Scottish & Southern Electricity Networks

SSEN Transmission

New Suite of Transmission Structures: NeSTS (SSEN003)

Project Closedown Report

March 2023

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Overview of NeSTS

Scottish Hydro Electric Transmission plc (SSEN Transmission) has developed a New Suite of Transmission Structures (NeSTS), which have been deployed on the transmission network.

Overhead lines (OHLs) built using transmission structures are the most visible element of the transmission network. The impact OHLs have on the environment can cause stakeholders concern.

The only available alternative to the steel lattice structures traditionally used in OHL construction is the T-Pylon. Developed by National Grid, the T-Pylon reduces the visual impact of OHLs but may be unsuited to areas with challenging terrain and a propensity for severe weather events.

Establishing new infrastructure in these areas is essential to connect renewable generation, so there is a need for a new type of structure to address stakeholder concern.

The NeSTS project was funded by the Network Innovation Competition in 2015 and has subsequently developed innovative designs for OHL structures based on new technologies and techniques and driven by stakeholder engagement targeting:

- Improved OHL environmental performance by lowering visual and construction impacts; and
- Lower OHL whole life asset costs via reduced land, construction, maintenance, and outage requirements.

The new suite of structures has been deployed on the transmission network and stakeholders have assessed its performance against these targets.

This report documents these assessments, the project outputs, and discusses what's next for NeSTS.

Summary

The Project has successfully designed and validated a new form of overhead line support driven by stakeholder engagement to address concerns regarding the environmental impacts of overhead lines, primarily regarding their visual impact.

Its Successful Delivery Reward Criteria have been delivered without material delay despite the impacts of the COVID19 pandemic and two delays imposed by modified connection applications.

These resulted in a change in scope, to necessitate the Project procuring and managing the trial OHL construction.

This change was agreed with Ofgem as a pragmatic alternative to delaying the trial OHL by several years, and has been discussed in the 2020 and 2021 Project Progress Reports available on the Project website (www.NeSTSproject.com/document-library/).

Statutory consultee stakeholders have compared the NeSTS trial OHL at Loch Quoich with the newly constructed L7c lattice steel OHL at Loch Laro. Some of them assessed the New Suite of Transmission Structures offers lower environmental impact than traditional lattice steel supports, primarily by reducing visual impact.

Some were equivocal, highlighting the subjective nature of this topic.

While this indicates the need for caution in use of summary statistics, these are presented herein and indicate a marginal aesthetic and landscape fit improvement using NeSTS.

This assessment validates the digital design and visualisation tools the Project has developed despite its subjectivity, being limited by the landscape where the trial overhead line is situated and the fact that, with only one exception, the individuals performing the post construction assessment were different to those who assessed at the design stage.

Figure 1: NeSTS trial Overhead Line at Loch Quoich

Summary

The construction impacts and costs (reported in SDRC 11.7 – Trial OHL Energisation) are comparable to those of traditional lattice steel OHL supports, although potential improvements may be available if caisson foundations can be developed based on the augering or pyrotechnic techniques the Project investigated, or the vibratory piling techniques in use in the USA.

While design improvements have been made, the maintenance and outage requirements are similar to those of existing supports.

The nature of the trial OHL has not provided evidence to enable quantification of land cost benefits.

The c33% reduction in the number of supports in a NeSTS overhead line will result in some cost saving in these areas, but it is likely to be of second-order.

The Project currently assesses that the whole life asset costs of NeSTS overhead lines are comparable to those of lattice steel overhead lines and that further work to understand the potential benefits will require evidence from several deployments of NeSTS.

Figure 2: New L7c Overhead Line at Loch Laro

The New Suite of Transmission Structures has been developed and demonstrated at 132kV. The digital design tools, drawings, and technical specifications are appended to this report, have been shared with the GB Transmission Owners (TOs), and are published on the Project website (www.NeSTSproject.com/elearning-designtools/)

This evidence fulfils the requirements for the Project's eighth Successful Delivery Reward Criterion, 11.8 NeSTS Closedown Report.

The Project anticipates similar design choices and therefore benefits are available at 275 and potentially at 400kV. The geometry of 275kV supports has been designed and prototyped, but not translated into digital design tools, drawings, or validated with testing. No work at 400kV has been undertaken yet.

Summary

Deploying NeSTS carries risk as its supply chain is new to the GB market.

The risk is only likely to be taken if the lower visual impact and reduced footprint result in faster and easier consenting of overhead lines.

Whether the preference for NeSTS expressed by some statutory consultees results in this is likely to vary from project to project and perhaps by Local Planning Authority.

The Project has developed tools to facilitate the visualisation of multiple design options at an early stage in project development which should enable discussion of consenting options during pre-consultation engagements early in the overhead line development process and stimulate deployment of the New Suite of Transmission Structures.

GB deployment is likely to stimulate GB supply chain development and the reduce deployment risk.

