Bath BSP and Melksham GSP

Network Development Report – South West

May 2024

Electricity Distribution

nationalgrid

Contents

Bath BSP and Melksham GSP

1. Network Overview

Bath Bulk Supply Point (BSP) is fed from Melksham Grid Supply Point (GSP) via a double-circuit steel tower line. There are two 90 MVA 132/33 kV transformers at Bath BSP. Bath BSP feeds a predominantly urban area, with most demand coming from Dorchester Street Primary substation.

Bath BSP is fed via two 132 kV circuits along the AG route from Melksham GSP. There are also 33 kV interconnections to Radstock BSP and Entry Hill, which are normally open. The firm capacity of Bath BSP is 90 MVA, with the limit being the ancillaries of the Grid Transformers.

The Group Demand at Bath BSP is about 75.46 MVA which places it in Class D of Engineering Recommendation (EREC) P2 relating to security of supply. Approximately 52,300 customers are supplied from Bath BSP.

This report does not cover all the electrical network fed from Melksham GSP, only the 132 kV network that supplies Bath BSP.

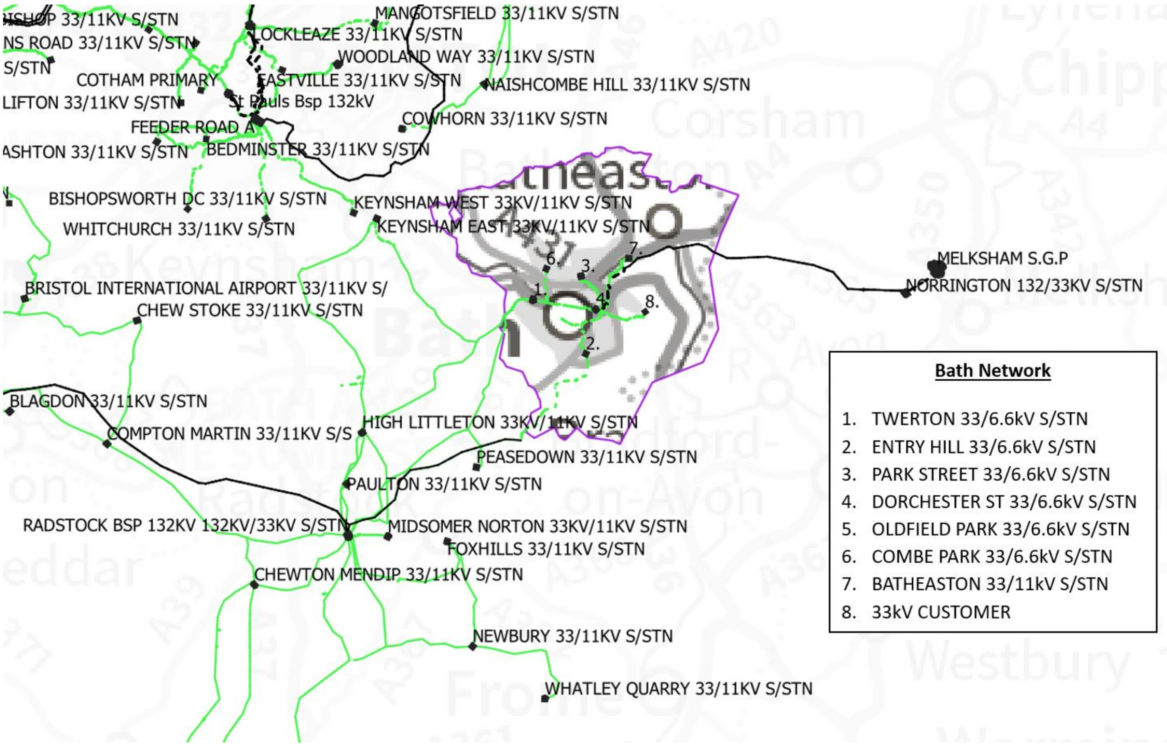

Figure 1.1.1 Bath BSP geographic network coverage

This report discusses all existing and future network constraints over a 0-10 year horizon associated with the 33/11 kV and 33/6.6 kV transformers, 33 kV circuits, 132/33 kV transformers and 132 kV circuits which supply and are supplied by Bath 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, 2032 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 Bath BSP and Melksham GSP network is arranged as follows:

