RULE

Australian Energy Market Commission

CONSULTATION PAPER

NATIONAL ELECTRICITY AMENDMENT (TRANSMISSION LOSS FACTORS) RULE

PROPONENT

Adani Renewables

6 JUNE 2019

INQUIRIES

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ABOUT THE AEMC

The AEMC reports to the Council of Australian Governments (COAG) through the COAG Energy Council. We have two functions. We make and amend the national electricity, gas and energy retail rules and conduct independent reviews for the COAG Energy Council.

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1 INTRODUCTION

Adani Renewables has submitted two rule change requests to the Australian Energy Market Commission (AEMC or Commission) relating to the transmission loss factors framework in the national electricity market (NEM):

- On 27 November 2018, Adani Renewables submitted a rule change request seeking to redistribute the allocation of the intra-regional settlement residue (IRSR) so it applies equally between generators and networks users who are subject to non-locational prescribed transmission use of system (TUOS) charges. [1]
- On 5 February 2019, Adani Renewables submitted a rule change request seeking to change the marginal loss factor (MLF) calculation methodology to an average loss factor methodology. [2]

Both rule change requests are available on the AEMC website.

The Commission has consolidated these two rule change requests under s. 93 of the National Electricity Law (NEL) to enable it to address the overlapping issues arising from these requests. The rule changes will be progressed under the title *Transmission loss factors* under the project code ERC0251.

The scope of this consolidated rule change process will be cognisant of what is being addressed in the AEMC Coordination of generation and transmission investment implementation (COGATI) bi-annual review[3] and the Transparency of new projects rule change.[4] Both of these projects are key to addressing the state of change in generation occurring in the NEM.

This consultation paper seeks to facilitate discussion on the two rule changes requests from Adani Renewables and more generally, the framework and operation of MLFs. This consultation paper will explain:

- what IRSR and MLFs are
- context around MLFs currently
- outline the proponent's rule change requests
- the proposed assessment framework
- outline related work the AEMC is undertaking and explore other complementary or alternative solutions.

Appendix A provides a comprehensive summary of the current rules and framework regarding loss factors.

In addition to seeking submissions this paper, the AEMC will be holding a stakeholder forum on 4 July 2019, in Brisbane in relation to the transmission loss factor rule change requests to

1 See: https://www.aemc.gov.au/rule-changes/intra-regional-settlement-residue-reallocation

2 See: https://www.aemc.gov.au/rule-changes/loss-factor-frameworks

3 See: https://www.aemc.gov.au/market-reviews-advice/coordination-generation-and-transmission-investment-implementation-access-and

4 See: https://www.aemc.gov.au/rule-changes/transparency-new-projects

outline its approach for this rule change process and enable stakeholders to provide initial feedback on key issues and potential solutions.

To register your interest in joining this stakeholder forum please email the project leader via the AEMC website project page by 24 June 2019.

1.1 Project timeline

Table 1.1: Proposed project timeline

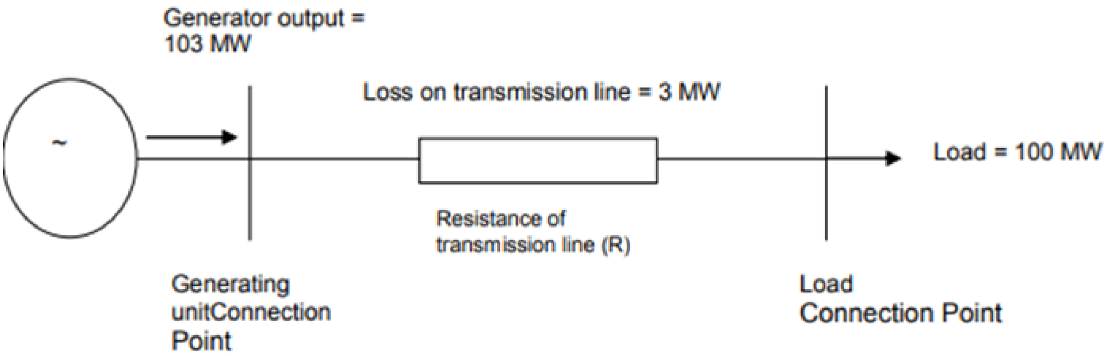
MILESTONE	DATE
Rule changes initiated and consolidated, consultation paper published	6 June 2019
Stakeholder workshop	4 July 2019 (Brisbane)
Submissions close for consultation paper	18 July 2019
Draft determination published	26 September 2019
Submissions close for draft determination	7 November 2019
Final determination published	19 December 2019

2 BACKGROUND

2.1 What are marginal loss factors?

When transmitting electricity from one point to another, a portion of the energy is lost in the form of heat due to electrical resistance. This occurs predominantly in transformers and transmission lines. These losses which occur through electricity flows are a function of physics and are unavoidable. Figure 2.1 below illustrates this.

Figure 2.1: Transmission line losses



Source: AEMO
Note: The diagram above represents the loss of electricity when sending electricity from point A (generator) to point B (load). If the generator is looking to supply 100MW of electricity to the load, then the generator will have to generate 103MW. It is therefore assumed that there will be a loss on the transmission line of 3MW.

In the NER, when these losses occur within a region they are represented as intra-regional loss factors, which are also known as MLFs. The reason intra-regional loss factors are commonly called MLFs is due to the marginal impact of losses considered when determining the value of the loss factor. Two other terms that are used interchangeably with MLFs are: transmission loss factors (because the factors or values apply to transmission connection points); and static loss factors (because a single unchanging value applies for a whole financial year). For consistency, the Commission will use marginal loss factor (MLF). The figure in Appendix A provides an illustration of the transmission loss factor framework.

MLFs represent the value of electrical energy that is lost when the next or marginal unit of electricity is transmitted across the transmission network. An MLF value specifically represents the losses between a generator or load connection point on the network and the regional reference node (RRN).

The RRN is a location used to represent the load centre of a region's transmission network where the electricity is dispatched to. There is an RRN for each region in the NEM (Queensland, New South Wales, Victoria, South Australia and Tasmania). Each regional reference price is based on the marginal cost of energy for supplying the relevant RRN.

MLFs are used to adjust electricity spot prices set at an RRN to reflect electrical losses between the RRN and a relevant connection point.[5] The MLF values are applied to the market settlements in the NEM which correlate with a generator's revenue.

The Australian Energy Market Operator (AEMO) is required to calculate and publish MLFs by 1 April each year.[6] The MLF is applied to each generator for the next 12 months from 1 July until 30 June.[7] AEMO is currently required to use a forward-looking methodology and must detail the methodology used in the calculations.[8] The forward-looking projections are based on expectations of the upcoming year's demand and dispatch patterns, the network flows and expected losses.

The local price of electricity at a connection point is equal to the regional price multiplied by the MLF. For a generator this normally means, the greater the marginal losses associated with supplying to the RRN, the lower its MLF value. As a result, for every unit of electricity required at the RRN, the generator is required to produce and dispatch more than one unit of electricity. To meet the demand forecast of the RRN more electricity must be generated to allow for the loss that occurs through transmission. Conversely, a generator with an MLF set above 1.0 will be paid for more than its output at its connection point. As a result, a generator's MLF can affect the commercial viability of a generator.

Calculating MLF values

An MLF is a ‘marginal’ figure rather than an average figure. As noted above, an MLF represents the electricity losses that would occur if one additional unit (1MW) of electricity was generated at that connection point. This approach is consistent with how other aspects of dispatch and pricing operate in the NEM on the basis that marginal pricing is generally considered to lead to the most efficient outcomes.

The MLF values assigned to generators vary according to a number of factors. As these factors change, an MLF will fall or rise. The factors that influence the value of an MLF include:

- the rated voltage and level of resistance of the transmission lines where the generator connects: the greater the voltage and lower the resistance of transmission lines between a generator and a load centre, the lower the electrical losses that occur and results in higher MLFs.
- whether there is an over supply of generation in that area: a greater number of generators relatively close to one another may be more likely to result in lower MLFs, particularly if the generators are of the same type and have very similar generation dispatch patterns.

5 AEMO, *Forward-looking transmission loss factors,* 8 February 2017, p. 5.

6 Clause 3.6.1(f) of the NER.

7 Rule 3.6 of the NER. AEMO deferred finalisation of the 2019-20 MLFs. It advised the Australian Energy Regulator (AER) that recalculations were required to accommodate substantial and credible updated information on the status of several committed projects which emerged after calculation of the draft loss factors in March 2019. Therefore, final publication was deferred until 10 May 2019.

8 Clauses 3.6.1(c), 3.6.2(d), (d1) and (g) and 3.6.2A(b) of the NER.

- the distance which generated electricity travels between its connection point and load centre: the greater the distance the greater the losses will be.

2.2 What are intra-regional settlement residues?

Intra-regional settlement residues arise from the wholesale market settlement process. The value of transmission loss factors impacts on the settlements made to generators and market customers.

AEMO carries out a 'settlement' process in the NEM so that generators are paid for the electricity generated and 'market customers' pay for the electricity used.[9] This process of calculating the financial liabilities of market participants is carried out weekly. The settlement process is based around each region. This results in settlements residues because:

- The value of the electricity in one region will be different to its value in another region when that electricity moves from the first region to the second. The difference in the value arises from the different prices in the two regions, including a reflection of the electrical losses that occur on the interconnector between the two regions.[10] These residues are inter-regional (between region) settlement residues.
- Marginal loss factors are used to adjust prices between the RRN and the transmission connection point of a customer. This tends to recover more from customers than what is required to pay generators for the electricity generated. In addition, some metering inaccuracies arise in the measurement of electrical flows. The difference arising results in intra-regional (within a region) settlements residues.

Intra-regional settlement residues are paid to the transmission network service provider (TNSP) for the associated region and are used to reduce TUOS charges that are ultimately paid by electricity customers.[11]

2.3 Why the current interest in loss factors?

MLFs have always been a part of the NEM.

Previously, MLFs were reasonably predictable with less variability. This reflected the stability of the generation sector: much of the supply into the NEM was provided by relatively few, large generators with consistent dispatch patterns. In addition, many of these generators were securely connected (that is, connected with high voltage and low resistance transmission lines) to key demand locations.[12] This enabled market participants to accommodate MLF impacts in their operational and investment decisions.

9 A market customer is a party registered with AEMO under clause 2.3.4 of the NER who is connected to the 'national grid' to take electricity from a connection point. Market customers may be retailers supplying end consumers or large end consumers who participate directly in the wholesale market.

10 In other words, a price separation occurs between regions from the interconnector's transfer limits. When the flow on an interconnector is limited by a network constraint, the energy flow is generally from the lower priced region to the region with the higher priced. This means that the energy is paid for in the exporting region at a lower price than that paid by customers in the importing region, resulting in a settlement residue.

11 Note that only customers pay TUOS charges. The IRSR are returned to customers on a postage stamp basis. This means there is no link between the accrual of IRSR and the manner in which it is distributed to customers.

