Network Loss Factor Methodology 2026

Date: 23rd January 2026

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1. Introduction

The Electricity Industry Participation Code requires that Electricity Distributors calculate and publish a loss factor for each loss factor code in the registry. As these loss factors are used by the Reconciliation Manager in allocating volumes of energy at Grid Exit Points to market participants, they are referred to in this report as reconciliation loss factors (RLFs).

This report presents the RLFs that should be applied to each customer's metered energy to recover upstream losses on Top Energy's Network (TEN) for the financial year 2024-2025. It also outlines the methodology, assumptions and data used for the calculation of the RLFs.

The methodology described in this report is based on the requirements set out in the Electricity Authority's "*Guidelines on the calculation and the use of loss factors for reconciliation purposes V2.3*[I]" issued on 26 June 2018.

Where half hourly revenue data is not available, SCADA data is used. To calculate the Technical Losses at each stage of the Network, DigSILENT PowerFactory was used. Top Energy's network model is detailed to the HV terminal of distribution transformers.

This Network Loss Factor Methodology is available from Top Energy's website at https://topenergy.co.nz/tell-me-about/top-energy-group/publications-and-disclosures

2. Background

Reconciliation Losses are the difference between the total energy injected into the network and the total energy withdrawn from the network at the consumer connection points. These can be measured directly using metering data and include both technical and non-technical losses.

Technical losses are a physical consequence of the transfer of electricity over the network. They occur over all parts of the network and vary with voltage, line length, conductor size and the amount of power being transferred. Technical losses form most of the total reconciliation losses and, while they cannot be measured directly, they can be estimated to a high level of accuracy through mathematical analysis and computer modelling of network performance.

The Guidelines discuss a range of ways in which technical losses attributable to consumers connected to the network can be disaggregated and therefore separately calculated. However, due to the vast number and significant diversity of the customers connected to the distribution network, it is not feasible to measure or calculate the losses caused by each individual customer and so some level of averaging is necessary. To this end, Top Energy generally disaggregates based on the voltage at which a customer is connected. Exceptions to this rule are large generators and loads connected to the Top Energy Network, which are treated as individually calculated customers and provided with site-specific loss factors.

Non-technical losses arise through metering errors, theft, and errors in the back-office processing of electricity accounts by retailers. There is no way they can be measured or directly estimated so they are normally derived by subtracting the estimated technical losses from the directly measured reconciliation losses.

I This document can be made available from http://www.ea.govt.nz/ This document contains detail requirements and criteria required by the Electricity Authority for loss factor calculation, methodologies, and processes.

An RLF is normally expressed as a multiplier and is used to estimate the total energy that needs to be injected into the network to produce the measured consumption at each ICP. The RLF is calculated as 1/(1-loss ratio) where the loss ratio equals the average proportion of losses over the network in the delivery of electricity from the point of injection to each metering point.

The non-site-specific loss ratios used to calculate the RLF's in this report are calculated for each voltage level. The RLFs representing the energy losses at each network voltage level are applied to the total energy delivered at that voltage level of the network, irrespective of whether the energy is delivered to consumers connected at that voltage or to consumers connected at a lower voltage.

3. Definitions and Abbreviations

EA Electricity Authority.

RLF Reconciliation Loss Factor.

Embedded Generation A generator which operates one or more generating units that are directly connected to a distribution network and injects energy into a distribution network.

SCADA Supervisory Control And Data Acquisition – SCADA systems are typically used to perform data collection and control at the supervisory level in a distribution network.

LLF Load Loss Factor – The LLF is the ratio between the instantaneous losses incurred at the peak load and the average instantaneous losses.

ICP Installation Control Point – An ICP is a unique number that identifies an individual power connection.

GXP Grid Exit Point

UF Utilisation Factor – Utilisation factor is the ratio of the maximum non-coincident kVA demand on the component to the rating of the component.

LV Low Voltage.

HV High Voltage.

TH Total Hours – Total number of hours in one year (8760 or 8784 in leap years).

THH Total Half Hours – Total number of half hourly recordings in one year.

