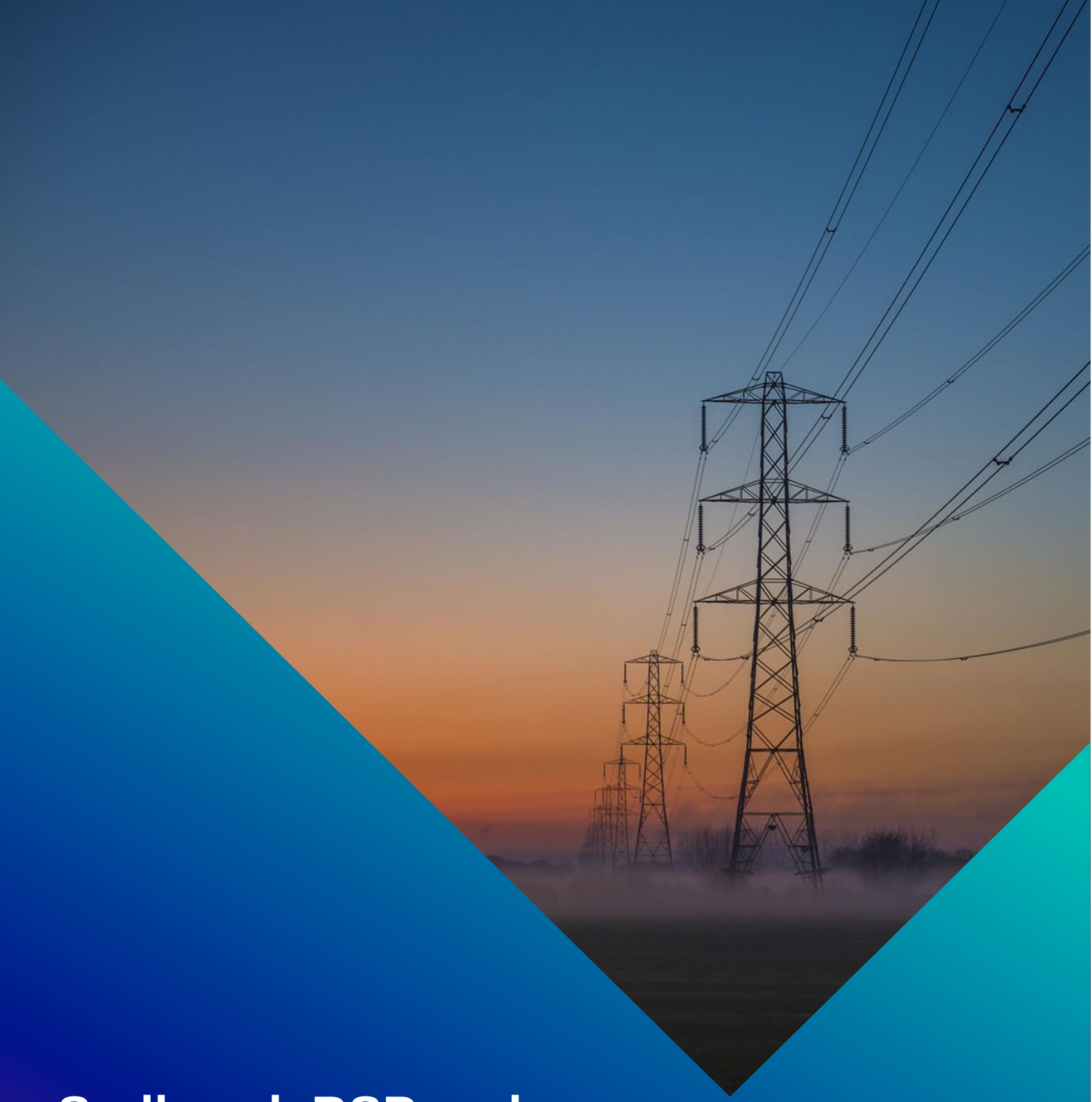

Sudbrook BSP and Associated 33 kV Network

Network Development Report – South Wales

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Electricity Distribution

nationalgrid

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Sudbrook BSP and Associated 33 kV Network

1. Network Overview

Sudbrook Bulk Supply Point (BSP) supplies a semi-rural area of 33 kV network, with demand centres at Chepstow and Caldicott. It is supplied from two 132 kV circuits from Uskmouth GSP. Sudbrook BSP together with its primary substations supplies approximately 18,500 customers.

