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Reliability Panel AEMC
27 October 2016

Draft Determination
Review of the System Restart Standard
Submission

I am pleased to make a submission to the Reliability Panel in response to the Draft Determination, Review of the System Restart Standard.

This submission has been prepared by Russ Skelton & Associates on behalf of:

Snowy Hydro Limited
CS Energy
AGL Energy
Tomago Aluminium Company
Origin Energy
ERM Power

We look forward to discussing this submission with the Reliability Panel.

The submission is attached.

Regards,

Russ Skelton

Draft Determination
Review of the System Restart Standard

A Submission to Reliability Panel AEMC

Prepared on behalf of:

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CS Energy
AGL Energy
Tomago Aluminium Company
Origin Energy
ERM Power

October 2016

Submission to AEMC Reliability Panel in response to:

"Review of the System Restart Standard"

Executive summary

This submission is in response the Reliability Panel's Draft Determination of the System Restart Standard.

The Reliability Panel has proposed a System Restart Standard that is based for the first time on an economic analysis of the costs and benefits of the provision of System Restart Ancillary Services (SRAS).

The use of an economic approach was a key recommendation of our submission to the Reliability Panel's "Review of the System Restart Standard'. It is pleasing to see the introduction of this approach, however we have a number of concerns with how this approach was implemented.

The key concerns are:

1. The limited scope of the analysis of uncertainty. Major areas of uncertainty such as risks of generator restarting, risks that generators that have restarted will subsequently trip and risks associated with TNSPs establishing network paths, both to provide supply to generators to enable them to restart and to restore load, were all ignored in the analysis.
2. The appropriateness of the analytical approach used. The approach should have included a simulation of all of the risks associated with restoring load from a system wide black event.
3. The generator restoration curves provided by AEMO. These curves are crucial to the analysis but appear to be quite optimistic when compared to historical outcomes. This submission includes a comparison of the AEMO curves with historical outcomes.
4. The basis for and validity of a range of key input assumptions such as:
   - That consumer load will be restored 90 minutes after supply
   - That there will be no network failures that will impact the restoration process
   - The value of the "default outage"
   - The reliability of SRAS sources
5. Limiting the range of possible SRAS sources to those that had previously provided offers to AEMO.

It would appear that if the analysis had been implemented so that these concerns were dealt with, the analysis would likely have indicated the net benefit of greater levels of SRAS procurement than those reflected in the Panel's Draft Determination.

The approach by the Reliability Panel to limit the SRS to defining what is in effect a "procurement standard" to guide AEMO in sourcing SRAS is accepted. However, it is important that the Panel inform stakeholders what they expect will be achieved in terms of timing and certainty of load restoration in various areas of the network as a result of implementing the proposed SRS. Of particular concern would be sensitive loads and key areas of load such as the CBDs of capital cities. At this stage there is no clear information provided on these expectations.

The Panel has also noted that AEMO is required to consult with TNSPs during the SRAS procurement process to "identify and resolve issues in relation to the capability of any SRAS proposed". The Panel encourages AEMO to explore ways of improving this consultation. To ensure that these consultations are effective we recommend that the Panel independently seek confirmation from the TNSPs that they are satisfied with the outcomes of the SRAS procurement process.

Submission to AEMC Reliability Panel in response to:

"Review of the System Restart Standard"

A number of preliminary observations are made of the recent system black in South Australia. In summary these are:

1. Both contracted SRAS sources were unable to operate as contracted. This is a realized probability of failure of 100% compared to the 3.07%[1] predicted in the Draft Determination.
2. In order to achieve system restart, AEMO sought to direct a previous provider of SRAS to provide this service but this was not possible as the capability was no longer available.
3. The actual generator restoration timing achieved was significantly slower than predicted in the Draft Determination.
4. The restoration process clearly experienced setbacks and did not follow the smooth process as has been assumed in the Draft Determination.
5. Ultimately the restoration was entirely dependent on the Heywood interconnector. It is sobering to contemplate what would have occurred if this interconnection had been damaged as a result of the severe weather events at the time.

[1] Page 42 Deloitte – Economic Assessment – Table 7.3

Submission to AEMC Reliability Panel in response to:

"Review of the System Restart Standard"

Submission to AEMC Reliability Panel in response to:

"Review of the System Restart Standard"

Introduction

This submission has been prepared by Russ Skelton & Associates on behalf of the following organizations:

1. Snowy Hydro Limited
2. CS Energy
3. AGL Energy
4. Tomago Aluminium Company
5. Origin Energy
6. ERM Power

This submission is in response to the Draft Determination resulting from a Review of the System Restart Standard published by the Reliability Panel AEMC (the Panel) on 25 August 2016.

The submission will:

1. Compare the approach adopted in developing the draft System Restart Standard (SRS) to the recommendations made in our previous submission to the Reliability Panel.
2. Discuss our key concerns with the draft determination. Some of these arise from the lack of acceptance of our recommendations but largely relate to how the proposed SRS has been developed.
3. Make a number of other comments and observations.
4. Respond to the additional recommendations made by the Reliability Panel.
5. Make some preliminary observations in light of the recent system black in South Australia.

Comparison with recommendations

A summary of the recommendations that we made in our submission to the "Review of the System Restart Standard" is:

1. The System Restart Standard (SRS) should define the outcomes required in terms of the time to restore a defined quantity of load with a defined reliability. This would require that System Restart Ancillary Services encompass not only generators that can restart without an external supply but the performance of other generators and also network providers that would be required to provide supply to customers with the specified time frame.
2. That rather than this SRS being uniform across all sub-regions that the standard can vary from sub-region to sub-region.
3. Sub-regions for the purposes of applying the SRS should be determined primarily on the basis of the economic characteristics of the load within a region, including whether any of the loads are considered sensitive. The technical characteristics of the region being an important but secondary consideration.
4. The Restart Standard that applies to each sub-region be determined on the basis of an economic trade-off between the costs of the provision of additional SRAS compared to the additional benefits to customers in terms of reduced restoration times and reliability with which these can be achieved.
5. To improve the validation of AEMO's compliance with the SRS, that AEMO be required to provide much more transparency on how it has met the SRS through its actions.

