FORWARD-LOOKING TRANSMISSION LOSS FACTORS

FINAL REPORT AND DETERMINATION

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EXECUTIVE SUMMARY

The publication of this Final Report and Determination (Report) concludes the Rules consultation process conducted by AEMO to amend the methodology for forward-looking transmission loss factors (FLLF methodology) under the National Electricity Rules (NER).

The NER require AEMO to calculate and publish, by 1 April each year, the inter-regional loss factor equations and intra-regional loss factors for interconnectors and transmission connection points in the National Electricity Market (NEM) for the next financial year. The FLLF methodology sets out the process by which these factors are determined, based on the principles in the NER.

This consultation focused on the following key areas of the methodology:

- Load forecast data.
- Controllable network element flow data.
- Generator data.
- Supply demand balance.
- Publication.
- Unexpected and unusual system conditions.

AEMO's final determination is to amend the **Forward-Looking Transmission Loss Factors** methodology in the form published with this Report. The effective date of the amended methodology will be 18 December 2020. The amended methodology will apply to the calculation of MLFs for the 2021-22 financial year onwards.

CONTENTS

1. STAKEHOLDER CONSULTATION PROCESS

AEMO has consulted on amendments to the FLLF methodology in accordance with the Rules consultation procedures in rule 8.9 of the National Electricity Rules (NER).

AEMO's timeline for this consultation is outlined below.

Deliverable	Indicative date
Notice of first stage consultation and Issues Paper published	20 August 2020
First stage submissions closed	25 September 2020
Draft Report & Notice of second stage consultation published	6 November 2020
Submissions due on Draft Report	27 November 2020
Final Report published	18 December 2020

The publication of this Report concludes this consultation.

Note that there is a glossary of terms used in this Report at **Appendix A**.

2. BACKGROUND

2.1. NER requirements

The NER requirements for AEMO to establish methodologies relating to the determination of inter-regional loss factor equations and intra-regional loss factors are set out in five separate clauses in rule 3.6:

Clause 3.6.1(c):

> *AEMO must determine, publish and maintain, in accordance with the Rules consultation procedures, a methodology for the determination of inter-regional loss factor equations for a financial year, describing inter-regional loss factors between each pair of adjacent regional reference nodes in terms of significant variables.*

Clause 3.6.2(d):

> *AEMO must determine, publish and maintain, in accordance with Rules consultation procedures, a methodology for the determination of intra-regional loss factors to apply for a financial year for each transmission network connection point.*

Clause 3.6.2(d1):

> *AEMO must determine, publish and maintain, in consultation with Registered Participants, a procedure that includes a description of the manner in which AEMO will, if two intra-regional loss factors apply to a transmission network connection point, apply two intra-regional loss factors in central dispatch and spot market transactions. The procedure determined under this paragraph (d1) must describe how AEMO will identify and measure the generation and load at each transmission network connection point and apply the relevant intra-regional loss factor against that generation or load.*

Clause 3.6.2(g):

> *AEMO must, in accordance with the Rules consultation procedures, determine, publish and maintain the methodology which is to apply to the calculation of average intra-regional loss factors, determined in accordance with clause 3.6.2(b)(3), for each virtual transmission node proposed by a Distribution Network Service Provider.*

Clause 3.6.2A(b):

> *AEMO must determine, publish and maintain, in accordance with the Rules consultation procedures, a methodology for:*
>
> *(1) forecasting the load and generation data to be used in both the determination of inter-regional loss factor equations and intraregional loss factors, including new or revised intra-regional loss factors for connection points that are established or modified, respectively, during the financial year in which the intra-regional loss factors are to apply;*
>
> *(2) modelling additional load and generation data, where required, to be used in determining inter-regional loss factor equations; and*
>
> *(3) the collection of relevant data from Registered Participants, including without limitation deadlines for the provision of that data by Registered Participants.*

Clauses 3.6.1(d), 3.6.2(e) and 3.6.2A(d) of the NER respectively set out the principles that AEMO is required to implement in the relevant methodology for inter-regional loss factors, intra-regional loss factors, and forecast load and generation data.

The FLLF methodology incorporates the methodologies developed to address each of the above NER requirements.

2.2. Context for this consultation

The matter for consultation is proposed amendments to the FLLF methodology. AEMO is seeking to improve the methodology for determining intra-regional loss factors, commonly referred to as marginal loss factors (MLFs).

2.3. First stage consultation

AEMO issued a Notice of First Stage Consultation and an Issues Paper on 20 August 2020.

AEMO received four written submissions in the first stage of consultation, from AGL Energy (AGL), the Clean Energy Investor Group (CEIG), ERM Power (ERM) and Origin Energy (Origin). Copies of all written submissions (excluding any confidential information) have been published on AEMO's website at: https://aemo.com.au/en/consultations/current-and-closed-consultations/forward-looking-transmission-loss-factors.

AEMO held three stakeholder workshops with participants in June 2020. Copies of session notes and slide packs from the workshops are published on AEMO's website at: https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/market-operations/loss-factors-and-regional-boundaries/review-of-marginal-loss-factor-calculation-processes.

AEMO also held an information session with participants on 14 September 2020, providing an opportunity to address questions and clarifications on the Issues Paper.

2.4. Second stage consultation

AEMO issued a Notice of Second Stage Consultation and its Draft Report and Determination on 6 November 2020.