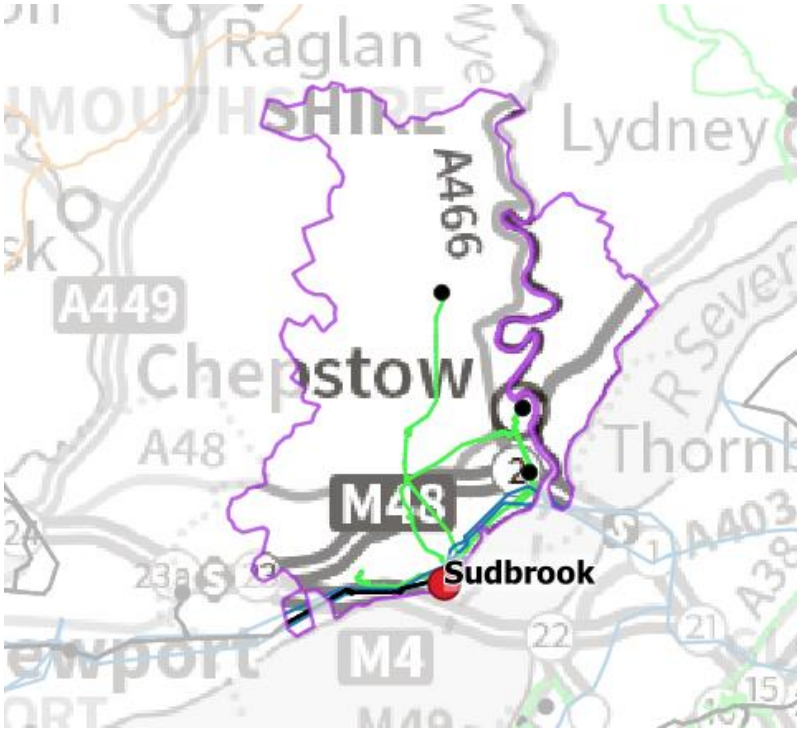

Figure 1.1 - Sudbrook BSP geographic network coverage

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

For the purposes of this analysis the NGED Best View Distribution Future Energy Scenario (DFES) has been used to study the years 2022 (baseline), 2028 and 2034, with consideration given to how proposals could change under the other scenarios. Five representative days have been studied across the four seasons: Winter Peak Demand, Intermediate Warm Peak Demand, Intermediate Cool Peak Demand, Summer Peak Demand and Summer Peak Generation.

1.1 Network Topology

The Sudbrook BSP network is arranged as follows:

- Two grid transformers running in parallel, one connected to each of the incoming 132 kV circuits.
- A two section 33 kV bar at the BSP.
- Two on-site primary transformers supplying the local Sudbrook Primary
- Four additional outgoing 33 kV circuits supplying four remote primary substations and several generation connections.
- Caldicott Primary is connected to Sudbrook BSP via a single 33 kV circuit, however an interconnector is available at the BSP to allow the circuit to be supplied via either 33 kV bar section.
- Additionally, Caldicott Primary's 11 kV bar is interconnected at 11 kV to Sudbrook Primary 11 kV bar.

