Public

Future Proofing Transmission Loss Factor (TLF) Process

Incorporating the lessons NESO and Elexon have learned following the 2025/2026 TLF publication

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NESO
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Summary

Transmission Loss Factors (TLFs) determine the volume of energy that is lost as a result of being transported across the transmission network. The BSC settlement process factors these losses into settlement payments. TLFs have financial implications for both generation and large embedded demand users. NESO supports the TLF process by sharing transmission network data and High Voltage Direct Current (HVDC) metered volumes. Elexon operates the TLF process in conjunction with the TLF Agent (Siemens). GB is split into fourteen zones (corresponding to the fourteen Grid Supply Points) and a TLF is published for each zone, and each zone has a TLF value for each season. Elexon publish the TLFs circa 3 months in advance and they become effective from 1 April each year.

Elexon published the TLF values for 2025/26 in December 2024. In January 2025 industry participants identified deviations in the data when compared to previous years and between TLF zones for the same year. Elexon and NESO investigated this and found missing data from the network data file supplied by NESO.

NESO investigated the root cause and concluded that it was due to manual Python script configuration changes following a PowerFactory[1] software upgrade. The purpose of this document is: -

- To outline the activities NESO performs to support the TLF process.
- Understand the root cause of the error identified with the original 2025/2026 TLF values.
- Record NESO and Elexon improvement actions that will prevent this error from re-occurring.

This exercise also presents an opportunity to demonstrate the TLF data-sharing protocols between NESO and Elexon, with the objective of identifying potential improvements to the TLF process.

[1] DIgSILENT PowerFactory – Software for the analysis, planning and optimization of power systems.

Scope

In scope

- Activities performed by NESO to support the delivery of the TLFs.
- The data sharing and reconciliation activities shared between NESO and Elexon.
- Output of Elexon's and NESO's lessons learned exercise.

Out of scope

- In flight BSC code modification changes covered by P485 and P493. See Appendices 3 and 4 for further details.

Overview of TLF submission process

NESO supplies Elexon with two datasets to support the TLF process:

1. High Voltage Direct Current (HVDC) metered volumes data.

A half hourly active power data extract for the Western HVDC link from an internal NESO datastore for each season for the entire year. The dataset includes data for the period 01/09 until 31/08 for the year prior to each submission.
The HVDC data is well understood and generates few queries. There is no modelling of the data, and the only transformation is to reformat the data into a format specified by Elexon.

2. Transmission Network Data.

This data supports the creation of the 'network mapping statement' and the 'transmission network data' datasets.
Transmission Network Owners share their respective PowerFactory models with NESO. NESO uses Python scripts and PowerFactory to extract the relevant data which is then validated with the Transmission Owners until all queries are resolved. NESO then collates and consolidates data to form a subset of the Electricity Ten Year Statement (ETYS) Appendix B publication. This data is shared with Elexon to form the basis of the TLF network data submission. More information on the ETYS process can be found in Appendix 2.

Summary of 2025/2026 TLF issue

The 2023 ETYS Appendix B dataset (published March 2024) omitted the following nodes:

Node 1	Node 2	OHL Length (km)	Cable Length (km)	Circuit Type	R (% on 100 MVA)	X (% on 100 MVA)	B (% on 100 MVA)	Winter Rating (MVA)	Spring Rating (MVA)	Summer Rating (MVA)	Autumn Rating (MVA)
HAKB4-	HARK41	9.857	0.000	OHL	0.0176	0.1957	5.7308	2213	2126	1980	2126
HAKB4B	HARK41	9.857	0.000	OHL	0.0176	0.1957	5.7308	2170	2084	1941	2084
MEDB4A	STWB4R	87.852	0.000	OHL	0.0779	1.5089	59.0491	3326	3326	3326	3326
MEDB4B	STWB4Q	87.852	0.000	OHL	0.0779	1.5089	59.0491	3326	3326	3326	3326

The impact was the TLF data had changed significantly from previous years, particularly in North Scotland and South Scotland. These TLFs became effective from 1 April 2025. Scottish Power Renewables raised BSC modification (P485) to stabilise the 2025/26 TLF values at the 2024/25 levels until the issue was investigated and resolved. The stabilised TLFs became effective from 16 April 2025. Further details on P485 can be found in Appendix 3

The TLF values were re-calculated to include the missing nodes. These became effective from 1 June 2025.