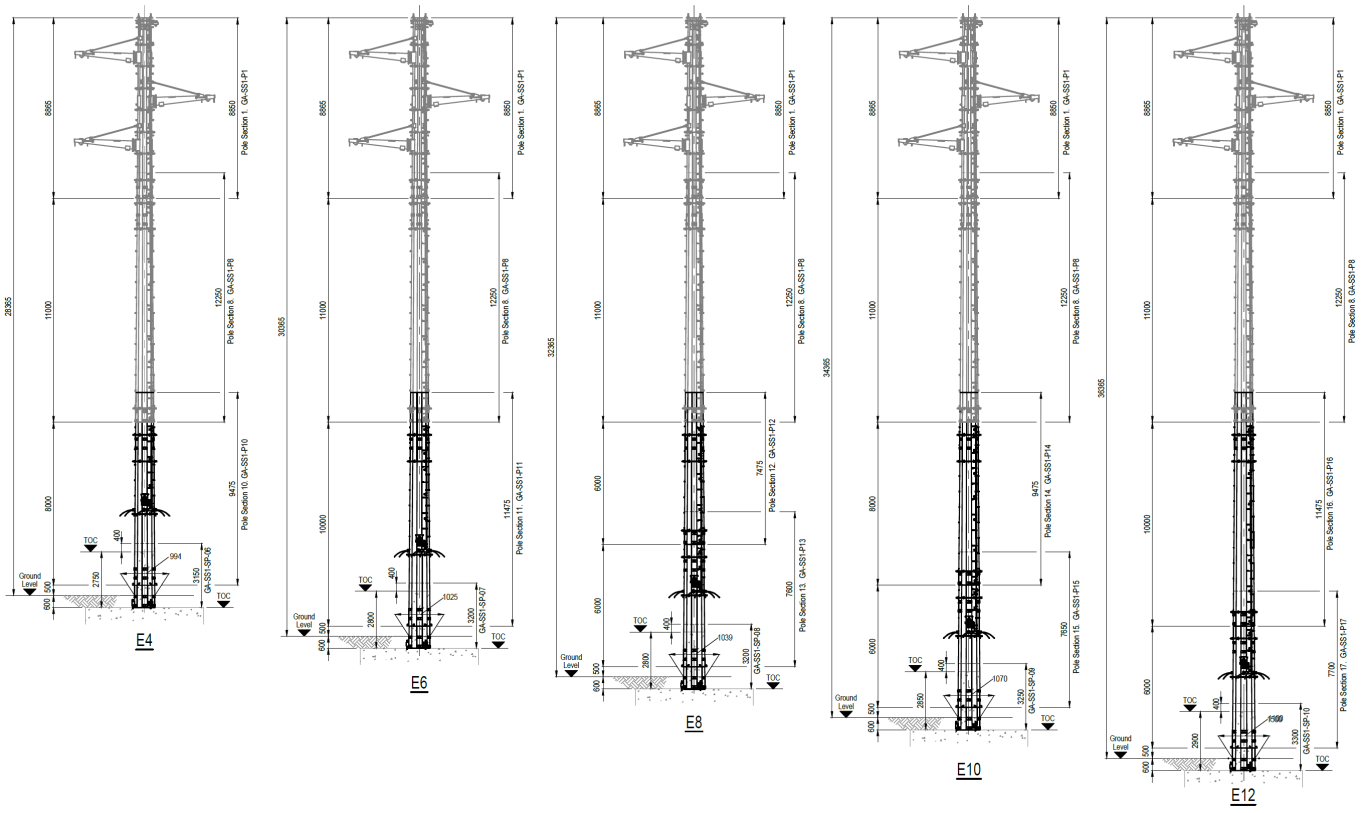


Figure 3: Excerpt from NeSTS 132kV SS1 Key Diagram

Project Outputs

Stakeholder Response to NeSTS

The Project has engaged a range of expert stakeholders to inform the development of NeSTS, and to assess its outputs.

These include Governmental Agencies, Local Authority Planners, focussed interest groups, landowners, internal and external overhead line design and construction engineers, and the supply chain.

The outputs of these engagements in the design phase have been reported in each of the Project's previous SDRC submissions. Updates focussing on specific groups of stakeholders response to NeSTS as the Project closes follow.

Statutory Consultees

Statutory consultees represent our society and consent overhead lines on its behalf. They have therefore been engaged as the arbiters of NeSTS environmental performance and have greatly influenced the NeSTS design.

This has been reported in detail in the project's first two SDRC submissions, Design Selection and Outputs of Stakeholder engagement.

In summary, the statutory consultees requested longer spans between overhead line supports, so that there would be fewer supports per kilometre of line in contradiction to the initial expectations that shorter supports would be preferred. And, that there would be less asymmetry in appearance of tension supports and greater continuity with suspension supports.

The images in Figure 1 and Figure 2 illustrate the former. The latter has been delivered on the drawing board and in 3d models of overhead lines, but not in construction yet as insufficient length of NeSTS line has been built to facilitate its demonstration.

At the design stage, in response to visualisations enabled by 3d modelling, the statutory consultees assessed that NeSTS would reduce the visual impact compared to traditional lattice steel design as shown in Figure 4.

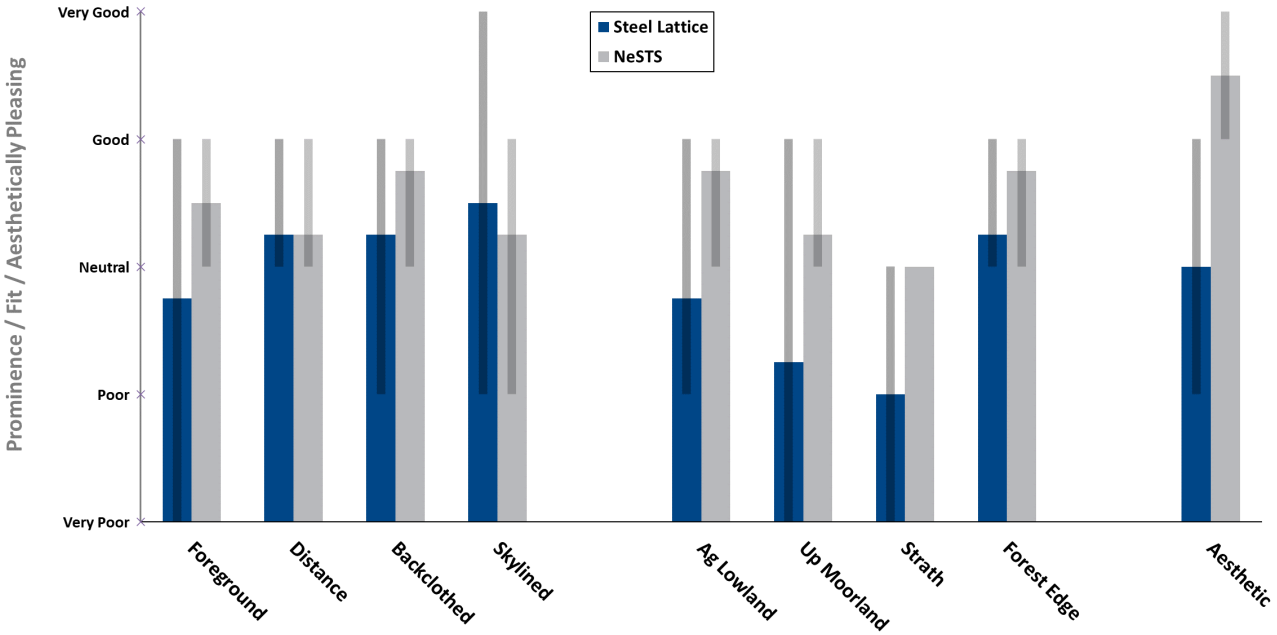


Figure 4: Consultee Stakeholder Visual Impact Assessment Summary at design stage

Statutory consultees were then engaged following construction of the NeSTS trial overhead line at Loch Quoich and a comparable new L7c overhead line at Loch Laro. The same assessment methodology was used to assess the as built performance of the overhead line supports, albeit constrained to the upland moorland landscape of both overhead lines and is summarised in Figure 5.

