Paignton BSP and Associated 33 kV Network

Network Development Report – South West

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Electricity Distribution

nationalgrid

Contents

Paignton BSP and Associated 33 kV Network

1. Network Overview

Paignton Bulk Supply Point (BSP) supplies a mixture of urban and rural sections of 33 kV network, in South Devon. It is supplied from two 60/90 MVA 132/33 kV GTs connected to the R-route 132 kV circuit which forms part of the interconnection between Abham and Exeter Grid Supply Points (GSP). Paignton BSP feeds approximately 47,300 customers.

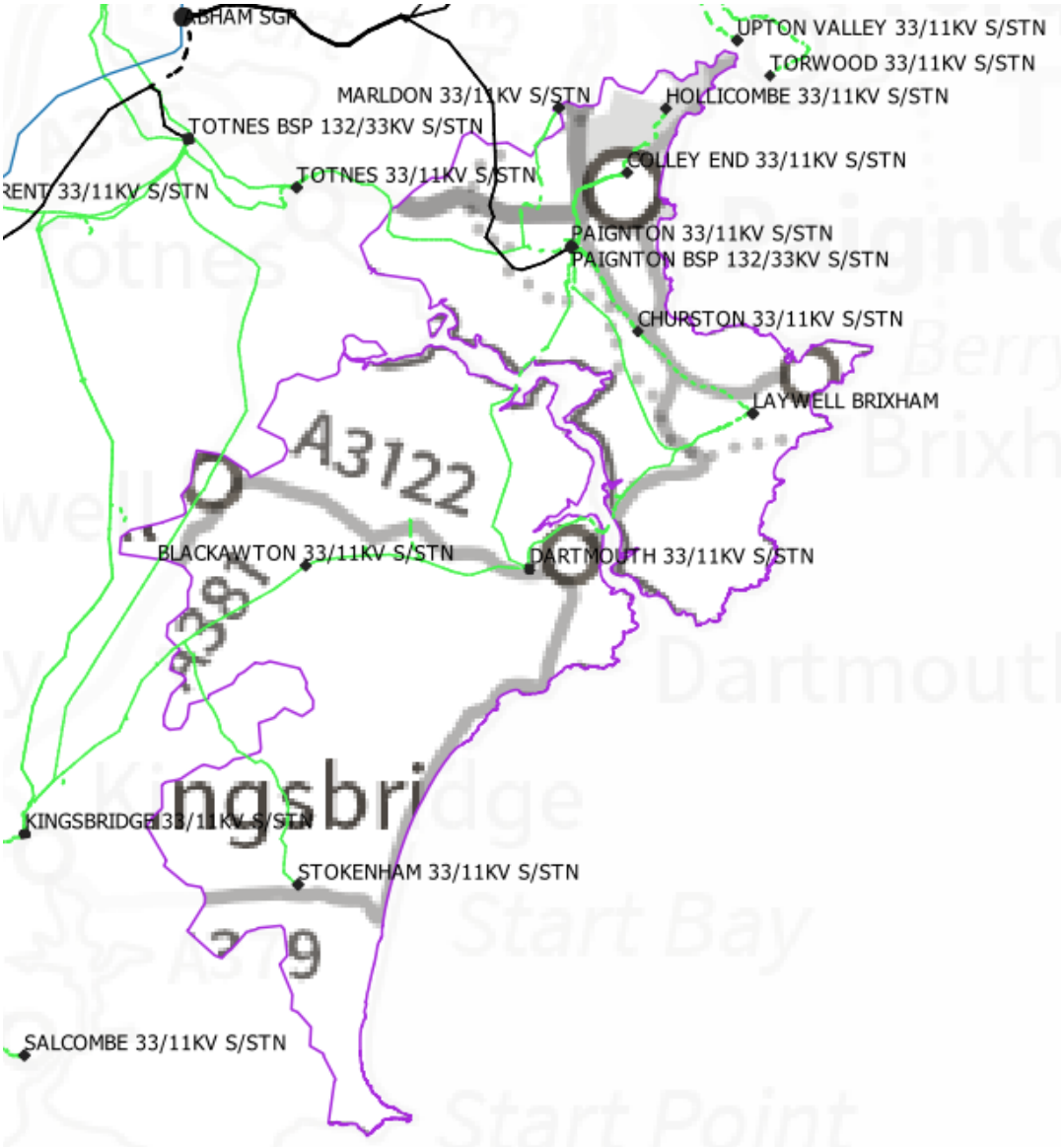

Figure 1.1 Paignton BSP geographic network coverage

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 and 132/33 kV transformers which supply Paignton 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 Paignton BSP network is arranged as follows:

- Paignton, Colley End, Hollicombe & Churston Primaries are each supplied via two transformer feeders.
- A 33 kV ring supplying Laywell Brixham, Dartmouth, Blackawton and Stokenham Primaries, along with connections to a 33kV demand customer and three 33 kV connected generators and normally open 33 kV interconnection with Totnes BSP teed off the Totnes-Salcombe circuit.
- A 33 kV circuit providing interconnection with Totnes BSP with a tee-off to a single transformer Primary at Marldon which is normally run open on circuit breaker 4L5 at Paignton.