- Two 132 kV circuits from Melksham GSP feed two Grid Transformers (GTs), GT1 and GT2. These GTs run in parallel and supply load downstream of Bath BSP.
- There are two normal open points (NOPs) at Twerton Primary substation. Twerton Primary is a 33/6.6 kV site which is normally fed by a single 33 kV circuit from Bath BSP but with interconnection available to Radstock BSP.
- Combe Park Primary substation is supplied by two 33 kV circuits which are connected to a 33 kV busbar at Twerton Primary.
- There is a normal open point at Entry Hill Primary substation. Entry Hill is a 33/6.6 kV site normally fed from Bath BSP by two 33 kV circuits but with available interconnection to Radstock BSP.
- Oldfield Park Primary substation is a 33/6.6 kV site fed via two circuits that run from 33 kV busbars at Entry Hill.
- Park Street Primary substation is 33/6.6 kV site fed via two separate 33 kV feeder circuits from Bath BSP.
- Dorchester Street Primary substation is a 33/6.6 kV site fed via four circuits from Bath BSP.
- There is a normal open point at Batheaston Primary substation, which is a 33/11 kV site fed from Bath BSP. Batheaston is made up of three transformers with three separate feeders. The Primary is normally fed via two 33 kV circuits with a third 33 kV circuit on ‘hot standby’. This topology is required as there is no option to backfeed Batheaston Primary from another Primary due to the difference in secondary voltage between Batheaston and other Primary substations in Bath.
- A 33 kV customer is fed via two 33 kV circuits from Bath BSP.
- A 33 kV circuit from SSEN’s Norrington Bulk Supply Point to Batheaston Primary substation can be established in an emergency where both 132 kV circuits from Melksham GSP to Bath GSP are off supply due to a 132 kV cable fault (see NGED internal policy ST: OC21AH/1). This would restore some load that is normally fed from Bath BSP.

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.

- Following an outage of the 33 kV circuit between Bath BSP and Twerton Primary, Combe Park Primary and Twerton Primary substations are fed from Radstock BSP via separate 33 kV circuits connecting to Radstock BSP by an auto-changeover scheme on 1L5 and 3L5 at Twerton, which first opens the 2S0 section breaker at Twerton Primary substation.
- For an arranged outage of Main 2 busbar or 2H4 disconnector at Twerton, the 33 kV circuits from Radstock to Twerton are closed.
- For an arranged outage of the 2S0 section breaker at Twerton, the 33 kV circuit from Radstock to the Main 3 busbar at Twerton is closed.
- For a fault or arranged outage of one of the normally closed 33 kV circuits between Bath BSP and Batheaston Primary, the 33 kV circuit on ‘hot standby’ is closed.

- For the loss of an infeed to a transformer under arranged outages at any of the Primary substations fed from Bath BSP, the circuit breaker on the lower voltage side of the transformer is opened to prevent back-energisation.

- For an arranged outage of 2S0 section breaker at Bath BSP, outgoing 33 kV circuits from Main 1 busbar are opened as well as 11L5 on Main 3 busbar.

- For arranged outage of 3S0 section breaker at Bath BSP, various 33 kV circuits fed from Bath BSP are opened to prevent Main 1 busbar and Main 2 busbar being connected via the 11 kV or 6.6 kV busbars at Primary substations.

- For an arranged outage of Main 3 busbar at Bath BSP, outgoing 33 kV circuits from Bath BSP Main 1 busbar are opened.

2. Summary of Network Constraints

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

- GT1 demand overload when GT2 is off supply at Bath BSP.
- GT2 demand overload when GT1 is off supply at Bath BSP.
- Capacity of 132 kV circuit infeeds into Bath BSP from Melksham GSP.
- Lost load at Combe Park Primary substation in the event of an arranged or fault outage of Main 3 busbar at Twerton Primary substation.
- Transformer overloads at Park Street Primary substation when one of the two circuit infeeds to Park Street is off supply.
- Dorchester Street Primary substation transformer overloads and 33 kV circuit infeed overloads under various N-1 conditions.

