MSIP Heysham OPS

National Grid Electricity Transmission
Medium Sized Investment Project

January 2025

Contents

Investment Summary

Project Name	Heysham Control & Protection Schemes	**Delivery year**	[redacted]
Drivers for the Investment	**Customer Generation Connection** To enable delivery of contracted connection at Heysham for Electricity Northwest Limited's (ENWL) 130.5MW of embedded generation, amidst existing technical and capacity constraints at Heysham.		
Key considerations & challenges	**Cost efficiency:** Identifying the most cost-efficient solution in the interest of current and future consumers. **NESO recommendation:** Fulfilling the requirements of the NESO's recommendation, reflecting the most efficient solution for consumers in facilitating the connection. **Regional Strategy:** Ensuring the investment complements local regional strategy to support wider regional connections and makes use of available capacity on existing sites. **Delivery Date:** Delays have already been experienced on this scheme due to delayed development of technical information. Any further impact to the delivery date will depend on outage availability and alignment between the installation and commissioning strategy.		
Optioneering	NGET, ENWL and NESO collaboratively evaluated 7 high level solutions to address the constraints at Heysham in the best interest of consumers. Options included: • A 'Do Nothing' was rejected as a lack of intervention would result in failure to accommodate the contracted embedded generation to ENWL's network. • 3 variations of options that would require installation of a supergrid transformer (SGT) at Heysham. • 2 options focused on upgrades to the protection and control schemes at Heysham. • 1 option to develop a new grid supply point (GSP) with new SGTs at Middleton, near Heysham. The options focused on upgrades via modification of the existing protection and control management system at the Heysham substation were taken forward as an immediate term solution. These two options differed on their comprehensiveness. Additionally, the option to develop a new GSP at Middleton was also taken forward as a longer-term solution to addressing further volumes of embedded generation that would also be required to connect,		
Proposed Solution	The proposed efficient solution to enable the volume of embedded generation to connect to ENWL's network via Heysham is: • Upgrade via a comprehensive modification of the existing Heysham Overload Protection Scheme (HOPS) and Auto Tripping Scheme (HATS) to be extended to cover the embedded generation connecting to ENWL's network, as well as the installation of a new Heysham Auto Close Scheme (HACS). • We also propose to construct a new GSP at Middleton with two SGTs to provide long-term capacity for a greater portion of ENWL's additional connection needs. The needs case for this Middleton GSP project is addressed separately as part of our RIIO-T3 submissions.		
Outputs of the Investment	**Customer Connection:** This investment will enable a 130.5 MW embedded generation connection for ENWL at the Heysham 132kV Grid Supply Point (GSP). **Security of Supply:** the modification of the protection and control schemes at Heysham contributes to ensuring security of supply by addressing key constraints at Heysham to strengthen the network's ability to accommodate additional generation.		
PCD Primary Output	Upgrade the protection and control schemes at Heysham GSP to facilitate the connection of 130.5MW of embedded generation via ENWL's network by [redacted].		
Estimated Cost (price base 2018/19)	The 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 – [redacted]		
Spend profile	**T2 (FY2022 – FY2026) and prior:** [redacted]	**T3 (FY 2027 – FY2031):**	**T4+ (FY 2032+):**
Reporting table	Annual RRP – PCD Table RIIO-T3 Pipeline Log – 10.5	**PCD Modification Process**	Special Condition 3.14, Appendix 1

Historic funding interactions	No existing funding in RIIO-T1 or RIIO-T2.

1 Executive summary

1.1 Context

This paper presents NGET's proposed investment to upgrade and extend the existing protection and control systems at Heysham 132kV GSP in order to facilitate 130.5MW of embedded generation connection at the Heysham 132kV GSP and seeks to demonstrate the consumer interest in the associated investment.

This Medium Sized Investment Project (MSIP) paper 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.

1.2 What is the background to this Investment?

In 2018, Electricity North West Limited (ENWL), a distribution network operator (DNO) in Northwest England, submitted a request to connect 134 MW[1] of embedded generation to the transmission network via the Heysham 132kV Grid Supply Point (GSP), owned and operated by NGET.

The initial connection offer to ENWL proposed installing a fourth 400/132kV Super Grid Transformer (SGT) at Heysham to feed the shared 132kV busbar, with an Available for Commercial Load (ACL) date of October 2021.

In 2019, this scheme was halted to allow NESO to conduct a Regional Development Programme (RDP) review. By 2020, the RDP concluded that implementing protection and control mechanisms that disconnect generators from the grid during system faults or instability, would provide a more economic means of connecting the embedded generation, rather than installing an additional SGT.

Subsequent project progressions by ENWL, driven by the growing demand for network capacity due to a surge in embedded generation applications, prompted re-evaluations of the technical and capacity requirements at Heysham. These project progressions meant a significant increase in total generation capacity to be connected, surpassing the initial application and necessitating both immediate and longer-term solutions to connect the increasing requests.

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

NGET, in collaboration with ENWL and NESO, assessed a range of solutions to meet the investment drivers in a way that best serves the interests of consumers. The collaborative development of options focused on balancing technical, operational, and financial considerations to effectively address the volume of embedded generation contracted to connect at Heysham.

- We considered that a 'Do Nothing' option would not address the constraints at Heysham and therefore it would not be feasible to connect the contracted embedded generation at Heysham.
- Three options that would have required the installation of an SGT were considered. We determined that these SGT related options were of a high cost relative to the benefits, and that the infrastructure upgrades that would be required as part of their installation would present disruptions to existing networks and customers.
- We assessed that modifications to existing protection and control systems could provide a lower-cost and less invasive solution to enable the connection of embedded generation. While this alone would not provide a long-term solution, it was considered a viable short-term intervention to accommodate some of the contracted generation.

[1] Note that the initial amount of embedded generation ENWL intended to connect was 134MW. Some of this generation has fallen away, hence the 130.5 MW to be connected.

We also assessed that given the volume of embedded generation projects in ENWL's pipeline, it was essential to develop a network solution capable of addressing both more immediate connection needs and a long-term solution to accommodate the additional portion of connections required. The development of a new Grid Supply Point (GSP) at Middleton offered a scalable and adaptable solution to accommodate increasing demand and generation effectively.

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

The preferred option to facilitate the contracted connection of ENWL's embedded generation involves modifications and enhancements to the existing control and protection schemes at Heysham. This option is comprised of the following components:

- Modification and extension to Heysham Overload Protection Scheme to include circuits to ENWL's generation connections and SGT1, SGT2 & SGT3.
- Modification/ extension of the existing Heysham Auto Tripping Scheme to include circuits to ENWL's generation connections and SGT1, SGT2 & SGT3
- Installation and implementation of the Heysham Auto Close Scheme to include circuits to ENWL's generation connections and SGT1, SGT2 & SGT3.