Submission to AEMC Reliability Panel in response to:

"Review of the System Restart Standard"

Standard definition

The Draft Determination divides the restoration of load into three stages. These stages being; restarting the system, restoring generation and restoring load. The Draft Determination makes it clear that the standard is "only concerned with the first stage of the restoration process"[2] and in effect is a "procurement target for AEMO when it procures SRAS"[3].

It would still be preferred that the Standard be an output standard and define the expected times and certainty with which load would be restored. This would assist greatly in creating a clear expectation on parties responsible for restoring load and a much clearer understanding for stakeholders on what are realistic expectations for the restoration of load.

It is noted that "in formulating the Draft Standard, the Panel has considered the timings and expectations for the restoration of a load on a regional basis" [4].

It is also noted that the basis for the economic analysis was the rate at which load was expected to be restored.

As a result, at this stage it is accepted that setting the standard as a procurement target for AEMO is appropriate.

However we consider it is imperative that the Panel, based on advice from TNSP's and AEMO, clearly articulate what it expects the proposed SRS will achieve in terms of the rate of restoration of loads as the SRS and the Draft Determination provide no information on this. This is particularly important for key load areas – such as sensitive loads and capital city CDB's.

SRS varying between sub-regions

The Draft Determination has accepted this recommendation and has, as a result, proposed different standards for different regions.

Sub-regions to be determined on an economic basis

The Draft Determination makes it clear that the guidelines that will be provided to AEMO for it to use to determine electrical sub-networks are entirely technical.

However it is worth noting that the Panel is proposing to require that, in addition to the SRS, AEMO procure SRAS north of Sydney in NSW. This in effect creates a northern NSW sub-region. It is understood that this requirement arose from an assessment of the economics of load restoration in NSW. While this additional requirement is supported it appears that a more effective way to achieve this would be to define an additional sub-region. If, as it appears, that the processes for defining sub-regions needs to be revised this should occur.

SRS for each sub-region to be determined on an economic basis

Given that this was the key recommendation of our submission it is pleasing to see that the Draft Determination accepts this recommendation. The Panel engaged Deloitte Access Economics (Deloitte) to undertake the economic analysis to determine the draft SRS. They were provided with advice from AEMO on a range of inputs to this analysis.

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[2] Page 12, Draft Determination
[3] Page 14, Draft Determination
[4] Page 23, Draft Determination

While the use of an economic approach is pleasing we have significant concerns about how the economic analysis was undertaken. In particular:

- Specific input assumptions
- The basis for some key inputs – in particular the generator restoration curves used
- The limited scope of the analysis

We will provide a more detailed explanation of our concerns in a following section of this submission.

Improved transparency on how AEMO satisfies SRS

The Draft Determination did not introduce any requirements for AEMO to disclose information to stakeholders that would assist them in forming a view on whether AEMO has actually satisfied the SRS.

On the basis of the current level of information disclosure, it is very difficult for stakeholders to understand the basis on which AEMO actually satisfies the SRS.

In fact, the only requirement is to require them to consult with TNSP's. While we support this requirement we will suggest some improvements in how this could be done.

Key Concerns

We have a number of key concerns with the Draft Determination. These are:

Approach to determining probability of a black start event

The probability of a black start event has been determined for each NEM region on the basis of an extreme value analysis of historical load shedding events.

This approach is problematic with regard to South Australia. From May 2016 with the exit of Northern Power Station, South Australia is now operating in a low inertia state. This is likely to materially alter the likelihood of a system black event as a consequence of a major network or generation failure.

Limited scope of probabilistic analysis

It appears from the Draft Determination and the Deloitte report that the scope of the probabilistic analysis was limited to probability of contracted SRAS sources operating and the probability of a system black. As stated in the Deloitte report *"The results presented are based on a set of "base case" assumptions. The three key variables that drive this estimated benefit and their associated uncertainty are discussed in Appendix B (VCR), Appendix C (probability of system black) and Appendix D (composite reliability)."*[5]

Or as stated in the Draft Determination the *"economic assessment considered the:*

- *incremental direct, indirect and social costs of outage*
- *probability of a major supply disruption requiring SRAS*
- *expected quantity of unserved energy likely to occur during such a major supply disruption*
- *expected length of outage*
- *aggregate reliability of SRAS portfolio"* [6]

[5] Page 16 Deloitte report

[6] Page 25 Draft Determination

From the Draft Determination, the Deloitte report and the presentation made at the recent Forum it appears that generator restoration curves are an expected outcome and that the speed of load restoration is assumed to follow generation restoration by a fixed 90 minutes.

In effect the only probabilistic analysis seems to be to consider the impact of varying the number of sources of SRAS and varying their "composite reliability".

In our view, in addition to this, at least 3 other key areas of uncertainty should have been explicitly modeled. Our submission on the AEMC consultation paper[7] outlined these risks at length. We summarise these areas of uncertainty below.

Uncertainty of generator restarting

Restarting generation units under black start conditions represents a significant challenge. The plant may have suffered damage as part of the initial black start event, either directly or via tripping as the system failed. The generators are complex and require a number of detailed steps to restart, auxiliaries must first be powered, communications may be partial or non-existent and staff may be laboring as part of a double shift by the time a particularly unit is called on to restart.

Uncertainty of generator remaining in service after restart

Even if a unit is restarted successfully, there is an increased chance that any given unit may fail within hours of returning to service particularly when synchronized to a fragile network that is being slowly re-energized. Any subsequent failure may trigger further network and generator trips and potentially reverse the load restoration process.

Uncertainty of TNSP being able to establish network paths

The transmission operator is unlikely to know the cause of the shutdown, nor what is serviceable on the network. Therefore any restoration plan must be as flexible and resilient as possible. Initially the network must first be fully disconnected to ensure that only the intended equipment is re-energised.

