FORWARD-LOOKING TRANSMISSION LOSS FACTORS

CALCULATION METHODOLOGY

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AUSTRALIAN ENERGY MARKET OPERATOR

VERSION RELEASE HISTORY

VERSION	DATE	BY	CHANGES
6.2	8 Dec 2016	SP&C	Updates to the Methodology to include changes resulting from the Draft Determination of the 2016 Rules Consultation
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3.0	1 April 2010	ESOPP	Methodology for Calculating Forward-Looking Loss Factors: Final Methodology updated to include changes resulting from the more recent Rules Consultation completed on 27 February 2009.
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CONTENTS

1. INTRODUCTION

This document specifies how AEMO calculates *marginal loss factors* (MLF) and *inter-regional* loss factor equations, using a forward looking loss factor (FLLF) methodology (the Methodology), and prepares load and generation data to calculate the MLFs.

This Methodology commences on 30 October 2014.

This Methodology may only be amended in accordance with clauses 3.6.1(c) and 3.6.2(d), (d1), 3.6.2A(b) and 8.9 of the National Electricity Rules (NER).

If there is any inconsistency between this Methodology and the NER, the NER will prevail to the extent of that inconsistency.

2. PURPOSE

MLFs are used in the *National Electricity Market* (NEM) to adjust electricity prices to reflect the energy lost in transporting electricity across networks. *Intra-regional loss factors* and *Inter-regional loss factor* equations apply for a financial year (1 July – 30 June).

2.1 MLFs and electrical losses

Electrical losses are a transport cost that need to be priced and factored into electrical energy prices. In the NEM, MLFs represent electrical losses between a *connection point* and a *regional reference node* (RRN). The factors are used to adjust electricity *spot prices* set at the RRN to reflect electrical losses between the RRN and a relevant *connection point*.

In a *power system* electrical losses are a function of the *load, network* and *generation* mix which is constantly changing. Another feature of electrical losses is that they increase quadratically to the electrical power transmitted (losses $\propto$ current^2). These variables mean that a single MLF for each *connection point* is necessarily an approximation.

2.2 Marginal losses

The NEM uses marginal costs as the basis for setting *spot prices* in line with the economic principle of marginal pricing. There are three components to a marginal price in the NEM: energy, losses and congestion.

The *spot price* for electrical energy is determined, or is set, by the incremental cost of additional *generation* (or demand reduction) for each *dispatch* interval. Consistent with this, the marginal loss is the incremental change in total losses for each incremental unit of electricity. The MLF of a *connection point* represents the marginal losses to deliver electricity to that *connection point* from the RRN.

3. REGULATORY REQUIREMENTS

This Methodology applies to AEMO and any Registered Participants who are required to provide information and assistance to AEMO in the calculation of the MLFs and the preparation of *load* and *generation* data for those purposes.

Clauses 3.6.1 and 3.6.2 of the NER require AEMO to calculate, annually, *intra-regional loss factors* and *inter-regional loss factor* equations, respectively, for a financial year, and *publish* the results by April 1. Clause 3.6.2A requires AEMO to prepare *load* and *generation* data to calculate the MLFs. Clauses 3.6.1(c) and 3.6.2(d), (d1) and 3.6.2A(b) of the NER require AEMO to detail the methodology to be used in these calculations.

There are extensive requirements to be met in developing the Methodology, all of which are reflected in this document.

4. PRINCIPLES

Consistent with the NER requirements detailed in clauses 3.6.1, 3.6.2 and 3.6.2A, AEMO has established the following principles to develop this Methodology:

- Best approximation to full nodal pricing in line with *market* design principles.
- Loss factors to be forward looking.
- Complete year of historical data rather than a representative sample.
- Minimal extrapolation to modify historical data.
- Loss factors to be based on marginal losses at each *connection point*.

5. FORWARD-LOOKING LOSS FACTOR METHODOLOGY

An overview of this Methodology is illustrated below, and a timeline is set out in Appendix A. Data requirements are listed in Appendix C.