The upgrading of the control and protection at Heysham allows immediate connections for some embedded generation, whilst addressing fault level and reverse power flow challenges. The longer-term solution of a new Middleton GSP for ENWL via extension of the substation allows for the connection of further embedded generation and provides capacity for future connections.

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?

The proposed investment at Heysham is designed as a necessary and targeted solution to meet current contracted obligations.

The longer-term solution involves the extension of the Middleton 400kV substation, which will serve to establish a new GSP for ENWL, enabling them to connect a further 504.7 MW of embedded generation to their network by 2029.

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

- The current programme for the scheme is still being finalised due to the complexity of coordinating multiple stakeholders. Estimated revised milestones have been provided based on best possible information, but they remain subject to change. Ongoing engagement with all parties aims to establish an aligned delivery timeline.
- Planned outages are dependent on aligning with third-party generators and NESO's requirements. This creates uncertainty around the availability and timing of outages. Regular engagement with outage planners and monthly meetings are mitigating this risk by closely tracking outage opportunities.
- Delays to the provision of design information could impact project timelines. To mitigate this, design work is being prioritised, and NG technical information is being shared promptly with contractors to advance their design activities.

Following an investment driver to facilitate the connection of embedded generation at Heysham 132kV GSP, we have collaboratively undertaken an assessment to balance the need for a cost-efficient solution that enables these connections amidst site constraints and avoids and uneconomic network reinforcements.

Our solution to address the driver is to comprehensively upgrade the existing control & protection schemes at Heysham, allowing headroom for the embedded generation to connect to the system. As part of this, the design of the schemes will be extended to trip off non-critical embedded generation in the event of a fault or overload.

2 Introduction

2.1 Project background

This paper presents the investment needs case and associated efficient costs for enabling the connection of 130.5MW of embedded generation connections via Electricity North west Limited (ENWL) network at the Heysham 132kV Grid Supply Point (GSP). The scheme to enable this generation, of which the majority is renewable, is referred to as the Heysham Protection & Control Scheme.

The Heysham GSP is located in North Lancashire and supplies electricity to approximately 50,000 customers across North Lancashire and South Cumbria. The GSP comprises three 240MVA transformers connected to Heysham 400kV substation. Heysham supports ENWL's peak demand of up to 147MVA and connects two Bulk Supply Points (BSPs) and nine primary substations.

The site hosts several large offshore wind farms that contribute significant levels of renewable energy which has resulted in export constraints, creating a need for intervention to accommodate additional generation from the distribution network[2]. This investment proposal seeks to enable ENWL's generation connections at Heysham, amidst the site constraints.

2.1.1 Chronology to the request

Initial Offer for Embedded Generation (2018)	• ENWL submitted a request to connect 134 MW of embedded generation at Heysham. • Initial solution involved installing a 4th Super Grid Transformer (SGT) at Heysham to meet capacity requirements
RDP Review (2019 - 2020)	• NESO conducted a Regional Development Programme (RDP), determining that installing a new SGT at Heysham was not the most cost-effective solution. • NESO recommended modifying the protection and control systems to manage post fault overloads.
Transition to Protection Schemes Solution (2020 - 2021)	• Connection agreement with NESO signed for the scope of works to upgrade/extend the existing protection schemes to allow the connection of ENWL's embedded generation. • This would allow connections by tripping the embedded generation during fault scenarios.
Increase in ENWL Project Progression Requests (2021-2023)	• ENWL continued submitting project progressions for additional embedded generation, leading to increased demand beyond the capability of the extended control schemes. • Several engagements occured disbetween NESO, ENWL and NGET regarding the amount of embedded generation, the connection solution and the most cost effective solution.
Immediate and Long Term Solutions (2023 Onwards)	• Proceeding with the plan to upgrade the protection schemes to facilitate near term connections. • Transitioned future connections to Middleton via two-step offers. • Middleton GSP emerged as the long-term solution for accomodating the growing pipeline of embedded generation, reflecting the evolution of regional network needs.

2 Electricity Northwest Limited Regional Insights (February 2021)

The growing need for embedded generation connections at Heysham led to an evolution of solutions to balance capacity, cost, and technical feasibility. Initially, a 4th SGT at Heysham was proposed to support new generation connections. However, NESO's RDP[3] identified this as a costly approach and recommended modifying existing protection to facilitate connections on a non-firm basis.

As ENWL continued to submit project progressions, increasing generation demand exceeded the capacity of these schemes, prompting a shift to scalable alternatives. This ultimately led to the reassessment of solutions to support ongoing regional growth amidst constraints at Heysham.

2.1.2 MSIP Eligibility

SpC 3.14.6 Category (f) a system operability, constraint management or 0MW connection project or substation work which is required to accommodate embedded generation.

2.2 Regional and strategic context

The Northwest of England is a cornerstone of the UK's energy sector, boasting a rich and diverse energy portfolio that spans nuclear power, offshore wind, natural gas, and emerging renewable technologies.

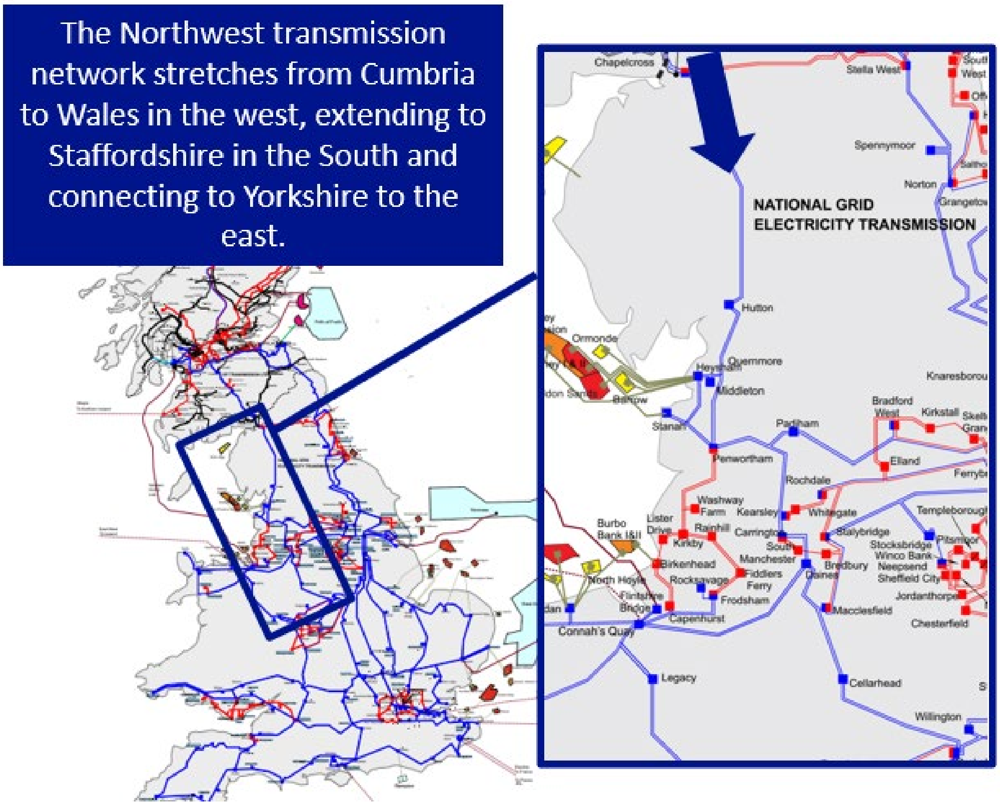
This includes in particular nuclear energy assets, particularly the Sellafield site in Cumbria, which is one of the most complex nuclear facilities in the world. Additionally, the Heysham nuclear power stations in Lancashire continue to be significant contributors to the UK's low-carbon electricity supply, underscoring the region's long-standing importance in nuclear energy.

