Distribution Loss Factor Calculation Methodology

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TasNetworks acknowledges the palawa (Tasmanian Aboriginal community) as the original owners and custodians of lutruwita (Tasmania). TasNetworks, acknowledges the palawa have maintained their spiritual and cultural connection to the land and water. We pay respect to Elders past and present and all Aboriginal and Torres Strait Islander peoples.

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Contents

1. Introduction

Network losses are electrical energy (active energy) losses incurred in transporting electricity over transmission and distribution networks. Electrical energy losses associated with a distribution system can be classified as losses comprising:

- Technical losses associated with the flow of electricity and the resistance of the electrical circuits (series losses);
- Technical losses associated with "leakage" of electrical energy associated with "charging up" or "excitation" of the network and occur regardless of the amount of electrical power flowing through the network (shunt losses);
- Non-technical losses due to metering data errors, un-metered supply estimation errors, unbilled customers, billing anomalies, information system deficiencies and theft.

Distribution Loss Factors (**DLFs**) are calculated annually by Distribution Network Service Providers (**DNSPs**) in accordance with the requirements of the National Electricity Rules (the Rules) to determine the average electrical energy losses attributable to a distribution network in conveying electricity from a transmission network connection point (**TNCP**) or virtual transmission node to a distribution customer connection. These loss factors account for both technical and non-technical losses.

DLFs are used in the National Electricity Market for several purposes, including;

- During dispatch, to reflect the relative losses of different market participant generation and loads (as applicable) when considering the economic dispatch of resources to meet supply and demand in each trading interval; and
- During settlement, as a notional adjustment to the electrical energy flowing at a connection point, to determine the adjusted gross energy at the connection point in each trading interval.

This document set outs TasNetworks' methodology for calculating DLFs. This document is published on TasNetworks' website at www.tasnetworks.com.au/Planning-our-network and made available upon request to interested persons.

2. Requirements of the National Electricity Rules

TasNetworks has developed this methodology consistent with clause 3.6.3 Distribution Losses in the Rules[1]. The Rules are not prescriptive, and TasNetworks' approach is consistent with the principles described, provides a fair and equitable result, and is consistent with ensuring that the application of DLFs results in all energy losses being accounted for and recovered by affected parties in the market.

Annex A: Requirements of the National Electricity Rules lists the requirements of the Rules and the section of TasNetworks methodology that addresses the requirement.

3. Methodology

At the time of publication, the AER has not published a methodology for the determination of DLFs, and therefore, TasNetworks has published this methodology as required by clause 3.6.3(g)(2). It conforms to the principles described in clause 3.6.3 of the Rules.

[1] NER Rule 3.6: Network Losses and Constraints - AEMC Energy Rules

Clause 3.6.3(b)(1) of the Rules states "Distribution loss factors notionally describe the average electrical energy losses for …the financial year in which they apply". Accordingly, TasNetworks uses forecast network flows in the network analysis used to derive DLFs, with forecasts determined for each network level and asset as appropriate.

Consideration of future trends in network losses also includes changes in load patterns including embedded generation penetration, power factor and network configuration and expansion. Equipment utilisation changes, asset replacements, development of new sub-transmission, zone substations, and HV distribution all are considered when determining the DLFs.

This methodology is consistent with these non-prescriptive principles and aims to provide a fair and equitable result consistent with ensuring that the application of DLFs results in all energy losses being accounted for and recovered from the relevant distribution customers.

3.1. Average DLF Calculations

The method of calculating average DLFs is based on Rules clause 3.6.3(b)(2). TasNetworks' DLF average methodology encompasses one state-wide region for all its DLF calculations across six network levels.

The network levels (voltage classes) are classified as shown in Table 1.

Table 1: Network Levels and DLF Codes

Network Level and DLF Code	Voltage Level	Description
PATR	44 kV, 33 kV, 22 kV or 11 kV	Direct connection to transmission network connection point at a distribution voltage level
PAST	44 kV or 33 kV	Connection to sub-transmission lines that emanate from transmission connection points or interconnect between zone substations
PAZN	22 kV or 11 kV	Direct connection to zone substation
PAHV	22 kV or 11 kV	Connection to high voltage distribution feeder that emanates either from a transmission connection point or a zone substation
PADS	400 V	Direct connection to distribution substation
PALV	400 V or 230 V	Connection to low voltage lines that provide reticulation to customer premises.