12 An example is the Latrobe generators connected to Melbourne.

However, in the current climate MLFs are difficult to forecast accurately and incorporate into decision-making for some market participants. This is due to new generators emerging in very different parts of the NEM compared to the locations of the established generation fleet. In particular:

- New generators are connecting at the remote edges of the national grid. While such locations may suit some types of generation, it is often the case that the transmission infrastructure in those areas were not built to support a large injection of generation.
- The location of generators in peripheral network locations has resulted in these generators also being a significant distance from demand centres. As a result, the electricity from these generators is travelling significant distances to reach customers, resulting in greater losses of electricity en route.[13]

Each of these above is exacerbated if, as has been observed recently, a number of new generators of the same type locate near each other. The geographical proximity of generators adds to the difficulties in transmitting electricity significant distances on stringy transmission lines. This is illustrated in Appendix B. In addition, this can be compounded if the generators are of the same type and so are likely to have correlated, rather than offsetting, dispatch patterns.

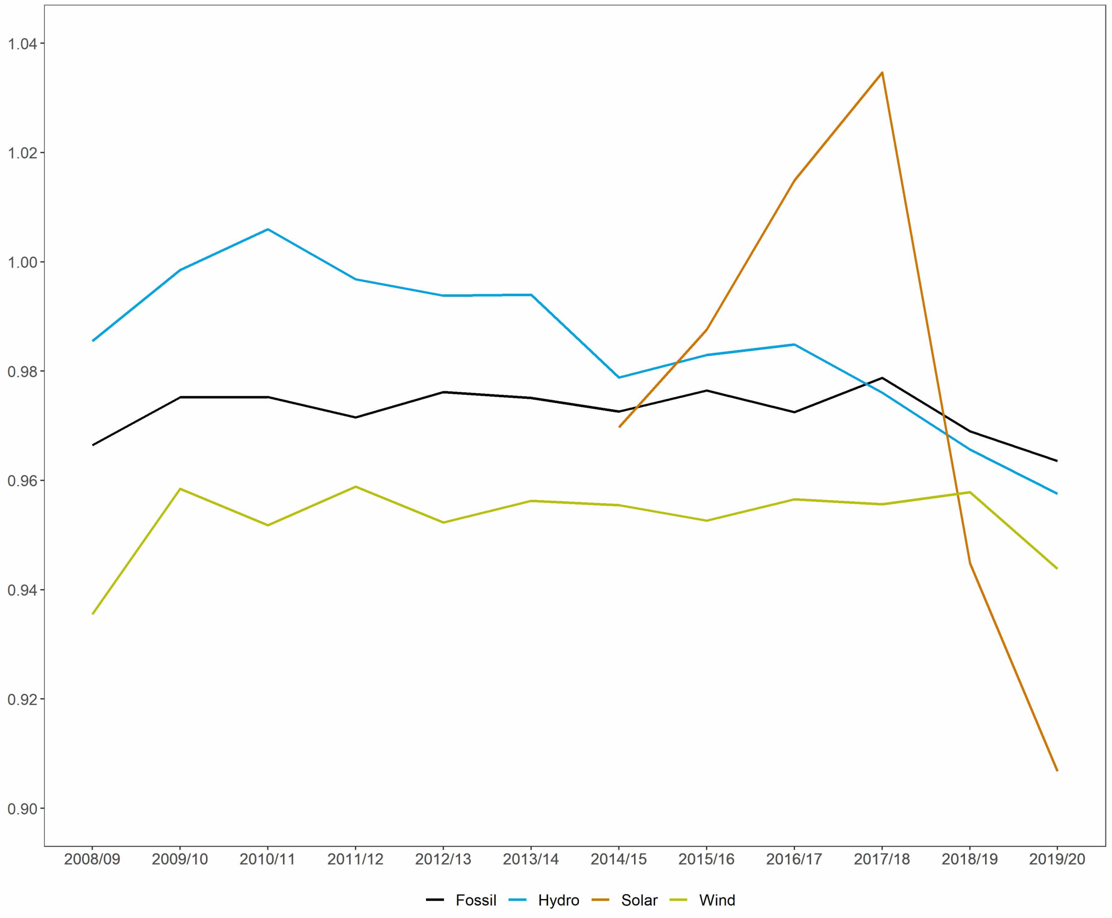
The other compounding feature about loss factors is the speed of which new renewable generators can be (and have been) constructed. In the past, construction of a significant coal or gas-fired generator took years and the planning processes and requirements required before the build provided electricity market participants with information and time to consider the implications of the new generator on their own business. This would have included consideration of what changes to MLF values might arise from the investment. Furthermore, the pace of connection means that predicted connection dates and ratings of new generating systems in the upcoming year remain uncertain due to commercial and network complexities that frequently remain unresolved less than a year in advance. These factors can result in a material difference to the forward-looking MLF calculation for some market participants.

In contrast, renewable generators can be built relatively quickly. While there are still pre-build processes to navigate, the speed of these investments has significantly reduced the opportunity for existing market participants to fully consider the impact new generators may have on transmission losses. In addition, the rapid pace of these investments has added to the difficulty for some market participants to accurately forecast MLFs and their impact.

Together, these recent developments in the generation sector have resulted in a recent year-on-year trend of MLFs being lowered in value with less predictable forecasting values (see Figure 2.2 below).

13 See Appendix B for maps illustrating the change in generation locations in the NEM.

Figure 2.2: MLFs in the NEM, 2008-2009 to 2019-2020



Source: AEMC, from AEMO data.

Note: The graph depicts two types of datasets from AEMO. First, published MLFs by NEM regions for each financial year since 2008-2009; and second, data on the current registration and exemption lists containing all registered participants in the NEM, registration applicants, registrations that are ceasing or suspended, information about generators and scheduled loads, ancillary services, and registration exemptions. The latter dataset provides information on the fuel source of each generator. These two datasets have been combined using the dispatchable unit identifier (DUID), which provides the data on the MLFs by DUID by fuel source in the NEM regions for each financial year. The MLFs have then been averaged by fuel source for each financial year. The graph illustrates the declining trend of MLFs for generation from 2017-2018.

AEMO's publication of loss factors across the NEM has highlighted the importance of understanding what MLFs are and how they impact on the profitability of generators. The previous years' publications illustrate this lowering value trend in variability that ultimately influences generators' financial position and future investments in generation, particularly in renewables.[14]

Appendix A provides a comprehensive summary of the current rules and framework applied to loss factors in the NEM.

14 AEMO, *Regions and marginal loss factors: FY 2019-20*, May 2019.

3 ADANI RENEWABLES' RULE CHANGE REQUESTS

3.1 The rule change requests

The proponent's two rule change requests are summarised below.

3.1.1 Intra-regional settlement residue reallocation

Adani Renewables submitted a rule change request to the Commission on 27 November 2018 to reallocate the IRSR to generators and market customers evenly. As explained in Appendix A, the IRSR is currently distributed to the TNSP for the associated region and is used to off-set TUOS charges. This means that market customers are ultimately the sole beneficiaries of the IRSR as only market customers pay TUOS charges.[15]

The proponent's rationale for generators and transmission network customers to share the IRSR relates to the issues that it has identified with the current approach:[16]

- that the calculations of loss factors give rise to approximations rather than actuals
- high IRSR reflects an "error" between actual and forecast transmission loss factors and consequently efficient dispatch is undermined and investment signals are impacted
- the allocation of residues on a postage stamp basis exacerbates the impact of inaccurate MLFs.

Adani Renewables has stated that if a generator were to receive part of the IRSR as it has proposed, then that distribution of funds would result in "an improved effective MLF (less losses) for generators that have been subject to inaccuracies and therefore more competitive generation bidding, resulting in lower prices to market customers".[17] Specifically, it stated that redistributing half of the IRSR funds to generators would:[18]

> correct for any inaccuracies associated with the MLFs, and associated inefficiencies caused by these inaccuracies. While this change to the reallocation process will not directly address the cause of inefficiencies caused by inaccurate MLFs, it may go some way to reducing the impacts this inaccuracy has on the investment and operational efficiency of the NEM.

In the rule change request, Adani Renewables has stated that under the current system a generator with an artificially low MLF as a result of forecast error, has its revenue and dispatch time reduced, and this works in opposition to micro economic competitive market fundamentals.[19] Adani Renewables summarise the proposed rule change by stating:[20]

> *Adani Renewables proposes a rule change so that the process for the allocation of IRSRs be revised to include generation connection points and not only the network*

15 See section 2.2 of this consultation paper.
16 Adani Renewables, rule change request, 27 November 2018, p. 7.
17 Adani Renewables, rule change request, 27 November 2018, covering letter.
18 Adani Renewables, rule change request, 27 November 2018, pp. 7-8.
19 Adani Renewables, rule change request, 27 November 2018, p. 10.
20 Adani Renewables, rule change request, 27 November 2018, p. 3.

> *users who are subject to non-locational prescribed TUOS charges. The result of this rule change will be lower effective MLFs for generators that have been subject to inaccuracies and therefore more competitive generation bidding, resulting in lower prices to market customers.*

While Adani Renewables has not included a proposed rule with its rule change request, it has identified that clause 6A.23.3 of the NER requires IRSR to be allocated between transmission customers based on their proportionate use of the relevant transmission assets. Adani's proposal implies a change to this provision would be necessary to achieve its objective.[21]

3.1.2 Marginal loss factors

The second rule change request submitted by Adani Renewables on 5 February 2019, argues that the existing MLF calculation methodology is out-dated and no longer fit-for-purpose. Adani Renewables states that "current rules are resulting in high inaccuracies and hence, distort the market through inefficiencies in operational and investment decision making".[22] In its view, "MLF inaccuracies" result in IRSR accruing.

Further, Adani Renewables has suggested that "the inaccuracy in forecasting MLF for the following year/s results in generators assuming an artificially increased bid price as a result of an incorrect MLF".[23] This, in Adani Renewables' view, subjects generators to increased risk of not being dispatched, resulting in increased cost of generation to all market customers.

To address these concerns, Adani Renewables' proposal is to move from the current forward-looking MLF methodology to an average loss factor methodology. Adani Renewables asserts that this change "from MLFs (with IRSR reallocation to include generators) to an average loss factor methodology will be a further improvement as average loss factors can be calculated at the commencement of each year (rather than a wash up of IRSRs in arrears)".[24]

Adani Renewables has noted that requirements for the calculation of intra-regional loss factors are set out in clause 3.6.2 of the NER. It has not proposed any specific amendments to these provisions. However, it does argue that AEMO must be required to calculate intra-regional loss factors according to "the average loss factor methodology". As a result:[25]

> *This calculation will as 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 and little or no IRSR.*

By changing the transmission loss factor calculations to an average rather than marginal methodology, Adani Renewables has suggested two benefits will arise:[26]

21 Adani Renewables, rule change request, 27 November 2018, p. 9.

22 Adani Renewables, rule change request, 5 February 2019, covering letter.

23 Adani Renewables, rule change request, 5 February 2019, covering letter.

24 Adani Renewables, rule change request, 5 February 2019, p. 3.

25 Adani Renewables, rule change request, 5 February 2019, p. 9.

26 Adani Renewables, rule change request, 5 February 2019, p. 10.

- that "the electricity market will exhibit behaviour closer to that of a competitive market" and lower prices will result
- with more accurate loss factors, new and existing financiers of generation investment will be more confident and will invest to provide greater supply of electricity.

3.2 Questions for stakeholders

QUESTION 1: IDENTIFYING THE PROBLEM

(a) Do you agree with the problems identified by Adani Renewables in relation to:

- the current distribution of the IRSR to market customers only
- that the current marginal loss factor methodology produces "inaccurate" results

(b) Do these problems have a material impact on the long-term interest of consumers?

(c) Do you have other concerns (not identified by Adani Renewables) about the operation and impact of the transmission loss factor framework?