3. Network Constraint Details and Solution Options

3.1 Bath BSP 132 kV/33 kV Grid Transformer Capacity and 132 kV circuit infeed 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
Bath GT1 thermal overload	Bath GT2 arranged or fault outage	None	2032	2032	2032	2034
Bath GT1 thermal overload	Bath Main 2 busbar arranged or fault outage	None	2032	2032	2032	2034
Bath GT2 thermal overload	Bath GT1 arranged or fault outage	None	2032	2032	2032	2034
Bath GT2 thermal overload	Bath Main 1 busbar arranged or fault outage	None	2032	2032	2032	2034
132 kV circuit Melksham 510 to Bath Main busbar 2 thermal overload	Bath Main 1 busbar arranged or fault outage	None	-	2032	-	-
132 kV circuit Melksham 110 to Bath Main 1 busbar thermal overload	Bath Main 2 busbar arranged or fault outage	None	-	2032	-	-

Uncertainty under other Distribution Future Energy Scenarios: Under the DFES 2022 Leading the Way scenario, the constraint is expected to occur in 2029. Under the Falling Short scenario, the constraint is expected 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 3.1.2 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	Uprate 132/33 kV Grid Transformers at Bath BSP by carrying out ST: SD8C checks.	×	×	✓	Viable
2	Install additional 132/33 kV Grid Transformer and associated switchgear at Bath BSP.	✓	×	✓	Discounted
3	Install a new 132/33 kV Bulk Supply Point close to Bath.	✓	✓	×	Viable
Operational Mitigation					
4	Adjust normal running arrangement to transfer demand to Radstock BSP	✓	×	✓	Discounted
Load Management Schemes					
-	*None identified*	-	-	-	-
Flexibility services					
5	Procure flexibility at locations normally fed from Bath 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 – Uprate 132/33 kV Grid Transformers at Bath BSP by carrying out ST: SD8C checks

Capacity Released for constraint(s) considered: Up to 24 MVA **Viable**

Detailed description: The existing Grid Transformers at Bath BSP are currently assumed to be limited by their nameplate rating (90 MVA). However, the transformer windings are likely capable of carrying greater load, as high as 117 MVA Winter cyclic rating. 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. By carrying out checks on the transformer ancillaries of the two Grid Transformers at Bath BSP, the transformers can be run at a higher capacity.

Following these checks, it is likely that the capacity in winter will be increased to **114 MVA**, with the 33 kV switchgear at Bath BSP expected to be the limiting factor in the winter. However, this would not relieve the constraint on the warmer Intermediate Warm or Intermediate Cool representative days.

If NGED’s internal policy relating to transformer ratings is reviewed, the predicted Grid Transformer overloads at Bath BSP in 2032 could be relieved by uprating the Grid Transformers. Currently, NGED policy does not distinguish between summer and intermediate cool ratings, which may be overly pessimistic.

New limiting factor for constraint(s) considered: 33 kV switchgear at Bath BSP if the Grid Transformers can be uprated (114 MVA in winter), otherwise the capacity of the GTs at Bath BSP are the limiting factor (117 MVA in winter). In other seasons, the 132 kV infeeds limited to 112 MVA are the limiting factor.

Option 2 – Install additional Grid Transformer at Bath BSP

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

Detailed description: An additional Grid Transformer could be installed at Bath BSP. Bath BSP has three sections of 33 kV bar, so one section of bar is available. An extra 60/90 MVA transformer would create capacity under an N-1 condition. This site would become a three-transformer site which is projected to supply more than 100 MVA in the future. This large load fed from one site is not a desirable network configuration when compared to splitting the load across more substations, as the three transformer site offers less redundancy.

