13 October 2016

Ms. Anne Pearson
Chief Executive
Australian Energy Market Commission
PO Box A2449
Sydney South NSW 1235

Emergency under-frequency control schemes and Emergency over-frequency control schemes - ERC0212 and ERCO213 (8 September 2016)

Dear Ms. Pearson

The Energy Networks Association (ENA) welcomes the opportunity to make a submission to the Australian Energy Market Commission (AEMC) on the Emergency under-frequency control schemes and Emergency over-frequency control schemes rule change proposals.

The ENA is the national industry association representing the businesses operating Australia's electricity transmission and distribution and gas distribution networks. Member businesses provide energy to virtually every household and business in Australia.

The ENA understands that this rule change proposal is closely linked with other concurrent AEMC rule change consultations on related power system security rule change proposals. As a result, the ENA recommends that the AEMC closely assess our other submission made to the System Security Market Frameworks Review (8 September 2016) consultation paper.

This submission highlights the following:

- ENA agrees there is an increased likelihood that managing extreme system frequency events will become more material for the National Electricity Market (NEM) ;
- Amendments to current regulatory arrangements to provide greater clarity on responsibility of, and roles for, these schemes will be essential. It would be important to achieve a best practice regulatory approach to the review of these schemes;
- Frameworks should enable new technology and innovative options and enable a robust and predictable process for the reclassification of non-credible contingencies will be applied by AEMO;
- The ENA would welcome opportunities to work with the AEMC and stakeholders in the development of any new incentive arrangements;
- The costs of these schemes will be contingent on the solutions, design and reach of the schemes; and
- Over-frequency control schemes need to be similar to Under-frequency control schemes in allowing for graduated response outcomes.

The ENA's specific responses to the Consultation Paper questions are included in Attachment # 1.

Should you have any additional queries, please feel free to contact Norman Jip, ENA's Senior Program Manager – Transmission on (02) 6272 1521 or njip@ena.asn.au.

Yours sincerely

John Bradley
Chief Executive Officer

Attachment 1 – ENA's Specific responses to Consultation Paper questions

Question 1 - Materiality of issues impacting management of extreme frequency events

(a) Are the issues identified by the proponent likely to have a material impact on the NEM, over the medium to longer term?

The ENA agrees that the management of extreme frequency events is becoming more significant for the NEM. This is one issue that has been identified by the AEMO-led Power System Issues Technical Advisory Group (PSITAG) and subsequent work-streams for the whole of industry, more generally, to address. This is why the ENA has been actively supporting, and participating in, the work of both AEMO's PSITAG and the associated AEMC led Future Power System Security Technical Working Group.

The issues identified by the South Australian Minister for Mineral Resources and Energy are valid and in some regions; and under some situations, extreme frequency events are a meaningful contemporary concern, as they have the potential to have a material impact if not appropriately managed. These include: (i) Under-Frequency Load shedding (UFLS) schemes becoming less effective over-time as overall inertia declines; (ii) the assumed size of load blocks in UFLS schemes being less certain with significant amounts of embedded generation; and (iii) un-coordinated loss of generation where extreme over-frequency incidents occur.

This exposure will only increase in the medium term.

A more extreme instance involved the events of the South Australian state-wide blackout on 28 September 2016.

In Tasmania, the management of system frequency has been an issue for some time due to the relatively small size of the power system and the lack of availability of fast raise Frequency Control Ancillary Services (FCAS). Further, the generator contingency size has been capped[1] in the frequency operating standards and a number of tripping schemes[2] have been deployed to ensure that resultant net contingency size is below that cap.

An additional issue to be noted is the use of Rate of Change of Frequency (RoCoF) protection for Distributed Energy Resources (DER), for anti-islanding purposes and for generator's own protection purposes. For generators less than 30kVA, networks typically do not specify RoCoF protection for anti-islanding (but do specify the setting), but focus on the generator providing anti-islanding protection. However, RoCoF protection is commonly applied, and typically is specified for generators greater than 30kVA. The operation of this protection has the potential, whilst the network remains active, to exacerbate RoCoF and lead to further implications and operating consequences.

