Project Code/Version Number:
SSEN03/V2.0

1. Project Summary

1.1. Project Title:	New Suite of Transmission Structures (NeSTS)
1.2. Project Explanation:	Overhead lines (OHLS) are the most recognisable aspects of the transmission network. The New Suite of Transmission Structures project will create a new breed of overhead line supports that are smaller, better for the environment and could save up to £174 million for customers before 2050.
1.3. Funding Licensee:	Scottish Hydro Electric Transmission plc (SHE Transmission)
1.4. Project Description:	1.4.1. The Problems it is exploring The GB network is undergoing significant reinforcement and expansion to accommodate the connection of renewable generation essential for the delivery of The Carbon Plan. NeSTS addresses two problems: a. The increase in renewable generation is driving the need for new OHLs, often in remote areas with limited infrastructure and challenging construction and operational conditions. b. OHLs are the most visible elements of the electricity network and there is, at times, opposition to new projects. Besides the T-Pylon, OHL design has remained static for 90 years, despite new technologies and techniques which could offer environmental benefits and savings to customers. 1.4.2. The Method that it will use to solve the Problem NeSTS will develop innovative designs for OHL supports – these are expected to be smaller and better for the environment than traditional designs, while delivering cost savings for customers. The new suite of structures will then be deployed on the transmission network. The project leverages learning from the NIA_SHET_0010 project and will prototype and test the new structures, before detailing the designs for deployment on a planned overhead line project. Two innovative tools will support effective knowledge dissemination – the Support Assessment Matrix and a visualisation software tool. 1.4.3. The Solution it is looking to reach by applying the Method The NeSTS project develops and demonstrates a new alternative to conventional supports. The project offers a fully validated suite of supports tested against a range of conditions

	representative of GB's networks. The designs offer benefits through reduced foundations, civil requirements and improved stakeholder acceptance than traditional supports. 1.4.4. The Benefits of the project NeSTS offers anticipated financial and environmental benefits to customers. Transmission Operators benefit from reduced construction requirements and NeSTS's compatibility with the harsh terrain and weather associated with areas with abundant renewable sources.

1.5. Funding

1.5.1 NIC Funding Request (£k)	£6,639k	1.5.2 Network Licensee Compulsory Contribution (£k)	£750k
1.5.3 Network Licensee Extra Contribution (£k)	N/A	1.5.4 External Funding – excluding from NICs (£k):	N/A
1.5.5. Total Project Costs (£k)	£7,501k		

1.6. List of Project Partners, External Funders and Project Supporters	Scottish Power Transmission and National Grid Electricity Transmission have confirmed their position as project supporters. Energyline Ltd designed the tower structure suites for the Network Innovation Allowance (NIA) project and will continue to work on the design as a project supplier. Social Market Research Ltd will work as project supplier to support stakeholder consultation. TNEI is a project supplier and will validate the benefits offered by the new OHLs.

1.7 Timescale

1.7.1. Project Start Date	05 January 2016	1.7.2. Project End Date	31 March 2022

1.8. Project Manager Contact Details

1.8.1. Contact Name & Job Title	Frank Clifton (Project Development Manager)	1.8.2. Email & Telephone Number	fnp.pmo@sse.com 01738 456414

1.8.3. Contact Address	Future Networks, Scottish and Southern Energy Power Distribution, Inveralmond House, 200 Dunkeld Road, Perth PH1 3AQ
1.9: Cross Sector Projects (only include this section if your project is a Cross Sector Project).	
1.9.1. Funding requested the from the Electricity NIC (£k, please state which other competition)	N/A
1.9.2. Please confirm whether or not this Electricity NIC Project could proceed in the absence of funding being awarded for the other Project.	This project will not go ahead without NIC funding. The funding request only seeks to cover the additional costs and risks of deploying NeSTS for the first time. This funding will provide resources for knowledge capture and dissemination, stakeholder engagement, modification of industry standards, and additional support from Energyline Ltd on a technical basis. Because the designs have not yet been trialled in GB, this project would be considered as too high risk to proceed without NIC support.

Section 2: Project Description

Section 10 contains details of links and sources referenced throughout the submission.

2.1. Aims and objectives

Overhead lines (OHLs) are the most widely recognised component of the GB electricity transmission network. New OHLs can incur opposition at the planning stages due to their perceived negative visual and environmental impact. The New Suite of Transmission Structures (NeSTS) will develop and demonstrate a completely new approach to OHL design, to deliver anticipated environmental benefits and savings of up to £174 million for future investment in the country's Transmission System.

2.1.1 Overview

This section describes the aims and objectives of the project.

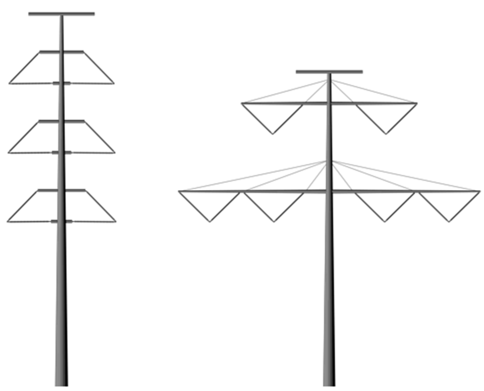
The current energy 'trilemma' concerning security of supply, sustainability and affordability poses a number of challenges to Transmission Operators (TOs). TOs must:

- create additional network capacity for the connection of renewable energy;
- develop a network which can cope with rising volumes of customer demand; and
- deliver both without any compromise to system safety or integrity.

In order to meet these challenges all TOs in Great Britain (GB) have plans to reinforce and upgrade the transmission network. This will be achieved by the creation of new infrastructure, including a significant number of new OHLs. Transmission customers and developers seeking connection will pay for some of this work through Transmission Network Use of System[1] (TNUoS) charges and TOs must reduce costs where practical.

The objective of this NIC project is to develop and demonstrate new OHL support designs on an OHL project. If successful, the new designs could deliver cost and environmental benefits. The funding request covers only the additional, incremental costs associated with first time deployment – the cost for the main OHL project will be met by established funding mechanisms such as the Volume Driver mechanism[2]. NeSTS will leverage the benefits of a number of new technologies and techniques that have been developed or trialled individually but have not been deployed together at scale. Without validation and confidence gained through NIC development and demonstration, TOs are unlikely to adopt these innovations into their asset portfolios.

Figure 2.1 The NeSTS 510 series (left) and 540 series (right)



An ongoing SHE Transmission NIA project developed eight OHL suites and shortlisted two for further development and demonstration (pictured left). These designs are provisional and may be modified throughout the NIC project. The first is the 510 series: a single pole with vertical, insulated cross arms. The second is the 540 series: again a single pole, but with tri-form lattice cross arms.

2.1.2 The Problem

This section describes (i) how the increase in new, low carbon generation is driving the need for new OHLs and (ii) the need to innovate new support designs to provide new options for locations where traditional supports, or recently developed structures such as the T-Pylon may be unsuitable.

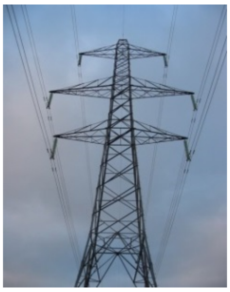


Figure 2.2 Traditional steel lattice suspension supports

GB's existing transmission network was largely created in the 1950s. The network's transformation included the wide-scale deployment of steel lattice supports, as shown in Figure 2.2, the design of which was created in the 1920s. The steel lattice design offered the necessary separation of conductors between each phase and from the ground, and was at that time readily accepted by the public.

OHL supports over the last 85 years in GB have generally used the same design. They typically feature a steel lattice tower with a single earth wire at the apex, and insulators attached to the cross arms. Whilst these OHLs are safe and reliable, there are new challenges associated with necessary network investment. The drivers behind this investment and TO priorities are outlined below.

Low carbon networks and resilience

SHE Transmission is undertaking £3-£5 billion[3] of infrastructure investment throughout RIIO: T1 alone – the other TOs have similar investment plans, which are outlined in Appendix 4. This is necessary to facilitate the transition to a low carbon economy, as mandated by the UK Government through the Climate Change Act[4] and The Carbon Plan[5].

Traditionally, a relatively small number of centralised, fossil-fuelled power stations have met electricity demand. The existing transmission infrastructure has ensured a secure, safe and reliable energy supply, accommodating well understood and largely static demand profiles. However, the grid was not designed to support large volumes of energy being transferred from geographically dispersed sources such as renewable, nuclear and carbon capture and storage. New infrastructure is therefore required.

In many of these locations, there is little or no existing transmission infrastructure and new OHLs are likely to be required to connect renewable energy. In areas with existing infrastructure, it may be necessary to rebuild OHLs and supports to cope with the cumulative impact of new renewable connections. Renewable energy sources, such as wind farms, are much more geographically dispersed than traditional power stations and may be situated in coastal and/or remote locations, often at higher altitudes. The new OHLs and supports need to withstand strong winds and heavy ice accretion. Construction of new infrastructure can be challenging due to terrain and access issues. Figure 2.3 shows a traditional OHL support in construction. In uneven, mountainous terrain, the foundations and the support need to be carefully designed to withstand risks caused by side slope. Additional leg extensions may be necessary to ensure that appropriate phase and ground clearances are maintained. Additional bracing and strengthening is often required to ensure that the support is robust enough to cope with ground conditions and local weather events.

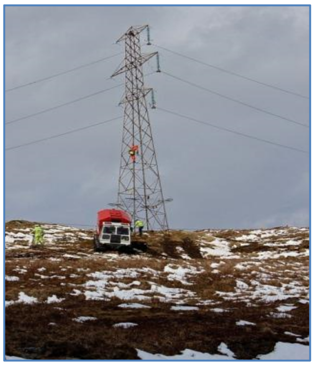


Figure 2.3: Steel lattice tower in construction

Figure 2.4: Fallen tower after 2013 snow storm

The prevalence of severe weather events in remote regions can dramatically affect the asset health of infrastructure. For instance, in the Scottish Highlands, low temperatures cause frequent ice accretion, affecting mechanical load on OHL supports. In critical conditions, weather events can result in conductors snapping, cross-arms breaking, and in the most extreme cases, supports overturning. Figure 2.4 shows a broken OHL support following the storms seen in Arran and Kintyre in 2013. Lightning can also cause faults on OHLs through damage to insulators or conductors. Unearthed wooden poles such as the 132kV Trident may incur complete structural failure.

New infrastructure projects entail substantial civil engineering as well as electrical and mechanical works. Permanent and temporary access roads are necessary to enable movement of heavy goods, cranes and vehicles to every OHL support along the entire route length of a circuit, which can span several dozen kilometres. Each section of the circuit needs careful environmental management to protect vulnerable flora, fauna, earth composition and hydrology. Civil and environmental management for OHLs can form a significant proportion of the total cost of new infrastructure.

Visual and environmental impact

An increasing number of stakeholders have expressed concerns about the impact of network construction and operation on communities and the environment. OHL projects in particular, can be contentious; the Beauly Denny project alone received in excess of 17,000 responses during the consultation period. These are largely related to concerns around the visual impact of new overhead line infrastructure. Significant delays can arise at project consent stages as a result, which have corresponding impacts on costs.

While undergrounding infrastructure using cables is an alternative, in many cases this is impractical and can be prohibitively expensive. Underground cables may also negatively affect the environment more than OHLs would. For example, civil works for underground cables involves trench excavation that can leave visual ‘scars’ on the landscape. This can result in the compaction of soil which can harm local bio-diversity. Installing an OHL is generally the most cost effective and least harmful option. National Grid Electricity Transmission (NGET) has sought a way to improve the visual and environmental impact of OHLs through the T-Pylon. SHE Transmission welcomes the development of the T-Pylon but recognises that there are limitations to its application, which creates a need for alternative solutions such as NeSTS.

The T-Pylon

The T-Pylon, pictured in Figures 2.5 and 2.6, is a monopole structure with diamond shaped insulators, and is shorter than 400kV traditional steel lattice supports. It was developed following a DECC and NGET design competition and the final design selected by the public. The T-Pylon met with approval by the public in a YouGov poll[7] carried out in April 2015. Out of 2,444 respondents, 59% liked the design of the T-Pylon, compared to only 36% of people having a positive view on steel lattice supports.

Figure 2.5: Artist impression of T-Pylon (NGET) **Figure 2.6: T-Pylon in construction (NGET)**

The T-Pylon design has undergone additional engineering development since the initial concept due to electrical and mechanical requirements. Learning from the project confirms that the T-Pylon may best suit low level terrain for 400kV overhead line projects, such as that depicted in Figure 2.5. However, preliminary discussions with NGET have suggested that the T Pylon does not lend itself to deployment in challenging environments.

Of the three GB TOs, SHE Transmission's network geography and climate poses the greatest challenges for T-Pylon deployment. The higher altitudes, problematic access and likelihood of severe weather in areas such as the Highlands are best suited for architectures such as the T-Pylon.

Conclusion

The need to reinforce and expand the transmission network will likely require a significant number of new OHL projects. New OHLs using traditional designs can cause concern amongst stakeholders. However, the only alternative OHL design is the T-Pylon which is unsuited to areas with challenging terrain and propensity for severe weather. Establishing connections in these areas is essential to connect renewable generation - there is, therefore, a needs case for a new type of OHL design.

2.1.3 The Method

This section describes the method being trialled to solve the problems.

SHE Transmission will develop a New Suite of Transmission Structures (NeSTS) and then demonstrate these on the live transmission network on an OHL project. The suite incorporates the full range of supports required to deliver a project including suspension, terminal, and light and heavy angle supports. The innovation in NeSTS arises from the development and demonstration of a range of new technologies and techniques, brought together for the first time. These could include:

§ new electrical and mechanical arrangements to create a new OHL support layout;

- the use of novel insulator and conductor arrangements such as insulated cross arms, innovative new lightning protection and high temperature low sag conductors technology;
- improve electrical performance and resilience, extending asset life
- reduced maintenance requirements and improved operational performance ; and
- new foundation techniques proven in other industries.

The NIC project leverages learning from the NIA NeSTS project (NIA_SHET_0010), which enabled the development of preliminary designs. The NIA project reviewed a selection of emerging technologies, and evaluated practices and technologies which had been successfully implemented outside of GB. The outputs of the project included several designs meriting further development and the development of the Support Assessment Matrix (SAM). Appendix 10 contains the NIA project's progress report

It is anticipated that NeSTS will create a suite of OHL supports that are smaller than traditional steel lattice supports, with reduced foundations and civil requirements. This could create savings of up to £174 million (see Section 3 for business case), achieved through the simpler tower and reduced civil works for access and foundations. NeSTS could also produce environmental benefits and aligns with several aims of The Carbon Plan – this is discussed in Section 4.1. The shorter height, reduced access requirements and smaller footprint could improve visual amenity while causing less disruption to local wildlife and land. Crucially, the new design may help to ease the consenting process.

The project consists of two discrete phases; the first 'development' phase will include a review of the work to date to validate the NeSTS concept and will see the, creation and testing of initial prototypes. Crucially, key stakeholders will be consulted early in the project to seek their initial feedback on the new design. Our strategy is to continue the Stakeholder Engagement activities throughout the project and is described in detail in Appendix 3. Similarly material suppliers and construction contractors will also be engaged to ensure that the new solution can be successfully delivered. At the end of this phase, a stage gate will review the business case and assess the impact of recent policy developments on the future requirement for OHLs. This safeguards the remaining project funds of £5 million. The NeSTS project will only proceed to the next phase if the business case remains positive. The second 'demonstration' phase will refine the designs for the chosen route to ensure that they are ready to proceed to construction and conduct full scale testing before moving to implementation and energisation. Suitable equipment will be procured and installed to monitor the performance of the new supports. While the second phase lists knowledge dissemination as part of its activities, please note that knowledge will be disseminated incrementally throughout the project. Figure 2.7 provides a brief guide to the project programme – the full programme is described in Appendix 5. This Method will drive the designs from a technology readiness level of 4 to 8, providing TOs with the necessary confidence for deployment. NeSTS will be designed to ensure optimum scalability at 132kV and potentially to 400kV.

Figure 2.7: Brief guide to NeSTS programme

Phase	Stage	Activities
PHASE 1 – DESIGN DEVEL	Stage 1.1 – Concept Proving	Internal review of NIA project outputs and confirm requirements
		Third Party technical review of work to date.
		Refine assessment & selection criteria

		Initial engagement with Statutory Authorities and other stakeholders
		Initial engagement with material suppliers and contractors
		Develop full suite of supports
		Prepare prototype scope and testing requirements
		Refine design and confirm preferred solutions
	Stage 1.2 – Prototypes and Initial Testing	Build scale prototypes - 'fit' and connection check
		Confirm requirements and design for ancillary equipment and facilities
		Prove elements and components
		Evaluate outputs
	Stage 1.3 – Parallel Design	Select potential trial routes
		Select contractor
		Evaluate against conventional options for route application
		Conventional application - planning and environmental appraisal
		Conventional application – main works
		Conventional application – associated works
		New design application - planning and environmental appraisal inc technical assurance
		New design application - main works
		New design application – associated works.
		Compare and review NeSTS with conventional supports
		Refine design further
	Stage 1.4 – Prep for Full Scale Testing	Finalise full scale and component testing requirement
		Develop testing - procurement and technical management
		Evaluate outputs and designs
		Prepare Phase 2 specification
		Evaluate Business Case.
STAGE GATE		**Review Stage 1 outputs and NeSTS Business Case**
PHASE 2 – DEMONSTRATION AND IMPLEMENTATION	Stage 2.1 – Planning and Evaluation for the New Design inc Full Scale Testing	Apply for planning & environmental consent
		Test components and main elements at full scale.
		Design details of new structures
		Evaluate Outputs
		Type test support at European test facility
		Consultation with stakeholders
	Stage 2.2 – Implementation and Construction	Deliver construction of project using new design approach
		Develop new operational practices to suit new designs
		Develop new technology specific tools and equipment
	Stage 2.3 – Monitoring and Evaluation	Procure equipment for monitoring and evaluation of installed design
	Stage 2.4 – Knowledge Dissemination	Implement learning & dissemination activities (note this stage will run concurrently with all other stages throughout the project)

2.1.4 The Development or Demonstration being undertaken

This section outlines the project programme.

The NeSTS project has two phases. NIC funding provides support for the additional, incremental costs of developing and deploying NeSTS for the first time only. NIC funding is essential to give TOs sufficient confidence that NeSTS is a suitable alternative to conventional supports and the T-Pylon. NIC funding enables SHE Transmission to conduct the following tasks:

- development and demonstration of NeSTS concept including design, construction, operation and maintenance ;
- consult with licensees, statutory authorities, supply chain and other stakeholders;
- carry out prototype testing and evaluation;
- develop policies/ processes for construction, safety, operation and maintenance; and
- Gather, analyse and share learning from the project.

The detailed programme can be seen in Appendix 5, and is outlined below. The prototype testing and full scale deployment on the live network are essential to understand NeSTS's (i) resilience (ii) suitability for a future deployment within a comprehensive range of ground conditions and (iii) electrical and mechanical performance. This will provide TOs with the information needed to adopt NeSTS.

Stakeholder consultation forms an important part of the project. Experience gained during consultation on SHE Transmission existing projects has strongly indicated that statutory authorities, planners, licensees and other stakeholders would welcome innovation that could reduce the visual and environmental impact of infrastructure projects. The NIC programme will include additional consultation with statutory authorities, licensees and the supply chain from the start of the project and will continue this throughout the project to develop NeSTS supports that are technically, visually and environmentally acceptable.

Phase 1: Design Development and Testing

Stage 1.1: Design Review and Concept Proving (January 2016 - January 2017)

The first stage of the project will review the NIA outputs and establish the potential for additional innovation. It will then develop the suite of supports, and prepare the prototype and testing specification. A third party technical review of the work to date to validate the outputs from the NIA project will be undertaken. This will also identify the key design areas and risks which will be the focus of the early stages of the NIC project. This stage includes early engagement with key statutory bodies to capture their views and gauge the acceptability of the new supports, this will allowing their views to be considered as the design is developed and providing an opportunity for them to indicate the locations and environments which are best suited to the new supports. Engagement with material suppliers and construction contactors will allow them to contribute to the development of the designs.

Stage 1.2: Prototypes and Initial Testing (December 2016 – September 2017)

Stage 1.2 involves further stakeholder consultation to include licensees, statutory authorities and the supply chain, as well as other interested parties. This will inform the refinement of the design. Scale prototypes will be created to verify the fit and connection, and to test the components. Requirements for ancillary equipment and facilities will be considered before evaluating outputs and refining the designs.

Stage 1.3: Parallel Design (January 2017 – March 2018)

This stage selects potential project routes for the trial. The designs are evaluated against traditional supports for a route application. The conventional design will be developed alongside the new designs to avoid any potential delay to the delivery of the project. The construction contractor will be identified at this stage to ensure that they are fully engaged in the design process. Further technical assurance will be conducted to ensure that the designs developed are robust.

Stage 1.4: Preparation for Full Scale Testing (September 2017- October 2018)

Stage 1.4 finalises full scale testing requirements and implements a competitive process to procure testing management. This stage will also see the information on the business case being collated. This will see a qualitative and quantitative Assessment of the project informed by the Sustainable Commercial Model (SCM). The SCM was developed on an earlier NIA funded project and provides a mechanism for considering not just the economic cost but the wider holistic value of new support designs.

Stage Gate: (October – November 2018)

The stage gate between Phases 1 and 2 of NeSTS will be a formal process involving SHE Transmission's Innovation Steering Board and Director of Transmission. At this point, SHE Transmission will evaluate whether NeSTS will deliver the projected benefits and decide whether to proceed with NeSTS to full demonstration on the live network. This will also give an opportunity to assess the future requirement for OHLs in light of recent UK Government policy development regarding renewable generation.

Phase 2: Implementation

Stage 2.1: Planning and Evaluation inc Full Scale Testing (July 2018 – December 2019)

At this stage further component testing and element testing will be undertaken. At this point, any final design modifications will be actioned and the designs will be fully type tested in a dedicated facility. This is crucial in ensuring the design is supply chain ready and acceptable to other TOs. SHE Transmission will instigate a planning and consent application for the OHL, involving formal consultation with stakeholders.

Stage 2.2 Implementation and Construction (November 2018 - July 2020)

It is at this stage that NeSTS moves to construction and commission. New operational practices, tools and equipment will be developed and tested. The construction methodology will be validated, including access, egress and plant requirements.

Stage 2.3: Monitoring and Evaluation (April 2020 – March 2021)

Stage 2.3 will involve the procurement and set up of monitoring equipment to evaluate the performance of the NeSTS designs. Typically this will include thermal imagery, noise and electro-magnetic field surveys and dynamic response and partial discharge monitoring. The monitoring regime will be determined to reflect the selected supports.

Stage 2.4: Knowledge dissemination (November 2016 – March 2022)

SHE Transmission will share outputs to maximise the value of NIC funding. A key output will be the publication of a cost-benefits analysis tool, visualisation tools and an e-learning module. This is described in Section 5 of this document.

2.1.5 The Solution

This section describes the solution which is enabled by solving the problem.

The NeSTS solution is a suite of OHL support designs, to include suspension, tension and terminal supports, applicable at all transmission-level voltages. This approach is anticipated to offer cost and environmental benefits when compared to traditional OHL supports. Knowledge from the project offers several outputs for the industry.

Firstly, the NeSTS designs are fully validated and provide investment-level confidence to licensees. They have been tested and evaluated against a range of climate and topographical challenges. A cost-analysis tool and visualisation tool will help licensees to evaluate NeSTS for application on their networks.

All TOs work with stakeholders to improve the visual and environmental impact of their work. NeSTS's reduced height and foundation requirements may result in less controversy during the planning stages of an OHL project and beyond. If this is the case, time and costs may be saved during the consent processes, and ultimately, new projects may be more quickly facilitated. The outputs from the early stage stakeholder consultation may also help inform planning for future OHL projects. The NeSTS project is designed to bring the new supports into business as usual (BaU) by TOs through the knowledge dissemination plan. The plan supports TOs but also aims to ensure that statutory authorities, landowners and the supply chain benefit from learning gained throughout the life of the project.

2.2. Technical description of Project

Section 2.2 provides a technical overview of the method and outlines why NeSTS is innovative (and carries an element of risk). Additional information can be found in Appendices 7 and 10.

The project delivers NeSTS through NIC's allowed Technology Readiness Levels of 4 to 8. NeSTS will develop and provide technical specifications for a new type of OHL supports that are smaller and have reduced foundation and civil engineering requirements than traditional OHL supports. The project involves extensive design, testing and stakeholder consultation to create new supports with improved environmental and visual impact. The technology readiness level of individual components is at 4 at the moment and will be moved through to 8 by the end of the project. This is described in Section 6.

As described earlier in this section, OHL support design in GB has changed very little in almost 90 years despite the development of new technologies and techniques. TOs do not have the necessary confidence to deploy these as BaU without a full demonstration of their effectiveness. The many complexities involved in OHL projects mean that first-time NeSTS application without NIC-funded demonstration would create cost and time risks wholly unsuited to a BaU project. For example, TOs would need to work with stakeholders through the planning and consent stages to introduce the new technologies. Introducing unfamiliar network components without first informing their design through comprehensive engagement with statutory authorities could cause delays at the planning stages of a new project. Therefore, it is necessary to conduct a full development and demonstration NeSTS project, funded using the protection of NIC.

External funding has not been sought for this project. This is because the NeSTS Method will be trialled on a SHE Transmission OHL project. Experience shows that potential issues with concurrent funding or governance caused by an organisation other than SHE Transmission would present unacceptable risk to the selected OHL project's delivery timescales. SHE Transmission will work collaboratively on NeSTS with several participants. Project suppliers and supporters are listed below. Selection processes are described in Section 4.4.

