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CLEAN ENERGY COUNCIL

15 August 2019

Mr John Pierce AO
Chair
Australian Energy Market Commission
PO Box A2449
Sydney South NSW 1235

Lodged by email: Andrew.Splatt@aemc.gov.au

Dear Mr Pierce,

Supplementary Submission to Transmission Loss Factors Rule Change Proposal (ERC0251): Consultation Paper

The Clean Energy Council (CEC) is the peak body for the clean energy industry in Australia. We represent and work with hundreds of leading businesses operating in renewable energy and energy storage along with more than 6,000 solar and battery installers. We are committed to accelerating the transformation of Australia's energy system to one that is smarter and cleaner.

The CEC thanks the Australian Energy Market Commission (AEMC) for the opportunity to provide a supplementary submission in response to the consultation paper on the transmission loss factors rule change proposal. This consultation is critical as the recent year-on-year volatility in Marginal Loss Factors (MLFs) has been challenging for both existing generators and investors and developers of new generation. Following further member discussions and supported by independent technical advice, the CEC strongly believes that amendments to the transmission loss factors framework are justified to achieve the National Electricity Objective (NEO) by ensuring this framework remains fit for purpose for the National Electricity Market (NEM).

A revised loss factor approach is warranted

As described in our earlier submission, the current loss factor approach has resulted in significant year-on-year variations in MLFs, which is an unmanageable risk that cannot be hedged by industry. For existing generators, MLFs directly impact revenue and therefore significant adjustments materially influence their financial sustainability, which in turn is currently leading to refinancing requirements and financial distress and could lead to future default and supply disruption. For prospective generators, because MLFs are an unhedgeable risk, this volatility is expected to increase the risk premium for new investments, increasing the levelised cost of energy and potentially deterring new investment in new generation. This is at a time when unprecedented levels of new investment are required to maintain reliability and stabilise wholesale prices as a number of large thermal generators retire and need to be replaced.

The CEC believes the transmission loss factor approach should:

- Support the energy transition at least cost
- Provide efficient and timely investment and locational signals
- Ensure efficient dispatch
- Ensure efficient and accurate settlement process that appropriately allocates risk.

While it is theoretically ideal if all objectives could be met equally, this is rarely possible in reality. On balance, we consider that supporting the energy transition at least cost is the most important of these objectives in order to encourage market-led and competitive development of generation to replace retiring thermal generators in an efficient and timely manner. This in turn requires certainty of loss factors. The CEC appreciates this results in a trade-off against dispatch efficiency, but we believe some reduction in dispatch efficiency, noting dispatch in the NEM is already imperfect today, will deliver cost savings and overall long-term customer benefit as a result of providing greater investor certainty.

It is worth noting that certainty does not necessarily mean stability. Certainty refers to having confidence in the extent to which a loss factor will change over a future period of time. A loss factor approach that provides a high degree of certainty will allow loss factors to vary but in a predicable manner. Stability is one approach to providing certainty focused on restricting the level of movement in a loss factor. The CEC has considered certainty versus stability and believes certainty is more efficient and therefore preferable as it allows investors and developers to make informed long-term decisions.

The CEC supports an Average Loss Factor (ALF) approach as the preferred option that best supports investment certainty. An ALF approach would address current generator concerns, principally as ALFs are likely to be less variable than the current MLF methodology while still preserving the locational signal as the relative order of loss factors is retained. An ALF approach also improves the accuracy of the settlement process as generators would earn revenue on their dispatch that reflects the actual losses across their dispatch volume rather than the entire dispatch volume receiving the loss factor of the marginal additional unit of dispatch. This accuracy of settlement would remove the current systematic Intra-Regional Settlement Residue (IRSR) surplus. We contend this approach may result in some reduction in dispatch efficiency as it does not align with the NEM's marginal approach to dispatch. However, the benefits from an improvement in investment certainty will likely outweigh this. In addition, it is worth noting that the current MLF approach is not completely consistent with the NEM's marginal dispatch approach given annual volume-weighted MLFs do not correspond to the five-minute marginal price at which electricity is dispatched.

The CEC considers the ability for an ALF approach to improve investment certainty is likely to contribute to the achievement of the NEO as it will improve the provision of information to assist investors and developers in making well-informed decisions on efficiency investment in generation capacity in the NEM. Under the current MLF methodology, investors and developers have little certainty about loss factor trajectories, which in turn is introducing a risk premium to the cost of capital. A higher level of certainty through an ALF approach reduces the risk of the investment, which translates to a lower cost of capital that can ultimately lead to more generation being developed under the same market conditions and therefore lower wholesale electricity prices and lower retail prices for consumers.

Across all five regions of the NEM, an ALF approach was found to lead to the lowest baseload prices.[1] This impact is more significant when considered alongside the volume of electricity dispatched during the year. For example, Queensland consumers would receive a benefit of almost $120 million from reduced wholesale prices in 2019/20 under an ALF approach. This translates to a $12 per annum saving on a typical consumer bill, which could increase in future once the effects of reduced cost of capital and increased renewable investment are factored in.[2]

The benefits of an ALF approach to new generation investment is evident through a case study example looking at a specific Renewable Energy Zone (REZ).[3] REZs are a key component of the Australian Energy Market Operator's (AEMO's) Integrated System Plan (ISP) so highlighting the impact of the loss factor approach on REZs is important as the industry seeks to deliver the benefits of the optimised transmission system requirements outlined in the ISP. Analysis confirms that MLFs reduce considerably as additional new generation capacity is built in a REZ while ALFs reduce far less with this new build, allowing greater volumes of new generation at a given capture price. When capture prices are not held constant, they are higher under ALFs than under the current MLF approach, which makes a greater additional capacity of renewables projects financially viable than if the current MLF approach is retained. The additional certainty offered by ALFs alongside an expected reduction in cost of capital would further enhance the viability of developing new generation.

Quantitative analysis shows that for both generation and load across the NEM, moving to an ALF approach can be expected to reduce the spread of loss factors and increase their concentration in a narrower range. Connection points with poor MLFs currently, namely generators at the lower end of the range of MLFs and loads at the higher end of the range of MLFs, would have more favourable loss factors under this approach.[4] The anticipated reduction in loss factor volatility would also smooth price volatility, leading to reduced wholesale prices and reduced retail prices for consumers.

Given an ALF approach would achieve the NEO, the CEC believes the AEMC is justified in making this rule change irrespective of any potential reforms to the way that transmission losses are dealt with in dispatch and settlement that may arise through the Coordination of Generation and Transmission Investment (CoGaTi) work program and the Energy Security Board's post-2025 market review. Improving incentives for new generation investment even in the short-term is imperative to address the challenges with the current MLF methodology and ensure continued investment in new generation that is needed as part of the NEM's current transition. In considering the different loss factor options, the CEC identified the relative simplicity of an ALF approach as an additional benefit as it could be implemented quickly so as to be in place for the publication of the 2020/21 loss factors.

Attached to this submission is technical advice prepared by Baringa Partners. This advice provides further qualitative and quantitative detail to support the comments made above. Specifically, the advice considers the merits of the different options against the principles for loss factors, discusses international precedents for the different options and outlines

[1] Baringa Partners report, p. 18.
[2] Ibid., pp. 26-28.
[3] Ibid., pp. 30-32.
[4] Ibid., pp. 24-26.

quantitative analysis to illustrate the potential impacts of changing the transmission loss factor approach in the NEM.

Complementary measures would support a revised loss factors approach

To further improve the efficacy of an ALF approach, the CEC supports two complementary measures that will provide greater loss factor certainty and predictability for investors and developers, thereby reducing risks and costs of the new generation needed across the NEM.

Firstly, investors and developers currently lack visibility of important new connection information, such as the pipeline of new connection inquiries and the development status of approved new projects. This hinders informed decision-making, delays and adds costs to project planning and approvals and creates a disincentive for the coordination of connections.

Although it is inevitable that there will always be some level of uncertainty around new projects with proposals often flagging their connection interest well in advance of having secured financial close, greater transparency can nonetheless help to reduce the unknowns. Understanding that a significant volume of connection inquiries has been made in a given area is likely to lead to more informed decisions than not having any information at all, even if many of these inquiries will not materialise as commissioned projects. Given this, the CEC supports in principal the transparency of new projects rule change project. The proposed transparency reforms will benefit prospective investors and developers by providing a clearer picture of the pipeline of new proposed projects in different areas of the network.

Secondly, the CEC considers there are additional actions that AEMO could pursue directly in relation to loss factors. As indicated in our earlier submission, we support AEMO's proposal to publish more frequent non-binding guidance on future loss factors as this can assist market participants to understand and better prepare for future binding loss factors.

AEMO also calculates transmission loss factors in the NEM using a model, methodology and data that are not entirely publicly available. As a result, it is challenging for prospective investors, developers and their advisors to forecast loss factors with confidence that they will align with AEMO's calculations. This introduces uncertainty and therefore risks and costs for new generation.

A greater availability of data and information from AEMO would enable independent modelling by investors, developers and their advisors to better predict loss factors. This will allow proponents to better assess loss factor risk as they do for wholesale power price risk already. Publication of AEMO's loss factor model, network data and nodal load data could significantly improve certainty and reduce costs and risks of new generation investment. There may, however, be some limitations to publishing this material because of confidentiality barriers, however publishing even a greater subset of this material than is currently available would still benefit the sector. If these limitations cannot be overcome, we support further exploration of a modelling and information sharing arrangement between AEMO and "accredited" consultants.

Thank you again for the opportunity to provide a supplementary submission on this critical consultation. If you would like to discuss any of the issues raised in this submission, please contact me on the details below.

Yours sincerely,

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TRANSMISSION LOSS FACTORS

INPUT TO CEC RESPONSE TO AEMC CONSULTATION ON TRANSMISSION LOSS FACTORS (ERC-251)

Client: Clean Energy Council

August 2019

Version History

Version	Date	Description	Prepared by	Approved by
1.0	15/08/2019	Final version	Jacqui Fenwick Peter Sherry	Peter Sherry

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Executive summary

Transmission loss factors are fundamental to the National Electricity Market (NEM) dispatch process and provide important locational investment signals for new generation. The current Marginal Loss Factor (MLF) approach was designed to ensure a relatively efficient dispatch, but it introduces significant uncertainty and costs for new generation investment in areas remote from load. As such, while the current approach has its merits, it is arguably no longer fit for purpose in an energy system requiring substantial new capacity build over the coming decades, much of which is expected to be renewables in locations far from the major load centres.

A transmission loss factor mechanism should support the energy transition at least cost, by providing certainty for developers and investors, providing timely and efficient investment signals, supporting efficient dispatch, and enabling accurate settlement. These outcomes are important to delivering price and reliability benefits for consumers in the long-term, in line with the National Electricity Objective (NEO).

We have assessed a number of potential alternative loss factor approaches against these criteria and have undertaken some indicative quantitative analysis to demonstrate the potential impacts they might have in the NEM. Both 'Compressed MLFs' and Average Loss Factors (ALFs) would reduce the cost of capital for new investment and enable more projects to be financially viable. We find that ALFs offer the greatest potential reduction in wholesale electricity prices as they have the greatest impact on the costs of price-setting marginal plant. Of the options analysed, we find that both Compressed MLFs and the ALF can support the development of new generation capacity at least cost by providing generators access to stronger revenues and maintaining more favourable loss factors as the capacity of new build increases.