One prospective approach, is that the management of extreme frequency events should be considered as a single issue rather than two related; but separate issues. The setting design of any UFLS scheme will be heavily influenced by the need to limit overshoot to prevent inadvertent operation of any Over Frequency Generator Shedding (OFGS) schemes that may be present, and similarly the setting design for any OFGS scheme will be heavily influenced by the presence of a UFLS scheme.

In addition, any consideration will also need to take account of any potential:

- new arrangements for the provision and management of system frequency
- changes to the frequency operating standards, and
- changes to the provision of FCAS.

Question 2 - Ability of current frameworks to deliver effective emergency frequency control schemes

[1] 144 MW.
[2] AETV Generator Contingency Scheme (GCS) and the Basslink Frequency Control System Protection Scheme (FCSPS).

(a) Do current frameworks, including currently allocated responsibilities of different parties, allow for the effective consideration of all physical solutions to extreme frequency events?

The ENA suggests that the current regulatory arrangements would be significantly improved if there was greater clarity of the respective roles and obligations for all parties involved in managing extreme frequency events.

A clearly defined set of principles that places unambiguous obligations on the relevant parties will be required to provide certainty on the ability of AEMO and Network Service Provider's (NSPs) to implement emergency control schemes to manage extreme frequency events (under and over) in a timely manner and that the schemes can be monitored and maintained efficiently. This is especially the case should over frequency generator shedding occur. Relying on a good-will approach amongst parties to these issues is indeed fraught**.**

The ENA is aware that the AEMC's Technical Working Group is already examining some of these issues, but for completeness, ENA considers that the following areas should be of particular focus for the AEMC:

- Unambiguously allocating responsibility for (a) defining non-credible contingency events to be covered by the emergency control schemes, and (b) for the design of these schemes. On the latter, the existing requirement of 60 per cent of the load may be appropriate in some systems/areas but not for others. In lengthy transmission systems, such a quantum of shed load would result in severe overvoltage issues. Overvoltage can lead to additional tripping of generators and even damage to transformers. Tripping of generators can exacerbate the overvoltage.
- Whether the schemes should also focus more on a hybrid load perspective that includes solar photovoltaics and batteries, as well as a more realistic supply and demand continuum, rather than the discrete players the NEM commenced with (i.e. generators, transmission, distribution, and customer roles).
- Recognising that current arrangements could be enhanced to cater for two-way interconnector flows with the potential for significant flow changes over relatively short intervals.
- Prioritising a coordinated control approach for DER, and
- Noting that oversight of UFLS schemes are not the sole responsibility of one party, and the way they are managed by jurisdictions can and do have significant impacts across different sectors of the economy and community. One example is the multi-party, Victorian Electricity Emergency Committee – Technical Working Group (VEECTWG) that oversees the Victorian UFLS scheme. This involves AEMO as Transmission Network Service Provider (TNSP), the Jurisdictional System Security Coordinator (JSSC), government and Distribution Network Service Providers[3].

Since energy sector transformation is rapid there is a need for vigilance and accountability in identifying and addressing effects that could impact system security. The ENA supports a best practice approach to oversight of UFLS effectiveness and considers this should be adequately articulated through the National Electricity Rules (NER).

Question 3 - Potential changes to emergency frequency control schemes

[3] *The role of the group is "to maintain documentation associated with load shedding facilities, load shedding priorities, and load restoration priorities. The working group also reviews the operation of load shedding facilities after electricity emergency incidents. It will also periodically review load shedding and restoration priorities in consultation with stakeholders and review electricity emergency incidents, continuously improving emergency procedures and load shedding and restoration priorities"* (refer AEMO website).

(a) Do the current NER frameworks already allow for, actively prevent, or fail to account for, new technologies that could be used to provide more effective emergency frequency control schemes? How would these new technologies work and what kind of solutions can they provide?

(b) Is there a need for a framework to identify specific non-credible contingencies that AEMO should develop emergency frequency control schemes to address?

(c) Could this issue be addressed by AEMO reclassifying certain currently non-credible events as credible, under NER clause 4.2.3A?

Response to 3 (a): The ENA observes that the current NER framework is somewhat neutral on technology. It does not preclude it, but alternatively, it is not a strong enabler of the implementation and deployment of such schemes. It also does not adequately address requirements for DER or storage options.