The transmission network is designed to operate with power measured in GW. However, the first load to be established will only be a matter of a few MW, which gives rise to a number of technical issues.

The first circuit to be energised will experience very high volts, which must be regulated if damage to insulation is to be avoided. Once the first circuit is established, then the distributor will pick up a small amount of load at the receiving end, which, if done correctly, will manage the voltage to an acceptable level. Thereafter the distribution substations along the restoration path must also be made ready, by opening of all circuit breakers (now possibly in the region of 50-60 circuit breakers at larger distribution substations). Once this is done, a selected few distribution feeders are re-energised to put on the amount of load requested. Too much load will probably cause generators or load, to trip. Too little load and the voltage will remain too high to energise the next line. Using this technique of restoring a line then picking up a small amount of load enables the operator to progressively restore the network. Incrementally more generation and stabilising load can be added to the skeletal network until the system is fully restored, a process which can take many hours.

Each successive re-energisation creates a further risk of further network trips, loss of restored lines and, in a worst-case scenario, a return to system black.

Aggregate uncertainty

Restarting the system to achieve restoration of load is a multi-step process across SRAS units, network elements, main generating units and load elements (via reconnection of parts of the

[7] Russ Skelton & Associates, *A Submission to Reliability Panel AEMC*, December 2015, pp12-15.

distribution network). Each step in this process has its own capabilities, reliabilities and costs. A simplified view of these steps is:

1. SRAS units starting and being able to provide power to the network.
2. Network connections, between operating SRAS units and generators able to restart, being established and secured.
3. Generators restarting after receiving external supplies.
4. Restoration of incremental load to stabilise network and increases in generation to match added load.
5. Network connections between additional operating generators established and secured.
6. Load being restored in combination with generation being increased to achieve full restoration.

Steps 4-6 are repeated until the entire electrical sub-network is re-energised and all load is restored.

Collectively, a load restoration path is comprised of a sequence of steps involving SRAS units, network elements, main generating units and load elements. At each step there is always a risk that a given element may not restart or resynchronise successfully. This would require additional attempts of that failed step until a successful result was achieved. Additionally, a failure of any element may trip some, or all, of the restoration path already successfully restarted.

The aggregate restoration time will depend on:

- The starting conditions, namely the level of SRAS and the capabilities of the wider generation units and network elements. Starting with more SRAS geographically diverse providers is likely to increase the chances of a successful restart and reduce overall restoration times, but will involve higher SRAS costs.
- The restoration path may involve higher probabilities of success, different risks or prioritise different loads (for example sensitive loads such as hospitals or smelters may be prioritised to some extent).
- The level of success for a given restoration path. The probability of every element along the path starting successfully on the first try is small. In practice, there is likely to be a number of failures of varying severity and impacts.

This multi-step process, where failures occur at multiple points across the network, was evident in the recent South Australian black event. Over the period 4-6 hours after the initial event, there were multiple instances where restored load reduced materially. We interpret this as successive failures during the restart process, not of SRAS units but of wider generation and network elements.

Any economic assessment attempting to compare the cost of a system black event (a function of load restoration time) to the cost of SRAS sources needs to establish a robust linkage between the number and quality of SRAS providers and the ultimate impact on load restoration times.

Appropriateness of analytical approach

There appears to be two broad approaches that could credibly establish a quantitative relationship between the number and quality of SRAS units and the load restoration time. Both involve capturing the aggregate uncertainty through to final load restoration.

1. **Use historical data.** There are very few credible data points to use and none until very recently for any NEM region. Using data from other jurisdictions could potentially be informative but only if factors such as the number of SRAS units during a black event and other critical network characteristics (e.g. availability of interconnectors) can be controlled for. This would enable some relationship between the number of SRAS units and ultimate load restoration time to be established using econometric techniques.

2. **Simulate the relationship.** The alternative approach is to simulate contingent probabilities of failure across not just SRAS units, but also main generating units and network elements.

There is no evidence that Deloitte has pursued either of these approaches. Historical data has only been used to estimate the probability of a black start event[8] - not with regard to restarting the system. Simulation has only considered the probability of SRAS units starting[9], not the contingent probabilities relating to successfully restarting main generating units, network elements and restoring load. In large part, the analysis seems to assume that SRAS units will only have a limited impact on overall restoration times as a starting point. As such it is unsurprising that the analysis identifies net benefits for only low levels of SRAS provision.

Probability analysis with more sources of SRAS would result in shifts in expected outcomes not just certainty of outcomes

The Draft Determination and the presentation made at the recent Forum by the AEMC both indicate that the view of the Panel is that increasing the number of SRAS sources does not significantly change expected overall restoration times. For example the statement that "*procuring more than one SRAS source in each of these locations within the electrical sub-network generally does not improve the speed of the restoration process but does provide an additional level of redundancy, thus increasing the probability that the fastest reasonably practical restoration can be achieved when allowing for the reliability of the individual SRAS sources.*" [10] This statement is fundamentally contradictory. It seems difficult to reconcile that additional SRAS units can "*[increase] the probability that the fastest reasonably practical restoration can be achieved*" yet "*does not improve the speed of the restoration process*".

This position is further contradicted by Deloitte's approach with respect to the "default" blackout restoration time. Deloitte state "*In the low probability case that the procured SRAS is not successful, we assume that the system will eventually be restored, but over a longer period, defined as the 'default blackout'".* I.e. overall restoration time is a function of the number of SRAS units and their ability to start successfully.

The only way to establish this with any confidence would be to undertake a simulation as suggested above. We are of the view that increasing the number of SRAS sources would both improve the expected restoration times and the reliability of achieving this time. This would particularly be the case given the historical asymmetry of the probability distributions for generator failures. Our submission on the AEMC consultation paper included an example of these distributions.[11]

Limiting the range of potential SRAS sources

In our view the economic analysis completed by Deloitte should have considered a wider range of potential sources rather than limiting it to only sources that had previously been offered to AEMO.