Installing a new Grid Transformer would likely be fed via a new 132 kV circuit. This new 132 kV circuit would increase capacity to 180 MVA under N-1 conditions. Possible options for a new circuit include:

1) A ‘tee-off’ from the XW route north-west of Bath. Approximately 8750 m of 132 kV cable would need to be laid.
2) A new 132 kV circuit installed between Melksham GSP and Bath BSP. This would require an extra bay at Melksham GSP. An additional 132 kV circuit alongside the AG route from Melksham could be installed, however the cable sections of this route may not have sufficient space for an additional 132 kV cable, so it is likely that an alternative route from Melksham GSP to Bath BSP would be chosen.
3) 132 kV cable laid from the Y route which is currently connected to Churchill BSP and Sandford GSP.

The new Grid Transformer could be looped into the existing 132 kV circuits into Bath BSP however the existing 132 kV circuits would require overlaying with a higher rated cable as they are forecasted to overload following the busbar fault conditions listed in Table 3.1.1. The existing circuits are limited to 112 MVA in the Intermediate Cool season. Approximately 3200 m of 0.5 in^2 copper cable would require overlaying with 630 mm^2 copper cable for this option.

Remaining with only two 132 kV infeeds to Bath BSP would not provide an increase in capacity at Bath BSP if both circuits into Bath BSP are lost (N-2). This would mean that the network is non-compliant with Engineering Recommendation P2 if the Group Demand at Bath BSP exceeds 100 MW in the future.

All new cable routes suggested are subject to route surveys. One barrier to this solution of an additional Grid Transformer is the limited physical space available at the current Bath BSP site.

New limiting factor for constraint(s) considered: If a new 132 kV circuit is installed, GT capacity limits firm capacity (N-1) to 180 MVA. If the new Grid Transformer is instead connected to the existing 132 kV circuits between Melksham GSP and Bath BSP, the limiting factor will be these circuits.

Option 3 – Install new 132/33 kV Bulk Supply Point close to Bath

Capacity released for constraint(s) considered: 90 MVA + **Viable**

Detailed description: A new BSP initially consisting of a single 60/90 MVA transformer but with room to install a second 60/90 MVA transformer can be built near Bath and connected to Melksham GSP by installing a new 132 kV circuit.

Capacity at Bath BSP and Radstock BSP can be created by transferring demand fed from each onto a new BSP. A BSP located between Bath and Radstock would be preferable. Any proposed location will be subject to site surveys.

A new BSP could be fed from a range of 132 kV circuits. To provide the greatest wider benefit to the NGED network, a new 132 kV circuit from Melksham GSP is recommended. The load on the SGTs at Sandford GSP and the outgoing circuits from there will be reduced by load being transferred from Radstock BSP to a new BSP fed from Melksham GSP.

New limiting factor for constraint(s) considered: Capacity of Grid Transformers at Bath BSP and the new BSP. Overall capacity of these Grid Transformers is 180 MVA under a First Circuit Outage where one of the three Grid Transformers is lost.

Option 4 – Adjust normal running arrangement to transfer demand to Radstock BSP

Capacity Released for constraint(s) considered: Approximately 45 MVA **Discounted**

Detailed description: Load can be shifted by closing the interconnections at Twerton and Entry Hill, such that Twerton, Combe Park and Entry Hill are supplied by Radstock BSP under normal operating conditions.

The Grid Transformers at Radstock are already expected to overload in 2034 under an N-1 condition so this solution would make that overload even worse.

New limiting factor for constraint(s) considered: Capacity of Radstock Grid Transformers (90 MVA).

Option 5 – Procure flexibility at Bath BSP

Estimated Flexibility Required (MVA): 35 MVA **Viable**

Detailed description: Flexibility services could be procured to alleviate the projected overloads seen on the GTs at Bath BSP and overloading on 132 kV circuit infeeds. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

In the short term, carry out ancillary checks on the Grid Transformers at Bath BSP and await a review of NGED internal policy relating to transformer ratings. The constraint in 2032 would be relieved by applying the winter cyclic rating to the Grid Transformers throughout the Intermediate Cool and Winter periods and overlaying sufficient 132 kV cable. In addition, the DNOA process may recommend that flexibility services are procured.

