Feckenham GSP Network

Network Development Report – West Midlands

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Electricity Distribution

nationalgrid

Contents

Feckenham GSP Network

1. Network Overview

Feckenham is a 66 kV Grid Supply Point (GSP) that supplies a relatively large area covering Stratford, Evesham, Stow, and parts of Worcestershire areas, connecting over 149,000 customers. The network comprises several 66 kV circuits, interconnected and meshed together in certain areas, supplying twenty primary substations in total.

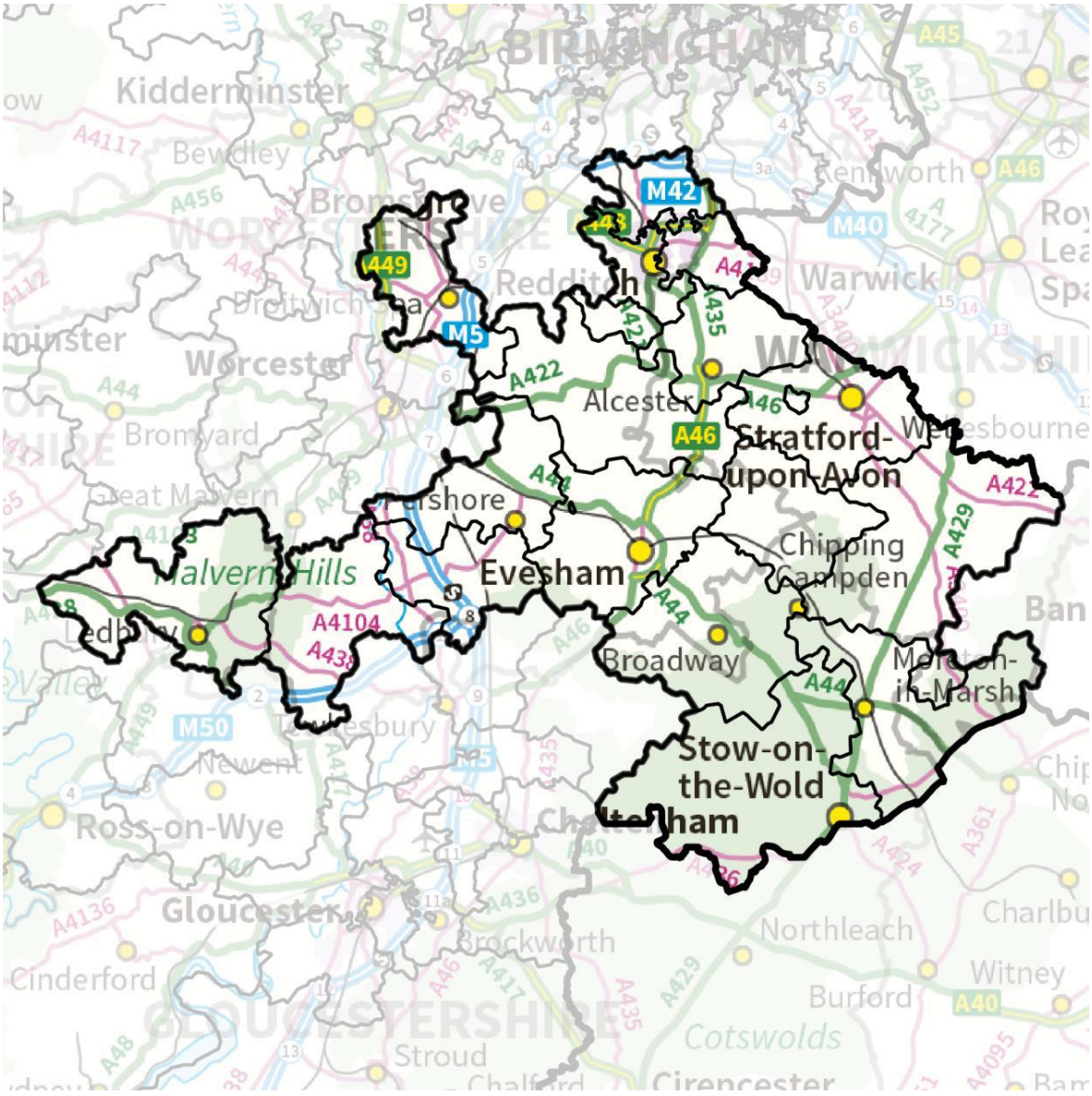

Figure 1.1 Feckenham GSP geographic network coverage

This report discusses existing and future network constraints over a 0-10 year horizon associated with Feckenham and its downstream network. It uses the methodology outlined in the Network Development Plan Methodology Report with Network Operability Modelling applied as outlined further below.

For the purposes of this analysis the NGED Best View Distribution Future Energy Scenario (DFES) has been used to study each year up to and including 2034. Representative days for each of the four seasons (Winter, Intermediate Cool, Intermediate Warm, and Summer) have been studied to cover the edge case scenarios for the network.

1.1 Network Topology

Feckenham GSP is a 66 kV site fed via three 400/66 kV Super Grid Transformers (SGTs), and one 275/66 kV SGT (supplied via a 400/275 kV transformer); all running solid through the 66 kV ring busbar configuration.

The GSP feeds twenty 66/11 kV primary substations supplying local demands, most of which are connected through circuits configured as a ring, and interconnected with each other. These are broken down below for clarity.

- Great Alne, Drayton Farm, and Stratford primaries form a ring to the north of Feckenham, supplied via two 66 kV circuits either side, with an interconnector between Stratford and Shipston normally run closed.
- Bevington, Long Marston, and Shipston primaries are fed via two 66 kV circuits from Feckenham, run closed via Shipston's ringed busbar configuration, with interconnections to Stratford (to the north) and Morton (to the south), both normally run closed.
- Epwell and Bloxham primaries have a pair of 66 kV circuits from Shipston, with one half of the primaries on the Feckenham network and the other half fed out of a single 132/66 kV transformer at Banbury Bulk Supply Point (BSP), normally run split with the Feckenham network.
- Broadway, Stow, and Moreton primaries are fed via two 66 kV circuits within the Feckenham network, one from Shipston and the other from Evesham primary.
- Evesham, Strensham, Pershore, and Droitwich T3 are fed via three 66 kV circuits from Feckenham; two via Evesham and one on the northern side between Feckenham and Droitwich/Pershore tee.

