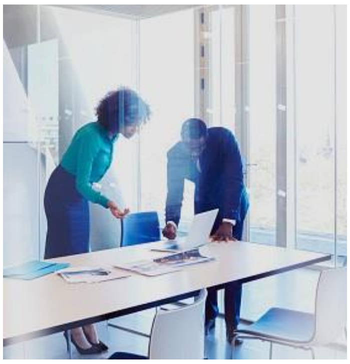

Protected Event - Destructive high winds in South Australia leading to multiple generation trips

AEMC - Reliability Panel

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To assist the Reliability Panel in its consideration of AEMO's request, GHD has assessed the technical feasibility of the options presented by AEMO and of the cost of AEMO's recommended option and the benefits it is expected to generate. Our conclusion is that the option recommended by AEMO is justified based on the estimated weighted net benefit and the conservative assumptions made by AEMO in calculating the net benefit.

GHD's assessment has considered the following material provided to the Reliability Panel by AEMO:

- The report titled, "AEMO Request for Protected Event Declaration – November 2018";
- An accompanying spreadsheet detailing the cost benefit assessment of AEMO's recommended option, and
- Further information provided by AEMO in response to RFI's issued by the Reliability Panel on 11 February 2019. This included both information provided in a written response and clarification provided during a teleconference with AEMO, GHD and the AEMC on 20 February 2019.

We have also considered issues raised in submissions received by the Reliability Panel in response to the consultation paper. Specifically submission received from the following parties were considered:

- South Australian Department for Energy and Mining;
- Snowy Hydro;
- Energy Networks Australia;
- ElectraNet;
- Origin;
- Meridian Energy, and
- AGL

The evidence provided by AEMO demonstrates that a reasonable set of options has been considered in determining the recommended option.

The recommended option selected by AEMO to address the protected event involves applying pre-contingent import[1] constraint on the Heywood interconnector whenever destructive winds as forecast in SA and to upgrade the SIPS to provide greater confidence that it will respond to events. AEMO has presented economic analysis to demonstrate that the cost of the SIPS upgrade is justified by the increased confidence that the scheme will operate to prevent an interconnection trip and widespread loss of supply in SA.

[1] In this report the term "import" is used to describe importing of power from Victoria to South Australia via Heywood or Murraylink interconnectors

While there is a risk that delivering the enhanced SIPS may take longer than planned due to the time taken to implement a reliable phasor measurement based trigger, the steps proposed to investigate and refine the design should minimise the risk of the scope and cost increasing significantly.

Delays in commissioning the enhanced SIPS should not impact the economic justification even if a new HVAC interconnection proceeds. This is because much of the enhanced scheme can be reused as part of the interconnector SPS, hence there is little risk of stranded investment.

In making a protected event declaration under clause 5.20A.4(b)(4) of the NER, the Reliability Panel may consider the target capabilities for the proposed emergency frequency control scheme that is proposed to respond to the protected event. GHD considers that it would be appropriate to specify target capabilities for the control scheme which reflect the following:

- The improved confidence in the ability of the upgraded SIPS to control protected events. The improved confidence should be sufficient to justify the proposed expenditure on the upgraded SIPS
- The appropriate pre-contingent import limit. It is recommended that the import limit be initially set at 250 MW and reviewed taking into account the extent to which it binds and the demonstrated capability of the SIPS to support a less restrictive limit.
- The appropriate trigger event for pre-contingent constraints. The proposed trigger based on BOM forecast of destructive winds is appropriate.
- Specific SIPS functionality that delivers the target confidence level by reliably detecting an event and triggering the appropriate control action recognising the available BESS and load shedding capacity.

2. Introduction & Purpose

AEMO has requested the Reliability Panel declare a protected event under the National Electricity Rules (NER) to assist AEMO in maintaining power system security in South Australia. AEMO has proposed that the protected event be defined as “the loss of multiple transmission elements causing generation disconnection in the South Australia region during forecast destructive wind conditions”.

To assist the Reliability Panel in its consideration of AEMO’s request, GHD has assessed the technical feasibility of the options presented by AEMO and of the cost of AEMO’s recommended option. GHD recognises that this report may be published by the Reliability Panel.

