



DISTRIBUTION LOSS FACTOR CALCULATION METHODOLOGY



Hill Michael are engaged by network service provider Capcoal (CAPNSP) to manage their NSP obligations as per the NER rules. This document outlines the calculation methodology used by Hill Michael for distribution loss factors for the 08/09 financial year.

In this document, the terms in italics have meanings as defined in the NER. Relevant extracts from the NER, including Clause 3.6.3, have been reproduced as Attachment 1.

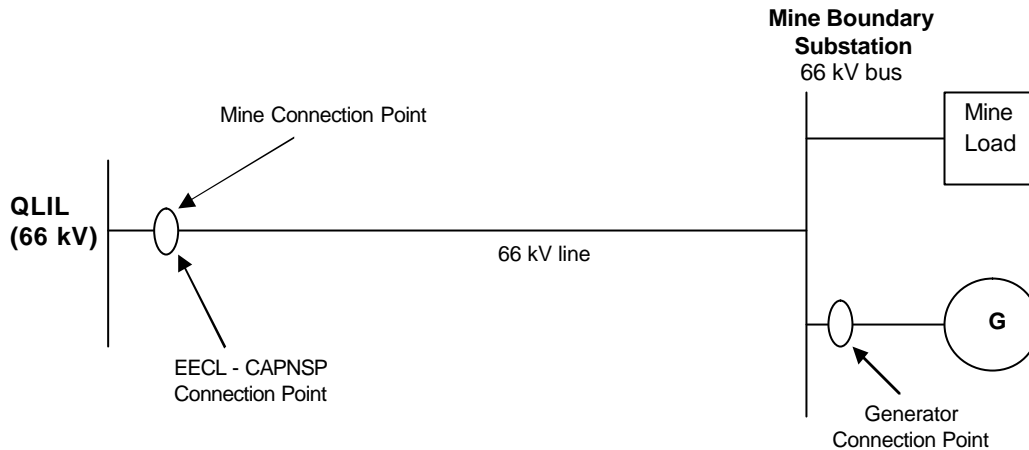
CAPCOAL DLF CALCULATION

The Capcoal Network Service Provider (CAPNSP) operates a 66kV distribution network which is connected to the Ergon Energy Corporation Limited (EECL) Lilyvale substation. Clause 3.6.3 of the National Electricity Rules (NER) discusses distribution losses in the context of the National Electricity Market (NEM). In particular, a Distribution Network Service Provider must calculate the Distribution Loss Factor (DLF) for the connection points on its distribution network.

CAPNSP has one connection point on its distribution network and the site specific DLF for this connection point has been calculated in accordance with the methodology approved by the Queensland Competition Authority (QCA) as described in **Report NCM 17699 Determination of Distribution Loss Factors for Embedded/Local Generators**. A copy of this report is provided as Attachment 2 to this document.

Capcoal Distribution Network Service

CAPNSP has only one customer – the embedded generator owned and operated by Energy Developments Ltd (EDL) – and therefore, CAPNSP has only one *distribution network connection point*. The Capcoal German Creek mine is a customer of EECL and the mine *distribution network connection point* is located at the Lilyvale 66 kV bus. The mine connection point is also the CAPNSP connection point to the EECL network service. The EDL embedded generator *distribution network connection point* is at the Oaky Creek site. The diagram below shows the location of the various connection points.



Simplified representation of the CAPNSP distribution network

EDL Generator DLF Calculation

The site specific DLF for the EDL embedded generator will be calculated using a Marginal Loss Factor (MLF) approach and will be in accordance with the methodology approved by the QCA as described in **Report NCM 17699 Determination of Distribution Loss Factors for Embedded/Local Generators**

The EDL embedded generator's connection point has been assigned to the Lilyvale transmission network connection point (QLIL) and this has been approved by NEMMCO.

The DLF is a static loss factor which is to apply to the embedded generator *distribution network connection point* for the full financial year. The steps undertaken to calculate the DLF are summarised below.

1. Request German Creek mine consumption and EDL embedded generation forecasts for 08/09 financial year.
2. Prepare/review the DINIS network model for the CAPNSP distribution network by incorporating any changes to the network occurring in the period leading up to the financial year for which the embedded generator DLF is being calculated;
3. Run a set of load flow studies in DINIS for each month of the next financial year using the forecast mine load and embedded generation data.
4. Calculate the MLF and DLF in accordance with the methodology approved by the QCA as described in **Report NCM 17699 Determination of Distribution Loss Factors for Embedded/Local Generators**.