Offshore wind energy is another major pillar of the North West's energy landscape. The Irish Sea hosts several large-scale wind farms, including Burbo Bank and the Walney Extension, which was the world's largest offshore wind farm at its completion. These wind farms are essential to the UK's renewable energy strategy, generating substantial amounts of clean electricity and supporting the country's commitment to reducing carbon emissions. The region's coastal geography, coupled with strong winds, makes it an ideal location for further offshore wind development, and ongoing projects continue to expand this capacity.

Significant amounts of renewable power generated in Scotland flow into Northern England through two 400kV transmission corridors splitting the northern network between East and West. The excess generation and power from the Scottish Transmission Network flows through the region towards demands centres in the Midlands and the South of England during periods of high wind and solar generation in the UK.

[3] A Regional Development Programme (RDP) is a method of addressing areas of the network that have inherent challenges due to the connection of large volumes of Distributed Energy Resources (DER). RDPs aim to introduce methods significantly enhancing transmission and distribution system coordination and control. They also provide new tools and resources to manage system constraints, ultimately reducing consumer costs.

Figure 1: Power flow from Scotland into the Northwest region



Customer Connections

As of July 2024, there was circa 0.6GW of contracts for new demand connections and 12.6GW for generation connections in the region to 2034. There is a strong likelihood that not all of this generation and demand will connect due to various customer factors.

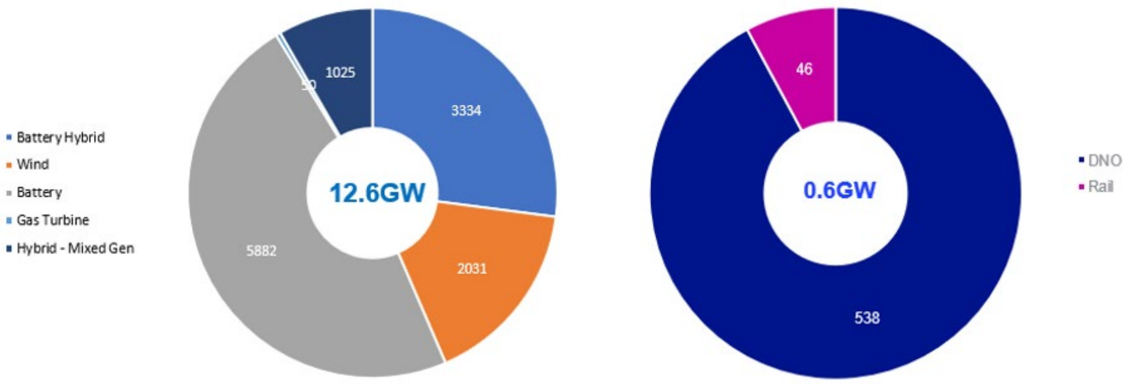


Figure 2: Contracted Generation and Demand Offers to 2034

Proximity to the B7a boundary

Heysham is adjacent to the B7a constraint boundary, which is one of the most constrained areas in the UK where wind farms and other low carbon technologies are regularly curtailed.

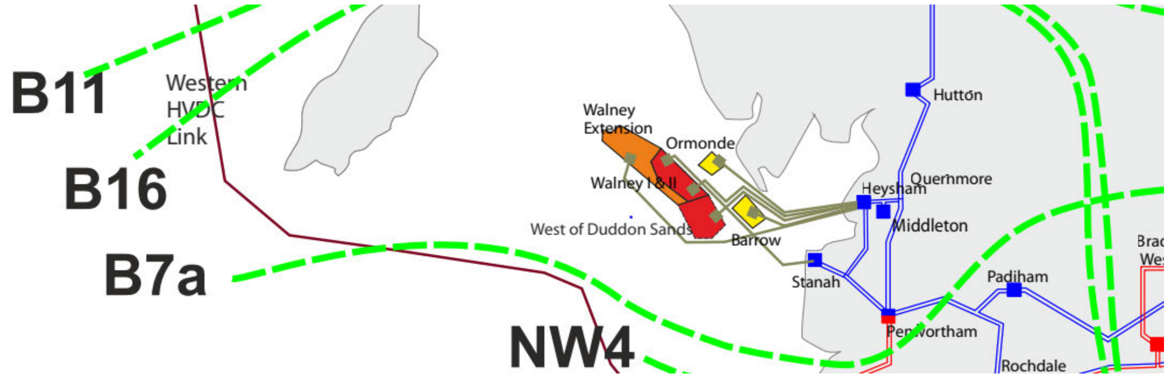


Figure 3: Proximity of Heysham to the B7a boundary.

2.3 How does this investment relate to our T3 submission?

Although this MSIP is being submitted under the RIIO-T2 price control, it interacts with and forms part of the same regional strategy outlined in NGET's RIIO-T3 Business Plan[4]. Under our regionally focused RIIO-T3 plan we are extending the Middleton substation as a strategic response to capacity constraints and growing embedded generation at Heysham. By creating additional capacity at Middleton, we provide a long-term solution for relieving pressure on Heysham, facilitating the connection of clean power sources, and supporting ENWL's distribution network. This ensures more efficient and faster connections for future customers while addressing the scalability challenges at Heysham.

The project provides cost effective short term benefits to allow further embedded generation to connect, while the longer-term network upgrade is planned and developed.

2.3.1 Alignment with Ofgem's consumer outcomes

System efficiency

75MW of the 130.5MW embedded generation contracted to connect Heysham will implement Battery Energy Storage System (BESS) technology. During periods of high renewable output and low demand, BESS can store excess energy that would otherwise be curtailed. This reduces curtailment costs and ensures more renewable energy is utilised. This stored energy can then be discharged during periods of high demand, helping to balance power flows across the B7a boundary whilst supporting the UK's transition to net-zero emissions.

