# Bowhays Cross BSP and Associated 132kV Network

Network Development Report – South West

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Electricity Distribution

nationalgrid

# Contents

# Bowhays Cross BSP and Associated 132kV Network

## 1. Network Overview

Bowhays Cross Bulk Supply Point (BSP) supplies a mostly rural area of 33 kV network, with the bulk of the demand centred around Williton and Watchet (supplied by Bowhays Cross primary), Minehead (supplied by Alcombe and Pertion primaries), Holford, Luckwell Bridge and Wiveliscombe. The BSP is supplied from two 132/33 kV GTs at Bowhays Cross BSP, fed via two 132kV circuits from Bridgwater Grid Supply Point (GSP). Bowhays Cross BSP supplies approximately 21,000 customers.

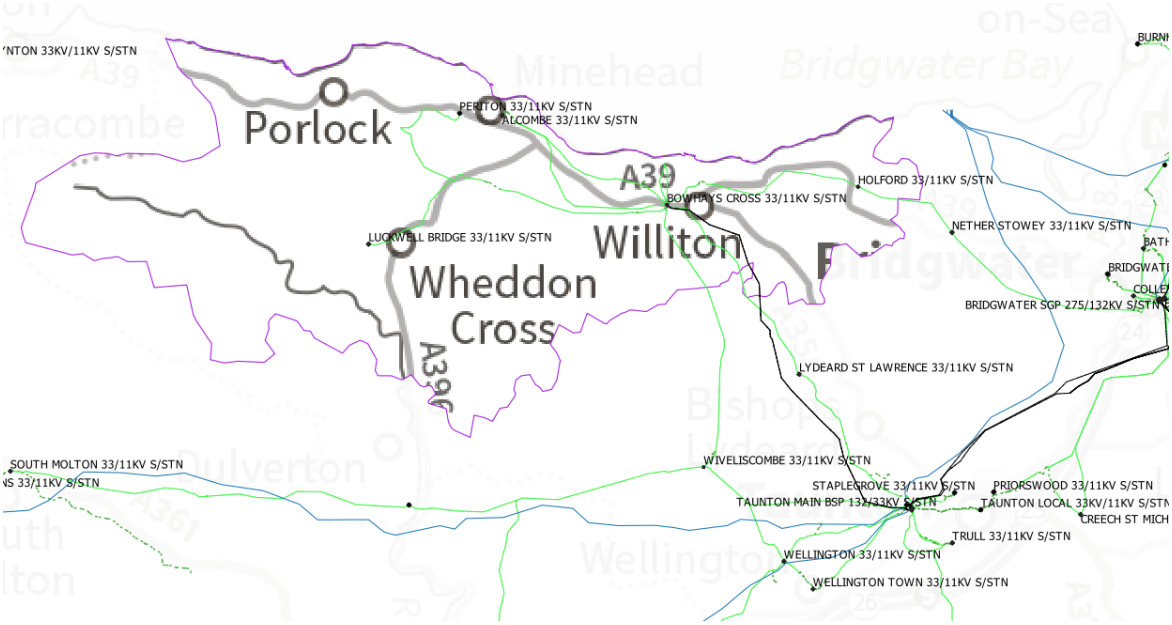


*Figure 1.1 Bowhays Cross BSP geographic network coverage*

This report discusses all existing and future network constraints over a 0-10 year horizon associated with the 33/11kV transformers, 33kV circuits, 132/33kV transformers and 132kV circuits which supply and are supplied by Bridgwater BSP. This uses the methodology outlined in the Network Development Plan Methodology Report with Network Operability Modelling applied as outlined below.

For the purposes of this analysis the NGED Best View Distribution Future Energy Scenario (DFES) has been used to study the years 2022 (baseline), 2028 and 2034, with consideration given to how proposals could change under the other scenarios. The two most onerous half-hours have been studied for each of the five representative days considered: Winter Peak Demand, Intermediate Warm Peak Demand, Intermediate Cool Peak Demand, Summer Peak Demand and Summer Peak Generation.

## 1.1 Network Topology

The Bowhays Cross BSP network is arranged as follows:

- GT1 and GT2 run in parallel supplying a two-section indoor 33kV switchboard. The 132kV sides of these GTs are supplied by two 132kV circuits from Taunton GSP.
- Bowhays Cross Local Primary is supplied via two 33kV circuits from Bowhays Cross BSP and is located within the same site as the BSP.
- Luckwell Bridge and Periton Primary substations are single transformer primary substations supplied on the same single 33kV circuit from Bowhays Cross BSP.
- Alcombe Primary has two primary transformers supplied by two 33kV circuits. There is an 11kV interconnection between Alcombe and Periton Primary substations which parallels the two substations via the 11kV under normal running.
- Holford Primary substation is a single transformer primary supplied by a single 33kV circuit. The circuit continues past Holford where there is a normal open point at Nether Stowey separating the circuit which continues on to Bridgwater BSP.
- Nether Stowey is normally fed from Bridgwater BSP but is supplied by Bowhays Cross BSP in the event of a fault/outage.
- There is a normal open point at Wiveliscombe Primary which is normally fed from Bowhays Cross BSP but is supplied from Taunton BSP via Exebridge and Wellington in the event of a fault/outage.
- There is a normal open point at Lydeard St Lawrence which is normally supplied from Taunton BSP but is supplied from Bowhays Cross BSP in the event of a fault/outage.