  Out of this ring, a 66 kV radial circuit from Strensham supplies Brotheridge Green, Tewkesbury 66/11 kV primary, and Ledbury T2 (with interconnection to the Hereford network, via Ledbury, normally run open).
- At Droitwich, T1 and T2 are on Bishops Wood network via a 66 kV interconnector from Stourport BSP, normally run split with the Feckenham network.
- At Evesham, there is a 66 kV radial feeder picking up Wormington primary, with an interconnector to Port Ham network that normally runs open at Wormington.
- Redditch South, Ipsley, and Redditch North primaries are fed via three 66 kV circuits; two via Redditch South and run in parallel with each other, and the third picks up Redditch North T1 and Redditch South T2 only, and is run split from the other two.

  This part of the network also has interconnection to Bishops Wood via a 66 kV circuit to Redditch North picking up T3 only.

1.2 Network Operability Modelling

The analysis modelling covers automation and manual switching schemes that represent how the network is generally operated. Some of the main ones are listed below.

Feckenham 66 kV:

- Arranged outages affecting the infeed to Bloxham and Epwell from Banbury results in Shipston 66 kV busbars being closed in to pick up the demand.
- For arranged outages affecting the main infeeds to some of the interconnected rings, open points are introduced to prevent (following a subsequent fault outage) thermal overloads or voltages falling outside of statutory limits. This includes:
    - Splitting the 66 kV network between Stratford and Shipston for outages at either side. This may involve splitting between Shipston and Morton as well.
    - Transferring Epwell and Bloxham to Banbury BSP for outages along the Feckenham-Bevington-Long Marston-Shipston circuits, but on a longer term basis the 66 kV circuits to Bevington, approximately 8.5 km of 0.1 in Aluminium Conductor Steel Reinforced (ACSR) double circuit tower line, may need to be uprated.
    - Splitting the 66 kV network at Evesham for outages affecting the Feckenham-Evesham circuits.
- Arranged or fault outages leading to loss of a primary transformer at Feckenham primary, Bevington, Long Marston, Shipston, Epwell, Bloxham, Stratford, Great Alne, Broadway, Evesham, Pershore, Droitwich, Redditch South, Redditch North, and Ipsley results in the 11 kV at these sites being closed in to backfeed from the other transformer(s).

2. Summary of Network Constraints

The following constraints were identified for the Best View Scenario, for which mitigation options are covered further down in the report:

- Epwell transformer overload
- Shipston transformer overload
- Evesham transformer overload
- Stratford transformer T1 and T2 overload
- Pershore transformer overload
- Broadway transformer overload
- Redditch North transformer T1 overload
- Broadway-Stow-Moreton 66 kV ring constraints
    - Evesham to Broadway 66 kV circuit overload
    - Broadway to Northwick tee 66 kV circuit overload
    - Northwick tee to Stow tee 66 kV circuit overload
    - Stow tee to Moreton 66 kV circuit overload
    - Moreton to Shipston 66 kV circuit overload
    - Voltage constraints at 66 kV
- Feckenham-Evesham-Strensham network
    - Feckenham to Evesham_9L5 66 kV circuit overload
    - Evesham to Strensham 66 kV circuit overload
    - High and Low volts at 66 kV across the ring

Transmission-Distribution interface

Feckenham GSP is a 400/66 kV site and the boundary between the transmission and distribution network for that area. New Connection activity at the distribution network, both demand and generation, have triggered constraint at the transmission network with regards to SGT capacity and 400 kV circuit ratings. Proposals to mitigate are being considered including adding additional SGTs on site, but on a longer term basis, a second GSP around Evesham may need to be considered.

3. Network Constraints and Solution Options

3.1 Epwell transformer overload

Constraint Overview

Generation Demand

Epwell primary is a 66/11 kV site consisting of two 10 MVA primary transformers (commissioned in 1963) with T1 normally fed from Banbury BSP and T2 from Feckenham via Shipston.

The primary is Class B under Engineering Recommendation P2, expected to become Class C by 2028.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.1.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Epwell transformer overload	N-1: Outage of either of the two transformers at Epwell	2028	Baseline	Baseline	2029

Uncertainty under other Distribution Future Energy Scenarios: The constraints above are identified under Best View and worsened under some of the other Distribution Future Energy Scenarios. The demand in the region is generally on an upward trend indicating constraints are potentially getting worse if not addressed, but the trigger year may vary depending on how quickly demand and/or generation materialises.

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 identified constraint(s)

Option	Description	Solves constraint	Potentially economic	Wider benefit	Viable or Discounted
1	No Intervention	×	✓	×	Discounted
Reinforcement (build) options					
2	Uprating the existing transformers	✓	✓	×	Viable
3	Adding a third transformer	✓	✓	×	Viable
Operational mitigation					
4	Load transfers	×	✓	×	Discounted
Load Management Schemes					
5	Post-fault inter-trips	×	✓	×	Discounted
Flexibility services					
6	Flexibility service procurement	✓	✓	×	Viable

Solution Development

These options have been assessed on their technical viability and cost-effectiveness pending a more detailed cost benefit analysis (CBA) by the DNO. The section below covers more detail on these options.

Option 1 – No Intervention

Estimated capacity released: 0 MVA

Discounted

Detailed description: The constraint is anticipated to trigger by 2029 with the demand projected to continue increasing thereafter. Doing nothing could therefore lead to thermal overloads and the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Rating of existing transformers

Option 2 – Uprating the existing transformers

Estimated capacity released: 20 MVA

Viable

Detailed description: Uprating the existing transformers, the works include:

- Replacing the existing 10 MVA transformers with 20/40 MVA units
- Replacing the existing 1250 amp 11 kV board with a 2000 amp rated one

New limiting factor: Rating of transformers

Option 3 – Adding a third transformer

Estimated capacity released: 20 MVA

Viable

Detailed description: Adding a third transformer on site, the works include the following:

- Extending the 66 kV busbars with additional two bus-section circuit breakers and a new transformer bay
- Installing a third 66/11 kV transformer rated 12/24 MVA
- Installing an additional 11 kV 2-section board suitably interconnected with the existing

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A couple of MVAs

Discounted

Detailed description: Epwell primary has limited 11 kV interconnection to other sites, which may be used to manage the baseline constraints in the interim but will be insufficient as a medium-long term solution.

New limiting factor: Rating of the transformers

Option 5 – Load Management Schemes: Post-fault inter-trips

Estimated capacity released: 0 MVA

Discounted

Detailed description: Epwell primary is Class B under Engineering Recommendation P2, expected to become Class C by 2028 which would require restoration of the demand within 15 minutes for a circuit outage; therefore demand disconnection schemes (or similar) would make the site non-compliant.