Given the limited flexibility in offers sought by AEMO, it would have been worthwhile to explore with the market whether other potential sources of SRAS could have been attracted if offers were sought on different terms and conditions. For example, potentially longer contract terms that would provide a greater time frame over which a service provider could recover initial capital costs. Also it would be have useful to explore if some of the NSW generators who could potentially provide trip to

[8] Deloitte, *Economic assessment of System Restart Ancillary Services in the NEM*, August 2016, table 2.1

[9] Deloitte, *Economic assessment of System Restart Ancillary Services in the NEM*, August 2016, table 3.3

[10] Page 33 – Draft Determination

[11] Russ Skelton & Associates, *A Submission to Reliability Panel AEMC*, December 2015, page 22.

house capability would be prepared to do this on different terms and conditions than those defined by AEMO.

Without exploring these alternatives it is difficult to be confident the outcomes of the analysis were actually optimum. In our view, a number of potentially lower economic cost options were excluded from the analysis.

Also, given that the previous tender processes conducted by AEMO were undertaken in a different environment it is not clear that the results of those processes would be appropriate for use in economic analysis to determine the SRS.

Generator restoration curves used in economic analysis

A key input to the economic analysis was the generator restoration curves provided by AEMO. We are concerned that these curves are quite optimistic compared to what would realistically be achieved during the restoration process following an actual system black.

Basis for curves

From the supplementary information provided by AEMO it is clear that they are based entirely on data provided in planning documents and information provided in tenders. No use has been made of historical data on units returning to service – particularly after major incidents. We are of the view that historical experience – particularly experiences where generators were strongly incentivised to perform at maximum – are a much more reliable guide to timing of restoration than analysis that excludes this data.

Historically based curves

For comparison with the AEMO developed curves we have used the history of return to service following a major incident in NSW in July 2009 as a basis to develop alternative curves.

The assumptions used to develop these curves are:

Assumptions

System Restart Services Available

- NSW 1 - AGL Hydro units in Vic
- NSW 2 - Snowy units - Currently not contracted
- NSW 3 - Eraring units via Eraring GT
- NSW 4 - Liddell units via Hunter Valley GT's - currently not contracted

Transmission and generator constraints

- Southern NSW to Central NSW capability of 3,200 MW until first Central/Northern NSW generator synchronised then limited to 1,700 MW until 4-5 units at either Central Coast or Hunter Valley in-service and stable after which up to 3,200 MW flow available
- Qld to NSW limited to 400 MW from +30 mins restricted to supply northern NSW load due to voltage stability until first Hunter Valley unit in-service then O MW until 3rd Hunter Valley unit is in-service and stable after which full flow available
- Kangaroo Valley 80 MW only due to water conservation and the need to operate other units in synchronous condenser mode for the provision of voltage stability support
- Kangaroo Valley water exhausted after 10 hours of operation

NSW 1 scenario

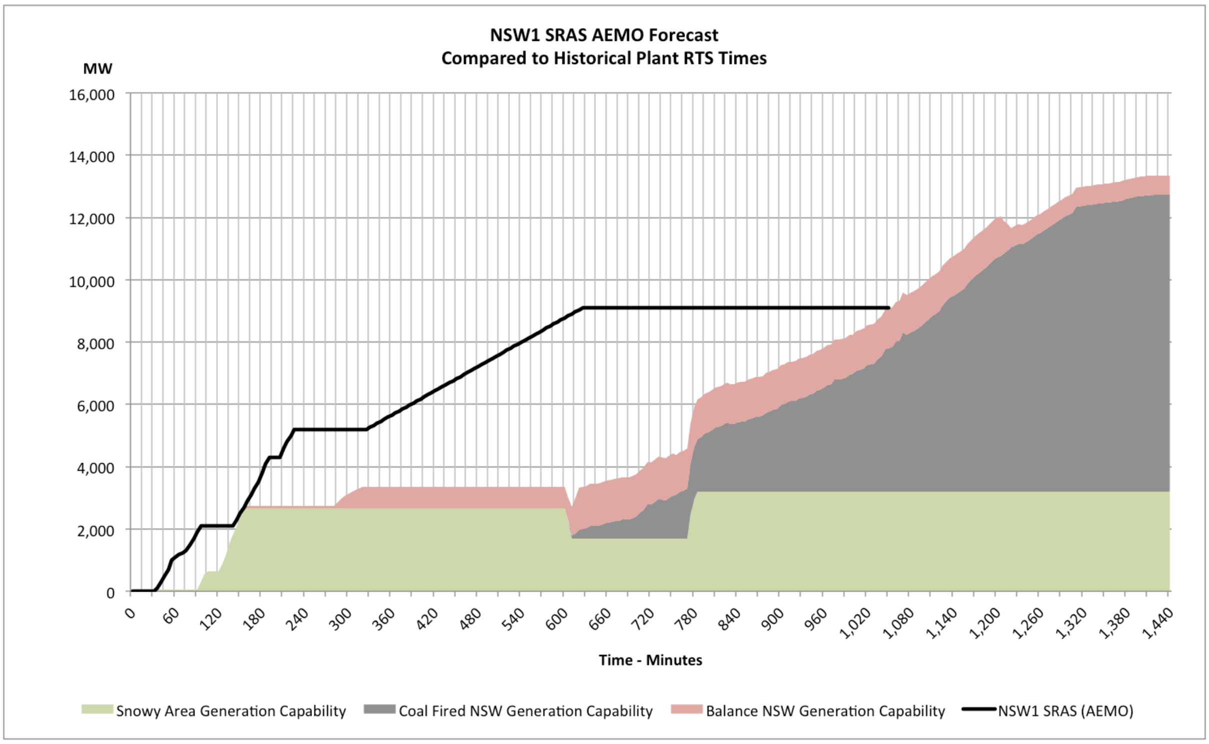
- At + 90 mins auxiliary power available to Upper Tumut
- At + 120 Mins auxiliary power restored to Lower Tumut and network to Canberra restored
- At + 135 mins auxiliary power restored to Kangaroo Valley
- At + 150 mins auxiliary power restored to Tallawarra

