ENERGEX's Distribution Loss Factor Methodology

Introduction

Section 3.6.3 of the National Electricity Rules (NER) requires that Distribution Network Service Providers each year calculate Distribution Loss Factors (DLFs) for their networks. Distribution Loss Factors (DLFs) are defined in the National Electricity Rules as a notional description of the average electrical energy losses incurred by the transmission of electricity on a distribution network between the Transmission Network Connection Point (TNCP) and the Distribution Network Connection Point (customer's point of connection) for the financial year period. They are used in the settlement process as a notional adjustment the electrical energy metered at the distribution network connection point (customer billed energy) to the gross energy purchased at the transmission network connection points.

Methodology

In broad terms, the Rules require that site-specific DLFs are calculated for:

- embedded generators with greater than 10 MW of generation;
- all customers of greater than 10 MW demand or 40 GW.h annual consumption i.e. Individually Calculated Customers (ICCs); and
- generators of less than 10 MW or 40 GWh per annum capacity where the Generator meets reasonable costs for ENERGEX to perform the necessary calculations.

DLFs for all other customers may be calculated on an average basis, which effectively means determining DLFs for each voltage level of the network.

The methodology used by ENERGEX involves a full recalculation of all DLFs (both average and site specific) every three years. In the intervening years, site specific DLFs are calculated, but all average DLFs are simply reviewed, based on allocation of network losses in the same proportions as was determined at the last full recalculation.

The annual DLF review also requires that a reconciliation of the previous year's calculated distribution loss factors be completed. The DLFs of the previous financial year are used to calculate the losses on the distribution network for that year. These are then compared to historical metered data and reasons for discrepancies are explained/reconciled.

Site Specific Customer Calculations

Regardless of whether a full re-calculation of DLFs is being undertaken (every third year), or only a review, the methodology for determining DLFs for Site Specific Customers is identical.

Site specific DLFs are calculated using load flow analysis based on the customers forecast demand data and network load data for the year in which the DLFs are to be applied. The analysis involves load flow studies on the directly connected network between the customer connection point and the transmission network connection point. The directly connected network is defined as all network which will experience a change in power flow due to a change in customer loads. In addition, iron losses of the transformers included in the directly connected network are calculated and apportioned based on the ratio of customer load and network load flowing through the transformer.

ENERGEX uses the Marginal Loss Factor methodology to calculate site specific DLFs. This process involves determining the losses for the customer by assessing the relativity between the change in system load associated with a change in the customer's load.

Calculation of Average Loss Factors (for full recalculation)

Average DLFs are calculated for each significant supply level in the network, with DLFs for major customers being calculated individually in order to determine the losses directly attributable to their loads (as discussed above).

The average DLF categories applied by ENERGEX are:

- 132/110 kV Network;
- 33 kV Network;
- 11 kV bus;
- 11 kV line;
- LV bus; and
- LV line

The method used to calculate average DLFs is to carry out a series of load flow studies to determine the losses at the coincident network peak, followed by the application of calculated Loss Load Factors (LLFs) to obtain the actual losses.

The transmission and subtransmission systems are modelled using appropriate load flow packages. Losses on the 11 kV distribution system are calculated using forecast feeder peak demand data and feeder length data which is obtained from ENERGEX's corporate database. Losses at the LV bus are calculated based on the average impedance of distribution transformers, and losses in the LV network are calculated as the difference between the total losses (calculated by the difference between total purchases and total sales), and the losses resulting from the higher voltage network studies.

The DLFs for the network are then calculated based on the formula:

$$\text{DLF} = \frac{\text{Losses (GW.h) for section of Network - ICC Losses}}{\text{Sum of sales (GW.h) for all sectors downstream and including that sector (excluding sales to ICCs)}}$$

1.1 Calculation of Loss Load Factors

Loss Load Factors (LLFs) are calculated based on load duration curves, which are computed from half-hour average demands over a full year. The Load duration curve is squared and then averaged to obtain the LLF. The LLFs are then applied to the losses calculated at peak demands to determine the actual losses.