Had the TLF values not been amended, there would have been a commercial impact to generators, as explained in the P485 Final Modification Report (FMR)[2].

Root cause analysis

The root cause was investigated by NESO in conjunction with DIgSILENT, the vendor of the PowerFactory software.

The exclusion of the four transmission circuits from the published Appendix B datasets was traced back to an issue in step 2 of the workflow chart (see Appendix 1). This step executes an internally developed Python script to extract data from PowerFactory models.

Prior to the ETYS 2023 Appendix B publication, the PowerFactory software was upgraded from version 2019 to version 2022. This upgrade introduced a compatibility issue that affected the execution of the Python script used for data extraction. NESO raised a support call with DIgSILENT in July 2023 to investigate this issue. NESO also attempted to resolve the problem by adjusting the configuration of the ETYS Year 01 script with the aim to proceed with data extractions as a workaround. DIgSILENT subsequently recommended fixes to the Python script which resolved the compatibility issue. However, the earlier manual configuration changes applied for ETYS Year 01 were not reverted

[2] https://www.elexon.co.uk/bsc/documents/change/modifications/p485-final-modification-report-public/

following the script modifications. This oversight is the root cause which led to the exclusion of the four transmission circuits from the final dataset.

The network data is onerous and generates many queries each year due to the need for significant comparison and checking to ensure consistency across all ETYS years. NESO investigates each query with the Transmission Owner and corrects data errors accordingly. Despite internal due diligence NESO did not identify this error. NESO published this data on its website as part of the ETYS 2023 publication.

Lessons Learned

After identification of the 2025/2026 TLF issue, NESO and Elexon carried out a Lessons Learned review to prevent recurrence. Joint workshops examined the full process and data sharing, and each organisation reviewed its own procedures.

The issue has highlighted vulnerabilities in several areas of the process. The lessons for NESO and Elexon are summarised below.

NESO

Finding	What we have changed	How this provides improvement
Impact analysis for PowerFactory upgrades was insufficient.	NESO now follows a formal process to test workflows before any future PowerFactory software upgrades.	Confirms that the workflows operate as expected before and after each upgrade.
Engagement with NESO's vendor could have been improved	Engagement with the software vendor has been improved to ensure timely support for Python scripts used in data extraction, including resolution of compatibility issues.	Better understanding of the root cause of script errors allows NESO to make better decisions to resolve script errors.
Step 2 in the Appendix B process requires manually applying software settings, which introduces risk to the process.	The application of settings for each PowerFactory model in Step 2 of the workflow is now automated.	Automation eliminates manual errors and improves consistency.

There has been limited verification of the PowerFactory software settings.	NESO have added a new verification step to confirm that the settings applied in Step 2 are correct. This includes checking that the relevant PowerFactory schemes are active and that load flow simulations run successfully.	This verification step ensures that the correct settings are applied.
There has been limited reconciliation of network data between years.	NESO now reconciles the current transmission data against the same data for the previous year.	NESO flags, investigates and discusses any anomalies in consultation with the relevant Transmission Owner until resolved.
Elexon's published TLF data was presumed accurate, and there was insufficient validation of this information by both Elexon and NESO.	NESO will review the published TLF values against TLF values for previous years.	This provides a qualitive check of the TLF output data. Any unexpected deviance compared to previous years is investigated and resolved.

Elexon

Finding	What we have changed	How this provides improvement
The NESO input data was assumed to be correct and there was insufficient validation by Elexon and NESO of the input data, which excluded valid Circuits from the TLF calculation.	Earlier validation will ensure that the Reference Network Mapping Statement (NMS / TLFA-I001) and Network Data (ND / TLFA-I004) are more consistent with each other.	Elexon's previous process did not validate the NMS and the ND until the data was initially processed by Siemens.

