

Kells 275 kV Substation Rebuild

Final Options Report

September 2025

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Kells 275 kV Substation Rebuild

Final Options Report

September 2025

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Glossary

AIS	Air Insulated Switchgear
CB	Circuit Breaker
CT	Current Transformer
CENELEC	European Committee for Electrotechnical Standardisation
GIS	Gas Insulated Switchgear
NPV	Net Present Value
NIEN	Northern Ireland Electricity Networks
OHL	Overhead Line
PEA	Preliminary Ecological Appraisal
SONI	System Operator for Northern Ireland
TSSPS	Transmission System Security and Planning Standards
UG	Underground
SF6 Gas	Sulfur Hexafluoride Gas

1 Introduction

1.1 Overview

Mott MacDonald have been appointed by SONI (System Operator for Northern Ireland) to undertake an optioneering feasibility assessment for the redevelopment of Kells 275 kV substation located in County Antrim.

This report was preceded by an Interim Options Report¹, which identified and assessed a long list of development options (a total of seven options). The Interim Options Report concluded by proposing a short list of four options for further assessment by this Final Options report.

1.2 Project Background

The existing Kells substation is a 275/110 kV substation located approximately 3km southeast of the village of Kells in Co. Antrim, Northern Ireland (Irish National Grid co-ordinates: 317906E, 396445N).

The substation was originally constructed in the 1970s, and consists of a 275 kV Mesh, connecting four 275 kV Circuits and two 275 kV Interbus Transformers, as well as an 110 kV Air Insulated Switchgear (AIS) Double Busbar Substation. The 275 kV Mesh consists of two main busbar sections, 1A and 2A, running East-West through the compound parallel with the 110 kV AIS Busbars, both of which are normally energised. There are also four high level diagonals running North-South through the compound. The catenary conductors on these diagonals provide interconnection between the main busbars, 275 kV transformer terminations and the 275 kV circuits. The four circuits terminating at the 275 kV compound are the following:

- Ballylumford – Kells
- Kells – Magherafelt
- Kells – Kilroot 'A'
- Kells – Kilroot 'B'

The Ballylumford – Magherafelt 275 kV Circuit, which shares double circuit towers with the Kells – Magherafelt and Ballylumford – Kells 275 kV Circuits, also passes from the north of the substation.

SONI have identified several requirements for Kells 275 kV substation. These include:

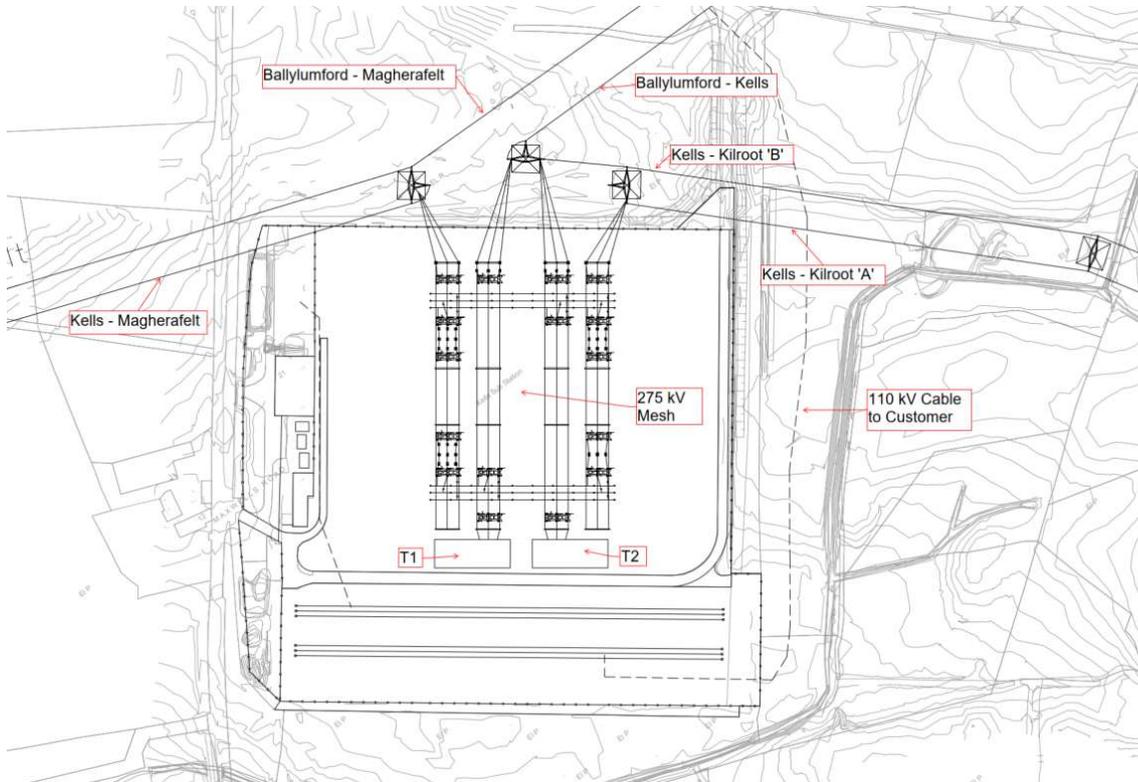
- The need to address a known issue relating to the deflection of the substation catenary support structures (concrete 'A' frames) and their deflection under fault conditions.
- The long term need to turn in the nearby Ballylumford-Magherafelt 275 kV circuit.
- Addressing limitations with the existing mesh arrangement.
- Replacing the ageing 275kV equipment (circa. 55 years old) in the medium term.
- The need for a third 275/110kV transformer in the medium term.

The 275 kV switchyard is an AIS mesh arrangement. The original design intent for the substation was to build out in a breaker and a half arrangement, with four 275 kV diagonals, and space in the 275 kV platform for a further four 275 kV diagonals in future. However, due to

¹ 229101463 Kells 275 kV Substation Rebuild – Interim Options Report, Mott MacDonald, March 2025

constraints at the time of construction, the design was adapted to a four-corner mesh, with the interbus transformers sharing their respective mesh corners with outgoing 275 kV circuits.

Figure 1.1: Kells 275 kV Substation – Existing Layout



Source: Mott MacDonald

1.3 Aim of this Report

Due to the nature of the site at Kells 275 kV substation, limitations of the existing substation and future performance requirements, a technical assessment of the most suitable potential options to redevelop the substation is required. This report builds on the Interim Options Report¹ and is the development of a further assessment of the technical, economic, deliverability and environmental aspects of each of the shortlisted options. This report shall also provide a recommendation of an emerging preferred option to be brought forward for further development.

1.4 Structure of this Report

- Chapter 2 of this report provides an overview of the project and describes the existing substation arrangement, while also detailing the future performance requirements of the substation. Additionally, the assessment criteria for feasibility study of the short-listed options are described.
- A high-level description of the short-listed options is provided in Chapter 3.
- Chapters 4 to 7 present the assessment of each of the options under consideration.
- Chapter 8 provides an overall comparative evaluation of the options. It details how each option is scored, provides comparative commentary on the key differences between the options and explains why one option is preferable over another.
- Relevant appendices are included as referenced in the body of the report.

1.5 Key Assumptions

The following key assumptions have been considered in the assessment of the shortlisted options:

- Note the following assumptions relating to the economic evaluations:
 - The capital costs are based on the costs schedule provisionally agreed with SONI, refer to Appendix E.
 - Any costs sourced from Euro (€) sources have an exchange rate of 0.84 applied to convert to British Pounds (£).
 - Operation & Maintenance costs calculated based on 1.3% of capital costs as per SONI standard Net Present Value (NPV) template.
 - Discount factor of 3.5% assumed as per SONI standard Net Present Value (NPV) template.
 - Equipment must be replaced when it reaches 60 years old.
 - It is assumed that the relatively small lengths of 275 kV cable required for some of the options can be easily procured along with other cable orders being placed by SONI/Northern Ireland Electricity Networks (NIEN).
 - It is assumed that an SF6 gas alternative solution will be available for option 4 (GIS), however at the time of developing this report, the costs associated with non-SF6 Gas are unknown and therefore SF6 costs are assumed.
- Note the following assumptions relating to the implementation timelines:
 - Assumed dates, as advised by SONI, for the Utility Regulator approval, planning design, planning application approval, detailed design and construction mobilisation are illustrated in the outage timeline for each option. Refer to Appendix D.
 - Note that the Kells 275 kV Substation Interim options report did not include the time required for UR approval, planning design, planning application approval and construction mobilisation so the timelines appeared more favourable than in this Final options report.
 - Also note that in the Kells 275 kV Substation Interim options report, the Option 2 timeline appears to be optimistic because the construction start date in was in July meaning it was possible to use that year to replace the A frames on the first diagonal. In contrast, the dates advised by SONI indicate a construction start date in September meaning due to outage season constraints it would not be possible to use that year to replace the A-frames on the first diagonal and the construction would have to wait until the start of the outage season the next year.
 - Outage season starting 01 April and ending 31 October each year.
- It is assumed that the existing control building can be reused for the new AIS substation in option 3B.
- It is assumed that the new 110kV cable connection from the new Kells 110kV Cluster Substation to the existing Kells 110 kV Substation will not impact the proposed Kells 275 kV rebuild designs.
- It is assumed that the 110kV busbar at Kells can be split for on a temporary basis to allow the existing 275kV equipment and the new 275kV equipment to be energised and connected to the 110kV busbar at the same time without backward power flows through the 110kV busbar.
- The review of the applicability of planning permission for each option has not been informed by any Habitats Regulations Assessment (Stage 1 or 2) (therefore the requirements for planning permission may alter subsequent to the completion of such assessments).

- The review of the applicability of planning permission assumes that all options will not result in the requirement for Environmental Impact Assessment.
- The review of planning applicability assumes that no new site accesses or amendments to existing site accesses will occur under any option.
- Ecological constraints have been informed by a preliminary site walkover survey only, conducted on 07 June 2024, 19 March and 03 April 2025, including the use of camera traps. Dense vegetation and time constraints meant that the entirety of this embankment could not be thoroughly checked. Temporal changes in flora and fauna assemblage can occur overtime, this report can only provide a snapshot of the ecological activities at the time of the survey undertaken.
- There are no unknown underground utilities/services within the substation compound or NIEN owned land.

2 Overview of the Project

SONI have identified several requirements for Kells 275 kV substation. These include the need to address a known issue relating to the deflection of the substation catenary support structures and their deflection under fault conditions, the long term need to turn in the nearby Ballylumford-Magherafelt 275 kV circuit and addressing limitations with the existing mesh arrangement.

Due to the complexity of the site, the various needs, and the lack of an obvious preferred solution, the proceeding Interim Options Report¹ presented a technical assessment of the options considered for the rebuild of the Kells 275 kV substation and provided a recommendation of a short list of options to be brought forward for further assessment.

The interim options report for this project involved a technical assessment of a long list of six options for the refurbishment and asset replacement of Kells 275 kV Substation. Included in the options was the 'status quo' option which was assessed to aid the justification and evaluation of the alternative options. Under the long list assessment of the options the Economic (Capital Costs), Technical, and Deliverability criteria were assessed. Using the criteria assessed each of the six proposed options were scored. From the assessment, the following options were proposed for the shortlist of this final options report for more in-depth assessment:

- Option 1 – Status Quo (shortlisted by SONI requirement)
- Option 3B – Breaker and a Half arrangement including change to the circuit arrangement
- Option 4 – New 275 kV Gas Insulated Switchgear (GIS) substation
- Option 6 – New 275 kV AIS substation partially using existing AIS substation land

2.1 Scope of Assessment

The scope of this feasibility study is to carry out a multi-criteria assessment for the shortlisted options for the refurbishment and replacement of assets in Kells 275 kV substation. Additionally, the 'status quo' option will also be assessed to aide comparison with and justification for the additional options. The key criteria that will be appraised under this shortlist assessment expand on those examined in the Interim Options report, detailed in section 2.2.

The assessments detailed in this report are desk-based and supplemented by a Preliminary Ecological Appraisal (PEA) including a bat roost potential assessment on specifically identified trees, a badger survey and local survey information. This desktop optioneering exercise is considered to remain a live exercise up to the point planning consent is sought. The desktop exercise is a comprehensive evaluation that should be revisited at key milestones to ensure its continued relevance. This includes considering updates in legislation, policy, guidance, and the availability of new data.

Designer risk assessments are also produced but do not directly factor into the scoring. These are available in Appendix G.

The options assessed in this study are:

- Option 1 – Status Quo
- Option 3B – Breaker and a half arrangement (including change in circuit arrangement)
- Option 4 – New 275 kV GIS substation
- Option 6 – New 275kV AIS substation partially using existing AIS substation land

2.2 Evaluation Criteria

2.2.1 Economic Performance

The economic assessment of each option takes the following sub-criteria into account, as agreed with SONI:

- **Capital Cost:** The costs associated with the installation and removal of substation equipment will be sourced and referenced in the Bill of Quantities for each Option, refer to Appendix E.
- **Net Present Value (NPV):** The NPV assessed will follow the implementation timelines of each option to more accurately represent the breakdown of the capital cost of each of the options. The elements impacting the NPV of each option are provisionally agreed with SONI.

2.2.2 Technical Performance

The technical assessment of each option takes the following sub-criteria into account, as agreed with SONI:

- **Compliance with Safety Standards:** The project should comply with relevant safety standards such as those from the European Committee for Electrotechnical Standardisation (CENELEC). Materials should comply with IEC or CENELEC standards.
- **Compliance with System Reliability and Security Systems:** The project should comply with the Northern Ireland Transmission System Security and Planning Standards (TSSPS).
- **Headroom:** This is the amount of additional capacity that is available for the future without upgrades.
- **Expansion/Extendibility:** This considers the ease with which the solution option can be expanded, for example it may be possible to uprate an overhead line to a higher capacity or a new voltage in the future.
- **Technology Operational Risk:** This sub-criterion aims to capture the risk of operating different technologies on the networks.

Note that it is determined that there is negligible difference between the options above regarding repeatability so therefore it will not be assessed.

2.2.3 Deliverability Performance

The deliverability assessment of each option takes the following sub-criteria into account, as agreed with SONI:

- **Outage Assessment and Implementation Timelines:** Assesses the relative length of time until energisation, and the extent of outages required to implement the solution (assess significant differences).
- **Project Plan Flexibility:** Does the project plan allow for some flexibility if issues arise during design and construction?
- **Supply Chain Constraints:** Assesses any significant risks from a supply chain perspective which could negatively impact the deliverability of the solution.
- **Planning Considerations:** Consider the applicability of permitted development rights / planning permission for each option.
- **Constructability:** Assesses the feasibility and relative construction efficiency for each option.
- **Geotechnical Considerations:** Assesses any significant risks relating to existing ground conditions which may negatively impact on civil construction works.

Note that the sub-criteria “Dependence on other projects” as described in the proposal, is now included in the Outage assessment and implementation timeline section of each option.

Additionally, the sub-criteria “Risk of untried technology” as described in the proposal, is now included in the Technology Risk section of each option.

Further to these criteria, associated safety risk for each option will be assessed and included in this section.