Network data

- Prepare a network model that best represents the power system in the Target Year

Load forecast data

- Prepare load forecasts for existing and new connection points for the Target Year

Controllable network element flow data

- Prepare flow data used for existing controllable Market Network Service Provider (MNSP) network elements and controllable regulated network elements
- Estimate flow data for new controllable MNSP network elements and controllable regulated network elements

Generation data

- Prepare historical data for existing generation units
- Estimate generation profiles for new generating units
- Determine maximum capacities of exising and new generating units

Suppy and demand balance

- Determine the Interconnector limits
- Restore supply-demand balance by applying minimal extrapolation to generating units

Intra-regional loss factors

- Calculate loss factors at each connection point for each trading interval
- Calculate voume weighted marginal loss factors

Inter-regional loss factor equations

- Determine inter-regional loss factor equations

Publication and updates

- Publish intra-regional loss factors and inter-regional loss factor regions by 1 April

5.1 Network data

A model of the *power system* for the Target Year is required to simulate *load* flows. This section describes how the network model is constructed.

5.1.1 Identify future augmentations

AEMO consults with Transmission Network Service Providers (TNSPs) to identify committed transmission augmentations expected to be commissioned during the Target Year. The TNSPs check that identified augmentations satisfy the commitment criteria set out in the AEMO Electricity Statement of Opportunities (ESOO). TNSPs then supply AEMO with sufficient network data for the identified augmentations to be represented in the network model.

5.1.2 Prepare a base case load flow

AEMO takes a single snapshot of the NEM transmission network from the AEMO Energy Management System (EMS). AEMO then modifies the snapshot to:

- Include all known *connection points* (existing and planned).
- Represent anticipated system normal operation.
- Include committed network augmentations.
- Maintain a voltage profile that represents high l*oad* conditions.

5.2 Load forecast data

Load flow simulation studies require *load* forecasts for the Target Year. AEMO, or the relevant TNSP, forecasts *load* at each *connection point* based on historical data from the previous financial year (e.g. Target Year is 2015-16, calculation is in 2014-15, and historical data is 2013-14).

5.2.1 Forecasting connection point load

AEMO, or the TNSP, produces *connection point load* forecasts for each *load connection point* by 15 January each year. If the TNSP produces the forecast, then AEMO provides to the TNSPs, by 15 October, relevant historical connection point *load* data for the previous financial year.

The *connection point load* forecasts are:

- Based on historical *connection point* data (retaining the same weekends and public holidays).
- Consistent with the latest annual regional *load* forecasts prepared by AEMO or the TNSP.
- Based on 50% probability of exceedance and medium economic growth conditions.
- To include any known new *loads*.
- To include existing and committed *generation* that is embedded in the distribution network.
- An estimate of the active and reactive power at each *connection point* for each trading interval.

5.2.2 AEMO due diligence

Where a TNSP provides the *connection point* forecasts, AEMO reviews the forecasts to ensure that:

- The aggregated *connection point* annual energies (accounting for estimated transmission losses) match the latest ESOO.
- The aggregated maximum demand matches the latest ESOO (accounting for estimated transmission losses and *generating unit* auxiliaries).
- The differences between the historical and forecast data for selected *connection points* are acceptable.

AEMO and TNSPs consult to resolve any apparent discrepancies in the *connection point* data.

5.3 Controllable network element flow data

Controllable network elements (DC links) include both controllable *Market Network Service Providers* (MNSPs) and controllable regulated network elements. Flows on DC links form an input to *load* flow simulation studies unless they operate in parallel to other regulated network elements (AC circuits).

Flows on DC links that operate in parallel with AC circuits are not inputs to *load* flow simulation studies. Such flows are determined by *load* flow simulation studies and are described in section 5.5.3 (Parallel AC and DC links).

5.3.1 Controllable Network Elements with historical flow data

AEMO assumes that flows in MNSP DC links are unchanged from historical flows. If flows in MNSP DC links are likely to change in response to modified *generation* profiles, in accordance with section 5.5.6 or 5.9, then AEMO adjusts historical flows on MNSP DC links to reflect the change in *generation* profiles.

5.3.2 New Controllable Network Elements

For new or recently commissioned DC links where there is no historical flow, AEMO assumes a value of zero (less than 1 MW) for each trading interval.

5.4 Generation data

Load flow simulation studies require a base set of *generation* data as an input. For existing *generating units*, AEMO uses *generation* data from the previous financial year. For new *generating units* AEMO estimates *generation* from similar *generating units*.