4 ASSESSMENT FRAMEWORK

4.1 Achieving the NEO

Under the NEL the Commission may only make a rule if it is satisfied that the rule will, or is likely to, contribute to the achievement of the national electricity objective (NEO).[27]

The NEO is:[28]

> To promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to -
>
> (a) price, quality, safety, reliability and security of supply of electricity; and
>
> (b) the reliability, safety and security of the national electricity system.

Based on a preliminary assessment of this rule change the Commission considers that the aspects of the NEO relevant to this rule change are the promotion of efficient investment in and operation of electricity services with respect to price and reliability.

4.2 Proposed assessment framework

In assessing the rule change requests against the NEO, the Commission proposes to consider the following:

- impact of the proposal on efficient investment
- impact of the proposal on the efficient operation of providing electricity services
- the allocation of risk under the proposal.

These are discussed below in turn.

4.2.1 Impact on efficient investment

In the context of MLFs, achieving efficient investment requires the calculated MLF values to send efficient locational signals for people considering investing in new generation (or load). This will occur where:

- MLFs reflect actual losses as accurately, as reasonably practicable
- MLFs, and changes to them, can be forecast as accurately as reasonably practicable by investors so that they can act on those locational signals.

In assessing potential changes to the marginal loss factor framework, the Commission will consider whether the suggested changes will improve the provision of information to assist stakeholders in making well-informed decision on efficient investment in generation capacity and load in the NEM.

27 Section 88 of the NEL.

28 Section 7 of the NEL.

4.2.2 Impact on the efficient operation of providing electricity services

MLFs influence generator bidding and plant operation, and therefore changes in how MLFs are determined which can influence operational decisions by generators and dispatch decisions by AEMO.

Of particular interest in this rule change process is whether changes to the transmission loss factor framework will support, and be consistent with, providing electricity services efficiently. This includes considering whether changes to the transmission loss factor framework will enable more informed operational decisions to be taken by generators and other market participants and enable AEMO to dispatch the lowest cost generation, which should flow through to lower consumer prices.

4.2.3 Allocating of risk arising from changing intra-regional loss factor values

In general, it is desirable that the party that is allocated a risk has the incentive and ability to manage that risk because there is a clear link between that party's actions on the outcomes of the risk.

In the case of MLFs, there is a risk to transmission connected generators (and load) and market customers in regard to the value that will be calculated by AEMO at any time and that this value may change over time. However, these market participants may also be able to make decisions that impact on the value of the MLF allocated to them. For example, by decisions on where to locate a generator and how to allocate risk under their connection agreement. In contrast, end-use consumers are not able to influence or manage the risks associated with MLFs.

In considering whether the marginal loss factor framework should be changed, the Commission will consider the impact the change may have on the allocation of risk between different market participants, and market participants and consumers.

QUESTION 2: PROPOSED ASSESSMENT FRAMEWORK

(a) Do stakeholders agree with the proposed assessment framework?

(b) Are there any additional considerations that the Commission should take into account?

4.3 Making a more preferable rule

Under s. 91A of the NEL, the Commission may make a rule that is different (including materially different) to a proposed rule (a more preferable rule) if it is satisfied that, having regard to the issue or issues raised in the rule change request, the more preferable rule will or is likely to better contribute to the achievement of the NEO.

5 IMPROVING THE LOSS FACTOR FRAMEWORK

This chapter provides an overview of AEMO's current work in relation to the transmission loss factor framework. It also defines the scope of this rule change process and the related work already being carried out by the Commission.

This chapter also identifies a number of elements within the transmission loss factor framework where the selection of a different approach would change the operation of the framework. These potential options may be either alternative or complementary to Adani Renewables' proposed solutions. Stakeholders are invited to comment on these framework elements, or any other relevant matters, in considering whether, and how, the transmission loss factor framework can be improved.

5.1 Current work

There are three key pieces of work related to MLFs and its related framework currently being carried out by AEMO and the AEMC.

AEMO is currently working on changes to its operations within the framework that can be made without making an amendment to the NER.

The Commission currently has two related pieces of work; the COGATI review and a consolidated rule change process on Transparency of new projects.

These are outlined in more detail below.

5.1.1 AEMO work

AEMO has recently indicated through a number of different mediums that they are committed to providing the market with as much transparency as possible to help market participants better anticipate and manage changes in MLFs.

It has stated:[29]

> ...AEMO is looking to help market participants understand the potential changes by publishing as much information as we can about where new generators are being built. We are also planning to publish loss calculations more frequently so that there is greater transparency for potential investors.

AEMO's current work program can be undertaken without the need for rule changes. It anticipates that additional transparency will enable market participants to obtain a better understanding of the developments occurring in the generation sector which will in turn, assist in making investment decisions.

In addition, AEMO has been closely engaged with the AEMC in relation to COGATI, the Transparency of new projects rule change process and this rule change process on transmission loss factors.

29 Audrey Zibelman, *AEMO working closely with industry as the energy system evolves*, 2 May 2019, http://energylive.aemo.com.au/News/AEMO-works-closely-with-industry-in-evolving-energy-systems

5.1.2 COGATI

The Commission published a consultation paper on 1 March 2019 for *Coordination of generation and transmission investment — access and charging.* This review seeks to develop the necessary regulatory reforms to implement the recommended phased approach to access and charging reform. The review is considering reforms to the way generators access and use the transmission network, as well as a review of the charging arrangements which enable TNSPs to recover the costs of building and maintaining transmission infrastructure, both within and between regions.

The differences between transmission and generation decision-making processes are manifesting in a range of issues currently being experienced by investors, which includes MLFs.

Any reforms to current access and charging arrangements for the national grid could have implications for the appropriate approach to calculating MLFs. For example, in markets where there are locational marginal prices, MLFs are calculated dynamically at each location in real time. As a result, reforms to the loss factor framework will have to be considered alongside the development of reforms to the access arrangements.

The COGATI review is focused on holistic solutions to making investment decisions for the electricity transmission and generator sectors through access reforms for the national grid. The Commission is working with the ESB, AER, AEMO, as well as interested stakeholders to progress the COGATI review.

The Commission will consider the interactions between Adani Renewables' rule change requests and the COGATI review throughout the rule change process. Given the broader approach of the COGATI review, this rule change process will be focussed on the transmission loss factor framework in the context of concerns being raised about it today.

5.1.3 Transparency of new projects

The Commission has initiated a rule change process which consolidates three rule change requests which seek to increase transparency of new generators connecting to the transmission network.

These rule changes come as significant changes occur in the NEM with the increasing penetration of renewable generation (such as wind and solar) a key trend. TNSPs are receiving an unprecedented volume of generation connection enquiries with 50GW of proposed (mainly renewable) projects in various stages of development roughly equivalent to current capacity in the NEM.[30]

Changing market dynamics have also given rise to new business models, with developers now commonly building and selling generation assets prior to connecting them to the transmission system.

The three rule changes received relate to transparency of new projects in the NEM:

30 AEMO, *Electricity statement of opportunities*, September 2018.

- On 15 December 2018, the Australian Energy Council submitted a rule change request to the Commission seeking to improve information provision in the NEM. There are four key elements in this request:

1. Codifying AEMO's generation information page in the NER.
2. Imposing a requirement on intending participants to notify AEMO of any change to the information they provided during the intending participant registration process (for example, when the nature of their project changes).
3. Broad reforms to the intending participant category (for example, requiring new project developers to register as an intending participant), consistent with the proposals made by AEMO (discussed below).
4. Changes to assist AEMO in disclosing confidential information, where that information has subsequently reached the public domain.

- On 31 December 2018, AEMO submitted a rule change request to allow a developer to register as an intending participant for the purposes of building a grid-scale generating system or an industrial development (e.g. a load), despite such a person never intending to register as market participant.
- On 15 March 2019, Energy Networks Australia submitted a rule change request to explicitly allow TNSPs to publish certain information (including proponent name, size, location, estimated completion date, primary technology and broad function) they have received from connection applicants regarding new and proposed connections.

The Commission consolidated these three rule change requests to best address the overlapping issues and facilitate efficient stakeholder engagement. A consultation paper was published on 18 April 2019.

The transparency of new projects rule change is closely related to the issues raised by the rule change requests from Adani Renewables, which is looking at increasing information about the new projects connecting to the system. In initial discussions regarding recent year-on-year lowering of MLFs some stakeholders have suggested that more information about forthcoming generation projects would allow investors to better forecast potential changes to MLFs that may arise. The Commission will also have regard to the progress of this rule change.

However, transparency of the MLF framework itself is also relevant to the consideration of the issues identified by Adani Renewables, which will be considered through this rule change.

5.2 Other considerations

In establishing the current transmission loss factor framework, a number of implementation decisions were made. However, these choices can be reassessed and different options may now be considered more appropriate.

In the following, the Commission has identified a number of elements (including those identified by Adani Renewables) within the transmission loss factor framework where changes could be made. Stakeholders are invited to consider these issues, and any other matters they consider relevant, in relation to the future development of the transmission loss factor framework.

5.2.1 Should intra-regional and inter-regional loss factors be marginal or average?

The current framework for treating losses in the NEM is to use MLFs for both inter-regional and intra-regional energy flows. The advantages of this approach include:

- consistency with the NEM dispatch process where prices are based on the incremental cost of meeting the last unit of demand
- treating intra-regional and inter-regional energy flows on the same basis, at least in terms of being based on marginal impacts on losses.

A potential alternative, as proposed in Adani Renewables' rule change request, is to use average intra-regional loss factors for energy flows within a region. This approach raises a number of questions for stakeholders to consider:

- whether the benefits of average loss factors would compensate for the reduction in the efficiency of the dispatch process?
- should average loss factors also be used for inter-regional energy flows?
- would the use of average loss factors retain the current locational nature of loss factors?
- how would AEMO calculate an average loss factor, and what costs would be incurred in developing and implementing a process to determine average loss factors?
- could average intra-regional loss factors be determined for each transmission connection point and thus continue to provide a granular price signal for the efficient dispatch of the market and for long-term generation investment.

5.2.2 Allocation of intra-regional settlements residues

Currently the IRSR are allocated only to market customers. A positive IRSR is distributed to the TNSPs to then pass on to market customers by a reduction in their TUOS charges.

Alternatives to this approach could include:

- allocating the IRSR to both market customers and generators as proposed by Adani Renewables
- AEMO distributing the IRSR directly to market customers, avoiding the cash flow passing through the TNSPs.

In considering these alternatives, stakeholders may have regard to:

- how the IRSR accumulates and what parties fund this accumulation
- what systems are needed to be put in place to implement a different flow of funds
- what benefits would arise from a change to the distribution of IRSR
- how any changes would affect efficient investment and operation decisions of market participants.

5.2.3 Should multiple loss factors be used?

At present a single intra-regional loss factor value applies for a financial year, for each transmission connection point (noting that two values may be used for some storage schemes). However, the use of a single loss factor value for each connection point for a year may not represent the system conditions sufficiently well to provide efficient signals to market participants.

A number of potential alternatives to a single intra-regional loss factor value for a transmission connection point for a financial year include:

- using different values for each week, month or quarter which may potentially better reflect seasonal effects on the flows in the transmission network
- using peak and off-peak loss values (potentially combined with seasonal values)
- using loss factors that apply for multiple financial years
- using real-time loss factors that are calculated every trading interval to better reflect system conditions.