2.1.1 Technically feasible options for managing the protected event.

Our assessment has specifically considered the following questions:

- Is AEMO’s assessment of the technical feasibility of the options it has identified for managing the protected event accurate? Are there any errors or omissions in AEMO’s analysis?
- Are there other viable options for managing the protected event which were not identified by AEMO?
- Is AEMO’s recommended option the most appropriate option for managing the protected event from a technical perspective?
- Are AEMO’s proposed target capabilities for the upgrade to the System Integrity Protection Scheme appropriate? Is it necessary for the upgraded SIPS to be capable of compensating for the loss of 500 MW of generation in the South Australia region under AEMO’s recommended option?
- Is the proposed high capacity interconnector between South Australia and New South Wales likely to have an impact on the feasibility or necessity of AEMO’s recommended option for managing the protected event in the future?

2.1.2 Costs to implement AEMO’s recommended option

Our assessment has considered the costs estimates provided by AEMO to implement the recommended option for managing the protected event.

There are two elements of cost identified by AEMO: the market cost of constraining dispatch to limit the maximum import into South Australia on the Heywood interconnector, and the cost of implementing the modification to the SIPS. We have considered each of these elements separately to assess the reasonableness of the costs proposed by AEMO.

3. Assessment of options

To complete of technical and economic assessment of the application for declaration of a protected event, we have reviewed the following material provided to the Reliability Panel by AEMO:

- The report titled, "AEMO Request for Protected Event Declaration – November 2018";
- An accompanying spreadsheet detailing the cost benefit assessment of AEMO's recommended option, and
- Further information provided by AEMO in response to RFI's issued by the Reliability Panel on 11 February 2019. This included both information provided in a written response and clarification provided during a teleconference with AEMO, GHD and the AEMC on 20 February 2019.

We have also considered issues raised in submissions received by the Reliability Panel in response to the consultation paper. Specifically submission received from the following parties were considered:

- South Australian Department for Energy and Mining;
- Snowy Hydro;
- Energy Networks Australia;
- ElectraNet;
- Origin;
- Meridian Energy, and
- AGL

The following sections present our technical assessment of options for addressing the protected event, our review of the costs estimate for implementing AEMO's preferred solution and our assessment of net benefits of the recommended option.

Section 4 presents our conclusions.

3.1 Assessment of technical feasibility

The protected event declaration is intended to manage risks relating to transmission faults during destructive wind conditions in South Australia causing generation disconnection and subsequent major supply disruption. AEMO has proposed that a combination of the following measures be implemented to manage the protected event:

- Pre-contingent import limit placed on the Heywood interconnector, and
- Enhanced System Integrity Protection Scheme (SIPS)

3.1.1 Pre-contingent import constraint

AEMO proposes to limit imports across the Heywood interconnector to 250 MW whenever the Bureau of Metrology (BOM) issues destructive wind warnings for South Australia. This action is intended to provide a margin or headroom between the import level across Heywood and the stability limit of approximately 600 MW. Various factors may mean that the headroom provided by the pre-contingent constraint on imports is not always effective in preventing a trip of the interconnector if multiple generators trip. Factors identified by AEMO include:

- Actual flows exceeding the import limit set in the NEM dispatch engine. The NEM dispatch engine is not always able to keep interconnector flows to within the specified import limit this can lead to actual flows exceeding the limit. When this occurs the headroom provided by the import limit is diminished.
- Feathering of wind generators during high wind events adding to the increase in imports across the interconnector; and
- Transmission faults reducing interconnector capability and the hence the stability limit.

To help mitigate these limitations the SIPS provides a backup control action.

3.1.2 Upgrade to the SIPS

The existing SIPS is designed to provide three escalating control actions to provide further mitigation of the risk of the Heywood interconnection tripping as a result of the increased flow caused by the loss of multiple generators in South Australia following transmission faults. The first phase of the scheme is triggered by flows on the interconnection exceeding pre-set limits. When this trigger is reached the SIPS sends control signals to Battery Energy Storage Systems (BESS) in South Australia to generate power to arrest the increasing interconnector flow.

