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EXECUTIVE SUMMARY

This report summarises the findings of the Strategic Proposal Back Check and Review (BCR) for the Yorkshire Green Energy Enablement (GREEN) Project (the Project).

The Future Energy Scenarios (FES) produced annually by the Electricity System Operator (ESO) suggest that North to south power flows in the UK will increase significantly in the next ten years due to increased generation capacity connecting to the electricity network. There is growth forecast in offshore wind and interconnection capacity in Scotland and the North East of England. To ensure that suitable capacity exists on the network, several new and expansion projects (including this Project) will be required in the coming years to meet the increased levels of electricity generation.

As part of the 2019 Strategic Proposal process, a longlist of 379 strategic options were identified which were then reduced to a shortlist of 105 strategic options by the use of a technical and benefit filter. A workshop was held to identify a Strategic Proposal considering the findings of specialist (technical, socio-economic, environmental, programme and cost) appraisals in accordance with National Grid's statutory and licence obligations. The 2019 Strategic Proposal was to construct a new 400kV double circuit overhead line from a point on the Norton - Osbaldwick overhead line to Poppleton 275kV substation. This would include a new 6km route and was considered to be the most economical, environmentally, and technically preferred option, largely due to the significantly shorter length of the new 400kV connection compared to the others.

Options have also been tested against the FES by the ESO's Network Options Assessment (NOA). Five options were entered into NOA 5 (2019/20), and NOA recommended to 'proceed' with 'OPN2' (the 2019 Strategic Proposal).

The generator background and the requirements of the electricity transmission system are dynamic and subject to constant change, meaning that National Grid regularly reviews its decisions in light of the latest information. The potential options to meet the system requirement were identified on the basis of the system background identified in FES 2019. This iteration of FES did not take account of three customer connections at Creyke Beck, two of which were not subject to connection agreements when the FES 2019 were prepared.

An assessment undertaken in June 2020 identified additional customers not included in FES 2019 and that the 2019 Strategic Proposal would not be able to accommodate the required rating of the Project due to overloading at Poppleton and Monk Fryston substations. This has subsequently triggered the requirement to undertake a BCR to ascertain whether the 2019 Strategic Proposal remains the overall best option for the Project.

This BCR reviews the 2019 Strategic Proposal and the 2019 shortlisted strategic options identified as part of the 2019 Strategic Proposal process to ascertain the extent to which they could meet the new rating requirement and the change to the Project scope and costs, and therefore be suitable for further options appraisal as part of the BCR process. The same key criteria (ability to meet the earliest in-service date of 2027, ability to minimise the length of the new 400kV connection, and ability to minimise the cost) which drove the decision-making process during the 2019 Strategic Proposal process have been used for the BCR process.

For the review of the 2019 Strategic Proposal, the technical difficulties at the substations are overcome by constructing a new substation at Monk Fryston and a new substation at either 'York North' or 'Poppleton South'. This has led to the 2019 Strategic Proposal being revised into six variant strategic options (consisting of both overhead line (OHL) and underground

cable (UGC) technology sub-options) which have been considered against the key criteria and taken forward for BCR options appraisal, with updated 2020/2021 costings used.

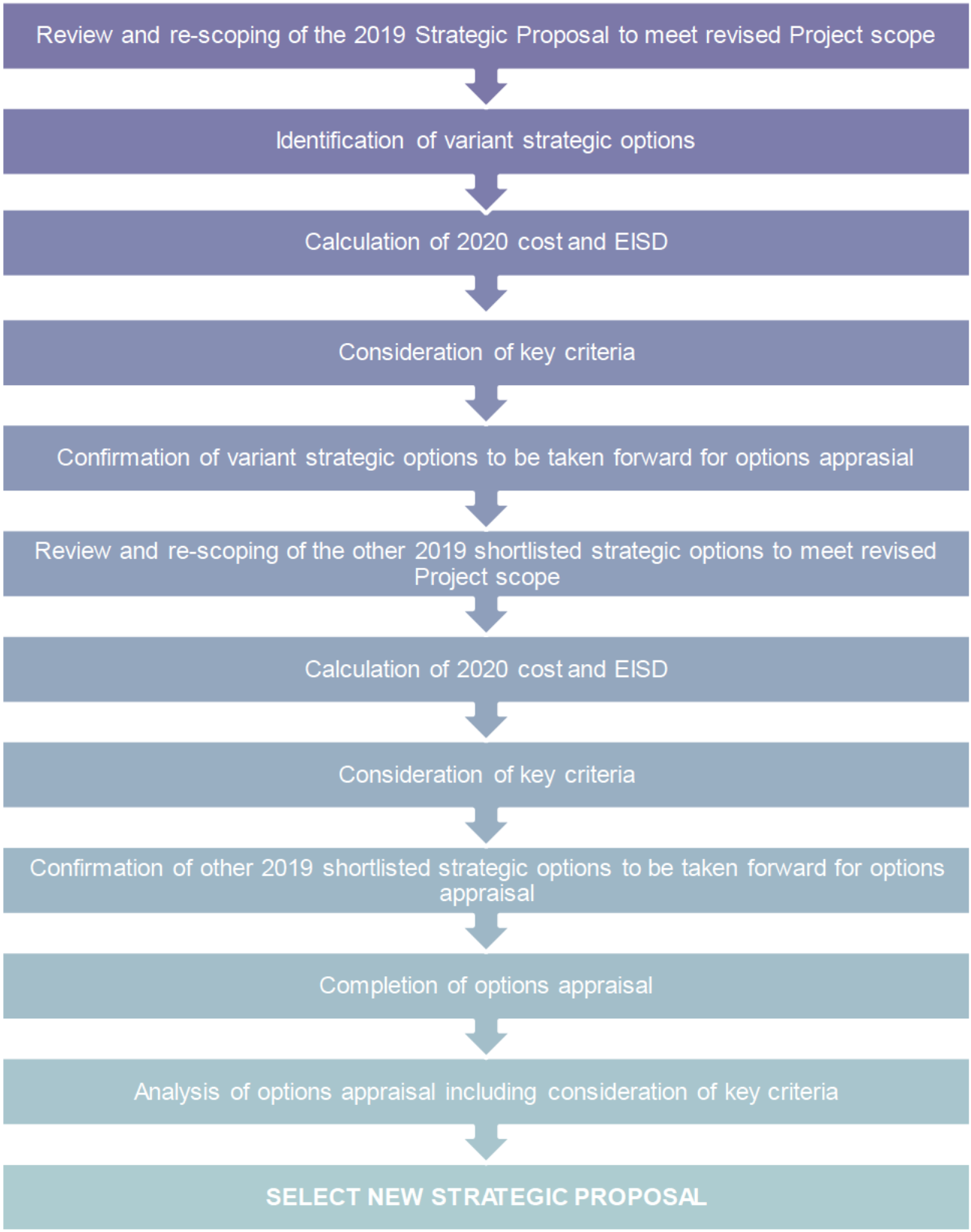
For the review of the other shortlisted strategic options from 2019, further studies providing a greater understanding of the other substations has enabled the review and re-scoping of those strategic options that were deemed to still be applicable to the revised Project scope. This process identified 28 strategic options (all consisting of OHL technology only). Taking the boundary constraint costs into consideration, 21 of the 28 remaining strategic options are more expensive than the most expensive of the six variant strategic options (OHL only), they all have an EISD of 2029 (two years beyond the desired date), and all have an average connection length four times longer than the six variant strategic options. After consideration of the key criteria, all 21 of the 28 remaining strategic options are considered unsuitable to be taken forward for BCR options appraisal.

Again, taking the boundary constraint costs into consideration, the remaining 7 (of the 28 remaining) strategic options are either within the cost range (2 nr.) or cheaper (5 nr.) than the cheapest of the six variant strategic options (OHL only). They all have an EISD of 2029 (two years beyond the desired date), and all have an average connection length 3.6 times longer than the six variant strategic options. Whilst the five strategic options that have cheaper costs provide a clear cost benefit, the cost benefit is not considered to be so substantial as to outweigh the disbenefits associated with the substantially longer EISD and connection length. Therefore, after consideration of the key criteria, all the remaining 7 (of the 28 remaining) strategic options are considered unsuitable to be taken forward for BCR options appraisal.

Each of the six variant strategic options have been robustly appraised in accordance with National Grid's Options Appraisal Guidance and in consideration of a range of technical, environmental, socio-economic, cost and EISD issues. On balance, taking into consideration all of the assessment work which has been undertaken relating to the environment, socio-economics, technical, cost and programme (EISD), the current Strategic Proposal is Option 1B (OHL) – New Substation at 'York North' (400kV substation at Monk Fryston).

A flow process showing the key stages of the BCR process key stages is illustrated below at **Inset 1**.

Inset 1: Key Stages of the BCR Process – Flow Process



GLOSSARY OF KEY TERMS

Term	Definition
Back Check and Review	Process undertaken at key project milestones to ensure that the assumptions in relation to the Strategic Proposal remain valid, and/or where potentially material changes to the Project may arise. The purpose of BCR is to provide a sense check, using the appraisal process to ascertain whether the Strategic Proposal remains the overall best option for the Project.
Benefit filter	Filtering of strategic options to remove any option that does not offer some material benefit over another option (to prevent assessment of multiple options which do the same thing).
Boundary constraint costs	Additional annual payment made (in addition to the constraint costs) where reinforcement delays and increase in boundary capability across boundaries B7, B7a, and B8 would result in sub-optimal operation of the transmission network.
Circuit breaker	A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by excess current from an overload or short circuit. Its basic function is to interrupt current flow after a fault is detected.
Constraint costs	Annual payment made to constrain generation and manage power flows where forecast power flows are unable to be met by reinforcing the boundary (of the electricity transmission system).
Development Consent Order (DCO)	A DCO is the legal instrument by which the Secretary of State grants consent for development under the Planning Act (2008) (as amended).
Double circuit	Double Circuit Transmission Line refers to the arrangement in which a total of six conductors are provided to make two different Transmission Circuit. In Double Circuit Transmission Line, there are two circuits each consisting of three conductors corresponding to three phases.
Double tee	A connection from both circuits on either side of the same structure, creating a third and fourth circuit on another structure.
Earliest in-Service Date (EISD)	Date by which the Project must be delivered to meet the Project Need Case and subsequently not incur annual boundary constraint costs.
East Coast Main Line (ECML)	Electrified railway between London and Edinburgh.

Term	Definition
Eastern Link	Project for two bi-directional high voltage direct current subsea links between Scotland and the north of England to reinforce network capability issues.
Electricity Act 1989	Act establishing the licensing regime and regulator for the electricity supply industry.
Electricity System Operator (ESO)	Body required to support and guide the future development of the electricity transmission system in Britain.
Electricity transmission system	The electricity transmission system is made up largely of 400kV, 275kV and 132kV assets connecting separately owned generators, interconnectors, large demands fed directly from the transmission system, and distribution systems. The 'transmission' classification applies to assets at 132kV or above in Scotland or offshore. In England and Wales, it relates to assets at 275kV and above. The electricity transmission system is designed to make sure there is sufficient transmission capacity to ensure that the system can be operated in an economic and efficient way by the ESO, ensuring power can be moved from where it is generated to demand centres across Britain. This planning and development of the electricity transmission system is governed by the SQSS which ensure that the network is developed and operated securely and is resilient to any foreseeable network faults and disruption.
Future Energy Scenarios (FES)	Published annually by the ESO to indicate future power requirements and where future connections may occur across the network.
Gas Insulated Line (GIL)	GIL consists of a tubular aluminium conductor to carry the current, enclosed in a rigid metallic tube that is filled with an insulating gas (usually sulphur hexafluoride or a mixture of nitrogen and sulphur hexafluoride gases).
Isolator	Isolator is a manually operated mechanical switch which separates a part of the electrical power. Isolators are used to open a circuit under no load. Its main purpose is to isolate one portion of the circuit from the other and is not intended to be opened while current is flowing in the line.
Key criteria	Criteria used (ability to meet the earliest in-service date of 2027, ability to minimise the length of the new 400kV connection, and ability to minimise the cost) to drive the decision-making process during the 2019 Strategic Proposal and BCR process.
Mega Volt Amp (MVA)	Electrical unit used for the apparent power in an electrical circuit.

Term	Definition
National Grid	National Grid operate the national electricity transmission network across Great Britain and own and maintain the network in England and Wales, providing electricity supplies from generating stations to local distribution companies. It does not distribute electricity to individual premises, but its role in the wholesale market is vital to ensuring a reliable, secure and quality supply to all.
Network Options Assessment (NOA)	Where a requirement for additional transmission network capacity has been identified, this is the process to identify a range of reinforcement options, and cost benefit analysis of those options (undertaken by ESO) to determine if a reinforcement is economic and should be progressed.
Network Rail	Body which owns, operates and develops Britain's railway infrastructure.
Offline	Not connected to the electricity network.
Options appraisal	A robust and transparent process used to compare options and to assess the positive and negative effects they may have across a wide range of criteria including environmental, socio-economic, technical and cost factors. The outcome is to identify a Strategic Proposal for the Project.
Options Identification & Selection	Work undertaken to determine the preferred corridor and preliminary routeing and siting options for the Yorkshire Green Energy Enablement (GREEN) Project. It is intended to demonstrate how National Grid's statutory duties, licence obligations, policy considerations, environmental, socio-economic, technical, cost, and programme issues have been considered and provide information on the approach to the identification and appraisal of route corridors and siting locations.
OPN2	Option recommended in the NOA process to proceed with (subsequently leading to the identification of the 2019 Strategic Proposal.
Outage	The withdrawal from service of any part of the transmission system for a period of time in connection with repair, maintenance, or construction of the transmission system.
Overhead Line (OHL)	Conductor (wire) carrying electric current, strung from pylon to pylon.
Power control devices	Power control devices are designed to increase or decrease the apparent reactance of a line, thereby pushing power away from or pulling more power towards the circuit on which they are installed on

Term	Definition
Preliminary Route Swathe	A broad swathe of land within which a new electricity transmission connection could be routed.
Project Need Case	Sets out the reasons why the Project is required.
Pylon	Overhead line structure used to carry overhead electrical conductors, insulators and fittings.
Rating	Power rating limits are usually set as a guideline by the manufacturers, protecting the equipment and simplifying the design of larger systems, by providing a level of operation under which the equipment will not be damaged while allowing for a certain safety margin.
Reconductoring	The replacement of old conductors (wires), insulators, earthwires, etc on an existing overhead line.
Sealing End Compound (SEC)	Electrical infrastructure used as the transition point between overhead lines and underground cables. A compound on the ground acts as the principal transition point.
Security and Quality of Supply Standards (SQSS)	The SQSS sets out a coordinated set of criteria and methodologies that the Transmission Licencees shall use in the planning and operation of the national electricity transmission system.
Site of Special Scientific Interest (SSSI)	An area of land designated by Natural England as of special interest by reason of its flora, fauna or geological or physiographical features.
Siting Area	An area of land within which a new SEC or substation could be sited.
Strategic Proposal	The outcome of the strategic options appraisal; the Strategic Proposal is then taken forward to the Options Identification & Selection stage.
Substation	Electrical equipment in an electric power system through which electrical energy is passed for transmission, transformation, distribution or switching.
Super Grid Transformer	Used at substations along the electricity transmission system to increase or reduce voltage.
Sulphur Hexafluoride Gas (SF_6)	An extremely potent and persistent man-made greenhouse gas that is primarily utilized as an excellent electrical insulator and arc suppressant. It is inorganic, colourless, odourless, non-flammable, and non-toxic.

Term	Definition
Technical filter	Filtering of strategic options to remove any option that does not meet the need case or otherwise would not meet the standards set out in the Security and Quality of Supply Standards (SQSS).
Underground Cable (UGC)	An insulated conductor designed for underground installation.
Uprating	Changing the capacity of existing overhead line by replacing the existing conductors with larger capacity conductors.
Yorkshire Green Energy Enablement (GREEN) Project (the Project)	The Project is required to reinforce the north to south boundary flow by 2027 enabling National Grid to meet future system demands which include several Green Energy customer connections such as Eastern Link (wind/hydro), Continental Interconnector (Wind) and Hornsea SuperConnection (Wind).