2.2.4 Environmental Performance

Using the PEA of the long-listed options in the Interim Options Report, a further environmental appraisal of each of the shortlisted options will be produced. This will include the carbon footprint assessment of each option and comparatively assess high level environmental issues pertinent to the study area, specifically, biodiversity, water resources (including flood risk), landscape/visual impact and nuisance/disturbance. Further explanations of what each sub-criteria assesses are outlined below:

- **Biodiversity:** This criterion examines the proximity to and potential connectivity with ecologically protected species, habitats and sites, in particular European designated sites, protected waters, and nationally designated ecological sites. Known sensitive and protected habitats and species within the receiving environment are considered in the context of construction phase activities and access and post construction. Publicly available data relating to fauna, flora and fisheries together with data gathered from targeted site visits were used to inform the evaluation.
- **Water resources:** This criterion examines the context of surface water bodies and their sensitivities, and the implications of the Project on the ability to achieve or retain Water Framework Directive Good Status. The evaluation is carried out having regard to the proximity of site options to streams, rivers or lakes, water supply protection areas, rivers used for [potable] water abstraction and the requirement for water crossings.
- **Climate, Sustainability and Flood Risk:** This criterion examines the use of natural resources during construction, such as significant levels of cut or fill, required due to the topographical, geological or hydrological features present at the site. Publicly available geotechnical reports are accessed where available to assist in the identification of strata beneath the sites and therefore the likelihood for cut/fill activities or piling. Additionally, it examines the potential for greater or lesser carbon footprint based on the use of natural resources and significant use of concrete which results in larger carbon footprints. Flood risk is considered with regard to the sensitivity of the site options to flooding using recorded flood events, predictive flood mapping (including the consideration of climate change) and topography to identify localised flood risk.
- **Carbon footprint:** Qualitative identification of the carbon footprint based on new assets only.
- **Archaeology and Cultural Heritage:** This criterion examines the proximity to and potential views to and from recorded archaeological sites, architectural sites, [ancient] burial sites, areas of archaeological potential, historic and Listed Buildings and Architectural Conservation Areas designated by the local planning authority. Sites and Monuments Records (NISMR) and NI Buildings Database have been referenced.
- **Designated Landscapes, protected views and scenic routes:** This sub-criterion examines the Local Development Plan designations, landscape character areas, scenic routes and protected views associated with each of the site options under consideration. Landscape relates to assessing effects of a development on the landscape as a resource in its own right and is concerned with how the proposal may affect the elements that make up the landscape, the aesthetic and perceptual aspects of the landscape and its distinctive character.
- **Lands, soils and hydrogeology:** This criterion examines the nature of the bedrock, soils/subsoils, aquifer type and vulnerability.

- **Land Use compatibility:** This examines the existing land uses within and surrounding Kells substation with regard to its compatibility with the proposed land use changes associated with the proposed project and impacts to landowners/users in relation to access to properties or operation of businesses. This criterion also examines any approved planning applications in the last five years submitted to the local planning authority or The Department of Infrastructure, within a 1km radius. It considers those planning applications which may impact upon the development of any option in terms of potential for significant in-combination effects on the receiving environment.

2.2.5 Criteria Ranking

Each option will be assessed against the key criteria and will be assessed in accordance with the colour code shown in Figure 2.1.

Figure 2.1: Criteria Ranking



Source: Mott MacDonald

3 Design Options

3.1 Option 1 – Status Quo

The current substation layout and equipment retained in their current arrangement.

3.2 Option 3B – Breaker and a half arrangement (including change in circuit arrangement)

- Replace all 275 kV substation assets (high and low level busbars, structures, and disconnectors).
- Convert substation from mesh to a breaker and a half arrangement.
- Project remains within the substation boundary.
- Construct and equip four new diagonals in the available spare footprint on either side of the current arrangement.
- Assess and potentially re-use some Current Transformers (CTs) and Circuit Breakers (CBs).
- Two new transformers to be installed and connected to the new breaker and a half diagonal.
- Move existing Overhead Line (OHL) circuits to the outermost diagonals, energise new transformers, and connect to the 110 kV substation.
- Rebuild offline centre diagonals as breaker and a half arrangement.
- After rebuilding the centre diagonals turn in the Ballylumford-Magherafelt OHL circuit, this allows for the change in circuit arrangement.

3.3 Option 4 – New 275 kV GIS substation

- Construct a new GIS substation (including GIS building) within the existing Kells Substation Compound.
- Phased demolition of the existing 275 kV AIS substation including the existing transformers.
- Turn in the Ballylumford-Magherafelt OHL circuit.
- Two new transformers to be installed offline.
- Minimal impact on footprint, allowing for new NIEN support buildings (RP7 Programme).
- Consider and assess cable derating and cable-sealing compounds.

3.4 Option 6 – New 275 kV AIS substation

- Develop a new AIS substation partially within the existing compound and on NIEN-owned land.
- Divert tributary of the Kellswater River and divert the 110 kV cable from Battery Storage Facility to allow build out onto the NIEN-owned land to the East of the substation.
- Two new transformers to be installed offline.
- Transfer Kilroot diagonals, then connection transformer via temporary cable.
- Decommission previous Kilroot diagonals.
- Build out remaining bays for the new AIS substation.
- Turn in the Ballylumford-Magherafelt OHL circuit and existing Magherafelt diagonals.

3.5 Design changes since interim options report

The key design changes to Options, since the Kells 275 kV Substation Rebuild interim options report (Rev B) was issued, are summarised below:

- Option 1 – Status Quo (shortlisted by SONI requirement)
 - No change

- Option 3B – Breaker and a Half arrangement including change to the circuit arrangement
 - Proposed OHL tower locations were modified to avoid the Ecology (Badger) exclusion zones, where practicable, refer to PEA Report in Appendix F for details.
 - Existing transformers T1 and T2 were shown as decommissioned as part of the works.

- Option 4 – New 275 kV GIS substation
 - The GIS building and gantries were moved to be within the existing Kells 275kV compound to avoid the Ecology (Badger) exclusion zones, where practicable, refer to PEA Report in Appendix F for details.
 - Phased removal of existing Kells 275kV substation diagonals rather than complete demolition in a single phase due to space restrictions.
 - Link between new GIS and existing Kells 275kV substation during build out of GIS is now connected through low level equipment in Kilroot A diagonal instead of direct to Busbar 2A. This is to try to maintain the existing mesh protection arrangement.
 - GIB design rearranged for improved accessibility.
 - Fire wall added to new transformer T3
 - Two new transformers were shown to be replaced offline instead of in-situ to avoid extensive outages.
 - The 275kV cable used for transformer T3 was replaced with GIB as per SONI preference.
 - Proposed OHL tower locations were modified to avoid the Ecology (Badger) exclusion zones, where practicable, refer to PEA Report in Appendix F for details.
 - Existing transformers T1 and T2 were shown as decommissioned as part of the works.

- Option 6 – New 275 kV AIS substation partially using existing AIS substation land
 - 110 kV Substation extension previously included as part of Option 6 was removed due to Ecological constraints
 - New control building added due to limited space in existing control building.
 - Fire wall added to new transformer T3.
 - 275kV Link cable to existing transformer T1 kept in place after T1 demolished to allow for future connection.
 - Proposed OHL tower locations were modified to avoid the Ecology (Badger) exclusion zones, where practicable, refer to PEA Report in Appendix F for details.
 - Existing transformers T1 and T2 were shown as decommissioned as part of the works.
 - Two new transformers were shown to be replaced offline instead of in-situ to avoid extensive outages.

4 Assessment – Option 1

4.1 Introduction

Option 1 is based upon assessing the sustainability issues presented by keeping the current 'A' frame structures in their current guise and the potential for degradation over the long term due to the Serviceability Limit State (SLS) being exceeded. Alongside this the current mesh arrangement was also assessed from an electrical standpoint.

It must be noted that if a “do-nothing” approach was taken, the potential degradation of the concrete 'A' frames could result in spalling of the concrete to the point where it becomes a significant risk to health and safety at work.

4.2 Economic Performance

4.2.1 Capital Costs

Given that there are no physical works proposed under Option 1, there are no immediate capital costs associated with Option 1.

However, it must be noted that if a “do-nothing” approach was taken, the potential degradation of the concrete 'A' frames could result in spalling of the concrete to the point where it becomes a significant risk to health and safety at work. Considering this and the age of the other existing 275kV equipment at Kells, the NPV assessment addressed in section 4.2.2, considers the capital costs associated with replacing the equipment.

A criteria ranking of Low (Yellow) is assigned to Capital costs for Option 1.

4.2.2 Net Present Value

Due to the age of the existing 275kV equipment at Kells, the NPV assessment considers the costs associated with replacing the equipment at a total capital cost of £29.88M.

The Net Present Cost of this option is £32.75M. See Appendix E for associated NPV Calculation.

A criteria ranking of Low-Moderate (Green) is assigned to Net Present Value for Option 1.

4.2.3 Overall Economic Performance Scoring

With regard to the criteria assessed, the Economic Performance criteria ranking for Option 1 is assessed to be Low-Moderate (**Green**).

4.3 Technical Performance

4.3.1 Compliance with Safety Standards

This option generally complies with relevant safety standards such as those from the European Committee for Electrotechnical Standardisation (CENELEC). It should be noted that conformance with the latest Standards for existing installations is not explicitly stated in the Electricity at Work Regulations 1989 and, as such, is not a legal obligation.

However, if any major works (such as upgrade of equipment) were required at the substation, the design would have to comply with the latest Standards (specifically IEC 60865). To add to

this point, it is known that the Serviceability Limit State (SLS) of the existing A-frames is exceeded by the anticipated loads under fault conditions and so the existing A-frames would not be compliant with the latest Euro Codes if they became applicable.

It must be noted that if a “do-nothing” approach was taken, the potential degradation of the concrete ‘A’ frames could result in spalling of the concrete to the point where it becomes a significant risk to health and safety at work.

Additionally, although it does not impact the scoring, please also see the Designer risk assessment produced, which is available in Appendix G.

A criteria ranking of Moderate-High (Blue) is assigned to Compliance with Safety Standards for Option 1.

4.3.2 Compliance with System Reliability and Security Standards

Option 1 does appear to comply with the SONI TSSPS and the SONI Operation Security Standards.

However, it should also be noted that the Kells 275kV substation has known operational resiliency issues as described in the SONI/NIEN Joint Investigation, titled “Extreme Weather Event 30/31 March 2010”. Some key relevant points raised in the SONI/NIE report are as follows:

- “On two occasions 275kV line trips caused the loss of both interbus transformers at Kells Main Substation as the configuration of this substation with a line and transformer in a mesh-corner arrangement means the transformer trips along the line. These incidents caused an overload on the Kells-Coleraine 110kV line and low voltage alarms at Antrim Main, Ballymena Main and Glengormley Main.”
- “The lines associated with the two interbus transformers at Kells are BPS-Kells and KPS-Kells B. These lines suffered 13 faults and 24 faults respectively and on two occasions the faults occurred almost simultaneously so that for short periods both interbus transformers were disconnected.”
- “The four 275kV lines serving Kilroot suffered a total of 76 faults and at 00.09 the cumulative effect of faults left Kilroot disconnected from load and caused the generator K2 to trip while supplying 128MW. The sequence of events indicates that the tripping of K2 can be attributed to the fact that both interbus transformers at Kells were isolated following faults on their associated lines.”

The SONI/NIE report also made the following relevant recommendations for Kells substation:

- “SONI and NIE to review the suitability of the configuration of Kells and Hannahstown 275kV Substations and make recommendations for improvements in operational resilience.”
- “Kells Main is configured so that it can be adapted from a mesh arrangement to a switch and a half arrangement. This would avoid loss of a transformer for a line fault and give greater operational flexibility.”

In addition, mesh arrangements as implemented in Kells 275 kV Substation are less preferable from a system reliability standpoint when compared with double busbar or breaker and a half arrangement. This is because a fault on a line, or maintenance within the mesh, causes the mesh to become sectionalised or split. A further line fault can cause a split in two places. This can disable the mesh from allowing the through flow of power. This risk is not present in double busbar or breaker-and-a-half arrangements, which offer greater operational flexibility and fault tolerance. The Kells 275 kV substation is a critical node on the backbone 275 kV ring and the current mesh configuration incurs risks.

This limitation of the current mesh arrangement is particularly in effect in Kells where the transformers are effectively teed onto the OHL circuits, and consequently forced outages of the transformers can occur as a result of line faults. While the transformers are “N-1” redundant, if the demand was higher at the substation, there would be a higher risk of overloading other transformer which may be non-compliant with section 3.8 of the TSSPS. This also excludes the available bays from being used for generation connections as a fault on the overhead line connected to the same diagonal would cause loss of power infeed and therefore non-compliant with section 2.6.1 of the TSSPS.

This option also has the disadvantage of not meeting the long term need to turn in the nearby Ballylumford-Magherafelt 275 kV circuit which would increase security of supply.

A criteria ranking of High (Dark Blue) is assigned to Compliance with System Reliability and Security Systems for Option 1.

4.3.3 Headroom

The existing substation rating is limited by the Artech CA-300 CTs which have a rating of 1000 Amps. Modern 275 kV Substations would typically consider a busbar rating of 3150 Amps, with feeder bays rated for 2500 Amps. As the Artech CA-300 CTs are retained under this option, the headroom in the substation remains limited.

Additionally, at a minimum, the concrete A-frames and associated catenaries would need to be replaced in this option. Replacing the A-frames and associated catenaries would likely trigger the need for the design of the whole 275kV substation, considering the current low-level busbar phase spacing, to comply with the latest Standards (specifically IEC 60865) as mentioned in section 4.3.1.

A criteria ranking of Moderate-High (Blue) is assigned to Headroom for Option 1.

4.3.4 Expansion/Extendibility

Option 1 results in no change to the electrical mesh arrangement, this means that there are only two available spare bays. However, these spare bays would likely only be suitable for transformer connections which would be effectively teed onto the OHL circuits, and consequently forced outages of the transformers can occur as a result of line faults. This poses a limitation on the long term need to turn in the Ballylumford-Magherafelt OHL circuit.

It should also be noted that this option does not easily cater for an offline transformer replacement; if new transformers were required, they would likely require in-situ replacement, which would require a long duration outage (several months) for the new transformer bund to set. If the transformers were replaced offline, they would be required to be cabled into the available spare bays.

While there is space available either side of the existing 275 kV substation to build out new diagonals within the existing substation compound, this would likely trigger the need for the whole 275kV substation to comply with the latest Standards as mentioned in section 4.3.1.

A criteria ranking of Moderate-High (Blue) is assigned to expansion/extendibility for Option 1.

4.3.5 Technology Operational Risk

The technological operation risk is low due to no new technology being implemented in this solution.

A criteria ranking of Low-Moderate (Green) is assigned to Technology Operational risk for Option 1.

4.3.6 Overall Technical Performance Scoring

With regard to the criteria assessed, the Technical Performance criteria ranking for Option 1 is assessed to be High (**Dark Blue**).

4.4 Deliverability Performance

The deliverability of Option 1 naturally scores well as it is based on a “do nothing” approach. However, it must be noted that if a “do-nothing” approach was taken, the potential degradation of the concrete ‘A’ frames could result in spalling of the concrete to the point where it becomes a significant risk to health and safety at work.

