Network of Illawarra Consumers of Energy

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LMP Rule Change Request

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Contents

Glossary

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
Collective or Collective of Energy Ministers	The collective of energy ministers that has previously gone by the names of the Ministerial Council on Energy, the Standing Committee on Energy and Resources, and the COAG Energy Council, but as of May 2020 became both the National Cabinet Energy Committee and the Energy Ministers Meeting. Since September 2022, the body has been called the Energy and Climate Change Ministerial Council.
FTR	Financial Transmission Rights
LMP	Locational Marginal Pricing
NEM	National Electricity Market
NEO	National Electricity Objective
NER	National Electricity Rules
NICE	Network of Illawarra Consumers of Energy
REZ	Renewable Energy Zone
TUOS	Transmission Use of System

Introduction

NICE

The Network of Illawarra Consumers of Energy (NICE) is an informal network advocating for the energy transition to a net-zero carbon future to be managed with the interests of consumers at heart. This necessary transition must occur at least cost to consumers while maintaining the reliability and security of energy services, appropriate consumer protections for essential services and a just transition for affected workforces.

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[redacted]

The LMP Rule Change

NICE requests the Australian Energy Markets Commission (AEMC) to commence the process required to make the Locational Marginal Pricing (LMP) rule change described in this paper (see The Rule Change). In short, the request is for the AEMC to introduce LMP as proposed by the AEMC in September 2020 in the paper *Transmission Access Reform: Updated Technical Specifications and Cost-Benefit Analysis*[1].

Since the Collective of Energy Ministers[2] rejected the AEMC's proposed rule in September 2020, many hours of work have been committed to pursuing a chimera of an alternative model proposed by stakeholders. The Collective's rejection and all subsequent work have been distorted by requiring the AEMC to solve for the 'basis risk' (see below) introduced by LMP. However, it is no more necessary for the AEMC to design derivatives for this risk than for any other risk in the market, none of which it does.

Therefore, in making the LMP rule, the AEMC should only consider making an associated Financial Transmission Rights (FTRs) rule if a consensus is reached between market participants on an FTR model. If no consensus is reached, LMP alone should be introduced, and financial markets should be left to sort out the issues of instruments to manage risk.

In making this request, we note the following:

1. The prevalence of LMP in comparable electricity markets in other countries.

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[1] https://www.aemc.gov.au/sites/default/files/2020-09/Interim%20report%20-%20transmission%20access%20reform%20-%20Updated%20technical%20specifications%20and%20cost-benefit%20analysis%202020_09_07.PDF
[2] We use this term to refer to the body referred to in legislation as the MCE

2. The benefits are documented in the AEMC's earlier report and the cost-benefit analysis prepared by NERA.[3]
3. The benefits of creating value for storage are derived from the price differential between the nodal price at the generation point and the price received from the load.
4. The current NEM could not function without the financial contract market that developed without any involvement by the regulatory body (then NECA).

In considering a rule change request under s88 of the NEL, the AEMC may only make a Rule if it is satisfied that the Rule will or is likely to contribute to the achievement of the national electricity objective. In our submission to the consideration of the change to the national energy objectives, NICE proposed the following formulation:

> *The objective of energy policy is that consumers, collectively now and in the future, pay no more than necessary for the energy services they need as we transition to a net-zero emissions economy, with no one left behind while maintaining a reliable system.*

While our advocacy was unsuccessful, this formulation encapsulates the various items listed in the NEO – namely efficiency in the long term interests of consumers with respect to price and service quality characteristics and the achievement of emission reduction targets. The move to LMP has the following specific benefits:

1. At least 2% reduction in wholesale electricity costs.
2. Increased investment in storage which has system security benefits as well as potential further reductions in prces paid by consumers.
3. More efficient utilisation of transmission assets and hence probably a reduction in TUOS as a percent of total industry costs.

[3] https://www.aemc.gov.au/sites/default/files/2020-09/NERA%20report%20Cost%20Benefit%20of%20Access%20Reform%202020_09_07.pdf

Background

LMP in comparable markets

This rule change is designed to introduce nodal pricing, also known as Locational Marginal Pricing (LMP), into the National Electricity Market.

