Abergavenny BSP, Panteg BSP and Associated 66 kV Network

Network Development Report – South Wales

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Electricity Distribution

nationalgrid

Contents

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1. Network Overview

Supplied by a system of 132 kV circuits between Rassau Grid Supply Point (GSP) and Uskmouth GSP (the AE and J Routes) is the Abergavenny/Panteg group. This area of interconnected 66 kV network supplies a significant geographic area of mostly rural demand to the north of Abergavenny town as well as circuits towards Panteg for several widely spaced load centres to the south and east. Due to the distances involved and historically low load density; 66 kV was used as a compromise between the cost and impact of 132 kV and the voltage performance of 33 kV. The two primary circuits between the main in-feed at Abergavenny BSP and the bulk of the demand to the north are routed through the Bannau Brycheiniog National Park (The Brecon Beacons).

Supplied from two 132/66 kV Grid Transformers (GTs) at Abergavenny BSP and a third at Panteg BSP, the 66 kV and below networks supply approximately 54,500 customers.

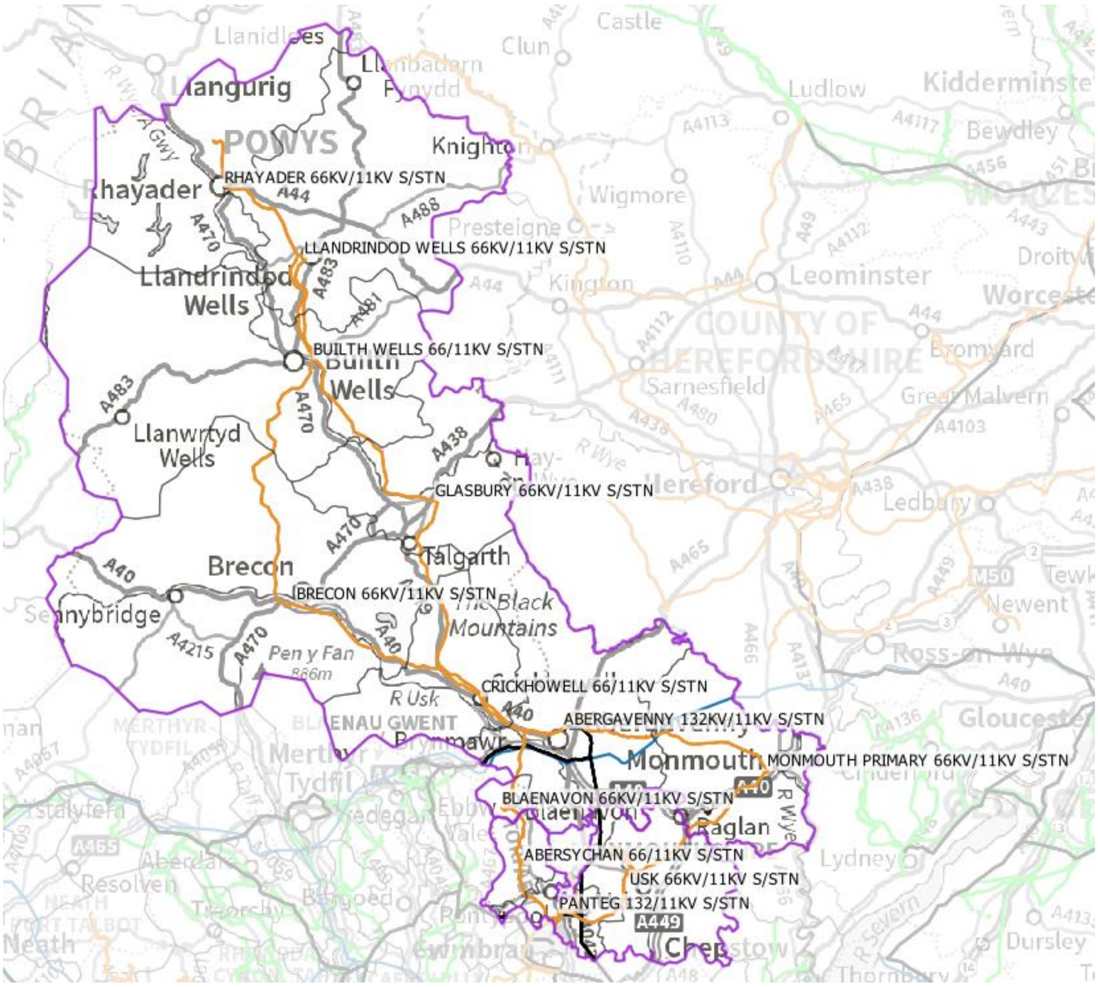

Figure 1.1 – Abergavenny and Panteg BSP geographic network coverage

This report discusses all existing and future network constraints over a 0-10 year horizon associated with the 66 kV circuits and primary substation transformers which are supplied by the Abergavenny/Panteg Group. 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 Abergavenny/Panteg Group network is arranged as follows:

- Abergavenny BSP is supplied by two 132 kV circuits from Rassau GSP, supplying two 132 kV bar sections. A pair of 132/11 kV transformers are present for the load of the immediate area around Avergavenny town and a pair of 132/66 kV transformers which supply the interconnected group beyond. The Abergavenny 132/11 kV transformers have been reviewed during the assessment of Rassau GSP group and won't be considered here.
- The 132 kV circuits continue via Pontypool North BSP to Panteg BSP. Panteg BSP currently has three operable sections at 132 kV, the section supplying the 132/66 kV GT is directly fed from Rassau GSP.