Using multiple loss factors values within a financial year would improve the ability of the loss factors to reflect actual system losses and could potentially improve the efficiency of the dispatch in the NEM and reduce the size of the IRSR. However, using multiple loss factor values within a financial year would add complexity that would need to be managed by AEMO and stakeholders as it may make it harder to forecast MLFs. Further, the use of real-time loss factors may improve operational and dispatch decisions. However, it would also mean that stakeholders would not know their loss factor values in advance, which could make trading in the NEM more complicated and give less certainty when making investment decisions.

In regard to this issue, stakeholders may consider:

- would using multiple intra-regional loss factor values be likely to better reflect transmission network flows and improve the efficiency of the dispatch process
- what systems need to be put into place to implement a more granular approach to transmission loss factors
- if the additional complexity of using multiple intra-regional loss factor values is likely to outweigh the potential improvements in the efficiency of the dispatch process
- how many, and which, intra-regional loss factor values should be used
- whether the benefits of calculating loss factors in real-time would likely outweigh the additional complexity and reduced certainty regrading loss factors for the year.

5.2.4 How often should transmission loss factors be calculated

Currently AEMO determines the intra-regional loss factors once a year as directed by the NER. Increasing the frequency of this calculation would:

- increase the administrative burden for AEMO
- increase the complexity for stakeholders
- mean the loss factors would be fixed for a shorter period, potentially reducing certainty for market participants

- result in the impacts of changes in generator behaviour and new generating units being reflected into the loss factor sooner, better reflecting the actual flows in the transmission network and providing generation proponents more timely information on the impacts of other generators on their projects.

To consider whether the frequency of the transmission loss factor calculation should be changed from the current annual cycle, stakeholders may like to consider:

- if the potential benefits of more frequently determined intra-regional loss factors would be likely to outweigh the costs
- what is the appropriate frequency for determining intra-regional loss factor values.

5.2.5 How much notice is given to market participants

Under the current arrangements AEMO is required to publish the MLF values each 1 April to apply for 12 months from 1 July. This provides market participants three months notice of any changes to the intra-regional loss factor values and the inter-regional loss factor equations.

However, a shorter or longer period of notice may now be more appropriate or desirable. Deciding on the amount of notice to provide market participants needs to balance:

- the benefits for market participants and investors of increased notice of changes in loss factors
- the ability for the transmission loss factors to reflect recent changes in generator behaviour and new generating units.

The Commission is seeking stakeholders' views on the amount notice AEMO should provide to market participants when it determines new intra-regional loss factors.

5.2.6 Using a forward-looking or backward-looking methodology

The MLFs in the NEM were initially calculated using a backward-looking methodology using actual settlements data. This approach introduced a two-year delay between changes in generation and the impact on the loss factor values. The impact of this delay was reduced in 2003 with the change to the forwarding-looking methodology. This approach is still used and includes forecasts and extrapolation of historical settlements data to anticipate changes in the transmission network flows.

The Commission is seeking stakeholders' views on whether the current forward-looking approach to determining loss factors should be retained.

5.2.7 Using a collar and cap

Some stakeholders have indicated that in their view, a "collar and cap" mechanism should be applied to MLFs. One approach could be to apply a band within which all intra-regional loss factors must sit. For example, all loss factors must be between 0.8 and 1.1. Another approach to collar and cap could be to apply a constraint to the change made to an intra-regional loss factor value by AEMO. For example, the maximum change to a loss factor is +/- five per cent.

The rationale for this approach is that setting a limit within which loss factors values would sit would provide generators with a degree of certainty about how high or low their loss values would be.

However, using a collar and cap may result in transmission loss factors that may not accurately reflect the loss of electricity from a transmission connection point to the RRN at all times or for all locations. As losses must always be accounted, such a result would pass the cost of the lost electricity to consumers.

5.2.8 Grandfathering MLFs

Building on the proposed introduction of a collar and cap mechanism, some stakeholders have suggested that grandfathering MLFs year-on-year would provide a short-term solution to the current variability in MLFs.[31]

Some stakeholders have suggested that a grandfathering arrangement would work by assigning a better (higher) value MLF through a to existing transmission connection points for the remaining life of that generator. Lower MLFs would apply to new transmission connection points. The rationale being that it would provide a project certainty in terms of what intra-regional loss factor that applies to it. This would allow generators and their investors to predict and manage the financial risk of MLFs.

However, grandfathering loss factors may lead to inefficient investment and operational decisions for generators for the same reasons as a collar and cap mechanism: it would not accurately reflect the loss of electricity from a generator to the RRN. Furthermore, grandfathering could distort investment signals and discourage future investment in generation by treating incumbent generators more favourably than new entrants.

5.3 Questions for stakeholders

QUESTION 3: CHANGING THE TRANSMISSION LOSS FACTOR FRAMEWORK

What improvements do you suggest could be made to elements of the transmission loss factor framework and why? In particular with reference to:

(a) calculating transmission loss factors on a marginal or average basis

(b) allocating intra-regional settlements residues

(c) the frequency of calculating MLFs

(d) the notice period provided to market participants

(e) whether a forward-looking or backward-looking methodology should be used

(f) if a collar and cap should be applied to transmission loss factors

31 See submissions to the COGATI consultation paper from ARENA, Neoen and Lighthouse Infrastructure.

(g) if grandfathering MLFs should occur.

6 LODGING A SUBMISSION

Written submissions on the rule change request must be lodged with Commission by 18 July 2019 online via the Commission's website, www.aemc.gov.au, using the "lodge a submission" function and selecting the project reference code ERC0251.

The submission must be on letterhead (if submitted on behalf of an organisation), signed and dated.

Where practicable, submissions should be prepared in accordance with the Commission's guidelines for making written submissions on rule change requests.[32] The Commission publishes all submissions on its website, subject to a claim of confidentiality.

All enquiries on this project should be addressed to Andrew Splatt on (02) 8296 0623 or andrew.splatt@aemc.gov.au.

32 This guideline is available on the Commission's website www.aemc.gov.au.

ABBREVIATIONS

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
COGATI	Coordination of generation and transmission investment implementation review
Commission	See AEMC
ESB	Energy Security Board
IRSR	intra-regional settlement residue
MCE	Ministerial Council on Energy
MLF	marginal loss factor
NEL	National Electricity Law
NEO	National electricity objective
RRN	regional reference node
TNSP	transmission network service provider
TUOS	transmission use of system

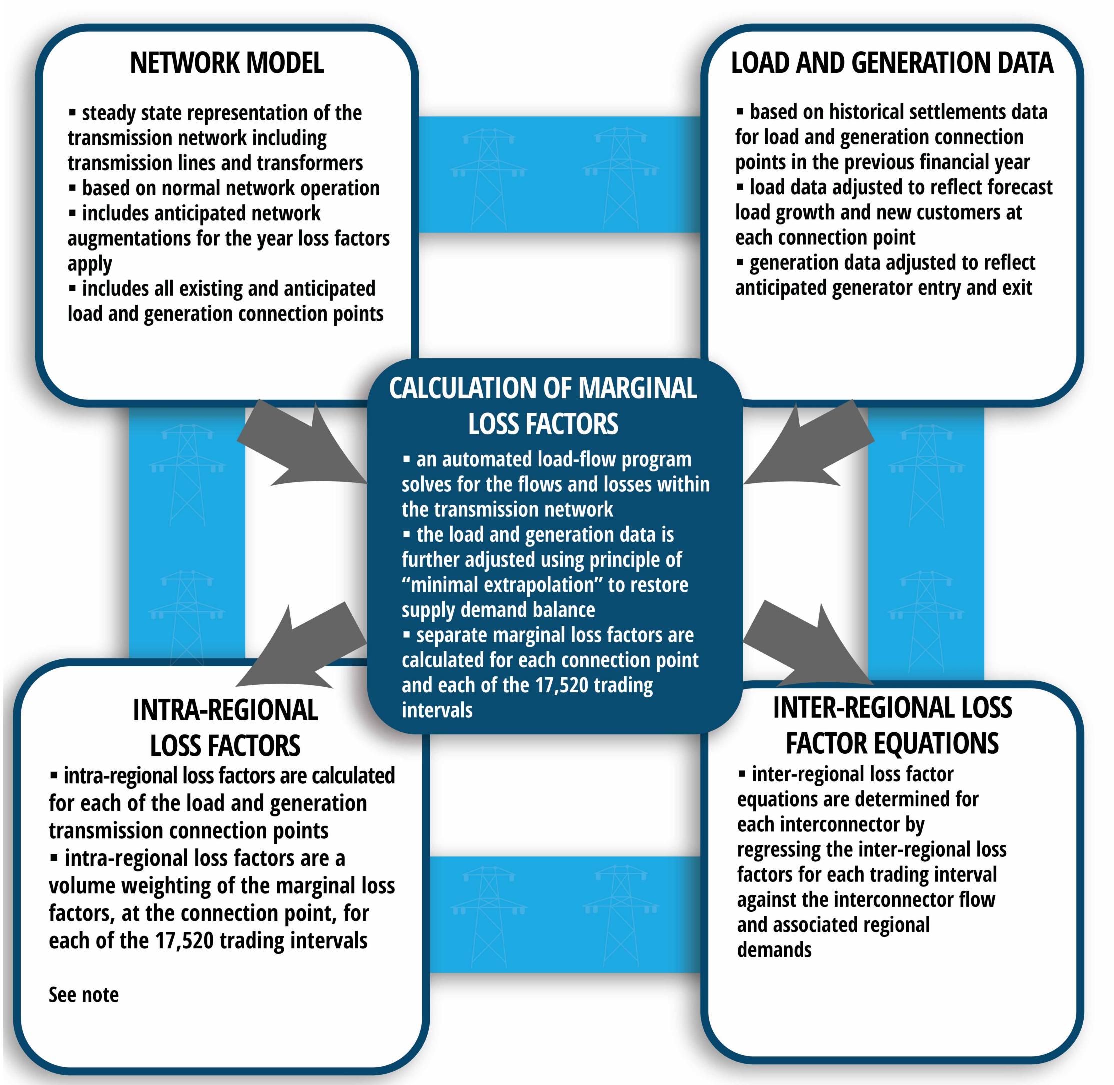
A CURRENT LOSS FACTORS FRAMEWORK

A.1 Current NER arrangements

The requirements in relation to the calculation of inter-regional and intra-regional loss factors for the NEM transmission networks are found in clauses 3.6.1, 3.6.2 and 3.6.2A of the National Electricity Rules (NER). In addition to these provisions, AEMO also publishes its calculation methodology.

Figure A.1 below illustrates the process for calculating the intra-regional and inter-regional loss factors.

Figure A.1: Loss factor calculation process



Source: AEMC

Note: The intra-regional loss factors are also often referred to as marginal loss factors (MLFs), transmission loss factors or static/single loss factors.

