Street BSP and Associated 132 kV Network

Network Development Report – South West

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Electricity Distribution

nationalgrid

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Street BSP and Associated 132 kV Network

1. Network Overview

Street Bulk Supply Point (BSP) supplies a sparse area of 33 kV network, mostly in Somerset. It is supplied from two 132/33 kV Grid Transformers (GTs) (one at Street BSP and one at Bridgwater BSP). Bridgwater BSP together with Street BSP supplies approximately 93,000 customers.

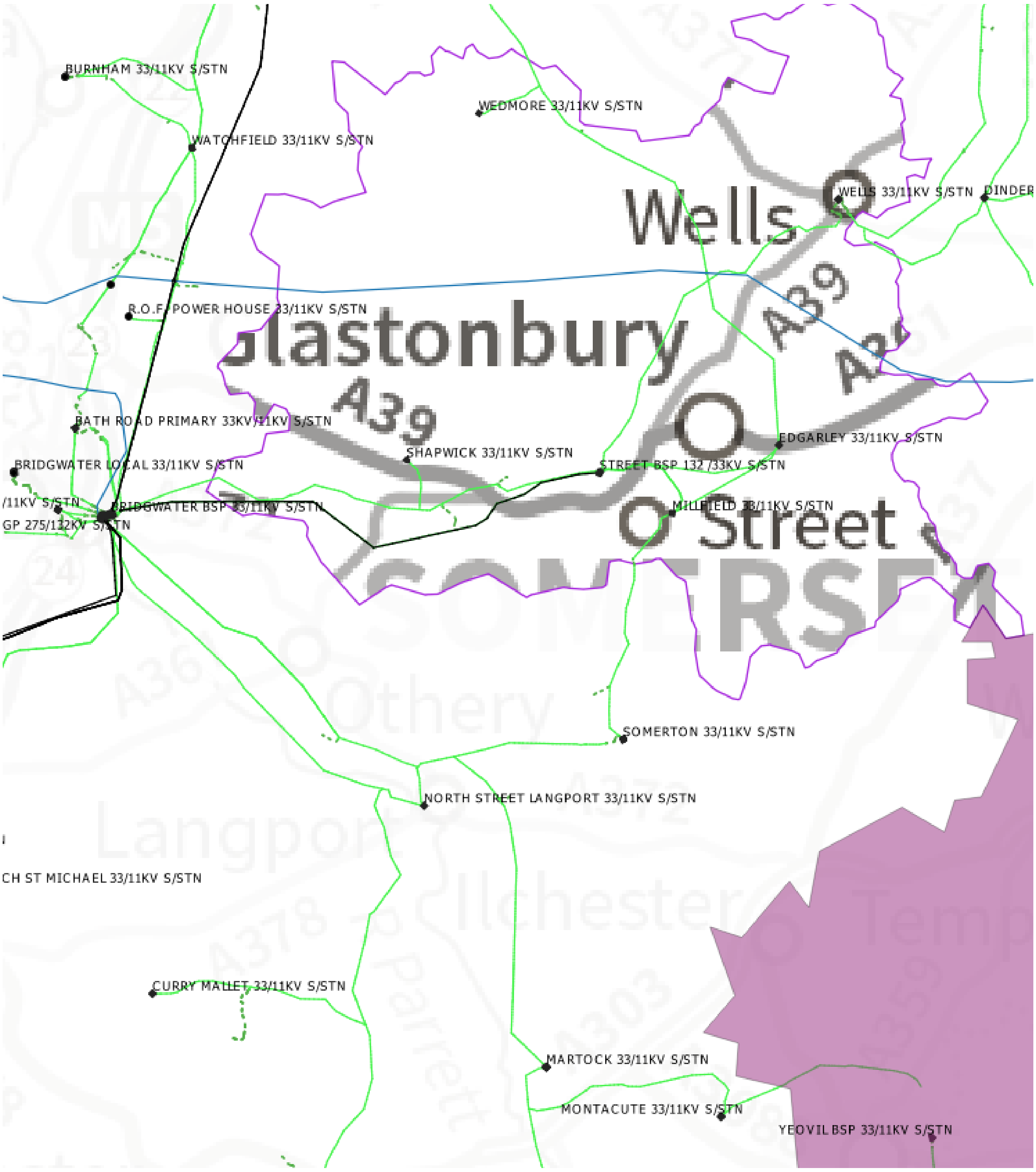

Figure 1.1 Street BSP geographic network coverage

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, 132/33 kV transformers and 132 kV circuits which supply and are supplied by Street 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 Street BSP network is arranged as follows:

- GT1, GT2 and GT4 currently run in parallel supplying Bridgwater BSP, whilst GT3 is run split from the rest of the GTs at Bridgwater, in parallel with GT1 at Street BSP to supply Street.
- There is a normal open point at North Street Langport primary separating two 33 kV circuits between Bridgwater and North Street Langport, with one of the circuits also supplying Street BSP.
- Shapwick is a single transformer Primary off Bridgwater GT3 busbar.
- On the circuit between Bridgwater GT3 board and Street GT1 there is North St Langport Primary T2, Martock Primary T2 (these two primaries are shared between Bridgwater and Yeovil respectively), Somerton Primary and Millfield Primary T2 also connect to it.
- Off Street GT1 bar, there is a spur to Wells where the circuit goes to Radstock BSP, separated by a normal open point.
- Another circuit off Street GT1 busbar goes past Millfield Primary T1 and two single transformer Primaries Edgarly and Wedmore with the circuit following on to Churchill BSP, separated by a normal open point.

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.

- DOC protection for Millfield Primary T1 and T2.
- Transfers of the primaries to other BSPs for Street GT1, GT1 busbar arranged outages and outages affecting the supply from Street to the primaries in the group: Wedmore to Churchill BSP, Wells to Radstock BSP, Martock T2 load to Yeovil and North Street Langport to Bridgwater transfers for Street GT1, GT1 busbar arranged outages and most outages in the primaries in the group.
- Split Street BSP for a Main 2 outage to avoid 11 kV throughflows.
- 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 Street 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:

- Street BSP 132/33 kV GT1 overload
- Bridgwater 19L5 to Street 2L5 33 kV circuit ring overload including the following sections:
    - Bridgwater 19L5 to North Street Langport 33 kV tee circuit overload
    - North Street Langport Tee to Somerton 1L3 33 kV circuit overload
    - Millfield 2L3 to Somerton 2L3 circuit overload
    - Street 2L5 to Millfield 33 kV circuit overload
- Low voltage across several 33 kV primary substation busbars and single customer sites at 33 kV
- Lost load at Street BSP for a Bridgwater Main 1 busbar fault
- Millfield 33/11 kV T2 reverse powerflow overload due to DOC protection not operating
- Millfield 33/11 kV T1 and T2 overload
- Edgarly Single Transformer primary 11 kV backfeed overloads and low voltage on 11 kV network
- Martock 33/11 kV T1 and T2 overload
- Shapwick Single Transformer primary 11 kV backfeed overloads and low voltage on 11 kV network

3. Network Constraint Details and Solution Options

3.1 Street BSP 132/33 kV GT1 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 3.1.1 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
Street GT1 overload	Bridgwater GT3 fault	None	Baseline	Baseline	Baseline	Baseline

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 3.1.2 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	Replace Street GT1 with a 90 MVA unit	✓	×	×	Discounted
2	Install additional 132 kV circuit between Bridgwater GSP and Street BSP and a second grid transformer (GT2)	✓	✓	✓	Viable
Operational Mitigation					
3	Transfer demand to other BSPs	×	×	×	Discounted
4	Change running arrangement to parallel all four transformers at Bridgwater BSP	✓	✓	✓	Viable
Load Management Schemes					
5	Uprate the existing GT at Street via use of cyclic ratings	✓	✓	✓	Viable
Flexibility services					
6	Procure flexibility under Street BSP at 33kV 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 Operator (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 the single grid transformer at Street overloading for the condition described above. This would lead to an inability to meet the Security of Supply requirements of Engineering Recommendation P2 for Street BSP as all of the demand could not be picked up via 33 kV circuits from other BSPs if protection operated to disconnect the overloaded transformer for this event.