		Elexon will bring this process step earlier in the calendar, when the draft Network Data is received from NESO. This will allow Elexon more time to identify and resolve any queries with NESO.
Following the issue being raised by industry participants, Elexon was able to identify the root cause in the NESO Network Data, which was validated by comparing the TLFs produced by Elexon's own Load Flow Model (LFM). This identified the issue was with the Network Data and not the Load Flow Model.	Elexon will perform pre-calculations of the TLFs to help identify issues earlier in the process. Elexon will utilise its in-house Python Load Flow Model to run the calculation earlier to get warning of any issues. Elexon will apply a threshold to trigger an investigation comparing any change with the previous year's values. Elexon will perform a pre-calculation:- • Once Elexon receives the TLFA-I004 file from NESO (using the new TLFA-I004, but previous year's versions of all the other input data files); and • Once a complete set of input files is received (but prior to sending them to Siemens).	This provides a timely qualitive check of the TLF input data. Any unexpected deviance compared to previous years is investigated and resolved

Joint NESO / Elexon Opportunities

Finding	What we have changed	How this provides improvement
The annual network data exchange with Elexon generates many queries and these are resolved through email exchange.	Queries will be resolved via NESO / Elexon close collaboration. Any queries or issues will be managed through NESO/Elexon workshops and formally tracked.	The benefit of the collaboration will be as follows: - • Queries will be resolved sooner, ensuring the root cause of each query is fully understood and addressed. • Options to resolve the query are discussed and if appropriate implemented, thus preventing similar queries from re-occurring in the future. • Escalation of any outstanding queries or issues which are not resolved in a timely manner.

Appendices

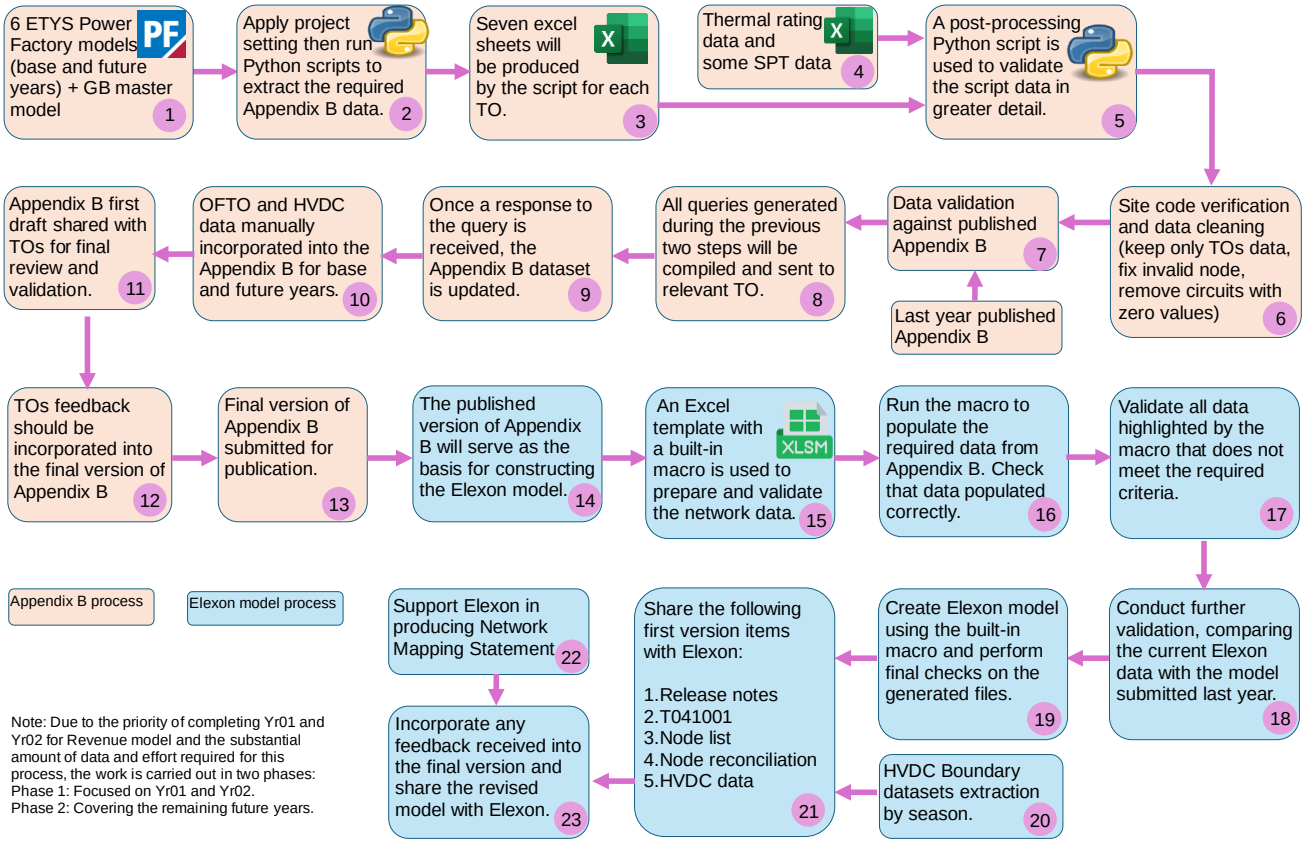
Appendix 1. Overview of the NESO aspects of the TLF process.