If the BESS response is insufficient, a second stage is triggered, which sends control signals to a pre-defined set of loads in South Australia to trip simultaneously.

As a last resort, protection on the interconnection will operate if necessary, tripping the interconnector and islanding South Australia to prevent instability that would otherwise occur if interconnector flows were allowed to increase beyond the stability limit.

Electromagnetic transient (EMT) studies performed by AEMO have identified a number of limitations with the design of the existing SIPS. AEMO has estimated that these limitations may mean that the existing SIPS is ineffective in mitigating the risk of tripping the interconnection in about 30% of cases. Upgrades to the SIPS scheme have been proposed to address these known limitations and lift the effectiveness of the scheme to mitigate the risk of the interconnection tripping in 90% of cases[2].

The upgrades are intended to provide the following improved functionality:

- Enhancements to the central processing system to better manage the amount of battery response and load shedding response available at any time. This should better ensure an appropriate level of load shedding is available and protect against over or under shedding. Improved monitoring of the battery status and the actual load available to be shed should also consider the amount of embedded generation (ie roof top photo-voltaic generation) that might also be tripped with any load blocks.
- Use of phasor measurements to provide a more robust process for triggering the load shedding response than can be achieve relying on the existing distance relays.

3.1.3 Extent of options considered by AEMO

AEMO is seeking to mitigate the risk of post-contingent flows on the Heywood interconnection encroaching on stability limits resulting in a trip of the interconnection. The analysis and evidence provided by AEMO has demonstrated that without appropriate controls there is a risk that transmission faults in South Australia could

[2] These confidence levels are embedded in the economic assessment spreadsheet provided by AEMO.

lead to the trip of multiple generators, increasing imports beyond stability limits and tripping the interconnection. Loss of the interconnection under these circumstances is likely to cause significant loss of load in South Australia and potentially resulting in a black system.

There are two sets of controls that could be considered to mitigate the risk of such events:

- The first set involves taking pre-contingent action to establish headroom on the interconnector to allow the increase in flow towards SA that would result from the multiple generator trips;
- The second set involves taking immediate post-contingent actions to adjust the level of load and generation in South Australia to rapidly arrest any increase in the interconnection flow.

The options considered by AEMO for responding to the event have considered a combination of the two sets of controls. GHD agrees that a combination of the two sets of controls is likely to provide the optimum solution for mitigating the risk associated with the protected event.

GHD's initial review of the set of options considered by AEMO identified that controlling the flow on Murraylink may provide an alternative option worth considering. AEMO has provided additional information regarding the potential to incorporate control of flow over Murraylink. The information provided identified a number of complicating factors that would need to be addressed for control of the Murraylink flow to be included as an option for managing the event. The key issues identified included:

- Increasing imports into South Australia across Murraylink following the loss of generating units in South Australia would reduce the increase in imports across the Heywood interconnector. A run-forward control action[3] could therefore help keep the Heywood interconnector from tripping. Run-forward control actions are however difficult to manage due to uncertainty regarding the capability of the power system upstream and downstream of Murraylink to accommodate the increased power transfers. The existing configuration of dispatch constraints do not provide a reliable indication of run-forward capability, as a result only schemes that run-back the Murraylink flow to 0 MW could be considered;
- The effectiveness of run-back schemes would be limited by the pre-contingent flow present on Murraylink. In addition a run-back scheme would only be of benefit if Murraylink was exporting prior to an event;
- Establishing a pre-contingent export on Murraylink may incur counter price flows. The conditions that would benefit from a post contingent run-back of Murraylink would be those where the pre-contingent flow on Heywood was from Vic to SA. In this scenario establishing an export across Murraylink would incur counter price flows and negative settlement residues across Murraylink and impose additional costs on the market.
- Upgrades are required to Murraylink to enable a run-back. Currently a run-back on Murraylink requires a manual reset, to re-establish dispatch control via the NEM dispatch engine. Hence inclusion of Murraylink in a run-back scheme would reduce dispatch control and may introduce difficulties in managing the power system after any event.

GHD is satisfied that the identified issues mean that it is reasonable to exclude control of the flow across Murraylink from options to address the protected event.