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

Option 1 – Replace Street GT1 with a 90 MVA unit

Capacity Released for constraint(s) considered: 30 MVA **Discounted**

Detailed description: Replacing the 60 MVA grid transformer with a 90 MVA unit would remove the overload observed. However, this releases a very small capacity for a large cost and does not provide a benefit to the wider area including the 33 kV circuits between Bridgwater and Street which are limited in capacity. Therefore this option is not cost-effective.

New limiting factor for constraint(s) considered: Capacity of GT at Street.

Option 2 – Install additional 132 kV circuit between Bridgwater GSP and Street BSP and a second grid transformer (GT2)

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

Detailed description: There is already a circuit of 132 kV construction operating at 33 kV between Bridgwater BSP and Street BSP. This work would involve completing necessary upgrades to the towers, earthing and foundations to operate the circuit at 132 kV to facilitate the installation of a second grid transformer. Additional 132 kV plant and associated civil works will be required at Bridgwater GSP and Street BSP, as well as 33 kV plant at Street BSP.

If Street BSP is to be run completely split from Bridgwater BSP following this reinforcement, cyclic ratings will still be required for GT1 at Street to prevent an overload under FCO of the proposed GT2, as Street BSP Group Demand is projected to exceed 60 MVA. GT2 should be a 90 MVA unit to mitigate against GT1 FCO. In addition, 33 kV circuit reinforcement out of Street BSP will be required in order to release the additional GT capacity and prevent overloads during Main 1 or Main 2 busbar faults. In particular, 33 kV upgrades will be required between Street BSP and Millfield Primary substation and potentially elsewhere. Adding a 1S0 breaker at Millfield would help with the overloads so should be considered alongside any circuit upgrades.

New limiting factor for constraint(s) considered: Capacity of existing GT at Street.

Option 3 – Transfer demand to other BSPs

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

Detailed description: This option would involve moving primary substations onto adjacent bulk supply points to reduce demand on Street BSP. The options include transferring Martock to Yeovil BSP and Wells to Radstock BSP. However, there is insufficient 33 kV circuit capacity and the distance to these alternative BSPs is very long resulting in voltage drop. Therefore, this option is not possible without costly 33 kV upgrades and would not create much capacity for future growth. Therefore this option is not viable.

New limiting factor for constraint(s) considered: 33 kV circuit capacity of adjacent BSPs

Option 4 – Change running arrangement to parallel all four transformers at Bridgwater BSP

Capacity Released for constraint(s) considered: 0MVA **Viable**

Detailed description: This option would involve running all four transformers at Bridgwater BSP in parallel with a transformer on hot standby for fault level mitigation if required. This would mean for the fault of on transformer at Bridgwater three would remain in parallel with the transformer at Street BSP and prevent an overload in the baseline scenario. However, there is a limit to the amount of demand at Street which can be picked up at Bridgwater meaning longer term reinforcement would be required to release significant capacity.

New limiting factor for constraint(s) considered: 33 kV circuit capacity between Bridgwater and Street

Option 5 – Uprate the existing GT at Street via use of cyclic ratings

Capacity Released for constraint(s) considered: 18 MVA **Viable**

Detailed description: Uprate the existing GT at Street 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, Current Transformers (CTs), cables (including cabling within the substation), switchgear, tap changer, transformer bushings, conservator and earthing transformer.

New limiting factor for constraint(s) considered: Cyclic rating of transformer.

Option 6 – Procure flexibility under Street BSP at 33 kV or below

Estimated Flexibility Required (MVA): 3 MVA+ **Viable**

Detailed description: Flexibility services could be procured to alleviate projected overloads during any fault/outage resulting in Bridgwater GT3 or associated busbars or 132 kV circuit being out of service. However, due to the complex nature of the parallel between Street and Bridgwater BSPs it is possible that this may not be a viable option.

Solution Recommendation

It is recommended to firstly assess if the existing GT at Street can be uprated via use of cyclic ratings to prevent overloads in the baseline scenario. If the capacity is limited by ancillary equipment then this will be the new limiting factor for the transformer capability.

In addition, it is recommend to assess paralleling all four gird transformers at Bridgwater via the 33 kV switchboard to mitigate the overload observed in the baseline scenario, putting a grid transformer on hot standby if necessary for fault level issues.