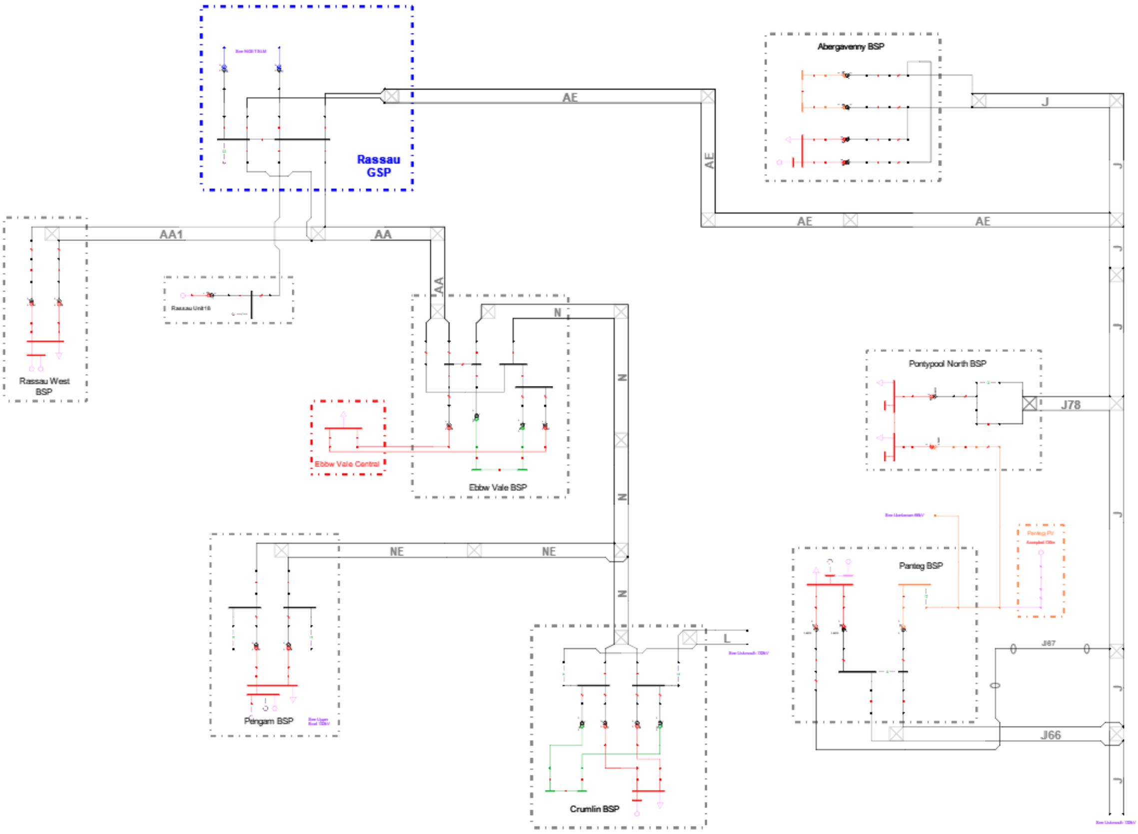

Figure 1.2 - Rassau GSP Single Line Diagram

- The 66 kV network is formed into large rings fed from Abergavenny BSP.
- The "Northern Ring" out of Abergavenny supplies a total of six primary substations and two 66 kV wind farms. There is a full single busbar at Builth Wells primary substation, the further out Llandrindod Wells Primary is fed from there with Rhayader primary substation and the wind farms teed off of one side.
- Glasbury 11 kV bar is complemented with three capacitor banks. These can be used in order to boost the 66 kV voltage on the Northern Ring. These banks are used during periods of high demand to protect the network against potential voltage drops if 66 kV circuit faults were to occur.
- The "Southern Ring" between Abergavenny and Panteg BSP supplies a further four primary substations and two 66 kV solar parks.

