National Grid Electricity Plc

Special Condition 2K.4 – Transmission Losses Report

Reporting Period 1 April 2019 to 31 March 2020

Introduction

National Grid Electricity Transmission (NGET) has a licence obligation that, “On or before 31 October 2014 and for each subsequent year, unless the Authority directs otherwise, the licensee must publish an annual Transmission Losses report for the previous Relevant Year prepared in accordance with the provisions of this condition to be published on, and be readily accessible from its website, and to include in reasonable detail:

(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;

(b) a progress report on the implementation of the licensee’s strategy under paragraph 2K.2, including the licensee’s estimate of the contribution to minimise Transmission Losses on the licensee’s Transmission System that has occurred as a result; and

(c) any changes or revisions the licensee has made to the strategy in accordance with paragraph 2K.2 of this condition.

There is also the requirement, as part of SC2K.5 to include “a description of any calculations the licensee has used to estimate Transmission Losses on the licensee’s Transmissions System.”

As part of RIIO-2 development, this special condition will be removed. An updated strategy will be submitted to Ofgem to be implemented in RIIO-2. Reporting of losses will form part of the Annual Environmental Report in the next price control. Final guidance for the content of this report will be agreed as part of Final Determinations in December 2020.

2K.4 (a) Transmission Losses for this reporting period

Transmission Losses have been calculated for the 2019/20 financial year for the England & Wales system. The calculation is based on the latest applicable settlement metering available for generation, demand and Interconnector Balancing Mechanism Units, together with operational metering for the boundaries between the Scottish and England & Wales systems.

Overall the losses are calculated by taking the difference between the sum of infeed to and the sum of the offtakes from the transmission system. This is carried out using data from the Elexon SAA-IO14 data feed. This is then converted to a percentage using the total system infeed (generation).

Table 1 shows last year’s losses and the Table 2 shows historical losses for comparison purposes in order to see changes based on the losses strategy and changes to load and non-load related activities. The total overall GB loss for some of these historic years has changed slightly, as calculated purely from the sum of all BMU settlement metering (generation positive, demand negative), due to later settlement run data now being available. The data extracted from our systems now is slightly different from the earlier reports because more recent finalised settlement run data is available in our systems from Elexon's submissions to us. This means that the 2018/19 figure has also changed slightly this year now final settlement figures are available.

Table 1 – Losses from the England & Wales transmission system – 2019/20 reporting period		
	Loss (TWh)	Loss %
England and Wales (NGET)	5.675	2.24

Table 2 – Historical losses from the England & Wales transmission system – RIIO-T1 to date							
	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Loss (TWh)	4.566	4.578	4.598	4.033	4.422	4.577	5.675
Loss (%)	1.60%	1.64%	1.70%	1.49%	1.65%	1.76%	2.24%

This data is published on the ESO's website each month as part of their licence requirement for special condition 4I. https://www.nationalgrideso.com/balancing-data/monthly-transmission-loss-data-4l. It is not possible to quantify the exact causes for the increase in losses from 2018/19 to 2019/20 (4.577TWh to 5.675TWh). It can be seen from data from previous years that losses will vary from year to year due to various factors. However, as the largest increase over the T1 period, further analysis was carried out and the potential reasons for this increase were:

- Increased generation on the periphery of the system, predominately wind, combined with the steep decline of traditional sources especially coal, which tend to be at the heart of the network. Coal generation has reduced significantly and wind/solar is growing exponentially
- Quad boosters – it's difficult to measure their use as they are always 'on' but the extent to which they alter power flows can be configured at the ESO's discretion. There is also the counterargument that quad booster use can avoid/defer further transmission network investment, thereby potentially reducing losses.

Other underlying reasons for transmission losses include

- Operational measures are also taken to manage system compliance and security which may affect transmission losses.
- Reactive compensation equipment (MSCs, reactors, SVCs) all have resistive losses associated with their operation. However, they will also compensate for reactive power travelling on the OHLs from distant sources, they also have the effect of reducing losses by providing reactive power locally. It is not certain whether the total effect will be positive or negative because this can vary depending on system and contracted background.

National Grid's approach for the management of transmission losses remains unchanged from that outlined in the December 2013 published strategy document (as required by Special Condition 2K paragraph 2 of the Transmission Licence) and the subsequent update in October 2014. We are in the process of updating the strategy for RIIO-2 and the requirements of the Annual Environmental Report

In addition to ongoing network investment and to ensure effective and innovative future development of the network, National Grid is investigating new conductor types to install on the network which could provide benefits including increased capacity, reduced noise and reduced resistance. These conductors may be considered for use on the network in due course following R&D activities and Type Registration.

As more generation is being connected at the periphery of the network, the losses are expected to increase. Load losses do not linearly change with circuit loading, but are proportional to the square of the current carried. A particularly heavily loaded circuit in one year contributing significantly to the total losses may be less loaded the next year and have a much smaller proportion of the total losses. Local reactive support for voltage management also avoids the transmission of reactive power over distances that would otherwise increase system losses.

