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Mr Sebastian Henry
Senior Advisor
Australian Energy Market Commission
Lodged electronically

Re: Submission on Power System Security Consultation Paper

Intelligent Energy Systems (IES) is a provider of advisory services, software and data solutions to the Australian and international electricity and gas markets. Our applications and systems are licensed to a range of energy market participants including government, regulators, market operators, generators, retailers, network businesses and consumers.

IES appreciates the opportunity to provide our perspectives on the AEMC's consultation paper *"System Security Market Frameworks Review"*. Our comments are presented below.

Question 1 – Managing changes in system frequency

The consultation paper provides a brief discussion about the RoCoF access standards for generators in the NEM, however there is no discussion about what RoCoF different generators can technically withstand. The distinction between a regulated requirement and a technical capability will become increasingly important if there is an incentive to be capable of withstanding high RoCoFs.

Existing literature has thus far suggested that thermal generators have a relatively tight operating requirement for transient frequency stability. This is particularly the case for combined cycle gas turbine (CCGT) generators, which are designed to operate at specific frequencies. Contrastingly, hydro generators and wind turbines have a low requirement for transient frequency stability. Solar PV generators exhibit a similarly low requirement to these other renewable energy generators, however they are constrained by their inverter limits.

In addition to not outlining the technical capabilities of generators, the consultation paper has not given attention to the RoCoF capabilities of assets in the transmission and distribution networks (particularly transformers), as well as equipment located at end users' sites. These assets should also be considered.

These technical capabilities become increasingly important with the prospect of the NEM having an increased penetration of renewable energy generation in the future. In addition to a future decrease in power system inertia, there may be an increased ability of withstanding high RoCoF events than at present. This is due to the low requirement of renewable energy generators for transient frequency stability, as outlined above. One option is to provide a financial reward for being capable of withstanding these events (or a penalty of not being able to). This would provide an incentive for generators to be designed and installed according to these requirements.

The consultation paper gives particular attention to South Australia, due to the region's high amount of installed renewable (non-synchronous) generation, and a reliance on the Heywood

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interconnector. The risk of a region islanding is integrally linked to power system security, and thus power system security should be thought of on both a NEM-wide and a regional basis.

<u>Question 2 – Power system strength</u>

A lack of system strength may have been a contributing factor to the cascading of the South Australian region into system black on 28 September, 2016. The problem in this instance may be adequately addressed by requiring appropriate technical standards on asynchronous installations, or at least the larger ones. A market-based solution may not be as effective here given that system strength, or lack of it, tends to be localised.

<u>Question 3 – RoCoF standard</u>

The consultation paper highlights the increasing risk of high RoCoF events. As these events will threaten the security of the power system, a standard for RoCoF could be beneficial. This standard ought to state that the maximum RoCoF must be at least equal to the minimum access standard for new generators in the NEM (i.e. 1 Hz/ s for one second). However, it might be more appropriate for the maximum RoCoF to be more than this; possibly defined by the maximum RoCoF a group of market participants can withstand (e.g. all generators and all transformers in the NEM).

But the imposition of a NEM-wide RoCoF standard might be become complicated due to the varying technical abilities of existing generators. The existing minimum access standard applies to all generators connecting to the NEM *after 2007*, with AEMO unable to ascertain the technical capabilities of generators that were connected *prior to 2007*. These older generators may in fact not be capable of withstanding a RoCoF of 1 Hz/ s for one second. If the RoCoF standard is set higher than what existing generators can manage, these generators may be forced to perform upgrades, or even retire their plants.

Alternatively, the RoCoF standard could apply only to new market assets. Although this would avoid the possible costs imposed on older generators, it would result in not all market assets being able to withstand high RoCoF events. This might undermine the very purpose of the RoCoF standard.

The consultation paper suggests that a new category of contingency events could be established (events that have a low probability of occurring, yet high consequences if they do occur). IES supports this recommendation as it would enable AEMO to procure sufficient power system security services to withstand these events. Ultimately, this would lead to increased demand in the FCAS markets; increasing revenue for FCAS providers and increasing the amount of cost recovery from the FCAS markets.

