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NETWORK SERVICE PROVIDER

DISTRIBUTION LOSS FACTOR

ANGLO COAL

CAPCOAL NSP

AUSTRALIAN ENERGY REGULATOR

FINANCIAL YEAR 2012-13

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Document History and Status

Revision	Date issued	Reviewed	Approved	Date approved	Revision type
Rev 0	14 Dec 2011				Internal Draft
Rev 1					

Project Number	:	CCM 3386
Name of Project	:	CCM NSP Services 2011-12
Report	:	HMA Report (CCM3386) CapCoal DLF Calculation_2012-2013-20111205(NG).doc
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Document Version	:	1.0
Report Status	:	Issue for Audit
Last Revised	:	2011

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1. SUMMARY

The terms of Hill Michael's engagement with Capcoal Network Service Provider (NSP) include calculation of distribution loss factors in accordance with Section 3.6.3 (i) of the National Electricity Rules (NER). An extract of the relevant clause from the current version (Version 46) of the NER is given below:

"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 AEMO for publication by 1 April. Before providing the distribution loss factors to AEMO for publication, the Distribution Network Service Provider must obtain the approval of the AER for the distribution loss factors it has determined for the next financial year."

CAPNSP has only one customer with existing 32 MW embedded generator owned and operated by Energy Developments Ltd (EDL). [redacted] Due to this change Hill Michael has calculated the distribution loss factors for two scenarios and submits option 2 as the most likely scenario. The embedded generation is dependent on the mine for fuel (coal seam methane gas), therefore, changes to the production level of the mine will impact the generation output.

Scenario 1: With existing 32 MW embedded generator

This is calculated based on the historical metered generation and mine load data for the year 2010/11.

Scenario 2: [redacted]

This is calculated based on the forecast generation for the year 2012/13 and historical mine load for the year 2010/11.

The site specific Distribution Loss Factors (DLF) calculated using a Marginal Loss Factor (MLF) approach for the EDL embedded generation connected to the **Capcoal NSP** is as follows.

Scenario	Load data	DLF
1 – Existing EDL	Historical metered generation and mine load data	1.0011
2 – EDL expansion	Forecast generation and historical mine load data	0.9956

This distribution loss factors have been calculated in accordance with the methodology approved by the QCA as described in **Report NCM 17699 Determination of Distribution Loss Factors for Embedded/Local Generators**.

In addition to the NER obligations, as required by the Australian Energy Regulator, this report has been provided to IES (Intelligent Energy Systems) for independent positive certification. Additional supporting evidence has been provided to IES to enable independent verification of calculations.

2. METHODOLOGY AND CALCULATIONS

2.1 METERED DATA - GENERATION AND CONNECTION POINT

The reconciled metered data for the parent meter and the revenue meter at the generator (National Metering Identifiers are given below) have been obtained from the authorised Metering Provider.

Parent NMI	QAAALV0001
TNI / MDA	QLIL/Ergon Energy
Generator NMI	7102000033

Below is the summary of the half hourly metered data based on the most recent data available for a consecutive 12 month period at the time of determining loss factors. The mine load is estimated based on the difference between the connection point and the generation metered data.

- Connection Point (MWh): This is the total energy from connection point meter.

  Net negative energy indicates that the energy provided by generation is higher than the energy consumed by the load for that month. The converse is true for Net positive energy.

- Generation (MWh): This is the monthly energy output of the generator measured at the generator revenue meter.

  Net negative energy indicates the energy provided by the generators to the system

- Estimated Mine Load (MW): Difference of Connection Point (MWh) and Generation (MWh) converted to MW. The conversion between MWh to MW is calculated based on 24 hours a day operation of the mine.

Date	Connection Point (MWh)	Generation (MWh)	Estimated Mine Load (MW)
Oct-10	[redacted]	[redacted]	[redacted]
Nov-10	[redacted]	[redacted]	[redacted]
Dec-10	[redacted]	[redacted]	[redacted]
Jan-11	[redacted]	[redacted]	[redacted]
Feb-11	[redacted]	[redacted]	[redacted]
Mar-11	[redacted]	[redacted]	[redacted]
Apr-11	[redacted]	[redacted]	[redacted]
May-11	[redacted]	[redacted]	[redacted]
Jun-11	[redacted]	[redacted]	[redacted]
Jul-11	[redacted]	[redacted]	[redacted]
Aug-11	[redacted]	[redacted]	[redacted]
Sep-11	[redacted]	[redacted]	[redacted]

Table 1: Metered Data for 2010/11

2.1.1 Generation and Load Projection for 2011/12

2.1.1.1 Generation Projection

Scenario 1: Without EDL expansion

EDL Power Station has 32 MW installed capacity at unity power factor will be available in 2012/13. Due to unavailability generation forecast, historical generation data for the year 2010/11 was considered for the DLF calculation.

