Scottish & Southern Electricity Networks

Scottish Hydro Electric Transmission

Transmission Losses Report 2019/20

October 2020

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1. Introduction

Scottish Hydro Electric Transmission plc (SHE Transmission) has a licence obligation to publish an annual transmission losses report every financial year in accordance with Special Condition 2K of our licence. This is the report for the 2019/20 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.

SHE Transmission continuously monitor and estimate the losses on the transmission network, and endeavour to minimise the losses by implementing our Transmission Losses Strategy Rev 3.0[1] published in October 2016.

We estimate that losses on our network will increase in the long term due to the rapid growth of renewable generation in the North of Scotland and the long distance over which the renewable power requires to be transmitted. In the RIIO-2 Draft Determinations - Electricity Transmission Annex[2] 2.112, Ofgem pointed out, "… we do not think it is appropriate to emphasise loss minimisation in a Licence condition for the TOs … We think that a Licence condition to minimise losses could give undue weight to reducing losses in network investment decisions over factors such as cost and system need, which are important considerations to ensure that any proposed investment is economic and efficient." SHE Transmission share the same view and will continue to prioritise economic and efficient investment decisions based on the most relevant key factors as well as doing our best to mitigate the losses increase in the long term.

[1] https://www.ssen.co.uk/WorkArea/DownloadAsset.aspx?id=12077

[2] https://www.ofgem.gov.uk/system/files/docs/2020/07/draft_determinations_-_et_sector_0.pdf

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2. 2019/20 Transmission Losses

2.1 Losses Reported by the ESO

The ESO has determined that SHE Transmission's losses in 2019/20 were 0.437TWh, which was equivalent to 2.22% of the total electricity transmitted. Figure 1 shows the variation in losses over the past 10 years, where there have been average annual losses of 0.32TWh.

Power losses are an inevitable consequence of generating, transmitting and distributing electricity to consumers. Transmission losses are mainly determined by the power dispatch set by the operation of the electricity market and the balancing actions taken 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 outages, quadrature boosters and static var compensators, which are mostly under the operational responsibility of the ESO and outside of our control, particularly in operational timescales.

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 some major transmission upgrade projects, such as Beauly-Denny 400kV overhead line and Crossaig-Hunterston 220kV subsea cables, have been commissioned and 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 would increase transmission loading and losses.

In 2019/20, 35MW offshore generation as well as 74.4MW new embedded generation were connected to our network, further to the 1184MW renewable generation connected in 2018/19. The higher utilisation of transmission assets and continued increase in renewable generation development facilitated by the "Connect and Manage" regime have led to a reversal in the recent trend of declining losses. Annual losses have increased by 0.09TWh since 2018, while the total annual electricity generated on SHE Transmission network has increased by 2.82TWh every year since 2018 and hits 20TWh in 2019/20.

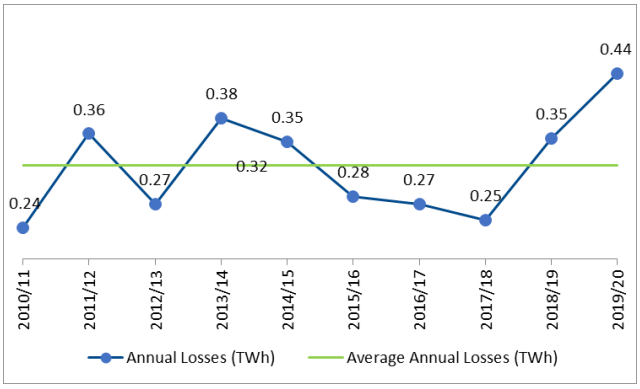


Figure 1. SHE Transmission's annual losses between 2010/11 and 2019/20 as reported by the ESO

2.2 Losses Estimated by SHE Transmission

We have validated the transmission losses reported by the ESO using regression analysis according to the methodology described in our Losses Strategy[3] published in October 2016. A quadratic loss factor equation has been derived to establish the relationship between loss and load level, as shown below:

$$\text{Loss factor} = -0.001144 - 0.012157L + 0.131888L^2$$

Where L is the load level in per unit of annual peak demand

Using the system peak demand and the load duration curve from 2019/20, and applying the above loss factor equation, the annual transmission losses on SHE Transmission's network were estimated to be 0.420TWh, shown in Table 1. The estimated figure is close to the 0.437TWh losses figure reported by the ESO.