Finally, beyond these options, to release significant transformer capacity at Street BSP for future growth, subject to a cost benefit analysis, it is recommended to install an additional 132 kV circuit between Bridgwater GSP and Street BSP and a second grid transformer (GT2). To fully utilise this capacity 33 kV circuit upgrades in the Street area are required.

3.2 Bridgwater 19L5 to Street 2L5 33 kV circuit ring overload, reverse power flow, low voltage, lost load

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
Bridgwater 19L5 to North Street Langport 33 kV tee circuit overload	Street 33 kV Main 1 Busbar Fault	None	Baseline	Baseline	Baseline	Baseline
North Street Langport Tee to Somerton 1L3 33 kV circuit overload	Street 33 kV Main 1 Busbar Fault	None	2028	2028	2028	2028
Millfield 2L3 to Somerton 2L3 circuit overload	Bridgwater 33 kV Main 2B Busbar fault	None	Baseline	Baseline	Baseline	Baseline
Street 2L5 to Millfield 33 kV circuit overload	Bridgwater 33 kV Main 2B Busbar fault	None	Baseline	Baseline	Baseline	Baseline
Millfield T2 reverse powerflow overload due to DOC protection not operating under certain conditions	Street 33 kV Main 1 Busbar Fault	None	-	Baseline	2028	Baseline
Low volts at single customer sites	Street 33 kV Main 1 Busbar Fault	None	Baseline	Baseline	Baseline	Baseline
Lost load at Street BSP	Bridgwater 132 kV Main 1 busbar fault	None	Baseline	Baseline	Baseline	Baseline

Uncertainty under other Distribution Future Energy Scenarios: As the majority of the constraints occur under the baseline scenario, 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 these constraints 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	Reinforce existing 33 kV circuits/install additional 33 kV circuits	✓	×	✓	Viable
2	Install additional 132 kV circuit between Bridgwater GSP and Street BSP and a second grid transformer (GT2) and carry out 33 kV circuit reinforcement	✓	✓	✓	Viable
Operational Mitigation					
3	Transfer demand to other BSPs	×	×	×	Discounted
Load Management Schemes					
4	Post-fault transfers	×	×	×	Discounted
Flexibility services					
5	Procure flexibility under Street 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 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 0 – No Intervention

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

Detailed description: Street BSP has only one 132 kV circuit and grid transformer feeding it, running in parallel with Bridgwater BSP via long 33 kV circuits. For the loss of the main 132 kV infeed into Street BSP, the 33 kV circuits from Bridgwater supplying Street are overloaded and voltage drop is below statutory limits in the baseline scenario for the conditions described above.

Therefore, doing nothing to mitigate the constraint results in a non-compliant network with no capacity for future growth.

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

Option 1 – Reinforce existing 33 kV circuits/install additional 33 kV circuits

Capacity Released for constraint(s) considered: Approximately 2 MVA — Viable

Detailed description: This solution involves upgrading the overloaded sections of 33 kV circuit and providing a further 33 kV circuit infeed from Bridgwater via 6L5 to North Street Langport including the installation of a section breaker (1S0) at North Street Langport. In addition, new selections on the 132 kV and 33 kV busbars at Bridgwater GSP and BSP would be required to prevent lost load for a Bridgwater Main 1 132kV busbar fault. A 33kV 1 S0 could also be installed at Millfield to prevent reverse power flow overloads through Millfield T2.

Whilst this option does provide a lot of benefits and improved network performance in the baseline scenario, it is unlikely to cater for significant growth in the Street area and also leaves voltage performance below statutory limits at several sites for a Street Main 1 busbar fault, including 33 kV customers. One solution to this may be to use voltage support equipment such as a capacitor.

Nonetheless, 33 kV reinforcement would be required around almost the entire ring between Bridgwater 19L5 and Street 2L5 to support growth. In addition, for the loss of the single 132 kV infeed into Street, all of Street BSP is still fed from long 33 kV circuits from Bridgwater meaning performance is only marginally improved for a significant cost.

Therefore, this option in isolation is unlikely to be a viable long term solution, but elements of it may act as a short term solution to mitigate baseline constraints, in conjunction with a longer term view to install a second 132 kV circuit and grid transformer between Bridgwater GSP and Street BSP. This will also involve carrying out the necessary 33 kV upgrades to split Bridgwater and Street BSPs.

