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Dear Sir/Madam

Queensland Renewable Energy Expert Panel Draft Report – AEMO Submission

Thank you for the opportunity to submit to this consultation paper to the Queensland Renewable Energy Expert Panel (Panel). As the independent National Electricity Market (NEM) and Western Electricity Market (WEM) market and systems operator, and the NEM National Electricity Transmission Planner, AEMO is pleased to support the Queensland Government in its efforts to deliver strategic and considered energy policies in the long-term interest of both the state and the wider Australian community.

AEMO supports broad industry, community and government engagement on major energy policy initiatives as a means of developing and implementing best-practice solutions to efficiently reduce carbon emissions at the least cost to the consumer. AEMO's primary responsibility as the independent market and power systems operator is to manage and maintain power system security. This role is undertaken within the legislated policy and market frameworks of the day and in adherence to the National Gas and Electricity Objectives and Rules. Recognising that the energy market and power system is changing, AEMO has a major internal work program and is consulting closely with the local and international energy community to understand the implications of these changes. It is with this independent and wide-ranging view of the complexities, challenges and opportunities facing our fast evolving energy industry that AEMO has considered and responded to this Draft Report.

We note that the Panel forecasts the proposed policy would deliver the 4,000 to 5,500 MW of new large scale renewable generation capacity over approximately 7 years. Taken together with the existing renewable generation in Queensland and the expected ongoing growth in small scale renewable generation, this could mean that there is 11,000 MW of intermittent generation in Queensland by 2025. This quantity of intermittent generation relative to the total customer demand in Queensland is challenging for conventional market modelling to represent. We recommend that further consideration be given to the modelling and, in particular, the projected impacts on other market participants as a result of the proposed policy. Better visibility of the possible outcomes of this projected level intermittent generation on existing and future market participants would add to the understanding of the policy impacts and its consequences.

Following Australia's 2015 Paris 21st Conference of Parties emission abatement commitment (COP21 commitment) to reduce emissions to 26–28 per cent on 2005 levels by 2030, AEMO supports state and federal government efforts to lower emissions in the electricity sector, while maintaining the reliability and security of the national energy market. The CoAG

Energy Council has requested advice from AEMO on how any power system security issues that arise from these changes might be managed. AEMO has been working on these issues through the Future Power System Security program (FPSS) and collaborating with the Australian Energy Market Commission (AEMC) through its recently announced System Security Markets Review. Both organisations are working hard to deliver a package of changes to the market and regulatory frameworks to support the energy industry as it transitions to a lower emissions future. AEMO presumes that power system security and reliability of energy supply will continue to be key considerations in the Queensland Government's decision to adopt a 50% renewable energy target. This submission includes some insights and advice on these areas based on work completed to date under our FPSS program.

AEMO acknowledges and supports the Queensland Government's intention to minimise the total cost of any renewable energy target on customers, and emphasises that the design of the final scheme should seek to support and/or complement important NEM investment and operational incentives as a means of building a stronger, more resilient interconnected power system.

AEMO would welcome the opportunity to discuss the issues raised in this submission, including further information in our planning and forecasting reports and FPSS program.

Should you have any questions in relation to this submission, please contact Ms Nicole Nsair on (03) 9609 8451.

Yours sincerely

David Swift
Executive General Manager, Corporate Development

1. Introduction

AEMO's vision is the long-term security of energy for all Australians.

AEMO performs our gas and electricity functions as prescribed in the National Gas and Electricity Laws and Rules under the guidance of the National Gas and Electricity Objectives, and operates Western Australia's Wholesale Electricity Market (WEM) and South West Interconnected System in accordance with the WEM Rules and related WEM Market Procedures.

Under these objectives and rules, AEMO is tasked with promoting efficient investment in, and the efficient operation and use of natural gas and electricity services for the long-term interest of Australian consumers, with respect to:

- Price, quality, safety, reliability and security of supply of electricity and natural gas; and,
- Reliability, safety and security of the national electricity system.

AEMO is fuel and technology neutral – we do not discriminate against or show bias towards any energy fuel or technology in performing our functions as Australia's independent energy market and power system operator.