The current framework appears focused on 'static' load, and the simple use of frequency thresholds for shedding load which appears inadequate for future NEM requirements.

AEMO have also tended to typically seek design settings based on technical capabilities of installed equipment rather than propose settings potentially requiring costly upgrades to the control system(s).

Consequently, the ENA proposes some changes to the current framework. Some suggestions include:

- The NER framework could include advanced performance requirements for load shedding options. There is also potential for the use of load shed blocks to be displaced with fast acting individual customer targeted schemes.
- Considering the participation of mini-grids which may have the incentive to disconnect and preserve local supply, but potentially increasing the consequences for the broader power system.
- DER could have standards that force a governor style response from storage (assuming not in AS4777) rather than requiring accompanying communications.
- Applying fast ramping of industrial loads. Major Industrial (MI) loads (pot lines and furnaces etc.) that take their load via power electronics are in some cases capable of fast ramping rather than tripping. In some specific situations it may be just as, or more, effective to provide the MI load with a fast ramp signal rather than trip the load.
- Some MI loads have portions of their load which may result in adverse outcomes if tripped without notice (i.e. environmental impact or plant damage). While the NSP may want to maintain control/ownership of the relays, there are situations where it is advantageous to open circuit breakers deep within the MI plant. While these arrangements are not prevented under the existing arrangements a framework that helps facilitate these types of outcomes may be beneficial, and
- In some situations, rapid response generators may also be capable of providing emergency frequency response (for e.g. tail water suppression). Again while not prevented, they are also not actively facilitated by existing arrangements.

Response to 3 (b): The ENA argues that there is a clear need for a robust framework to identify specific non-credible contingencies that AEMO should develop for these schemes to address. This would assist in providing transparency and clear obligations (for example, sub-regions, and Central Business Districts' requirements).

NER clause S5.1.8 already requires NSPs or registered participants to install schemes to minimise disruption. However, without a clear definition of protected events (and RoCoF standards), it would be inefficient to install schemes for all non-credible events. Further, the ENA notes that with the onset of more extreme frequency issues this clause has not kept pace to adequately address these emerging concerns. As outlined in the ENA's concurrent response to the AEMC on its System Security Market Frameworks Review consultation, the system changes resulting in the loss of synchronous generation were not contemplated at the time of the development of the

current regulatory framework. It is necessary and timely to examine the institutional and regulatory responsibilities as applied to this clause.

To address the current uncertainty of roles and responsibilities, clause S5.1.8 could be expanded to provide TNSPs with explicit responsibility for managing change in frequency including fast frequency response for a predefined set of non-credible contingency events. This approach would leverage the existing capability, information management systems and forecasting capacity of TNSPs given their current responsibilities. For instance, modern TNSP infrastructure such as Optical Ground Wire (OPGW) systems provide fast communication capabilities which may support management of change in frequency.

The economic efficiency with which TNSPs achieve such explicit obligations for system strength outcomes would remain the subject of regulatory oversight. This would provide explicit arrangements for TNSPs to leverage existing capacities or procure efficient support as required to meet relevant regulatory obligations.

» Where it is technically feasible to do so, and it has been independently established that there is a clear economic benefit to implementing an emergency frequency control scheme to reduce the impact of a small number of defined non- credible contingencies (i.e. protected events), it would seem sensible to do so.

Response to 3 (c): The ENA acknowledges that AEMO has the existing ability to reclassify certain non-credible events as credible, under NER clause 4.2.3A. The crux of the issue is how AEMO decides to apply such a capability. The ENA asks that AEMO be more judicious in signalling potentially high-impact incidents to the market and stakeholders. In hindsight, there may have been cause to do so ahead of the events of 28 September 2016 in South Australia when lightning and extreme weather was in proximity to the 275kV transmission lines in the State's mid-north. The current system is quite binary and also does not necessarily fully consider High Impact Low Probability events.

If specific non-credible contingencies are to be identified, and addressed, the outcomes sought may need to be specific, to ensure cost-benefit analysis is appropriately accounted for. The general reclassification provision, and treatment in that event, may not be appropriate to all of the specific 'protected events' identified.