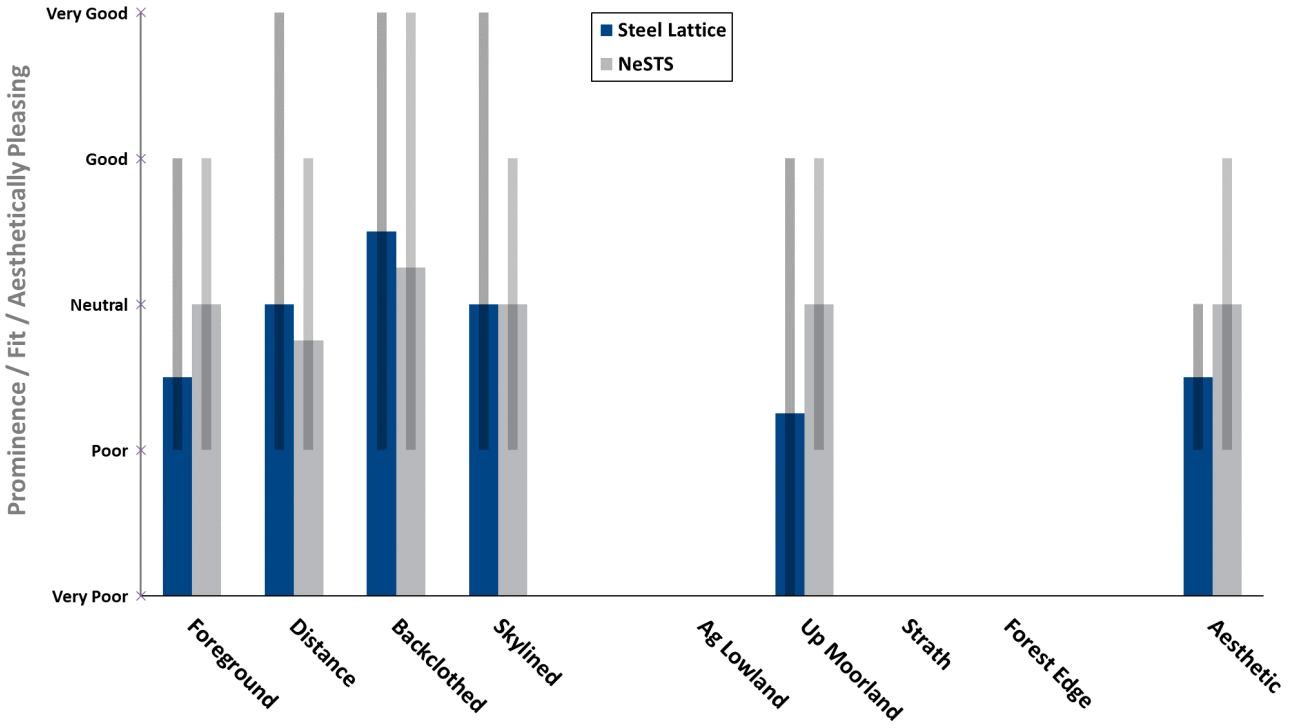


Figure 5: Consultee Stakeholder Visual Impact Assessment Summary post construction

The narrow, superimposed bars showing the range of the scoring illustrate the divergence of opinion and the subjectivity of the assessments.

Of note are:

- That two of the local planning authorities represented had some preference for NeSTS, while one had some preference for lattice steel;
- The individuals performing the assessments on behalf of their organisations had changed between the design and post construction stage excepting one; and
- While the performance improvements in landscape fit and overall aesthetics have reduced from design to post construction evaluation, they persist.

Comments accompanying scoring follow and further illustrate the subjectivity of the assessment:

From stakeholder 1;

- "The lattice style design is visually permeable in the skyline or where big skies exist. The monopole is more appropriate in the fore ground or against a backcloth i.e. it has a better fit."

- "A trial in other landscape types, for example lowland agriculture would be of benefit to see if the scoring was higher in a more lowland or forestry setting. It would also be of benefit to extend the use of the new pole design to 275kV and 400kV OHL's as these are often the most contentious given their scale and distance."

- "Neither are visually pleasing because of the 'industrial' nature of the design, and therefore both are neutral."

From stakeholder 3;

- "The solidity of the monopole makes it function poorly in foreground, skyline and back clothed settings as it obscures view, creating a visual 'stop' rather than allowing the filtered views through that the steel lattice does.
  That solidity and greater unbroken surface are also prevents (sic) it working well at greater distance as it reflects more light in an unbroken area, making the object itself more defined and prominent than a steel lattice."
- "The solidity of the monopole is less sympathetic to moorland settings and will tend to me (sic) more prominent over greater distance than steel lattice."
- "As objects, devoid of any other consideration, the monopole would probably score higher, it has a more clarity of form, a pleasing softening of light and shade on its tower rather than the more binary light/shade on any given part of the steel lattice, but the monopole is too much its own thing, too solid, carrying too much visual mass to sit comfortably in a wide range of landscapes and compositions.
  There are some settings it might look more fitting, near airports perhaps where its echoes of aeroplane fuselage might seem more appropriate."

From stakeholder 4;

- "I should again emphasise that these are the views of someone who is not a landscape specialist."

- "Difficult to score objectively due to limitations with visualisations, e.g. scores may be different under different lighting conditions or in a different landscape type. I've also not considered the factor that fewer monopoles would be required for a given length of line which might offset the reduction in scores for some of the criteria if a whole project consideration was to be made."

- "Judgement here is affected by familiarity. Steel lattice towers are already a feature of upland moorland landscape types in some places whereas the monopole structures are novel and so the eye will be attracted to them. Fit might be better in other landscape types."

- "Probably unlikely that any transmission support structure is likely to be visually pleasing. In aesthetic/experiential terms the monopoles feel somehow threatening or sinister – possibly related to the colour as well as the relatively massive structure, but again this is affected by the limitations of the visualisations and the novelty of the monopoles."

One of the organisations was not able to provide scores, and provided comments from their team instead. These are;

- "The monopoles do a better job than the lattice towers all round – they remind me of some of the early telephone poles."

- "My feeling is that they're a lot more solid, so though they're narrower, they may be more visible. It's not clear whether the surface is reflective or not, and the current pylons are most visible when they reflect the light. Also the new proposal is shown as dark in colour, which isn't good – grey or greenish grey would probably be better. All in all, I'm not sure that it's an improvement."

- "In general my thoughts are the new design would be an improvement because:
  - there is an increased span between them. This should mean less pylons overall and perhaps more scope for keeping them as far away from heritage assets as possible.
  - the design is slimmer and more compact. This is particularly apparent when the pylons are skylined where there is, I think, a considerable improvement on the wider lattice towers. Skylining is usually where

impacts are greatest for us. The new design may be less of an improvement when backclothed, because that's where the lattice structure becomes less solid and noticeable. However, backclothed pylons are usually less of a problem for us. I also prefer the aesthetics. I don't feel particularly able to say if this would vary if they were near or far. The information provided doesn't seem to have visuals that allow that sort of comparison."

- "My instinct is that the monopoles are an improvement. The lattice towers aren't really permeable so they effectively appear like bigger blocks, so while the monopoles are thicker, they seem to be more recessive in the landscape."

The Scottish Environmental Protection Agency do not provide assessment of visual impact as they are primarily concerned with the environmental impact of construction. They have agreed with the broad conclusions reported in the Project's seventh SDRC Energisation of Trial Overhead Line which is that the construction impacts of NeSTS are similar to those of lattice steel supports, at least until embedded caisson foundations can be developed for NeSTS.

The Energy Consents Unit have participated in the stakeholder engagements but have recused themselves from scoring as they are the ultimate decision maker on overhead line consents.

The similarity of the pre and post design assessments, despite the divergence of opinions and subjectivity noted indicates that the visualisation tool developed and used by the project has proved effective.