Infrastructure fit for a low-cost transition to net zero & Long-term value for money

It is estimated that technologies like battery storage systems – supporting the integration of more low-carbon power, heat and transport technologies – could collectively save the UK energy system up to £40 billion by 2050[5], ultimately reducing consumer energy bills.

[4] National Grid Electricity Transmission - RIIO-T3 Business Plan

[5] Department for Business, Energy & Industrial Strategy (2020) https://www.gov.uk/government/news/battery-storage-boost-to-power-greener-electricity-grid

3 Establishing Need

3.1 Overview

Table 1: Summary of Investment Driver

Summary of Primary Driver		Date
Customer Connection	• Heysham is a constrained site due to the significant amount of generation connected. • Electricity Northwest Limited (ENWL) established a connection agreement to connect embedded generation to their network via Heysham GSP, which requires intervention to manage the constraints. • Subsequent project progressions from ENWL necessitated additional capacity to accommodate further connections. • The constraints at the site necessitate the implementation of upgrades to the existing protection and control schemes at Heysham to provide ENWL a connection for a portion of their generation connections, with a longer-term solution also required to accommodate future connections in the region.	[redacted]

3.2 Load related drivers

Table 2: Details of Generation connections

Customer Name	Project Name	Project Type	MW Generation	ACL Date	SGT dates	Customer Status
ENWL	Heysham OPS	Embedded Generation	130.5W	[redacted]	N/A	Customer in a signed position with active engagement on the project.

Heysham GSP

Heysham GSP is a 400/132kV substation situated in the Northwest of England significantly influenced by the presence of nearby large-scale energy generation, including a nuclear power station and several contracted offshore wind farms.

While Heysham has sufficient capacity to meet local demand, it faces significant constraints on export capacity due to several large offshore wind farms connected to the substation. With renewable generation output far exceeding local consumption, transmission capacity has already been exceeded, creating challenges for accommodating new renewable generation projects. Generation customers wishing to connect in the Heysham area are therefore not able to progress to energisation without some level of transmission restrictions or reinforcements.

i. <u>Fault Level limitations</u>

The fault level limitations at Heysham are caused by high fault current contributions from nearby generators and transformers (e.g. offshore wind farms). If the fault levels exceed the equipment ratings, it could lead to equipment damage and safety hazards. This limits further generation connections without risk to equipment or safety.

ii. <u>Thermal Capacity Constraints</u>

Heysham GSP is primarily used for exporting power from nearby offshore windfarms and other embedded generation. During high generation periods, power flows in the reverse direction—from the distribution network back into the transmission network. Thermal capacity of the GSP is limited by the reverse power flow limit of a single SGT. This is driven by the need to maintain security of supply during outage conditions when, for a further SGT fault, the site will be left with one SGT in service. This is referred to as an ‘N-2 event.

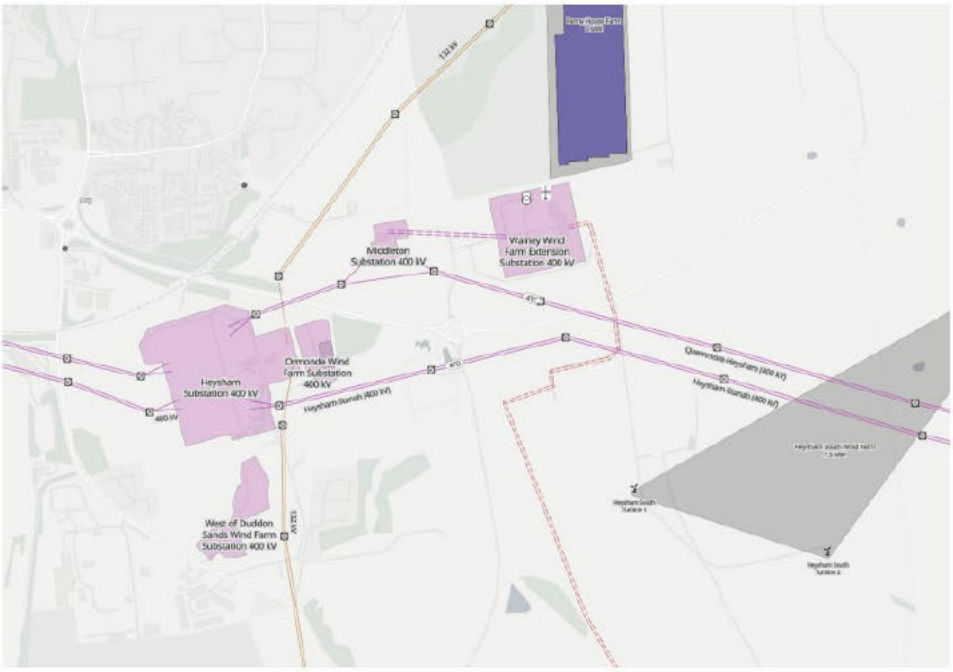


Figure 4: Location overview of Heysham substation

ENWL's embedded generation connection request

ENWL, the Distribution Network Operator (DNO) for the region, has driven the demand for additional generation capacity at Heysham, receiving a high volume of connection applications from embedded generators to connect to their GSP.

As capacity constraints emerged, ENWL submitted multiple Project Progressions to NGET and NESO, highlighting the need for transmission-level upgrades to support the additional generation. The original connection arrangement was deemed insufficient given the existing constraints, prompting a re-evaluation of the strategy. ENWL, NGET, and NESO have since developed a coordinated plan to address the rapid increase in embedded generation demand at Heysham.

Intervention is now required to deliver a solution that enables these generation connections (see Table 3) without exacerbating capacity constraints, as unmitigated increases in generation cannot be connected without the risk of transformer overloads and network instability under fault conditions or outages.

Table 3: Embedded Generation to be connected via ENWL's Heysham GSP

Relevant Embedded Power Station	Developer Capacity (MW)	Technology
[redacted]	75	BESS
[redacted]	34	Fossil Gas
[redacted]	9.5	Solar
[redacted]	12	Solar
	130.5	

3.3 Existing and planned future network

Figure 5 below displays the onshore transmission system in the Northwest of England region. The region largely comprises of 400kV substations and circuits (shown in blue) but also includes 275kV substations and circuits (shown in red) primarily in the Mersey area, the Pennines region and North Wales.

There is approximately 16GW of generation already connected in this region, comprising a variety of technologies including, Combined Cycle Gas Turbines (CCGTs), offshore wind farms, nuclear, pumped storage and interconnectors. A further 42GW of new generation capacity is now contracted to connect in the Northwest both at transmission and within the DNO networks.

Power flows in the region are predominantly North to South, with power being transmitted from the Scottish Transmission system via the AC circuits into Harker substation and into Connah's Quay 400kV substation in North Wales via the Western HVDC link. The primary routes for power to exit the Northwest is via the transmission corridors between Connah's Quay and Ironbridge through to Feckenham substation, and between Daines and Drakelow (highlighted in yellow).