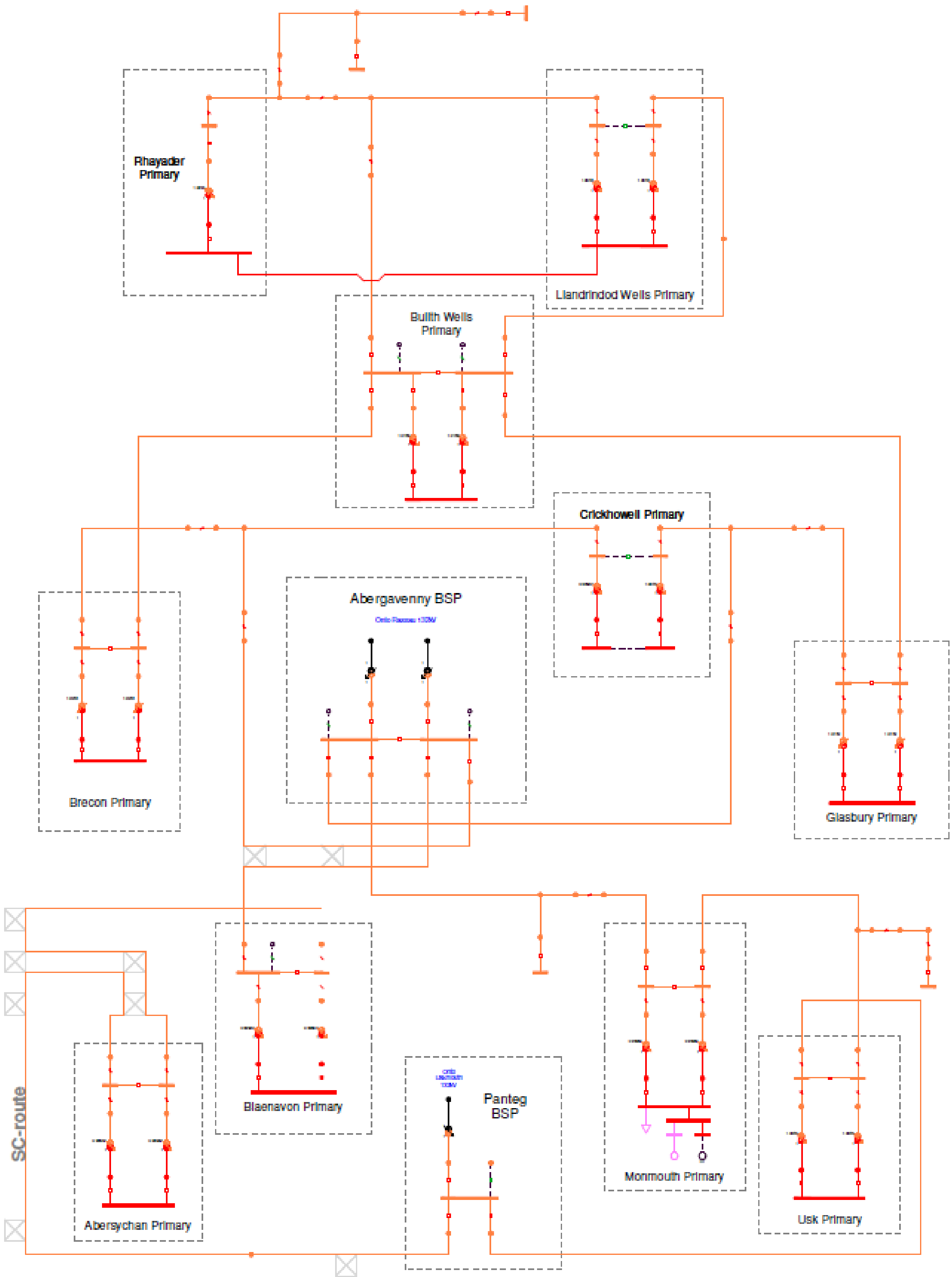

Figure 1.3 - Abergavenny/Panteg Group 66 kV

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.

- Upstream 132 kV outages or 66 kV outages at Abergavenny will often cause the loss of one of the 132 kV in-feeds at Abergavenny. A single transformer is not capable of supplying the whole group so the Southern Ring is split away from Abergavenny during these conditions to ensure network integrity during any potential following faults. Load will be lost for some subsequent faults and as much as possible (depending on prevailing conditions) can be restored afterwards.
- In addition, for Abergavenny GT outages, the Northern 66 kV ring will also be split into two radial circuits to avoid potentially problematic topologies that can result for some following faults.
- Some 132 kV arranged outages around this group require the transfer of Panteg BSP into Uskmouth GSP, to avoid potential overloads for the faults that may follow. This is achieved with the 132 kV bus section breaker at Panteg 132 kV bar.
- Intertripping is present from the 66 kV breakers at Builth Wells towards Llandrindod Wells and Rhayader primary substation to ensure the circuits are tripped cleanly, this relates to a significant generation unit embedded within Rhayader’s 11 kV network which may need to constrain their export.

2. Summary of Network Constraints

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

- 66 kV voltage and circuit overloads north of Abergavenny BSP
- Primary transformer capacity around Builth Wells area
- Blaenavon primary transformers overload
- Brecon primary transformers overload

3. Network Constraint Details and Solution Options

3.1 66 kV voltage and circuit overloads north of Abergavenny BSP

