18 July 2019

Mr John Pierce
Chairman
Australian Energy Market Commission
PO Box A2449
Sydney NSW 1235

Lodged online via: www.aemc.gov.au
Project reference: ERC0251

Dear Mr Pierce,

National Electricity Amendment (Transmission Loss Factors) Rule: Consultation Response

Lighthouse Infrastructure Management Limited (Lighthouse Infrastructure) welcomes this opportunity to respond to the Australian Energy Markets Commission (AEMC) consultation *National Electricity Amendment (Transmission Loss Factors) Rule* issued 6 June 2019 (Consultation Paper). In doing so we refer to the rule change requests submitted to AEMC by Adani Renewables on 27 November 2018 and 5 February 2019 (Rule Change Requests).

Summary

Lighthouse Infrastructure is an institutional infrastructure investor, whose investment mandates explicitly focus on facilitating the infrastructure development needed for Australia's future. We have arranged funding for some of Australia's earliest utility scale solar PV generation projects and hope to continue supporting a renewable electricity transformation that we consider is critical for the wellbeing of our society and environment.

Electrical losses are a physical reality of the system, and material enough to be accounted for in market design. However the present loss factor regime, in which loss factors are identified on a marginal flow basis and reset each year, is a major impediment to investment in new renewable generation. This impediment is so great that we consider it is causing inflated electricity prices to persist and thereby undermining the National Electricity Objective (NEO). In this submission we highlight that:

A. Identifying loss factors on a marginal basis leads to substantial over-recovery of actual losses. We provide a numerical illustration of how this occurs, and that it consequently prevents efficient investment that would reduce power prices.
B. Unpredictability of loss factors is as much of a barrier to efficient investment as their absolute levels. The annual resetting of loss factors that creates this unpredictability does not represent a useful economic signal when applied to low or zero marginal cost renewable generators. Further, losses created by new generators are typically allocated to the detriment of existing nearby generators. This absence of a causer pays approach is the most challenging source of loss factor unpredictability.
C. More fundamentally the trend toward higher system losses must be addressed by planning-led coordination of generation and transmission development. Market design improvements will not compensate for a sub-optimal underlying physical system. Ultimately unnecessary losses will increase the cost of electricity for consumers.

We endorse the suggestion of the Rule Change Requests to replace marginal loss factors (MLF) with average loss factors (ALF). Specifically we suggest deriving ALF from MLF by way of square root or a similar simple compression algorithm[1]. This would appropriately address over-recovery and reduce volatility, and in our expectation allow a recommencement of renewable investment that will reduce wholesale prices. Notably it would retain powerful locational signalling. We acknowledge that it would weaken the ability of the dispatch process to accurately identify the marginal cost generator, but consider that the resulting cost to consumers would be less than the cost of stalling renewables investment.

Adoption of ALFs is not a complete or perfect solution to the aforementioned challenges. It lessens, rather than removes, uncontrollable loss factor uncertainty. It does not improve allocation of losses to those that cause them, nor does it mitigate underlying losses. We strongly recommend AEMC and other market bodies address these issues as part of other broader reform programs. In particular we suggest that the loss factors for certain new generators could be assigned on a permanent basis at the time of project commitment (so-called 'grandfathering'). More complete solutions of this nature will take years to design and implement. In the meantime, ALF can be implemented for FY2021 and would quickly put downward pressure on prices to the benefit of consumers.

Our submission is informed by the experience of recent investment in projects that are now operating. Equity returns have been reduced c. 30% by MLFs materialising lower than forecasts by expert and independent due diligence advisors only two years ago. It is difficult to accept that this represents an efficient market mechanism; at the time of our investment commitments we faced a clear locational signal to build and months after doing so received an opposite regulatory signal best described as 'don't let anyone else build'. We have little capacity to respond, with an entirely fixed cost base and largely immovable infrastructure.