Potentially, a more efficient approach may be to create a third category of events (separation events) which are targeted at facilitating a combination of measures to manage the contingency. That is, the contingency may be mitigated by a combination of system control schemes, and constraint equations, with the objective being to reduce the magnitude of the contingency to a point that it can be managed by other conventional systems/frameworks (e.g. FCAS).

Question 4 – Governance arrangements

(a) What roles should be played by different parties, including AEMO, NSPs, JSSCs, market participants and the Reliability Panel, in the framework for emergency frequency control?

(b) What would an appropriate incentive regime for NSPs look like if they were tasked with additional roles in developing, monitoring and adapting emergency frequency control schemes?

Response to 4 (a): The ENA considers that with time the NEM will require more sophisticated emergency load shedding and frequency control schemes. The JSSC, AEMO, TNSPs and DNSPs will all have roles in relation to performance.

The objective could be assigned by the AEMC's Reliability Panel and included in the Rules. The Panel should also determine RoCoF standards and the non-credible events which emergency control schemes should protect against. Other parties should provide input into the Panel's processes (either directly or through consultation opportunities).

As proposed in our response to Question 2, roles and responsibilities will need to be made unambiguous. This is especially the case in meeting the new paradigm facing the industry, for both under and over frequency control schemes. As noted in the Consultation Paper, existing arrangements around OFLS is unclear, and the over-frequency relays tend to protect the generator rather than the power system and may result in an uncoordinated response that needs to be mitigated against.

The ENA expects that any new framework would:

- Require generators to participate in emergency control schemes where it was determined necessary by the Australian Energy Market Operator (AEMO) and the relevant NSP. Details associated with their participation could form part of the generator performance standard documentation.
- Require loads to participate in emergency control schemes where it was determined necessary by AEMO and the relevant NSP. Details associated with their participation could form part of the connection agreement documentation.
- Require the relevant NSP(s) to implement emergency control schemes where it was determined necessary under the Rules and/or AEMO guidelines, and provide advice to AEMO on appropriate settings.
- Require AEMO to provide oversight of the settings for the emergency control schemes and coordination across jurisdictions where required. AEMO should also be responsible for ensuring that the principle of "*sharing the pain*" between Jurisdictions is preserved.
- Require the Reliability Panel to establish and periodically review any framework that was established.
- Allow the JSSC the flexibility to apply complementary or additional requirements for a specific jurisdiction if they felt it necessary for their jurisdiction. For example, there will be a need for load and generation profiles on the distribution networks to be mapped to enable the most effective load shedding arrangements. Effectiveness may also require more granular load shedding solutions in the future. The DNSP may be best placed to analyse these effects in conjunction with its existing planning roles, and
- There would also be a role for an independent arbiter to ensure that generators offered sufficient FCAS services to limit the number of operations of the emergency control schemes. An over-riding concern is that generators may choose not to offer FCAS services to maximise energy output.

Response to 4 (b): The ENA considers that an appropriate incentive scheme could be warranted, noting that NSPs need not participate in over frequency control schemes. AEMO should develop these emergency frequency control schemes in collaboration with NSPs.

- The details of such a scheme would need to be cognisant of, and complimentary to, existing schemes. At this stage, such a scheme would be contingent on the scope and design of these emergency control schemes.
- Any incentive scheme should be based on the principles that it should not penalise an NSP for factors beyond its control, reward for innovation (e.g. similar to NCIPAP-style expenditure), not be amended without appropriate notification, and not leave a NSP in a worse financial or commercial situation, in meeting any new obligation.
- A least cost approach needs to be balanced against reasonably expected outcomes from these schemes.
- Incentives for NSPs could focus on improvements in effectiveness of the load shedding schemes, having regard to factors such as: confidence in outcome based on data analysis and solution philosophy, equity for customers, long-run costs, and actual performance.

The ENA and its member businesses are willing to work with the AEMC and other stakeholders in any further deliberations on how an appropriate incentive scheme for emergency frequency control schemes would operate. It appears crucial that NSPs be integrally involved in its development and potential implementation.

» In terms of funding for these schemes, the ENA considers that funding should be made available to NSPs to provide the equipment to effectively implement a scheme which takes account of issues arising from the operation of the scheme (such as overvoltage). Further, NSPs must have the ability to recover legitimate costs incurred in fulfilling their obligations with respect to the implementation and maintenance of emergency control schemes.