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. The voltage based constraints are managed through the use of power factors for some generation, agreements with certain customers extending the minimum voltages that it is permissible to supply them at and the use of the capacitors at Glasbury. Whilst the voltage concerns are not driving the requirement of a solution for this constraint, they do limit the options for reinforcement as they must also be resolved.

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
66 kV circuit between Abergavenny and Glasbury overload	66 kV circuit between Abergavenny and Brecon	None	2029	2029	2029	2032
66 kV circuit between Abergavenny and Brecon overload	66 kV circuit between Abergavenny and Glasbury	None	2029	2029	2029	2032
66 kV voltage issues (high or low depending on season)	66 kV circuit between Abergavenny and Brecon	None	2028	2028	2034	2034
66 kV voltage issues (high or low depending on season)	66 kV circuit between Abergavenny and Glasbury	None	2028	2028	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: Under the Leading the Way scenario the thermal constraints are forecast by 2027, under Consumer Transformation by 2029, under System Transformation by 2031 and under Falling Short by 2032.

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	Reinforce the existing 66 kV circuits	✓	×	×	Discounted
2	Construct a third 66 kV circuit	✓	×	✓	Viable
3	Construct a new 132 kV circuit to supply a new BSP	✓	✓	✓	Viable
Operational Mitigation					
4	Transfer demand at 66 kV	×	×	×	Discounted
5	Transfer demand at 11 kV	×	×	×	Discounted
Load Management Schemes					
6	Post-fault transfers	×	×	×	Discounted
Flexibility services					
7	Procure flexibility across the group	✓	×	✓	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 Abergavenny BSP

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

Option 1 – Reinforce the existing 66 kV circuits

Capacity Released for constraint(s) considered: Approximately 5-10 MVA **Discounted**