AEMO identified five options for mitigating the risk arising from the protected event. GHD has reviewed each options and the reasons provided by AEMO regarding whether the option is capable of addressing the event.

[3] A "run forward control" action is defined as a control action which will increase the power flow in a given direction where as a "run back control" action is defined as an action which will reduce the power flow in the given direction.

Table 1 – Feasibility of Options

Option	Assessment of Feasibility
Rely solely on the existing SIPS	PSCAD[4] analysis completed by AEMO identified that the existing SIPS may not reliably detect events leading to unstable interconnector flows. In addition, the limited response capability of the existing SIPS means that if there is a high pre-contingent import on the Heywood interconnection the SIPS may not prevent tripping of the interconnection. GHD is satisfied that this option is not able to address the protected event
Incorporate more load and/or BESS into existing SIPS	The lack of additional BESS capacity makes this option infeasible at present. GHD is satisfied that this option is not currently able to address the protected event. We understand the upgraded SIPS could incorporate additional BESS capacity if it becomes available.
Implement a high-speed post-separation tripping scheme	The low inertia in South Australia coupled with generation loss and loss of the interconnection do not provide sufficient time for a post separation response. GHD is satisfied that this option is not able to address the protected event.
Upgrade the SIPS	Without the pre-contingent constraint of imports this option alone may not address protected events that occur with high pre-contingent imports across the Heywood interconnection. GHD is satisfied that this option is not able to address the protected event
Upgrade the SIPS and limit total Heywood import capacity during destructive wind conditions	GHD is satisfied that this option is able to address the protected event.
Include control of Murraylink flow in the upgraded SIPS and limit total Heywood import capacity during destructive wind conditions	GHD is satisfied that this option has a number of complications which are likely to make it less effective in addressing the protected event than other options proposed by AEMO.
Limit total import capacity during destructive wind conditions	GHD is satisfied that this option is not able to address the protected event as there is a risk that the headroom provided by a pre-contingent constraint on the interconnection will not be effective in all cases.

[4] PSCAD is power system analysis software used by AEMO for EMT studies.

Table 1 presents over assessment of the feasibility of each of the five options considered by AEMO and two additional options identified by GHD.

The evidence provided by AEMO demonstrates that a reasonable set of options has been considered in determining the recommended option.

3.1.4 Selection of recommended option

The recommended option selected by AEMO to address the protected event involves applying pre-contingent import constraint on the Heywood interconnector whenever destructive winds are forecast in SA and to upgrade the SIPS to provide greater confidence that it will respond to events. AEMO has presented economic analysis to demonstrate that the cost of the SIPS upgrade is justified by the increased confidence that the scheme will operate to prevent an interconnection trip and widespread loss of supply in SA.

GHD is satisfied that the process applied by AEMO to justify the recommended option is appropriate. Section 3.2 summarises our review of the scope and cost of the SIPS upgrade and Section 3.3 presents our review of the cost benefit assessment of the recommended option.

3.1.5 Appropriate target capabilities for the upgraded SIPS

In making a protected event declaration under clause 5.20A.4(b)(4) of the NER, the Reliability Panel may consider the target capabilities for the proposed emergency frequency control scheme that is proposed to respond to the protected event. GHD considers that it would be appropriate to specify target capabilities for the control scheme which reflect the following:

- The improved confidence in the ability of the upgraded SIPS to control protected events
- The appropriate pre-contingent import limit
- The appropriate trigger event for pre-contingent constraints
- Specific SIPS functionality

3.1.5.1 Confidence in SIPS response to events

The cost benefit assessment presented by AEMO identifies that improving the confidence that the SIPS will control a protected event from 70% to 90% is sufficient to justify the expected cost of the SIPS upgrade. GHD adjusted the cost benefit model to identify the improvement required to deliver benefits which just meet the cost of the upgrade. That analysis suggests that to justify an upgrade costing $5m, a 12% improvement in the confidence of addressing the protected event is required under the worst case scenario modelled by AEMO.

A target capability could be specified requiring the upgraded SIPS provide a sufficient improvement in the confidence that the SIPS will control a protected event to justify the cost of the upgrade. Specifying the requirement in this manner allows AEMO and ElectraNet to optimise the scope of work for the upgrade once the initial phase of trials and PSCAD simulations exploring the use of phasor measurements have been completed. The benefit of a staged development to mitigate uncertainty is further discussed in section 3.2.2.