4.4.1 Outage Assessment and Implementation Timelines

There are no outages or implementation timelines associated with Option 1 as no works are carried out, as part of this option.

A criteria ranking of Low (Yellow) is assigned to Outage Assessment and Implementation timelines for Option 1.

4.4.2 Project Plan Flexibility

As there are no outage stages or construction being undertaken. The flexibility of the project is non-applicable.

A criteria ranking of Low (Yellow) is assigned to project plan flexibility for Option 1.

4.4.3 Supply Chain Constraints

There are no supply chain constraints associated with Option 1 as no new equipment will be required.

A criteria ranking of Low (Yellow) is assigned to Supply chain constraints for Option 1.

4.4.4 Planning Considerations

There are no proposed works/development associated with Option 1, therefore there is no requirement to seek planning permission.

A criteria ranking of Low (Yellow) is assigned to Planning Considerations for Option 1.

4.4.5 Constructability

Option 1 does not require NIEN or external construction input as there is no replacement of assets within the substation.

A criteria ranking of Low (Yellow) is assigned to Constructability for Option 1.

4.4.6 Overall Deliverability Performance Scoring

With regard to the criteria assessed, the Deliverability Performance criteria ranking for Option 1 is assessed to be Low (**Yellow**).

4.5 Environmental Performance

The environmental performance of Option 1 naturally scores well as it is based on a “do nothing” approach. However, it must be noted that if a “do-nothing” approach was taken, the

potential degradation of the concrete 'A' frames could result in spalling of the concrete to the point where it becomes a significant risk to health and safety at work.

No potential impacts are predicted to occur with potential works consisting of maintenance at most.

There is no land take or habitat loss expected to occur as a result of the works proposed within Option 1. However, some mitigation may be required with regards to mammals' activity in the area particularly badgers due to the identification of badger setts in the immediate vicinity of the existing substation site.

With regard to the criteria assessed, the Environmental Performance criteria ranking for Option 1 is assessed to be Low (**Yellow**).

4.6 Option 1 Criteria Scoring

The ranking for the main criteria for this option is presented below:

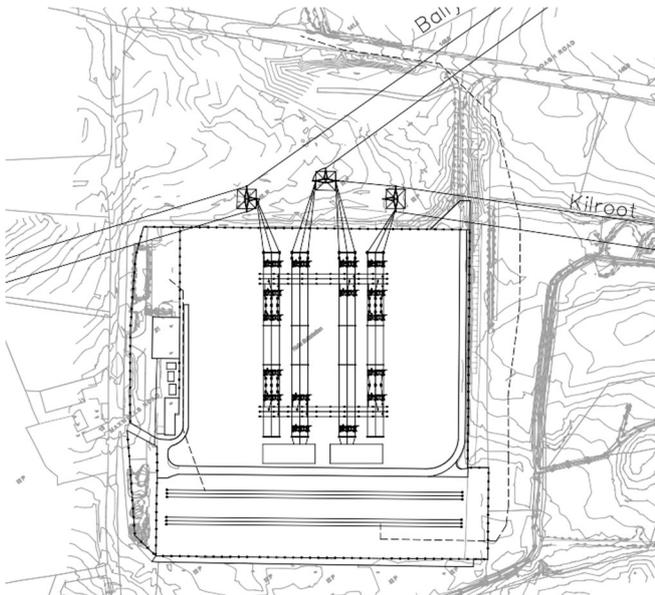
Criteria	Option 1
Economic	Low-Moderate Risk
Technical	High Risk
Deliverability	Low Risk
Environmental	Low Risk

5 Assessment – Option 3B

5.1 Introduction

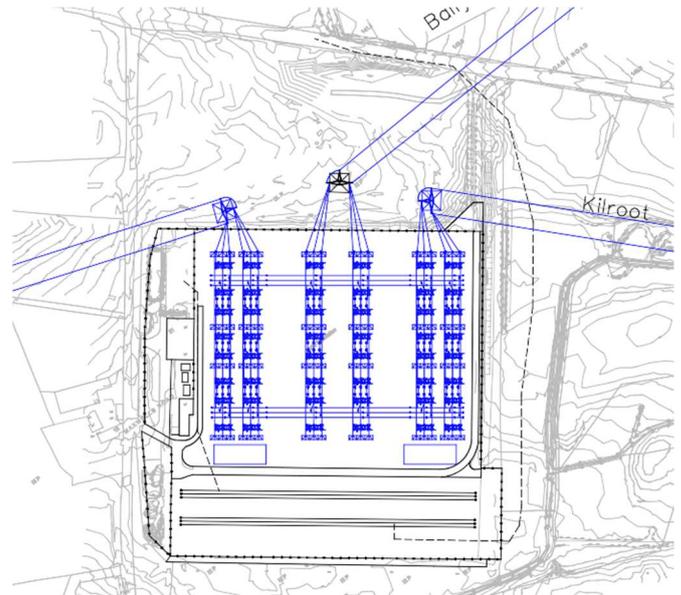
Option 3B is based on the replacement of all elements of the existing AIS substation. Option 3B equips four new diagonals on the outer free space either side of the existing equipment footprint, with two new transformers connected to the new outer diagonals. A new OHL terminal tower for the Magherafelt circuits will be installed to turn in both circuits to the two new diagonals (west side of the substation) and energise one of the new transformers. Similarly, a new OHL terminal tower for Kilroot circuits will be installed to turn in both circuits to the two new diagonals (east side of the substation) and energise the other new transformers. Once this work is completed the existing diagonals are disconnected and rebuilt offline as breaker and a half, to allow the turn in of the Ballylumford-Magherafelt 275 kV circuit.

Figure 5.1: Kells 275 kV Existing Layout



Source: Mott MacDonald

Figure 5.2: Option 3B Proposed Layout



Source: Mott MacDonald

5.2 Stage by Stage Description of the Proposed Solution

The indicative stage by stage presentation of this solution can be found in the stage by stage layout drawings in Appendix A, associated SLDs in Appendix B, and elevation drawings in Appendix C.

Stage 1 involves the offline build-out of two new outer diagonals on each side of the existing 275kV substation. These diagonals will be interconnected via two new 275kV underground (UG) cable circuits. Additionally, a new temporary overhead line angle tower will be built (note, tower position considers exclusion zone around Badger Setts, refer to PEA Report in Appendix F). This stage is estimated to take 18 months in total, excluding a 12-month lead time for the AIS substation. The 275kV UG cable circuits will take 4 months, and the new OHL tower and

enabling works will take 5 weeks. Outages will include Busbar 1A and 2A for 1 week each for the final connections of cable sealing ends (CSEs).

Stage 2 involves construction of a new OHL terminal tower in proximity to the Ballylumford terminal tower, after moving the Ballylumford-Magherafelt circuit to the new temporary tower constructed at the previous stage. This stage is estimated to take 5 weeks. An outage will be required on the Magherafelt circuit for 2 weeks to install the new terminal tower and make new connections. An outage will also be required on the Ballylumford-Magherafelt circuit for 1 week to complete its diversion.

In Stage 3, the Magherafelt circuit will be moved to the new terminal tower. This stage is estimated to take 1 week, with outages required on the Magherafelt circuit for the duration of the works.

Stage 4 involves moving the Ballylumford circuit to an existing tower. This stage is estimated to take 1 week, with outages required on the Ballylumford circuit for the duration of the works.

In Stage 5, a new temporary OHL tower is built. The Kilroot B circuit will be moved to the new tower. This stage is estimated to take 5 weeks, with outages required on the Kilroot B for 1 week to transfer the circuits to the new tower.

Stage 6 involves building a new OHL tower, which will become the new terminal tower for the Kilroot circuits. The Kilroot A circuit will be moved to the new tower, and the old OHL tower will be decommissioned. This stage is estimated to take 5 weeks, with outages required on Kilroot A for 2 weeks for top of the tower build and transferring the circuit to the new tower.

Stage 7 involves moving Kilroot B circuit to the new Kilroot circuit terminal tower and decommissioning of the temporary tower. This stage is estimated to take 5 weeks with outages required on Kilroot B for 1 week to transfer the circuit. At the conclusion of this outage, all existing circuits will have been transferred to the new diagonals, and the existing Kells 275 kV mesh can be de-energised.

Stage 8 involves the demolition of the old 275 kV AIS Substation including both existing transformers T1 and T2. This stage is estimated to take 6 months total and can be executed offline without the need for an outage.

Stage 9 involves the offline build-out of two new 275 kV diagonals and busbars, the removal of 275 kV UG link cables, and the connection of 275 kV busbars. This stage is estimated to take 9 months, with the new 275kV diagonals requiring the full duration. The removal of 275 kV UG link cables will take 10 weeks. Outages will be required on Busbar 2A and Busbar 1A for 2 weeks each for the change-over from link cables to busbar interconnection.

Stage 10 involves transferring the Ballylumford circuit to the central terminal tower and terminate to one of the new central diagonals while demolishing the old OHL tower. This stage is estimated to take 3 weeks in total, with 1 week to move the OHL circuit and 2 weeks to demolish the old OHL tower. An outage will be required the Ballylumford circuit for 1 week.

Stage 11 involves the Ballylumford-Magherafelt circuit will be turned in, and its associated temporary tower demolished. This stage is estimated to take 2 weeks, with outages affecting the new Ballylumford-Kells and new Magherafelt-Kells circuits for 1 week each to transfer the circuits to new towers.

Stage 12 shows the Option in its final arrangement.

5.3 Economic Performance

5.3.1 Capital Costs

The capital cost of this option is £51.06M. See Appendix E for associated bill of quantities.

A criteria ranking of Moderate (Dark Green) is assigned to Capital Costs for Option 3B.

5.3.2 Net Present Value

The Net Present Cost of this option is £57.98M. See Appendix E for associated NPV Calculation.

A criteria ranking of Moderate (Dark Green) is assigned to Net Present Value for Option 3B.

5.3.3 Overall Economic Performance Scoring

With regard to the criteria assessed, the Economic Performance criteria ranking for Option 3B is assessed to be Moderate (**Dark Green**).

5.4 Technical Performance

5.4.1 Compliance with Safety Standards

This option complies with relevant safety standards such as those from CENELEC. Materials will comply with IEC or CENELEC standards. As the majority of works take place in proximity to live equipment, due care and planning will be required to ensure the safe execution of works. The sequencing of works has been produced with Safe Working Clearances requirements in mind.

Note that the location of the proposed new OHL tower, at stage 3, under the existing Ballyumford-Magherafelt circuit will be subject to further assessment of any potential oversailing of the Kells 110 kV Cluster project.

Additionally, although it does not impact the scoring, refer to the Designer risk assessment produced, in Appendix G.

A criteria ranking of Low-Moderate (Green) is assigned to Compliance with safety standards for Option 3B.

5.4.2 Compliance with System Reliability and Security Standards

Kells 275 kV Substation is identified by NIEN as one of its most strategic sites which requires the highest resilience.

Option 3B, does comply with the SONI Transmission System Security and Planning Standards and the SONI Operation Security Standards.

It should be noted that the breaker & a half arrangement provides superior operational flexibility, when compared to double busbar, as circuit breaker maintenance can be carried out without the need for a circuit outage resulting in greater security of supply.

This option also has the advantage of meeting the long term need to turn in the nearby Ballylumford-Magherafelt 275 kV circuit which would increase security of supply.

A criteria ranking of Low (Yellow) is assigned to Compliance with system reliability and security systems for Option 3B.

5.4.3 Headroom

The existing substation rating is limited by the Arteche CA-300 CTs which have a rating of 1000 Amps. Modern 275 kV Substations would typically consider a busbar rating of 3150 Amps, with feeder bays rated for 2500 Amps.

This option includes for replacement of all existing assets and therefore can be designed with current standard primary equipment ratings, significantly increasing the headroom within the substation.

A criteria ranking of Low (Yellow) is assigned to Headroom for Option 3B.

5.4.4 Expansion/Extendibility

Currently there are two spare bays within the substation footprint, however the spare bays are likely only be suitable for transformer connections. This option would provide four spare bays once completed with the advantage that the nearby Ballylumford-Magherafelt 275 kV circuit has been turned in. The spare bays with this option could be used for any type of connection (cable, OHL or transformer). There is sufficient space within the substation footprint to allow a third 275/110kV transformer to be installed in the medium term. One of the spare bays would be reserved for a third 275/110kV transformer expected to be required in the medium term.

As Option 3B involves developing two new diagonals in the available space either side of the existing substation, there would be no further space within the existing compound to further expand/extend the 275 kV substation. However, there is potentially space in between the diagonals for a further two diagonals to be built out if required in the future.

A criteria ranking of Low-Moderate (Green) is assigned to Expansion/extendibility for Option 3B.

5.4.5 Technology Operational Risk

The technological risk associated with option 3B is low given that the breaker and a half arrangement is used by NIEN on the 275 kV network. Also noted is, depending on assessment of the current CT's and CB's, reusing them may present technological restrictions and future issues.

A criteria ranking of Low-Moderate (Green) is assigned to Technology operational risk for Option 3B.

5.4.6 Overall Technical Performance Scoring

With regard to the criteria assessed, the Technical Performance criteria ranking for Option 3B is assessed to be Low-Moderate (**Green**).

5.5 Deliverability Performance

5.5.1 Outage Assessment and Implementation Timelines

Option 3B has an implementation timeline of approximately 451 weeks. The timeline includes assumed dates, as advised by SONI, for the Utility Regulator approval, planning design, planning application approval, detailed design and construction mobilisation. The timelines for the various construction stages are estimated as part of this assessment and consider outages and outage seasons which have an impact on various stages of work.

It is anticipated that construction works will be finished by Q2 2035. It is noted however, that by Stage 5 of this option, the new 275 kV substation in a breaker and a half arrangement, with

increased capacity and reliability compared to the existing Kells 275 kV substation (4 feeder bays and 2 transformer bays) will be operational by late Q2 2033.

To facilitate construction of this option there is the requirement for approximately 15 separate outages on busbar sections and feeder circuits. The outages required are detailed in Table 5.1, while the implementation timelines for all options are detailed in Appendix D.

Contractors would have to be synchronised with the approval for outages and mobilise and demobilise accordingly.

Table 5.1: Option 3B – Required Outages

Outage	Number of Outages	Total Outage Period (Weeks)
Kilroot 'A'	1	2
Kilroot 'B'	2	2
Ballylumford 'A'	2	2
Magherafelt 'A'	2	3
Ballylumford – Magherafelt	1	1
Ballylumford 'B'	1	1
Magherafelt 'B'	2	3
Busbar 1A	2	2
Busbar 2A	2	2
Summary	15	18

Note that where there are two interbus transformers in service, outages on a third interbus transformer are not considered in the above assessment as it is not a risk towards network reliability.

A criteria ranking of Low-Moderate (Green) is assigned to outage assessment and implementation timelines for Option 3B.

5.5.2 Project Plan Flexibility

The plan is split into the aforementioned stages, this allows for flexibility in between stages taking breaks in construction if required.

There is limited flexibility to change the location of the new diagonals as they are being constructed in the limited available space within the existing substation compound.

