MSIP Operational Tripping Systems (OTS)

National Grid Electricity Transmission
Medium Sized Investment Project

January 2025

Contents

Investment Summary

Project Name	Operational Tripping Systems (OTS)	**Delivery year**	[redacted]
Drivers for the Investment	Operational Tripping Systems (OTS) protect the power system against overload or instability where, under a fault/s condition, a portion of generation can no longer be connected to the system. The following drivers necessitate the need for an OTS: **Customer Connections** – Viking Link (East Anglia), Dogger Bank C and Sofia windfarms (Lackenby) and Open Cycle Gas Turbine (OCGT) for VPI Immingham (Killingholme). **NESO driven wider works** – Planning requests to facilitate EC5[1] Enduring Constraint Management Intertrip Service (Pathfinder East Anglia) and B6 Constraint Management Intertrip Service (Anglo-Scottish).		
Key considerations & challenges	**Alignment with NESO planning request** – where applicable, investments should be delivered to meet requirements established by or in agreement with NESO. **Time** – investments should be delivered as efficiently as possible for project deadlines. **Cost** – investments should be delivered as economically as possible, having consideration to project deadlines. **Future proofing** – investments should, if economical, stand the test of time for future customers and long-term consumer interest.		
Optioneering	**Option A**: 'Do Nothing', **Option B**: 'Market based solution' and **Option C**: 'Network Reinforcement', such as building or uprating the network, have been considered but discounted. The main choice is either to **Option D**: 'Extend/Upgrade OTS' or **Option E**: 'Install a new OTS'. Option D presents a more efficient solution and will be preferred, provided it delivers the required outputs and is possible at a particular location.		
Solution	All solutions are a mixture of hardware/physical installation and software based. Option D is favoured in four projects, Option E is favoured in one. **East Anglia – Option D:** This project has been completed. It involved extending and modifying the East Anglia OTS (EAOTS) to include new circuits through the addition of monitoring equipment [redacted], as well as installing tripping equipment at [redacted] to facilitate tripping of Viking Link as well as modification to OTS logic. **Lackenby – Option E:** Installation of OTS logic units at [redacted] substation and associated software mapping to receive monitoring signals and relay trip/de-load signals. Installation of switchgear status monitoring and trip equipment at remote end sites and protection monitoring on all circuits. OTS design will also facilitate future connections. **Killingholme – Option D:** Extension/modification of the existing Killingholme OTS to include new circuits resulting from the addition of the Open Cycle Gas Turbine (OCGT) generator at Humber Refinery as well as modification to OTS logic. **Pathfinder East Anglia – Option D:** Modification of the EAOTS through installation of OTS trip devices [redacted] to trip or de-load [redacted] per substation and add protection operation and switchgear status monitoring devices [redacted] for each of [redacted], change monitoring interface devices across the region to stability monitoring interfaces and install thermal monitoring devices at selected sites. Upgrade of existing control systems to accommodate additional data points and [redacted] **Anglo-Scottish – Option D:** Installation of new OTS relay panels [redacted] within the B7a transmission boundary and installation of relays at substations to trip newly monitored circuits.		
Outputs of the Investment	**Network resilience** – Operational Tripping Systems protect against unacceptable thermal overload or stability conditions on the network.		

[1] EC5 relates to a GB Transmission Boundary. A map of boundaries, including B6 can be seen within this link: ETYS 2022 AppA A2-A3.cdr

PCD Primary Output	**East Anglia** – Deliver upgrades to the East Anglia OTS to facilitate tripping of Viking Link interconnector [redacted] **Lackenby** – Deliver a new OTS in the area by [redacted] to facilitate tripping of Dogger Bank C and Sofia windfarms. **Killingholme** – Deliver upgrades to the Killingholme OTS [redacted] to trip the Open Cycle Gas Turbine (OCGT) [redacted] **Pathfinder East Anglia** – Deliver upgrades to the East Anglia OTS [redacted] to trip/de-load generation customers at multiple sites as well as upgrade monitoring across the region. **Anglo Scottish** – Deliver extensions to the Line End Open scheme of the Anglo Scottish OTS [redacted]
Estimated Cost (price base 2018/19)	**The current total project costs: East Anglia** c.£[redacted], **Lackenby** c.£[redacted], **Killingholme** c.£[redacted], **Pathfinder East Anglia** c.£[redacted], **Anglo-Scottish** c.£[redacted] **The current direct cost of the projects and funding allowances requested: East Anglia** c.£[redacted], **Lackenby** c.£[redacted] **Killingholme** c.£[redacted] **Pathfinder East Anglia** c.£[redacted], **Anglo-Scottish** c.£[redacted]

Spend profile	**T2 (FY2022 – FY2026):**	**T3 (FY 2027 – FY2031):**	**T4+ (FY 2032+):**
East Anglia	c.£[redacted] (100%)		
Lackenby	c.£[redacted] (100%)		
Killingholme	c.£[redacted] (100%)		
Pathfinder East Anglia	c.£[redacted] (71%)	c.£[redacted] (29%)	
Anglo Scottish	c.£[redacted] (88%)	c.£[redacted] (12%)	

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 within RIIO-T1 or RIIO-T2.		

1. Executive summary

1.1 Context

This paper, together with the associated cost models, summarises National Grid Electricity Transmission's (NGET) proposed investment into five Operational Tripping System (OTS) related projects and seeks to demonstrate the consumer interest in the associated investments. This Medium Sized Investment Project (MSIP) seeks approval of the need for the investments, as well as approval of the proposed solution and requested funding allowances for efficient spend on the project. An indicative funding allowance request has been provided alongside this MSIP for the Anglo Scottish OTS project, however requested funding allowances for efficient spend on that project will be sought via an updated submission in April 2025 as agreed with Ofgem.

An OTS is a mechanism designed to monitor several circuits and, in the event of a fault, would carry out automatic switching or trip generation to avoid instability or unacceptable thermal conditions on the transmission system.

For the purposes of this MSIP, the five projects within scope of this submission will be referred to as:

- East Anglia,
- Lackenby,
- Killingholme,
- Pathfinder East Anglia, and
- Anglo-Scottish.

We have decided to bundle the projects into a single, combined MSIP submission, with the aim of making Ofgem's assessment process more efficient, without limiting the level of scrutiny. While there are some specific issues for each project, once need has been established, the key optioneering decision is whether to upgrade/extend an existing OTS or to install a new OTS.

While all projects relate to an OTS, the scope and level of work involved in each project is not identical. For instance, the Pathfinder East Anglia differs from the other schemes listed due to the higher number of sites involved. As a result, it has greater interactions with the existing network and interfaces with legacy substations and equipment which, coupled with the high level of connections and ASTI supporting work in the region, presents a larger scale of challenge to overcome. The differences among the projects are therefore reflected in the scheme values and risk allowances.

1.2 Background to the investments

These investments result from either a NESO[2] planning request as part of wider, Pathfinder works (Pathfinder East Anglia, Anglo Scottish) or Transmission Owner Construction Agreements (TOCA) between NESO-NGET[3] in response to a customer connection (East Anglia, Killingholme, Lackenby). Each project background is summarised within the table below. The investments are designed to prevent thermal overloading or instability issues and

[2] At the time the planning requests or Transmission Owner Construction Agreements were made, the National Energy System Operator (NESO) was the National Grid Electricity System Operator (NGESO), to reflect the current status of the System Operator, NGESO will be referred to as NESO for the purpose of this paper.

[3] Agreements in the form of Transmission Owner Construction Agreements (TOCA) follow a bilateral connection agreement secured between NESO and the customer seeking connection. NGET support the development of the OTS works through power system studies.

improve the management of constraints which should provide for a more stable supply of electricity and lower costs, which ultimately delivers benefits for consumers.[4]

Table 1 - Summary of project backgrounds

East Anglia	This project has been completed and is linked to the Viking Link (VL) interconnector connected to the transmission system at Bicker Fen 400 kV. In 2021, following Viking Links connection request, the TOCA between NESO and NGET required an extension to the existing East Anglia OTS for additional monitoring of selected circuits and to trip VL if required. The ability to trip VL and monitor additional circuits were originally due to be incorporated into the wider Pathfinder East Anglia project. However, this specific project was prioritised to avoid the interconnector being operationally restricted and therefore not providing the full MW of contracted generation to consumers by agreed connection dates. Broader renewal of the East Anglia OTS will be covered under the Pathfinder East Anglia project.
Lackenby	Dogger Bank C and Sofia offshore windfarms have a TOCA to connect into Lackenby 400kV. Before the windfarms can export onto the network an OTS is required to allow system access to be achieved without NESO incurring significant constraint costs to secure the system for a subsequent double circuit fault, i.e. a N-1-D condition. Under these scenarios SQSS allows for the use of operational measures such as OTS's to provide transmission capacity.
Killingholme	[redacted] are constructing an Open Cycle Gas Turbine (OCGT). To enable the tripping of generation, an additional connection to monitor and trip the OCGT is required leading to the modifications of the existing Killingholme OTS. Before the OCGT can export onto the network an OTS is required to ensure that system access can be achieved without NESO incurring significant constraint costs to secure the system for a subsequent double circuit fault, i.e. a N-1-D condition. Under these scenarios SQSS allows for the use of operational measures such as OTS's to provide transmission capacity.
Pathfinder East Anglia	NESO have initiated EC5-Enduring: Constraint Management Intertrip Service (CMIS). The CMIS looks for ways to reduce the cost of managing constraints and is procured by NESO through tenders with generators in the area that can be connected to the East Anglia OTS. Once the commercial parties are accepted into the CMIS, NGET shall, by virtue of a STCP 16-1 Investment Planning request,[5] connect them into the OTS. This strategy involves building intertrip links between generation across the EC5 region and the East Anglia Operational Tripping Scheme as well as upgrading the OTS so it can trip generators much faster. The Network Options Assessment (NOA) is way NESO assess major National Electricity Transmission System (NETS) reinforcements. Reinforcements are analysed by NESO in a Cost Benefit Analysis to determine which should be designated a 'Proceed' recommendation. In the NOA Refresh (21/22) NESO made recommendations for this work to Proceed (NOA codes CS07 and CS08).

[4] For instance, NESO estimate that building post-fault intertrip links between generation across the EC5 region and the East Anglia Operational Tripping Scheme, will bring approximately £760m in savings during the 2025-2030 period.

[5] This is an individual Code Procedure covering the processes relating to Section D Part One 'Transmission Planning' of the System Operator – Transmission Owner Code (STC).

Anglo Scottish	NESO have also initiated a CMIS for the B6 boundary. The B6 CMIS identified a benefit in extending the Line End Open (LEO) scheme of the Anglo-Scottish OTS towards the B7a boundary so that at least an additional 400MW can be allowed to flow pre-fault across the B7a boundary meaning more renewable energy can remain connected on the system. NESO, through the NOA, made recommendations for the scheme to be extended (NOA codes CS05 and CS06).