Code The Electricity Authority's Electricity Industry Participation Code

Guidelines The Electricity Authority's Guidelines on the calculation and the use of loss factors for reconciliation purposes

4. Network Energy Losses

Network Energy losses are categorised mainly in three different categories as following:

4.1 Reconciliation Losses

The Electricity Authority's "*Guidelines on the calculation and the use of loss factors for reconciliation purposes V2.3*" recommends Reconciliation Losses to be calculated from the immediate past 12 months' energy injection and consumption information for an electrically connected network. To this end, in its annual review of loss factors Top Energy generally uses the 12 months from 1st September in the previous financial year to 31st August in the current financial year to calculate the loss factors for the following financial year. Where data is not available, for example for new connections, data is projected from what data is available and/or from other information known about the connection.

These losses are the difference between the energy delivered and the energy sold in the Top Energy Network. In calculating these losses, Top Energy accounts for the energy contributions from Transpower at the Grid Exit Point (KOE), as well as from the Ngawha Geothermal Power Station, which comprises two distinct sections: Ngawha A and Ngawha B. Ngawha A feeds into the sub-transmission level, whereas Ngawha B connects at the transmission level, each influencing the network's losses at different voltages. Moreover, the energy contribution from the solar farms located in the network's northern region are also factored into the loss calculations.

4.2 Technical Losses

Technical losses represent the electricity that is consumed during the delivery to customers' installations. There are two components of technical losses on a distribution network.

a. Load Losses: These losses depend on the quantity of electricity being supplied through the network. At any given time, these losses are proportional to the square of the current being supplied through the network equipment such as sub-transmission, distribution and LV lines, zone substation and distribution transformers. These losses are also known as copper losses or I^2R losses.

b. No-load Losses: These losses are constant and do not depend on load. These losses arise from the standing or iron losses of the network transformers (both zone substation and distribution transformers).

Losses at peak demand are calculated on the relevant part of the network using Top Energy's DigSILENT PowerFactory load flow package. The associated total energy losses over a twelve-month period were calculated applying an appropriate Load Loss Factor[ii] (LLF) as follows:

$$\text{Load Energy Losses (kWh)} = \text{Load Losses at Peak Demand (kW)} \times \text{TH (hrs)} \times \text{LLF} \qquad (i)$$

The LLFs for TE's Network and site-specific industrial customers were calculated using 2024-2025 actual metered data.

[ii] Load Loss Factor is explained in detail in Section 5

The No-load Losses for substation transformers were obtained from manufacturer's data and test sheets. The associated energy losses are calculated as follows:

No-Load Energy Losses (kWh) = No-Load Losses (kW) x TH (hrs)

(ii)

The LLF was not applied to No-load Losses as these losses are not dependent on transformer loading and do not vary with time. The No-load Losses are multiplied by total hours to calculate the no-load energy losses over the one-year period.

The No-load Losses for distribution transformers were calculated in a similar manner to substation transformers by applying equation ii, using the No-load Losses supplied by the manufacturer. However, as distribution transformers are not currently modelled in DIgSILENT a different approach was used to calculate the distribution transformer load losses.

Manufacturers' data provides the load loss when a transformer is operating at its rated load. The actual distribution transformer peak load losses were assessed by applying a UF, and a LLF was then applied to convert this to annualised energy losses.

Using this data, the annualised load energy losses associated for each type of distribution transformer can be calculated using Equation iii:

Load Energy Losses (kWh) = Load Losses (kW) at Max. Rating x (UF (%)^2) x LLF x TH (hrs)

(iii)

4.3 Low Voltage (LV) Network and Non-Technical Losses

Non-technical Losses are the difference between Reconciliation Losses and Technical Losses for the entire network. These losses include unaccounted energy due to theft, meter inaccuracy and minor billing errors.

Due to the nature of the of LV network, its low level of loading and the extensive modelling data that would be required, it is impractical to calculate the LV network's load losses using load flow studies with a high level of accuracy. With such limitations, Top Energy does not separately calculate LV network losses but includes them in its derivation of non-technical losses (which are derived by subtracting high voltage and distribution transformer technical losses from the total measured reconciliation losses). The approach is valid if it is assumed that Non-technical Losses primarily occur at LV level. This applies to the Top Energy network, where only three large consumers are metered at 11kV or above. Hence Non-technical Losses are only allocated to LV network consumers.