New limiting factor: Engineering Recommendation P2 non-compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 7 MW+ Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could help alleviate the constraint and defer reinforcement. This option would be subject to a cost benefit analysis closer to the time, including all necessary sufficiency checks.

New limiting factor: Rating of the transformers

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue option 2 above (uprating the existing transformers) as it avoid complicating the network and will likely be a more cost-effective solution especially when considering the age of the existing assets.

The baseline constraints however may need to be managed via load transfers in the interim, but this would not be an enduring solution.

Any reinforcement solution however would be subject to a CBA by the DNO, and in this case, it would then be tested against the flexibility market as part of the Distribution Network Options Assessment (DNOA) process.

3.2 Shipston transformer overload

Constraint Overview

Generation Demand

Shipston primary is 66/11 kV site consisting of two 12/24 MVA transformers (commissioned in 2021) fed from the Feckenham network. The primary is Class C under Engineering Recommendation P2.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.2.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Shipston transformer overload	N-1: Outage of either of the two transformers at Shipston	-	2029	2030	-

Uncertainty under other Distribution Future Energy Scenarios: The constraints above are identified under Best View and worsened under some of the other Distribution Future Energy Scenarios. The demand in the region is generally on an upward trend indicating constraints are potentially getting worse if not addressed, but the trigger year may vary depending on how quickly demand and/or generation materialises.

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 identified constraint(s)

Option	Description	Solves constraint	Potentially economic	Wider benefit	Viable or Discounted
1	No Intervention	×	✓	×	Discounted
Reinforcement (build) options					
2	Uprating the existing transformers	✓	✓	×	Viable
3	Adding a third transformer	✓	✓	×	Viable
Operational mitigation					
4	Load transfers	×	✓	×	Discounted
Load Management Schemes					
5	Post-fault inter-trips	×	✓	×	Discounted
Flexibility services					
6	Flexibility service procurement	✓	✓	×	Viable

Solution Development

These options have been assessed on their technical viability and cost-effectiveness pending a more detailed CBA by the DNO. The section below covers more detail on these options.

Option 1 – No Intervention

Estimated capacity released: 0 MVA

Discounted

Detailed description: The constraint is anticipated to trigger by 2033 with the demand projected to continue increasing thereafter. Doing nothing could therefore lead to thermal overloads and the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Rating of existing transformers

Option 2 – Uprating the existing transformers

Estimated capacity released: 12 MVA

Viable

Detailed description: Uprating the existing transformers, the works include:

- Replacing the existing 12/24 MVA transformers (commissioned in 2021) with 20/40 MVA units.

[The 11 kV board is 2000 amp rated and would therefore not need to be replaced.]

New limiting factor: Rating of transformers

Option 3 – Adding a third transformer

Estimated capacity released: 18 MVA

Viable

Detailed description: Adding a third transformer on site, the works include the following:

- Establishing a new 66 kV transformer bay at Shipston, between the Long Marston no1 and Stratford bays.
- Installing a third 12/24 MVA 66/11 kV transformer at Shipston
- Installing an additional 2-section 11 kV board suitably interconnected with the existing
- A couple of 66 kV and 11 kV terminal wood poles on-site may need to be undergrounded to provide additional space for the new assets

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A few MVAs

Discounted

Detailed description: Shipston primary has limited 11 kV interconnection to other sites, which may be utilised to manage the constraints in the interim but will be insufficient longer term, and therefore not viable as an enduring solution.

New limiting factor: Rating of the transformers

Option 5 – Load Management Schemes: Post-fault inter-trips

Estimated capacity released: 0 MVA

Discounted

Detailed description: Shipston primary is Class C under Engineering Recommendation P2 which would require restoration of the demand within 15 minutes for a circuit outage; therefore demand disconnection schemes (or similar) would make the site non-compliant.

New limiting factor: Engineering Recommendation P2 non-compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 2 MW+

Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could help alleviate the constraint and defer reinforcement. This option would be subject to a cost benefit analysis closer to the time, including all necessary sufficiency checks.

New limiting factor: Rating of the transformers

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue option 3 above (adding a third transformer) as it will likely be more cost-effective and avoid having to decommission relatively new assets that still have many years of service.

Given the constraints are observed in the intermediate cool and intermediate warm seasons only, and that the demand is not dominated by commercial nor industrial load, it will be worth re-assessing the seasonal ratings of these transformers before commencing any physical works.

Any reinforcement solution however would be subject to a CBA by the DNO, and in this case, it would then be tested against the flexibility market as part of the DNOA process.

3.3 Evesham transformer overload

Constraint Overview

Generation Demand

Evesham primary is 66/11 kV site consisting of two 30 MVA transformers (commissioned in 1963) fed from Feckenham 66 kV network. The primary is Class C under Engineering Recommendation P2.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.3.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Evesham transformer overload	N-1: Outage of either of the two transformers at Evesham	2031	Baseline	2027	-

Uncertainty under other Distribution Future Energy Scenarios: The constraints above are identified under Best View and worsened under some of the other Distribution Future Energy Scenarios. The demand in the region is generally on an upward trend indicating constraints are potentially getting worse if not addressed, but the trigger year may vary depending on how quickly demand and/or generation materialises.

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 identified constraint(s)

Option	Description	Solves constraint	Potentially economic	Wider benefit	Viable or Discounted
1	No Intervention	×	✓	×	Discounted
Reinforcement (build) options					
2	Uprating the existing transformers	✓	✓	×	Viable
3	Adding a third transformer	✓	✓	×	Viable
Operational mitigation					
4	Load transfers	×	✓	×	Discounted
Load Management Schemes					
5	Post-fault inter-trips	×	✓	×	Discounted
Flexibility services					
6	Flexibility service procurement	✓	✓	×	Viable

Solution Development

These options have been assessed on their technical viability and cost-effectiveness pending a more detailed CBA by the DNO. The section below covers more detail on these options.