Scenario 2: [redacted]

[redacted]

2.1.1.2 Mine Load Projection:

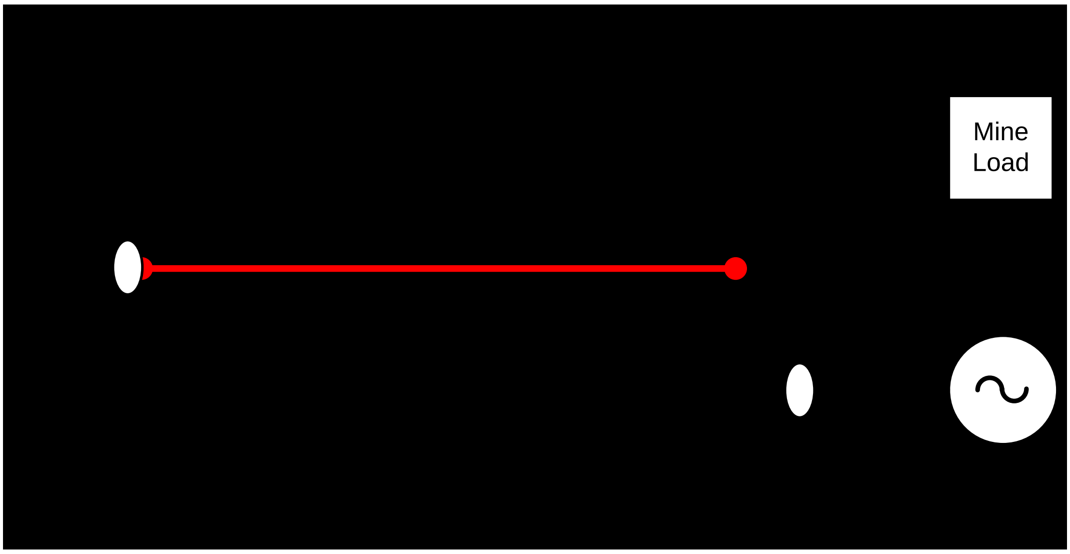
As there is no change in the mine load in 2012/13 the forecast is based on the historical mine load data for 2010/11.

Date	Scenario 1 Generation (MW)	Generation expansion (MW)	Scenario 2 Generation (MW)	Mine Load (MW)	Mine Load PF
Jul-12	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Aug-12	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Sep-12	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Oct-12	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Nov-12	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Dec-12	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Jan-13	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Feb-13	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Mar-13	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Apr-13	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
May-13	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Jun-13	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 2: Generation and mine load data for the year 2012/13

2.1.2 Network Connection Points

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. [redacted]



[redacted]

2.1.3 Methodology

EDL Generator DLF Calculation

The site specific DLF for the EDL embedded generator is calculated using a Marginal Loss Factor (MLF) approach in accordance with the methodology approved by the QCA as described in **Report NCM 17699 Determination of Distribution Loss Factors for Embedded/Local Generators.** (Refer APPENDIX 3 – REPORT NCM17699)

The DLF is a static loss factor applied 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 expected mine consumption, embedded generation forecasts and network changes to the NSP for the 2012-13 financial year.

2. Request the recent metered data from the metering data provider for the year 2010/11.

3. Prepare and review the network model for the CAPNSP distribution network by incorporating any proposed changes to the network occurring in the period leading up to the financial year for which the embedded generator DLF is being calculated.

   The PSS/SINCAL network model (given in appendix 2 – SCHEMATIC OF caPCOAl nsp) represents the following:

   a. Lilyvale (QLIL) 66 kV connection point is modelled as an **infinite bus**;

   b. German Creek mine load is located at the 66 kV bus at the Mine Boundary Substation;

   c. EDL Generation is connected to the 66 kV network.

4. Using the Network Model and Load Flow Analysis, the following steps are performed.

   - Run a set of load flow studies for each month of the next financial year using the forecast mine load and embedded generation data.