Detailed description: The existing circuits are constructed of 150 mm^2 AAAC AL3 “Ash” conductor, already a relatively large size. Moving from this conductor to sizes which are available on similar structures will only bring incremental improvements, especially with regards to the voltage performance. If the supporting structure’s heights require a greater than 10% increase (likely, if an enhanced running temperature was to be specified) to support the new conductor then a revised planning consent would be required despite re-using the existing route. Approximately 65 km of conductor replacement would be required to clear the initial thermal constraints, however much of the rest of the ring would require improvement as time goes on, the total ring length is around 114 km. Due to high costs and limited benefit this option has been discounted due to poor cost benefit.

New limiting factor for constraint(s) considered: The new thermal rating would be dependent on any conductor clearance limitations but for comparative purposes 175 mm^2 “Elm” conductor running at the same 50^0C operating temperature would be limited to 55.7 MVA

Option 2 - Construct a third 66 kV circuit

Capacity released for constraint(s) considered: 15-20 MVA **Viable**

Detailed description: The shortest new circuit construction which brings real benefit would be between Abergavenny BSP and Brecon Primary, a distance of approximately 30km. As this route would be largely within the extent of the National Park a predominantly cable construction would be expected, increasing costs. Assuming appropriate revisions to the running arrangements of the group this circuit will effectively remove Brecon primary substation from the worst case outages. Careful operation of the resultant network will be required as there are many N-2 risks to avoid with the new topology, it is expected that various 66 kV splits would be required for the different arranged outages.

New limiting factor for constraint(s) considered: The limiting factor will still be the rating of the 150 mm^2 Ash conductor, which is 50.4 MVA in winter, albeit with one or two less primary substations being supplied over it under the worst case outages.

Option 3 - Construct a new 132 kV circuit to supply a new BSP

Capacity released for constraint(s) considered: 50-70 MVA **Viable**

Detailed description: An extension of Option 2 would be to run the new circuit at 132 kV rather than 66 kV. This would bring some significant advantages and disadvantages.

The source of the 132 kV circuit would need to be a 132 kV source that doesn’t already supply Abergavenny BSP, the closest location is Rassau GSP. There is difficulty at Rassau creating connection points so this scheme may require waiting for other works at that site (see section 3.1 of the Rassau GSP report) in order to proceed. A new site or major extension to an existing site would be required at the remote end in order to site the required Grid Transformer. The initial proposal is to form a new site to the north of Brecon town (outside the National Park), obtaining and consenting this compound will be an additional challenge. The resultant new circuit distance is approximately 25km. Once again, a largely cable construction would be expected through the National Park.