Contents

1 Background

This report has been prepared by Baringa Partners to support the Clean Energy Council's submission to the AEMC Transmission Loss Factors consultation (ERC0251). The analysis in this report is intended to be illustrative and should not be interpreted or used as projections for financing purposes.

Marginal Loss Factors (MLFs) apply to transmission-connected generation and load in the Australian National Electricity Market (NEM), with a direct impact on the dispatch and settlement processes. Historically, MLFs have been relatively stable and predictable, reflecting a stable generation portfolio located close to load centres. As a result, the methodology for calculating loss factors has been largely uncontroversial and has attracted little attention.

However, in recent years MLFs have become less predictable and have reduced significantly year-on-year in some areas of the network, with major impacts on the revenue of affected generation. This is illustrated in Figures 1 and 2, below, which show just two years of changes in published MLFs across the NEM. Amongst other factors, this MLF reduction reflects the rapid development of renewable generation into areas with the strongest resources, but a long distance from major load centres and/or into weaker areas of the network. This has increased the physical electrical losses on some transmission lines, which feeds through (on a marginal basis) into MLFs at individual connection points in these regions. MLF volatility also reflects the impact of other factors such as changes to interconnector flows and unexpected closure or unavailability of thermal plant.

Figure 1: Map showing changes in published generation MLFs from 2017-18 to 2018-19

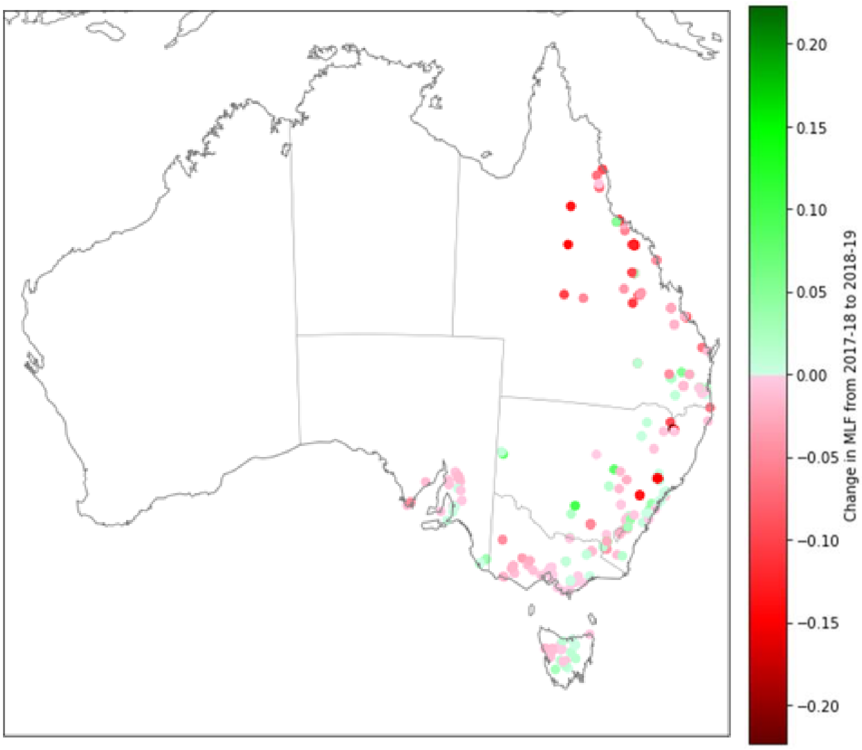
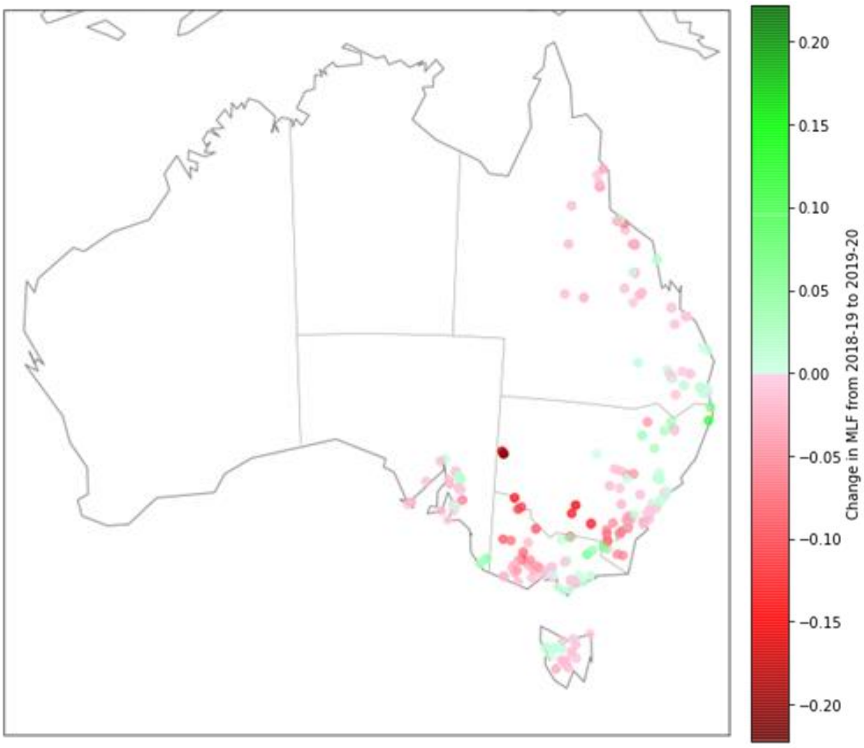


Figure 2: Map showing changes in published generation MLFs from 2018-19 to 2019-20



Under the current MLF approach, the risk associated with changes in loss factors is largely borne by generators – both existing generators and new connections. Retailers and large transmission-connected customers are also impacted by changes in MLF, but the magnitude of change is typically less material, and is mitigated by the surplus provided to customers through the Intra-Regional Settlement Residue (IRSR) process.

For existing generation, MLF reductions have a direct impact on wholesale market revenues, which these generators have no opportunity to hedge or respond to. A generator that connected to the network when there was sufficient capacity to support it can later be hindered by MLF reductions that are out of its control and which it cannot readily mitigate through its own decisions.

For prospective new generation connections, MLFs now introduce a significant risk that can be a significant barrier to the financial feasibility of a project. MLFs that are difficult to predict introduce additional revenue uncertainty for new projects, which translates to a cost premium imposed by investors. Unlike other forms of risk inherent to generation investment, MLF risk is difficult to hedge against.[1]

If we expected a relatively static energy market over the coming decades, the challenges of the current MLF approach would likely be inconvenient for a few affected stakeholders but unlikely problematic for the system as a whole. This is because the current transmission network was built to facilitate the connection of the current thermal generation located close to thermal resources.

However, in the context of a rapidly transitioning market that is, and will continue to be, increasingly dependent on renewable resources, the current MLF approach poses a significant challenge.

[1] Larger investors may be able to manage the risk by investing in a geographically diverse portfolio of projects, but there are no mainstream financial products available to hedge MLF risk.

Maintaining the current MLF approach is increasing the costs of, and deterring, investment in new generation, at a time in which unprecedented levels of new investment will be required to provide cheap energy and maintain reliability as large thermal plant near retirement. Modelling for AEMO's inaugural 2018 Integrated System Plan (ISP) identified that approximately 54 GW of new generation and storage will be needed in the NEM by 2040 to replace retiring thermal plant at least cost.[2,3] AEMO's least cost modelling (taking into account both the costs of generation and transmission) identifies that much of this new generation capacity will need to come from solar and wind located away from load centres, in what it has described as 'Renewable Energy Zones (REZs)'. Without this generation into REZs, the cost of the transition would increase above this least cost optimal scenario presented in the ISP.

Given how important this new generation will be from both a reliability and a cost perspective, it is relevant to consider whether the current loss factor approach remains fit for purpose to incentivise and deliver the investment. It could be argued that the current approach is not suitable to deliver on the National Electricity Objective (NEO), as it is increasingly less able to promote the efficient investment needed to deliver lower prices and reliability for consumers in the long term.

In November 2018 and February 2019, Adani Renewables submitted two separate rule change requests to the AEMC, proposing two key reforms to the transmission loss factor approach:

- A change to the **intra-regional settlement residue (IRSR) allocation rules**, so that IRSR is allocated equally between generators and networks users who are subject to non-locational prescribed TUOS charges.
- A change to the rules prescribing AEMO's **transmission loss factor calculation methodology**, to shift from a marginal loss factor methodology to an average loss factor methodology.

In June 2019, the AEMC published a consultation paper seeking stakeholder feedback on a consolidated *Transmission Loss Factors* rule change request, in response to the two requests by Adani Renewables. The AEMC has used the consultation process to seek feedback more broadly on how transmission losses and any resulting IRSR should be dealt with in the NEM, and have been open to considering a wider range of options than those in the Adani Renewables requests.

1.1 Broader regulatory context

The AEMC's *Transmission Loss Factors* rule change request is progressing concurrent to a number of other relevant work programs, including:

- the Transparency of new projects rule change request;[4]
- the Coordination of Generation and Transmission Investment (CoGaTI) implementation work program;[5] and
- the ESB's NEM 2025 Market Design work program.[6]

[2] AEMO, Integrated System Plan 2018, https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/ISP/2018/Integrated-System-Plan-2018_final.pdf
[3] Based on AEMO's Neutral ISP planning scenario.
[4] AEMC, Transparency of new projects rule change request, https://www.aemc.gov.au/rule-changes/transparency-new-projects
[5] AEMC, Coordination of Generation and Transmission Investment implementation – access and charging, https://www.aemc.gov.au/market-reviews-advice/coordination-generation-and-transmission-investment-implementation-access-and
[6] COAG Energy Council, NEM 2025 Market Design, http://www.coagenergycouncil.gov.au/publications/post-2025-market-design-national-electricity-market-nem

It is not yet clear how the various pieces of work will interact if each progresses to rule changes and implementation. In particular, if dynamic regional pricing is introduced in July 2022, as proposed in the CoGaTI Directions Paper, this would fundamentally transform the way that transmission losses are dealt with in dispatch and settlement.

Irrespective of these related work programs, the view of the CEC is that the challenges of the current transmission loss factor approach need to be addressed in the short term to provide the right incentives for new generation investment in the next few years, as a transitional phase until the CoGATI reforms are implemented. The costs of retaining the status quo and waiting for the (still uncertain) outcome of CoGATI to be implemented are considered too high.

This report therefore canvasses a number of potential options that could be adopted in the near-term to account for losses in a way that better supports ongoing and efficient investment in new generation as the energy sector transitions.

1.2 Background to the current loss factor methodology

The current methodology applied to the treatment of transmission losses in dispatch and settlement is based on forward-looking projections of losses for each transmission-connected generation or load connection point, updated each financial year.

The MLF for a connection point represents an *estimation* of the electricity losses that would occur between the connection point and the regional reference node if one additional unit of electricity is generated (or used, in the case of load).

MLFs are used by AEMO's NEM Dispatch Engine (NEMDE) when issuing dispatch instructions, and are also used to determine how much each generator is paid for its dispatched generation during settlement. Generators are paid the relevant Regional Reference Price (RRP) multiplied by their MLF, so an MLF of less than 1.0 results in a discounting of the RRP received. Conversely, for customers an MLF of less than 1.0 will result in a discount to the RRP paid.