The NESO process to deliver the TLF datasets has two components.

1. Create ETYS Appendix B data.
2. Create the TLF datasets.

The following two sections describes that process. This includes: -

1. The process workflow.
2. The detail behind each step in that workflow.



The following tables describe the detail behind each step in the process workflow above. Each step in the process workflow is numbered. Each numbered step refers to the equivalent numbered step in the table below.

Create ETYS Appendix B data.

Step	Detail
1	Appendix B is an annual NESO activity in which asset data (circuits, transformers, and reactive compensation equipment) owned by the respective Transmission Owners (TOs) is published. Each TO provides six ETYS models to NESO, from which the Appendix B data is extracted. Where foreign keys (that uniquely identify a line or a transformer) or transformer thermal ratings are missing from the ETYS models, the GB master model is used to supplement the data.
2	Different settings are applied to each TO due to the varying modelling approaches used. For NGET, time settings are configured to reflect seasonal thermal rating variations, enabling the script to extract the relevant data. For SPT, a specific configuration is selected to correctly calculate the line parameters. NESO needs to ensure that the release schemes are active and that the load flow is running correctly, so the settings are applied as intended. Using two Python scripts, (one for NGET and another for SPT and SHET), extract the required Appendix B data from the ETYS models. Each script identifies and selects the appropriate models for the respective TO. They extract the base year data (ETYS Yr01) and report any changes between the base year and future years.
3	Executing the script will result in the generation of seven CSV files for each TO. Two files are produced for each of the following asset categories—circuits, transformers, and reactive compensation equipment—covering both the base and future years. The seventh file reports any missing elements.
4	Validate and compare the extracted data and map certain assets to NESO's site code management system, (known as the Reference Database (RDB)) using additional reference documents including thermal rating data and SPT transformer/circuit node mappings (Node1/Node2) to RDB.

Step	Detail
5	Execute a post-processing Python script to validate the earlier script output data in greater detail. The output files generated by the initial script serve as inputs to this script, along with the additional documents referenced in the previous step. The script produces a single file in Appendix B format, enriched with additional columns to validate the script output. This validation includes checks for invalid node names, impedance values, and parameter consistency for each TO.
6	Cross-check site codes and names against NESO site code management system, the reference database (RDB) and ETYS models, and investigate any discrepancies. Retain only transmission voltage levels for each TO, excluding lower voltages unless those nodes are specifically used in the Appendix B data. Remove zero-length circuits unless they contain non-zero parameters or are required for network continuity. This validation should be carried out using the related PowerFactory model, ensuring that any retained zero-length circuits are justified. Exclude super-grid transformer circuits and circuits with zero parameter values. Correct any invalid node names to align with the standard nomenclature.
7	Manually validate output data by comparing it with the previous year's Appendix B data. Each year's dataset must be compared against the corresponding year in the prior publication. If any parameters—such as thermal rating, resistance (R), reactance (X), susceptance (B), circuit length, circuit type, or connection voltage—have changed, these differences should be highlighted and clarified with the relevant TO.
8	Compile queries generated during the data validation and cleaning process into a query list template and send to each TO. Each TO will receive a separate query list, covering both the base and future years, for review and clarification.
9	Update the Appendix B dataset following responses from the TO.

Step	Detail
10	Incorporate Offshore Transmission Owner (OFTO) and HVDC data into the Appendix B dataset. These assets are not explicitly modelled within the ETYS models, their validation and compilation are carried out manually. This data is sourced from NESO's internal repositories and cross-checked against the previously published Appendix B data to ensure consistency and accuracy.
11	Share the first draft of Appendix B, including OFTO and HVDC data with the TOs for final review and validation.
12	Incorporate any responses received from the TOs into the final version of Appendix B to ensure accuracy and completeness.
13	Submit the final version of Appendix B to the relevant NESO team for publication.