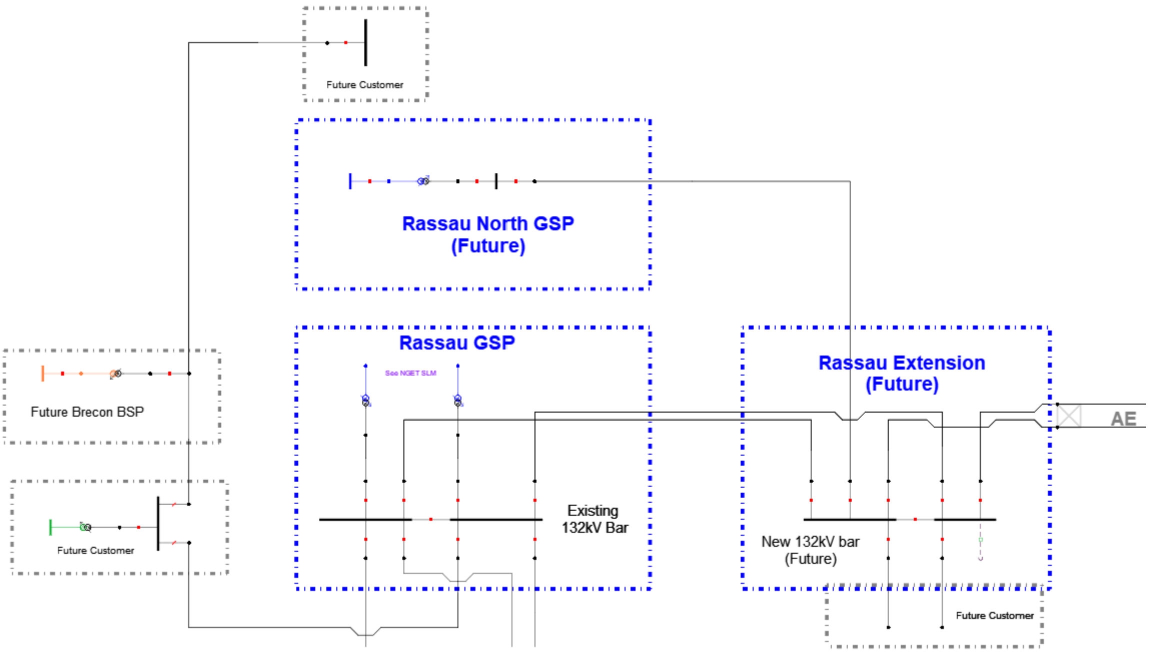

Figure 3.1 - Possible future 132 kV arrangement, see Rassau report section 3.1

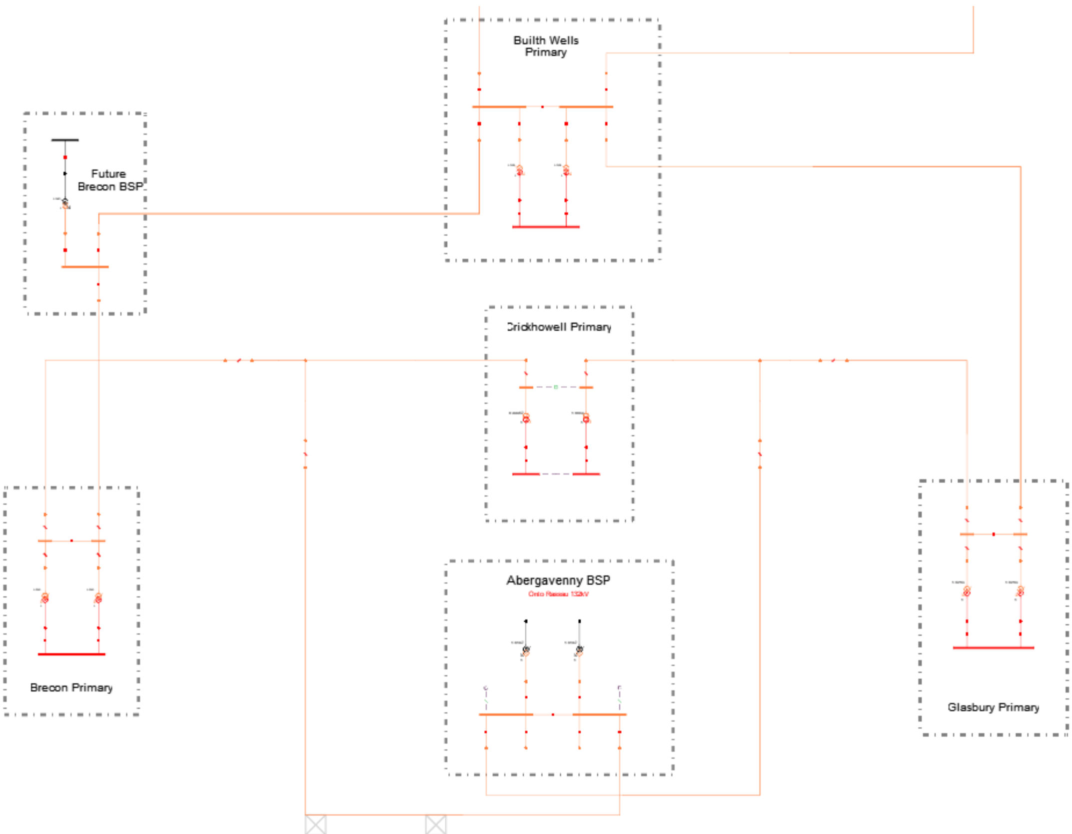

Figure 3.2 – Potential future 66 kV arrangement

A key constraint of the new 66 kV network topology will be the loss of the single circuit between the new in-feed and the Builth Wells bar, as the future forecasts are that the Builth/Llandrindod/Rhayader area is to experience a significant increase in load. A second 66 kV circuit between the new in-feed and the Builth Wells bar may be required to improve the resilience of the final network arrangement. The further north the new site is deployed the easier resolving these future constraints will be.