Option 1 – No Intervention

Estimated capacity released: 0 MVA

Discounted

Detailed description: The constraint is imminent and the demand is projected to continue increasing. Doing nothing could therefore lead to thermal overloads and the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Rating of existing transformers

Option 2 – Uprating the existing transformers

Estimated capacity released: 8 MVA

Viable

Detailed description: Uprating the existing transformers, the works include:

- Replacing the existing 30 MVA transformers with 20/32/40 MVA units
- Replacing transformer T1 11 kV circuit breaker CB22, and the interconnector CB20, with 2000 amp rated ones

New limiting factor: Rating of transformers

Option 3 – Adding a third transformer

Estimated capacity released: 30 MVA

Viable

Detailed description: Adding a third transformer on site, the works include the following:

- Establishing a new 66 kV transformer bay on the busbars connecting the Strensham 66 kV circuit
- Installing a third 66/11 kV transformer rated 20/40 MVA
- Installing an additional 11 kV 2-section board suitably interconnected with the existing
- Replacing the 11 kV transformer circuit breaker CB22 and the interconnector CB20, with 2000 amp rated ones
- Undergrounding terminal wood poles to the Eastern side of the side to create space for the additional assets; this may also require undergrounding wood poles on the South Western side if necessary.

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A few MVAs

Discounted

Detailed description: Evesham primary has limited 11 kV interconnection to other sites, which may be used to manage the baseline constraints in the interim but will be insufficient as a long term solution.

New limiting factor: Rating of the transformers

Option 5 – Load Management Schemes: Post-fault inter-trips

Estimated capacity released: 0 MVA

Discounted

Detailed description: Evesham primary is Class C under Engineering Recommendation P2 which would require restoration of the demand within 15 minutes for a circuit outage; therefore demand disconnection schemes (or similar) would make the site non-compliant.

New limiting factor: Engineering Recommendation P2 non-compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 10 MW+

Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could help alleviate the constraint and defer reinforcement. This option would be subject to a cost benefit analysis closer to the time, including all necessary sufficiency checks.

New limiting factor: Rating of the transformers

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue option 3 above (adding a third transformer) as it will be the most enduring solution and therefore more economical in the long run. Option 2 (replacing the existing transformers) only releases approximately 8 MVA of capacity, which will be insufficient by 2040.

Load transfers will need to be utilised in the interim to manage the baseline constraints; along with utilising higher ratings for the Intermediate Cool and Intermediate Warm seasons especially since the demand at Evesham is not dominated by commercial nor industrial loads.

Any reinforcement solution however would be subject to a CBA by the DNO, and in this case, it would then be tested against the flexibility market as part of the DNOA process.

3.4 Stratford transformer T1 and T2 overload

Constraint Overview

Generation Demand

Stratford is a 66/11 kV primary substation consisting of three 20/40 MVA transformers fed out of Feckenham 66 kV network. The transformers run split at 11 kV where T1 and T2 backfeed each other, and T3 is backfed from T1. The site is Class C under Engineering Recommendation P2.

The table below outlines the constraints identified for Best View, the conditions they occur under, and the triggering year per season.

Table 3.4.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Stratford transformer T1 and T2 overload	N-1: Outage of either T1 or T2 resulting in the demand being fully picked up by the other	2029	2025	2027	2030

Uncertainty under other Distribution Future Energy Scenarios: The constraints above are identified under Best View and worsened under some of the other Distribution Future Energy Scenarios. The demand in the region is generally on an upward trend indicating constraints are potentially getting worse if not addressed, but the trigger year may vary depending on how quickly demand and/or generation materialises.

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 identified constraint(s)

Option	Description	Solves constraint	Potentially economic	Wider benefit	Viable or Discounted
1	No Intervention	×	✓	×	Discounted
Reinforcement (build) options					
2	Adding a fourth transformer at Stratford	✓	✓	×	Viable
3	Adding a third transformer at Great Alne	✓	✓	×	Viable
Operational mitigation					
4	Load transfers and split schemes	✓	✓	×	Viable
Load Management Schemes					
5	Post-fault inter-trips	×	✓	×	Discounted
Flexibility services					
6	Flexibility service procurement	✓	✓	×	Viable

Solution Development

These options have been assessed on their technical viability and cost-effectiveness pending a more detailed CBA by the DNO. The section below covers more detail on these options.

Option 1 – No Intervention

Estimated capacity released: 0 MVA

Discounted

Detailed description: The constraint is imminent and the demand is projected to continue increasing. Doing nothing could therefore lead to thermal overloads and the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Rating of existing transformers

Option 2 – Adding a fourth transformer at Stratford

Estimated capacity released: 30 MVA

Viable

Detailed description: Adding a fourth transformer on site, the works include:

- Extending the 66 kV busbars to include an additional bus-section circuit breaker and a new 66 kV transformer bay
- Installing a fourth 66/11 kV transformer rated 20/40 MVA
- Installing an additional 11 kV 2-section board interconnected with the existing
- Purchasing additional land to accommodate the new assets

New limiting factor: Rating of the transformers

Option 3 – Adding a third transformer at Great Alne

Estimated capacity released: 18 MVA

Viable

Detailed description: Adding a third transformer at Great Alne and upgrading the 11 kV interconnections to Stratford, the works include:

- Extending the 66 kV busbars to include an additional bus-section circuit breaker and a new 66 kV transformer bay
- Installing a third 66/11 kV transformer rated 20/40 MVA
- Installing an additional 11 kV 2-section board interconnected with the existing
- Upgrading the 11 kV network to allow some of the projected future demand to be picked up by Great Alne instead of Stratford

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: 15 MVA

Viable

Detailed description: T1 and T2 at Stratford currently backfeed each during an outage which can cause an overload, the proposal is to redistribute the 11 kV demand, during a transformer outage, between the existing two remaining transformers in-service.

New limiting factor: Rating of existing transformers

Option 5 – Load Management Schemes: Post-fault inter-trips

Estimated capacity released: 0 MVA

Discounted

Detailed description: Stratford primary is Class C under Engineering Recommendation P2 which would require restoration of the group demand within 15 minutes for a first circuit outage; therefore demand disconnection schemes (or similar) would make the site non-compliant.

New limiting factor: Engineering Recommendation P2 non-compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 15 MW+

Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could help alleviate the constraint and defer reinforcement. This option would be subject to a cost benefit analysis closer to the time, including all necessary sufficiency checks.

New limiting factor: Rating of the existing transformers

Solution Recommendation

It is recommended to pursue option 4 above (operational mitigation) as it is likely to be the most cost-effective solution and would allow for better utilisation of the existing assets.

Any reinforcement solution however would be subject to a CBA by the DNO, and in this case, it may be tested against the flexibility market as part of the DNOA process. The flexibility option however, although may be technically viable, is not likely to be as cost-effective as the Operational mitigation option.