1. INTRODUCTION

1.1 Introduction

1.1.1 This report summarises the findings of the Strategic Proposal Back Check and Review (BCR) for the Yorkshire Green Energy Enablement (GREEN) Project (hereinafter referred to as the Project). This report should be read in conjunction with other supporting documents, namely the Yorkshire GREEN Project Strategic Proposal Report (2019) and the Yorkshire GREEN Project Need Case.

1.1.2 The BCR process is to be undertaken at key project milestones to ensure that the assumptions in relation to the Strategic Proposal remain valid, and/or where potentially material changes to the Project may arise. The purpose of BCR is to provide a sense check, using the appraisal process to ascertain whether the Strategic Proposal remains the overall best option for the Project. It is important that this method is used to compare the strategic options and analyse their relative costs and benefits to best meet the needs of National Grid's customers and consumers, whilst also meeting National Grid's various statutory duties and other commitments.

1.1.3 As of July 2020, the Project was at the Options Identification & Selection stage based on the 2019 Strategic Proposal (OPN2') which had been recommended by the Network Options Assessment (NOA) (see **Section 4.1** of this report for further details) and the subsequent 2019 Strategic Proposal process undertaken. The 2019 Strategic Proposal process identified a shortlist of 105 strategic options, which consisted of 30 separate strategic options, each of which was considered for three different types of technology: overhead line (OHL), underground cable (UGC), and gas insulated line (GIL), plus additional sub-options for those strategic options that would require upgrades to existing infrastructure (see **Section 3.1** of this report for further details).

1.1.4 The Options Identification & Selection work reached a stage where the Preliminary Route Swathes and Siting Areas were discussed and agreed by the Project team prior to the commencement of the stage 1 appraisal process. The Option Identification & Selection work was then placed on hold (effective 06 July 2020 (see **Section 4.1** of this report for further details) and prior to the commencement of the stage 1 appraisal process) to enable the BCR process to be completed. The outcome of the BCR process resulted in the identification of the current Strategic Proposal, and the recommencement of the Option Identification & Selection work, based on the current Strategic Proposal. This work recommenced in September 2020.

1.1.5 This BCR process has been undertaken in accordance with National Grid's statutory duties under the Electricity Act 1989 including Section 9 which states that key drivers are to '*develop and maintain an efficient, co-ordinated and economical system of electricity transmission*' and Schedule 9 which states that, when formulating proposals, it is necessary for National Grid to have regard to the *'desirability of preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest'.* The BCR process has also been undertaken in accordance with National Grid's Options Appraisal Guidance.

2. PROJECT NEED CASE

2.1 Overview

2.1.1 The Future Energy Scenarios (FES) produced annually by the Electricity System Operator (ESO) suggest that North to south power flows in the UK will increase significantly in the next ten years due to increased generation capacity connecting to the electricity network at all levels, transmission and distribution. There is particular growth forecast in offshore wind and interconnection capacity in Scotland and the North East of England. To ensure that suitable capacity exists on the network, a number of new and expansion projects (including this Project) will be required in the coming years to meet the increased levels of electricity generation.

2.1.2 An overview of the specific reasons why the Project is required is provided within the Project Need Case and should be read in conjunction with this report.

3. OVERVIEW OF PREVIOUS STRATEGIC OPTIONS ASSESSMENT (2019)

3.1 General Overview and Background

3.1.1 To identify a Strategic Proposal, National Grid is required to balance technical, socio-economic, environmental, and cost considerations in accordance with its statutory and licence obligations. As part of the 2019 Strategic Proposal process, a workshop was held in December 2019 to identify a Strategic Proposal taking into account the findings of specialist (technical, socio-economic, environmental, programme and cost) appraisals.

3.1.2 A longlist of strategic options was identified by National Grid in a workshop by selecting 'start' and 'end' points which would provide opportunities to meet the Project Need Case. The outcome of the workshop was the identification of a longlist of 379 strategic options.

3.1.3 To then filter the longlist down to a shortlist of strategic options, a high-level review was undertaken whereby each strategic option was subject to review by the use of a technical and benefit filter consistent with National Grid's Options Appraisal Guidance as follows:

- Technical filter – filtering of strategic options to remove any option that does not meet the need case or otherwise would not meet the standards set out in the Security and Quality of Supply Standards (SQSS).
- Benefit filter – filtering of strategic options to remove any option that does not offer some material benefit over another option (to prevent assessment of multiple options which do the same thing).

3.1.4 A number of strategic options were discounted using the benefit filter; these were typically options which would require longer routes than alternatives which would do the same thing i.e. the additional length was not considered to offer benefits relative to other options (resulting in those strategic options being discounted). A limited number of options were discounted using the technical filter.

3.1.5 The outcome of this exercise was the identification of a shortlist of 105 strategic options. This shortlist consisted of 30 separate strategic options, each of which was considered for three different types of technology (OHL, UGC, and GIL), plus additional sub-options for those strategic options that would require upgrades to existing infrastructure (see below for further details).

3.1.6 A key consideration which influenced the selection of the 2019 Strategic Proposal (from the shortlist of 105 strategic options) was the ability to upgrade or enhance existing infrastructure; as a starting presumption, National Grid considers these options to be preferable to options which would require wholly new infrastructure. This approach is consistent with National Grid's statutory duty to have regard to amenity under Section 38 of the Electricity Act 1989 and promotes more sustainable development. National Grid will only propose to build wholly new infrastructure where existing infrastructure cannot be technically or economically upgraded to meet system security standards and regulatory obligations.

3.1.7 There were five main strategic options which included a combination of new infrastructure and upgrades to existing infrastructure, which consisted of either reconductoring (at 275kV) or uprating (to 400kV) the existing XC/XCP overhead lines

between Poppleton 275kV substation (or the tee off point on the XC/XCP/XD overhead lines) and Monk Fryston 275kV/400kV substation. These comprised:

- strategic options connecting into Poppleton 275kV substation and then upgrades to the existing Poppleton-Monk Fryston 275kV overhead line (the XCP/XC route); or
- strategic options connecting onto the Poppleton - Monk Fryston 275kV overhead line and then upgrades to the existing XCP/XC route.

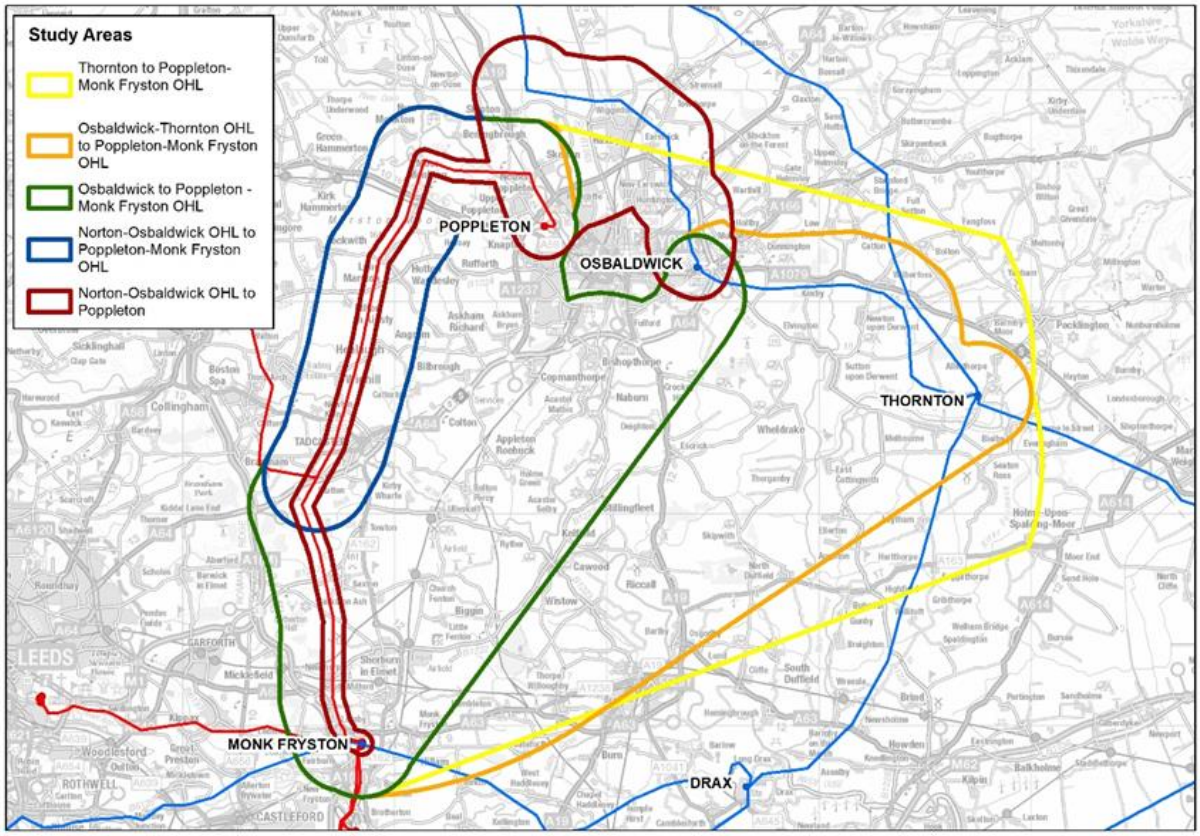
3.1.8 The Project Need Case could be met by reconductoring the existing XCP/XC route and continuing to operate it at 275kV. **Table 3.1** and **Figure 3.1** below summarise the main strategic options which involve upgrading existing infrastructure. The majority of 'start' points are located to the east of Poppleton and York. They would require a longer new build route around the south of York resulting in the potential for greater environmental effects, in particular relating to landscape and visual effects, as well as increased cost, and were therefore considered less preferable to options which 'start' north or west of York.

Table 3.1: 2019 Strategic Options utilising Existing (Upgraded) Infrastructure

Reference	'Start'Point	'End' Point	Approximate Connetion Length	Total (Capital and Lifetime) Cost (2019 estimate)	Earliest in-Service Date (EISD)
2TW-NOR/OSB-POP-CYR (2019 Strategic Proposal)	Norton-Osbaldwick overhead line	Poppleton Substation	6km	£159.9m	2027
THO-XC-POP/MON-CYR	Thornton Substation	Poppleton-Monk Fryston overhead line	32km	£424.07m	2028
OSB-XC-POP/MON-CYR	Osbaldwick Substation	Poppleton-Monk Fryston overhead line	19km	£408.9m	2028
2TW-NOR/OSB-XC-POP/MON-CYR	Norton-Osbaldwick overhead line	Poppleton-Monk Fryston overhead line	27km	£244.9m	2027

Reference	'Start'Point	'End' Point	Approximate Connetion Length	Total (Capital and Lifetime) Cost (2019 estimate)	Earliest in-Service Date (EISD)
4ZR-OSB/THO-XC-POP/MON	Osbaldwick-Thornton overhead line	Poppleton-Monk Fryston overhead line	24km	£317.6m	2028

Figure 3.1: 2019 Strategic Options connecting to Poppleton Substation or the XC Route



3.1.9 There were two strategic options which 'start' on the existing Norton-Osbaldwick overhead line (2TW) and 'end' either at Poppleton 275kV substation or on the existing XC/XCP route. At the time of undertaking the 2019 Strategic Proposal work, subject to further detailed studies and identification of any additional constraints, it was considered preferable to connect directly into the existing Poppleton substation as opposed to routeing past it to connect onto the XC route which would require a new substation. Whilst this would require an extension to Poppleton substation and increases the length of the XCP/XC route to be reconductored, it was believed at the time that space for the extension was available at the existing Poppleton substation site and that this option would reduce the amount of new build infrastructure required.

3.1.10 More details of the 2019 Strategic Proposal process are included in the Yorkshire GREEN Project Strategic Proposal Report (2019).

3.2 Key Considerations for the Selection of the 2019 Strategic Proposal

3.2.1 A Strategic Proposal was identified in December 2019 which was to construct a new 400kV double circuit overhead line from a point on the Norton - Osbaldwick overhead line to Poppleton 275kV substation (**Figure 3.2**). This would include a new 6km route (point-to-point distance) and was considered to be the most economical and technically preferred option.

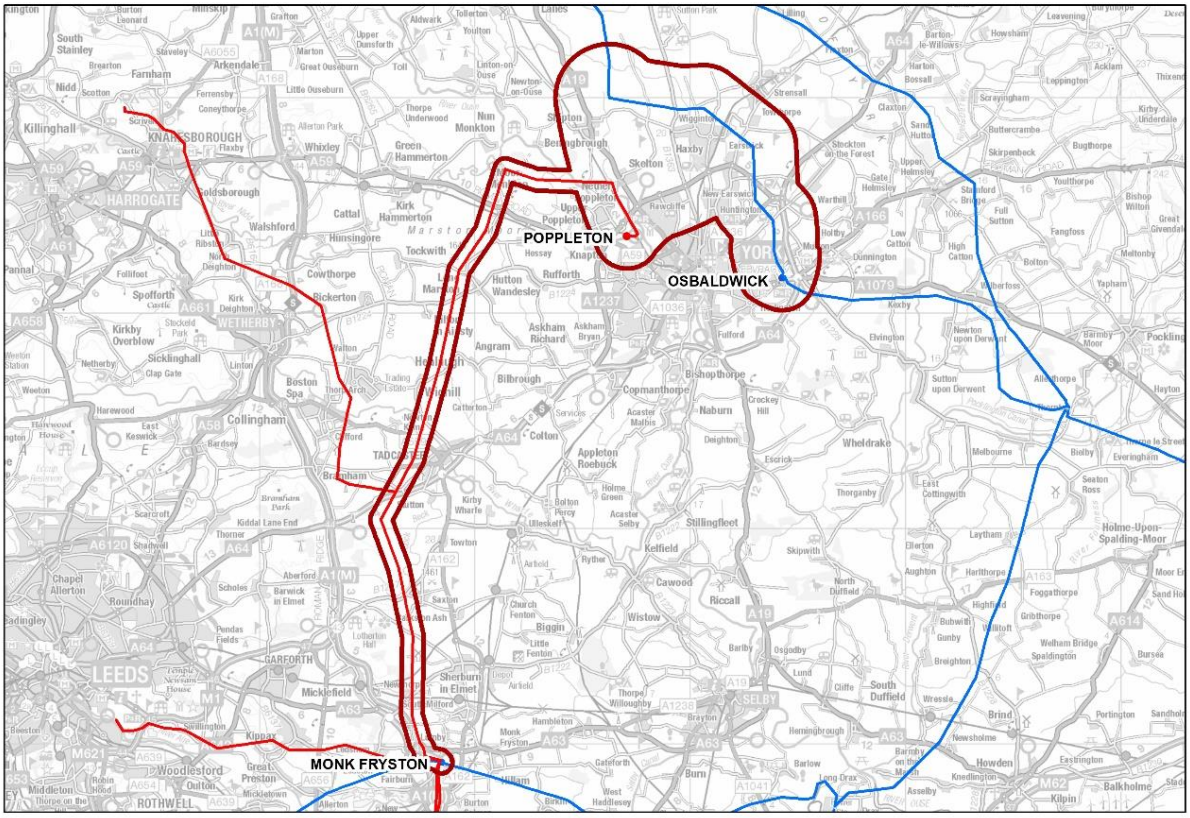
3.2.2 Additionally, in environmental and socio-economic terms, the 2019 Strategic Proposal had comparatively less impact than other new build alternative options

which would be approximately 19km to 40km in length. These works would be coupled with reconductoring the existing 275kV route from Poppleton to Monk Fryston (XCP/XC route) for approximately 38km to increase the capacity of the existing route.

3.2.3 Consequently, one of the key differentiators resulting in the selection of the 2019 Strategic Proposal was the significantly shorter length of the new build 400kV (overhead line) connection.

3.2.4 With a shorter connection it is reasonable to assume (all other things being considered equal) that the cost, impact on land take, and the environmental and socio-economic impact of the 2019 Strategic Proposal would also be minimised as far as practicable, in accordance with Section 9 and Schedule 9 of the Electricity Act 1989.

Figure 3.2: 2019 Strategic Proposal



3.3 Overview of 2019 Strategic Proposal

3.3.1 The 2019 Strategic Proposal comprised a mixture of new-build and upgraded infrastructure including:

- A double tee-off from the existing Norton - Osbaldwick 400kV overhead line (2TW line) and approximately 6km of new build 400kV overhead line to Poppleton substation.
- Installation of two Sealing End Compounds (SECs), and a short section of underground cable to duck one circuit under the existing 2TW 400kV overhead line.

