Lea Marston GSP Network

Network Development Report – West Midlands

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Electricity Distribution

nationalgrid

Contents

Lea Marston GSP Network

1. Network Overview

Lea Marston is a 132 kV Grid Supply Point (GSP) that feeds the western regions of Birmingham, connecting over 125,000 customers. The network comprises of several 132 kV circuits distributed across the region, connecting ten Bulk Supply Points (BSPs) within the West Midlands network (most of which are 132/11 kV sites), and two BSPs that fall within NGED's East Midland network towards Tamworth.

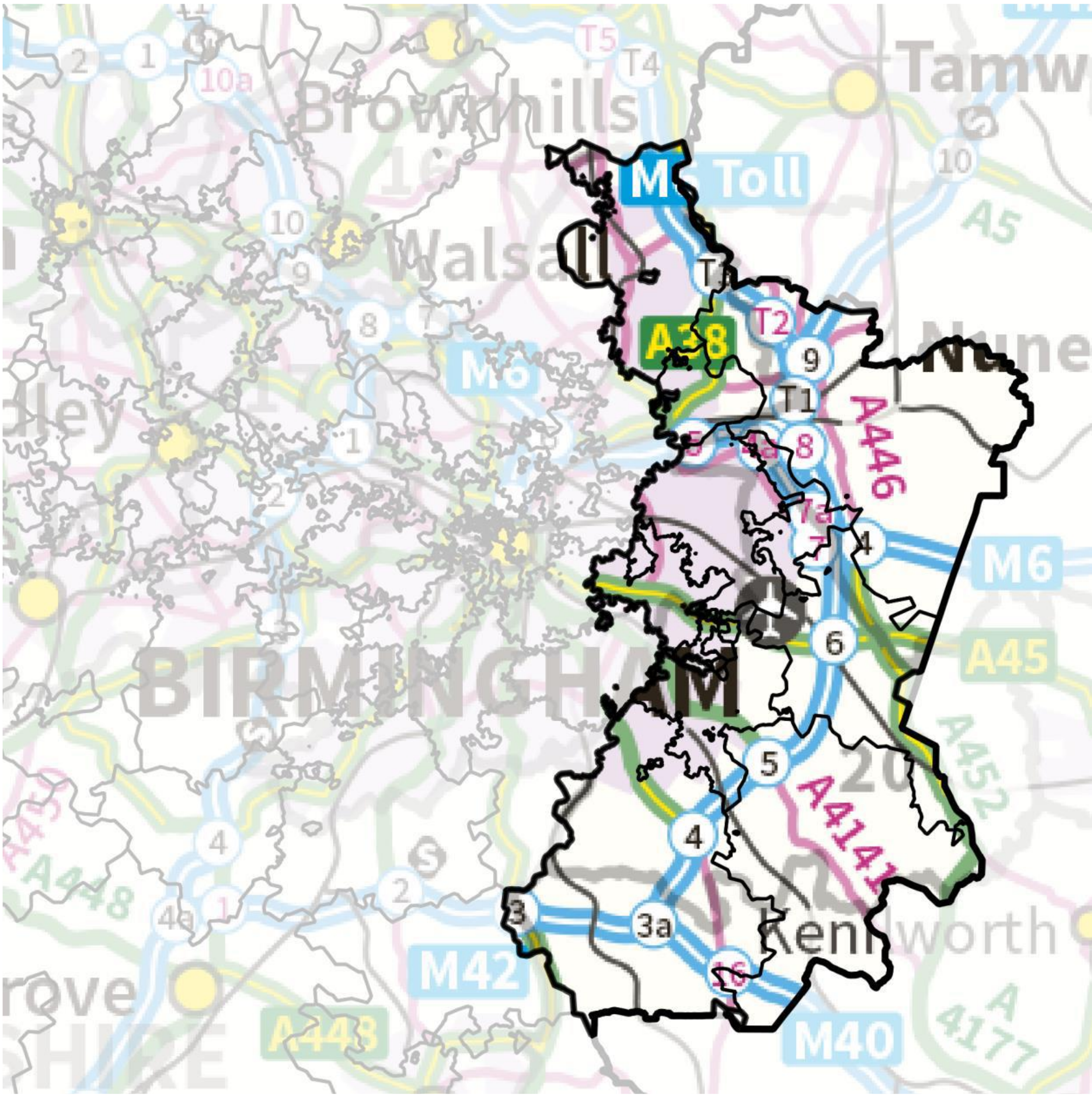

Figure 1.1 Lea Marston GSP geographic network coverage

This report discusses existing and future network constraints over a 0-10 year horizon associated with Lea Marston GSP and its downstream network that falls in the West Midlands area. 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

Lea Marston GSP is a 400/132 kV site fed via four 240 MVA Super Grid Transformers (SGTs), normally running solid through a two section 132 kV double busbar configuration. The GSP supplies ten 132/11 kV BSPs that fall within the West Midlands area, and these are listed below.