Subject to the final agreement of commercial arrangements the three project suppliers are likely to be:

- **Energyline**, which would continue its current technical supplier role in the NIA project for the application design and assume responsibility for design assurance and technical approval.

- **Social Market Research**, which would assist in the customer engagement involved in the project such as developing and managing customer survey, interviews and events. It would support the analysis of data for reports which would inform and assess the NeSTS design.

- **TNEI**, which would provide independent validation of the financial and environmental benefits of the NeSTS approach.

National Grid Electricity Transmission and Scottish Power Transmission are confirmed as project supporters and as participants on the project's working group.

2.3. Description of design of trials

This section outlines how NeSTS is designed to produce statistically sound results and robust learning outputs.

NeSTS will be deployed on a selected OHL project over a length of circuit. This presents a range of ground, altitude and climate issues to test the new supports and de-risk future deployment. Monitoring after installation will provide analysis of movement, vibration and noise.

SHE Transmission has adopted clear learning objectives for NeSTS, defined as a discrete work package and supported by established knowledge management procedures. Please see Section 5 for full details of the NeSTS project's knowledge dissemination plans. Building on the approach taken on SHE Transmission's Multi-Terminal Test Environment project, a working group will be set up to provide a platform for sharing OHL learning and good working practice. This enables all TOs to benefit from learning from both NeSTS and other OHL developments including the T-Pylon.

SHE Transmission's innovation projects use governance processes based on its 'business as usual' Large Capital Project governance parameters to ensure robust methodology and good practice. This includes the use of 'Stage Gates' to evaluate projects at pivotal stages before allowing them to proceed to subsequent phases. As shown in Section 6 the usual Stage Gates will be in place for the NeSTS Project – however, an additional Stage Gate will be added between Phases 1 and 2 of NeSTS. This allows the project team to evaluate the merits of progressing to full construction and deployment or whether to close the project.

2.4. Changes since Initial Screening Process (ISP)

SHE Transmission has developed the programme further and established project suppliers. The funding request has reduced from £7.7 million to £6.6 million.

Section 3 Project Business Case

Please note that further information for this section can be found in Appendix 4 and 6.

3.1. Introduction

SHE Transmission, NGET and SPT share statutory duties as transmission licensees: to ensure the development and maintenance of an efficient, coordinated and economical system of electricity transmission; to facilitate competition in the supply and generation of electricity; and to have due regard for preservation of amenity. The drive toward a low carbon electricity sector, and in particular, the growth in new renewable generation in remote areas requires an increase in network capacity through the creation of new infrastructure. The cost of new infrastructure will be factored into GB electricity consumers' bills.

TNEI analysis, based upon information contained in NGET's Ten Year Statement[7], shows that, on average, up to 250km new OHL projects are planned each year on the GB transmission network during the RIIO-T1 period (see Appendix 4 for further details). Increasing volumes of renewable generation combined with the anticipated increase in future electrical demand require significant investment to provide the necessary network capacity. SHE Transmission is investing to upgrade and reinforce the network, with a £3bn - £5bn investment programme in progress[3]. The other TOs have similar investment plans during this period.

3.2 Deriving the business case

This section describes the approach used to ensure the NeSTS business case is robust and how results from the project are designed to be statistically sound. The section links to 4g of the NIC Governance Document's Evaluation Criteria:

'Demonstration of a robust methodology and that the project is ready to implement.'

SHE Transmission, with support from TNEI, has used several sources of data to calculate the project's business case. The include (i) National Grid's Electricity Ten Year Statement[7] (ETYS) (ii) National Grid's Future Energy Scenarios 2014[8] (FES) and (iii) NGET's Transmission Entry Capacity(TEC) Register[9], supplemented by additional information from SHE Transmission and Energyline.

3.2.1 Future OHL Build Requirements

The ETYS was analysed to identify the projected volumes of additional OHL required by each of the TOs during the RIIO: T1 period. This new infrastructure is largely driven by the growth in new renewable generation and increased electricity demand. This analysis is described in more detail in TNEI's report, contained in Appendix 4. Beyond the RIIO: T1 period, the FES have been used as a basis for assessing the need for new infrastructure in the longer term. The FES models a range of scenarios for the development of the GB transmission system, which have been used for TNEI's analysis.

The TEC Register holds details of generation projects seeking to connect to the transmission network, at various stages of scoping, consenting and construction. The TEC Register was also considered as part of TNEI's analysis. Overall, the analysis contained in Appendix 4 suggests that on average 250km of new infrastructure will be required each year.

3.2.3 Calculating financial benefits

In the FES, four scenarios are considered; No Progression, Slow Progression; Low Carbon Life and; Gone Green. In order to avoid overstating the business case for NeSTS, SHE Transmission and TNEI have used a cautious approach to quantify benefits. Therefore we have opted to consider only the No Progression and Slow Progression scenarios to assess the potential financial benefits. The annual totals are shown in Figures 3.1 and 3.2, below.

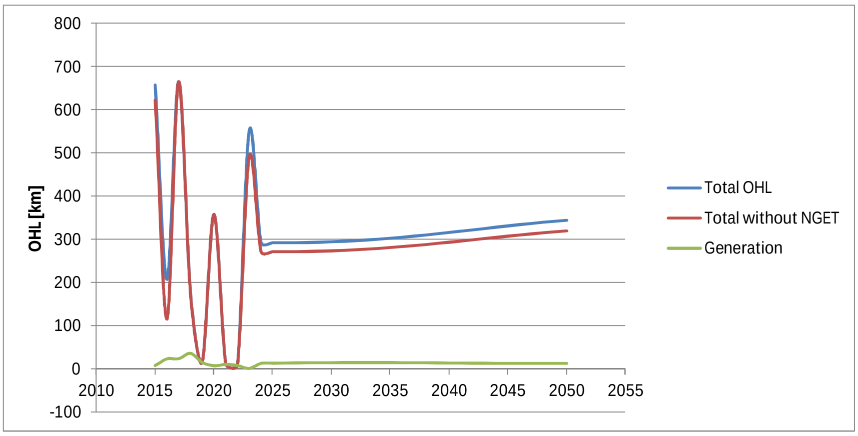


Figure 3.1: Annual installed OHL per km based on FES No Progression scenario

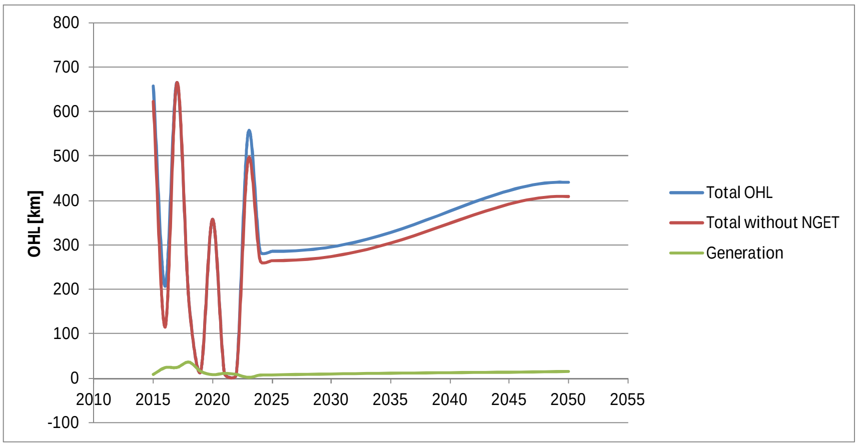


Figure 3.2: Annual installed OHL per km based on FES Slow Progression scenario

The new designs are applicable to 132kV, 275kV and 400kV and learning will be made available to all GB network licensees. However, it is recognised that NeSTS will not be applicable for every new OHL project. Therefore, TNEI's analysis of new infrastructure plans to 2050 is based on the following assumptions:

- Most new infrastructure at 132kV will take place in Scotland. A review of the RIIO: ED1 business plans for English and Welsh distribution network operators did not indicate a significant volume of new 132kV OHL build. For this reason, the business case has discounted 132kV in England and Wales.
- NGET are likely to use the T-Pylon for new 400kV OHL projects, as it has been specifically designed for application in the NGET territory. 400kV projects in England and Wales have therefore also been excluded from the business case.

§ Analysis of the TEC register suggest that there are a limited number of renewable projects which will require new build OHL infrastructure to connect to the network. Therefore, these have also been excluded from the analysis.

In June and July 2015 the UK Government announced significant changes to the support regime for renewable generation[13]. This may introduce a further degree of uncertainty around the development of a number of planned renewable projects. The project team will review further developments in UK Government policy at the stage gate between Phases 1 and 2 of the NeSTS project.

SHE Transmission and the other TOs are progressing works to meet the connection requirements of applications to date. Despite the recent Government announcements, we have seen relatively few connections being terminated and so expect to continue to deliver to meet the needs of the generation developers in an economic and efficient manner. Full details of the methodology, assumptions and results are contained in Appendices 4 and 6.

3.3 NeSTS financial benefits

This section aligns with Evaluation Criterion 4b of the NIC Governance Document:

'Provides value for money to gas / electricity distribution / transmission Customers.'

3.3.1 OHL project costs

SHE Transmission has used a blend of historical cost data, project design information and information available through SHE Transmission's and Scottish Power Transmission's Charging Statements[10] to identify typical costs elements in OHL projects, as described in Appendix 6. NGET's information is not published in their Charging Statement. Costs for an OHL project depend on voltage rating, location, ground conditions, construction method, transport and logistics, and environmental and consent factors. Construction and materials for foundations influence costs heavily. However, costs published in the TOs' Charging Statements provide an estimate of the potential cost of new OHL build - these costs are outlined below.

Figure 3.3: Typical cost of OHL infrastructure

	275kV £000s/km	132kV £000s/km
SPT	£1,833k	£834k
SHE Transmission	£1,103k	£793k
NGET	Not available	Not available
Average	£1,468k	£813k

3.3 2. Potential for cost benefits to customers

SHE Transmission investigated the potential for cost savings in deploying NeSTS at 275kV and 132kV and compared these figures to the costs of a traditional steel lattice tower; the results of this suggest that NeSTS could create considerable savings if a successful trial leads to GB-wide deployment. Based on information from the supply chain, SHE Transmission expects the cost of new OHL projects could be reduced by up to 10% over a whole asset life basis. Initial benefits assumptions are shown in Figure 3.4. However, NIC funding is required to fully explore the advantages of the NeSTS approach.

Figure 3.4: Cost comparison between lattice steel design and NeSTS, per km in £k - confidential

NeSTS will help save costs associated with the following:

- **Foundations**: the construction of appropriate foundations forms a significant element of the overall cost of an OHL project. The move to a monopole style construction will reduce the foundation area required and could facilitate the use of alternative foundation styles such as caissons. This less invasive style of foundation will also help avoid additional costs of managing works in sensitive environmental areas. Foundations will be influenced by ground conditions and geotechnical requirements. Further information is contained in Appendix 7
- **Installation:** the move to a simpler support with fewer components should reduce the time required to install and erect the new supports.
- **Structure costs:** the proposed supports are heavier than their traditional equivalents and require more steel. However, as the structures are simpler with fewer components, there will savings associated with galvanizing and fabrication activities. Overall, the cost of the new structure has been estimated to be broadly similar to the current design, and savings are derived from foundations and operating costs.
- **Conductor systems**: The new design uses twin earth wire arrangement for compliance with new design standards; therefore, the conductor cost has increased.
- **Off-site manufacture**: The proposed design has fewer components, and is more readily assembled off site. This provides an advantage of reducing the volume of components requiring on-site assembly.
- **Reduced operating costs:** The NIC NeSTS designs seek to remove or minimise access and maintenance requirements and therefore reduce maintenance costs and, importantly, outage costs over the life of the assets.

The information contained in Appendix 4 indicates that the majority of the OHL work planned by the TOs is for reinforcement or refurbishment projects. The financial benefits for TO reinforcement and refurbishment projects flow directly to transmission customers through Transmission Use of System charges[1]. SHE Transmission has adopted a conservative view that NeSTS will be suitable for up to 15% of the anticipated projects and has calculated cost savings on this basis. Should NeSTS be applied to up to 15% of new OHL projects between 2023 and 2050 and achieves a reduction in costs of 10%, this could facilitate savings of up to £174 million, as shown in Figure 3.5

Figure 3.5 Potential NeSTS benefits

Number of projects 2023 to 2050	Slow Progression	No Progression
Benefit at 5% cost saving (£m) if 5 % of OHL projects are NeSTS-compatible	£29.0M	£25.7M
Benefit at 10% cost saving (£m) if 15% of OHL projects are NeSTS-compatible	£174.1M	£154.1M

3.4 Accelerates low carbon sector

This section describes NeSTS's potential to accelerate the development of a low carbon energy sector as per the NIC Governance Document's Evaluation Criterion 4a:

'Accelerates and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and/or existing customers.'

The growth in transmission infrastructure is driven by the TOs' requirement to respond to increasing generation connections and rising electricity demand. NeSTS provides TOs with a new alternative to traditional designs and in some cases, underground cables. Planning and consent applications for OHL projects take significant time and can add delay, uncertainty and cost to projects - having an additional option for the structures may help alleviate this. The stakeholder consultation programme planned during the initial design stages of the project will allow SHE Transmission to consider stakeholder views when refining the design. The NeSTS project should help TOs to ensure the continued delivery of the infrastructure required to allow new low carbon generation to connect. The smaller foundations associated with the monopole designs could enable a less environmentally intrusive construction process. Further information can be found in Section 4.1.

3.5 Innovation with a purpose

This section describes how NeSTS aligns with the role of innovation in SHE Transmission's business plan and Evaluation Criterion 4d:

'Is innovative and has an unproven business case where the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness.'

The NeSTS solution has the potential to deliver benefits for customers by proposing a simpler, more compact design of OHL support. Whilst the proposed design has been identified from the ongoing NIA project following robust design assessment it still requires further development and testing to give TOs confidence to deploy the new design. The design development will also include engagement with key stakeholders to consider their input to the final suite of supports. No individual project can carry the additional cost or risk associated with developing and implementing an alternative design. This NIC project seeks funding for this development work, the appropriate testing and the additional costs associated with the first time deployment. The use of NIC will ensure that the outcomes are available for all licensees which will help ensure that transmission customers may received the financial benefits.

3.6 Relevance and timing

This section describes how NeSTS meets SHE Transmission's business objectives in relation to relevance and timing as described in Evaluation Criterion 4f of the NIC Governance Document. The other TOs have similar objectives and commitments.

The Innovation Strategy, described in SHE Transmission's business plan[3] (2011) commits the company to several innovation objectives. The NeSTS project will deliver learning which contributes directly to the delivery of the following objectives:

Figure 3.6: SHE Transmission Innovation Strategy objectives and NeSTS's contribution

Objective	Contribution
Accelerating network development and connections including the integration of increasing volumes of renewable generation.	Provision of a new option for OHLs, which could reduce consenting risks and reduce construction times.
Minimising the cost of providing network capacity.	The new support designs could reduce the cost and time required for construction of projects.
Maintaining and improving network performance.	NeSTS are designed to maintain network security and integrity.
Remaining at the forefront of innovation to maintain the company's record of providing the highest standards of service at the lowest possible cost.	The NeSTS project will allow GB TOs to take advantage of advances in new technologies and techniques with cost and environmental advantages. It also offers TOs an opportunity to benefit and learn from previous Ofgem-funded innovation projects.

NeSTS will complement SHE Transmission's approach to working in a sustainable manner. We operate in some of the most scenic and environmentally sensitive areas of GB – our Sustainability Statement[11], describes how SHE Transmission supports GB low carbon objectives. NeSTS contributes to these objectives as Figure 3.7 shows.

Figure 3.7: SHE Transmission sustainability commitments

Objective	Contribution from NeSTS
Protecting, restoring and enhancing biodiversity.	NeSTS is anticipated to provide solutions which require less materials, civil works and reduced access arrangements.
Preserving our visual amenities.	NeSTS is expected to reduce visual impact by reducing height of towers.
Minimising our carbon footprint.	In using fewer materials and reducing the size of the OHL supports we aim to reduce the overall carbon footprint of our new infrastructure.

All TOs are required to invest in new infrastructure to support the transition to a low carbon economic base. GB-wide adoption of NeSTS will result in reduced costs for network licensees and ultimately, for customers.

Section 4: Benefits, timeliness, and partners

4.1 This section addresses Evaluation Criterion 4.a as described in the NIC Governance Document V2.1:

'Accelerates the development of a low carbon energy sector and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and/or existing customers.'

4.1.1. NeSTS's contribution to the UK Government's current strategy for reducing greenhouse gas emissions, as set out in The Carbon Plan.

NeSTS complements The Carbon Plan's[5] strategy to reduce carbon emissions in several ways. The following section describes which aspects of The Carbon Plan are facilitated by NeSTS and how GB-wide roll-out of NeSTS can contribute to the Plan's objectives:

NeSTS helps to fulfil the need for a stronger, larger, more flexible grid to manage increased customer demand: The Carbon Plan advises that "Beyond 2030, as transport, heating and industry electrification occurs, low carbon capacity will need to rise significantly…We are likely to need 100 gigawatts (GW) or more of new, low carbon generation capacity in 2050." (2.153, page 72) NeSTS provides additional OHL support options for the expansion and reinforcement of the transmission network. The Carbon Plan recognises that average electricity demand may rise by between 30% and 60% and advises that "the grid will need to be larger, stronger and smarter to reflect the quantity, geography and intermittency of power generation." (4.4, page 9). Using NeSTS as part of the grid's transformation will help to create the strong, interconnected network required to meet the increase in customer demand in an economical way.

NeSTS is designed to cope with the difficult terrain and climatic challenges found in areas with the greatest abundance of renewable generation sources: The Carbon Plan states that: "The Government is committed to dramatically increasing the amount of renewable electricity generation in the UK…Making use of some of the best wind and marine resources in Europe will help lower emission and the demand for fossil fuels." (2.167, page 79). As described in Section 2, the provision of additional network capacity is fundamental to the future connection of new renewable generation. This requires the installation of new OHLs where there is currently little or no infrastructure. In zones with rich renewable sources there are often difficult terrain and weather issues. OHLs and supports must be capable of withstanding the severe winds, ice accretion and/or high saline conditions found in these zones. NeSTS will be designed with these conditions in mind. Construction of OHLs in areas with large volumes of rock and side slope is also problematic. Reducing civil and foundation requirements will facilitate savings associated with the installation process.

NeSTS supports The Carbon Plan's aim of creating energy security with a view to minimising costs: Page 14 of The Carbon Plan states that the Government is determined to tackle climate change and maintaining energy security while maximising benefits and minimising costs to customers. Deploying NeSTS as part of future infrastructure projects will help to provide the network capability needed to provide a secure, reliable network. In facilitating the core infrastructure required to facilitate the connection of new renewables, NeSTS increases the diversification of renewable energy sources available to ensure a secure energy supply. Meanwhile, it is anticipated that

NeSTS will produce benefits of up to £174 million before 2050, meeting The Carbon Plan's desire to minimise costs to customers.

The NeSTS project outputs will be shared in time for the fourth carbon budget:

The fourth carbon budget runs from 2023 to 2027 and aims to reduce carbon emissions by 50% compared to base levels set in 1990. Learning from NeSTS will be shared incrementally throughout the project so that TOs may integrate NeSTS into future network planning within the fourth carbon budget's timescales. This aligns with The Committee on Climate Change's advice, described in The Carbon Plan on page 23:

"All sectors of the economy will need to play their part by the time of the fourth carbon budget but the CCC's advice focuses on the need for….decarbonisation of the power sector."[5] (page 23, section 2.12.).

NeSTS fits The Carbon Plan's view on the role of innovation: "Innovation will be crucial to delivering the cost reductions we expect to see in technologies that are critical to delivering the fourth carbon budget. This innovation will transform UK infrastructure to support the transition to the low carbon economic base." (3.35, page 114).

NeSTS is expected to deliver an innovative solution that connects new renewable generation whilst saving up to £174 million for customers.

4.1.2 Network capacity released by NeSTS

SHE Transmission does not expect the roll-out of NeSTS to deliver more new network capacity directly. However, a general acceptance by our statutory consultees may assist in the planning process and lead to reduced construction timescales. However, we believe that NeSTS could help to deliver some of the new infrastructure requirements more economically than using traditional OHL supports alone.

4.1.3 NeSTS's environmental benefits to customers

The NeSTS proposal is expected to deliver several environmental benefits to customers.

Reduced impact on local flora, fauna, geology and hydrology: The reduced foundations and ground footprint could improve the impact of our work on land, drainage and local wildlife, and less drilling in areas with large ground rock volumes. There may be a reduced need for land clearance also, which may bring additional benefits such as decreased peat management requirements.

Efficient connection of renewables: The new NeSTS designs will be trialled on a section of SHE Transmission's network, which is the most challenging in GB. This allows SHE Transmission to prove NeSTS's suitability for difficult terrains and weather, and will prove NeSTS's suitability for new infrastructure projects that will facilitate quick and effective connection of renewable energy across GB.

Improved visual amenity: Traditional steel lattice towers are not always viewed favourably by local residents, local business owners, land owners, environmental groups and local authorities. NeSTS supports are designed to be smaller and less visually intrusive across a range of landscapes, and it is hoped that NeSTS will meet the approval of statutory authorities, land owners and members of the public. This could help new OHL projects pass more quickly through planning applications and public consultation.

4.1.4. The expected financial benefits the project could deliver to customers.

The base case cost has used 275kV OHLs to understand potential benefits. A kilometre of OHL at 275kV is estimated to cost £1.47 million on average. SHE Transmission has used a very cautious calculation to understand the expected financial benefits that NeSTS can offer customers, as described in Section 3 and Appendices 4 and 6. If up to 15% of the new infrastructure uses NeSTS, and NeSTS provides a saving of 10%, the overall savings equate to £174 million before 2050 (see Section 3 and Appendix 6 for details of this calculation). For network infrastructure projects, these savings flow to customers via the Transmission Use of System charges.

4.2 This section addresses Evaluation Criterion 4.b as described in the Network Innovation Competition Governance Document V2.1:

"Provides value for money to electricity transmission customers"

4.2.1 NeSTS's potential Direct Impact on a Network Licensee's electricity network or on the operations of the GB System Operator;

The Direct Impact of the NeSTS project is the provision of a validated new approach to OHL supports design and construction, applicable to all transmission voltage ranges. The project will instil deployment-level confidence amongst TOs. Deployment of NeSTS is expected to produce measurable cost savings in comparison to a traditional steel lattice approach. These costs savings would flow to transmission customers as described in 4.1.4 above. For TOs, NeSTS could improve the carbon footprint of new OHL projects because of NeSTS's reduced land take, foundations and civils requirements. NeSTS can be applied to any type of new OHL project, such as new infrastructure and new connection projects on the transmission system, which generally facilitate the connection of new renewable generation.

4.2.2 Justification that the scale/cost of the Project is appropriate in relation to the learning that is expected to be captured

SHE Transmission believes that the scale and cost of the NeSTS project delivers good value in comparison with the anticipated knowledge and learning that the project will produce. The knowledge and learning plan is described in Section 5, and aims to not only inform TOs, but also statutory authorities, the supply chain and other stakeholders who can influence new OHL projects. Section 2 and Section 3 outline the need for new infrastructure, even in the most pessimistic outcome in terms of future energy policy and legislative developments still indicate a need for significant volumes of new OHL infrastructure. The project's monitoring and evaluation, the Support Assessment Matrix and the Visualisation Tool will facilitate the quick and efficient adoption of NeSTS by other TOs. All GB TOs have stated their interest in NeSTS and have agreed to participate in the Infrastructure Working Group.

4.2.3 The processes employed to ensure that the Project is delivered at a competitive cost.

NeSTS is designed to optimise delivery at a competitive cost. The project plans early engagement with material suppliers and construction contractors to raise their awareness and allow them to contribute to the design. NIC funds cover only the additional, incremental costs of delivering NeSTS for the first time. NIC support will provide the design, testing, management, learning and stakeholder engagement needed to facilitate a solution that is ready for implementation for 'business as usual' amongst TOs. Expenditure will be carried out within SHE Transmission's Large Capital Projects governance processes and an appropriate competitive procurement procedure used to secure equipment.

4.2.4 The expected proportion of the benefits which will accrue to the electricity Transmission System as opposed to other parts of the energy supply chain.

For infrastructure projects, NeSTS benefits will flow directly to transmission customers. For generators seeking new connection, this will depend on the CUSC[12], governed by National Grid System Operator. From the analysis carried out by TNEI (see Appendix 4), the majority of NeSTS deployments are likely to be for infrastructure projects.

4.2.5 How Project Partners have been identified and selected including details of the process that has been followed and the rationale for selecting Project Participants and ideas for the Projects

Project participants were identified through the ENA Collaboration Portal and through SHE Transmission Procurement's Framework procedures. Rationale for selecting project participants and ideas are discussed in Section 4.4.

4.2.6 The costs associated with protection from reliability or availability incentives and the proportion of these costs compared to the proposed benefits of the Project.

There are no costs associated with protection from reliability or availability incentives.

4.3 This section addresses Evaluation Criterion 4.d as described in the Network Innovation Competition Governance Document V2.1:

"Is innovative (i.e. not business as usual) and has an unproven business case where the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness".

4.3.1 This section describes how (i) the project is innovative and (ii) shows that new learning will result from the project.