A.1.1 Intra-regional loss factors

Intra-regional loss factors notionally describe the marginal impact of electrical energy losses for electricity transmitted between a RRN and a transmission connection point in the same region for a defined time period and associated set of operating conditions.[33] Intra-regional loss factors are also commonly referred to as marginal loss factors (MLFs), transmission loss factors and static loss factors.[34]

AEMO must determine, publish and maintain a methodology for the determination of intra-regional loss factor equations for a financial year.[35] Publication of the intra-regional loss factors it determines by 1 April prior to the financial year in which they are to apply.[36]

When preparing this methodology, AEMO must implement a set of principles that can be summarised as follows:[37]

- the intra-regional loss factors are to apply for a financial year
- an intra-regional loss factor must, 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 RRN in the same region for each trading interval of the financial year in which the intra-regional loss factor applies
- the intra-regional loss factors must aim to minimise the impact on the central dispatch process of generation and scheduled load compared to that which would result from a fully optimised dispatch process taking into account the effect of losses
- the intra-regional loss factors are determined using forecast load and generation data, as described in clause 3.6.2A
- the intra-regional loss factor for a transmission network connection point is determined using a volume weighted average of the marginal loss factors for the transmission network connection point for the financial year in which the intra-regional loss factor applies
- flows in network elements that solely or principally provide market network services will be treated as invariant.[38]

Generally a single intra-regional loss factor applies for each transmission connection point for a financial year. However, two intra-regional loss factors can be applied when AEMO determines, in accordance with its loss factor methodology, 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 RRN.[39] Two intra-regional loss factors may be required for storage facilities

33 NER clause 3.6.2(b)(1).

34 Intra-regional loss factors are commonly called marginal loss factors because the marginal impact on losses is considered when determining the value, transmission loss factors because they apply to transmission connection points and static loss factors because a single static values applies for a whole financial year.

35 NER clause 3.6.2(d)

36 NER clause 3.6.2(f1).

37 NER clause 3.6.2(e)

38 The losses within market network services are treated separately.

39 NER clause 3.6.2(b)(2)(i)

(e.g. pump storage or batteries) when the energy at the transmission connection point is both positive (generating) and negative (load) to prevent the volume weighting process from determining a meaningless single static intra-regional loss factor.[40]

Intra-regional loss factors may, with the agreement of the AER, be averaged over an adjacent group of transmission network connection points within a single region to define a virtual transmission node (VTN) with an intra-regional loss factor calculated as the volume weighted average of the intra-regional loss factors of the constituent transmission network connection points.[41] VTNs are currently defined in New South Wales, South Australia and Tasmania.[42]

Intra-regional loss factors are used as price multipliers that are applied to the regional reference price to determine the local spot price at each transmission network connection point and VTN.[43]

In addition, AEMO determines intra-regional loss factors for new and modified connection points in the financial year in which an intra-regional loss factor is to apply if it did not determine an intra-regional loss factor in the preceding financial year.[44] AEMO must, as far as practicable, follow its methodology when determining these intra-regional loss factors.[45]

A.1.2 Inter-regional loss factors

Under clause 3.6.1 of the NER, inter-regional loss factors describe the marginal impact of electrical energy losses for electricity transmitted from a regional reference node (RRN) in one region to the RRN in an adjacent region.[46]

AEMO must determine, publish and maintain a methodology for the determination of inter-regional loss factor equations for a financial year,[47] in accordance with the rules consultation procedures.[48]

When preparing this methodology, AEMO must implement the principles pursuant to clause 3.6.1(e) of the NER:[49]

- replace the original principles

AEMO must publish the inter-regional loss factor equations it determines by 1 April prior to the financial year in which they are to apply.[50]

40 A volume weighted loss factor can become meaningless when the total energy at a connection point is close to zero; that this the sum of the generation is approximately equal to the sum of load over the financial year. When this occurs both the numerator and the denominator in the calculation approach zero and the ratio becomes poorly defined. This is discussed further in section 5.6.1 of version 7 of AEMO's "Forward-looking transmission loss factors" methodology.

41 NER clause 3.6.2(b)(3).

42 Regions List and Draft Marginal Loss Factors: FY 2019-20, published by AEMO on 1 April 2019.

43 NER clause 3.6.2(c).

44 NER clause 3.6.2(i).

45 NER clause 3.6.2(j).

46 NER clause 3.6.1(b)(1).

47 NER clause 3.6.1(c).

48 The rules consultation procedures are defined in rule 8.9 of the NER.

49 NER clause 3.6.2(e).

50 NER clause 3.6.1(f).

A.1.3 Load and generation data used to determine inter-regional loss factor equations and intra-regional loss factors

Clause 3.6.2 of the NER obligates AEMO, in accordance with the rule consultation procedures, to determine, publish and maintain a methodology for determining the load and generation data to be used to determine the inter-regional loss factor equations and intra-regional loss factors for each financial year. This methodology includes:[51]

- forecasting the load and generation data to be used to determine the inter-regional loss factor equations and the intra-regional loss factors. This includes new or revised intra-regional loss factors for connection points that are established or modified during the financial year in which the intra-regional loss factors apply
- modelling any additional load and generation data, where required
- the collection of relevant data from registered participants.

In preparing the methodology for forecasting and modelling load and generation data, AEMO must implement the following principles:[52]

- the forecast load and generation data must be representative of expected load and generation in the financial year in which the inter-regional loss factor equations or intra-regional loss factors are to apply, having regard to;
  - actual data from the previous the 12 month period defined by the methodology
  - projected load growth between the 12 month period of the actual data and the financial year for which the inter-regional loss factor equations and intra-regional loss factors apply
  - the projected network configuration and projected network performance for the financial year in which the inter-regional loss factor equations and intra-regional loss factors apply.
- additional modelled load and generation data sets must only be used in the determination of inter-regional loss factor equations where the range of forecast load and generation data is not sufficient to derive inter-regional loss factor equations to apply over the full range of transfer capability of the regulated inter-connector.

In addition, registered participants are required to provide the information set out in the methodology developed and published by AEMO. This information includes the deadlines for the provision of that information and any other obligations with respect to the provision of that information are required to be included in AEMO's published methodology.[53]

A.1.4 Application of the intra-regional loss factors

The intra-regional loss factors determined by AEMO are applied in the AEMO market systems. This occurs in the following ways:

51 NER clause 3.6.2A(b).

52 NER clause 3.6.2A(d).

53 NER clause 3.6.2A(e)

- semi-scheduled and scheduled generators' dispatch offers are divided by the intra-regional loss factor (to refer the offer to the RRN)[54]
- scheduled loads' dispatch bids are divided by the intra-regional loss factor (to refer the offer to the RRN)[55]
- the local spot price at each transmission network connection point is the spot price at the assigned regional reference node multiplied by the relevant intra-regional loss factor applicable to that connection point (the local spot price is not actually used further in the NER)[56]
- being used in the calculation of compensation in relation to AEMO directions[57]
- when determining the settlements payments (paid by market customers and paid to generators) by multiplying the measured energy in the trading interval, the regional spot price and the relevant intra-regional loss factor.[58]

A.2 AEMO's role in determining intra-regional loss factors

As discussed in earlier, the NER provides a number of key principles that AEMO must follow when it determines the inter-regional loss factor equations and the intra-regional loss factors each financial year. In addition, AEMO is required to produce and publish its methodology for determining the loss factors. This methodology is available on the AEMO website.[59]

AEMO uses an automated load flow program to calculate the loss factors for the financial year on which the inter-regional and intra-regional loss factors apply.[60] This program requires a network model that represents the region's transmission network plus the connection energy flows for each trading interval for the generators and loads connected to the transmission network.

The following discussion summarises AEMO's forward-looking intra-regional loss factor methodology and its application and includes:

- network model
- load forecast data
- controllable network element flow data
- generation data
- restoring the supply and demand balance
- intra-regional loss factors
- inter-regional loss factor equations

54 NER clause 3.8.6(h)(3).
55 NER clause 3.8.7(f).
56 NER clause 3.9.1(c).
57 NER clause 3.12.2(a)(2).
58 NER clause 3.15.6(a).
59 http://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Loss_Factors_and_Regional_Boundaries/2017/Forward-Looking-Loss-Factor-Methodology-v70.pdf
60 AEMO uses the TPRICE program for calculating the NEM loss factors.

- publication of the loss factors.

A.2.1 Network model

The inter-regional and intra-regional loss factors are determined from the losses that occur for energy flows within the region's transmission network. Therefore, an important input when determining the loss factors is a suitable model of the NEM transmission network.[61]

The network model AEMO uses is a single network representation to represent the normal network configuration that is anticipated for the financial year in which the inter-regional and intra-regional loss factors will apply. This model is based on the existing network plus any network augmentations that are expected to be commissioned during that year. Information on expected network augmentations are those which have been determined in consultation with the transmission network service providers (TNSPs) who supply relevant network data regarding these augmentations.

In addition, AEMO must ensure that the network model includes all existing connection points and those that are anticipated to be established before the end of the financial year which the inter-regional and intra-regional loss factors will apply.

A.2.2 Load forecast data

The automated load flow program used to calculate the inter-regional and intra-regional loss factors requires estimates of the energy consumed at each load connection point for each trading interval. This load energy information is provided to AEMO by TNSPs. AEMO performs due diligence on the provided data to ensure the forecasts are consistent with the most recent load forecasts used in its electricity statement of opportunity (ESOO) document.

The connection point load forecasts provided by the TNSPs:

- are based on reference year connection point data (retaining the same weekends and public holidays)[62]
- are consistent with the latest annual regional load forecasts prepared by AEMO or the TNSP
- are based on 50 per cent probability of exceedance and medium economic growth conditions
- include any known new loads
- include existing and committed generation that is embedded in the distribution network
- are an estimate of the active and reactive power at each connection point for each trading interval.

61 AEMO bases the network model on the PSSE load flow models it uses for contingency analysis and for the initial conditions for the more detailed stability studies it performs to assess system security.

62 The reference year is previous financial year to the year when the loss factors are determined. For example, the 2019-20 loss factors are determined in the 2018-19 year and the reference year is 2017-18.

A.2.3 Controllable network element flow data

Energy flows in a transmission network from generators to load centres and are generally passively distributed throughout the transmission network. The distribution of flows is predominantly determined by the impedances of the transformers and transmission lines, plus their topology. The exceptions to this are the Murraylink, Teranora and Basslink controllable network elements (DC links) where the flows on these links can be actively controlled through the AEMO dispatch process.

The Murraylink and Teranora network elements are regulated interconnections that operate in parallel with the Heywood and QNI[63] interconnectors respectively. In these cases the automated load flow program will determine the flows on these elements as a proportion of the Heywood and QNI flows.[64]

In contrast, the Basslink interconnector is an unregulated interconnector that operates as a market network service. To determine the flows on Basslink AEMO assumes that its flows are unchanged from the reference year.

A.2.4 Generation data

In addition to the network model, the load data and the flows on controllable network elements, the automated load flow requires a set of generation data by connection point for each trading interval.

For the existing generating units, AEMO uses the generation data from the reference year.

For new generating units AEMO estimates generation data from similar existing generating units that have a known generation profile. In addition, AEMO assumes the dispatch of new committed generating units to be zero for trading intervals prior to the commissioning date reported in the latest ESOO.[65]Once commissioned, AEMO estimates the output of new generating units by shaping and scaling generation data from similar generating units that operated in the reference year data by:

- identify generating units in the NEM that use similar technology and fuel type (AEMO tries to only use data from generating units that are up to five years old, but does relax this to 10 years if no suitable data is otherwise available)
- find the average output of the similar generating units as a percentage of their winter rating from the reported in the latest ESOO
- determine the output of the new generating units by scaling the average output profile by the nameplate rating of the new generating unit.

Once a generating unit has been operating for two years AEMO will have sufficient actual data included in the relevant reference year.