Nodal pricing is used in all US-based markets (CAISO, ERCOT, PJM, New England, New York), New Zealand and Chile; Ontario (Canada) implemented nodal pricing on 1 May 2025. The European Union, a political union, is the only major market where it is not used.

Nodal pricing is known to be the only approach to adequately price wholesale electricity as it explicitly accounts for congestion costs. Only nodal pricing sends the correct price signals to suppliers participating in the market at the correct location.

In most implementations, LMP has been accompanied by FTRs. FTRs were originally justified in the AEMC's earlier work by the artificial surplus created by setting the purchase price of electricity as the nodal price at the point of provision rather than the weighted average of the dispatch prices. This rule change, consistent with the AEMC's 2020 paper, proposes that weighted average prices are used which have a lower surplus. It is proposed that this surplus be used to offset TUOS charges.

The second reason for creating FTRs is as a risk management tool for generators that find themselves behind constraints. It is our belief that if there is a need for financial derivatives to manage risk, these will be developed by financial markets, as they were for the energy-only market risk management instruments.

The adoption of LMP has long been resisted in Australia, at the expense of consumers. The current practice of zonal pricing generates large rents to a few well-organised and vocal suppliers. This is in contrast to the obligations of the AEMC under the National Energy Rules, which mandate that the market deliver the efficient (lowest-cost) solution to consumers. The arguments put forth by suppliers resisting the introduction of nodal pricing are vacuous and self-serving.

LMP has emerged as an issue in the NEM Review, which is being chaired by Tim Nelson. At a seminar in Sydney for the review the Chair indicated they were unlikely to make recommendations to implement LMP on the basis that it will take at least five years before it can be implemented (to allow existing contracts to expire) and State Governments have addressed issues of transmission and generation coordination through their disparate Renewable Energy Zone (REZ) policies.

This ignores the old adage that the best time to plant a tree is twenty years ago and the second best time is today. The programs being deployed by States may well have been unnecessary if the Collective had made the LMP rule when first proposed. The programs being deployed are short-term and only focused on REZs.

The 'missing' in our market is storage, storage creates energy demand when energy is plentiful and cheap and provides energy when it is scarce and expensive. Every weapon available should be deployed to induce more storage investment in places where it can make the greatest difference, which is on the generation side of transmission constrained by excessive weather-dependent generation.

More simply, the amount of storage required in the NEM necessitates the introduction of LMP.

What is LMP?

LMP is the practice whereby electricity is priced at each significant injection and withdrawal node on the electrical network. This contrasts with the NEM practice, which only uses five reference nodes to set prices – one in each state. Nodal pricing was introduced in a seminal paper by Bohn, Caramanis and Schweppe (1984)[4].

At a fundamental level, it is a very simple proposition. Transporting electricity entails losses and is subject to transient congestion because any transmission line has a finite capacity. Therefore, electricity's value differs according to location and time of day; electricity at point A at time t need not be the same good as electricity at location B at the same time t, nor as electricity at the same point A but at time t or t+1.

We already accept the latter; consequently, at the behest of the AEMC, the NEM prices electricity every five minutes to reflect temporal variations in market conditions. LMP is the spatial equivalent to the frequent pricing and re-pricing of the NEM; it allows for as many prices as there are locations. Another way of saying it is that LMP delivers as many prices as there are goods. In contrast, zonal pricing constrains the number of prices.

With too few prices, efficiency is necessarily lost. Allowing fewer prices than goods to price is tantamount to asserting, for example, that all cars should be sold at the same price, irrespective of their costs and attributes. In the case of electricity supply the relevant attribute is the location of the generation. No one believes this is a reasonable proposition.

In a pure LMP design, the electricity market 'settles all resource injections and withdrawals at the same location at the same point in time at the same market clearing spot price.' (Harvey & Hogan 2022) Unfortunately, in the Australian market, there is no market mechanism for determining the withdrawal price; load does not submit a demand schedule that determines a clearing price at the point of withdrawal. Consequently, applying LMP will result in the price at withdrawal points always being the price required for the last unit of energy delivered. That is the old Zonal price.