The volatility we have experienced is highly unusual in an infrastructure capital context. Despite being enthusiastic and experienced renewables investors our investment program in that sector is now on hold.

These historic experiences should inform the AEMC, but reform should maintain a forward-looking view. An agenda motivated by the NEO will focus on enabling investment in critical generation supply in the future, both immediate and long term. The interests of existing generators, renewable and non-renewable, must be treated with respect but are not the primary motivations of this reform.

Identifying the problem

We agree with the Rule Change Requests that the current loss factor regime undermines pursuit of the NEO and therefore warrants reform. In this section we expand on the issues labelled A and B in the summary section of this submission, and illustrate how they can be alleviated by an ALF regime.

A. Over-recovery of losses is a barrier to price reduction

It is a physical reality that energy is lost in its transmission from a generator to a consumer. We agree with a market design that adjusts revenues paid to generators to account for the energy that is generated but lost to lines resistance rather than available for consumer use. However, the present MLF regime over-recovers these losses, often by a factor of more than two times. This is illustrated in a simplified example below. In this sense we agree with the Rule Change Requests that MLF is an inaccurate reflection of losses; in fact it is worse than inaccurate, it is a systematic exaggeration of losses.

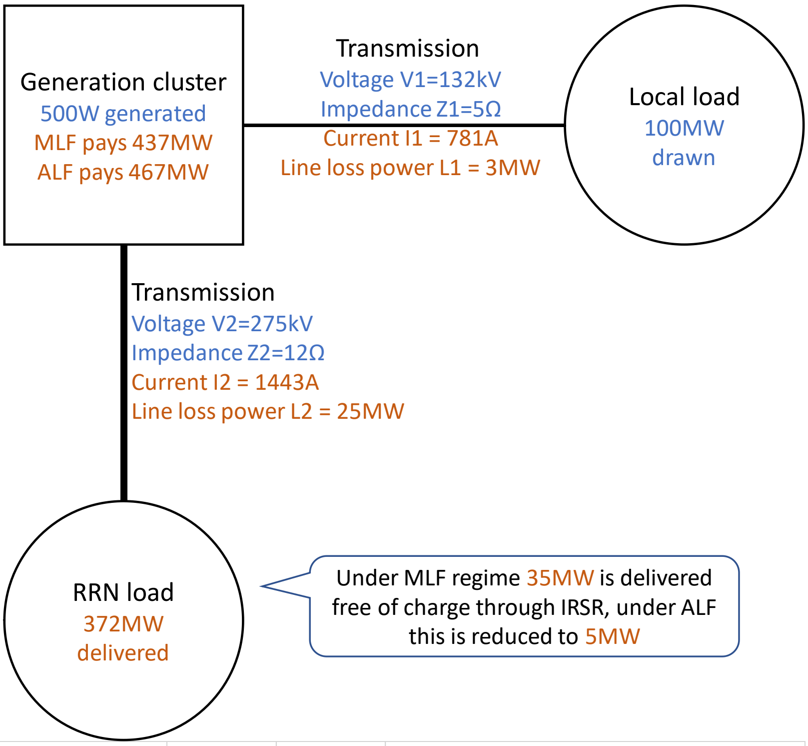
The degree of over-recovery is greater when the underlying losses are greater, and as illustrated by Figure 2.2 of the Consultation Paper we are now in a trend toward greater losses due to fringe of grid renewable developments. Consumers are disadvantaged because over-recovery from such developments means fewer of them will enter the market and opportunities to reduce power prices are foregone or delayed.

[1] More precisely, ALF for a connection point would be derived by calculating settlement-interval level MLFs using AEMO's existing method, converting settlement-interval MLF to ALF as the square root, then weighting settlement-interval level ALFs over expected settlement-interval power transfer to create annual ALF. We acknowledge that an ALF derived in this fashion is not a perfect identification of actual losses.

Illustration of losses between fringe-of-grid generation and central load

In this illustration a 500MW generation cluster supplies a small local load by way of a 132kV line of 5Ω impedance, and a large distant load at the regional reference node by way of a 275kV line of 12Ω impedance[2].