New limiting factor for constraint(s) considered: Existing 33 kV sections which are not upgraded and voltage below statutory for certain fault conditions even following upgrade works.

Option 2 – Install additional 132 kV circuit between Bridgwater GSP and Street BSP and a second grid transformer (GT2) and carry out 33 kV circuit reinforcement

Capacity released for constraint(s) considered: Viable

Up to 60 MVA at Street BSP dependant on 33 kV reinforcement

Detailed description: There is already a circuit of 132 kV construction operating at 33 kV between Bridgwater BSP and Street BSP. This work would involve completing necessary upgrades to the towers, earthing and foundations to operate the circuit at 132 kV to facilitate the installation of a second grid transformer. Additional 132 kV plant and associated civil works will be required at Bridgwater GSP and Street BSP, as well as 33 kV plant at Street BSP. Installing a three-panel 33 kV switchboard at Street as part of this would allow two circuits to Millfield and one to Edgarly to be connected to independent bar sections to mitigate against a busbar fault taking out two circuits and causing an overload. Furthermore, ancillary rating limitations of the existing GT1 should be reinforced where required to allow a full cyclic rating to be used.

Providing a second 132 kV circuit and grid transformer in isolation does not solve all of the constraints as there would still be a single 33 kV parallel ring between Bridgwater and Street BSPs supplying several primary substations. Therefore, a 33 kV circuit fault could still take out either end of the ring causing overloads and voltage drop. Furthermore, leaving Street BSP and Bridgwater BSP in parallel would not be a desirable running arrangement as it would leave six grid transformers in parallel causing fault level to increase, as well as making the network more complex and harder to design protection schemes for.

To mitigate against 33 kV overloads and allow the Bridgwater and Street BSP groups to be split, additional 33 kV circuits would be required from Street to Millfield and Street to Somerton, as well as a potential need to reinforce the 33 kV circuit between Bridgwater and North Street Langport. A section breaker (1S0) would be required at North Street Langport and Millfield primary substations to allow for this configuration.

New limiting factor for constraint(s) considered: Existing GT at Street and 33 kV circuit capacity.

Option 3 – Transfer demand to other BSPs

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

Detailed description: This option involves transferring demand to nearby BSPs to reduce the demand on Street and the associated constraints.

There are 33 kV circuits between Street BSP and Radstock, Churchill and Yeovil BSPs. These are all upwards of 22 km away meaning there are significant voltage drop issues when feeding any significant demand at Street at present. Candidates for transfer include Wells Primary onto Radstock BSP and Martock Primary onto Yeovil BSP due to having multiple 33 kV circuit infeeds nearby and distances to the respective BSP. Transferring of Wells results in 33 kV circuit overloads out of Radstock BSP and Radstock GT overloads under N-1 (first circuit outage) meaning this option is not possible without significant reinforcement which would also need to mitigate P18 circuit complexity issues. Transferring of Yeovil would need to be agreed with SSE and would require significant 33 kV reinforcement between Yeovil and Martock, as well as Yeovil 132 kV reinforcement to be carried out by SSE. Therefore, demand transfer does not present a viable solution to demand growth at Street.

New limiting factor for constraint(s) considered: Capacity at nearby BSPs

Option 4 – 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: Post-fault ratings and post-fault transfer options.

Option 5 – Procure flexibility under Street BSP at 33 kV or below

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

3 MVA+ (located at substations on Bridgwater 19L5 to Street 2L5)

Detailed description: Flexibility services could be procured to alleviate projected overloads. However, due to the interconnected nature of this network using flexibility may be too complex to be feasible as it would be needed at several primary substations, meaning the feasibility of this will need to be assessed further. If used, flexibility could act to defer reinforcement if proven cost-effective.

