Scottish & Southern Electricity Networks

Scottish Hydro Electric Transmission

Transmission Losses Report 2018/19

October 2019

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1. Introduction

Scottish Hydro Electric Transmission plc (SHE Transmission) has a licence obligation to publish a transmission losses report every financial year in accordance with Special Condition 2K of our licence. This is the report for the 2018/19 financial year.

Special Condition 2K requires this report to include:

- 2K.4(a): The level of transmission losses from the licensee's transmission system, measured as the difference between the units of electricity metered on entry to the licensee's transmission system and the units of electricity metered on leaving that system
- 2K.4(b): A progress report on the implementation of the licensee's strategy, including the licensee's estimate of the contribution to minimise transmission losses on the licensee's transmission system that has occurred as a result
- 2K.4(c): Any changes or revisions the licensee has made to the strategy
- 2K.5: The strategy and the report must contain or be accompanied by a description of any calculations the licensee has used to estimate transmission losses on the licensee's transmission system.

The total annual losses on SHE Transmission's network are provided by National Grid Electricity System Operator (ESO). The ESO's calculation uses data from the Elexon SAA-IO14 data feed, as laid out in the ESO's "Transmission Losses Calculation – Joint TO Methodology". For the avoidance of doubt, the ESO is responsible for the accuracy of the annual transmission losses figures.

Elexon reported the GB transmission Losses and currently accounts for about 2% of the electricity transmitted. While we endeavour to minimise losses when making investment decisions, using new technology or operating at higher voltages and ratings where appropriate, it is estimated that losses on SHE Transmission network will increase in the long term due to the growth of renewable generation in the North of Scotland and the long distance over which the renewable power requires to be transmitted. We will continue to monitor the losses on our network and assess how they can be reduced in our investment decisions and innovation projects.

2. 2018/19 Transmission Losses

2.1 Losses Reported by the ESO

The ESO has determined that SHE Transmission's losses in 2018/19 were 0.35TWh. Figure 1 shows the variation in losses over the last 10 years, where there has been average annual losses of 0.31TWh, peaking at 0.38TWh in 2013/14, with a low of 0.24TWh in 2010/11.

Losses vary from year to year, however, there was a steady decline in transmission losses between 2013/14 and 2017/18. This period is when a number of major projects, such as Beauly-Denny 400kV overhead line and Crossaig-Hunterston 220kV subsea cables, have had a strong impact in reducing losses, by providing additional high voltage paths across the network and to the rest of Great Britain. Increasing volumes of large generators on the distribution network during that period has also contributed to the decrease in transmission losses. These generators can supply local demand, which reduces load on the relatively high-loss 132kV circuits that connect the distribution network to the transmission system at grid supply points (GSPs). However, as more generators connect to the

distribution network, generation may exceed local demand, and the excess power is exported from the GSP onto the transmission network which could increase transmission loading and losses.

In 2018, 1184MW of new renewable generation connected to our transmission system, including Beatrice and Stronelairg windfarms. The higher utilisation of transmission assets and renewable generation connections facilitated by the "Connect and Manage" regime has led to a reversal in the recent trend of declining losses, with a 0.1 TWh increase in 2018/19 compared to 2017/18. This has been corroborated by our analysis for the Electricity Ten Year Statement: the 2018/19 SHE Transmission losses under the average cold spell winter peak demand scenario (132MW) are 38% higher compared to 2017/18 (95MW).

Power losses are an inevitable consequence of generating, transmitting and distributing electricity to consumers. Transmission losses are mainly determined by the generation dispatch through the market and balancing actions by the ESO, and can be affected by several factors such as the volume of electricity transmitted, the number of circuits and their resistance, the electrical distance between generations and demand, as well as the use of operational measures such as circuit switching and use of reactive compensation equipment and transformer tap settings for voltage control and quadrature boosters for power flow control, which are under the responsibility of the ESO and out of our control in operational timescales.