3.5 Pershore transformer overload

Constraint Overview

Generation Demand

Pershore primary is 66/11 kV site consisting of two transformers:

- T1: 20/26 MVA unit commissioned in 2015, and
- T2: 12/24 MVA unit commissioned in 2013

The site is fed out of the Feckenham-Evesham-Shipston-Pershore 66 kV ring, and is considered Class C under Engineering Recommendation P2.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.5.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Pershore transformer overload	N-1: Outage of either of the two transformers at Pershore	-	2034	-	-

Uncertainty under other Distribution Future Energy Scenarios: The constraints above are identified under Best View and worsened under some of the other Distribution Future Energy Scenarios. The demand in the region is generally on an upward trend indicating constraints are potentially getting worse if not addressed, but the trigger year may vary depending on how quickly demand and/or generation materialises.

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 identified constraint(s)

Option	Description	Solves constraint	Potentially economic	Wider benefit	Viable or Discounted
1	No Intervention	×	✓	×	Discounted
Reinforcement (build) options					
2	Uprating the existing transformers	✓	✓	×	Viable
3	Adding a third transformer	✓	✓	×	Viable
Operational mitigation					
4	Load transfers	×	✓	×	Discounted
Load Management Schemes					
5	Post-fault inter-trips	×	✓	×	Discounted
Flexibility services					
6	Flexibility service procurement	✓	✓	×	Viable

Solution Development

These options have been assessed on their technical viability and cost-effectiveness pending a more detailed CBA by the DNO. The section below covers more detail on these options.

Option 1 – No Intervention

Estimated capacity released: 0 MVA

Discounted

Detailed description: The constraint is anticipated to trigger by 2034 with the demand projected to continue increasing thereafter. Doing nothing could therefore lead to thermal overloads and the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Rating of existing transformers

Option 2 – Uprating the existing transformers

Estimated capacity released: 12 MVA

Viable

Detailed description: Uprating the existing transformers, the works include:

- Replacing both of the existing 66/11 kV transformers with 20/40 MVA units
- Replacing the existing 1250 amp 11 kV board (commissioned in 1994) with a 2000 amp rated one

New limiting factor: Rating of transformers

Option 3 – Adding a third transformer

Estimated capacity released: 18 MVA

Viable

Detailed description: Adding a third transformer on site, the works include the following:

- Extending the 66 kV busbars (towards the north of the site) including a second bus-section circuit breaker and a third transformer bay
- Installing a third 12/24 MVA rated 66/11 kV transformer
- Installing an additional 11 kV 2-section board suitably interconnected with the existing

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: Limited

Discounted

Detailed description: Pershore primary has limited 11 kV interconnection to other sites, which is insufficient to mitigate the constraints above longer term.

New limiting factor: Rating of the transformers

Option 5 – Load Management Schemes: Post-fault inter-trips

Estimated capacity released: 0 MVA

Discounted

Detailed description: Pershore primary is Class C under Engineering Recommendation P2 which would require restoration of the demand within 15 minutes for a circuit outage; therefore demand disconnection schemes (or similar) would make the site non-compliant.

New limiting factor: Engineering Recommendation P2 non-compliance

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 0.7 MW+ Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could help alleviate the constraint and defer reinforcement. This option would be subject to a cost benefit analysis closer to the time, including all necessary sufficiency checks.

New limiting factor: Rating of the transformers

Solution Recommendation

With regards to reinforcement build options, it would be recommended to pursue option 3 above (adding a third transformer) as it will likely be more cost-effective and avoids having to decommission relatively new assets that still have many years of service.

Given the constraints are observed in the intermediate cool season only, and that the demand is not dominated by commercial nor industrial load, it will be worth re-assessing the seasonal ratings of these transformers before commencing physical works.

Any reinforcement solution however would be subject to a CBA by the DNO, and in this case, it would then be tested against the flexibility market as part of the DNOA process.

3.6 Broadway transformer overload

Constraint Overview

Generation Demand

Broadway primary is a 66/11 kV site consisting of two 12/24 MVA transformers (commissioned in 1966) fed from Feckenham GSP via Evesham. The 11 kV board is 1250 amp commissioned in 2015.

The primary is Class C under Engineering Recommendation P2.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.6.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Broadway transformer overload	N-1: Outage of either of the two transformers at Broadway during times of minimum demand and peak generation.	-	-	-	2029

Uncertainty under other Distribution Future Energy Scenarios: The constraints above are identified under Best View and worsened under some of the other Distribution Future Energy Scenarios. The generation in the region is generally on an upward trend indicating constraints are potentially getting worse if not addressed, but the trigger year may vary depending on how quickly demand and/or generation materialises.

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 identified constraint(s)

Option	Description	Solves constraint	Potentially economic	Wider benefit	Viable or Discounted
1	No Intervention	×	✓	×	Discounted
Reinforcement (build) options					
2	Uprating the existing transformers	✓	✓	×	Viable
3	Adding a third transformer	✓	✓	×	Viable
Operational mitigation					
4	Load transfers	×	✓	×	Discounted
Load Management Schemes					
5	Active Network Management or similar	✓	✓	×	Viable
Flexibility services					
6	Flexibility service procurement	×	✓	×	Discounted

Solution Development

These options have been assessed on their technical viability and cost-effectiveness pending a more detailed CBA by the DNO. The section below covers more detail on these options.

Option 1 – No Intervention

Estimated capacity released: 0 MVA

Discounted

Detailed description: The constraint is anticipated to trigger by 2029 with the generation projected to continue increasing thereafter. Doing nothing could therefore lead to thermal overloads of the assets with potential safety implications on staff and the general public.

New limiting factor: Rating of existing transformers

Option 2 – Uprating the existing transformers

Estimated capacity released: 12 MVA

Viable

Detailed description: Uprating the existing transformers, the works include:

- Replacing the existing 12/24 MVA transformers with 20/40 MVA units
- Replacing the existing 1250 amp 11 kV board with a 2000 amp rated one

New limiting factor: Rating of transformers and circuits

Option 3 – Adding a third transformer

Estimated capacity released: 18 MVA

Viable

Detailed description: Adding a third transformer on site, the works include the following:

- Extending the 66 kV busbars to include an additional bus-section circuit breaker and a transformer bay
- Installing a third 12/24 MVA rated 66/11 kV transformer on site
- Installing an additional 11 kV 2-section board suitably interconnected with the existing
- Undergrounding the terminal poles to the south eastern side of the substation may be necessary to create enough space for the additional assets

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: A few MVAs

Discounted

Detailed description: Broadway primary has limited 11 kV interconnection to other sites, which is insufficient to mitigate the constraints above.