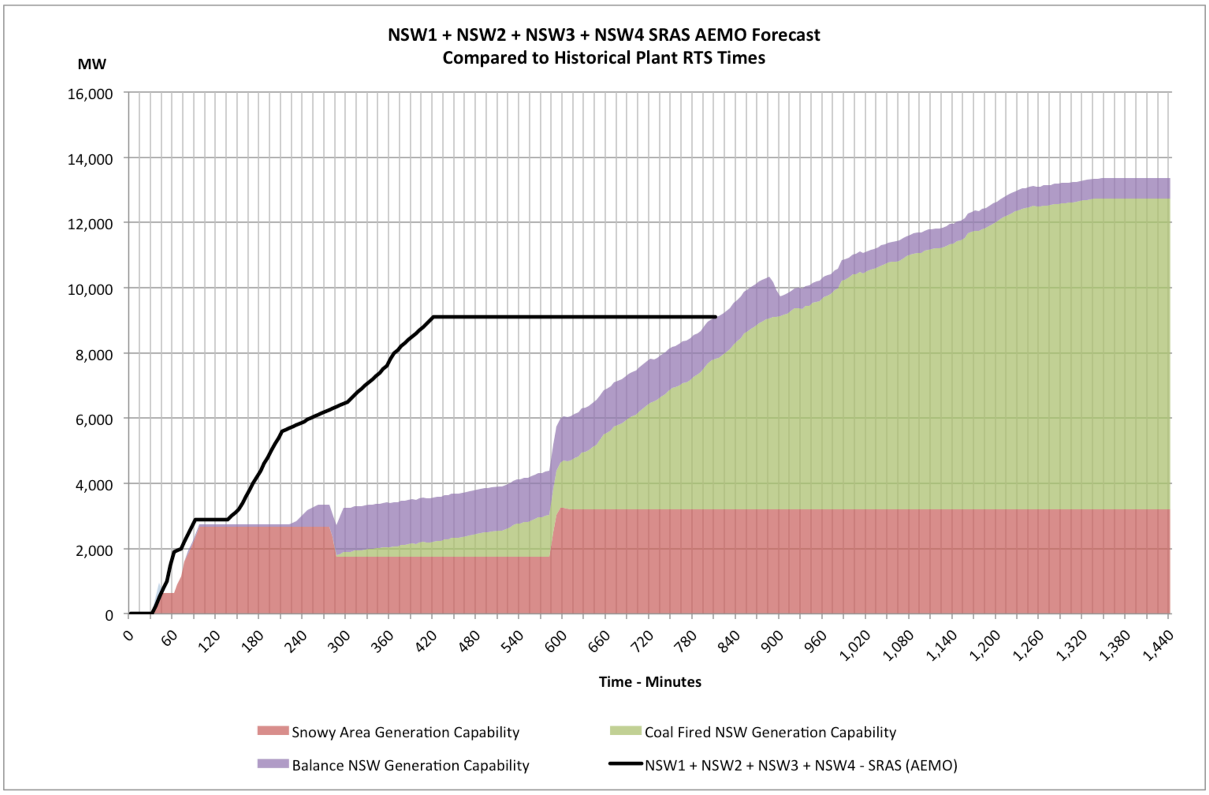
- At + 210 mins auxiliary power available to Eraring, Vales Point and Colongra units
- Due to Turbine cooling issues, RTS of Eraring and Vales point is delayed by 3 hours
- At + 270 mins auxiliary power available to Bayswater, Mt Piper and Liddell units
- Due to turbine cooling issues, RTS of Bayswater, Mt Piper and Liddell is delayed by 4 hours
- The NSW Toshiba 660 MW units in NSW RTS is based on the RTS of BW units 1 to 4 following the station trip on 2 July 2009 adjusted due to delays for return of auxiliary power supplies
- Liddell units RTS based on normal RTS profiles for hot or warm restarts - only 3 Liddell units assumed available within 24 hours
- Fuel at Colongra is exhausted after 15 hours of full load operation
- Uranquinty is not considered to be fuel constrained but is not able to be used in the initial RTS stages due to voltage issues in the Southern NSW network

<u>NSW 1 to 4 Scenario</u>

- At + 30 mins auxiliary power available to Upper Tumut, Eraring and Liddell
- At + 60 Mins auxiliary power restored to Lower Tumut and network to Canberra restored
- At + 75 mins auxiliary power restored to Kangaroo Valley
- At + 90 mins auxiliary power restored to Tallawarra
- At + 150 mins auxiliary power available to Vales Point and Colongra units
- Due to Turbine cooling issues, RTS of Vales point is delayed by 2 hours
- At + 210 mins auxiliary power available to Bayswater and Mt Piper units
- Due to turbine cooling issues, RTS of Bayswater and Mt Piper is delayed by 3 hours
- The NSW Toshiba 660 MW units in NSW RTS is based on the RTS of BW units 1 to 4 following the station trip on 2 July 2009 adjusted due to delays for return of auxiliary power supplies
- Liddell units RTS based on normal RTS profiles for hot or warm restarts - only 3 Liddell units assumed available within 24 hours
- Fuel at Colongra is exhausted after 15 hours of full load operation
- Uranquinty is not considered to be fuel constrained but is not able to be used in the initial RTS stages due to voltage issues in the Southern NSW network

The graphs comparing our restoration curves with those prepared by AEMO are shown below. It is important to note that both curves are available generator capacity. This is because the historical data is derived from circumstances where all the available capacity was fully dispatched by displacing existing higher priced generation without any limitations imposed by the transmission system.





From these comparisons it appears that the restoration curves used in the Draft Determination are quite optimistic compared to historical experience.

Also the recent experience as a result of the system black in South Australia only serves to reinforce this concern.

Key assumptions basis and validity

No impact of transmission network damage

The Draft Determination indicates that it was assumed that *"there is sufficient redundancy in the transmission network such that there is no impact of network damage on the restart or restoration process"*[12] . Given that transmission failures are historically the major cause of system incidents that have resulted in black system events, it is difficult to understand the basis for this assumption. The recent system black in South Australia being a case in point.