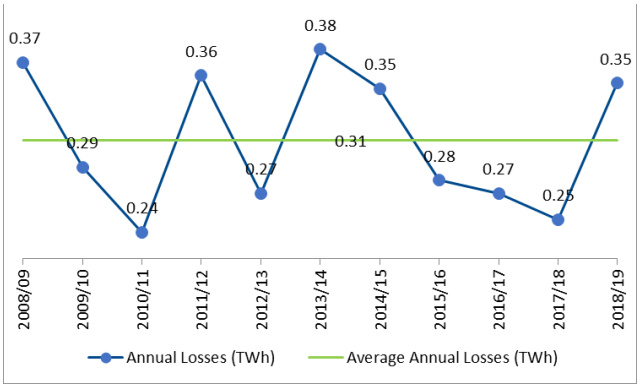


Figure 1. SHE Transmission's annual losses between 2008/09 and 2018/19 as reported by the ESO

2.2 Losses Estimated by SHE Transmission

In line with the losses estimation described in our Losses Strategy published in October 2016, SHE Transmission independently carried out sense-checks of the losses figures reported by the ESO using regression analysis. A quadratic loss factor equation has been derived to establish the relationship between loss and load level, as shown below:

$$\text{Loss factor} = 0.110091 - 0.296236L + 0.226254L^2$$

Where L is the load level in per unit of annual peak gross demand at SHE Transmission network

Using the system peak demand and the load duration curve from 2018/19, and applying the above loss factor equation, the annual transmission losses on SHE Transmission's network were estimated to be 0.3441TWh, shown in Table 1. The estimated figure is similar to the 0.35TWh losses figure reported by the ESO.

Table 1: Estimated Annual Losses for 2018/19

% of System Peak Demand	Load Level in per unit	Hours of Occurrence	Losses (TWh)
90-100	0.95	25	0.0014
80-90	0.85	25	0.0009
70-80	0.75	221	0.0058
60-70	0.65	816	0.0185
50-60	0.55	2395	0.0646
40-50	0.45	3123	0.1220
30-40	0.35	2017	0.1189
20-30	0.25	138	0.0120
10-20	0.15	0	0.0000
0-10	0.05	0	0.0000
Total		**8760**	**0.3441**

3. Strategy Implementation

We consider transmission losses when carrying out option assessments for load/non-load reinforcements as well as when specifying and procuring equipment. We endeavour to minimise SHE Transmission's losses through the appropriate use of low-loss technologies, such as extra high conductivity All Aluminium Alloy Conductor (AAAC) and Aluminium Conductor Composite Core (ACCC) conductors, High Voltage Direct Current (HVDC) systems, or by upgrading parts of our network to operate at higher voltages and ratings. Meanwhile, we will continue to monitor the level of losses, investigate unusual losses figures, and consider losses when making investment decisions.

3.1 Load Related Reinforcement Projects

There were two major overhead line reinforcement projects completed in 2018. In July, the new Spittal – Mybster 132kV circuit was completed to connect renewable generation at Mybster. It consists of a 5km double circuit overhead line strung with 700mm^2 AAAC conductor that has high capacity and low impedance. In November, we completed reconductoring of the Fort Augustus – Fort William 132kV west circuit, replacing the existing conductor with a larger one with lower resistance.

We have also undertaken major substation reinforcements, including the new 275/132kV Loch Buidhe and Fyrish substations, and the Blackhillock 400/275kV substation development, which will allow power to flow on higher voltage routes with lower losses. Transformer upgrades such as the Spittal SGT Capacity Upgrade have enabled new generators to connect with the additional benefit of reduced no-load losses.

The Caithness-Moray HVDC link was also completed in 2018/19, connecting converter stations at Spittal in Caithness with Blackhillock in Moray with a 113km subsea cable that can transmit up to 800MW with reduced losses compared to comparable onshore AC circuits.

It is important to note that these projects use low-loss technologies with the potential to reduce losses only where network loading remains constant, which is not the case for load related reinforcements intended to enable more generation. For example, a larger diameter conductor or transformer with a lower resistance connecting to a GSP may have lower losses when supplying the GSP demand, but the additional generation on the GSP could increase the average current flowing on the circuit and thus the losses, overriding the effect of the lower resistance equipment with a net increase in losses.

3.2 Non-load Related Asset Replacement Projects

Under the condition-based asset replacement programme in 2018/19, 51km of overhead line between Blackhillock and Kintore has been reconductored with 300mm^2 extra high capacity AAAC, which has lower losses compared to the old 160mm2 Aluminium Conductor Steel-Reinforced (ACSR) conductors.

The 2km 132kV underground cable between Dudhope and Glenagnes has been replaced with a larger cable with higher ratings (increased from 120MVA to 145MVA) to supply demand in Dundee with reduced losses.