New limiting factor: Rating of the transformers

Option 5 – Load Management Schemes

Estimated capacity released: 0 MVA

Viable

Detailed description: Implementing some form of load management to mitigate the generation constraints; this may be achieved in one of two ways:

- Implementing Active Network Management (ANM) to curtail generators downstream of the primary in anticipation of an outage that may trigger the constraints above
- Broadway primary runs split at 11 kV, therefore the solution includes implementing a disconnection scheme to trip off generation prior to restoring supplies.

New limiting factor: Rating of the existing transformers

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 6 MW+

Discounted

Detailed description: Flexibility services through generation turn down and/or demand turn up could help alleviate the constraint but the current flexibility process is not capable of mitigating generation type constraints.

If and when the flexibility services develop further to include export constraints, then this option would become viable but will still remain subject to a cost benefit analysis, including all necessary sufficiency checks.

New limiting factor: Rating of the transformers

Solution Recommendation

It is recommended to pursue option 5 above (load management schemes) as it is likely to be the most cost-effective solution and allow for better utilisation of the existing assets.

Where a reinforcement build option becomes necessary, then option 2 (uprating the existing transformers) would be desirable considering the scheme's deliverability and age of the existing assets.

3.7 Redditch North transformer T1 overload

Constraint Overview

Generation Demand

Redditch North primary is a 66/11 kV site consisting of three transformers,

- T1: 20 MVA transformer, commissioned in 1962, normally fed out of Feckenham GSP
- T2: 20 MVA transformer, commissioned in 1961, normally fed out of Feckenham GSP
- T3: 20/40 MVA transformer, commissioned in 2000, normally fed from Bishops Wood GSP

T1 and T3 backfeed each other during an outage, and T2 is backfed from T3 when off supply.

The primary is Class C under Engineering Recommendation P2.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.7.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Redditch North transformer T1 overload	N-1: Outage of transformer T3 at Redditch North, during times of minimum demand and peak generation.	-	-	-	Baseline

Uncertainty under other Distribution Future Energy Scenarios: The constraints above are identified under Best View and worsened under some of the other Distribution Future Energy Scenarios. The generation in the region is generally on an upward trend indicating constraints are potentially getting worse if not addressed, but the trigger year may vary depending on how quickly demand and/or generation materialises.

Solution Options

A list of each of the options considered for this constraint is given in the table below.

Table 3.7.2 solution options to identified constraint(s)

Option	Description	Solves constraint	Potentially economic	Wider benefit	Viable or Discounted
1	No Intervention	×	✓	×	Discounted
Reinforcement (build) options					
2	Uprating the existing transformer	✓	✓	×	Viable
Operational mitigation					
3	Load transfers	✓	✓	×	Viable
Load Management Schemes					
4	Active Network Management or similar	✓	✓	×	Viable
Flexibility services					
5	Flexibility service procurement	×	✓	×	Discounted

Solution Development

These options have been assessed on their technical viability and cost-effectiveness pending a more detailed CBA by the DNO. The section below covers more detail on these options.

Option 1 – No Intervention

Estimated capacity released: 0 MVA

Discounted

Detailed description: The constraint is imminent with the generation projected to continue increasing thereafter. Doing nothing could therefore lead to thermal overloads of the assets with potential safety implications on staff and the general public.

New limiting factor: Rating of the existing transformer

Option 2 – Uprating the existing transformer

Estimated capacity released: 10 MVA

Viable

Detailed description: Uprating the existing 20 MVA 66/11 kV transformer at Redditch North with a 20/40 MVA unit.

The 11 kV board is 2000 amp and therefore not anticipated to need replacement yet.

New limiting factor: Rating of the 11 kV switchgear

Option 3 – Operational mitigation: Load transfers

Estimated capacity released: 10 MVA

Viable

Detailed description: Redditch North transformer T1 and T3 backfeed each other during an outage, the proposal is therefore to utilise T2 as well and redistribute the demand and generation (via the 11 kV network) during these outages.

Longer term, and where the 11 kV network downstream is incapable to evenly redistributing the site's demand and generation, additional 11 kV sections may be required on site to facilitate such reconfigurations.

New limiting factor: Rating of the transformers

Option 4 – Load Management Schemes

Estimated capacity released: 0 MVA

Viable

Detailed description: Implementing some form of load management to mitigate the generation constraints; this may be achieved in one of two ways:

- Implementing Active Network Management (ANM) to curtail generators downstream of the primary in anticipation of an outage that may trigger the constraints above.
- Redditch North primary runs split at 11 kV across three transformers, therefore the solution would involve implementing a disconnection scheme to trip off generation prior to restoring supplies.

New limiting factor: Rating of the existing transformers

Option 5 – Flexibility service procurement

Estimated Flexibility Required (MW): 4 MW+ **Discounted**

Detailed description: Flexibility services through generation turn down and/or demand turn up could help alleviate the constraint but the current flexibility process is not capable of mitigating generation type constraints.

If and when the flexibility services develop further to include export constraints, then this option would become viable but will still remain subject to a cost benefit analysis, including all necessary sufficiency checks.

New limiting factor: Rating of the transformers

Solution Recommendation

It is recommended to pursue a mixture of option 3 (load transfers) and option 4 (load management schemes) as both are likely to be very cost-effective solutions and allow for better utilisation of the existing assets.

Where a reinforcement build option becomes necessary, then option 2 (uprating the existing transformer) could be considered.

3.8 Broadway-Stow-Moreton 66 kV ring constraints

Constraint Overview

Generation Demand

Broadway, Stow, and Moreton primary substations are 66/11 kV sites on the Feckenham 66 kV network fed via two circuits; one via Evesham through the Evesham-Broadway circuit, and the other via Shipston through the Shipston-Moreton circuit.