In the absence of demand-side participation, the price at withdrawal should be the weighted average price of injection; no artificial surplus should be constructed. This deviation from the AEMC's original recommendation has implications for the design of financial derivatives.

Financial Transmission Rights (FTRs)

Because the prices at locations A and B may differ at the same time *t* under LMP, this pricing approach entails what is called 'basis risk'. This risk is real but easily managed. It arises because a

[4] For those interested the paper preceded Schweppe et al's *Spot Pricing of Electricity* (Schweppe et al. 1988)by four years.

retailer may contract with a generator for delivery at a certain price, but the realised price at the withdrawal node differs. It exists in any electricity market, not just in Australia; other jurisdictions have overcome this problem. It is easily managed: (i) if observing systematic price differences between nodes, the contract price parties agree on should also reflect them, and (ii) price differences give rise to a merchandising surplus (i.e. the price difference multiplied by the volume) that can be securitised in the form of FTRs. These securities allow market participants seeking a locational hedge to purchase that insurance at a fair price. They render the basis risk eminently manageable. It has been managed in California and other markets for about 20 years.

The exact design of FTRs has been used throughout the nodal pricing debate as a tool against nodal pricing. We note that similar arguments about contracting emerged in the discussion of five-minute settlement. However, in that case, the AEMC wisely recognised that it was not its job to design financial derivatives to manage financial risk.

The Rule Change

Description of the rule change

In its September 2020 paper the AEMC proposed to draft a rule change package with features described in paragraphs 38 to 56. This proposal varies from these arrangements by also changing the settlement price for loads, and not proposing FTRs.

Scheduled market participants would no longer be settled for their energy at a region wide price multiplied by a static marginal loss factor. Instead, they would be settled at the LMP at their location. LMPs are the incremental change in the cost of dispatch of meeting an incremental change in load at that location. These LMPs differ to one another as a result of losses and congestion, which impact different locations differently across the transmission network. The marginal effect of losses would be dynamically included in the LMPs, replacing the static marginal loss factor regime. This will send better locational signals and information to participants, enabling them to make better investment and operational decisions, using the transmission network more effectively.

Non-scheduled market participants (including loads) would continue to face a region-wide price, but that price would now be calculated as the volume weighted average price (VWAP) of the LMPs of nonscheduled market participants. This will minimise impacts on the financial contract market and promote liquidity.

The above pricing arrangements would result in settlement residues as a result of congestion and losses - the difference between what load pays and what generators are paid for energy. All settlement residues relating specifically to losses would be calculated and returned directly to consumers through an offset to their transmission use of system (TUOS) charges - just as intra-regional settlement residues (which relate to losses) are currently returned to consumers.

Comparison to current arrangements

While the introduction of LMPs and FTRs is a substantial change to the current arrangements, many of the concepts, such as settlement residue and FTRs have direct analogies.

Prices already locationally vary across the NEM as a result of varying marginal loss factors applied to the regional prices for generators and load connected within each region, and different regional prices between regions. This results in settlement residues. Intra-regional settlement residue is already used to offset TUOS charges.

The introduction of LMPs results in more efficient price signals for locating new investment compared to the existing regional pricing and static marginal loss factor regime.

Implementation and initial arrangements

These arrangements would be introduced approximately four years after the final rule is made. The AEMC is referred to Table 1 of its 2020 paper for a summary of the updated technical specifications (ignoring those that refer to FTRs).

Benefits of LMP

Socially efficient pricing

The virtues of LMP have been laid out by a long list of authors (Cramton 2017; Hogan 1999, 2021; Katzen & Leslie 2024; Wolak 2021). This is just a sample. Green (2007) estimates the benefits of LMP adoption in England and Wales to be 1.3% of the welfare of generators (i.e. their profits). Compared to the NEM, this likely underestimates the true benefit of LMP because (a) the price cap in the NEM is larger than in the UK, which makes for large price variations that LMP can generate, and (b) it only considers 13 pricing nodes.