The transmission capability of the Northwest is limited by the pre-fault ratings of the circuits on these corridors. Offers issued to all customers over the last 3.5 years have included the requirement to reconductor the circuits on these transmission corridors. However, with the increasing volume of generation that has applied to connect in the Northwest, the capability of the reconductored circuits will be exceeded, resulting in a need to establish a new circuit route from North Wales to South Wales. In addition to these limitations imposed on new connection in the Northwest there is a local issue for new capacity seeking connection into the network in North Wales.

Figure 5: Onshore transmission system in the Northwest of England region

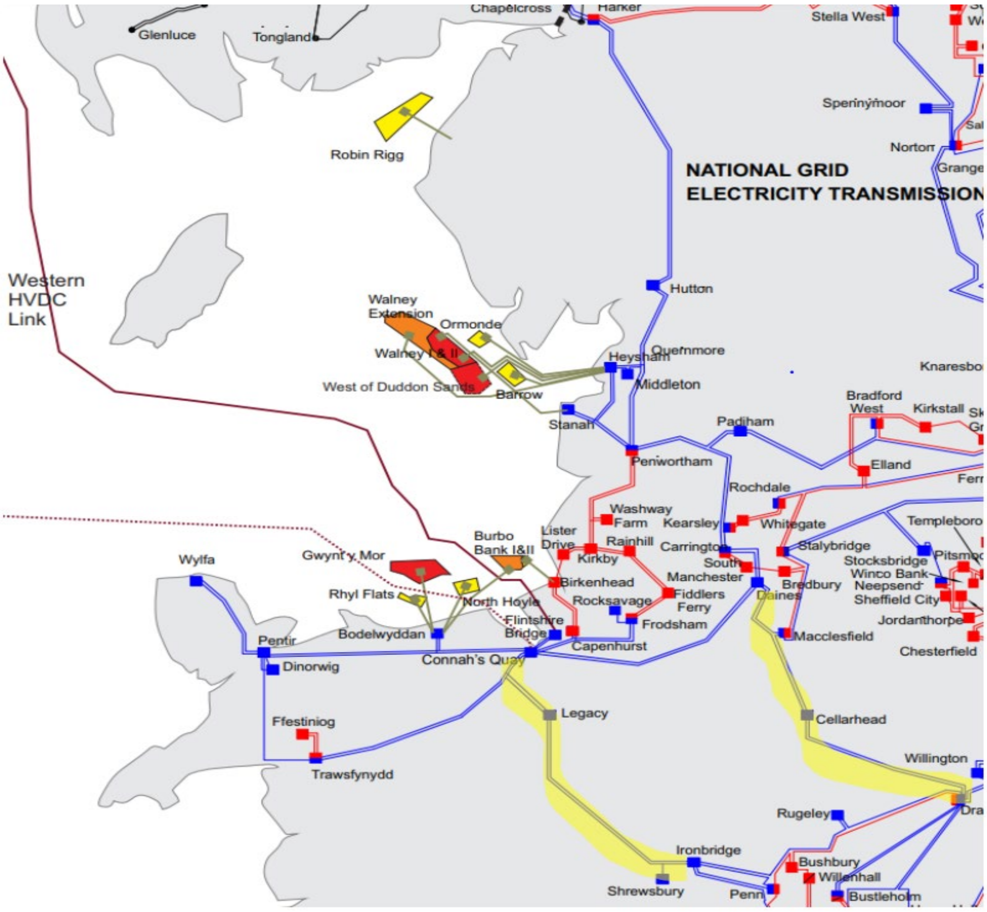
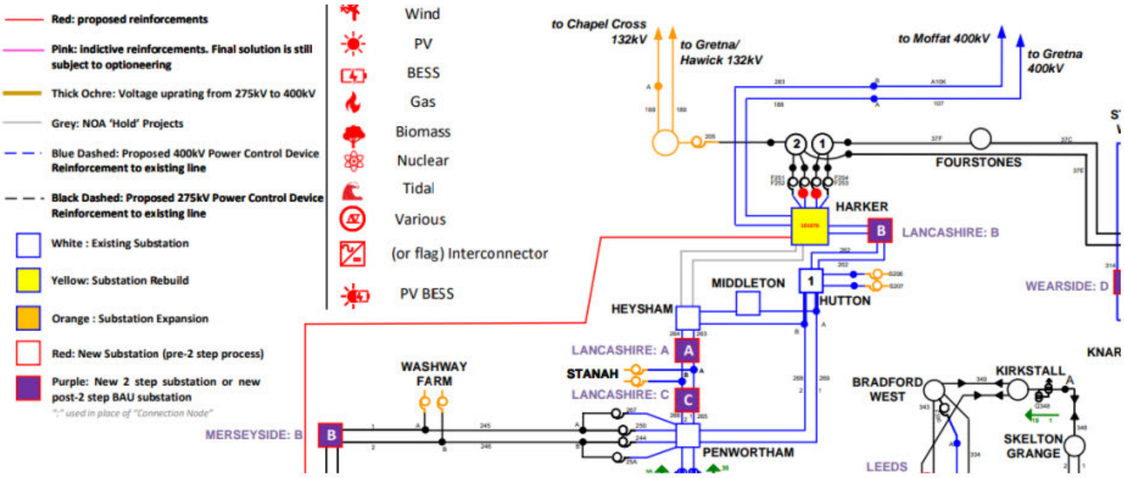


Figure 6 below shows a schematic of the existing and planned future network in the Lancashire region near Heysham.

Figure 6: Future network configuration around Heysham



4 Optioneering

4.1 Overview

The section summarises our assessment of options to address the needs case established in the previous section. We collaborated with NESO and ENWL to explore solutions that would accommodate the volume of embedded generation connections to ENWL's network via Heysham GSP in a way that best serves the interest of current and future consumers.

Each of the options were assessed against the following criteria:

- NESO's recommendation
- Technical feasibility
- Disruptions to existing systems
- Accommodation of ENWL's anticipated generation
- Reliable and resilient connections
- Infrastructure Costs

In summary, our collaborative consideration of options against the key criteria above determined that the most efficient and practical approach was to enable a proportion of the contracted volume of embedded generation to be connected at Heysham by upgrading the control and protection schemes, whilst the remaining volume of embedded generation would be accommodated by the development of a new GSP for ENWL at Middleton substation.

This approach ensures that the immediate connection requirements (130.5MW) at Heysham are met at a low cost in the best interest of consumers, while the new GSP at Middleton provides long-term capacity for the majority (504.7MW) of ENWL's pipeline of connections in the region.

An overview of the options considered is highlighted in Table 4 below.