However, a longer term solution is to reinforce the network. It is recommended that a new BSP, as discussed in Option 3, is installed between Bath BSP and Radstock BSP.

A new BSP is preferable when compared to other reinforcement because of the wider benefit to the NGED network beyond the Bath area. It will also solve the EREC P2 security of supply constraint on the network that is projected for 2032 when group demand fed from Bath BSP exceeds 100 MW. Given that Radstock BSP is also forecasted to supply more than 100 MW in the future, it is unlikely that demand could simply be shifted onto Radstock BSP to resolve this EREC P2 constraint. A new BSP would be more resilient than adding an extra GT and 132 kV circuit at Bath.

It will take many years to secure land for a new BSP and to install long circuits associated with the BSP. As a result it is recommended that NGED begin detailed design for a new BSP whilst also implementing the short term solution suggested.

3.2 Lost Load at Combe Park Primary

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
Lost load at Combe Park Primary substation	Arranged outage of Main 3 busbar at Twerton Primary substation.	N/A	Baseline	Baseline	Baseline	2032
Lost load at Combe Park Primary substation	Fault outage of Main 3 busbar at Twerton Primary substation.	N/A	Baseline	Baseline	Baseline	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.

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 Benefit	Potential to be cost effective	Viable or Discounted
0	No Intervention	×	×	×	**Discounted**
Reinforcement					
1	Redesign Twerton Primary substation	✓	✓	×	**Viable**
2	Install new BSP and change running arrangement	✓	✓	×	**Viable**
Operational Mitigation					
	None identified	-	-	-	-
Load Management Schemes					
-	*None identified*	-	-	-	-
Flexibility services					
3	Procure flexibility at Combe Park	✓	✓	✓	**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 lost load for the conditions described above.

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

Option 1 – Redesign Twerton Primary substation

Capacity Released for constraint(s) considered: Up to 22.9 MVA **Viable**

Detailed description: Redesign Twerton Primary substation such that 33 kV infeeds to Combe Park Primary are supplied from separate 33 kV busbars at Twerton.

Currently, Twerton Primary runs such that the two outgoing 33 kV circuits to Combe Park are fed from the same busbar at Twerton.

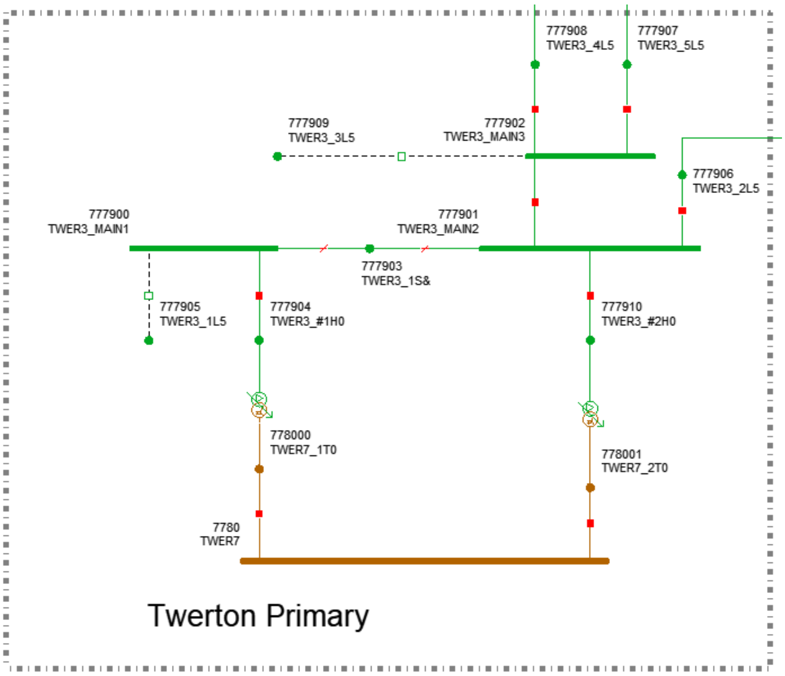

Figure 3.2.1: Twerton Primary substation single-line diagram

By carrying out work to reconfigure Twerton Primary substation such that Combe Park is fed from different busbars, a single busbar outage will no longer cause Combe Park to be off supply. An auto changeover scheme is currently in place such that Combe Park and Twerton are fed from Radstock BSP when there is a loss in supply to Twerton from Bath BSP.