Table 1: Estimated Annual Losses for 2019/20

% of System Peak Demand	Load Level in per unit	Hours of Occurrence	Losses (TWh)
90-100	0.95	27	0.004
80-90	0.85	141	0.018
70-80	0.75	677	0.066
60-70	0.65	1589	0.113
50-60	0.55	2496	0.122
40-50	0.45	2527	0.077
30-40	0.35	1188	0.019
20-30	0.25	107	0.001
10-20	0.15	8	0.000
0-10	0.05	0	0.000
Total		**8760**	**0.420**

3. Strategy Implementation

We consider transmission losses when carrying out option assessments for load and/or non-load reinforcements as well as when specifying and procuring equipment. We endeavour to minimise losses on SHE Transmission's network through the appropriate use of low-loss technologies, such as extra high conductivity AAAC and ACCC conductors, 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 several major overhead line reinforcement projects completed in 2019/20. The 44km Fort Augustus – Fort William 132kV circuit FFE was refurbished and reconductored with Monte Carlo ACCC with the connection of Kinlochleven GSP substation reinstated to connect onto that circuit. The new ACCC conductor is twice as strong as the previous steel core wire, 70% lighter and able to carry twice the amount of power with a winter post-fault continuous rating of 255MVA, as part of our strategy to use high capacity, high conductivity conductor.

Approximately 20km of new 275kV double circuit overhead line (810MVA winter post-fault continuous rating) between Knocknagael substation and the new 275/132kV Tomatin substation were also constructed. As part of this reinforcement, the 132kV overhead line from Tomatin to Boat of Garten GSP was also reconductored to a higher capacity – 215MVA. The reinforcement will enable

[3] https://www.ssen.co.uk/WorkArea/DownloadAsset.aspx?id=12077

more renewable connections while allowing power to flow on higher voltage circuits with lower losses.

We have also invested in the Elgin – Nairn network to fully refurbish many of the towers and upgrade the 33km 132kV double circuit overhead line capacity from 126MVA to 241MVA winter post-fault continuous rating. The refurbishment will enable more renewable power connections and maintain security of supply, and the new conductors will help minimise losses.

It is important to note that these projects use low-loss technology with the potential to reduce losses where network loading remains constant. Generally, this is not the case for load related reinforcements intended to enable more power generation. For example, a larger diameter conductor or transformer with a lower resistance connecting to a GSP substation may have lower losses when supplying the GSP demand, however, the additional generation on the GSP could increase the average current flowing on the circuit and thus increase the absolute losses. Nevertheless, although this increase in current flow can result in a net increase in losses, the effect of the lower resistance equipment is to reduce the magnitude of the increase.

3.2 Non-load Related Asset Replacement Projects

Under the condition-based asset replacement programme in 2019/20, 17.5km of 132kV double circuit overhead line between Craigiebuckler and Kintore has been reconductored with 300mm^2 extra high capacity AAAC with 230MVA winter post-fault continuous rating to provide reduced losses for the same loading level.

The 7.8km 132kV double circuit overhead line St Fergus – Peterhead Grange has also been replaced with a larger conductor with higher ratings (increased from 126MVA to 241MVA) to supply demand in Peterhead and to allow more power flow south with reduced losses.

At Lunanhead GSP, we replaced the poor-condition 90MVA grid transformer GT2 with a new 120MVA transformer to address the User's demand and embedded generation increase forecast with the benefit of reduced losses at the same loading level.

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.