3.1.5.2 Import limit

The AEMO proposal for addressing the protected event calls for imports across the Heywood interconnection to be limited to 250 MW. Through discussion, AEMO has clarified that once the capability of the upgraded SIPS is established there may be a case for reviewing this limit. The need for a review would also be driven by the extent to which the constraint binds.

AEMO expects that on average there may be 2.3 events per year requiring the import constraint to be imposed to manage the risk posed by destructive winds. It is recommended that the import level be set at 250 MW initially and reviewed as part of future Power System Frequency Risk Reviews considering the impact the pre-contingent import constraint has had on the market and the capability of the upgraded SIPS.

3.1.5.3 Trigger level

AEMO has proposed that the import constraint be imposed whenever there is a forecast of destructive winds in South Australia. This threshold has been chosen as destructive winds include winds that exceed 140 km/hr and ElectraNet has advised that the majority of 275 kV transmission lines in South Australia are at risk when wind gusts exceed 140 km/hr[5]. GHD therefore considers that this is an appropriate trigger for enacting the import constraint and this trigger level could be specified as a performance criteria.

3.1.5.4 SIPS functionality

To maximise the confidence that the enhanced SIPS will mitigate a protected event it should be capable of:

- Identifying the emergency condition and reliably triggering appropriate control actions (BESS, Load shedding, interconnector trip) with the specified level of confidence
- determining the appropriate amount of control action to avoid exceeding maximum transfer limits across the relevant network elements
- monitoring the availability of control actions such as amount of available battery energy storage and load shedding and adjusting control actions to accommodate changes in availability

3.1.6 Impact of proposed SA to NSW interconnection

The proposed establishment of a High Voltage AC (HVAC) interconnection between SA and NSW has the potential to impact the need for control actions to manage the protected event. AEMO has confirmed that if a new interconnector is constructed, loss of synchronism due to loss of generation under destructive wind conditions is not expected to require limits on interconnector flows, and the protected event may need to be changed to manage a loss of an interconnector instead. With two HVAC interconnections into SA, there should be sufficient capacity available to accommodate the increase in import that would follow from any destructive wind event that resulted in multiple generator trips.