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Notes:

- The only customer connected to CAPNSP is the embedded generator. The German Creek mine connection point is at the CAPNSP connection point to the EECL network service at Lilyvale.
- The losses in the CAPNSP distribution network have been calculated using load flow studies where losses are calculated as part of the calculation of energy flows and power balances.
- The distribution losses between the 66kV CAPNSP connection point at Lilyvale and the EDL embedded generator connection point at the German Creek Mine Boundary Substation are relevant to the calculation of the EDL embedded generator site specific DLF.
- The DINIS network model represents:
 - (a) the Lilyvale (QLIL) 66 kV connection point as an infinite bus; and
 - (b) the German Creek mine load at the 66 kV bus at the Mine Boundary Substation.

[Confidential Network Information Withheld]

CAPNSP network configuration in DINIS (as at February 2008)



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Attachment 1: Extracts from the National Electricity Rules (Prior to January 2008)

3.6.3 Distribution losses

- (a) *Distribution losses* are *electrical energy losses* incurred in the conveyance of electricity over a *distribution network*.
- (b) *Distribution loss factors*:
- (1) notionally describe the *average electrical energy losses* for electricity transmitted on a *distribution network* between a *distribution network connection point* and a *transmission network connection point* or *virtual transmission node* for the financial year in which they apply;
 - (2) will be either:
 - (i) a site specific *distribution loss factor* derived in accordance with the methodology determined by the *Jurisdictional Regulator* or the *Distribution Network Service Provider* pursuant to clause 3.6.3(h), for each *distribution network connection point* of the following types:
 - (A) a *connection point* for an *embedded generating unit* with actual *generation* of more than 10MW, based on the most recent data available for a consecutive 12 month period at the time of determining the *distribution loss factor*. Where relevant data is not available for a consecutive 12 month period as a *distribution network connection point* is newly established or has been modified, a *Network Service Provider* may determine whether an *embedded generating unit* has *generation* of more than 10MW, based on its best projection of *generation* in the *financial year* in which the *distribution loss factor* is to apply, taking into account the terms of the relevant *connection agreement*;
 - (B) a *connection point* for an end-user with actual or forecast *load* of more than 40GWh or an electrical demand of more than 10MW, based on the most recent data available for a consecutive 12 month period at the time of determining the *distribution loss factor*. Where relevant data is not available for a consecutive 12 month period as a *distribution network connection point* is newly established or has been modified, a *Network Service Provider* may determine whether an enduser has *load* of more than 40GWh or forecast *peak load* of more than 10MW, based on its best projection of *load* in the *financial year* in which the *distribution loss factor* is to apply, taking into account the terms of the relevant *connection agreement*;
 - (C) a *connection point* for a *market network service provider*; and
 - (D) a *connection point* between two or more *distribution networks*; or



- (ii) derived, in accordance with the methodology determined by the *Jurisdictional Regulator* or the *Distribution Network Service Provider* pursuant to clause 3.6.3(h), using the 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* (determined in accordance with clause 3.6.3(d)(2)) assigned to that *transmission network connection point* or *virtual transmission node*, for all *connection points* on a *distribution network* not of a type described in clause 3.6.3(b)(2)(i);
- (3) are to be used in the settlement process as a notional adjustment to the electrical energy, expressed in MWh, flowing at a *distribution network connection point* in a *trading interval* to determine the *adjusted gross energy* amount for that *connection point* in that *trading interval*, in accordance with clause 3.15.4.
- (b1) Where a *Generator* meets the reasonable cost of the *Distribution Network Service Provider* in performing the necessary calculation in respect of a *generating unit* of up to 10MW or 40GWh per annum capacity, the *Distribution Network Service Provider* must calculate a site specific *distribution loss factor* that, notwithstanding any other provision of the *Rules* to the contrary, for the purposes of the *Rules* is to apply in respect of that *generating unit* on the same basis as applies for a *generating unit* of more than 10MW or 40GWh per annum capacity as though the *generating unit* were a unit of more than 10MW or 40GWh per annum capacity.
- (c) Each *Distribution Network Service Provider* must assign each *connection point* on its *distribution network*, of a type described in clause 3.6.3(b)(2)(i), to a single *transmission network connection point* taking into account normal *network configurations* and predominant *load flows*.
- (a1) **[Deleted]**
- (d) Each *Distribution Network Service Provider* must assign each *connection point* on its *distribution network*, not of a type described in clause 3.6.3(b)(2)(i):
 - (1) where practicable, to a single *transmission network connection point* or otherwise, to a *virtual transmission node*, taking into account normal *network configurations* and predominant *load flows*; and
 - (2) to a class of *distribution network connection points* based on the location of, *voltage* of and pattern of electrical energy flows at the *distribution network connection point*.
- (e) So far as practicable, the assignment of *connection points* on the *distribution network* to:
 - (1) *transmission network connection points* under clause 3.6.3(c); or
 - (2) *transmission network connection points* or *virtual transmission nodes* and a class of *distribution network connection points* under clause 3.6.3(d),must be consistent with the geographic boundaries of the *pricing zones* determined in accordance with clause 6.5.2 for use in *distribution service pricing*, and the *voltage* levels incorporated within those *pricing zones*.
- (f) The assignment of *connection points* on a *distribution network*:



- (1) to a single *transmission network connection point* under clause 3.6.3(c); or
- (2) to a *transmission network connection point* or *virtual transmission node* and a class of *distribution network connection points* under clause 3.6.3(d), is subject to the approval of the relevant *Jurisdictional Regulator* and the *Distribution Network Service Provider* must inform NEMMCO of such approved assignments.
- (g) *Distribution loss factors* must be determined by a *Distribution Network Service Provider* for all *connection points* on its *distribution network* either individually, for all *connection points* assigned to a single *transmission network connection point* under clause 3.6.3(c), or collectively, for all *connection points* assigned to a *transmission network connection point* or a *virtual transmission node* and a particular *distribution network connection point* class under clause 3.6.3(d), in accordance with:
- (1) the methodology developed, *published* and maintained by the *Jurisdictional Regulator* for the determination of *distribution loss factors*; or
- (2) where the *Jurisdictional Regulator* has not *published* a methodology under clause 3.6.3(g)(1), the methodology developed, *published* and maintained by the *Distribution Network Service Provider* for the determination of *distribution loss factors*.
- (h) The methodology for the determination of *distribution loss factors* referred to in clause 3.6.3(g) must be developed having regard to the following principles:
- (1) The aggregate of the *adjusted gross energy* amounts for a *distribution network*, determined in accordance with clause 3.15.4 using the *distribution loss factors* for the *financial year* in which the *distribution loss factors* are to apply should equal, as closely as is reasonably practicable, the sum of:
- A the amount of electrical *energy*, expressed in MWh, flowing at all *connection points* in the *distribution network* in the *financial year* in which the *distribution loss factors* are to apply; and
- B. the total *electrical energy losses* incurred on the *distribution network* in the *financial year* in which the *distribution loss factors* are to apply.
- (2) The methodology used to determine *distribution loss factors* for a *financial year* should incorporate provisions requiring a *Distribution Network Service Provider* to undertake a reconciliation between the aggregate of the *adjusted gross energy* amounts for its *distribution network* for the previous *financial year* determined in accordance with clause 3.15.4 using the *distribution loss factors* that applied for *connection points* in that *distribution network* in the previous *financial year* and the sum of:
- (i) the amount of electrical *energy*, expressed in MWh flowing, at all *connection points* in its *distribution network* in the previous *financial year*; and
- (ii) the total *electrical energy losses* incurred on its *distribution network* in the previous *financial year*.



- (3) The *distribution loss factor* for a *distribution network connection point*, other than those described in clause 3.6.3(b)(2)(i), is determined 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* assigned to that *transmission network connection point* or *virtual transmission node* for the *financial year* in which the *distribution loss factor* is to apply.
 - (4) The *distribution loss factor* for a *distribution network connection point* described in clause 3.6.3(b)(2)(i) is determined using the *average electrical energy loss* between the *distribution network connection point* and the *transmission network connection point* to which it is assigned in the *financial year* in which the *distribution loss factor* is to apply.
 - (5) In determining the *average electrical energy losses* referred to in clauses 3.6.3(h)(3) and (4), the *Distribution Network Service Provider* must use the most recent actual *load* and *generation* data available for a consecutive 12 month period but may adjust this *load* and *generation* data to take into account projected *load* and / or *generation* growth in the *financial year* in which the *distribution loss factors* are to apply.
 - (6) In determining *distribution loss factors*, flows in *network elements* that solely or principally provide *market network services* will be treated as invariant, as the methodology is not seeking to calculate the *marginal losses* within such *network elements*.
- (i) Each year the *Distribution Network Service Provider* must determine the *distribution loss factors* to apply in the next *financial year* in accordance with clause 3.6.3(g) and provide these to NEMMCO for *publication* by 1 April. Before providing the *distribution loss factors* to NEMMCO for *publication*, the *Distribution Network Service Provider* must obtain the approval of the relevant *Jurisdictional Regulator* for the *distribution loss factors* it has determined for the next *financial year*.