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

Within Pathfinder East Anglia and Anglo-Scottish projects, factors which dictate the options for OTS projects, such as locations or circuits to be monitored, are determined by NESO as part of Pathfinder initiatives following their NOA process.

Within East Anglia, Killingholme and Lackenby projects, the customer connections presented us with an initial decision to mitigate network thermal/stability issues; build or update the network to alleviate network thermal/stability constraints; or provide an OTS solution. In each case, an OTS solution was preferred because this is considered an economic measure to address the circuit overloads or stability issues compared to investing in new circuits, reconductoring or uprating/rebuilding substations and towers. We have conducted power system studies to develop OTS requirements which are then recorded within the contractual agreement (TOCA) between ourselves and NESO.

Due to the directions from NESO but also factors such as the location of customers due to connect, the scope of optioneering is narrower in the case of OTS projects. For Pathfinder East Anglia and Anglo Scottish, we have considered (i) **alignment with NESO planning request**, (ii) **time**, (iii) **cost**, and (iv) **future proofing**. For East Anglia, Killingholme and Lackenby projects the same criteria are considered, albeit alignment with the NESO planning request is excluded as it is not relevant.

Table 2 provides a summary of how each option compares to these criteria, with more detail provided in section 4 of this paper.

Table 2 - Option appraisal

Option	A	B	C	D	E
Option Title	**Do nothing**	**Market based solution**	**Network reinforcement (build/uprate network)**	**Extend /upgrade existing OTS**	**Install new OTS**
Anglo Scottish OTS & Pathfinder East Anglia (unless specified responses relate to both projects)					
Alignment with planning request	Would not align with planning request or NESO requirement	Would not align with planning request or NESO requirement	Would not align with planning request or NESO requirement	Aligns with planning request or NESO requirement	Would not align with planning request or NESO requirement.
Timing of programme & resources	N/A - would deliver nothing.	N/A - would deliver nothing.	Building/uprating network is likely to take longer in comparison to OTS works.	Less time than full strip out and new installation.	More time required to undertake full strip out and new installation.
Cost	Long term disbenefits for consumers resulting from lack of constraint management.	Long term disbenefits for consumers resulting from lack of constraint management.	More costly to build/uprate network in comparison to extend/modify or install new OTS.	Less cost than full strip out and new installation.	More cost involved in full strip out and new installation.
Capacity & future development potential	Would not future proof.	Would not future proof.	Future proofing could occur.	Pathfinder East Anglia – future proofing included in design.	Installation of a new OTS could conceivably include future proofing.

				Anglo-Scottish – No future proof.	
East Anglia OTS & Killingholme OTS (unless specified responses relate to both projects)					
Timing of programme & resources	N/A - would deliver nothing.	N/A - would deliver nothing.	Risk significantly missing ACL dates.	Less time than full strip out and new installation.	More time required to undertake full strip out and new installation.
Cost	Long term disbenefits for consumers resulting from lack of constraint management.	Long term disbenefits for consumers resulting from lack of constraint management.	More costly to build/uprate network in comparison to extend/modify or install new OTS.	Less cost than full strip out and new installation.	More cost involved in full strip out and new installation.
Capacity & future development potential	Would not future proof.	Would not future proof.	Future proofing could occur.	East Anglia OTS - No future proofing in design. Killingholme OTS – design does not future proof.	Installation of a new OTS could conceivably include future proofing.
Lackenby OTS					
Timing of programme & resources	N/A - would deliver nothing.	N/A - would deliver nothing.	Risk significantly missing ACL dates.	Time considered neutral among options due to there being no viable option to extend an OTS – leaving only the option of a new installation.	
Cost	Long term disbenefits for consumers resulting from lack of constraint management.	Long term disbenefits for consumers resulting from lack of constraint management.	More costly to build/uprate network in comparison to extend/modify or install new OTS.	Cost considered neutral among options due to there being no viable option to extend an OTS – leaving only the option of a new installation.	
Capacity & future development potential	Would not future proof.	Would not future proof.	Future proofing could occur	No viable option to future proof an existing OTS	Future proofing is included within design scope.

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

East Anglia - Option D: Modify and extend East Anglia OTS to accommodate Viking Link connection at Bicker Fen. This involves new circuit monitoring equipment at [redacted] to monitor associated circuit combinations between these sites as well as modifications to trip the Viking Link interconnector.

Lackenby - Option E: Install new OTS equipment with OTS logic units at Lackenby 275 kV. This shall deliver new OTS logic units [redacted], relevant software mapping to monitor signals and relay trip/de-load signals, switchgear status monitoring [redacted] Tripping equipment shall be installed at remote ends with protection monitoring on all associated circuits.

Killingholme - Option D: Modify the existing Killingholme OTS to accommodate OCGT for VPI Immingham at Humber Refinery. This option modifies the existing Killingholme OTS to include the OCGT Generator connection, thus allowing for generation to be tripped if necessary.

Pathfinder East Anglia - Option D: Modify East Anglia OTS to upgrade monitoring, addition of circuits and accommodate future connections into transmission network. This will deliver OTS trip and de-load devices at [redacted] at each site, some of whom are CMIS service providers. Protection operation, switchgear monitoring, stability monitoring and stability monitoring interfaces will be installed at all sites across the East Anglia region, with thermal monitoring devices (where there is no direct connection to generation) installed at North London

sites. The OTS logic and control systems will be upgraded and modified to accommodate the additional data points that require monitoring.

Anglo Scottish - Option D: Extension of Line End Open (LEO)[6] scheme to collect information from 8 sites within the B7a transmission boundary. This involves extending the LEO scheme to collect the plant and protection status from [redacted] within the B7a boundary. OTS relay panels and relays (to trip) shall be installed.

Funding allowances are sought as part of this MSIP submission. The direct costs for these investments are, in 18/19 prices: **East Anglia** c.£[redacted], **Lackenby** c.£[redacted], **Killingholme** c.£[redacted], **Pathfinder East Anglia** c.£[redacted], **Anglo-Scottish** c.£[redacted]. 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?

In the case of these investments, our definition of future proofing means a design that can facilitate the monitoring, tripping and/or de-loading of generation beyond what is presently necessary, but which can be reasonably foreseen, and which caters for the future transmission network and consumer demand. Where possible, future proofing has been included.

East Anglia – The works were designed to only provide Viking Link trip functionality and monitoring of associated circuits within the region. Future proofing was not included as it would delay the interconnector exporting electricity at full capacity. Furthermore, the Pathfinder East Anglia project will future proof the regional East Anglia OTS.

Lackenby – The Lackenby OTS is future proofed based on our assessment, supported by [redacted], of the likely number of future customer connections within the region. Due to these connections, the OTS shall be readily re-configurable to cater for further system developments, including circuit monitoring at additional substations and output signals for generator tripping, HVDC interconnector run-back/run-up, and fast Close/Trip of reactive compensation at additional sites. [redacted]

Killingholme – The existing Killingholme OTS is functioning at capacity; it is therefore not possible to future proof the OTS without significant spend which is not considered efficient due to the lack of connections into the OTS we foresee in the near future.

Pathfinder East Anglia – The NESO planning request and Functional Requirement Specification (FRS) agreed with NESO accommodates future proofing in the number of servers and control systems deployed [redacted] control systems over two servers will be installed providing for more capacity of data points to monitor than is currently required without having to add a further control systems. Furthermore, future proofing is accommodated through the number of generation customers [redacted] that can be monitored by the OTS who may connect to the [redacted] substations under the EC5 CMIS initiative ([redacted]).

Anglo-Scottish – This is a NESO driven Pathfinder project informed by their Network Options Assessment (NOA) process. The NESO planning request initiating this project does not include design solutions which would be considered to future proof, and if we decided to include, would exceed the scope of works we have been asked to undertake.

[6] This Line End Open scheme collects plant and protection status information from circuit ends along the routes crossing boundary B6, which are then transmitted back to the Anglo-Scottish OTS logic units.

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

The following risks and uncertainties to the successful delivery of each project is detailed below including how they have been accounted for. The East Anglia project for the Viking Link connection is not included as this has been delivered at the time of writing this MSIP.

Lackenby - An uncertainty we have accounted for is damage of OTS assets in delivery, or on site. Shipping accidents or the result of attacks on route to site will damage equipment delaying OTS in service. We plan to mitigate this by holding discussions with the supplier to ensure equipment is suitably packaged as well as handled and shipped with care.

Additionally, there is risk in relation to long lead times for OTS equipment leading to potential project delays. We have sought to manage this by issuing instructions to the contractor to commence work on long lead time items [redacted].

Killingholme & Anglo Scottish - In both projects, outage availability, change, or cancellation presents an uncertainty leading to missed milestones. We plan to mitigate this uncertainty by following our internal processes to record known outage date requirements within the NESO eNAMS system and have regular reviews with the outage planning team.

Furthermore, National Grid Commissioning Engineers are required to sign off of the final completed works. There is a possibility they may be under resource pressures and unavailable leading to delays to OTS in service dates. We will account for this my proactively working with the relevant resourcing teams to ensure dates are known and resources appropriately provided where possible.

Pathfinder East Anglia - The project involves multiple sites across the East Anglia region and into North London mentioned later in the paper. Unlike the other OTS projects mentioned, it therefore has a larger number of interface risks with interdependencies on other projects in train within the region (examples of these others project can be seen in 2.2.1 of this paper).

Changes to these other projects through delays, phasing or scope changes, are likely to impact on Pathfinder East Anglia; for example, [redacted] (part of the Bramford to Twinstead Reinforcement, an ASTI project) would necessitate a design change, as well as associated cost and time impacts. We are managing these risks through regular interface meetings with other project teams to forewarn us of any potential impacts. [redacted]

Outage availability also presents an uncertainty in this project. The project relies on a complex level of outages to be completed across 2025-2026 with very little flexibility. Due to the level of outages already forecast in the congested East Anglia region we have not been granted specific outages for this project in 2025. In order to meet the agreed NESO project completion deadline, we have utilised existing planned outages which are linked to other projects. While this limits the overall number of outages it presents a challenge if other projects have outages cancelled or delayed. We plan to account for this as much as possible through regular cross-functional and cross business meetings to discuss project dependencies and outage plans. Furthermore, we plan to work with the contractor to vary the sequence of works as any outage changes present themselves, our contingency value has also apportioned some cost for possible 'outage plan churn', meaning the impact of these changes on the contractor's sequence of works can be managed efficiently.