AEMO publishes planning and forecasting data to support efficient decision making and long-term investment in Australia's electricity markets and infrastructure services. These include the *National Electricity Forecasting Report* (NEFR), *Electricity Statement of Opportunity* (ESOO) and the *National Transmission Network Development Plan* (NTNDP), state planning reports, solar and wind energy forecasting, and general generation information.

AEMO also publishes planning and forecasting information to support decision-making and long-term investment in Australia's gas markets. This information includes the *National Gas Forecasting Report* (NGFR) and the *Gas Statement of Opportunity* (GSOO). AEMO assesses whether gas reserves are able to meet the anticipated maximum demand and annual consumption of gas as forecast in the NGFR.

Like many other established energy systems around the world, Australia's energy industry is undergoing rapid change as conventional, centrally dispatched and synchronous generation is displaced in the generation mix by intermittent, non-synchronous generation including a growing proportion of distributed generation, such as wind and solar photovoltaics (PV) generation. This is changing the way we as an industry must approach and maintain power system security and energy supply reliability in our power system.

AEMO has established a dedicated work stream under the Future Power System Security (FPSS) program to address operational challenges that are expected to arise, and are arising, as a result of this changing generation mix. Our recent FPSS Progress Report published in August 2016[1] outlines the strategic approach of this work through identifying technical challenges for the operation of the power system, that are likely to arise as new technologies enter the market, and the generation mix continues to change. AEMO would be more than happy to discuss the challenges and outcomes arising from this work package and what actions may be required to deliver secure operating arrangements in Queensland in parallel with the introduction of the proposed renewable energy policy.

[1] Details of the Future Power System Security program are available at: http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Securityand-Reliability

2. Policy Context

The COAG Energy Council is undertaking a major line of work to better integrate environmental and energy policy across all levels of government and institutions. The need for changes to the national electricity rules and regulatory arrangements is also currently being considered by AEMO and the AEMC. In keeping with AEMO's obligations under the National Electricity and Gas Objectives, AEMO recommends that the Queensland government engage closely in this work as it pursues its renewable generation initiatives. This should ensure that environmental objectives can be achieved at the lowest total cost and without compromising power system security and reliability of energy supply.

2.1. Type and location of electricity generation technology

Through AEMO's National Transmission Planning function, we observe many technological advancements in renewable energy, which in turn affects their ideal locations. For example, during the last decade, geothermal generation from remote inland locations was predicted to become a major source of renewable supply, and large network investments were promoted at the time to connect them. These learnings suggest that the market is best served by policies that allow generation to evolve over time, and at the location that both best suits the resources and costs to deliver the energy to customer.

AEMO considers that it would be prudent for the measures put in place to implement the policy objective, to be as neutral as possible to the type and location of generation technology deployed, and for the measures to focus on the total delivered cost. Environmental policies should therefore, where possible, be able to make use of the widest range of technologies as they develop.

2.2. Modelling the transition into renewables

To meet the 50% renewable energy target, the Panel forecasts the deployment of 4,000–5,500 MW of new large scale renewable generation capacity over approximately seven years. This would represent the most rapid rate of generation investment the Queensland power system has experienced. Given this, it is important to consider the practical challenges that such a swift transition implies; challenges which may not be identified by conventional market modelling tools alone.

Conventional marketing tools typically simplify future years into a small number of large time periods representing hundreds of real hours, and dispatch generation around those periods. The models find a lowest cost/most profitable generation portfolio from these periods and effectively average outcomes across a wide spread of similar real hours.

AEMO uses such market modelling tools in its own planning function, and finds that these models' simplifications are acceptable when assessing the energy market through periods of relatively gradual change, and where intermittent generation plays a relatively small part.

From AEMO's current forecast[2] to 2026, taking into account the combination of existing and committed new generation plus expected small-scale renewables growth, we estimate the Queensland region to have installed approximately 1,000 MW of wind, 674 MW of large solar and up to 3,800 MW[3] of small-scale solar generation capacity. The proposed Queensland renewable policy will add 4,000 to 5,500MW of generation, implying a total of almost 11,000MW of intermittent generation. Given the limited capacity of interconnection to New

[2] AEMO Generation Information Pages https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information

[3] AEMO 2016 National Electricity Forecasting Report

South Wales, the majority of this intermittency will have to be supplemented by varying output from other generators in Queensland to meet demand.