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 arranged outage on either 33 kV busbar at Paignton the normal open point on 6L5 near Slade Farm is moved to isolator 2L3 at Blackawton, which transfers the demand at Blackawton and Stokenham to Totnes BSP.
- For an arranged outage of either grid transformer at Paignton, the normal open point on 6L5 near Slade Farm is moved to 4L5 at Dartmouth which transfers the demand at Blackawton and Stokenham along with two 33 kV connected generators to Totnes BSP.
- Curtailment of 33 kV connected generators within the group are modelled are a variety of arranged outages, as outlined in customer connection agreements.

2. Network Constraints and Solution Options

2.1 Summary of Network Constraints

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

- Paignton BSP 132/33 kV Grid Transformer overloads
- Churston 33/11 kV T1 & T2 overloads
- Hollicombe 33/11 kV T1 & T2 overloads
- Colley End 33/11 kV T2 overload
- Laywell 33/11 kV T1 overload
- Paignton BSP to Laywell 33 kV circuit overloads

3. Network Constraint Details and Solution Options

3.1 Paignton BSP 132/33 kV GT Overloads

Generation | Demand

Constraint Overview

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

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
Paignton GT1 overload	Paignton GT2 fault	None	2032	2032		2030
Paignton GT2 overload	Paignton GT1 fault	None	2032	2032		2030

Uncertainty under other Distribution Future Energy Scenarios: Constraints may be triggered earlier for higher growth scenarios

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	Up-grade transformer (DOC) protection to increase the reverse powerflow rating	✓	×	✓	Viable
2	Application of an increased rating following checks on ancillaries	✓	×	✓	Viable
Operational Mitigation					
-	*None Identified*	-	-	-	-
Load Management Schemes					
-	*None Identified*	-	-	-	-
Flexibility services					
3	Procure flexibility under Paignton BSP at 33 kV or below	✓	✓	✓	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 Distribution Network Operator (DNO) to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the Distribution System OperatorDSO as part of the Distribution Network Options Assessment (DNOA) process.

Option 1 – Upgrade transformer (DOC) protection to increase the reverse powerflow rating

Capacity released for constraint(s) considered: TBC

Viable

Detailed description: Uprate the existing GTs at Paignton via use of cyclic ratings in accordance with British Standard 171/IEC60076 and NGED Standard Technique SD8C. This requires a capability assessment of all ancillaries, such as busbars, isolators, CTs, cables (including cabling within the substation), switchgear, tap changer, transformer bushings, conservator and earthing transformer. In addition, an assessment of the cyclic profile of the load is required to determine if transformer temperature and ageing is within acceptable limits.

New limiting factor for constraint(s) considered: TBC

Option 2 – Application of an increased rating following checks on ancillaries

Capacity released for constraint(s) considered: 24 MVA (Winter cyclic)

Viable

Detailed description: Uprate the existing GTs at Paignton via use of cyclic ratings in accordance with British Standard 171/IEC60076 and NGED Standard Technique SD8C. This requires a capability assessment of all ancillaries, such as busbars, isolators, CTs, cables (including cabling within the substation), switchgear, tap changer, transformer bushings, conservator and earthing transformer. In addition, an assessment of the cyclic profile of the load is required to determine if transformer temperature and ageing is within acceptable limits.

New limiting factor for constraint(s) considered: 114 MVA (2000A 33 kV circuit breaker).

Option 3 – Procure flexibility under Paignton BSP at 33 kV or below

Flexibility service type: Generation turn up/demand turn down

Detailed description: Flexibility services could be procured to alleviate projected overloads (during peak demand conditions) seen on the Grid Transformers at Paignton. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

It is recommended to up-grade the transformer (DOC) protection to increase the reverse powerflow rating of both grid transformers at Paignton BSP (Option 1) by 2030. In addition to undertake n assessment using NGED Standard Technique SSD8C to achieve the full rating of the grid transformers (Option 2) by 2032.