As the new diagonals can be constructed offline, the return to service times are relatively short and are mainly driven by switching times and stringing of OHL lead-ins.

A ranking of Low-Moderate (Green) is assigned to Project Plan Flexibility for Option 3B.

5.5.3 Supply Chain Constraints

Option 3B's suggested replacement of the A frames used the NIEN standard steelwork gantries which are not deemed vulnerable to supply chain constraints or issues, inclusive of their foundations. The flexible conductor suggested in the replacement is common and readily available.

The remaining 275 kV equipment required along with the flexible busbar will be sourced where possible from NIEN resources, however these would be vulnerable to supply chain constraints. Where possible the reuse of CTs and CBs shall be assessed as this will aid the sourcing of equipment.

Additionally, a new transformer is also proposed within option 3B. Transformers are subject to significant supply chain constraints including long lead times due to order list demands placed on manufacturers and significant cost increases.

A criteria ranking of Moderate (Dark Green) is assigned to Supply chain constraints for Option 3B.

5.5.4 Planning Considerations

Option 3B comprises new and replacement AIS equipment, steelwork and gantries within the existing substation compound, and two new OHL towers outside the existing substation compound.

Permitted development rights are applicable to operational land (in this context NIEN operational land) under Class C (h)² – “*any other development carried out in, on, over or under the operational land of the undertaking*”. In this regard it is important to define the term ‘operational land’.

The definition of operational land in relation to Schedule 14 is defined in Section 2 (1) of The Planning (General Permitted Development) Order (Northern Ireland) 2015, as;

“(a) land which is used for the purpose of carrying on their undertakings; and

(b) land in which an interest is held for that purpose;

not being land which, in respect of its nature and situation, is comparable rather with land in general than with land, which is used, or in which interests are held, for the purpose of carrying on those undertakings:

Provided that where an interest in land is held by such undertakers for the purpose of carrying on their undertaking and—

(a) the interest was acquired by them on or after 1st October 1973; or

(b) it was held by them immediately before that date but the circumstances at that date were such that the land did not fall to be treated as operational land had this Order applied to it,

that land shall not be treated as operational land unless there is in force with respect to the land a planning permission granted on an application made in that behalf under Part 3 of the 2011 Act for its development and that development, if carried out, would involve the use of the land for the purpose of the carrying on of the undertaking”.

NIEN’s land folio is thus considered to comprise operational land in accordance with the definition above, as an interest is held by NIEN in this land for future expansion/ development of the substation and for the provision of related electricity transmission infrastructure.

The proposed new and replacement plant and equipment within the existing substation compound, which is considered NIEN operational land, will not exceed 18m threshold pursuant to Class C.1 (e) [Development not Permitted]. In this instance, proposed works within the existing substation compound are considered permitted development under Class C (h) [i.e. development on operational land of an electricity undertaker].

² Pursuant to Schedule, Part 14 – Development By Statutory And Other Undertakers – Development Permitted under Article 3, of The Planning (General Permitted Development) Order (Northern Ireland) 2015 (Statutory Rules No.70 of 2015)

The two proposed replacement OHL towers are located in lands adjoining the existing substation which is under NIEN ownership, and which also contain existing electrical transmission infrastructure – existing OHL towers.

It is considered that the proposed OHL towers fall under the definition of “electric line” as an OHL tower comprises “support” for an electricity conductor line, as prescribed within The Electricity (Northern Ireland) Order 1992 (as amended), under Section 3 – Interpretation, ie;

“*electric line*” means any line which is used for carrying electricity for any purpose and includes—

- a. any support for any such line, that is to say, any structure, pole or other thing in, on, by or from which any such line is or may be supported, carried or suspended;
- b. any apparatus connected to any such line for the purpose of carrying electricity; and
- c. any wire, cable, tube, pipe or other similar thing (including its casing or coating) which surrounds or supports, or is surrounded or supported by, or is installed in close proximity to, or is supported, carried or suspended in association with, any such line”

Pursuant to Class C [Permitted Development for electricity undertakers], “electric lines” are not listed as permitted development, therefore planning permission is required to be obtained. Under Class C (b) only feeder or service pillars and/or above or below ground substations relating to an electric line installations are permitted, not the electric line in and of itself.

A criteria ranking of Low-Moderate (Green) is assigned to Planning considerations for Option 3B.

5.5.5 Constructability

Option 3B would require NIE Networks personnel to deliver all the works as all works will happen within the live substation. A turn-key contractor solution would be challenging due to the proximity to the existing live 275kV equipment. Despite this, proximity outages are not required as the newly built out diagonals are constructed away from the live assets, with the centre diagonals only removed after all circuit transfers have been completed.

Due to the planned stages of this option, space is better utilised and allows for better access to undertake works. There is space available either side of the outer diagonals for machinery or other equipment. Outages are required in some cases to allow for transferring OHL circuits and for change-over from 275kV busbar link cables to busbar; this may require work crews to mobilise and demobilise many times. Additionally, the works must be synchronised with approvals for outages.

The majority of the works are within the existing substation compound; therefore, site access is already established, and the ground conditions are reasonably understood. However, as the option includes work outside the compound, ground conditions are unknown at this stage, and access would likely require some ground and vegetation clearance works and there is no current access point via the existing substation compound.

A criteria ranking of Low-Moderate (Green) is assigned to Constructability for Option 3B.

5.5.6 Geotechnical Considerations

The proposed Option 3B development is predominantly located on the existing engineered substation platform, where ground conditions are indicated to comprise engineered Made Ground (up to 2m thick) overlying Glaciofluvial Deposits comprising “compact” sand and gravel with clay pockets and firm to stiff Glacial Till to 10m depth. Although available historical ground investigation indicates the presence of localised thin layers of Peat and Organic Clay/Alluvium Deposits beneath the platform it is expected that these were removed during construction.

Ground conditions north of the platform in the area of the proposed OHL towers are indicated to comprise localised Made Ground, of unknown composition and thickness, and up to 2m of very soft to soft Peat and very soft to soft Organic Clay/Alluvium (only locally present), overlying “compact” Glaciofluvial Deposits and firm to stiff Glacial Till to 10m depth.

Groundwater is indicated to be present at shallow depths (1-2m depth).

Geotechnical risks to the proposed Option 3B development are predominantly associated with the presence of the very soft to soft ground conditions in the area of the proposed OHL towers, that present a potential risk of excessive/differential ground settlement and bearing capacity failure of shallow foundations, and potential excavation instability (or collapse) during the construction phase. The presence of shallow groundwater that may be encountered in any excavations may promote further groundworks instability. In addition, there is the risk of potential obstructions associated with naturally occurring cobbles and boulders present within the glacial deposits which may influence choice of piled solutions, as well as the potential for existing foundations, buried structures and services associated with the existing substation.

The current ground risks (as identified at desktop stage) associated with the existing development site can be further understood through implementation of a targeted ground investigation. This investigation should aim to characterise ground and groundwater conditions (including engineering properties and geo-environmental conditions) at the site which will facilitate ground risk management and inform civil engineering design and construction of suitable foundations, cable trough works and drainage for the development option to be progressed further. It is envisaged that cohesive glacial soils with boulder obstructions may promote non-driven piled foundation solutions and imported granular fills may be required to enhance poor ground bearing characteristics below shallow foundations.

A criteria ranking of Low-Moderate (Green) is assigned to Geotechnical Considerations for Option 3B.

5.5.7 Overall Deliverability Performance Scoring

With regard to the criteria assessed, the Deliverability Performance criteria ranking for Option 3B is assessed to be Low-Moderate (**Green**).

5.6 Environmental Performance

5.6.1 Biodiversity

While the majority of the proposed site works for Option 3B will occur within the curtilage of the existing substation some works will occur outside of the existing substation site. Development is proposed to occur to the north of the substation within the woodland and scrub area, where the relocation of some of the towers will require vegetation clearance to be carried out to both facilitate the tower relocation as well as access to the works areas.

In order to facilitate the proposed works for Option 3B habitat clearance, vegetation and tree removal will be necessary to facilitate tower relocations, realigning of the conductor and machinery access for works to be carried out.

None of the trees within proposed works areas were considered to be suitable for roosting bats or exhibited any potential roosting features. As such it is concluded that currently there is no impact to roosting bats will occur as a consequence of Option 3B. However, the habitat clearance, vegetation and tree removal will impact local bats foraging and commuting on site as they travel through the wider area.

The proposed works for Option 3B are considered to impact the local badgers both directly and indirectly through disturbance such as noise, vibration and human activity as well as through habitat loss and potential loss of a sett. An outlier sett - OS1, is located within 30m of the proposed location of a temporary tower, while the relocation works of the OHL towers north of the existing substation site will impede upon the 30m exclusion zone for annex sett. Therefore, a sett closure is required for the annex and outlier sett OS1 sett present on site. Details regarding procedures for badger sett closures are outlined in Appendix F.

A criteria ranking of Moderate-High (Blue) is assigned to Biodiversity for Option 3B.

5.6.2 Water Resources

The closest surface water feature is located approximately 50m east of the substation, a tributary of the Kellswater River (European Identification Code: GBNI1NB030302014) runs along the southeastern boundary of the existing substation, and continues along the southwest boundary, to the rear of the substation. This watercourse will not be impacted by Option 3B as the majority of the works are located within the existing substation site, while OHL tower relocation will have a greater separation distance than the works within the substation and no direct works are required to the Kellswater River tributary.

A criteria ranking of Low-Moderate (Green) is assigned to Water Resources for Option 3B.

5.6.3 Climate, Sustainability and Flood Risk

There is limited increased risk to flooding as the works under Option 3B within the substation compound will not result in any changes to the existing ground cover or ground levels which may otherwise result in increases to flood risk on or off-site. The number of towers to the north of the substation of with new towers causing minimal changes to ground conditions and therefore limiting flood risk.

Option 3B will not rely on any large or significant volumes of concrete, and as this option mostly is contained within the spatial extent of the existing substation there is a reduced need for earthworks activities (soil/rock removal) or use of aggregate fill.

A criteria ranking of Low-Moderate (Green) is assigned to Climate, Sustainability and Flood Risk for Option 3B.

5.6.4 Carbon Footprint

As described above, this option entails supply and construction of new and replacement AIS equipment, steelwork and gantries within the existing substation compound, as well as new OHL towers. This option also entails decommissioning and disposal of the equipment.

The supply of new equipment, its transport to site and installation will incur GHG emissions from the materials and equipment manufacturing (embodied carbon), as well as from their transport to site and installation process. Likewise, the decommissioning of equipment and disposal will require work on site, transport to waste disposal facility and waste treatment process³, all of these generating GHG emissions.

This option entails the use of AIS equipment, therefore emissions from use of SF6 gas (considering that SF6-free live tank AIS CBs at this voltage level are not readily unavailable) are expected during the installation, operation and decommissioning phases. Some GHG emissions associated with maintenance and repair works during the asset operational life can be expected

³ It is acknowledged that waste processing routes can vary depending on material type and disposal method chosen, certain routes such as recycling of material components might not lead to net GHG emissions. This is not considered in detail in the context of a qualitative carbon footprint assessment.

although their significance will likely to be low compared to emissions from equipment and materials supply and installation.

During the asset operation there will be transformer power losses, which will incur in carbon emissions (e.g. indirect emissions from the generation of the power that is lost), these can account for a significant proportion of the overall asset carbon footprint.

On a qualitative basis, the carbon footprint impact for this option is estimated to be moderate when compared to the other options evaluated. As a carbon footprint quantification has not been completed, the qualitative assessment is only based on the described scope of design for this option, indicative bill of quantities and estimated capital cost, and consideration of the impact of operational emissions (e.g. power losses).

A criteria ranking of Moderate (Dark Green) is assigned to Carbon Footprint for Option 3B.

5.6.5 Archaeology and Cultural Heritage

No recorded archaeological features/remains are located in the works areas related to Option 3B, however, potential exists for unrecorded below ground archaeological remains to be present at the areas of the new towers.

A criteria ranking of Low-Moderate (Green) is assigned to Archaeology and Cultural heritage for Option 3B.

5.6.6 Designated Landscapes, protected views and scenic routes

There are negligible changes to landscape/visual impact as a result of the works under Option 3B. The works will be of a similar, scale, design and nature as the existing electrical infrastructure within Kells substation. There is no change to the overall number of OHL towers under Option 3B, with a total of three OHL towers required under this option, with proposed towers located in the general locality of those to be removed.

A criteria ranking of Low-Moderate (Green) is assigned to Designated Landscapes, protected views and scenic routes for Option 3B.

5.6.7 Lands, soils and hydrogeology

The site of the existing Kells substation is recorded as being underlain by made ground with the surrounding area underlain by Till (superficial geology) and bedrock is recorded as Lower Basalt Formation.

The substation site and immediate surrounding area is underlain by a bedrock aquifer, categorised as "Moderate potential productivity fracture flow".

There is no superficial aquifer underlying Kells substation or within a 1km radius.

The groundwater vulnerability in the area underlying Kells substation and immediate surrounding area is rated as 2 – second lowest vulnerability classification.

Due to the works related to Option 3B being mainly located within the existing substation there is limited risk to soils/subsoils or aquifers from this option due to the limited earthworks required.

A criteria ranking of Low-Moderate (Green) is assigned to Lands, soils and hydrogeology for Option 3B.

5.6.8 Land Use compatibility

Option 3B is predominately contained within the existing substation site, therefore no change in land use will occur. Typically, OHL towers can and do occur in any land use type, the new towers under Option 3B will be located in close proximity to the existing OHL towers.

The existing site is approximately 3km from Kells village, and the lands surrounding the existing site are predominantly agricultural fields. The closest residential property to the existing substation is less than 50m to the east.

The planning applications approved in the vicinity of the existing substation relate mostly to single residential dwellings and applications relating to the existing substation. In March 2019, an application was granted for a Battery Energy Storage facility, approximately 140m northeast of the existing substation (application reference: LA03/2018/0984/F), which is now operational.

Option 3B will not result in any change to the existing land use, as all works are to be undertaken on lands within the ownership of NIE Networks as such the lands will continue to be facilitate electricity transmission infrastructure and does not result in a non-compatible land use.

A criteria ranking of Low-Moderate (Green) is assigned to Land use compatibility for Option 3B.

5.6.9 Overall Environmental Performance Scoring

With regard to the criteria assessed, the Environmental Performance criteria ranking for Option 3B is assessed to be Low-Moderate (**Green**).