- Elmdon BSP consisting of three Grid Transformers (GTs); two three-winding 132/11/11 kV transformers running in parallel via a single winding from each, and one two-winding 132/11 kV transformer running split from the other two.
- Copt Heath BSP consisting of two three-winding 132/11/11 kV transformers fed via two 132 kV circuits from the GSP. The transformers are connected to six sections of 11 kV busbars, and normally run split with each other.
- Solihull BSP consisting of two three-winding 132/11/11 kV transformers fed via two 132 kV circuits from the GSP via Copt Heath 132 kV busbars. The transformers are connected to four sections of 11 kV busbars, and normally run split with each other.
- Shirley BSP consisting of three 132/11 kV transformers supplied via one circuit from Copt Heath (feeding GT1) and two from Kitwell GSP network (feeding GT2 and GT3). The 132 kV busbars are split between the two GSP networks, all three transformers run split at 11 kV.

[Shirley GT1, Elmdon, Copt Heath, and Solihull BSPs form a 132 kV closed ring with one side fed via a circuit between Lea Marston and Elmdon, and the other side of the ring fed via two circuits between Lea Marston and Copt Heath.]

- Hams Hall South BSP consisting of two three-winding 132/11/11 kV transformers fed via two 132 kV circuits from the GSP. The transformers are connected to six sections of 11 kV busbars, and normally run split with each other.
- Chelmsley Wood BSP consisting of two 132/11 kV transformers fed via two 132 kV circuits from the GSP network. The transformers are connected to two sections of 11 kV busbars, and normally run split with each other.
- Kitts Green BSP consisting of three 132/11/11 kV transformers fed via two 132 kV circuits from the GSP network. The transformers are connected to six sections of 11 kV busbars, and normally run split with each other.
- Boughton Road BSP consisting of two three-winding 132/11/11 kV transformers fed via two 132 kV circuits that run split; one from Lea Marston network (via Kitts Green) and the other from Nechells East network (via Sparkbrook). The transformers are connected to four sections of 11 kV busbars, and normally run split with each other.

[Boughton Road GT1, Kitts Green BSP, Chelmsley Wood GSP, and Hams Hall South GT3 form a 132 kV closed ring with one side fed via a circuit between Lea Marston and Kitts Green, and the other side of the ring fed via a circuit between Lea Marston and Hams Hall South/Chelmsley Wood tee.]

- Sutton Coldfield BSP consisting of two three-winding 132/11/11 kV transformers fed via two 132 kV circuits from the GSP network. The transformers are connected to eight sections of 11 kV busbars, and normally run split with each other.
- Castle Bromwich BSP consisting of two three-winding 132/11/11 kV transformers fed via two 132 kV circuits running split; one from Lea Marston GSP and the other from Nechells East GSP (via Erdington). The transformers are connected to six sections of 11 kV busbars, and normally run split with each other.

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.

Lea Marston 132 kV:

- Arranged outages at the GSP busbars causing a split configuration results in the reserve busbars being closed in to maintain parallels.
- Outages affecting one of the infeeds to the Elmdon-Solihull-Copt Heath ring results in the remaining two in-service infeeds being run split, with the option of transferring Shirley GT1 to Kitwell GSP network.
- Arranged outages affecting the infeed to Boughton Road or parts of Kitts Green results in the outages sections being transferred to Nechells East network via Boughton Road 132 kV bus-section circuit breaker.
- Arranged outages affecting the 132 kV infeed to Castle Bromwich results in its 132 kV bus-section circuit breaker being closed in to pick up the demand.
- Arranged or fault outages leading to loss of a GT at any of the 132/11 kV BSPs within Lea Marston's West Midlands network results in the 11 kV being closed in (and reconfigured in some cases) to backfeed the demand.

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:

- Solihull grid transformer overload
- Lea Marston to Copt Heath 132 kV circuit overload

Transmission-Distribution interface

Lea Marston GSP is a 400/132 kV site and forms the boundary between the transmission and distribution networks in the East Birmingham 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 uprating the existing assets at Lea Marston and establishing another GSP at a location suitable for the wider network.