Solution Recommendation

It is recommended to firstly assess the feasibility of procuring flexibility across multiple primary substations in Street and carry out a cost benefit analysis of this against the reinforcement. The reinforcement recommended is to carry out 33 kV reinforcement of the Street BSP network, as well as installing a second grid transformer at Street BSP. This includes the following elements, subject to detailed design and surveys:

- Install section breaker (1S0) at North Street Langport – if done first this could mitigate many baseline constraints before the full works are completed.
- Upgrade existing 33 kV circuit to operate at 132 kV between Bridgwater GSP and Street BSP to facilitate the installation of a second grid transformer (GT2) at Street.
- Reinforce any ancillary restrictions, such as switchgear, on Street GT1 as part of this work.
- Install 3 panel 33 kV switchboard at Street BSP, splitting two Millfield and Edgarly circuits onto different sections.
- Install new 33 kV circuits between Street BSP and Millfield and Street BSP and Somerton
- Install section breaker (1S0) at and Millfield
- 33 kV reinforcement from Bridgwater 19L5 to North Street Langport
- Install voltage support, such as a capacitor, in the vicinity of Martock
- Incorporate Edgarly 33 kV circuit works into 33 kV circuit reinforcement work

This would provide significant benefit to several primary substations at present by splitting the long 33 kV ring between Bridgwater and Street as well as creating capacity for long term growth.

3.3 Millfield Transformers T1/T2 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 3.3.1 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
Millfield T1 overload	Millfield T2 fault	None	2032	2032	2032	2032
Millfield T2 overload	Millfield T1 fault	None	2032	2032	2032	2032

Uncertainty under other Distribution Future Energy Scenarios: Under Leading the Way Scenario, this constraint is predicted to arise in 2030 and under falling short is it predicted to arise in 2036.

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	Replace Millfield T1 and T2 with a 20/40 MVA units and ancillaries	✓	×	×	Discounted
2	Install third primary transformer (T3)	✓	×	✓	Viable
3	Upgrade nearby primary substation and 11 kV circuits to transfer demand	✓	✓	✓	Viable
Operational Mitigation					
4	Transfer demand to other Primaries	×	×	×	Discounted
Load Management Schemes					
-	*None Identified*	-	-	-	-
Flexibility services					
5	Procure flexibility at Millfield Primary 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 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. This would lead to an inability to meet the Security of Supply requirements of Engineering Recommendation P2 for Millfield Primary substation.

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

Option 1 – Replace Millfield T1 and T2 with a 20/40 MVA units and ancillaries

Capacity Released for constraint(s) considered: 15 MVA **Discounted**

Detailed description: This option involves replacing the 12/24 MVA transformers with 20/40 MVA transformers. This would also involve replacing/adding 33 kV circuits as well as upgrading switchgear at Millfield in order to allow usage of the higher capacity. In addition, the existing transformers were installed in 2004 meaning they would not be due for replacement in 2032. Therefore, it is not an economical option to replace the transformers with larger ones particularly given the limited capacity released.

New limiting factor for constraint(s) considered: New 20/40 MVA transformers

Option 2 – Install third primary transformer (T3)

Capacity Released for constraint(s) considered: 23 MVA **Viable**

Detailed description: This option would involve installing a third primary transformer at Millfield as well as a further 33 kV circuit and switchgear upgrades.

New limiting factor for constraint(s) considered: Capacity of 3 x 12/24 MVA transformers

Option 3 – Upgrade nearby primary substation and 11 kV circuits to transfer demand

Capacity released for constraint(s) considered: Up to 9 MVA **Viable**

New limiting factor for constraint(s) considered: 11 kV transfer capacity

Detailed description: This option would involve upgrading Edgarly Primary substation to install a second primary transformer, 33 kV circuit upgrades and 11 kV circuit upgrades to transfer demand from Millfield to Edgarly where required. Edgarly is the closest primary substation to Millfield but is currently only a single transformer primary. It is limited by the 11 kV backfeed capacity for the loss of the single transformer at present as discussed in Edgarly constraint section of this report. Therefore, upgrading the site to a two transformer primary would benefit both Millfield and Edgarly. This is likely to require 11 kV circuit upgrades to allow demand at Millfield to be transferred over to Edgarly and make full use of the upgraded capacity.

Option 4 – Transfer demand to other Primaries

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

Detailed description: This option would involve transferring demand away from Millfield to Edgarly as the only nearby primary. However, Edgarly primary is a single transformer primary and does not have sufficient capacity to pick up further demand as it is limited by the 11 kV backfeed capacity for the loss of the single transformer. Therefore, without upgrades as described above this is not a technically viable option.