5.4.1 New generating units

AEMO calculates loss factors based on committed and existing generating units published in the latest ESOO. AEMO updates this list of generating units, up to 15 January, with new *generation* information published on the AEMO website.[1]

5.4.2 New generating unit dispatch

AEMO assumes the dispatch of new committed *generating units* to be zero for trading intervals prior to the committed commissioning date reported in the latest ESOO. Once commissioned, AEMO estimates the output of committed new *generating units* by shaping and scaling appropriate historical data for generating units of similar technology and fuel type as follows:

1. Identify *generating units* in the NEM that use similar technology and fuel type, and are up to five years old. Where there are no appropriate *generating units* up to five years old, use data up to 10 years old.
2. Find the average output of the similar *generating units* as a percentage of their winter rating from the latest ESOO.
3. Determine the output of the new *generating units* by scaling the average output profile by the nameplate rating of the new generating unit.

A new *generating unit* in the second year of operation will generally have an incomplete year of historical data for the previous financial year. In this case, the procedure above is used to estimate the dispatch for the period prior to the historical data being available.

5.4.3 Hydro and wind generating units

AEMO consults with the proponents of new hydro or wind *generating units* to determine an anticipated *generation* profile. AEMO assesses the *generation* profile in accordance with Appendix B to ensure that the information supplied by the proponent is credible.

[1] The Generation Information Page on AEMO's website. AEMO periodically updates this page.

Where the proponent is unable to provide such a profile, then AEMO uses a flat *generation* profile equal to the product of the anticipated utilisation factor and the nameplate rating of the *generating unit.*

5.4.4 New technologies and fuel types

For new *generating units* that utilise a new technology or fuel type, AEMO assesses the *generation* profile in accordance with Appendix B to ensure that the information supplied by the proponent is credible.

5.4.5 Retired generating units

Generating units that retire in the financial year in which the loss factors apply are identified in the latest ESOO or AEMO website.[1] The dispatch output of retiring plant is set to zero from the retirement date specified in the latest ESOO.[2]

AEMO consults with the registered owners of the retiring *generating* unit if the information in the latest ESOO or on AEMO's website[1] is insufficient to provide an exact retirement date.

5.4.6 Generating unit capacities

AEMO sets the maximum capacity of each *generating unit* to the value published in the latest ESOO.[2] AEMO uses separate values for summer and winter, where summer is defined as 1 December to 31 March.

AEMO then estimates sent-out capacity because *load* flow simulation studies require sent-out *generation* data. AEMO estimates the sent out capacity of *generating units*, for both summer and winter, by subtracting an estimate of auxiliary *load* from the maximum capacity. AEMO estimates the auxiliary *load* from the difference between SCADA *generating unit* terminal output, as obtained from the AEMO EMS, and the sent-out value for the same trading interval. Where the auxiliaries *loads* are separately measured or negligible, AEMO will not correct the historical *generation* data.

Reductions in capacity

AEMO uses a reduced generating capacity if the capacity of a *generating unit* is forecast to be reduced for reasons other than for maintenance. If the capacity has been restored from a reduced capacity in the prior year(s), then AEMO in consultation with the registered owner will backfill the historical profile of the *generating unit* to represent the restored capacity.

Reductions in capacity due to maintenance

AEMO ignores a capacity reduction if the capacity of a *generating unit* is forecast to be reduced for maintenance reasons. AEMO will consult with the registered owner to determine if the forecast capacity reduction is maintenance related.

5.5 Supply-demand balance

AEMO uses the minimal extrapolation principle to balance supply and demand. AEMO uses *generation* data from the previous financial year (historical *generation* data) and then extrapolates this data to balance supply and demand. This follows updating of the network model, scaling the *connection point loads*, and including any committed new *generating units*.

The availability of a *generating unit* is used to denote the level to which it can be dispatched. An availability of zero means the *generating unit* is unavailable for dispatch. A *generating unit* is considered available in a period if its availability in the equivalent historic period was greater than zero.

AEMO obtains the availability status of each *generating unit* for each trading interval from *market* data. The availability of a *generating unit* is a factor that is considered in the adjustment of the supply-demand balance for those trading periods when it is necessary to increase the level of *generation*. This is discussed in section 5.5.2.