AEMO received one written submission in the second stage of consultation (a further submission from CEIG) and held one information session with participants on 17 November 2020. Copies of the submission and slide packs from workshops and information sessions are available at the pages linked in section 2.3 above.

3. SUMMARY OF MATERIAL ISSUES

The key material issues arising from AEMO's proposal or raised by Consulted Persons are summarised in the following table:

No.	Issue	Raised by
1.	Reference Data	AEMO
2.	MNSP rule change implementation	AEMO
3.	Generator capacities	AEMO
4.	New generation profiles	AEMO
5.	Minimum stable operation levels of thermal plant	AEMO
6.	Minimal extrapolation theory	AEMO
7.	Extrapolation capping	AEMO
8.	Parallel AC/DC interconnectors	AEMO
9.	Intra-regional limits	AEMO
10.	Transparency of MLFs	AEMO
11.	Intra-year revisions	AEMO
12.	Energy generation forecast study	AEMO
13.	Treatment of problematic historical data	AEMO
14.	Treatment of connected loads in close proximity to interconnectors	ERM
15.	Net energy balance and dual MLFs	AEMO

A detailed summary of issues raised by Consulted Persons in submissions together with AEMO's responses, is contained in **Appendix B**.

4. DISCUSSION OF MATERIAL ISSUES

This section contains a brief summary of the issues, submissions and AEMO's assessment and final decision on each of them. For completeness, this section covers the feedback provided in submissions to both rounds of consultation.

For a more detailed discussion of the issues, please refer to AEMO's issues paper and participant submissions, at: https://aemo.com.au/en/consultations/current-and-closed-consultations/forward-looking-transmission-loss-factors. Note that issues 14 and 15 were not discussed in the Issues Paper, as they were identified during the consultation.

4.1. Reference data

Currently AEMO follows a three-year cycle for the use of load data in the MLF calculation. AEMO requested feedback on the suitability of the timeline in the context of an increasingly dynamic market. Stakeholders provided feedback on this issue as follows:

- Origin supported the use of more recent data if it improves accuracy and can be incorporated in a timely manner.
- ERM stated that the choice of historical reference year would have a relatively minor impact of the accuracy of the FLLF.

4.1.1. AEMO's assessment

AEMO agrees with ERM that the likely impact of incorporating more recent load data would be of relatively low value. Further investigation to identify and implement suitable changes would require significant resources due to the fact that the MLF process relies on a large number of inputs that use the financial year definition. AEMO therefore considers that the potential limited benefit is not justified.

4.1.2. AEMO's conclusion

No changes to the FLLF methodology will be made in respect of reference load data for the MLF calculation.

4.2. MNSP rule change implementation

Historically, the NER mandated that Market Network Service Providers (MNSPs) were to be treated as invariant. A recent rule change[1] removed this requirement and as such options for incorporation of MNSPs (Basslink) into the supply/demand balancing process have been investigated.

- AGL supported AEMO modelling Basslink as a dispatchable element.
- ERM requested that AEMO provide supporting evidence on the benefit/disbenefit of incorporating Basslink into dispatch.

4.2.1. AEMO's assessment

AEMO has further investigated the potential options for incorporation of MNSPs into the global supply and demand balancing process. However, modelling has shown that adjusting Basslink flows in response to changes in Tasmania supply/demand balance was less reflective of typical operation, and resulted in poorer MLF outcomes for both Tasmania and the mainland. Historical analysis has shown that Basslink operation is governed by additional factors other than just Tasmania supply/demand balance, for instance commercial operation and FCAS services with the mainland.

4.2.2. AEMO's conclusion

No changes to the FLLF methodology will be made to incorporate MNSP dispatch outcomes at this stage, but AEMO will reconsider this issue when assessing future alternatives or upgrades to the current MLF engine.

4.3. Generator capacities

Generating unit summer capacities are derived from the Electricity Statement of Opportunities (ESOO) based on a 10% probability of exceedance, which tends to lead to generators being constrained in the FLLF model to output levels well below their likely actual maximum output levels. AEMO proposed substituting this with typical summer capacities instead. Stakeholders provided feedback on this issue as follows:

- Origin supported the proposal and suggested the possibility of using a weighted mean of summer temperatures.
- ERM supported the proposal.

4.3.1. AEMO's assessment

Based on current Generator Information data, the use of typical summer capacities results in 3% greater capacity of total generation available in the FLLF study.

[1] AEMC, Transmission Loss Factors, at: https://www.aemc.gov.au/rule-changes/transmission-loss-factors

	Summer capacity	Typical summer capacity
Total capacity (commissioned and committed)	47,606 MW	49,200 MW

An analysis of a range of different types of generation indicates that typical summer capacities generally are more reflective of historical output than summer capacities. In general, the use of typical summer capacities is likely to lead to more reflective MLF outcomes.

4.3.2. AEMO's conclusion

AEMO will implement a change to the FLLF methodology to specify the utilisation of typical summer capacities.

4.4. New generation profiles

The processes described in the FLLF methodology for forecasting new generation profiles are outdated and in need of revision to more accurately reflect likely output. For solar and wind, AEMO proposed to align the FLLF methodology with the processes described in the Market Modelling Methodologies document[2]. For other generation and storage types, AEMO proposed to update the FLLF methodology to clarify that it will consult with proponents to determine an appropriate profile. Stakeholders provided feedback on this issue as follows:

- AGL suggested using a commissioning profile dependent on location for solar, and for AEMO to consider providing input into the commercial operational date for the plant.
- CEIG supported the proposal.
- Origin supported the proposal.
- ERM supported the proposal.

