MSIP Pathfinder Sellindge

National Grid Electricity Transmission
Medium Sized Investment Project

January 2025

Contents

Investment Summary

Project Name	Sellindge Pathfinder	**Delivery year**	[redacted]
SpC 3.14.6 Category	(f) a system operability, constraint management or 0MW connection project National Energy System Operator (NESO) driven.		
Drivers for the Investment	**To provide a new 0MW demand connection for network stability.** Sellindge 400kV substation was identified by NESO to deliver the grid stability services in Pathfinder Phase 3.		
Key considerations & challenges	Key considerations and challenges in delivering this investment include: ▪ **Delivery Timescales:** Enabling the contracted customer connection date in [redacted] and to facilitate an accelerated transition to net zero whilst addressing network operability challenges. ▪ **Land & consent:** Working within land constraints in extending substation site layouts. ▪ **Stakeholder Views:** NESO led industry engagement supported the development of cost-effective solutions to enhance network capacity by increasing network inertia/short circuit level.		
Optioneering	**NGET assessed options across five overarching categories including:** ▪ Three option categories (do nothing, whole system solution, and market-based solutions) which could not provide the required physical connection to the customer. ▪ One option for the construction of a new substation, which was considered excessive. ▪ Nine Gas Insulated Switchgear (GIS) options to extend the existing National Grid Electricity Transmission (NGET) substation (with a variety of technology types), of which three options were shortlisted.		
Proposed Solution	NGET proposes to extend the existing Sellindge substation GIS building to facilitate the extension of main and reserve busbars. This includes the construction and commissioning of: • A new GIS bay • Civil works • Associated Protection & Control (P&C) This will enable the connection of the customer's synchronous compensator on the user site. GIS is the only feasible technology option due to site space constraints.		
Outputs of the Investment	Deployment of synchronous compensators across all regions in stability Pathfinder Phase 3 will procure 7.5 Giga Volt Amperes (GVA) of Short Circuit Level (SCL) and 15 Giga Watt seconds (GW.s) of inertia. NESO estimates that, without the integration of Pathfinders across all regions, consumers in England and Wales may incur an additional [redacted] in constraint actions to manage stability between [redacted] and [redacted]. Addressing grid stability will also enable greater integration of low carbon technologies on to the network.		
PCD Primary Output	Substation extension at Sellindge 400kV to enable the customer connection with [redacted] by [redacted]		
Estimated Cost (price base 2018/19)	Our total cost for the investment and funding allowance being sought is: The current total cost of the project is: [redacted] The total direct cost of the project - the funding this MSIP seeks is [redacted]		
Spend profile	[redacted]	[redacted]	[redacted]
Reporting table	Annual RRP - PCD Table	**PCD Modification**	Special Condition 3.14, Appendix 1
Historical funding interactions	No existing funding in RIIO-T1 or RIIO-T2.		

1. Executive summary

1.1 Context

This paper summarises NGET's proposed investment to extend Sellindge 400kV substation and seeks to demonstrate the consumer interest in the associated investment.

This Medium Sized Investment Project (MSIP) seeks approval of the need for the investment, as well as approval of the proposed solution and requested funding allowances for efficient spend on the project. The funding is required by NGET to deliver works in response to the National Energy System Operator (NESO) Stability Pathfinder Phase 3 project and to enable the delivery of the project in line with the contracted customer connection date in [redacted].

1.2 What is the background to this Investment?

As part of their role, NESO is responsible for ensuring the security, operability, and reliability of the electricity system during the transition to net zero. Recent developments in decarbonisation, decentralisation, and digitalisation are driving considerable changes within the electricity network, impacting the operation of the transmission system. By [redacted], it is anticipated there will be a significant increase in low carbon generation and interconnection, both of which will pose operability challenges.

Grid stability, which has traditionally been supplied as an inherent by-product of traditional generation (coal and gas plants), represents one of those challenges. As traditional generation is phased out, there is a decline in the inherent stability of the system with inertia and short circuit levels falling. A power network operating without required levels of mechanical inertia is unstable, suffers from issues of power quality and is susceptible to blackouts.

In [redacted], NESO identified the Southeast as a region requiring stability solutions for the transmission system. NESO issued a tender to procure services to deliver sustainable solutions at a low cost, known as the Network Options Assessment (NOA) Stability Pathfinder Phase 3[1]. Following this assessment, it was determined that Sellindge 400kV substation had a connection bay available to accommodate the Pathfinder Phase 3 solution. [redacted] were awarded the contract to deliver stability solutions for the Southeast of England. NGET has a contractual obligation to provide a connection to this customer.

NESO in collaboration with NGET identified this site as an appropriate Grid Supply Point (GSP) with adequate capacity to support the stability pathfinder scheme, thereby reserving capacity at this location. As the owner of the transmission system, NGET is tasked with ensuring that stability solutions are integrated safely and effectively within the network, in accordance with the Security and Quality of Supply Standard (SQSS). Although the customer has been granted the contract to implement the stability scheme via NESO's tender process, the connection of the synchronous compensators to the transmission system necessitates infrastructure modifications at Sellindge, which is the responsibility of NGET.

1.3 What have we considered in developing options for this investment?

NGET assessed a range of solutions to meet the investment drivers in a way that best serves the interests of consumers. We considered solutions across five categories. In evaluating these options, we considered the ability to meet the NESO contracted timeline for delivering the work stability solution, costs, technology type, and other factors that are relevant to consumers.

Whilst further detail regarding the optioneering process is provided in sections 4 and 5 of this submission, a brief summary of the options considered is explained below.

In line with the reopener guidance set out by Ofgem, we considered three options as standard, **do nothing (Option A)**, **market based (Option B)**, and **whole system solutions (Option C)**. These were discounted due to their inability to provide a compliant and viable customer connection and

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[1] ESO Transparency Forum, [redacted] https://www.neso.energy/what-we-do/systems-operations/operational-transparency-forum

because they would not address the grid stability needs identified by NESO, leading to increased constraint costs.