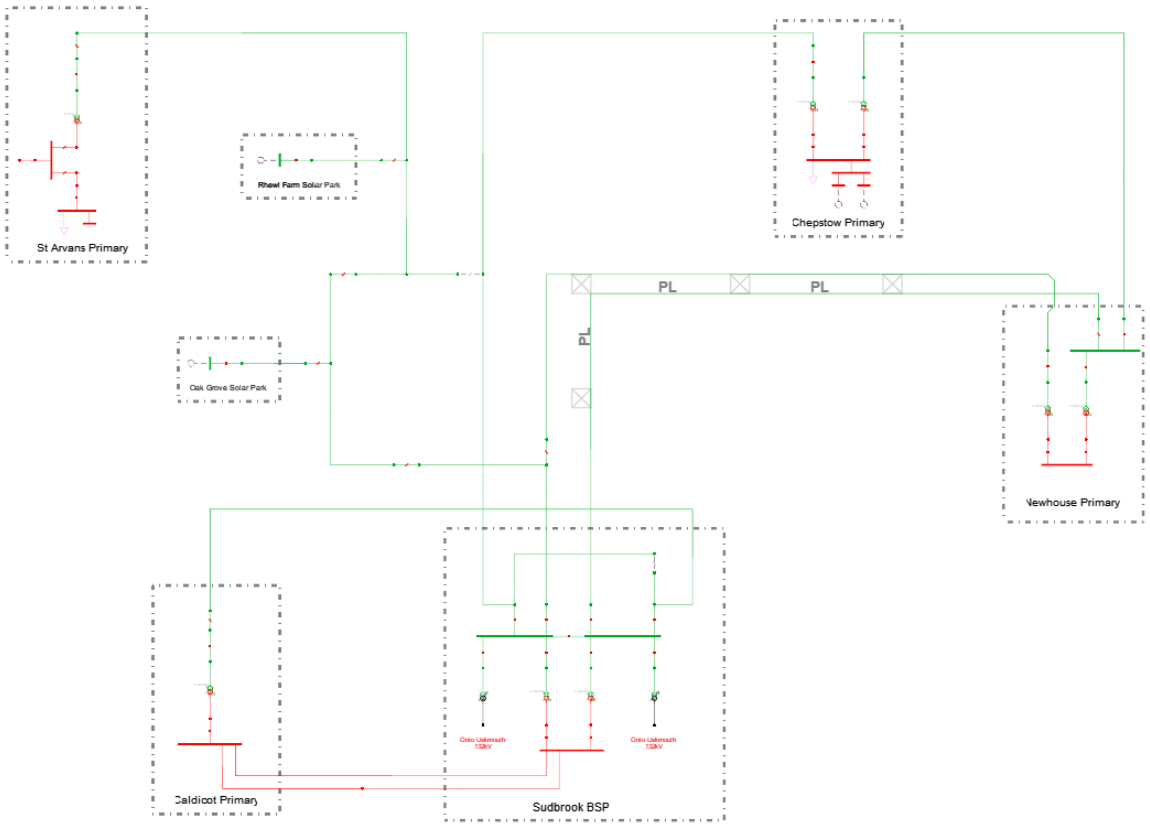

Figure 1.2 - Sudbrook BSP 33 kV network

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.

- Sudbrook BSP is a recipient of intertripping signals from Uskmouth GSP, a fault seen by circuit breakers 1005 or 1205 at Uskmouth GSP will generally trip Sudbrook 2T0 or 1T0 respectively.
- Caldicott Primary is normally transferred at 33 kV to bar section 1 for arranged outages of 4L5 or bar section 2.
- Remote ABSDs at Runston ('RUNS3_3L9' and 'WYEV3_4L9') are used to retain supplies to St Arvans Primary from Sudbrook BSP whenever possible.

2. Summary of Network Constraints

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

- Sudbrook Primary and Caldicott Primary
- Chepstow Primary transformers and Sudbrook 2L5 circuit

3. Network Constraint Details and Solution Options

3.1 Sudbrook Primary and Caldicott 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 3.1.1 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
Sudbrook T3 overload	Fault of Sudbrook Main 2 bar	None	2032	2029	2030	2031
Sudbrook T4 overload	Arranged outage of Sudbrook Main 1	Fault of Caldicott T2	2032	2029	2030	2031
Caldicott T2 overload	Fault of either Sudbrook T3 or T4	None	2031	2031	2032	2033

Uncertainty under other Distribution Future Energy Scenarios: Generally, the higher growth scenarios will advance the requirement by a year or two whilst the lower growth scenarios will delay the constraint by a similar amount.

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	New 33 kV circuit and Caldicott T1 to fully split primaries	✓	✓	✓	Viable
2	Reinforce 11 kV circuits to transfer demand to other Primaries	✓	×	✓	Discounted
Operational Mitigation					
3	Transfer demand to other Primaries	×	×	✓	Discounted
Flexibility services					
4	Procure flexibility at both primary substations	✓	×	✓	Viable

Solution Development

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

Option 0 – No Intervention

Capacity Released for constraint(s) considered: 0 MVA

Discounted

Detailed description: Doing nothing to mitigate the constraint would result in overloads for the conditions described above. This would lead to an inability to meet the Security of Supply requirements of Engineering Recommendation P2 for one or other of the primaries.

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

Option 1 – New 33 kV circuit and Caldicott T1 to fully split primaries

Capacity Released for constraint(s) considered: 8 MVA

Viable

Detailed description: Caldicott Primary is supplied by a single transformer, with two normally in service back feeds at 11 kV to provide supplies during outage conditions. These back feeds effectively mean that a single Sudbrook Primary transformer will be called on to supply the full load of both sites for certain faults. By fully splitting the two sites these constraints can be resolved.

A second transformer may be possible on the Caldicot site if the old 11 kV switch room is demolished to make room and any remaining equipment within re-sited. A second 33 kV circuit would be required from Sudbrook BSP to Caldicot Primary. The arrangement of the 33 kV bars at Sudbrook BSP will need to be considered to ensure correct distribution of the outgoing circuits.

New limiting factor for constraint(s) considered: 23 MVA

Option 2 – Reinforce 11 kV circuits to transfer demand to other Primaries

Capacity Released for constraint(s) considered: 0 MVA

Discounted

Detailed description: Due to the relatively high growth forecast for Caldicot Primary it is unlikely that modest load transfers will be suitable. Given the scope of the potential overloads a substantial load transfer into Magor Primary would be the most credible solution. Unfortunately Magor Primary is also forecast to grow substantially and there may not be enough spare capacity there to transfer enough load to resolve the constraints without causing further issues.

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

Option 3 – Transfer demand to other Primaries

Capacity Released for constraint(s) considered: dependent on 11 kV

Discounted

Detailed description: As with Option 2, long term load transfers may be counterproductive, however temporary transfers may be useful for deferring the works.