4.4.1. AEMO's assessment

AEMO considers that the proposed changes to the determination of the new generation profiles will ensure that MLF outcomes in respect of new wind and solar generation are more reflective of marginal electrical energy losses. AEMO believes that concerns around fixed commissioning profiles can be mitigated by giving proponents an opportunity to propose an alternative where they can provide supporting evidence demonstrating why the alternative will provide a more reflective forecast of timing and generation output during the commissioning period.

4.4.2. AEMO's conclusion

AEMO will determine new generation profiles in the FLLF methodology for wind and solar consistent with the Market Modelling Methodologies document. The methodology will also be amended to clarify provisions for proponents to review the profiles and consult on alternative proposals.

4.5. Minimum stable operation levels of thermal plant

AEMO sought feedback from stakeholders on the proposed manual process to determine, and then implement, minimum stable operation levels of thermal plant in the FLLF model. The Input and

[2] https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/Inputs-AssumptionsMethodologies/2019/Market-Modelling-Methodology-Paper.pdf

Assumptions Workbook[3] (a supporting document for the ESOO) was identified as one possible source of information that could assist in the assessment of minimum stable operation levels.

- CEIG stated that by using data from the Input and Assumptions Workbook to determine appropriate minimum operation levels, the MLF calculation is likely to over-estimate thermal plant MLFs and underestimate non-thermal plant MLFs. CEIG suggested AEMO should use historic thermal generator bidding data instead (based on bids at price band 1) plus the volumes bid at lower than -$100.
- Origin supported AEMO's approach where it ensures that minimum stable operational levels are met.
- ERM requested further details on the proposed change and expressed concerns about the proposed source of the minimum stable operation levels. ERM suggested that direct enquiries to proponents, rather than the use of third-party consultants, may be more suitable.

4.5.1. AEMO's assessment

MLF calculations should not be materially impacted by disregarding real operational limits such as minimum stable operation levels. AEMO agrees with CEIG and ERM that the Input and Assumptions Workbook alone is not sufficiently reliable for this purpose. The data from the Input and Assumptions Workbook should be assessed in conjunction with historical data and in consultation with the respective generator in order to determine appropriate minimum stable operation levels.

Note that a determination of minimum stable operation levels in respect of a generator would be a resource-intensive task and this process would need to be limited to scenarios that AEMO has identified as material.

4.5.2. AEMO's conclusion

AEMO will review supply and demand balancing outcomes for potential material impacts from minimum stable operation levels for large thermal units. Where a potential material impact is identified, AEMO will adjust and perform reruns as necessary.

Where there is a potential material impact identified, AEMO will estimate minimum stable operation levels based on data from the ESOO, historical data, and information provided in consultation with generators.

4.6. Minimal extrapolation theory

AEMO sought feedback as to whether the principle of minimal extrapolation remained fit for purpose given increasingly rapid changes to the generation mix. Minimal extrapolation is used to adjust generation to account for changes in supply and demand patterns between the Reference Year and the Target Year. The principle of minimal extrapolation is intended to avoid the need for complex generation modelling, by scaling generation only by the minimum amount needed. The changing generation mix has led to some issues with minimal extrapolation, as it was only originally intended for thermal and hydro generation.

- CEIG stated that the decision to retain the classification of wind and solar generation as energy-limited (revised to resource constrained) is likely to lead to over-prediction of future wind and solar generation and under-prediction of thermal generation. CEIG also stated that much of the economic curtailment typically occurs during times of high solar generation.
- Origin stated that the principle should be retained, but that the generation categories should be expanded. More complex systems, such as the use of short-run marginal cost (SRMC) estimates, may be problematic in the changing generation mix.

[3] The 2019 Input and Assumptions workbook can be found at https://aemo.com.au//media/files/electricity/nem/planning_and_forecasting/inputs-assumptions-methodologies/2019/2019-input-and-assumptionsworkbook-v1-3-dec-19.xlsx?la=en

- ERM noted that the use of an SRMC bidding based dispatch model would improve forecast dispatch outcomes for MNSPs and requested further details on the proposed options.

4.6.1. AEMO's assessment

AEMO agrees with Origin that, in the absence of a more fundamental change to the MLF calculation engine, the principle of minimal extrapolation should be retained. AEMO notes that both the expansion of generation categories and the implementation of an SRMC bidding based dispatch model would require a substantial investment in updating the MLF calculation engine.

AEMO agrees with CEIG that, the existing process of allocating wind and solar generators to the energy-limited (now resource constrained) is likely to result in an over-prediction of wind and solar generation and under-prediction of thermal generation. However, AEMO notes that economic curtailment levels for wind and solar generation are currently not in alignment with the economic behaviour of thermal generation. As such AEMO does not find it appropriate to incorporate wind and solar generation at the same level as thermal generation within the minimal extrapolation theory.

AEMO notes the feedback from CEIG that economic curtailment of wind and solar generation is diurnal in nature, tending to occur mostly during periods of high solar generation.