(i) Section 2 describes the minimal changes in OHL support design in around ninety years. The most radical development in recent times has been NGET's T-Pylon, which is currently undergoing trials. However, preliminary discussions with NGET have suggested that the T Pylon does not lend itself to deployment in challenging environments. This still leaves a gap for a new approach to OHL supports, particularly for areas with the richest renewable resources, such as coastal and mountainous locations, which NeSTS can address. NeSTS provides a cost effective option for the full range of geographic and climatic conditions which may be encountered across GB.

The NeSTS approach integrates several innovations, proposing an entirely new approach to OHL support design. The innovative elements of the designs could include a combination of the following:

§ new insulator arrangements;

- new mechanical/structural layout;
- use of novel materials for elements of the supports; and
- use of new foundation and construction techniques and materials.

Some of the potential innovations have been tested individually e.g. SHE Transmission successfully led an earlier NIA project to explore the use of insulated cross arms. Equipment was initially installed off-line in the Lecht and St Fergus areas of Aberdeenshire (exposed, high altitude environments known for severe winds, heavy ice loading and high saline conditions). After initial testing, the cross arms were then retrofitted onto an existing line for further monitoring and evaluation. The project has generated confidence in the new technology but this will be optimised if the cross arms can be deployed with other new technologies in an integrated way on new build structures. Several NGET and SPT projects also influenced the design, such as 'A Tool for Evaluating OHL Performance under Novel Technology Implementation' and 'Trial and Performance Assessment of ACCR Conductors'.

The NIA_SHET_0010 project has created a series of new designs for OHL supports with innovative layouts. These aim to reduce the height and foundation requirements for OHLs and may use new, alternative materials for construction. These have never been tested at reduced or full scale and will need significant further development and testing through NIC before they can be deployed on the network.

Where appropriate, NeSTS may use innovative foundation materials and techniques. For example, caisson foundations have been used in other industries (such as civil engineering for bridge crossings) but have not been used in electrical engineering and construction of OHL lines. The selection of materials for elements of the OHL supports may enable other novel techniques for the civils requirements to be considered for the project.

Note that there are many potential options for different aspects of the design and construction of the NeSTS supports. Evaluation and review of technologies are factored into the first, or development, phase of the project. While SHE Transmission is confident that NeSTS can bring environmental and cost benefits, these innovations have not been tested together and there is an inherent risk associated with first-time deployment. For this reason, and to provide deployment-level confidence in other TOs, NeSTS needs NIC support.

(ii) Using NIC allows the project to effectively capture and disseminate knowledge and will help to avoid duplication across the transmission sector. NIC funding will provide support for the development and dissemination of knowledge, using innovative tools such as the Support Assessment Matrix, the Visualisation Tools and the e-learning module.

The e-learning module will, in particular, encourage supply chain familiarity with the NeSTS design, which facilitates a competitive market for future procurement. The visualisation tool app will enable education and familiarisation for TOs, but also planners and other statutory authorities, for future NeSTS planning applications. NIC funding will also support the project in securing the learning objectives, as described in Section 5.

4.3.2 This section describes why SHE Transmission could not fund such a project as part of our business as usual activities.

There are several risks associated with the NeSTS project, which do not allow GB TOs to adopt NeSTS as 'business as usual'. OHL projects costs on average, £1.47 million per kilometre, according to TOs' Statement of Charges[10]. Deploying NeSTS on OHL projects without a demonstration first creates excessive and unacceptable cost and operational risks to any TO.

NeSTS designs incorporate a range of innovations which have not been proven together at scale - NeSTS need further development and testing before demonstration can take place. Without a NIC demonstration, there is insufficient confidence to deploy as 'business as usual' due to the novelty of the method.

NeSTS is expected to generate cost and environmental benefits but the dissemination of learning is essential to provide sufficient reassurance in the designs. If NeSTS were to be funded under 'business as usual', SHE Transmission could not allocate funding for the incremental costs of knowledge capture and dissemination. Without a learning capture and share plan, TOs would be less likely to integrate NeSTS into their networks. Similarly, the lack of familiarisation with NeSTS amongst the supply chain and amongst statutory authorities could result in delays and uncertainty during procurement and planning stages of a project. It is recognised that there are already funding mechanisms in place to reduce the visual impact of OHLs, most notably the Visual Amenity Allowance. However, this only applies to existing infrastructure within National Parks and designated Areas of Outstanding Natural Beauty. NeSTS applies to new build OHLs, therefore the use of the Visual Amenity Allowance is not permitted to fund this initial deployment. Also, the Visual Amenity Allowance cannot be used for the development and demonstration of unproven technologies.

4.4 Involvement of other partners and external funding

This section addresses Evaluation Criterion 4.e as described in the Network Innovation Competition Governance Document V2.1

4.4.1 This section outlines NeSTS collaboration with project participants

NeSTS will be used on a SHE Transmission infrastructure project, with set timescales and priorities. The timescales are driven by a number of parameters, including the construction schedule, and crucially outage dates which are agreed years in advance. It is imperative for the timely delivery of the OHL project that SHE Transmission controls the outcomes of the project - the addition of a project partner could create a level of unnecessary additional risk. Instead, the project will work with named supporters and suppliers. Section 4.4.2 describes how project participants were selected.

NeSTS aims to create a functional specification which can be freely offered to GB licensees, thus enabling competition and further cost savings for customers. All three GB TOs will have the opportunity to influence the functional specification, therefore maximising NeSTS's industry acceptance and potential for application across GB. For this reason, transmission network licensees have agreed to be project supporters rather than partners. Letters of support for the project have been received from Scottish Power Transmission and National Grid Electricity Transmission following ongoing discussions relating to the NIA and NIC NeSTS projects (see Appendix 13). Both TOs have also confirmed their participation in quarterly Working Group meetings. Subject to the final agreement of commercial arrangements other project participants and their roles are described below.

Energyline (EL) is an engineering consultancy specialising in the design and construction of transmission voltage OHL projects. EL have extensive experience in the design and development of OHL projects and have provided key input to a number of SHE Transmission's ongoing OHL projects. EL has worked on the NIA NeSTS project to develop initial designs and feasibility, and will continue to provide design and technical support throughout the lifecycle of the NIC project. EL will continue to work on the application design and will also assume responsibility for design assurance and technical approval. EL is a project supplier.

Social Market Research (SMR) will act as project supplier for stakeholder engagement. The project (in Phase 1 in particular) involves significant work with licensees, statutory authorities, landowners, the supply chain and the public. This work is necessary to understand stakeholder viewpoints and inform the NeSTS design. SMR will provide services including the development and management of surveys, interviews and events. These activities will provide quantitative and qualitative data analysis and reports which will be used to inform and assess the NeSTS design.

TNEI will act as project supplier to independently validate the financial and environmental benefits of the NeSTS approach, giving reassurance to licensees adopting NeSTS for deployment.

Both Energyline and Social Market Research are SHE Transmission's Framework Contractors. SHE Transmission asserted that previous procurement activities ascertained that they could provide best value. TNEI has previously been involved in a NIC project with SHE Transmission

HE Transmission may elect to work with an academic institution on the knowledge and dissemination work package of the programme and if this option is pursued, will go through a competitive exercise to do so after funding is awarded. An Expression of Interest has already been issued to identify potential suppliers who have capability in this area. Alternatively, SHE Transmission may opt to capture and disseminate knowledge without the use of academic partners.

For NeSTS to be successful it will require engagement and support from a range of groups a comprehensive stakeholder engagement package will be implemented from the outset of the project and will be maintained throughout the project's lifecycle. The strategy for Stakeholder engagement is shown in more detail in Appendix 3; key stakeholders identified include:

- statutory authorities who are affected by our work such as planners, community and environmental organisations;
- land owners or managers who may have OHL supports installed on their land;
- the supply chain, which needs to understand the new supports and/or insulator arrangements; and
- members of the public who are interested in or who may be affected by our work.

Consultation will not only allow us to understand the priorities of our stakeholders but will give them the opportunity to input to the design process, this is particularly important for planners and other statutory authorities. It will also allow us to prepare and educate the supply chain and material suppliers ahead of NeSTS deployment. This could support a more straightforward planning and consent process and facilitates a robust supply chain for NeSTS in the future.

4.4.2 Systems or processes used to (i) identify potential project partners and (ii) identify ideas for projects.

(i) SHE Transmission uses several methods to identify potential innovation project participants. These are:

- ongoing stakeholder engagement through meetings, workshops and events;
- procurement arrangements such as competitive procurement exercises, framework agreements and requests for information; and
- the ENA Collaboration Portal.

Project supplier EL worked closely with SHE Transmission on the ongoing NIA project (NIA_SHET_0010), creating the support designs and developing the Support Assessment Matrix. This organisation is therefore considered to be well placed to continue design work into the NIC project. EL has considerable experience in planning OHL projects and will also support SHE Transmission with the testing and evaluation of the new suite of supports. EL is a SHE Transmission Framework Contractor – membership on the Framework is only approved after procurement activities ascertain that any supplier can provide best value.

Project supplier TNEI was identified on the ENA Collaboration Portal. The consultancy has also previously worked on SHE Transmission's NIC Modular Approach to Substation Construction (MASC) bid. This gives reassurance that TNEI understands the purpose and aims of the NIC and can make an excellent contribute to the validation of savings and environmental benefits through the NeSTS approach.

SMR is SHE Transmission's Framework Contractor for stakeholder engagement, and has worked on the NIC MASC project, and on SHE Transmission's RIIO Stakeholder Engagement Incentive work. The organisation is experienced in the delivery of objective, considered data analysis and was chosen to ensure that NeSTS stakeholder consultation will be thorough, impartial and balanced.

(ii) SHE Transmission generates ideas for innovation projects through a series of processes:

- Ongoing communication and an 'open door' approach are offered to the supply chain and academics for initial appraisal of novel technologies, practices and commercial arrangements. Events such as 'speed dating' are also arranged to welcome new ideas and technologies.
- Each year, senior management develop a set of current problem statements to be solved; these align with SHE Transmission's Innovation Strategy[11] and form the basis for workshops and events.
- Representatives from across the business collaborate in groups and workshops to identify ideas for projects.

- SHE Transmission regularly reviews new technologies and practices from overseas.
- Learning from previous projects (those of SHE Transmission and other licensees) is reviewed to evaluate outputs and consider further development and/or demonstration.

In order to select potential projects for the NIC, ideas are reviewed and scored against the Innovation Strategy and the RIIO business plan. Successful ideas are then matched to the appropriate funding stream e.g. NIA, NIC, Innovate UK, and 'business as usual' funding. Research is undertaken to ensure there is no replication across the industry and to understand current learning on the key objectives the project looks to achieve. Initial approval to proceed with the project may then be sought by SHE Transmission's senior management team.

The concept for the NeSTS project was initially developed in an innovation workshop in November 2013. Due to the low technology readiness at that point, NeSTS was registered as an NIA project for initial development. The NIA outputs have been very strong but further development and a demonstration is needed to provide licensees with the confidence to deploy the new solution on the Network.

4.4.3 Subcontracting partners

The project participants are not required to recruit other collaborators.

4.4.4 External and additional funding

The NIC funding request covers only the incremental costs of developing and deploying NeSTS for the first time. NeSTS will be deployed for the first time on a planned transmission OHL project, which has already been funded using the established industry mechanisms. Therefore, no additional external funding has been sought for the NeSTS project.

4.5 Relevance and Timing.

This section addresses Evaluation Criterion 4.f as described in the Network Innovation Competition Governance Document:

'Relevance and timing: When evaluating how projects perform against this criterion, consideration will be given to the appropriateness of the timing of the proposed project. This is to reflect that knowledge and technology will both be expected to change over the duration of the NIC.'

Please note that supplementary information for this section can be found in Appendix 6.

4.5.1 This section describes why the problem we are looking to investigate or solve is relevant and warrants funding in the context of the current low carbon or environmental challenges the electricity sector faces.

As described in Sections 2 and 3, TOs currently face a number of challenges in the transition to a low carbon economy and in achieving the targets set out in The Carbon Plan. These include the need to provide additional network capacity to cope with increased customer demand, greater reliance on electricity and the penetration of renewable generation. This must be achieved while also maintaining system security and reliability. Stakeholders are requesting that we minimise the environmental and visual impact of our work. TOs must also seek to reduce costs to customers where practical. NeSTS can help TOs with these challenges by providing a cost effective OHL support option for new projects. NeSTS is relevant to all TOs for several reasons;

- The project is designed to optimise NeSTS's scalability. The NeSTS designs are planned to be scalable to voltages between 132kV and 400KV.
- NeSTS's knowledge plan will deliver learning to TOs incrementally over the project lifecycle. The first OHL will be commissioned by July 2020; the operation will then be evaluated to give network licensees the knowledge and tools required to factor NeSTS into their overhead line development plans from 2021 and beyond.
- Proving the benefits of NeSTS through the NIC enables TOs to more quickly adopt the technology. This allows TOs to contribute to the third and fourth carbon budgets (2022 and 2027 respectively).
- The project will leverage learning from previous work related to new cross arm and conductor technologies, and help to integrate learning outputs into business as usual.

4.5.2 This section discusses how, if the method proves successful, it would form part of (SHE Transmission's) future business planning and how it would impact on its business plan submissions in future price control reviews.

(i) Over the coming decade SHE Transmission and the other TOS have a requirement to expand the transmission network significantly to prepare for the move to a low carbon economy. There is a degree of uncertainty in terms of new generation as a result of recent announcements on renewable subsidies. SHE Transmission and the other TOs are progressing works to meet the connection requirements of applications to date. Despite the recent Government announcements, we have seen relatively few connections being terminated and so expect to continue to deliver to meet the needs of the generation developers in an economic and efficient manner. SHE Transmission has therefore opted to take a cautious view of NeSTS benefits in order to avoid overstating these. Our analysis has focused on NGET's 'No Progression' and 'Slow Progression' scenarios in the FES[8].

If the method proves successful, SHE Transmission and other GB TOs can use the Support Assessment Matrix (see Appendix 14) to compare the cost and benefits between traditional supports and the new NeSTS approach. This will allow further options for TOs to consider when planning new OHL projects, this additional option as well as being more cost effective may prove to be more acceptable to consenting bodies and other interested parties. The extensive engagement planned for the initial stages of NeSTS will allow the views and concerns of these stakeholders to be considered in the development of the final design. This will help to reduce the risk and cost associated with a protracted consenting process.

When proven, the NeSTS solution will give network licensees an economical new option for constructing new OHL infrastructure which, depending on circumstances, may prove to be more beneficial than the conventional solutions currently available. If widely adopted by TOs, the NeSTS solution could deliver benefits of up to £174m by 2050. A fuller description on this analysis can be viewed in Appendices 4 and 6.

Section 5: Knowledge Dissemination

5.1 Learning generated

This section outlines the level of incremental learning expected to be provided by the NeSTS project; and the applicability of the new learning to the planning, development and operation of an efficient transmission system and network licensees.

5.1.1 Incremental learning

Effective knowledge capture and dissemination is critical to innovation projects. SHE Transmission adopts clear learning objectives supported by established knowledge management principles and procedures. Six learning objectives have been set for NeSTS, which will be supported by detailed work plans throughout the project.

Develop a proven series of NeSTS design specifications: The NeSTS project will further develop outputs from the NIA project and demonstrate these on the live transmission network. This will allow us to create the project's key output – a set of design specifications which can be shared with licensees and the supply chain. The specifications will take into account NeSTS's electrical, mechanical and civil engineering requirements. Throughout the project the design activities will be subject to regular review and technical assurance by a combination of internal SHE Transmission Technical staff and by suitably qualified third parties. This will provide a robust validation of the design works undertaken.

Inform policy and procedure: Each stage of the project will inform new policies and procedures for construction, operation, maintenance and safety. The development of these documents is fundamental to the successful adoption of NeSTS by other licensees.

Create future usage options: NeSTS will be deployed and assessed against a range of terrain and climate scenarios that are representative of conditions found across GB. We will also implement a programme of prototype and component testing to measure NeSTS against severe weather events. This allows licensees and the supply chain to understand the conditions in which NeSTS is optimally suited, and creates confidence in the new designs.

Evaluate acceptance of alternative OHL supports by the consent and stakeholder processes: During the project's first phase, a comprehensive stakeholder consultation will include discussion with licensees, landowners, statutory authorities and the supply chain. This allows us to understand and accommodate key priorities into the design where practical. Subsequent planning and consent for the planned OHL project will be evaluated to see the benefits of using NeSTS in comparison to conventional OHL methodology, and outputs from this learning objective will be shared with all stakeholders. This process will be informed by the use of the Sustainable Commercial Model in order to provide a more holistic assessment of the various design options.

Develop and validate Support Assessment Matrix: The Support Assessment Matrix (SAM) was developed through the NIA NeSTS project to evaluate and compare a series of OHL support designs against a set of Main Design Aspects (MDAs):

i. Electrical issues such as audible noise, electro-magnetic fields, radio interference, lightning performance and surge impedance loading.
ii. Support and foundation issues e.g. the number of elements and joints in a support, side slope complexity, structure weights, ice accretion, and reliability of single circuits, foundation complexity and compatibility with twin earth wires.
iii. Mechanical issues such as insulator arrangements, suitability for insulated cross arms, and conductor galloping.
iv. Construction matters like type testing, complexity of support fabrication, and support/insulator supply chain familiarity, access and egress, footprint and assembly areas, route dismantling and tension support.
v. Maintenance topics including: suitability for operational activities, component replacement, phase and earth wire conductor repairs and surface treatment and preparation.
vi. Operational safety issues such as live line working, circuit demarcation and management of induced voltages, currents, and application of additional earthing.
vii. Environmental topics including height, supports per km, visual impact, support shape, design aesthetics, corridor width, effect on birds and tension support continuity.
viii. Failure modes, asset management and condition monitoring data.

The SAM will be developed further and validated by NeSTS to produce a highly useful matrix available to the supply chain and to licensees. This creates a centralised vehicle to evaluate and facilitate future OHL support innovations.

Create a transmission infrastructure working group: The NeSTS project will form a working group to create and share best working practices for OHL supports, similar to the Energy Storage Operators' Forum. The OHL working group will review and share best practice worldwide to facilitate further improvements in OHL methodology. This group may integrate the MASC working group so that OHL and substation interfaces are considered and outcomes are compatible.

5.1.2 Applicability of new learning

The NeSTS project is applicable to the planning, development and operation of an efficient transmission system to other licensees. Even the most conservative assumptions within National Grid's Future Energy Scenarios[8] will require additional transmission infrastructure to be put in place, often in mountainous or coastal locations or areas with heavy ground rock for the connection of renewables. There is also a corresponding need to maintain resilience and network reliability. From the ongoing stakeholder engagement work undertaken for existing projects there is clear evidence of a need for an alternative to traditional OHL designs. NeSTS offers TOs an effective alternative and/or complement to conventional supports and the T-Pylon in network planning and development across all transmission voltages.

All TOs are working with statutory authorities and other stakeholders to improve the impact of infrastructure on visual amenity and the environment. Project learning will enable TOs to (i) view improvements in stakeholder acceptance and issues at the planning and consent stages of the planned OHL project and (ii) evaluate consequential benefits. This will help TOs to evaluate the potential effectiveness of NeSTS deployment in network planning and development.

NeSTS will drive new learning in construction, safety, operation and maintenance of the new OHL supports. The project gathers and shares knowledge around NeSTS's suitability in terms of operational activities, access and egress and conductor/earth wire repairs. If appropriate, new tools, manuals, policies and procedures will be developed and disseminated to the supply chain and to licensees for integration into their own working practices. This facilitates straightforward integration of NeSTS into TOs' everyday operations.

5.2 Learning dissemination

This section addresses:

- **SHE Transmission's plans to disseminate knowledge from the project, both to licensees and other interested parties**
- **the methodology used to capture and disseminate knowledge.**

5.2.1 Dissemination plan

A finalised knowledge dissemination road map will be developed at the outset of the project. Ultimately, the aim of the NeSTS knowledge dissemination plan is to facilitate and accelerate the adoption of project learning outcomes into standard business practices for licensees. The dissemination plan also aims to be accessible and useful to other interested parties. Several innovative new tools will be developed – an interactive e-learning module, the Structure Assessment Matrix and a visualisation tool. SHE Transmission will develop and promote dissemination using the following methods and channels.

NeSTS e-learning module: Education and familiarisation amongst all stakeholders are essential to the successful integration of NeSTS across GB. An interactive e-learning module will be developed for NeSTS. There will be several components to the course, which can be taken separately or together as one comprehensive learning package to include access and egress, design and operation. These components consider selected themes such as environment, mechanical and electrical issues, and community and visual impact. This will be offered freely to the supply chain, licensees and statutory authorities.

Visualisation tool: A software application will be developed to enable stakeholders to visualise NeSTS against a series of landscapes using a tablet PC. The user can customise a circuit by changing landscapes and adding or removing NeSTS and conventional tower types, to show the designs in context. The project will create a series of artistic impressions to illustrate NeSTS supports against a sequence of pre-defined landscapes. Selected images will also visualise NeSTS foundations and the underground landscape. These images will show NeSTS in context with typical topography found in GB – not only will this tool be useful for future network planning, it will help to inform stakeholders.

NeSTS decision tool: A decision tool based around the SAM will be developed as part of this project which provides a cost-benefit analysis of NeSTS supports compared to traditional designs for a given set of parameters. While this will be a relatively high-level comparison tool, providing a 'quick-and-easy' method for initial cost-benefit analysis will improve awareness of NeSTS as an option and pave the way for adoption to business as usual. This will also provide TOs with a tool which can be used to quickly assess the merits of future innovations such as new materials or conductor types.

Progress and completion reports on the ENA Learning Portal: Progress reports will be completed at every stage of the project, and the final outcomes and learning of the project will be compiled in a closedown report; these will contain sufficient detailed, technical information to enable transmission licensees to use NeSTS as a design option.

Dissemination events and webinars: At significant milestones SHE Transmission will host events for other TOs and interested parties to present learning and encourage questions and feedback.

Conferences: The project's objectives, development and results will be presented at relevant conferences including LCNI and All Energy. This is an efficient way of raising the profile of the research and increasing traffic to the webpage and attendance at dissemination events.

SSEPD website, press releases and social media: A dedicated project page on the SSEPD website will provide updates on the current stage of the project and offer project documents and relevant links to other projects. Press releases will also be used to raise awareness of the project at key milestones. The SSEPD Future Networks Knowledge Sharing Group on LinkedIn will provide updates and links to project news, and promote events and the sharing of outputs.

We recognise that different groups will have different interests in the learning generated by the NeSTS project and that dissemination is most effective when the messages and methods are tailored to the audiences' needs. Our dissemination will focus on the following groups:

i. **Network licensees:** GB TOs are the primary audience for the project as they are largely responsible for the development of new OHL transmission infrastructure. The aim of communication is to inspire investor-level confidence in the NeSTS approach. The project will enable TOs to build on each others' learning and work towards specifying consistent requirements in a consistent way.
ii. **Developers of standards and network codes:** Design specifications from the NeSTS project will provide a valuable input into the process of making any appropriate changes or amendments to the various industry operating practises required in order to fully benefit from new OHL support methodology.
iii. **Supply chain:** Suppliers of insulators and of supports will need to understand the electrical, technical, operational, construction and maintenance requirements of NeSTS. The final design specifications provide the technical and narrative detail required for successful supply chain support; these are validated by evaluation and monitoring outcomes of the new supports over a range of conditions.
iv. **Statutory authorities and planners:** the development of OHL infrastructure typically requires the consent from a range of consenting and regulatory bodies including planning authorities, environmental agencies and other interested parties.
v. **Government and regulators:** While not considered a primary target audience for learning, the development of standards will be of interest to policy makers and

Ofgem. Validated project outputs offer these stakeholders confidence to approve plans put forward by licensees.

5.2.2 Learning capture and dissemination methodology

NeSTS's integration into the GB transmission network depends upon the reliability and robustness of learning capture and dissemination. Project outputs will be reviewed both internally and by external third parties to safeguard their validity.

The Structure Assessment Matrix (SAM) has been designed by Energyline using a range of weightings to compare electrical, mechanical and environmental attributes. The SAM will be developed further to provide a transparent, straightforward method to compare OHL support designs.

NeSTS will be subjected to component and type testing by the third party at prototype stage, to ensure the structures are likely to perform as expected before deployment.

SHE Transmission will work with Social Market Research (SMR) on stakeholder consultation. SMR will apply a range of qualitative and quantitative techniques and provide feedback that is validated and impartial.

SHE Transmission has calculated the business case for NeSTS in Section 3, estimating financial benefits of up to £174 million and a range of environmental benefits. TNEI or other suitable organisation will be invited to assess the outputs of NeSTS at Stage 5 of the project, providing an independent appraisal of actual benefits achieved.

SHE Transmission's knowledge management procedures are based on sound principles and are monitored to ensure effectiveness:

Reapplication of experience: SHE Transmission is committed to learning from previous research; literature reviews plus stakeholder consultation will be part of the development of detailed studies to achieve the learning objectives described in Section 5.1.1. This will enable NeSTS to generate new learning. Where necessary, studies and learning objectives may be refined to ensure the project builds on current knowledge rather than reproducing it.

Continual learning capture: The capture of formal technical learning relating to the objectives above will be supplemented by reflection on the process of project delivery to identify lessons learned. The project team has built a schedule of lessons learned reviews into the outline project plan, and will refine this schedule during the course of the project. Findings from lessons learned reviews will be validated by SHE Transmission's internal Project Review Board and disseminated to relevant groups.

5.3 IPR

It is our intention that the work undertaken using NIC funding will adhere to the NIC default IPR arrangements.

Section 6: Project Readiness

This section describes the NeSTS project's project plan, risk register, management and mitigation plans, and contingency plans.