[2] Or as updated on AEMO's website - Generation Information Page.

5.5.1 Excess generation

There will be an excess of *generation* for each trading interval where the forecast connection point loads have grown by less than the initial forecast of the output of the new *generating units*.[3] For these trading intervals, AEMO reduces the net *generation* by scaling the output of all the *generating units* in proportion to their historical output.

For new *generating units*, AEMO scales the initial estimate of the output in the same manner as the historical output of the existing *generating units*. For energy limited *generating units*, including pumps, AEMO does not adjust the output.

5.5.2 Insufficient generation

There will be a deficit of *generation* for each trading interval where the *connection point loads* have grown by more than the initial estimate of the output of the *new generating units*.[3] For these trading intervals, AEMO increases the net *generation* in the following order of priority:

1. The spare capacity of non-energy limited *generating units* that are currently running (ON) is dispatched in proportion to the spare capacity of each *generating unit*.
2. The capacity of the non-energy limited *generating units* that were not running (OFF) but available is dispatched in proportion to the capacity of each *generating unit*.
3. Dispatchable pumps are reduced in proportion to their historical *load*.
4. The capacity of the non-energy limited *generating units* that were not running (OFF) and are unavailable is dispatched in proportion to the capacity of each *generating unit.*
5. The spare capacity of hydro *generating units* is dispatched in proportion to the spare capacity of each *generating unit*.
6. Dummy *generating units* (created in the *load* flow simulation due to a *generation* shortfall created) are dispatched at the RRN.[4]

The extrapolated generation energy is subject to the following:

$$Gen_{forecast} > Gen_{hist} \times Gen_{ret\,\%} \times Percent\_demand\_increase \times buffer$$

where:

$Gen_{forecast}$ = Extrapolated generation energy (GWh)

Gen_{hist} = 5-year historical average (GWh) ignoring outliers in years t-2 to t-5

$Gen_{ret\_\%}$ = Retired generation in target year as a % total NEM generation (%)

$Percent\_Demand\_increase$ = Percentage increase in NEM demand in target year compared to historical year (%)

$Buffer$ = Factor to account for variations from the 5-year average and/or conditions where insufficient generation exists

AEMO does not adjust the output of transmission connected wind farms, and for new *generating units,* AEMO scales the initial estimate of the output in the same manner as the historical output of the existing *generating units*.

5.5.3 Parallel AC and DC links

For *inter-regional* flows where a regulated DC link is in parallel to other AC circuits, AEMO apportions flow between the DC and AC elements in proportion to the maximum capabilities of the DC and AC circuits. AEMO uses different ratios where the capabilities are not the same in each direction.

AEMO treats new regulated DC links in parallel with other AC circuits in the same manner as existing DC links in parallel with other AC circuits.

[3] Network augmentations also affect the supply/demand balance by altering the network losses.
[4] Dispatching a dummy generating unit at the RRN is equivalent to *load* shedding.

5.5.4 Interconnector limits

AEMO implements representative interconnector limits for summer and winter, and peak and off peak periods for the Target Year consistent with the limits described in the latest ESOO. AEMO consults with TNSPs when developing these representative limits.

AEMO may need to adjust *generation* to maintain *inter-regional* flows within the respective transfer capabilities. This requirement could arise through the interaction of interconnector limits and *load* growth and new *generation.*

5.5.5 Switchable connection points

A *generating unit* or *load* may be physically switchable between two (or more) *connection points.* An example is Yallourn Unit 1 which can either be connected to the Victorian 500 kV or 220 kV networks. For these types of connections, AEMO allocates the *load* or *generating unit* metering data to the appropriate *connection point*. AEMO then calculates separate loss factors for each *connection point* and volume weights these loss factors to give a single MLF.

AEMO assumes that for trading intervals where the *generating unit* is ON, the *connection point* is unchanged from the state in the historical *generating unit* data. Further, when the *generating unit* or *load* is OFF but is required to be dispatched, then AEMO assume that the *connection point* state has not changed since the last known state. This is in accordance with the principle of minimum extrapolation.