We then considered options to **make use of existing NGET substations (Option D)** or to **build a new substation (Option E)**. Option E was not shortlisted because it was deemed excessive and inefficient for consumers from a cost and timing perspective given the available capacity at Sellindge.

We therefore subsequently focused on options to extend or utilise existing substations (Option D). Options differed based on configuration of equipment and were shortlisted based on various factors, such as: relative cost (need for additional equipment), procurement lead times, site space and land footprint constraints, safety, health & security, and the environment. Buying additional land at Sellindge was discounted due to the impacts that this would have on the timely delivery of the Pathfinder 3 connection, as well as the cost to consumers.

For the delivery of Pathfinder Phase 3 at Sellindge, we considered nine options, of which three options were progressed to detailed options analysis (D-6, D-7, and D-8):

- **D-6:** GIS bay and cable termination to the north side of the substation, cable route under the proposed GIS building; PRR located on the west side of the substation, positioned on the base slab above substation level.
- **D-7:** GIS bay and cable termination to the north side of the substation, cable route located to the west of the substation and beneath the building; PRR located on the west side of the substation positioned on the base slab above substation level.
- **D-8:** GIS bay and cable termination to the north side of the substation, cable route located to the west of the substation and beneath the building; PRR located close to the access road.

1.4 What is the preferred option and what outputs does it deliver?

The preferred option is summarised below. It aligns with NESO's strategic priorities for enhancing inertia and SCL in the southeast region, fulfilling the requirements set out in NESO Stability Pathfinder Phase 3. The proposed design aims to deliver connection while providing the greatest benefit in terms of consumer value.

Key features for the preferred option include:

- Development of the GIS building and the relocation of the GIS platform to facilitate the extension of the main and reserve busbars
- 400kV cable route bypasses the Cheriton circuit and eliminates the need for any work on the main access road during the construction phase.

Funding allowances are sought as part of this MSIP submission. The direct costs for this investment are [redacted] (18/19 prices). Further details related to the makeup of these requested allowances are detailed within the cost model available alongside this submission.

1.5 How has future proofing been considered in the proposed investment?

During the project's development, initial discussions considered the potential for futureproofing; however, it became evident that there was limited opportunity for further expansion at the site. Due to space constraints and the site reaching its capacity, both in terms of land footprint and connection of available bays, focus has been placed on delivering the contracted customer connection for the Pathfinder solution in line with timelines specified by NESO, which is the primary investment driver.

1.6 What are the uncertainties and how have they been accounted for?

The risks and uncertainties to the successful delivery of this project include:

- **Customer Delays:** There is a risk that the customer's works may impact on the delivery of NGET scope. This is due to interface between the customer's construction works and the delivery of the infrastructure scope. This is an external dependency to the project from the customer. This may result in a delay to the ACL date, and additional costs for demobilisation and remobilisation.

- **System Outages:** There is a risk that outages may be cancelled, delayed, or changed. This could be due to safety incidents, unforeseen events, or changes in outage plans. This could cause potential contractor downtime, demobilisation, or remobilisation, ultimately causing delay and cost to the project.
- **Interfacing Works:** There may be interfacing works, leading to issues on site. This is due to interface issues arising between the contractor and other parties. This could ultimately lead to possible stand downs, delay and cost to the project.
- **Shipping Route**: There is a risk the delivery of the project goods may be delayed due to shipping routes being changed. Any diversions may impact on delivery times, ultimately resulting in delay and additional cost to the programme.
- **Long Lead Items for GIS Bay:** There is a risk that the GIS bay may not be delivered in time, due to this being a long lead item. This could result in delays to the project timeline.

Following a NESO-driven investment driver to enhance grid stability in the South East (South Coast) of England, NGET will implement infrastructure works to connect one Synchronous Condenser at Sellindge 400kV substation.

NGET proposed an extension to Sellindge 400kV substation to accommodate a user bay to host the stability service connection.

The designs will deliver the essential infrastructure to meet the customer's needs, ensuring a reliable and efficient connection, while providing the greatest benefits in terms of consumer value.

2. Introduction

2.1 Project background

This paper presents the investment case and associated efficient costs for our preferred solution for delivering stability services at Sellindge 400kV substation, as identified through the NESO Pathfinder Phase 3 project.

The grid stability project at this substation is essential to supporting the UK's decarbonisation goals and achieving a net-zero economy by [redacted]. As the transition to renewable energy accelerates, there is an increasing demand for innovative stability solutions to ensure grid reliability, as the stabilising properties traditionally provided by transmission connected synchronous generation is gradually phased out.

NESO commenced a Network Options Assessment (NOA) Stability Pathfinder Phase 3 project to find the most cost-effective way to address stability issues. This scheme focuses on increasing system inertia at short circuit level (SCL) in England and Wales. Ultimately, these solutions support a more affordable, reliable, and sustainable electricity system while advancing the transition to a low-carbon energy future.

The substation selected to provide the stability services is illustrated in Figure 1.