6.1 Level of protection required for cost over-runs and unrealised direct benefits.

SHE Transmission confirms that the default level of 5% of the funding request to safeguard against cost over-runs and 50% of any shortfall in Direct Benefits is requested.

6.2 Evidence that NeSTS can start in a timely manner

6.2.1 Project Readiness Summary

The NeSTS NIC builds upon an existing NIA project which concludes in October 2015. The combination of the outputs from the NIA project and the development work already undertaken ensure that the NIC NeSTS project is poised to start, with all of the key stakeholders ready to participate, the resources and project framework in place, and the project planning at an advanced stage. The NeSTS project will be delivered within SSE's Major Projects Governance Framework (tailored for innovation projects), with the Innovation Steering Board as the Project Board and Stewart Reid (Head of Asset Management and Innovation) as the Project Director.

The following appendices support the Project Readiness of the project:

- Appendix 1: Full Submission Spreadsheet;
- Appendix 5: Detailed Project Plan;
- Appendix 6: Business Case Supplementary Information;
- Appendix 8: Risk Register and Contingency Plan;
- Appendix 12: Organogram;
- Appendix 9: Funding Commentary

6.2 Project Start

The NeSTS project is ready to commence; the NIC project has already passed Gates 0 and 1 as defined in the company's governance procedures, in early preparation for the delivery of the project. Key roles within the delivery team have already been filled and we are prepared for the transition to full project delivery upon award of NIC funding.

The NeSTS project has been prepared with support received at all levels of SHE Transmission's management hierarchy (see Appendix 9 for a description). The project board includes members of the senior management team including Colin Nicol (Managing Director of Networks) and David Gardner (Director of Transmission), each of whom is actively committed to the successful delivery of the project.

The project team includes:

- Project Director: Stewart Reid (Head of Asset Management and Innovation)
- Project Development and Stakeholder Engagement: Frank Clifton (Project Development Manager)
- Project Manager: Tim Sammon (NeSTS Project Manager)
- Communications: Avril Vera-Leon (Communications Manager)
- Transmission Operations : Peter Dale (Director of Transmission Operations)
- Engineering: Andrew Scott (Head of Engineering)
- Stakeholder Engagement: Richard Baldwin (Head of Environment)
- Connections and Commercial: Kenny Stott (Transmission Policy Manager)
- Recruitment and Training Lead: Matthew Allan (HR Manager, Networks)
- Learning and Dissemination Lead: Maria Liendo (Commercial and Knowledge Manager)
- Legal: Helen McCombe (Senior Commercial Solicitor and Legal Manager)
- Regulation: Andrew Wright (Networks Regulation Manager)
- Finance: Steven Kennedy (Director of Finance – Networks) / Davina Button (Future Networks Accountant)
- Procurement and Commercial: Carl Lappin and Paul Leddie (Commercial and Procurement Managers)

The availability of the above resources to start in January 2016 has been agreed and there are no concerns associated with starting the project on schedule. The project team will primarily be based in SHE Transmission's offices in Perth and Glasgow.

6.3 Cost Estimates

The following process has been adopted to ensure that the cost estimates included in this proposal are robust:

- The functional requirements were defined with input from project supporters; this consists of internal and external stakeholders.
- Each element of the technical and non-technical requirements have been based on learning captured from SHE Transmission's previous experience, and on external quotations where appropriate.

Note that the funding requested from the NIC for this project is to cover only the **additional costs and risk of deploying this technology for the first time** on the GB network. The remaining costs i.e. costs normally associated with the construction of a traditional new overhead line will be secured via the standard industry mechanisms. The initial project identified for the first installation will be selected during Stage 1 of the project, at this stage it is anticipated that this will be funded via the Volume Driver mechanism.

SHE Transmission has created an initial but detailed project costing based around estimates from previous transmission overhead line projects. These cost estimates have been developed using information available through SHE Transmission's Procurement team. This team use competitive processes and a series of framework arrangements to ensure value for money.

SHE Transmission has a portfolio of OHL projects in various stages of development, refinement, construction and commissioning. This is supported by commercial arrangements with consultants, designers, equipment suppliers and other technical specialists to ensure the delivery of the portfolio. Where appropriate, SHE Transmission will build on these relationships to ensure the successful delivery of the NeSTS project.

Again, procurement has been carried out using fair and transparent processes. Future suppliers e.g. contractors for the build will be procured using SHE Transmission's standard procurement processes, which includes an existing framework agreement with selected external organisations. Anticipated roles for the project include:

- project suppliers;
- material suppliers;
- installers;
- project management design and support;
- technical specialist;
- technical assurance;
- analysis support; and
- learning support.

Other roles may be identified as the project develops.

For the internal labour elements of the project, the established SHE Transmission rates for staff time have been used. All other cost elements are based on discussions with manufacturers and historic experience from other innovation projects.

6.4 Minimising cost overruns

The NeSTS project will be managed in accordance with SHE Transmission's Large Capital Projects Governance Framework and its established Programme Management Procedures. This is a whole lifecycle tool, designed to ensure projects are governed, developed, approved and executed in a consistent and effective manner, with consideration of best practice in project delivery.

As this project uses these arrangements as a basis, sufficient rigour is employed to confirm the project is well controlled and managed, and will lead to a successful conclusion. Additionally, the same successful management formulae used for previous NIC projects (Multi-Terminal Test Environment and Modular Approach to Substation Construction) will be extended to this project.

The Governance Framework requires projects to be divided into phases, with gates at appropriate decision points and clear, consistent deliverables for each gate. Project governance rules are established and defined for each phase, with standard project organisational structures and key roles.

As the NeSTS project develops through the inception and opportunity assessment stages, it is subject to stage gate reviews. The initial reviews consider project readiness and the underlying business case in order to ascertain whether the project should proceed or whether further work is required. Similarly, as the project enters key stages, it will be reviewed to assess the cost and completion of deliverables.

Each of the work packages has identified risks and developed mitigating actions to form the basis of the contingency plans. Risk management will be conducted in accordance with the Large Capital Projects Governance Framework.

6.5 Benefits Estimates

The following process has been adopted to estimate the benefits of the project:

- Initial benefits were identified by the NeSTS project team, using base case costs derived from previous projects and SHE Transmission's and SPT's Charging Statements[10]. These were compared to potential savings per cost element of OHL projects as supplied by Energyline.
- These initial figures were peer-reviewed by TNEI to produce a revised, independent view of potential benefits.
- Given that the benefits are comprised of both direct and indirect benefits, they are considered accurate to within +/-25%.
- In general a very conservative view has been taken in estimating the potential benefits that the NeSTS solution will enable. However, even in the worst-case FES scenario of No Progression and minimum benefits of 5%, the project still has potential to deliver over £174 million in savings to customers before 2050.

Recent announcements from the GB Government indicate potential changes to the support regime for renewable developments. This will introduce greater uncertainty in the number of new renewable projects being implemented in the long term, and may have a consequential impact on the volume of OHL required to connect renewables to the network. Therefore, we have planned a business case review at the end of Phase 1 of the project, to ensure that anticipated benefits can still be realised.

The new designs could possibly offer other benefits not quantified as part of the business case i.e. extended asset life, reduced maintenance and crucially reduced or avoided consenting costs. . This will be considered during the project's execution. These other benefits include the elimination of access roads, possibly avoiding underground cabling or asset sharing. We will also evaluate whether there could be additional benefits realised by sharing learning worldwide.

6.6 Minimising shortfalls in direct benefits

The NeSTS project seeks to secure funding for the **additional cost** of installing the new suite of supports for the first time. The cost of providing the conventional solution is being funded via the existing industry arrangements, at this stage it is anticipated that this will be via the Volume Driver Mechanism.

6.7 Quality Plan

All information contained in this proposal (including appendices) has been subject to a rigorous process to assure validity and accuracy which includes peer review; external expert review; and internal management review. This is supported by SHE Transmissions internal process and procedures which ensure compliance with Standard Licence Condition B23, Data Assurance Requirements and the Data Assurance Guidance

6.8 Project Reviews

External technical validation activities will be undertaken throughout the project including an initial assessment of the NIA project outputs. A review meeting is held to examine the current status of a project prior to any significant cost commitment such as equipment procurement. Concerns must be addressed before a project team may make a large purchase; any concerns which cannot be satisfied follow a strict escalation procedure, with Ofgem informed if this is the next appropriate action.

6.9 Process for Suspending the Project

The project is subject to the company's gated project management process, and at each gate the project's feasibility and risks will be reviewed before a project may proceed to the its next steps or "gate".

Furthermore, regular risk review workshops exist to escalate a significant risk or issue that requires a decision on the feasibility of the project. Any resulting proposed change to the project or request to suspend the project would then be submitted to Ofgem for approval.

6.10 Cross-Sector

This project is not part of a cross-sector project.

6.11 Project Plan

A detailed work programme plan can be found in Appendix 5, and an overview is provided below. Please note that due to page limit and formatting constraints, the project programme on Appendix 5 shows that Learning and Dissemination concludes in January 2021 but this stage is designed to conclude in March 2022.

The NeSTS project delivery will be managed using SHE Transmission's Major Projects Governance Framework (a mandatory requirement for projects of this size within SHE Transmission).

The Framework has five phases with 'gate keeping' as the project moves through the phases. The purpose of the gates is to ensure transparency, scrutiny and appropriate approval on project development and required deliverables. Clarity on project risks as well as benefits will assist with business decision making. An example of SHE Transmission's gated management process can be seen on Figure 6.a.

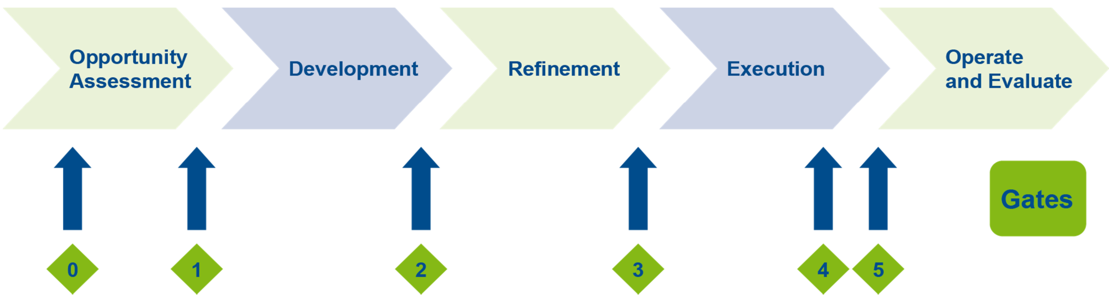


Figure 6.a SHE Transmission's gated management process for innovation projects

Six gates exist as shown in Figure 6a, where project development, definition and key deliverables are assessed to ensure the project benefits and opportunities are being fully exploited and project risks are understood, mitigated and controlled. For the NeSTS project a crucial stage will be the revaluation of the business case at the end of Stage 1; this will allow the final design to be selected and also allow time for the project team to consider the impact of any policy changes on the anticipated benefits from the project

Gates 0 and 1: Opportunity Assessment

The Stage Gate 0 and Stage Gate 1 were passed prior to submitting the NIC funding request for the NeSTS trial. Deliverables at the end of Stage Gate 1: Business Strategy and Regulatory Fit Analysis, Cost Estimate Classification 0, Business Case, Conceptual Design and approved Initial Screening Proforma for the NIC.

Stage Gate 2: Development

The NIC NeSTS project is currently within this phase.

Deliverables by the end of Stage Gate 2 include: Preliminary Site Feasibility Study, Cost Estimate Classification 1, Business Case, Project Development Plan, Governance, Development Resource Review, Project Safety Health and Environment Review, Environmental Requirements, Design Development, Technology Overview, Risk Management and approved NIC Full Submission.

Stage Gate 3: Refinement (Design) and Prototyping

In this phase the design of the NeSTS project will be fully developed with the following deliverables expected:

Health and Safety Plan, Environmental Requirements, Cost Estimate Classification 2, Business Case, Project Development, Contract and Procurement Strategy, Planning Permission and Land Options, Governance, Refinement Resource Review, Detailed Site Feasibility, Design Development Document, Risk Management Plan, Quality Management and Lessons Learned Review. In addition to these activities the NeSTS project will undertake additional Technical Assurance and Stakeholder Engagement activities.

The Stage Gate between Phases 1 and 2 of the project will be included during the Stage Gate 3 process. This is the final review before the project proceeds to the construction phase. At this time, we will re-evaluate the project's business case in light of learning gained and any new developments in relation to government policy on renewables.

Stage Gate 4: Execution (Build)

In this stage the NeSTS project will be constructed and commissioned.

Deliverables at this stage include: Health and Safety Plan, Cost Estimate Classification 3, Business Case, Operation Plan, Resource Review, Risk Management Plan, Quality Management, Lessons Learned and Testing & Commissioning Plan

Stage Gate 5: Operation and Evaluation

Two years of operations and monitoring will be undertaken using the NIC funding to deliver the following: Health and Safety Plan, Resource Review, Quality Plan, Project Handover Plan, Lessons Learned and Concluding Report.

6.12 Work Packages

Funding secured under the NeSTS NIC bid will facilitate all of the necessary work to accelerate the solution into 'business as usual' through sharing the learning and knowledge amongst the other network licensees. There are six key work packages associated with this NIC bid, to ensure that the full potential is achieved, as described below;

- **WP1 – Project Management**: phased over the duration of the project and associated with the internal resources required to deliver successful analysis, proactive engagement from stakeholders and dissemination of learning to the industry.
- **WP2 - Prototype and Initial Testing**: phased over Years 2 and 3, during which time the civil, structural, safety, operational and future versatility of the NeSTS chosen solution will be identified and developed in detail. This will include initial scale models, and testing of components and sub assemblies. A crucial element of this work package will be the extensive stakeholder engagement planned to assess the acceptability of the new NeSTS solution. The development of detailed strategies to integrate into 'business as usual' will also begin within WP2.
- **WP3 – Parallel Design Process**: phased between Years 2 and 3. This will include the detailed route planning and detailed design utilising the NeSTS solution on a planned overhead line project. This will be done in parallel with a traditional OHL design to ensure that the planned construction programme is achieved.
- **WP4 Full Scale Testing**: starts in Year 3 and concludes in Year 4. This will involve the full scale testing of a new NeSTS support structure to ensure that it meets the necessary design criteria and standards.
- **WP5 Planning, Construction and Monitoring Processes:** starts in Year 3 and continues to Year 5. This will include the development of the new processes and procedures required to construct the NeSTS solution for the first time. This stage will include the construction of a project using the new solution. Further work will include monitoring of the new solution to ensure it is performing as anticipated. We will also establish base asset data such as degradation and failure modes.
- **WP6 – Knowledge Dissemination:** phased over the duration of the project and designed to facilitate knowledge share with all interested parties, to integrate NeSTS into "business-as-usual" processes.

Each work package has been further subdivided into specific tasks. A lead will be a pointed to each task; they will be responsible of the delivery of the outputs and will be coordinated by the project manager. The work packages are described in Appendix 5.

6.12 Project Programme

The outline work programme is included in Appendix 5. This programme will allow the full scale development and testing of the NeSTS solution as well as the development of both the NeSTS design and its conventional alternatives to be designed and developed in parallel in order to ensure that SHE Transmission meets its programme requirements.

Section 7: Regulatory Issues

7.1 Derogations and exemptions

SHE Transmission confirms that there is no request for derogation, licence consent, licence exemption or change to the current regulatory arrangements in order to implement the NeSTS project.

7.2 NeSTS functional specifications and relevant legislation

The functional specifications for NeSTS will adhere to all relevant, mandatory legislation, including:

- Electricity Supply Regulations 1988;
- Electricity at Work Regulations 1989;
- Electricity Safety, Quality and Continuity Regulations 2002;
- System Operator Transmission Owner Code 2004; and
- Construction (Design and Management) Regulations 2015.

It may be possible for NeSTS to inform and influence future amendments to regulations and a proportion of funding will be allocated to identify opportunities for this.

Section 8: Customer Impact

This section addresses Evaluation Criterion 4.g as described in the Network Innovation Competition Governance Document V2.1 in terms of customer impact:

'Demonstration of a robust methodology and that the project is ready to implement.'

This project will develop and demonstrate NeSTS on a selected transmission OHL project on the network. The OHL project will work in accordance with SHE Transmission's Large Capital Projects Governance framework and Ofgem's Guaranteed Standards.

As the OHL project must proceed regardless of NIC funding awards being granted, funding for the general delivery of the project will be held in a separate bank account as indicated in the NIC Governance Document. In the event that NIC funding is not awarded, the OHL project will proceed using standard OHL support designs to ensure the timely delivery of the project.

8.1 NeSTS and Relevant Customers

This section describes the customer impact of project implementation, including planned mitigations.

NeSTS will have no interaction with Relevant Customers and there is no requirement for a Customer Engagement Plan or Data Protection Plan.

8.2 Supply interruptions

This section describes planned and unplanned customer interruptions, including planned mitigations.

Most of the work to develop and demonstrate NeSTS will take place away from the network. This includes design development and testing, which will be done in dedicated facilities. If NeSTS progresses beyond the Gate at the end of Stage 1 and proceeds to delivery it will be constructed a commissioned in accordance with the appropriate SHE Transmission procedures. Any outages will be carefully co-ordinated with the System Operator to ensure no adverse impact on the integrity of the network.

Section 9: Successful Delivery Reward Criteria

The following section describes the success criteria for the project, the completion of which are key milestones and indicators of the project's success, linked to the project programme (see Appendix 5). Progress against these criteria will be monitored and reported on during project delivery.

Criterion 9.1 NeSTS design selection

Key milestones at this stage in the project are (i) the completion of the development of the Support Assessment Matrix and (ii) the selection of the final support designs.

Evidence: The deliverable for these milestones is the publication of the initial outputs of the Support Assessment Matrix, which will be offered to TOs to compare different types of OHL supports in a technically balanced manner, incorporating the electrical, mechanical, environmental and construction and operational factors of OHL design. An accompanying report will provide the technical details of the selected designs. This will be produced by 30th September 2016.

Criterion 9.2 Output of stakeholder engagement

The success of the NeSTS project depends upon comprehensive consultation with stakeholders, to include TOs, landowners, statutory authorities and the supply chain. SHE Transmission will implement a programme of stakeholder engagement, supported by project supplier Social Market Research (SMR). This will include organised events and one to one interviews. SMR will provide the necessary quantitative and qualitative analysis to understand key priorities. SHE Transmission will factor these viewpoints into the functional specification for NeSTS where practical.

Stakeholders for the project include (i) SHE Transmission internal stakeholders (ii) Transmission operators (iii) supply chain (iv) statutory authorities and (v) landowners.

Evidence: Evidence will consist of a report describing the outputs from stakeholder engagement and demonstrate where these outputs have influenced the NeSTS designs by 30th September 2017.

Criterion 9.3 Creation of technical specification

The NeSTS OHL circuit will be designed in parallel with a traditional OHL support design – this is to create contingency in the event that NeSTS is not approved for demonstration at the stage gate process. The new technical specification for the supports will show how NeSTS design can be practically applied on a project, and is a key learning output for TOs and the supply chain. This will inform the procurement exercises for the initial deployment.

Evidence: The outputs of this stage will be completed by 30th August 2018.

Criterion 9.4 Stage Gate – Decision Point / Review of business case

The first phase of the project, which constitutes the development stages, will conclude with a stage gate to determine whether NeSTS business case is sufficiently validated to proceed to deployment and demonstration. The stage gate is a formalised step the in project programme involving SHE Transmission's Director of Transmission and the SHE

Transmission Steering Board. The learning gathered at this point will be assessed to ensure that NeSTS still has a positive business case – impacts of any energy policy developments regarding renewable generation will be considered as part of the decision process. In order to move into Phase 2 of the project, the modelling work must show a positive return on investment.

Evidence: The project team will provide a detailed analysis document which explains how the business case has developed and how new political developments have influenced this. This will be published by 31st March 2019.

Criterion 9.5 Completion of type testing

Within the first stage of Phase 2 (the demonstration part of the project), the detailed designs will enable the construction of a NeSTS OHL support structure, which will be tested at a dedicated testing facility. The OHL support will be put through a series of tests in order to ensure that it complies with the relevant standards and specifications including BS EN 60652 and BS EN 61773. The completed test results will provide clear analysis regarding NeSTS's capabilities.

Evidence: The type testing conclusions will be published by 31st October 2019.

Criterion 9.6 Energisation of NeSTS OHL

The energisation of the NeSTS OHL circuit is the culmination of the construction and commissioning of a section of the project is a key milestone.

Evidence: A full report detailing outputs and knowledge capture will be published – this will include an evaluation comparing NeSTS construction, commissioning and energisation with that of a typical steel lattice tower project. This will be delivered by 31 October 2020.

Criterion 9.7 Publication of e-learning and visualisation tools

Knowledge capture and dissemination is of high importance to the project and the acceleration of NeSTS into TOs' business as usual activities. SHE Transmission will develop an e-learning module to assist with training and familiarisation activities amongst TOs and the supply chain. A visualisation tool will also be created to assist TOs with network planning, and to share learning with stakeholders.

Evidence: The development of both tools will be completed by 31st March 2021.

Criterion 9.8 Project closedown report

At the end of the project, full evaluation and key learning points will be considered for inclusion in a comprehensive project closedown process. This will include learning gathered from knowledge events and the progress of the MASC substation during operation.

Evidence: A detailed closedown report will be delivered by the 31st March 2022.

Section 10: Lists of appendices and references

	References
1	**Transmission Network Use of System Charges (TNUoS)**, National Grid System Operator: https://www.ofgem.gov.uk/electricity/transmission-networks/charging
2	**Volume Driver Mechanism, Annual Performance Report 2014-2015,** SHE Transmission: Accessed online 23 July 2015: https://www.ssepd.co.uk/TransmissionPriceControlReview/
3	**SHE Transmission Business Plan (2011)**, SHE Transmission: Accessed online 16 July 2015: http://www.ssepd.co.uk/TransmissionPriceControlReview/
4	**Climate Change Act (2008)**, UK Government: Accessed online 01 June 2015: http://www.legislation.gov.uk/ukpga/2008/27/contents
5	**The Carbon Plan (2011)**, Department of Energy and Climate Change: Accessed online 01 June 2015: http://www.legislation.gov.uk/ukpga/2008/27/contents
6	**Electricity Ten Year Statement (2014)**, National Grid: Accessed online 01 June 2015 http://www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/Electricity-ten-year-statement/
7	**Electricity Pylons Survey (2015)**, YouGov: Accessed online 04 June 2015 https://yougov.co.uk
8	**Future Energy Scenarios (2014),** National Grid: Accessed online 01 June 2015: http://fes.nationalgrid.com/
9	**Transmission Entry Capacity Register (2015)**, National Grid: Accessed online 15 June 2015: http://www2.nationalgrid.com/UK/Services/Electricity-connections/Industry-products/TEC-Register/
10	**Charging Statements (2014):** SHE Transmission - https://www.ssepd.co.uk/Library/ChargingStatements/SHET/ Scottish Power Transmission - http://www.scottishpower.com/userfiles/document_library/SP-Transmission-Statement-of-the-Basis-of-Charging-2013-14.pdf
11	**Sustainability Statement (2015),** SHE Transmission: Accessed 01 May 2015: https://www.ssepd.co.uk/Search/?q=sustainability%20statements
12	**Connection and Use of System Code (CUSC)**, National Grid: http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/Connection-and-Use-of-System-Code/
13	https://www.gov.uk/government/speeches/statement-on-ending-subsidies-for-onshore-wind

ofgem

Appendix 1: Benefit Tables

KEY

Method	Method name
Scenario 1	15% of OHL suitable for method under Gone Green Scenario
Scenario 2	15% of OHL suitable for method under Low Carbon Life Scenario
Scenario 3	15% of OHL suitable for method under Slow Progression Scenario
Scenario 4	15% of OHL suitable for method under No Progression Scenario

Financial benefit (£m) – 5% Saving								
Scale	Method	Method Cost (5%)	Base Case Cost	Benefit			Notes	Cross-references
				2020	2030	2050		
Post-trial solution (individual deployment)	Scenario 1						No financial benefit for single roll-out solution. Financial benefits will be achieved through licensee scale and GB scale rollout.	See Appendix 4 and 6 for further details.
	Scenario 2							
	Scenario 3							
	Scenario 4							
Licensee scale If applicable, indicate the number of relevant sites on the Licensees' network.	Scenario 1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	((Number of km : Based on 15% of sites being suitable for NeSTS	See Appendix 4 and 6 for further details. NB the Base Case cost has been based on information in SHE Transmission Charging Statement.
	Scenario 2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
	Scenario 3	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
	Scenario 4	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
GB rollout scale If applicable, indicate the number of relevant sites on the GB network.	Scenario 1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	(Number of km : Based on 15% of sites being suitable for NeSTS:	See Appendix 4 and 6 for further details. Base Case cost based on information from TOs Charging Statement
	Scenario 2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
	Scenario 3	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
	Scenario 4	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		