Create TLF Datasets

Step	Detail
14	Develop revenue models for Year 01 and Year 02 following the completion of Phase One of the Appendix B data. Models for subsequent years will be prepared once Phase one is finalised. The published version of Appendix B will serve as the basis for constructing the Elexon model. Transmission model data is shared with Elexon in the agreed format.
15	Prepare and validate the network data required by Elexon using an Excel spreadsheet template with a built-in macro. Ensure the location of the Appendix B file is correctly defined and that no filters are applied in any tab of the template before running the macro.
16	Populate the required data from the Appendix B file using an Excel macro. After execution, verify that all data is populated correctly and without errors message. If

Step	Detail
	any data is missing or if the macro encounters issues, manually input the necessary information.
17	Validate all invalid site codes, nodes with differing voltages (circuits), nodes with identical voltages (transformers), circuits with zero parameter values. Any data highlighted by the macro is corrected by navigating to the specific tab where the error occurs. Use ETYS PowerFactory models and other internal data sources (RDB, OFTO data, previous queries related to Appendix B) to resolve these issues. Exclude circuits with parameter values less than 0.001 and override the associated node to maintain connectivity.
18	Compare the current Elexon model data with the model submitted the previous year. Review for any node name changes or parameter discrepancies. Use available data sources and the offline transmission analysis model to investigate and resolve any inconsistencies.
19	Generate the Elexon model using the built-in Excel macro function. Once the model is created, check the output files to ensure accuracy and completeness.
20	Extract the HVDC data from the NESO data historian. This data is a seasonal boundary dataset based on metered values and includes half-hourly active power measurements for the Western HVDC link, segmented by season across the full year. After extraction, the data is processed using a Python script to format and organise it according to Elexon's requirements.
21	Share the following first version items with Elexon: T041001, HVDC data, node list, and node reconciliation, and release notes. The release notes must detail any overrides or adjustments made, including instances of islanded networks caused by embedded OFTOs.

Step	Detail
22	Support Elexon in the production of a Network Mapping Statement by identifying the nodes in provided transmission data to which generators and demand should be mapped.
23	Incorporate any feedback received into the final version of the Elexon model. Once updated, share the revised model with Elexon to ensure alignment and completeness.

Appendix 2. Overview of the ETYS process.

NESO produces the ETYS report annually. This models the transmission network over several years against likely future energy scenarios.
NESO receives PowerFactory network models from each Transmission Owner, which are validated before combined to create a single GB wide transmission network model.
NESO then models the data and produces the annual ETYS report along with supporting documents.
An output from the ETYS process is 'Appendix B'. Appendix B describes the transmission system technical data and includes the basic network parameters such as connectivity and impedances that allow modelling of the transmission network. This dataset forms the basis for the transmission network data which is shared with Elexon.

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Appendix 3. Relationship with Modification P485.

The TLF issue resulted in a noticeable difference in the TLFs in 2025/26 when compared to the TLF values for 2024/25.
Scottish Power Renewables raised BSC Modification P485[3] to stabilise the 2025/26 TLFs at 2024/25 values to allow for the difference to be investigated. This was presented to BSC panel on 19 March 2025, and the modification was approved by the Authority and implemented on 16 April 2025.
This investigation concluded that there was an error with the network data supplied by NESO. This prompted a thorough investigation into the root cause and lessons learned, the details of which are captured in this paper.

[3] Decision on Balancing and Settlement Code (BSC) modification proposal P485 'Stabilise the Transmission Loss Factor (TLF) for BSC Year 2025/26 at 2024/2025 levels'

Appendix 4. Relationship with Modification P493.

P493 was raised by Scottish Power Renewables on 3 July 2025 to:
"Provide additional predictability and transparency to compliment the TLF calculation process by providing annualised publications to industry stakeholders. These publications are intended to maintain industry confidence by clearly outlining upcoming changes and the key factors influencing them."
The scope of this Lessons Learned document focusses on understanding the root cause of the TLF issue that occurred earlier this year, NESO – Elexon interactions in this process, and identification of potential improvements. This document can be used to support progression of the P493 modification.