FACT SHEET - OCTOBER 2024

Marginal Loss Factors and Network Congestion in Queensland

About this fact sheet

For Queensland to meet its decarbonisation targets, significant changes in generation and expansion of the transmission network are needed. In response, transmission power flow patterns have the potential to vary significantly from historical trends, which may lead to changes in Marginal Loss Factors (MLFs) and the potential for network congestion.

This fact sheet provides explanatory information on MLFs and network congestion to help inform a wide range of stakeholders involved in the process of establishing new generation and loads in Queensland.

Marginal Loss Factors

What are MLFs

MLFs are a mechanism to account for the cost of energy lost in transmission. The manner in which this cost is apportioned is designed to provide market signals to guide efficient generation and load development and operation.

As power flows through the transmission system from generators to loads, some of the energy is lost through heat in the transmission lines. This lost energy is referred to as transmission losses. Losses increase with the volume of energy being transported, and the distance the energy travels. Transmission losses mean that more energy needs to be generated than is consumed.

MLFs represent incremental losses between generators and loads at various connection points on the network and the market's Regional Reference Node (RRN). The RRN for Queensland is the South Pine 275kV substation in Brisbane's northside.

The more that a generator needs to increase generation to supply an additional unit of load at the RRN, to overcome any increase in transmission losses, the lower its MLF will become. For example, to supply an additional 1.0MW of power to the RRN, a particular generator might need to increase its output by 1.1MW, to account for the extra 0.1MW of power which is lost in the transmission network while transporting an extra 1.0MW of power from the generator to the RRN.

Another generator may only need to increase its output by 0.9MW to enable 1.0MW of power to be supplied to the RRN if the 0.9MW shift in power flows across the network results in a 0.1MW reduction in transmission losses.

MLFs also apply to loads including both pure loads and energy storages when they are charging. In the case of loads, MLFs represent the increase in generation at the RRN to supply an extra unit of load at its connection point, accounting for transmission losses.

In each National Electricity Market (NEM) region, the wholesale price is defined at the RRN. The MLF at the RRN is set at 1.0 by default. The MLF for each generator and load is calculated relative to the RRN considering its location on the network as well as its generation or consumption pattern. The Australian Energy Market Operator (AEMO) updates MLFs by 1 April each year for the following financial year, using a defined calculation methodology.

Generators with similar operating profiles such as two solar farms in a similar network location will usually have similar MLFs. But because the MLF calculation considers generation output patterns, it is possible for two different types of generators such as a solar farm and a wind farm at a similar location to have significantly different MLFs.

Similarly, two loads in close proximity can have similar or contrasting MLFs depending on the similarity of their load profiles. If a load changes its operating profile its MLF can change in response. For example, if an industrial load switches from having a constant consumption pattern to using more power during daylight hours, its MLF will become similar to a nearby solar farm.

Understanding revenue generation and loss

For the purposes of dispatch and settlement in the NEM, the local price of electricity at a connection point is equal to the regional price multiplied by the MLF, and so affects a generators wholesale electricity market revenue or a load's wholesale electricity purchase price.

From a generator's perspective, the higher the marginal losses required to supply the RRN, the lower the relevant MLF which results in a lower local price relative to the regional price.

A low MLF reduces wholesale revenue for a generator but also reduces wholesale electricity costs for a load. A high MLF will have the opposite effect.

SIMPLIFIED EXAMPLE OF PRICING FOR A GENERATOR

If the electricity spot price is $100/MWh a generator with an MLF of:

- 0.9 would receive $90/MWh (0.9 x $100)
- 1.0 would receive $100/MWh
- 1.05 would receive $105/MWh which is a premium on the spot price.

Similarly, for a load with an MLF of 0.9 would pay $90/MWh at settlement.

Balancing generation and load

MLFs tend to become most acute in areas where there is a frequent mismatch between the local load and generation, either in general or at certain times of the day.

If a generator or load experiences a MLF of less than one, this means that generation in the area is frequently in excess of local load at the times when the generator or load is operating. This signal incentivises the development of additional load in the area or for existing load to adjust its operations to consume more power at the times when there is a local surplus. This signal also discourages the development of further generation with a similar operating profile as it will increase the local surplus.

The reverse situation applies for an MLF greater than one. In both cases, these signals incentivise balancing generation and load.

Network congestion

Understanding network congestion

The transmission network has a limited capacity to transport power, and AEMO's dispatch process must respect this capacity to ensure the power system is not overloaded and remains secure. To achieve this, network constraints are built into the market dispatch process which aim to respect these limits while:

- dispatching generators in order from lowest to highest offer price
- scheduling load from highest to lowest bid price.