AEMO uses a forward-looking methodology to calculate MLFs, meaning MLFs are projections of future losses for the following financial year, rather than based on actual losses in that given year. The methodology draws on actual data from the reference year, which is two years prior to the year projected (for example, 2019-20 MLF calculations use the reference year 2017-18). Adjustments are made for system changes, or projected system changes, from the historical data year to the forecast year which are expected to influence line losses, such as new generation and storage projects (incl. committed projects expected to be commissioned in the relevant year) and network reinforcements.

AEMO calculates MLFs for each connection point in each trading interval in the relevant year. For each connection point, the trading interval MLFs are then volume-weighted across the year to give a single annual average value. An alternative dual MLF process is used for some connection points with storage assets or low 'Net Energy Balance (NEB)'.

Losses on a particular line are a function of generation, load and network factors. For example, losses are impacted by the capacities and dispatch profiles of connecting generators, the distance to load, and the rated voltage and resistance of a transmission line. Transmission losses are not linearly related to the amount of power on the line, but increase quadratically (i.e. losses = $current^2$).

Two key reasons that discrepancies arise between calculated MLFs and actual line losses are:

- Applying marginal loss values to a generator's entire volume will overstate the losses as a whole, as physical losses actually accrue on an average basis.
- Network, generation and load parameters that impact losses will vary between those assumed in the model and those in reality.

The first of these discrepancies tends to result in inaccuracies in the settlement process, as losses are over-recovered by AEMO on a marginal basis, compared to the actuals. Under the current MLF mechanism, AEMO is therefore 'long' in settlement and tends to accrue significant positive intra-regional settlement residues (IRSR) in each region[7]. This IRSR is paid to customers via TNSPs, as a reduction in transmission use of system (TUoS) charges. As more generation locates in the regions with best renewable resources but lower MLFs, this inaccuracy in settlement becomes more material, with the IRSR inefficiencies borne entirely by generation.

Establishing a mechanism that better reflects actual physical losses and therefore reduces this inaccuracy in settlement is a key element of the proposed rule change.

More detail on the current methodology and IRSR process can be found in the AEMC's Transmission Loss Factor consultation paper, the Adani Renewables proposed rule change, as well as in AEMO's Forward-Looking Transmission Loss Factors methodology and the guiding principles in the National Electricity Rules (3.6.2).

[7] South Australia is the current exception to this, where negative settlement residues are not uncommon.

2 Principles for transmission loss factors

The transmission loss factor approach should, first and foremost, aim to deliver the National Electricity Objective (NEO):

"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:

- *price, quality, safety and reliability and security of supply of electricity*
- *the reliability, safety and security of the national electricity system."* [8]

The Clean Energy Council (CEC) has developed a number of key principles to underpin a new approach to transmission loss factors, consistent with the NEO, informed by views from a range of CEC members impacted by the current MLF mechanism[9].

The CEC members put forward that the transmission loss factor approach should:

- Support the energy transition at least cost;
- Provide efficient and timely investment and locational signals;
- Ensure efficiency of dispatch through NEMDE; and
- Ensure efficient and accurate settlement processes that appropriately allocate risk.

These principles are in line with achieving the NEO, particularly with regard to delivering price and reliability outcomes in the long term interests of consumers.

Table 1: Summary of alignment between key principles identified by the CEC and the NEO

Key principles for transmission loss factors	National Electricity Objective alignment
Support the energy transition at least cost	Consistent with achieving price benefits for consumers, by ensuring new generation is built in resource-rich areas as part of the least cost future energy mix (as identified in the ISP). Consistent with achieving reliability of electricity supply and the electricity system, by supporting new generation development as thermal plant retire.
Provide efficient and timely investment and locational signals	Consistent with achieving price benefits for consumers, by ensuring investors and developers are seeing clear signals they can respond to with investment in locations that will deliver efficient long-term outcomes for consumers.
Ensure efficiency of dispatch through NEMDE	Consistent with achieving price benefits for consumers by delivering dispatch directions that minimise costs and inefficiencies with respect to bids and losses.

[8] National Electricity Law, Part 1, Section 7

[9] Baringa Partners facilitated a series of roundtable workshops with representatives of Clean Energy Council member organisations in July and August 2019, to discuss positions on the AEMC's Transmission Loss Factor rule change consultation paper. Participants included representatives of investor groups, developers, and gentailers, and brought a diversity of perspectives to the table. In this session, participants agreed key principles and objectives which should underpin loss factor reform. These were reflected in the Clean Energy Council's submission to the AEMC (published on the AEMC's website).

Ensure efficient and accurate settlement processes that appropriately allocate risk	Consistent with achieving reliability of electricity and the electricity system, by supporting efficient new generation development as thermal plant retire, with risk and cost more reflective of actual losses.

CEC members also highlighted the importance of identifying a simple loss factor approach which does not require significant additional data or systems to implement. This was primarily driven by an interest in implementing loss factor reforms in the near-term, ahead of any reforms coming via the CoGaTi review.

Members emphasised the need for greater transparency of both potential new network connections and of AEMO's MLF modelling data and approach as 'no regrets' measures.

2.1 Support the energy transition at least cost

Supporting the energy transition at least cost ultimately means adopting a loss factor approach that will encourage market-led and competitive development of new generation in time to replace retiring thermal plant in the NEM.

AEMO's inaugural ISP sought to identify the least-cost energy transition path as thermal plant retire. In doing so, AEMO found that renewable energy generation located in defined 'Renewable Energy Zones (REZs)' would play a critical role. These REZs are located in regions of the NEM with excellent resources and often close to the existing transmission network, but in some cases with significant network augmentation required. The ISP modelling identified the least cost mix of generation and transmission to support the transition away from thermal generation over the next 20-30 years.

One of the key parameters for supporting investment in new generation is certainty. It is important to note that 'certainty' is not necessarily synonymous with 'stability' in this context, as explained in the box below.

Certainty versus stability

Although often considered interchangeably, certainty and stability of loss factors are two distinct outcomes achieved with different loss factor approaches.

Certainty refers to having confidence in the extent to which a loss factor will change over a future period of time. A loss factor approach that provides a high degree of certainty may result in loss factors that vary year-to-year and over the long-term, but in a predictable manner or within known bounds. Certainty allows investors, developers and planners to make decisions about the future with an understanding of how the loss factor is likely to move over this time.

Stability, by comparison, refers to the amount of movement in a loss factor from year-to-year or over a future period of time. A loss factor approach that provides a high degree of stability will result in limited, if any, movement in a loss factor over a period of time. Stability of a loss factor is one approach to providing certainty.

Of these two outcomes, certainty is generally what investors need. Certainty, rather than stability, is critical to informing long-term investment decisions and therefore important for supporting new generation. Stable loss factors are just one possible approach to achieving certainty, but may not be the most efficient or effective option for doing so.

In general, a higher level of certainty of future loss factors for a prospective project reduces the risk of the investment, which translates to a lower cost of capital. A lower cost of capital, in turn, is likely to lead to more projects securing funding because the financial return needed to make the project viable is lower. Increased renewable capacity, developed at a lower cost, can reduce wholesale prices to the benefit of consumers.

Conversely, uncertainty of future loss factors for a prospective project increases investment risk and subsequently the cost of capital for a project. We are seeing this with the current MLF approach, under which many investors and developers have little certainty about loss factor trajectories and are introducing a risk premium to the cost of capital to account for this.

An increase in the 'equity hurdle rate' as a result of ongoing and unhedgeable MLF exposure post financial close will directly translate into an increase in the weighted average cost of capital (WACC) for a new generator. This in turn would be expected to directly impact on the project's 'Levelised Cost of Energy (LCOE)', which is a measure of the average minimum price at which electricity must be sold in order to break-even over the lifetime of the project. This is illustrated in the solar PV and onshore wind projections below, which show the LCOE impact over time of a 1 per cent change in WACC.

Figure 3: Indicative LCOE for utility-scale solar PV in the NEM, with and without a 1% WACC reduction

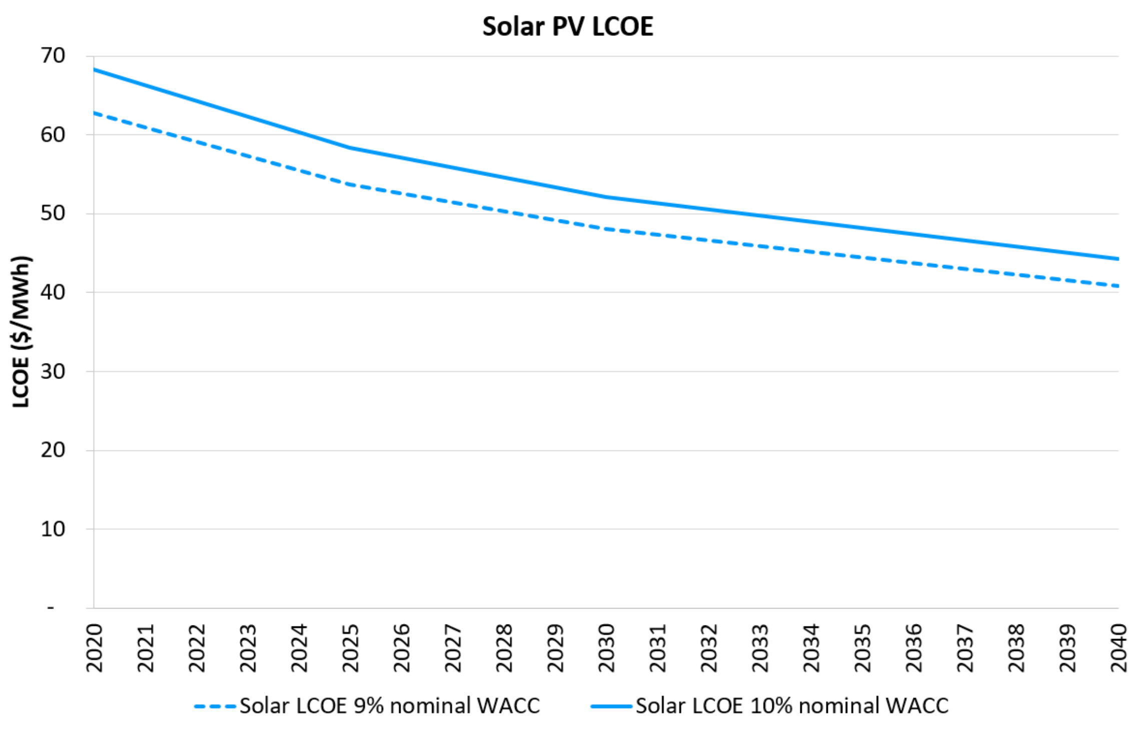
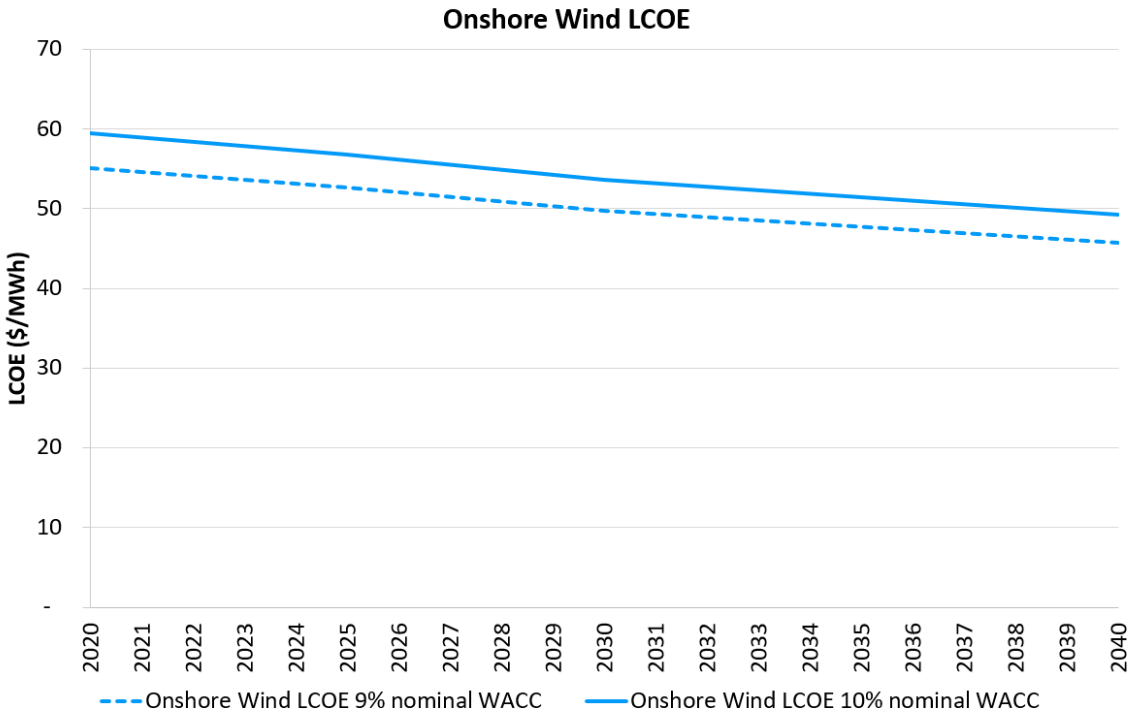