Scale	Method	Method Cost (10%)	Base Case Cost	Benefit			Notes	Cross-references
				2020	2030	2050		
Financial benefit (£m) – 10% saving								
Post-trial solution (individual deployment)	Scenario 1						[No financial benefit for single roll-out solution. Financial benefits will be achieved through licensee scale and GB scale rollout.	See Appendix 4 and 6 for further details.
	Scenario 2							
	Scenario 3							
	Scenario 4							
Licensee scale If applicable, indicate the number of relevant sites on the Licensees' network.	Scenario 1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	((Number of km : Based on 15% of sites being suitable for NeSTS	See Appendix 4 and 6 for further details. NB the Base Case cost has been based on information in SHE Transmission Charging Statement.
	Scenario 2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
	Scenario 3	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
	Scenario 4	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
GB rollout scale If applicable, indicate the number of relevant sites on the GB network.	Scenario 1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	(Number of km : Based on 15% of sites being suitable for NeSTS:	See Appendix 4 and 6 for further details. Base Case cost based on information from TOs Charging Statement
	Scenario 2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
	Scenario 3	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
	Scenario 4	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		

ofgem

RIIO NIC NETWORK INNOVATION COMPETITION

Electricity NIC – carbon and/or environmental benefits

<table>
<tr><th colspan="9">Capacity released and/ or environmental benefit (kVA/ kWh)</th></tr>
<tr><th>Scale</th><th>Method</th><th>Method Cost</th><th>Base Case Cost</th><th>2020</th><th>2030</th><th>2050</th><th>Notes</th><th>Cross-references</th></tr>
<tr><td>Post-trial solution
(individual deployment)</td><td>Method 1</td><td></td><td></td><td></td><td></td><td></td><td>[explain circumstances where benefits may be larger or less that those stated – including the upper and lower limits]</td><td>[cross-references to where underlying calculations/ assumptions are explained in the submission]</td></tr>
<tr><td>Licensee scale
If applicable, indicate the number of relevant sites on the Licensees' network.</td><td>Method 1</td><td></td><td></td><td></td><td></td><td></td><td>(Number of sites:___)</td><td></td></tr>
<tr><td>GB rollout scale
If applicable, indicate the number of relevant sites on the GB network.</td><td>Method 1</td><td></td><td></td><td></td><td></td><td></td><td>(Number of sites:___)</td><td></td></tr>
<tr><td rowspan="3">If applicable, indicate any carbon and/or environmental benefits which cannot be expressed as kVA or kWh.</td><td colspan="6">Post-trial solution: [Explain any carbon and/ or environmental benefits which cannot be expressed as kVA or kWh]</td><td rowspan="3">There are a number of key environmental benefits which will arise from NeSTS, these predominantly arise from the reduction in civil works, vehicle movements etc. which occur with the move to a monopole solution.</td><td rowspan="3"></td></tr>
<tr><td colspan="6">Licensee scale: [Explain any carbon and/ or environmental benefits which cannot be expressed as capacity or kVA or kWh]</td></tr>
<tr><td colspan="6">GB rollout scale: [Explain any carbon and/ or environmental benefits which cannot be expressed as kVA or kWh]</td></tr>
</table>

ofgem RIIO NIC NETWORK INNOVATION COMPETITION

Appendix 2: Extract of Full Submission Spreadsheet

The complete Full Submission Spreadsheet was submitted separately via Huddle. The table below summarises the Outstanding Funding request;

Outstanding Funding required							
	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Labour	£46,215	£308,287	£315,582	£271,037	£274,316	£265,501	£1,480,938
Equipment	£4,725	£17,630	£5,739	£10,849	£6,101	£187,664	£232,708
Contractors	£153,000	£793,362	£1,525,878	£1,213,174	£955,885	£168,609	£4,809,907
IT	£9,675	£25,674	£50,186	£53,269	£28,472	£17,037	£184,313
IPR Costs	£0	£0	£0	£0	£0	£0	£0
Travel & Expenses	£450	£7,423	£16,262	£3,945	£2,033	£12,580	£42,693
Payments to users & Contingency	£0	£0	£0	£0	£0	£0	£0
Decommissioning	£0	£0	£0	£0	£0	£0	£0
Other	£0	£0	£0	£0	£0	£0	£0
Total	£214,065	£1,152,376	£1,913,647	£1,552,274	£1,266,806	£651,391	£6,750,559
					NIC FUNDING REQUEST £		**£6,638,881**

Strategy

SHE Transmission has an established portfolio of large capital projects currently in development and delivery. Early stakeholder engagement is critical to our success and is ingrained in our everyday practices. We work with a wide range of stakeholders, including: strategic stakeholders, keen to ensure that the delivery of our projects meets our licence obligations (to develop, operate and maintain a safe, reliable and efficient transmission network); statutory authorities and key consultees tasked with supporting the development and consenting of our projects; politicians; landowners; local residents; and the general public which our projects serve.

In the delivery of these projects we have developed an extensive list of stakeholders whom we believe add particular insight into our day-to-day business. We have categorised our stakeholders based upon our existing relationships with them; the level of influence they have over our business and processes; and their interest in helping us shape it. This stakeholder list will be used to inform and select the key stakeholders necessary to closely engage with on NeSTS project.

We have created a centralised stakeholder contact and record management system to enable us to actively manage engagement within projects and across the business. This is managed in accordance with our Data Protection Policy and ISO 9001:2008.

Effective and timely stakeholder engagement is critical to the success of NeSTS.
A key objective of the stakeholder engagement strategy is to create the conditions for the capture, recording, analysis, application and feedback of a representative range of customer views. It is important that these views are used to shape the development of the project. As many differing views will be received it will be necessary to carefully consider these on their own merits to reach a robust decision on the appropriate way to progress. This will need to balance the views of our stakeholders with the objectives of the project and be communicated in open and transparent feedback.

We will engage Social Market Research (SMR) to further develop and refine our engagement strategy. SMR will provide the following services:

- Stakeholder engagement scoping and planning;
- Design of discussion and topic guides for events;
- Use of voting software including programming;
- Recruitment and logistics support;
- Provision of moderators;
- Management of stakeholders at events;
- Analysis and reporting of event feedback; and
- Production of final report.

They key stakeholder groups that will be engaged throughout the project are:

- Electricity network licensees;
- Supply chain members;
- Statutory authorities such as [redacted], Local Authorities and other consenting agencies;
- Non-statutory consultees such as [redacted]; and
- Members of the public and landowners, and their representatives.

Engagement to date

Over the last 10 years there has been a change in perception from stakeholders on the acceptability of steel lattice towers in the environment in which SHE Transmission operates. This has been communicated through formal and informal engagement (for example public exhibitions, face to face meeting, responses to consultation documents and representations through the planning process) and places increased importance on robust assessment of the effect of such proposals on landscape and visual amenity, including consideration of the alternatives that exist to help reduce such effects. This has been embodied in planning policy and Environmental Impact Assessment.

In terms of academic research, Goulty, G (1989) Visual Amenity Aspects of High Voltage Transmission, Wiley-Blackwell, 100, states “Whilst accepting that public opinion polls are open to a wide interpretation it is apparent that there seems to be a public preference for poles”, and a YouGov poll carried out in April 2015 showed that the T-Pylon developed by National Grid met with approval by the public. Out of 2,444 respondents, 59% liked the design of the T-Pylon, compared to only 36% of people having a positive view on traditional lattice towers. A copy of this survey can be found at https://yougov.co.uk).

On our projects to date, we have witnessed multiple pressure groups being established to object to our proposals on the basis of landscape and visual effects (for example Highlands Before Pylons - http://www.hbp.org.uk/) and as part of the consenting process we receive many objections. For example, Beauly Denny received in excess of 17,000 objections, the majority of which cited landscape and visual concerns.

To date, statutory authorities in the North of Scotland have been introduced to the NeSTS projects at our regional Liaison meetings and are keen to get involved in helping to shape the direction of the project.

Figure AP3.1 illustrates our proposed Stakeholder activities throughout the lifecycle of NeSTS and the purpose of each step is discussed below:

Design Review and Concept proving

Early engagement with Statutory Authorities and Key consultees (including the consenting bodies, [redacted]), landowners and the general public is a key step in allowing us to refine our technology options and tower design suites. The feedback from this consultation will be used to prove the assumptions we have made using the assessment matrix on the tower suite options identified in the NIA project in order to validate our current preferred options. We are confident the assessment to date is robust but should feedback suggest areas of further assessment or refinement, we will undertake this as necessary. The output of this engagement will be the collation of all comments in our consultation database and the production of a Report on Consultation that orders, analyses and responds to the feedback generated. This will be shared with the stakeholders.

In addition to this engagement we have also developed a ‘Sustainable Commercial Model’ that aims to quantify the ‘value’ (positive and negative) that our projects have on the environment, land use and other socio-economic factors. This value is directly influenced by stakeholder consultation and has been used to develop a better understanding of benefits of changes in design and mitigation options. This model was developed under another NIA project (NIA_SHET_0001) but has been used to good effect on our Beauly Denny projects and it is proposed that we use this model to inform our stakeholder engagement activates in the option selection and validation stages.

Prototypes and Initial Testing

Stakeholder engagement at this stage will focus on dissemination of the decision on which options to progress and verification of potential 'live' demonstration projects that we consider suitable to pilot the new tower suite. The selection of the pilot project is a critical decision that will influence the success of the wider NeSTS project and as such 'buy-in' from the consenting bodies, statutory authorities and key consultees who have influence over the consenting process is key. A briefing note will be produced explaining the rational for selection of the pilot project.

Parallel Design/Preparation for full scale testing

As this point the NeSTS project will be run in parallel with our standard Business as Usual (BaU) project development process through the pilot project. We have a robust and clearly defined process (set out through internal guidance and legislative requirements) and this will be rigorously followed to ensure stakeholder engagement is effective. Stakeholder feedback will be obtained through a variety of forms including public exhibitions, workshops, consultation documents, and the statutory EIA and consenting engagements requirements. The purpose of this stage is to develop a consentable route/project that meets our licence obligations whilst utilising the proposed new tower suite. Again, all comments will be recorded in the consultation database and inform our suite of structured outputs culminating in a design, route and environmental assessment of the proposed pilot project for which consent applications can be submitted. A key element of this stage to compare the impact of using a non-standard OHL support design compared to traditional support solutions

Planning and Evaluation inc Full scale testing

Again, the stakeholder engagement activities in this stage will be led by our standard project processes and statutory requirements. This stage of engagement is formal and is contained within the statutory consenting process. It will provide an opportunity for all stakeholders to comments on the proposals in the pilot project for which consent in being sought. The difference in this step is that feedback will be given directly to the consenting authorities to enable them to determine the application. Where necessary we will respond to the consenting authority to provide further clarification and answers to any questions or comments posed by the consultees.

Implementation and construction

As part of any construction project we develop a stakeholder and communications plan. This identifies all stakeholders that need to be engaged, how and when throughout the construction phase of the project. Typically this involves Statutory authority liaison meetings, community liaison groups, email and website updates. The purpose of this engagement is to ensure the project is developing in line with the expectations of the stakeholders and that any concerns can be identified early and resolved quickly. All communications will be captured in the consultation database.

Monitoring and Evaluation

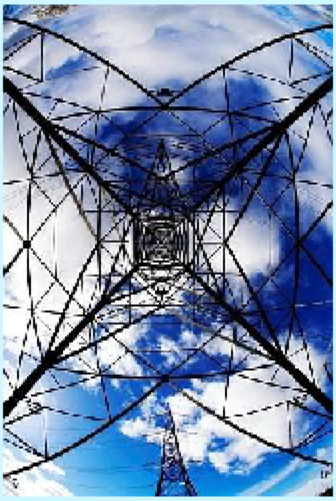
Following completion of the pilot project there is an important exercise to revisit the aims and objectives of the NeSTS project and review how successful it has been in relation to addressing and building on the stakeholders expectations. We propose to have a final statutory authorities and key consultees working group to review the project and identify key learning that has been achieved. We will also seek confirmation that the final design of new tower suites will be an acceptable alternative to existing options. This will involve a site visit to allow a 'real' appreciation of the final product in the landscape for which it is designed and a post construction landscape and visual assessment to compare the predicted effects with those that have actually occurred. In addition to the working group we also propose to re-engage the focus groups that fed into the concept feasibly stage. The result of these engagement activities and our technical review will inform an important element of the projects learning. .

Figure AP3.1 – Stakeholder Engagement Strategy

Stage	Stakeholder Engagement	Output/feedback
Stage 1.1 Concept Proving	• Workshops (Statutory Authority and Key consultees) x2 • Face to Face interviews (Statutory Authorities and Key	• Consultation database • Sustainable Commercial Model • Report on consultation
Stage 1.2 Prototypes and initial testing	• Update presentation (Statutory Authority and Key consultees) x1 • Pilot project verification workshop (Statutory Authority and Key consultees) x1 • Meetings. teleconferences, phone calls, emails (All consultees) - as required	• Consultation database • Briefing note on project selection rational
Stage 1.3 Parallel Design Stage 1.4 Preparation for Full Scale Testing	• Pilot project route optioneering/selection workshops x2 (statutory Authorities and Key Consultees) • Preferred corridor public exhibition (Public, Landowners, Communities) x1 • Preferred Route Consultation Document (All Stakeholders) • Report on Consultation (All stakeholders) • Environmental Impact Assessment (EIA) o Screening request (Statutory Authorities) o Scoping request (Statutory Authorities and Key consultees) o EIA topic specific consultation (Statutory Authorities and Key Consultees)	• Consultation database • Consultation Document • Exhibition materials • Report on Consultation • Screening Request • Scoping Report

Stage	Stakeholder Engagement	Output/feedback
Stage 2.1 Full scale testing and Planning and Evaluation for the New Design	• Ad-Hoc Pre- application consultation (Statutory Authorities and Key Consultees) – As required • Scottish Government Pre-application Gate check • Submit Electricity Act (s37) consent application (All Stakeholders) • Public Notices of application and Exhibitions (Public, Landowners, Communities) x1	• Consultation database Application pack (including EIA) • Public Notices • Exhibition Materials
Stage 2.2 Implement-ation and Construction	• Meetings. teleconferences, phone calls, emails (All stakeholders) - as required • Liaison meetings (Statutory Authorities) - Quarterly • Community Liaison Groups (Public, Landowners, Communities) - Quarterly	• Consultation database
Stage 2.3 Monitoring and Evaluation	• Project Evaluation Workshop (Statutory Authorities and Key Consultees) x1 • Focus Groups (Public, Landowners, Communities) x10	• Consultation database • Post-construction Landscape/Visual Assessment • Lessons Learned Report
Stage 2.4 Knowledge Dissemination	• Industry conferences (x2) • Papers in relevant industry journals • Document Dissemination	• Close Down Report • SAM • Visualisation tools • Learning Module

Appendix 4: TNEI Market Assessment



Title: NeSTS NIC Market Assessment Report

Client: SHE Transmission

Report Nº: 10290-04-R4

Date: 29 July 2015

Part of the Petrofac Group

DOCUMENT HISTORY AND STATUS

CONFIDENTIALITY (Confidential or not confidential):	
Project No.:	10290
Project Name:	NIC Bid Supports
Author:	Alan Mason
Issued by:	TNEI Services Ltd

Revision	Date issued	Reviewed by	Approved by	Date Approved	Revision Type
R0	09/05/2015	C Cleary	Alan Mason	10 June 2015	Preliminary Draft
R1	30/06/2015		Alan Mason	30 June 2015	Transmission upgrade figures amended
R2	10/07/2015		Alan Mason	10 July 2015	Minor text changes
R3	24/07 2015		Alan Mason	24 July 2015	Transmission figures updated
R4	28/07/2015		Alan Mason	28 July 2015	Minor text changes

Quality Assurance
TNEI is registered with Ocean Certification Limited (Certificate Number C145013 Q) as compliant with International Standard EN ISO 9001:2008. All work conducted by TNEI, its subsidiary companies and its subcontractors is carried out in accordance with in-house procedures and documentation.

Disclaimer
THE CONTENTS OF THIS DOCUMENT ARE FOR THE CONFIDENTIAL USE OF ONLY THOSE PERSONS TO WHOM IT IS INTENDED, AND MAY NOT BE REPRODUCED OR CIRCULATED IN WHOLE OR IN PART.

CONTENTS

1 Introduction

TNEI Services Ltd has been commissioned by Scottish Hydro Electric Transmission Ltd (SHE Transmission) to investigate the volume of overhead lines (OHL) that will be constructed up to 2050. As the new suite of tower structure designs may be commonly used for 132kV and 275kV applications it has been necessary to apply a number of filters to the total volume of lines to be constructed. The resultant figures provide an indication of the number of kilometres of the new design that could be deployed in the future.

TNEI have identified that there are three drivers for the construction of 132kV and 275kV overhead lines over the next 35 years, these are:

- Transmission line reinforcement in the National Grid (NGET), Scottish Power Transmission (SPT) and SHE Transmission regions;
- 132kV distribution line upgrade and replacement by the DNOs in England and Wales;
- 132kV and 275kV generation connections.

The report will detail the data used to calculate the volume of overhead line construction from all three of these sources. In addition, an explanation is provided on how each data set is processed to remove reinforcements that would not be compatible with the new suite of tower structure designs.

The rate of overhead line construction over the next 35 years will be driven by changes to electricity demand and the changing generation mix. For each of the three sources above, planning data is provided up to the mid 2020's. In order to predict the development of the network up until 2050 a number of growth scenarios need to be considered. National Grid provides figures for four growth scenarios as part of the Future Energy Scenarios (FES). These are:

- **Gone Green** The most optimistic growth strategy with little restraint on cost and a high investment level for infrastructure;
- **Low Carbon Life** Represents long term consensus on decarbonisation but short term volatility over energy policy and targets;
- **Slow Progression** Similar goals and targets to Gone Green but growth is constrained by low economic activity;
- **No Progression** There is low economic activity, policy and regulation remain the same as today and no new targets are introduced.

All four of these scenarios are applied to the calculated data and provide a spread of figures for the growth of overhead line construction.

The standard convention for expressing the volume of transmission lines is in km. This convention is maintained for this report. Where overhead line construction has been expressed in monetary terms this has been converted to km. The number of towers that will be required for 1km of overhead line will vary depending on a number of factors including voltage level, capacity and terrain.

2 Data Sources and Processing

This section outlines the data sources used to calculate the total amount of overhead line construction that will occur up to the end of the respective planning and funding periods. In addition the assumptions used to filter out schemes unsuitable for new suite of tower designs are also presented.

2.1 Transmission Line Reinforcement

The majority of overhead line construction is for transmission line reinforcement. There are a number of factors that will drive the need to construct new transmission assets. These may include an increase in demand, the replacement and upgrading of existing assets, the removal of constraints and the connection of new generation. Each transmission operator will strategically plan all of these network upgrades and provide details of these as part of the National Grid Electricity Ten Year Statement (ETYS). The ETYS is provided as a spreadsheet that lists details for each connection. This includes; the two connection nodes, the year of construction, the length, the circuit type and the status. The 2014 ETYS provides data for network upgrades up to 2024. The following filters were applied to the data:

- The ETYS included all transmission voltages from 132kV and above - upgrades specific to 400kV were removed;
- Only upgrades classed as 'addition' were used. Those classed as 'change' were assumed to refer to conductor restringing;
- Where two overhead lines of the same length were listed, this was assumed to be a double stringed tower so only one length was used.

2.2 Distribution Network 132kV Networks

The distribution network operators in England and Wales own and operate the 132kV network. The DNOs publish their plans for network upgrades and reinforcements as part of their RIIO–ED1 business plans. For this report each RIIO–ED1 statement was reviewed and a figure for annual 132kV work was calculated. The annual combined expenditure on 132kV lines for all the DNOs can be expressed as an equivalent length of 53km of new OHL (based on £1m per km of OHL). However it was decided not to include any of the distribution networks for the following reasons:

- Much of the costs quoted will be spent on refurbishment and replacement rather than building new overhead lines.
- New 132kV circuits are likely to either be buried underground in urban environments, and wooden pole OHLs will be used in rural environments.

2.3 Future Generation Connection

All generation connection applications that could use the new suite of tower designs are listed in the Transmission Entry Capacity (TEC) Register. This register covers all generation that is contracted to National Grid for transmission entry rights. It covers generation sites connected to a transmission line or embedded in a distribution network. For economic reasons generation projects tend to be built as close as possible to a suitable grid entry point. They therefore represent a relatively small percentage of the overall overhead line or cable connections installed in the UK. In order to obtain a figure for the annual volume of overhead line for generation connections that could use a revised tower structure the following assumptions were made:

- All generation below 32MW was assumed to be embedded in the distribution network and was disregarded;
- Any generation lower than 90MVA and connected at 132kV was discarded. Below 90MVA it is possible to use a wooden pole and project economics would dictate that this method would be used;
- Any generation above 1500MW is considered as connecting at 400kV. This is based on the rating of a 275kV overhead line.

Once the above filters were applied the remaining generation applicants were investigated. Where the location could be identified, the distance from this to the nearest connection point was measured and this was assumed to be the length of the overhead line. For sites where the location could not be found, an average distance of 8.49km was used based on the figures for the known sites. Offshore connections have a nominal value of 1km, as these tend to have connection points to the transmission grid close to land fall.

A final filter was applied to account for projects that may not go ahead. The TEC Register lists projects with one of the four following statuses. Scoping, Awaiting Consents, Consents approved or Under Construction/ Commissioning. The following weightings were applied depending on the status of the project.

Table 1 Project Success Rate

Project Status	Success
Scoping	**30 %**
Awaiting Consents	**50 %**
Consents Approved	**80 %**
Under Construction/ Commissioning	**100 %**

3 Application of Future Energy Scenarios

The two most conservative outputs of the National Grid Future Energy Scenarios were used to calculate the growth in demand of overhead line build up to 2050. Electricity usage was used to calculate transmission upgrades and generation demand was used for overhead line build for generation connections. Each of these growth strategies was calculated for the four scenarios listed in the introduction. Figure 1 below shows the growth scenarios driven by electricity usage while

Figure 2 shows the growth scenarios driven by generation.

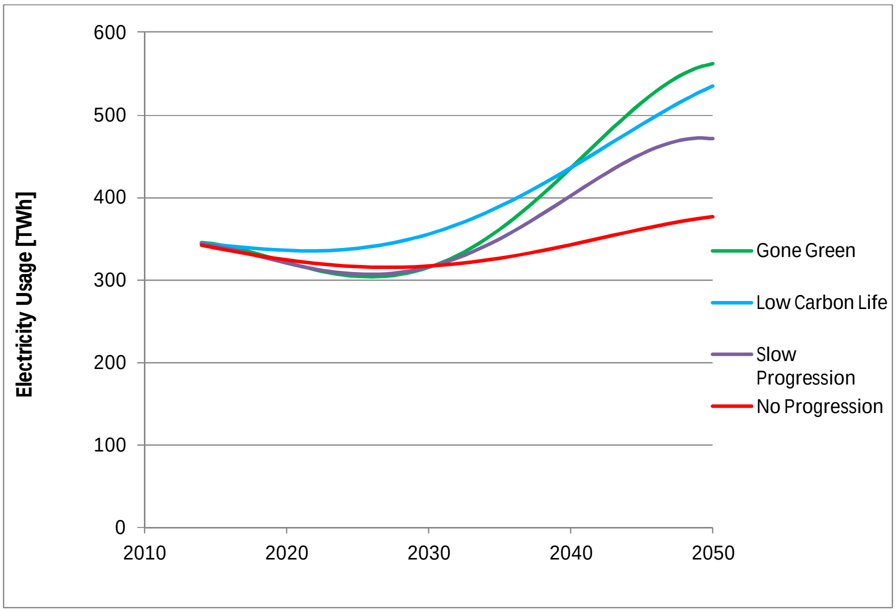


Figure 1 Electricity Usage

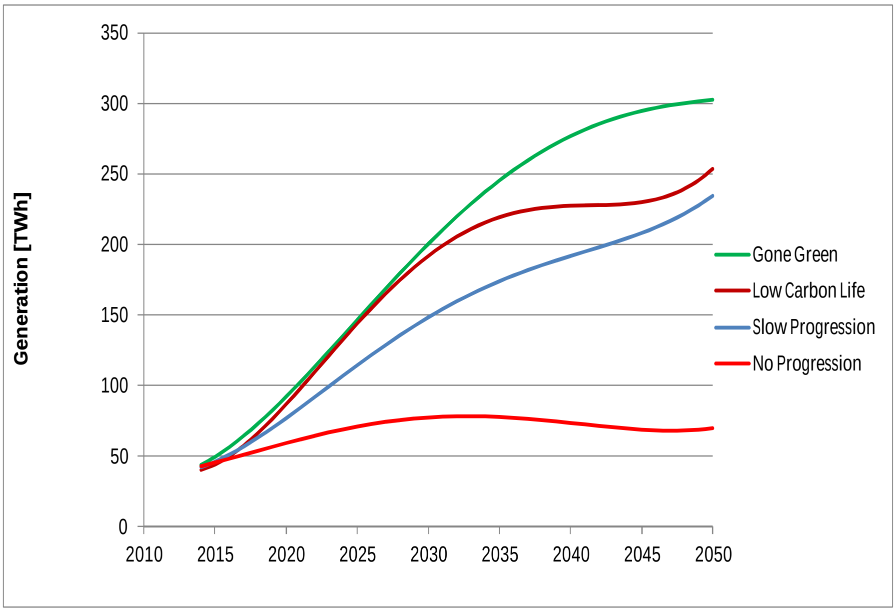


Figure 2 Generation

4 Results

4.1 Individual Components

The individual components for transmission reinforcement and generation connection are shown in Figure 3 and Figure 4 respectively. Both are shown with a Slow Progression growth forecast. The transmission data shows a highly cyclical build programme with SHE Transmission responsible for the bulk of the work, and SPT picking up towards the end of the ETYS planning period. There is little activity from National Grid in these plots and this will reflect the fact that the data for 400kV reinforcements has been stripped out. The generation data shows a much lower volume of overhead line build. This shows a peak of activity that corresponds to the original ROC deadline of April 2017.