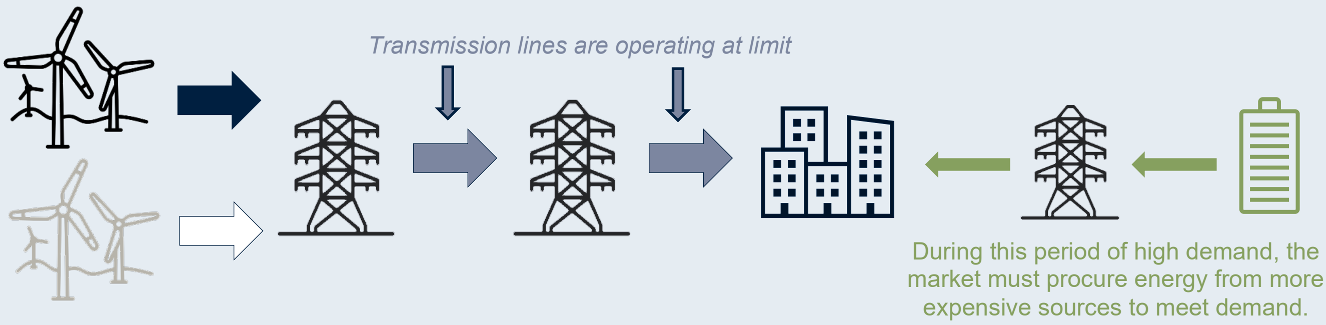
This process will continue until the generation is equal to the load.

In a situation where the lowest cost dispatch of generation and load would result in a limit being exceeded, a constraint representing that limit is said to bind. This means that generators contributing to the binding constraint may not be able to be dispatched even if they have additional capacity at a cheaper price than the electricity spot price. This leads to what is referred to as network congestion, and the generator is said to be curtailed.

A renewable generator is also said to be curtailed when it is dispatched at a level below its availability due to the electricity spot price being lower than the price at which a generator is bidding its capacity into the market. This condition is increasingly common on mild sunny days and the electricity market spot price is negative. This form of curtailment is unrelated to network congestion.

Curtailment of renewable resources

In this scenario, generation from numerous low-cost wind farms could overload transmission lines if all were dispatched. Lower-cost sources are curtailed (grey wind farm) so energy can be securely provided.



Network congestion reduces the amount of energy that can be sold at the electricity spot price and therefore reduces revenue for generators that have been curtailed.

Whereas MLFs are a fixed scaling factor on price that does not change throughout the financial year, congestion depends on the specific network conditions, such as when there is reduced network capacity due to planned or unplanned network outages or high network power flows such as those associated with high demand periods.

A level of network congestion is economically efficient, with the economic cost of the curtailed generation needing to be weighed against the cost of increasing network capacity.

Key considerations and forward planning

Nationwide, supply and demand trends are changing rapidly due to the shifting energy mix. This will lead to year-on-year changes in MLFs and congestion, worsening in areas with high renewable energy generation or those far from load centres and improving in response to the progressive implementation of network upgrades. These changes demonstrate a need for developers of generation and load to carefully plan for scenarios in both the interim and longer-term.

Actions from other parties may also have an impact on individual project outcomes and future market developments. For better understanding of potential project outcomes across a range of possible futures scenarios, specialised advice should be considered.

Powerlink's approach in managing MLF impacts and network congestion

Powerlink is taking proactive steps to reduce MLFs and congestion on the network. We are delivering the SuperGrid transmission backbone, which will include new 500kV transmission lines, enabling the efficient transfer of large volumes of renewable and stored energy, addressing Queensland's transforming energy needs.

The SuperGrid transmission backbone will also provide a flexible platform to allow for future expansion as new loads emerge. Our role as the Renewable Energy Zone (REZ) Delivery Body will assist in coordinating how renewable projects connect to the transmission network in REZs. This will ensure the right generation mix, in the right location and at the right time.

Powerlink is implementing new technology including Dynamic Line Ratings to update transmission line capacity in real-time and get more out of the transmission network. Unlike traditional Static Line Ratings that use fixed assumptions, this system can determine if more electricity can be dispatched along a line based on real-time measurements.

Additionally, the implementation of Powerlink's Wide Area Monitoring Protection and Control (WAMPAC) enables us to work our transmission network harder, reduce customer outage impacts and avoid delays to capital projects. The system can quickly detect and respond to events on the network to maintain stability. Improved operation and utilisation of the network increases the availability of the network outages required to undertake works on the system, better meets the needs of renewable generators and minimises market impacts.

Further reading

For additional information, please refer to the following resources:

- epw.qld.gov.au/energy/energy-jobs-plan
- aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/market-operations/loss-factors-and-regional-boundaries

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