3.15.4 Adjusted energy amounts- connection points

Where a *connection point* is not a *transmission network connection point*, the *adjusted gross energy* amount for that *connection point* for a *trading interval* is calculated by the following formula:

$$\text{AGE} = \text{ME} \times \text{DLF}$$

where:

AGE is the *adjusted gross energy* amount to be determined;

ME is the amount of electrical *energy*, expressed in MWh, flowing at the *connection point* in the *trading interval*, as recorded in the *metering data* in respect of that *connection point* and that *trading interval* (expressed as a positive value where the flow is towards the *transmission network connection point* to which the *connection point* is assigned and negative value where the flow is in the other direction); and

DLF is the *distribution loss factor* applicable at that *connection point*.



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average electrical energy loss

The volume-weighted average of the *electrical energy losses* incurred in each *trading interval* over all *trading intervals* in a defined period of time

electrical energy loss

Energy loss incurred in the production, transportation and/or use of electricity.



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ATTACHMENT 2:

REPORT NCM 17699

**DETERMINATION OF DISTRIBUTION LOSS FACTORS FOR EMBEDDED/LOCAL
GENERATORS**

25 February 2008



DETERMINATION OF DISTRIBUTION LOSS FACTORS FOR EMBEDDED/LOCAL GENERATORS

REPORT NCM17699

1.0 Introduction

Section 3.6.3 of the National Electricity Code describes the requirement for Distribution Loss Factors for Market Generators (or market generating units). The NEC goes on to describe the Distribution Loss Factor for a market generating unit as:

“a site specific factor that describes the volume weighted average electricity loss incurred in the *distribution* of electricity between a *transmission network connection point* and the relevant *Generator’s connection point* for a defined period of time and associated operating conditions.”

This Code clause indicates that non-scheduled market generators are to be allocated an average rather than a half hourly marginal distribution loss factor. This interpretation is consistent with previous decisions of the Jurisdictional Regulator in relation to distribution loss factors for generators not directly connected to the transmission network.

This paper sets out the process that ENERGEX Limited and Ergon Energy Corporation Limited (“the Distributors”) propose to use for calculating DLF’s for those NEMMCO registered embedded generators who are not selling their entire energy output to the local retailer and therefore require a DLF.

2.0 Calculation Methodology

The procedure developed by the Distributors for calculation of DLF’s for distribution network connected market generators is:

Step 1

The appropriate part of the subtransmission network should be modelled by including all directly connected 132kV, 66kV, 33kV, 22kV, and 11kV customers along with direct connected loads representative of the 22kV and 11kV feeders (lumped at the 22kV and 11kV buses and/or distributed along the feeder on which the embedded generator is connected). The Embedded Generators should be modelled at their metering points. The Transmission Network Connection Point may be modelled as an infinite bus.



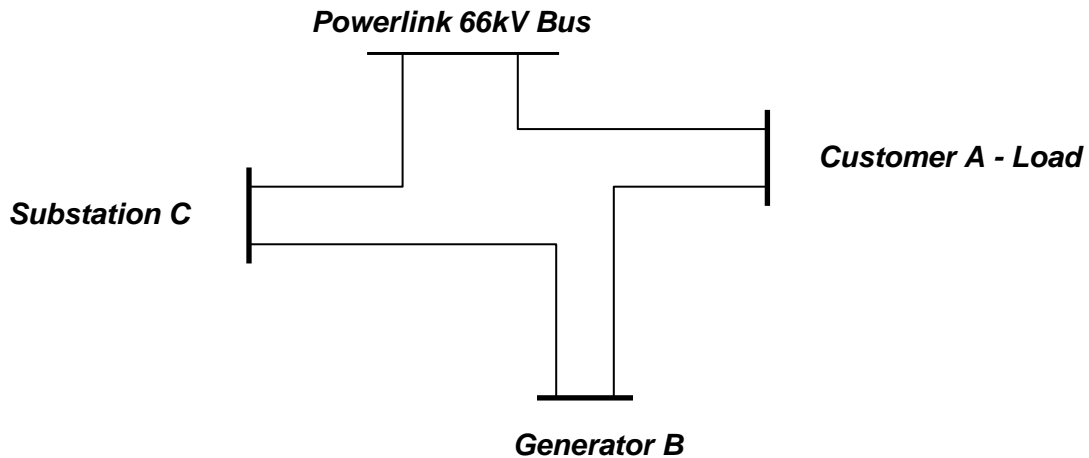
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A set of generator operating states is developed relative to the network load and generation patterns with a state for each reasonable distinguishable discrete generator/load condition. Each state will be defined by a time period, a constant average load and a constant average generator output. The load and generation are the averages during the time period of the operating state being studied. The operating states combined must occupy the full time frame associated with the required DLF. This will normally be one year.