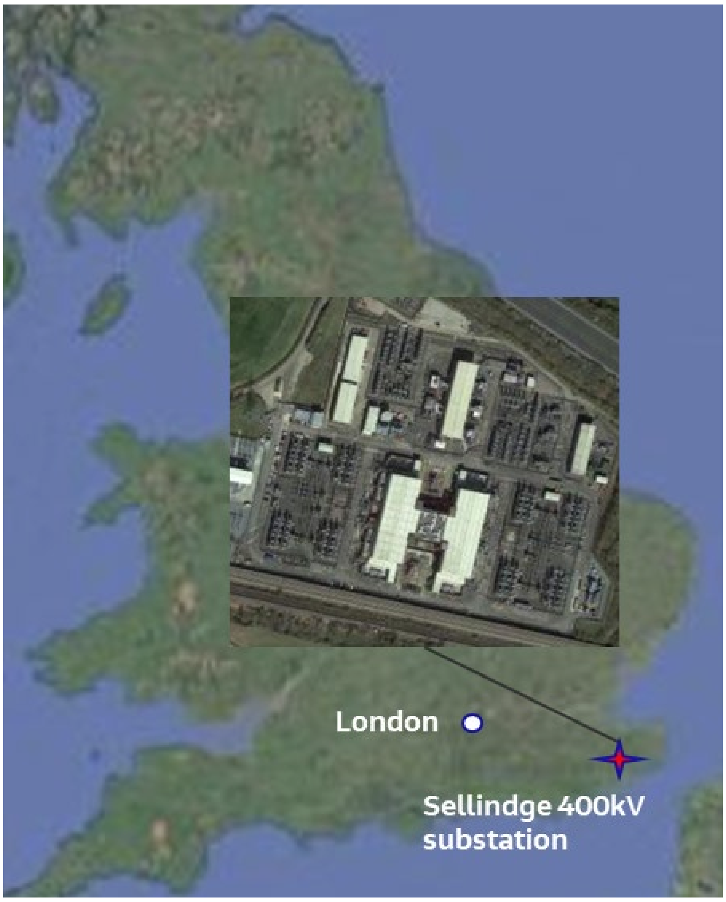

Figure 1: Sellindge 400kV substation location

2.1.1 Chronology to the request

The National Energy System Operator (NESO) is responsible for ensuring the security, operability, and reliability of the electricity system. In [redacted], NESO announced a pledge to operate a 100% zero carbon national electricity transmission network by [redacted]. To deliver this, NESO established Stability Pathfinders[2] to support the development, adoption, and delivery of new technologies to generate

[2] ESO Transparency Forum, [redacted], Operational Transparency Forum | National Energy System Operator

important system characteristics, such as system inertia. Pathfinder Phases were determined by the following regional groupings:

- Phase One: GB Wide - Inertia and dynamic reactive power (0MW synchronous compensators only)
- Phase Two: Scotland - Inertia, SCL, and dynamic reactive power
- Phase Three: England and Wales - Inertia, SCL, and dynamic reactive power (0MW synchronous compensators only)

NESO's Stability Pathfinder Phase 3 project sought to address grid stability challenges through a competitive tender process for the procurement of inertia and SCL across five regions in England and Wales. NGET, in collaboration with NESO, identified the South-East (also referred to as South Coast) as at risk due to the increased adoption of renewable energy technologies, resulting in the need for regional stability and Sellindge as a suitable substation with available connection bays to address the requirement for network stability.

NESO - Identification of GB [redacted]	• NESO's System Operability Framework highlighted the operability risks associated with declining traditional generation, driving the need for stability solutions. • NESO requested NGET to complete an initial analysis to confirm which substations within each region of need could accommodate a new connection for stability solutions
Pre-Tender Consultation and [redacted]	• NESO published draft tender documents, including technical specifications. Market participants were invited to express their interest in the tender. • NESO reserved a number of connection points (bays) on the network, based on tehnical effectiveness and connection opportunities, for tender participants to implement solutions including Sellindge 400kV substation
Tender Launch (December [redacted]	• Registered participants submitted technical and commercial proposals. • NGET feasilibily studies report was produced for the reserved connection points at substations to inform tender submissions. • The tender submission deadline was [redacted].
Pathfinder Contract Awards (November [redacted]	• NESO awarded contracts worth £1.3 billion to six companies for solutions providing 7.5 Giga Volt Amperes (GVA) of Short Circuit Level (SCL) and 15 Giga Watt seconds (GW.s) of inertia across all regions in England & Wales[#]

Figure 2: NESO Pathfinder Phase 3 Chronology

2.1.2 Consumer Benefit

Stability services are essential to support the UK's broader decarbonisation targets. Traditional fossil fuel generation provides grid stability as generation is synchronous. Renewable generation, such as wind and solar, are non-synchronous and therefore require synchronous compensation to maintain grid stability. Synchronous compensators are therefore used to help maintain grid stability when renewable energy sources are increasing. The connection of stability services at Sellindge substation will thus enable further renewable integration into the grid on the South Coast. This in turn benefits the UK's Net-Zero commitments while maintaining quality of supply in line with the Security and Quality of Supply Standards (SQSS). This project will improve SCL during system faults, enhancing the grid's ability to manage disturbances and maintain stability.

NESO estimates that failing to address stability requirements throughout England and Wales through Pathfinder Phase 3, will cost an additional [redacted] for system inertia management from [redacted] This figure represents the cost of maintaining fossil fuel generation as a stabilising measure, which would be evident in consumer energy bills and would also fail to meet the UK's Net Zero commitments.

2.2 Regional and strategic context

London and the Southeast are predominantly net importers of energy. Central and Greater London account alone for 20% of the national power demand, primarily due to high commercial loads. These lead to summer peak demand sometimes exceeding winter peaks. Electricity demand in the region is expected to grow further over the next 20 years due to ongoing decarbonisation efforts and Data Centre connections.

The need for accelerated network investment due to the growing pipeline of connections is well established.[4] The 275kV and 400kV transmission networks in London and the Southeast (Figure 3) are designed to meet London's electricity needs and support coastal interconnector power exchanges (which allow for swings for both the import and export of energy). The region is experiencing rapid development of non-synchronous renewable energy projects. Non-synchronous generation reduces system inertia, necessitating significant electricity network reinforcement. NGET's system will need to adapt to the needs of the distribution networks and accommodate the large generation and demand customer connections pipeline in the region.

By focusing on necessary network upgrades and ensuring the system can manage the increased demand, the Pathfinder project supports England's strategic goals for a sustainable and resilient energy future.