While the tool has proved effective, it requires substantial computing power to interact with. This has limited some stakeholder ability to create design scenarios and interact with it independently of the Project team.

Whether the preference for NeSTS expressed by some statutory consultees results in their use on overhead line development is likely to vary from project to project and may be by Local Planning Authority.

The design and visualisation tools detailed in this report facilitate the visualisation of multiple design options at an early stage in project development which enable informed discussion and assessment of design options during pre-consultation engagements early in the overhead line development process.

Project Outputs

Stakeholder Response to NeSTS

Supply Chain

The steel monopole form the stakeholders selected for NeSTS is widely used internationally.

The Project engaged in extensive benchmarking activities to incorporate the international body of knowledge into the NeSTS designs and specifications.

This included allowing for variation in pole diameter and connection details to enable manufacturers to compete and suggest efficient ways of delivering the required structural performance. This is common practice in the USA where the supply chain for steel monopoles is well developed, and involves manufacturers underwriting significant design liability.

Replicating this in the GB supply chain has proved impractical, as overhead lines are typically supplied by contractors who are exposed to all the associated liabilities, and who do not have trusted suppliers of steel monopoles. Main contractors have had difficulty obtaining reliable and timely quotes for supply of steel poles.

In response, the Project has increased the level of design detail in its engineering outputs to avoid the need for design input by pole manufacturers.

However, supply of steel monopoles is new to the GB contractors who supply overhead lines and therefore presents risk which is difficult to quantify.

And currently, the tooling and galvanising facilities to manufacture the full suite of NeSTS are not available in GB.

There are several fabricators with the necessary skills and appetite for investment should demand emerge, although domestic galvanising capacity may be more difficult to evolve.

In the meantime, NeSTS support procurement risk remains the primary adoption barrier for main contractors and OHL construction projects in GB.

Internal Teams

The risk perceived in the supply chain is reflected in increased transaction costs for internal project management, procurement and commercial teams when procuring overhead lines. Mitigating benefits, such as the easier consenting of overhead line projects will be required if these transaction costs are to be incurred.

Lattice steel overhead lines are functioning well on the GB network, and their design, construction and maintenance are well understood.

The Project has therefore embodied many aspects of our existing solutions in the NeSTS designs, making incremental improvements where rational.

An example of this is in access provision, where the NeSTS designs have embodied existing step bolts and compatible climbing equipment and processes. Incremental improvements have been realised by improving the ergonomics of the climbing rails, in providing wider surfaces for footing on cross arms, and in provision of lifting points for equipment.

The surface coating of the steel poles offers the advantages of enabling thicker zinc, and factory applied duplex paint coating. These are designed to offer superior corrosion performance and require less painting than the equivalent steel lattice towers, although the tanks required to galvanise the large tubes involved do not exist in GB currently.

The spigot foundation connection and feature free pole bases offer more tamper proof structures, which require less tertiary anti-climbing devices to be installed, maintained, and navigated. They also present a structure which livestock are less likely to interact with, and occupy a much lower footprint on the ground.

The cross arms and cross arm connections are stronger than equivalent lattice structures which enables less staying during some construction and wiring procedures.

However, while these improvements are nice to have and have been well received by TO engineering and asset management teams, they do not result in technical preference to lattice steel supports.

The NeSTS supports enable the use of standard overhead line operating and maintenance practices for lattice steel

towers with only new reference drawings to stipulate attachment and lifting points and their capacities required. They are considered equivalent to lattice steel supports by operations and maintenance teams.

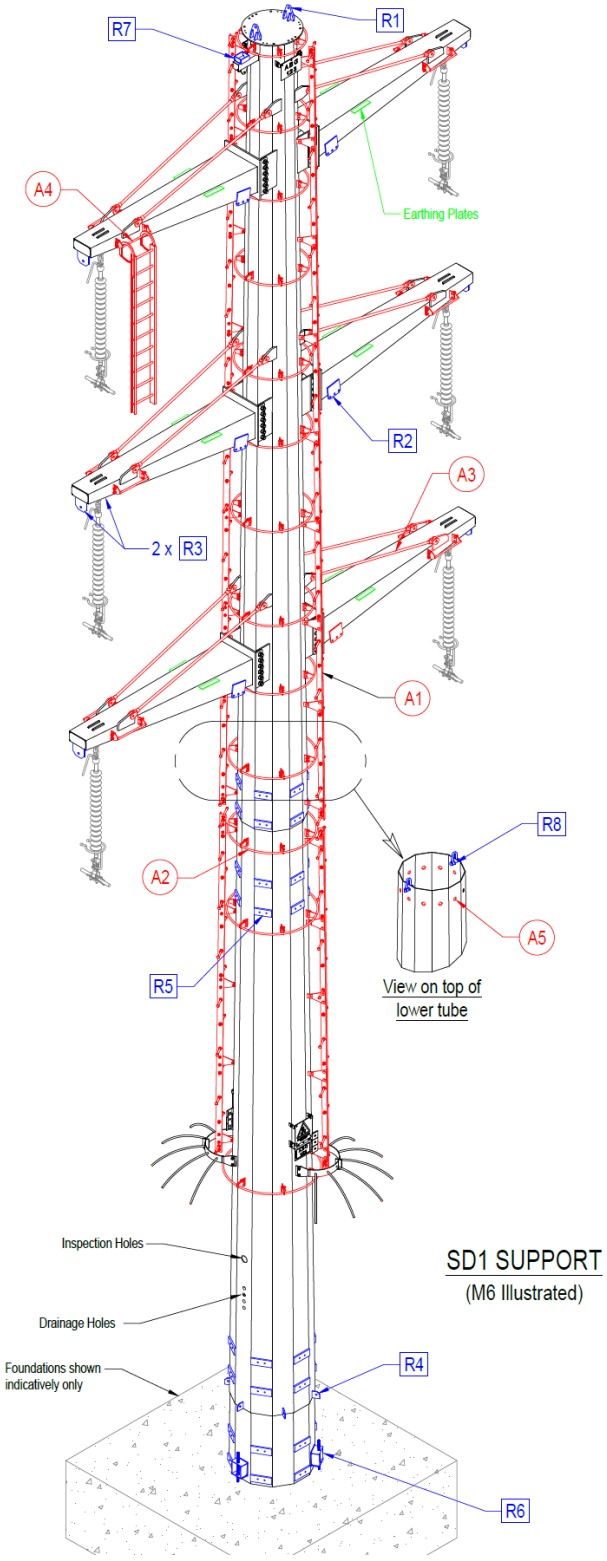


Figure 6:excerpt from NeSTS 132kV SD Construction and Maintenance drawing

Project Outputs

Design Tools

Technical Specifications

The NeSTS 132kV technical specifications for Single Circuit and Double Circuit supports are appended to this report.

They define the NeSTS supports, their design constraints, and some of the manufacturing requirements and have been formatted to enable review and publication by the Overhead Line Panel at the Energy Networks Association.