3.2 Churston T1 & T2 Overloads

Generation | Demand

Constraint Overview

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

Table 3.2.1 constraint(s) and condition under which constraint occurs

Constraint	N-1 Condition	Subsequent N-2 Condition	First year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Churston T1 overload	Churston T2 or Paignton 9L5 circuit outage	None	2028	2028	2030	
Churston T2 overload	Churston T1 or Paignton 8L5 circuit outage	None	2028	2028	2030	

Uncertainty under other Distribution Future Energy Scenarios: Constraints may be triggered earlier for higher growth scenarios

Solution Options

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

Table 3.2.2 solution options to solve constraint(s)

Solution Options	Description	Solves Constraint	Wider Area Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Review transformer ratings	✓	×	✓	Viable
2	Replace transformers with larger units	✓	×	✓	Viable
Operational Mitigation					
-	*None Identified*	-	-	-	-
Load Management Schemes					
-	*None Identified*	-	-	-	-
Flexibility services					
3	Procure flexibility under Churston at 11 kV or below	✓	×	✓	Viable

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Review transformer ratings

Capacity released for constraint(s) considered: Subject to review

Viable

Detailed description: Overloads do not occur until 2028. It is therefore possible that this constraint could be delayed slightly by reviewing NGED's internal policy regarding transformer ratings, which does not currently distinguish between summer and intermediate cool ratings (which may be overly pessimistic). This solution is dependent on an internal review and would not be a long term solution.

New limiting factor for constraint(s) considered: Subject to review

Option 2 – Replace transformers with larger units

Capacity released for constraint(s) considered: TBC

Viable

Detailed description: Replace transformers with larger units (12/24 MVA).

New limiting factor for constraint(s) considered: TBC

Option 3 – Procure flexibility under Churston at 11 kV or below

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

Viable

Detailed description: Flexibility services could be procured to alleviate projected overloads seen on the transformers at Churston. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

It is recommended that a review of NGED's internal policy regarding transformer ratings is undertaken (Option 1) and in the longer term if necessary to replace the transformers (Option 2).

3.3 Hollicombe T1 & T2 overloads

Generation **Demand**

Constraint Overview

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

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

Constraint	N-1 Condition	Subsequent N-2 Condition	First year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Hollicombe T1 overload	Hollicombe T2 or Paignton 9L5 outage	None	2028	2028	2030	-
Hollicombe T2 overload	Hollicombe T1 or Paignton 8L5 outage	None	2028	2028	2030	-

Uncertainty under other Distribution Future Energy Scenarios: Constraints may be triggered earlier for higher growth scenarios

Solution Options

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

Table 3.3.2 solution options to solve constraint(s)

Solution Options	Description	Solves Constraint	Wider Area Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	**Discounted**
Reinforcement					
1	Review transformer ratings	✓	×	✓	**Viable**
2	Replace transformers with larger units	✓	×	×	**Viable**
Operational Mitigation					
-	*None Identified*	-	-	-	-
Load Management Schemes					
-	*None Identified*	-	-	-	-
Flexibility services					
3	Procure flexibility under Hollicombe at 11 kV or below	✓	✓	✓	**Viable**

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Review transformer rating

Capacity released for constraint(s) considered: TBC

Viable

Detailed description: Overloads do not occur until 2028. It is therefore possible that this constraint could be delayed slightly by reviewing NGED's internal policy regarding transformer ratings, which does not currently distinguish between summer and intermediate cool ratings (which may be overly pessimistic). This solution is dependent on an internal review and would not be a long term solution.

New limiting factor for constraint(s) considered: TBC

Option 2 – Replace transformers with larger units

Capacity released for constraint(s) considered: TBC

Viable

Detailed description: Replace transformers with larger units (12/24 MVA).

New limiting factor for constraint(s) considered: TBC

Option 3 – Procure flexibility under Hollicombe at 11 kV or below

Flexibility service type: Generation turn up/demand turn down

Viable

Detailed description: Flexibility services could be procured to alleviate projected overloads during any fault/outage resulting in a Hollicombe transformer or circuit being out of service. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

It is recommended that a review of NGED's internal policy regarding transformer ratings is undertaken (Option 1) and in the longer term if necessary to replace the transformers (Option 2)

3.4 Colley End T1 & T2 Overloads

Generation **Demand**

Constraint Overview

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

Table 3.4.1 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
Colley End T1 overload	Colley End T2 or Paignton 5L5 circuit outage	None	2030	2032	2034	-
Colley End T2 overload	Colley End T1 or Paignton 2L5 circuit outage	None	2030	2032	2034	-

Uncertainty under other Distribution Future Energy Scenarios: Constraints may be triggered earlier for higher growth scenarios

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 Area Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Review transformer ratings	✓	×	✓	Viable
2	Replace transformers with larger units	✓	×	×	Viable
Operational Mitigation					
-	*None Identified*	-	-	-	-
Load Management Schemes					
-	*None Identified*	-	-	-	-
Flexibility services					
3	Procure flexibility under Colley End at 11 kV or below	✓	×	✓	Viable

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Review Transformer rating

Capacity released for constraint(s) considered: TBC

Viable

Detailed description: Overloads do not occur until 2030. It is therefore possible that this constraint could be delayed slightly by reviewing NGED's internal policy regarding transformer ratings, which does not currently distinguish between summer and intermediate cool ratings (which may be overly pessimistic). This solution is dependent on an internal review and would not be a long term solution.