[redacted]

2.3 MSIP Eligibility

The Sellindge project meets the MSIP criteria under Special Condition (SpC) 3.14.6 (f) a system operability, constraint management or 0MW connection project (NESO driven).

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3 [redacted], NESO, ESO announces new contracts to deliver [redacted] in savings, https://www.neso.energy/news/eso-announces-new-contracts-deliver-over-ps14-billion-savings

4 DESNZ & Ofgem ([redacted], Connections Action Plan; https://www.gov.uk/government/publications/electricity-networks-connections-action-plan

2.4 T3 Interactions

While this MSIP is being submitted under the RIIO-T2 price control period, we have ensured alignment with initiatives outlined in our RIIO-T3 Regional Report *South East: Future Network Blueprint*.[5] Through this blueprint, we are enhancing existing networks to ensure adequate capacity for electricity transmission in the region.

The Sellindge substation grid stability Pathfinders aligns with the ambitions set out in our RIIO-T3 business plan to facilitate the shift towards a clean and sustainable energy network for the future. These investments are critical for aligning with Ofgem's T3 consumer outcomes (see Table 1).

Our RIIO-T3 business plan included an Engineering Justification Paper (EJP) for a proposed investment at the Sellindge 400kV Substation. That investment will enable NGET to abate existing, and future, SF6 emissions from the site. This will in turn reduce the total SF6 emissions from the transmission network to contribute to meeting the required short- and long-term SF6 emission reduction targets and to remain on track for the Net Zero target by [redacted].

Table 1: Alignment with Ofgem T3 consumer outcomes

Infrastructure fit for a low-cost transition to net zero	Supports the Pathfinders project, which is required for ensuring system stability as low-carbon technologies are integrated into the grid, which is a key element of expected new generation in the South East over the T3 period.
System efficiency and long-term value for money	The Pathfinders project avoids increased constraint costs as the network would otherwise rely on costly balancing measures.

5 South East: Future Network Blueprint

3. Establishing Need

3.1 Overview

This section sets out the key driver of the investment need. This is summarised in Table 2 below.

Table 2: Summary of Investment Driver

Summary of Primary Driver			Date
Pathfinder Phase 3	NESO requested (NGET) to conduct a high-level analysis to assess which substations in the region have capacity to accommodate a new connection. Sellindge 400kV substation in the South-East (South Coast) was identified as having an available connection bay to accommodate the Pathfinder Phase 3 solution.		[redacted]
Customer Connections	**Pathfinder**	This investment is driven by a signed customer connection request. The customer [redacted] was successful in their tender to provide stability services to NESO and has been awarded contract to deliver this solution. NGET is obligated by our licence to provide a connection to the customer. A formal application was submitted, forming the basis of the needs case for the proposed investment works, detailed in this submission.	[redacted]

3.2 Generation related drivers

Table 3 provides further details on the proposed customer connection.

Table 3: Details of Generation Driver

Customer Name	MVA Demand	Available for Commercial Load Date (ACL)[6]	Customer Status
[redacted]	50 MVA User Synchronous Compensator	[redacted]	Customer has signed a connection agreement specifying ACL dates.

3.2.1 Grid Stability

The national electricity networks are a complex system that must meet engineering needs for reliable power flows. These needs include inertia, short circuit level, voltage control, and system restoration. Traditionally, system needs have been met by synchronous generation sources such as coal, gas, and nuclear plants. When synchronous sources are running in most cases they have a stabilising effect on the system. However, the rapid increase and integration of variable renewable technologies (wind, solar and other technologies) means there is a reduction in synchronous generation on the network. Non-synchronous generation does not have the same stabilising effect which means additional actions are required to maintain system reliability.

The NESO Operability Strategy Report December [redacted][7] outlined plans on how NESO will look to address the stability challenges by incorporating the use of new synchronous assets such as synchronous compensators. These assets can provide stability to the network with minimal impact on the electricity market. Unlike traditional generation sources, synchronous compensators require only a relatively small demand and do not need to export large volumes of power to provide stability. This will ensure the system always remains stable, even when network conditions are changing. By exploring new sources of stability such as synchronous compensators, the electricity system can continue to deliver safe and reliable electricity and move towards a sustainable and resilient future.

NESO identified 5 regions of need: North-East England, East of England, South Coast, South West England and South Wales. These regions were chosen because Phase 3 needs to procure Short Circuit Level (SCL) which is highly locational in nature, with effectiveness reducing as the electrical

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[6] The Available for Commercial Load (ACL) date refers to the date recorded as the first commercial use of the connection

[7] https://www.neso.energy/document/227081/download

distance increases. Presently there is a 15GW SCL and inertia need across all regions. NESO identified regional grid stability requirements are highlighted in Table 4.

Short Circuit Level (SCL)

SCL measures the system's ability to manage faults (such as those resulting from weather, equipment failure, or lightning) ensuring there is adequate fault current for protective devices, like circuit breakers, to operate effectively.

A high (SCL) enhances voltage stability, minimising significant fluctuations during disturbances and aiding in quicker recovery of the grid. Conversely, operating a system with a low SCL may result in a longer recovery time following a disturbance.

Inertia

Electricity for the grid is generated by machines that have large rotating components. These components rotate at the appropriate frequency to maintain a balance between supply and demand. The kinetic energy stored in parts is referred to as inertia. In the event of a sudden change in system frequency, these components will continue to rotate and mitigate that change, thereby assisting in stabilising the grid following disturbances.

Table 4: Regional grid stability requirements as determined by NESO

Region	SCL and Inertia Need
North-East England	500 MVA
East of England	2000 MVA
South Coast	2000 MVA
South-West England	500 MVA
South Wales	2500 MVA
Total Inertia across all these regions	**15 GW**

In NESO document Network Options Assessment (NOA) Stability Pathfinder Phase 3 - Regions of Need and Network Diagram Details" [8] NESO's model identified the threshold that distinguishes substations inside and outside the regions of need. Additionally, NESO requested NGET to conduct a high-level analysis to determine which substations had the capacity to accommodate a new connection. Following NESO's assessment, it was determined that Sellindge 400kV substation has the capacity to accommodate the Pathfinder Phase 3 solution.