Question 5 – Costs to participants

(a) What kind of costs are likely to be faced by participants if a new framework for emergency frequency control schemes is introduced?

On this particular question, the ENA provides some indicative positions.

The potential costs associated with implementing EFCS for NSP's will depend on, amongst other considerations:

» The technical performance required from the schemes and/or intended solution
  - A restriction of RoCoF by introducing technical obligations on generators will have minimal costs on NSPs. However, costs associated with a wide area control scheme will depend on the existing infrastructure of the NSP.
  - It is assumed that the ultimate aspiration will be to move towards a locally deployed adaptive scheme that is capable of accepting inhibits (based on active power direction), having multiple setting groups selected in real time by one or more system parameters (i.e. system inertia) and that the relays will be capable of definite time, and $\Delta f/\Delta t$ settings.
  - The time frame for when this level of sophistication is required will vary across the various regions and hence it is expected that cost will vary greatly. Also associated with any intelligent adaptive scheme will be the cost of establishing and maintaining high availability, high speed communications with the field devices.
» What proportion of existing assets can be used (existing UFLS relays, bay controllers etc.) in the new schemes?
» Does the scheme need to be fully duplicated, or only duplicated for loads above a certain MW threshold? and
» If it only involves reprogramming or procuring smarter relays, then it will likely be of a minor quantum.

More broadly, some other participant costs may include, but not be limited to:

  - If constraints on the transmission network are involved, then potentially significant costs to market participants could arise (ultimately customers) as there will likely to be winners and losers
  - Consideration of the accountabilities of mini-grids, and
  - Such schemes will impact generator performance standards (GPS) of different technologies and it appears the role of loads which have no GPS equivalent, will also require examination. This could lead to necessary upgrades and associated costs.

» The cost of implementing emergency control schemes should be borne by NSP's in the first instance and form part of the regulated asset base (on the understanding that such costs will be recoverable).
» There should be no financial payments for other parties to participate in the scheme(s) as they all should enjoy the benefits of these schemes, and their operation should be a rare event.

Question 6 – Managing over frequency events

(a) What should a framework for managing extreme over frequency events look like?

The ENA considers that a framework for managing over frequency events should be modelled on a similar basis as Under Frequency Load Shedding Scheme arrangements.

- Under such arrangements, generators are required to support full load rejection, therefore enabling the NSP to sequence trips. This may require some flexibility depending upon system configuration. To the fullest extent possible, the same parties should be involved in determining these scheme arrangements.
- Consideration may also need to be given to evaluate a possible role for inverter connected DER to provide governor style responses.
- The ENA notes that generators will likely play the role that NSPs play in UFLS schemes in terms of the setting, testing and maintaining of the relays for OFLS.
- Any such arrangement should not see NSPs be compelled to compensate for any market impacts of potential OFLS events.
- A jurisdiction that has had some experience with emergency over-frequency schemes is Tasmania. Analysis of such arrangements could be instructive for the AEMC as to the potential application of similar schemes in other regions of the NEM. Tasmania has had in place various systems to manage extreme over frequency events since 2006. The existing Tasmanian arrangements consist of three coordinated schemes:

i) The Tasmanian Lower FCAS reduction scheme

This scheme was implemented during the 2016 energy supply challenge to reduce the Tasmanian requirement for fast lower FCAS services. The over frequency trip settings (f) have been designed to provide a staggered response over a narrow band.

ii) The Tasmanian over frequency Coordination (OFC) scheme

The OFC scheme is a set of coordinated over frequency trip settings (f+Df/Dt & f+t) that have been determined by the Network Service Provider (NSP) for generators that have agreed to plant limitations (e.g. negotiated access standards) and are implemented on the existing generator relays and open the generator circuit breaker.

iii) The Tasmanian over-frequency generator shedding (OFGS) scheme

The OFGS is a scheme that is owned and maintained by the NSP. It is a coordinated scheme (f+Df/Dt & f+t) that (where possible), opens the NSP circuit breaker at the point of connection to the shared network.

Significantly, the settings for all over frequency schemes have been determined to provide a graduated response to over frequency events.