- Extension and reconfiguration of the existing Poppleton 275kV substation to install new inter-bus transformers and convert to a four-switch mesh substation.
- Installation of Power Control Devices along one circuit of the new 400kV overhead line, assumed to be at Poppleton substation.
- Reconductor approximately 38km of the existing Poppleton - Monk Fryston 275kV overhead line (XCP/XC line).
- Construction of two SECs at the junction of the XC and XD 275kV lines at Tadcaster and a short section of underground cable.
- Installation of a circuit breaker and isolator at the existing Osbaldwick substation.

4. KEY DRIVER FOR BACK CHECK AND REVIEW

4.1 Overview

4.1.1 The ESO is required to support and guide the future development of the electricity transmission system in Britain. As part of this role, each year the ESO produces and publishes the FES. These are developed in consultation with industry stakeholders to identify what 'credible futures' might exist, when considering the rate at which Britain may decarbonise, the impact of de-centralisation of supply and how consumer behaviour will impact demand.

4.1.2 The FES scenarios indicate future power requirements and where future connections may occur across the network. Initially based on FES 2019, the power flow from North to South is expected to increase significantly in the next 10 years across all four FES scenarios. The FES showed a requirement to increase the network capability to accommodate this increase in generation. The Transmission Owner (TO) proposes several reinforcements that could solve these boundary issues which are included in the annual NOA process which recommends an option to proceed with.

4.1.3 Five options were entered into NOA 5 (2019/20), and NOA recommended to 'proceed' with 'OPN2' (the 2019 Strategic Proposal). For further information on the NOA process and options, see the Project Need Case.

4.1.4 The generator background and the requirements of the electricity transmission system are dynamic and subject to constant change, meaning that National Grid regularly reviews its decisions in light of the latest information. The potential options to meet the system requirement were identified on the basis of the system background identified in FES 2019. This iteration of FES did not take account of three customer connections at Creyke Beck, two of which were not subject to connection agreements when the FES 2019 were prepared. All three of these customer connections now have a signed connection agreement in place; the Project is necessary as enabling works for these connections.

4.1.5 Sensitivity studies were therefore undertaken in June and July 2020 to assess the impact of these additional connections on the Poppleton – Monk Fryston (XC) route, and if the proposed scope of OPN2 as set out in NOA could accommodate these connections. The sensitivity studies showed that these additional connections could not be accommodated with 1100 Mega Volt Amp (MVA) rating as initially set out in NOA as the additional connections will impact on the power flow.

4.1.6 Further studies were undertaken in June and July 2020 which identified that 1500MVA would be sufficient to accommodate the boundary increase and customer connections. In undertaking further power system studies as part of the development of the Project and based on the proposed Project scope, it was determined that the existing substation equipment at Poppleton and Monk Fryston substations would be overloaded. Therefore, the proposed extension of Poppleton substation and the assumed connection into the existing Monk Fryston substation with no further works required at Monk Fryston substation (as described in the 2019 Strategic Proposal) are therefore not technically feasible solutions.

4.1.7 As a result, there is a requirement to rebuild both substations (at Poppleton and Monk Fryston) to accommodate the new and upgraded circuits proposed. Further detail of the assessment undertaken with regards to how new substations could be delivered,

and National Grid's view that this would require offline substation builds for both Poppleton and Monk Fryston, is provided below.

Poppleton Substation

4.1.8 Poppleton 275kV substation is in the centre of the plot that National Grid owns, shown as the red boundary on **Figure 4.1**.

4.1.9 The existing Poppleton 275kV substation feeds the Distribution Network Operator 33kV substation which supplies the power for a significant portion of the city of York; in addition, Network Rail has connections from the substation for the East Coast Main Line (ECML). Due to these connections, the substation must stay in service while any new works take place. The existing substation would need to be live during any construction works on the site. Due to the substation's location which is tightly constrained by other built and planned development, it is not possible to construct a new 275kV substation within the existing land boundary (or even adjacent to it) as there is not enough space available to accommodate it (the new substation would require an area of approximately 300m x 250m). The site is enclosed on three sides, with industrial buildings to the north and west, and the ECML to the north east. To the south east there is the site of the old sugar beet factories, (shown on **Figure 4.1**), occupied by large settlement ponds. This site has planning permission for 1100 new homes which also limits the ability to construct a new substation in that area (see **Section 4.2** of this report for further details of granted and pending planning permissions).

Figure 4.1: Existing Poppleton 275kV Substation (land ownership in red)

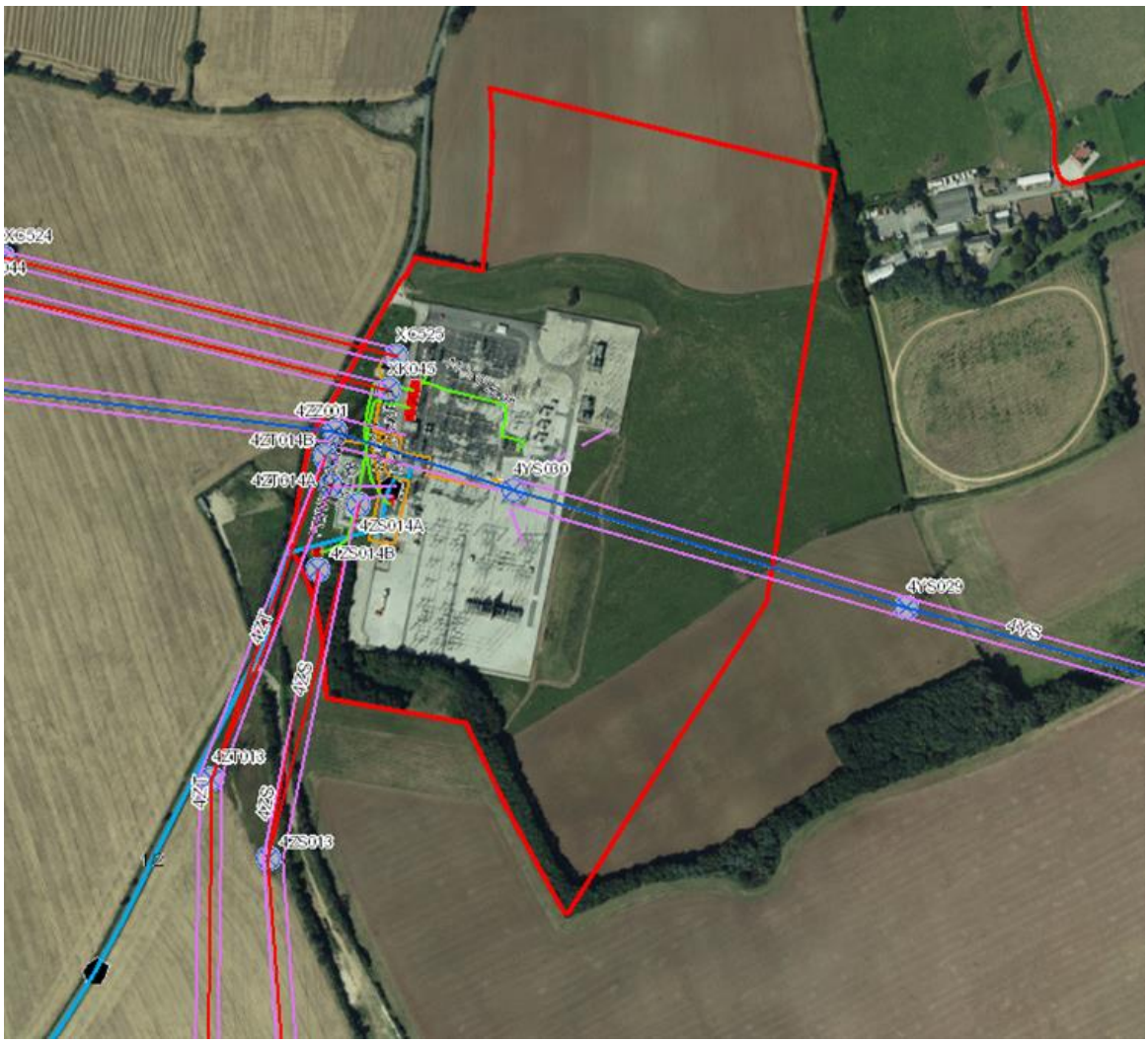
4.1.10 Additional complexities arise on the site given the need to transfer the circuits from the existing substation to the new substation, and the time required to undertake this

to ensure that there is not a loss of supply would mean that the earliest in service date (EISD) required of 2027 could not be achieved.

Monk Fryston Substation

4.1.11 A new substation will also be required at Monk Fryston which is able to be accommodated within the land surrounding Monk Fryston and potentially within National Grid's existing land boundary (**Figure 4.2**).

Figure 4.2: Existing Monk Fryston 275kV/400kV Substation (land ownership in red)



4.1.12 **Based on the technical information provided above, the 2019 Strategic Proposal, OPN2, is no longer technically feasible in the form originally envisaged**. This work consequently triggered the need to identify a new Strategic Proposal via the BCR process; further details on the BCR process are provided at **Section 5** of this report.

Other Considerations

4.1.13 As a result of the Options Identification & Selection work undertaken for the 2019 Strategic Proposal, additional information was established in relation to details regarding the nature and location of strategic development plan allocations and

planning applications. This additional information is also relevant to the BCR process (see **Section 5** of this report) and the BCR appraisal (see **Section 6** of this report).

4.1.14 The key findings relate to the allocation of land immediately south of the existing Poppleton substation for housing in the adopted York Local Plan (2005) and the emerging York Local Plan for strategic housing. Additionally, two planning permissions have been granted and one planning application is pending (awaiting decision) at land surrounding the existing Poppleton substation:

- 1,100 dwellings and mixed community use development on site of former Sugar Beet Factory and Manor School (planning application reference: 15/00524; planning permission granted);
- 271 dwellings on land north of Boroughbridge Road (planning application reference: 14/02979 and 20/00774; planning permission granted); and
- 60 affordable dwellings on land south of Boroughbridge Road (planning application reference: 20/00752; awaiting decision).

4.1.15 The presence of the planning permissions (and pending planning application) detailed above covering a wide geographical area in what is a physically constrained area around the existing Poppleton substation would add a significant obstacle (with respect to routeing the 400kV connection and siting the substation) to the use of this land as part of any new substation development at Poppleton.

5. BACK CHECK AND REVIEW PROCESS

5.1 Introduction

Overview

5.1.1 In light of the new technical information (see **Section 4.1** of this report) and the increased rating requirement resulting in a change to the Project scope, this BCR reviews the 2019 Strategic Proposal and the 2019 shortlisted strategic options (from the 2019 Strategic Proposal process) to ascertain the extent to which they would meet the new rating requirement and therefore be suitable for further options appraisal as part of this BCR process.

5.1.2 This review has the potential for the 2019 Strategic Proposal and the 2019 shortlisted strategic options to:

- be amended and then either be taken forward for further options appraisal as part of this BCR process or be assessed as unsuitable for further options appraisal; and
- remain in their 2019 form and then either be taken forward for further options appraisal as part of this BCR process or be assessed as unsuitable for further options appraisal.

5.1.3 In addition, there is the potential for new strategic options to be identified and then either be taken forward for further options appraisal as part of this BCR process or be assessed as unsuitable for further options appraisal.

Key Criteria

5.1.4 As part of this review, the same key criteria (see **Table 5.1** below) which drove the decision-making process during the 2019 Strategic Proposal process remain valid during this BCR process. The key criteria has been used during this review to assess whether or not the 2019 Strategic Proposal and the 2019 shortlisted strategic options are to be taken forward for further options appraisal as part of this BCR process.

Table 5.1: Key Criteria

Criteria	Background
Ability to meet the earliest in-service date (EISD) of 2027	A key driver for this Project is to relieve boundary constraints and unlock the potential of other key projects including Eastern Link, Continental Interconnector, and Hornsea SuperConnection. The Eastern Link is due to connect in 2027, and without this Project in place, the benefits of the Eastern Link project cannot be realised; this would result in significant annual boundary constraint costs.[1]

[1] Boundary constraint costs are considered to be significant where this may affect National Grid's ability to perform their statutory duties to develop and maintain an efficient, co-ordinated and economical system of electricity transmission.

Criteria	Background
	As a result of this, a key driver for the Project is for it to be in place and in service by 2027. Further information on the driver behind the desired EISD of 2027 is provided in the paragraph after **Table 5.1**.
Ability to minimise the length of the new 400kV connection	A key driver for this Project is to minimise the length of the new 400kV connection. In doing so, the number of environmental and social receptors impacted by the 400kV connection is reduced which helps to minimise any potential environmental effects and land take.
Ability to minimise the cost	A key driver for this Project is to select the most economical option, based on the capital and lifetime costs of the option.

Ability to Meet the EISD of 2027 – Further Information

5.1.5 As demonstrated in **Section 5.2**, **Section 5.3** and **Appendix A** of this report, the EISD varies across the different strategic options, ranging from 2026 to 2029. NOA (2019/20) contained options that had EISD dates in 2026, 2027 and 2028, whilst previous strategic options from the 2019 Strategic Proposal process and reviewed (and rescoped and costed where applicable) as part of this BCR process show strategic options with EISD dates of 2028 and 2029.

5.1.6 In NOA (2019/20), options were provided that had an EISD of 2026 and following the results of NOA, it demonstrated that these strategic options provided no additional benefit and were not the most economical options; NOA showed that the extra spend required to deliver in 2026 did not outweigh the constraint savings, hence the signal not to proceed. There were also options entered into NOA that had a delivery date of 2028; these were 400kV options which could provide more capability than a 275kV option. These 400kV options did not receive a proceed signal as they are not deemed the most economical due to the additional constraint costs incurred by delaying the EISD by 1 year.

5.1.7 The option with an EISD of 2027 was given the proceed signal as this is deemed to be the most efficient option, with a balance of capital cost and constraint costs.

5.1.8 In addition to the NOA outputs, National Grid has three signed connection offers that require a connection to be in service by 2027, or at least two of these connections would not be able to connect to the network, occurring additional constraint costs not shown by NOA.

5.1.9 Those strategic options reviewed as part of this BCR process with an EISD of 2029 would incur 2 years of boundary constraint costs and not allow those customer connections onto the network for two years. The EISD of 2027 is critical to a Strategic Proposal being selected as the most economical, as well as enabling the contracted customer connections to connect to the network.

5.2 Review of 2019 Strategic Proposal

Overview

5.2.1 The 2019 Strategic Proposal has been taken as a starting point, with further technical studies undertaken to ascertain the extent to which the technical difficulties and impracticalities for Poppleton 275kV substation and Monk Fryston 275kV/400kV substation (see **Section 4.1** of this report) could be resolved and alternative solutions implemented.

5.2.2 The identified technical difficulties relating to Poppleton and Monk Fryston substations are overcome by the following substation works:

- construction of a new 275kV substation or 400kV substation at Monk Fryston; and
- construction of a new 275kV or 400kV substation at 'Poppleton South' (in close proximity to the existing Poppleton 275kV substation), or, construction of a new 275kV or 400kV substation at 'York North' (in close proximity to the 'East to West' (Skelton to Moor Monkton) section of the existing 275kV XCP overhead line).

5.2.3 There are two separate substation solutions for Monk Fryston, a re-build of the 275kV substation, and a new 400kV substation (constructed offline). The existing 275kV XC overhead line currently terminates into the existing Monk Fryston 275kV substation, however the existing equipment cannot accommodate the required rating, therefore a rebuild would be required. There are substantial works required to rebuild the existing 275kV substation and potentially up to 9 circuits that would be required to be transferred to the new substation which would require substantial outages and would not be in service for 2027. Another solution at Monk Fryston is to build an offline 400kV substation and connect the new 400kV substation to the existing 400kV substation; this would require fewer circuits to be transferred into the new substation.

5.2.4 The 'York North' substation (alternative to 'Poppleton South') has been derived due to the presence of physical constraints (at Poppleton South), together with the now known planning constraints (consisting of strategic housing local plan allocations and granted planning permissions, as outlined in **Section 4.2** of this report), in and around the Poppleton area with the potential to result in significantly greater difficulties in completing a 400kV connection to Poppleton. The 'York North' option would ensure the length of the new 400kV connection is minimised (to minimise environmental effects and land take).