A table of operating states with time periods, average loads and average generator outputs should be developed

An example network is described below:



Customer A has a single shift operation and a load of 10MW between 0700 and 1700.

Generator B has an output of 15MW over the period 0600 to 2100. The generator output and operating periods for the full year are to be specified by the Financially Responsible market Participant. Only one average DLF will be calculated for the year.

Substation C is a domestic type load which can be characterised by 0700 to 1800 – 5MW, 1800 to 2100 – 8MW and 2100 to 0700 - 2MW



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The resultant discrete operating states table would be :

<i>State</i>	<i>Duration</i>	<i>Load A</i>	<i>Gen B</i>	<i>Sub C</i>
1	0700 – 1700	10MW	15MW	5MW
2	1700 – 1800	0	15MW	5MW
3	1800 – 2100	0	15MW	8MW
4	2100 – 0600	0	0	2MW
5	0600 – 0700	0	15MW	2MW

State 4 does not need to be modelled as the Generator is not operating during that period.

As an alternative the operating states table may be developed from a load duration curve when sufficient data exists and the generator output is reasonably constant

Step 2

A load flow study is run for each of the relevant operating states with the average load and average generation in that state.

The output from the embedded generator is incremented and the load flow studies are repeated for each of the relevant operating states with the same average loads

The net increase in system demand (generation output plus Transmission Network Connection Point load) for each operating state is recorded.

The Marginal Loss Factor for that generator in that operating state is calculated by dividing the net system demand (generator output plus load at the Transmission Network Connection Point) increase by the increase in generation and subtracting the result from 1. [There has been no change in load so that the net system demand change is a loss change



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due to sourcing the increment from the generator instead of from the Transmission Network Connection Point].

$$MLF = 1 - (\text{System Demand Increase} / \text{Generator Output Increase})$$

Step 3

Convert the set of Marginal Loss Factors to an equivalent set of Distribution Loss Factors by taking the square root of the MLF.

Note:

- *Distribution Loss Factor (average) = SQRT(MLF X LF)*
- *As we are using constant average loads to model for each operating state, the Load Factor (LF) = 1 for that state*
- *Thus in this model DLF (average) = SQRT(MLF)*

An operating states table is then built with MLF, DLF' and the energy exported by the Generator during that operating state.

The table developed for our example is:

State	MLF	DLF	Energy Exported
1	1.04	1.02	150 MWh
2	0.96	0.98	15 MWh
3	0.98	0.99	45 MWh
5	0.88	0.94	15 MWh

Step 4

The annual volume weighted distribution loss factor for each generator is calculated from the tabulated DLF's and generation energy exported for each of the discrete operating states .

For example, in our test network the DLF would be



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$$\begin{aligned} \text{DLF} &= \frac{1.02 * 150 \text{ MWh} + 0.98 * 15 \text{ MWh} + 0.99 * 45 \text{ MWh} + 0.94 * 15 \text{ MWh}}{(150 + 15 + 45 + 15) \text{ MWh}} \\ &= 1.006 \end{aligned}$$

Step 5 - Two or more generators in the network

Steps 1 to 4 are undertaken to calculate the DLF for each generator separately. The DLF for any generator is calculated by incrementing only that generator's output and running all the load flow studies with the average generation from each of the other generators.

3.0 Reality Check

A generator which is reducing losses in the system will have a DLF greater than unity. That is, the losses in the network are reduced by taking incremental supply from the generator rather than from the Transmission Network Connection Point and therefore more capacity is saved at the Transmission Network Connection Point than was added by the generator. A DLF greater than unity will result in the generation energy adjusted to the Transmission Network Connection Point being greater than the metered generator energy output.

A generator which increases losses will have a DLF below unity.

These DLF's for embedded generators are consistent with the TLF's applied to transmission grid connected generators. That is if the generator adds to the total amount of losses in the system, then the DLF or TLF will be less than unity. If the generator reduces the losses in the system, the DLF or TLF will be greater than unity.

K Kehl
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