PLS Pole Models

The NeSTS supports have been modelled in Power Line Systems (PLS) Pole, and the models are available for download from the Project website (www.NeSTSproject.com/elearning-designtools/) as e-appendices to this report. (They are impractical to append in print, as are the 3d models and drawings.)

These enable the design of overhead lines using the industry standard software toolset, PLS Computer Aided Design Draft.

A PLS pole model of a NeSTS 132kV single circuit SS1 STD support is shown in Figure 7

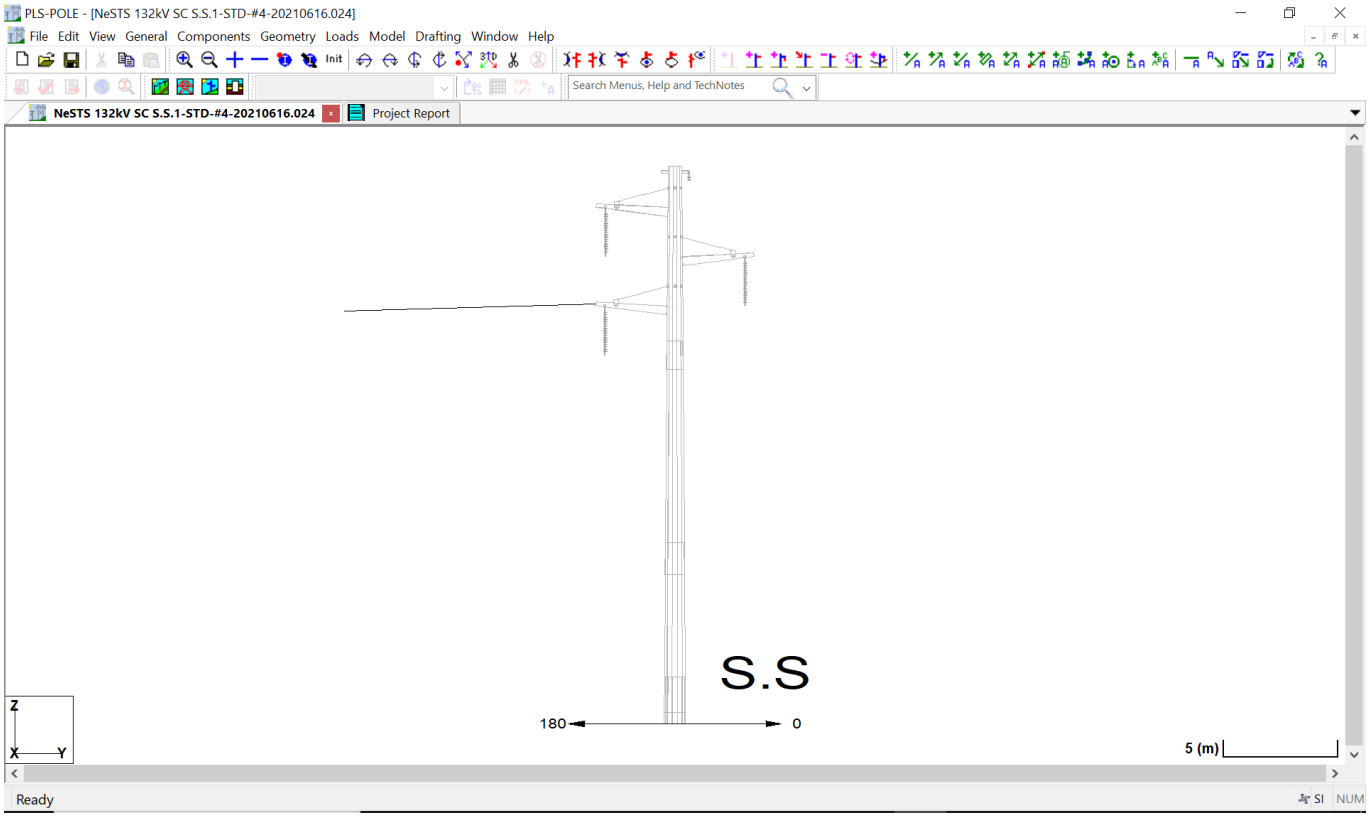


Figure 7: PLS Pole model of a NeSTS 132kV SC SS1 STD Pol

Project Outputs

Design Tools

Drawings

The drawings for the NeSTS 132kV Single Circuit and Double Circuit suites of supports are also available for download at www.NeSTSproject.com/elearning-designtools/.

The drawings, in combination with the Technical Specifications which define some manufacturing process and quality standards, enable the manufacturing of the poles without design input from a manufacturer.

3D Models

3d models of all the supports in the NeSTS 132kV Single Circuit and Double Circuit Suites are available for download at www.NeSTSproject.com/elearning-designtools/.

These models enable the visualisation and routing/alignment design of overhead lines using the visualisation tool described in the following section.

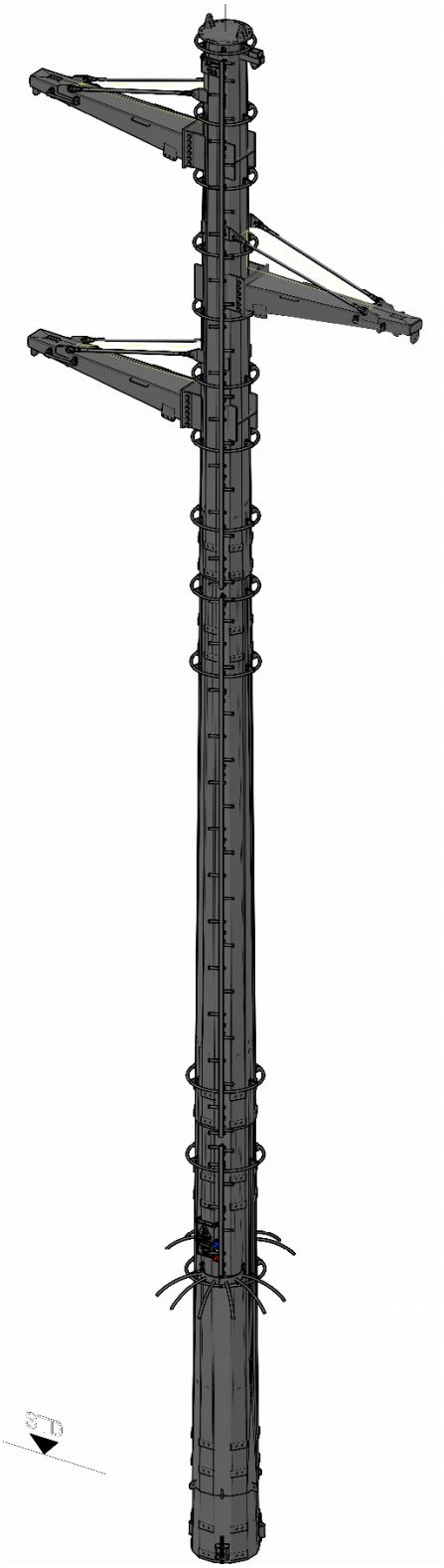


Figure 8: 3d model of a NeSTS 132kV SC SS1 STD Pole

Project Outputs

Visualisation Tool

The Project has been developing the use of the Topaz 3D Modeller platform to enable visualisation of overhead line design options, supported by supplier partners 3D Web Technologies, ASH, and Energyline.