The operator of a switchable *load* or *generating unit* may consider that in the Target Year, the switching pattern of their *generating unit* will differ significantly from the historical switching pattern. Where the operator expects that the *generating unit* switching will differ by more than five days in aggregate, then the associated TNSP consults with the operator of the *generating unit*, to prepare an appropriate switching profile for the Target Year.

5.5.6 Abnormal generation patterns

This clause applies when a *Generator* or AEMO believes that an historical *generation* profile will not reflect a future *generation* profile.

A *Generator* may, on its own initiative or at AEMO's request, provide an adjusted *generation* profile to AEMO by 15 November. AEMO then reviews the adjusted *generation* profile, and considers whether to use the adjusted *generation* profile in lieu of the historical *generation* profile. AEMO may only decide to accept an adjusted generation profile if it is satisfied that:

- The historical *generation* profile is clearly unrepresentative of the expected *generation* profile for the following year.
- The adjusted *generation* profile is independently verifiable and based on physical circumstances only, such as:
  - Drought conditions.
  - Low storage levels or rainfall variability for hydroelectric *generating units*.
  - Major plant failures resulting in forced outages of greater than four weeks.
  - Failure in the supply chain impacting on fuel availability.
- The adjusted *generation* profile is not *market*-related and does not arise as a result of the financial position of the *Generator*.
- The adjusted *generation* profile is not claimed to be confidential, as AEMO will *publish* it along with its reasoning for using an adjusted *generation* profile as part of the report accompanying the publication of the MLFs.

AEMO may seek an independent review of any adjusted *generation* profile submitted by a *Generator.*

If AEMO accepts an adjusted *generation* profile, this information is published on 1 April. The information is aggregated quarterly on a regional or sub-regional level.

AEMO historically reviews how adjusted *generation* profiles compared with actual *generation* profiles. AEMO publishes a summary of the review, with *generation* profiles aggregated quarterly on a regional or sub-regional level.

AEMO calculates, and publishes in October each year, indicative extrapolated *generation* data for scheduled *generating units* along with key inputs and modelling assumptions to assist *Generators* to identify grossly incorrect historical *generation* data. The calculation will be approximate and will:

- Only reflect information known at the time.
- Only include existing and major new *connection points*.
- Only include an approximate load forecast.
- Be based on the previous year's network model, and will not include new augmentations.

5.6 Intra-regional static loss factors

AEMO uses TPRICE[5] or an equivalent software application to calculate loss factors. The calculation algorithm can be summarised as:

- A load *flow* is solved for each trading interval using the supplied *generation* and *load* data.
- The MLFs for the *load* flow swing bus[6] are calculated for each *connection point* and *trading interval* from a Jacobian matrix.
- The MLFs for the associated RRN are calculated for each trading interval as the ratio of the *connection point* loss factor to the associated RRN loss factor.
- For each *connection point*, the *marginal loss factors* (with respect to the RRN) for each trading interval are volume weighted by connection point MLFs (with respect to the RRN) to give the static MLF.

AEMO may include a number of voltage control buses to improve the stability of the *load* flow solution. AEMO limits the use of voltage controlled buses to those on the backbone of the high voltage network.

5.6.1 Dual MLFs

AEMO calculates dual MLFs for transmission network *connection points* where a single MLF for the transmission network *connection point* does not satisfactorily represent transmission network losses for active energy *generation* and consumption. AEMO applies to duals MLFs to:

- Transmission network connection points classified as Pump Storage Schemes.
- Other transmission network connection points where the net energy balance (NEB) is less than 30%.

The NEB threshold test is as follows:

Determine the percentage NEB by expressing the net energy at a transmission connection point as a percentage of the total energy generated or consumed at a transmission connection point, whichever is greater.

$$\mathrm{NEB} = \frac{\mathrm{Absolute(Sum\ of\ energy\ generated\ and\ consumed)}}{\mathrm{Maximum(Absolute(energy\ generated), Absolute(energy\ consumed))}}$$

Where

$\mathrm{Absolute}(\mathrm{x})$ is the absolute value of x; and

$\mathrm{Maximum}(\mathrm{x},\mathrm{y})$ is the maximum value of x and y.

Refer to Appendix D for a worked example.

[5] The TPrice application calculates the loss factor for each *connection point* and RRN referred to the *load* flow swing bus defined in the network model. The loss factor of *connection point* A referred to *connection point* B is defined as the ratio of their respective loss factors with respect to the swing bus.