Figure 4: Indicative LCOE for onshore wind in the NEM, with and without a 1% WACC reduction



A higher cost of capital for new generation projects, leading to a higher LCOE, will ultimately lead to less generation being developed under the same market conditions, and the generators that are already committed/operational needing to recover higher costs. Both of these factors could lead to higher wholesale electricity prices. On average, wholesale electricity prices make up around 34 per cent of residential electricity bills[10], and the impact of loss factors on wholesale prices can be expected to flow on to consumers through this component of their bills.

2.2 Efficient and timely investment signals

In the current NEM regulatory framework, transmission loss factors are an important mechanism for providing locational and temporal investment signals for the development of new generation. Ideally, a loss factor should provide investment signals that incentivise the development of low cost generation and storage solutions when and where they are needed to deliver maximum benefit to the market. The strength of the locational signal should take into account the needs of the system, providing a balance of risk between generators and consumers. Critically, for efficient investment signals, the loss factors should be reflective of actual losses as far as possible.

Although MLFs do provide a locational signal, it has been harder for investors to act on this signal in recent years, due to the uncertainty of what the loss factor at a given connection point will actually be at the time the network connection is finalised. Then, of most concern to investors, the signal can also shift after financial close such that the original locational decision (based on the locational signal provided by MLF at that time) may be undermined or even reversed with hindsight.

[10] AEMC, 2019 Retail Energy Competition Review final report, https://www.aemc.gov.au/market-reviews-advice/2019-retail-energy-competition-review

As well as a locational investment signal, loss factors should provide temporal investment signals to incentivise the development of new generation in a given location when it is most beneficial to the NEM.

The current MLF approach is based on historic actual losses adjusted to account for recent and projected system changes and is reasonably suitable in a stable environment. However, as network connections and system changes are becoming more rapid, annually published loss factors are becoming less timely. MLFs published in April are increasingly likely to be out of date before the financial year they apply to has even commenced. They will only become further removed from true marginal losses as the year progresses and the system deviates further from the original MLF forecast. More frequent loss factor publication could help to address this, but it is still questionable whether this could provide an efficient investment signal.

Any revisions to the current approach to transmission loss factors should provide efficient locational and temporal investment signals to deliver the efficient investment decisions that reflect system needs.

2.3 Efficiency of dispatch

Loss factors play an integral role in the NEM dispatch process. As outlined in a number of recent papers and in many of the submissions to the AEMC's Transmission Loss Factor consultation paper,[11] loss factors are incorporated directly into the NEM Dispatch Engine (NEMDE) and affect merit order and the clearing price of dispatch. In summary, the NEMDE clearing algorithms adjust dispatch offers from individual generators by their loss factors so that the dispatch offers reflect the costs of a marginal unit of generation with losses accounted for.

In theory, losses should be accounted for on a marginal basis to ensure efficient dispatch in a market/region with a single marginal clearing price, as both the losses and clearing price relate to marginal supply. A move away from a marginal loss factor approach will result in a divergence from the marginal-based dispatch mechanism, potentially introducing distortions to bidding behaviour and thus inefficiencies in dispatch.

However, while the current MLF approach is based on losses on the marginal unit of supply and is therefore consistent with the marginal unit approach to dispatch, there are potential distortions and inaccuracies associated with the annual volume-weighted MLFs approach (i.e. the current system is by no means providing a 'perfect' dispatch). It is not clear how material these potential distortions are, but the imperfections should be acknowledged in the context of a potential move away from the current mechanism on the basis of improving investor certainty.

This is ultimately one of the judgements that the AEMC needs to make – is a material improvement in investor certainty worth some reduction in dispatch efficiency (from an imperfect dispatch today)?

2.4 Efficient and accurate settlement process

As with dispatch, loss factors play an integral role in the NEM settlement process. Generators are paid for their dispatched volume at the regional NEMDE clearing price multiplied by their loss factor.

[11] AEMC, Transmission Loss Factors consultation paper, workshop materials and submissions, https://www.aemc.gov.au/rule-changes/transmission-loss-factors

This means that generators with loss factors less than 1.0 are paid a discounted price relative to the RRP, while those with loss factors greater than one are paid a premium.

Under the current approach, the MLF is used to adjust the price for a generator's entire dispatch volume, even though this loss factor reflects the losses on the marginal unit of supply and not losses across the total generation volume actually dispatched. In practice, this means generators are paid less for their generation, as they pay for higher losses than are actually incurred. Because most consumers pay for generation at the RRN price, AEMO recovers more from customers for dispatched electricity than it pays to generators for the dispatch. The MLF approach therefore leads to settlement residues accruing to AEMO. These IRSRs are returned to customers through a reduction in TUoS charges.

The current loss factor approach is, by design, inefficient and inaccurate relative to actual line losses. The cost of the inefficiency and inaccuracy is directly borne by generators (and indirectly by consumers that will inevitably pay a higher wholesale electricity cost if price-setting generators have factored the inefficiency into their dispatch offers). Consumers receive 100 per cent of the IRSR, which offsets some, if not all, of the inefficiency premium they pay for, however there is no mechanism for generators to recoup the lost costs. The proposed rule change suggests there should be a more equitable split of IRSR between generators and consumers.

Any revised approach to calculating loss factors should prioritise efficient and accurate settlement, rather than an inefficient and inaccurate approach that imposes costs on generators. This is especially the case given the transition required in the NEM, in which more rather than less new generation investment is needed as the thermal plant retires.

A more accurate settlement process will inevitably result in lower settlement residues accruing to AEMO and being passed on to consumers. This is a more efficient outcome.

It may also mean that AEMO, as the 'clearing house', is no longer able to maintain the significant positive settlement balance that it currently does. While these potential knock-on effects for AEMO's balance sheet do require careful consideration, this should not be a driving factor in the design of the losses mechanism itself.

3 Options for reform

In this section, we investigate a number of potential transmission loss factor options and consider their merits against the principles above.

We have focused on loss factor methodology options only and have not explicitly investigated alternative approaches to IRSR allocation. As flagged in section 2, a loss factor approach that improves the accuracy of settlement will reduce the IRSR accrued by AEMO and passed on to consumers.

Note that this report does not recommend a specific loss factor option, but investigates a number of potential options and the opportunities and limitations of each.

3.1 Range of loss factor options considered

The below table reflects how a range of potential loss factor approaches compare to the current annual MLF approach.

Table 2: Comparison of a range of loss factor approaches to the current MLF approach

Loss factor approach	Supports new investment	Efficient and timely investment signals	Efficiency of dispatch	Efficiency of settlement	Simplicity of implementation
Grandfathering MLFs	Green	Yellow	Red	Red	Simple
Cap and floor	Green	Yellow	Red	Red	Simple
Compressed MLF	Green	Green	Red	Green	Simple
Average Loss Factor (ALF)	Green	Green	Red	Green	Simple
MLF dispatch, ALF settlement	Green	Green	Red	Green	Complex
Moving average MLF	Yellow	Red	Red	Red	Simple
Seasonal, or peak/off-peak	Yellow	Red	Green	Red	Somewhat complex
Dynamic MLFs	Red	Red	Green	Red	Complex

Note: red means the loss factor approach performs worse than MLF, green means it performs better, and yellow indicates an immaterial difference.

Based on CEC feedback, we have focused in detail only on those options that are expected to improve investor certainty and enable the transition at least cost, which include:

- Compressed MLFs

- Average Loss Factors (ALFs)
- MLFs for dispatch and ALFs for settlement
- Grandfathering of MLFs

These options are discussed in more detail in sections 3.2 to 3.5 below.

The remainder of these options in Table 1 have not been pursued further in this paper. These include:

- **Cap and Floor:** this option could look quite similar to grandfathering (i.e. a new project could lock in a cap and floor at the time of investment), so we have not considered it separately.
- **Moving average MLF:** We have not investigated this approach in further detail as, although this option reduces year-to-year variability, it ultimately retains many of the current challenges of the MLF approach and just delays when the full burden of MLF reductions are felt. By introducing a delay, a moving average MLF would reduce the alignment between the outturn marginal losses in the system and when they are reflected in the MLF. This would not support new investment compared to the current approach.
- **Seasonal MLFs or peak/off-peak MLFs:** We have not investigated these options further as they would also retain many of the current loss factor challenges, including being challenging to predict and potentially highly volatile year-to-year as new generators connect. Although this approach would be more accurate to outturn marginal losses than the current approach, it would not improve investor certainty.
- **Dynamic loss factors:** This option would see loss factors calculated for each connection point in each settlement interval, reflecting close to real-time estimated line losses. This approach would lead to more efficient dispatch compared to the current approach. However, dynamic loss factors significantly increase uncertainty for investors and are likely to result in even higher cost of capital and investment hurdles than under the current mechanism. Further, a dynamic loss factor approach will take a long time to be implemented and is not a suitable near-term solution to the current challenges of loss factors.

3.2 Compressed MLFs

Summary:

- Supports new investment: Greater certainty than with current annual MLFs because compressed MLFs are likely to vary less. Although the *range* of potential MLFs is more predictable, the actual value is no more predictable than under the current approach.
- Efficient and timely investment signals: Provides a locational signal, arguably more aligned with actual losses, although the strength of the signal is dampened relative to the current approach. The relative ranking of locational signals between connection points under MLF is maintained under this approach, but relative competitiveness may change.
- Efficiency of dispatch: Dispatch efficiency is preserved by retaining a marginal approach, albeit with less accurate marginal losses factoring in.

- Accuracy of settlement and appropriate risk allocation: The errors between forecast MLF and actual losses would be expected to be much smaller, and therefore the IRSR error will be smaller. This would be a more efficient risk allocation if the compression factors reflect actual losses.
- Implementation timeframe: This approach could be implemented with minor Rule changes and a Methodology change, and is therefore a short-term implementation option.