5.7 Option 3B Criteria Scoring

The main criteria scoring for this option is presented below:

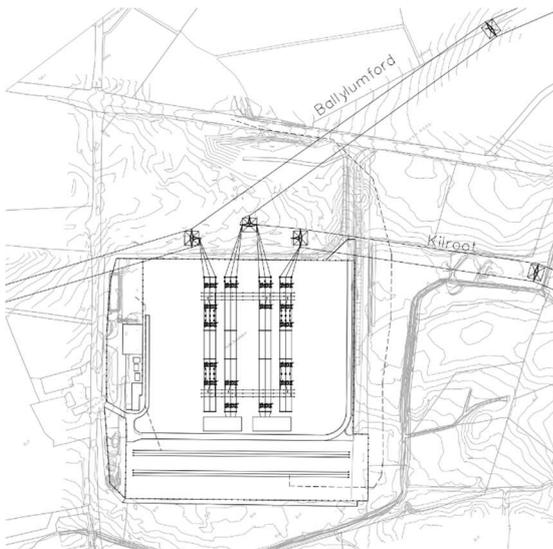
Criteria	Option 3B
Economic	Moderate Risk
Technical	Low-Moderate Risk
Deliverability	Low-Moderate Risk
Environmental	Low-Moderate Risk

6 Assessment – Option 4

6.1 Introduction

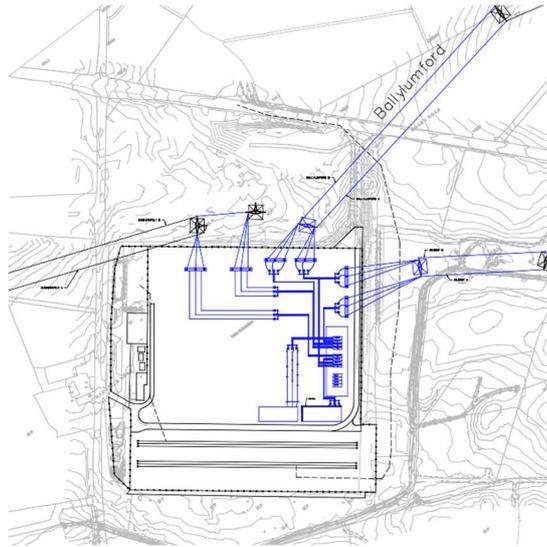
Option 4 includes the construction of a new 275 kV GIS substation on the current NIE Networks substation compound and owned land while decommissioning the existing AIS substation.

Figure 6.1: Kells 275 kV Existing Layout



Source: Mott MacDonald

Figure 6.2: Option 4 Proposed Layout



Source: Mott MacDonald

6.2 Stage by Stage Description of the Proposed Solution

The indicative stage by stage presentation of this solution can be found in the stage by stage layout drawings (Appendix A), associated SLDs (Appendix B), and elevation drawings (Appendix C).

Stage 1 involves the offline build-out of a new GIS substation (including new GIS building) within the existing substation compound, gas-insulated busbar (GIB), OHL angle tower, OHL gantries, and new interbus transformer. This stage is estimated to take 18 months in total, excluding a 24-month lead time for the transformer and an 18-month lead time for the GIS. The transformer installation will take 6 months, and the remaining works will take 12 weeks.

Stage 2 involves moving the Kilroot 'A' circuit to the new tower installed in the previous stage and connecting the GIB to low level equipment in the Kilroot 'A' diagonal. The remaining equipment, gantries and A frames in Kilroot 'A' are demolished, including the conductor back to the pre-existing OHL tower. This stage is estimated to take 10 weeks, with outages of 1 week to move the Kilroot 'A' circuit to the new tower, 9 weeks proximity outage on Kilroot 'B' and Busbar 1A and 2A for 2 weeks (The maximum individual outage is 1 week duration) while demolishing Kilroot 'A' equipment.

In Stage 3, the Kilroot 'B' circuit will be moved to the new OHL angle tower. The Kilroot 'B' diagonal and the Busbar 1A are removed, including the removal of the Kilroot terminal tower, down conductors and Transformer 2. This stage is estimated to take 17 weeks, with outages of, 1 week affecting Kilroot 'B' to transfer the circuit to the new tower, a 2-week proximity outage on

the remaining Kilroot 'A' diagonal equipment and Busbar 1A and 2A for 2 weeks (The maximum individual outage is 1 week duration) while decommissioning Kilroot 'B' equipment.

Stage 4 involves construction of a new OHL angle tower, gantries (within the existing Substation compound), and GIB, including enabling works. The Ballylumford circuit will be moved to the new tower. This stage is estimated to take 12 weeks, with an outage required on the Ballylumford circuit for 1 week to transfer the circuit to the new tower.

In Stage 5, the Magherafelt circuit will be moved to a new tower (central tower previously used for Ballylumford and Kilroot 'B'). This stage is estimated to take 1 week, with an outage required on the Magherafelt circuit for the duration of the works.

Stage 6 involves demolishing the remaining Magherafelt and Ballylumford diagonals, low level equipment remaining from Kilroot A, along with the Busbar 2A, remaining Busbar 1A, and connections to the existing transformer T1. Additionally, it encompasses building out a new gantry, GIB and AIS busbar including a new AIS busbar connection to a new transformer T2. This stage is estimated to take 34 weeks. The installation of the new transformer T2 requires 34 weeks. Demolishing the remaining existing 275 kV equipment including remaining 1A busbar and 2A busbar requires 12 weeks. The GIB and new AIS busbar installation will take 12 weeks, the gantry installation will take 4 weeks with GIB and new busbar, and the demolition of the corner of the mesh nearest to transformer T2 and the build-out of the new busbar connection to transformer T2 will take 10 weeks. Outages will affect transformer T1 for 10 weeks.

At Stage 7, the Magherafelt circuit is transferred to the new gantry, with a duration of 1 week. There is therefore an outage of 1 week on the Magherafelt line to complete the transfer.

Stage 8 involves building new GIB, AIS busbar, and gantry, and turning in the Ballylumford-Magherafelt circuit to the existing Ballylumford-Kilroot OHL tower. This stage is estimated to take 12 weeks in total, with the GIB and AIS busbar requiring the full duration. The gantry will take 4 weeks, and moving the circuits to the new towers will take 2 weeks. Outages will affect the Ballylumford-Magherafelt circuit for 1 week to transfer the circuits to the new towers.

Stage 9 shows the Option in its final arrangement.

6.3 Economic Performance

6.3.1 Capital Costs

The capital cost of this option is £61.60M. See Appendix E for associated bill of quantities.

Option 4 has the highest capital cost, primarily due to the GIS equipment; however, as it falls within the current compound there is no evident requirement for cut and fill for the substation, certain cut and fill may be required for the new OHL towers and gantries. Within the option new OHL towers and gantries are proposed, which along with the substation will require planning permission and all of its associated costs.

While this option is viable for a turn-key contractor solution, the specialist contractors required for GIS and GIB works may incur higher costs.

A criteria ranking of Moderate-High (Blue) is assigned to Capital Costs for Option 4.

6.3.2 Net Present Value

The Net Present Cost of this option is £69.37M. See Appendix E for associated NPV Calculation.

A criteria ranking of Moderate-High (Blue) is assigned to Net Present Value for Option 4.

6.3.3 Overall Economic Performance Scoring

With regard to the criteria assessed, the Economic Performance criteria ranking for Option 4 is assessed to be Moderate-High (Blue).

6.4 Technical Performance

6.4.1 Compliance with Safety Standards

This option complies with relevant safety standards such as those from CENELEC. Materials will comply with IEC or CENELEC standards. As the majority of works take place in proximity of live equipment, due care and planning will be required to ensure the safe execution of works. The sequencing of works has been produced with Safe Working Clearances requirements in mind.

Additionally, although it does not impact the scoring, please also see the Designer risk assessment produced, which is available in Appendix G.

A criteria ranking of Low-Moderate (Green) is assigned to Compliance with Safety standards for Option 4.

6.4.2 Compliance with System Reliability and Security Standards

Kells 275 kV Substation is identified by NIEN as one of its most strategic sites which requires the highest resilience.

Option 4 does comply with the SONI Transmission System Security and Planning Standards and the SONI Operation Security Standards.

It should be noted that the double busbar arrangement provides inferior operational flexibility, when compared to breaker & a half, as circuit breaker maintenance can be carried out without the need for a circuit outage resulting in greater security of supply.

This option also has the advantage of meeting the long term need to turn in the nearby Ballylumford-Magherafelt 275 kV circuit which would increase security of supply.

A criteria ranking of Low-Moderate (Green) is assigned to Compliance with system reliability and security standard for Option 4.

6.4.3 Headroom

The existing substation rating is limited by the Artech CA-300 CTs which have a rating of 1000 Amps. Modern 275 kV Substations would typically consider a busbar rating of 3150 Amps, with feeder bays rated for 2500 Amps.

This option includes for replacement of all existing assets and therefore can be designed with current standard primary equipment ratings, significantly increasing the headroom within the substation.

A criteria ranking of Low (Yellow) is assigned to Headroom for Option 4.

6.4.4 Expansion/Extendibility

Since this option involves the construction of a full new 12-bay GIS substation, there will be available bays for new connections making it simple to expand the network in this area without any upgrades to the substation.

At energisation, eight bays will be in use (including two for turning in the nearby Ballylumford-Magherafelt 275 kV circuit) so there will be four spare bays for future expansion. One of the spare bays would be reserved for a third 275/110kV transformer expected to be required in the medium term.

A criteria ranking of Low-Moderate (Green) is assigned to Expansion/extendibility for Option 4.

6.4.5 Technology Operational Risk

As this option is based on a new build GIS substation there are a variety of issues that present themselves. It is expected that the UK government will align with the EU directive (2024/573) relating to the use of fluorinated greenhouse gases (including SF6 gas). According to *article 13, clause 9 (d)* of this EU directive, restrictions will be placed on putting new SF6 switchgear into operation from the 1st January 2032.

Additionally, at present there are issues such as performance and reliability, technical adaptation, cost, and environmental impact with the SF6-alternatives being presented.

Currently, there is no gas or gas mixture available which matches the technical performance of SF6.⁴ The most sustainable alternative to SF6 is the use of compressed synthetic air⁴ (mixture of clean air, nitrogen and oxygen) with vacuum interrupters. However, while this alternative has a neutral climate effect and advantages associated with handling and safety, its' dielectric strength is less than SF6 and therefore the resulting GIS has a larger footprint.⁵

Other alternatives such as PFAS gas mixtures (commonly C4-FN or C5-FK) are considered as they achieve approximately the dielectric strength of SF6, and therefore similar footprint, while offering significantly reduced global warming potential compared to SF6. However, C4-FN and PFAS gases have known environmental issues and a limited number of manufacturers. For example, 3M were fined due to environmental and health issues associated with PFAS gases. Due to this, 3M are stopping all manufacturing of PFAS gases (including C4-FN) by the end of 2025.⁶

The reliability of the alternatives to SF6 is difficult to prove as SF6 alternatives for these higher voltages were only introduced around 2017 and therefore there is limited experience within the industry in relation to their long-term performance.

There is a lack of clear costs associated with SF6-alternative technology which has a direct impact on the availability of the technology. This also leads to a lack of evidence regarding the issues which impact their reliability and how SF6-alternative equipment compares to that currently used in SF6 GIS stations, regarding maintenance and the expert engineers required to undertake this maintenance. If repairs or invasive maintenance is required on the GIS equipment, there is a dependency on the manufacturer/OEM to carry out the works rather than NIEN personnel. This poses a risk of prolonged outages and limited flexibility where the specialist staff from the manufacturer/OEM have limited availability. This is an ongoing problem that NIEN are facing with GIS equipment.

⁴ Cigre, Paper No. 124, "Long-term performance and decomposition of Fluoronitrile-containing gas mixtures in gas-insulated systems", 2023, link: <https://cigre.org.uk/web-cont1001/uploads/Long-term-performance-and-decomposition-of-Fluoronitrile-containing-gas-mixtures-in-gas-insulated-systems.pdf>

⁵ Cigre, A3/B3 Colloquium 2023 Preferential Subject (PS1) Study Committee (B3, A3), "Zero Emission F-gas-free 420 kV GIS for a Net Zero Carbon Future", 2023, link: <https://cigre.org.uk/web-cont1001/uploads/Zero-Emission-F-gas-free-420-kV-GIS-for-a-Net-Zero-Carbon-Future.pdf>

⁶ 3M, 3M to Exit PFAS Manufacturing by the End of 2025, December 2022, link: <https://news.3m.com/2022-12-20-3M-to-Exit-PFAS-Manufacturing-by-the-End-of-2025#:~:text=Exit%20all%20PFAS%20manufacturing%20by%20the%20end%20of,fulfill%20current%20contractual%20obligations%20during%20the%20transition%20period.>

A criteria ranking of Moderate-High (Blue) is assigned to Technology operational risk for Option 4.

6.4.6 Overall Technical Performance Scoring

With regard to the criteria assessed, the Technical Performance criteria ranking for Option 4 is assessed to be Low-Moderate (**Green**).

6.5 Deliverability Performance

6.5.1 Outage Assessment and Implementation Timelines

Option 4 has an implementation timeline of approximately 469 weeks. The timeline includes assumed dates, as advised by SONI, for the Utility Regulator approval, planning design, planning application approval, detailed design and construction mobilisation. The timelines for the various construction stages are estimated as part of this assessment and consider outages and outage seasons which have an impact on various stages of work.

It is anticipated that construction works will be finished by late Q3 2035. To facilitate construction of this option there is the requirement for approximately 14 different outages on busbar sections, feeder circuits and transformers. The outages required are detailed in Table 6.1, while the implementation timelines for all options are detailed in Appendix D.

Contractors would have to be synchronised with the approval for outages and mobilise and demobilise accordingly.

Table 6.1: Option 4 - Required Outages

Outage	Number of Outages	Total Outage Period (Weeks)
Kilroot 'A'	2	3
Kilroot 'B'	2	10
Ballylumford 'A'	1	1
Magherafelt 'A'	2	2
Ballylumford 'B'	1	1
Magherafelt 'B'	1	1
Transformer T1	1	10
Busbar '1A'	2	2
Busbar '2A'	2	2
Summary	14	32

Note that where there are two interbus transformers in service, outages on a third interbus transformer are not considered in the above assessment as it is not a risk towards network reliability.

A criteria ranking of Moderate (Dark Green) is assigned to Outage Assessment and implementation timelines for Option 4.

6.5.2 Project Plan Flexibility

The plan for this option is split into the aforementioned stages this allows for flexibility in between stages taking breaks in construction if required.

Due to the nature of GIS substations having a small physical footprint, it allows greater flexibility in optimally locating the substation on site.

Due to the offline construction of the GIS substation, the option has relatively short return to service times, mainly driven by switching times and stringing of OHL lead-ins.

A criteria ranking of Low-Moderate (Green) is assigned to Project Plan flexibility for Option 4.

6.5.3 Supply Chain Constraints

As Option 4 is a new build GIS substation, it is expected that the UK government will align with the EU directive (2024/573) relating to the use of fluorinated greenhouse gases (including SF6 gas). According to *article 13, clause 9 (d)* of this EU directive, restrictions will be placed on putting new SF6 switchgear into operation from the 1st January 2032. Therefore, it may be vulnerable to the variety of supply issues associated with the SF6 alternatives, such as price and availability and unreliability. Notably, as advised by NIEN, there is a very limited number of suppliers of certain SF6-free alternative gases which poses supply chain risks.

The new SF6 alternative equipment as with all GIS is subject to specifically trained labourers for construction and maintenance. Additionally, the GIS is vulnerable to manufacturer price and availability and is likely to be affected by long order list delays.

Within this option, a new transformer is also proposed. Transformers are subject to significant supply chain constraints including long lead times due to order list demands placed on manufacturers and significant cost increases.