ASH have developed the use of the Topaz 3D modelling platform to enable the photo-montage of overhead lines using 3d models supplied by Energyline in differing landscapes to be produced. Examples follow in Figure 9.

Figure 9: Example of photo-montage of overhead lines created by ASH using Topaz

3D Web Technologies have created 3d models of various overhead lines to enable interaction with them. Their development of the platform has enabled manipulation of the following environmental features:

- Vegetation and its seasonal appearance
- Sky appearance in different weather conditions
- Natural lighting at different time and date

Constructed features are modelled in 3D and represented in the models to the level of detail suited to the purpose – this can range from simple coloured block representation of structures to fully detailed representations.

Proposed overhead lines can be modelled using libraries of 3d support models, and several variants or options can be switchable within the same model at a keystroke. The platform has been developed to enable network owning users to define these lines using a simple csv definition of their coordinates and components.

A user interface allowing overhead line assets to be interrogated and edited interactively is also provided which enables overhead line routes and alignments to be developed and visualised by geographically diverse teams in real time. Images illustrating some of these capabilities are shown in Figure 10.

Project Outputs

Visualisation Tool

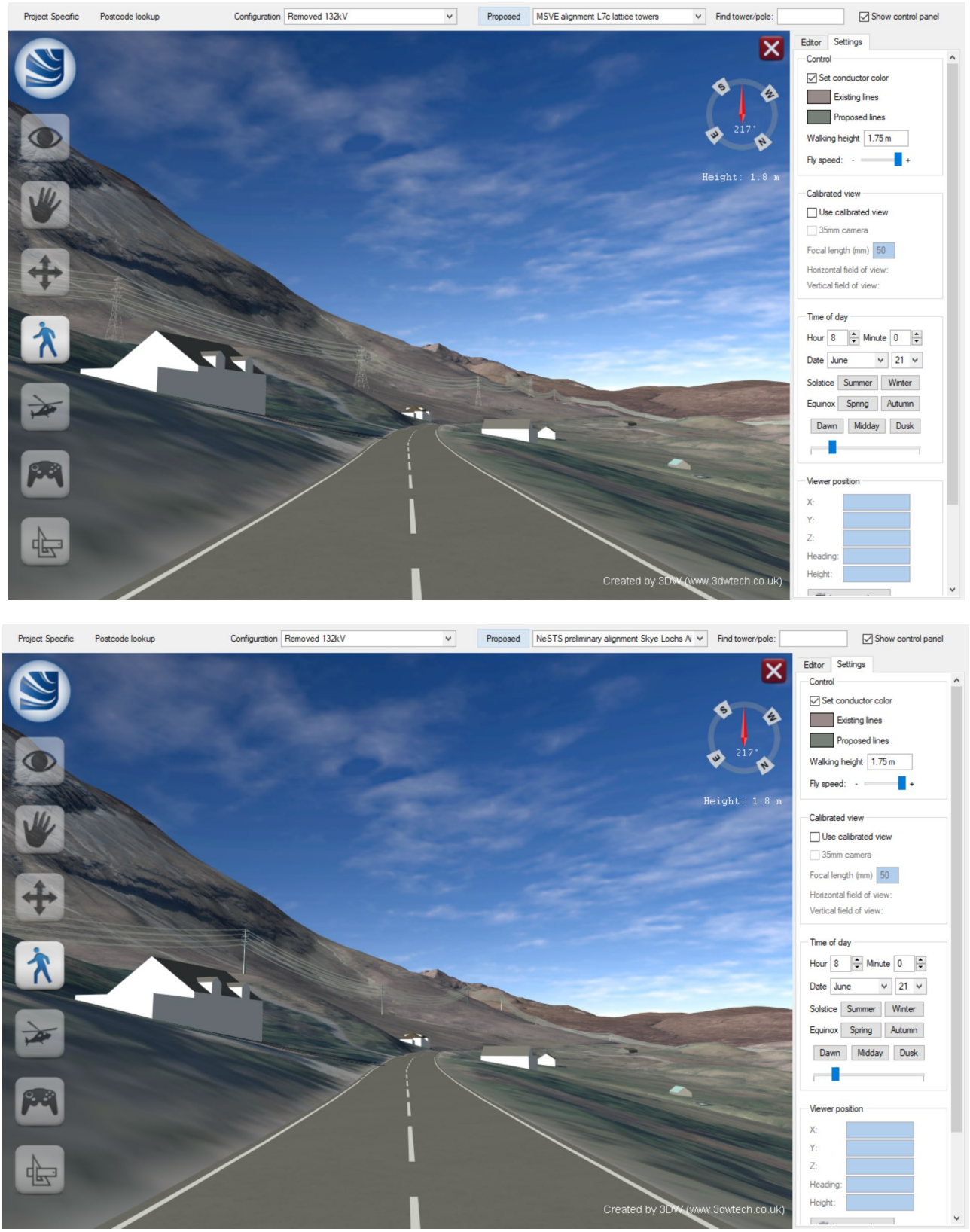


Figure 10: 3D model images of different overhead line design options at Loch Sligachan

Project Outputs

E-Learning Module

The visualisation tool capabilities are difficult to adequately describe in print, and they are one of the outputs best explained in an e-learning module which is available on the Project website at www.NeSTSproject.com/elearning-designtools/

The module also provides explanation of the other outputs discussed in and appended to this report, and provides contact information for the supplier partners who can assist new users with understanding and implementation of NeSTS project outputs.