4.6.2. AEMO's conclusion

AEMO will implement a change to the methodology, allowing AEMO to adjust the forecast generation profiles for both wind and solar to represent commercial curtailment. The levels of economic curtailment will be based on observations from the reference year and will be applied on a regional basis. The curtailment will be performed by scaling forecast generation profiles based the behaviour observed in the reference year.

AEMO will consider this issue further when assessing future alternatives or upgrades to the MLF calculation engine.

4.7. Extrapolation capping

AEMO sought feedback on the merits of retaining extrapolation capping (whereby AEMO caps forecast generation in situations such as the exit of a large generator to ensure that generation forecasts remain consistent with historical outcomes), or whether any other possible improvements could be made to MLF outcomes following the exit of a large generator.

- ERM suggested that the process implemented prior to the closure of Hazelwood Power Station is unlikely to be required for the 2021-22 financial year, however retention of this process is warranted for future years unless an appropriate SRMC bidding methodology is applied.

4.7.1. AEMO's assessment

There is no basis for AEMO to pursue changes to extrapolation capping at this stage.

4.7.2. AEMO's conclusion

No changes to the FLLF methodology will be made in respect of extrapolation capping, but AEMO will reconsider this issue when assessing future alternatives or upgrades to the MLF calculation engine.

4.8. Parallel AC/DC interconnectors

AEMO proposed an alternative approach to modelling DC interconnectors (where they are parallel with AC interconnectors) involving allocating flows using a ratio derived from historical flows within the reference year.

- Origin supported AEMO's proposed approach.
- ERM supported AEMO's proposed approach where the relationship is derived from historical behaviour under all system normal conditions, noting that if a suitable SRMC bidding methodology could be implemented, the tying of flows between parallel AC and DC interconnectors would be unnecessary.

4.8.1. AEMO's assessment

Utilising the relationship (under system normal conditions) between historical flows as a basis for forecast flows for parallel AC/DC interconnectors will lead to MLF outcomes that are more reflective of marginal electrical energy losses.

4.8.2. AEMO's conclusion

AEMO will incorporate this change and expand the historical samples to include intervals where flows were bound by system normal limits.

4.9. Intra-regional limits

AEMO sought feedback as to whether stakeholders would value the addition of a section in the FLLF methodology that delineated AEMO's approach to managing intraregional limits.

- AGL supported AEMO publishing the process for managing intra-regional limits in the methodology as well as details of the limits themselves.
- Origin supported AEMO publishing the process for managing intra-regional limits.
- ERM supported AEMO publishing the process for managing intra-regional limits and requested that AEMO provide details on the proposed changes.

4.9.1. AEMO's assessment

The addition of a description of the process for management of intra-regional limits within the FLLF methodology will increase transparency for participants.

4.9.2. AEMO's conclusion

AEMO will include a description of the process it follows to manage intra-regional limits in the FLLF methodology and a requirement to publish details of any intra-regional limits that have been considered in the MLF report. This is included in Section 5.5.6 of the methodology.

4.10. Transparency of MLFs

AEMO sought feedback on whether the existing MLF report publication timetable (including the preliminary MLF report) was fit for purpose. AEMO also proposed the addition of a scenario sensitivity study.

- AGL supported the addition of a preliminary MLF report and noted that a draft report publication a month or two before March 2021 would be ideal.
- CEIG supported the addition of a preliminary MLF report and supported AEMO publishing indicative MLF forecasts once a year for a few years ahead. CEIG otherwise noted that the existing level of reporting on MLF calculations was appropriate.
- Origin supported ongoing publication of the two additional reports. A scenario sensitivity report should include information on volatility of MLFs.

- ERM supported the addition of a sensitivity report, however suggested that this be expanded to consider significant changes in hydro generation due to forecast water inflows in the target year. ERM supported the addition of a preliminary report to be published in November.

4.10.1. AEMO's assessment

AEMO notes that earlier publication of the draft report is not practicable due to the timing of the generation information page publication (being late January).

AEMO is of the view that forecasts attempting to look beyond the target year would involve a significant cost, and that the indicative MLF forecasts beyond the target year are unlikely to be reflective of the eventual MLFs.

Both the preliminary MLF report and proposed scenario sensitivity report will assist stakeholders in decision-making processes and are worthwhile.

4.10.2. AEMO's conclusion

AEMO will include a provision in the FLLF methodology for a preliminary MLF report to be published each November and will continue working towards the development of a scenario sensitivity analysis. A scenario sensitivity report would consider any factors that are likely to materially impact the target year.

4.11. Intra-year revisions

AEMO sought feedback on some proposed improvements to the process for dealing with intra-year revisions of MLFs. The improvements consist of specifying fixed periods for revisions to the MLF publication for the relevant year (which will reflect any intra-year revisions) and specifying a process for the notification of intra-year MLF revisions.

- AGL proposed that upgrades and new builds be included in the model 'as they occur'.
- Origin supported AEMO's proposed process.
- ERM supported AEMO's proposed process.

Recent feedback from stakeholders also highlighted to AEMO that the FLLF methodology does not expressly document the process for intra-year revisions to MLFs; which AEMO is required to perform in the circumstances set out in clause 3.6.2(i)(2) of the NER.

4.11.1. AEMO's assessment

With regard to AGL's submission, AEMO notes that its network model is forward-looking and inclusive of committed network augmentations.