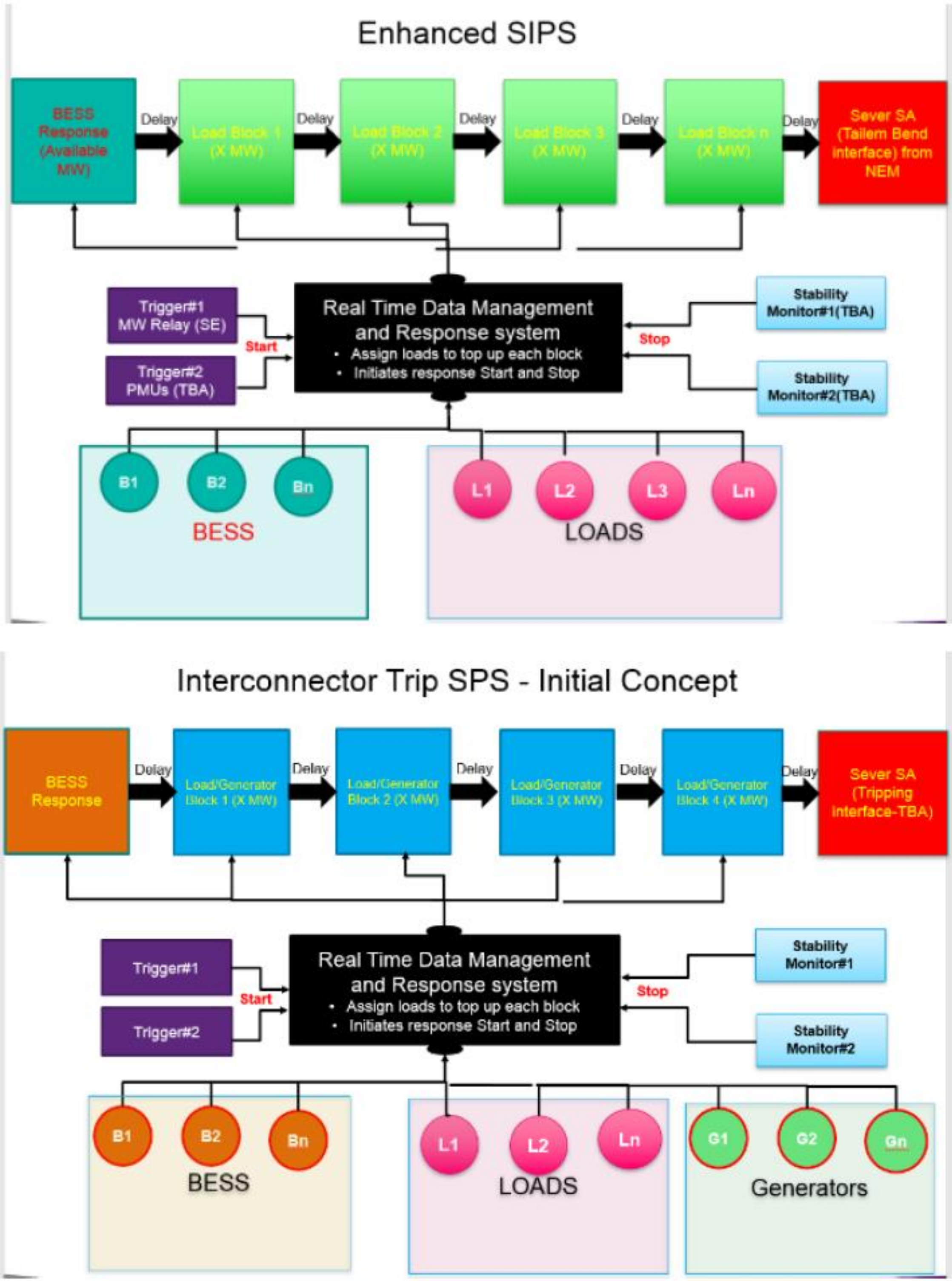
With two HVAC interconnections, the critical contingency is accommodating the loss of both circuits of either interconnector. The design of the proposed SA to NSW interconnector assumes that a special protection scheme (SPS) will be required to respond to such an event and arrest the increase in interconnector flows before the stability limit is reached. AEMO has confirmed that many elements of the upgraded SIPS scheme can be reused as part of the interconnector SPS.

Figure 1 illustrates the key components of the enhanced SIPS and the interconnector SPS. The key differences between the SIPS and the SPS are the elements that detect the triggering events. While it is proposed that phasor measurements will be used to trigger load shedding via the SIPS, the status of circuit breakers on the interconnection will be relied upon for the SPS. Other aspects of the two schemes are quite similar. The phasor measurement units (PMUs) that will provide the phasor measurements for the SIPS are being installed under a separate project to the SIPS upgrade to provide wide area measurements for SA. The PMUs are therefore required irrespective of the SIPS upgrade and will not be stranded by the development of a new HVAC interconnection.

[5] Confirmed by AEMO in written response to RFI 11 dated 21/2/2019

GHD therefore agrees that it is unlikely that development of a new HVAC interconnection will strand a material portion of the capital deployed to upgrade the SIPS.

Figure 1 – Comparison of enhanced SIPS and interconnector SPS [6]



[6] Provided by AEMO in written response to RFI 11 dated 21/2/2019. Figure 1 shows the initial design concept which may be refined during detailed design.

3.2 Costing of options

3.2.1 Scope definition and areas of uncertainty

The SIPS upgrade relies on phasor measurement based triggers providing a more reliable system than the existing SIPS. While phasor measurement technology is quite mature, there are relatively few examples around the world where this technology has been deployed to provide protective tripping functions such as proposed for the enhanced SIPS. A key risk for the SIPS upgrade is the implementing the phasor measurement trigger that can reliably operate for all system events and operating conditions.