Furthermore, the project has uncertainties due to the number of legacy sites [redacted] which give rise to the potential for greater latent defects, unrecorded modifications or deterioration requiring rectification and potential project delay. Desktop studies have been undertaken to understand the level of any issues at these sites, but physical site assessments have only just commenced with the mobilisation of the contractor. We have agreed in principle with the contractor how to remediate hazards with representative rates in place to manage any cost growth. Finally, the scale of sites which pre-date 2000 may mean asbestos presents an uncertainty impacting this project. We have already sought to mitigate this risk through desktop studies and have recently begun site assessments to understand the level of asbestos presence. We plan to manage this uncertainty further through completion of all site visits and using licenced contractors to undertake air quality monitoring and cable pulling activities as necessary.

In light of these challenges, we are requesting a larger contingency value than other OTS projects. We believe that to deliver the Pathfinder East Anglia project to the timescales set by NESO, and in a landscape of multiple concurrent projects, this sum is required, giving us confidence to deliver this project which is designed to benefit consumers through lower constraint costs.

The five Operational Tripping System related investments are made to assure the reliability of electricity transmission. A single, preferred option per project has been identified. It is our view that these preferred options present the most efficient solution to resolve the drivers behind the investments. Qualitative assessments focussing on alignment with the NESO planning request, time, cost and future proofing, has led to preferred options which provide an effective and efficient solution for consumers. As such, and due to only one preferred option remaining in each project following the qualitative appraisal, quantitative cost benefit analyses have not been undertaken.

Our preferred options either relate to an extension or modification of existing in-situ OTS asset, or the installation of a brand-new OTS asset where one did not previously exist. The focus for selecting our preferred options has been to ensure the required output is delivered to consumers as efficiently as possible.

2. Introduction

2.1 Project background

This paper presents the investment case and associated efficient costs, or indicative efficient costs in the case of Anglo Scottish,[7] for five National Grid Electricity Transmission (NGET) projects related to Operational Tripping Systems (OTS).

2.1.1 MSIP Eligibility

This paper is submitted under Special Condition 3.14 of NGET's Transmission License. These projects fall under 3.14.6 (f) being projects connected to a system operability, constraint management or 0MW connection project or substation work, which is required to accommodate embedded generation, which in each case has been requested in writing by the NESO.

As agreed with Ofgem in January 2025, in the case of Anglo Scottish OTS, we are submitting this MSIP submission in the January 2025 MSIP reopener window to evidence and seek approval of the investment needs case for the project, however we are not seeking funding allowances for full efficient costs as part of this submission.

We will not obtain full cost clarity for this investment until April 2025, due to delays to procuring the contractor. As such, the cost model provided alongside this submission is an indicative summary of efficient costs only. We will follow up with an updated funding request to this submission in April 2025.

2.1.2 Operational Tripping Systems

The power system network has a finite capacity for electricity that can be transmitted across it, which, if exceeded, could lead to a range of undesirable conditions that would affect the security of the system, including thermal overloading of circuits, power system instability, unacceptable voltage performance.

An OTS can offer a practical, cost-effective alternative which may be deployed in cases where the Security and Quality of Supply Standards (SQSS) does not preclude the use of tripping schemes when there is a need to provide transmission capacity to mitigate the effects of secured events on the transmission system.

Broadly, OTS's involve the automatic tripping of circuit breakers to prevent abnormal system conditions occurring such as thermal overload and system instability problems. Unacceptable conditions can occur due to a transient or persistent fault. Generally, if post fault overloading exceeds the appropriate time limit for the circuit, generator tripping/de-loading will occur (although in some locations the signal to trip may be avoided if it is possible to utilise delayed auto re-close (DAR)), and the generator removed from the GB Transmission System.

The Grid Code defines four categories of system to generator intertripping schemes (OTS), which are deployed to manage conditions. These are summarised below but are not the formal definitions used within Grid Code.

- Category 1 – Arising from a variation from connection design request from a User, where the User is prepared to accept a lower level of security then that required by SQSS.
- Category 2 – To cater for circuit maintenance conditions where a subsequent double circuit fault would result in unacceptable loadings conditions on a circuit to which the User being tripped off would be fully effective on the overload.
- Category 3 – To alleviate overloads that could occur on a third parties assets post fault, used as an alternative to reinforcing the third parties system.

[7] Full efficient costs will be presented in a resubmission later in 2025 as agreed with Ofgem.

- Category 4 – For the purposes of post fault system restoration in a timely and efficient manner.

OTS have developed substantially in the last 20 years, from being electromechanical hardware for monitoring and tripping with solution non-specific communication channels and a central logic controller-based hardware, to 'Wide area OTS' which can which provide monitoring and tripping function across sizeable parts of the network, and with this, further complexity in the delivery of modifications. Where once implementation and modification/extension of OTS could be accomplished without the Original Equipment Manufacturer (OEM), solutions today are often digitally integrated with OEM specific digital communication thus necessitating OEM involvement.

2.1.3 The projects

The five projects detailed within this application are:

- East Anglia,
- Lackenby,
- Killingholme,
- Pathfinder East Anglia,
- Anglo-Scottish.

All projects, either extend or upgrade aspects of an existing in-situ OTS asset, such as enabling it to cover further circuit combinations, increasing the speed of tripping/de-load, amending operating logic or increasing the capacity of the OTS considering likely future connections. In the case of the single project involving the installation of a new OTS asset where one does not currently exist, this involves addition of new OTS logic units, monitoring and corresponding tripping Intelligent Electronic Devices (IED) at local and a series of remote sites.

2.1.4 Importance of the investment

We are licensed under the Electricity Act 1989 to transmit electricity subject to certain standard and special conditions. Section 9(1)(a) reads that it is the duty of the electricity distributor to *"develop and maintain and efficient, coordinated and economical system of energy transmission".*

At their core, all projects are concerned with network reliability. The works involved protect consumer demand and/or Distribution Network Operator (DNO) networks against the loss of the generator/super-grid system connections or islanding of generation, which may otherwise result in unacceptable disturbances. Having an effective OTS in place, that monitors a correct range of circuits, allows generation restrictions to be reduced, minimising or eliminating generation restriction costs, and ensures security standards can be maintained.

As the nature of the GB electricity transmission system responds to changes in generation and demand, it is our submission that these investments will bring network reliability benefits for UK consumers.

2.1.5 Chronology to the request

The figure below provides key dates behind each project contained within this submission.

Figure 1 - Chronology to request

	2020	2021	2022	2023	2024	2025	2026
East Anglia		TOCA signed	Investment internally approved		Works completed		
Lackenby			TOCA signed		Investment internally approved		Works planned completion
Killingholme	TOCA signed			Original investment internally approved	TOCA variation. Investment internally re-approved.	Works planned for completion	
Pathfinder East Anglia			NESO submit planning request			Investment internally approved	Works planned completion
Anglo-Scottish		NESO submit planning request			Investment internally approved		Works planned completion

2.2 Regional and strategic context

The increase in the type and amount of generation across the network has meant investments into OTS to ensure network operability and resilience. Information particular to each region impacted by OTS investments within this submission are detailed below. Figure 3 provides the geographical location of each project.

2.2.1. Central East Region – 'Pathfinder East Anglia' and 'East Anglia'

In the central East region, customer connections is a core theme. Our East Anglia: Future Network Blueprint (submitted as part of our T3 Business Plan, expects a significant growth in low carbon and renewable generation will transform the region. In T3 we expect 12.6 GW of generation to be connected and 240 MVA of capacity to be added. Viking Link (VL) is the UK's first connection with renewable energy-rich Denmark and an instrumental step towards achieving net zero carbon emissions. National Grid Viking Limited, partnering with Energinet in Denmark, have completed works on VL, a 765km, subsea HVDC interconnector joining the network at Bicker Fen substation. In addition to Viking Link, there is also many generation connections (existing* and near future by 2030) linked to the East Anglia OTS covered below, but also ASTI linked projects such as the (BTNO) Bramford to Twinstead Reinforcement.

[redacted]

Due to this, the area is considered one of the major corridors to deliver power from the North across the country. The growth in low carbon, renewable energy generation will increase the

power transfer requirements of the region and across transmission boundaries resulting in the EC5-Enduring: Constraint Management Intertrip Service (CMIS) launched by NESO. The CMIS is an initiative designed to manage both identified thermal and stability concerns, retain the flow of electricity across the region and avoid or lower constraint costs.

2.2.2. Northeast – 'Lackenby'

The Northeast of England has several generation connections in the pipeline. In our North East: Future Network Blueprint submitted as part of our T3 Business Plan, expects 1.6 GVA capacity to be added and 9.9 GW of generation to connect, some of which will be offshore windfarms. Located more than 130km off the Northeast coast, 'Dogger Bank Wind Farm' will be capable of powering up to 6 million homes annually,[8]with an operational life of around 35 years.[9] [redacted] is leading the development and construction of the wind farm, with work to be delivered in three phases, Dogger Bank A, B and C, each delivering 1.2 GW generation capacity. Dogger Bank C is due to connect in 2025 along with [redacted] 1.4 GW 'Sofia Offshore Wind Farm' also located in the Dogger Bank area of the North Sea.

Connection agreements are in place with these customers for connection into Lackenby 400kV substation. In addition to these connections there are potential future connections in the form of:

[redacted]

Finally, the proposed [redacted]

2.2.3. Northeast Lincolnshire – 'Killingholme'

The region principally consists of a mixture of wind, Combined Cycle Gas Turbine (CCGT), Combined Heat and Power (CHP), coal or biomass generation plant feeding into several 400kV or 200 kV substations. The area has plans for a decarbonised industrial cluster, transforming it into the world's first next zero carbon industrial cluster by 2040,[10] supported in part by National Grid Ventures Humber Low Carbon Pipelines project.[11] Alongside these wider regional works, [redacted], a combined heat and power station, are developing an Open-Cycle Gas Turbine (OCGT) connection to Humber Refinery 400 kV substation. This connection will necessitate a modification of the existing Killingholme OTS to protect against post fault instability or thermal overloads.