AEMO is of the view that the proposed changes to the notification process for intra-year revisions, the introduction of a fixed timeframe for MLF report updates, and the inclusion of a description of the revision process, will all improve transparency on intra-year MLF revisions for stakeholders.

4.11.2. AEMO's conclusion

The proposed changes to the process for notifying and reporting on intra-year revisions of MLFs will be implemented.

AEMO has added an additional section 5.11 within the FLLF methodology to clarify both the triggers and process for intra-year revisions to MLFs.

4.12. Energy generation forecast study

AEMO sought input from stakeholders on whether there was merit in including wind and solar generation in the energy generation forecast study.

- CEIG supported this inclusion as well as requesting more information from AEMO on key drivers of year-on-year changes.
- Origin supported this inclusion.
- ERM supported this inclusion.

4.12.1. AEMO's assessment

The addition of wind and solar generation to the energy generation forecast study will improve the level of information provided to stakeholders by the study and the transparency of MLF inputs, as well as providing wind and solar proponents an equal opportunity to provide feedback on generation levels.

4.12.2. AEMO's conclusion

The proposed changes to the energy generation forecast report will be implemented.

4.13. Treatment of problematic historical data

AEMO sought feedback on the existing framework for managing unusual events that could impact the reference data.

- Origin noted that a specific process for dealing with such conditions could be defined in the FLLF methodology but noted the difficulty of doing so, and said that in any event, AEMO should be transparent in how it has treated such data in the modelling.
- ERM requested AEMO engage further with participants in relation to this issue.

4.13.1. AEMO's assessment

AEMO notes the competing interests of flexibility in the FLLF methodology and transparency and certainty for participants. On balance, AEMO considers that it would be impractical to determine a more prescriptive process that could address multiple potential scenarios.

4.13.2. AEMO's conclusion

No changes to the FLLF methodology will be made in respect of problematic historical data.

4.14. Treatment of connected loads in close proximity to interconnectors

ERM raised the issue of MLFs for connection point locations in close proximity to interconnectors. Where large variations in year-on-year interconnector flow occurs, the MLFs in these locations may experience high levels of year-on-year volatility as well as extreme outcomes if those locations are also in remote and electrically weak sections of the network.

ERM requested AEMO to commence further discussions with interested stakeholders as a matter of urgency.

4.14.1. AEMO's assessment

AEMO agrees with ERM's statement of the issue but has not identified a practical solution that can be addressed within the scope of this review of the FLLF methodology.

4.14.2. AEMO's conclusion

No changes to the FLLF methodology will be made in respect of the treatment of connected loads in close proximity to interconnectors.

4.15. Net energy balance and dual MLFs

Under rule 3.6.2(b)(2)(i), AEMO may calculate two intra-regional loss factors for a transmission network connection point, where a single volume weighted loss factor is not reflective of that connection point's marginal electricity energy losses. Under the existing FLLF methodology, dual MLFs are applied to transmission network connection points for pump storage schemes or where a net energy balance (NEB) of <30% is observed.

4.15.1. AEMO's assessment

The number of transmission network connection points across the NEM for which a dual MLF is appropriate is increasing as the system flows become more bi-directional. AEMO analysis indicates that many of these are not meeting the existing NEB threshold, leading to non-reflective single volume weighted loss factors being applied. AEMO has also assessed the current set of transmission network connection points in the MLF model and is confident that a material increase in the number of connection points to which dual MLFs apply is practicable. See **Appendix C** for further information.

4.15.2. AEMO's conclusion

AEMO proposes to expand the threshold to include multiple triggers for dual MLF application as described in **Appendix C**, and expand the default application of dual MLFs to from pumped storage schemes to any storage schemes (including batteries for example).

5. OTHER MATTERS

The recent Transmission Loss Factors rule change[4] removed the reference in clause 3.6.2(e)(4) to a specific time interval for the calculation of MLFs, allowing this to be specified in the FLLF methodology. The methodology may now specify a longer or shorter period of time than the current 30-minute trading intervals. The choice of interval remains subject to the principle that MLFs should describe the average of the marginal losses for electricity transmitted between a transmission network connection point and the regional reference node as closely as is reasonably practicable for each trading interval. AEMO has defined a new term, 'Sample Interval', in the methodology. This is currently described as a 30-minute period, reflecting the existing methodology.

AEMO has made several additional drafting changes to clarify the meaning and use of defined terms in the FLLF methodology. These include confirming that the 'connection point' term refers only to transmission network connection points (for which AEMO determines MLFs), and clarifying terminology used in relation to commissioning and full commercial operation of plant.

6. DETERMINATION

Having considered the matters raised in submissions, AEMO's determination is to amend the FLLF methodology in the form published with this Report. The effective date of the amended methodology is 18 December 2020. The amended methodology will apply to the calculation of MLFs for the 2021-22 financial year onwards.