## 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.

- Nether Stowey 2T0 breaker closed to supply Nether Stowey via Bowhays Cross BSP 4L5 circuit for a fault/outage affecting T1 or the supplying 33kV circuit from Bridgwater BSP.
- Wiveliscombe 2T0 breaker closed to supply Wiveliscombe via Taunton BSP 2L5 circuit for a fault/outage affecting T1 or the supplying 33kV circuit from Bowhays Cross BSP.
- Lydeard St Lawrence 2T0 breaker closed to supply Lydeard St Lawrence via Bowhays Cross BSP 5L5 circuit for a fault/outage affecting T1 or the supplying 33kV circuit from Taunton BSP.
- Various winter arranged outages not permitted due to SCO overloads.
- Various SCO overloads solved by network reconfiguration for arranged outages.
- For the loss of an infeed to a transformer at any of the primaries fed from Bowhays Cross BSP under arranged outages, the lower voltage side circuit breaker is opened to prevent back-energisation.

## 2. Summary of Network Constraints

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

- Bowhays Cross GT overloads
- Bowhays Cross T1 and T2 overloads
- Bowhays Cross to Alcombe 33kV circuit overload (3L5 circuit)
- Periton T1 overload
- Alcombe T1 overload
- Luckwell Bridge T1 overload
- Luckwell Bridge Transformer primary 11kV backfeed overloads and low voltage on 11kV network

# 3. Network Constraint Details and Solution Options

## 3.1 Bowhays Cross BSP GT Overload and Bowhays Cross Primary Transformer Overload (uprate via application of cyclic rating)

### Constraint Overview

Generation Demand

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

*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 |
| Bowhays Cross BSP GT1/GT2 overload | Bowhays Cross GT1/GT2 fault | None | 2032 | 2033 | 2034 | 2034 |
| Bowhays Cross Primary T1/T2 overloads | Bowhays Cross T1/T2 faults | None | 2031 | 2032 | 2033 | 2033 |

**Uncertainty under other Distribution Future Energy Scenarios:** Bowhays Cross BSP GT overloads are predicted to arise in 2031 under Leading the Way Scenario, and under Falling Short in 2038. Bowhays Cross Primary Transformer Overloads are predicted to arise in 2030 under Leading the Way Scenario, and under Falling Short in 2037.

### Solution Recommendation

Uprate the existing transformers at Bowhays Cross BSP and Bowhays Cross Primary 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.

## 3.2 Alcombe and Periton Primaries transformer and circuit 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 winter peak demand.

*Table 3.2.1 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 |
| Periton to Alcombe 11kV circuit overload | Bowhays Cross Main 2 busbar fault | None | Baseline | Baseline | Baseline | Baseline |
| Periton T1 overload | Alcombe T1/T2 arranged outage | Alcombe T1/T2 fault | Baseline | Baseline | Baseline | Baseline |
| Bowhays Cross to Alcombe 33kV circuit overload (3L5 circuit) | Bowhays Cross Main 2 busbar fault | None | 2032 | 2032 | 2033 | 2033 |
| Alcombe T1 overload | Bowhays Cross Main 2 busbar fault | None | 2032 | 2032 | 2032 | 2032 |

**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. It is possible that the constraints forecast to occur in 2032 do not materialise, however, these constraints are all related and it is therefore proposed to solve them through a common solution.

### Solution Recommendation

It is recommended that the Periton and Alcombe 11kV group is split by opening the 11kV circuit which is run normally closed to parallel Alcombe and Periton (PERI5 - ALCO5 L1). This mitigates the constraints described above as there is no parallel for the Bowhays Cross Main 2 busbar fault and Alcombe can be supported by one of the two transformers on site without the need for support from Periton via the 11kV parallel.

This will require an assessment of the 11kV backfeed which supplies Periton Primary in the event of a fault/outage of the single primary transformer at Periton to ensure an appropriate automated switching scheme is applied to restore Periton.