Similarly, this new category of contingency events could be used to define the inertia (or fast frequency response) required within a region.

Recent experiences in Ireland have highlighted potential issues with an increased RoCoF standard. Ireland previously had a RoCoF Grid Code standard of 0.5 Hz/s, however have since increased this to 1 Hz/s (measured over 500 ms). Although most generators were believed to be able to withstand the higher RoCoF, conventional (i.e. thermal) generators believed that they were unsure of the impact of the increased RoCoF, with potential modification required. This modification could take between 12 and 18 months, and be very expensive. The thermal generators furthermore noted that the benefit of the increased RoCoF would be for new and existing wind farms, and thus they would lose out on revenue from energy sold.

To ensure timely compliance with the new RoCoF standard, a daily penalty for late compliance and a daily incentive for early compliance were imposed. For a 400 MW unit, this could amount to 1,500 Euro per day if compliance is achieved earlier than required.

A similar mechanism cold be used in the NEM to ensure appropriate incentives are in place for all NEM participants to comply with a RoCoF standard.

Question 4 – inertia and fast frequency response

The consultation paper highlights how inertia acts as the immediate response following a contingency event, fulfilling a vital role before the fastest FCAS response comes into play. Currently (and in the past) there is and has been an abundant supply of inertia within the NEM. However, this is beginning to change. The increase in renewable (non-synchronous) generation will cause a decrease in power system inertia. There are two main methods that can be used to mitigate this issue;

- regulate a specific regional (or NEM-wide) requirement for power system inertia, leading to an inevitable curtailment of low-SRMC renewable energy generation; or
- enable fast frequency response services to compensate for the decrease in power system inertia.

Ultimately, some combination of inertia and fast frequency response can be determined to manage power system security.

In addition to existing synchronous generators, inertia could be supplied by synchronous condensers or flywheels. Literature has also suggested the possibility of extracting synthetic inertia from double fed induction generator (DFIG) wind turbines. Fast frequency response could be supplied by curtailing generator output (to enable both raise and lower), battery storage, central management of loads, or loads carefully tuned to respond appropriately to frequency events. Other fast frequency response sources are likely to emerge if there is a financial incentive for development to take place.

Question 5 – procurement of systems security services

As outlined previously, the expected increase in renewable energy generation will lead to a reduction in power system inertia. This will ultimately cause a reduced ability to manage the RoCoF within the NEM.

AGL's suggestion to establish an inertia market in the NEM is sound. This would ensure there is sufficient provision of inertia, and incentivising the supply of inertia from market participants. However, AGL's suggestion refers solely to inertia, whereas a market should be established to consider both inertia and fast frequency response (a FFR market).

The new FFR market ought to have the following characteristics:

- The market can be solved on either a regional or NEM-wide basis, to account for the possibility of a particular region separating and becoming islanded.
- The market is solved simultaneously with the existing FCAS market to enable a cost-effective supply. This is contrasted with AGL's suggestion of long-term contracts, which will become costlier.
- The market incentivises the provision of inertia from incumbent (and future) generators, which are (and will be) providing a valuable commodity.
- The market incentivises the provision of fast frequency response from all market participants.

Question 6 – cost recovery

As outlined previously, it is essential that the new FFR market incentivises the provision of both inertia and fast frequency response. Cost recovery philosophies are either “beneficiaries pay” or “causer pays” as is applied to regulation cost recovery.

One possible design is that all generators have an expected inertia/ fast frequency response. If generators provide more than this, they earn; if generators provide less than this, they pay. This design would act to create strong incentives for the provision of an inertia/ fast frequency response.

An alternate design is that all generators pay for the inertia/ fast frequency response supplied to the market. The cost recovery could be based on a generator’s energy supply over a given time period, or their installed capacity.

Other arrangements are possible and should be explored.

Please do not hesitate to contact me should you require any clarifications or further information regarding this submission.

Yours sincerely

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