Conventional market modelling is unable to fully contemplate the day to day technical and operating challenges of this imperative. Constraints related to minimum generator output levels, start-up delays and start-up costs are largely ignored in market modelling. While such approximations are acceptable where the intermittent generation share is small, or where the non-intermittent plant is highly flexible (e.g. hydro, gas or battery), it is not adequate where plant is less flexible, as is the case with Queensland's black coal fleet or bagasse generators.

The market modelling commissioned by the Panel forecasts that, despite the additional renewable energy, the majority of the black coal fleet will remain profitable in 2025 and continue to deliver reliable capacity. This outcome is based on conventional market modelling which generally has the shortcomings outlined above.

More accurately representing the volatility of this intermittent generation and considering the dispatch viewed across a sequential hourly time-series of daily supply/demand variations would reveal whether the required operating regimes for that plant was physically realistic or not. AEMO notes that if this reveals that the operating regime for some of these generators will be less profitable than conventional modelling anticipates, those plants could close earlier than anticipated. This could have impacts on prices, investment and the resulting generation outcomes, not forecast by the original modelling. This is a risk for consideration in the Panel's considerations.

Further to the dispatching of Queensland coal fleet at lower levels, there is also potential for the power system to be more susceptible to rapid changes in frequency, and to larger frequency deviations following a separation event. These attributes are already being experienced in the South Australian power system. AEMO anticipates that this challenge will emerge in other regions, such as Queensland and Tasmania that could, in an extreme event, separate from the remainder of the NEM, as the whole system evolves.

2.3. Policy design

The considerations raised above could be moderated by a least-cost, geographically neutral approach. For example, AEMO also notes the Australian Capital Territory (ACT) and California sub-national jurisdictions each have ambitious renewable energy targets that do not oblige the generation to be physically located within their own jurisdictions. At the same time transparent accounting ensures integrity in delivery of their environmental objectives. These approaches lower total cost to their customers and eases the transition in the jurisdiction's own energy market.

2.4. Network Strength in Queensland

AEMO has observed a reduction in system strength in certain parts of the power system as the generation mix has changed across the NEM. Reduced system strength can:

- Affect the ability of new generation to connect to the network.
- Compromise the effectiveness of protection systems that detect and clear equipment faults, and the ability of non-synchronous generation to operate as designed.
- Result in greater difficulty in maintaining stable voltages in some parts of the network, particularly during disturbances.

The cost of the installation of power electronic connected wind generation or large scale solar PV generation to remote parts of the Queensland transmission network is likely to be

increased by the need to provide additional equipment, such as synchronous condensers, to maintain levels system strength and allow the generation to behave in a stable and predictable manner.

Based on our work completed to date as part of the FPSS program, AEMO has observed that the withdrawal of conventional thermal generation through retirement, mothballing or simply not being dispatched will reduce the system strength in any given area and could adversely impact on the performance of power electronic connected generation and protection systems in that area.

2.5. Inertia and Frequency Control Ancillary Services

The discussion from the Draft Report addresses the issues of inertia and frequency control ancillary services (FCAS). AEMO notes that these issues are quite separate. With high levels of renewable penetration expected as a result of the proposed target, it is likely that non-synchronous generators could be used to provide some FCAS services. However AEMO expects there will still be some requirement for synchronous inertia in this system. Potentially this would be supplemented by emulated inertia and new fast frequency response services from a range of technologies.

AEMO notes that this proposed renewable energy policy will at times mean that asynchronous generation (for example, wind and solar PV) will be very high relative to Queensland demand, and conventional energy generation will be displaced. AEMO expects that this will have a large impact on the operational aspects of the network, including security and stability. Through our FPSS program of work, AEMO is working to address this and to determine solutions for the NEM.