3. Network Constraints and Solution Options

3.1 Solihull grid transformer overload

Constraint Overview

Generation Demand

Solihull BSP consists of two three-winding 132/11/11 kV transformers that normally run split but backfeed each other under outage scenarios. 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 and season.

Table 3.1.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Solihull grid transformer overload	N-1: Outage of either transformer	Baseline	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	Adding a third transformer at Solihull	✓	✓	×	Viable
3	Adding a third transformer at Copt Heath	✓	✓	×	Viable
Operational Mitigation					
4	Load transfers	✓	✓	×	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 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 imminent and the demand is projected to continue increasing. Doing nothing could therefore lead to thermal overloads, as described above, and to the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Rating of transformers

Option 2 – Adding a third transformer at Solihull

Estimated capacity released: 38 MVA

Viable

Detailed description: Adding a third transformer at Solihull, the works include:

- Establishing a 132 kV compound to include 3 sections with two bus-section circuit breakers, three transformers bays, and two circuit feeder bays. One of the bus-section circuit breakers is to run normally open.
- Installing a 132/11 kV 15/30 MVA transformer.
- Installing an additional 2-section 11 kV busbar suitably interconnected with the existing.
- Carrying out site checks allowing the existing transformers to utilise their cyclic ratings.

New limiting factor: Rating of the transformers

Option 3 – Adding a third transformer at Copt Heath

Estimated capacity released: 38 MVA

Viable

Detailed description: Adding a third transformer at Copt Heath, the works include:

- Installing a 132 kV bus-section circuit breaker between the Solihull no2 feeder and the Shirley/Elmdon circuit.
- Installing another 132 kV bus-section circuit breaker and a third transformer bay, between Copt Heath GT2 and the incoming circuit from Lea Marston.
- Installing a 132/11 kV 15/30 MVA transformer at Copt Heath.
- Installing an additional 2-section 11 kV busbar suitably interconnected with the existing.
- Carrying out site checks allowing the existing transformers at Solihull and at Copt Heath to utilise their cyclic ratings.

New limiting factor: Rating of the transformers

Option 4 – Operational mitigation: Load Transfer

Estimated capacity released: 20 MVA+ Viable

Detailed description: The site currently runs split at 11 kV with GT1 and GT2 backfeeding each other under outage conditions. The solution is to better utilise the network capacity in the area, and is in two-fold:

- Carrying out site checks at Solihull allowing the existing transformers to utilise their cyclic ratings. This would mitigate the constraint up to and including 2028.
- Transferring a couple of MVAs of demand to Copt Heath BSP.

New limiting factor: Rating of the transformers

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

Estimated capacity released: 0 MVA Discounted

Detailed description: The site is Class C under Engineering Recommendation P2 which would require restoration of the group 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): 19 MW + Viable

Detailed description: Flexibility services through generation turn up and/or demand turn down could be procured to 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: Existing transformer ratings

Solution Recommendation

It is recommended to pursue option 4 above (operational mitigation) as it is likely to be the most cost-effective solution and could allow for better utilisation of the assets by potentially enabling the cyclic ratings of the transformers.

Longer term, and where the option above has been exhausted, then option 3 above (adding a third transformer at Copt Heath) would be the next viable reinforcement build option as it is likely to be more deliverable and economical than option 2 (adding a third transformer at Solihull).

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 Distribution Network Options Assessment (DNOA) process.

3.2 Lea Marston to Copt Heath 132 kV circuit overload

Constraint Overview

Generation | **Demand**

Shirley GT1, Elmdon, Copt Heath, and Solihull BSPs form a 132 kV closed ring with one side fed via a circuit between Lea Marston and Elmdon, and the other side of the ring fed via two circuits between Lea Marston and Copt Heath.

Arranged outages affecting one of the infeeds to the ring results in the remaining two 132 kV circuits in-service being run split such that Elmdon and Solihull are on one circuit, and Copt Heath is on the other; Shirley is transferred over to Kitwell GSP network.

The group is Class D under Engineering Recommendation P2.