While the deployment of PMU based triggered is new in the Australian context, the staged approach proposed (please see section 3.2.2) for the SIPS upgrade project should reduce the risk of any substantial increase in costs. It is more likely that the additional testing proposed may extend the time taken to implement the enhanced SIPS.

3.2.2 Mitigation measures to address uncertainty

AEMO has provided further details of the approach being used to address the uncertainty surrounding the successful deployment of phasor measurement triggers. GHD has reviewed the proposed approach and believes that appropriate measures have been included to address the uncertainty. Specifically the proposed approach includes:

- Current Activities
  - Early installation of PMU to assess reliability and data quality
  - Engagement with providers with experience in installing PMU based tripping schemes elsewhere in the world[7]
- Extensive PSCAD studies and hardware in the loop tests to confirm the reliability of PMU based tripping schemes
- A hold point prior to hardware procurement and implementation of a modified scheme to ensure planned PMU deployment will deliver the required improvement to the reliability of the SIPS and if necessary adjust the design prior to procurement (mid 2020). The timing of the hold point will allow the committed status of a new interconnector to be considered when finalising the final design of the enhanced SIPS.

At the hold point it is expected that the design of the enhanced SIPS will be reviewed to ensure that the ability of the enhanced SIPS to control protected events is sufficient to justify the proposed expenditure required to implement the enhanced scheme.

3.3 Assessment of costs and benefits

GHD has reviewed the cost benefit assessment provided by AEMO. Our key observations include:

[7] AEMO has advised that engagement with GE has occurred and GE has had continued involvement in the deployment of PMU systems in Iceland. Where phasor measurements are used to trigger control actions to improve resilience and security of the Icelandic power system. Iceland is one of the more advanced deployments of PMU triggered controls in the world.

- The inputs to the cost benefit assessment are generally consistent with input data used in the modelling AEMO undertakes for the ISP. SRMC for coal and gas fired generation is consistent with the ISP input data[8].
- The reliability improvement delivered by the enhanced SIPS scheme assumes a VCR which is twice the level recommended in the 2014 VCR assessment undertaken by AEMO. AEMO has provided reasonable evidence from the 2016 SA blackout to substantiate doubling of the VCR for blackouts.
- AEMO has assessed the net benefit for a neutral, best and worst case scenario and used them to developed a weighted annual net benefit. The weighted annual net benefit of the recommended option is $5.4m. All scenarios delivered annual net benefits of between $9.8m and $1.5m.
- GHD has recalculated the net benefits using the same approach as AEMO with the VCR set to the level recommended in the 2014 VCR assessment. This changed input assumption delivered a reduced weighted annual net benefit of $1.9m.
- AEMO has estimated that it will cost between $4m and $5m to implement the enhanced SIPS. This cost appears reasonable given the scope of work proposed.[9]
- The approach used to calculate the benefits delivered by the recommended option for addressing the protected event is quite conservative and likely to under value benefits for the following reasons:
  - Despite historical evidence suggesting that it is unlikely for the import constraint to bind when the import limit is reduced to 250 MW during destructive wind conditions in SA, the assessment of benefits has assumed that for all periods with destructive winds forecast is SA the interconnected is constrained off its dispatch target by between 50 MW and 400 MW. The data from 2017/18 shows that there were 32 periods where the AEMO set the import limit to 250 MW and for approximately 1% of the time the interconnector was constrained by the import limit.

    Repeating the AEMO net benefit assessment with the interconnector constrained for 1% of the time increased the weighted net benefit to $6m. With all scenarios delivering an increased annual net benefit ranging from $9.9m to $2.7m.
  - The economic benefit attributed to the recommended option has been calculated by only considering the additional reliability improvement that results from the greater confidence that the SIPS will mitigate the event (ie a 20% improvement in the confidence level from 70% to 90% has been assumed by AEMO). This is a reasonable measure of the improvement expected to be gained from the SIPS upgrade, however it discounts the 70% of occasions where the combination of the existing SIPS and the pre-contingent constraint would address the protected event. That additional reliability benefit (ie 70%) would be delivered by the recommended option. However it should probably be reduced by the capital cost of any elements of the existing SIPS used as part of the enhanced SIPS. If the entire reliability improvement was considered, it would significantly increase the weighted net benefit.
  - If the recommended option prevents a blackout in 90% of circumstances and the full value of the avoided load interruption is counted towards the net benefit, the net benefit for the recommended option would increase significantly from that calculated by AEMO. GHD calculated the weighted annual net benefit delivered by the recommended option could increases to $30m. However this

[8] The heat rates used in the AEMO assessment appear to differ from those in the ISP input data however adjusting the heat rates to align with the ISP inputs did not produce a material change in the calculated net benefit.