The volume-weighted average DLF calculations of the average electrical energy losses are conducted at each of the network levels in accordance with clause 3.6.3(b)(2)(ii) of the Rules.

TasNetworks uses the following approaches in its calculation of average DLFs:

- Root Mean Square Demand; and
- Half-hourly loading.

TasNetworks calculates average losses for each network level using the most appropriate of these approaches for the various network level components. All approaches utilise forecast load and generation data for the year in which they apply, with the network levels modelled in load flow software to calculate losses. When calculating losses, at each network level, when actual transformer impedance data is unavailable, typical transformer impedance values are used to account for copper and iron losses.

A DLF is calculated for each network level, and customers are allocated the appropriate DLF for the network level to which their electrical installation is connected. The DLF categories relating to the six network levels are shown in Table 1 and the calculations that determine each DLF are shown in Annex B: Average DLF Calculations.

The DLF_{PALV} for customers connected to a low voltage line at 230/400 V is determined differently to the remaining DLFs. All losses not allocated to one of the other network levels or to site-specific customers are allocated to this network level. This ensures that forecast energy purchases are equal to the sum of energy sales multiplied by DLF at each level of the network. This reflects the complex and varied nature of low voltage systems across TasNetworks which cannot be readily modelled to allow a more specific calculation of losses attributable to low voltage lines.

TasNetworks reports its overall distribution network losses in its annual Regulatory Information Order response. This value is used in calculated the expected total system losses in the forecast year.

3.2. Site Specific Customer Connection Points

The method for calculating site-specific DLFs is based on Rules clause 3.6.3(b1) that requires the application of average electrical energy loss. TasNetworks uses the following approaches in its calculation of site-specific DLFs:

- Root Mean Square Demand; and
- Half-hourly loading.

TasNetworks calculates average losses for each site-specific customer using the most appropriate of these approaches. All approaches utilise forecast load and generation data for the year in which they apply, with the site-specific connection points modelled in load flow software to calculate losses. When calculating losses for SSCs, when actual transformer impedance data is unavailable, typical transformer impedance values are used to account for copper and iron losses.

It is also necessary to allocate network losses between site-specific customers and other customers in a shared system. To achieve this, the methodology is as follows:

- The losses on each segment of the network due to all listed specific customers is aggregated and subtracted from the total calculated network losses on each segment of the network;
- All site-specific customer sales in each segment of the network are aggregated and subtracted from the total network sales on each segment of the network; and
- The balances in the network losses and sales are then used to determine the volume weighted average DLFs for general users.

3.3. Reconciliation of Energy and Losses

TasNetworks undertakes a reconciliation of the energy entering its network (from TNCPs and embedded generation) and energy exiting its network (through sales to end customers) for the previous financial year as required under clause 3.6.3(h)(2) of the Rules.

This reconciliation applies the relevant DLFs to the metered energy exiting the network (to account for system losses from demand), the relevant DLFs to metered energy entering the network (to account for system losses from embedded generation) and compares it against the metered energy entering the distribution network at TNCPs. This reconciliation (amongst other things):

- Determines the reconciliation error for the stated financial year;
- Determines if losses were over or under-recovered in the financial year; and
- Allows investigation of any anomalies identified during the reconciliation process.

TasNetworks strives to keep reconciliation error (as a percentage of both purchases and sales) as low as possible and considers it against a materiality threshold to determine if further investigation into the calculated reconciliation error is required.

3.3.1. Relationship of DLFs to Adjusted Gross Energy

Clause 3.6.3(b)(3) of the Rules provides that DLFs must be applied in the settlement process as a notional adjustment to the electrical energy (in MWh) flowing at a distribution network connection point during a trading interval. This is used to determine the Adjusted Gross Energy (**AGE**) for that connection point in accordance with clause 3.15.4, which includes unaccounted for energy (**UFE**).

Additionally, clause 3.6.3(h)(1) requires that the aggregate of adjusted gross energy (as defined in clause 3.15.4) should closely equal the sum of energy flowing at connection points and losses in the network in the forecast financial year. The mathematical equations which support the calculation of AGE are included in Annex C.