63 QNI is the Queenslnad to New South Wales interconnector.

64 See section 5.5.3 of he AEMO forward-looking loss factor methodology.

65 The Commission understands AEMO sough subsequent commissioning updates from all committed generation proponents for this years MLF determination.

Hydro and wind generating systems are rated differently as their output is energy constrained or intermittent. AEMO consults with the proponents of new hydro or wind generating units to determine an anticipated generation profile. Where the proponent is unable to provide a suitable 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. AEMO's methodology also includes a general approach to estimating the generation profile for new generating units that utilise a new technology or fuel type.

AEMO's determination of the generation data also needs to account for retiring generating units. Thus, AEMO sets the output to zero for generating units that are identified as retiring in the latest ESOO.

Finally, AEMO will also modify generation data when either AEMO or the associated generator considers that the operation during the reference year is unlikely to be representative of generation expected from a generating unit during the year that the inter-regional and intra-regional loss factors apply. This may occur for a number of reasons including significant droughts that limit the output of the generating unit, or prolonged outages for maintenance etc.[66]

A.2.5 Restoring the supply and demand balance

In the reference year the energy supplied by generation balances the energy consumed by the loads plus the losses in the network. However, this supply-demand balance will no longer occur for the year in which the inter-regional and intra-regional loss factors are being determined. This is because demand has been adjusted to account for load growth and new loads, and supply has been adjusted to account for new generation and generator retirement. In addition, network augmentations have been included and these may also affect the losses in the transmission network.

This supply-demand balance needs to be restored for the network flows to be representative of the flows in transmission network to be representative of the future financial year when the inter-regional and intra-regional loss factors will apply. To restore the supply-demand balance AEMO uses a process it calls the minimal extrapolation principle. This is done by adjusting the output of all the dispatchable generating units that are operating in that trading interval.

For periods of excess generation, where load has increased by less than the initial forecast of the output of the new generating units, AEMO reduces the net generation by scaling the output of all the generating units in proportion to their output in the reference year. AEMO does not adjust the output of energy limited generating units such as pump storage schemes.

For periods of insufficient generation, where load has grown by more than the initial forecast of the additional generation or due to generation retirement, AEMO increases the net generation. This is a more complex process than reducing the output of the generation as it

66 Additional details are available in section 5.5.6 of its forward-looking loss factor methodology.

needs to consider output limits on generating units and which units could have potentially operated at that time.[67]

When adjusting the generation to restore the supply-demand balance, the minimal extrapolation principle also needs to consider interconnector limits. Failure to consider interconnector limits could potentially result in flows that are beyond the secure limit of the interconnector and would not be representative of the network flows that could occur. Therefore, AEMO implements interconnector limits that are representative of the limits it expects to apply for summer and winter, and for peak and off-peak periods, for the financial year that the inter-regional and intra-regional loss factors will apply. AEMO consults with TNSPs when developing these representative limits. Considering the interconnector limits means that AEMO may need to adjust generation differently in different regions to maintain inter-regional flows within the respective transfer capabilities.

A.2.6 Intra-regional loss factors

The automated load flow program solves for the network flows, and the associated loss, for each trading interval using the generation and load data described above. The loss factors for each load and generation connection point, with respect to their RRN, are extracted from the load flow solution for each trading interval. This results in 17,520 marginal loss factor values for each transmission connection point in the NEM.[68]

The intra-regional loss factor value for a given transmission connection point is the volume weighted average of the 17,520 intervals, where the weights are the energy generation and/or consumption values for each trading interval.

The use of volume weights to average the marginal loss factors for the trading intervals means that the resulting single intra-regional loss factor value is representative of periods of either high generation or consumption, for a generating unit or load connection point respectively.

Following the determination of the intra-regional loss factors for each of the transmission connection points, AEMO also calculates the loss factors for any VTNs.[69]

A.2.7 Inter-regional loss factor equations

In addition to providing intra-regional loss factors for each trading interval, the automated load flow solution provides the inter-regional loss factors between the adjacent RRN.

Inter-regional loss factor equations are then determined for each interconnector by regressing the inter-regional loss factors for each trading interval against the interconnector

67 Additional details on the process AEMO uses for period in insufficient generation are available in section 5.5.2 of its forward-looking loss factor methodology.

68 In a leap year there are 17,568 trading intervals due to the presence of 29 February.

69 Clause 3.6.2(b)(3) of the rules allows, with the agreement of the AER, for intra-regional loss factors to be averaged over an adjacent group of transmission network connection points. If averaging is used, the relevant transmission network connection points will be collectively defined as a VTN. The intra-regional loss factor for the VTN is calculated as the volume weighted average of the intra-regional loss factor loss factors of the constituent TNIs. AEMO's forward-looking transmission loss factors methodology explains the specific method that it uses. VTNs are used for some connection points in New South Wales, South Australia and Tasmania.

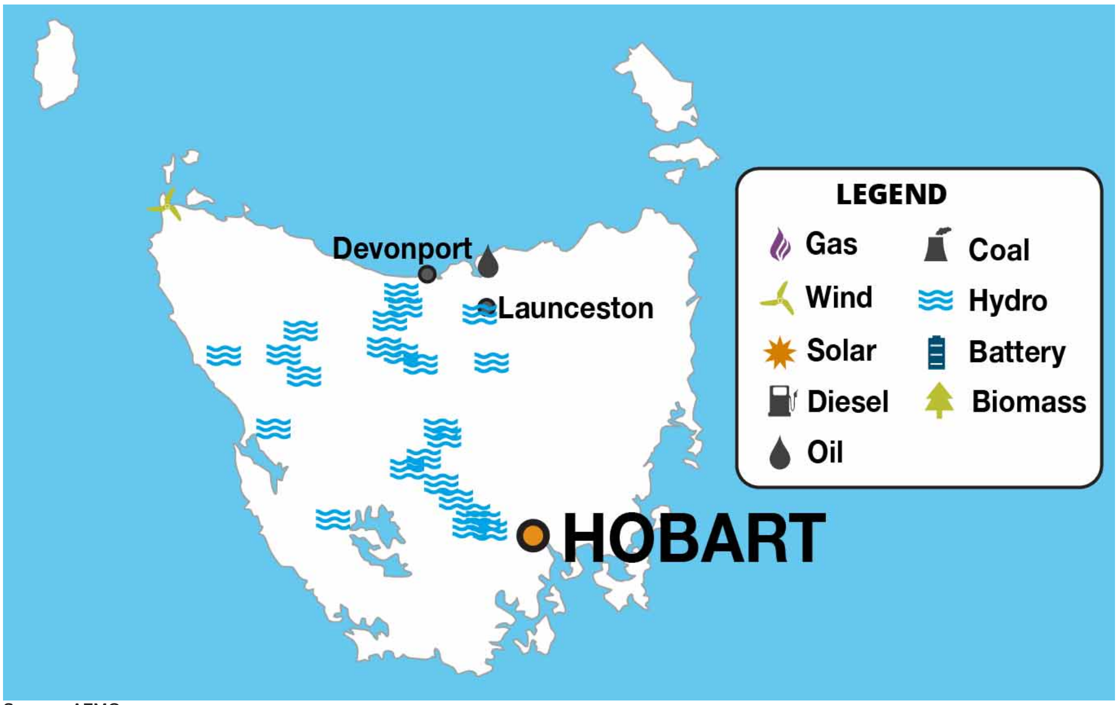
flows by trading interval. The quality of the regression is improved by also including the regional demand values in the associated regions into the regression models.

B CHANGE IN GENERATION MAPS

The information contained in these maps, including the location and generation type, has been prepared by the AEMC as a general guidance and for information purposes only. The information is based on publicly available sources, and has bot been independently verified by the AEMC, and therefore, may not be complete, accurate or up to date.