5.2.5 One of the key physical constraints in the Poppleton area is the presence of the existing 275kV XCP overhead line as it heads south to Poppleton 275kV substation from Skelton for approximately 4km. The XCP overhead line in this location navigates through a physically constrained environment consisting of built development, a railway line, the River Ouse, woodland, and Clifton Ings and Rawcliffe Meadows Site of Special Scientific Interest (SSSI). Therefore, the 2019 Strategic Proposal could also be revised whereby this section of the existing 275kV XCP overhead line is realigned to connect to 'Poppleton South' from the west, freeing up the current alignment south of Skelton which would then be adopted by the new 400kV overhead line connection into 'Poppleton South'.

5.2.6 After consideration of the above solutions, six variant strategic options have been identified, summarised below and shown at **Figure 5.1, Figure 5.2 and Figure 5.3**:

- Variant strategic option 1A: New 275kV or 400kV substation at 'York North', and a new 275kV substation at Monk Fryston.
- Variant strategic option 1B: New 275kV or 400kV substation at 'York North', and a new 400kV substation at Monk Fryston.
- Variant strategic option 2A: New 275kV or 400kV substation at 'Poppleton South', and a new 275kV substation at Monk Fryston.
- Variant strategic option 2B: New 275kV or 400kV substation at 'Poppleton South', and a new 400kV substation at Monk Fryston.
- Variant strategic option 3A: New 275kV or 400kV substation at 'Poppleton South', the partial realignment of the existing XC/XCP overhead line, and a new 275kV substation at Monk Fryston.
- Variant strategic option 3B: New 275kV or 400kV substation at 'Poppleton South', the partial realignment of the existing XC/XCP overhead line, and a new 400kV substation at Monk Fryston.

Figure 5.1: Variant Strategic Option 1A/1B

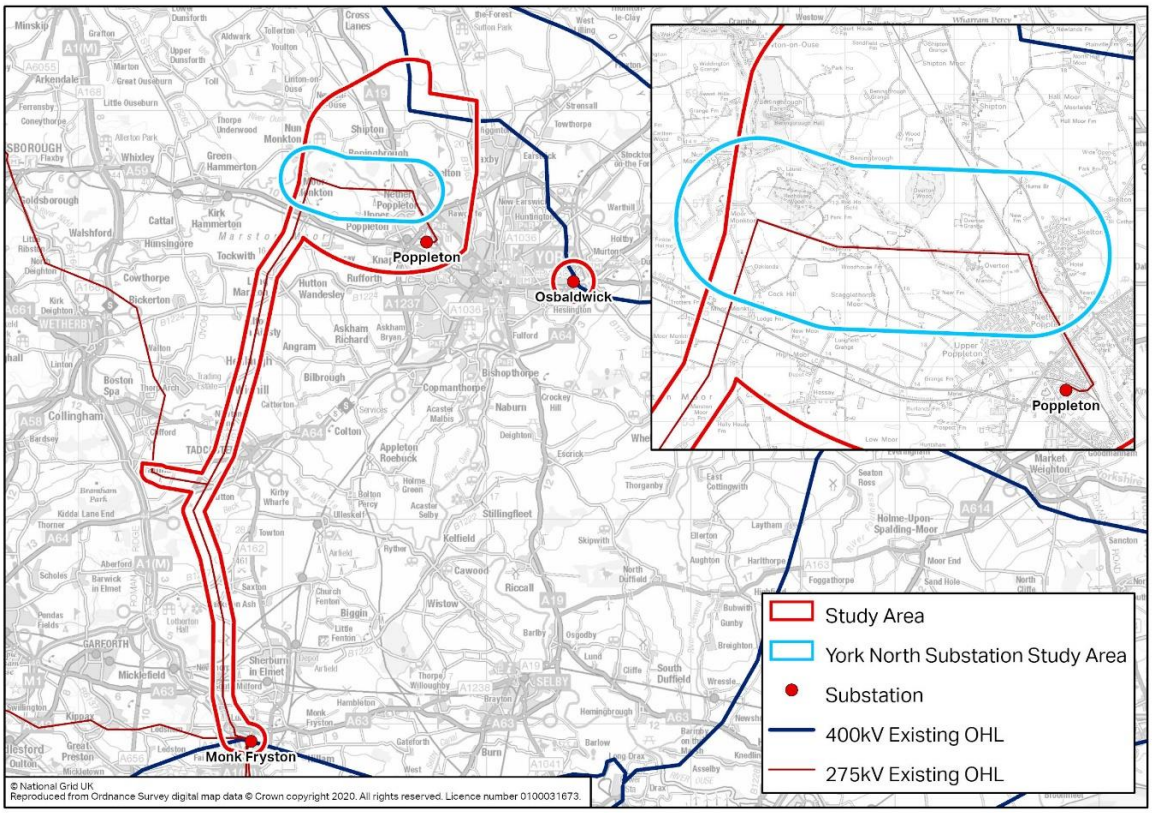


Figure 5.2: Variant Strategic Option 2A/2B

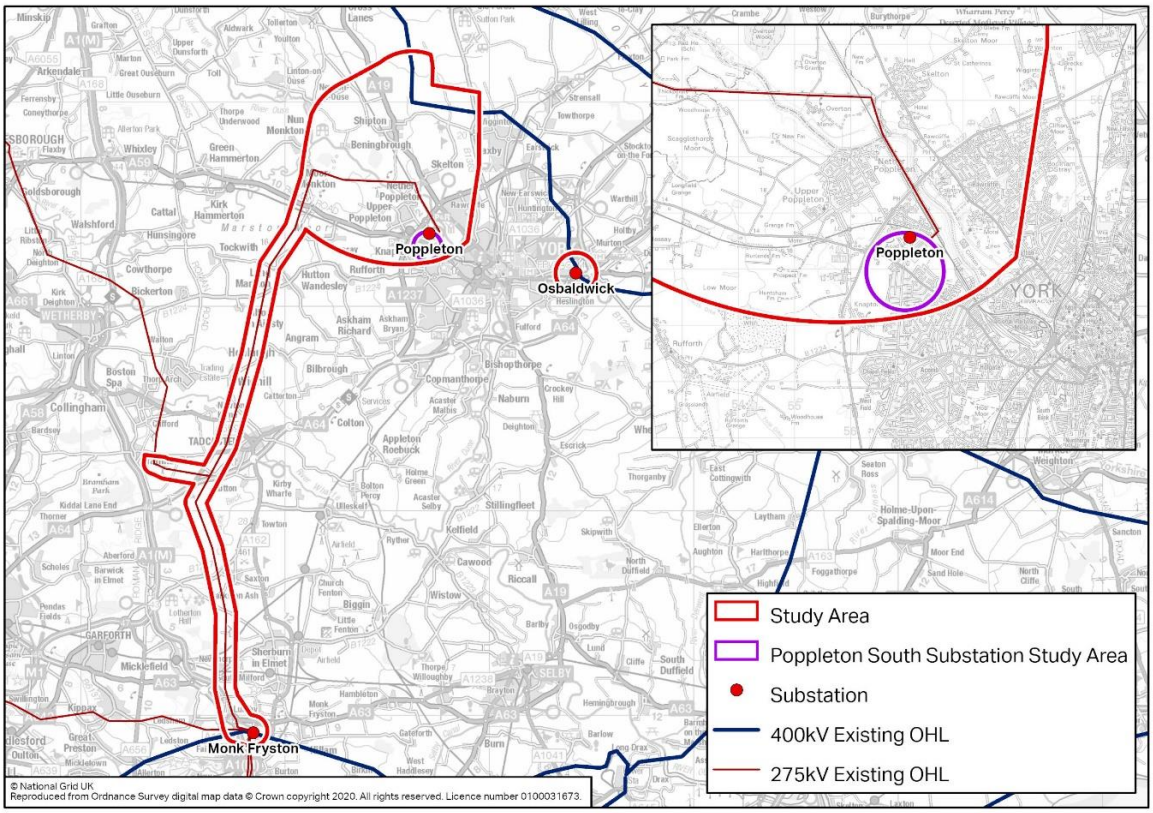
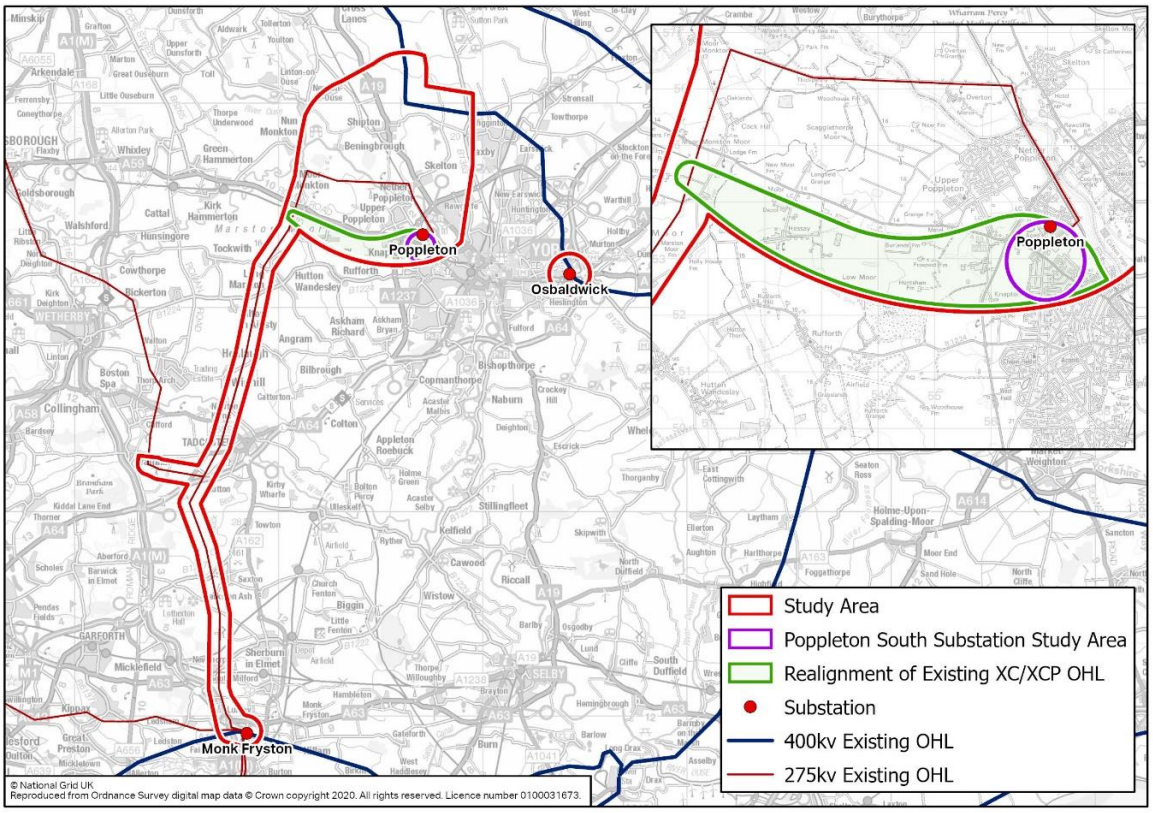


Figure 5.3: Variant Strategic Option 3A/3B



5.2.7 During the 2019 Strategic Proposal process, for each strategic option, three different technology options (OHL, UGC, and GIL) were considered for the new 400kV connection. The Yorkshire GREEN Project Strategic Proposal Report (2019) stated *'during the appraisal process, National Grid updated its SF_6 policy to minimise the use of SF_6. GIL technology is currently only available with the use of this gas, and while a clean air alternative is potentially going to be developed, it is unlikely that it would be available in the project's timescales. GIL options would have a potentially greater climate change impact than alternative technologies and are therefore not considered appropriate for this project and have been discounted'.* Therefore, only OHL and UGC technology options will be considered as part of the BCR options appraisal process; GIL technology options have been discounted.

5.2.8 For all six variant strategic options (and consistent with the 2019 Strategic Proposal), the existing 275kV XC/XCP route would be reconductored (at 275kV) from either 'Poppleton South' or 'York North' to a new substation at Monk Fryston to increase the rating of the existing route.

Consideration of the Six Variant Strategic Options and the Key Criteria

5.2.9 A summary of the six variant strategic options and consideration of the key criteria is provided in **Table 5.2** below and the succeeding paragraphs.

Table 5.2: Six Variant Strategic Options and Consideration of Key Criteria

Variant Strategic Option	**Technology**	**2020 EISD**	**Approximate Connection Length (km)**	**2020 Total (Capital and Lifetime) Cost (£m)**	**Are boundary constraint costs applicable** (in addition to 2020 Total Cost)? [2]
Variant strategic option 1A – new 275kV substation at Monk Fryston, new 275kV or 400kV substation at 'York North', new 7.5km 400kV connection	OHL	2028	7.5	401.06 – 430.19	Yes – significant boundary constraint costs to be added
	UGC	2027	7.5	524.16 – 624.84	No boundary constraint cost

[2] Boundary constraint costs are considered to be significant where this may affect National Grid's ability to perform their statutory duties to develop and maintain an efficient, co-ordinated and economical system of electricity transmission.

Variant Strategic Option	Technology	2020 EISD	Approximate Connection Length (km)	2020 Total (Capital and Lifetime) Cost (£m)	Are boundary constraint costs applicable (in addition to 2020 Total Cost)? [2]
Variant strategic option 1B - new offline 400kV substation at Monk Fryston, new 275kV or 400kV substation at 'York North', new 7.5km 400kV connection	OHL	2027	7.5	401.49 – 430.72	No boundary constraint cost
	UGC	2026	7.5	524.64 – 627.93	No boundary constraint cost
Variant strategic option 2A - new 275kV substation at Monk Fryston, new 275kV or 400kV substation at 'Poppleton South', new 7.5km 400kV connection	OHL	2028	7.5	427.60	Yes – significant boundary constraint costs to be added
	UGC	2027	7.5	562.66	No boundary constraint cost
Variant strategic option 2B- new offline 400kV substation at Monk Fryston, new 275kV or 400kV substation at	OHL	2027	7.5	407.71	No boundary constraint cost
	UGC	2026	7.5	562.54	No boundary constraint cost

Variant Strategic Option	Technology	2020 EISD	Approximate Connection Length (km)	2020 Total (Capital and Lifetime) Cost (£m)	Are boundary constraint costs applicable (in addition to 2020 Total Cost)? [2]
'Poppleton South', new 7.5km 400kV connection					
Variant strategic option 3A - new 275kV substation at Monk Fryston, new 275kV or 400kV substation at 'Poppleton South', new 7.5km 400kV connection and partial realignment of the existing 275kV XC/XCP overhead line between Moor Monkton Grange and the existing Poppleton 275kV substation.	OHL	2028	7.5	431.81	Yes – significant boundary constraint costs to be added
	UGC	2027	7.5	551.78	No boundary constraint cost
Variant strategic option 3B - new offline 400kV substation at Monk Fryston, new 275kV or 400kV substation at	OHL	2027	7.5	432.15	No boundary constraint cost
	UGC	2026	7.5	551.97	No boundary

Variant Strategic Option	Technology	2020 EISD	Approximate Connection Length (km)	2020 Total (Capital and Lifetime) Cost (£m)	Are boundary constraint costs applicable (in addition to 2020 Total Cost)? [2]
'Poppleton South', new 7.5km 400kV connection and partial realignment of the existing 275kV XC/XCP overhead line between Moor Monkton Grange and the existing Poppleton 275kV substation.					constraint cost

5.2.10 Variant strategic option 1A and 1B have a cost range provided, whereas the others have a single cost for each one. This is because variant strategic option 1A and 1B have a much greater degree of flexibility with regards to the location of the 'York North' substation (to be sited within 1.5km of the 'East to West' (Skelton to Moor Monkton) section of the existing 275kV XCP overhead line) which subsequently provides different scenarios (and costs) for:

- the length of the new 400kV connection;
- the length of 275kV reconductoring required of the existing 275kV XC/XCP overhead line; and
- the arrangement of the 275kV and 400kV connections between the 'York North' substation and the existing 275kV XC/XCP overhead line.

5.2.11 With the exception of variant strategic option 1A, 2A, and 3A (All OHL), all variant strategic options would meet the EISD of 2027. Despite the longer EISD (2028) for variant strategic option 1A, 2A and 3A (all OHL), they are almost identical in scope to the remaining variant strategic options, have lower costs, and have the same minimised connection length.

5.2.12 All six variant strategic options have an assumed point to point connection length of approximately 7.5km; this is compliant with the strong preference to minimise the

length of the new 400kV connection which will also subsequently minimise environmental effects and land take.

