# LT637 Alyth Area Low Voltage Project

## Engineering Justification Paper – Load

**SSEN Transmission**

Document Classification | Confidential

Scottish & Southern Electricity Networks
TRANSMISSION

# Executive Summary

This paper is an addendum to the Steady State Voltage Engineering Justification Paper T3BP-EJP-086 (EJP) submitted in our Clean Power 2030 Supplementary submission in February 2025. It has been prepared in response to the Draft Determinations[1] categorisation of optioneering as 'not justified' and Scope Confidence as 'Low Confidence'. Notably, the need was categorised as 'justified' based on the evidence included in the EJP submission and support for this investment being confirmed by the National Energy System Operator (NESO).

This addendum presents the detailed, multi-disciplinary optioneering work undertaken since the February 2025 submission. Its purpose is to demonstrate how the optimal solution has been identified to meet the approved system need.

Steady-state system analysis was conducted to assess the requirement for voltage support across our network through to 2030 and beyond. This analysis ensures compliance with planning and operational voltage limits in accordance with the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS). The original EJP submission included investment proposals for both High Voltage (EJP Lite 1) and Low Voltage (EJP Lite 2) interventions.

The Low Voltage assessment identified a minimum requirement of 450MVAr of capacitive reactive compensation in the Alyth area, connected at 400 kV. It was acknowledged that further optioneering would be necessary to determine the most effective solution. The original EJP submission proposed high-level solution to address this high voltage need comprised the following:

- One +/-250 MVAr STATCOM, connected at 400kV into the Alyth Area
- One 225MVAr MSCN connected at 400kV into the Alyth Area.

For further detail regarding the identified need, please refer to the Steady State Voltage Engineering Justification Paper (Scheme Reference: T3BP-EJP-086).

This EJP addendum focuses on the detailed optioneering of the inductive reactive compensation solution required in the Alyth area to address the Low Voltage need under heavily loaded system conditions. The optioneering analysis has considered a range of material factors, including:

- the technical effectiveness and system performance of available technologies,
- spatial and bay availability constraints at existing substations,
- the impact of contracted customer connections, and
- supply chain deliverability and associated timescales.

Following completion of the optioneering analysis, the preferred solution is to implement the required reactive compensation in the Alyth area as defined below:

- One +/-250MVAr STATCOM at Alyth 400kV Substation
- One 225MVAr MSCDN at Hurlie 400kV Substation

The total initial project cost for this solution is [redacted] Following notional approval of need in and the Draft Determinations, we are requesting through in this addendum the preferred solution option approval for this project within the RIIO-T3 delivery plan. Costs will be submitted under the Load Related Reopener (LRR) mechanism.

## Project Summary Table

| | | | | |
|---|---|---|---|---|
| Name of Scheme | Alyth Area Low Voltage Project | | | |
| Associated Strategy | [redacted] | | | |
| Investment Driver | CP2030 – Voltage Compliance | | | |
| Scheme Reference Number | SHT20686 | | | |
| Outputs | • One +/-250MVAr STATCOM at Alyth 400kV Substation<br>• One 225MVAr MSCDN at Hurlie 400kV Substation | | | |
| [redacted] | [redacted] | | | |
| [redacted] | [redacted] | | | |
| Applicable Reporting Tables | 6.1 Scheme C&V Load Actuals | | | |
| Historic Funding interactions | | | | |
| Spend Apportionment | ET1 | ET2 | ET3 | ET4 |
| | | [redacted] | [redacted] | [redacted] |

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# 1. Introduction

This Engineering Justification Paper (EJP) addendum sets out our optioneering for the capital investment of reactive compensation equipment in the Alyth area of our network during the RIIO-T3 period (April 2026 to March 2031). This investment will ensure continued safe, secure, and reliable operation of the SSEN Transmission network and contribute to UK Net Zero and Clean Power 2030 targets.