New limiting factor for constraint(s) considered: 11 kV backfeed capacity at Edgarly Primary

Option 5 – Procure flexibility at Millfield Primary at 11 kV or below

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

Detailed description: Flexibility services could be procured to alleviate projected overloads and potentially defer reinforcement.

Solution Recommendation

It is recommended to upgrade Edgarly primary substation and consider if 11 kV circuit upgrades can be made to transfer demand away from Millfield primary. It is possible flexibility could be used to defer reinforcement, however, the upgrades would provide benefit to both Edgarly and Millfield so may be more cost-effective. Finally, to release significant capacity at Millfield a third transformer could be installed at Millfield once the other options have been fully utilised by demand growth.

3.4 Edgarly Single Transformer primary 11 kV backfeed constraints

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 3.4.1 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
11 kV backfeed overloads and low voltage on 11 kV network	Edgarly T1 Fault	None	Baseline	Baseline	Baseline	Baseline

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 3.4.2 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 additional primary transformer (Edgarly T1) and 33 kV circuit	✓	✓	✓	Viable
2	Install additional 11 kV circuits/reinforce circuits for 11 kV backfeed	✓	✓	✓	Viable
Operational Mitigation					
-	*None Identified*	-	-	-	-
Load Management Schemes					
-	*None Identified*	-	-	-	-
Flexibility services					
3	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 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 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 Edgarly primary substation.

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

Option 1 – Install additional primary transformer (Edgarly T1) and 33 kV circuit

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

Detailed description: This option would involve connecting in a second 33 kV circuit via the existing 33 kV circuits or via a new circuit to Millfield to split Edgarly onto its own ring and installing a second primary transformer. This would release a significant amount of capacity and offer the potential to transfer some demand away from Millfield primary substation via 11 kV circuits where the transformers are predicted to overload in 2028 Best View.

New limiting factor for constraint(s) considered: Existing 7.5/15 MVA transformer

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

Capacity released for constraint(s) considered: Viable

Approximately 1.8 MVA dependent on 11 kV upgrades carried out.

Detailed description: This option would involve assessing upgrades for the existing 11 kV backfeeds which supply Edgarly during a transformer fault/arranged outage. It may be possible to upgrade the existing circuits or install new 11 kV circuits to release capacity. However, the substations which supply these 11 kV circuits and associated 33 kV circuits are very limited in capacity meaning this option would not release a significant amount of capacity.

New limiting factor for constraint(s) considered: 11 kV circuits backfeeding Edgarly for the loss of T2.

Option 3 – Procure flexibility on overloaded feeders under backfeed conditions

Estimated Flexibility Required (MVA): Viable

0.5MVA+ (located on overloaded 11 kV feeders)

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.

Solution Recommendation

It is recommended to install an additional 33 kV transformer and 33 kV circuit infeed via the existing 33 kV circuits or via a new circuit to Millfield to split Edgarly onto its own ring. This releases significant capacity at Edgarly and benefits Millfield 33 kV circuit and transformer overloads meaning it is likely to offer the most cost-effective long term solution for demand growth in the area.

3.5 Martock Transformers T1/T2 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 summer peak demand.

Table 3.5.1 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
Martock T1 overload	Martock T2 Fault	None	2028	2028	2028	2028
Martock T2 overload	Martock T1 Fault	None	2028	2028	2028	2028

Uncertainty under other Distribution Future Energy Scenarios: Under leading the way scenario this constraint is also predicted to arise in 2028, under falling short scenario this constraint is predicted to appear in 2035.

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 Martock T1 and T2 with a 12/24 MVA units and ancillaries	✓	✓	✓	Viable
2	Install third primary transformer (T3)	✓	×	×	Discounted
Operational Mitigation					
3	Transfer demand to other Primaries	✓	✓	✓	Viable
Load Management Schemes					
-	*None Identified*	-	-	-	-
Flexibility services					
4	Procure flexibility at Martock Primary	✓	✓	✓	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 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. This would lead to an inability to meet the Security of Supply requirements of Engineering Recommendation P2 for Martock Primary substation.