   - Note the loss on the NSP network for the forecast generation level (A).

     [As indicated in Figure 1, the NSP network is between the 66kV CAPNSP connection point at Lilyvale and the EDL embedded generator connection point at the German Creek Mine Boundary Substation.]

   - Increment the generation by 1 MW and note the new loss on the NSP Network (B).

   - The loss due to the increment in generation per MW is calculated (B-A)/1000.

5. 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**.

2.1.4 Distribution Loss Factor

As per the Australian Energy Regulator (AER) letter dated 19th December 2005, the 18.5 km long 66 kV radial overhead electricity line from the Lilyvale substation up to the Capcoal boundary substation is deemed the Capcoal NSP. Therefore, only the loss related to this 18.5 km NSP line is considered for the DLF calculation.

Extract of the AER document in year 2005 is show below.

Specified distribution system

1. The Exemption is limited to the distribution system ("Distribution System") specified in the exemption granted by the National Electricity Code Administrator Ltd on 30 June 2005 under clause 2.5.1(d)(2) of the National Electricity Code to Anglo Coal (Capcoal Management) Pty Ltd.

   Note: In effect, the Exemption applies to the distribution system that is owned by Capricorn Coal Developments Joint Venture (consisting of Anglo Coal (German Creek) Pty Ltd, Jena Pty Ltd, and Mitsui German Creek Investment Pty Ltd) ("Capcoal Joint Venture") and comprises:

   (a) the 66 kV radial overhead electricity line, approximately 19 km in length, originating at Ergon Energy Corporation Ltd's Lilyvale substation and extending to Anglo Coal's Lease Boundary Substation ("overhead line"); and

   (b) parts of the Anglo Coal Lease Boundary Switchyard including the busbar, connections and electrical apparatus connected to the overhead line.

2.1.4.1 Scenario 1: [redacted]

The loss under existing generation on the NSP network is noted (A), then the generation is incremented by 1 MW and the new loss on the NSP network is observed (B). The difference in the loss after the 1 MW increment is (B-A)/1000 per MW. The marginal loss factor is 1 less the loss per MW of generation increment.

The volume weighted DLF is weighted on the average forecast generation per month.

DLF calculation results for the historical generation and mine load data for the year 2010/11 is given in Table 3.

Period	Scenario 1 Generation (MW)	Mine Load (MW)	A (kW) NSP Loss	B (kW) NSP Loss for Increment in Generation	MLF [1 - (B-A)/1000]	DLF SQRT (MLF)
Jul-12	[redacted]	[redacted]	[redacted]	[redacted]	1.0083	1.0042
Aug-12	[redacted]	[redacted]	[redacted]	[redacted]	1.0114	1.0057
Sep-12	[redacted]	[redacted]	[redacted]	[redacted]	1.0101	1.0051
Oct-12	[redacted]	[redacted]	[redacted]	[redacted]	1.0021	1.0010
Nov-12	[redacted]	[redacted]	[redacted]	[redacted]	1.0006	1.0003
Dec-12	[redacted]	[redacted]	[redacted]	[redacted]	0.9967	0.9983
Jan-13	[redacted]	[redacted]	[redacted]	[redacted]	1.0004	1.0002
Feb-13	[redacted]	[redacted]	[redacted]	[redacted]	1.0020	1.0010
Mar-13	[redacted]	[redacted]	[redacted]	[redacted]	0.9976	0.9988
Apr-13	[redacted]	[redacted]	[redacted]	[redacted]	1.0000	1.0000
May-13	[redacted]	[redacted]	[redacted]	[redacted]	1.0020	1.0010
Jun-13	[redacted]	[redacted]	[redacted]	[redacted]	1.0061	1.0030
	Volume weighted average DLF with historical generation and mine load data					**1.0011**

Table 3: Volume Weighted Average DLF without EDL expansion

The volume weighted average DLF value of 1.0011 is calculated based on the historical generation and mine load data. As per the data shown in Table 3, in most of the months mine load is higher than the generation. This result in to a DLF figure greater than one.

2.1.4.2 Scenario 2: [redacted]

The loss under scenario 2 on the NSP network is noted (A), then the generation is incremented by 1 MW and the new loss on the NSP network is observed (B). The difference in the loss after the 1 MW increment is (B-A)/1000 per MW. The marginal loss factor is 1 less the loss per MW of generation increment.