This paper is an addendum to the Steady State Voltage Engineering Justification Paper (EJP) submitted in our Clean Power 2030 Supplementary submission in Feb 2025. It has been prepared in response to the Draft Determinations[2] categorisation of optioneering as 'not justified' and Scope Confidence as 'Low Confidence'. Notably, the need was categorised as 'justified' on the basis of the evidence included in the EJP submission and support for this investment being confirmed by the NESO.

This addendum presents the detailed, multi-disciplinary optioneering work undertaken since the February 2025 submission. Its purpose is to demonstrate how the optimal solution has been identified to meet the approved system need.

# 2. Investment Needs Case

Steady-state system analysis was conducted to assess the requirement for voltage support across our network through to 2030 and beyond. This analysis ensures compliance with planning and operational voltage limits in accordance with the NETS SQSS. The original EJP submission included investment proposals for both High Voltage (HV) (EJP Lite 1) and Low Voltage (LV) (EJP Lite 2) interventions.

The Low Voltage assessment presented identified a minimum requirement of 450 MVAr of capacitive reactive compensation in the Alyth area, connected at 400kV. It was acknowledged that further optioneering would be necessary to determine the most effective solution.

For further detail regarding the identified need, please refer to the Steady State Voltage Engineering Justification Paper (Scheme Reference: T3BP-EJP-086).

# 3. Optioneering

The LV assessment presented in the original EJP submission identified a minimum requirement of 450MVar of capacitive reactive compensation is required on the 400kV network in the Alyth area. It was acknowledged that further optioneering would be necessary to determine the most effective solution.

Figure 1 Single Line Diagram (SLD) illustrates the East Coast 400kV SSEN Transmission network in 2030 post Accelerated Storage Transmission Infrastructure (ASTI) this includes new 400kV substations at Hurlie and Emmock. The SLD also shows the STATCOM at Alyth which was recently 31/1/24 installed as part of the East Coast 400kV upgrade. In addition, we have an aging Static Var Compensator (SVC) on the 275 kV busbar at Tealing for which a replacement strategy is currently being developed.

[redacted]

The original EJP submission proposed high-level asset solution to address the low voltage system requirements comprised of the following:

- One 250 MVAr STATCOM, connected in the Alyth Area
- One MSCDN 225 MVAr connected in the Alyth Area

The optioneering analysis in this paper has considered a range of material factors, including:

- the technical effectiveness and system performance of available technologies,
- engineering, spatial, consenting and bay availability constraints at existing substations,
- the impact of contracted customer connections as detailed in [redacted]

## 3.1. Option Combinations

**System Requirements**

- The **minimum system requirement** of 450MVAr of capacitive reactive compensation in the Alyth area shall comprise of an approx. 50/50 split of both static and dynamic reactive compensation solutions. This is required to address the exceedances of the NETS SQSS steady state voltage limits and voltage step limits in 2032 and beyond.

**Bay availability**

- Space for one 400kV fully populated feeder bay at Alyth 400kV Double Busbar, [redacted] which has been allocated the remaining other spare bay at Alyth)
- Utilisation of spare bays at nearby 400kV Hurlie and Emmock 400kV substations

**Existing site footprint constraints**

The bay availability, technology options and the existing site drawings were assessed to determine what could be physically accommodated within the existing substation footprint.

- Potentially available space within Alyth substation footprint for STATCOM
- Space available within the Hurlie and Emmock 400kV substation footprint for MSCDN

There is one spare bay at Alyth and based on the space available with the substation footprint this was allocated to the STATCOM. Therefore, additional system studies[1] were carried out and confirmed locating the MSCDN at the nearby 400kV substations at Hurlie or Emmock will meet the NETS SQSS steady state voltage limits and voltage step limits in 2032.