2K.4 (b) Progress on implementation of Transmission Losses Strategy for this reporting period

Information shown in this section is in the context of National Grid ESO operating the full GB system but NGET only owning and being responsible for the assets of the England and Wales transmission system.

National Grid's approach for the management of transmission losses remains unchanged from that outlined in October 2014 update to the December 2013 published strategy document. Utilisation of National Grid's Whole Life Value framework assists the selection of economically justified investments based on a broad range of investment criteria, including consideration of transmission losses. Where the Whole Life Value framework identifies that the cost of transmission losses is material to the investment decision and that sufficient certainty of future year-round transmission flows make the analysis worthwhile, then further detailed transmission loss assessments will be undertaken that quantify year-round transmission losses.

National Grid has been considering transmission losses in equipment specifications and procurement processes in line with this strategy prior to its launch, so non-load related investments delivered can be attributed to this strategy.

Transmission network developments that have passed or shall pass through the optioneering phase after National Grid's transmission losses strategy release in December 2013 (and subsequent October 2014 update) present the greatest opportunity for the consideration of transmission losses to influence the chosen investment solution. All schemes where optioneering has taken place since December 2013 (load and non-load) have been assessed under National Grid's Whole Life Value framework. Of these investment decisions, optioneering has identified that losses could be material to the investment decision in some instances.

In alignment with the Whole Life Value assessment, transmission losses have been considered for different transmission solutions. Studies concluded that under peak system conditions, investment solutions that employed a new circuit would experience up to a 25% reduction in losses on local transmission circuits, justifying a clear benefit for investment for system peak conditions to reduce losses.

As a result of the 2019/20 Network Option Assessment 5, the following schemes are being progressed by National Grid Transmission Owner which were identified as reducing losses on the system in the Transmission Strategy:

- Eastern Scotland to North East England (two options) HVDC connections
- East coast onshore 275kV upgrade and 400kV incremental reinforcement
- Power control devices on multiple transmission lines in England
- 225MVar MSCs in north east region and at Burwell Main
- Central Yorkshire reinforcement
- Series reactors at Thornton
- A new circuit between Bramford and Twinstead Tee
- Kemsley-Littlebrook reconductoring

The reconductoring works completed between Harker, Hutton and Quernmore Tee have increased transfer capability across B7 boundary and also reduced transmission losses due to the less resistive conductor type used. The same is also true for the reconductoring works completed on the Trawsfynydd-Treuddyn circuit. The new overhead line commissioned between Sellindge and Canterbury to facilitate the NEMO connection to Belgium also used the lower loss conductor type.

2K.5 Calculations used to estimate Transmission Losses

Two sources of losses occur on a transmission system; fixed and variable.

Fixed losses occur within the iron cores of transformers, cables and overhead lines whenever the circuit is energised. The magnitude of these losses is not dependent on the magnitude of the current being carried by the conductor but rather the magnetic field created by the applied voltage and the induced currents this creates within the iron core. As the voltage is more or less constant, these losses are also considered non-varying

Variable Losses are the “classic” losses which vary with the current carried by the conductor. These losses occur in cables, overhead lines and transformers and are dependent on the degree of resistive heating experienced. Losses in transmission systems are a function of the current carried by the conductors. The loss experienced in a conductor carrying alternating current is given by the equation I2R, where I is the current and R is the resistance of that conductor. This resistance causes energy to be absorbed by the conductor which results in the conductor heating up in the same way as an electric bar heater or the element in a kettle. This energy is lost to the surroundings. The resistance of an individual conductor is in turn a function of the materials used in its construction, how these are combined, and the length of the conductor. Multiple transmission system components can be considered as a single route with its own characteristics. In this way, the route that energy fed in to the north of Scotland takes to reach the demand centres in the south of England can be thought of as a very long conductor. As a longer length increases the overall resistance, and hence transmission losses, we can see that the location of generation infeed relative to demand will affect the level of transmission losses experienced.

The calculations outlined below show how the ESO estimates the overall Transmission Losses, taking into consideration the collection of metered information detailing the power flow onto and off the Electricity System.

$$\text{Losses} = \sum_{MWh>0} \text{MeteredOutput} + \sum_{\text{MWh}<0} \text{MeteredOutput}$$

$$BoundaryLosses(TWh) = \frac{\left(\frac{ConstrainedFlow}{100}\right)^2 \times kmWT \times R\% / km}{\frac{CCTWT}{CapWT}}$$

$$Annual\ MWh\,Losses = \frac{\left(\frac{(LoadLoss_{Old} - Load\ Loss_{New})}{\Delta} + (No\,LoadLoss_{Old} - No\,Load\,Loss_{New})\right) \times \frac{50}{52} \times 8760h}{1000}$$

$$\Delta = \frac{1}{(RMS\ average\ \ transformer\ loading)^2}$$

$$TotalLosses(TWh) = \left(\sum BoundaryLosses\,per\,boundary\right) + Load\,\text{Re}lated\,Losses + Fixed\,Losses$$