Successful Delivery Reward Criteria Summary

SDRC	Due	Description	Evidence	Status
11.1	30/9/2016	**NeSTS Design Selection** The completion of the development of the Support Assessment Matrix. This will be offered to TOs to compare different types of overhead line supports in a technically balanced manner, incorporating the electrical, mechanical, environmental and construction and operational factors of overhead lines design. Selection of the final support designs.	Publish the initial outputs of the Support Assessment Matrix. An accompanying report will provide the technical details of the selected designs by 30 September 2016.	**Completed (SDRC met)** A report on NeSTS Design Selection and the completed Support Assessment Matrix were published on 30 September 2016. http://www.nestsproject.co.uk/wp-content/uploads/2016/06/SSEN003-NeSTS-Design-Selection-v1.0.pdf
11.2	30/09/2017	**Output of Stakeholder Engagement** Implement a programme of stakeholder engagement, supported by a suitable project supplier. This will include organised events and one to one interviews. Quantitative and qualitative analysis will be provided to understand key priorities. SSEN Transmission will factor these viewpoints into the functional specification for NeSTS where practical.	Report to the Authority with an assessment on the need for a Customer Engagement Plan and/or data protection strategy by 30 June 2016. Publish a report describing the outputs from stakeholder engagement and demonstrate where these outputs have influenced the NeSTS designs by 30 September 2017.	**Completed (SDRC met)** An assessment that a Customer Engagement Plan was not required was submitted on 3 May 2016. The Authority agreed with this assessment on 5 July 2016. A report on Outputs of Stakeholder Engagement was published on 28 September 2017. http://www.nestsproject.co.uk/wp-content/uploads/2016/06/SSEN003-NeSTS-Outputs-of-Stakeholder-Engagement-v1.0.pdf
11.3	30/8/2018	**Creation of Technical Specification** The NeSTS overhead lines circuit will be designed in parallel with a traditional overhead lines 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.	Publish a report on the outputs of the technical specifications of the NeSTS design stage by 30 August 2018.	**Completed (SDRC met)** A report on Creation of Technical Specification was published on 30 August 2018. http://www.nestsproject.co.uk/wp-content/uploads/2018/08/SSEN003-NeSTS-Creation-of-Technical-Specifications-v1.0.pdf

Successful Delivery Reward Criteria Summary

11.4	31/12/2018	**Decision Point / Review of business case** Review the NeSTS business case to conclude whether or not the Project should continue to Phase 2. 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 and the results of stakeholder engagement will be considered as part of the decision process. It will involve SSEN Transmission's Director of Transmission and the SSEN Transmission Steering Board.	Submit an update to Section 3 and Appendix 6, the business case of the Full Submission, to the Authority evaluating the project and recommending whether or not to proceed to Phase 2 by 31 December 2018.	**Completed (SDRC met)** A report on NeSTS Stage Gate – Decision to Proceed containing updates to Section 3 and Appendix 6 of the NIC Full Submission was submitted on 28 September 2018. The Authority approved the decision to proceed on 20 December 2018. http://www.nestsproject.co.uk/wp-content/uploads/2018/10/SSEN003-NeSTS-Stage-Gate-Decision-to-Proceed-v1.0.pdf
11.5	30/09/2019	**Type Testing Agreement** Within the first stage of Phase 2 (the demonstration part of the project), the detailed designs will enable the construction of a NeSTS overhead lines support structure, which will be tested at a dedicated testing facility. This is crucial in ensuring the design is supply chain ready and acceptable to other TOs.	A signed agreement with a dedicated testing facility by 30 September 2019.	**Completed (SDRC met)** A signed agreement with a dedicated testing facility was submitted on 30 September 2019.
11.6	20/02/2020	**Completion of Type Testing** The overhead lines 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.	Publish a report on the outputs of the type testing conclusions by 20 February 2020.	**Completed (SDRC met)** A report on the outputs of the type testing conclusions was submitted on 28 May 2020. Its delivery was delayed by COVID19 control measures and discussed with Ofgem. http://www.nestsproject.co.uk/wp-content/uploads/2020/08/SSEN003-NeSTS-Outputs-of-Type-Testing-v1.0.pdf
11.7	29/01/2021	**Energisation of NeSTS Overhead Lines** The energisation of the NeSTS overhead lines circuit is the culmination of the construction and commissioning of a section of the project is a key milestone.	Publish a full report detailing outputs and knowledge capture including an evaluation comparing NeSTS construction, commissioning and energisation with that of a typical steel lattice tower project by 29 January 2021.	**Completed (SDRC met)** A report detailing outputs and knowledge capture including an evaluation comparing NeSTS construction, commissioning and energisation with that of a typical steel lattice tower project was submitted on 28 January 2022. It was delayed by a change in site agreed with Ofgem. https://www.nestsproject.co.uk/wp-content/uploads/2023/03/SSEN003-NeSTS-Trial-Overhead-Line-Energisation-v1.0.pdf

Successful Delivery Reward Criteria Summary

SDRC	Due	Description	Evidence	Status
11.8	31/03/2022	**Publication of e-learning and visualisation tools and project closedown report** Knowledge capture and dissemination is of high importance to the project and the acceleration of NeSTS into TOs' business as usual activities. SSEN 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. 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 NeSTS OHL during operation.	Complete development of both tools and share with TOs and deliver detailed closedown report to Ofgem by 31 March 2022.	**On Target** Stakeholder assessment of the trial OHL was delayed to allow comparison with the Dalchork – Loch Buidhe line in construction. Development of e-learning and visualisation tools was completed, and a detailed closedown report was submitted to Ofgem on 30 March 2023. https://www.nestsproject.co.uk/wp-content/uploads/2023/03/SSEN003-NeSTS-Project-Closedown Report-v1.0.pdf

	Completed (SDRC met)		Emerging issue, remains on target		SDRC completed with material delay
	On target		Unresolved issue, material delay likely		Not completed and late

Business Case Discussion

The Project business case, presented in its Full Submission and refreshed in SDRC 11.4 NeSTS Stage Gate, available at https://www.NeSTSproject.com/document-library/ , calculated the potential value of NeSTS deployments should lower whole life costs be available compared to the traditional lattice steel alternative .

As discussed in this report, the Project has reported that NeSTS overhead line whole life costs are comparable to existing lattice steel overhead lines.

The value of easier consenting through increased stakeholder acceptance of overhead line projects is currently intangible, although the avoidance of delay due to prolonged determinations or Public Local Inquiries would be of benefit to the Transition to Net Zero and therefore customers.

An illustration of the time that can be involved in consenting overhead lines is provided by SSEN Transmission's Creag Dhubh – Dalmally 275kV Connection project, where consultation started in 2016, a section 37 application was made in 2022, and a Public Local Inquiry has been trigged by the Local Planning Authority's objection to it (Creag Dhubh - Dalmally 275kV Connection - SSEN Transmission (ssen-transmission.co.uk).

If NeSTS can address the concerns causing delay at comparable cost to the designs being objected to on future overhead line projects such as this, then its business case is positive.

The needs for evidence of this from several deployments of NeSTS and reduction in risk associated with its new supply chain are also apparent.

Project Expenditure and Budget Summary

The table below details the spend to date against the Project budget for each cost category.

Cost Category	Total Budget	Spend to Date	Comment
Labour			
Project team resource costs	£1,645.49k	£1,003.99k	
Equipment			
Prototyping, testing, and modelling	£258.56k	£389.36k	See note 1.
Contractors			
Project team resource costs	£5,344.34k	£5,337.53k	
IT			
IT Infrastructure	£204.79k	£617.25k	See note 2.
Travel & Expenses			
Travel & Expenses	£47.44k	£53.63k	
Total	**£7,500.62k**	**£7,401.76k**	*See note 3*

Notes:

1. The Project conducted more prototyping, testing and modelling than originally planned.
2. The Project produced more virtual design tools than originally planned.
3. Up to 30 March 2023 the project spent £7,401,757. The project has outstanding commitments which will be accounted for in April 2023 which will result in a revision of these data. This will be reported to Ofgem in April 2023.
4. Up to 23 January 2023 the project bank account had been credited with £39403.9 in interest payments. The assumed amount of interest at the time of the Full Submission was £111678.52, resulting in a budget shortfall of £72274.62. These data will be revised following the final bank account transactions and reported to Ofgem in April 2023.