Clause 3.15.4 is administered by AEMO as part of the market settlement process. AEMO calculates the AGE and UFE amounts allocated to each retailer as part of the settlement process. As AGE and UFE are calculated ex post and DLFs are calculated ex ante, TasNetworks aims to calculate DLF values using forecast metered energy and losses in the network such at all losses are accounted for i.e. the total UFE over a financial year is as close as possible to zero.

3.3.2. Relationship between reconciliation error and UFE

UFE is calculated on a per trading interval basis, considering the energy flowing at each TNCP and the aggregation of downstream metered energy flows (i.e. either energy consumption or generation quantities) multiplied by the relevant DLF(s). UFE is the difference between the flows at the TNCP and the sum of all other metered quantities multiplied by the relevant DLF(s). As DLFs are calculated as an average loss factor, on an annualised basis, their accurate representation of actual losses, in a specific trading interval may be imperfect.

The calculation of both UFE and the reconciliation error rely upon the application of DLFs to metered energy quantities, and the summation of all UFE for all dispatch intervals should be broadly consistent with the determined reconciliation error. In practice these two values will unlikely achieve perfect alignment due to metering data errors, profiling of reads to the trading interval (5 minute) level, un-metered supply estimation errors, unbilled customers, billing anomalies, information system deficiencies and theft (i.e. non-technical losses). As described in section 3.3.1, TasNetworks aims to derive DLF values such that UFE equals zero.

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TasNetworks understands the impacts UFE can have on different market participants and subject to a materiality threshold will determine if further investigation into differences between UFE and the reconciliation error is required.

4. Independent audit verification

Clause 3.6.3(i) of the Rules states that DNSPs must obtain approval from the AER for the distribution loss factors it has determined for the forthcoming financial year, then provide these to AEMO for publication by 1 April each year. TasNetworks has processes in place to conform with these requirements, including independent verification by an external auditor to further-validate DLF results.

Annex A: Requirements of the National Electricity Rules

Rule	Description	Section reference
3.6.3(i)	Each year the DNSP must determine the distribution loss factors to apply in the next financial year in accordance with 3.6.3(g) and provide these to AEMO for publication by 1 April. Before providing the distribution loss factors to AEMO for publication, the DNSP must obtain the approval of the AER for the distribution loss factors it has determined for the next financial year.	3/4
3.6.3(b)(1)	Requires the calculation of a site specific DLF where connected party meets the reasonable cost of the DNSP in performing the necessary calculation.	3
3.6.3(b)(2)	Clause 3.6.3(b)(2) requires that DLFs will be either site specific for certain types of connection points described in clauses 3.6.3(b)(2)(i)(A) and (B). Alternatively, they are based on network average DLFs based on voltage or connection point classes[2] (average DLF) as defined in clauses 3.6.3(c), (d), (e) and (f).	3.1
3.6.3(g)	Requires that DLFs must be determined for all connection points either: • individually, for all connection points assigned to a single TNCP; or • collectively, for all connection points assigned to a TNCP or a virtual transmission node and a particular distribution network connection point class	3
3.6.3(h)	Requires that the methodology to calculate DLFs to apply in the coming financial year must be developed having regard to principles; summarised as: • the aggregate of all the adjusted gross energy[3] amounts for a distribution network should equal, as closely as is reasonably practicable, the sum of: o the aggregate of electrical energy flowing at all connection points in the distribution network; and	3.2/3.3

[2] NER clause 3.6.3(b)(2)(ii) DLFs will be derived using the forecast volume weighted average of the average electrical energy loss between the transmission network connection point or virtual transmission node to which it is assigned and each distribution network connection point in the relevant voltage class.

[3] 'adjusted gross energy' as defined in clause 3.15.4 includes a term unaccounted for energy (UFE).

- the total "actual" electrical energy losses incurred on the distribution network;

- being able to demonstrate the extent to which the objective above has been achieved through a reconciliation based on the previous financial year's actual results;
- for non-site-specific connection points, determining the DLF by using a volume weighted average of the average electrical energy loss between the transmission network connection point or virtual transmission node to which it is assigned and each distribution network connection point in the relevant class of distribution network connection points;
- for site specific connection points, determining the DLF by reference to the average electrical energy loss between the distribution network connection point and the transmission network connection point to which it is assigned;
- using the most recent actual load and generation data available for a consecutive 12-month period to determine the average electrical energy losses referred to above, adjusted if necessary to consider projected load and or generation growth in the financial year in which the distribution loss factors are to apply; and
- treating flows in network elements that solely or principally provide market network services as invariant. It is noted that in 2026 this principle is not relevant to the distribution network in Tasmania.