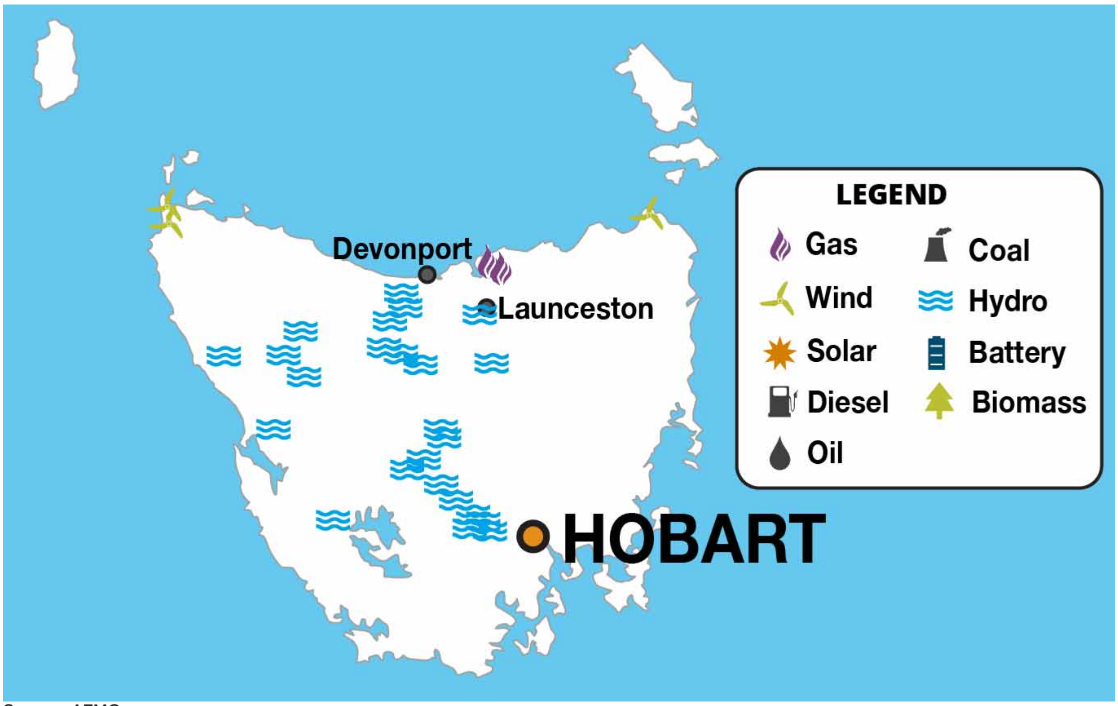
B.1 Tasmania

Figure B.1: Location of generation in Tasmania 2002



Source: AEMC

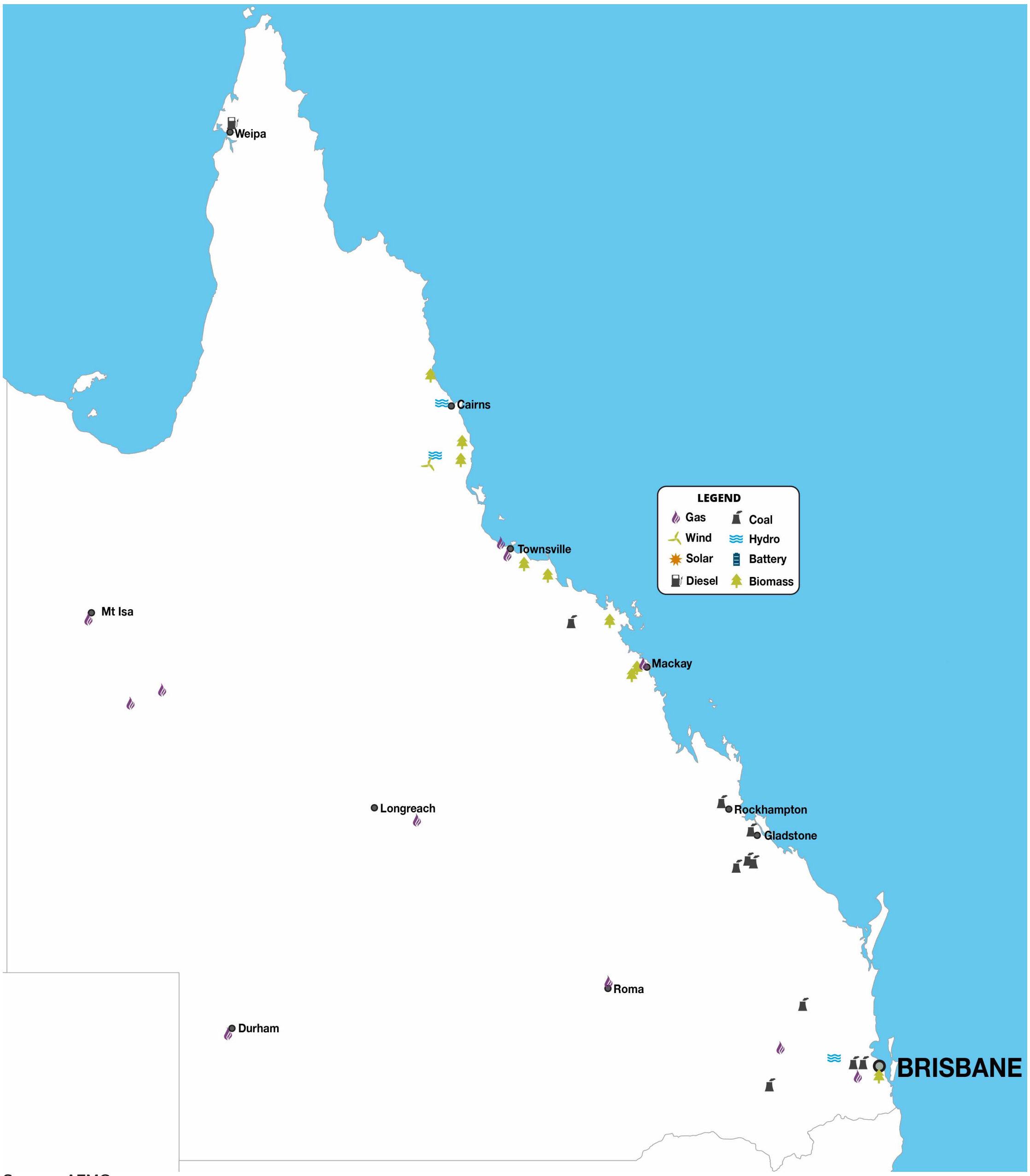
Figure B.2: Location of generation in Tasmania 2019



Source: AEMC

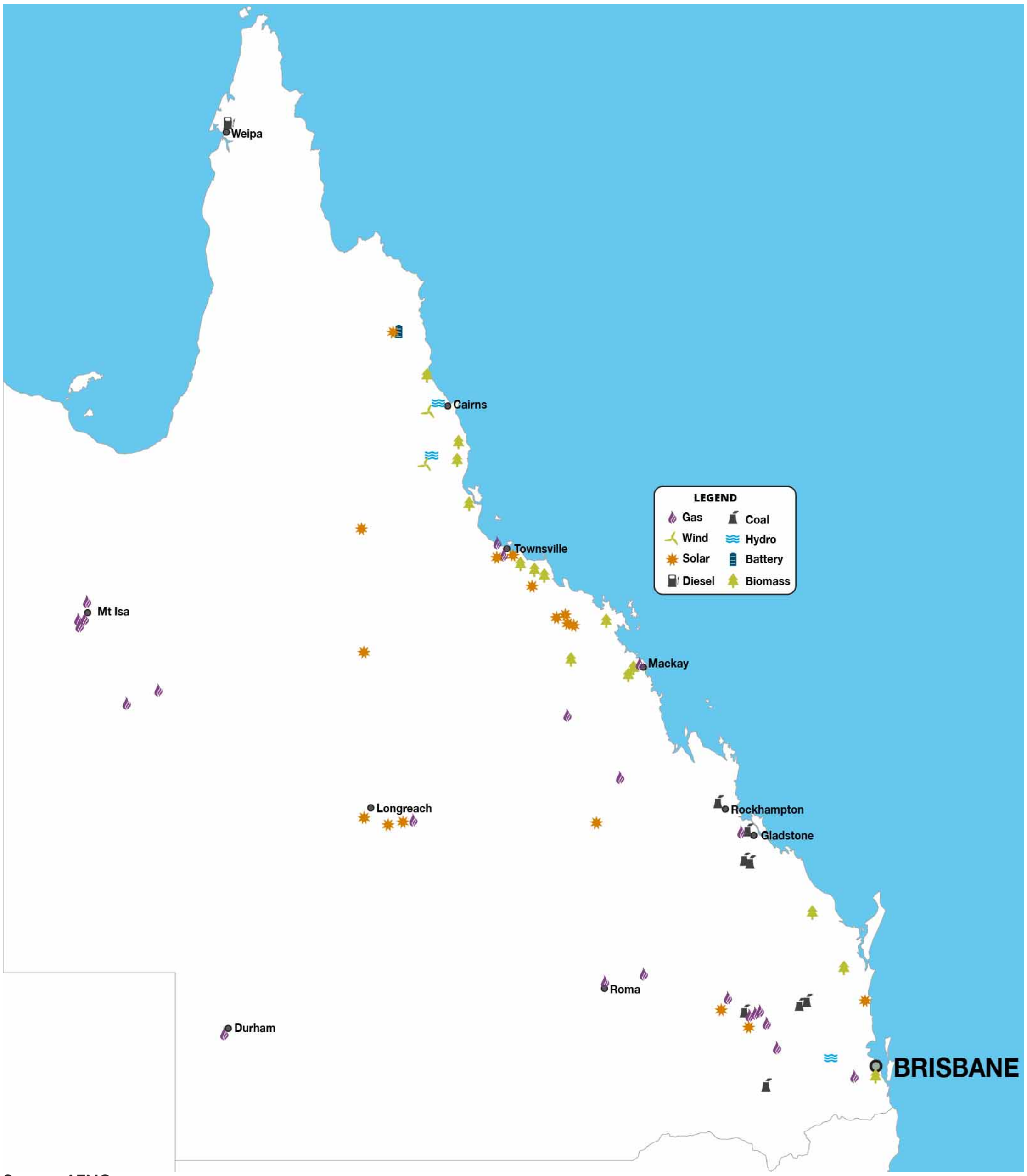
B.2 Queensland

Figure B.3: Location of generation in Queensland 2002



Source: AEMC

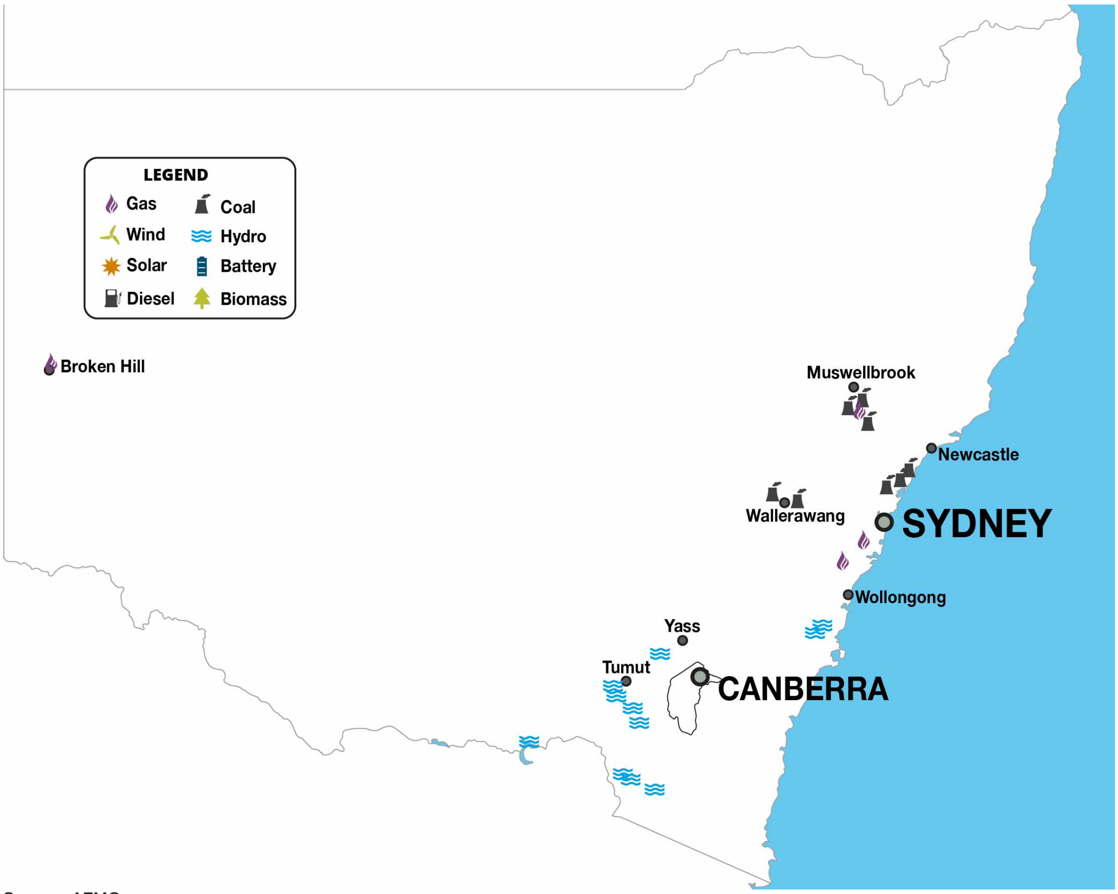
Figure B.4: Location of generation in Queensland 2019