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

Option 1 – Replace Martock T1 and T2 with a 12/24 MVA units and ancillaries

Capacity Released for constraint(s) considered: 12.7 MVA **Viable**

Detailed description: The existing 7.5/15 MVA units at Martock were installed in 1972 meaning they may be approaching a need for replacement due to age and condition. If forecasted demand growth materialises, replacement before 2028 would be required to prevent overloads. Any limiting ancillary equipment would also require replacement.

New limiting factor for constraint(s) considered: New Primary transformer capacity

Option 2 – Install third primary transformer (T3)

Capacity Released for constraint(s) considered: 15 MVA **Discounted**

Detailed description: This option would involve installing another transformer at Martock as well as associated switchgear and civil works. However, there are not enough 33 kV circuits to provide a further infeed for a third transformer and the site is limited in space, meaning significant additional works including 33 kV reinforcement would be required. Therefore, this option is not technically viable.

New limiting factor for constraint(s) considered: Capacity of existing transformers and 33 kV circuits

Option 3 – Transfer demand to other Primaries

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

Up to 2 MVA (dependent on 11 kV circuit capacity)

Detailed description: Transferring approximately 2 MVA demand to Montacute primary from Martock may enable the reinforcement to be deferred provided there is sufficient 11 kV capacity. This demand would need to be taken from the 11 kV feeders supplied from the Yeovil side in order to prevent 33 kV circuit overloads on the Yeovil side by adding additional demand (from the Street BSP side of Martock). Nonetheless, further reinforcement will be required for longer term growth at Martock. This solution may be implemented for a limited time to defer reinforcement if proven cost-effective.

New limiting factor for constraint(s) considered: 11 kV circuit capacity.

Option 4 – Procure flexibility at Martock Primary

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

Detailed description: Flexibility services could be procured to alleviate projected overloads and will be subject to a cost benefit analysis against the other reinforcement options.

Solution Recommendation

It is recommended to assess whether flexibility or 11 kV transfers can defer reinforcement and carry out a cost benefit analysis against replacing the transformers sooner. Longer term the transformers at Martock should be replaced with 12/24 MVA units to facilitate further demand growth and replace aging transformers.

3.6 Shapwick Single Transformer primary 11 kV backfeed constraints

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 3.6.1 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
11 kV backfeed overloads and low voltage on 11 kV network	Shapwick T1 Fault	None	Baseline	Baseline	Baseline	Baseline

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 3.6.2 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	Install additional primary transformer (Shapwick T2) and 33 kV circuit	✓	✓	✓	Viable
2	Install additional 11 kV circuits/reinforce circuits for 11 kV backfeed	✓	✓	✓	Viable
Operational Mitigation					
-	*None Identified*	-	-	-	-
Load Management Schemes					
-	*None Identified*	-	-	-	-
Flexibility services					
3	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 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 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 Shapwick primary substation.

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

Option 1 – Install additional primary transformer (Shapwick T2) and 33 kV circuit

Capacity Released for constraint(s) considered: 2 MVA — Viable

Detailed description: This option would involve connecting in a second 33 kV circuit via the existing 33 kV circuit between Bridgwater and Street into Shapwick primary and installing a second 7.5/15 MVA primary transformer in order to provide a more secure supply under N-1 (first circuit outage). As the existing transformer is a 5/6.25 MVA unit this does not release significant capacity for the future but does solve the baseline issues. Therefore, 11kV upgrades may be more suitable subject to further study and cost benefit analysis if required.

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

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

Capacity released for constraint(s) considered: Up to 2 MVA — Viable

Detailed description: This option would involve assessing upgrades for the existing 11 kV backfeeds which supply Shapwick during a transformer fault/arranged outage. It may be possible to upgrade the existing circuits or install new 11 kV circuits to release capacity up to the full 6.25 MVA rating of the transformer.

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

Option 3 – Procure flexibility on overloaded feeders under backfeed conditions

Estimated Flexibility Required (MVA): 0.8 MVA+ — 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.

Solution Recommendation

It is recommended to carry out a cost benefit analysis to determine if flexibility would be cost-effective in deferring reinforcement. It is likely that 11 kV circuit reinforcement offers the best reinforcement option due to the 5/6.25 MVA existing transformer limiting the benefit of having a second transformer due to N-1 capacity.