[6] The selection of swing bus does not directly affect the *marginal loss factors* with respect to the assigned *regional reference node*. There is a small effect on the flows in the network flows from changing the swing bus and this has a small indirect effect on the loss factors.

5.6.2 Virtual transmission nodes (VTN)

AEMO calculates intra-regional loss factors which are averaged over an adjacent group of transmission network connection *points* collectively defined as a VTN. Refer to Appendix E for the calculation methodology.

5.7 Inter-regional loss factor equations

5.7.1 Regression procedure

AEMO determines *inter-regional marginal loss factor* equations by using linear regression analysis. The procedure is as follows:

- The *marginal loss factors* for each of the RRNs, defined with respect to the swing bus, are extracted from the output of the TPRICE run used to calculate the *intra-regional loss factors*.
- For each pair of adjacent RRNs:
  - The *inter-regional marginal loss factors* are calculated for each trading interval as the ratio of *marginal loss factors* of the associated RRNs.
  - The inter-regional loss factor equations are estimated by regressing the *inter-regional marginal loss factors* against the associated interconnector flow and selected regional demands.

The regional demands are included in the inter-regional loss factor equations if they significantly improve the fit of the regression equation.

Where the fit of an *inter-regional loss factor* regression is poor, then AEMO considers using additional variables in the regression analysis, including:

- The output of specific *generating units* that affect the *inter-regional losses* (for example losses on QNI would be affected by *generation* at Millmerran).
- Transfers on other interconnectors.

Including these variables would require alterations to the AEMO *market* systems.

5.7.2 Loop flows

At present the regional model of the NEM is linear because interconnectors between regions do not form loops. Loop flows may be introduced in the future if additional interconnectors are built between regions that are not currently interconnected or if the region model is modified.

If loops are introduced into the NEM regional model, then the forward-looking loss factor methodology may need to be revised.

5.7.3 Modelled generating unit and load data

Where the range of interconnector flows is less than approximately 75% of the technically available range of the interconnector flows or where the regression fit is poor, the resulting *inter-regional* loss faction equation will be unrepresentative.

For these scenarios the *load* and *generating unit* data are scaled in a power simulation tool to produce a set of randomly distributed flows covering the technically available range of the interconnector flows. The regression analysis is repeated using the modelled data obtained from these flows. The modelled *generating unit* and *load* data would not be used for calculating *intra-regional loss factors*.

5.8 Publication

AEMO *publish*es the *intra-regional loss factors* and *inter-regional loss factor* equations by 1 April prior to the Target Year.

5.9 Unexpected and unusual system conditions

In developing this methodology, AEMO used best endeavours to cover all expected operating and system conditions that could arise when producing the *load, generating unit* and network dataset that represents the Target Year.

In practice, unexpected operating or system conditions can arise that are not covered in this Methodology. If this arises, then AEMO will make a judgement based on the principles listed in the NER and in section 5. All such judgements that AEMO is required to make while developing the MLFs will be identified in the *published* report listing the loss factors.

5.10 New connection points or interconnectors

AEMO publishes MLFs and *inter-regional loss factor* equations by 1 April prior to each Target Year. If AEMO is notified after 1 April of new connection points or new interconnectors that require MLFs *or inter-regional loss factor* equations, then AEMO follows the procedure specified in this section.

5.10.1 Network

The *network* representation used to calculate the MLFs for the new *connection point* is based on the *network* used to perform the most recent annual MLF calculation.

The *network* representation is modified to incorporate the new *connection point*. This may include addition of new or changed *transmission elements* or modifications to existing *connection points*.

5.10.2 Generation and Load data

The *connection point load* and *generating unit* data used to calculate the MLFs for the new *connection point* is based on the *connection point* data used to perform the most recent annual MLF calculation.

If the new *connection point* is a *load,* the relevant TNSP supplies AEMO with the *load* data for each *trading interval* following the commissioning of the *connection point*. If the new *connection point* is a *generating unit,* AEMO determines an estimate of the *dispatch* for the new *generating unit* using the procedure set out in section 5.4.

