flexibility at Liskeard Primary substation

Estimated Flexibility Required (MVA): 5.49 MVA + **Viable**

Detailed description: Flexibility services could be procured to alleviate projected thermal overloads caused by demand. As demand increases, more flexibility services will be required. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

If unable to procure sufficient flexibility, work should be carried out to replace existing transformers with 20/40 MVA transformers at Liskeard Primary substation. These transformers may be replaced due to their age within the next 10 years. If the transformers are not replaced, a new Primary substation could be built near Liskeard and new circuits installed to feed the substation to de-load Liskeard Primary substation.

3.8 Callington Transformer Capacity

Constraint Overview

Generation | Demand

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

Table 3.8.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Warm	Int Cool	Summer
T1 thermal overload at Callington Primary substation	Arranged outage causing T2 to be off supply.	None	-	-	2034	-
T2 thermal overload at Callington Primary substation	Arranged or fault outage causing T1 to be off supply.	None	-	-	2034	-

Uncertainty under other Distribution Future Energy Scenarios: Under the Leading the Way scenario, this constraint is forecasted to occur in 2033. Under the Falling Short scenario, the constraint is forecasted to occur later than 2035.

Solution Options

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

Table 3.8.2 solution options to solve constraint(s)

Solution Options	Description	Solves Constraint	Wider Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Replace 7.5/15 MVA transformers with 12/24 MVA transformers.	✓	✓	✓	Viable
Operational Mitigation					
2	Reconfigure 11 kV network	✓	✓	✓	Viable
3	Limit outage window	✓	✓	✓	Viable
Load Management Schemes					
	None identified	-	-	-	-
Flexibility services					
4	Procure flexibility at Callington Primary substation	✓	✓	✓	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.

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

Option 1 – Replace 7.5/15 MVA transformers with 12/24 MVA transformers

Capacity Released for constraint(s) considered: Up to 9 MVA

Viable

Detailed description:

Replace transformers at Callington Primary substation with 12/24 MVA units.

New limiting factor for constraint(s) considered: 33 kV circuit infeeds to Callington Primary substation.

Option 2 – Reconfigure 11 kV network

Capacity Released for constraint(s) considered: None

Viable

Detailed description:

Reconfigure 11 kV network to transfer load away from Callington Primary for arranged outages. This constraint only occurs following an arranged outage and can be avoided by transferring demand normally fed by Callington Primary substation to other Primary substations.

New limiting factor for constraint(s) considered: 7.5/15 MVA transformers at Callington Primary substation.

Option 3 – Limit outage window

Capacity Released for constraint(s) considered: None

Viable

Detailed description:

This constraint is only forecasted to occur during the Intermediate Cool season and therefore can be avoided by taking the arranged outage at a different point during the year.

New limiting factor for constraint(s) considered: 7.5/15 MVA transformers at Callington Primary substation.

Option 4 – Procure flexibility at Callington Primary substation

Estimated Flexibility Required (MVA): 0.30 MVA

Viable

Detailed description: Flexibility services could be procured to alleviate projected thermal overloads caused by demand. As demand increases, more flexibility services will be required. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

Option 2 and Option 3 can be combined such that the outage is taken only outside of the Intermediate Cool months and overall demand fed from Callington is reduced when compared to the normal 11 kV arrangement.

3.9 Looe Transformer Capacity

Constraint Overview

Generation | **Demand**

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

Table 3.9.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Warm	Int Cool	Summer
T1 thermal overload at Looe Primary substation	Arranged outage causing T2 to be off supply.	None	-	2034	2034	-
T2 thermal overload at Looe Primary substation	Arranged outage causing T1 to be off supply.	None	-	2034	2034	-

Uncertainty under other Distribution Future Energy Scenarios: Under the Leading the Way scenario, this constraint is forecasted to occur in 2031. Under the Falling Short scenario, the constraint is forecasted to occur later than 2035.

Solution Options

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

Table 3.9.2 solution options to solve constraint(s)

Solution Options	Description	Solves Constraint	Wider Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	✗	✗	✗	Discounted
Reinforcement					
1	Replace 7.5/15 MVA transformers with 12/24 MVA transformers	✓	✓	✓	Viable
Operational Mitigation					
2	Reconfigure 11 kV network to transfer load away from Looe Primary for arranged outages	✓	✓	✓	Viable
3	Limit outage window	✓	✓	✓	Viable
Load Management Schemes					
	None identified	-	-	-	-
Flexibility services					
4	Procure flexibility at Looe Primary substation	✓	✓	✓	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.

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

Option 1 – Replace 7.5/15 MVA transformers with 12/24 MVA transformers

Capacity Released for constraint(s) considered: Viable

Detailed description:

Replace transformers at Looe Primary substation with 20/40 MVA units.

New limiting factor for constraint(s) considered: Circuit infeeds to Looe Primary substation.

Option 2 – Reconfigure 11 kV network to transfer load away from Looe Primary for arranged outages.

Capacity Released for constraint(s) considered: None Viable

Detailed description:

This constraint only occurs following an arranged outage and can be avoided by transferring demand normally fed by Looe Primary substation to other Primary substations.

New limiting factor for constraint(s) considered: N/A (still the transformers at the same rating)

Option 3 – Limit outage window

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

Detailed description:

This constraint is only forecasted to occur during the Intermediate Cool and Intermediate Warm seasons and therefore can be avoided by taking the arranged outage at a different point during the year.

New limiting factor for constraint(s) considered: N/A (still the transformers at the same rating)

Option 4 – Procure flexibility at Looe Primary substation

Estimated Flexibility Required (MVA): 0.71 MVA Viable

Detailed description: Flexibility services could be procured to alleviate projected thermal overloads caused by demand. As demand increases, more flexibility services will be required. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

Option 2 and Option 3 can be combined such that the outage is taken only during the summer months and overall demand fed from Looe is reduced when compared to the normal 11 kV arrangement.

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