3. Queensland Network Connections and Auction Design

3.1. Connections to the network

Currently the AEMC is considering a Rule change to introduce contestability in the provision of connections to the NEM, except in Victoria where this already exists. AEMO welcomes reforms that allow contestable providers to build, own, operate and maintain the contestable part of the shared network. AEMO has seen and continues to see the delivery of connections in a more cost effective and timely manner in Victoria where competition for the provision of connections is business as usual.

The Panel has recommended further investigation of the concept of developing renewable energy hubs or zones with the potential for this to be linked to any future reverse auction process. AEMO agrees that this may be a more efficient way to build shared connection assets, i.e. at a hub, rather than with a separate terminal station for each new generator. The AEMC's rule change is exploring how to build connection assets that allow for the efficient long term development of the network, without imposing inappropriate additional costs on first movers. The Panel might consider the timing of these reforms and how they would fit with the proposed growth in new renewable generation seeking connection to the system.

In Victoria, AEMO, as the Victorian Transmission Network Service Provider (TNSP) and Transmission Planner, has regard to future requirements when a new connection is proposed, which may include recommending the acquisition of an option to procure additional land space for potential expansions of assets. This potentially improves the ability for system security and network strength to be properly considered during the connection process as it limits the number of physical 'cut-ins' along the length of a transmission line. In Queensland this role is performed by the TNSP, Powerlink. This could be important to

providing efficient connections in areas of the grid that are attractive for new renewable generation.

3.2. Evaluating grid interactions through a network connection auction process

The NEM's undefined shared network access framework is known to create locational inefficiencies and generator risks[4]. Congestion in the network is shared between all parties in a congested area according to the economic dispatch process. There is no obligation for a new entrant to upgrade the shared network or to compensate the incumbent generators experiencing congestion.

The result of the NEM's arrangements is that a congested location can still appear individually attractive to a developer, even if, as a result of its investment, no additional renewable energy as a whole is transported to customers.

AEMO believes the most efficient way to develop renewable energy generation and minimise adverse impacts on generators and consumers, is for their risks to be part of the investment decision. If generators can be encouraged to locate at locations with higher network capacity and strength then total costs and generator risks are lowered. It is then more likely the renewable energy generation target can be met. As the National Electricity Rules (NER) alone do not fully address these issues, the government's auction mechanism provides an opportunity to partly overcome them.

AEMO notes the discussion by the Panel around efficiency of network connections and coordinating approaches to network expansion. AEMO recognises the consideration of developing renewable energy hubs by the Panel and suggests that the overall cost of the required network connection could be identified through the auction design process. AEMO suggests that the auction should weight projects according to the following criteria:

- Effects on grid stability, or the costs of correcting this;
- The cost of congestion, either on the generator itself or other generators; and,
- The cost of customer funded network expansion that is likely to be justified as a result of the generator's connection.

Additionally, the network interactions should be extended to the distribution network, as renewable energy projects often connect into distribution voltages, and these generators will impact both the distribution and transmission networks.

Advice on these matters could be sought from AEMO as the National Transmission Planner, Powerlink as the TNSP for Queensland, and, where relevant, the Distribution Network Service Providers (DNSPs).

3.3. Data Streams

AEMO is supportive of the work that the Standing Council is undertaking on the Energy Market Transformation Project and welcomes the Queensland Governments commitment to include data transfers and requirements into this policy. AEMO sees the collection and storage of data as very important and considers registers are to be national to assist the work for the assessment of technical challenges that are likely to emerge as the generation in the National Energy Market (NEM) continues to change. AEMO's FPSS work program

[4] For detailed discussion on these issues, see AEMC Transmission Frameworks Review, http://www.aemc.gov.au/Markets-Reviews-Advice/Transmission-Frameworks-Review and Optional Firm Access http://www.aemc.gov.au/Markets-Reviews-Advice/Optional-Firm-Access,-Design-and-Testing

seeks to address this and the impact from consumers as they become more active in understanding how their demand is met.