It is acknowledged that catering for *"all possible multiple transmission elements would be impractical"*[13]. However we are confident that a likely and representative range of scenarios could be considered we would expect this would be less than 10 per region.

The other reason given for not undertaking this analysis, is that *"if attempted it would lead to very high SRAS costs"*[14] seems inappropriate. Analysis should not be avoided because the answer may not be seen as desirable.

Consumer load restored 90 minutes after supply

The Draft Determination makes the assumption that *"for the purposes of the economic analysis, it has been assumed that consumer load is restored at the same rate as the generation but with a 90 minute time lag"*[15]*.* It is noted that the Draft Determination provides no basis for this assumption but more importantly as indicated above there are a number of sources of uncertainty in the load restoration process and these ought to have been taken into account and simulated not simply assumed to be a constant value.

Delays and failures of the generation and load restoration process are ignored

The Draft Determination makes the assertion that *"In an actual restoration process there is a chance of a generation or network failure that introduces a subsequent delay to the restoration process after the end of Stage 1 of the restoration process. However the possibility of such delays is not related to the procurement of SRAS, so such delays have been ignored in the economic assessment and are, therefore, not relevant to the setting of the Draft Standard"* [16]. Again referring to the discussion on uncertainty above, the impact of these delays and how they may be affected by changing both the number and geographic diversity of SRAS sources ought to be a key part of the analysis – not merely ignored.

In our view it is clear that an increased number of geographically diverse SRAS sources, energising an increased number of generators would both reduce the expected time of restoration and improve the certainty of achieving this. This is clearly relevant to setting the standard.

Composite reliability of SRAS sources

We note the use of composite reliability as a means of introducing some treatment of the risk that while a SRAS source may be available that it may not operate when required to do so. This has been termed reliability – the probability of success.

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[12] Page 36 – Draft Determination

[13] Page 37 – Draft Determination

[14] Page 37 – Draft Determination

[15] Page 37 – Draft Determination

[16] Page 37 – Draft Determination

The additional information provided by AEMO on the calculation indicates that the calculation of reliability is based on a theoretical analysis based on data provided the generators. We are concerned that this has resulted in optimistic estimates of the reliability of SRAS sources.

For example, we note the acknowledgement by Deloitte in their report of the low levels of historical reliability of trip to house load schemes and although they consider the reported levels as being pessimistic that they should be taken into account. However the reliability figures quoted for both Victoria and Queensland where we understand some of the SRAS sources are trip to house load schemes are 60%[17] or more. This is surprising given the historical experience. In our submission to the Review of the System Restart Standard we quoted the experience of Italy and Switzerland during a system black on 28 September 2003 where a success rate for trip to house load schemes of less than 30% was realised.

We also note that AEMO, in it's supplementary information state, that a generator that provides trip to house capability would be "scored higher" if it had more units that could potentially supply the SRAS service. We assume that being "scored higher" would result in a higher assumed composite reliability. However this would be problematic if AEMO has only contracted for one unit worth of trip to house capability as it would likely result in only one unit being enabled for SRAS provision.

As we understand to be the case, SRAS contracts may only specify that one unit with a quantity of MW is to be supplied at one time with trip to house capability. There is no requirement that more than 1 unit be armed for trip to house. AEMO is not in a position to treat these arrangements as BOGOF's.[18]

Based on these observations our view is that the composite reliability of trip to house schemes should be a lot less than the 60% or more used. An estimate in the range of 20% to 30% would appear more reasonable.

The recent experience in South Australia, where both SRAS sources failed would also indicate that all the reliabilities used are optimistic.

We would expect that if more realistic reliability estimates were used that this would result in the procuring of more SRAS services.

Comments, observations and questions.

Basis for proposed standard

The proposed standard in the Draft Determination defines a requirement of x% of average load within y hours. These values vary from region to region.

In each region the values proposed are well within what it is expected will be achieved with the full range of SRAS options considered. In fact it appears from the graphs in Figures 6.3 to 6.8[19] that this could be achieved with less services than currently contracted. It is difficult to understand the basis for choosing these values and it is concerning that the new standard appears to be set at such a low level.

The revised standard also incorporates a requirement of an "aggregate reliability" of 90% for each of the electrical sub-networks. Again it is not clear from the Draft Determination how this was

[17] Page 79 Deloitte – Economic Assessment – Table 19

[18] Buy one get one free

[19] Pages 61 to 71 – Draft Determination

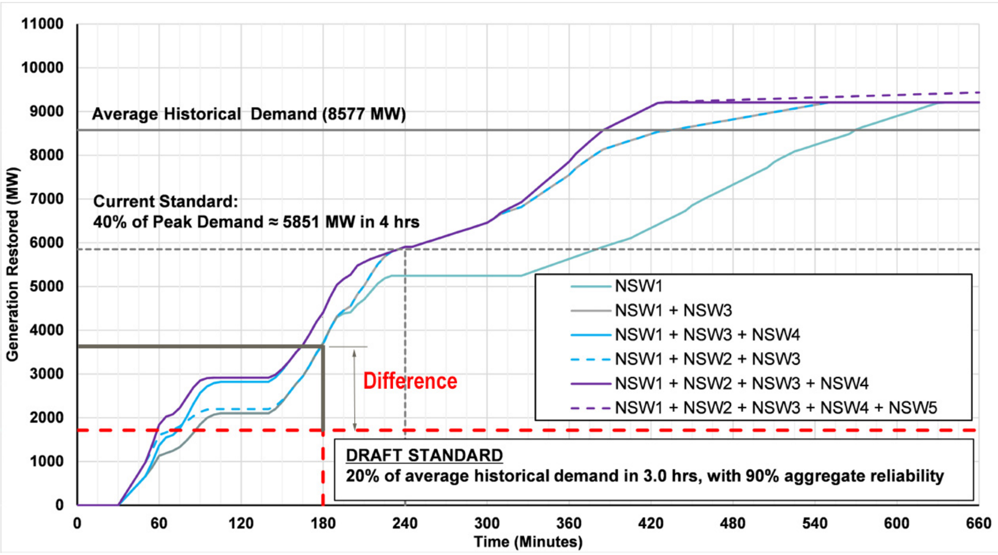
determined. Given the importance of this requirement further explanation would be helpful. Also we are concerned that the requirement is so low. A more acceptable level would be at least 96%. This could be achieved by two SRAS sources with individual reliabilities of 80%.