2.2.4. Border – 'Anglo Scottish'

The Border is the B6 boundary separating the Scottish Power (SP) transmission and National Grid (NG) transmission interface. Generation capacity in Scotland heavily exceeds demand and is set to increase in the next 10 years. Scotland will be expected to export power into England, and as renewable generation increases, so to the level of transfer requirements.[12] A key area of congestion is the Anglo-Scottish (B6) boundary which occasionally requires renewable generation to be turned down pre-fault and can lead to higher constraint costs. Additionally, the B7a boundary from Northern England into the rest of England creates a 'bottleneck' for the transfer of Scottish generation. To relieve these issues and allow more renewable energy to

[8] 6 million homes powered per annum based on Typical Domestic Consumption Values (Medium Electricity Profile Class 1, 2,900kWh per household; OFGEM, January 2021), typical 55% wind load factor, and projected installed capacity of 3.6GW.
[9] Our History - Dogger Bank Wind Farm
[10] Leading companies agree to develop plan for the world's first zero carbon cluster in the UK's Humber region | National Grid Group
[11] National Grid announces preferred route for pipelines to decarbonise Humber industry | National Grid Group
[12] Ibid

remain connected and not constrained pre-fault, the B6 CMIS initiative and planning request from NESO to extend the Line End Open (LEO) scheme towards the B7a boundary materialised. The LEO is a fundamental aspect of the SPT-NGET Interconnector Control Schemes (ICS) System Integrity Protect Scheme (SIPS) collecting plant and protection status information from circuit ends along the routes crossing boundary B6, which are then transmitted back to Anglo-Scottish OTS logic units.

2.3 RIIO T3 interactions

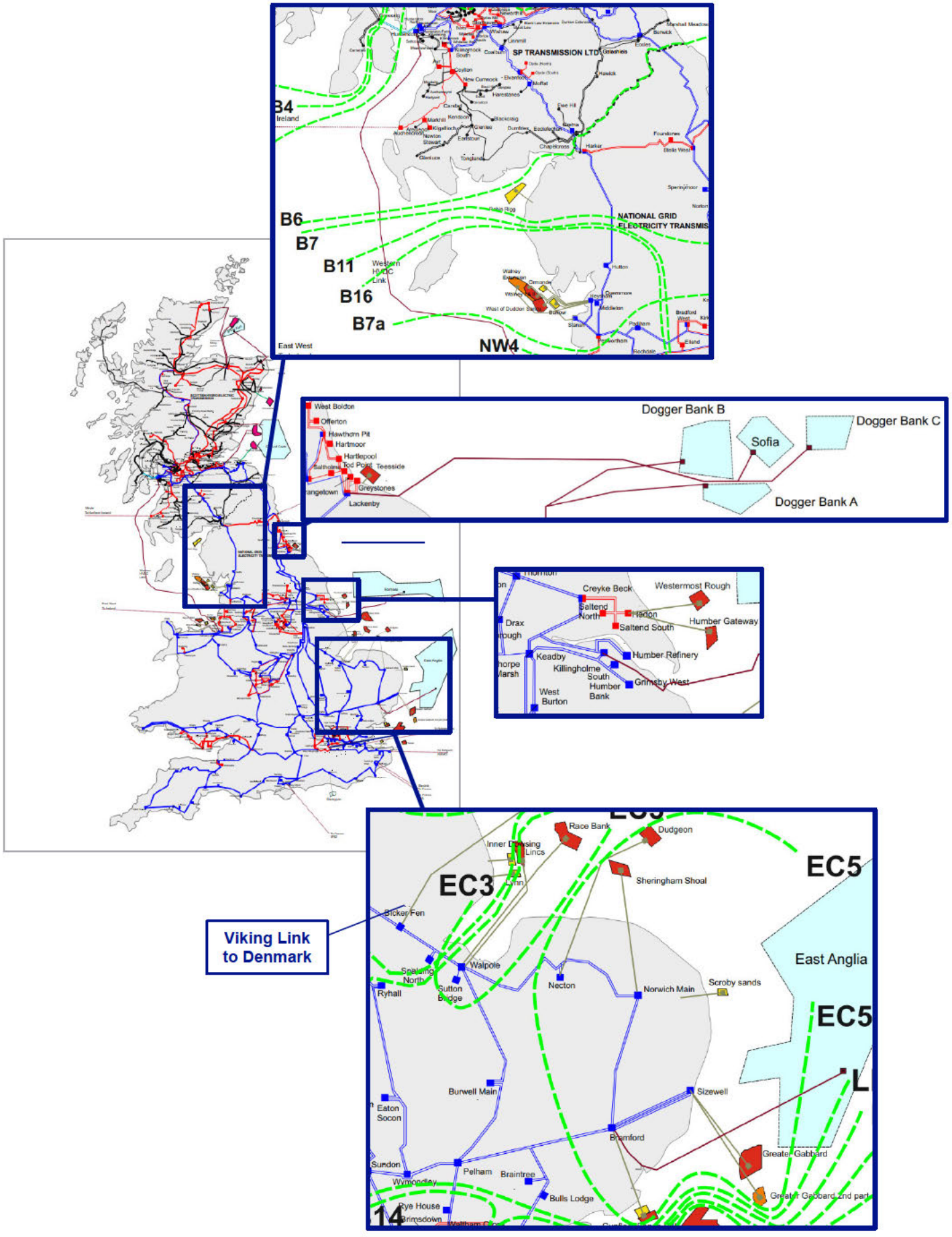
This section details how the investments compare with Ofgem's RIIO T3 consumer outcomes,[13] which we believe set important markers to ensure our decisions provide value for existing and future customers, hit our joint Net Zero aims and provide necessary infrastructure for resilient networks.

Figure 2 - Alignment with Ofgem T3 consumer outcomes

Secure and resilient supplies	OTS are used for network resilience and constraint management purposes.
System efficiency and long-term value for money.	OTS present a more economical and efficient alternative to transmission reinforcements such as building/uprating more of the network to reduce/avoid constraints.

[13] Ofgem kickstarts conversation on future energy price controls funding to pave the way for net zero | Ofgem

Figure 3: NGETs transmission network with project regions



3. Establishing Need

3.1 Overview

This section sets out the drivers behind each of the investments. This is summarised in Table 3 below.

Table 3: OST Projects - Investment driver overview table

	Projects				
Driver	**East Anglia**	**Lackenby**	**Anglo Scottish**	**Pathfinder East Anglia**	**Killingholme**
Customer Connection					
NESO driven wider works					

3.2 Customer Connections

In the case of East Anglia, Lackenby and Killingholme, the investments are in response to customer connections. As mentioned earlier, rather than building or uprating the network to mitigate unacceptable network conditions, SQSS does not preclude the use of tripping schemes when there is a need to provide transmission capacity to mitigate the effects of secured events on the transmission system.

3.2.1. East Anglia

In the East Anglia project, Viking Link, presents additional generation from Denmark of up to 1.4 GW additional capacity which we estimate to deliver £5.2bn in benefits to UK consumers.[14] VL was connected and operational from December 2023 but, to utilise its full capacity benefits, modifications to the existing East Anglia OTS to monitor additional circuits was required. The work was required by Grid Code to manage the thermal constraints during N-1-D faults (i.e. a double circuit fault) in the area by tripping the interconnector instead of investing new circuits or reconductoring.

3.2.2. Lackenby

The customer connections of Dogger Bank C and Sofia windfarms and future connections in the form of [redacted] drive this investment.

Installing a new OTS at Lackenby will allow renewable energy from Dogger Bank C and Sofia windfarms to be exported onto the transmission network in the long term. Furthermore, the Lackenby OTS will allow system access to be achieved without NESO incurring significant constraint costs to secure the system for a subsequent double circuit fault, i.e. a N-1-D condition. Under these scenarios SQSS allows for the use of operational measures such as OTS's to provide transmission capacity. [redacted]

[14] National Grid launches Viking Link, the next step towards a North Sea super-grid | National Grid Group

3.2.3. Killingholme

The connection of an Open Cycle Gas Turbine (OCGT) in 2025, capable of producing 299MW of energy from natural gas, necessitates the extension of the existing OTS to ensure thermal stability.

The Killingholme OTS is required to ensure that system access can be achieved without the system operator incurring significant constraint costs to secure the system for a subsequent double circuit fault, i.e. a N-1-D condition. Under these scenarios SQSS allows for the use of operational measures such as OTS's to provide transmission capacity. In addition, in the case [redacted], the OTS will also be used for the purpose of system restoration. This will result in the generator being tripped off following a double circuit fault of the Humber Refinery – Killingholme 400kV and Creyke Beck – Humber Refinery Keadby 400kV circuits, allowing for the re-establishment of this circuit route in a timely and efficient manner.

Table 4 provides a summary of the customer confidences of each connection mentioned above.

Table 4 - Summary of customer connection confidence

	Customer	Connection confidence	Rationale for rating
East Anglia	[redacted]		Connection is completed[redacted]
Lackenby	[redacted]		[redacted] we have strong confidence due to their large-scale offshore wind farm investments.
	[redacted]		[redacted] we have strong confidence due to their large-scale offshore wind farm investments.
	[redacted]	Amber	[redacted]
	[redacted]		[redacted]
Killingholme	[redacted]		[redacted]

3.3 NESO driven wider works

This driver is associated with the Pathfinder East Anglia and Anglo Scottish projects and is linked with wider works related to NESOs constraints management initiatives. In short, constraints on a transmission system occur when not enough generation can travel across a system boundary. In this scenario, NESO will incur constraint costs, which they forecast could

peak in 2026 at an estimated £2.25 billion per year,[15] as payments to generators on the limiting side of the boundary to not generate electricity, and to additional generators brought on below the boundary.

3.3.1. Pathfinder East Anglia

To manage constraints and reduce network congestion costs, NESO have initiated EC5-Enduring: Constraint Management Intertrip Service (CMIS).

The CMIS will enable NESO to instruct NGET and the applicable generator/s to be armed to the OTS and in the event of certain network faults, the OTS will send a signal for the generator to be tripped off or deload to 0MW. This strategy involves building post-fault intertrip links between generation across the EC5 region and the East Anglia Operational Tripping Scheme, which NESO estimate will bring approximately £760m in savings during the 2025-2030 period.[16]

The upgraded East Anglia OTS will maximise the operational capability of the OTS and minimise the constraint cost under N-1 (i.e. fault outage of a single circuit), N-1-1 (i.e. fault outage of a single circuit during the prior outage of a circuit) or N-1-D (i.e. fault outage of a double circuit) outages. [redacted] To further uprate these circuits, all substations & towers will need to be uprated/rebuilt.

3.3.2. Anglo-Scottish

NESO have also initiated the B6 CMIS initiative, it will mean the NESO can instruct relevant Transmission Owners (TO) to arm generators to the OTS, and, in the event of certain network faults, the OTS will send a signal for the generator to be tripped off. Through this initiative it has been determined that there is a benefit in extending the LEO scheme of the Anglo-Scottish OTS towards the B7a boundary, meaning, that at least an additional 400MW can be allowed to flow pre-fault across the B7a boundary.[17]

[redacted] To complete this activity, we plan to extend the Line End Open (LEO) schemes toward the B7a boundary.

3.3.3 Network Options Assessment (NOA)

In both cases, Pathfinder and Anglo-Scottish, the planning requests submitted to us to undertake the works result from NESOs Network Options Assessment (NOA) 2021/2022 refresh. The NOA is key part of the network development process enabling the delivery of the government's offshore wind ambition and a way NESO assess major National Electricity Transmission System (NETS) reinforcements. Options are analysed by NESO in a Cost Benefit Analysis to determine which should be progressed.