A criteria ranking of Moderate-High (Blue) is assigned to Supply Chain constraints for Option 4.

6.5.4 Planning Considerations

Option 4 comprises a new 275 kV GIS substation, including GIS and AIS equipment, and a new GIS building (i.e. an existing substation being replaced by a new substation), the height of this new building will be decided at detailed design, however it is confirmed that it will be a single storey building (c. 6.5m high) and will therefore not exceed 15m in height and will house control equipment which requires to be protected. The steelwork within the existing substation compound will not exceed 18m in height. Two new OHL towers are required along with associated gantries in lands to the northeast and east, in lands under the ownership of NIEN.

The proposed electrical infrastructure within the existing substation compound is considered to comprise permitted development pursuant to The Planning (General Permitted Development) Order (Northern Ireland) 2015, Part 14 – Development by Statutory and Other Undertakers, Class C (h) – Electricity undertakings. Restrictions on permitted development are applicable to Class C (h), specifically in relation to Option 4 these are listed under C.1 (e) (ii) which states that development which is not permitted includes *“the installation or erection by way of addition or replacement of any plant or machinery exceeding 18 metres in height or the height of any plant or machinery replaced, whichever is the greater”*. The replacement structures and new structures within the substation will not exceed 18m, therefore permitted development rights apply to development proposed within the curtilage of the existing substation compound.

The proposed GIS building under Option 4 falls under Class C (g) – *“the erection on operational land of the undertaking of a building solely for the protection of plant and machinery”*. There is a restriction placed on Class C (g) under C.1 (d) which states any building must not exceed 15 metres in height. The proposed GIS building will be single storey, and will not exceed 15m in height, and will be located on NIEN operational land. Permitted development rights are therefore considered to apply to the construction/development of this building.

As discussed under Option 3B (Section 5.5.4 of this report), the two proposed OHL towers for Option 4 will require planning permission, the OHL towers are considered to be defined under

the definition "electric line" which is not listed under Class C – Electricity Undertakings and therefore planning permission is required for these OHL towers.

A criteria ranking of Low-Moderate (Green) is assigned to Planning Considerations for Option 4.

6.5.5 Constructability

As Option 4 is built on the available space within the substation compound and utilising NIEN owned land for end masts and gantries. A turn-key contractor solution would be viable and therefore would not have a substantial impact on NIEN resources. However, there will be interfaces between the contractor and NIEN that must be considered and agreed (e.g. segregation of earth grid common with live substation).

The GIS would require specialist contractors who may have limited availability, posing a risk to the construction. Similarly, NIEN resources and specialist contractors would be required for the Gas Insulated Busbar (GIB) works.

As the majority of works will be constructed offline and can be segregated from live substation equipment, there is more unimpeded access for machinery and equipment as well as reduced outages. This avoids the need for work crews to mobilise and demobilise many times.

The majority works are within the existing substation compound; therefore, site access is already established, and the ground conditions are reasonably understood. However, as the option includes work outside the compound, sub-surface ground conditions are unknown at this stage, and access would likely require some ground and vegetation clearance works and there is no current access point via the existing substation compound.

A criteria ranking of Moderate-High (Blue) is assigned to Constructability for Option 4.

6.5.6 Geotechnical Considerations

The proposed Option 4 development is predominantly located on the existing engineered substation platform, where ground conditions are indicated to comprise engineered Made Ground (up to 2m thick) overlying Glaciofluvial Deposits comprising "compact" sand and gravel with clay pockets and firm to stiff Glacial Till up to 10m depth. Although available historical ground investigation indicates the presence of localised thin layers of Peat and Organic Clay/Alluvium Deposits beneath the platform it is expected that these were removed during construction.

Ground conditions northeast of the platform in the area of the proposed OHL towers are indicated to comprise localised Made Ground, of unknown composition and thickness, and up to 2m of very soft to soft Peat and very soft to soft Organic Clay/Alluvium (only locally present), overlying "compact" Glaciofluvial Deposits and firm to stiff Glacial Till to 10m depth.

Groundwater is indicated to be present at shallow depths (1-2m depth).

Geotechnical risks to the proposed Option 4 development are largely similar to Option 3B and are predominantly associated with the presence of the very soft to soft ground conditions in the area of the proposed OHL towers, that present a risk of excessive / differential settlement and bearing capacity failure of shallow foundations, excavation instability / collapse, exacerbated by the presence of shallow groundwater. In addition, there is the risk of potential obstructions in the form of cobbles and boulders present in the glacial deposits; and foundations, buried structures and services associated with the existing substation.

Implementation of a project-specific ground investigation will inform appropriate foundation, cabling and drainage designs to accommodate and manage the ground risks at the site. Construction proposals in terms of foundations will be as advised for Option 3B.

A criteria ranking of Low-Moderate (Green) is assigned to Geotechnical Considerations for Option 4.

6.5.7 Overall Deliverability Performance Scoring

With regard to the criteria assessed, the Deliverability Performance criteria ranking for Option 4 is assessed to be Moderate (**Dark Green**).

6.6 Environmental Performance

6.6.1 Biodiversity

Option 4 will require the removal of vegetation, habitat clearance and the felling of some trees in order to facilitate the works in the woodland/scrub area northeast of the existing substation site and to accommodate the relocation of towers and realigning of the associated conductors. There were no trees identified and assessed within the proposed works areas which were considered to be suitable for roosting bats or exhibited any potential roosting features. As such it is concluded that no impact to roosting bats will occur as a consequence of Option 4. However, the habitat clearance, vegetation and tree removal will impact local bats foraging and commuting on site as they travel through the wider area.

The proposed works for Option 4 are considered to impact the local badgers both directly and indirectly through disturbance such as noise, vibrations and human activity as well as through habitat loss and potential loss of a sett.

A sett closure may be required for the annex sett. Details regarding procedures for badger sett closure are outlined in Appendix F.

Option 4 will involve works directly adjacent to the Kellswater River tributary posing a risk of impact to the water quality of the watercourse directly on site as well as downstream beyond the boundaries of the proposed development site. These impacts may have the potential to indirectly and directly impact aquatic ecological receptors as well as sensitive habitats and otter. The potential impacts to otters from the proposed development are concluded to primarily centre on disturbance and habitat impacts.

A criteria ranking of Moderate-High (Blue) is assigned to Biodiversity for Option 4.

6.6.2 Water Resources

The proposed OHL tower to the east of the substation is located approximately 30m from a watercourse – tributary of the Kellswater River. The ecological status of the watercourse is categorised as 'moderate'. This proposed scenario of an OHL tower in proximity to the Kellswater River tributary is already present, with an existing tower with a similar separation distance from the river located further to the east.

There is no requirement for in-stream works to facilitate the construction of the proposed OHL tower however there is potential for pollution risk from construction activities, such as concrete pouring related to tower foundations, which has potential to result in detrimental water quality impacts if not appropriately mitigated.

A criteria ranking of Moderate (Dark Green) is assigned to Water Resources for Option 4.

6.6.3 Climate, Sustainability and Flood Risk

There is limited increased risk to flooding as Option 4 does not result in any changes to the existing ground cover or ground levels which may otherwise result in increases to flood risk on or off-site. The proposed GIS building is located within the identified floodplain, which can be

mitigated through the application of appropriate freeboard levels. The new OHL tower to the east is located in present day floodplain (for rivers); however, due to the limited foundation footprint there is limited impact on flood risk elsewhere.

Option 4 will not rely on any large or significant volumes of concrete, and as this option mostly is contained within the spatial extent of the existing substation, although it is noted that this option does include a GIS building compared to Option 3B. Notwithstanding, there remains a limited need for earthworks activities (soil/rock removal) or use of aggregate fill due to works occurring predominately within the substation compound and there is one additional OHL tower than the extant scenario.

A criteria ranking of Low-Moderate (Green) is assigned to Climate, Sustainability and Flood Risk for Option 4.

6.6.4 Carbon Footprint

This option entails of a full new 275 kV GIS substation on the current NIE Networks substation compound and owned land and decommissioning the existing AIS substation. It also entails new OHL towers.

Similar to Option 3B, Option 4 requires supply of new equipment, its transport to site and installation which will incur in GHG emissions from the materials and equipment manufacturing (embodied carbon), as well as from their transport to site and installation process. Likewise, the decommissioning of equipment and disposal will require work on site, transport to waste disposal facility and waste treatment process⁷, all of these generating GHG emissions.

This option entails the use of GIS equipment, which in this instance will use SF6-free gas, therefore emissions from gas during the installation and operation of the GIS equipment will result in a small carbon impact (compared to SF6 use). Some GHG emissions associated with maintenance and repair works during the asset operational life can also be expected. During the asset operation there will be transformer power losses, which will incur in carbon emissions (e.g. indirect emissions from the generation of the power that is lost), these can account for a significant proportion of the overall asset carbon footprint.

On a qualitative basis, the carbon footprint impact for this option is estimated to be moderate when compared to the other options evaluated. As a carbon footprint quantification has not been completed, the qualitative assessment is only based on the described scope of design for this option, indicative bill of quantities and capital costs, and consideration of the impact of operational emissions (e.g. power losses and minor emissions from SF6-free gases).

A criteria ranking of Moderate (Dark Green) is assigned to Carbon Footprint for Option 4.

6.6.5 Archaeology and Cultural Heritage

No recorded archaeological features/remains are located in the works areas related to Option 4; however, potential exists for unrecorded below ground archaeological remains to be present at the areas of the new towers.

A criteria ranking of Low-Moderate (Green) is assigned to Archaeology and Cultural Heritage for Option 4.

⁷ It is acknowledged that waste processing routes can vary depending on material type and disposal method chosen, certain routes such as recycling of material components might not lead to net GHG emissions. This is not considered in detail in the context of a qualitative carbon footprint assessment.

6.6.6 Designated Landscapes, protected views and scenic routes

The proposed works under Option 4 are of a similar design, scale and nature as the existing electrical infrastructure within and surrounding Kells substation. There is one additional OHL tower based on the current baseline; however, this single additional tower will have negligible impact when compared against the current baseline.

A criteria ranking of Low-Moderate (Green) is assigned to Designated Landscapes, protected views and scenic routes for Option 4.

6.6.7 Lands, soils and hydrogeology

Due to the works related to Option 4 being predominately located within the existing substation there is limited risk to soils/subsoils or aquifers from this option due to the limited earthworks required.

A criteria ranking of Low-Moderate (Green) is assigned to Lands, soils and hydrogeology for Option 4.

6.6.8 Land Use compatibility

Option 4 will not result in any change to the existing land use, as all works are to be undertaken on lands within the ownership of NIE Networks, as such, the lands will continue to facilitate electricity transmission infrastructure and does not result in a non-compatible land use. The proposed OHL tower to the east will be located within agricultural lands. Notwithstanding, OHL towers by virtue of their nature and design are required to traverse many different land types, therefore the location of the proposed OHL tower in agricultural land will not impact the continued use of the abutting agricultural lands. There is no non-compatibility with extant land uses under Option 4.

A criteria ranking of Low-Moderate (Green) is assigned to Land use compatibility for Option 4.

6.6.9 Overall Environmental Performance Scoring

With regard to the criteria assessed, the Environmental Performance criteria ranking for Option 4 is assessed to be Moderate (**Dark Green**).

6.7 Option 4 Criteria Scoring

The main criteria scoring for this option is presented below:

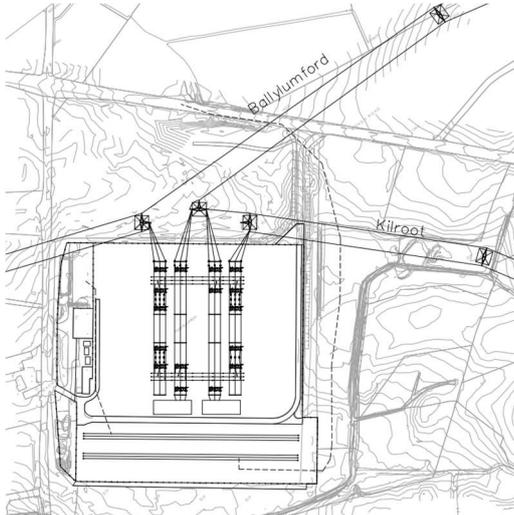
Criteria	Option 4
Economic	Moderate – High Risk
Technical	Low-Moderate Risk
Deliverability	Moderate Risk
Environmental	Moderate Risk

7 Assessment – Option 6

7.1 Introduction

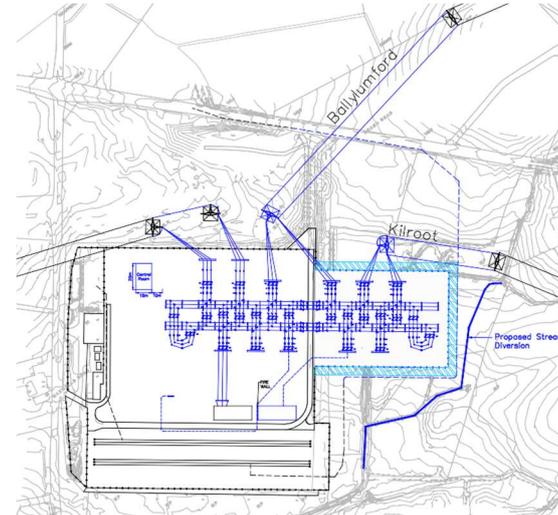
Option 6 is a partially offline build AIS substation solution. In this option a number of bays are built on NIEN owned land. This allows a transfer of the Kilroot circuits and a new transformer via temporary cable. This option allows the existing diagonals to be demolished to build out the remaining bays of the new AIS substation to be built out into the existing compound. This allows the Ballylumford-Magherafelt circuit to be turned in, and the Magherafelt and Ballylumford diagonals to be tied into the new substation. This option will require the diversion of a tributary of the Kellswater river.

Figure 7.1: Kells 275 kV Existing Layout



Source: Mott MacDonald

Figure 7.2: Option 6 Proposed Layout



Source: Mott MacDonald

7.2 Stage by Stage Description of the Proposed Solution

The indicative stage by stage presentation of this solution can be found in the stage by stage layout drawings (Appendix A), associated SLDs (Appendix B), and elevation drawings (Appendix C).

Stage 1 involves diverting the existing stream (tributary to the Kellswater River) on the NIEN owned land to the east of the existing 275 kV compound. Additionally cut and fill works on the NIEN owned land are required as the 110 kV Kells Battery Energy Storage customer connection underground cable (UG) is diverted around the planned development area with the redundant portion of cable removed. A total duration of the works is 52 weeks, with the cut and fill and cable diversion requiring 28 weeks, stream diversion 16 weeks and 8 weeks to remove the redundant cable. A 4-week outage of the 110 kV cable is required for its diversion and connection.

Stage 2 involves the offline build-out of a new AIS substation, including enabling works and new control room. This stage is estimated to take 18 months, excluding a 12-month lead time for the AIS substation.

At stage 3, a new transformer T3 and 275kV UG cable connection will be installed, along with 275kV UG link cables between the new double busbar and existing mesh. This stage is estimated to take 6 months in total, with the transformer build-out requiring the full duration and the UG cable circuits installation taking 3 months. Outages will be required on Busbar 2A and the Magherafelt diagonal on the existing 275kV AIS substation for less than 1 week to make the final UG cable connection.