Katzen and Leslie (2024) conservatively estimated mispricing in the NEM of up to $358 million, or 2.2% of all spot maket revenues in 2019. As they note "This signifies the potential for short- and long-run efficiency gains to exist from having price signals more closely linked to the economic actions of market participants." As a first step in considering this rule change request the AEMC should commission these authors or a consultant to repeat the analysis for each year since 2019. This would provide additional information on whether the impact of mispricing is changing over time.

The most important property of LMP is that it prices electricity correctly at each node in the sense that it equates the price received by the supplier to the marginal benefit accrued by the buyer(s). In that sense, it is also a fair price. Hence, LMP delivers socially efficient pricing; this is the point first demonstrated by Bohn, Caramanis and Schweppe (1984). In the language of the National Electricity Rules (NER), it delivers a cost-minimising dispatch subject to constraints. That is currently not the case under zonal pricing, simply because the social benefit differs across locations as soon as a transmission line becomes congested. Another way of stating social efficiency is to say that LMP delivers the correct price signals to suppliers. For example, if a transmission line is congested, the nodal price at that point corresponds to the marginal value to a consumer because they cannot withdraw more energy. It also corresponds to the marginal value delivered by suppliers because they cannot inject more. Finally, suppliers can either (i) locate their production facility elsewhere or (ii) convince the transmission operator to expand capacity, if the benefit outweighs the cost.

Storage

These benefits of LMP are well known and readily exploited in other jurisdictions. The introduction of storage supercharges them; one can foretell that a successful roll-out of storage capacity requires LMP to be implemented. In a recent article, Johan, Leslie, Meares and Pendlebury (2021) document exactly this fact for the current configuration of the NEM. This is a new impetus for this pricing method.

LMP is essential to storage deployment because it is understood that storage should take advantage of price differences (energy arbitrage). LMP multiplies the number of price variations that storage operators can take advantage of and arbitrage away. At present, at most five pricing nodes can give rise to variations, and therefore (i) few opportunities to exploit them and (ii) no incentive to install storage at different locations. LMP provides many more pricing nodes and therefore many more opportunities for price variations over a day. In addition, it provides incentives to locate where the price volatility is the highest, that is, exactly where the congestion is the sharpest. Storage can be used to alleviate congestion, but for this to become a reality, this congestion has to be made transparent. LMP is the only way to do so.

Finally, combined with LMP, storage can contribute to optimising the investment in building transmission. Depending on electricity flows, that is, on demand patterns, storage can be located at the load centre or the generation centre to enhance the utilisation of the transmission line.

This property is best explained through an example. There are two time periods, 1 and 2, which correspond to a low and high demand state. Low demand is 50 MW, and high demand is 100 MW. The generation facility is a solar farm that can produce as much as 150 MW in period 1 (day) or 0 in period 2 (night). Solution 1: In period 1, the solar farm injects 50 MW into the transmission line and stores 100 MW in a storage unit at the generation centre. In period 2, it sends 100 MW to the load centre from the storage. Therefore, the transmission line requires 100 MW capacity, which is used in full only in period 2. Solution 2: The transmission line is only 75 MW. In period 1, the solar farm injects 75 MW, 25 MW of which is stored at the load centre, and another 75 MW is stored at the generation centre. In period 2, it sends 75 MW over the line from the storage. Added to the 25 MW already at the load centre, this quantity meets the demand. The storage capacity is the same, but the line capacity is significantly smaller. It is used at the same (maximum) rate over the two periods.

How does one implement this solution in a decentralised market where private investors seek reasonable returns? LMP is completely necessary for this outcome. With a single price (even if adjusted for marginal losses), the storage unit is indifferent as to its location.

Contribution to the achievement of the NEO

The NEO as specified in s7 of the NEL has three elements:

> *The objective of this Law is to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to—*
>
> > *(a) price, quality, safety, reliability and security of supply of electricity; and*
> > *(b) the reliability, safety and security of the national electricity system; and*
> > *(c) the achievement of targets set by a participating jurisdiction—*
> >
> > > *(i) for reducing Australia's greenhouse gas emissions; or*
> > > *(ii) that are likely to contribute to reducing Australia's greenhouse gas emissions.*

In its document *How the National Energy Objectives Shape our Decisions*,[5] the AEMC explains that there are three types of efficiency: productive, allocative and dynamic. Havyatt (2017) refers to this as the 'Hilmer trilogy' as it is a description used far more in Australia than anywhere else. In the paper he concludes that 'in practical application, despite the variety of ways to dissect the

[5] https://www.aemc.gov.au/sites/default/files/2023-09/Publication2%20-%20Guide%20to%20AEMC%20decision%20making%20-%20Sep%202023.pdf

concept of efficiency, the outcome of efficiency in all cases is the same – consumers, collectively now and in the future, pay no more than they need to.'