[4] AEMC, Transmission Loss Factors, at: https://www.aemc.gov.au/rule-changes/transmission-loss-factors

APPENDIX A. GLOSSARY

Term or acronym	Meaning
AC	Alternating Current
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
BOM	Bureau of Meteorology
DC	Direct Current
DCA	Dedicated Connection Asset
ESOO	Electricity Statement of Opportunities
FLLF	Forward-Looking Transmission Loss Factor
FY	Financial Year
GWh	Gigawatt-hour
ISP	Integrated System Plan
MLF	Marginal Loss Factor
MNSP	Market Network Service Provider
MW	Megawatt
NEM	National Electricity Market
NEMDE	National Electricity Market Dispatch Engine
NEMWeb	NEM Data Portal
NER	National Electricity Rules
NREL	National Renewable Energy Laboratory
RRN	Regional Reference Node
SAM	System Advisory Model
SRMC	Short Run Marginal Cost
TNSP	Transmission Network Service Provider

APPENDIX B. SUMMARY OF ISSUES RAISED IN SUBMISSIONS AND AEMO RESPONSES

No.	Consulted person	Issue	AEMO response
1	AGL	AGL considers it is a good approach for AEMO to consider intra-regional constraints in the methodology, however this was limited to a few selected constraints, deemed to regularly bind under system normal conditions. AGL's view is that AEMO should ensure the constraints selected adequately capture any existing/emerging constraints, as omissions will have material impacts on the Marginal Loss Factors (MLFs). Further, AGL recommends that AEMO publish the details of any such constraints, as well as the process and methodology of adjusting generation to satisfy the constraints, to give stakeholders greater understanding and provide effective transparency in the MLF methodology.	See section 4.9
2	AGL	In AEMO's new plant commissioning profiles, AEMO proposes: i. Wind – linear ramp of capacity of 9 months ii. Solar – 1/3 capacity for 4 weeks; 2/3 for 4 weeks; full capacity thereafter AGL considers this solar commissioning profile too optimistic and only representative of projects in strong network locations. For example, history points to much longer timeline for solar farms in the West Murray region. AGL would like to suggest a solar commissioning profile that is dependent on the network location (e.g. low system strength = longer commissioning), as this would better capture the actual ramp-up. AGL would like AEMO to consider providing input into the Commercial Operation Date (COD) of committed projects. The COD of committed projects should reflect the most accurate estimates, not exclusively from a project proponents' perspective, but also from AEMO's connections team.	See section 4.4
3	AGL	AEMO is currently using a static network configuration to model the full-year MLF's, which means any network upgrades or new builds that occur halfway through the year are not captured. AGL considers this 2 will have material impact on the MLF calculations and suggests that upgrades and new builds be included as they occur.	See section 4.11
4	AGL	AEMO's proposal to publish a preliminary MLF report in November 2020 is welcomed. Ideally, AGL would appreciate if the draft report could be published a month or two before March 2021 to allow more time for participants to review ahead of finalisation.	See section 4.10

No.	Consulted person	Issue	AEMO response
5	CEIG	CEIG would support AEMO making their MLF model shareable with market participants without commercially sensitive data.	At this stage AEMO is unable to separate the model from commercially sensitive data, however AEMO will continue to work towards seeing what information from the model could be extracted and shared with participants.
6	CEIG	CEIG noted that it was difficult to comment on the impact of the three-year cycle without visibility of the sensitivity of AEMO's model to the reference year.	As stated in Section 4.1, the MLF model is not currently capable of doing studies with different reference year definitions. This would require a disproportionately large allocation of resources across AEMO to achieve.
7	CEIG	Where possible, CEIG would find it beneficial if AEMO could disclose generation assumptions applied in the MLF calculation. This transparency would allow market participants to review the assumptions more broadly than their own project and enable MLF forecasters to reconcile and calibrate their models. It also appears that some of the generator-inputted data on AEMO's Generation Information page has been inaccurate in the past. AEMO producing its own profiles based on the commissioning trends it is seeing should improve the accuracy of MLFs.	See section 4.4
8	CEIG	By using the minimum load values from the 2019 Input and Assumptions Workbook (2019 Workbook), CEIG believes that the MLF calculation is likely to frequently underestimate actual dispatched generation from thermal plants (during periods of excess renewable generation) and as a result, over-estimate dispatched non-thermal generation. This will have the effect of over-estimating Page 3 of 4 the MLF of thermal plants and under-estimating the MLF of non-thermal generation during those periods. When determining how low a thermal generating plant will ramp down during periods of excess generation, CEIG proposes that AEMO uses its historic thermal generator bidding data rather than the minimum load values from the 2019 Workbook. AEMO could use the volume each generator typically bids at Price Band 1, plus the volume bid in any other price bands that have a bid price below -$100. These values are more representative of what the plant will ramp down to when renewable generation is very high than the minimum load values from the 2019 Workbook (which tend to be materially lower than the Price Band 1 volume)	See section 4.5

No.	Consulted person	Issue	AEMO response
9	CEIG	The release of AEMO's Preliminary report and the associated presentation from AEMO during the recent MLF determination process was valuable in understanding the expected trend in MLFs based on the interim assumption update. CEIG would also support AEMO publishing indicative forecasts once a year for a few years out (for example target year + 1 out to target year + 5) in the same way that the UK National Grid does for their transmission network use of system charges. CEIG appreciates that the ISP provides more forecasting of MLFs than is currently done under the FLLF methodology, but the ISP is only updated every 2 years. More regular forecasting by AEMO would again assist in better benchmarking for the industry. CEIG has found AEMO's timing for reporting on the various stage of MLF calculations to be appropriate.	See section 4.10
10	CEIG	CEIG is supportive of changes that increase the transparency of the MLF calculation. Given the increasing role of wind and solar generation, providing this information as part of the Energy Generation Forecast Study will be increasingly relevant over time. CEIG believes that the Energy Generation Forecast Study and stakeholder engagement would benefit from more detailed commentary and notes being included on the key drivers of the year on year changes to provide additional transparency.	See section 4.12
11	ERM	ERM considered that the choice of reference year to be less important compared to the forecast of regional maximum demands and energy consumption, and does consider there to be a case for changing reference year.	See section 4.1
12	ERM	ERM agrees that the current process of treating MNSPs as invariant may lead to a degree of inaccuracy, but considers that supporting evidence be provided prior to considering any changes.	See section 4.2
13	ERM	ERM supports the change to use typical summer capacities	See section 4.3
14	ERM	ERM agrees that the current process of managing new generation defined in the methodology is no longer appropriate and supports the proposed changes.	See section 4.4
15	ERM	ERM recommends that further details be provided prior to considering the issue of minimum stable operation levels, and also suggests that obtaining the latest information directly from participants may be more preferable than using published information on minimum stable operation levels may be less	See section 4.5