Stage 4 involves building a new temporary OHL angle tower and moving the Kilroot 'B' circuit to the new tower. This stage is estimated to take 4 weeks, with outages required on the Kilroot 'B' circuit for 1 week to make the final connections.

At stage 5, the Kilroot 'A' circuit will be moved to the new temporary tower installed in stage 4. This stage is estimated to take 1 week, with outages required on Kilroot 'A' for the duration of the works.

Stage 6 involves building a new OHL angle tower and moving the Kilroot 'A' circuit to the new tower and make connections to the new Kilroot A bay in the new double busbar substation. This stage is estimated to take 4 weeks, with outages required on the Kilroot 'A' circuit for 1 week to make the final connections.

In Stage 7, the Kilroot 'B' circuit will be moved to the new OHL tower and connected into the new Kilroot B within the new double busbar AIS substation. The old Kilroot A OHL tower will be decommissioned. This stage is estimated to take 3 weeks in total, with 1 week to move the OHL circuit and 2 weeks to demolish the existing OHL tower. Outages will be required on the Kilroot 'B' circuit for 1 week.

Stage 8 involves demolishing the temporary OHL tower built at stage 4 and building a new OHL angle tower to accommodate the Ballylumford circuit into the new double busbar. This stage is estimated to take 5 weeks, with outages required on the Ballylumford circuit for 1 week to transfer the circuit to the new tower.

In Stage 9, the Magherafelt circuit is diverted into the new AIS substation utilising the existing OHL tower built in Stage 8. This stage is estimated to take 1 week, with outages affecting Magherafelt for the duration of the works.

Stage 10 involves demolishing half of the existing 275kV AIS substation, including transformer T2 and extending the new 275kV AIS double busbar substation. This stage is estimated to take 10 months in total, with 3 months for demolishing half of the old 275kV AIS substation, including T2 and 7 months for the extension of the new 275kV AIS substation. Outages will be required on transformer T2 for the duration of the works. Busbar 1A and 2A of the existing Kells 275 kV substation for 1 week each to disconnect busbars from portion being demolished.

At stage 11, a new transformer T2 is installed along with building out a new AIS busbar connection to transformer T2. This stage is estimated to take 24 weeks.

Stage 12 involves demolishing the remaining half of the existing 275 kV AIS substation, including transformer T1 and the final extension of the new 275 kV AIS substation. This stage is estimated to take 42 weeks in total, with 10 weeks to remove transformer T1, 12 weeks for demolishing the remaining half of the existing 275 kV AIS substation, and 20 weeks for the extension of the new 275 kV AIS substation. It should be noted that the 275 kV underground link cable to T1 installed in stage 3 will remain in place to be available for future connections.

In Stage 13, the Magherafelt circuit will be moved to a new bay on the 275 kV AIS substation. This stage is estimated to take 1 week, with outages affecting the Magherafelt circuit for the duration of the works.

Stage 14 involves turning in the Ballylumford-Magherafelt circuit to the new substation. This stage is estimated to take 2 weeks, with outages affecting the Ballylumford and Magherafelt circuits for 1 week each to transfer the circuits to the new towers.

Stage 15 shows the Option in its final arrangement.

7.3 Economic Performance

7.3.1 Capital Costs

The capital cost of this option is £58.06M. See Appendix E for associated bill of quantities.

Option 6 proposes a new build 275 kV substation partially on the adjoining NIEN owned land extending into the existing compound after demolishing the existing equipment. Due to this a significant cost involved is the cut and fill works required to ensure the new compound is on the same level as the existing.

Furthermore, as shown in the stage by stage layout drawings (see Appendix A) and mentioned in section 7.2, the 110 kV underground cable connecting to the battery storage facility must be relocated, increasing the costs.

A criteria ranking of Moderate (Dark Green) is assigned to Capital Costs for Option 6.

7.3.2 Net Present Value

The Net Present Cost of this option is £66.21M. See Appendix E for associated NPV Calculation.

A criteria ranking of Moderate-High (Blue) is assigned to Net Present Value for Option 6.

7.3.3 Overall Economic Performance Scoring

With regard to the criteria assessed, the Economic Performance criteria ranking for Option 6 is assessed to be Moderate-High (**Blue**).

7.4 Technical Performance

7.4.1 Compliance with Safety Standards

This option complies with relevant safety standards such as those from CENELEC. Materials will comply with IEC or CENELEC standards. As the majority of works take place within the proximity of live equipment, due care and planning will be required to ensure the safe execution of works. The sequencing of works has been produced with Safe Working Clearances requirements in mind.

Additionally, although it does not impact the scoring, please also see the Designer risk assessment produced, which is available in Appendix G.

A criteria ranking of Low-Moderate (Green) is assigned to Compliance with Safety standards for Option 6.

7.4.2 Compliance with System Reliability and Security Standards

Option 6 does comply with the SONI Transmission System Security and Planning Standards and the SONI Operation Security Standards.

This option also has the advantage of meeting the long term need to turn in the nearby Ballylumford-Magherafelt 275 kV circuit which would increase security of supply.

It should be noted that the double busbar arrangement provides inferior operational flexibility, when compared to breaker & a half, as circuit breaker maintenance can be carried out without the need for a circuit outage resulting in greater security of supply.

A criteria ranking of Low-Moderate (Green) is assigned to Compliance with System Reliability and Security standards for Option 6.

7.4.3 Headroom

The existing substation rating is limited by the Artech CA-300 CTs which have a rating of 1000 Amps. Modern 275 kV Substations would typically consider a busbar rating of 3150 Amps, with feeder bays rated for 2500 Amps.

This option includes for replacement of all existing assets and therefore can be designed with current standard primary equipment ratings, significantly increasing the headroom within the substation.

A criteria ranking of Low (Yellow) is assigned to Headroom for Option 6.

7.4.4 Expansion/Extendibility

Since this option involves the construction of a full new 11-bay (excluding coupler bays) AIS substation, there will be available bays for new connections making it simple to expand the network in this area without any upgrades to the substation. At energisation, 8 bays will be in use (including two for turning in the nearby Ballylumford-Magherafelt 275 kV circuit) so there will be three spare bays for future expansion. One of the spare bays would be reserved for a third 275/110kV transformer expected to be required in the medium term.

Further expansion is limited but if required can be accommodated via removing the end coupler on the control building end of the substation and adding two new bays.

A criteria ranking of Moderate (Dark Green) is assigned to Expansion/extendibility for Option 6.

7.4.5 Technology Operational Risk

With Option 6 proposing a full new build 275 kV AIS substation, it offers a lower technological operational risk, as it is much more reliable and offers greater system flexibility, especially from the standpoint of maintenance and ease of working.

A criteria ranking of Low-Moderate (Green) is assigned to Technology Operational risk for Option 6.

7.4.6 Overall Technical Performance Scoring

With regard to the criteria assessed the Technical Performance criteria ranking for Option 6 is assessed to be Low-Moderate (**Green**).

7.5 Deliverability Performance

7.5.1 Outage Assessment and Implementation Timelines

Option 6 has the longest implementation timeline of approximately 502 weeks. The timeline includes assumed dates, as advised by SONI, for the Utility Regulator approval, planning design, planning application approval, detailed design and construction mobilisation. The timelines for the various construction stages are estimated as part of this assessment and consider outages and outage seasons which have an impact on various stages of work.

It is anticipated that construction works will be finished by Q2 2036. To facilitate construction of this option there is the requirement for approximately 13 different outages on busbar sections, feeder circuits and transformers T1 and T2. The outages required are detailed in Table 7.1, while the implementation timelines for all options are detailed in Appendix D.

Contractors would have to be synchronised with the approval for outages and mobilise and demobilise accordingly.

Table 7.1: Option 6 - Required Outages

Outage	Number of Outages	Total Outage Period (Weeks)
Kilroot 'A'	2	2
Kilroot 'B'	2	2
Ballylumford 'A'	1	1
Magherafelt 'A'	3	3
Ballylumford 'B'	1	1
Magherafelt 'B'	1	1
Transformer T2	1	4
Busbar '1A'	1	1
Busbar '2A'	1	2
110 kV BESS Cable	1	4
Summary	13	21

Note that where there are two interbus transformers in service, outages on a third interbus transformer are not considered in the above assessment as it is not a risk towards network reliability.

A criteria ranking of Moderate-High (Blue) is assigned to Outage assessment and implementation timelines for Option 6.

7.5.2 Project Plan Flexibility

The plan is split into the aforementioned stages this allows for flexibility in between stages taking breaks in construction if required.

As Option 6 is partially built in the existing substation compound, it offers limited flexibility in optimally locating the new substation on site.

Due to the offline construction of the AIS substation, the option has relatively short return to service times, mainly driven by switching times and stringing of OHL lead-ins.

A criteria ranking of Moderate (Dark Green) is assigned to Project Plan flexibility for Option 6.

7.5.3 Supply Chain Constraints

Option 6 has a number of supply chain constraints, with the predominant being a new transformer, which has substantial lead times, extremely high manufacturer demand and increasing costs.

Additionally, all associated AIS switchgear, primary equipment, steelwork and cabling can be subject to the same constraints however these are typically not as significant, especially in regard to lead times.

A criteria ranking of Moderate (Dark Green) is assigned to Supply chain constraints for Option 6.

7.5.4 Planning Considerations

The lands related to the location of the proposed AIS substation which extends into lands to the east of the existing substation compound may not be considered to comprise 'operational land' as per the definition with The Planning (General Permitted Development) Order (Northern Ireland) 2015, as it is unknown whether planning permission was previously sought for these lands for the purpose of electricity undertakings by NIEN.

For the purpose of this assessment the assumption has been applied that planning permission has not been previously granted for electricity undertakings outside the existing substation compound, as such the definition of 'operational land' only relates to the existing Kells substation compound. In this regard, all works related to Option 6 will require planning permission as there are no permitted development rights applicable, as was otherwise available to Option 3B or 4 which are proposed on/within operational land.

A criteria ranking of Moderate (Dark Green) is assigned to Planning consideration for Option 6.

7.5.5 Constructability

Option 6 partially utilises the adjoining NIEN owned land and partially uses the existing substation compound. A turn-key contractor solution would be viable and therefore has a limited impact on NIEN resources. However, there will be interfaces between the contractor and NIEN that must be considered and agreed (e.g. segregation of earth grid common with live substation). Additionally, the relocation of the existing 110 kV cable to the battery storage facility, would require NIEN resources.

As large portion of the new substation built outside of the existing substation compound will be constructed offline and can be segregated from live substation equipment, there is more unimpeded access for machinery and equipment as well as reduced outages. This avoids the need for work crews to mobilise and demobilise many times.

Due to the proposed location of Option 6, a significant cut and fill program will be required to establish access and sub-surface ground conditions as well as to ensure the new substation is constructed on the same ground level as the current 275 kV equipment. Additionally, there is an existing stream (tributary to the Kellswater River) which will have to be culverted.

A criteria ranking of Moderate (Dark Green) is assigned to Constructability for Option 6.

7.5.6 Geotechnical Considerations

The proposed Option 6 development layout overlies the existing engineered substation platform and the undeveloped land to the east of the existing substation with new OHL towers to the immediate north and northeast.

Ground conditions beneath the existing engineered substation platform are indicated to comprise engineered Made Ground (up to 2m thick) overlying Glaciofluvial Deposits comprising "compact" sand and gravel with clay pockets and firm to stiff Glacial Till up to 10m depth. Although available historical ground investigation indicates the presence of localised thin layers of Peat and Organic Clay/Alluvium Deposits beneath the platform it is expected that these were removed during construction.

To the east of the existing platform the ground conditions are unproven. Geological mapping indicates the presence of Alluvium overlying Glaciofluvial Deposits and Glacial Till. Based on the available historical ground investigation elsewhere on site it is expected that the Alluvium deposits will comprise very soft to soft clay with pockets/layers of Peat that may be several metres thick.

Ground conditions north of the platform in the area of the proposed OHL towers are indicated to comprise localised Made Ground, of unknown composition and thickness, and up to 2m of very soft to soft Peat and very soft to soft Organic Clay/Alluvium (only locally present), overlying “compact” Glaciofluvial Deposits and firm to stiff Glacial Till.

Groundwater is indicated to be present at shallow depths (1-2m depth).

For development within the existing substation footprint and OHL towers to the north, geotechnical risks to the proposed Option 6 development are largely similar to Option 3B and 4, i.e. poor ground bearing soils and potential for excessive settlements below shallow foundations; and the presence of buried structures and services. For development to the east out with the existing substation footprint, soft compressible alluvial soils, peat and a high groundwater table may pose similar risks in terms of unsuitability of shallow foundations and unstable / flooded groundworks, although risk severity will be dependent on construction levels including finished engineered platform levels. There may be an opportunity to source suitable granular fill materials from the glaciofluvial deposits however, this will be dependent on cut/fill balance and positioning of the engineered platform.

The current ground risks (as identified at desktop stage) associated with the existing development site can be further understood through implementation of a targeted ground investigation, in particular within the eastern part of the development site (out with the substation). This investigation should aim to characterise ground and groundwater conditions (including engineering properties and geo-environmental conditions) at the site which will facilitate ground risk management and inform civil engineering design and construction of suitable foundations, earthworks and drainage for the development option. It is envisaged that cohesive glacial soils with boulder obstructions may promote non-driven piled foundation solutions whilst imported granular fills may be required to satisfy material quantities required to construct the engineered platform.

A criteria ranking of Moderate (Dark Green) is assigned to Geotechnical Consideration for Option 6.

7.5.7 Overall Deliverability Performance Scoring

With regard to the criteria assessed, the Deliverability Performance criteria ranking for Option 6 is assessed to be Moderate (**Dark Green**).

7.6 Environmental Performance

7.6.1 Biodiversity

Option 6 will require the removal of vegetation, habitat clearance and the felling of some trees in order to facilitate the works in the woodland/scrub area northeast of the existing sub-station site and accommodate the relocation of towers and relining of OHL routes. None of the trees within proposed works areas were considered to be suitable for roosting bats or exhibited any potential roosting features. As such it is concluded that no impact to roosting bats will occur as a consequence of Option 6. However, the habitat clearance, vegetation and tree removal will impact local bats foraging and commuting on site as they travel through the wider area.

The proposed works for Option 6 are considered to impact the local badgers both directly and indirectly through disturbance such as noise, vibration and human activity as well as through habitat loss and potential loss of a sett. An outlier sett - OS1, is located within 30m of the proposed location of a temporary tower, while the relocation works of the OHL towers north of the existing substation site will impede upon the 30m exclusion zone for annex sett. Therefore,

a sett closure is required for the annex and outlier sett - OS1. Details regarding procedures for badger sett closure are outlined in Appendix F.

In order to facilitate the proposed works for Option 6 habitat clearance, vegetation and tree removal will be necessary to facilitate tower relocations and machinery access for works to be carried out.