5.2.13 The total (capital and lifetime) cost of each of the six variant strategic options ranges between:

All Technology Options

- £401.06m and £627.93m (excluding boundary constraint costs).

OHL Technology Options

- £401.06m and £432.15m (excluding boundary constraint costs).

UGC Technology Options

- £524.16m and 627.93m (UGC technology options) (no boundary constraint costs).

5.2.14 Whilst the total costs above represent a clear cost increase compared to the 2019 Strategic Proposal, it is expected that all of the other strategic options from 2019 would also increase in total cost due to the additional information now available on the other substations (and other components) and boundary constraint costs; this is explained further in **Section 5.3** of this report.

Variant Strategic Options to be Taken Forward for BCR Options Appraisal

5.2.15 After consideration of the key criteria set out in **Section 5.1** of this report, all six variant strategic options (revised from the 2019 Strategic Proposal and including OHL and UGC technologies) are considered suitable to be taken forward for BCR options appraisal (see **Table 5.4, Table 5.5** and **Section 6** of this report).

5.3 Review of Other 2019 Strategic Options

Overview

5.3.1 Due to the further power system studies, coupled with a greater understanding of the other substations (based on initial studies undertaken by other projects), it is possible to review and update (re-scope) the other shortlisted strategic options (2019) to ensure they have a consistent level of detail and consideration as the six variant strategic options identified in **Section 5.2** of this report.

Strategic Options no longer Applicable

5.3.2 Prior to the re-scoping exercise, a separate exercise has been undertaken to determine which of the other 2019 shortlisted strategic options (totalling 105 options, including all the sub-options that allowed for the upgrading of existing infrastructure), were deemed to be no longer applicable to the BCR process (see also **Appendix A** of this report). The following other shortlisted strategic options have not been considered any further:

- 49 strategic options (coloured grey in Appendix A) were each deemed to be no longer applicable for one of the following reasons:

  - Superseded by previous review and amendment resulting in the six variant strategic options identified in **Section 5.2** of this report.
  - GIL is no longer being considered as a technology option (also see **Section 5.2** of this report).
  - No Project Need Case for 400kV uprating works (to the existing 275kV XC and XCP overhead lines) based on the FES scenarios and the NOA outputs as it has been demonstrated that reconductoring at 275kV would be sufficient to meet the boundary transfer requirements. Uprating would result in an EISD of 2027 and be significantly more expensive as it is likely to necessitate the rebuilding of the lines.

- A further 28 strategic options (coloured red in **Appendix A**) were considered against the key criteria and were not considered suitable to be taken forward for BCR options appraisal for the following reasons:
  - Their 2019 costings are already more expensive (an increase of between £132.34m and £588.66m) than the most expensive of the six variant strategic options (with 2020 costs). Their cost would only increase further should the additional works now known to be required at other substations (see below for further detail) be used to re-scope and re-cost these issues to 2020/2021 prices.
  - They all have an EISD of 2028 and therefore would not meet the desired 2027 EISD. In addition, this would incur additional boundary constraint costs which would be added to the costings set out in the bullet point above.
  - They would each require a new 400kV connection length of between 19.47km and 39.51km with an average length of 29.32km); this is significantly longer (between 2.5 and 5 times longer) than the six variant strategic options.

5.3.3 The above process is summarised at **Appendix A** of this report and resulted in 28 remaining strategic options (coloured orange in **Appendix A**) from the 2019 shortlist of 105 strategic options. All 28 of the remaining strategic options are for an overhead line 400kV connection and range in length between 19.47km and 39.51km.

Re-Scoping and Additional Substation Information (and other components)

5.3.4 These 28 remaining strategic options were then re-scoped (based on the additional substation (and other components) information – see below) and re-costed to allow a fair review. The re-costing exercise has been undertaken using 2020/2021 prices (to match the costing exercise undertaken for the six variant strategic options). It should be noted that the costing exercise as part of the 2019 Strategic Proposal process was undertaken using 2019/2020 prices. The re-scoping and re-costing exercise has been undertaken to enable the 28 remaining strategic options to be considered against the key criteria set out under **Section 5.1** of this report.

5.3.5 A key assumption made during the 2019 Strategic Proposal process was that it was possible for all existing substations to accommodate a two-bay extension; all options were costed in 2019 on this basis. Following further studies, that assumption is no longer valid, and the following substations would instead require a rebuild (where technical issues with the fault level are likely) or a new substation build (where it is likely there would be no space available to accommodate a two-bay extension):

- Osbaldwick, Thornton, Keadby and Creyke Beck – a full rebuild of the substation, assumed to be on adjacent land.
- Drax, Eggborough – a new substation (and connection back to the existing substation) assumed to be approximately 3km from the existing substation.
- Ferrybridge – a new substation (and connection back to the existing substation) assumed to be approximately 1km from the existing substation.

5.3.6 Of the 28 remaining strategic options, 15 require two new substations, 11 require one new substation and two require no new substation works (just power control devices and cable sealing ends).

5.3.7 The following additional works have also been included in the re-costing exercise where applicable:

- Sections of underground cable to enable the existing circuits that are connected to the substations above to be transferred to the new substations.
- Power control devices required on the new 400kV connection.
- Strategic options that utilise the existing XC/XCP route would require steel work replacement on that overhead line.
- Strategic options that terminated into an existing 275kV substation require four SGTs (previously two).
- SECs and cable sealing ends.
- Temporary overhead line diversions.

5.3.8 Further details as to the extent to which each of the 28 remaining strategic options would require additional works is provided at **Appendix A** of this report.

Consideration of the 28 Remaining Strategic Options and the Key Criteria

5.3.9 Provided below at **Table 5.3** and the succeeding paragraphs is a summary extract from **Appendix A** of the 28 remaining strategic options as well as further information regarding the consideration of the 28 remaining strategic options and the key criteria as described at **Section 5.1** of this report. In acknowledgement that all 28 remaining strategic options are all OHL technology (none are for UGC), reference is made in the subsequent analysis, where relevant, to the technology (OHL or UGC) of the six variant strategic options to enable a fair comparison to be made.

Table 5.3: 28 Remaining Strategic Options and Consideration of Key Criteria

Ref.	Option Name	2020 Total (Capital and Lifetime) Cost (£m)	2020 Total Cost plus Boundary Constraint Cost (£m)[3]	2020 EISD	Approximate Connection Length	Take Forward for BCR Options Appraisal (Consideration of key Criteria)?
13	4ZR-OSB_THO-4VJ-DRA_EGG-CYR	283.92	Two years of significant boundary constraint costs to be added	2029	25.49	These 7 of the 28 remaining strategic options are either within the cost range or cheaper (a decrease of between £3.27m and 43.57m) than the cheapest of the six variant strategic options (OHL only). They all have an EISD of 2029 (two years beyond the desired date), and all have a connection length between 24.03km and 31.10km (with an average length of 27.27km, 3.6 times longer than the six variant strategic
16	4ZR-OSB_THO-4YS-MON_EGG-CYR	296.60	Two years of significant boundary constraint costs to be added	2029	28.98	
52	OSB-4VJ-DRA_EGG-CYR	318.55	Two years of significant boundary constraint costs to be added	2029	24.88	
55	OSB-4YS-MON_EGG-CYR	322.17	Two years of significant boundary constraint costs to be added	2029	26.33	
28	4ZR-OSB_THO	324.22	Two years of	2029	31.1	

[3] Boundary constraint costs are considered to be significant where this may affect National Grid's ability to perform their statutory duties to develop and maintain an efficient, co-ordinated and economical system of electricity transmission.

Ref.	Option Name	2020 Total (Capital and Lifetime) Cost (£m)	2020 Total Cost plus Boundary Constraint Cost (£m)[3]	2020 EISD	Approximate Connection Length	Take Forward for BCR Options Appraisal (Consideration of key Criteria)?
	-MON-CYR		significant boundary constraint costs to be added			options). Whilst the five strategic options that have cheaper costs than the six variant strategic options provide a clear cost benefit, the cost benefit is not considered to be so substantial as to outweigh the disbenefits associated with the substantially longer EISD and connection length. Therefore, after consideration of the key criteria set out in **Section 5.1** of this report, all 7 of the 28 remaining strategic options are considered unsuitable to be taken forward for BCR options appraisal.
19	4ZR-OSB_THO-DRA-CYR	338.89	Two years of significant boundary constraint costs to be added	2029	24.03	
79	THO-4YS-MON_EGG-CYR	360.63	Two years of significant boundary constraint costs to be added	2029	30.11	
76	THO-4VJ-DRA_EGG-CYR	397.73	Two years of significant boundary constraint	2029	24.31	These 21 of the 28 remaining strategic options are more expensive

Ref.	Option Name	2020 Total (Capital and Lifetime) Cost (£m)	2020 Total Cost plus Boundary Constraint Cost (£m)[3]	2020 EISD	Approximate Connection Length	Take Forward for BCR Options Appraisal (Consideration of key Criteria)?
			costs to be added			than the most expensive of the six variant strategic options (OHL only), they all have an EISD of 2029 (two years beyond the desired date), and all have a connection length between 19.47km and 39.51km (with an average length of 29.99km, four times longer than the six variant strategic options). Therefore, after consideration of the key criteria set out in **Section 5.1** of this report, all 21 of the 28 remaining strategic options are considered unsuitable to be taken forward for BCR options appraisal.
67	OSB-MON-CYR	407.15	Two years of significant boundary constraint costs to be added	2029	27.49	
37	4ZR-THO_CRE-DRA-CYR	416.75	Two years of significant boundary constraint costs to be added	2029	27.33	
22	4ZR-OSB_THO-EGG-CYR	424.00	Two years of significant boundary constraint costs to be added	2029	29.46	
49	CRE-ZDA-KEA_THM-CYR	433.57	Two years of significant boundary constraint costs to be added	2029	39.51	
103	THO-ZDA-KEA_THM-CYR	482.86	Two years of significant boundary constraint costs to be added	2029	32.81	
31	4ZR-OSB_THO	492.85	Two years of	2029	24.27	

Ref.	Option Name	2020 Total (Capital and Lifetime) Cost (£m)	2020 Total Cost plus Boundary Constraint Cost (£m)[3]	2020 EISD	Approximate Connection Length	Take Forward for BCR Options Appraisal (Consideration of key Criteria)?
	-XC-POP_MON		significant boundary constraint costs to be added			
94	THO-MON-CYR	512.12	Two years of significant boundary constraint costs to be added	2029	33.37	
58	OSB-DRA-CYR	521.10	Two years of significant boundary constraint costs to be added	2029	24.62	
82	THO-DRA-CYR	521.64	Two years of significant boundary constraint costs to be added	2029	21.44	
61	OSB-EGG-CYR	531.97	Two years of significant boundary constraint costs to be added	2029	27.99	
85	THO-EGG-CYR	545.99	Two years of significant boundary constraint costs to be added	2029	29.04	

Ref.	Option Name	2020 Total (Capital and Lifetime) Cost (£m)	2020 Total Cost plus Boundary Constraint Cost (£m)[3]	2020 EISD	Approximate Connection Length	Take Forward for BCR Options Appraisal (Consideration of key Criteria)?
40	4ZR-THO_CRE-KEA-CYR	552.85	Two years of significant boundary constraint costs to be added	2029	28.93	
43	CRE-DRA-CYR	557.64	Two years of significant boundary constraint costs to be added	2029	38.72	
25	4ZR-OSB_THO-FER-CYR	558.42	Two years of significant boundary constraint costs to be added	2029	35.04	
70	OSB-XC-POP_MON-CYR	576.13	Two years of significant boundary constraint costs to be added	2029	19.47	
97	THO-XC-POP_MON-CYR	643.27	Two years of significant boundary constraint costs to be added	2029	31.98	
46	CRE-KEA-CYR	662.12	Two years of significant boundary	2029	31.86	

Ref.	Option Name	2020 Total (Capital and Lifetime) Cost (£m)	2020 Total Cost plus Boundary Constraint Cost (£m)[3]	2020 EISD	Approximate Connection Length	Take Forward for BCR Options Appraisal (Consideration of key Criteria)?
			constraint costs to be added			
64	OSB-FER-CYR	664.14	Two years of significant boundary constraint costs to be added	2029	31.76	
91	THO-KEA-CYR	729.22	Two years of significant boundary constraint costs to be added	2029	33.92	
88	THO-FER-CYR	738.42	Two years of significant boundary constraint costs to be added	2029	36.67	

Ability to Minimise the Cost

5.3.10 The 28 remaining strategic options have a total (capital and lifetime) 2020 cost (excluding boundary constraint costs) broken down as follows:

- The total cost of each of the 28 remaining strategic options is between £283.92m and £738.42m (compared to between £401.06m and £432.15m for the six variant strategic options (OHL only) and between £524.16m and £627.93m for the six variant strategic options (UGC only)).
- Five of the 28 remaining strategic options are more expensive (an increase of between £15.34m and £110.49m) than the most expensive of the six variant strategic options (OHL and UGC).
- 17 (including the five above) of the 28 remaining strategic options are more expensive (an increase of between £1.42m and £306.27m) than the most expensive of the six variant strategic options (OHL only).

- Three of the 28 remaining strategic options have costs that are comparable (within the cost range) with the six variant strategic options (OHL only).
- Eight of the 28 remaining strategic options are cheaper (a decrease of between £3.33m and £117.14m) than the cheapest of the six variant strategic options (OHL only); this includes the two strategic options that require no new substation works (Ref. 13 and Ref. 16 in **Table 5.3** above).

5.3.11 All 28 remaining strategic options have a 2029 EISD (see further information below with respect to EISD); each would therefore incur two years of significant boundary constraint costs[4] and would result in:

- Eight of the 28 remaining strategic options being more expensive than the most expensive of the six variant strategic options (OHL and UGC).
- 21 (including the eight above) of the 28 remaining strategic options being more expensive than the most expensive of the six variant strategic options (OHL only).
- Two of the 28 remaining strategic options with costs that are comparable (within the cost range) with the six variant strategic options (OHL only).
- Five of the 28 remaining strategic options that are cheaper than the cheapest of the six variant strategic options (OHL only); this includes the two strategic options that require no new substation works (Ref. 13 and Ref. 16 in **Table 5.3** above).

Ability to Meet Earliest in-Service Date of 2027

5.3.12 All 28 of the remaining strategic options previously (in 2019) had an EISD of 2028; all 28 now have a revised (in 2020) EISD date of 2029, missing the desired EISD by two years.

5.3.13 As set out in **Section 1** of this report, National Grid undertakes the BCR process at key project milestones to ensure that the assumptions in relation to the Strategic Proposal selected remain valid, and/or where potentially material changes to the Project may arise. In addition, as set out in **Section 4.1** of this report, the generator background and the requirements of electricity transmission system are dynamic and subject to constant change, meaning that National Grid is required to review its decisions in light of the latest information. It is therefore not uncommon for other shortlisted strategic options (either in their original form or revised) to have EISD dates later than originally envisaged due to the fact that no development work has been undertaken on those options whilst the Strategic Proposal has developed through the Options Identification & Selection process. This places additional emphasis on the importance of robust decision making throughout the BCR process and in the selection of a new Strategic Proposal.

Ability to Minimise Connection Length (and Minimise Environmental Effects and Land Take)

5.3.14 The 28 remaining strategic options range in length between 19.47km and 39.51km with an average length of 29.32km). 26 of the remaining strategic options are more

[4] Boundary constraint costs are considered to be significant where this may affect National Grid's ability to perform their statutory duties to develop and maintain an efficient, co-ordinated and economical system of electricity transmission.

than three times longer than the six variant strategic options set out in **Section 5.2** of this report, whilst 11 (of the 26) are more than four times longer than the six variant strategic options. The two shortest of the remaining strategic options have connection lengths of 19.47km and 21.44km, which is more than 2.5 times longer than the six variant strategic options.

5.3.15 When compared to the six variant strategic options, the 28 remaining strategic options are not considered to meet (as effectively) one of the key Project drivers to minimise the length of the new 400kV connection which (all other things being considered equal) would help to minimise any potential environmental effects and land take.