The NOA project codes CS07 and CS08 relate to 'Commercial solution for East Anglia – stage 1 and 2' and is the Pathfinder East Anglia project. While project codes CS05 and CS06 relate to 'Commercial solution for Scotland and the north of England – stage 1 and 2' and is the Anglo Scottish project. The economic cost-benefit analysis conducted on both concluded that they should be recommended to proceed.

3.4 National Energy System Operator request or TOCA

Within Anglo Scottish and Pathfinder East Anglia projects, the STCP 16-1 Investment Planning request details the works required in specific regions and sites, [redacted]

Within Lackenby, East Anglia and Killingholme, the OTS scheme requirements are defined as part of the Customer Connection Offer and are governed by the Grid Code (CC.6.3.17), which states that the System Operator (NESO) may require that an OTS is installed as a condition of

[15] National Grid: How are we helping manage consumer energy bills?

[redacted]

a Connection Offer supported by power system studies carried out by the Transmission Owner. In these projects therefore, the Transmission Owner Construction Agreement between NESO and NGET specify the OTS functionality required and at which locations and, [redacted]

4. Optioneering

The process of assessing potential options in the case of these OTS projects did not require a detailed cost benefit analysis (CBA). It was deemed in these instances that carrying out a CBA was not proportionate to making an 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.

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, we identified the following options:

- Option A: Do nothing
- Option B: Market based solution
- Option C: Network reinforcements (build/uprate network)
- Option D: Extend/upgrade existing OTS
- Option E: Install new OTS

Within Pathfinder East Anglia and Anglo-Scottish projects, factors which dictate the options for OTS projects, such as locations or circuits to be monitored, are determined by NESO as part of Pathfinder initiatives following their NOA process.

Within East Anglia, Killingholme and Lackenby projects, the customer connections presented us with an initial decision to mitigate network thermal/stability issues; build or update the network to alleviate network thermal/stability constraints or provide an OTS solution. In each case, an OTS solution was preferred because this is considered an economic measure to address the circuit overloads or stability issues compared to investing new circuits, reconductoring or uprating/rebuilding substations and towers.

Due to the directions from NESO but also factors such as the location of customers due to connect, the scope of optioneering is narrower in the case of OTS projects. For Pathfinder East Anglia and Anglo Scottish, we have considered (i) **alignment with NESO planning request**, (ii) **time**, (iii) **cost**, and (iv) **future proofing** when appraising options. For East Anglia, Killingholme and Lackenby projects the same criteria is considered, but alignment with the NESO planning request is excluded as it is not relevant.

We have considered, but **discounted** across all projects, the following options:

- Option A: Do nothing.
- Option B: Market based solution.
- Option C: Network reinforcements (build/uprate network)

Options A and B are discounted. In these options none of the network reliability or constraint management benefits would be realised as nothing physical will be delivered. Further information on these options against the criteria can be seen in Table 5.

Option C is discounted. Option C includes the building or uprating of more of the network to reduce or avoid thermal and stability constraints. Such a solution is likely to take longer to implement, (criteria ii) and is less cost effective than to extend/modify an OTS or install a new one (criteria iii). While such an approach could conceivably future proof (criteria iv) it is considered inefficient to keep building more network to mitigate potential faults, where an OTS can produce the same output for consumers in a practical, cost-effective way.

With Options A – C discounted, also considered were the following:

- **Option D:** Extend/upgrade existing OTS.
- **Option E:** Install new OTS.

Extension or upgrade (Option D) is differentiated in this paper from new installation (Option E) on the basis that in the case of the former the project does not lead to a new OTS system where one did not previously exist. While Option D projects may include the addition of new hardware or software this is primarily to extend or modify the functionality of an existing OTS.

Option D is preferred in all projects bar Lackenby. Unlike Lackenby, where there is no pre-existing OTS suitable to extend or upgrade, the installation of a new OTS on other projects would be disproportionate and bring less value for consumers. Installation of a new OTS would involve higher capital costs to consumers (criteria (iii)), longer installation and longer scheme outages (criteria (ii)), providing no additional benefit. Modifications and extensions also align with NESO direction/NGET-NESO agreements, criteria (i), also a key driver for the works. Furthermore, the option will be in the interests of the network resilience and accommodation of customer connection or wider work drivers.

In Lackenby, Option E is preferred. The installation of a new OTS is required as there is no existing one in the vicinity suitable to modify or extend and therefore no alternative option exists. As part of a Front-End Engineering Design (FEED) report,[18] the option to locate OTS logic units at different substations ([redacted]) was considered.

Based on this qualitative review, [redacted] was preferred due to space constraints at [redacted] which would have required the building of an additional room but for no material benefit to consumers.

While there is an OTS in the area, Lackenby-Greystones-Wilton OTS, this is a 'local scheme' meaning it only monitors circuits by taking input from a single physical location, such as one substation rather than a geographical region ('wide area scheme') as per the required design. The existing OTS only monitors the status of the four Lackenby-Greystones 275kV circuits at the Greystones substations only, implemented through hardwired circuits without an Intelligent Electronic Device (IED) feeding into OTS Logic units, and as such could not be extended.

Furthermore, the Lackenby area was selected for the logic units as this is where the generation is being connected, where all circuits are connected to and from where the power is being evacuated in all directions making it the most optimal place for the units to be installed.

Table 5 summarises the options appraisal described above.

Table 5 - Options appraisal

Option	A	B	C	D	E
Option Title	**Do nothing**	**Market based solution**	**Network reinforcement (build/uprate network)**	**Extend /upgrade existing OTS**	**Install new OTS**
Anglo Scottish OTS & Pathfinder East Anglia (unless specified responses relate to both projects)					
Alignment with planning request	Would not align with planning request or NESO requirements	Would not align with planning request or NESO requirements	Would not align with planning request or NESO requirements	Aligns with planning request or NESO requirement	Would not align with planning request or NESO requirements.
Timing of programme & resources	N/A - would deliver nothing.	N/A - would deliver nothing.	Building/uprating network is likely to take longer in comparison to OTS works.	Less time than full strip out and new installation.	More time required to undertake full strip out and new installation.
Cost	Long term disbenefits for consumers resulting from lack of constraint management.	Long term disbenefits for consumers resulting from lack of constraint management.	More costly to build/uprate network in comparison to extend/modify or install new OTS.	Less cost than full strip out and new installation.	More cost involved in full strip out and new installation.
Capacity & future development potential	Would not future proof.	Would not future proof.	Future proofing could occur.	Pathfinder East Anglia – future proofing included in design.	Installation of a new OTS could conceivably include future proofing.

[18] [redacted]

				Anglo-Scottish – No future proof.	
East Anglia OTS & Killingholme OTS (unless specified responses relate to both projects)					
Timing of programme & resources	N/A - would deliver nothing.	N/A - would deliver nothing.	Risk significantly missing ACL dates.	Less time than full strip out and new installation.	More time required to undertake full strip out new installation.
Cost	Long term disbenefits for consumers resulting from lack of constraint management.	Long term disbenefits for consumers resulting from lack of constraint management.	More costly to build/uprate network in comparison to extend/modify or install new OTS.	Less cost than full strip out and new installation.	More cost involved in full strip out and new installation.
Capacity & future development potential	Would not future proof.	Would not future proof.	Future proofing could occur.	East Anglia OTS - No future proofing in design. Killingholme OTS – design does not future proof.	Installation of a new OTS could conceivably include future proofing.
Lackenby OTS					
Timing of programme & resources	N/A - would deliver nothing.	N/A - would deliver nothing.	Risk significantly missing ACL dates.	Time considered neutral due to there being no viable option to extend an OTS – leaving only the option of a new installation.	
Cost	Long term disbenefits for consumers resulting from lack of constraint management.	Long term disbenefits for consumers resulting from lack of constraint management.	More costly to build/uprate network in comparison to extend/modify or install new OTS.	Cost considered neutral due to there being no viable option to extend an OTS – leaving only the option of a new installation.	
Capacity & future development potential	Would not future proof.	Would not future proof.	Future proofing could occur	No viable option to future proof an existing OTS	Future proofing is included within design scope.

Based on the qualitative analysis we recommend the following options (covered in Table 6) for each project. These options represent the best solution to deliver the investment drivers, in the interests of current and future consumers.

Table 6 - Summary of preferred option

East Anglia	**Option D:** Modify and extend East Anglia OTS to accommodate Viking Link connection at Bicker Fen.
Lackenby	**Option E:** Install new OTS equipment with OTS logic units at [redacted]
Killingholme	**Option D:** Modify the existing Killingholme OTS to accommodate OCGT [redacted] at Humber Refinery.
Pathfinder East Anglia	**Option D:** Modify East Anglia OTS to upgrade monitoring, addition of circuits and accommodate future connections into transmission network.
Anglo – Scottish	**Option D:** Extension of LEO scheme to collect information [redacted] within the B7a transmission boundary.

4.1 Preferred solutions

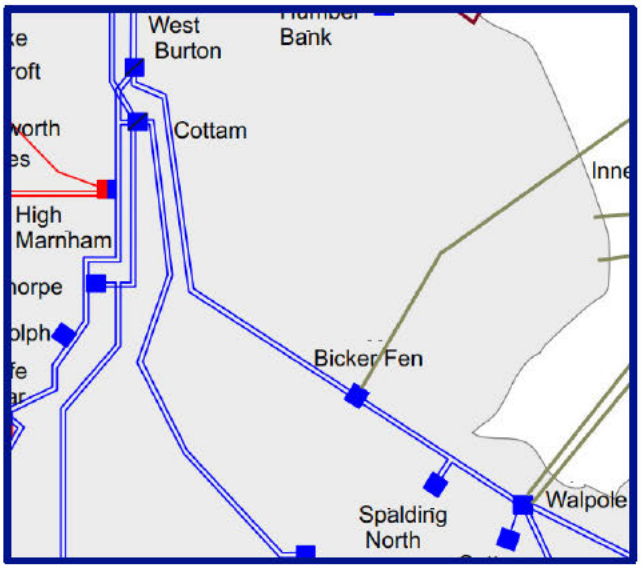
4.1.1. East Anglia

The work on the East Anglia OTS for Viking Link involved extensions to cover additional monitoring and tripping of circuits, due to the new Viking Link HVDC Interconnector. The following work has been undertaken:

[redacted]

The works detailed above were originally due to be part of the Pathfinder East Anglia project which would include upgrades. However, time constraints, due to the imminent connection of a fully contracted customer (Viking Link), and ensuring SQSS compliance, led to this extension being completed to provide further functionality to accommodate Viking Link. While these works and the Pathfinder East Anglia works both require outages, which we would have liked to limit, we decided to proceed with the Viking Link works to avoid the interconnector being operationally restricted and therefore not meeting customer connection dates.