Running the new circuit at 132 kV would permit substantial new capacity to be created in addition to the improvements at 66 kV. This area has been highlighted as a priority area by the Welsh Assembly for renewable energy generation, new schemes could be made viable by this work.

A key advantage of this option is that you are bringing the voltage control up from Abergavenny BSP to the new BSP, potentially reducing the distance over which voltage can rise by up to 30 km. This hugely improves voltage performance at the remote ends of the 66 kV, effectively resolving all current and future voltage constraints whilst there is a connection to the new voltage controlled bar.

Another advantage would be reduced losses from the higher voltage of distribution.

The 132 kV construction will bring increased construction costs as well as planning difficulties from the required Development Consent Order.

New limiting factor for constraint(s) considered: Typical 132 kV cable for such a project might be 630 mm^2 XLPE, with a winter thermal rating of 256 MVA.

Option 4 – Transfer demand at 66 kV

Capacity Released for constraint(s) considered: 0 MVA

Discounted

Detailed description: The 66 kV network is isolated from adjacent networks, no 66 kV transfers are available.

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

Option 5 – Transfer demand at 11 kV

Capacity Released for constraint(s) considered: 0 MVA

Discounted

Detailed description: There are only very limited transfers that are available to bring demand out of the area of concern to an adjacent network, this is largely because the National Park is effectively the line of constraint and the only transfers are small circuits that cross the Park. Given the scale of the constraint these transfers will not provide an enduring solution however they might be useful for scheduling assistance.

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

Option 6 – Post-fault transfers

Capacity Released for constraint(s) considered: 5 MVA

Discounted

Detailed description: As with Option 5, there are inadequate available transfers to provide a long term solution

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

Option 7 – Procure flexibility across the group

Estimated Flexibility Required (MVA): 23.7 MVA by 2034 (Best View)

Viable

Detailed description: Flexibility services could be procured to alleviate projected overloads in the short term. This could defer reinforcement but due to the large quantity of flexibility required in the long term this may not be a viable permanent solution. Given the complexity of the probably solutions in this network, the available flexibility should be tested for use in scheduling and constraint deferral.

Solution Recommendation

It is recommended to proceed with Option 3 which will create substantially more new capacity at a proportionally more economic cost. This is the most complex and time consuming Option and has interactions with the progression of works at Rassau GSP for both reinforcement and customer connections. It is recommended that 11 kV transfers and flexibility availability are investigated in case this subordinate work must be delayed.

3.2 Primary transformer capacity around Builth Wells area

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
Builth Wells primary transformer overload from demand growth	Fault of either Builth Wells transformer	None	2033	2031	2031	2033
Rhayader primary transformer overload from generation growth	Fault of either Builth Wells transformer	None	n/a	n/a	n/a	2026

Uncertainty under other Distribution Future Energy Scenarios: Under the Leading the Way scenario the thermal constraints are forecast by 2025, under Consumer Transformation by 2025, under System Transformation by 2027 and under Falling Short by 2029.

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	Replace existing transformers at Builth Wells	✓	✓	✓	Viable
2	Develop Rhayader primary substation	✓	✓	✓	Viable
Operational Mitigation					
3	11 kV demand transfers to adjacent primary substations	×	×	×	Discounted
Load Management Schemes					
4	Post-fault transfers	×	×	×	Discounted
Flexibility services					
5	Procure flexibility	✓	✓	✓	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 Builth Wells Primary and Rhayader Primary.

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

Option 1 – Replace existing transformers at Builth Wells

Capacity Released for constraint(s) considered: 8 MVA

Viable

Detailed description: The existing transformers are 7.5/15 MVA rated, they could be replaced with a pair of 11.5/23 MVA units. This will resolve the demand led issues at Builth Wells primary substation but will not help the generation led issues at Rhayader primary substation unless it is possible to transfer sufficient 11 kV from Rhayader to Builth Wells.