The volume weighted DLF is weighted on the average forecast generation per month.

DLF calculation results for the historical generation [redacted] and mine load data for the year 2010/11 is given in Table 4.

Period	Scenario 2 Generation (MW)	Mine Load (MW)	A (kW) NSP Loss	B (kW) NSP Loss for Increment in Generation	MLF [1 - (B-A)/1000]	DLF SQRT (MLF)
Jul-12	[redacted]	[redacted]	[redacted]	[redacted]	1.0083	1.0042
Aug-12	[redacted]	[redacted]	[redacted]	[redacted]	1.0114	1.0057
Sep-12	[redacted]	[redacted]	[redacted]	[redacted]	1.0101	1.0051
Oct-12	[redacted]	[redacted]	[redacted]	[redacted]	0.9901	0.9950
Nov-12	[redacted]	[redacted]	[redacted]	[redacted]	0.9887	0.9943
Dec-12	[redacted]	[redacted]	[redacted]	[redacted]	0.9850	0.9925
Jan-13	[redacted]	[redacted]	[redacted]	[redacted]	0.9886	0.9943
Feb-13	[redacted]	[redacted]	[redacted]	[redacted]	0.9901	0.9950
Mar-13	[redacted]	[redacted]	[redacted]	[redacted]	0.9858	0.9929
Apr-13	[redacted]	[redacted]	[redacted]	[redacted]	0.9881	0.9940
May-13	[redacted]	[redacted]	[redacted]	[redacted]	0.9901	0.9950
Jun-13	[redacted]	[redacted]	[redacted]	[redacted]	0.9939	0.9969
	Volume weighted average DLF with historical generation plus EDL expansion and mine load data					**0.9956**

Table 4: Volume Weighted Average DLF with EDL expansion

The volume weighted average DLF value of 0.9956 is calculated based on the historical generation [redacted] and mine load data. As per the data shown in Table 4, [redacted] the generation is higher than the mine load. This results in to a lower DLF figure than Scenario 1.

3. APPENDIX 1 – EXTRACTS OF GENERATOR SPECIFICATIONS

4. APPENDIX 2 – SCHEMATIC OF CAPCOAL NSP

Figure 2: CAPCOAL Network as modelled in PSS/SINCAL

5. APPENDIX 3 – REPORT NCM17699

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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.

DETERMINATION OF DISTRIBUTION LOSS FACTORS FOR EMBEDDED/LOCAL GENERATORS

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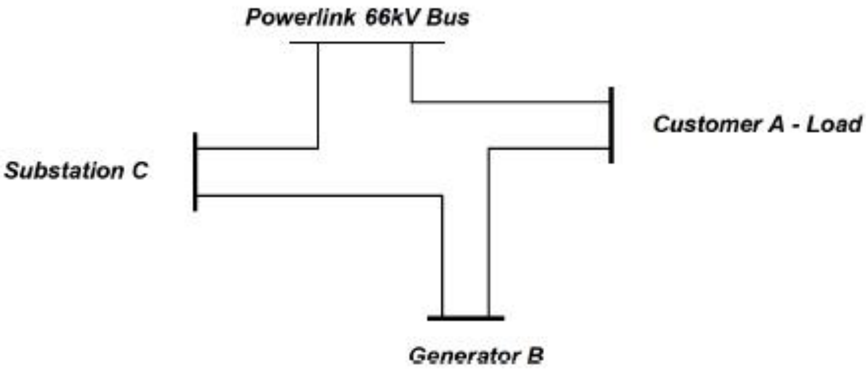
A set of generator operating states is developed relative to the network load and generation patterns with a state for each reasonable distinguishable discrete generator/load condition. Each state will be defined by a time period, a constant average load and a constant average generator output. The load 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 :

State	*Duration*	*Load A*	*Gen B*	*Sub C*
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 - (System Demand Increase/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

DETERMINATION OF DISTRIBUTION LOSS FACTORS
FOR EMBEDDED/LOCAL GENERATORS

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$$DLF = \frac{1.02 * 150\ MWh + 0.98 * 15MWh + 0.99 * 45\ MWh + 0.94 * 15MWh}{(150 + 15 + 45 + 15)\ MWh}$$

$$= 1.006$$

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 that unity. If the generator reduces the losses in the system, the DLF or TLF will be greater than unity.

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