## 3.3 Luckwell Bridge 11kV backfeed and transformer overload

### Constraint Overview

Generation | **Demand**

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

*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 |
| 11kV backfeed overloads and low voltage on 11kV network | Luckwell Bridge T1 fault | None | Baseline | Baseline | Baseline | Baseline |
| Luckwell Bridge T1 overload | None (intact) | None | 2030 | 2031 | 2032 | 2032 |

### 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 | Install additional primary transformer (Luckwell Bridge T2) and 33kV circuit | ✓ | ✓ | ✓ | **Viable** |
| 2 | Install additional 11kV circuits/reinforce circuits for 11kV backfeed | ✓ | ✓ | ✓ | **Viable** |
| 3 | Combination of 11kV and 33kV reinforcement | ✓ | ✓ | ✓ | **Viable** |
| **Operational Mitigation** | | | | | |
| - | *None Identified* | - | - | - | - |
| **Load Management Schemes** | | | | | |
| - | *None Identified* | - | - | - | - |
| **Flexibility services** | | | | | |
| 4 | Procure flexibility on overloaded feeders under backfeed conditions | ✓ | ✓ | ✓ | **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 and voltage drop for the conditions described above. This would lead to an inability to meet the Security of Supply requirements of Engineering Recommendation P2 and statutory voltage limits for Luckwell Bridge primary substation.

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

### Option 1 – Install additional primary transformer (Luckwell Bridge T2) and 33kV circuit

**Capacity Released for constraint(s) considered:** 3.75 MVA

Viable

**Detailed description:** This option would involve installing in a second 33kV circuit from Bowhays Cross BSP to Luckwell Bridge and installing a second primary transformer in order to provide a more secure supply under N-1 (first circuit outage). The circuit would be a significant length, however it would offer significant benefit to the area and significantly improve voltage performance during faults and outages. Particularly given that Luckwell Bridge supplies a 19.3km 11kV circuit to the West of the substation which currently needs to be interconnected to the next closest primary during a transformer fault/outage, which is another 14km away (Periton). Pertion is also on the same 33kV circuit as Luckwell Bridge meaning both single transformer sites can be taken out by a single 33kV circuit fault/outage, leaving only Alcombe in the area to pick up both sites through very long 11kV circuits. Therefore, a new circuit 33kV circuit into the area would have significant benefit and facilitate a second transformer as well as possible upgrades to Periton and Alcombe in the future.

**New limiting factor for constraint(s) considered:** Existing 5/6.25MVA transformer

### Option 2 – Install additional 11kV circuits/reinforce circuits for 11kV backfeed

**Capacity released for constraint(s) considered:** Up to 3.75MVA

Viable

**Detailed description:** This option would involve assessing upgrades for the existing 11kV backfeeds which supply Luckwell Bridge during a transformer fault/arranged outage. It may be possible to upgrade the existing circuits or install new 11kV circuits to release capacity up to the full 6.25MVA rating of the transformer. This may also require voltage regulation devices to be installed to support voltage given the significant length of circuits. This will be subject to further study and it may not solve the constraint in isolation, therefore a cost benefit analysis of all 33kV options and 11kV options should be carried out.

**New limiting factor for constraint(s) considered:** Existing 5/6.25MVA transformer

### Option 3 – Combination of 11kV and 33kV reinforcement

**Capacity released for constraint(s) considered:** Unknown

Viable

**Detailed description:** The closest primary to Luckwell Bridge is Periton which is partly used to supply Luckwell Bridge during a fault/outage of the Luckwell Bridge single transformer. However, they are on the same 33kV circuit meaning a fault/outage affecting this circuit takes out both substations. Alcombe is the next closest primary which would be left to supply Luckwell Bridge and Periton via the 11kV. Due to the significant length of these circuits this will exacerbate overload and voltage drop issues. Therefore, one option would be to consider a further 33kV infeed into Periton, for example by a new circuit from Alcombe or via a new circuit to Timberscombe which could later be extended to Luckwell Bridge to facilitate a second transformer installation.

Whilst this improves the segregation on the 33kV network, it does little to improve the 11kV network which still travels significant lengths to supply the area during the loss of the transformer at Luckwell Bridge. Therefore, also reinforcing this and installing voltage compensation in conjunction with the 33kV reinforcement may be required, subject to design and cost benefit analysis.

**New limiting factor for constraint(s) considered:** Existing 5/6.25MVA transformer

### Option 4 – Procure flexibility on overloaded feeders under backfeed conditions

**Estimated Flexibility Required (MVA):** 1MVA+

Viable

**Detailed description:** Flexibility services could be procured to alleviate projected overloads. This could defer reinforcement, however there is a risk that it is not possible to secure sufficient flexibility on the affected feeders, particularly given the voltage drop issues present.

## Solution Recommendation

Firstly, flexibility should be considered to determine if this offers a means to defer costly reinforcement.

Following this, it is recommended to carry out a cost benefit analysis of options 1, 2 and 3. This will involve studying 11kV and 33kV reinforcement options to determine which combination offers most capacity and voltage improvement to the area at the best cost.

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