These parameters are labelled in blue in the adjacent diagram. The resulting power flows and losses are labelled in orange and their derivation is shown in the table below.



<u>Power delivery to local load and associated losses</u>			
Load power P1	100	MW	*Illustrative of typical network situation.*
Transmission voltage V1	132	kV	*"*
Line impedance Z1	5	Ohms	*"*
Current I1	781	A	*Solve for current based on P1, V1 and Z1.*
Line loss power L1	3	MW	*=I1^2*Z1*
Power consumed by local load and its transmission	103	MW	*=P1+L1*
<u>Power delivery to RRN and associated losses</u>			
Generator power total	500	MW	*Illustrative of typical network situation.*
Transmission voltage V2	275	kV	*"*
Line impedance Z2	12	Ohms	*"*
Generator power left over for RRN and its transmission P2	397	MW	*Generator power - local load consumption.*
Current I2	1443	A	*=P2/V2*
Line loss power L2	25	MW	*=I2^2*Z2*
Power delivered to RRN	371.95	MW	*=P2-L2*
<u>Marginal loss factor analysis: repeat analysis with 1MW extra generation</u>			
Generator power total	501	MW	*Add 1MW to generation.*
Transmission voltage V2	275	kV	*As above.*
Line impedance Z2	12	Ohms	*"*
Generator power left over for RRN	398	MW	*"*
Current I2	1447	A	*"*
Line loss power	25	MW	*"*
Power delivered to RRN	372.82	MW	*"*
MLF	0.874		*= Δ power delivered to RRN / Δ generation*
<u>MLF/ALF assessment</u>			
Power supplied to loads	472	MW	*94.4%*
Generation credited under MLF	437	MW	*87.4%*
Generation 'gifted' to load through IRSR under MLF	35	MW	*7.0%*
ALF (calculated as square root of MLF)	0.935		
Generation credited under ALF	467	MW	*93.5%*
Generation 'gifted' to load through IRSR under ALF	5	MW	*0.9%*

[2] For simplicity analysis is made in single phase, however conclusions are unchanged in three phase analysis.

The key points of this illustration are that:

- 500MW is generated. 28MW (5.6%) of generation is lost to lines resistance, and the remaining 472MW (94.4%) is consumed at the two load centres.
- The generators' marginal loss factor is 0.874, so that the generators are only paid for 437MW (87.4%) of generation. In effect 35MW (7.0%) of generation is transmitted from generators to consumers free of charge.
- The generators' average loss factor, calculated as the square root of its MLF, is 0.935. Under this regime generators would be paid for 467MW (93.5%) of generation, and only 5MW (0.9%) is transmitted to consumers free of charge.

Having demonstrated how over-recovery arises and its magnitude when generation is not near regional load centres, we will now explain how this has a disproportionately negative effect on the wholesale prices faced by consumers. For the sake of clarity we will borrow figures from the prior illustration.

Illustration that losses over-recovery prevents wholesale price relief

The 0.87 MLF illustrated above is indeed indicative of prospective renewable generation developments in the NEM at present. Consider the investment case for such projects. Suppose that based on each project's generation performance and cost base the investment case is viable[3] should the generator earn revenues of $50/MWh. To achieve net revenues of $50/MWh under the MLF regime the market price must be $57.22/MWh.

If the long term average energy price is expected to be >$57.22/MWh then a project will achieve funding commitment and be built. By introducing this extra low or zero marginal cost generation to the supply stack the outlook for electricity prices will decrease slightly. If the long term average outlook remains >$57.22/MWh then another project will be funded and built, further reducing the price outlook. Development activity will continue until the outlook is approximately $57.22/MWh, at which point it will not be economic to continue.