New limiting factor for constraint(s) considered: Capacity of 33 kV circuit from Bath BSP to Twerton. This single 25.1 MVA circuit supplies Twerton and Combe Park.

Option 2 – Install new BSP and change running arrangement

Capacity Released for constraint(s) considered: 22.9 MVA **Viable**

Detailed description:

Install new BSP such that 33 kV infeeds to Combe Park Primary are supplied from separate 33 kV busbars at the BSP.

If a new BSP is installed, as discussed in Section 3.1, Combe Park could be supplied via separate 33 kV bars at the new BSP which would mean that a single busbar outage will no longer cause Combe Park to be off supply.

New limiting factor for constraint(s) considered: 22.9 MVA rating of the 33 kV circuit infeeds to Combe Park.

Option 3 – Procure flexibility at Combe Park

Estimated Flexibility Required (MVA): 9.85 MVA + **Viable**

Detailed description: Flexibility services could be procured at Combe Park Primary substation to reduce the demand at Combe Park Primary substation. A reduction in demand would mean that the 6.6 kV network backfeed would be more capable of supplying the demand at Combe Park Primary substation. The amount of flexibility required increases as demand increases.

Solution Recommendation

It may be possible to procure flexibility at Combe Park Primary substation to push back the need to reinforce the network subject to a cost benefit analysis confirmation through the DNOA process.

This constraint would not be the trigger for a new BSP but if one is to be built, it is recommended that Combe Park is fed from the new BSP by installing two 33 kV circuits and removing the connection to Twerton Primary.

It is recommended that Twerton Primary is redesigned and work carried out so that Combe Park is fed from separate 33 kV busbars if the proposed BSP is not built.

3.3 Park Street Transformer Capacity

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
Park Street T1 thermal overload	Park Street T2 off supply due to arranged or fault outage.	N/A	2032	2032	2034	2034
Park Street T2 thermal overload	Park Street T1 off supply due to arranged or fault outage.	N/A	2032	2032	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: Under the DFES 2022 Leading the Way scenario, the constraint is expected to occur in 2030. Under the DFES 2022 Falling Short scenario, the constraint is expected to occur in 2034.

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	Reinforce both 10 MVA transformers at Park Street with 12/24 MVA transformers	✓	✓	✓	Viable
2	Install additional transformer at Park Street Primary substation	✓	×	×	Discounted
Operational Mitigation					
-	*None identified*	-	-	-	-
Load Management Schemes					
-	*None identified*	-	-	-	-
Flexibility services					
3	Procure flexibility at Park Street 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: Under an N-1 condition where one of the transformers at Park Street Primary substation is out of service, the other transformer at Park Street will overload.

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

Option 1 – Reinforce both 10 MVA transformers at Park Street with 12/24 MVA transformers

Capacity Released for constraint(s) considered: 14 MVA

Viable

Detailed description: Replace the 10 MVA transformers at Park Street with 12/24 MVA transformers. The transformers should be dual rating (33/11 kV and 33/6.6 kV) to ensure they can be used in the event of the Bath 6.6 kV network being changed to 11 kV. This solution can be considered as cost effective as the transformers will not need changing again before 2050.

A wider benefit of this solution is the possible availability of Park Street to supply some demand currently fed from Dorchester Street.

New limiting factor for constraint(s) considered: Transformers to be installed at Park Street with a sustained (nameplate) rating of 12/24 MVA.

Option 2 – Install additional transformer at Park Street Primary substation

Capacity Released for constraint(s) considered: 10 MVA

Discounted

Detailed description:

Install an additional transformer, rated at 12/24 MVA, with associated switchgear at Park Street and additional 33 kV circuit from Bath BSP. A dual rated transformer is recommended.