LV and Non-technical Energy Losses = Reconciliation Losses – Total Upstream Technical Losses

(iv)

Top Energy has analysed this approach and compared it with what is recommended in the Electricity Authority Guidelines, concluding that the use of the recommended approach would not materially impact the RLFs applied to any ICP.

5. Load Loss Factor

The LLF is the ratio between the average instantaneous losses over a 12-month period, and the instantaneous losses incurred at the peak load during the same period. It is proportional to the square of the load and expressed as:

$$LLF = \sum_{n=1}^{THH} \left(\frac{Load^2_n}{PeakLoad^2} \right) / THH$$

(v)

Where: $Load_n$ = the 30-minute average load in the nth period
THH = the number of 30-minute load recordings in one year
Peak load = the highest 30-minute average load in one year

For the network LLF, a single value has been applied across all parts of the network, excluding distribution transformers. This LLF was calculated using the metered data for the past 12 months, including power injected at the Kaikohe Grid Exit Point from both the grid, solar farms and Ngawha power stations. A separate LLF is calculated for JNL as a site-specific industrial customer, using JNL's half-hourly metering data. Separate LLFs were also applied to distribution transformers as described in section 6.6.

A sensitivity test has been undertaken to assess the impact of applying different load factors across a feasible range and found that most material relative impact on calculated RLFs was under 0.6% and most were under 0.25%. Based on these findings, Top Energy is confident that using a uniform load factor across the entire network, excluding distribution transformers, is an effective approach.

6. Load Loss Factor

Figure 1 represents the application of the RLFs at different network stages. This figure does not include the application of any site-specific ICP.

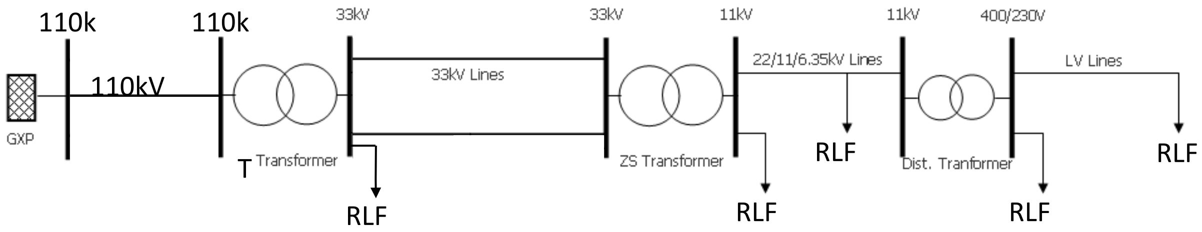

Figure 1: RLF Application at Different Network Stages

6.1 **Reconciliation Loss Factor**

The Reconciliation Loss Factor for the entire network is calculated using Equation vi

$$\text{RLF R} = 1/\left(1-\left(\frac{\text{Reconciliation Losses (kWh)}}{\Sigma\ \text{Energy Injected (kWh) for Entire Network}}\right)\right)$$

(vi)

Where Reconciliation Loses are the measured losses on the network over a twelve-month period and the total energy injected is the metered injection over the same period.

As indicated in Figure 1, loss factors can be calculated in a similar way for different network segments where the losses are the calculated losses for that segment and the energy injected refers to the energy injected into a particular segment. Calculation of the losses for each network segment is discussed further below. The energy injected is equal to the energy injected into the entire network, less calculated upstream losses, less energy supplied to customers directly connected at an upstream voltage.

The cumulative RLF at any network voltage level is the product of all upstream RLFs.

6.2 **Transmission (110kV) Losses**

Transmission losses are distributed evenly among all consumers, including those in the southern region. However, the losses at the Kaikohe transmission substation warrant special attention due to the influence of the Ngawha Power station and its high load factor. When Ngawha A is operational, its output typically feeds directly into the Kaikohe 33kV network, bypassing the Kaikohe 110kV transformers. On the other hand, Ngawha B connects to the 110kV busbar at Kaikohe, so the load and no-load losses on the Kaikohe transformers are considered.