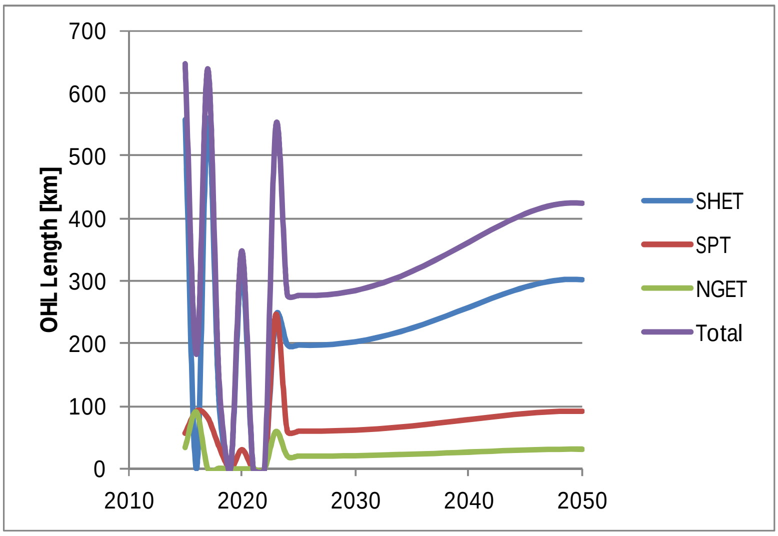


Figure 3 Transmission Line Reinforcement

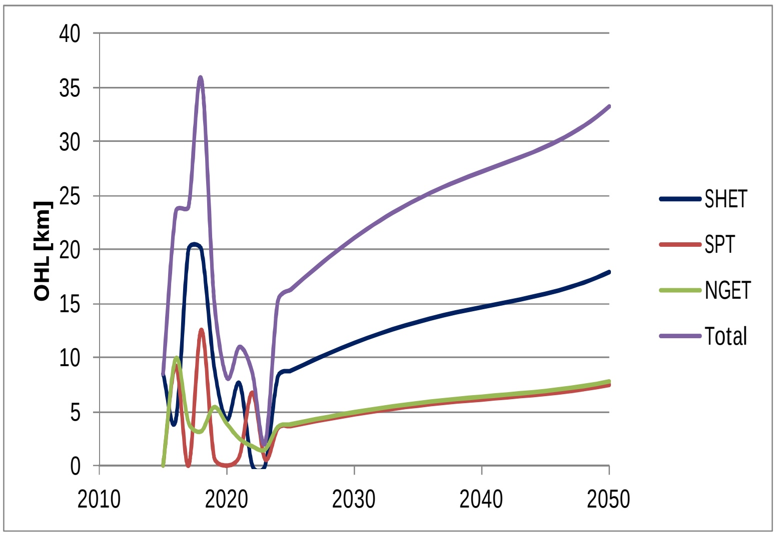


Figure 4 Generation Connections

4.2 Total Capacity

Four figures are presented below that represent the total volume of overhead line production up to 2050 that would be suitable for the new suite of tower designs. The four energy scenarios are presented below starting with Gone Green and moving through to No Progression. The two larger plots show the total with and without the demand from National Grid. It has been identified that the new suite of tower structure designs will not be applicable to installations in England and Wales as they will mostly be at 400kV and use the new National Grid T-Pylon design. The green plot shows the minimal contribution generation connections make to the total amount. Table 2 gives a comparison of the different growth rates that will occur at 2050 for OHL in Scotland. The starting point at 2024 will be 276km per annum.

Table 2 Annual Volumes in 2050 (Scotland only)

Scenario	Annual Volumes in 2050
Gone Green	**487.7 km**
Low Carbon Life	**425.1 km**
Slow Progression	**408.7 km**
No Progression	**319.1 km**

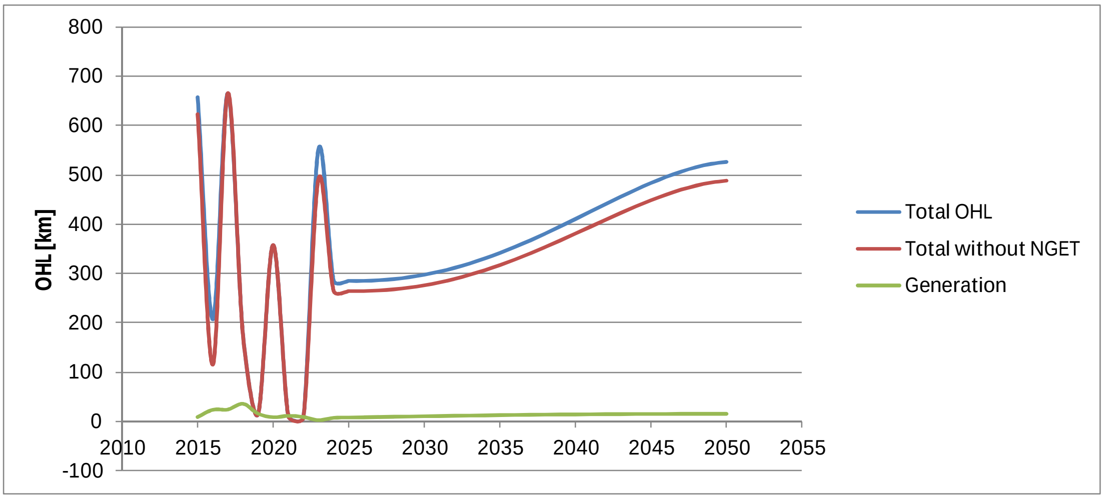


Figure 5 Total OHL under Gone Green

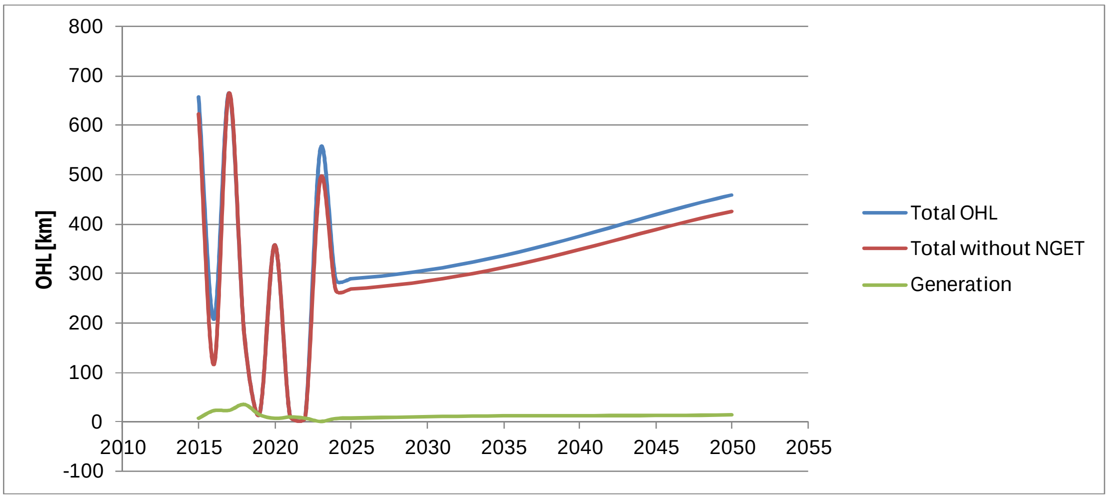


Figure 6 Total OHL Construction under Low Carbon Life

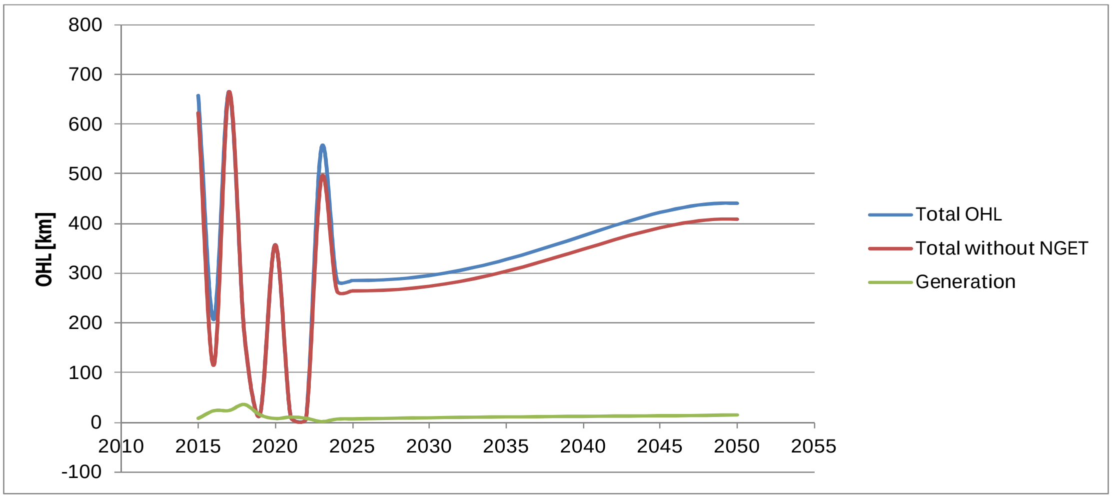


Figure 7 Total OHL Construction under Slow Progression

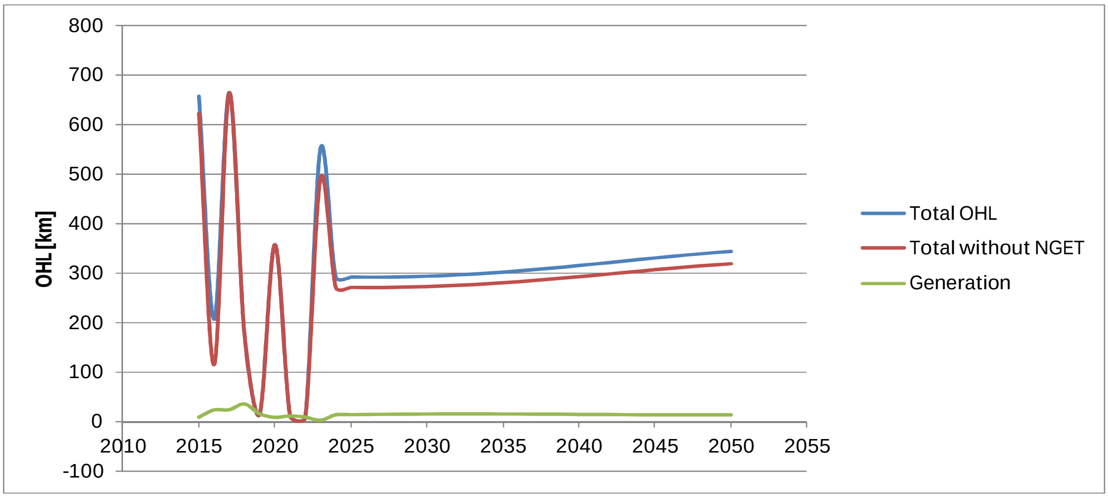


Figure 8 Total OHL Construction under No Progression

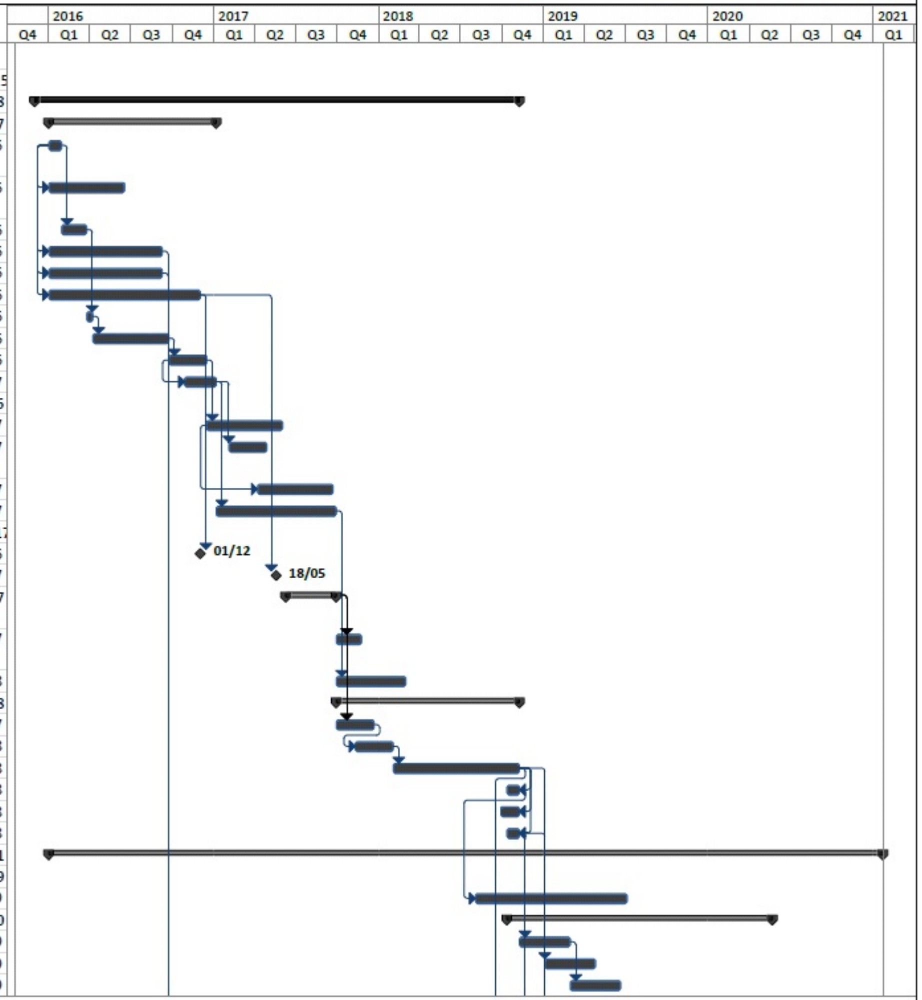
ofgem

RIIO NIC NETWORK INNOVATION COMPETITION

Appendix 5: Programme

Network Innovation Competition 2015 — New Suite of Transmission Structures - NeSTS

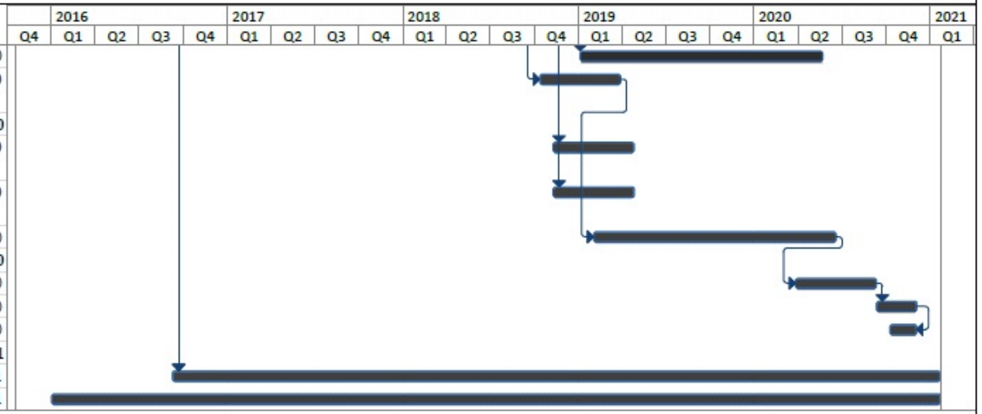
ID	Task Name	Duration	Start	Finish
1	**NeSTS Programme**			
2	Project Direction	0 days	Mon 30/11/15	Mon 30/11/15
3	Phase 1	768 days	Tue 01/12/15	Thu 08/11/18
4	Stage 1.1 Design Review and Concept Proving	265 days	Fri 01/01/16	Thu 05/01/17
5	Internal review of NIA outputs and confirm requirements	1 mon	Fri 01/01/16	Thu 28/01/16
6	Third party technical review (NIA output and NIC concept proving)	6 mons	Fri 01/01/16	Thu 16/06/16
7	Refine assessment & selection criteria	2 mons	Fri 29/01/16	Thu 24/03/16
8	Initial engagement with statutory consultees	9 mons	Fri 01/01/16	Thu 08/09/16
9	Initial engagement with supply chain	9 mons	Fri 01/01/16	Thu 08/09/16
10	Identify candidate routes	12 mons	Fri 01/01/16	Thu 01/12/16
11	Confirm preferred solutions	0.5 mons	Fri 25/03/16	Thu 07/04/16
12	Develop full suite of supports (x2)	6 mons	Fri 08/04/16	Thu 22/09/16
13	Prepare prototype and testing requirements	3 mons	Fri 23/09/16	Thu 15/12/16
14	Refine designs	2.5 mons	Fri 28/10/16	Thu 05/01/17
15	Stage 1.2 Prototypes and Initial Testing	10.25 mons	Wed 16/12/15	Tue 27/09/16
16	Build scale prototypes - fit and connection checks	6 mons	Fri 16/12/16	Thu 01/06/17
17	Confirm requirements for, and design of, ancillary equipment and facilities	3 mons	Fri 03/02/17	Thu 27/04/17
18	Component/element proving	6 mons	Fri 07/04/17	Thu 21/09/17
19	Evaluate outputs & refine design	9.5 mons	Fri 06/01/17	Thu 28/09/17
20	Stage 1.3 Parallel Design	16.25 mons	Tue 01/12/15	Mon 27/02/17
21	Confirm candidate route	0 days	Thu 01/12/16	Thu 01/12/16
22	Appoint main contractor	0 days	Thu 18/05/17	Thu 18/05/17
23	Evaluation against conventional options for route application	80 days	Fri 09/06/17	Thu 28/09/17
30	Compare and review NeSTS with conventional supports	2 mons	Fri 29/09/17	Thu 23/11/17
31	Refine designs	5.5 mons	Fri 29/09/17	Thu 01/03/18
32	Stage 1.4 Preparation for Full Scale Testing	290 days	Fri 29/09/17	Thu 08/11/18
33	Finalise full scale and component testing requirements	3 mons	Fri 29/09/17	Thu 21/12/17
34	Develop testing - procurement and management	3 mons	Fri 10/11/17	Thu 01/02/18
35	Evaluate outputs & refine designs	10 mons	Fri 02/02/18	Thu 08/11/18
36	Prepare Phase 2 specification	1 mon	Fri 12/10/18	Thu 08/11/18
37	Evaluate business case	1.5 mons	Fri 28/09/18	Thu 08/11/18
38	Stage Gate	1 mon	Fri 12/10/18	Thu 08/11/18
39	Phase 2	1320 days	Fri 01/01/16	Thu 21/01/21
40	Stage 2.1 Planning and Evaluation inc Full Scale Testing	18 mons	Fri 22/06/18	Thu 07/11/19
41	Planning & environmental consenting	12 mons	Fri 03/08/18	Thu 04/07/19
42	Full scale component / main element testing	420 days	Fri 12/10/18	Thu 21/05/20
43	Supports	4 mons	Fri 09/11/18	Thu 28/02/19
44	Foundations	4 mons	Fri 04/01/19	Thu 25/04/19
45	Conductor Systems	4 mons	Fri 01/03/19	Thu 20/06/19



Task — Milestone ◆ — Summary

Network Innovation Competition 2015 | New Suite of Transmission Structures - NeSTS

ID	Task Name	Duration	Start	Finish
46	Detailed design of new supports	18 mons	Fri 04/01/19	Thu 21/05/20
47	Type testing of supports at test facility and allowance for further foundation tests	6 mons	Fri 12/10/18	Thu 28/03/19
48	**Stage 2.2 Implementation and Construction**	**21 mons**	**Fri 09/11/18**	**Thu 18/06/20**
49	Development of new operational practices to suit new designs	6 mons	Fri 09/11/18	Thu 25/04/19
50	Development of new technology specific tools and equipment	6 mons	Fri 09/11/18	Thu 25/04/19
51	Construction of project using new design approach	18 mons	Fri 01/02/19	Thu 18/06/20
52	**Stage 2.3 Monitoring and Evaluation**	**9 mons**	**Fri 27/03/20**	**Thu 03/12/20**
53	Design and specify monitoring system	6 mons	Fri 27/03/20	Thu 10/09/20
54	Procure,install and test monitoring system(s)	3 mons	Fri 11/09/20	Thu 03/12/20
55	Analysis and reporting	2 mons	Fri 09/10/20	Thu 03/12/20
56	**Stage 2.4 Knowledge Dissemination**	**66 mons**	**Fri 01/01/16**	**Thu 21/01/21**
57	Stakeholder engagement	57 mons	Fri 09/09/16	Thu 21/01/21
58	Learning and dissemination activities	66 mons	Fri 01/01/16	Thu 21/01/21



Task | Milestone ◆ | Summary

Appendix 6: Business Case Supporting Information

6.1 Purpose

This appendix provides further supporting information on the project's Business Case.

6.2 Overhead Line Cost Elements

This section demonstrates the typical cost elements of OHL projects and shows the cost savings associated with a NeSTS approach when compared to traditional designs.

6.2.1 Typical Overhead Line Cost Elements

There are a number of factors which need to be considered when developing an overhead line (OHL) project. These are described in Appendix 3. To quantify the benefits of NeSTS, it is useful to outline the compulsory elements involved in the development and construction of a new OHL, as described in Figure A6.1, below.

Figure A6.1 Key elements involved in the development and construction of a new OHL

Overhead line cost elements	
Design and engineering	This includes; design and development of the solution; route investigation; structural design to ensure structures are suitable for the location and; climatic conditions.
Planning and consent applications	This consists of securing wayleaves, environmental assessments, archaeological investigations and easements.
Project Management	OHL projects are generally complex and have lengthy timescales. Many stakeholders may be involved and robust project management is required.
Preliminary works and site establishment	This includes establishment of welfare facilities and site compounds. In some cases, additional satellite compounds may be necessary depending on the location of the project. Facilities are also required for the delivery of materials and equipment to the location.
Access and road upgrades	Temporary and permanent road access is generally required for the transport of machinery and equipment to OHL support sites. Requirements vary depending upon the proposed overhead line route. This is necessary both for construction and ongoing maintenance.
Foundations	Installation of foundations for supports is crucial; the requisites vary according to the geotechnical conditions of OHL location.
Support construction	Supply, fabrication and installation of supports necessitate temporary access equipment.
Conductor systems	The conductors, including earth wires require significant planning for deployment.
Interface cabling	Again, planning is required to facilitate the connection to substation and switchgear.
Commissioning	Outage planning and commissioning requirements must also be considered.

The elements described in Figure A6.1 outline the typical elements involved in the development and construction of an OHL project. These elements have been assigned typical cost attributes in Figure A6.2 below. Note that these elements will incur a wide range of costs depending on the particular route, access arrangements, ground conditions or environmental factors of any individual project. However, Figure A6.2 outlines typical cost attributes of each element. For the purposes of this exercise the land cost and cost of off-site infrastructure have been excluded.

Figure A6.2 Chart depicting the cost elements attributed to elements of a traditional OHL build - confidential

The final cost of each installation will vary according to location, site details, electrical network, rating, climatic factors, access arrangements, environmental factors, ground conditions, consenting and any wayleave or easement requirements.

6.2.2 OHL costs using a traditional approach

To asses the cost benefit of the proposed solution it is first necessary to understand the cost of traditional OHL projects. As described previously there can be significant cost variance depending on specific project requirements. However, the benefits have been assessed using information available in the TO Charging Statements[10]. Note that NGET costs were not available for this analysis[10].

Figure A6.3 – Typical OHL Costs from TO Charging Statements

Base Case Costs per OHL voltage in £000s/km		
TO	**275kV**	**132kV**
SPT	£1,833	£ 834
SHE Transmission	£1,103	£ 793
Average Cost	£1,468	£814

6.2.3 OHL costs using a NeSTS approach

As stated within the main document, the NeSTS approach and the move to a new mechanical layout has the potential to reduce the cost of OHL projects in a number of areas, including:

§ **Foundations**: the construction of OHL support foundations forms a significant element of the overall cost of an OHL project. The move to a monopole-style support will reduce the footprint required for foundations and could facilitate the use of alternative foundation techniques such as caissons. This will be influenced by specific ground conditions and geotechnical requirements. Further details on the benefits from the foundation design are as shown in Appendix 7

§ **Installation:** the move to a simpler structure with fewer components should reduce the time required to install and erect the new supports.

§ **Support costs:** the proposed supports are heavier than their traditional equivalents and require more steel. However, as the supports are simpler with fewer components there are savings associated with galvanization and fabrication. As a result, the overall cost of the new support has been estimated to be similar to the current design.

§ **Conductor systems**: The new design proposes a twin earth wire arrangement to offer improved protection; therefore, the overall conductor cost has increased.

§ **Off-site manufacture**: The proposed design has fewer components which can be more readily assembled off site. This will reduce the volume of components which require to be assembled on site.

Initial analysis and comparison with existing cost models; have indicated the following cost profile for a NeSTS project:

Figure A6.3 Chart depicting the types of costs attributed to the NeSTS approach - confidential

An assessment of typical design information for an OHL project suggests that the NeSTS approach has the potential to reduce the overall cost by up to 10% compared with traditional designs. The cost savings for individual projects will be determined by the specific requirement of the project and the route selected. Figure A6.4 below indicates the comparison between a traditional and NeSTS solution, costs indicated are per km.

Figure A6.4 Cost comparisons of traditional methodology and the NeSTS approach - confidential

As shown in Figure A6.4, the NeSTS approach is expected to deliver a sizeable decrease in the cost of the foundations and site costs. SHE Transmission has used these cost saving assumptions together with the Market Assessment Document prepared by TNEI (see Appendix 4), to estimate the overall financial benefits from NeSTS by 2050, summarised in Figure A6.5.