One barrier to this solution is the limited space available at Park Street Primary substation.

New limiting factor for constraint(s) considered: Combined rating of the remaining in-service transformers (20 MVA) at Park Street Primary substation following an outage of one of the transformers.

Option 3 – Procure flexibility at Park Street Primary substation

Estimated Flexibility Required (MVA): 5 MVA

Viable

Detailed description: Flexibility services could be procured at Park Street Primary substation to reduce the demand at Combe Park. A reduction in demand would mean that the 6.6 kV network backfeed would be more capable of supplying the demand at Park Street. The amount of flexibility required increases as demand increases.

Solution Recommendation

It may be possible to procure flexibility at Park Street Primary substation to push back the need to reinforce the network subject to a cost benefit analysis confirmation through the DNOA process.

The preferred reinforcement option is to replace both the transformers with 12/24 MVA dual rating (option of 33/11 kV or 33/6.6 kV) transformers. This option (Option 1) would remove the need for any further reinforcement at Park Street up to 2050 according to the DFES Best View growth projection.

This solution is preferred because both the transformers at the site are due for asset replacement within the next 10 years anyway due to their age. If Option 2 was chosen, a total of three transformer changes at Park Street would be required before 2050 instead of two.

3.4 Capacity of Dorchester Street Transformers and 33 kV circuit infeeds

Constraint Overview

Generation Demand

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

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
Dorchester Street T3 overload	Arranged outage on circuit between Bath BSP 7L4 and Dorchester Street T2.	None	2032	2032	-	-
Dorchester Street T3 overload	Fault outage on circuit between Bath BSP 7L5 and Dorchester Street T2.	None	2032	2032	-	-
Dorchester Street T3 overload	Arranged outage of an isolator immediately surrounding Main 1 busbar at Bath BSP.	None	2032	2032	-	-
Dorchester Street T3 overload	Arranged or fault outage of Main 1 busbar at Bath BSP.	None	2032	2032	-	-
Dorchester Street T3 overload	Arranged outage of Main 3 busbar at Bath BSP.	None	2032	2032	-	-
Dorchester Street T2 overload	Arranged or fault outage of Main 2 busbar at Bath BSP.	None	2032	2032	-	-
Dorchester Street T2 overload	Arranged outage of an isolator immediately surrounding Main 2 busbar at Bath BSP.	None	2032	2032	-	-
Dorchester Street T2 overload	Arranged or fault outage on circuit between Bath BSP Main 2 busbar and Dorchester Street T3.	None	2032	2032	-	-

Overload of 33 kV circuit between Bath BSP 7L5 and Dorchester Street T2	Arranged or fault outage on 33 kV circuit between 12L4 at Bath BSP and T3 at Dorchester Street	None	2032	2032	-	-
Overload of 33 kV circuit between Bath BSP 7L5 and Dorchester Street T2	Arranged outage of any isolator immediately surrounding Main 2 busbar at Bath BSP.	None	2032	2032	-	-
Overload of 33 kV circuit between Bath BSP 7L5 and Dorchester Street T2	Arranged or fault outage of Main 2 busbar at Bath BSP.	None	2032	2032	-	-
Overload of 33 kV circuit between Bath BSP 7L5 and Dorchester Street T2	Arranged outage of section breaker 3S0 at Bath BSP.	None	2032	2032	-	-
Overload of 33 kV circuit between Bath BSP 4L5 and Dorchester Street T1	Arranged or fault outage on 33 kV circuit between 13L4 at Bath BSP and Dorchester Street T4.	None	2034	2032	-	-
Overload of 33 kV circuit between Bath BSP 4L5 and Dorchester Street T1	Arranged or fault outage of Main 2 busbar at Bath BSP.	None	2034	2032	-	-

Uncertainty under other Distribution Future Energy Scenarios: Under the DFES 2022 Leading the Way scenario, the constraint is expected to occur in 2032. Under the DFES 2022 Falling Short scenario, the constraint is expected to occur in 2034.