Table 4: Overview of options considered at Heysham

Option	Description	Rationale
Do Nothing **Rejected**	No intervention to accommodate the load driver at Heysham.	**Does not meet connection needs** • A lack of intervention fails to address ENWL's connection requirements or the operational constraints at Heysham.
Installation of a 4th SGT at Heysham **Rejected**	Installation of an additional SGT at Heysham.	**Inefficient, costly and operationally disruptive** • NESO determined that the capital cost of building a 4th SGT will likely outweigh the overall cost of operationally managing the existing GSP. • This option would require accompanying infrastructure upgrades, including replacement NGET, ENWL and EDF 132kV circuit breakers. ENWL fault level issues at lower voltages also require widespread infrastructure upgrades. • This option would result in operational disruptions to ENWL and EDF's Heysham Nuclear Power Station operations.
Upgrade to existing protection and control schemes **Selected**	Modifications and extensions to upgrade current protection and control systems at Heysham.	**Immediate-term cost-effective solution** • This is a cost-effective option with minimal infrastructure cost, and therefore supported by NESO. This option offers a holistic upgrade to the existing control and protection system and by extending it to provide a near term solution for

		accommodating a portion (130.5MW) of ENWL's generation. • Technically not feasible as a standalone solution in the long-term to cover the full scope of generation anticipated to connect to ENWLs network, however, it is a viable and economic solution overall when combined with a longer-term solution.
Additional SGT at Heysham 400kV with a new Heysham B 132kV Substation **Rejected**	Install an additional SGT at Heysham 400kV to feed into a newly established 132kV B substation. The B substation would have a dedicated bar for embedded generation.	**Limited security for generators and not economical** • Provision of a single SGT in this option would mean only limited security can be provided for ENWL's generation customers, i.e. a planned or fault outage of the SGT would result in the disconnection of the customers connected there for the duration of the SGT outage. • Lacks flexibility for future expansion and limits long-term cost efficiency. • This options would also require costly site upgrades and infrastructure modifications to accommodate.
New SGT(s) at Middleton **Selected as a separate longer-term solution.**	Construct a new GSP at Middleton with dedicated 132kV embedded generation bar and scalable infrastructure for future capacity.	**Future-proof and expandable** • This option focuses on Middleton as the primary site for expansion, reducing the need for upgrades at Heysham by shifting the load to Middleton. This therefore limits interference with ENWL's and Heysham Nuclear Power Station's current network operations. • Middleton offers more space and flexibility for expansion. • This setup allows for additional SGTs or circuit reinforcements in future to accommodate an additional portion of ENWL's increased generation connection needs.
Reinforce Heysham and create a dedicated 132kV bar at Middleton **Rejected**	Reinforce existing Heysham 132kV infrastructure with an SGT and build a new dedicated 132kV bar for embedded generation at Middleton.	**Uneconomic solution** • Comprehensive and future proof solution that addresses both immediate and future needs. • This is likely the costliest solution as it involves dual-site upgrades and infrastructure modifications. • Reinforcing the existing 132kV network at Heysham would cause operational disruptions to ENWL and Heysham Nuclear Power Station if implemented.

4.2 Approaches to upgrading the existing protection schemes

With the longer-term solution at Middleton addressed through RIIO-T3 and outside the scope of an immediate intervention, we explored two approaches to upgrading the protection schemes at Heysham.

These approaches differ in their scale: one focuses on simpler modifications to the existing protection systems, while the other involves a full system replacement and integration. Both aim to enable ENWL's embedded generation connections while managing network constraints by extending protection/tripping to cover generation connections to Heysham via ENWL's network.

4.2.1 Simpler upgrade – Targeted modification of the existing protection systems

This option involves modifying and extending the existing Heysham Overload Protection Scheme (HOPS) and Heysham Auto Tripping Scheme (HATS), while introducing a new Heysham Auto Close Scheme (HACS). This would allow the network at Heysham to accommodate ENWL's embedded generation connection efficiently by leveraging several components already in place.

- HOPS would be upgraded by modifying the central units to accommodate new trips and extending functionality with additional relays, terminal blocks, and selection switches.
- HATS would also be modified to include new selection capabilities (switches) and ensure compatibility with updated protection requirements, though redundancy[6] will not be added.
- HACS will be implemented using two new bay controller devices, housed in separate panels in the 132kV telecoms room, providing limited redundancy for auto-close functionality.

This solution enables selective tripping of ENWL's embedded generation during faults and improving the system's ability to manage reverse power flows and fault levels, creating operational headroom for new connections.

4.2.2 Comprehensive upgrade - Modification and Integration of protection systems into a new System

This would involve the replacement and full integration of the Heysham Overload Protection Scheme (HOPS), Heysham Auto Tripping Scheme (HATS), and the addition of a new Heysham Auto Close Scheme (HACS) into a unified system (Siprotec 5).

- The existing central units for HOPS would be replaced with two new Siprotec 5 devices, housed in separate panels to ensure compliance with TS3.24.64[7].
- HATS functionality would also be integrated into the Siprotec 5 system, adding redundancy that does not currently exist.
- HACS would be incorporated into the same Siprotec 5 devices, streamlining operations and reducing reliance on auxiliary contacts.
- Additionally, the solution will include updates to the Substation Control System (SCS) to accommodate new commands and alarms.

This approach offers a more robust solution to fault-level and reverse power flow management to create headroom for new connections

[6] Redundancy refers to the inclusion of additional or duplicate systems and components to ensure reliability and operational continuity in case of failures.

[7] NGET Technical Specification

4.3 Qualitative assessment of the protection and control system options

We carried out a qualitative analysis of the two approaches to determine the appropriate solution in the best interest of consumers, in consideration of the criteria outlined in Table 5 below.

Table 5: Summary of qualitative assessment of upgrade approaches

Criteria	Simpler upgrade	Comprehensive Upgrade
Compliance Preferred Option: Comprehensive	Does not comply with NGET Technical Specification TS3.24.64 due to the existing HOPS system housing both central units in a single panel, which fails to meet the standard for panel separation.	Fully compliant with NGET Technical Specification TS3.24.64 as the HOPS system is replaced with Siprotec 5 devices housed in separate panels, ensuring panel separation and adherence to standards.
Future Scalability Preferred Option: Comprehensive	Limited scalability as the existing systems are being modified and extended rather than replaced, making future expansions or additional functionality difficult and costly.	Highly scalable due to the Siprotec 5 integration, which supports future expansions and additional functionality, providing long-term flexibility and efficiency.
Redundancy Preferred Option: Comprehensive	Provides limited redundancy; the existing HATS system remains without redundancy, and the HOPS central units' shared housing poses a single point of failure. This means the system remains vulnerable to single points of failure.	Offers full redundancy for HATS and HOPS, eliminating single points of failure by housing devices in separate panels and streamlining auxiliary contact usage.
Operational Complexity Preferred Option: Comprehensive	Retains older systems, increasing operational complexity and requiring frequent maintenance to keep the modified system functional over time.	Simplifies operation and reduces maintenance needs by integrating HATS, HOPS, and HACS into a single, unified Siprotec 5 system.
Cost Preferred Option: N/A	Lower initial costs, making it a cost-effective solution in the short term, but higher lifecycle costs are expected due to maintenance and eventual system replacement.	Higher initial costs reflecting the investment in modern, compliant equipment, but lower operating costs due to reduced maintenance and long-term viability. Costs are still economical,
Installation Risks Preferred Option: Comprehnsive	Minimal installation risks due to reuse of existing equipment.	Higher risks due to more significant installation and commissioning activities.