Figure 4 - East Anglia OTS location of newly monitored circuits



4.1.2. Lackenby

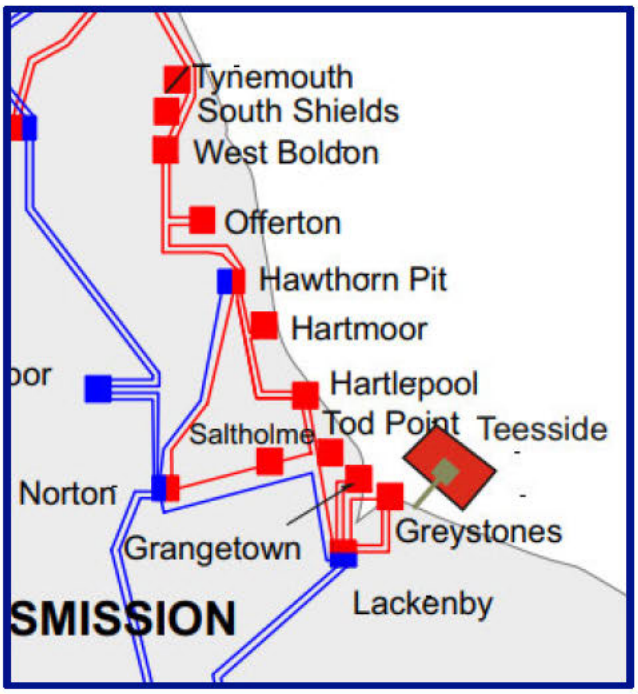
To permit Dogger Bank C and Sofia offshore windfarms to export into the transmission network, a new OTS system is required. The Lackenby OTS is required to trip/de-load generation in the event of single and double circuit faults which result in instability or thermal overloading of the transmission system.

The works involve:

[redacted]

The project shall also accommodate future connections into the OTS. The OTS shall be readily re-configurable to cater for further system developments, including circuit monitoring at additional substations and output signals for generator tripping, HVDC interconnector run-back/run-up, and fast Close/Trip of reactive compensation at additional sites. This should therefore accommodate future connections into the Lackenby OTS [redacted]

Figure 5 - Location of substations in scope of OTS



4.1.3. Killingholme

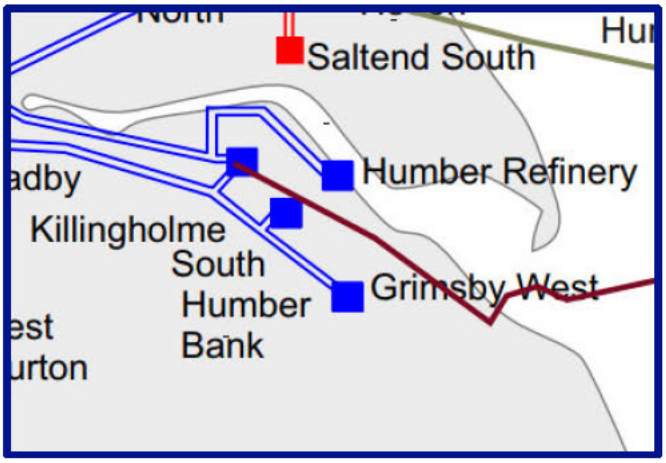
The existing Killingholme Operational Tripping Scheme (KOTS) is being extended to add an additional Generator Trip command to Humber Refinery 400kV substation due to the connection of the new [redacted].

Presently, The OTS equipment located at Creyke Beck 400kV, Grimsby West 400kV, Humber Refinery 400kV, Keadby 400kV, and South Humber Bank 400kV substations gather the relevant feeder circuit status information and send this information to the OTS equipment located at Killingholme 400kV substation. Circuit status information is also gathered locally at Killingholme 400kV substation for the Creyke Beck – Keadby, Humber Refinery, Keadby and South Humber Bank circuits. [redacted]

The works involve:

[redacted]

Figure 6 - Humber Refinery to Killingholme



4.1.4. Pathfinder East Anglia

The works involve:

[redacted]

The scope of works accommodate future proofing in the choice of servers and control systems. As mentioned, there are three control systems over two servers which provides for more capacity of data points to monitor than is currently required, even with the new generation connections and additional monitored circuits. However, this means more data points can be accommodated in the future without having to add a further control systems, it also means the systems are able to work faster, thus increasing the speed at which the reduction and management of constraints may occur. Furthermore, future proofing is also accommodated

[19] Existing generators have been directed by NESO to upgrade all their existing thermal monitoring to stability monitoring. The generators have the facility for stability monitoring, and this is outside the scope of NGET; however, interfaces are required at NGET sites to pick up stability monitoring signals from these existing generators to trip/de-load.

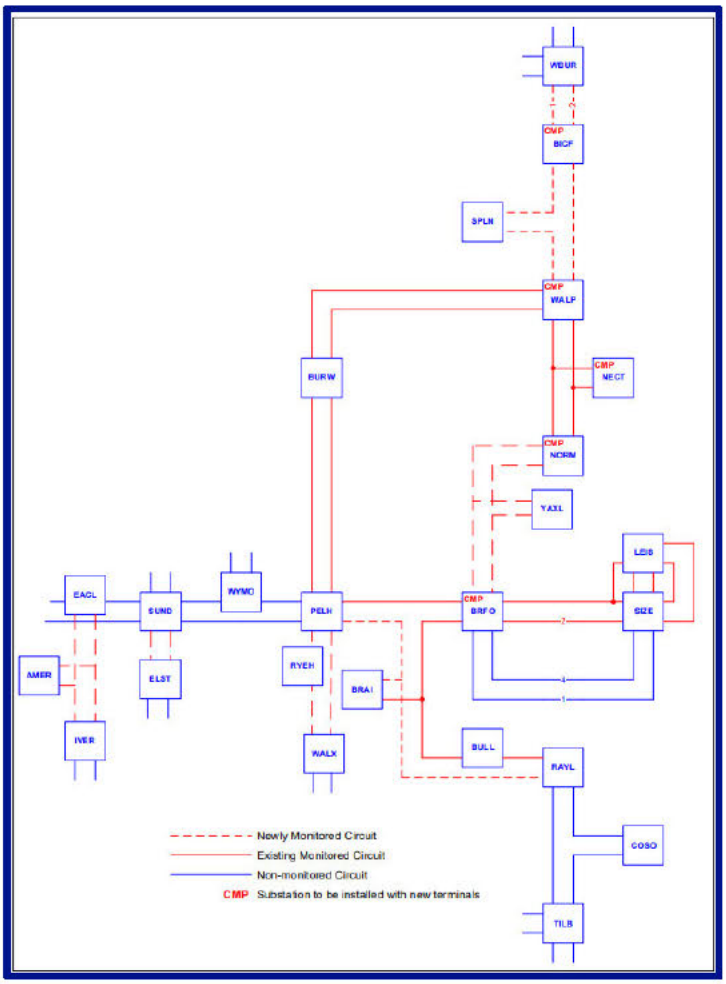
through the number of generation customers that may connect to [redacted]

Interactions with East Anglia OTS project

Both the 'East Anglia' project and the 'Pathfinder East Anglia' project undertake work at Bicker Fen substation. The work being undertaken is separate and explained as follows.

[redacted]

Figure 7 - Pathfinder East Anglia scope schematic



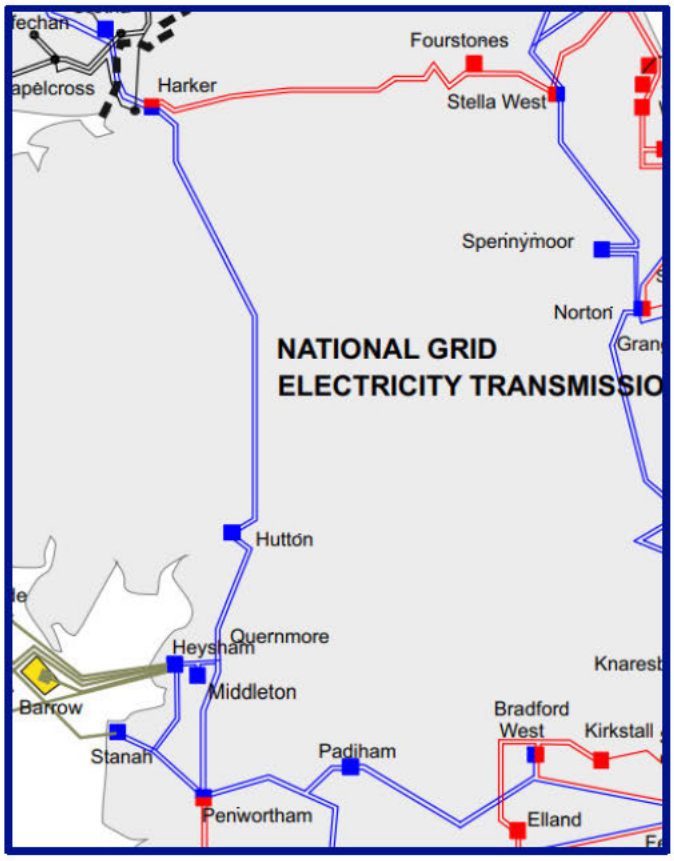
4.1.5. Anglo-Scottish

These works will require us to instal signalling equipment at the relevant substations, [redacted]

The works therefore involve:

[redacted]

Figure 5 - Location of substations in scope of works



5. Detailed costs

5.1 Introduction

This section provides a breakdown of the overall costs for all five projects including an expenditure profile for all Regulatory Years of delivery. The following cost estimate breakdown represents our current view of costs for the proposed investments. All costs are presented in 2018/19 price base, unless otherwise stated.

The Contractor's quotation return for delivery works associated with the Anglo Scottish project are due to be received in April 2025, therefore initial costs included within this MSIP submission are internal estimates only at this stage, based on the defined scope as detailed within the direct allocation documentation.

Upon completion of the procurement process and agreeing final contractor costs, NGET will provide an updated cost submission for the Anglo Scottish project in April 2025. This submission will detail the market tested pricing received as part of the procurement exercise and request full funding allowances for the scheme.

Appendix A of this document contains a list of the cost models and estimations of inflation submitted alongside this document. The cost models provide a detailed breakdown of the costs and should be read in conjunction with this chapter.