Remaining Strategic Options to be Taken Forward for BCR Options Appraisal

5.3.16 Taking the boundary constraint costs into consideration, 21 of the 28 remaining strategic options are more expensive than the most expensive of the six variant strategic options (OHL only), they all have an EISD of 2029 (two years beyond the desired date), and all have a connection length between 19.47km and 39.51km (with an average length of 29.99km, four times longer than the six variant strategic options). Therefore, after consideration of the key criteria set out in **Section 5.1** of this report, all 21 of the 28 remaining strategic options are considered unsuitable to be taken forward for BCR options appraisal.

5.3.17 Again, taking the boundary constraint costs into consideration, the remaining 7 (of the 28 remaining) strategic options are either within the cost range or cheaper than the cheapest of the six variant strategic options (OHL only). They all have an EISD of 2029 (two years beyond the desired date), and all have a connection length between 24.03km and 31.10km (with an average length of 27.27km, 3.6 times longer than the six variant strategic options). Whilst the five strategic options that have cheaper costs than the six variant strategic options provide a clear cost benefit, the cost benefit is not considered to be so substantial as to outweigh the disbenefits associated with the substantially longer EISD and connection length. Therefore, after consideration of the key criteria set out in **Section 5.1** of this report, all the remaining 7 (of the 28 remaining) strategic options are considered unsuitable to be taken forward for BCR options appraisal.

Table 5.4: Variant Strategic Options to be Appraised for Strategic Proposal Back Check and Review (Component Led Version)

Project Component	Applicable to Variant Strategic Option?					
	Option 1A	Option 1B	Option 2A	Option 2B	Option 3A	Option 3B
A double tee off (requiring 2 x SECs and a section of underground cable) would be constructed from the XC 275kV overhead line to the XD 275kV overhead line at Tadcaster.	Applicable to all six variant strategic options					
Power control devices would be installed on one of the circuits of the new 400kV overhead line.						
A new circuit breaker and an isolator would be installed at Osbaldwick 400kV substation.						
A new 275kV substation would be constructed at Monk Fryston.	YES		YES		YES	
A new 400kV substation would be constructed (offline) at Monk Fryston and would connect back into the existing 275kV Monk Fryston substation via interbus SGTs; the reconductored 275kV XC overhead line would be transferred to the new Monk Fryston 400kV substation via interbus SGTs.		YES		YES		YES
The existing 275kV XC overhead line and the existing 275kV XCP overhead line between Monk Fryston 275kV/400kV substation and the new 275kV or 400kV substation constructed at 'York North' would be reconductored, and any pylon	YES	YES				

Project Component	Applicable to Variant Strategic Option?					
	Option 1A	Option 1B	Option 2A	Option 2B	Option 3A	Option 3B
steelwork or foundation strengthening undertaken.						
The existing 275kV XC overhead line and the existing 275kV XCP overhead line between Monk Fryston 275kV/400kV substation and the new 'Poppleton South' 275kV or 400kV substation would be reconductored, and any pylon steelwork or foundation strengthening undertaken.			YES	YES		
The existing 275kV XC and XCP overhead line would be realigned from Moor Monkton Grange to provide a realigned connection to the new 'Poppleton South' 275kV or 400kV substation from the west.					YES	YES
The existing (and realigned) 275kV XC and XCP overhead line between Monk Fryston 275kV/400kV substation and the new 'Poppleton South' 275kV or 400kV substation would be reconductored, and any pylon steelwork or foundation strengthening undertaken.					YES	YES
The reconductored 275kV XCP overhead line would be turned into the new 275kV or 400kV substation at 'York North'.	YES	YES				
The existing Poppleton 275kV substation would remain in operation.	YES	YES				

Project Component	Applicable to Variant Strategic Option?					
	Option 1A	Option 1B	Option 2A	Option 2B	Option 3A	Option 3B
A new 275kV or 400kV substation would be constructed at 'York North'.	YES	YES				
A new circuit breaker would be installed at existing Poppleton 275kV substation.	YES	YES				
A new 275kV or 400kV substation would be constructed at 'Poppleton South'. The existing circuits and connections would be transferred from the existing Poppleton 275kV substation to the new 'Poppleton South' 275kV or 400kV substation. The existing Poppleton 275kV substation would be decommissioned and dismantled.			YES	YES	YES	YES
A new terminal pylon would be required in proximity to 'Poppleton South' 275kV or 400kV substation (close to existing pylon XCP024). The existing pylons XCP024, XCP025 and XCP026 would be dismantled.			YES	YES		
A new 400kV overhead line (approximately 7.5km in length) (with double tee arrangement requiring 2 x SECs and a section of underground cable) would be constructed from the 2TW or YR 400kV overhead line (between Norton and Osbaldwick) to the new 275kV or 400kV substation at 'York North'.	YES	YES				
A new 400kV overhead line (approximately 7km in length) (with double tee arrangement requiring			YES	YES	YES	YES

Project Component	Applicable to Variant Strategic Option?					
	Option 1A	Option 1B	Option 2A	Option 2B	Option 3A	Option 3B
2 x SECs and a section of underground cable) would be constructed from the 2TW or YR 400kV overhead line (between Norton and Osbaldwick) to the new 'Poppleton South' 275kV or 400kV substation.						
The new 400kV overhead line would adopt the previous alignment of the XCP overhead line at Skelton to the new 'Poppleton South' 275kV or 400kV substation.					YES	YES

Table 5.5: Variant Strategic Options to be Appraised for Strategic Proposal Back Check and Review (Option Led Version)

Variant Strategic Options to be Appraised for Strategic Proposal Back Check and Review
Project Components Common to all Variant Strategic Options
• A double tee off (requiring 2 x SECs and a section of underground cable) would be constructed from the XC 275kV overhead line to the XD 275kV overhead line at Tadcaster. • Power control devices would be installed on one of the circuits of the new 400kV overhead line. • A new circuit breaker and an isolator would be installed at Osbaldwick 400kV substation.
Variant Strategic Option 1A - Project Components
• A new 275kV substation would be constructed at Monk Fryston.

Variant Strategic Options to be Appraised for Strategic Proposal Back Check and Review
• The existing 275kV XC overhead line and the existing 275kV XCP overhead line between Monk Fryston 275kV/400kV substation and the new 275kV or 400kV substation constructed at 'York North' would be reconductored, and any pylon steelwork or foundation strengthening undertaken. • The reconductored 275kV XCP overhead line would be turned into the new 275kV or 400kV substation at 'York North'. • The existing Poppleton 275kV substation would remain in operation. • A new 275kV or 400kV substation would be constructed at 'York North'. • A new 400kV overhead line (approximately 7.5km in length) (with double tee arrangement requiring 2 x SECs and a section of underground cable) would be constructed from the 2TW or YR 400kV overhead line (between Norton and Osbaldwick) to the new 275kV or 400kV substation at 'York North'. • A new circuit breaker would be installed at existing Poppleton 275kV substation.
Variant Strategic Option 1B - Project Components
• A new 400kV substation would be constructed (offline) at Monk Fryston and would connect back into the existing 275kV Monk Fryston substation via interbus SGTs; the reconductored 275kV XC overhead line would be transferred to the new Monk Fryston 400kV substation via interbus SGTs. • The existing 275kV XC overhead line and the existing 275kV XCP overhead line between Monk Fryston 275kV/400kV substation and the new 275kV or 400kV substation constructed at 'York North' would be reconductored, and any pylon steelwork or foundation strengthening undertaken. • The reconductored 275kV XCP overhead line would be turned into the new 275kV or 400kV substation at 'York North'. • The existing Poppleton 275kV substation would remain in operation. • A new 275kV or 400kV substation would be constructed at 'York North'. • A new 400kV overhead line (approximately 7.5km in length) (with double tee arrangement requiring 2 x SECs and a section of underground cable) would be constructed from the 2TW or YR 400kV overhead line (between Norton and Osbaldwick) to the new 275kV or 400kV substation at 'York North'.

Variant Strategic Options to be Appraised for Strategic Proposal Back Check and Review
• A new circuit breaker would be installed at existing Poppleton 275kV substation.
Variant Strategic Option 2A - Project Components
• A new 275kV substation would be constructed at Monk Fryston. • The existing 275kV XC overhead line and the existing 275kV XCP overhead line between Monk Fryston 275kV/400kV substation and the new 'Poppleton South' 275kV or 400kV substation would be reconductored, and any pylon steelwork or foundation strengthening undertaken. • A new terminal pylon would be required in proximity to 'Poppleton South' 275kV or 400kV substation (close to existing pylon XCP024). The existing pylons XCP024, XCP025 and XCP026 would be dismantled. • A new 275kV or 400kV substation would be constructed at 'Poppleton South'. The existing circuits and connections would be transferred from the existing Poppleton 275kV substation to the new 'Poppleton South' 275kV or 400kV substation. The existing Poppleton 275kV substation would be decommissioned and dismantled. • A new 400kV overhead line (approximately 7km in length) (with double tee arrangement requiring 2 x SECs and a section of underground cable) would be constructed from the 2TW or YR 400kV overhead line (between Norton and Osbaldwick) to the new 'Poppleton South' 275kV or 400kV substation.
Variant Strategic Option 2B - Project Components
• A new 400kV substation would be constructed (offline) at Monk Fryston and would connect back into the existing 275kV Monk Fryston substation via interbus SGTs; the reconductored 275kV XC overhead line would be transferred to the new Monk Fryston 400kV substation via interbus SGTs. • The existing 275kV XC overhead line and the existing 275kV XCP overhead line between Monk Fryston 275kV/400kV substation and the new 'Poppleton South' 275kV or 400kV substation would be reconductored, and any pylon steelwork or foundation strengthening undertaken. • A new terminal pylon would be required in proximity to 'Poppleton South' 275kV or 400kV substation (close to existing pylon XCP024). The existing pylons XCP024, XCP025 and XCP026 would be dismantled.

Variant Strategic Options to be Appraised for Strategic Proposal Back Check and Review
• A new 275kV or 400kV substation would be constructed at 'Poppleton South'. The existing circuits and connections would be transferred from the existing Poppleton 275kV substation to the new 'Poppleton South' 275kV or 400kV substation. The existing Poppleton 275kV substation would be decommissioned and dismantled. • A new 400kV overhead line (approximately 7km in length) (with double tee arrangement requiring 2 x SECs and a section of underground cable) would be constructed from the 2TW or YR 400kV overhead line (between Norton and Osbaldwick) to the new 'Poppleton South' 275kV or 400kV substation.
Variant Strategic Option 3A - Project Components
• A new 275kV substation would be constructed at Monk Fryston. • The existing 275kV XC and XCP overhead line would be realigned from Moor Monkton Grange to provide a realigned connection to the new 'Poppleton South' 275kV or 400kV substation from the west. • The existing (and realigned) 275kV XC and XCP overhead line between Monk Fryston 275kV/400kV substation and the new 'Poppleton South' 275kV or 400kV substation would be reconductored, and any pylon steelwork or foundation strengthening undertaken. • A new 275kV or 400kV substation would be constructed at 'Poppleton South'. The existing circuits and connections would be transferred from the existing Poppleton 275kV substation to the new 'Poppleton South' 275kV or 400kV substation. The existing Poppleton 275kV substation would be decommissioned and dismantled. • A new 400kV overhead line (approximately 7km in length) (with double tee arrangement requiring 2 x SECs and a section of underground cable) would be constructed from the 2TW or YR 400kV overhead line (between Norton and Osbaldwick) to the new 'Poppleton South' 275kV or 400kV substation. • The new 400kV overhead line would adopt the previous alignment of the XCP overhead line at Skelton to the new 'Poppleton South' 275kV or 400kV substation.
Variant Strategic Option 3B - Project Components
• A new 400kV substation would be constructed (offline) at Monk Fryston and would connect back into the existing 275kV Monk Fryston substation via interbus SGTs; the reconductored 275kV XC overhead line would be transferred to the new Monk Fryston 400kV substation via interbus SGTs.

Variant Strategic Options to be Appraised for Strategic Proposal Back Check and Review
• The existing 275kV XC and XCP overhead line would be realigned from Moor Monkton Grange to provide a realigned connection to the new 'Poppleton South' 275kV or 400kV substation from the west. • The existing (and realigned) 275kV XC and XCP overhead line between Monk Fryston 275kV/400kV substation and the new 'Poppleton South' 275kV or 400kV substation would be reconductored, and any pylon steelwork or foundation strengthening undertaken. • A new 275kV or 400kV substation would be constructed at 'Poppleton South'. The existing circuits and connections would be transferred from the existing Poppleton 275kV substation to the new 'Poppleton South' 275kV or 400kV substation. The existing Poppleton 275kV substation would be decommissioned and dismantled. • A new 400kV overhead line (approximately 7km in length) (with double tee arrangement requiring 2 x SECs and a section of underground cable) would be constructed from the 2TW or YR 400kV overhead line (between Norton and Osbaldwick) to the new 'Poppleton South' 275kV or 400kV substation. • The new 400kV overhead line would adopt the previous alignment of the XCP overhead line at Skelton to the new 'Poppleton South' 275kV or 400kV substation.

Core Assumptions

- The new 275kV or 400kV substation at 'York North' would be within 1.5km of the 'East to West' (Skelton to Moor Monkton) section of the existing 275kV XCP overhead line.
- The new 275kV or 400kV substation at 'Poppleton South' would be on land immediately south east or in very close proximity to existing Poppleton 275kV substation.
- The new 275kV or 400kV substation at Monk Fryston would be on land immediately adjacent the existing Monk Fryston 275kV/400kV substation.
- The reconductoring of the 275kV XC/XCP overhead line would be undertaken using its existing 275kV alignment; pylon steelwork or foundation strengthening may be required.

6. APPRAISAL OF STRATEGIC OPTIONS

6.1 Approach and Scope of Appraisal

6.1.1 Each of the six variant strategic options identified in **Table 5.4** and **Table 5.5** above have been robustly appraised, consistent with the approach taken during the 2019 Strategic Proposal process, and in accordance with National Grid's Options Appraisal Guidance. Options appraisal considers a range of technical, environmental, socio-economic, cost, and programming issues for each strategic option.

6.1.2 **Table 6.1** below identifies the range of issues considered by the options appraisal. The objective of the options appraisal is to identify a new Strategic Proposal which meets the Project Need Case whilst also taking account of National Grid's statutory and licence obligations. The options appraisal is also able to identify (where appropriate) key differentiators or issues which may make particular strategic options unfeasible and/or more or less preferable.

Table 6.1 Scope of Options Appraisal

Topic	Sub-topic Considerations
Technical Appraisal	System Operation Construction / Delivery Operational / Maintenance Technology Commercial / Regulatory / Third Party
Environmental Appraisal	Physical Environment Biological Environment Landscape and Visual Historic Environment
Socio-economic Appraisal	Settlement and Population Tourism and Recreation Land Use Infrastructure
Programme Appraisal	Likely Route to Consent Duration to Consent Duration to Construct EISD
Cost Appraisal	Capital Cost Lifetime Cost Cost Benefit Appraisal

Topic	Sub-topic Considerations
Boundary Transfer Capability	Boundary Transfer

6.2 Key Findings of the Options Appraisal and Selection of Current Strategic Proposal

Introduction

6.2.1 For each of the six variant strategic options, technical, environmental, socio-economic, cost and programme appraisals have been undertaken. A workshop was held in August 2020 to review and discuss the findings of the options appraisal.

6.2.2 This section provides a summary of the appraisal results highlighting the key findings which influenced the selection of the current Strategic Proposal.

Considerations Consistent for all Six Variant Strategic Options

6.2.3 The six variant strategic options would require a new 400kV connection approximately 7.5km in length (as the crow flies).

6.2.4 Two different technologies have been considered: OHL and UGC. From a cost perspective, OHL was considered to be preferable as it is considerably cheaper than UGC. At this stage in the development of the Project, there are no planning policy reasons (e.g. nationally designated landscapes or national parks) which would require UGC to be used instead of an OHL. However, appropriate consideration would be given to UGC should there be constraints identified in the future that would necessitate its use in line with National Grid's mitigation hierarchy.

6.2.5 From an environmental and socio-economic perspective, there are no discernible differences between each of the 'A' and 'B' options (i.e. no difference between Option 1A and 1B, nor between 2A and 2B, nor between 3A and 3B), as the differences are largely technical and cost driven in relation to the type of substation build at Monk Fryston (see **Section 5.2** of this report for further details regarding the drivers behind the decision to consider either a rebuild of the 275kV substation or a new 400kV substation at Monk Fryston).