No.	Consulted person	Issue	AEMO response
17	ERM	ERM supports the view that the current minimal extrapolation theory is no longer fit for purpose, and considers that a SRMC bidding approach should be investigated. ERM also requests further information be provided to allow stakeholders to thoroughly review.	See section 4.6
19	ERM	ERM agrees that the extrapolation capping process may not be required for the 2021/22 financial year, but should be retained unless SRMC bidding is implemented.	See section 4.7
21	ERM	ERM supports the proposed change to the modelling of flows on parallel AC/DC interconnectors, except if SRMC bidding is implemented.	See section 4.8
22	ERM	ERM supports the inclusion of intra-regional constraints in the FLLF study, and recommends that additional details be provided prior to implementing changes.	See section 4.9
23	ERM	ERM supports the additional sensitivity report, and the publication of a preliminary MLF forecast report in November each year.	See section 4.10
24	ERM	ERM supports the changes to increase the frequency of review.	See section 4.11
25	ERM	ERM believes the publication of the generation forecast study as a critical component of the FLLF process, and also recommend that the report include forecast output from wind and solar generation. ERM also recommends that AEMO proactively seek confirmation from participants that the forecast generation is acceptable.	See section 4.12
26	ERM	ERM recommends that AEMO engage further with participants on unexpected and unusual system conditions.	See section 4.13
27	ERM	ERM suggests that AEMO engage with stakeholders as a matter of urgency to develop options to amend the methodology or seek changes to the NER if needed.	See section 4.14
28	Origin	We support the use of more recent data for the reference year if AEMO considers it improves accuracy and can be incorporated in a timely manner.	See section 4.1
29	Origin	We support AEMO exploring the inclusion of Basslink in the supply and demand balancing process by modelling the interconnector as a dispatchable element, allowing it to operate in a similar manner to a thermal generator.	See section 4.2

No.	Consulted person	Issue	AEMO response
30	Origin	We agree that it is inappropriate to use summer peaking temperatures in the methodology as this would unnecessarily restrict generation capacity. We support the use of typical summer capacities instead, as these temperatures are more realistic. AEMO could also explore using a weighted mean average of all summer temperatures, to the extent that this differs from its typical summer capacities and improves accuracy	See section 4.3
31	Origin	We support AEMO's proposed approach to producing new generation profiles. It is important that AEMO seeks feedback on its profiles from the relevant proponent where it produces them internally.	See section 4.4
32	Origin	We support AEMO's proposal to use a process where supply and demand balancing outcomes are reviewed, and adjustments made as needed, to ensure minimum stable operation levels are met.	See section 4.5
33	Origin	We consider that AEMO should retain the minimal extrapolation theory but expand on generation categories used in the reference year to ensure a more accurate reflection of real-life outcomes. Using more complex systems such as short-run marginal cost in the balancing process may be problematic given the rapidly changing generation mix.	See section 4.6
34	Origin	We support the method that AEMO has identified and trialled, i.e. a line-of-best-fit based on historical observations for allocating flows on parallel AC/DC interconnectors.	See section 4.8
35	Origin	We support the addition of a new section in the methodology to cover the process for managing intra-regional constraints. These types of constraints are binding more often under system normal conditions and greater transparency on how they are implemented is welcome.	See section 4.9
36	Origin	We support the ongoing publication of the two additional reports (scenario sensitivity study and the preliminary report). The extra publications give stakeholders more opportunities to provide feedback on the forecasts and are useful for planning purposes. We suggest that the scenario sensitivity study should include information on the volatility of MLFs.	See section 4.10
37	Origin	Given the rapid changes in generation mix and volume of new projects, intra-year revisions are likely to be required more. As a result, we support transparency of any process AEMO intends to use to revise MLFs.	See section 4.11

No.	Consulted person	Issue	AEMO response
38	Origin	We support expanding the energy generation forecast study to include both wind and solar generation.	See section 4.12
39	Origin	We consider that it would be beneficial for the methodology to set out a specific process to be used to account for problematic data. We recognise, however, that it may be difficult to implement a specific methodology. In any case, it is important that AEMO is transparent in how it has treated such data in the modelling.	See section 4.13
40	CEIG	CEIG notes that, in section 5.5.1 of the Draft FLLF Methodology v8.0, to maintain the supply-demand balance during periods of excess generation, generation from non-energy limited generating units is reduced, while generation from energy limited generating units (including wind and solar) is not reduced unless other generation reduces to zero or below minimum stable generation limits. However, recent years have seen increasing levels of economic curtailment of wind and solar, much of which occurs during peak solar hours which are likely to be periods of excess generation. The proposed methodology is therefore likely to over-predict future wind and solar profiles (which will result in an overly low MLF for wind and solar generators) and under-predict thermal generation (which will give thermal generators an overly high MLF)	See section 4.6