Lessons Learned for Future Innovation Projects

The Project intended to demonstrate its trial overhead line as part of a business as usual development project.
The purpose was to recover the costs of the demonstration using revenues, thereby reducing the cost of the innovation project.

This practice should be avoided in future as it subjects the innovation project to risks it cannot manage or mitigate, placing the funds and results in jeopardy, and proving very difficult to manage as detailed below.

Initially, the planned NeSTS trial OHL deployment was on the North Argyll connection project—now known as the Creag Dhuhb – Dalmally 275kV connection project discussed previously.

As the background generation requirements changed the programme of that project, and it was delayed, the NeSTS programme could not wait and a new project was sought for deployment.

In the meantime, the Project needed to complete its stage gate, which required a full overhead line design exercise. The Dalchork – Loch Buidhe overhead line project was used for this purpose, but could not be used for deployment because of the uncertainty of NeSTS stage gate approval.

The Dalchork – Loch Buidhe project was also subject to changed requirements in background generation, and its specification was changed from 275kV to 132kV.

This forced NeSTS to redesign at 132kV, having already completed 275kV design and prototyping at considerable expense, and to fund an extra full overhead line design exercise to what was planned.

The Aberarder wind farm connection project was then selected for NeSTS deployment. This involved a change from double circuit 132kV at 348MVA to single circuit 132kV at 49MVA.

The Project therefore had to repeat the design and prototyping tasks for a second time, at further considerable unplanned expense.

The Aberarder windfarm connection application was modified once, which pushed the NeSTS programme to the limit allowed by Network Innovation Competition governance, but was then modified a second time and its programme was decommitted.

This left the Project with little time, and no obvious deployment plan.

In consultation with Ofgem, it was decided that the trial overhead line would repair the QB1 circuit feeding Skye where it had been destroyed by landslide.

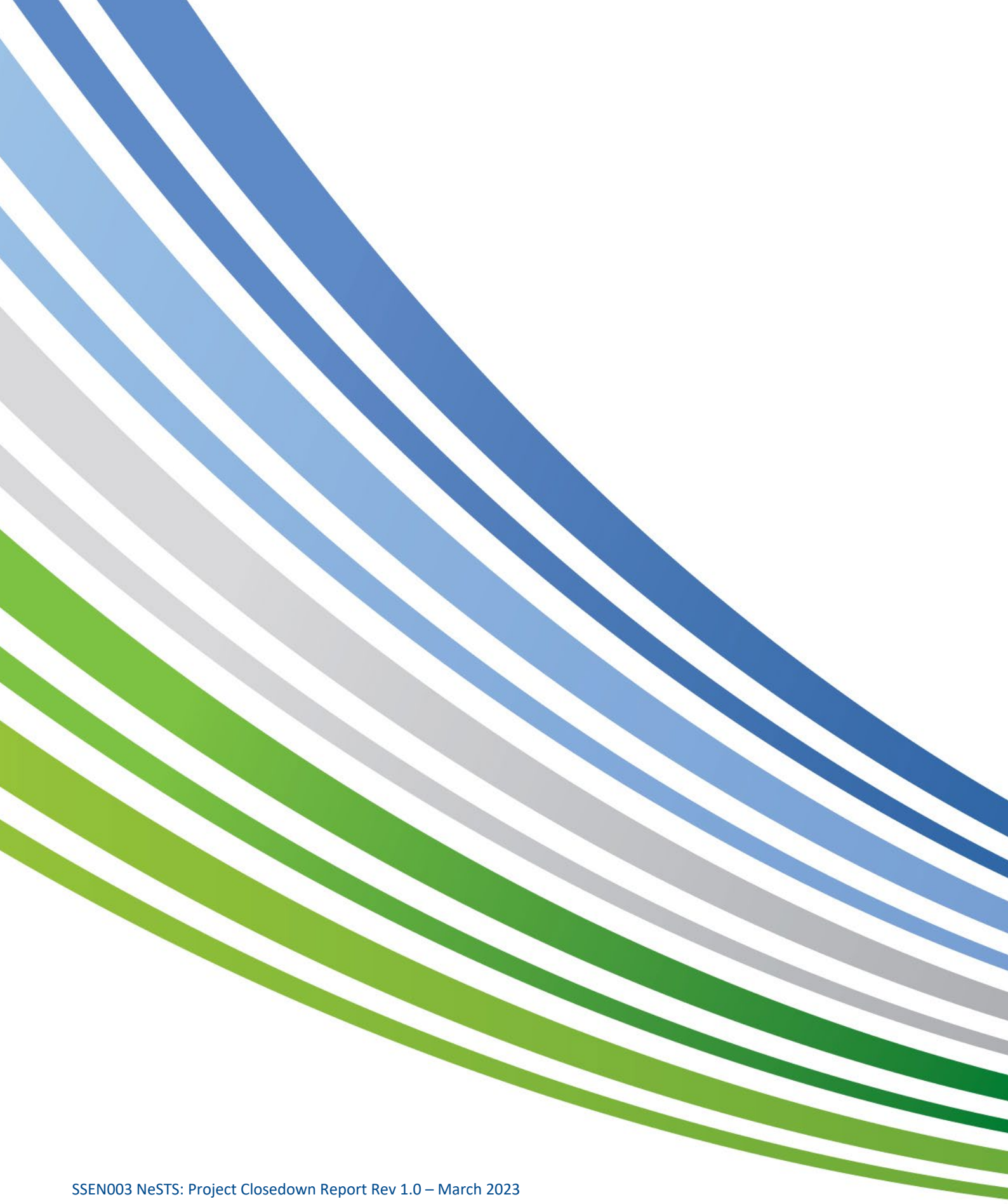
This has been completed satisfactorily and has solved a difficult problem at a very challenging site but involved the Project procuring and managing the construction of the trial overhead line which was outwith its planned scope.

This was completed during the COVID19 pandemic which constrained many of the Project's testing and construction activities to further complicate its management.

While the Project has been successful despite these difficulties, it would be more straightforward to fund trial deployments of innovation within innovation projects.

Project Team Contact Details

NeSTS Project Manager:	Tim Sammon Tim.sammon@sse.com +44 7469 411 397
SSEN Transmission Innovation:	TransmissionInnovation@sse.com
Energyline: Overhead Line Design Engineers	Jonathan Sherwood Jonathan.sherwood@energyline.ltd.uk
Norpower: Main Contractor, NeSTS Trial OHL	Neil Lamont neil@norpower.co.uk
3D Web Technologies Visualisation Tool Developer	Andy Dennison andyd@3dwtech.co.uk
ASH: Photomontage and visual impact assessment methodology developer	Jennifer Skrynka JSkrynka@ashglasgow.com



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