6.2.6 Further information regarding the selection of the current Strategic Proposal is provided below.

Key Findings – Environmental and Socio-economic

6.2.7 From an environmental and socio-economic perspective, the appraisal shows that Option 3A and Option 3B would be the least preferred of the six variant strategic options because the realignment of the existing 275kV XCP overhead line between Moor Monkton Grange and Poppleton 275kV substation (to allow the alignment to be used for the new 400kV connection to Poppleton) would lead to the requirement for new infrastructure in an area where currently there is none; this has the potential to lead to greater environmental and socio-economic effects.

6.2.8 Option 1A and 1B would result in the construction of a new substation on 'greenfield' land whilst Options 2A, 2B, 3A, and 3B have the potential for the new substation to

be constructed on previously developed land. However, two planning permissions, plus a further planning application – decision pending (see **Section 4.2** of this report for further details of local plan allocations and planning applications) for new housing on land immediately south of the existing Poppleton 275kV substation (consistent with the adopted York Local Plan and the emerging York Local Plan for strategic housing land allocations), combined with the physically constrained nature of the site and surrounds of the existing Poppleton substation would result in a significant obstacle for the selection of any of the variant strategic options involving a new substation at 'Poppleton South' (i.e. Option 2A/2B, Option 3A/3B).

6.2.9 Whilst Options 1A and 1B would lead to some localised landscape and visual effects at the new 'York North' substation site, the need for a new substation at 'Poppleton South' would also lead to additional environmental effects (including landscape and visual, and potential ecological effects on the nearby SSSI). The 400kV connection route for Option 1A/1B has greater potential to be shorter and therefore minimise environmental effects and land take (depending on the location of the 'York North' substation) compared to Options 2A, 2B, 3A, and 3B which would require a 400kV connection further south to Poppleton.

6.2.10 From an environmental and socio-economic perspective, Option 1A and Option 1B are preferred. The sensitivities associated with a new build substation on greenfield land are considered to be outweighed by the potential for a shorter 400kV connection (compared to Options 2A, 2B, 3A, and 3B), the significantly greater certainty that a 400kV connection can be physically and technically achieved to the new substation (compared to Option 2A/2B) and the environmental effects associated with constructing new 400kV overhead line infrastructure in an area where there is currently none (Option 3A/3B).

Key Findings - Technical

6.2.11 **Table 6.2** below provides a summary of the options appraisal from a technical (total cost and EISD) perspective.

Table 6.2: Summary of Six Variant Strategic Options from a Technical Perspective

Variant Strategic Option	Technology	2020 EISD	Approximate Connection Length (km)	2020 Total (Capital and Lifetime) Cost (£m)	Are boundary constraint costs applicable (in addition to 2020 Total Cost)? [5]
Variant strategic option 1A – new 275kV substation at Monk Fryston, new 275kV or 400kV substation at 'York North', new 7.5km 400kV connection	OHL	2028	7.5	401.06 – 430.19	Yes – significant boundary constraint costs to be added
	UGC	2027	7.5	524.16 – 624.84	No boundary constraint cost
Variant strategic option 1B - new offline 400kV substation at Monk Fryston, new 275kV or 400kV substation at 'York North', new 7.5km 400kV connection	OHL	2027	7.5	401.49 – 430.72	No boundary constraint cost
	UGC	2026	7.5	524.64 – 627.93	No boundary constraint cost
Variant strategic option 2A - new 275kV substation at Monk Fryston, new 275kV or 400kV substation at 'Poppleton South', new 7.5km 400kV connection	OHL	2028	7.5	427.60	Yes – significant boundary constraint costs to be added
	UGC	2027	7.5	562.66	No boundary constraint cost

[5] Boundary constraint costs are considered to be significant where this may affect National Grid's ability to perform their statutory duties to develop and maintain an efficient, co-ordinated and economical system of electricity transmission.

Variant Strategic Option	Technology	2020 EISD	Approximate Connection Length (km)	2020 Total (Capital and Lifetime) Cost (£m)	Are boundary constraint costs applicable (in addition to 2020 Total Cost)? [5]
Variant strategic option 2B- new offline 400kV substation at Monk Fryston, new 275kV or 400kV substation at 'Poppleton South', new 7.5km 400kV connection	OHL	2027	7.5	407.71	No boundary constraint cost
	UGC	2026	7.5	562.54	No boundary constraint cost
Variant strategic option 3A - new 275kV substation at Monk Fryston, new 275kV or 400kV substation at 'Poppleton South', new 7.5km 400kV connection and partial realignment of the existing 275kV XC/XCP overhead line between Moor Monkton Grange and the existing Poppleton 275kV substation.	OHL	2028	7.5	431.81	Yes – significant boundary constraint costs to be added
	UGC	2027	7.5	551.78	No boundary constraint cost
Variant strategic option 3B - new offline 400kV substation at Monk Fryston, new 275kV or 400kV substation at 'Poppleton	OHL	2027	7.5	432.15	No boundary constraint cost
	UGC	2026	7.5	551.97	No boundary

Variant Strategic Option	Technology	2020 EISD	Approximate Connection Length (km)	2020 Total (Capital and Lifetime) Cost (£m)	Are boundary constraint costs applicable (in addition to 2020 Total Cost)? [5]
South', new 7.5km 400kV connection and partial realignment of the existing 275kV XC/XCP overhead line between Moor Monkton Grange and the existing Poppleton 275kV substation.					constraint cost

6.2.12 As described at **Section 5.2** of this report, Option 1A and Option 1B have a cost range provided (rather than a single cost) because they have a much greater degree of flexibility with regards to the location of the 'York North' substation, and the subsequent effects on the length of the new 400kV connection, the length of 275kV reconductoring required, and the arrangement of the 275kV and 400kV connections between the 'York North' substation and the existing 275kV XC/XCP overhead line.

6.2.13 When comparing 'A', 'B' and 'C' variants separately, the appraisal shows that the total costs for the UGC options are notably more expensive than for the corresponding OHL options; 2020 total costs (plus boundary constraint costs where applicable) have been used here. Therefore, from a cost perspective, OHL options are preferred.

6.2.14 The appraisal shows that there is very little discernible difference in the costs between the six variant strategic options (when comparing UGC options against each other). There is also very little discernible difference when comparing the OHL options against each other with the exception of the 'A' variants which have higher total costs (than the corresponding 'B' variants) due to each having a boundary constraint cost added.

6.2.15 All of the 'A' (OHL) options have a later EISD of 2028 (which means each option would incur an additional boundary constraint cost, all of the 'B' (UGC) options have an earlier EISD of 2026 and the remainder ('A' (UGC) and 'B' (OHL) options) have an EISD of 2027.

6.2.16 From a technical perspective, Option 1B (OHL) is preferred. This is for several reasons, which include:

- Options involving an OHL 400kV connection are cheaper than and preferred to options involving a UGC 400kV connection.
- The development of a new 'York North' substation avoids the constraints associated with the current 'Poppleton South' site and its surrounds.
- It meets the critical EISD of 2027 (as opposed to Option 1A (OHL), Option 2A (OHL), and Option 3A(OHL)).
- It offers less constrained overhead line entries with fewer significant crossings.
- It enables the opportunity to shorten the length of reconductoring work (depending on the substation siting work associated with the Option Identification & Selection process).
- It requires less construction works than for the other strategic options.
- A new Monk Fryston 400kV substation allows for:
  - fewer circuits to transfer into the new substation;
  - opportunity to re-use some of the existing 400kV substation to reduce the amount of new build required; and
  - the circuits to be transferred are shorter in length (vs 'A' options), resulting in lower cost.

Selection of the Current Strategic Proposal

6.2.17 Therefore, on balance, taking into consideration all of the appraisal work which has been undertaken relating to the environment, socio-economics, technical, cost and programme (EISD), the current Strategic Proposal is Option 1B (OHL) (*Option 1B – New Substation at 'York North' (400kV substation at Monk Fryston*).

7. CONCLUSIONS

7.1 Overview

7.1.1 FES produced annually by the ESO suggest that north to south power flows in the UK will increase significantly in the next ten years due to increased generation capacity connecting to the electricity network. There is growth forecast in offshore wind and interconnection capacity in Scotland and the North East of England. To ensure that suitable capacity exists on the network, several new and expansion projects (including this Project) will be required in the coming years to meet the increased levels of electricity generation.

7.1.2 Options have been tested against the FES by the ESO's Network Options Assessment (NOA). Five options were entered into NOA 5 (2019/20), and NOA recommended to 'proceed' with 'OPN2' (the 2019 Strategic Proposal).

7.1.3 The generator background and the requirements of the electricity transmission system are dynamic and subject to constant change, meaning that National Grid regularly reviews its decisions in light of the latest information. The potential options to meet the system requirement were identified on the basis of the system background identified in FES 2019. This iteration of FES did not take account of three customer connections at Creyke Beck, two of which were not subject to connection agreements when the FES 2019 were prepared.

7.1.4 This BCR reviews the 2019 Strategic Proposal and the other shortlisted strategic options identified as part of the 2019 Strategic Proposal process to ascertain the extent to which they could meet the new rating requirement and the change to the Project scope and costs, and therefore be suitable for further options appraisal as part of the BCR process. The same key criteria (ability to meet the earliest in-service date of 2027, ability to minimise the length of the new 400kV connection, and ability to minimise the cost) which drove the decision-making process during the 2019 Strategic Proposal process have been used for the BCR process.

7.1.5 For the review of the 2019 Strategic Proposal, the technical difficulties at the substations are overcome by constructing a new substation at Monk Fryston and a new substation at either 'York North' or 'Poppleton South. This has led to the 2019 Strategic Proposal being revised into six variant strategic options (consisting of both overhead line (OHL) and underground cable (UGC) technology sub-options) which have been considered against the key criteria and taken forward for BCR options appraisal, with updated 2020/2021 costings used.

7.1.6 For the review of the other shortlisted strategic options from 2019, further power system studies coupled with other studies providing a greater understanding of the other substations has enabled the review and re-scoping of those strategic options that were deemed to still be applicable to the revised Project scope. This process identified 28 strategic options (all consisting of OHL technology only). Taking the boundary constraint costs into consideration, 21 of the 28 remaining strategic options are more expensive than the most expensive of the six variant strategic options (OHL only), they all have an EISD of 2029 (two years beyond the desired date), and all have an average connection length four times longer than the six variant strategic options. After consideration of the key criteria, all 21 of the 28 remaining strategic options are considered unsuitable to be taken forward for BCR options appraisal.

7.1.7 Again, taking the boundary constraint costs into consideration, the remaining 7 (of the 28 remaining) strategic options are either within the cost range (2 nr.) or cheaper (5 nr.) than the cheapest of the six variant strategic options (OHL only). They all have an EISD of 2029 (two years beyond the desired date), and all have an average connection length 3.6 times longer than the six variant strategic options. Whilst the five strategic options that have cheaper costs provide a clear cost benefit, the cost benefit is not considered to be so substantial as to outweigh the disbenefits associated with the substantially longer EISD and connection length. Therefore, after consideration of the key criteria, all the remaining 7 (of the 28 remaining) strategic options are considered unsuitable to be taken forward for BCR options appraisal.

7.1.8 Each of the six variant strategic options have been robustly appraised and evaluated in accordance with National Grid's Options Appraisal Guidance and in consideration of a range of technical, environmental, socio-economic, cost and EISD issues.

7.2 Selection of the Current Strategic Proposal

7.2.1 The current Strategic Proposal (Option 1B (OHL) - New Substation at 'York North' (400kV Offline Substation at Monk Fryston) - illustrated at **Figure 5.1** of this report) has been identified as follows:

- A new 400kV substation would be constructed (offline) at Monk Fryston and would connect back into the existing 275kV Monk Fryston substation via interbus SGTs; the reconductored 275kV XC overhead line would be transferred to the new Monk Fryston 400kV substation via interbus SGTs.
- The existing 275kV XC overhead line and the existing 275kV XCP overhead line between Monk Fryston 275kV/400kV substation and the new 275kV or 400kV substation constructed at 'York North' would be reconductored, and any pylon steelwork or foundation strengthening undertaken.
- The reconductored 275kV XCP overhead line would be turned into the new 275kV or 400kV substation at 'York North'.
- The existing Poppleton 275kV substation would remain in operation.
- A new 275kV or 400kV substation would be constructed at 'York North'.
- A new 400kV overhead line (approximately 7.5km in length) (with double tee arrangement requiring 2 x SECs and a section of underground cable) would be constructed from the 2TW or YR 400kV overhead line (between Norton and Osbaldwick) to the new 275kV or 400kV substation at 'York North'.
- Power control devices would be installed on one of the circuits of the new 400kV overhead line.
- A new circuit breaker would be installed at the existing Poppleton 275kV substation.
- A new circuit breaker and an isolator would be installed at Osbaldwick 400kV substation.
- A double tee off (requiring 2 x SECs and a section of underground cable) would be constructed from the XC 275kV overhead line to the XD 275kV overhead line at Tadcaster