Description:

A Compressed MLF approach would still be based on marginal losses, as per the current approach. Once the MLFs are calculated, AEMO would then adjust the values so that the overall spread of loss factors is reduced. This could be done by compressing the values towards one, or towards another value (likely reflecting outturn actual losses).

Compressed MLFs have the benefit of retaining the relative order of loss factors, so that connection points with higher actual losses will continue to have a lower loss factor than those with lower losses. By preserving the locational signal, this approach continues to incentivise efficient investment decisions, it just reduces the penalty (or reward) of locating in a region with higher (or lower) line losses. In practice, this approach would change the relative competitiveness of generators compared to the current uncompressed MLF approach, and it would therefore have the potential to change the merit order for some generators.

While connection points with very low MLFs are likely to benefit from loss factor improvements, there will inevitably be some connection points that find their MLFs are compressed downwards.

By reducing the magnitude of MLFs and bringing loss factors closer to actual line losses, the compressed MLF approach is expected to reduce the settlement residues accruing to AEMO. Assuming the current IRSR allocation approach is retained, this will result in less of a TUoS reduction being passed on to customer bills than under the current approach.

International Precedent:

Irish energy market

The Irish Energy Market currently applies compressed MLFs to account for transmission losses.

Like the NEM, the Irish market used to apply unadjusted MLFs. The compression step has been introduced into the loss factor methodology at the request of regulatory authorities[12], to reduce the range and therefore volatility of loss factors for the benefit of investors.

The compression factor algorithm used in the Irish market is based on a normalisation number (NN), which is a point of reference for the loss factors to be compressed around. The NN is chosen to ensure that, after compression is applied, the compressed losses are equal to the uncompressed losses (i.e. the forecast transmission losses for that month). The NN varies by month and time of day.[13]

[12] The Commission for Energy Regulation (CER) in Ireland and the Northern Ireland Authority for Utility Regulation (NIAUR) in Northern Ireland.

[13] Eirgrid and SONI, Transmission Loss Adjustment Factor Methodology Explanatory Paper, 2012, http://www.eirgridgroup.com/site-files/library/EirGrid/TLAF-Methodology-Explanatory-Paper-v1.0.pdf

If a connection point has an uncompressed MLF value that is less than the normalisation number (MLF<NN), the following compression algorithm applies:

$$Compressed\ MLF = \frac{NN - MLF}{2 * NN} + MLF$$

For example, if the normalisation number were 0.95 and the uncompressed MLF calculated for a connection point was 0.85, the compressed MLF would be 0.9.

$$Compressed\ MLF = \frac{0.95 - 0.85}{2 * 0.95} + 0.85$$

$$Compressed\ MLF = 0.90263$$

If a connection point has an uncompressed MLF that is greater than the normalisation number (MLF>NN), the following equation applies:

$$Compressed\ MLF = MLF - \frac{MLF - NN}{2 * NN}$$

For a connection point with an uncompressed MLF of 0.99, above the normalisation number of 0.95, the compressed MLF would be 0.97.

$$Compressed\ MLF = 0.99 - \frac{0.99 - 0.95}{2 * 0.95}$$

$$Compressed\ MLF = 0.96895$$

Alberta energy market (Canada)

A threshold-dependent compression factor is applied in the Alberta energy system, Canada. As discussed in the Average Loss Factor (ALF) section below, Alberta uses an average loss factor rather than a marginal loss factor to account for transmission losses. If annual ALF calculations determine any loss factors to sit outside of a defined threshold (+/-12%, in other words 0.88-1.12) the system operator revises all loss factors with the use of a compression factor. If loss factors for some generators or load remain outside of the threshold range even after the compression factor is applied, their loss factors are clipped in to the threshold (essentially a cap and floor).

The system operator is required to ensure that the losses captured by all loss factors are equal to the forecast total system losses. If the compression and clipping approach, above, does not result in this outcome, the system operator continues adjusting the compression factor and clipping the outliers until the forecast total system losses are met.

Application in the NEM

In applying a compressed MLF approach in the NEM, AEMO would need to run compression calculations and – to do so – would be required to choose a 'normalisation number' to centre the compression. This is likely to be determined to ensure the compressed losses equal the uncompressed losses across the system (as per the Irish approach). In the NEM, based on 2019-20 MLFs for all generation and load, this would be around 0.97-0.98.

In an operational sense, this loss factor approach is unlikely to require additional data from generators, load or the network. In terms of the policy and regulation, because this approach is based on marginal losses it would require less Methodology and Rules changes than some other alternative options. To minimise Rule changes, it is likely that the compression step would need to be applied to the MLFs calculated for each connection point in each trading interval, prior to volume-weighted averaging. However, legal advice would ultimately be needed to determine with confidence the policy and regulatory changes required.

3.3 Average Loss Factors

Summary:

- Supports new investment: Greater certainty than under the current annual MLF approach because, similarly to compressed MLFs, ALFs are likely to less than MLFs.
- Efficient and timely investment signals: Provides a locational signal which is more aligned with actual losses, though the strength of the signal is dampened relative to the current approach. The relative ranking of locational signals between connection points under MLF is maintained under this approach, but relative competitiveness may change.
- Efficiency of dispatch: some reduction in the efficiency of dispatch, as this loss factor approach would no longer use a marginal approach (notwithstanding that the current mechanism introduces inaccuracies).
- Accuracy of settlement and appropriate risk allocation: Greater accuracy of settlement, resulting in very limited IRSR. This would represent a more efficient risk allocation than the current MLF mechanism.
- Implementation timeframe: This approach would likely require both a Methodology change and a Rule change (as the current Rules requires marginal losses), and is therefore a short to medium-term implementation option.

Description:

An average loss factor approach reflects losses across the entire dispatch capacity of a generator, rather than the losses of adding an additional unit of output. So for a 100MW generator, the ALF reflects the losses of the full 100MWh volume of dispatch rather than the additional losses of dispatching 101st MWh as per an MLF approach.

Ultimately, this means that average loss factors are approximately half the value of marginal loss factors.[14] A generator with an MLF of 0.90 would have an ALF of around 0.95, which more closely

[14] In an ideal world where only line thermal losses are accounted, ALF can be calculated as ALF = 1 + (MLF-1)/2. However, when other losses are taken into account, such as transformer iron losses, this formula may be less accurate, and taking the square root of MLF may be more appropriate. The ALFs calculated using either method would be similar for connection points with MLFs in the range of 0.8-1.2, with

reflects actual losses than an MLF. This reduction in the range of potential movement in loss factors would improve investor certainty.

Like the compressed MLF approach, ALFs preserve the order of loss factors and therefore provide a locational signal for investors, albeit dampened relative to the current MLF approach. Like the compressed MLF approach, a change from the current MLF approach to an ALF approach could also change the relative competitiveness of some generators, as some will benefit more from the change than others.

Another positive of the ALF approach is that it significantly improves the accuracy of the settlement process. Generators would earn revenue on their dispatch that reflects the actual losses across their dispatch volume, rather than the entire dispatch volume receiving the loss factor of the marginal additional unit of dispatch. This would remove much of the current systematic IRSR surplus.

As with the compressed MLF approach, average loss factors would be expected to reduce settlement residues accruing to AEMO and would therefore reduce the IRSR allocated to TNSPs to offset TUoS charges on customer bills.

International Precedent:

Alberta energy market

The Alberta Energy System Operator calculates annual (calendar year) loss factors for connection points based on an average loss factor approach. In essence, the system operator looks at the losses in the system if a given generator (or load) is dispatching (or drawing electricity) throughout the year, and then considers losses in the system without this generator or load (alternative generators determined through merit order), and calculates the loss factor based on the difference.

The operator uses historic data from two years prior, as per the NEM, as well as data on new and committed projects, and considers twelve different network typologies which represent each month. Loss factors are calculated at an hourly resolution and annual volume-weighted averages are determined for each load and generator. A 'shift' factor is then applied to adjust loss factors such that the total losses projected with the loss factors equals the forecast total system losses for the given year, taking into account interregional losses.

If a change in the market or network occurs that would have change a loss factor by more than 2.5%, the system operator can adjust loss factors through the year.

As mentioned above, the Alberta energy market also introduces a loss factor compression process and a cap and floor if loss factors fall outside a specified range.

UK energy market

As of April 2018, the UK energy market applies seasonal average loss factors to account for losses in the transmission network. These are applied at a zonal level, based on 14 transmission network zones, rather than for individual connection points. Loss factors are typically lower in the North of the UK where the majority of generation is located, and positive in the South where the majority of

maximum differences of 0.0056. For simplicity, we have used the equation of ALF = 1 + (MLF-1)/2 for illustrations in the remainder of the report.

consumption is located, but the range is much lower given the relatively meshed network and the operation of the ALF mechanism.

Texas energy market

A more extreme example of average loss factor use is in the Texan network. The primary system operator in Texas (ERCOT) calculates a single average loss factor for the network and applies this equally to all generators and load. This postage stamp approach removes the locational signal and has been adopted, in part, to encourage the development of wind energy resources in the west of the state.

The development of the renewable energy zones, and the required network augmentations, have been centrally planned in advance (i.e. the plan itself provides the locational signals, rather than nodal losses).

Application in the NEM:

As explained above, the application of an ALF approach could help to improve investor certainty and the efficiency of settlement, but at the expense of some dispatch efficiency.

From an operational sense, adopting an ALF approach in the NEM is unlikely to require significant additional data from networks, generators or load. It would, however, require changes to AEMOs processes. However, because it requires a shift away from marginal losses, implementing this approach would require a rework of the relevant Rules as well as the methodology.

3.4 MLF for dispatch and ALF for settlement

Summary:

- Supports new investment: As with ALF, this option would be expected to increase investor certainty.
- Efficient and timely investment signals: As with ALF, provides a locational signal which is more aligned with actual losses, though the strength of the signal is is dampened relative to the current approach.
- Efficiency of dispatch: With MLF used in dispatch, the efficient marginal price signal could be maintained. However, this option introduces a risk of bidding distortion by price-setters if their MLF and ALF are different, which could affect the merit order.
- Accuracy of settlement and appropriate risk allocation: Greater accuracy of settlement, resulting in very limited IRSR. Less risk allocated to generators, more to customers.
- Implementation timeframe: Likely to require a Rule change and a change to settlement processes, and may therefore be challenging to introduce in the short-term.

Description:

The dual MLF-ALF approach would see two different methodologies used to account for losses – MLF for dispatch (as at present), and ALF for settlement.

In practice, this would mean that NEMDE issues dispatch instructions based on the MLF prescribed to each connection point. This would happen as it does now. By maintaining the marginal approach, this dispatch arrangement aligns with the marginal approach to setting the clearing price and therefore preserves the accuracy of dispatch in the current approach. Settlement would likely occur based on this dispatch, as it currently does, and AEMO would accrue MLF-based IRSR.

AEMO would then determine the ALFs for each connection point ex-post and use these loss factors to calculate the difference between the settlement monies paid/received using MLF and the settlements that would have been paid/received using ALFs. When AEMO comes to allocating the IRSR, the IRSR would be shared between generators and TNSPs (ultimately, consumers) such that generators are reimbursed the difference between the MLF-based settlement they initially received and the ALF-based settlement subsequently calculated.

This dual approach would provide the dispatch efficiency of MLFs as well as the settlement accuracy of an ALF approach. While it does not remove the loss factor uncertainty for new generation, the ability of generators to earn more through settlement than under the current MLF approach may incentivise new generation and therefore support the energy transition. If the IRSR approach is structured appropriately, the generator achieves the same outcome as under an ALF approach.