Figure A6.5 Table depicting the financial benefits from NeSTS if 5% of new OHL projects (in km) are suitable for NESTS

Projected volume of NeSTS application in km by 2050 if 5% of OHL projects are suitable for deployment	Slow progression	No progression
275kV	304km	270km
132kV	164km	145km
Benefit at 5% cost saving (£m)	£29.9	£25.7
Benefit at 10% cost saving (£m)	£58.0	£51.4

Figure A6.6 Table depicting the financial benefits from NeSTS with an assumption that 15% of new OHL projects (in km) are suitable for NESTS

Projected volume of NeSTS application in km by 2050 if 15% of OHL projects are suitable for deployment	Slow progression	No progression
275kV	913km	809km
132kV	492km	436km
Benefit at 5% cost saving (£m)	£87.0	£77.1
Benefit at 10% cost saving (£m)	£174.1	£154.2

In anticipating the future volumes of OHL required, it has been presumed that the majority of OHL required by NGET in England and Wales will use the T-Pylon design; therefore, they have been excluded from the calculations. Similarly, it has been assumed that 400kV works in Scotland will be delivered using recent designs such as the SSE400 used for the Beauly-Denny line.

In order to ensure a conservative, sensible view of potential benefits, SHE Transmission postulated that a traditional steel lattice or T-Pylon may be used for new OHL deployment at 132kV and 275kV – to this end, we have assumed that only between 5% and 15% of future new build OHL will be suitable for NeSTS.

Similarly, there is a degree of uncertainty about future renewable developments, following recent policy announcement by the Government. SHE Transmission and the other TOs are progressing works to meet the connection requirements of applications to date. Despite the recent Government announcements, we have seen relatively few connections being terminated and so expect to continue to deliver to meet the needs of the generation developers in an economic and efficient manner. Therefore, SHE Transmission has focussed on the two most prudent scenarios in the FES to estimate benefits. Note that all of the benefits arising from cost reductions in infrastructure projects will flow directly to transmission customers through TNUoS[1].

Despite the potential uncertainty over future OHL volumes, NeSTS represents good value for customers with only relatively modest volumes of OHL requiring to be built in order to recover the projects costs. Based on the costs identified in the TOs Charging Statements [10] the volume of new 275kV or 132kV OHL required to recover the project costs is shown below;

	Average Cost £000s/km	10% Cost Reduction	Minimum distance to recover NIC cost
275kV OHL	£1,468	£146k	45km
132kV OHL	£813	£81k	82km

As stated above SHE Transmission have taken a very prudent and conservative view on the potential savings which could accrue from the NeSTS project.

During the development of the project it was recognised that there was the potential to realise further benefits, however, at this stage it would have been inappropriate to try and quantify these benefits. The following areas will be explored and developed as the project develops

- **Consenting Costs:** if the NeSTS solution proves to be more readily accepted by statutory consultees then this could significantly reduce consenting costs including potentially lengthy and expensive public enquiries.
- **Undergrounding Costs:** currently one of the few options to traditional lattice steel towers is to use underground cables. In most instances this is many times more expensive than an OHL solution.
- **Operational Costs:** as the project develops it is anticipated that further methods of reducing maintenance and improving reliability will be identified. This will not only reduce operational costs but will also avoid associated outage and constraint costs.
- **Security:** in many instances the NeSTS design will provide a more robust and secure solution erg the second earth wire provides additional lighting protection. Again this will avoid potentially excessive repair costs.

It should also be recognised that there are an ongoing series of initiatives ongoing within the industry which could have an impact on the future need for new OHL infrastructure. These measures include the development of demand side solutions and automatic network management solutions which remove the need for reinforcement. Similarly, there are a other projects which are exploring alternative methods of reducing cable installation costs.

Appendix 7 – Foundation Details

The anticipated cost savings relating to the foundation design have been based on:

- **50% direct construction** related costs, including site/drainage reinstatement and corresponding crop losses.
- **50% scheme related costs** that are generally as a result of routing and micro-siting of consents e.g. agreements with third parties such as landowners.

A 50/50 ratio for division of costs is appropriate – in areas where land use and value is at a premium, scheme costs can be significant.

A review of construction cost proportions indicates that material/labour costs will account for around 30%, and plant/machinery at 70%, taking into account the wide range of possible factors and applications.

Given the range of support types, ground conditions and overall land/third party issues (values) it is not possible to derive a definitive rule for comparison. However, FigureA7.1 below illustrates the basis of the proposed savings by comparing the 510 series concept design support with an ‘equivalent’ L8RD lattice steel tower. Foundation details for both arrangements are shown in Figures A7.2 and A7.3 following the cost comparison.

Figure A7.1: Comparison between 510 and L8 RD OHL supports

Cost Aspect	L8 RD	NeSTS (510 Series)	Relative Value	Comment/ Basis
Reinforced Concrete Volume	$33m^3$	$30m^3$	0.91	
Excavation volume	$166.6m^3$	$30m^3$	0.18	
Spoil removed	$33m^3$	$30m^3$	0.91	
Installation Time (Effort)	2 weeks	1 week	0.5	Lattice steel could be up to 3 weeks on a side slope
Construction Impact/Working Area	$1225m^2$ (35m x 35m)	$200m^2$	0.16	Environmental surveys and mitigation, land damage, reinstatement of site, drainage repairs and crop loss

Land sterilisation (footprint at ground level)	49m^2 (7m x7m)	1.8m^2	0.04	Wayleave/ Servitude/ Easement costs for consent and future use
Land needed for design	331.2m^2 (18.2mx18.2 m)	87m^2	0.26	Initial micro siting, impact on third party apparatus , operations and future access

Route costs can vary significantly but the use of the new designs is expected to provide further cost efficiencies. Savings are anticipated from:

- **Direct construction** larger land-take differentials (in favour of monopoles) for taller supports, environmental surveys and mitigation, wider competition in foundation installation supplier base, opportunities for refinement/optimisation of designs.

- **Scheme costs** – the reduced need to divert third party apparatus away from the area of influence required for foundation design and/or restricting third party operations.

Based on the information in Figure A7.1 above, a potential cost saving of up to 35% has been derived from:

Direct costs/ scheme costs [A]	50:50
Material costs/ Other construction costs [B]	30:70
Relative value of Cost Aspect [C]	NeSTS value/ L8 RD value
Notes: 1. 'Other costs include: formwork, plant & equipment, site overhead costs etc. 2. The 'Relative value' values are based primarily on volume of concrete for 'Direct costs (materials)', and on footprint areas and construction times for 'Direct costs (other)' and 'Scheme costs'.	

Direct costs (materials)	[A]x[B]x[C]	0.5 x 0.3 x 0.9 =	0.14
Direct costs (other)	[A]x[B]x[C]	0.5 x 0.7 x 0.5 =	0.18
Scheme costs	[A]x [C]	0.5 x 0.2 =	0.10
Relative cost NeSTS/L8RD			0.42

A cost reduction of 58% is demonstrated in the table above, however, taking a prudent view a potential cost reduction of 50% has been considered for calculating the project benefits. Whilst it is acknowledged that the scheme related costs savings could be accounted for under different headings, the benefits all equate to the foundation design.

The expectation is that once optimisation studies and design refinement have been completed early in Phase 1 then the overall cost assessment can be modelled accurately using the parallel design and project specific information.

The expectation is that once optimisation studies and design refinement has been completed early in Phase 1 then the overall cost assessment can be modelled accurately using the parallel design and project specific information.

Figure A7.2 Standard Foundation for L8RD Tower

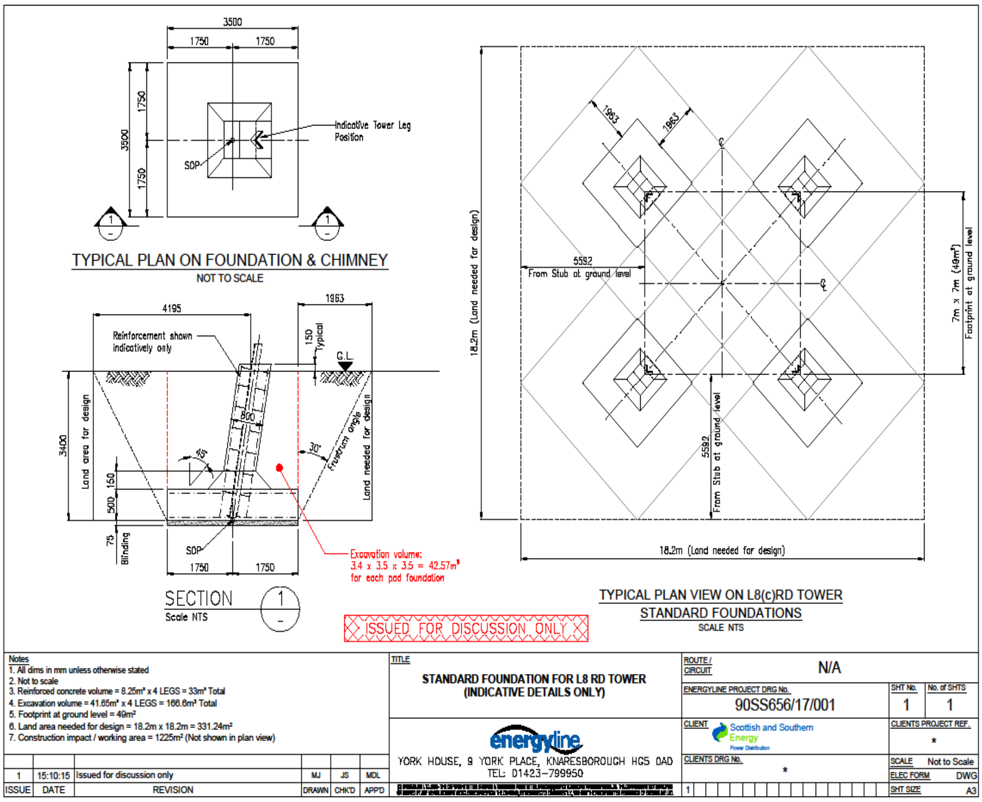
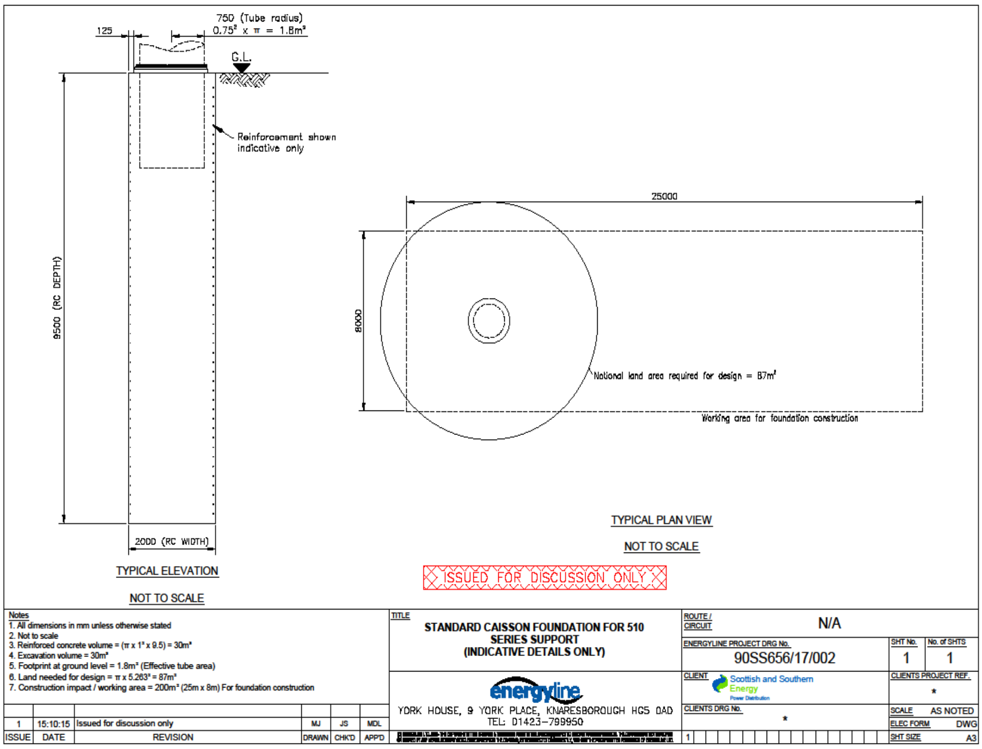


Figure A7.3 Standard Foundation for 510 Series Support



Appendix 8 – Risk Register and Contingency Plan

The Risk Management Process for the NeSTS project is designed to address all of the relevant activities described in the 'risk house of control' shown in Figure A8:1. It is aligned with the SSE Group's Business Risk and Internal Control Policy Framework.

This process will help to ensure that the required standards and considerations of both risks and opportunities are being followed. Additionally, the Risk Management Process allows all of the project level risks to be consolidated and therefore regularly and systematically reported, considered, and managed at a group level.

Risk Review Workshops will be held throughout the project – these Workshops are used to identify new risks and plan appropriate mitigations.

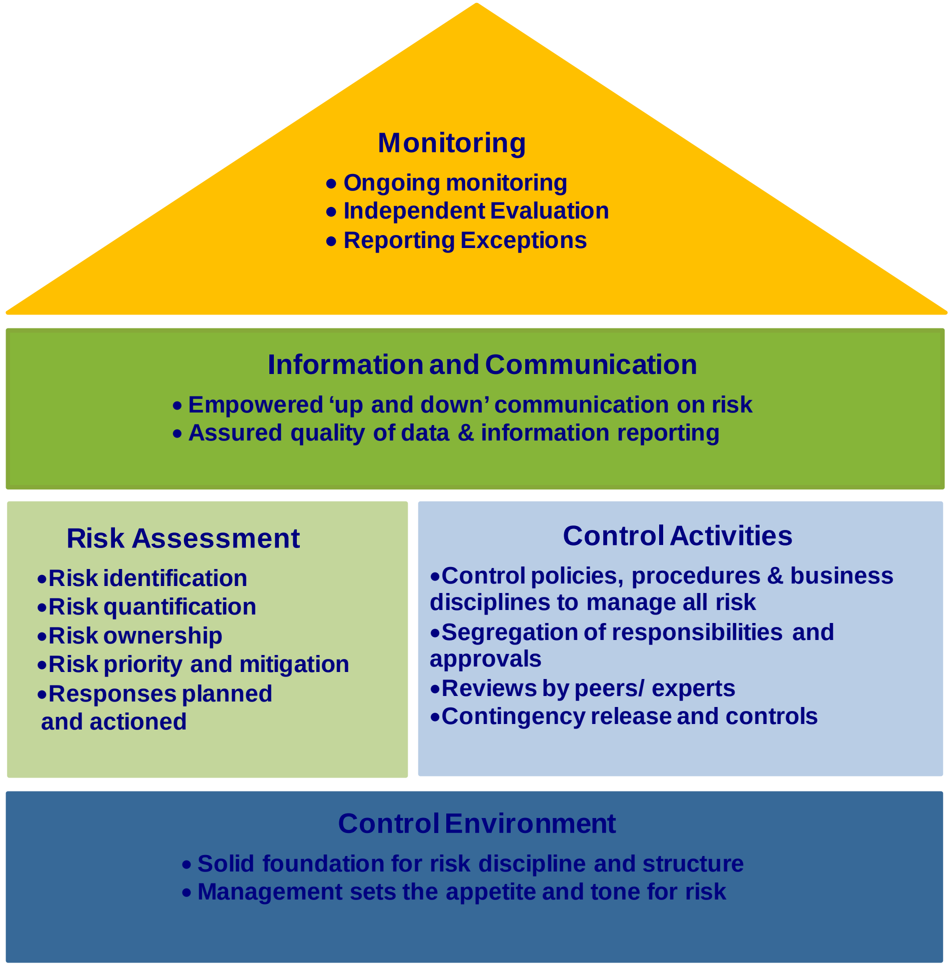


Figure A8:1 Risk House of Control

The following table shows an extract from the project's risk register.

Ref	Category	Title	Description	Severity or Impact				Likelihood	Risk Factor	Impact of Risk	Mitigation actions
				P	R	O	F				
R001	External Engagement	Project Identification for first deployment	Need to identify suitable site for first NeSTS application.	0	2	2	3	**2**	**7**	Delays the selection of NeSTS trial site, prolonging the realisation of benefits.	Identify appropriate OHL projects at early stage. Implement stakeholder engagement at early stage to refine selection criteria. Select site by the Stage Gate to allow early development of designs, considered risks and well thought through mitigation strategies.
R002	Technical	Prototype Testing	Failure of NeSTS design to achieve satisfactory outcomes during testing.	0	2	2	3	**2**	**7**	Delays project. Incurs additional cost, which will impact on the business case.	Develop designs on phased basis to identify and resolve issues at early stage. Initial testing and analysis of component/ scale models to highlight issues before full scale testing begins.

Ref	Category	Title	Description	Severity or Impact				Likelihood	Risk Factor	Impact of Risk	Mitigation actions
				P	R	O	F				
R003	Programme	Adverse Weather	Risk of severe weather events disrupting construction.	1	1	0	1	**3**	**3**	Delay in construction of the NeSTS trial and increase in costs, impacting on the business case.	Monitor progress of project. Allow adequate contingency in the programme to prepare for the possibility of severe weather events.
R004	Programme	Delay in Connect-ion of NeSTS project	Risk of delays caused through site selection challenges or planning and consent application issues.	0	3	2	2	**3**	**7**	Delay in construction of the NeSTS trial.	Identify appropriate OHL projects early. Implement stakeholder engagement promptly to understand key concerns and refine selection criteria. Site to be identified by the Stage Gate between Phase 1 and Phase 2. This will identify consenting risks at an early stage and allow appropriate changes to be implemented.

Ref	Category	Title	Description	Severity or Impact				Likelihood	Risk Factor	Impact of Risk	Mitigation actions
				P	R	O	F				
R005	Programme	Outage Schedule	Risk that planned outages are delayed, not approved or not available due to; other network requirements, interface with other projects or; delays to this project. Outages may also be cancelled at short notice due to critical network issues.	0	3	0	2	**2**	**5**	Delay in construction and commissioning of the NeSTS trial.	Initial outage details have been included in plan with System Operator as per our Network Access Policy. These are provisionally agreed two years in advance and finalised one year in advance. Ongoing interface management will be put in place. Outage coordination team to reschedule works if necessary.
R006	Programme	Execution of project plan.	Risk that landowners object to, or withdraw from, wayleave agreements during construction which results in delays, a need to change tower locations or reorganise necessary wayleaves.	1	1	0	1	**3**	**3**	Delay and additional cost associated with more costly or extended access arrangements.	Implement early stakeholder engagement programme and maintain relationships throughout the project. Show how stakeholder engagement has influenced designs.

Ref	Category	Title	Description	Severity or Impact				Likelihood	Risk Factor	Impact of Risk	Mitigation actions
				P	R	O	F				
R007	Technical	NeSTS Innovation	Difficulty in combining multiple innovations which could mean the solution is not as innovative as needs to be.	0	3	2	2	**3**	**7**	Delay or failure of the project.	Implement prompt dialogue with supply chain regarding equipment availability. Use SAM to develop requirements and analyse risks. Use scale models and sub-assemblies to understand potential conflicts and issues.
R008	Project Management	Control and maximise learning	Risk that key learning points could be missed.	1	1	0	1	**3**	**3**	Difficulty in accelerating solution into 'BaU', even if trial successful. Savings and environmental benefits would not be optimised.	Implement comprehensive learning plan. Have regular lessons learned reviews. Validate savings and benefits independently to instil confidence.
R009	Learning and Dissemination	Future Usage Options	Future usage options during project become obsolete due to changes in legislation or forecast network architecture.	0	2	0	0	**2**	**2**	Project impact and route to BAU is not clearly defined or understood.	Future usage options will be developed for a range of possible scenarios and levels of renewable connection and reinforcement. Review of business case at Stage Gate will inform future usage options.

Ref	Category	Title	Description	Severity or Impact				Likelihood	Risk Factor	Impact of Risk	Mitigation actions
				P	R	O	F				
R010	Learning and Dissemination	Poor attendance	Poor attendance / engagement at dissemination events.	1	3	0	0	**2**	**4**	Project outcomes not widely understood and not adopted into BAU.	Establish stakeholder contacts early. Maintain regular updates throughout e.g. bulletins, LinkedIn Group. Ensure events are appropriately tailored to desired audience and offer various formats i.e. webinars, structured events and teleconferences.
R011	Learning and Dissemination	Poor uptake of NeSTS outputs	Low engagement with/use of project outputs.	1	2	0	0	**2**	**2**	Project outcomes are disregarded and solution less likely to be integrated into BaU.	Establish Working Group to provide forum for TOs to understand learning and encourage take up of solution. Develop e-learning module to help industry with familiarisation.
R012	Stakeholder Engagement	Poor reception for NeSTS design	NeSTS solution not readily accepted by statutory consultees	1	3	2	2	**3**	**7**	Trial project not consented	Early stakeholder engagement to test opinion and seek input
R013	Technical Assurance	Design	Initial design work identified as being insufficient	1	1	0	1	**1**	**5**	Delay and cost to revise work to date.	Early technical assurance to ensure validity of NIA outputs.

Table A8:3 NeSTS project risk log

Table A8:2 below shows the mitigation measures which SHE Transmission would adopt for the four risks with a risk factor of 6 or above.

Ref	Risk	Immediate Actions	Interim Measures	Long Term Recovery
R001	Project identification for first deployment Need to identify suitable site for first NeSTS application.	Identify appropriate projects that have achieved planning consent and engage and achieve early agreement on the use of the NeSTS solution.	Identify sites awaiting planning consent and include NeSTS solution along with application.	Identify other sites where NeSTS may be applicable.
R002	Failure of NeSTS design to achieve satisfactory outcomes during testing.	Initial testing on sub assemblies and scale models to give early indication of issues.	Allow time for any issues identified during testing to be resolved prior to deployment. Any impact on cost and timescales to be addressed at Phase 1 Stage Gate.	If issues not resolved then planned OHL project to proceed using traditional designs.
R004	Delay in connection of NeSTS project due to site selection challenges or planning application issues.	Prompt stakeholder engagement in Stage 1 will ensure that NeSTS design reflects stakeholder priorities where appropriate.	Identify projects which would most benefit from NeSTS solution. Engage early to identify and manage any key concerns.	If issues not resolved then planned OHL project to proceed using traditional designs.
R007	Difficulty in combining multiple innovations on one single solution.	Engage with supply chain, use scale models and prototypes for key components. Implement prompt dialogue with supply chain regarding equipment availability. Use SAM to develop requirements and analyse risks.	Resolve issues during full scale testing. Use scale models and sub-assemblies to understand potential conflicts and issues.	If issues not resolved then planned OHL project to proceed using traditional designs.

Table A8:2 Mitigation measures for all NeSTS risks scoring over 6 on the Risk Register

Appendix 9: Funding Commentary

A9.1 Purpose

This appendix describes the assumptions made in developing the NeSTS project costs.

A9.2 Overall Cost Assumptions

- All internal resource costs are based on a rate of [redacted] per day, which includes an allocation of all overheads such as administrative support.
- All estimated costs have been modelled using the annual inflation rates provided by Ofgem.

A9.3 Work Packages

A9.3.1 Work Package 1 (Project Management) Cost Assumptions

The Work Package 1 costs cover Years 1 to 6 and are based on:

- Key SHE Transmission personnel required to manage and coordinate the delivery of the NeSTS project. This includes project management, support and stakeholder engagement activities over the life of the project. Estimated [redacted]
- IT specific support and integration into SHE Transmission systems. Estimated at [redacted]

A9.3.2 Work Package 2 (Prototype and Initial Testing) Cost Assumptions

Work Package 2 is phased over the first two full years; it involves the further refinement of the proposed designs, testing and prototyping of key components and importantly engagement with key stakeholders. The design development will also include the development and evaluation of ancillary equipment for construction and maintenance access for the new supports. Costs are based on the following elements:

- Concept refinement, including development of the full suite of structures including range of suspension, angle and terminal towers. This is estimated at [redacted].
- The project proposes to consult with a wide range of stakeholders including other TOs, statutory bodies and other interested parties – this is expected to cost [redacted]
- The NeSTS project will develop scale models, test components and critical elements to ensure fit and constructability. The project will also develop the necessary ancillary equipment and facilities required to ensure access to the structures for construction and maintenance, estimated at [redacted].

A9.3.3 Work Package 3 (Parallel Design Process) Cost Assumptions

Work Package 3 occurs between Years 2 – 3, as the new NeSTS supports will be used to implement an outline design in parallel with the traditional lattice steel designs. Costs for this work package incorporate the planning and environmental appraisal of the NeSTS along the selected route and are estimated at [redacted].

During this phase of the project a full review of the project business case will be undertaken to ensure that the anticipated benefits can still be achieved.

A9.3.4 Work Package 4 (Full Scale Testing) Cost Assumptions

Work Package 4 occurs between Years 3 – 4; this will culminate in a full scale test of the proposed NeSTS structure at a dedicated test facility. Costs are based on:

- Development of the testing specification and procurement of the test facility, estimated at [redacted].
- Delivery of full scale testing on supports and foundations at a specialist test facility. Costs are expected to be [redacted]..
- Analysis of results and evaluation of the design, estimated at [redacted]..

A9.3.5 Work Package 5 (Planning, Construction and Monitoring) Cost Assumptions

Work Package 5 occurs between Years 4 and 6. This will depend upon the programme for the planned overhead line project. The costs are based on:

- Full scale design for project based on new design to prepare information suitable for construction, estimated at [redacted].
- Further testing on final design of support structure to reflect specific designs – this is anticipated to cost [redacted].
- Additional costs for construction phase using new design will incur costs of [redacted].
- Additional sums to carry out monitoring and evaluation, estimated at [redacted].