[9] The review of the cost estimate will be completed once further details regarding the scope of work are provided by ElectraNet

weighted annual net benefit is optimistic as it does not take into account any capital expended to implement the existing SIPS scheme that contributes to achieving the 90% confidence level.

- AEMO has not explicitly included any payment to BESS in the cost benefit assessment. AEMO instead assumed that the enhanced SIPS will shed 250 MW of load to manage each contingency and has included the cost of this controlled load shedding valued at VCR. This approach is appropriate as it is assumed that any payment made to a BESS will be much less than the cost assumed for the controlled load shedding.

Our conclusion is that the option recommended by AEMO is justified based on the estimated weighted net benefit and the conservative assumptions made in calculating the net benefit.

While there is a risk that delivering the enhanced SIPS may take longer than expected due to the time taken to implement a reliable phasor measurement based trigger, the steps proposed to investigate and refine the design should minimise the risk of the scope and cost increasing significantly. Further, as implementation of a phasor measurement trigger is only a part of the SIPS scheme, the remaining capabilities (e.g. confirming the availability of load for shedding) should still provide benefits if implemented and commissioned.

Delays in commissioning the enhanced SIPS should not impact the economic justification even if a new HVAC interconnection proceeds. This is because much of the enhanced SIPS can be reused as part of the interconnector SPS, hence there is little risk of stranded investment.

4. Conclusions

4.1 Selection of options

The evidence provided by AEMO demonstrates that a reasonable set of options has been considered in determining the recommended option.

The recommended option selected by AEMO to address the protected event involves applying pre-contingent import constraint on the Heywood interconnector whenever destructive winds as forecast in SA and to upgrade the SIPS to provide greater confidence that it will respond to events. AEMO has presented economic analysis to demonstrate that the cost of the SIPS upgrade is justified by the increased confidence that the scheme will operate to prevent an interconnection trip and widespread loss of supply in SA.

4.2 Net benefits

Our conclusion is that the option recommended by AEMO is justified based on the estimated weighted net benefit and the conservative assumptions made in calculating the net benefit.

While there is a risk that delivering the enhanced SIPS may take longer than expected due to the time taken to implement a reliable phasor measurement based trigger, the steps proposed to investigate and refine the design should minimise the risk of the scope and cost increasing significantly.

Delays in commissioning the enhanced SIPS should not impact the economic justification even if a new HVAC interconnection proceeds. This is because much of the enhanced SIPS can be reused as part of the interconnector SPS, hence there is little risk of stranded investment.

4.3 Performance criteria

In making a protected event declaration under clause 5.20A.4(b)(4) of the NER, the Reliability Panel may consider the target capabilities for the proposed emergency frequency control scheme that is proposed to respond to the protected event. GHD considers that it would be appropriate to specify target capabilities for the control scheme which reflect the following:

- The improved confidence in the ability of the upgraded SIPS to control protected events. The improved confidence should be sufficient to justify the proposed expenditure on the upgraded SIPS
- The appropriate pre-contingent import limit. It is recommended that the import limit be initially set at 250 MW and reviewed annually taking into account the extent to which it binds and the demonstrated capability of the SIPS to support a less restrictive limit.
- The appropriate trigger event for pre-contingent constraints. The proposed trigger based on BOM forecast of destructive winds in SA is appropriate.
- Specific SIPS functionality that delivers the target confidence level by reliably detecting an event and triggering the appropriate control action recognising the available BESS and load shedding capacity.

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		Name	Signature	Name	Signature	Date
[00]	David Bones	Nalin Pahalawaththa		David Bones		26/2/2019
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Final	David Bones	Nalin Pahalawaththa		David Bones		20/3/2019

GHD Advisory

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