New limiting factor for constraint(s) considered: TBC

Option 2 – Replace transformers with larger units

Capacity released for constraint(s) considered: TBC

Viable

Detailed description: Replace transformers with larger units (12/24 MVA).

New limiting factor for constraint(s) considered: TBC

Option 3 – Procure flexibility under Colley End at 11 kV or below

Flexibility service type: Generation turn up/demand turn down

Viable

Detailed description: Flexibility services could be procured to alleviate projected overloads during any fault/outage resulting in a Colley End transformer or circuit being out of service. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

It is recommended that a review of NGED's internal policy regarding transformer ratings is undertaken (Option 1) and in the longer term if necessary to replace the transformers (Option 2).

3.5 Laywell 33/11 kV transformer Overloads

Constraint Overview

Generation Demand

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

Table 3.5.1 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
Laywell T1 overload	Laywell T2 outage	None	-	2034	-	-
:Laywell T2 overload	Laywell T1 outage	None	-	2034	-	-

Uncertainty under other Distribution Future Energy Scenarios: Constraints may be triggered earlier for higher growth scenarios

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 Area Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Review transformer ratings	✓	×	✓	Viable
2	Replace transformers with larger units	×	×	×	Viable
Operational Mitigation					
-	*None Identified*	-	-	-	-
Load Management Schemes					
-	*None Identified*	-	-	-	-
Flexibility services					
3	Procure flexibility under Laywell at 11 kV or below	✓	✓	✓	Viable

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Review transformer ratings

Capacity released for constraint(s) considered: TBC

Viable

Detailed description: Overloads do not occur until 2034. It is therefore possible that this constraint could be delayed slightly by reviewing NGED's internal policy regarding transformer ratings, which does not currently distinguish between summer and intermediate cool ratings (which may be overly pessimistic). This solution is dependent on an internal review and would not be a long term solution.

New limiting factor for constraint(s) considered: TBC

Option 2 – Replace transformers with larger units

Capacity released for constraint(s) considered: TBC

Viable

Detailed description: Replace transformers with larger units (12/24 MVA).

New limiting factor for constraint(s) considered: TBC

Option 3 – Procure flexibility under Laywell at 11 kV or below

Flexibility service type: Generation turn up/demand turn down

Viable

Detailed description: Flexibility services could be procured to alleviate projected overloads seen on the transformers at Laywell. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

It is recommended that a review of NGED's internal policy regarding transformer ratings is undertaken (Option 1) and in the longer term if necessary to replace the transformers (Option 2).

3.6 Paignton BSP to Laywell 33 kV circuit Overloads

Generation Demand

Constraint Overview

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

Table 3.6.1 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
Paignton BSP (6L5) to Laywell (1L5) 33 kV circuit	Paignton 33 kV Main 2 busbar fault	None	2025	2028	2030	-

Uncertainty under other Distribution Future Energy Scenarios: Constraints may be triggered earlier for higher growth scenarios

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 Area Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	Discounted
Reinforcement					
1	Reconductor circuit with larger conductor (150 sq.mm Cu or 200 sq.mm Al Alloy) and replace 400 A isolator	✓	×	×	Viable
Operational Mitigation					
-	*None Identified*	-	-	-	
Load Management Schemes					
-	*None Identified*	-	-	-	
Flexibility services					
2	Procure flexibility under Laywell or Dartmouth at 11 kV or below	✓	×	✓	Viable

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Reinforce existing 33 kV circuit

Capacity released for constraint(s) considered: 2.3 MVA

Viable

Detailed description: Re-conductor the existing circuits with larger conductor (150 sq.mm Cu or 200 sq.mm All Aluminium Alloy Conductor (AAAC)) and replace 400 A isolator.

New limiting factor for constraint(s) considered: 440 A (Current Transformer (CT) rating)

Option 2 – Procure flexibility under Laywell or Dartmouth at 11 kV or below

Flexibility service type: Generation turn up or demand turn down

Viable

Detailed description: Flexibility services could be procured to alleviate projected overloads seen on the Paignton BSP (6L5) to Laywell 33 kV circuit. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

It is recommended to re-conductor the overhead sections of the Paignton BSP (6L5) to Laywell 33 kV circuit and replace a 400 A isolator (Option 1).

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