To determine the load losses of the Kaitaia substation and the KOE-KTA 110kV line, load flow analyses were performed for the individual peak periods of the Southern/Eastern and Northern networks. These analyses utilized the network LLF, as outlined in Section 5, and the energy losses were computed using Equation (i).

6.3 **Sub-transmission Network (33kV line) Losses**

Specific load flow studies for the northern and southern 33kV networks were implemented to calculate the Load Losses in 33kV lines at peak demand. The actual peak demand for each 33/11kV substation was used.

The TE network LLF described in section 0 is applied to the Load Losses of the 33kV lines supplied from each transmission substation, thus calculating associated energy losses as per Equation i. In calculating the sub-transmission RLF an adjustment was made to remove the losses attributed to JNL in the calculation of JNL's site specific loss factor.

6.4 **Zone Substation Losses**

Zone substation models are developed, and load flow studies were carried out using the peak demand for each 11kV distribution feeder to obtain the Load Losses at peak demand.

The TE network LLF described in section 0 is applied to zone substation Load Losses to calculate associated energy losses.

The No-load Losses for all zone substation transformers are obtained from manufacturer's data sheets. Energy losses associated with No-load Losses of the zone substation transformers are calculated as per Equation ii.

6.5 **Distribution Network (22/11/6.35 kV Line) Losses**

Top Energy's Distribution Network, modelled using GIS data, includes detailed feeder backbone models starting from the 11kV bus at each zone substation and encompasses 2-wire and SWER lines with isolating transformers. For simplicity, all spur lines less than 500m are excluded and modelled as lump loads on the distribution feeder backbone. Load flow studies, based on 2012 peak demand data, have been used to obtain Load Losses.

All distribution data is currently being updated into DIgSILENT PowerFactory. This process is not yet finalized. Calculation have shown to be sufficiently accurate when comparing metered versus calculated (using the loss factors) energy injection into the network.

6.6 **Distribution Transformer Losses**

The rated Load and No-load Losses incurred in distribution transformers were obtained from Manufacturers' data sheets. Average losses are calculated for transformers including SWER isolating transformers categorized by type and size.

The number of transformers of each size is obtained from Top Energy's GIS database as disclosed in Top Energy's Asset Management Plan.

The Utilisation factors (UF) and LLFs used to calculate transformer load losses are based on the factors recommended in the *Guidelines on the calculation and use of loss factors v2.3*. The energy losses for the Load and No-load Losses are calculated using formula iii.

6.7 Low Voltage Network Losses

The RLF at LV Network level is calculated using energy losses obtained as per sub-section 4.3.

6.8 Low Voltage Embedded Generator Losses

An RLF equal to the TLF for general consumption to embedded generators less than 1MW, as these are generally connected to the LV network and have export peaks of similar size to the import peaks at the same location, with these export peaks not co-incident with the load peaks of other customers.

<table>
<tr><th>Loss Type</th><th>Losses Applied to</th><th>Load Losses</th><th>No-Load Losses</th></tr>
<tr><td>Reconciliation Losses</td><td>Entire Network</td><td colspan="2">Total Network Injection - Total Network Consumption</td></tr>
<tr><td rowspan="5">Technical Losses</td><td>Transmission (110kV)</td><td rowspan="4">Using DigSilent PowerFactory Simulation</td><td>Using Manufacturer's Data sheet and Test sheets</td></tr>
<tr><td>Sub-Transmission Network (33kV Lines)</td><td>N/A</td></tr>
<tr><td>Zone Substation</td><td>Using Manufacturer's Data sheet and Test sheets</td></tr>
<tr><td>Distribution Network (22/11/6.35kV Lines)</td><td>N/A</td></tr>
<tr><td>Distribution Transformers</td><td>Using Transformer count, % Utilisation Factor, Manufacturer's Data sheets, Appendix C of Draft Guidelines 2013</td><td>Using Manufacturer's Data sheet and Test sheets</td></tr>
<tr><td>LV and Non-Technical Losses</td><td>LV Network</td><td colspan="2">Reconciliation Losses – Total Upstream technical losses.</td></tr>
</table>

7. Site Specific Loss Factors for Large Loads

The Guidelines provide for site-specific RLFs to be calculated for large loads.