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	Uprate two transformers and overlay cable	✓	×	×	Viable
2	Uprate transformers at Dorchester Street Primary substation and rationalise Primary substation	✓	×	✓	Viable
Operational Mitigation					
3	Limit arranged outage window	×	×	✓	Viable

Load Management Schemes					
4	Transfer demand onto Park Street Primary substation	✓	×	✓	Viable
Flexibility services					
5	Procure flexibility at Dorchester Street 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: Under an N-1 condition where one of the transformers at Dorchester Street Primary substation is out of service, another transformer at Dorchester Street will overload.

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

Option 1 – Uprate two transformers and overlay cable

Capacity Released for constraint(s) considered: Up to 16 MVA

Viable

Detailed description:

Replace two of the 12/24 MVA transformers at Dorchester Street Primary substation with 20/40 MVA units. The two 20/40 MVA units are recommended to be connected to the same 6.6 kV busbar, for example the ‘K’ busbar, at Dorchester Street and the 33 kV circuits feeding the new units from Bath BSP should be overlaid to fully utilise the transformers. Following this reinforcement, more demand downstream of Dorchester Street Primary substation should be fed from this 6.6 kV busbar at Dorchester Street with the new transformers connected to it.

New limiting factor for constraint(s) considered: The two 33 kV circuit infeeds to Dorchester Street that are not recommended to be replaced in this solution.

Option 2 – Uprate transformers at Dorchester Street Primary substation and rationalise Primary substation

Capacity Released for constraint(s) considered: 22 MVA

Viable

Detailed description:

Replace three 12/24 MVA transformers to 20/40 MVA units at Dorchester Street Primary substation. Remove fourth circuit and transformer. Sections of the 33 kV circuits would also need to be upgraded to enable 35 MVA capacity.

The three transformers could be fed from three separate bars at Bath BSP via three circuits. This would require re-routing one of the existing circuits so that it connects to the Main 3 busbar at Bath BSP.

New limiting factor for constraint(s) considered: Combined capacity (70 MVA) of the remaining two in-service 33 kV circuits at Dorchester Street following an outage of one circuit between Bath BSP and Dorchester Street Primary substation.

Option 3 – Limit arranged outage window

Capacity Released for constraint(s) considered: None

Viable

Detailed description: Arranged outages could be limited to certain times during the year. This would resolve constraints identified that occur under arranged outage conditions. Overloads under arranged outage conditions were only identified during Winter and Intermediate Cool periods. By shifting these outages such that they are taken during Summer and Intermediate Warm periods, overloads that occur under arrange outage conditions could be avoided. This solution does not solve constraints that occur under first circuit outage (FCO) fault conditions.

New limiting factor for constraint(s) considered: 33 kV transformers at Dorchester Street Primary substation.

Option 4 – Transfer demand onto Park Street Primary substation

Capacity Released for constraint(s) considered: Up to 14 MVA

Viable

Detailed description: By reconfiguring the 6.6 kV network in Bath, demand currently fed by Dorchester Street Primary substation under intact conditions could be fed from Park Street Primary substation.

This option would be particularly suitable if the transformers at Park Street Primary substation are replaced with 12/24 MVA units as 14 MVA spare capacity is forecasted for 2034 under the Best View scenario if these units are installed.

New limiting factor for constraint(s) considered: Spare capacity at Park Street Primary substation.

Option 5 – Procure flexibility at Dorchester Street Primary substation

Estimated Flexibility Required (MVA): 5 MVA

Viable

Detailed description: Flexibility services could be procured to alleviate the projected overloads seen on the transformers at Dorchester Street Primary substation.

Solution Recommendation

Flexibility services should be procured where possible to resolve this constraint. If flexibility cannot be procured and there is insufficient spare capacity at Park Street Primary substation to transfer demand away from Dorchester Street Primary substation, reinforcement described in Option 1 should be carried out.

This constraint should be regularly reviewed as it is not expected to occur until 2032, so the nature of the constraint and the viability of solutions may change.

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