5.10.3 Methodology

The procedure in section 5.5 is applied to restore the supply-demand balance by making adjustments to the output of *generating units*. This would be the same procedure used by AEMO to perform the most recent annual MLF calculation. The *intra-regional loss factor* for the new *connection point* would be calculated using the procedure in section 5.6.

When AEMO calculates the MLF for a new *connection point*, MLF values for existing *connection points* in the vicinity may also be affected. However, when a new *connection point* is established after the MLFs have been *published,* AEMO will not revise the *published* MLFs for the existing connection points.

APPENDIX A. TIMELINE

Date	Action	Section
August	AEMO commences work for Target Year commencing on the following 1 July	
October	AEMO publishes indicative generation extrapolation results	5.5.6
15 October	AEMO provides historical connection point load data to TNSPs	5.2.1
15 November	Deadline for Generators to inform AEMO of abnormal generation conditions in the Target Year	5.5.6
15 January	Deadline for updates on AEMO website (Generation page) to be included.	5.4.1
15 January	TNSPs produce load forecast	5.2.1
1 April	AEMO publishes intra-regional loss factors and inter-regional loss equations on website	5.8
1 April to end of Target Year	AEMO calculates and publishes, as required • MLFs for newly registered connection points, and • inter-regional loss factor equations for new interconnectors	5.11
1 July	Intra-regional loss factors and inter-regional loss equations effective in market systems	2

APPENDIX B. NEW GENERATING UNITS

This appendix describes the process where proponents of a new *generating unit* provide to AEMO the information necessary to determine the forecast generating data. The process ensures that proponents provide credible information. The process is:

- AEMO assumes each new *generating unit* operates continuously at full capacity from its installation date.
- Reductions from full capacity are valid only if AEMO receives credible advice from the operator detailing:
  - Forced outages.
  - Planned outages.
  - An energy limit.
  - An intent to operate only when the relevant spot price exceeds a stated value, or
  - *Generation* being determined by factors outside the control of the *Generator* such as the seasonal nature of the fuel source.
- Any specified reductions due to forced outages are incorporated as a uniform reduction in availability.
- Any specified reduction due to planned outages is applied during periods specified by the Generator.
- Any specified energy limit shall be applied by distributing *generation,* from the previous financial year, from the highest price settlement period to lower-priced periods until the specified energy is exhausted.
- Where an intent to operate only above a specified price is applied, the *generation* profile comprises full capacity when the corresponding historical price exceeds the specified value, and zero at other times.
- Where an external factor is limiting production, the *generation* profile is as specified by the generator, provided this is accepted as reasonable by AEMO.

APPENDIX C. DATA REQUIRED BY AEMO

The following table summarises the data necessary for AEMO to implement the forward-looking loss factor methodology. The table includes a description and the source of each item of data.

Data	Description	Source
Existing Load Connection Points		
Connection point load	MW & MVAr by trading interval	AEMO or relevant TNSP (AEMO will estimate the data if it is not supplied)
New Load Connection Points		
Estimated commissioning date	Date of commercial operation	Latest ESOO, confirmed with proponent
Connection point load	MW & MVAr by trading interval	AEMO or relevant TNSP
Existing generating units		
Generator terminal capacity for summer and winter	Summer and winter MW values	Latest ESOO
Auxiliary requirements for summer and winter	Summer and winter MW values	AEMO estimate with consultation with the Generator
Historical generation profile	MW by trading interval	AEMO settlements data
Availability status by trading interval	Status by trading interval	AEMO market systems
New generating units		
Estimated commissioning date	Date of commercial operation	Latest ESOO, confirmed with the owner
Nameplate rating	MW	Latest ESOO, confirmed with the owner
Similar generating units	List of generating units	AEMO discussions with the owner
Generation profile of similar generating units	MW by trading interval	AEMO settlements data
Existing MNSP		
Historical energy transfer profile	MW by trading interval	AEMO settlements data
New MNSP		
Estimated commissioning date	Date of commercial operation	Latest ESOO, confirmed with proponent
Interconnector Capability		
Capacity in each	MW by trading interval	Latest ESOO, in consultation with the TNSPs
Existing transmission network		
Network data and configuration	Load flow, representative of system normal	EMS and operating procedures
Transmission network augmentations		
List of network augmentations	List of augmentations	Latest ESOO, in consultation with the TNSPs
Estimated commissioning date	Date of commercial operation	Latest ESOO, in consultation with the relevant TNSP
Network element impedances	Network element impedances	Relevant TNSPs

APPENDIX D. NEB CALCULATION EXAMPLE

Consider a transmission network connection point that includes two generators and two loads.