The proposed development works for Option 6 will also involve re-routing the watercourse which intersects through the proposed development site's eastern and southern eastern fields. The works pose a risk to the water quality of the watercourse potentially affecting sensitive ecological receptors such as fish. Option 6 will require additional ecological surveys to inform potential impacts and mitigation for habitats, aquatic flora and fish. The rationale for these surveys is outlined within the PEA in Appendix F. The potential impacts to otters from the proposed development are concluded primarily to centre around disturbance and habitat impacts. There is potential for direct impacts to otters through:

- Habitat loss
- Potential for temporary fragmentation of commuting routes/hunting grounds

However, long term the impacts to otter are not considered to be significant as banks become revegetated, and the otters will not have lost any connectivity along this watercourse through the wider area as part of their extended territory.

Culverts are considered to be detrimental to otters and can have a long-term negative impact on otter presence and activity in an area. Culverting will result in:

- A loss of bankside vegetation
- Increase in siltation of the watercourse and,
- Affect the riverbed both on site and downstream of the site
- Increases flow rates and therefore increases potential for otter drowning (especially during storm/flood events)

A criteria ranking of High (Dark Blue) is assigned to Biodiversity for Option 6.

7.6.2 Water Resources

Option 6 extends the existing substation compound to the east, resulting in the requirement to divert approximately 250m section the tributary to the Kellswater River to facilitate this expansion. This resulting hydro-morphological alteration has potential to impact the physical characteristics and ecological function of the river. River diversions can disrupt natural river processes, affecting flow, sediment transport, temperature, and overall habitat structure.

A criteria ranking of Moderate-High (Blue) is assigned to Water Resources for Option 6.

7.6.3 Climate, Sustainability and Flood Risk

The new offline AIS substation and new OHL tower are partially located with the mapped extents of the existing and future floodplain associated with the tributary of the Kellswater River. The proposed control cabin is located outside the present and future river floodplain. The proposed AIS building is located within the identified floodplain, which can be mitigated through the application of appropriate freeboard levels. Notwithstanding, the proposed AIS substation results in a change to existing ground levels to provide an extension of the substation, including the infilling of a section of the watercourse to facilitate this option. Option 6 represents the greatest change to existing ground levels and ground type, as such, this may have potential to impact flood risk within the substation and off-site due to the existence of a floodplain related to the adjacent Kellswater River tributary.

Option 6 will require the greatest level of earthworks (soil/rock removal) activities and use of aggregate fill due to work, similarly the extent of the works are the greatest under Option 6 and will result in the largest use of concrete compared to other options.

A criteria ranking of Moderate (Dark Green) is assigned to Climate, Sustainability and Flood Risk for Option 6.

7.6.4 Carbon Footprint

Similar to Option 3B, Option 6 requires supply of new equipment, its transport to site and installation which will incur in GHG emissions from the materials and equipment manufacturing (embodied carbon), as well as from their transport to site and installation processes. In this option the construction requires expanding the site footprint to occupy part of NIEN operational land, which imply land use change with potential net GHG emissions, however these are likely to be of low significance given the small area occupied.

The decommissioning of equipment and disposal will require work on site, transport to waste disposal facility and waste treatment process⁸, all of these likely to generate GHG emissions.

This option entails the use of AIS equipment, therefore emissions from use of SF6 gas (considering that SF6-free live tank AIS CBs at this voltage level are not readily unavailable) are expected during the installation, operation and decommissioning phases. Some GHG emissions associated with maintenance and repair works during the asset operational life can be expected although their significance will likely to be low compared to emissions from equipment and materials supply and installation. During the asset operation there will be transformer power losses, which will incur in carbon emissions (e.g. indirect emissions from the generation of the power that is lost), these can account for a significant proportion of the overall asset carbon footprint.

On a qualitative basis, the carbon footprint impact for this option is estimated to be moderate when compared to the other options evaluated. As a carbon footprint quantification has not been completed, the qualitative assessment is only based on the described scope of design for this option, indicative bill of quantities and capital costs, and consideration of the impact of operational emissions (e.g. power losses).

A criteria ranking of Moderate (Dark Green) is assigned to Carbon Footprint for Option 6.

7.6.5 Archaeology and Cultural Heritage

There is no risk to recorded archaeological features/remains, however, potential exists for unrecorded below ground archaeological remains to be present at the areas of the new tower/AIS substation.

A criteria ranking of Low-Moderate (Green) is assigned to Archaeology and Cultural Heritage for Option 6.

7.6.6 Designated Landscapes, protected views and scenic routes

There is an increase to landscape/visual impact as the works will comprise additional equipment/structures within the existing substation and new offline AIS substation which intensifies/expands electricity transmission infrastructure in the area. The greatest visual impacts occur from views into the site from the east, northeast and southeast, as there is limited existing screening of the proposed site for the extension of the substation. It is noted that the

⁸ It is acknowledged that waste processing routes can vary depending on material type and disposal method chosen, certain routes such as recycling of material components might not lead to net GHG emissions. This is not considered in detail in the context of a qualitative carbon footprint assessment.

closest residential property, located approximately 100m to the southeast of the substation extension is partially screened by an existing hedgerow/treeline.

Mitigation of the visual impacts through hedgerow and tree planting would be required should this option be progressed to construction.

A criteria ranking of Moderate (Dark Green) is assigned to Designated Landscapes, protected views and scenic routes for Option 6.

7.6.7 Lands, soils and hydrogeology

Option 6 will result in changes to lands/soils as infill activities will be required in order to provide a level platform for the AIS substation extension, which may have potential for changes to hydrogeology.

A criteria ranking of Moderate (Dark Green) is assigned to Lands, soils and hydrogeology for Option 6.

7.6.8 Land Use compatibility

The lands to the east of the existing substation, where the proposed extension is located, are currently agricultural lands, thus resulting in a change to the existing land use. Option 6 will be undertaken on lands within the ownership of NIE Networks, as such, the lands will facilitate the expansion of an established land use for electricity transmission infrastructure onto abutting lands. The proposed OHL tower to the east will be located within agricultural lands.

Notwithstanding, OHL towers by virtue of their nature and design are required to traverse many different land types, therefore the location of the proposed OHL tower in agricultural land will not impact the continued use of the abutting agricultural lands. Option 6 is a compatible land use as it provides an expansion of an abutting established utility infrastructure land use within NIE owned lands.

A criteria ranking of Low-Moderate (Green) is assigned to Land use compatibility for Option 6.

7.6.9 Overall Environmental Performance Scoring

With regard to the criteria assessed, the Environmental Performance criteria ranking for Option 6 is assessed to be High (**Dark Blue**).

7.7 Option 6 Criteria Scoring

The main criteria scoring for this option is presented below:

Criteria	Option 6
Economic	Moderate-High Risk
Technical	Low-Moderate Risk
Deliverability	Moderate Risk
Environmental	High Risk

8 Conclusion

8.1 Overview

SONI have identified several requirements for Kells 275 kV substation. These include:

- The need to address a known issue relating to the deflection of the substation catenary support structures (concrete ‘A’ frames) and their deflection under fault conditions.
- The long term need to turn in the nearby Ballylumford-Magherafelt 275 kV circuit.
- Addressing limitations with the existing mesh arrangement.
- Replacing the ageing 275kV equipment (circa. 55 years old) in the medium term.
- The need for a third 275/110kV transformer in the medium term.

This report builds on the Interim Options Report and is the development of a further assessment of the technical, economic, deliverability and environmental aspects of each of the shortlisted options. This report provides a recommendation of an emerging preferred option to be brought forward for further development.

The outcomes of the assessment are outlined in Table 8.1.

8.2 Comparative Evaluation

An overview of each of the sub-criteria for each of the shortlisted options is summarised in Table 8.1 to allow a comparative analysis of the rankings which has resulted in the overall performance ranking.



Table 8.1: Options Comparison Overview

	Option 1	Option 3B	Option 4	Option 6
Economic Performance				
Capital Costs	Yellow	Green	Blue	Green
Net Present Value	Green	Green	Blue	Blue
Economic Performance Subtotal	Green	Green	Blue	Blue
Technical Performance				
Compliance with Safety Standards	Blue	Green	Green	Green
Compliance with System Reliability and Security Systems	Dark Blue	Yellow	Green	Green
Headroom	Blue	Yellow	Yellow	Yellow
Expansion/Extendibility	Blue	Green	Green	Green
Technology Operational Risk	Green	Green	Blue	Green
Technical Performance Subtotal	Dark Blue	Green	Green	Green
Deliverability Performance				

	Option 1	Option 3B	Option 4	Option 6
Outage Assessment and Implementation Timelines	Yellow	Light Green	Green	Blue
Project Plan Flexibility	Yellow	Light Green	Light Green	Green
Supply Chain Constraints	Yellow	Green	Blue	Green
Planning Considerations	Yellow	Light Green	Light Green	Green
Constructability	Yellow	Light Green	Blue	Green
Geotechnical Considerations	Yellow	Light Green	Light Green	Green
Deliverability Performance Subtotal	Yellow	Light Green	Green	Green
Environmental Performance				
Biodiversity	Yellow	Blue	Blue	Dark Blue
Water Resources	Yellow	Light Green	Green	Blue
Climate, Sustainability and Flood Risk	Yellow	Light Green	Light Green	Green
Carbon Footprint	Yellow	Green	Green	Green
Archaeology and Cultural heritage	Yellow	Light Green	Light Green	Light Green
Designated Landscapes, protected views and scenic routes	Yellow	Light Green	Light Green	Green
Lands, soils and hydrogeology	Yellow	Light Green	Light Green	Green
Land use compatibility	Yellow	Light Green	Light Green	Light Green
Environmental Performance Subtotal	Yellow	Light Green	Green	Dark Blue
Overall Combined Score				
	Dark Blue	Light Green	Green	Dark Blue

8.2.1 Economic Performance

The economic performance of Option 1 naturally scores well as it is based on a “do nothing” approach. However, it must be noted that if a “do-nothing” approach was taken, the potential degradation of the concrete ‘A’ frames could result in spalling of the concrete to the point where it becomes a significant risk to health and safety at work. As reflected in the NPV calculation, Option 1 would require a full in-situ replacement of equipment in the near future, posing significant costs.

Options 4 and 6 perform similarly in the Economic Performance criteria with Option 4 being the most expensive option, primarily due to the GIS equipment.

Option 3B performs better than Options 4 and 6 under the Economic Performance criteria.

8.2.2 Technical Performance

Options 3B, 4 and 6 all have the advantage of meeting the long term need to turn in the nearby Ballylumford-Magherafelt 275 kV circuit.

As well as providing four fully equipped spare bays, Option 3B could potentially allow space in-between the diagonals for a further two diagonals (four bays) to be built out if required.

Options 3B, 4 and 6 include for replacement of all existing assets and therefore can be designed with current standard primary equipment ratings, significantly increasing the headroom within the substation.

Within Option 4, there are four spare bays available making it simple to expand the network in this area without any upgrades to the substation. However, the main constraint with option 4 is the uncertainty around the performance, reliability, technical adaptation, cost, and environmental impact of SF6-free alternatives.

Within Option 6, further expansion is limited but if required can be accommodated via removing the end coupler on the control building end of the substation and adding two new bays.

Option 1 is rated high-risk under technical performance due to the known operational resiliency issues as described in the SONI/NIEN Joint Investigation report, see section 4.3.2 for details. On this basis Option 1 is excluded from being proposed as the emerging preferred option. Additionally, it must be noted that if a “do-nothing” approach was taken, the potential degradation of the concrete ‘A’ frames could result in spalling of the concrete to the point where it becomes a significant risk to health and safety at work. On these bases Option 1 is excluded from being proposed as the emerging preferred option.

8.2.3 Deliverability Performance

The deliverability of Option 1 naturally scores well as it is based on a “do nothing” approach. However, it must be noted that if a “do-nothing” approach was taken, the potential degradation of the concrete ‘A’ frames could result in spalling of the concrete to the point where it becomes a significant risk to health and safety at work.

Options 3B, 4 and 6 all include a requirement for new transformers to be installed during the works sequence. Transformers are subject to significant supply chain constraints including long lead times due to order list demands placed on manufacturers and significant cost increases.

For option 3B, a turn-key contractor solution would be challenging due to the proximity to the existing live 275kV equipment, however the majority of the primary equipment installation works can be completed offline. Overall, the constructability of Option 3B scores better than options 4 and 6.

Option 4 has a moderate timeline yet requires the least number of outages of all the options. Option 4 also offers greatest project plan flexibility due to physical footprint of GIS substation. However, it is expected that the UK government will align with the EU directive (2024/573) relating to the use of fluorinated greenhouse gases (including SF6 gas). According to *article 13, clause 9 (d)* of this EU directive, restrictions will be placed on putting new SF6 switchgear into operation from the 1st January 2032.

Option 6 is the only option which will result in development requiring the culverting or diverting of the tributary of the Kellswater River. Potential for planning permission to be obtained for the entire development under option 6 may be more likely given the nature of the ecological impacts to the watercourse. Any permitted development rights may be lost should there be potential impacts to a European site (sites which protected under the Habitats or Birds Directives) caused by such works.

8.2.4 Environmental Performance

The environmental performance of Option 1 naturally scores well as it is based on a “do nothing” approach. However, it must be noted that if a “do-nothing” approach was taken, the potential degradation of the concrete ‘A’ frames could result in spalling of the concrete to the point where it becomes a significant risk to health and safety at work.

Options 3B, 4 and 6 will all include works to occur outside of the curtilage of the existing substation site. The area to the north of the existing site will require vegetation clearance works for all options to facilitate machinery and works to occur in the area for the relocation of OHL towers. Additionally, options 3B, 4 and 6 will each impact the annex badger sett located in this area as OHL towers are proposed for relocation within the 30m exclusion zone of this sett.

Options 3B and 6 will also impact outlier sett OS1 located to the north due to the proposed location of a temporary OHL tower to aid in facilitating works on site. It is considered all of the proposed design options will have a negative impact to the badgers on site due to the need for badger sett closures.

Options 4 and 6, however, are considered to have a greater impact ecologically due to proposed works occurring on the banks of the watercourse for Option 4 and 6. Option 4 will relocate a new OHL tower to the banks of the watercourse which will pose a risk to water quality increased risk of hydrocarbon spill, siltation and impacts to otters and habitats particularly downstream beyond the site boundaries. As a result, options 3B and 4 are considered to be equally impactful due to impacts to badger setts and otters via the water course for option 4.

Option 6 is considered to be the most impactful due to the proposal to also re-route the watercourse in order to facilitate the new AIS substation. This option impacts otter through fragmentation of extended territorial ranges as well as through habitat loss. Further ecological surveys are required to inform potential impacts and mitigation for habitats, aquatic flora and fish. In addition, Option 6 impacts badgers, with proposed works occurring within an exclusion buffer for an annex and outlier badger sett as detailed within the PEA in Appendix F.

8.3 Emerging Preferred Option

Based on the multi-criteria assessment presented in this report, Option 3B is recommended as the emerging preferred option.

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A. Stage by Stage Layouts

B. Stage by Stage SLDs

C. Elevation Drawings

D. Implementation Timelines

E. Net Presentation Value Calculations

F. Preliminary Ecological Assessment (PEA) Report

G. Designer Safety Risk Assessments