One key risk of the dual approach is that it may introduce the risk of distortions to bidding behaviour, where generators may bid to maximise their settlement (based on ALF) rather than for the most efficient dispatch. This is only likely to materialise as an issue in the case of price-setters in the market (typically thermal plant or storage) rather than price-takers that are not using their bids to set the wholesale price. Further, it is only likely to become an issue for generators with a notable difference between their MLF and ALF values, which is likely to be more common amongst renewable energy generators than for thermal.

By changing the allocation of IRSR, customers will receive less settlement residue benefit under this approach than under the current MLF methodology.

Application in the NEM:

Of the options investigated in this paper, this approach would potentially require the greatest changes to the rules and processes given its impact on both the settlement process and the allocation of IRSR. However, the data requirements would not be different to those already captured for the annual MLF approach.

Any further consideration of this approach should investigate the actual likelihood of distorted bidding behaviours, and weigh this risk against the potential benefits of such an approach.

3.5 Grandfathering of MLFs

Summary:

- Supports new investment: Greater investor certainty than under the current MLF approach, as an investor could essentially ‘lock-in’ the current MLF at the connection point (as determined by AEMO). Future investors could also lock in an MLF, but at a revised level for that future year.
- Efficient and timely investment signals: Similar to the current arrangements.

- Efficiency of dispatch: Could reduce the efficiency of dispatch by introducing a disconnect between a generator's grandfathered MLF and the current MLF used for dispatch.
- Accuracy of settlement and appropriate risk allocation: Likely to reduce the accuracy of settlement if grandfathered MLFs diverge significantly from ALFs over time. Settlement residues would be expected to increase as a result.
- Implementation timeframe: Requires a Rule change and a Methodology change, but is unlikely to require any additional data and is therefore a short-term option.

Description:

Grandfathering of loss factors could take a number of different forms, but most typically would see a generator retaining a static loss factor (for example, the loss factor it received in its first year after commissioning, or its loss factor in a set year) for either its remaining life or a set period of time. As new generators connect to the network, they would then be assigned MLFs based on their first year of commissioning, which would be calculated in the same way as at present, taking into account the marginal losses for the given connection point. MLFs allocated to the new generators would then also be locked in for their operational life or a set timeframe. This approach would result in a change in IRSR accruing to AEMO, as a result of the difference between grandfathered and actual MLFs.

An alternative approach would be to calculate MLFs for new connections that account for the marginal losses in an area of the network, rather than only the marginal losses of their specific connection (e.g. to maintain an IRSR surplus in that region). This approach would see new generators allocated lower MLFs than at present in order to compensate for the marginal losses that cannot be factored into the MLFs of existing connection points. We have assumed the former approach, rather than this second approach, in this report.

Grandfathering, of this nature, provides certainty to investors by locking in the loss factor at their connection point and removing all unpredictability. In this sense, grandfathering would remove loss factor risk for generators, assuming they are able to determine or predict their loss factor prior to securing finance. This could be expected to flow through to a lower cost of capital and could potentially reduce the financial barriers to some new generation being developed.

However, grandfathering achieves certainty at the expense of accuracy of dispatch, as the grandfathered MLF may diverge from the actual marginal losses at a connection point. Notably, there is a risk that generators with high actual losses will be dispatched over generators with lower actual losses due to the grandfathered loss factors. Likewise, this approach could reduce the accuracy of settlement to the extent that grandfathered MLFs diverge from ALFs.

Application in the NEM:

To introduce grandfathering would likely require both a methodology and a rule change. It is also quite likely to be polarising amongst stakeholders (e.g. incumbent vs new generators), and reform would potentially be delayed through the need to work through these issues.

The July submissions to the AEMC's Transmission Loss Factor consultation paper noted the potential to introduce a time-limited grandfathering arrangement specifically for new generation connecting into Renewable Energy Zones. While this would be likely to provide some certainty benefits and may help to incentivise new investment, the implications for efficiency of dispatch and accuracy of settlement should be considered in detail.

4 Impacts of loss factor reform

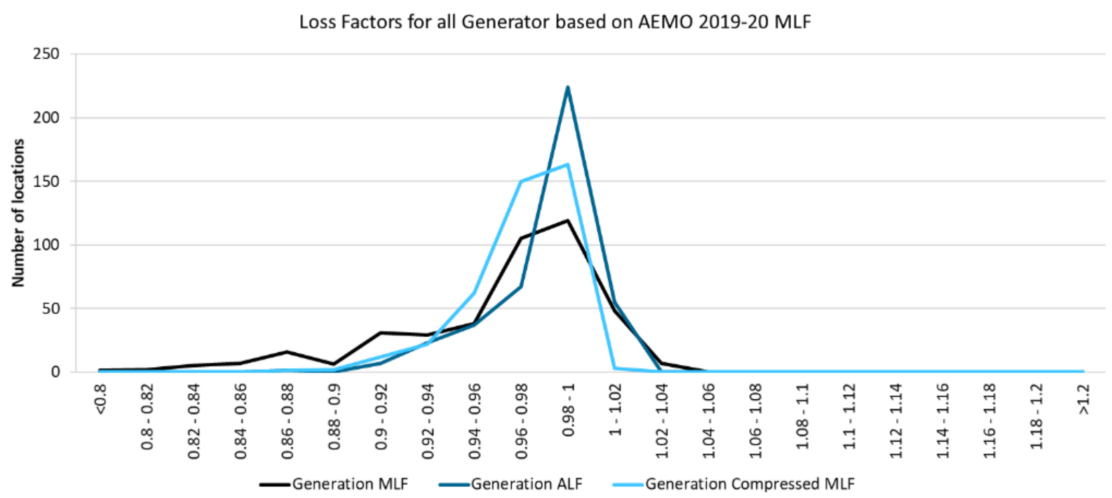
To illustrate the potential impacts of changing the transmission loss factor approach in the NEM, we have undertaken some high-level quantitative analysis in the Baringa NEM market model. This should not be taken as a projection suitable for investment purposes, rather it should be considered illustrative only.

4.1 Spread of 2019-20 loss factors: by approach

For both generation and load across the NEM, moving to a compressed MLF approach or ALF approach can be expected to reduce the spread of loss factors and increase their concentration in a narrower range. The ALF approach, in particular, concentrates generation loss factors closer to 1, as shown in Figure 5 (see Figure 7 for the equivalent load loss factor spread). Connection points with poor MLFs currently would have more favourable loss factors under this approach.

We have used participation factors to assess the volume-weighted distribution of generation (Figure 6) and load (Figure 8) between loss factors. Participation factors reflect the percentage (given as a decimal) of total generation or load volume (GWh), at the given loss factor.

Figure 5: The number of locations in the NEM assigned to different loss factors based on AEMO's 2019-20 MLFs, compressed-MLFs[15] and ALFs, for all generators.



[15] The compressed LFs are calculated with normalisation number (NN) being 0.977, the average MLF of all connection points in AEMO's MLF for FY2020.

Figure 6: The relative volume of generation in the NEM from connection points with different loss factors based on AEMO's 2019-20 MLFs, compressed-MLFs[16] and ALFs.

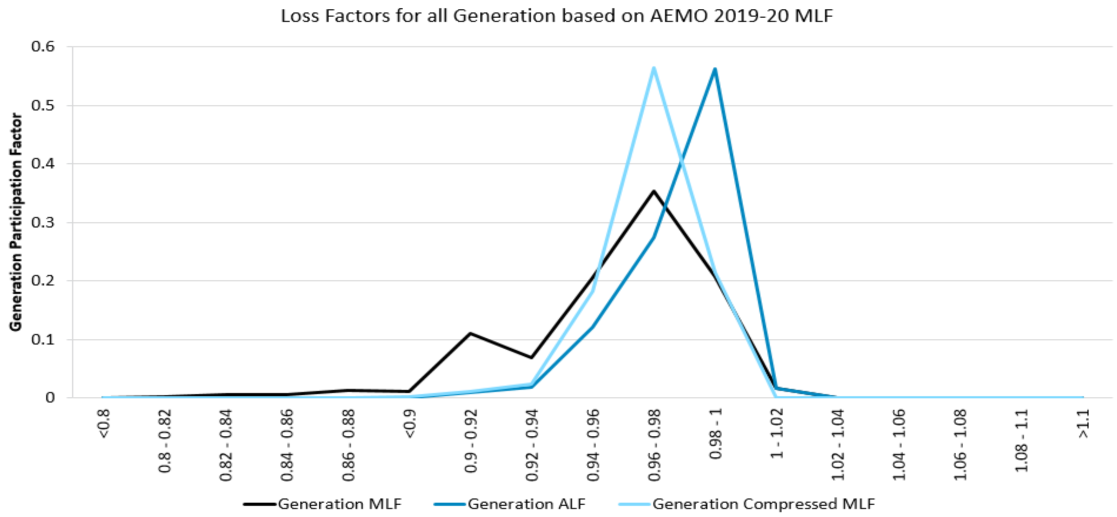
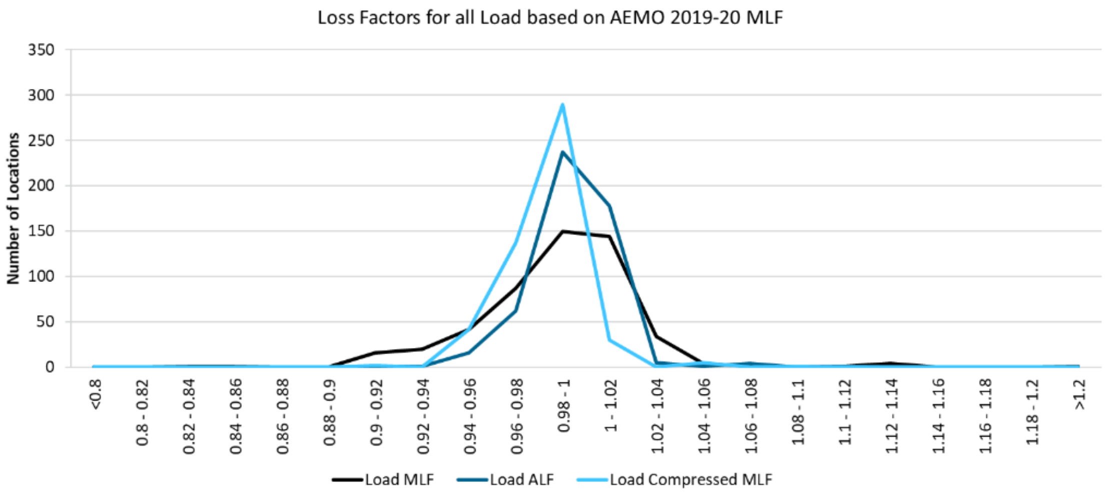


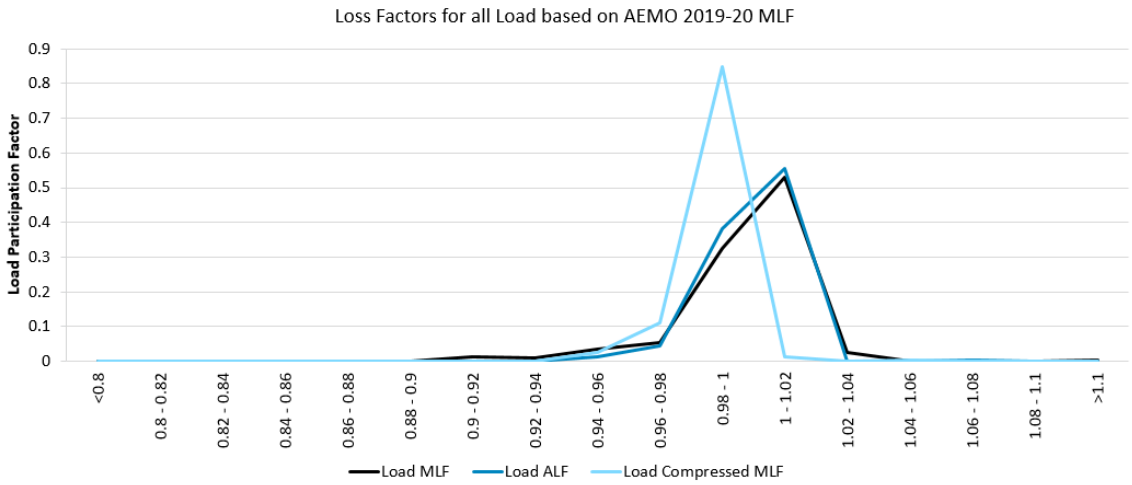
Figure 7: The number of locations in the NEM from connection points with different loss factors based on AEMO's 2019-20 MLFs, compressed-MLFs[17] and ALFs, for all load.