The outcome of the Stability Pathfinder Phase 3 tender assessment was published by NESO in [redacted]. NGET is obligated by our licence to provide a connection to the customer. A formal application was made, forming the needs case for the works proposed in this submission.

3.3 Existing and planned future network

3.3.1 Overview of the network today

The Southeast (South Coast) transmission network can act as both an importer and exporter of electricity, depending on interconnector power flows. Excess power on the transmission network flows into this region and heads to the interconnectors for export in times of high wind and solar generation in the UK. With increasing renewable power generation, high wind and solar output often flow through England and Wales to the Southeast, then export to Europe. These interconnectors create dynamic challenges for managing large power flows in either direction.

3.3.2 Strategic outlook of the network changes

By [redacted], NGET will deliver the connection of five new interconnectors in the Southeast that will bring approximately 8GW of import and export capability (Figure 4). Substation sites have been assessed to balance asset health, customer connections, and network upgrades. Seven substations are identified for rebuild, and eight new substations will provide additional capacity. For example, the Warley substation rebuild addresses deteriorating asset health and plans for a 400kV North London network. New transmission sites like Uxbridge Moor and Letchmore Heath will connect data centres and batteries, modernising London's industry.

[8] https://www.nationalgrideso.com/document/227121/download

Several reinforcement projects on the outskirts of London will support power transfer across the Southeast and bolster the supply into Central London. Upgrades to the Iver cables will increase capacity into West London, addressing cable asset health drivers. The investment at Sellindge is part of the strategy to reinforce the network infrastructure in the region.

[redacted]

3.3.3 Asset Health

The main driver for this investment is to implement NESO’s Stability Pathfinder Phase 3 solution, and as a result, site asset health has been given limited consideration during the project's development. High-level overview of Sellindge substation suggests that most of the assets are low risk (in good condition). It is important to highlight that this assessment is based on primary health drivers, such as family condition, age, and obsolescence. and does not consider other factors such as visual condition assessment, oil/SF6 top-ups, maintenance compliance, plant status issues, or open defects.

Any asset health-related works at Pathfinder sites will be efficiently managed through programmes of work or asset health intervention windows as part of T2, or through T3. Therefore, NGET are not seeking additional funding to address any asset health issues through the Pathfinder MSIP.

4. Optioneering

4.1 Overview

This section summarises the options we considered to address the needs case established in the previous section, in a way that best serves the interest of current and future consumers. In line with our optioneering process, for Sellindge, we identified the following high-level options:

A. A do-nothing option as a counterfactual option;

B. A market-based approach;

C. Non-transmission, whole system solution;

D. Making use of existing NGET substations;

E. A new substation.

In summary:

- **Options A-C** were discounted because they risk NGET's licence obligation to provide a customer connection. The grid stability needs identified by NESO would also remain unaddressed without action, leading to increased constraint costs, reliance on costly balancing measures, and operational risks to the grid. Optioneering was therefore focused on site-specific solutions to ensure the successful delivery of the Pathfinder Phase 3 solution.

  Options B & C were ruled out in early optioneering stages as NESO's advanced planning, supported by NGET's feasibility studies during the tender process, assessed the appropriateness of Sellindge substation and reserved the required connection bays.

- Options that **make use of the existing NGET Sellindge substation (Option D)** were then considered. We evaluated nine site-specific options at Sellindge substation to extend and utilise the existing infrastructure and to connect the Pathfinder 3 solution. Various options were evaluated to ensure optimal site layout and technology solution. Key factors for discounting options included technical feasibility and complexity for Options D-1 to D-5 and space constraints for D-9 for SF6-free GIS. (Buying additional land was discounted due to the impacts this would have on the timely delivery of the Pathfinder 3 connection, as well as the cost to consumers). Options D-6, D-7 and D-8 were shortlisted for detailed options analysis. Option D-7 was the selected as the preferred solution.

- We then considered options to **construct a new substation (Option E)**. This approach would construct an entirely new substation or consider alternative sites to connect the Pathfinder solution. This was not shortlisted because it was deemed excessive due to the technical feasibility and sufficient capacity of Sellindge substation to accommodate the stability solutions identified by NESO. Constructing a new substation or utilising an alternative location may incur substantial costs, entail planning challenges, and result in prolonged timelines, which would conflict with the operational objectives of the Pathfinder programme. This would lead to higher expenses for consumers and a potential risk to the quality of supply.

4.2 Assessment of high-level options

A summary of our assessment of the high-level options identified to meet the customer need is set out below. Each is assessed against the following criteria:

- Capacity and future development potential
- Design and technical complexities
- Operation and maintenance
- Safety, health and security
- Planning, land and consent
- Third party impact and network coordination
- Environment and sustainability
- Timing of programme and resources
- Cost

A summary of our initial options assessment is shown in Table 5 below.

Table 5: Summary of initial options assessment, Sellindge 400kV substation

Option	Option title	Option description	Taken Forward to Detailed Optioneering?	Rationale
D-1	GIS bay and cable to the south side of the substation, PRR located on the west side	GIS bay and cable termination to the south of the substation; Portable Relay Room (PRR) proposed at the West side of the substation with an extension of the existing platform.	**Not taken forward**	The option is not viable because the GIS termination and the 400kV cables are located in the area of the OHL winch machine.
D-2	GIS bay, cable, PRR to the north side of the substation	GIS bay and cable termination to the north side of the substation; PRR to the north side of the substation with an extension of the existing platform.	**Not taken forward**	The option is not feasible as the extended PRR platform is near to a live circuit.
D-3	GIS bay and cable termination to the south side of the substation,	GIS bay, cable termination similar to option D-1; PRR near the GIS building on a separate platform close to the ground level.	**Not taken forward**	The option is not feasible as the extended PRR platform is near to a live circuit.