The NEO specifies the rider that has to be applied to any consideration of cost, a vector of service or product characteristics that can be conveniently referred to as either quality or reliability. The AEMC guide demonstrates this vector characterisation by providing meanings for the words used in both sub-section 7(a) and sub-section 7(b). The distinctions between the meaning of reliability of supply and reliability of the system is a distraction.

These observations and the inclusion of emissions reduction provides the basis for our preferred description of the energy objectives as:

> *The objective of energy policy is that consumers, collectively now and in the future, pay no more than necessary for the energy services they need as we transition to a net-zero emissions economy, with no one left behind while maintaining a reliable system.*

This puts the emphasis on consumers rather than investment, but has entirely the same meaning.

The implementation of LMP is expected to reduce wholesale electricity costs by at least as much as the 2.2% of wholesale cost estimated by Katzen and Leslie (2024). Consumers will pay less. In addition by facilitating the economics of storage, it improves the storage business case. More storage will add to system reliability and to the speed at which renewables can replace fossil fuel based generation.

One objection raised about LMP is that it will take four or more years to implement. This means the benefits are equally delayed. However, this delay occurs whenever the decision is made to implement LMP. We have already lost five years since the AEMC's initial proposal, five years that have been wasted. The jurisdictional decisions relating to transmission and REZs will work in conjunction with LMP, they are not a substitute for it.

The introduction of LMP will contribute to the achievement of the NEO, and the contribution will be significant.

The "controversy"

Despite the recommendations of the AEMC, the Collective opted not to adopt LMP. Some parties argue that it is not necessary, that it is too difficult and that it is too risky to market participants. All these arguments are deeply flawed.

First, it is clear that efficiency requires LMP. That is, to satisfy the goals set out in the NER, LMP must be used. That point has been made repeatedly by numerous authors and is briefly articulated again in this Rule Change Request.

Second, the dispatch engine used by the Australian Energy Market Operator (AEMO), *NEMDE*, already produces a security-constrained dispatch, which means that all transmission constraints and security constraints are reflected in the dispatch in the form of shadow prices (Lagrange multipliers) on the constraints. In other words, *NEMDE* computes all these prices already, but they are not used for settlement. It is a small step to use these prices for settlement, that is, for incentive purposes.

Suppliers may need to make different bids to those they make under regional pricing to reflect different prices at different nodes. This adjustment is not a lot to ask of seasoned professionals (or their AI empowered trading bots) in the days of High Frequency Trading.

Third, LMP does entail what practitioners call 'basis risk'. As articulated before, this risk is managed using financial instruments; the most popular financial instruments are financial transmission rights. They have long been successfully used in US markets, so this is not a speculative claim to assert that it can be done. Furthermore, market participants, not consumers, should bear any residual risk. That is, even if consumers ultimately meet the aggregate cost of the system, having market participants face any residual risk generates incentives for them to manage that risk. This is something consumers cannot do. The basis risk still exists and is manifested by binding constraints reflected in higher average prices. In other words, today, consumers bear the cost of the basis risk. Under LMP, it is transferred back to market participants, which they have been actively resisting.

Of course, a consequence of efficiency in any market is that prices are more reflective of costs. The corollary of that is that economic profit will be confiscated from the market participants who face nodal prices.

Conclusion

In closing, adopting LMP is not only efficient but also fair. It delivers the outcome mandated by the National Electricity Objective (NEO); it is the only mechanism that can do so. LMP has long been resisted by the professionals of the NEM, at the expense of consumers, for reasons of expediency. There are no barriers to adopting LMP, and it is all the more important to do so to support the energy transition that is the policy of the Australian government.

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