[1] ASTI Low Voltage Assessment (Alyth) Optioneering Study Report

The output of the system studies helped define the options shown in Table 1 with corresponding Single Line Diagram (SLDs) shown in Appendix B: Single Line Diagrams.

| | Location of 250MVar STATCOM | Location of 225MVar MSCDN | Rationale | Progressed |
|---|---|---|---|---|
| Option 1(Shared bay for MSCDN and STATCOM at Alyth) | Alyth 400kV (shared) | Alyth 400kV (shared) | Reduction in utilisation of STATCOM and MSCDN due to sharing of bay.<br>Increased cost to house both reactive compensation devices at the same site additional bay/switchgear required | No |
| Option 2 (MSCDN at Hurlie) | Alyth 400kV bay | Hurlie 400kV bay | Reduced build requirement<br>lower risk from land, community and consents.<br>Space provision available at Hurlie | Yes |
| Option 3 (MSCDN at Emmock) | Alyth 400kV bay | Emmock 400kV bay | Reduced build requirement<br>lower risk from land, community and consents.<br>Space provision available at Emmock | Yes |
| Option 4 | New Satellite site 5km from Alyth | New Satellite site 5km from Alyth | Significant land, community and consenting<br>risk building a large site in close proximity to existing site.<br>High Cost<br>EISD - 2032<br>Other Generation Gate 1 Forecast | No |

*Table 1: List of Options*

This section takes forward Option 2 and 3 which were identified from **Error! Reference source not found.** as being the preferred options. Further engagement with our project and delivery teams highlighted preference to locate the MSCDN at Hurlie due the increased space availability compared to Emmock and for that reason Option 2 is selected as the preferred option.

Emmock is already a very large site with three Super Grid Transformer (SGT')s, a STATCOM and MSCDN on top of several circuits coming into the site. Hurlie on the other hand has recently experienced changes to reduce circuits into this substation its scope, following the Impact Assessment outcome earlier this year. This change has removed the need for some bays and provision of some plant from Hurlie freeing up planned space. The space created by this change leaves adequate room to facilitate this MSCDN with minimal change in the overall project scope and design.

Currently site selection for the STATCOM at Alyth has commenced and evaluation underway to determine if we can accommodate this in the existing Alyth 400 kV substation footprint or a satellite site close by. This paper has been costed assuming that a satellite site will be required. When this optioneering has concluded we will inform OFGEM of the preferred solution as part of the LRR process. Following this papers submission the project teams will continue to develop both options in parallel to find the optimum solution. The option to install the STATCOM at Alyth provides many advantages however noise and operational considerations need to be further investigated. The satellite site option is being explored currently to review available land and sites.

## 3.2. Preferred Option

As a result of the information provided, our proposed final solution for the Alyth Area LV Project is Option 2 as we are confident on the ability to deliver this.

The project scope comprises of the following works, to ensure continued NETS SQSS compliance in LV scenarios on the SSEN Transmission network from 2032 and beyond. The works associated with outlined below and shown in **Figure 2** and System Design Table in **Table 2**.

- One +/-250MVAr STATCOM at Alyth 400kV Substation
- One 225MVAr MSCDN at Hurlie 400kV Substation

[redacted]

| | | Current Network | Preferred Solution |
|---|---|---|---|
| **Thermal and Fault Design** | Voltage | N/A | N/A |
| | Continuous Rating | N/A | N/A |
| | Fault Rating | N/A | N/A |
| **ESO Dispatchable Services** | MVAR Rating | N/A | One +/-250MVAr STATCOM at Alyth 400kV Substation<br><br>One 225MVAr MSCDN at Hurlie 400kV Substation |
| **System Requirements** | GVA.s Rating | N/A | N/A |
| | Present Demand (if applicable) (MW) | N/A | N/A |
| | 2050 Future Demand (MW) | N/A | N/A |
| | Present Generation (if applicable) (MW) | N/A | N/A |

| | | | |
|---|---|---|---|
| | Future Generation Count (MW) | N/A | N/A |
| | Future Generation Capacity(MW) | N/A | N/A |
| **Initial Design Considerations** | Limiting Factor | *Worst Case Contingency:*<br>Double circuit outage along the Beauly - Denny 400kV OHL.<br>*Voltage limitations identified:*<br>Low voltage violations (and voltage step change identified along the east coast 400kV network. | N/A |
| | AIS / GIS | N/A | N/A |
| | Busbar Design | N/A | N/A |
| | Cable / OHL / Mixed | N/A | N/A |
| | Strategic Investment | N/A | Yes |