The outcome can be enhanced if instead losses are assigned in a manner that more closely reflects actual losses, such as an ALF of 0.93. The aforementioned developments would face a break-even market price of $53.48/MWh. More renewable developments will proceed than under the MLF regime, and the resulting outlook for energy prices will be reduced from $57.22/MWh to $53.48/MWh[4]. Consumers will benefit substantially from additional generation being built delivering a 6% reduction in prices, noting that it is applied to all energy dispatched not only that derived from renewables or associated with high losses.

B. Loss factor unpredictability increases the cost of capital

A separate barrier to efficient investment in new generation is that loss factors are unpredictable, creating a major source of uncertainty in the lifetime revenues to pay for investment. This is a distinct from the absolute level of losses, but of equal importance.

As explained in the prior section, consumers stand to benefit, in general, from continued investment in low marginal cost renewable generation[5]. In assessing whether or not to fund prospective developments investors identify an appropriate cost of capital; the higher this parameter the more profitable a project has to be to be assessed as feasible. A lower cost of capital will lead to more projects securing funding, ultimately benefiting customers.

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[3] By viable we mean neutral or positive on a net present value assessment.

[4] Specifically this is the outlook for energy prices at the time that the new generators are generating. It is acknowledged that a single wind or solar generator does not generate all of the time, however a diverse portfolio of them will generate a large proportion of the time, and with complementary storage can also reduce price when they are not generating.

[5] We acknowledge that high levels of renewable penetration will create the need for other system services that have their own costs. Nonetheless a cost-optimised system will feature a significantly enlarged renewable supply base, if only due to a large share of existing capacity nearing end of life or time for refurbishment, as illustrated by AEMO's 2018 Integrated System Plan.

Cost of capital is determined in part by broader macroeconomic factors, but substantially by the degree of confidence investors have that the expected financial returns of the project will materialise. In the case of renewable projects that assessment is typically made over the relatively long period of 30 years. The greater the risk, even if it represents symmetrical risk, the higher the cost of capital. It is for this reason that a majority of recent generation developments[6] have needed long term power purchase agreements; these improve investment viability even though they are typically at prices below the prevailing long term energy price outlook[7].

Loss factors now represent a major source of long term revenue uncertainty for prospective renewable generators. This has been illustrated particularly in the last two years, during which several projects have secured funding on the genuine expectation of a much higher MLF than that allocated by AEMO shortly thereafter. Infrastructure projects are developed so as to allocate various risks to the parties well placed to manage them, such as cost and speed of build, durability of equipment, fluctuation in power price. Loss factor risk is notably difficult to allocate in this fashion. In the case that a generator is electrically near to a load of equivalent size controlled by a single party, then there is an opportunity for a hedge with that party, however the capacity for such structures is at best shallow and in fact non-existent in many of the locations otherwise suitable for generation development.

We note that a small number of large NEM participants may be well placed to address loss factor risk through diversification of generation classes and locations, and through vertical integration to retailing. However we suggest that an efficient transition of the supply base could be inhibited by market concentration, and that it is of great value to consumers that other parties can feasibly enter and compete.

The Consultation Paper suggests that generation proponents are themselves best placed to manage loss factor risk: "*… by decisions on where to locate a generator and how to allocate risk under their connection agreement…*". We acknowledge that some parts of the network are physically less susceptible to MLF change than other areas. However we disagree that generation proponents can effectively manage loss factor risk. The major source of uncertainty facing an investor is not the level of loss factor that will prevail as a result of a generation development in and of itself, but instead the future deterioration that could occur if other third parties develop additional assets nearby. For example, the Broken Hill Solar Farm suffered a 22% reduction in its MLF between the 2018-19 year and the 2019-20 year. If other generators do materialise and erode the loss factor, a generator is not in a position to respond by moving to a better location. A renewable generator is a somewhat permanent and low marginal cost asset that will generate to its full capacity for its physical life of thirty years largely independent of market signals that arise during its life.