Source: AEMC

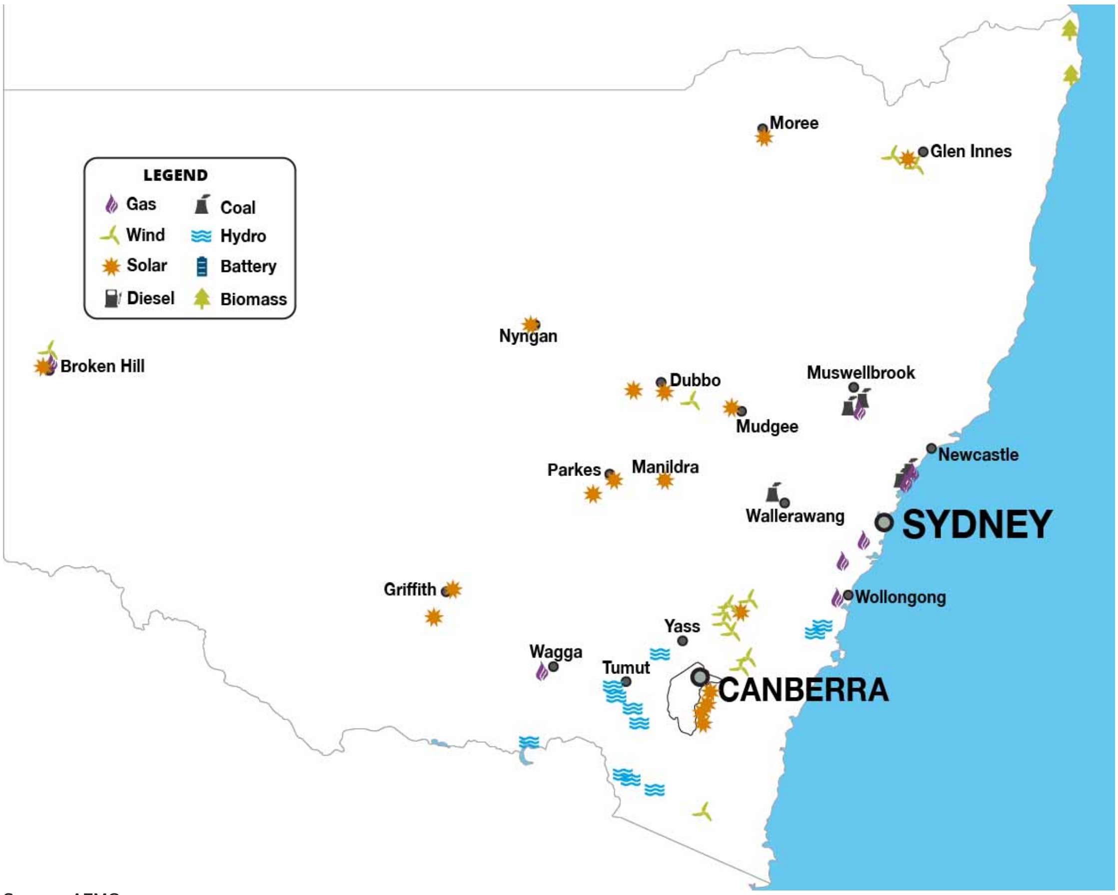
B.3 New South Wales

Figure B.5: Location of generation in New South Wales 2002



Source: AEMC

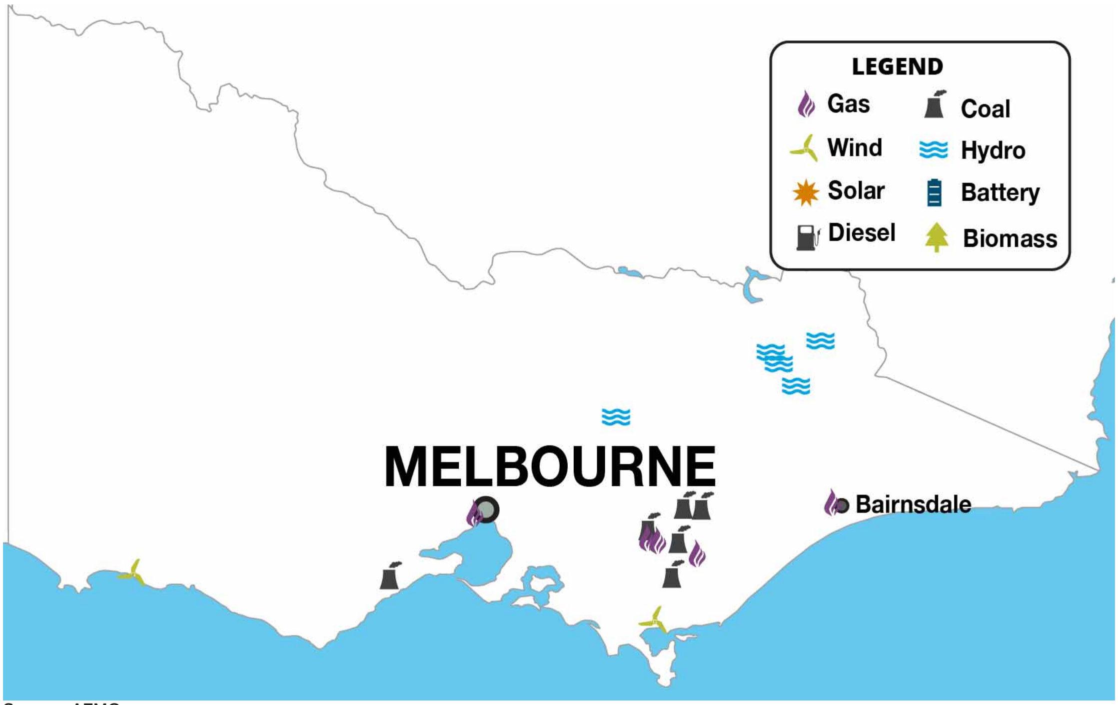
Figure B.6: Location of generation in New South Wales 2019



Source: AEMC

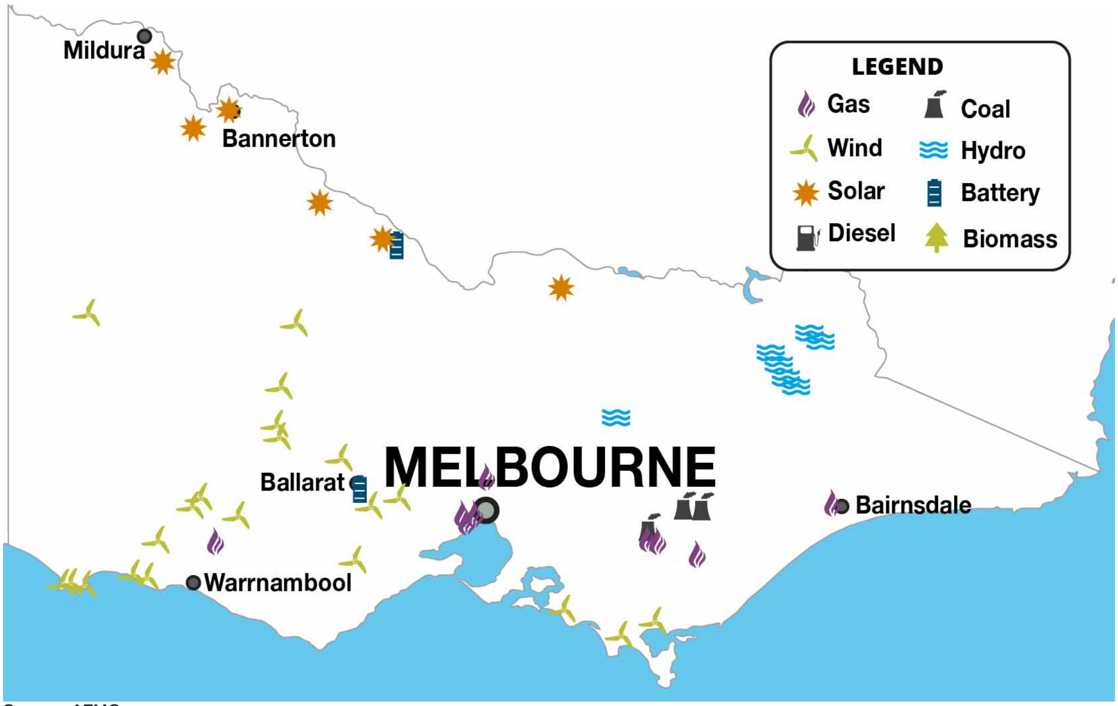
B.4 Victoria

Figure B.7: Location of generation in Victoria 2002



Source: AEMC

Figure B.8: Location of generation in Victoria 2019



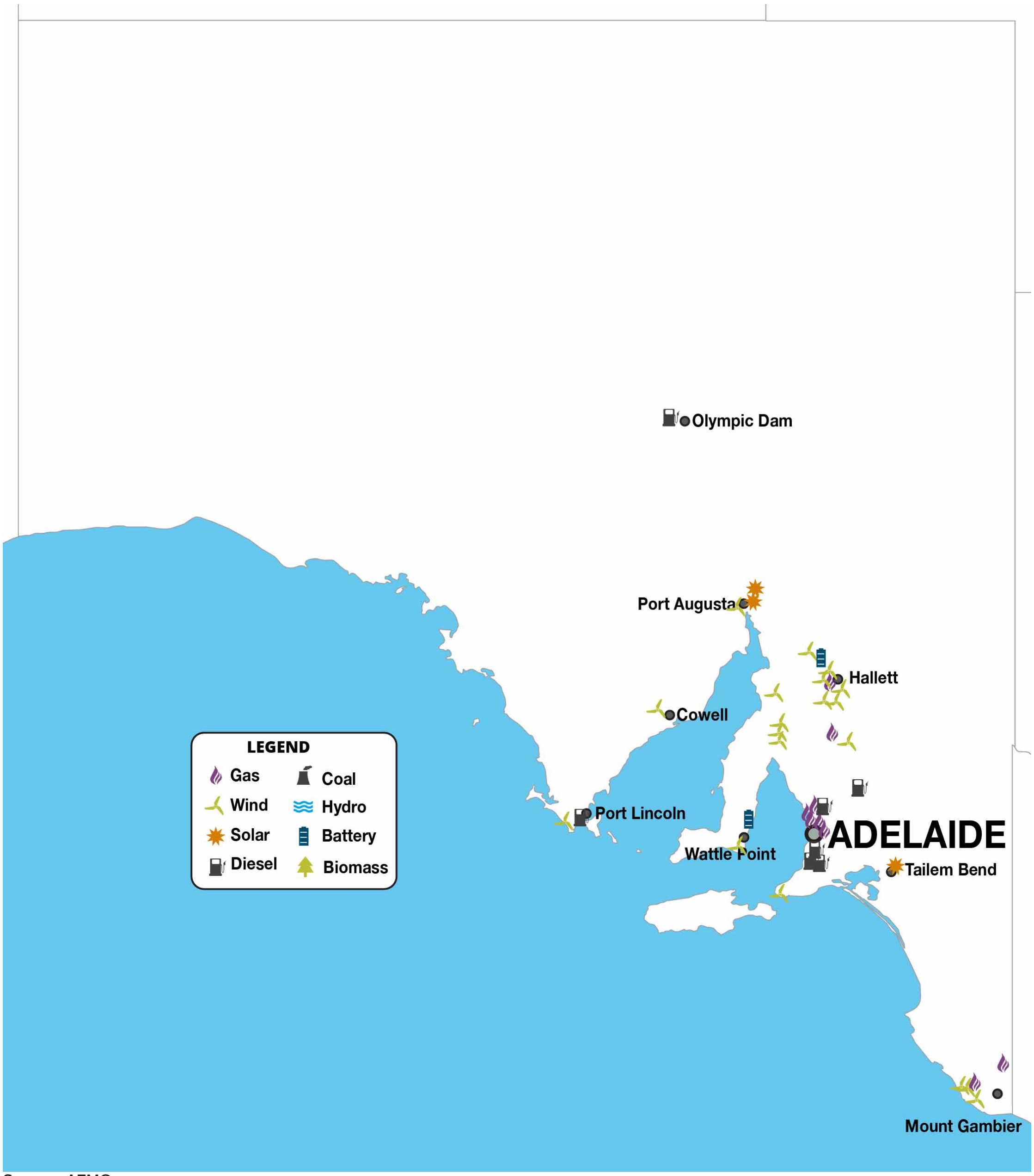
Source: AEMC

B.5 South Australia

Figure B.9: Location of generation in South Australia 2002

Source: AEMC

Figure B.10: Location of generation in South Australia 2019



Source: AEMC