The group is Class C under Engineering Recommendation P2.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.8.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Evesham to Broadway 66 kV circuit overload	N-1: Busbar outages at Shipston 66 kV resulting in Broadway, Stow, Moreton and part of Shipston primary being fed from this circuit	-	-	-	2027
Broadway to Northwick tee 66 kV circuit overload	N-1: Busbar outages at Shipston 66 kV resulting in Broadway, Stow, Moreton and part of Shipston primary being fed from this circuit	-	-	-	2032
Northwick tee to Stow tee 66 kV circuit overload	N-1: Outages affecting the 66 kV infeed to the group via Broadway	-	-	-	Baseline
Stow tee to Moreton 66 kV circuit overload	N-1: Outages affecting the 66 kV infeed to the group via Broadway	-	-	-	2026
Moreton to Shipston 66 kV circuit overload	N-1: Outages affecting the 66 kV infeed to the group via Broadway	-	-	-	2029
Voltage constraints at 66 kV	N-1: Outages affecting the 66 kV infeed to the group from either side	-	-	-	Baseline

Uncertainty under other Distribution Future Energy Scenarios: The constraints above are identified under Best View and worsened under some of the other Distribution Future Energy Scenarios. The generation in the region is generally on an upward trend indicating constraints are potentially getting worse if not addressed, but the trigger year may vary depending on how quickly demand and/or generation materialises.

Solution Options

A list of each of the options considered for this constraint is given in the table below.

Table 3.8.2 solution options to identified constraint(s)

Option	Description	Solves constraint	Potentially economic	Wider benefit	Viable or Discounted
1	No Intervention	×	✓	×	Discounted
Reinforcement (build) options					
2	Uprating the existing circuits	✓	✓	×	Viable
3	Installing a new 66 kV circuit to Moreton	✓	✓	×	Viable
Operational mitigation					
4	Load transfers	×	✓	×	Discounted
Load Management Schemes					
5	Active Network Management or similar	✓	✓	×	Viable
Flexibility services					
6	Flexibility service procurement	×	✓	×	Discounted

Solution Development

These options have been assessed on their technical viability and cost-effectiveness pending a more detailed CBA by the DNO. The section below covers more detail on these options.

Option 1 – No Intervention

Estimated capacity released: 0 MVA

Discounted

Detailed description: The constraint is imminent and the generation is projected to continue increasing. Doing nothing could therefore lead to thermal overloads (with safety implications on staff and the general public) and voltage exceeding statutory limits.

New limiting factor: Voltage limits and rating of the circuits

Option 2 – Uprating the existing circuits

Estimated capacity released: 30 MVA+

Viable

Detailed description: Uprating the existing 66 kV circuits, these include:

- Evesham to Broadway: 8.8 km of 0.175 in ACSR wood pole line
- Broadway to Northwick tee: 5.9 km of 0.175 in ACSR wood pole line
- Northwick tee to Stow tee: 8.4 km of 0.175 in ACSR wood pole line
- Stow tee to Moreton: 0.01 km of 0.175 in ACSR wood pole line
- Moreton to Shipston: replacing the 400 amp current transformers (CTs)

The above overhead line circuits would be required to achieve a minimum of 90 MVA summer sustained rating to have a long lasting effect; this is anticipated to require 300 mm All Aluminium Alloy Conductor (AAAC) designed to 75 degrees.

A substantial amount of this may need to be underground cable to resolve the voltage constraints; any cable sections are therefore anticipated to at least be 630 mm copper conductors laid direct.

New limiting factor: Voltage limits and rating of the circuits

Option 3 – Installing a new 66 kV circuit to the group

Estimated capacity released: 50 MVA

Viable

Detailed description: Adding a third 66 kV circuit to the group, the works include:

- Extending the 66 kV busbars at Evesham to include an additional bus-section circuit breaker and a new feeder bay
- Extending the 66 kV busbars at Moreton to include an additional bus-section circuit breaker and a new feeder bay
- Installing over 20 km of 66 kV circuit between Evesham and Morton substations
- Purchasing additional land at Evesham and at Moreton to facilitate the extensions above

New limiting factor: Voltage limits and rating of the circuits

Option 4 – Operational mitigation: Load transfers

Estimated capacity released: Very limited

Discounted

Detailed description: The group has very limited 11 kV transfers to other parts of the network, and are therefore insufficient to have a material impact on the constraints above.

New limiting factor: Voltage limits and rating of the circuits

Option 5 – Load Management Schemes

Estimated capacity released: 0 MVA

Viable

Detailed description: Implementing some form of load management to mitigate the generation constraints; this may be achieved by implementing Active Network Management (ANM) to curtail generators at 66 kV and/or 11 kV in anticipation of an outage that may trigger the constraints above

New limiting factor: Voltage limits and rating of the circuits

Option 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 6 MW+

Discounted

Detailed description: Flexibility services through generation turn down and/or demand turn up could help alleviate the constraint but the current flexibility process is not capable of mitigating generation type constraints.

If and when the flexibility services develop further to include export constraints, then this option would become viable, but will still remain subject to a cost benefit analysis, including all necessary sufficiency checks.

New limiting factor: Voltage limits and rating of the circuits

Solution Recommendation

It is recommended to pursue option 5 above (load management scheme) as it is likely to be the most cost-effective solution and allows for better utilisation of the existing assets.

3.9 Feckenham-Evesham-Strensham network

Constraint Overview

Generation Demand

Evesham is a 66/11 kV site fed via two direct circuits from Feckenham GSP.

Strensham, Pershore, and Droitwich T3 are subsequently supplied via a 66 kV feeder; one from Evesham to Strensham circuit, and the other from Feckenham to Droitwich/Pershore tee circuit, effectively forming a 66 kV closed ring.

Brotheridge Green, Tewkesbury 66/11 kV, and Ledbury T2 are then fed via a 66 kV radial feeder from Strensham (via Brotheridge Green).

The group is currently Class D under Engineering Recommendation P2.

The table below outlines the constraint identified for Best View, the conditions it occurs under, and the triggering year per season.

Table 3.9.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Feckenham to Evesham_9L5 66 kV circuit overload	N-1: Outages affecting the 66 kV infeed to Droitwich/Pershore tee from Feckenham	2031	Baseline	2025	2034
Evesham to Strensham 66 kV circuit overload	N-1: Outages affecting the 66 kV infeed to Droitwich/Pershore tee from Feckenham	2027	2028	2029	2034
High and Low volts at 66 kV across the ring	N-1: Outages to the infeeds causing low volts (or high during high generation), at Droitwich, Pershore, Strensham, Brotheridge Green and Tewkesbury	Baseline	Baseline	Baseline	Baseline

Uncertainty under other Distribution Future Energy Scenarios: The constraints above are identified under Best View and worsened under some of the other Distribution Future Energy Scenarios. The demand in the region is generally on an upward trend indicating constraints are potentially getting worse if not addressed, but the trigger year may vary depending on how quickly demand and/or generation materialises.

Solution Options

A list of each of the options considered for this constraint is given in the table below.