With a large degree of MLF risk that it cannot mitigate, as highlighted by FY2019 and FY2020 MLF determinations that were considerably different to investor expectations, investors are assigning a cost of capital premium to future renewables investments. This is causing projects that would otherwise secure funding to be delayed or shelved, representing missed opportunities to provide additional low cost supply and thereby reduce power prices.

To help quantify the effect, consider that as an equivalent to raising its cost of capital an investor will assess a project by adjusting its base case with a downside loss factor scenario[8]. We observe that it is typical for financiers to make a downward adjustment of 5%, though naturally this varies with network location and the specific views of the party making the assessment. As illustrated in the prior section, when renewables investments are assessed on the basis of loss factors that are 5% lower than a balanced assessment would indicate, it can be expected that fewer projects will be built such that power prices are 5% higher than they would otherwise be. Again a slight change in the economic assessment of renewables, which represents a small share of total generation, has disproportionate effect on the power prices borne by the whole market.

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[6] Putting aside those owned by entities that are vertically integrated with retailing businesses.

[7] More precisely the outlook for the bundled price of energy and LGCs.

[8] By base case we mean a revenue forecast that reflects a forecast of loss factors that takes into account all available information about what is likely to occur in the future in a balanced fashion such that it has a probability of exceedance of 50%. A downside case takes a deliberately bearish assessment of loss factors.

Adoption of ALF would not solve the root causes of the issues highlighted here. It would nonetheless have a profound effect on cost of capital by dampening the effect of those issues on the volatility of investment returns.

Broader Assessment Framework

We agree that in assessing loss factor reform the AEMC should consider efficiency of investment, efficiency of market operation, and seek that risks are allocated to parties best placed to manage them. The first section of this submission promoted an ALF regime on the basis of improving investment efficiency. In this section we comment on operational efficiency and risk allocation. We also argue that AEMC's assessment should consider the ease and speed of implementation of any reform.

Balancing efficiency of investment with efficiency of market operation

We acknowledge that replacement of MLFs with ALFs would erode efficiency of market operation. Specifically, it has the potential to cause dispatch of generators in an order that no longer perfectly represents marginal cost at the regional reference node.

We are not in a position to quantify the cost that this distortion is likely to cause, and it may be appropriate for the AEMC to do so as part of its rule change assessment. However, we wish to highlight two factors that indicate it will be found to be an acceptable cost:

- Dispatch is distorted only by the difference between MLF and ALF for generators at or near the margin. In a large majority of dispatch periods the generators at or near the margin have a fuel cost, and generators with a fuel cost tend to be in strong parts of the network such that the MLF is near to 1.0 and therefore the difference between MLF and ALF is small.
- The marginal cost dispatch framework is already limited by being applied at regional reference nodes rather than at all nodes. In this way the market design explicitly compromises purity of marginal cost dispatch in favour of other objectives. It is not unreasonable to consider the further compromise represented by average loss factors, if benefits in other areas are sufficiently great.

Nonetheless in assessing loss factor reform the AEMC will need to assess whether the benefits of investment efficiency outweigh the detriments arising from a loss of operational efficiency. We suggest that this prioritisation will ultimately reflect the degree to which the AEMC believes new investment in supply represents an opportunity of great value to consumers. We believe that new renewable supply can reduce energy prices, mitigate a security of supply crisis, and provide decarbonisation that is critical to widely held environmental objectives. If the AEMC shares this vision then a reduction in operational efficiency is likely to be an acceptable compromise. If however the AEMC considers that investment in renewable supply is of little long term relevance, then we expect it will retain the status quo MLF regime in favour of operational efficiency.

Allocating risk to where it can best be managed

We consider that the desire for risk to be allocated where it can best be managed is often mis-applied in the context of loss factors specifically for renewable generators.