4. Contracts for Differences Design

An important design feature of the NEM is the way it provides appropriate incentives to generators to deliver in accordance with customer needs. These signals self-correct over time as the patterns of demand and supply change. AEMO has rarely been required to intervene in the market, demonstrating the effectiveness of the NEM's pricing process. Considering the scale and geographic concentration of the proposed policy scheme, AEMO considers that the Panel should consider the importance and effectiveness of this NEM pricing process in its final recommendations, and that any final renewable energy target policies should seek to support and uphold this national pricing process.

To further explain this concept, consider the following categories of market signal:

1. Long-term supply-demand signals, i.e. whether new supply invests or disinvests to meet the growth or decline in customer demand.
2. Locational signals, i.e. whether generation is invested in a place where it is most useful, considering the limitations and losses of the network and the location of customer demand and other generators.
3. Short-term dispatch signals, i.e. whether the generator produces output correlated with the needs of the customer.

AEMO understands the proposed scheme is seeking to lower risk to renewable generators. The above three risks express the natural characteristics of the power system, and should the scheme immunise generators from these risks, the risk will not be eliminated but instead passed onto consumers in the form of higher future CFD payments. Where possible, the scheme should leave these signals with the generator, as they are the only party with some capability to respond and minimise them.

A well designed scheme would retain incentives to:

- locate new renewable generators in those parts of a region with lower losses.
- invest in technology that is better correlated to price and therefore customer demand. This preference is likely to have affected, at the margin, decisions to invest in Queensland large-scale solar and biomass plants versus southern wind generation. It is also affecting decisions to invest in tracking solar (which generates later into the afternoon peak) as opposed to non-tracking, and, in time, to encourage renewables to integrate with storage.
- curtail the output of LGC generators when there is excess supply and spot prices become negative.
- schedule renewable energy maintenance away from the times of demand peak and therefore highest spot price.

4.1. Preferred design of the contractual arrangemetns

As a general principle, AEMO encourages retention of market incentives upon generators and arrangements where the generators retain a level of exposure to the spot price.

Should the government choose to retain a CFD approach, then AEMO recommends the Queensland scheme incorporate some improvements and variations from the current ACT

scheme. AEMO has also recommended this approach to the Victorian Government in our submission to the Victorian renewable energy target proposal[5]. Our key recommendations and considerations are outlined below:

- Payouts under the CFD should be floored at zero spot price. As Queensland's solar generation penetration grows under the policy, there will be extended periods where zero marginal cost supply exceeds demand. If participating generators are immunised from negative price, then:
    - The market will not be able to resolve these surpluses, so that:
        - Prices will frequently fall to the market price floor of minus $1,000/MWh and causing extreme risks to other generators who are exposed to it; and,
        - AEMO may need to intervene in the market to restore security by directing solar generators to reduce output.
    - The Queensland government will have to make large CFD payments to cover participating generators' payments to AEMO when they generate into minus $1,000/MWh prices.
- CFD payments should be settled at the regional reference price, thereby retaining loss factor locational incentives with the generator.
- CFD payments should preferably be calculated against a price averaged over a longer period than half an hour in order to retain an incentive to produce at the times when prices are highest. This issue has influenced the choice of a seasonally averaged "baseload reference price" in the United Kingdom's CfD design, where,

  "…the intent is to ensure that the CfD Market Reference Price does not interfere with other important signals that impact behaviour and pricing within the GB energy market, and to allow the Market Reference Price to reflect local conditions…"[6]

Consistent with the ACT, and recommendations to the Victorian design, AEMO advises that should the Queensland renewable energy policy also adopt a CFD approach, the scheme should maintain:

- That the costs of connection remain with the generator as a means of developing a stronger foundation for a contestable connections market;
- Congestion risk, i.e. CFD payouts should be always be linked to realised output, thus retaining some locational incentive;
- Ancillary services "causer-pays" payments, which reward output predictability; and,
- The ability to sell ancillary services and retain revenue from it.

[5] For more details, see AEMO's submission to Victorian Renewable Energy Auction Scheme Consultation Paper at http://earthresources.vic.gov.au/energy/sustainable-energy/victorias-renewable-energy-targets

[6] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/404558/cfd_policy_drafting_up