A9.3.6 Work Package 6 (Knowledge & Dissemination) Cost Assumptions

Work Package 6 occurs throughout the project period to maximise the learning opportunities the costs are based on:

- Development of IT knowledge management application to benefit NeSTS, estimated at [redacted].
- Showcasing the NeSTS project at Industry Events, including travel and substance, estimated at [redacted].
- Development of e-learning materials and modules will cost in the region of [redacted].
- Reporting on the knowledge and dissemination of learning associated with NeSTS, including SHE Transmission communication management, estimated at [redacted].
- Development of a Visualisation Tool and e-learning and associated training materials and IT equipment estimated at [redacted].

Appendix 10: NIA_SHET_0010 NeSTS Progress Report (July 2015)

Date of Submission

July 2015

Network Innovation Allowance Project Progress Report

Notes on Completion: Please refer to the relevant **NIA Governance Document** to assist in the completion of this form. Please use the default font (Calibri font size 10) in any electronic submission. Please ensure all content is contained within the boundaries of the text areas.

Network Licensees must publish the required Project Progress information on the Smarter Networks Portal by 31st July 2014 and each year thereafter. The Network Licensee(s) must publish Project Progress information for each NIA Project that has developed new learning in the preceding relevant year.

Project Progress

Project Title		**Project Reference**
New Suite of Transmission Structures		NIA_SHET_0010
Funding Licensee(s)	**Project Start Date**	**Project Duration**
Scottish Hydro Electric Transmission plc (SHE Transmission)	December 2013	22 months

Nominated Project Contact(s)

David MacLeman

Scope

The intention of this project is to leverage existing innovations (e.g. insulated cross arms (ICAs) and low-sag conductors) to design a new suite of transmission structures to exploit their potential fully.

The scope of the project includes:

- Identify the requirements and standards that govern the 275kV transmission voltage;
- Assess new structure design options, including the use of new materials, from a review of what is being built internationally, and other innovations;
- Develop designs for a small number of the structure options that show the most potential;
- Finalise a design that should be taken forward for field trials and tests;

- Scale model prototypes of the new suite of structures;
- Assessment of the safety, health and environmental impact of the new design (with the aim of improving safety, and reducing the environmental impact); and
- Review the economics of the new structures (taking into account, foundations, access requirements, construction time and maintenance).

Note: the term 'Transmission Structure' has been used to indicate the breadth of scope of the project, i.e. the scope is not limited to considering just classic steel lattice towers, and will consider: poles, guide supported structures etc. as appropriate.

Objective(s)

The objective is to design a suite of new 275kV transmission structures, incorporating a range of innovations, that are smaller, cheaper and quicker to build, and easier to maintain. Safety and environmental impacts are also to be actively considered so that benefits from the new design can be maximised.

Success Criteria

Success criteria would be to provide a new developed design of a suite of 275kV transmission structures and produce scale models of the new design. At the end of this project, there should be sufficient understanding and confidence to decide whether to deploy the new structure designs as an alternative to the traditional designs. At this point, the decision should be made whether to go for full scale construction and testing.

Performance Compared to the Original Project Aims, Objectives and Success Criteria

The objective is to design a suite of new 275kV transmission structures, incorporating a range of innovations, that are smaller, cheaper and quicker to build, and easier to maintain. Safety and environmental impacts are also to be actively considered so that benefits from the new design can be maximised.

In this period the project has completed Stages 1, 2, 3 and 5. Work is progressing on Stage 4 (minor component builds) and Stage 6 (compiling reports).

Stage 2 was completed with the production of an Initial Design Brief and a support example booklet showing the range of support options that are available. This work was approved by the SHE Transmission Working Group and provided a sound platform for the Stage 3 work. As a result Stage 3 work made good progress and rather than selecting three or four designs, eight were taken forward for further design development and review.

It was at this time that Energyline Ltd introduced a Support Assessment Matrix to make a qualitative assessment of the eight supports under consideration. This allowed the Stage 3 works to develop promptly to a clear ranking of the supports against the criteria established in Stage 2.

Stage 3 work has concluded and a preferred design has been taken forward into Stage 4 for further development.

Stage 4 will require trial build of component parts for horizontal and vee support arrangements. Manufacturers have been approached for components to assist Energyline Ltd to build trial assemblies.

The construction of scale models (Stage 5) is complete and examples of the eight developed designs, including an L7 and an L8 RD for comparison purposes have been made.

The collation of materials for the final report in Stage 6 is underway.

The outcomes of the project's progress provide sufficient confidence that several of the designs warrant further development with a view to project-specific design and deployment on a planned transmission overhead line project.

Required Modifications to the Planned Approach During the Course of the Project

A number of minor modifications were made to the approach during Stages 2 onwards.

1. Firstly, the scale and wide range of supports available made the final selection of designs a complex task. As a result, eight were chosen to take forward. It was felt that to have taken forward a smaller number would not have given a sufficient number of supports for a valid comparison.
2. The landscape and environmental assessment work was more involved than expected and the consultant did a wide range search of historical consent applications by other TOs to further interrogate the environmental drivers.
3. The team will also now consider photo montage work to assist in presenting the design solutions.
4. Cost assessment work will now use ground profiles for existing overhead lines to make the cost comparison between structure options. The ground profile had three components to represent different terrains in the UK.

Lessons Learnt for Future Projects

1. The team met with professional engineers and designers in the industry who work for universities and other DNOs. Their feedback assisted the team in how it developed the project. We should always consider the support of wider energy industry specialists who can validate the approach and contribute to the process.
2. The project team also met with the NGET T-Pylon team to gain an insight into the issues that they have faced in the development of their structure.
3. Engaging with component manufacturers in the assessment of structures has been useful. Their input has allowed the team to better assess the relative merits and practicality of detailed component design. The insulator string design in particular has benefitted from this approach.

Note: The following sections are only required for those Projects which have been completed since 1st April 2013, or since the previous Project Progress information was reported.

The Outcomes of the Project

n/a

Planned Implementation

n/a

Other Comments

n/a

Appendix 11: Network Maps

Existing Transmission System

Key:

132kV circuit

275kV circuit

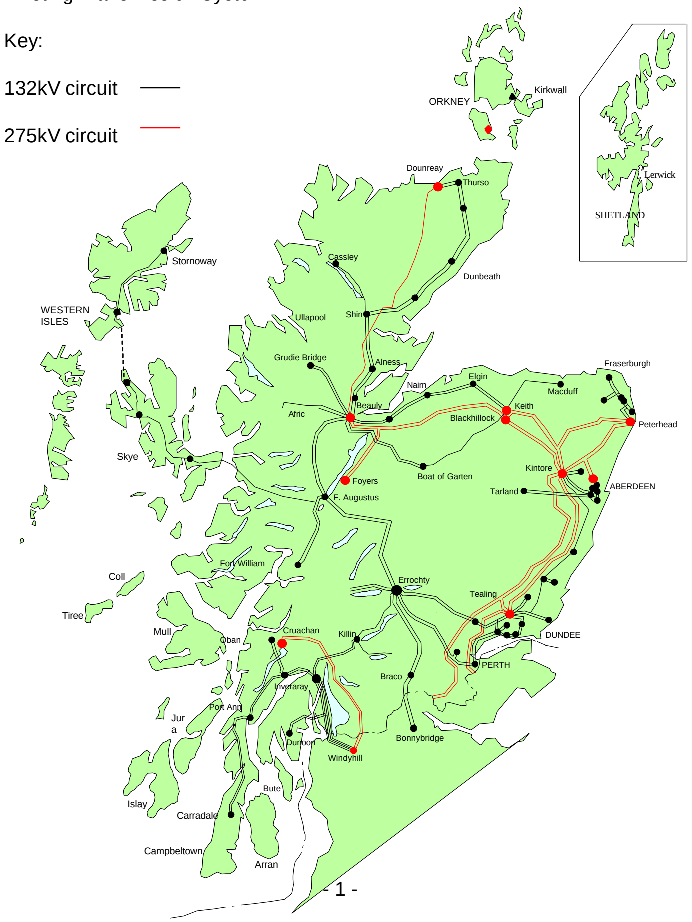
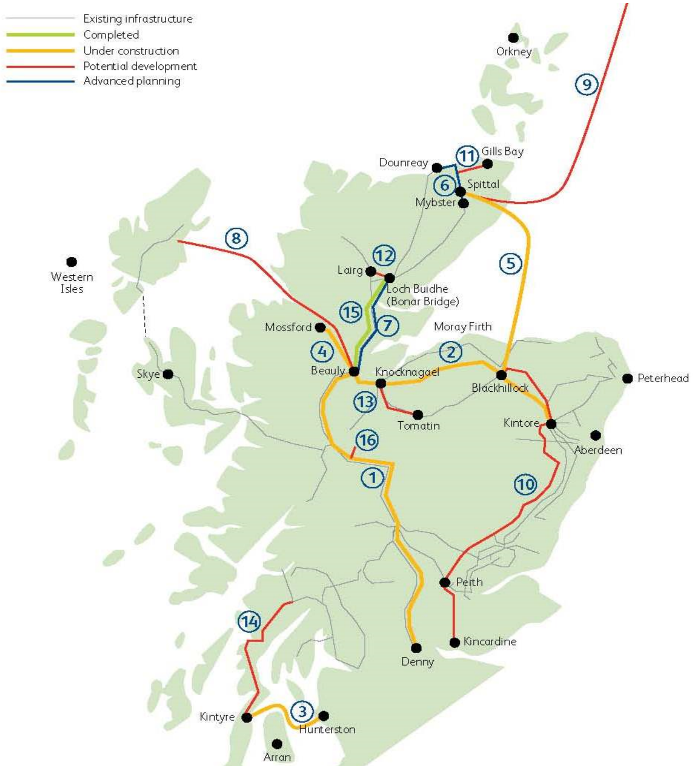


Figure A11.1 SHE Transmission's Existing Networks

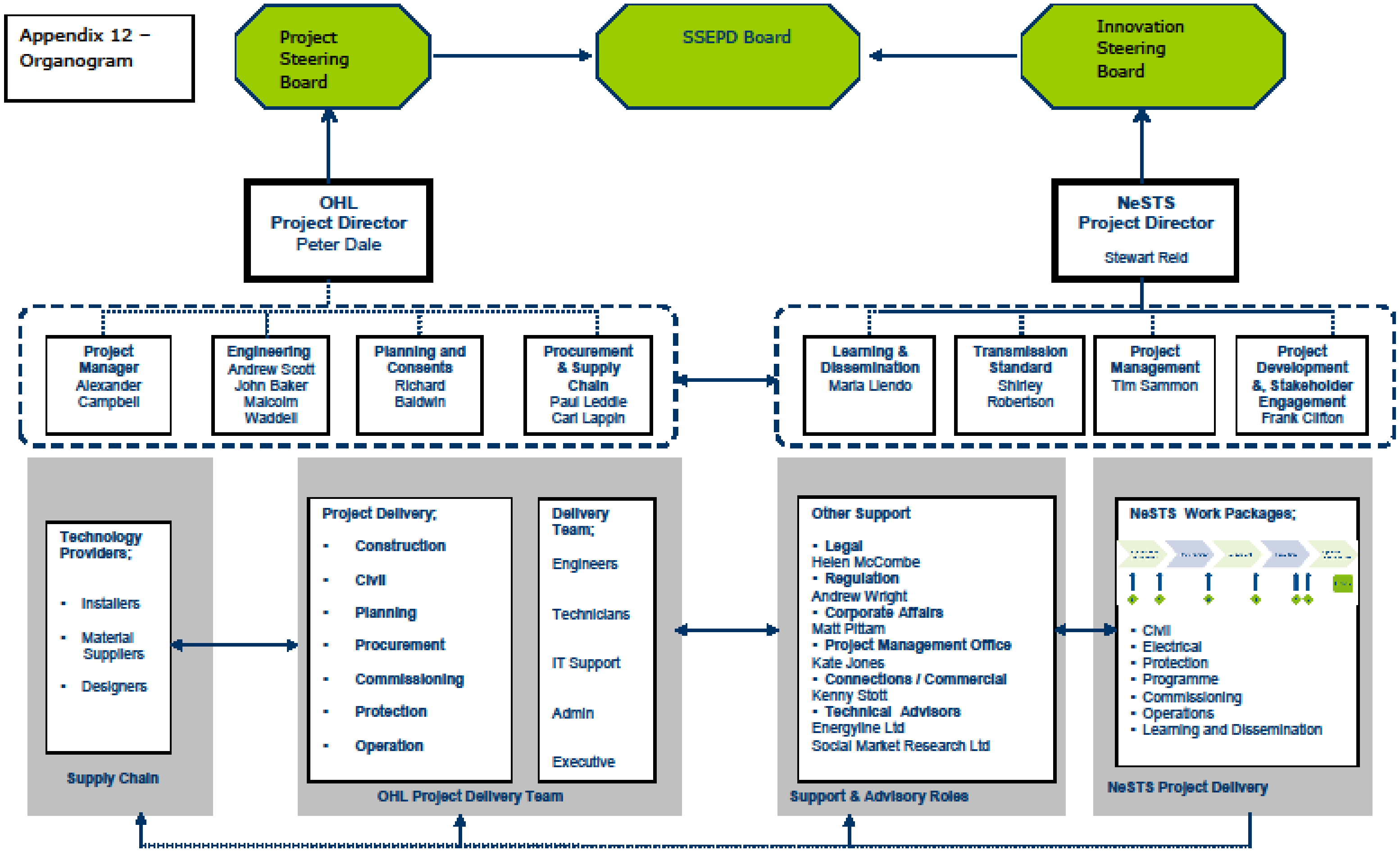


1 Beauly – Denny
2 Beauly – Blackhillock – Kintore
3 Kintyre – Hunterston Link
4 Beauly – Mossford
5 Caithness – Moray HVDC
6 Dounreay – Mybster
7 Beauly – Loch Buidhe Reconductoring
8 Western Isles Link
9 Shetland Isles Link
10 East Coast Phase 1
11 Gills Bay Radial
12 Lairg – Loch Buidhe
13 Knocknagael – Tomatin
14 Inveraray – Crossaig Reinforcement
15 Beauly – Loch Buidhe Reinforcement
16 Melgarve Substation (Stronelairg Wind Farm Connection)

Figure A.11.2 –Overview of planned and completed SHE Transmission projects to 2023

Appendix 12: Organogram

Electricity Network Innovation Competition Full Submission Appendices



ofgem

RIIO NIC NETWORK INNOVATION COMPETITION

Appendix 13: Letters of Support

nationalgrid

National Grid House
Warwick Technology Park
Gallows Hill, Warwick
CV34 6DA

Stewart Reid
Head of Future Networks
Scottish Hydro Electric Transmission Ltd
Inveralmond House
200 Dunkeld Road
Perth
PH1 3AQ

John Zammit-Haber
Innovation Manager
Electricity Transmission
Asset Management

john.zammit-haber@nationalgrid.com
Direct tel: 01926 654055

www.nationalgrid.com

14 July 2015

Our Reference IT/RD/15_07

Dear Stewart

Letter of Support in respect of the Scottish Hydro Electric Transmission Limited's Network Innovation Competition Proposal - "New Suite of Tower Structures (NeSTS)"

Thank you for your request of support for the proposed project entitled "New suite of Tower Structures (NeSTS)".

I can confirm that National Grid would like to support this NIC proposal. We believe that the NeSTS approach is worthy of further development and demonstration, and are interested in any potential benefits which may arise from the project that could be transferable to our own transmission network. As you are aware, National Grid is also interested in innovative developments which mitigate any environmental or visual impact for the Consumer. Therefore, we believe the scope of work proposed by the NeSTS project in relation to smaller tower supports and the use of novel materials, and reduced civil engineering requirements, has a basis for further consideration. The scalability of NeSTS is of special interest to us.

In order to provide specific support to the project I am delighted to confirm that both Mike Fairhurst (Overhead Lines Policy Technical Manager) and David Clutterbuck (Policy Overhead Line Specialist) will be the National Grid representatives for this project. I understand that it is your intention to hold meetings on average once a quarter. Mike and David will look to attend either jointly, or singly depending upon their respective availability. They will be able to transfer the knowledge gained through our own experience of developing and testing the new T-Pylon. In addition, they will be happy to facilitate the dissemination of any outputs or learning from NeSTS across National Grid, where feasible and appropriate.

Thank you once again, for the opportunity to collaborate with you. We wish you every success with your NIC proposal and look forward to working with you.

Yours sincerely,

J J Zammit-Haber

John Zammit-Haber
Innovation Manager

For and on Behalf of
National Grid Electricity Transmission plc

National Grid is a trading name for:
National Grid Electricity Transmission plc
Registered Office: 1-3 Strand, London WC2N 5EH
Registered in England and Wales, No 2366977

ofgem

RIIO NIC NETWORK INNOVATION COMPETITION

SP ENERGY NETWORKS

Stewart Reid
Head of Future Networks
Inveralmond House
200 Dunkeld Road
PERTH, Scotland
PH1 3AQ

Re: Scottish Hydro Electric Transmission's New Suite of Tower Structures (NeSTS) project

Dear Stewart:

We are pleased to confirm our position as project supporter for SHE Transmission's NeSTS project. SP Transmission's view is that the NeSTS approach merits further development and demonstration through the Network Innovation Competition. We believe that the NeSTS project could enable financial savings for customers, and accelerate the connection of renewable energy, while providing wider environmental benefits. Should the trials be successful, we would be interested in the possibility of including NeSTS for future transmission infrastructure planning.

We look forward to sharing learning from the project's outputs and we will participate in NeSTS stakeholder consultation and knowledge dissemination activities. We also confirm our participation in the working group – our representative on this group will be

Mr. Richard Wylie, Lead Overhead Line Engineer, SP Energy Networks

Overall, we perceive NeSTS to be a worthwhile and beneficial project which offers transmission network operators a suitable alternative to traditional overhead line support methodology. We look forward to collaborating with you as you develop the project in more detail.

May I take this opportunity to wish you every success for the 2015 NIC application!

Yours faithfully

James Yu PhD CEng MIET MITL
Future Networks Manager

James Yu

SP Energy Networks
Ochil House, 10 Technology Avenue,
Hamilton International Technology Park,
Blantyre, G72 0HT
Scotland

Email: James.Yu@scottishpower.com
Mobile: 0044 (0)7725410080

ofgem

RIIO NIC NETWORK INNOVATION COMPETITION

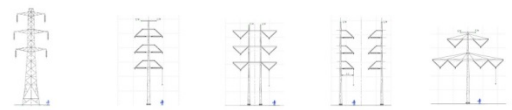
Appendix 14: Excerpt from Support Assessment Matrix

90SS545 - New 275kV Support Series

SUPPORT ASSESSMENT MATRIX

energyline

	L8RD M4.9	510 SERIES	520 SERIES	530 SERIES	540 SERIES
	(BENCHMARK)	OGA-202	OGA-204	OGA-206	OGA-223
Support Type	L8RD M4..9	Single Pole ICA 3-Xarm	2 Pole 3-Xarm	2 Single Pole 3-ICA, internal	Single pole, 2-lattice xarm
Conductor configuration	Vertical	Vertical	Vertical	Vertical	Tri-form
Nominal standard span (m)	305	200	200	200	200



MDA Weightings		
Electrical	5	0.05
Supports & Foundations	30	0.30
Mechanical & Electrical	10	0.10
Construction	10	0.10
Maintenance	5	0.05
Operational Safety	10	0.10
Environmental	30	0.30
Other	0	0.00
[Adjust total MDA weightings to 100]	100	

Main Design Aspect (MDA)		Design Aspect (DA)	Quant/ Qual	MDA weighting	Sub DA adjust't	Sub DA weighting	Overall weighting (%)	L8RD M4.9	Weighted score	510	Weighted score	520	Weighted score	530	Weighted score	540	Weighted score
Totals							1.00		56.58 %		55.49		52.84		47.11		54.89
Electrical	E.1	Audible Noise	Quant've	0.05	2.5	0.37	1.8%	9	0.17	5	0.09	6	0.11	1	0.02	7	0.13
Electrical	E.2	Magnetic Fields (external)	Quant've	0.05	1.2	0.18	0.9%	1	0.01	5	0.04	4	0.04	5	0.04	9	0.08
Electrical	E.3	Electric Fields (external)	Quant've	0.05	1.1	0.16	0.8%	1	0.01	3	0.02	3	0.02	4	0.03	9	0.07
Electrical	E.4	Radio Interference	Quant've	0.05	1	0.15	0.7%	9	0.07	5	0.04	6	0.04	1	0.01	7	0.05
Electrical	E.5	Earthing Performance	Qual	0.05	0.001	0.00	0.0%	7	0.00	3	0.00	9	0.00	1	0.00	3	0.00
Electrical	E.6	Lightning Performance	Quant've	0.05	0.001	0.00	0.0%	1	0.00	9	0.00	5	0.00	7	0.00	6	0.00
Electrical	E.7	Insulation Coordination	Quant've	0.05	0.8	0.12	0.6%	5	0.03	5	0.03	5	0.03	5	0.03	5	0.03
Electrical	E.8	Surge Impedance Loading (SIL)	Quant've	0.05	0.001	0.00	0.0%	1	0.00	7	0.00	5	0.00	7	0.00	7	0.00
Electrical	E.9	Electric Fields within/near structure	Quant've	0.05	0.1	0.01	0.1%	2	0.00	3	0.00	3	0.00	5	0.00	9	0.01
Electrical	E.10	Magnetic Fields within/near structure	Quant've	0.05	0.1	0.01	0.1%	4	0.00	6	0.00	5	0.00	7	0.01	1	0.00
					6.803	1.00	0.050		0.28		0.23		0.25		0.14		0.37
Supports & Foundations	S.1	Number of elements	Quant've	0.30	10	0.11	3.2%	1	0.03	8	0.25	9	0.28	7	0.22	8	0.25
Supports & Foundations	S.2	Number of joints	Quant've	0.30	10	0.11	3.2%	1	0.03	5	0.16	9	0.28	4	0.13	2	0.06
Supports & Foundations	S.3	Side slope added complexity	Quant've	0.30	5	0.05	1.6%	6	0.09	9	0.14	7	0.11	1	0.02	9	0.14
Supports & Foundations	S.4	Weight of structure (per km)	Quant've	0.30	20	0.21	6.3%	9	0.54	7	0.44	1	0.06	2	0.14	5	0.31
Supports & Foundations	S.5	Suitability to use of alternative materials	Qual	0.30	7	0.07	2.2%	2	0.04	7	0.15	9	0.20	8	0.18	5	0.11
Supports & Foundations	S.6	Reduction in reliability in single circuit configuration (i.e. strung	Quant've	0.30	3	0.03	0.9%	4	0.04	4	0.04	4	0.04	9	0.09	3	0.03
Supports & Foundations	S.7	Ice accretion performance	Quant've	0.30	1	0.01	0.3%	1	0.00	9	0.03	9	0.03	7	0.02	5	0.01
Supports & Foundations	S.8	Area for painting	Quant've	0.30	3	0.03	0.9%	1	0.01	9	0.09	9	0.08	7	0.07	5	0.04
Supports & Foundations	S.9	Implications of addition of extensions	Quant've	0.30	1	0.01	0.3%	5	0.02	9	0.03	8	0.03	8	0.03	9	0.03

90SS545-95-03-Issue4 Page 1 of 8 24/07/2015

Appendix 15: Energyline Ltd Company Information

AP15.1 About Energyline Ltd

Energyline Ltd is a privately owned company, established in 2002 and based in Knaresborough, North Yorkshire. Energyline's principal operations are centred on the provision of engineering, planning and environmental consultancy services to the electricity utilities and related suppliers. In general our services relate to the development of large transmission system capital projects at 132kV, 275kV and 400kV.

We undertake a broad range of engagements for the UKs main transmission system owners i.e. Scottish and Southern Energy Power Distribution (SSEPD) including Scottish Hydro Electric Transmission, National Grid (NG) and Scottish Power Energy Networks (SPEN) generally in respect of scheme development, costing, detailed design and delivery. We have a well-developed and leading capability in the condition assessment of transmission lines and also a broad range of related asset engineering services built around the experience and credentials of our principle staff.

Our capabilities and experience have seen continued and sustainable growth and together with our principal partners our capabilities and services cover the following main areas of operations:

- Overhead Line Design
- Overhead Line and Extra High Voltage (EHV) Cable Condition Assessments
- Planning and Environmental
- EHV Cable Design and Engineering
- Geomatics
- Civil and Structural Design
- Geotechnical
- Substation and Switchgear Design
- Project Services

Appendix 16: Extract from Social Market Research Ltd Proposal

Methods of Engagement

Having identified the range of stakeholders to engage with we will use a range of research methods to elicit opinion:

- Landowners / Landowners Federation [depth face-to-face / telephone interviews];
- Statutory Authorities [redacted]
- Other Transmission licensees [workshop events, depth face-to-face and telephone interviews];
- General public, community groups, communities likely to be affected [focus groups];
- Community representative organisations [depth face-to-face and telephone interviews];
- Other interested groups [depth face-to-face and telephone interviews];
- Ongoing deliberate events, events, seminars and briefings;
- Ongoing project publications, updates, communication.

Outputs and Deliverables

As noted previously all outcomes from the stakeholder engagement process will be published and made available to all stakeholders who engaged in the process as well as other interested parties. As the process rolls out we will ask stakeholders to tell us what ways they would like to be kept informed about the project, and we will use these methods as part of our overall engagement strategy.