5.1.1 Total Allowance Request

East Anglia

Total project costs are c.£[redacted]. NGET requests c.£[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 8 - Allowance request – East Anglia

	2018/19 price base (£)					
	T1 & Prior Costs	2021/22	2022/23	2023/24	2024/25	Total
Total project costs	[redacted]					
CAI						
Allowance Request (Direct Only)*						

*Remainder to be funded via Opex escalator

Lackenby

Total project costs are c.£[redacted]. NGET requests c.£[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 9 - Allowance request – Lackenby

	2018/19 price base (£)						
	T1 & Prior Costs	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Total project costs	[redacted]						
CAI							
Allowance request - Direct only*							

*Remainder to be funded via Opex escalator

Killingholme

Total project costs are c.£[redacted]. NGET requests c.£[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 10 - Allowance request – Killingholme

	2018/19 price base (£)		
	2024/25	2025/26	Total
Total project costs	[redacted]		
CAI			
Allowance Request (Direct Only)*			

*Remainder to be funded via Opex escalator

Pathfinder East Anglia

Total project costs are c.£[redacted]. NGET requests c.£[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 11 - Allowance request - Pathfinder East Anglia

	2018/19 price base (£)					
	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Total project costs	[redacted]					
CAI						
Allowance Request (Direct Only)*						

*Remainder to be funded via Opex escalator

Anglo Scottish

Total project costs are c.£[redacted]. NGET requests c.£[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 12 - Allowance request – Anglo Scottish

	2018/19 price base (£)						
	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	Total
Total project costs	[redacted]						
CAI							
Allowance request - Direct only*							

*Remainder to be funded via Opex escalator

5.1.2 Cost Summary

East Anglia

The total cost to develop and deliver this project is c.£[redacted] including indirect costs and costs incurred to date.

Table 13 - Cost Summary – East Anglia

Element	Total (£)	Classification
Contractor Costs		
Main Works Contractor	[redacted]	[redacted]
Third Party Costs	[redacted]	[redacted]
National Grid Costs		
ET Ops	[redacted]	[redacted]
Project Management	[redacted]	[redacted]
NGET Portfolio Costs	[redacted]	[redacted]
Total	[redacted]	

Lackenby

The total cost to develop and deliver this project is c.£[redacted] including indirect costs and costs incurred to date.

Table 14 - Cost Summary – Lackenby

Element	Total (£)	Classification
Contractor Costs	[redacted]	
Main Works Contractor		
Third Party Costs		
National Grid Costs		
ET Ops		
Project Management		
Project Services		
Support Functions		
Legal		
NGET Portfolio Costs		
Other		
Contract Inflation		
Risk		
Total		

Killingholme

The total cost to develop and deliver this project is c.£[redacted] including indirect costs and costs incurred to date.

Table 15 - Cost Summary – Killingholme

Element	Total (£)	Classification
Contractor Costs	[redacted]	
Main Works Contractor		
National Grid Costs		
ET Ops		
Project Management		
Project Services		
NGET Portfolio Costs		
Other		
Risk		
Total		

Pathfinder East Anglia

The total cost to develop and deliver this project is c.£[redacted] including indirect costs and costs incurred to date.

Table 16 - Cost Summary – Pathfinder East Anglia

Element	Total (£)	Classification
Contractor Costs	[redacted]	
Main Works Contractor		
Third Party Costs		
National Grid Costs		
ET Ops		
Project Management		
Project Services		
Support Functions		
NGET Portfolio Costs		
Other		
Estimated Inflation		
Risk		
Total		

We recognise the risk allowance requested is higher than in other projects, but it reflects the higher number of sites involved and therefore interactions with other works in the region, legacy sites and outage requirements. These risks are further developed in section 6 of this paper.

Anglo Scottish

The total cost to develop and deliver this project is c.£[redacted] including indirect costs and costs incurred to date.

Table 17 - Cost Summary – Anglo Scottish

Element	Total (£)	Classification
Contractor Costs	[redacted]	
Main Works Contractor		
Third Party Costs		
National Grid Costs		
ET Ops		
Project Management		
Project Services		
Support Functions		
NGET Portfolio Costs		
Other		
Estimated Inflation		

Element	Total (£)	Classification
Risk	[redacted]	
Total		

5.1.3 Cost Firmness

East Anglia

The table 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 [redacted] of the total costs are either incurred or have been contracted (cost firmness categories 1 and 2) giving strong confidence in our cost submission.

Table 18 - Cost Firmness – East Anglia

Cost Firmness	Total (£)	Notes
1 - Fixed	[redacted]	
2 - Agreed re-measurable		
3 - Agreed re-measurable future information		
4 - Estimated		
5 - Early Estimate		
Total		

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

Lackenby

The table 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 [redacted] of the total costs are either incurred or have been contracted (cost firmness categories 1 and 2) giving strong confidence in our cost submission.

Table 19 - Cost Firmness – Lackenby

Cost Firmness	Total (£)	Notes
1 - Fixed	[redacted]	
2 - Agreed re-measurable		
3 - Agreed re-measurable future information		
4 - Estimated		
5 - Early Estimate		
Total		

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

Killingholme

The table 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 [redacted] of the total costs are either incurred or have been contracted (cost firmness categories 1 and 2) giving strong confidence in our cost submission.

Table 20 - Cost Firmness – Killingholme

Cost Firmness	Total (£)	Notes
1 - Fixed	[redacted]	
2 - Agreed re-measurable		
3 - Agreed re-measurable future information		
4 - Estimated		
5 - Early Estimate		
Total		

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

Pathfinder East Anglia

The table 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 [redacted] of the total costs are either incurred or have been contracted (cost firmness categories 1 and 2), giving some confidence in our cost submission.

Table 21 - Cost Firmness – Pathfinder

Cost Firmness	Total (£)	Notes
1 - Fixed	[redacted]	
2 - Agreed re-measurable		
3 - Agreed re-measurable future information		
4 - Estimated		
5 - Early Estimate		
Total		

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

Anglo Scottish

The table 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 [redacted] of the total costs are either incurred or have been contracted (cost firmness categories 1 and 2). We expect this cost firmness to increase once we have full tendered costs and be reflected in our [redacted] submission.

Table 22 - Cost Firmness – Anglo Scottish

Cost Firmness	Total (£)	Notes
1 - Fixed	[redacted]	
2 - Agreed re-measurable		
3 - Agreed re-measurable future information		
4 - Estimated		
5 - Early Estimate		
Total		

Estimated costs relate to National Grid 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 projects, including the current high-level programme plan, procurement strategy and anticipated risks.

6.1.1 Delivery Programme

The current known delivery programme for each project is summarised below.

Table 23 - Delivery programme

East Anglia	Front End Engineering Design – [redacted] Detailed Design period: [redacted] First Site Access: [redacted] Commissioning: [redacted] OTS in service: [redacted]
Lackenby	Front End Engineering Design – [redacted] Detailed Design period: [redacted] First Site Access: [redacted] Commissioning: [redacted] OTS in service: [redacted]
Killingholme	Front End Engineering Design – [redacted] Detailed Design period: [redacted] First Site Access: [redacted] Commissioning: [redacted] OTS in service: [redacted]
Pathfinder East Anglia	Front End Engineering Design – [redacted] Detailed Design period: [redacted] First Site Access: [redacted] Commissioning: [redacted] OTS in service: [redacted]
Anglo Scottish	Front End Engineering Design – [redacted] Detailed Design period: [redacted] First Site Access: [redacted] Commissioning: [redacted] OTS in service: [redacted]

6.1.2 Procurement and Contracting Strategy

The tables below provide a summary of the procurement and contract information for each of the projects.

Table 24 - East Anglia procurement timeline and contracting strategy

East Anglia	
Procurement framework	[redacted]
Stage 1 Contract Award	[redacted]
Stage 2 Contract Award	[redacted]
Contract Type	[redacted]
Procurement approach	[redacted]

Table 25 - Lackenby procurement timeline and contracting strategy

Lackenby	
Procurement framework	[redacted]
Quote requested	[redacted]
Quote received	[redacted]
Contract Award	[redacted]
Contract Type	[redacted]
Procurement approach	[redacted]

Table 26 - Killingholme procurement timeline and contracting strategy

Killingholme	
Procurement framework	[redacted]
Quote requested	[redacted]
Quote received	[redacted]
Contract Award	[redacted]
Contract Type	[redacted]
Procurement approach	[redacted]

Table 27 - Pathfinder East Anglia procurement timeline and contracting strategy

Pathfinder East Anglia	
Procurement framework	[redacted]
Stage 1 Contract Award	[redacted]
Stage 2 Contract Award	[redacted]
Contract Type	[redacted]
Procurement approach	[redacted]

Table 28 - Anglo Scottish procurement timeline and contracting strategy

Anglo Scottish	
Procurement framework	[redacted]
Quote request	[redacted]
Quote received	[redacted]
Contract Award	[redacted]
Contract Type	[redacted]
Procurement approach	[redacted]

*Dates represent current planned timelines

The primary objective of our procurement and contracting strategy for these investments is the delivery of a high-quality project outcome satisfied in the most economic and efficient manner. Unfortunately, we have recently seen challenges in our supply chains across a range of projects at NGET, something which is noted within our Workforce and Supply-Chain Resilience Strategy, provided as part of our T3 Business Plan. In view of these market constraints, our procurement strategy has led us to direct allocation in all projects. Given the scale of investments, coupled with the timescales involved, our assessment was that a direct allocation approach would provide a proportionate strategy which has meant we have been able to, relatively quickly, confirm resource availability, enabling delivery of these projects in a time efficient manner and by skilled professionals experienced in undertaking similar projects.

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.

A summary of key risks against each project is provided within the tables below, as well as the risk mitigation activities, full details can be found within the relevant cost models. The East Anglia project is not included as the project has been delivered.

Table 29 - Lackenby risk and mitigation

Risks	Mitigation
Damage of assets in delivery/on site Shipping accidents/attacks on route to site damage equipment.	Discussions to be held with supplier to ensure equipment is packaged sufficiently and handled and shipped with care.
Lead time of equipment There are lead time delays in receiving equipment	A Project Management Instruction has been issued to [redacted] to commence works of long lead items such as the 19 inch rack carcasses - pending confirmation from panel design

Table 30 - Killingholme risk and mitigation

Risks	Mitigation
NG SAP & Commissioning Resources. Commissioning staff are a limited resource; resource demands unknown; unforeseen events. Could create delays to commissioning of OTS.	The NGET Project Manager will liaise with relevant resourcing teams to ensure dates are known and to ensure resource is available.

Risks	Mitigation
Outage availability. Unavailability or late cancellation of outages.	Outage date requirements are known, and we will follow our processes to ensure these are confirmed. NGET Project Manager to update the NESO eNAMS system.