Annex B: Average DLF Calculations

The mathematical equations used to calculate the DLFs for the six network levels are shown below.

- $PATR: DLF_{PATR} = 1$
- PAST: $DLF_{PAST} = 1 + \frac{\sum(Subtrans\ network\ losses) - \sum(Subtrans\ losses\ due\ to\ SSCs)}{\sum(Sales\ through\ Substrans\ network) - \sum(Sales\ to\ Subtrans\ connected\ SSCs)}$
- PAZS: $DLF_{PAZS} = 1 + \frac{\sum(Subtrans + Zone\ Tx\ losses) - \sum(Subtrans + Zone\ Tx\ losses\ due\ to\ SSCs)}{\sum(Sales\ through\ Substrans + Zone\ Txs) - \sum(Sales\ to\ Subtrans + Zone\ Tx\ connected\ SSCs)}$
- PAHV: $DLF_{PAHV} = 1 + \frac{\sum(Subtrans + Zone\ Tx + HV\ network\ losses) - \sum(Subtrans + Zone\ Tx + HV\ network\ losses\ due\ to\ SSCs)}{\sum(Sales\ through\ Substrans + Zone\ Txs + HV\ network) - \sum(Sales\ to\ Subtrans + Zone\ Tx + HV\ connected\ SSCs)}$
- PADS: $DLF_{PADS} = 1 + \frac{\sum(Subtrans + Zone\ Tx + HV\ network + LV\ subs\ losses) - \sum(Losses\ due\ to\ SSCs)}{\sum(Sales\ through\ Substrans + Zone\ Txs + HV\ network + LV\ subs) - \sum(Sales\ to\ SSCs)}$
- PALV: DLF_{PALV} is the distribution loss factor to be applied to customers connected to a low voltage line at 230/400 V. All losses not allocated to one of the other network levels or site-specific customers are allocated to this network level. This ensures that forecast energy purchases are equal to the sum of energy sales times DLF at each level of the network. This reflects the complex and varied nature of low voltage systems across TasNetworks which cannot be readily modelled to allow a more specific calculation of losses attributable to low voltage lines.

Annex C: Adjusted Gross Energy Calculations

Clause 3.15.4 defines

$$\mathrm{AGE} = \mathrm{ACE} + \mathrm{ASOE}$$

where AGE is adjusted gross energy, ACE is adjusted consumed energy and ASOE is adjusted sent out energy. Further,

$$\mathrm{ACE} = (\mathrm{ME}^{-} \times \mathrm{DLF}) + \mathrm{UFEA}$$

where ME- is the metered energy flowing away from the TNCP, DLF is the calculated DLF and UFEA is the share of unaccounted for energy allocated to that market connection point under clause 3.15.5. Finally,

$$\mathrm{ASOE} = (\mathrm{ME}^{+} \times \mathrm{DLF})$$

where ME- is the metered energy flowing away from the TNCP and DLF is the calculated DLF

Clause 3.15.5 defines

$$\mathrm{UFE} = \mathrm{TME} - \mathrm{DDME} - \mathrm{ADME}$$

Where UFE is unaccounted for energy, TME is TNCP metered energy, DDME is inter-distribution network metered energy and ADME is aggregate distribution metered energy. Further,

$$\mathrm{ADME} = \sum[(\mathrm{ME} -* \mathrm{DLF}) + (\mathrm{ME} +* \mathrm{DLF})]$$

and, since TasNetworks' distribution network does not have any connections to other DNSPs. We can write:

$$\mathrm{DDME} = 0$$

So:

$$\mathrm{UFE} = \mathrm{TME} - \sum[(\mathrm{ME} -* \mathrm{DLF}) + (\mathrm{ME} +* \mathrm{DLF})]$$

Since the aim of the DLF calculations is to derive DLF values such that UFE equals zero

$$\mathrm{TME} = \sum[(\mathrm{ME} -* \mathrm{DLF}) + (\mathrm{ME} +* \mathrm{DLF})]$$

DLFs for the forecast financial year are calculated to ensure this equation holds true based on forecast metered energy and losses in the network.

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