*Table 2: System Design Table*

# 4. Cost Information

## 4.1. Cost Summary

A summary of our cost breakdown can be found in **Table 3** below:

| Project Name | Description | Cost (£m) |
|---|---|---|
| STATCOM At Alyth | Establish a satellite substation approximately 2km from Alyth 400kV substation to house a STATCOM, circuit breaker and associated switchgear. Install approximately 2km of 400kV cable from the satellite site to Alyth to connect into a 400kV double busbar bay. | [redacted] |
| MSCDN at Hurlie | Installation of MSCDN at Hurlie 400 kV substation and to connect into a 400 kV double busbar. | [redacted] |

*Table 3: Project Cost Breakdown*

# 5. Project Delivery

## 5.1. Project Plan

The STATCOM at Alyth and MSCDN at Hurlie are due to be energised by 2032 and a Level 1 Programme is shown in Appendix C: LV Assessment: Programme.

## 5.2. Risk Mitigations

Key risks and mitigations associated with this project are set out in Appendix D: Key Risks.

# 6. Conclusion

This EJP outlines the need for 450 MVAr of capacitive reactive compensation equipment to be installed in the Alyth Area. This will enable sufficient voltage support on our network to maintain voltages within planning and operational limits in accordance with NETS SQSS as we develop the ASTI network and beyond.

Following detailed optioneering and analysis, our recommended solution is:

- One +/-250MVAr STATCOM at Alyth 400kV Substation
- One 225MVAr MSCDN at Hurlie 400kV Substation

The total initial project cost for this solution is [redacted]. Following notional approval of need in and the Draft Determinations, we are requesting through this addendum the preferred solution option approval for this project within the RIIO-T3 delivery plan. Costs will be submitted under the Load Related Reopener (LRR) mechanism.

We believe our preferred solution is the most efficient technical solution to ensure continued safe, secure, and reliable operation of the SSEN Transmission network whilst contributing to UK Net Zero and Clean Power 2030 targets.

# Appendix A: Customer Connection Background

| Generator Name | Technology | Transmission or Distribution | TEC (MW) | Connection Date | Forecasted To Receive Gate 2 Offer |
|---|---|---|---|---|---|
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |

*Table 4: Customer Connection Background*

# Appendix B: Single Line Diagrams

[redacted]

[redacted]

[redacted]

[redacted]

# Appendix C: LV Assessment: Programme

[redacted]

# Appendix D: Key Risks

The key risks identified for the programme and their associated mitigating actions are outlined below. The colour coding identifies the level of risk, with green representing low risk, amber representing medium risk and red representing high risk.

| Risk Description | Pre-Control RAG (LxI) | Risk Control Action | Post-Control RAG (LxI) |
|---|---|---|---|
| Site constraint - Existing substation site constraints resulting in delayed detailed design and sub optimal solutions. | | Mitigate with new secondary site with design catered to optimal solution. | |
| Contractor availability - Contractor availability due to wider network reinforcements/ workload. | | Mitigate through wider programme strategy/ collaboration. Ensure communication and planning with other projects within the region and under similar programme delivery times. | |
| Long lead time - Lead time on plant could impact the project programme. | | Mitigated through early planning and sufficient timescales incorporated in programme. | |
| Site selection - Poor site selection for secondary site/ compromised site requiring significant investment or re-siting and programme delays. | | Mitigate through detailed desktop site investigations and appropriate ground investigations (borehole &/or trial holes). | |
| Ground Conditions - Challenging ground conditions may require extensive ground improvement or material movement, potentially increasing project costs and causing construction delays. | | Mitigated through detailed desktop studies and targeted ground investigations to inform design and identify any need for ground improvement early. | |

*Table 5: Key Risks*