1.2 Transmission (132 and 110 kV) Network

Load flow studies are carried out down to the 33 kV or 11 kV busbar at all bulk supply points and direct transformation substations. The 132/33 kV, 110/33 kV, 132/11 kV and 110/11 kV transformer losses are subtracted from the transmission system losses. Losses calculated by these studies are converted to annual energy losses using the loss load factor for the system under consideration. The sum of the annual energy losses for all Transmission Network Connection Points (TNCPs) excluding ICC losses are then divided by the sum of all non-ICC energy sales through the 132 & 110 kV networks to obtain the DLF, viz:

$$\text{Transmission Average DLF} = \frac{\sum \text{Losses in GW.h - Transmission System ICC Losses}}{\sum \text{Energy Sales through the 110 kV Network in GW.h (excluding sales to ICCs)}}$$

1.3 Bulk Supply Networks

The bulk supply systems are modelled from the 33 kV busbar to the 11 kV busbar including 33/11 kV transformers. The peak losses in kW calculated from load flow studies is then converted to annual energy losses using the loss load factor. Losses attributed to the 132/33 kV, 110/33 kV, 132/11 kV and 110/11 kV transformers are to be added to the losses obtained from these load flows. The total energy supplied is taken from billed sales figures and the DLF derived by dividing the total losses excluding ICC losses by the total energy sales to non-ICC customers, viz:

$$\text{Bulk Supply} + 11\,\text{kV Bus DLF} = \frac{\sum \text{Losses in GW.h} - \text{ICC losses in the system}}{\sum \text{Energy Sales through 33 kV network in GW.h (excluding sales to ICCs)}}$$

The bulk supply and 11kV bus DLFs are then to be separated from the total DLF using ratios. The ratios currently used by ENERGEX are 0.651358 for the Bulk Supply System DLF and 0.348642 for the 11kV Bus DLF. These ratios are based on the 2007-08 DLF report by Connell Wagner Consultants. However, these ratios are to be validated during each full review. If these ratios are found to be no longer appropriate, they are to be recalculated, subject to the latest network configurations and consumption patterns.

1.4 11 kV circuits

Losses on 11 kV feeders are calculated using the length of each feeder and forecast peak demand data. The formula for determining 11 kV losses is as follows:

Feeder losses = $(\text{Peak Demand})^2$ * Resistance * Branching Factor

The feeder lengths are obtained from ENERGEX's corporate database, and allow calculation of the resistance of each feeder based on average overhead and underground resistances per unit length. The peak demand is also obtained from a corporate database, and a load growth is applied to determine peaks during the forecast year. Average branching factors are calculated for urban, rural and high-density feeders based on losses obtained for each 11 kV feeder during each full review. This data allows losses to be calculated for each 11 kV feeder.

An annual loss energy is then produced for each feeder using loss load factors, which are then summed to produce the total 11 kV feeder losses. The DLF is thus:

$$11\,\text{kV Circuit DLF} = \frac{\sum 11\text{kV Feeder Losses in GW.h - ICC Losses in System}}{\sum \text{Energy Sales through 11 kV Feeders in GW.h (excluding sales to ICCs)}}$$

1.5 LV bus & LV circuits

LV losses are generally determined as being the remaining losses when all calculated losses for the higher voltage networks have been deducted from the total network losses (known from purchases - sales).

LV losses then just need to be appropriately allocated between the LV Bus and LV Line categories. Studies undertaken in 2007 by Connell Wagner Consultants for the 2007-08 full review determined appropriate ratios for splitting LV losses between these categories. The calculated ratios are LV Bus = 0.422574 and LV line = 0.577426 of total LV losses. However, these ratios are to be validated during each full review. If these ratios are found to be no longer appropriate, they are to be recalculated, subject to the latest network configurations and consumption patterns.

Procedure

Once the DLFs are calculated and reconciled, a report is prepared, detailing the calculated site specific DLFs, together with the average DLFs at each voltage level in the system. This report must be submitted for approval to the Australian Energy Regulator (AER). Once approved, the AER forwards the DLFs to NEMMCO. The approved DLFs are then published by NEMMCO on its website by 1 April each year.