[16] The compressed LFs are calculated with normalisation number (NN) being 0.977, the average MLF of all connection points in AEMO's MLF for FY2020.

[17] The compressed LFs are calculated with normalisation number (NN) being 0.977, the average MLF of all connection points in AEMO's MLF for FY2020.

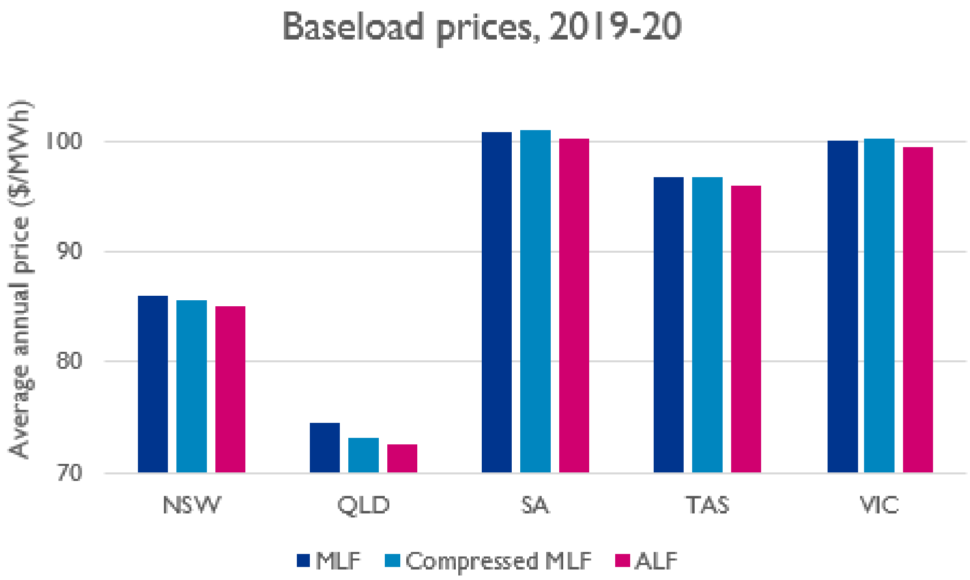
Figure 8: The relative volume of load in the NEM from connection points with different loss factors based on AEMO's 2019-20 MLFs, compressed-MLFs[18] and ALFs.



4.2 Impact of loss factor approach on wholesale prices

Our analysis of average wholesale electricity price projections for 2019-20 found the current MLF approach would lead to the highest baseload prices in QLD, NSW and TAS, and compressed MLFs would lead to the highest prices in SA and VIC. Across all five regions, the ALF approach was found to lead to the lowest baseload prices. This is shown in Figure 9, below.

Figure 9: Projected 2019-20 annual average baseload prices in each NEM region based on the current MLF approach, compressed MLFs and ALFs



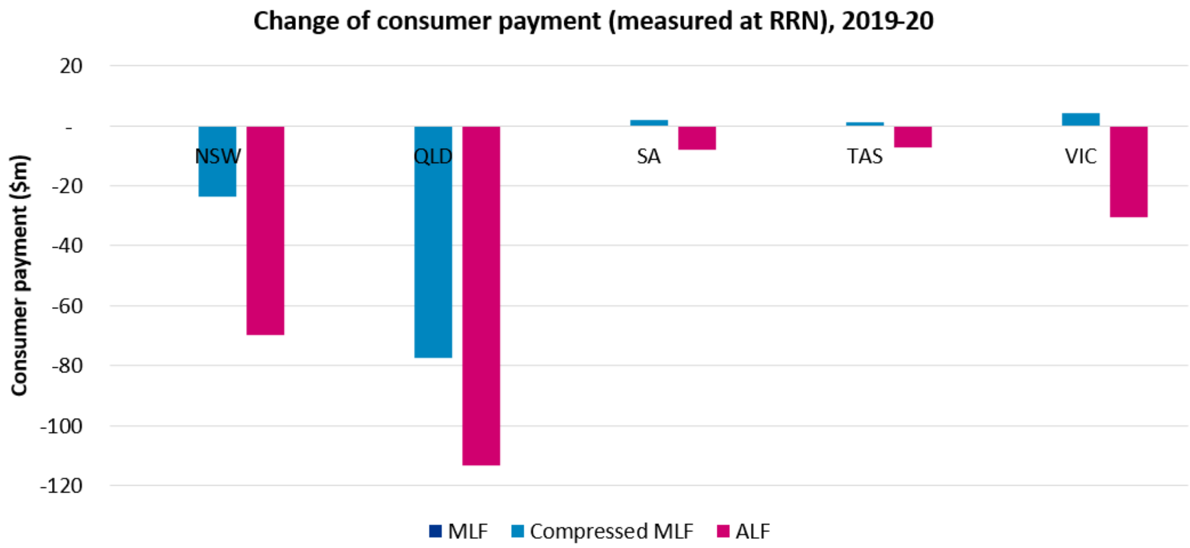
[18] The compressed LFs are calculated with normalisation number (NN) being 0.977, the average MLF of all connection points in AEMO's MLF for FY2020.

The variance between the wholesale costs under the different loss factor approaches is a result of the relative impact on revenue for price-setting in each region. Although typically far less impacted by low MLFs than renewable energy, there are some thermal plant across the NEM with relatively low MLFs under the current approach that would benefit from more favourable loss factors under compressed MLF and ALF regimes. More favourable loss factors mean these generators can bid lower and still cover their SRMCs, rather than bidding higher to account for less favourable loss factors. In SA, TAS and VIC, where compressed MLFs lead to slightly higher wholesale price outcomes for 2019-20, this is due to the price-setting plant in these regions having slightly worse loss factors under this approach.

It is important to note that the impact of loss factors on wholesale electricity prices, above, assumes the bidding strategies and scarcity uplift seen under the current approach is maintained under different loss factor approaches. In reality, we expect that some bidding behaviour may change, but we have not attempted to construct new potential bidding behaviours for the purposes of this report.

Although the average wholesale price differences under the different loss factor approaches are minimal in some regions, when considered alongside the volume of electricity dispatched through the year, the actual impacts are significant.

Figure 10: Projected changes in total consumer payments in each region (based on 2019-20 annual average baseload prices under the current MLF approach, compressed MLFs and ALFs, and projected load volumes)



This reduction in wholesale prices can be expected to flow through to a reduction in the wholesale price component of consumer bills. In QLD, for example, the reduction in total annual consumer payments for wholesale electricity with ALFs, shown in Figure 10 above, equates to around a two per cent reduction. If the wholesale component of an average residential bill in Queensland is around $600 per year[19], a two per cent reduction would represent around a $12 per annum saving (assuming wholesale price reductions flowed on to consumers). This wholesale price reduction could be even more significant in the long-term, once the effects of reduced cost of capital increased renewable

[19] ACCC, Restoring electricity affordability & Australia's competitive advantage, p366

investment are factored in. These long-term wholesale price changes would need to be weighed against the impact on network costs (e.g. through IRSR and TUoS) and other costs to assess the final retail bill impact.

4.3 Impact of loss factor approach on new investment

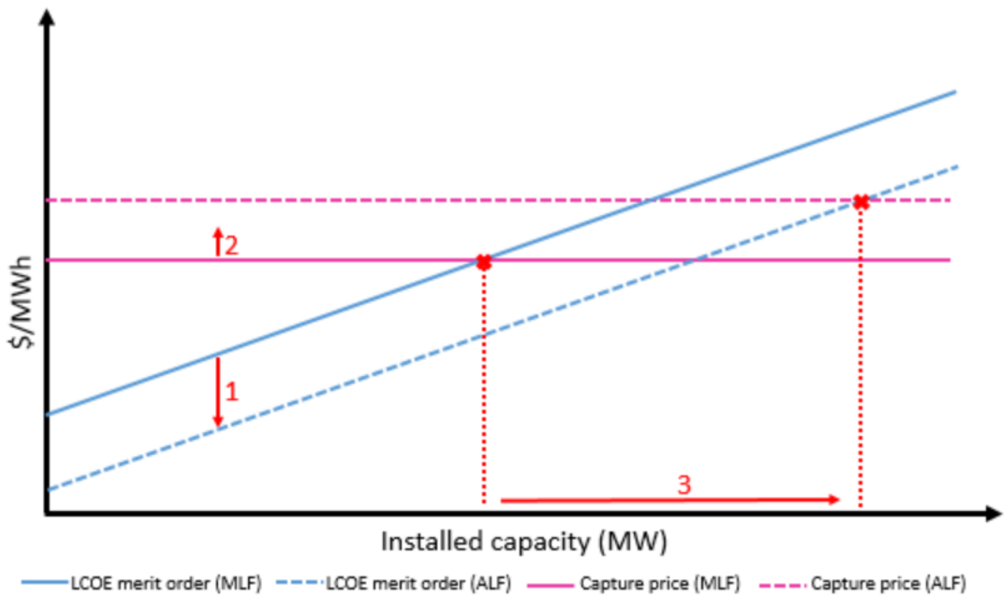
Alternative loss factor approaches can have a two-fold benefit for the development of new renewable energy capacity, relative to the current MLF approach:

1- A loss factor approach that gives investors and developers greater certainty, such as ALF or compressed MLF, is expected to reduce the cost of capital and therefore the LCOE for new generation. This enables further additional capacity to be built, which can reduce wholesale prices – as shown at '1' in Figure 11.

2- With a more accurate loss factor applied, such as ALF or compressed MLF, most connection points that have, or are likely to have, MLFs below 1 would see a direct uplift in revenue. This is because they are no longer having their entire load treated with the higher-than-actual marginal loss factor. The result is higher capture prices for this generation, improving the financial feasibility of more new projects – as shown at '2' in Figure 11.

Figure 11 below illustrates this two-fold benefit for the development of new capacity of shifting from the current MLF approach to an ALF approach (or another approach that improves certainty and capture prices for new renewable energy build). Marker '3' in Figure 11 shows the upward shift in installed capacity that is viable with a change in loss factor approach. This is particularly relevant in the context of the energy transition and development of new generation, including in REZs, to replace retiring thermal plant.