The preferred option is the comprehensive upgrade which modifies HOPS, HATS, and implements a new HACS with a unified Siprotec 5 system. It ensures compliance with TS3.24.64, provides full redundancy, offers scalability for future needs, and simplifies operations for enhanced reliability. While it has a higher upfront cost, it is still an economical solution to allow for increased generation, and is likely to see long-term benefits of lower maintenance and lifecycle costs.

The process of assessing our preferred upgrade to the control and protection schemes do not require further assessment via detailed cost benefit analysis (CBA) in addition to our qualitative assessment. It was deemed that carrying out a CBA was not proportionate to making and investment decision. Our assessment of the options has shown that the preferred option selected offers the safest and most efficient solution for consumers, enables the earliest customer connection date, and enables safer installation.

4.4 Preferred solution

Based on the collaborative assessments with NESO and ENWL, and our quantitative assessment of the comprehensive of protection and control schemes, our preferred solution to deliver the investment driver in the interests of current and future consumers is to implement a comprehensive upgrade for the protection and auto-close schemes at the Heysham. [redacted] Siprotec 5 relays is to be used to integrate the HATS, HOPS, and HACS functionalities within a single system.

The solution comprises of the following scope of works:

Modification/Extension of the Existing Schemes

I. Heysham Overload Protection Scheme (HOPS):

Extending the existing scheme to include circuits connected to embedded generators connected to ENWL's network via Heysham.

The existing equipment already monitors the SGT's current flow and these monitoring devices will be retained. The logic controller box will be modified to extend for new outputs from it to ENWL to trip the additional embedded generation. The tripping / decision making relays (6MD64) will be replaced with a new Siprotec 5 6MD85, which will have the same functionality as the existing unit and make extensions where required.

The HOPS works to prevent the remaining in-service transformer from being overloaded when the other two transformers are unavailable.

Figure 7 below depicts the logic flow diagram for the HOPS for the HOPS scheme. The HOPS scheme will trip embedded generation if two transformers are out of service (as indicated by their circuit breakers being OPEN) and the remaining transformer experiences an overload (on either HV or LV). The logic ensures that the system can continue operating as long as one transformer remains in service and is not overloaded

[redacted]

II. Heysham Auto Tripping Scheme (HATS)

Modify the scheme to trip additional embedded generation, thereby preventing islanding under fault conditions. The HATS functionality will be applied in the new 6MD85 to replicate what is already existing on site, and extend the logic to include ENWL generation.

Figure 8 below provides a logical flow diagram for the operation of the HATS scheme. Each part of the sequence corresponds to the logical conditions required to send a trip signal to effectively disconnect embedded generation only when all three SGTs at Heysham are lost due to outages or faults, preventing the risk of islanding[8].

At each stage, an OR function is used to determine if either the high voltage (HV) or low voltage (LV) breaker for a specific SGT is OPEN. The outputs of all SGT "OR" functions are fed into an AND gate. This ensures that the tripping logic is only activated if ALL SGTs (SGT1, SGT2, SGT3) are disconnected (i.e., all circuit breakers are OPEN).

[redacted]

Installation and Implementation of a New Auto-Close Scheme (HACS)

- The HACS functionality will be a new implementation, allowing two SGTs to remain on load while keeping one SGT on standby.
- The system will comprise two new 6MD85 bay controllers for system 1 and system 2, and will incorporate the full integration of HATS, and the integration of the HOPS central Units 1 & 2, along with the new auto close functionality.
- Incorporate existing overcurrent SGT monitoring relays for comprehensive integration across HV/LV circuits.

The logic, as illustrated in Figure x below, ensures that power delivery continues seamlessly when one of the on-load transformers is lost. The system continuously monitors the operational status of the two on-load transformers by checking the status of their circuit breakers. If either transformer experiences a fault or outage, the standby transformer is immediately energised and takes over the load from the faulted transformer.

[redacted]

8 This is where the embedded generation continues to energise the grid without connection to the main system.

Panel and Cabling Updates

- Installation of one new panel and utilisation existing panels, connecting Siprotec 5 devices to the 132kV junction box to leverage existing contacts, freeing up redundant connections.

The proposed solution, as described above, integrates the multiple functionalities (HATS, HOPS, and HACS) into a single relay system reduces the number of relays required on site, minimising equipment and installation costs in the best interest of consumers. Improved protection coverage is provided for all connected circuits including additional embedded generation and SGTs.

5 Detailed costs for the preferred solution

5.1 Introduction

This section provides a breakdown of the overall costs for the comprehensive upgrades to Heysham control and protection schemes, including an expenditure profile for all Regulatory Years of delivery.

The following cost estimate breakdown represents our latest view of costs for the proposed investment and all costs are presented in 2018/19 price base, unless otherwise stated.

Appendix C Cost Model submitted alongside this document provides a breakdown of the costs in more detail and should be reviewed alongside this chapter.

This Chapter is broken down into the following sections:

- Total Allowance Request
- Cost Estimate
- Cost Firmness

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 6: Allowance request

£m	T1 & Prior Costs	2021/22	2022/23	2023/24	2024/25	2025/26	Total
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

5.3 Cost Estimate

The total cost to develop and deliver the Heysham project is [redacted] including indirect costs and costs incurred to date.

Table 7 below shows a summary of total project costs.

Table 7: Cost Estimate

Element	Total (£m) (2018/19)	Classification
Contractor Costs		
Main Works Contractor	[redacted]	Direct
Third Party Costs	[redacted]	Direct/CAI
National Grid Costs		
ET Ops	[redacted]	Direct

Project Management	[redacted]	CAI
Project Services	[redacted]	CAI
NGET Portfolio Costs	[redacted]	CAI
Other	[redacted]	
Risk	[redacted]	Direct
Total	[redacted]	

5.4 Cost Firmness

Table 8 below shows the assessment of cost firmness using the classification outlined in the Ofgem LOTI reopener guidance document published on 29th March 2021. This shows that 70% of the total costs (firmness 1 and 2) are either incurred or have been contracted, giving high confidence in our cost submission.