Generation proponents can influence their loss factors through choice of network location. As explained earlier they have limited further ability to manage their loss factors:

- They cannot save fuel cost by generating less.
- They cannot relocate, or if they can it is an expensive exercise that would represent market failure.
- Co-locating storage could assist but its MLF benefit is shared with all nearby generators rather than captured by the party providing it.
- A generator cannot influence the commitment decisions of other new generators, which as described earlier accounts for a majority of the unexpected MLF erosion experienced recently.

Adoption of ALFs would not address these root causes, nor would it represent abolition of a locational signal, but it would recalibrate the strength of the signal to be commensurate with the degree of control generation proponents really hold.

Finally an average loss factor regime explicitly seeks to impose financial adjustments that reflect actual losses. Therefore we anticipate that it does not impose new or unreasonable risk on consumers.

Reallocation of IRSR

As illustrated earlier the use of MLFs over-recovers the value of losses. The additional recovery materialises as part of the intra-reginal settlement residue (IRSR) in each region each year, and is thereby passed back to consumers as a reduction in network connection charges.

We note that the Rule Change Requests suggested, as an alternative to average loss factors, a partial reallocation of IRSRs in favour of generators. Adoption of average loss factors would achieve this automatically. Further the way in which an ALF regime would effectively reallocate IRSR to generators would reflect the degree to which each generator suffers over-recovery of losses under the MLF regime. Any other approach to reallocating IRSR to generators would not as precisely mitigate the losses over-recovery issue.

In assessing the ALF proposal, we anticipate that consumers and their advocates will be concerned that IRSR is a valuable source of relief from network charges, and that by reducing IRSR an ALF regime will cause consumers to pay higher network charges. In particular there may be sensitivity to the heightened risk of negative IRSR that must be recovered from consumers via TNSPs. We agree that network charges will increase and that the risk of negative IRSR is heightened. However, we reiterate that consumers' total costs will reduce, because the IRSR pool is smaller than the reduction in energy costs likely to arise from greater supply, as illustrated in this paper. It is important to make a holistic assessment of the effect on consumers of the proposed reform.

Ease and speed of implementation

Ease and speed of implementation is an important further consideration in the AEMC's assessment. Power prices are at historically inflated levels and this is causing consumer harm through their direct costs and the reduced viability of Australian businesses. Reform that address investment inefficiencies could ease power prices as quickly as 18 months later, given the construction time for some renewable generators. By contrast reform that takes several years to settle and implement will delay power price relief.

As outlined earlier in the paper we feel that solutions to some aspects of the loss factor challenge lie in physical network development and reform of network access rights. AEMC and other market bodies are already considering these issues. We have considered carefully whether the prospect of improvement in these areas makes direct loss factor reform unnecessary or premature. We have concluded that the loss factor investment barriers are too urgent, and that addressing them is too valuable, to be delayed.

Replacement of MLFs with ALFs can be implemented quickly. We understand it warrants only minor amendment to AEMO's existing process and could be deployed in the next loss factor settings process in early 2020.

Reducing losses by coordinating generation and transmission

Loss factor challenges have their ultimate root cause in generation being less well connected to load centres than in the past. Whilst to some degree this reflects that strong sun and wind is often located further from population centres than coal and gas supplies, it is primarily due to changes in the processes through which generation and transmission are developed. Specifically, widespread disaggregation and privatisation of transmission and generation responsibilities, and a shift from central planning to market-based decision making, has made network-level coordination less efficient and effective. Regardless of the outcome of this loss factor-specific reform process, we urge AEMC and other market bodies to seriously consider and diligently address these broader issues.

Conclusion

Lighthouse Infrastructure supports the proposal made by the Rule Change Requests to replace the MLF regime with an ALF regime. This change would deliver immediate and sustained benefit to consumers through greater supply of low marginal cost renewable generation. It could be implemented as early as 2020 to maximise this benefit. However we do not consider this a complete solution, and expect that Australian electricity consumers would derive significant further benefit from more fundamental change to the processes for transmission development and generator access.

We would welcome further discussion with the AEMC and other market participants regarding the proposed reform.

Yours sincerely

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