Figure 11: Schematic reflecting the impact of a change in loss factor approach, from MLF to ALF, on capture price and capacity of renewable energy generation built



To understand the potential impact of loss factor approaches on new investment in the NEM, we have undertaken a case study analysis of the ISP-identified ‘Isaac Renewable Energy Zone’ in Queensland. This case study is included at Appendix 1 of this report.

Our analysis confirms that MLFs reduce considerably as additional new generation capacity is built in the REZ, while compressed MLFs and ALFs reduce far less with this new build, allowing greater volumes of new generation at a given capture price.

Our analysis also finds that, in the Isaac REZ, renewable capture prices are higher under ALFs and compressed MLFs than under the current MLF approach. This is expected to make a greater additional capacity of renewable projects financially viable than could be viable if the current MLF approach is retained. The additional certainty offered by ALFs and compressed MLFs, and expected reduction in cost of capital, would further enhance the viability of developing new generation using these loss factor approaches.

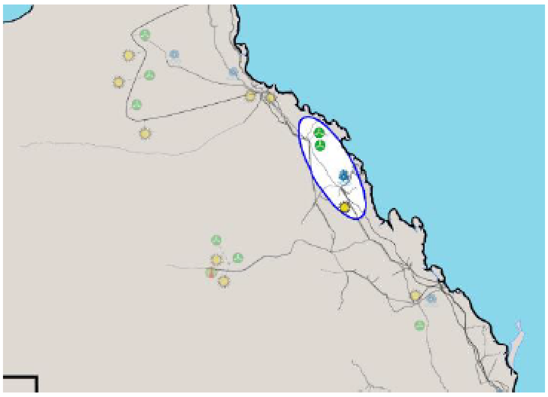
The additional investment in renewable capacity would be expected to reduce the wholesale price to the benefit of consumers in the long-term.

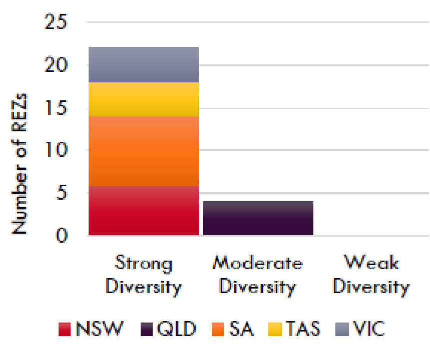
5 Appendix 1 - Quantitative case study

We have produced a brief quantitative case study to show how alternative loss factors approaches would better support new investment in an ISP-identified Renewable Energy Zones, and ultimately bring benefits to consumers.

We have used the Isaac REZ in Queensland as an illustrative example, as it has excellent resource quality, substantial resource potential, and reasonable network connectivity.

Figure 12: ISP 2018 REZ score card - Isaac[20]

Summary	REZ Priority Level = 3
The Isaac REZ covers Collinsville and Mackay. It has high quality solar and wind resources. There are many committed solar projects and many more proposed, totalling over 1,000 MW. The Queensland Government has also proposed funding to upgrade Burdekin Falls Dam and develop hydro power generaton (50 MW)[7].	

Renewable Resources	Solar	Wind	Diversity of Wind with other REZs
Resource Quality	B	B	
Potential (MW)	3,500	1,860	
Diversity	F	A	
Demand Matching Now 2030 2040	 D F F	 C C B	

Network Limitations	Existing	Upgraded	Network Description
Spare Network Capacity (MW)	2,000	-	275 kV and 132 kV circuits pass through this REZ. The amount of additional generation is limited by the transfer capacity from North Queensland to Central Queensland to South Queensland. The existing network can accommodate additional generation of approximately 2,800 MW from REZs in North Queensland. The potential for pumped hydro generation was identified in Isaac QLD REZ. Storing excess solar generation in pumped hydro would relieve network thermal capacity between North Queensland and Central Queensland.
Initial Loss Factor	B	-	
Loss Factor Robustness	B	-	

[20] AEMO, ISP 2018 Appendices document, https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/ISP/2018/ISP-Appendices_final.pdf, Page 13

Even though the ISP identifies the Isaac REZ as having good loss factor robustness, it has seen challenges of declining loss factors in recent years for new renewable projects. In AEMO's published MLFs for the 2019-20 Financial Year, solar farms with transmission connection points in the vicinity received MLFs of around 0.86, which are reduced from around 0.88 for FY 2019.

Taking AEMO's view of FY 2020 as the initial state, this case study will investigate the feasibility of further developments in the Isaac REZ with different loss factor options - MLF, Compressed MLF[21] and ALF.

The loss factor robustness of Isaac is banded as "B" in the ISP, which in AEMO's view means that 750-1000 MW of new generation capacity can be added before MLFs in this region drop by 0.05. For the purposes of this study, we take an optimistic view of this and make a linear extrapolation – we assume MLFs would be lower by 0.05 in the scenario of building 1000 MW of new solar projects in Isaac, and 0.1 lower with 2000 MW of new solar.

In such a way, our analysis is carried out in nine scenarios as listed in Table 3 below alongside the calculated loss factor under each.

Table 3: scenarios for quantitative analysis

Scenario	Loss Factor Option	Isaac Solar Capacity	Isaac Loss Factor
1	MLF	Base case	0.8641[22]
2	MLF	Isaac +1000MW	0.8141
3	MLF	Isaac +2000MW	0.7641
4	Compressed MLF	Base case	0.9219
5	Compressed MLF	Isaac +1000MW	0.8975
6	Compressed MLF	Isaac +2000MW	0.8731
7	ALF	Base case	0.9321
8	ALF	Isaac +1000MW	0.9071
9	ALF	Isaac +2000MW	0.8821

This analysis finds that solar MLFs in Isaac are sensitive to the development of new solar generation. New projects built in Isaac face a material risk of declining loss factors and thus heavily discounted revenues which could harm the economic viability of new investment. By contrast, the loss factor variance with new generation build are far lower under the alternative options. This demonstrates the strength of the locational signal under the different options.

Based on these results, we have undertaken a market simulation to determine the wholesale price effect of the different loss factors under the three different scenarios. As shown in figure 13, the wholesale electricity price in QLD is expected to decrease under the different scenarios, compared to the MLF base case. This can primarily be attributed to two factors:

- First, the marginal units which are price-setters in QLD are coal plants with MLFs typically in the range of 0.90-0.95 (e.g. Stanwell). Under compressed MLF or ALF approaches, the loss factors of these generators would be pushed up so that they can bid into the market at a lower price to receive the same amount of revenue at every trading interval. These are quantified by comparing the wholesale price among three scenario with base case

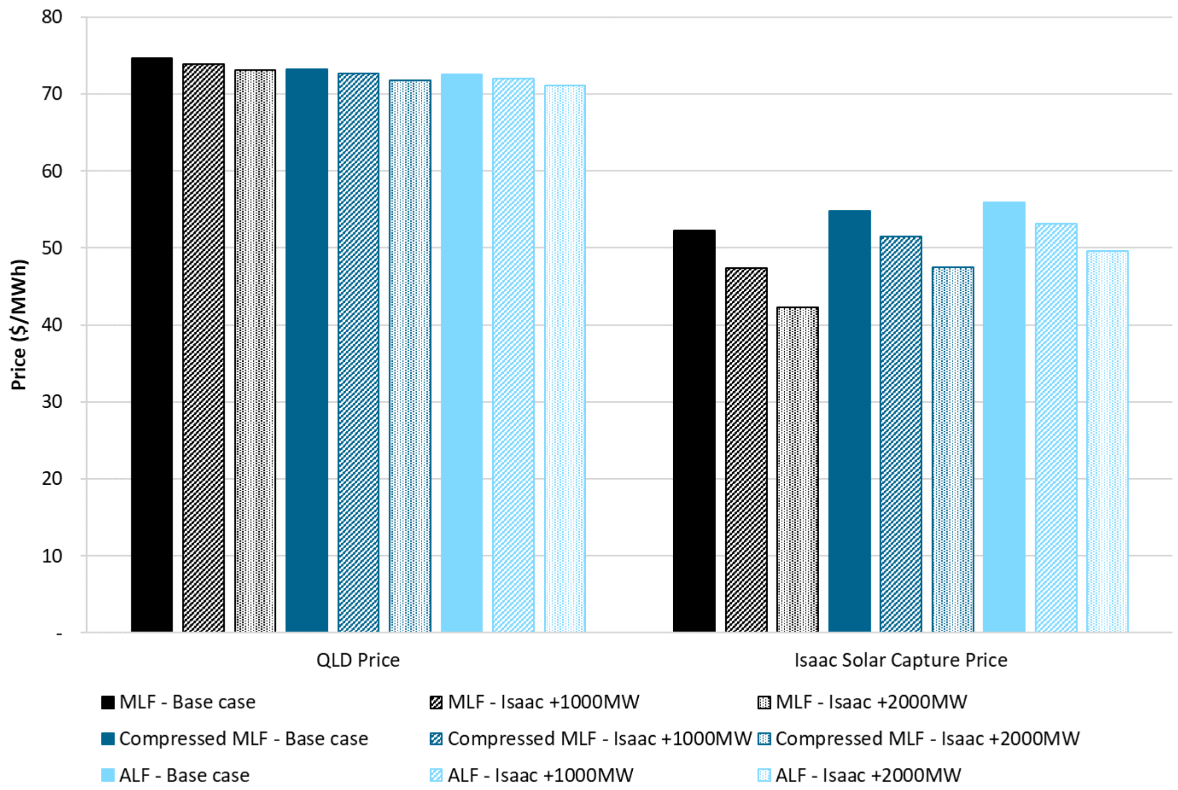
[21] The compressed LFs are calculated with normalisation number (NN) being 0.977 that is the average MLF of all connection points in AEMO's MLF for FY2020.

[22] The value of MLF for Isaac new solar projects are determined by taking the average MLF of all the solar farms in the vicinity of Isaac including Clare, Daydream, Hamilton, Hayman, Kidston, Ross River, Whitsunday, Clermont, Collinsville PV, Emerald, Haughton, Rugby Run solar farms, but excluding Sun Metals Solar Farms as it belongs to a hybrid transmission network identifier (TNI) with industrial load.

capacity built in Isaac, where we see a $1.38 and $2.02 / MWh reduction in annual time-weighted price with compressed MLF and ALF respectively.

- Second, the additional solar capacity developed under the additional solar build scenarios would help with wholesale price reduction, with a further reduction in the range of $0.6 to $0.9 / MWh achieved with an additional 1000 MW of solar built in Isaac across different scenarios.

Figure 13: Example QLD wholesale prices under different loss factor approaches



The benefit of having more solar capacity may not be achieved under the current MLF arrangement. As shown in figure 13, the capture price of the new solar projects in Isaac (loss factor adjusted) would decline by $4-$5 / MWh with 1000 MW of additional capacity growth, down from capture prices above $52/MWh in the Base Case. This would severely impact the economic viability of this additional investment, such that the investment may not even happen.

In the scenarios with ALF as the loss factor approach, reflecting actual losses, solar farms in Isaac would see an elevated capture price under current build out, relative to under the MLF approach, reducing to around $53/MWh with an additional 1000 MW of new solar generation. Given this value is still above the capture price achieved under the current MLF mechanism for Isaac (with no new investment), the financial viability of this additional 1000 MW of capacity is much stronger. Furthermore, as mentioned earlier, an ALF can be expected to deliver higher certainty and may result in a lower risk premium on the cost of capital (thus reducing LCOE). This reduction in LCOE means that more investment can be delivered at a given capture price.