Table 8: Cost Firmness

Cost Firmness	Total (£m)	Notes
1 - Fixed	[redacted]	Prior costs and 2024/25 actuals
2 - Agreed re-measurable	[redacted]	Contractor (less actuals)
3 - Agreed re-measurable future information	[redacted]	
4 - Estimated	[redacted]	Risk, NG costs, Third Party and Direct Procurement (less actuals)
5 - Early Estimate	[redacted]	
Total	[redacted]	

Estimated costs relate to NGET resource costs, calculated based on forecast days and standard rates, as well as risk for the remainder of the project.

6 Deliverability and risk

6.1 Deliverability

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

6.1.1 Delivery Programme

The key project milestones are summarised below. Please note that these are provisional dates based on NGET's best possible view of programme at the point of this MSIP submission. The dates provided will be finalised through collaborative engagement between customer, contractor, outage planning team, third party generators, NESO and NGET.

The estimated programme is based on likely availability of outages in [redacted] as advised by the outage planning team. However, the outages need to be aligned with third party generator outages who will be impacted by the works. Work is ongoing to align the outage period.

Table 9: Outline of the key project milestones

Milestone	Estimated Date
FEED Design Complete	[redacted]
Sanction (Internal)	[redacted]
Contract Award	[redacted]
First Site Access	[redacted]
OUTAGE 1 SGT1 install for system 1 and 2	[redacted]
OUTAGE 2 SGT2 install for system 1 and 2	
OUTAGE 3 SGT3 install for system 1 and 2	
OUTAGE 4 In service outages	
OUTAGE 5 SGT1 install for system 1 (finish off)	
OUTAGE 6 SGT2 install for system 1 (finish off)	
OUTAGE 7 SGT3 install for system 1 (finish off)	
OUTAGE 8 In service outages	
Available for Commercial Load	[redacted]
Completion	[redacted]

The current contracted ACL for this project is [redacted]. Delays in finalising technical input has caused programme delays which have been communicated with the customer and NESO. Once outage requirements have been finalised and outage availability confirmed, a revised programme will be agreed with the customer.

6.1.2 Procurement and Contracting Strategy

The Heysham scheme was contracted to [redacted] through the Light Current Turnkey Framework, with the [redacted] chosen to allocate the work on a "best for task" basis. [redacted] was selected due to their extensive prior involvement, including their installation of the original system and their familiarity with the project. The [redacted] has allowed us to achieve significant commercial value by establishing a contractually binding Fixed Price Activity Schedule, effectively mitigating a substantial portion of cost-related risk for NGET.

6.1.3 Risk and Risk Management

A risk management process has been used for managing reasonably foreseeable risks. The process employed is in line with ISO 31000:2009, Risk Management – Principles and Guidelines.

Table 10 below lists the key risks identified for the project, although the full Risk Register is included within tab 4.1 of the Cost Model appended to this submission.

Table 10 Delivery risks for Heysham

Risks	Mitigation
Planned Outage (Cancellation / Amendment): risk that outage bookings require changing due to project delays or NESO outage changes.	Engage with outage planners regularly to understand outage opportunities. Once confirmed, attend monthly outage planning meetings to keep track.
Design Delays: risk of delay in provision of technical information to contractor which may result in associated cost increase and/or delays to the ACL	Prioritise design information provision work with design assurance. Share NGET technical information with contractor as soon as available to advance design.
[redacted]	[redacted]
Cost Uncertainty: EHub estimates provided will not be 100% accurate. There is likely to be some variation.	Manage forecast monthly to understand cost variation
Lead times for procuring equipment: long lead times for required equipment may result in programme delays.	PMI issued for initial long lead order (July 2024), remaining equipment to be ordered upon receipt of technical information and development of design to necessary level of maturity.

7 Conclusion

This document is NGET's MSIP e-opener submission to Ofgem for the Heysham Protection & Control Scheme. It is submitted with reference to Special Condition 3.14 of NGET's Transmission Licence.

Table 11 below summarises the main investment driver, the selected option, estimated costs and expected outputs.

Table 11: Heysham Protection & Control Scheme Investment Summary

<table>
<tr><td>Main drivers</td><td colspan="3">Customer Generation Connection
To enable delivery of contracted connection at Heysham for Electricity Northwest Limited's (ENWL) 130.5MW of embedded generation, amidst existing technical and capacity constraints at Heysham.</td></tr>
<tr><td>Selected Option</td><td colspan="3">Upgrade via a comprehensive modification of the existing Heysham Overload Protection Scheme (HOPS) and Auto Tripping Scheme (HATS) to be extended to cover the embedded generation connecting to ENWL's network, as well as the installation of a new Heysham Auto Close Scheme (HACS).</td></tr>
<tr><td rowspan="2">Estimated Cost</td><td colspan="3">The 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].</td></tr>
<tr><td>T2 (FY2022 – FY2026) and prior:
[redacted]</td><td>T3 (FY 2027 – FY2031):</td><td>T4+ (FY 2032+):</td></tr>
<tr><td>Outputs</td><td colspan="3">Customer Connection: This investment will enable a 130.5 MW embedded generation connection for ENWL at the Heysham 132kV Grid Supply Point (GSP).
Security of Supply: the modification of the protection and control schemes at Heysham contributes to ensuring security of supply by addressing key constraints at Heysham to strengthen the network's ability to accommodate additional generation.</td></tr>
<tr><td>PCD Primary Output</td><td colspan="3">Upgrade the protection and control schemes at Heysham GSP to facilitate the connection of 130.5MW of embedded generation via ENWL's network by [redacted]</td></tr>
</table>

Following an investment driver to facilitate the connection of embedded generation at Heysham 132kV GSP, we have collaboratively undertaken an assessment to balance the need for a cost-efficient solution that enables these connections amidst site constraints and avoids and uneconomic network reinforcements.

Our solution to address the driver is to comprehensively upgrade the existing control & protection schemes at Heysham, allowing headroom for the embedded generation to connect to the system. As part of this, the design of the schemes will be extended to trip off non-critical embedded generation in the event of a fault or overload.

8 RIIO-T1 and RIIO-T2 allowances

There were no investments proposed for this project during either RIIO-T1 or T2 business plans submissions and so no funding was received. The Project does not have funding through any other price control mechanism.

9 Assurance and Point of Contact

Attached to this submission 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 17th February 2023.

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).

Appendices

[redacted]

[redacted]

[redacted]

Appendix C: Cost Model

Please see the accompanying Cost Model submitted alongside this MSIP.

'Appendix C - Heysham Cost Model - MSIP Jan 25'

Appendix D: Glossary

Acronym	Definition
MSIP	Medium Size Investment Project
GSP	Grid Supply Point
NGET	National Grid Electricity Transmission
NESO	National Electricity System Operator
ENWL	Electricity Northwest Limited
SGT	Supergrid Transformer
HOPS	Heysham Overload Protection Scheme
HATS	Heysham Auto Tripping Scheme
HACS	Heysham Auto Close Scheme
PCD	Price Control Deliverable

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