Option	Option title	Option description	Taken Forward to Detailed Optioneering?	Rationale
	PRR near GIS building on separate platform.			
D-4	GIS bay and cable termination to the south side of the substation, PRR at the north side with extension of existing platform.	GIS bay and cable termination to the south side of the substation and cable routed under the building; PRR to the north side of the substation with an extension of the existing platform.	**Not taken forward**	The option is not viable because the OHL cable winch area is obstructed and the cable crosses beneath the main gate.
D-5	GIS bay and cable termination to the south side of the substation, PRR at the west side with extension of the existing platform.	GIS bay and cable termination to the south side of the substation, cable route at the west of the substation and under OHL winch area; PRR to the west side of the substation with an extension of the existing platform.	**Not taken forward**	The option is not feasible as the Gas Insulated Busbar (GIB) termination along with 400kV cables are located in the OHL winch machine area.
D-6*	GIS bay - cable route under the proposed GIS building, PRR at the west side on the base slab.	GIS bay and cable termination to the north side of the substation, route cable under the proposed GIS building; PRR to the west side of the substation placed on the base slab above the substation level.	**Taken forward**	Compliant customer connection delivered. The 400kV cable route bypasses the access roads and other facilities. It requires the smallest building extension.
D-7*	GIS bay, cable route to the west of the substation, PRR at the west side on the base slab.	GIS bay and cable termination to the north side of the substation, cable route is considered to the west of substation and under the building; PRR to the west side of the substation placed on the base slab above the substation level.	**Taken forward**	Compliant customer connection delivered. The option avoids crossings the Cheriton circuit.

Option	Option title	Option description	Taken Forward to Detailed Optioneering?	Rationale
D-8*	GIS bay, cable route to the west of the substation, PRR close to access road.	GIS Bay and cable termination to the north side of the substation, cable route to the west of the substation and under the building; PRR close to the access road.	**Taken forward**	The option is feasible as it avoids crossing the Cheriton circuit. 400kV cable is extended to the north-west side of the substation for better connectivity to user site.
D-9	SF6 free GIS bay.	SF6 free GIS bay.	**Not taken forward**	The option is not feasible due to space constraints (two circuit breakers required for SF6 free solution, rather than a single breaker for SF6 variant).

* Options D-6, D-7, D-8 all propose the extension of the existing GIS bay, varying only in different solutions for routing the user cable.

The conclusion of the assessment is that Options D-6, D-7, D-8 were carried across into detailed option analysis. All these options are focused on the extension of the existing GIS building, varying only in different options for routing the user cable.

4.3 Qualitative options analysis

Table 6 below provides a summary of our detailed qualitative assessment of the relevant technical, environmental, planning, and socio-economic considerations pertaining to the shortlisted options

Table 6: Summary of qualitative analysis of shortlisted options

Option #	D-6	D-7	D-8
Option title	**Extension of GIS bay - cable route under the proposed GIS building**	**Extension of GIS bay - cable route to the west of the substation**	**Extension of GIS bay - cable route to the west of the substation. PRR close to access road**
Capacity & future development potential Preferred option: all equal	• Space constraints will limit future development. Both in terms of land footprint and connection of available bays	• Space constraints will limit future development. Both in terms of land footprint and connection of available bays	• Space constraints will limit future development. Both in terms of land footprint and connection of available bays
Design & technical complexities Preferred option: D-7	• Cable route is in proximity to OHL tower and new cyber security cables and may impact the car park. • The new PRR foundation will need to be constructed near the existing pile caps, with piles for the PRR platform on one side, and the current access road on the other.	• Additional platform extension and associated cost for proposed PRR room is reduced compared to option D-6. • GIB termination is at the north side and no foundation on OHL winch area. • It avoids works on main site access road and crossings of Cheriton circuit • Increased cable route length • Cable installed in access road and in the OHL winch machine equipment area, should not impact maintenance access and may need to be protected with suitable heavy duty covers.	• Additional platform extension and associated cost for proposed PRR room is reduced compared to option D-6. • GIB termination is on the north side and no foundation on OHL winch area. • 400kV cable is extended to north-west side of the substation for better connectivity to user site. • It avoids works on main site access road and crossings of Cheriton circuit. • The existing disrupted drainage manholes on north side of the GIS building and its associated piping arrangement needs to be relocated. • Increased cable route length.
Operations & maintenance	No significant difference compared to current situation.		

Option #	D-6	D-7	D-8
Option title	**Extension of GIS bay - cable route under the proposed GIS building**	**Extension of GIS bay - cable route to the west of the substation**	**Extension of GIS bay - cable route to the west of the substation. PRR close to access road**
Preferred option: all equal			
Safety, health & security Preferred option: all equal	No significant difference compared to current situation.		
Planning, land & consent Preferred option: all equal	Permitted development.		
Third party impact & network coordination Preferred option: all equal	No impact expected.		
Environment & sustainability Preferred option: all equal	• No significant impact on natural habitat. • SF6 will be utilised, as it is not feasible accommodate a GIS SF6 free solution.		
Timing of programme & resources Preferred option: D-7	• No significant challenge in terms of delivery timeline and use of resources.	• Fewer technical complexities in routing user cables, potentially minimising the impact on the delivery programme. • Most cost-effective solution.	• No significant challenge in terms of delivery timeline and use of resources.

The assessment in the above table demonstrates the comparative analysis between the shortlisted options against key criteria including technical, environmental, planning, and socio-economic considerations. The assessment highlights strengths and weakness for the shortlisted options. Option D-7 was selected as the preferred option for the investment driver.