Table 31 - Pathfinder East Anglia risk and mitigation

Risks	Mitigation
Interface Risk. The Transmission Network in East Anglia stands out in complexity due to the number of renewable energy connection projects and ASTI network reinforcement currently or planned to be in delivery (see 2.2.1). Any changes to those projects (delays, phasing or scope changes) will have an impact on the Pathfinder East Anglia programme costs and potentially cause design changes that must be absorbed by Pathfinder East Anglia. One example of this is the physical locations for OTS equipment at sites. Depending on the other projects, planned locations for OTS hardware may necessitate design changes if the existing space on site is used, [redacted] We cannot wait until the other projects have completed because this would risk missing the NESO required in service date of the OTS.	We plan to hold monthly cross-functional and cross business meetings to discuss project dependencies to forewarn of any potential risks. We have discussed with the contractor ([redacted]) the possibility of flexibility and included planning for scenarios where the priority of sites changes as the network is upgraded, or as new projects come online. [redacted]

Risks	Mitigation
Outage availability. Outage cancellation in the congested programme. The project requires a complex outage schedule which has limited flexibility, and which is largely dependent on other project outages within the region during 2025-2026 period. The outages in this project, with the exception of Bulls Lodge, are utilising existing outages but related to other projects. We have not been granted outages specifically for this project within 2025 due to the highly congested outages already in forecast. The alternative was to be provided outages in 2026 specific to this project, but this would risk missing the NESO agreed project completion date. While this means overall less outages on the network it does present additional challenge. Outage cancellation, or amendment postponing one or more sites integration into the system, would require re-planning of the sequence of work, and supporting resource, an impact which is compounded by the number of outages required and our reliance on other projects not changing or being cancelled.	We plan to account for this as much as possible through regular cross-functional and cross business meetings to discuss project dependencies and outage plans. Furthermore, we plan to work with the contractor to vary the sequence of works as any outage changes present themselves. The contingency value has also apportioned some cost for possible 'outage plan churn', meaning the impact of these changes on the contractor's sequence of works can be managed efficiently.
Legacy sites. Project scope exposes the project to a greater number of legacy sites, with some sites hosting significant packages of work.	We have undertaken desktop studies of our legacy sites [redacted] but a risk remains that physical site assessments, which have only just commenced in accordance with the [redacted] mobilisation programme, will give rise to potential issues such as latent defects, unrecorded modifications or deterioration of existing infrastructure We plan to complete all site assessments to enable a holistic view of any remediation work. Furthermore, the methods for remediating hazards are agreed in principle with the contractor and representative rates in place to manage cost growth during changes.
Asbestos Containing Materials. Asbestos is present requiring removal. Most sites pre-date 2000 [redacted] and therefore a significant risk of undiscovered asbestos remains.	We have already sought to mitigate this risk through desktop studies and have recently commenced physical site surveys. We will be using licensed contractors at a large number of sites [redacted] to undertake air quality monitoring and cable pulling activities in the presence of potential asbestos.

Table 32 - Anglo Scottish risk and mitigation

Risks	Mitigation
Outage availability. Planned outages may be cancelled or amended by outage planners.	Once [redacted] provide a programme with outage requirements, we will have regular reviews with [redacted] and NG outage planner.
NG Commissioning Resources Commissioning staff are a limited resource; resource demands unknown; unforeseen events. Could create delays to commissioning or review and approval of Risk Assessment and Method Statement.	Relevant personnel will be made aware of the project and current expected timeframes, once we have confirmed outage requirements, we will work with the resource planner to try and assign resource to the project.

7. Conclusion

This document is our MSIP re-opener submission to Ofgem for five Operational Tripping Scheme related projects. The projects are titled: East Anglia, Pathfinder East Anglia, Anglo-Scottish, Lackenby and Killingholme. It is submitted with reference to Special Condition 3.14 of NGET's Transmission License.

Table 33 summarises the investment drivers, the selected option, estimated costs and expected outputs.

Table 33 - Project Investment Summary

Main drivers	Operational Tripping Systems (OTS) protect the power system against overload or instability where under a fault/s condition a portion of generation can no longer be connected to the system. The following drivers necessitate the need for an OTS: **Customer Connections** - Viking Link (East Anglia), Dogger Bank C and Sofia windfarms (Lackenby) and Open Cycle Gas Turbine (OCGT) [redacted] (Killingholme). **NESO driven wider works** – Planning requests to facilitate EC5 Enduring Constraint Management Intertrip Service (Pathfinder East Anglia) and B6 Constraint Management Intertrip Service (Anglo-Scottish).
Selected Option	All solutions are a mixture of hardware/physical installation and software based. Option D is favoured in four projects, Option E is favoured in one. **East Anglia – Option D**: This project has been completed. It involved extending and modifying the East Anglia OTS (EAOTS) to include new circuits through the addition of monitoring equipment across [redacted] sites, as well as installing tripping equipment at [redacted] to facilitate tripping of Viking Link as well as modification to OTS logic. **Lackenby – Option E**: Installation of OTS logic units [redacted] substation and associated software mapping to receive monitoring signals and relay trip/de-load signals. Installation of switchgear status monitoring and trip equipment at remote end sites and protection monitoring on all circuits. OTS design will also facilitate future connections. **Killingholme – Option D**: Extension/modification of the existing Killingholme OTS to include new circuits resulting from the addition of the Open Cycle Gas Turbine (OCGT) generator at Humber Refinery as well as modification to OTS logic. **Pathfinder East Anglia – Option D**: Modification of the EAOTS through installation of OTS trip devices [redacted] to trip or de-load up to [redacted] connections per substation and add protection operation and switchgear status monitoring devices for [redacted] change monitoring interface devices across the region to stability monitoring interfaces and install thermal monitoring devices at selected sites. [redacted] **Anglo-Scottish – Option D**: Installation of new OTS relay panels [redacted] within the B7a transmission boundary and installation of relays at substations to trip newly monitored circuits.
PCD Primary Output	**East Anglia** – Deliver upgrades to the East Anglia OTS to facilitate tripping of Viking Link interconnector [redacted]. **Lackenby** – Deliver a new OTS in the area by [redacted] to facilitate tripping of Dogger Bank C and Sofia Windfarms. **Killingholme** – Deliver upgrades to the Killingholme OTS [redacted] to trip the Open Cycle Gas Turbine (OCGT) [redacted]

	Pathfinder East Anglia – Deliver upgrades to the East Anglia OTS [redacted] to trip/de-load generation customers at multiple sites as well as upgrade monitoring across the region in line with NESO requirements. **Anglo Scottish** – Deliver extensions [redacted] to the Line End Open scheme of the Anglo Scottish OTS.		
Estimated Cost	**The current total project costs: East Anglia** c.£[redacted], **Lackenby** c.£[redacted], **Killingholme** c.£[redacted], **Pathfinder East Anglia** c.£[redacted], **Anglo-Scottish** c.£[redacted] **The current direct cost of the projects and funding allowances requested: East Anglia** c.£[redacted], **Lackenby** c.£[redacted], **Killingholme** c.£[redacted], **Pathfinder East Anglia** c.£[redacted] **Anglo-Scottish** c.£[redacted]		
Spend Profile	**T2 (FY 2022 – FY 2026):**	**T3 (FY 2027 – FY2031):**	**T4+ (FY 2032+):**
East Anglia	c.£[redacted] (100%)		
Lackenby	c.£[redacted] (100%)		
Killingholme	c.£[redacted] (100%)		
Pathfinder East Anglia	c.£[redacted] (71%)	c.£[redacted] (29%)	
Anglo Scottish	c.£[redacted] (88%)	c.£[redacted] (12%)	
Outputs	Operational Tripping Systems which protect against unacceptable thermal overload or stability conditions on the network.		

The five Operational Tripping System related investments are made to assure the reliability of electricity transmission. A single, preferred option per project has been identified. It is our view that these preferred options present the most efficient solution to resolve the drivers behind the investments. Qualitative assessments focussing on alignment with the NESO planning request, time, cost and future proofing, has led to preferred options which provide an effective and efficient solution for consumers. As such, and due to only one preferred option remaining in each project following the qualitative appraisal, quantitative cost benefit analyses have not been undertaken.

Our preferred options either relate to an extension or modification of existing in-situ OTS asset, or the installation of a brand-new OTS asset where one did not previously exist. The focus for selecting our preferred options has been to ensure the required output is delivered to consumers as efficiently as possible.

8. RIIO-T1 and RIIO-T2 allowances

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

9. Assurance and Point of Contact

Provided with the MSIP portfolio of 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 17th February 2023.

This confirmation is provided by the NGET's, Head of Future Price Controls. 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: List of supplementary information

The cost models and estimations of inflation, where applicable, listed below are provided in support of this paper:

1. East Anglia OTS Reopener Cost Model
2. Lackenby OTS Reopener Cost Model

2.a Lackenby Estimated Inflation

3. Killingholme OTS Reopener Cost Model
4. Pathfinder East Anglia OTS Reopener Cost Model

4.a Pathfinder East Anglia Estimated Inflation

5. Anglo Scottish OTS Reopener Cost Model

5.a Anglo Scottish Estimated Inflation

Appendix B: Glossary

Acronym	Definition
AAL	Anticipated Asset Life
ACL	Available for Commercial Load
ASTI	Accelerated Strategic Transmission Investment
[redacted]	[redacted]
CAI	Closely Associated Indirect
CBA	Cost Benefit Analysis
[redacted]	[redacted]
CHP	Combined Heat and Power
CMIS	Constraint Management Intertrip Service
DNO	Distribution Network Operator
EAOTS	East Anglia
ECC	Engineering and Construction Contract
ECI	Early Contractor Involvement
[redacted]	[redacted]
eNAMS	Electricity Network Access Management System
ETYS	Electricity Ten Year Statement
FEED	Front End Engineering Design
FRS	Functional Requirements Specification
HVDC	High Voltage Direct Current
ICS	Interconnector Control Schemes
IED	Intelligent Electronic Device
ISOP	Independent System Operator and Planner
KOTS	Killingholme Operational Tripping Scheme
LEO	Line End Open
LOTI	Large Onshore Transmission Investment
MSIP	Medium Sized Investment Project
MWC	Main Works Contractor
NEC	New Engineering Contract
NESO	National Energy System Operator
NETS	National Energy Transmission System
NGESO	National Grid Electricity System Operator
NGET	National Grid Electricity Transmission
NOA	Network Options Assessment
OCGT	Open Cycle Gas Turbine
OEM	Original Equipment Manufacturer
OTS	Operational Tripping System
PCD	Price Control Deliverable
RRP	Regulatory Reporting Pack
SAP	Senior Authorised Person
SIPS	System Integrity Protect Scheme
SPT	Scottish Power Transmission
SQSS	Security and Quality Supply Standard
TOCA	Transmission Owner Construction Agreement
VL	Viking Link

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