Interval	Gen 1 (GWh)	Gen 2 (GWh)	Load 1 (GWh)	Load 2 (GWh)	Flow on transmission network connection point (GWh)		
					Net	Generation	Load
Period 1	12	2	0	-10	4	4	
Period 2	13	5	-2	-20	-4		-4
Period 3	11	8	0	-10	9	9	
Period 4	10	8	-1	-30	-13		-13
Period 5	9	6	0	-25	-10		-10
Period 6	21	8	-2	-10	17	17	
Period 7	15	2	-1	-15	1	1	
Period 8	13	0	-2	-25	-14		-14
Period 9	3	8	0	-30	-19		-19
Period 10	23	8	-1	-10	20	20	
Total	**130**	**55**	**-9**	**-185**	**-9**	**51**	**-60**

Net energy at transmission network connection point = 9 GWh

Net generation at transmission network connection point = 51 GWh

Net load at transmission network connection point = -60 GWh

$$\mathrm{NEB} = \frac{\mathrm{Absolute(Sum\ of\ energy\ generated\ and\ consumed)}}{\mathrm{Maximum(Absolute(energy\ generated), Absolute(energy\ consumed))}}$$

$$\mathrm{NEB} = \frac{\mathrm{Absolute}(9)}{\mathrm{Maximum}(\mathrm{Absolute}(51), \mathrm{Absolute}(-60))}$$

$$\mathrm{NEB} = 15\%$$

APPENDIX E. METHOD FOR CALCULATING AVERAGE TRANSMISSION LOSS FACTORS FOR VTNS

Each distribution network service provider (DNSP) must provide to AEMO by 1 March:

- A description of the DNSP's proposed VTNs, including an unambiguous specification of which transmission network connection points constitute the VTN; and
- Written approval from the AER for each proposed VTN as required by clause 3.6.2(b)(3) of the NER.

AEMO calculates the average loss factor for each VTN using the annual energy for the respective transmission network connection points as weightings for the marginal loss factors for the transmission network connection points that constitute the VTN.

The average transmission loss factor for the VTN is calculated according to:

$$MLF_V = \frac{\sum(MLF_n \times P_n)}{\sum P_n}$$

where

VTN V constitutes each transmission connection points n, as specified the DNSP and approved by the AER;

MLF_V is the marginal loss factor that applies for the next financial year to VTN V;

MLF_n is the intra-regional loss factor that applies for the next financial year to transmission connection point n; and

P_n is the annual energy for each transmission connection point n that was used to calculate the MLF_n for the next financial year.

The connection point data used by AEMO to calculate the P_n values used as weights is the same connection point data used to calculate MLF_n.

AEMO determines and publishes the intra-regional loss factors for each VTN requested by the DNSP in by 1 April. These VTN loss factors are to apply for the next financial year.

AEMO applies the intra-regional loss factors for each VTN from 1 July.

GLOSSARY

- In this document, a word or phrase in this style has the same meaning as given to that term in the NER.
- In this document phrases or acronyms have the meaning set out in the table below.
- Unless the context otherwise requires, this document will be interpreted in accordance with Schedule 2 of the National Electricity Law.

AEMO	The Australian Energy Market Operator
AER	Australian Energy Regulator
AC	Alternating current
Commissioning Date	Within this Methodology the commissioning date is defined as the anticipated date of commercial service.
DC	Direct current
DNSP	Distribution Network Service Provider
EMS	Energy management system
ESOO	Electricity Statements of Opportunities – published annually by AEMO in August
FLLF	Forward looking loss factors
MLF	Marginal loss factors
MNSPs	Market Network Service Providers
NEM	National Electricity Market
NER	National Electricity Rules
Pump Storage Schemes	A hydro generating unit, or group of hydro generating units, that can operate both as a generator and a pump
RRN	Regional reference node
TNSP	Transmission Network Service Provider
Target Year	The financial year (1 July - 30 June) in which particular loss factors and loss equations determined under this Methodology are to be applied