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

Option 2 – Develop Rhayader primary substation

Capacity released for constraint(s) considered: 19 MVA

Viable

Detailed description: Rhayader primary substation has a single 66 kV circuit and a singe 66/11 kV transformer. By 2034 the forecast is that significant generation connections will have pushed the site beyond its generation capacity. In addition, the demand of the site must be backfed from Llandrindod Primary under outage conditions at 11 kV, this interconnection is also at risk of overloading as demand grows at the site.

By building out Rhayader Primary Substation and transferring load within the Rhayader/Llandrindod/Builth 11 kV network, it should be possible to mitigate both sets of constraints by building out Rhayader. The core elements of the work are:

- One new 66/11 kV transformer at Rhayader Primary
- Around 10 km of new 66 kV circuit
- Sufficient switchgear to protect the new equipment

Additional elements which may be required:

- Additional 11 kV switchgear at Rhayader, or a whole new board, if the existing complement is insufficient.
- A replacement transformer for the existing unit if it is not suitable.
- Improvements to the existing intertripping systems between Builth/Llandrindod/Rhayader as required to bring it in line with the new topology.

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

Option 3 – 11 kV demand transfers to adjacent BSPs

Capacity Released for constraint(s) considered: 0 MVA

Discounted

Detailed description: Whilst the Rhayader/Llandrindod/Builth 11 kV network is reasonably strongly interconnected with itself, connections are very limited to the outside of this network area. It is not possible to transfer enough demand at 11 kV to provide a long term solution

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

Option 4 – Post-fault transfers

Capacity Released for constraint(s) considered: 0 MVA

Discounted

Detailed description: As with Option 3, there are inadequate available transfers to provide a long term solution

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

Option 5 – Procure flexibility

Estimated Flexibility Required (MVA): 1 MVA+ by 2034 Viable

Detailed description: We do not currently procure generation turn down flexibility services due to limitations in internal tooling. However we are looking to build out this capability, which should be available before intervention is needed. Separate flexibility procurements could be made for each site.

Solution Recommendation

Rhayader Primary is forecast to require reinforcement due to generation growth in a shorter period than Builth Wells Primary, if the required work there can be extended to substantially defer any work at Builth Wells with additional 11 kV transfers then that would be favourable.

3.3 Blaenavon primary transformers 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 for intermediate cool demands.

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
Blaenavon primary transformers overload	Fault or outage of the other transformer	None	2034	2032	2034	2033

Uncertainty under other Distribution Future Energy Scenarios: Under the Leading the Way scenario the constraint is forecast by 2033, under the other scenarios the constraint is 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 3.3.2 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 the Blaenavon primary transformers	✓	✓	✓	Viable
Operational Mitigation					
2	11 kV demand transfers to adjacent primaries	✓	×	✓	Viable
Flexibility services					
3	Procure flexibility for Newport East	✓	✓	✓	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 Blaenavon BSP.

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

Option 1 – Replace the Blaenavon primary transformers

Capacity Released for constraint(s) considered: 9 MVA — Viable

Detailed description: Replacing the 14 MVA rated units with new 11.5/23 MVA units would create sufficient new capacity to resolve the constraint.

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

Option 2 – 11 kV demand transfers to adjacent primaries

Capacity released for constraint(s) considered: 0 MVA — Viable

Detailed description: Blaenavon Primary is forecast to be 1.5 MVA overloaded by 2034, within the scope of this assessment 11 kV load transfers may be adequate to resolve the constraint.

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

Option 3 – Procure flexibility for Blaenavon primary substation

Estimated Flexibility Required (MVA): 1.5 MVA+ by 2034 — Viable

Detailed description: Flexibility services could be procured at Blaenavon to resolve this constraint.

Solution Recommendation

The group of primary substations in this area are not overloaded on aggregate, the scope of the constraint in this instance can likely be mitigated through 11 kV transfers. If 11 kV transfers are not possible or not recommended due to adjacent constraints then the reinforcement of Blaenavon primary is recommended through replacing the transformers.

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