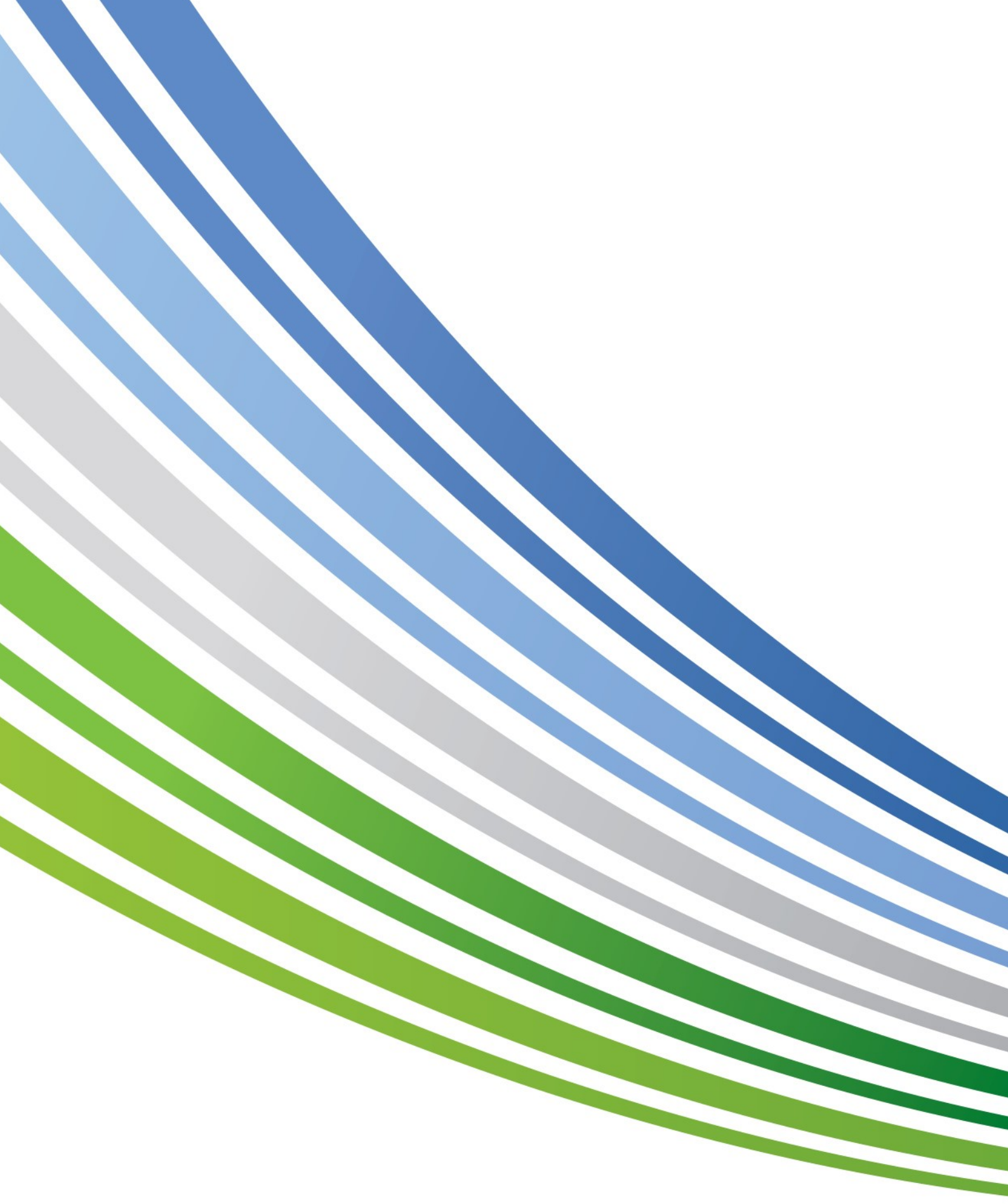
3.3 Equipment Specification and Procurement

The whole life cost including capitalised losses has been considered in our investment decisions to ensure efficient and economic designs for the specification and procurement of transformers, conductors, materials and other equipment.

4. Changes to Transmission Losses Strategy

We are not proposing any changes to the Transmission Losses Strategy Rev 3.0 published in October 2016.

For RIIO-T2, we have published the draft losses strategy consultation to support our "Network for Net Zero" vision.



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