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

Option 4 – Procure flexibility at both primary substations

Estimated Flexibility Required (MVA): 11 MVA by 2034

Viable

Detailed description: Flexibility services could be procured to alleviate projected overloads and could defer reinforcement. The difficulty will be that for the different constraints that are apparent here, different flexibility services will be required. This may increase the costs, it will certainly increase the complexity of the solution.

Solution Recommendation

It is recommended that 11 kV demands are monitored and organised as far as possible between the available in-feeds. When they become unmanageable to distribute an additional infeed should be constructed. Caldicot Primary is a good location for an additional infeed as it is central in the high growth area around the motorway. Flexibility may be useful at several stages of the works to either ensure overloads are avoided, alleviate constraints entirely or provide scheduling flexibility.

3.2 Chepstow Primary, Newhouse Primary and their upstream 33 kV circuits

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
Chepstow transformer overload	Chepstow T1 or T2 fault or outage	None	2033	2034	2034	2034
Sudbrook 1L5 to Chepstow 1H0	Newhouse 4L5 to Chepstow 2T0	None	2034	n/a	n/a	n/a
Sudbrook 2L5 to Newhouse 2L3	Sudbrook Main 1 fault	None	2032	2033	n/a	n/a

Uncertainty under other Distribution Future Energy Scenarios: Under the Leading the Way Scenario this constraint is predicted to arise in 2029 and under the Consumer Transformation Scenario in 2030. Under System Transformation and Falling Short it is projected to arise beyond the period of assessment.

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	Rebuild Chepstow Primary	✓	✓	×	**Viable**
2	Upgrade 33 kV and 11 kV to balance Chepstow and Newhouse primaries	✓	✓	✓	**Viable**
Operational Mitigation					
3	Transfer demand to other Primaries	×	×	×	**Discounted**
Flexibility services					
4	Procure flexibility at Chepstow 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 Chepstow Primary.

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

Option 1 – Rebuild Chepstow Primary

Capacity Released for constraint(s) considered: 9 MVA

Viable

Detailed description: Forecasted growth at Chepstow Primary will cause both its primary transformers and both upstream 33 kV circuits to exceed their rating at various stages. A comprehensive refurbishment of both the primary substation and its circuits will be required; replacing the Chepstow Primary transformers, reconductoring approximately 7,900 m of 33 kV circuit on the Sudbrook 1L5 to Chepstow circuit and a further 1,700 m of 33 kV circuit on the Sudbrook 2L5 to Newhouse/Chepstow circuit.

New limiting factor for constraint(s) considered: 23 MVA

Option 2 – Upgrade 33 kV and 11 kV to balance Chepstow and Newhouse primaries

Capacity Released for constraint(s) considered: 8 MVA

Viable

Detailed description: Whilst the forecasted growth is stronger at Chepstow Primary, developing Chepstow Primary may be less economic than developing the adjacent Newhouse Primary and transferring sufficient load towards it. The combined load of the substation pair does not exceed the combined capacity of the available transformers so with some 11 kV development it may be possible to balance the two sites such that neither set of transformers is overloaded.

With regards to the upstream 33 kV works, the aforementioned 1,700 m of refurbishment on the Sudbrook 2L5 circuit would still be required as this circuit will still see the combined load of both sites under some combinations of outages. The 7,900 m on Sudbrook 1L5 is avoided.

New limiting factor for constraint(s) considered: 23 MVA

Option 3 – Reinforce 11 kV circuits to transfer demand to other Primaries

Capacity Released for constraint(s) considered: 0 MVA

Discounted

Detailed description: Chepstow and Newhouse primaries are strongly connected with each other but are weakly connected with other sites. The best transfers would be towards St Arvans Primary. Unfortunately this site is a single transformer primary which relies on Chepstow Primary for its main backfeeds so load transfers in that direction would be unwound under certain outage conditions. Less significant transfers would be possible towards Caldicot/Sudbrook however they may not be enough.

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

Option 4 – Procure flexibility at Watchfield and/or Burnham Primary Substations

Estimated Flexibility Required (MVA): 1 MVA by 2034

Viable

Detailed description: Flexibility services could be procured at Chepstow Primary to release the constraint.

Solution Recommendation

The 33 kV circuit works on the Sudbrook 2L5 circuit should be prioritised as they are the first element of works to be required for either of the proposed reinforcement options. The distribution of demand growth and new connections on the Chepstow and Newhouse primary substations should be monitored and, where possible, pushed towards Newhouse to endeavour to keep Chepstow below its transformer ratings.

Flexibility may be useful as both an aid to defer the works or as an enduring solution if the growth isn't severe

Longer term one of the two primaries may benefit from transformer replacement, it may be easier to achieve at Newhouse Primary than Chepstow due to upstream 33 kV constraints.

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