4.4 Quantitative options analysis

The multi-criteria process summarised above for selecting the preferred option did not require a detailed Cost Benefit Analysis (CBA) in line with Ofgem's guidance. We have concluded it would not be proportional to scale and cost of the investments proposed [redacted]) to undertake a CBA process for this submission.

Our evaluation of the options indicates that the preferred solution provides the best value for consumers, the earliest connection date for the customer, and an appropriate level of technical and project risk.

4.5 Preferred solution

Based on the qualitative analysis, we have recommended Option D-7 as the best solution to deliver the investment driver, in the interests of current and future customers. Option D-7 primary benefit is that the 400kV cable route bypasses the Cheriton circuit and any construction activities on the main Sellindge access road during the extension's construction phase.

Site solution: As outlined in the previous sections, NESO has allocated space for a connection bay at Sellindge to accommodate the Pathfinder solution. This bay was reserved for [redacted] after they were successful in their tender to provide stability services to NESO.

The new bay is to be connected onto the east of the substation and will require relocation of the platform and extension of the GIS building. The new location for the platform obstructs the existing access road, hence a new access gate may be required.

Technology choice: Scope of works includes development of the existing GIS building to facilitate the extension of main three and reserve three busbars, including the supply, construction & commissioning of a new GIS bay (including bay equipment), civil works and associated Protection and Control (P&C). This is intended to connect the customer's synchronous compensator.

[redacted]

5. Detailed cost for preferred solution

5.1 Introduction

This section provides a high-level summary of the overall costs for the proposed extension at Sellindge substation, including an expenditure profile for all regulatory years of delivery. The costs presented in this section represent our latest view of costs for the proposed investment; all costs are presented in 2018/19 prices, unless otherwise stated.

The cost model submitted alongside this document, provides a breakdown of the costs in more detail and should be reviewed alongside this chapter.

5.2 Total Allowance Request

Total project costs are [redacted]. NGET requests [redacted] allowance is provided through the MSIP reopener mechanism to recover the direct portion of costs and deliver works described above. The MSIP reopener mechanism is subject to the Opex escalator and therefore indirect costs will be funded under this route.

Table 7: Allowance request - Cost Model tab reference 1.0

	2018/19 price base (£)
	[redacted]
Total project costs	
CAI	
Funding Request	

5.3 Cost Estimate

The total cost to develop and deliver the investment at Sellindge is [redacted] including indirect costs and costs incurred to date.

Table 8: Cost Summary - Cost Model tab reference 1.1

2018/19 price base (£)		
Element	**Total**	**CAI/Direct**
Contractor Costs		
Main Works Contractor	[redacted]	Direct
Third Party Costs	[redacted]	Direct/CAI
National Grid Costs	[redacted]	
ET Ops	[redacted]	Direct
Project Management	[redacted]	CAI
Project Services	[redacted]	CAI
Support Functions	[redacted]	CAI
NGET Portfolio Costs	[redacted]	CAI
Other	[redacted]	
Estimated Inflation	[redacted]	Direct
Risk	[redacted]	Direct
Total	[redacted]	

5.4 Cost Firmness

Table 9 below shows the assessment of cost firmness using the classification outlined in the Ofgem LOTI reopener guidance document published on [redacted]. This shows that only 6% of the total costs (firmness 1 and 2). We have low cost certainty because we are yet to have full tendered costs. This is also the reason why we have agreed to do a delayed cost submission later in [redacted]. Cost firmness will increase in later submissions.

Table 9: Cost Firmness - Cost Model Tab reference 1.9

Cost Firmness	Total (2018/19 Prices, £)	Notes
1 - Fixed	[redacted]	Prior costs and actuals
2 - Agreed remeasurable		
3 - Agreed remeasurable future information		
4 - Estimated		Risk and Third Party (less actuals)
5 - Early Estimate		Contractor and NG Costs (less actuals)
Total		

6. Deliverability and risk

6.1 Deliverability

This section sets out a summary of the key activities required for the delivery of the project, including the current high-level programme, procurement strategy and anticipated risks.

6.1.1 Delivery Programme

The project programme is illustrated in Table 10 below.

Table 10: Delivery programme at Sellindge

Activities	Date
Sanction	[redacted]
Gate C	
ITT	
Contract Award	
First Site Access	
Outages Start	
Site Works Complete	
Gate D	
Gate E	

The table above shows the key milestones of the delivery programme. The delivery programme is currently on track, with all milestones being met as scheduled. There are no known deviations or issues affecting the progress of the programme.

6.1.2 Procurement and Contracting Strategy

The procurement and contracting strategy for Sellindge adheres to the NGET procurement approvals process, ensuring that all projects meet strategic goals and technical requirements. This comprehensive approach involved a thorough assessment of different procurement options for the project, whereby the project has been procured via an established framework.

The Sellindge Pathfinder Phase 3 project will be executed using the RIIO T2 Mechanical & Electrical Installation Framework. This framework allows for the direct allocation of the project to a Main Works Contractor. Through the Portfolio Allocation Model, preferred suppliers are selected based on Best for Task criteria which includes factors such as contractor capacity, performance, site knowledge and geographical advantages. Interested suppliers are first identified through market engagement and a preferred contractor is then selected based on criteria responses.

A key component of our procurement strategy has been to use early contractor involvement (ECI). This approach has allowed us to procure long lead items and commence design work while the full fixed price was being developed. By engaging contractors early in the process, we have been able to address emerging issues proactively, compress project timelines, and ensure that all technical and commercial needs of the project are addressed.

6.1.3 Risk and Risk Management

A risk management process has been used for managing reasonably foreseeable risks. The process is in line with ISO 31000:2009, Risk Management - Principles and Guidelines. Table 11 below lists the key risks and mitigation strategies for Sellindge. A comprehensive risk register for the project is available within the cost model.