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Appendix A

Ref	SOA Option (2019)	Sub-Options	Technology	2019 EISD	2020 EISD	Connection Length (km)	2019 Capital Cost (£m)	2019 Lifetime Cost (£m)	2019 Total Cost (£m)	2020 Capital Cost (£m)	2020 Lifetime Cost (£m)	2020 Total Cost (£m)	2020 Total Cost plus Boundary Constraint Cost (£m)	2020 Additional Scope	Take Forward to BCR Options Appraisal?
13	4ZR-OSB_THO-4VJ-DRA_EGG-CYR		OHL	2028	2029	25.49	245.68	3.92	249.60	280.00	3.92	283.92	357.92	Power control devices, cable sealing ends	Not taken forward for BCR options appraisal (EISD / Length)
16	4ZR-OSB_THO-4YS-MON_EGG-CYR		OHL	2028	2029	28.98	256.20	4.40	260.60	292.20	4.40	296.60	370.60	Power control devices, cable sealing ends	Not taken forward for BCR options appraisal (EISD / Length)
52	OSB-4VJ-DRA_EGG-CYR		OHL	2028	2029	24.88	272.00	3.99	275.99	312.67	5.88	318.55	392.55	Power control devices, cable sealing ends, substation and UGC at Osbaldwick, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length)
55	OSB-4YS-MON_EGG-CYR		OHL	2028	2029	26.33	275.00	4.13	279.13	316.15	6.02	322.17	396.17	Power control devices, cable sealing ends, substation and UGC at Osbaldwick, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length)
28	4ZR-OSB_THO-MON-CYR		OHL	2028	2029	31.1	198.59	5.21	203.80	319.26	4.96	324.22	398.22	Power control devices, cable sealing ends, substation and UGC at Monk Fryston, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length)
19	4ZR-OSB_THO-DRA-CYR		OHL	2028	2029	24.03	250.68	3.71	254.39	334.75	4.14	338.89	412.89	Power control devices, cable sealing ends, substation and UGC at Monk Fryston, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length)
79	THO-4YS-MON_EGG-CYR		OHL	2028	2029	30.11	268.70	4.53	273.23	355.67	4.96	360.63	434.63	Power control devices, cable sealing ends, substation and UGC at Thornton, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length)
76	THO-4VJ-DRA_EGG-CYR		OHL	2028	2029	24.31	250.68	3.71	254.39	392.58	5.15	397.73	471.73	Power control devices, cable sealing ends, substation and UGC at Drax, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
67	OSB-MON-CYR		OHL	2028	2029	27.49	302.91	5.02	307.93	400.64	6.51	407.15	481.15	Power control devices, cable sealing ends, substations and UGC at Osbaldwick and Monk Fryston	Not taken forward for BCR options appraisal (EISD / Length / Cost)
37	4ZR-THO_CRE-DRA-CYR		OHL	2028	2029	27.33	256.19	4.19	260.38	411.12	5.63	416.75	490.75	Power control devices, cable sealing ends, substation and UGC at Drax, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
22	4ZR-OSB_THO-EGG-CYR		OHL	2028	2029	29.46	174.68	4.32	179.00	418.10	5.90	424.00	498.00	Power control devices, cable sealing ends, substation and UGC at Eggborough, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
49	CRE-ZDA-KEA_THM-CYR		OHL	2028	2029	39.51	284.23	5.76	289.99	427.24	6.33	433.57	507.57	Power control devices, cable sealing ends, substations and UGC at Creyke Beck and ZDA route, 2 x temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
103	THO-ZDA-KEA_THM-CYR		OHL	2028	2029	32.81	394.18	5.37	399.55	477.05	5.81	482.86	556.86	Power control devices, SECs and cable sealing ends, substation and UGC at Thornton, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
31	4ZR-OSB_THO-XC-POP_MON	Reconductor 275kV	OHL	2028	2029	24.27	311.04	6.53	317.57	485.54	7.31	492.85	566.85	Power control devices, SECs and cable sealing ends, substations and UGC at Thornton and Monk Fryston, SGTs, 2 x temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
94	THO-MON-CYR		OHL	2028	2029	33.37	294.12	5.63	299.75	506.46	5.66	512.12	586.12	Power control devices, SECs and cable sealing ends, substations and UGC at Thornton and Monk Fryston, 2 x temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
58	OSB-DRA-CYR		OHL	2028	2029	24.62	373.52	4.14	377.66	513.63	7.47	521.10	595.10	Power control devices, cable sealing ends, substations and UGC at Osbaldwick and Drax, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
82	THO-DRA-CYR		OHL	2028	2029	21.44	341.68	3.51	345.19	526.25	5.39	531.64	605.64	Power control devices, SECs and cable sealing ends, substations and UGC at Thornton and Drax, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
61	OSB-EGG-CYR		OHL	2028	2029	27.99	285.01	4.40	289.41	524.09	7.88	531.97	605.97	Power control devices, cable sealing ends, substations and UGC at Osbaldwick and Eggborough, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
85	THO-EGG-CYR		OHL	2028	2029	29.04	262.70	4.40	267.10	539.72	6.27	545.99	619.99	Power control devices, SECs and cable sealing ends, substations and UGC at Thornton and Eggborough, 2 x temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
40	4ZR-THO_CRE-KEA-CYR		OHL	2028	2029	28.93	193.10	4.40	197.50	546.29	6.56	552.85	626.85	Power control devices, SECs and cable sealing ends, substation and UGC at Keadby, 3 x temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
43	CRE-DRA-CYR		OHL	2028	2029	38.72	385.27	5.91	391.18	550.01	7.63	557.64	631.64	Power control devices, cable sealing ends, substations and UGC at Drax and Creyke Beck, 2 x temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
25	4ZR-OSB_THO-FER-CYR		OHL	2028	2029	35.04	210.61	5.76	216.37	550.07	8.35	558.42	632.42	Power control devices, SECs and cable sealing ends, substation and UGC at Ferrybridge, 3 x temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
70	OSB-XC-POP_MON-CYR	Reconductor 275kV	OHL	2028	2029	19.47	402.84	6.06	408.90	565.55	10.58	576.13	650.13	Power control devices, SECs and cable sealing ends, substations and UGC at Osbaldwick and Monk Fryston, SGTs, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
97	THO-XC-POP_MON-CYR	Reconductor 275kV	OHL	2028	2029	31.98	416.30	7.77	424.07	632.59	10.68	643.27	717.27	Power control devices, SECs and cable sealing ends, substations and UGC at Thornton and Monk Fryston, SGTs, 2 x temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
46	CRE-KEA-CYR		OHL	2028	2029	31.86	291.63	4.95	296.58	654.72	7.40	662.12	736.12	Power control devices, SECs and cable sealing ends, substations and UGC at Creyke Beck and Keadby, 4 x temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
64	OSB-FER-CYR		OHL	2028	2029	31.76	320.93	5.63	326.56	654.02	10.12	664.14	738.14	Power control devices, SECs and cable sealing ends, substations and UGC at Osbaldwick and Ferrybridge, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
91	THO-KEA-CYR		OHL	2028	2029	33.92	286.92	5.08	292.00	721.69	7.53	729.22	803.22	Power control devices, SECs and cable sealing ends, substations and UGC at Thornton and Keadby, 5 x temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
88	THO-FER-CYR		OHL	2028	2029	36.67	306.14	6.17	312.31	728.54	9.88	738.42	812.42	Power control devices, SECs and cable sealing ends, substations and UGC at Thornton and Ferrybridge, temporary OHL diversion	Not taken forward for BCR options appraisal (EISD / Length / Cost)
1	2TW-NOR_OSB-POP-CYR	Reconductor 275kV	OHL	2027		6.4	152.79	7.20	159.99	N/A	N/A	N/A	N/A	N/A	N/A - previously preferred strategic option - amended to new strategic option 1A/1B
7	2TW-NOR_OSB-XC-POP_MON-CYR	Reconductor 275kV	OHL	2027		27.09	238.66	6.32	244.98	N/A	N/A	N/A	N/A	N/A	N/A - amended to new strategic option 2A/2B
3	2TW-NOR_OSB-POP-CYR	Reconductor 275kV	GIL	2026		6.4	239.10	6.91	246.01	N/A	N/A	N/A	N/A	N/A	N/A - previously preferred strategic option - GIL is not being considered further
2	2TW-NOR_OSB-POP-CYR	Reconductor 275kV	UGC	2026		6.4	258.71	8.38	267.09	N/A	N/A	N/A	N/A	N/A	N/A - previously preferred strategic option - amended to new strategic option 1A/1B
9	2TW-NOR_OSB-XC-POP_MON-CYR	Reconductor 275kV	GIL	2026	N/A	27.09	340.53	6.32	346.85	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
8	2TW-NOR_OSB-XC-POP_MON-CYR	Reconductor 275kV	UGC	2026	N/A	27.09	350.30	7.57	357.87	N/A	N/A	N/A	N/A	N/A	N/A - amended to new strategic option 2A/2B
34	4ZR-OSB_THO-XC-POP_MON	Uprate to 400kV	OHL	2029	N/A	24.27	354.35	7.90	362.25	N/A	N/A	N/A	N/A	N/A	N/A - no Project need case for 400kV uprating
10	2TW-NOR_OSB-XC-POP_MON-CYR	Uprate to 400kV	OHL	2029	N/A	27.09	417.91	8.12	426.03	N/A	N/A	N/A	N/A	N/A	N/A - no Project need case for 400kV uprating
4	2TW-NOR_OSB-POP-CYR	Uprate to 400kV	OHL	2029	N/A	6.4	432.75	9.68	442.43	N/A	N/A	N/A	N/A	N/A	N/A - previously preferred strategic option - no Project need case for 400kV uprating
73	OSB-XC-POP_MON-CYR	Uprate to 400kV	OHL	2029	N/A	19.47	446.15	7.43	453.58	N/A	N/A	N/A	N/A	N/A	N/A - no Project need case for 400kV uprating
100	THO-XC-POP_MON-CYR	Uprate to 400kV	OHL	2029	N/A	31.98	459.61	9.14	468.75	N/A	N/A	N/A	N/A	N/A	N/A - no Project need case for 400kV uprating
11	2TW-NOR_OSB-XC-POP_MON-CYR	Uprate to 400kV	UGC	2029	N/A	27.09	517.53	9.22	526.75	N/A	N/A	N/A	N/A	N/A	N/A - no Project need case for 400kV uprating
12	2TW-NOR_OSB-XC-POP_MON-CYR	Uprate to 400kV	GIL	2029	N/A	27.09	519.78	7.98	527.76	N/A	N/A	N/A	N/A	N/A	N/A - no Project need case for 400kV uprating
6	2TW-NOR_OSB-POP-CYR	Uprate to 400kV	GIL	2029	N/A	6.4	532.08	9.54	541.62	N/A	N/A	N/A	N/A	N/A	N/A - previously preferred strategic option - no Project need case for 400kV uprating
5	2TW-NOR_OSB-POP-CYR	Uprate to 400kV	UGC	2029	N/A	6.4	553.29	11.01	564.30	N/A	N/A	N/A	N/A	N/A	N/A - previously preferred strategic option - no Project need case for 400kV uprating
78	THO-4VJ-DRA_EGG-CYR		GIL	2027	N/A	24.31	716.37	3.57	719.94	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
21	4ZR-OSB_THO-DRA-CYR		GIL	2027	N/A	24.03	718.13	3.57	721.70	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
54	OSB-4VJ-DRA_EGG-CYR		GIL	2027	N/A	24.88	741.58	3.71	745.29	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
42	4ZR-THO_CRE-KEA-CYR		GIL	2027	N/A	28.93	741.75	4.04	745.79	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
24	4ZR-OSB_THO-EGG-CYR		GIL	2027	N/A	29.46	742.51	4.04	746.55	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
84	THO-DRA-CYR		GIL	2027	N/A	21.44	746.12	3.52	749.64	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
15	4ZR-OSB_THO-4VJ-DRA_EGG-CYR		GIL	2027	N/A	25.49	754.12	3.92	758.04	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further

Ref	SOA Option (2019)	Sub-Options	Technology	2019 EISD	2020 EISD	Connection Length (km)	2019 Capital Cost (£m)	2019 Lifetime Cost (£m)	2019 Total Cost (£m)	2020 Capital Cost (£m)	2020 Lifetime Cost (£m)	2020 Total Cost (£m)	2020 Total Cost plus Boundary Constraint Cost (£m)	2020 Additional Scope	Take Forward to BCR Options Appraisal?
77	THO-4VJ-DRA_EGG-CYR		UGC	2027	2028	24.31	752.24	8.03	760.27	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
20	4ZR-OSB_THO-DRA-CYR		UGC	2027	2028	24.03	753.19	8.03	761.22	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
57	OSB-4YS-MON_EGG-CYR		GIL	2027	N/A	26.33	765.01	3.85	768.86	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
41	4ZR-THO_CRE-KEA-CYR		UGC	2027	2028	28.93	763.83	9.18	773.01	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
53	OSB-4VJ-DRA_EGG-CYR		UGC	2027	2028	24.88	770.61	8.17	778.78	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
14	4ZR-OSB_THO-4VJ-DRA_EGG-CYR		UGC	2027	2028	25.49	776.17	8.46	784.63	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
72	OSB-XC-POP_MON-CYR	Reconductor 275kV	GIL	2027	N/A	19.47	783.09	6.06	789.15	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
83	THO-DRA-CYR		UGC	2027	2028	21.44	783.76	7.45	791.21	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
33	4ZR-OSB_THO-XC-POP_MON	Reconductor 275kV	GIL	2027	N/A	24.27	785.98	6.54	792.52	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
30	4ZR-OSB_THO-MON-CYR		GIL	2027	N/A	31.1	790.80	4.24	795.04	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
56	OSB-4YS-MON_EGG-CYR		UGC	2027	2028	26.33	794.92	8.46	803.38	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
71	OSB-XC-POP_MON-CYR	Reconductor 275kV	UGC	2027	2028	19.47	796.20	9.69	805.89	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
32	4ZR-OSB_THO-XC-POP_MON	Reconductor 275kV	UGC	2027	2028	24.27	802.88	10.85	813.73	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
39	4ZR-THO_CRE-DRA-CYR		GIL	2027	N/A	27.33	813.65	4.05	817.70	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
63	OSB-EGG-CYR		GIL	2027	N/A	27.99	820.19	4.12	824.31	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
69	OSB-MON-CYR		GIL	2027	N/A	27.49	821.60	4.74	826.34	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
38	4ZR-THO_CRE-DRA-CYR		UGC	2027	2028	27.33	822.45	9.04	831.49	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
75	OSB-XC-POP_MON-CYR	Uprate to 400kV	GIL	2029	N/A	19.47	826.40	7.43	833.83	N/A	N/A	N/A	N/A	N/A	N/A - no Project need case for 400kV uprating
87	THO-EGG-CYR		GIL	2027	N/A	29.04	829.83	4.26	834.09	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
18	4ZR-OSB_THO-4YS-MON_EGG-CYR		GIL	2027	N/A	28.98	832.56	4.40	836.96	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
36	4ZR-OSB_THO-XC-POP_MON	Uprate to 400kV	GIL	2029	N/A	24.27	829.29	7.90	837.19	N/A	N/A	N/A	N/A	N/A	N/A - no Project need case for 400kV uprating
29	4ZR-OSB_THO-MON-CYR		UGC	2027	2028	31.1	829.74	10.44	840.18	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
74	OSB-XC-POP_MON-CYR	Uprate to 400kV	UGC	2029	N/A	19.47	839.52	11.06	850.58	N/A	N/A	N/A	N/A	N/A	N/A - no Project need case for 400kV uprating
62	OSB-EGG-CYR		UGC	2027	2028	27.99	842.49	9.04	851.53	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
60	OSB-DRA-CYR		GIL	2027	N/A	24.62	849.86	4.00	853.86	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
68	OSB-MON-CYR		UGC	2027	2028	27.49	847.97	9.58	857.55	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
35	4ZR-OSB_THO-XC-POP_MON	Uprate to 400kV	UGC	2029	N/A	24.27	846.19	12.21	858.40	N/A	N/A	N/A	N/A	N/A	N/A - no Project need case for 400kV uprating
81	THO-4YS-MON_EGG-CYR		GIL	2027	N/A	30.11	857.00	4.40	861.40	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
86	THO-EGG-CYR		UGC	2027	2028	29.04	857.52	9.32	866.84	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
48	CRE-KEA-CYR		GIL	2027	N/A	31.86	862.96	4.67	867.63	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
17	4ZR-OSB_THO-4YS-MON_EGG-CYR		UGC	2027	2028	28.98	860.92	9.47	870.39	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
59	OSB-DRA-CYR		UGC	2027	2028	24.62	879.31	8.46	887.77	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
27	4ZR-OSB_THO-FER-CYR		GIL	2027	N/A	35.04	888.56	5.48	894.04	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
23	4ZR-OSB_THO-EGG-CYR		UGC	2027	2028	29.46	886.90	9.61	896.51	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
80	THO-4YS-MON_EGG-CYR		UGC	2027	2028	30.11	897.02	9.76	906.78	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
47	CRE-KEA-CYR		UGC	2027	2028	31.86	928.14	10.19	938.33	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
26	4ZR-OSB_THO-FER-CYR		UGC	2027	2028	35.04	927.53	11.59	939.12	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
66	OSB-FER-CYR		GIL	2027	N/A	31.76	935.86	5.35	941.21	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
96	THO-MON-CYR		GIL	2027	N/A	33.37	943.47	5.49	948.96	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
93	THO-KEA-CYR		GIL	2027	N/A	33.92	961.22	4.94	966.16	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
65	OSB-FER-CYR		UGC	2027	2028	31.76	959.54	10.87	970.41	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
95	THO-MON-CYR		UGC	2027	2028	33.37	983.81	11.30	995.11	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
92	THO-KEA-CYR		UGC	2027	2028	33.92	987.05	10.76	997.81	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
105	THO-ZDA-KEA_THM-CYR		GIL	2027	N/A	32.81	1036.91	5.09	1042.00	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
90	THO-FER-CYR		GIL	2027	N/A	36.67	1055.51	6.18	1061.69	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
104	THO-ZDA-KEA_THM-CYR		UGC	2027	2028	32.81	1055.76	10.76	1066.52	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
99	THO-XC-POP_MON-CYR	Reconductor 275kV	GIL	2027	N/A	31.98	1067.01	7.78	1074.79	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
51	CRE-ZDA-KEA_THM-CYR		GIL	2027	N/A	39.51	1083.09	5.76	1088.85	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
89	THO-FER-CYR		UGC	2027	2028	36.67	1082.21	12.46	1094.67	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
98	THO-XC-POP_MON-CYR	Reconductor 275kV	UGC	2027	2028	31.98	1091.90	13.29	1105.19	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
102	THO-XC-POP_MON-CYR	Uprate to 400kV	GIL	2029	N/A	31.98	1110.32	9.14	1119.46	N/A	N/A	N/A	N/A	N/A	N/A - no Project need case for 400kV uprating
50	CRE-ZDA-KEA_THM-CYR		UGC	2027	2028	39.51	1121.72	12.49	1134.21	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)
101	THO-XC-POP_MON-CYR	Uprate to 400kV	UGC	2029	N/A	31.98	1135.21	14.66	1149.87	N/A	N/A	N/A	N/A	N/A	N/A - no Project need case for 400kV uprating
45	CRE-DRA-CYR		GIL	2027	N/A	38.72	1144.46	5.92	1150.38	N/A	N/A	N/A	N/A	N/A	N/A - GIL is not being considered further
44	CRE-DRA-CYR		UGC	2027	2028	38.72	1204.10	12.49	1216.59	N/A	N/A	N/A	N/A	N/A	Not taken forward for BCR options appraisal (EISD / length / cost)

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