Reduction in standard

Referring to Figure 6.5 in the Draft Determination it would appear that the Draft Standard is a significant reduction from the current standard. This Figure is reproduced below.

On the basis that the NSW1 + NSW2 line on this graph represents the expected outcome of the current SRAS procured by AEMO. AEMO would have procured this level of SRAS for NSW on the basis that it satisfied the current standard of 40% of peak demand in 4 hours. That being the case the equivalent demand at 3 hours would be approximately 3,800 MW or 44% of average historical demand and not 20% as proposed for the new SRS. The difference is as shown on the graph below.

Given the broad concern by market participants about the adequacy of the current SRAS arrangements it is troubling to see the standard further reduced.



Adjusted VCR values for outage declines as length of outage increases

The economic analysis undertaken by Deloitte for the Draft Determination used the VCR values provided by AEMO and are reported in table 5.2[20].

It is noted that the adjusted values for an outage decrease as the outage duration increases. This is puzzling and at least is worthy of some further explanation. It would be expected that rather the incremental cost of an outage would increase over time, or at a minimum be constant. This assumption has a material impact on the economic analysis and should be re-examined.

Impact of outage on sensitive loads

It is not clear from the Draft Determination or the economic analysis undertaken by Deloitte how the impact of a system black on sensitive loads such as aluminium smelters was taken into account. Given the large loss of economic value that would occur if a smelter were shut down as a result of a system black some further explanation of how this was taken into account in the analysis would be warranted. This is particularly important as it would appear from the restoration curves used in analysis that smelters would not survive the system black. This is a troubling outcome.

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[20] Page 39 – Draft Determination

Value of "default blackout"

To support the economic analysis it is necessary to use the concept of a "default blackout", which could be thought of as a "reasonable worst case" outcome. We accept the need for this. However the value of this "default blackout" has a material effect on the economic analysis and therefore, at a minimum, a range of values should be used to assess the impact on the outcome of the economic analysis.

To test this proposition we constructed a scenario where we assumed that the value of the "default blackout" was twice that assumed in the analysis. This resulted in an increase in the annualized benefits of various SRAS options as shown below:

	NSW1	NSW1 &3	NSW1, 3 & 4	NSW1, 2 & 3	NSW1, 2, 3, & 4	NSW1, 2, 3, 4 & 5
Difference in annualized benefit	$M 59.4	$M 8.1	$M 1.6	$M 1.5	$M 0.4	$M 0.1

Based on our understanding of SRAS costs this would appear to indicate if the value of the "default blackout" was increased that more SRAS sources ought to be procured. This warrants further investigation.

Apparent Comparison of "Marginal Economic Benefit" with "Average cost"

The graphs showing "Marginal Benefit of SRAS"[21] do not seem appropriate as they compare "Marginal Economic Benefit" with "Average Cost". This is clearly not the comparison that would be undertaken to determine the economic level of SRAS.

During the discussions at the recent Forum it became clear that the real problem was difficulty in demonstrating the economic trade-off without disclosing what is considered confidential information.

This makes the published graphs rather meaningless. It would be preferred that some other way of demonstrating to stakeholders the nature of the economic trade off be found.

Private SRAS arrangements

The Draft Determination suggests that *"in the event the individual sensitive loads, require an increased level of protection from major supply disruptions over and above that provided to them by the Draft Standard, then a solution is best negotiated between that load, the respective TNSP and generators, as well as potentially with the jurisdiction."*[22.] There are two significant problems with this proposal:

1. It is not at all clear how the parties to such an agreed solution could be assured that it could be effectively implemented at the time as a system black because as the Draft Determination acknowledges during the restoration process following a system black AEMO would be in total control of transmission and generation operations. This would require AEMO to agree to honor such a solution and it not clear how this would be achieved.
2. Also there would be a "free rider" problem created as a result of customers local to the sensitive load being restored earlier than they otherwise would have been. They would derive a significant benefit without contributing to the costs. This would need to be addressed in some way. Again however it is not clear how this could be done.

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[21] Figs 5.1, 5.2, 5.3, 5.4, 5.5 & 5.6 – Draft Determination – page 41 and following

[22] Page 56 – Draft Determination

Submission to AEMC Reliability Panel in response to:

"Review of the System Restart Standard"

Use of aggregate reliability in the Standard

The Draft Determination proposes the use of an aggregate reliability measure to indicate the probability of success of restoring generation and transmission. We support this approach but consider that it is too narrowly applied and should take into account all sources of uncertainty that will affect the restoration of load.

It would also be helpful for stakeholders to be provided with the details of the methodology and base data used to calculate these values.

Additional recommendations made by the Reliability Panel.

AEMO consultation with TNSPs during procurement process

This recommendation is supported but with an important modification. In our view it would not be adequate to rely on self-reporting by AEMO as to whether they have consulted appropriately with the TNSPs during the procurement process.

We are strongly of the view that it would be worthwhile for the Panel to have independent discussions with each of the TNSPs and seek their assurance that they are satisfied with the outcomes of the process undertaken by AEMO.

Enforcement of SRS

We agree that ensuring compliance with the SRS is a matter for the AER. However given the lack of transparency with respect to how AEMO have sought to comply with the SRS it is difficult for interested stakeholders to form a considered view as to whether there is an issue that would warrant investigation by the AER.

Additional information provided by AEMO

It was pleasing that the Panel, in response to our request, sought additional information from AEMO.

In response AEMO has provided a description of the data and methodologies used to determine generator restoration curves and SRAS reliability.