APPENDIX C. ANALYSIS OF NEB THRESHOLD

NER 3.6.2(b)(2)(i) states that the MLF applicable to a connection point will comprise of two intra-regional loss factors (a dual MLF) in the following circumstances:

> *"... where AEMO determines, in accordance with the methodology determined under clause 3.6.2(d), that one intra-regional loss factor does not, as closely as is reasonably practicable, describe the average of the marginal electrical energy losses for electricity transmitted between a transmission network connection point and the regional reference node for the active energy generation and consumption at that transmission network connection point;"*

A dual MLF will always provide a more reflective outcome for a connection point that has bidirectional flows, compared to a single volume weighted average MLF (see the **Example** below). Therefore, in accordance with the above rule, AEMO will calculate dual MLFs for connection points that are expected to have material bi-directional flows, using a test that will be reasonably practicable to implement.

The threshold for considering the application of dual MLFs is described as the 'NEB test' (see the **Example** below) and is intended to identify those bi-directional connection points where the application of a single volume weighted average MLF is likely to result in a markedly inaccurate representation of marginal electrical energy losses.

AEMO has observed that recent MLF calculations indicate that there are several connection points that do not meet the existing NEB test but have received single volume weighted MLFs significantly outside the range set by the MLFs that would apply if a dual MLF calculation was applicable. AEMO proposes to change the NEB threshold at which dual MLFs will apply as well as introduce two additional independent thresholds that will trigger dual MLF application for a connection point.

AEMO proposes the following changes to the dual MLF application threshold:

1. Increase the existing NEB test threshold from 30% to 50%.
2. Add a new test: Where the NEB is between 50% and 90% and the difference between the dual MLFs are more than 0.1, dual MLFs will apply.
3. Add a new test: Where the NEB is between 50% and 90% and the single MLF would be either greater than 1.1 or less than 0.9, dual MLFs will apply.

AEMO's analysis indicates that it is reasonably practicable to manage the corresponding expansion of the set of connection points to which dual MLFs apply. Accordingly, AEMO considers that this change to the FLLF methodology should be made to meet the requirements of NER 3.6.2(b)(2)(i).

EXAMPLE

The three scenarios below show how volume weighting is applied in the absence of a dual MLF.

Connection Point	Value	Interval 1	Interval 2	Result
Connection Point 1	MLF	0.9	1.1	**1**
	MWh	25	25	**50**
Connection Point 2	MLF	0.9	1.1	**0.5**
	MWh	150	-100	**50**
Connection Point 3	MLF	0.9	1.1	**1.5**
	MWh	-100	150	**50**

As can be seen for connection points 2 and 3 the resultant MLF is not only outside the range of the raw MLFs for the two intervals, the delta between the raw MLFs and the volume weighted MLF is material and

therefore not an accurate reflection of marginal electrical energy losses. For all three scenarios, both the raw MLFs and the net MWh flow are the same.

Both connection points 2 and 3 have an NEB of 33%, which under the current methodology would result in connection point 2 being assigned a single MLF of 0.5 and connection point 3 being assigned a single MLF of 1.5.

The NEB test has the following relationship with the outcome:

The relationship between the smallest gap, range and NEB can be expressed as:

$$\frac{Gap}{Range} = \left(\frac{1}{NEB}\right) - 1$$

The relationship between the largest gap, range and NEB can be expressed as:

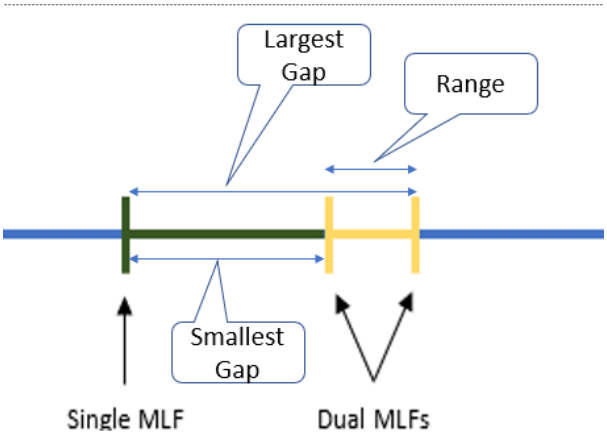
$$\frac{Gap}{Range} = \left(\frac{1}{NEB}\right)$$

Where

Gap = The difference between the dual MLF and the single MLF

Range = The difference between dual MLFs

NEB = Net energy balance as a factor



As there is a direct relationship between the NEB and the ratio of the Gap and the Range the NEB is a meaningful test to identify cases where a single volume-weighted MLF is not reflecting the marginal losses.

With the current NEB threshold of 30% this equates to the following for the smallest gap:

$$\frac{Gap}{Range} = \left(\frac{1}{0.3}\right) - 1 = 2.33$$

and for the largest gap:

$$\frac{Gap}{Range} = \left(\frac{1}{0.3}\right) = 3.33$$

If NEB of 50% is used the smallest Gap is equal to the Range.