Top Energy calculates a site-specific RLF for the Juken Nissho lumber mill near Kaitaia (JNL). Due to the low level of annual consumption of the AFFCO plant near Moerewa, the cumulative RLF corresponding to the location of the metering point on the network (RLF B), is applied to this customer.

The site-specific loss factor for JNL is determined using the pro-rated peak demand method as follows:

RLF_A is the same for JNL as for all other consumers, consistent with Top Energy's decision to allocate transmission losses across all consumers based on total consumption.

Technical losses on the sub-transmission network at peak load were determined for each network segment used to supply power to the mill. These are the 33kV lines between Kaitaia and the mill and the JNL zone substation transformers. The peak losses on each segment attributable to the mill have been estimated by pro-rating these losses based on the ratio of mill load to the total load on the segment. Annualised losses at each network level attributable to the mill are calculated using the mill's actual LLF.

No load losses on the NPL zone substation transformers have also been attributed to the mill by pro-rating annual no-load losses on each transformer by the ratio of the peak load attributable to the mill and the peak transformer load.

The sub-transmission RLF for the mill was then calculated using the equation i. This was multiplied by RFL_A to obtain the site specific RLF for JNL; this ensured the transmission losses are included.

The sub-transmission losses attributable to the mill are subtracted from the calculated technical losses of each sub-transmission network segment before calculating the sub-transmission network loss factor to avoid double counting.

8. Site Specific Loss Factors for Large-Scale Embedded Generation

The Code requires that a unique loss category code with a site-specific loss factor be applied to embedded generators of 10MW or more connected to a distribution network. To this end, Top Energy, in accordance with the Guidelines calculates site specific loss factors for these sites based on incremental impact.

In calculating the incremental impacts, the standard process outlined in the Guidelines has been followed, using 15th, 60th & 95th percentile generation and load values, with half-hour scenarios correlated and compared.

To simplify calculations the following assumptions have been made:

- It is assumed that generation at the three northern-area solar farms is broadly co-incidental so that the same scenario weightings can be used for all three in calculations of their incremental impact and the incremental effect of these farms generating at the same time is equitably represented.
- It is assumed that generation at the 33kV-connected Ngawha A geothermal plant is broadly co-incidental with generation at the 110kV-connected Ngawha B geothermal plant, and the same scenario weightings used.
- When the generators in one “co-incidence group” are under consideration, the generators in the other group are considered to be generating at median. This is considered fair as the periodicity of solar generation is over a 24-hour diurnal cycle, whilst geothermal generation is more constant, with the majority of variation occurring over an annual cycle. The changes in output from the two types of generation are therefore largely not co-incidental.

The losses on the network in each of the nine generation/load scenarios are then determined using DIgSILENT PowerFactory with each generator turned off and on then time-weighted according to the half-hourly correlation data. These losses are then input into calculations with time-weighted generation to determine the relevant loss factors and loss ratios, as outlined in the Guidelines.

9. Compliance Requirements

Once RLFs are calculated and applied to appropriate voltage level, the distributor must submit to the Electricity Authority its proposed loss factors for the next financial year, prior to 1 April of each year regardless of whether there is any change from the previous financial year, allowing two months notification of any changes. Moreover, a report detailing loss factor calculation methodology and the detailed RLF/Reconciliation Losses for each voltage level shall be prepared for the submission to the Electricity Authority as per the requirement specified in the Electricity Authority's Guidelines.

Top Energy undertakes an annual review of its loss factor calculations to consider new information and changes on the Network.

Approvals

REVIEWED BY:	Nishan Sooknandan Planning Manager	Date: 23/01/2026
APPROVED BY:	Claire Picking General Manager	Date: 23/01/2026

Version History

VERSION	APPROVED BY	DATE
1.0	General Manager	Jan/2013
2.0	General Manager	Jan/2018
3.0	General Manager	Jan/2024
4.0	General Manager	Jan/2026

Version Change Table

VERSION	PAGE	CHANGED BY	DESCRIPTION OF CHANGE
3.0	All	Carlo P	PowerFactory Model Updated; Recalculation of Loss Factors Completed; Kaitaia Solar Farm Included.
4.0	All	Mark D	Updated to outline site-specific loss factors and for general clarity.