This has enabled us to be confident that the restoration curves we have included in this report are representing the same thing as the curves provided by AEMO. However the difference remains unexplained.

We are very concerned that AEMO has relied exclusively on data provided in planning documents and information provided in tenders. Our curves however are based on actual historical outcomes. In our view AEMO should also take actual historical plant performance into account.

We are disappointed that at this stage AEMO have provided no data. Without this it is not possible to understand why the significant differences in expected outcomes remains.

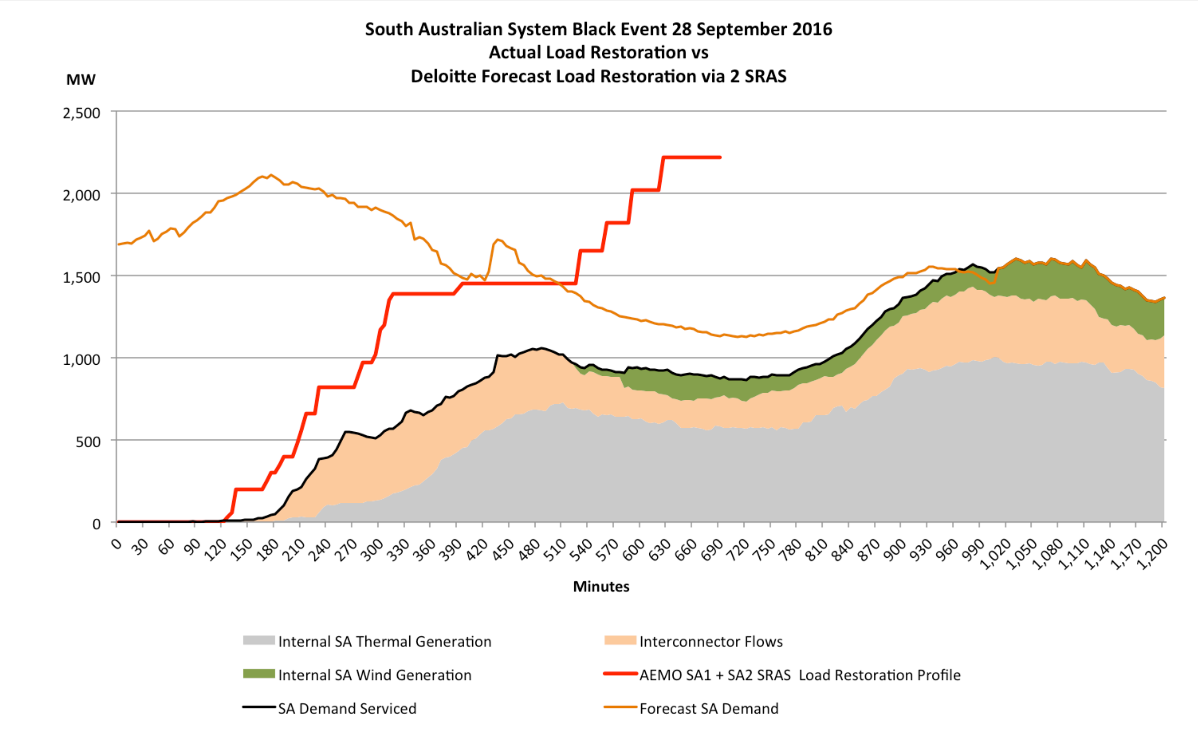
Observations of recent system black in South Australia.

We think it is useful to make a number of observations arising from the recent system black that occurred in South Australia at 15:48 local time, 28 September 2016.

1. AEMO's reports on this incident state that both SRAS sources contracted in South Australia did not operate as required. This creates some serious questions about the reliability assumptions

that are the basis for the Draft Determination. The lowest probability estimates in the Draft Determination would have resulted in a probability of both SRAS sources failing of 3.07%.

2. We understand that a previous supplier of SRAS was directed by AEMO to attempt to provide a SRAS service. However this was not possible, as the provider no longer possessed this capability. This reinforces the concerns we raised about the use of AEMO directions in our initial submission to the Reliability Panel.
3. The generator restoration timing was significantly slower than that assumed in the Draft Determination for South Australia. This is demonstrated in the following graph.



4. From the demand profile that was recorded during the restoration process it was clear that the restoration process was not a continuing increase in load but there were clear set backs in this process. This demonstrates that the uncertainty that we claim should be taken into account in determining the SRS is clearly evident in actual circumstances.
5. As a result of the inability of both South Australian SRAS sources to operate as contracted, the system restart was entirely dependent on the availability of the Heywood interconnector. It is sobering to contemplate what outcomes would have occurred if the Heywood interconnector had been damaged as a result of the severe weather.

Conclusion

The Reliability Panel in its issues paper outlined a framework to set the SRS via an economic assessment of the relative marginal costs and benefits of additional SRAS sources accounting for uncertainty in the restart process. We agree that such a framework is appropriate and fit for purpose.

However the assessment conducted by the Panel and its consultants seems at odds with such a framework. The assessment uses unrealistic assumptions and explicitly ignores important areas of uncertainty. In some cases, sources of marginal benefits of SRAS are explicitly excluded on the grounds that *"if attempted it would lead to very high SRAS costs".*[23]

While we have expressed some concerns with the Draft Determination, these could be resolved if:

1. The analysis undertaken had used more realistic assumptions on key inputs such as:
   - Generator restoration curves
   - Composite reliability of SRAS sources – in particular trip to house schemes
   - The value of the "default blackout"
2. The analysis had explicitly examined all the uncertainties associated with system restoration, in particular:
   - Uncertainties associated with establishing network paths
   - Uncertainties associated generators restarting and potentially tripping after restart

It would appear, on balance, that if the analysis had been undertaken in this manner, that it would indicate net benefits with respect to greater levels of SRAS procurement than the levels reflected in the Panel's draft determination. This approach would be entirely consistent with the framework outlined in the Panel's consultation process. The regrettable events in South Australia seem to further support this assertion.

[23] Refer – page 37 – Draft Determination