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

Table 3.2.1 overview of constraint

Constraint	Condition	Trigger year per season			
		Winter	Inter Cool	Inter Warm	Summer
Lea Marston to Copt Heath 132 kV circuit overloads	N-1: Outage of the Lea Marston-Elmdon 132 kV circuit	2029	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 3.2.2 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 132 kV circuits	✓	✓	×	Viable
3	Adding a fourth 132 kV circuit to the group	✓	✓	×	Viable
Operational Mitigation					
4	Split scheme and load transfers	✓	✓	×	Viable
Load Management Schemes					
5	Post-fault inter-trips	×	✓	×	Discounted
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 demand is projected to continue increasing. Doing nothing could therefore lead to thermal overloads, as described above, and to the inability to meet security of supply compliance with Engineering Recommendation P2.

New limiting factor: Rating of the 132 kV circuits

Option 2 – Uprating the existing 132 kV circuits

Estimated capacity released: 30 MVA **Viable**

Detailed description: Uprating the existing 132 kV circuits, the works include:

- Restringing approximately 15 km of 132 kV double circuit tower line between Lea Marston and Copt Heath, currently 0.175 in mix of Aluminium Conductor Steel Reinforced (ACSR) and Cadmium Copper (CadCu) conductors, with a larger conductor anticipated to be 300 mm All Aluminium Alloy conductor (AAAC).
- Restringing approximately 8 km of 132 kV single circuit tower line between Lea Marston and Elmdon (currently 0.175 in ACSR conductor) with a larger conductor, anticipated to be 300 mm AAAC.

New limiting factor: Rating of the 132 kV circuits

Option 3 – Adding a fourth 132 kV circuit to the group

Estimated capacity released: 91 MVA **Viable**

Detailed description: Adding a fourth circuit to the group, the works include:

- Establishing a new 132 kV bay at Lea Marston GSP.
- Installing approximately 9 km of 132 kV circuit between Lea Marston and Elmdon substations.
- Reconfiguring Elmdon 132 kV such that the circuit towards Copt Heath is relocated to the middle busbar; and connecting the new circuit (from Lea Marston) to the end busbar (GT1 side).
- Installing a 132 kV circuit breaker at Copt Heath (on the Elmdon/Shirley circuit) and operating it normally open. Where space may be restricted, installing a live tank circuit breaker would suffice as it would only need to be operated as a switch.

  [An alternative to the above is to relocate the Solihull no1 circuit (at Copt Heath) to the bay adjacent to Copt Heath GT2 connection, then install a bus-section circuit breaker between the two incoming circuits from Lea Marston, effectively creating a four-switch mesh with two open points to split the two Elmdon infeeds from the two Copt Heath infeeds.]
- Re-assessing the 11 kV fault levels at Elmdon with the potential to uprate the 11 kV circuit breakers on the sections that run in parallel between GT2 and GT3.

New limiting factor: Rating of the 132 kV circuits

Option 4 – Operational mitigation: Split scheme and load transfers

Estimated capacity released: 10 MVA+ **Viable**

Detailed description: Altering the split configuration to better utilise the existing assets, this includes the following:

- Outage of the Lea Marston-Elmdon feeder: splitting the network such that Elmdon and Copt Heath are on one feeder, and Solihull (via GT1 only) is on another
- Outage of either of the Lea Marston-Copt Heath feeders: splitting the network such that Elmdon is on one feeder and Copt Heath and Solihull on another
- Transferring Shirley GT1 to Kitwell GSP network

New limiting factor: Rating of the 132 kV circuits

Option 5 – 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 would require the immediate restoration of the group demand minus 20 MW following a first circuit outage, and then the entire 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 6 – Flexibility service procurement

Estimated Flexibility Required (MW): 32 MW + **Discounted**

Detailed description: Flexibility services through generation turn up and/or demand turn down may be of some benefit in certain outage scenarios however due to the ringed configuration, dispatching flexibility services to mitigate for a particular outage could cause an overload elsewhere under a different fault outage scenario.

New limiting factor: Rating of the 132 kV circuits

Solution Recommendation

It is recommended to initially pursue option 4 above (operational mitigation) as it can be implemented relatively quickly to resolve the baseline constraints.

As the demand continues to rapidly increase, with new developments connecting at 11 kV and at 132 kV, both reinforcement build options would eventually be required to meet the growing network needs.

It is anticipated that by 2033, reinforcement build option 2 (uprating the existing circuits) would need to be in place; and by 2040, reinforcement build option 3 (a new 132 kV circuit to the group) would be triggered.

In addition to the distribution constraints, the transmission network is also likely to require upgrade works of installing larger assets or establishing an additional GSP in the region; this could have an impact on option 3 above providing alternatives to the source of the fourth infeed with more opportunities of reconfiguring the 132 kV network.

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