Table 11: Delivery risks for Sellindge 400kV

Description	Mitigation
Customer Delays There is a risk that customer's works may impact on the delivery of NGET scope. This is due to interface between the customer's construction works and the delivery of the infrastructure scope. This is an external dependency to the project from the customer. This may result in a delay to the ACL date, and additional costs for demobilisation, remobilisation.	Bi-weekly co-ordination and interface meeting held. Ensure actions and issues are resolved.
System Outages There is a risk that outages may be cancelled, delayed, changed. This could be due to safety incidents, unforeseen events, or change in outage plans. This could cause potential contractor down time - demobilisation, remobilisation. Ultimately causing delay and cost to the project.	Ongoing liaison with NESO.
Interfacing Works There may be interfacing works, issues on site. This is due to interface issues arising between the contractor and other parties. Ultimately leading to possible stand downs, delay and cost to the project.	Ongoing weekly interface meetings.
Shipping Route There is a risk the delivery of the project goods may be delayed due to shipping routes being changed. Any diversions may impact on delivery times, ultimately resulting in delay and additional cost to the programme.	Regular reviews of supply chain with contractor early engagement.
Long Lead Items for GIS Bay There is a risk that the GIS bay may not be delivered in time, due to this being a long lead item. This will result in delays to the project timeline.	Orders have been placed for the equipment. Regularly engagement with the supplier. The contractor has a supplier engagement plan to manage supplier lead times and any potential slippage.

7. Conclusion

This document is the MSIP submission to Ofgem by NGET for the Sellindge Pathfinder. It is submitted with reference to Special Condition 3.14.6 (f) of NGET's transmission licence This paper demonstrates the need for investment at Sellindge 400kV, and the optioneering analysis that led us to our proposed solution. Table 12 below summarises the main drivers, the selected option, estimated costs and expected outputs.

Table 12: MSIP Project Investment Summary

Drivers of the investment	**To provide a new 0MW demand connection for network stability.** Sellindge 400kV substation was identified by NESO to deliver the grid stability services in Pathfinder Phase 3.
Selection Option	**Option (D-7): Extension of GIS bay - cable route to the west of the substation**. Includes development of the existing GIS building to facilitate the extension of main three and reserve three busbars, including the supply, construction & commissioning of a new GIS bay (including bay equipment), civil works and associated Protection and Control (P&C).
PCD Primary Output	Substation extension at Sellindge 400kV to enable the customer connection with [redacted]
Estimated Cost	Our total cost for the investment and funding allowance being sought is: The current total cost of the project is [redacted] The total direct cost of the project - the funding this MSIP seeks is: [redacted]
Spend profile	[redacted]
Outputs	Deployment of synchronous compensators across all regions in stability Pathfinder Phase 3 will procure 7.5 Giga Volt Amperes (GVA) of Short Circuit Level (SCL) and 15 Giga Watt seconds (GW.s) of inertia. NESO estimates that, without the integration of Pathfinders across all regions, consumers in England and Wales may incur an [redacted] in constraint actions to manage stability between [redacted] and [redacted]. Addressing grid stability will also enable greater integration of low carbon technologies on to the network.

Following a NESO-driven investment driver to enhance grid stability in the South East (South Coast) of England, NGET will implement infrastructure works to connect one Synchronous Condenser at Sellindge 400kV substation.

NGET proposed an extension to Sellindge 400kV substation to accommodate a user bay to host the stability service connection.

The designs will deliver the essential infrastructure to meet the customer's needs, ensuring a reliable and efficient connection, while providing the greatest benefits in terms of consumer value.

8. RIIO-T1 and RIIO-T2 allowances

There were no investments proposed for these projects during either RIIO-T1 or T2 business plans submissions. The projects do not have funding through any other price control mechanism.

9. Assurance and Point of Contact

Provided with the MSIP portfolio submissions is the assurance statement letter, providing written confirmation in line with the assurance requirements set out in Ofgem's Re-opener Guidance and Application Requirements Document, dated [redacted].

This confirmation is provided by the Head of Future Price Controls, Electricity Transmission. They provide the following statements below regarding how this MSIP application has been prepared and submitted in relation to each of the three assurance points requested by Ofgem:

- **a.** It is accurate and robust, and that the proposed outcomes of the MSIP submission are financeable and represent best value for consumers.
- **b.** There are quality assurance processes in place to ensure the licensee has provided high-quality information to enable Ofgem to make decisions which are in the interests of consumers.
- **c.** The application has been subject to internal governance arrangements and received sign off at an appropriate level within the licensee.

NGET's designated point of contact for this MSIP application is Leo Michelmore, Strategic Upgrade Regulatory Manager (leo.michelmore@nationalgrid.com).

Appendix A: Enlarged drawing of preferred option.

[redacted]

Appendix B: Glossary

Acronym	Definition
ACL	Available for Commercial Load
AIS	Air Insulated Switchgear
CAI	Closely Associated Indirects
CBA	Cost Benefit Analysis
ECI	Early Contractor Involvement
EPC	Engineering, Procurement, Construction
ESO	Electricity System Operator
GIB	Gas Insulated Busbar
GIS	Gas Insulated Switchgear
GTDS	Gunning Transmission and Distribution Services
M3	Main 3
MSIP	Medium Sized Investment Project
NESO	National Energy System Operator
NGESO	National Grid Electricity System Operator
NGET	National Grid Electricity Transmission
NOA	Network Option Assessment
OHL	Overhead Line
PRR	Portable Relay Room
RMHZ	Risk Mitigation Hazard Zones
SAP	System Average Price
SCL	Short Circuit Level
SF6	Sulphur Hexafluoride
SP3	Stability Phase 3

Appendix C: Cost model

Please see the accompanying Cost Models submitted alongside this MSIP: ‘Appendix C Pathfinder Sellindge – MSIP Jan 25 – Cost Model’

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