Table 3.9.2 solution options to identified constraint(s)

Option	Description	Solves constraint	Potentially economic	Wider benefit	Viable or Discounted
1	No Intervention	×	✓	×	Discounted
Reinforcement (build) options					
2	Uprating the existing circuits	×	✓	×	Discounted
3	Adding a Feckenham-Strensham circuit	✓	✓	×	Viable
4	Adding infeeds to Droitwich and Tewkesbury	✓	✓	✓	Viable
Operational mitigation					
5	Load transfers	×	✓	×	Discounted
Load Management Schemes					
6	Post-fault inter-trips	×	✓	×	Discounted
Flexibility services					
7	Flexibility service procurement	×	✓	×	Discounted

Solution Development

These options have been assessed on their technical viability and cost-effectiveness pending a more detailed CBA by the DNO. The section below covers more detail on these options.

Option 1 – No Intervention

Estimated capacity released: 0 MVA

Discounted

Detailed description: The constraint is imminent and the demand is projected to continue increasing. Doing nothing could therefore lead to thermal overloads, voltages dropping below statutory limits, and the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Low volts and rating of the existing circuits

Option 2 – Uprating the existing circuits

Estimated capacity released: 30 MVA

Discounted

Detailed description: Uprating the existing 66 kV circuits within the group, these are:

- Feckenham to Evesham_9L5: consisting of 21 km of 1000 mm Aluminium cable circuit
- Evesham to Strensham: consisting of 15.5 km of 200 mm AAAC overhead line circuit

The cable sections would need to be replaced with copper conductors, and the overhead line rebuilt with 300 mm AAAC design to 75 degrees.

The voltage constraint would however remain, and to have a material impact, the overhead line circuit above would need to be undergrounded. This would still not fully resolve the voltage constraints within the network, potentially leading to breach of statutory limits due to 66 kV connected customers.

New limiting factor: Low volts at 66 kV

Option 3 – Adding a Feckenham-Strensham circuit

Estimated capacity released: 80 MVA

Viable

Detailed description: Installing a new 66 kV circuit from Feckenham to Strensham, the works include:

- Extending the 66 kV busbars at Feckenham to include a new feeder bay
- Extending the 66 kV busbars at Strensham (on the Brotheridge Green side) to include an additional bus-section circuit breaker and a new feeder bay
- Installing over 20 km of 66 kV circuit between Feckenham and Strensham substations

New limiting factor: Rating of the existing circuits

Option 4 – Adding infeeds to Droitwich and Tewkesbury

Estimated capacity released: 80 MVA

Viable

Detailed description: Adding additional circuits to the group to transfer demand out under normal running and increase the interconnectivity to other GSPs. The works would be in two phases.

Phase 1:

- Extending the 66 kV busbar at Upton Warren BSP (on the GT3 side) by adding a new bus-section circuit breaker and a new feeder bay
- Installing approximately 8 km of 66 kV circuit from Upton Warren to Droitwich primary; the circuit would be required to have a minimum winter cyclic rating of 90 MVA, which is anticipated to be 630 mm copper (for any cable sections) and 300 mm AAAC designed to 75 degrees (for overhead line sections)
- At Droitwich primary,
    - Relocating the Feckenham/Pershore 66 kV circuit from 3L3 to 2L3, running disconnector 2L3 normally open
    - Connecting the new 66 kV circuit from Upton Warren onto disconnector 3L3
    - Maintaining the existing open point at bus-section 2S0

Phase 2:

- Establishing a 132/66 kV infeed at Tewkesbury BSP, works include:
    - Installing sealing ends at the spare 132 kV bay connected to disconnector 201
    - Installing a 90 MVA 132/66 kV transformer within the existing compound
    - Connecting the Grid Transformer (GT) to the new sealing end via a short, suitably rated, cable section
    - Installing 66 kV busbars to include a transformer circuit breaker and a feeder bay
- Installing approximately 3 km of 66 kV circuit from the new 66 kV busbars at Tewkesbury BSP to the spare 66 kV bay at Tewkesbury primary (via disconnector 1L3); the circuit is anticipate to be 630 mm copper underground cable.
- Running the new Tewkesbury 66 kV infeed split from the Feckenham network by either:
    - Opening the 66 kV and 11 kV at Tewkesbury primary, or
    - Opening the 66 kV and 11 kV at Brotheridge Green primary thus putting Tewkesbury primary, Brotheridge Green T2 and Ledbury T2 on the new GT

Phase 1 would mitigate the constraints up to 2030, after which phase 2 would be needed.

New limiting factor: Rating of circuits within the group

Option 5 – Operational mitigation: Load transfers

Estimated capacity released: A few MVAs

Discounted

Detailed description: The group has interconnections at 66 kV with Stourport (Via Droitwich) and Hereford (via Ledbury) but this is limited as it shifts the constraints to these networks, especially as the demand grows.

These interconnections could therefore be utilised to manage some of the baseline constraints in the interim but are not sufficient to mitigate all the constraints and therefore not a viable long term solution.

New limiting factor: Low volts and rating of existing circuits

Option 6 – Load Management Schemes: Post-fault inter-trips

Estimated capacity released: 0 MVA

Discounted

Detailed description: The group is Class D under Engineering Recommendation P2 which, for a first circuit outage, would require restoration of the immediate restoration of the demand minus 20 MW and full group demand within 3 hours; therefore demand disconnection schemes (or similar) would make the site non-compliant.

New limiting factor: Engineering Recommendation P2 non-compliance

Option 7 – Flexibility service procurement

Estimated Flexibility Required (MW): 30 MW+ (for thermal constraints)

Discounted

Detailed description: Flexibility services through generation turn up and/or demand turn down may reduce some risk on specific thermal overload scenarios, but it could be more detrimental to the network if different fault outages occur, considering the parallel ringed configuration. It is also not effective for the voltage constraints, nor for the generation triggered ones.

New limiting factor: Power Quality, low volts, and rating of existing circuits

Solution Recommendation

It is recommended to pursue option 4 above (adding infeeds to Droitwich and Tewkesbury) as it is long-lasting and likely to be the most cost-effective solution for the network. It also has the wider benefits of:

- Increasing the interconnection of Feckenham with Port Ham and Bishops Wood GSPs
- Improving the security of supply at Brotheridge Green and Tewkesbury primaries
- Simplifying the existing network

Option 5 (operational mitigation) may be utilised on an interim basis only to manage some of the baseline constraints, but as mentioned above it would be insufficient and therefore not viable as a long term solution.

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