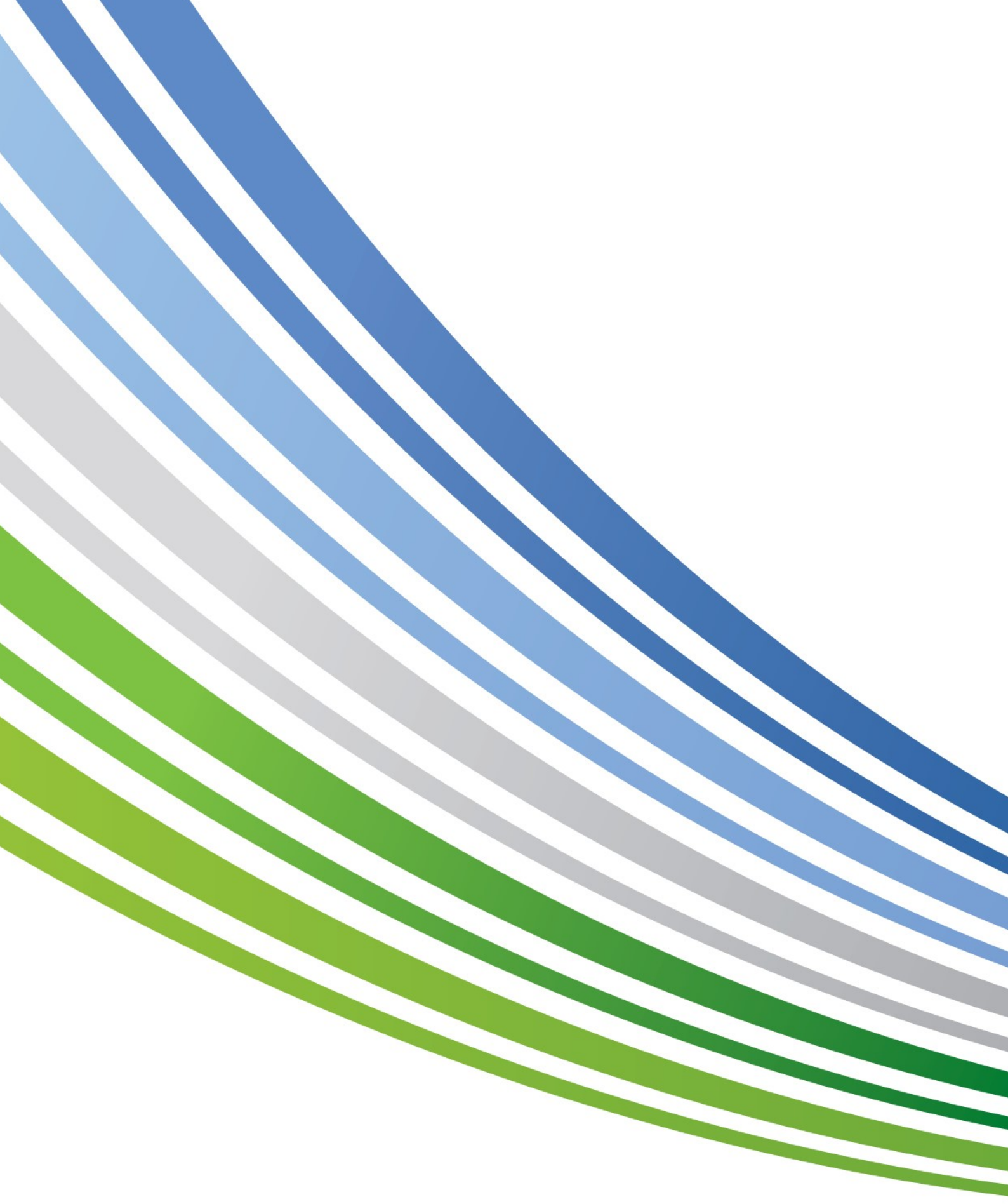
4. Changes to Transmission Losses Strategy

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

For the upcoming RIIO-T2, we have published our losses strategy[4] to support our "Network for Net Zero" vision, which has been accepted without any amendment in Ofgem's draft determinations[5] in Section 2.111 saying, "We are satisfied that if they implement their proposed losses strategies, the TOs will make a positive contribution to an efficient level of transmission losses, which we consider is in the interests of current and future consumers."

[4] https://www.ssen-transmission.co.uk/media/3750/losses-strategy.pdf

[5] https://www.ofgem.gov.uk/system/files/docs/2020/07/draft_determinations_-_et_sector_0.pdf



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