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21 June 2013

Anthony Bell
Director Network Operations and Development
Australian Energy Regulator
Level 35, 360 Elizabeth Street
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By email: anthony.bell@aer.gov.au

Dear Anthony

re: Heywood Interconnector Upgrade – AER information request

On 7 June 2013 you requested further information from ElectraNet to assist the AER in making its clause 5.16.6 determination of the Heywood Interconnector Upgrade RIT-T. The requested information included:

- A response to the matters raised in stakeholder submissions from Macquarie Generation, the Major Energy Users and GDF Suez; and
- Information requested by the AER's consultant Oakley Greenwood.

Attachment A is a joint ElectraNet and AEMO response that addresses the issues raised by Macquarie Generation, Major Energy Users and GDF Suez.

ElectraNet and AEMO have endeavoured to provide all information requested from Oakley Greenwood. However, as agreed with Oakley Greenwood, the information separating out operational costs and benefits between South Australian import and export conditions has not been provided due to the disproportionate effort required to provide this information.

With this exception, Attachment C provides the additional data that has specifically been requested by Oakley Greenwood.

Please contact Hugo Klingenberg (08) 8404 7991 for any enquiries in relation to this matter.

Yours sincerely

Rainer Korte
Executive Manager - Network Strategy and Regulatory Affairs

ATTACHMENT A

This attachment outlines ElectraNet and AEMO's responses to the submissions provided to the AER on ElectraNet's clause 5.16.6 determination request, including Frontier Economics' modelling accompanying the Macquarie Generation submission. The three major sections of this response align with the three submissions received by the AER.

1. Macquarie Generation and Frontier Economics' modelling

This section addresses issues raised in the Macquarie Generation submission and accompanying Frontier Economics (Frontier) report, focussing on explaining discrepancies between the Frontier Economics modelling and the Heywood RIT-T results. In particular:

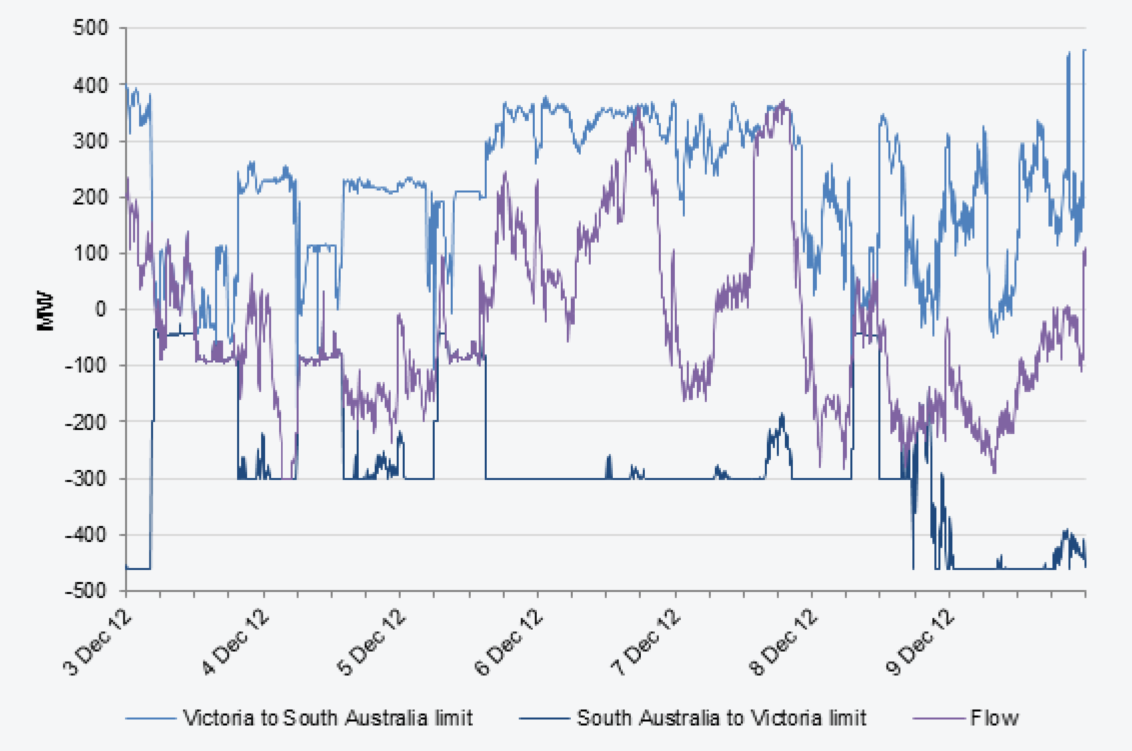
- Section 1.1 addresses questions raised on page 28 of the Frontier report in relation to the sensitivity of the market benefits to intra-regional constraints.
- Section 1.2 and 1.3 provides additional network modelling information presenting load flow and other analysis conducted during the scoping of augmentation options, which illustrate the significance of the intra-regional constraint changes expected from the augmentation.
- Section 1.4 discusses the questions on input assumptions raised by Frontier.

1.1. Market Benefits

Frontier asserts that Option 1b has significantly lower market benefits than indicated in the PACR. Frontier concludes that "the treatment of intra-regional constraints under ElectraNet/AEMO's approach is a large driver of this overall difference". ElectraNet and AEMO agree that this is likely to be the primary source of the discrepancy.

Figure 1 below is taken from AEMO's 2013 planning assumptions and methodology report. It demonstrates the typical volatility of the interconnector limits over the recent summer.

Figure 1 – Flow and limits on the Heywood interconnector during one week in December 2012



Frontier has "assumed that the interconnector is available bi-directionally at all times up to its full notional transfer limit of 460 MW." ElectraNet and AEMO consider this assumption does not enable the full market benefits to be measured to evaluate Option 1b accurately. The consequences of this assumption are significant.

Frontier firstly compares the benefits it has calculated with the costs and benefits of Option 1b. This is an unreasonable comparison. The interconnector is frequently restricted at levels below 460 MW. In particular, it is restricted by voltage stability limitations and thermal limits on the 132 kV network. Option 1b specifically addresses both of these limits. The cost of solving these limits in Option 1b is approximately 58 per cent or $62.7 million. The cost of an additional Heywood transformer is $37.4 million[1]. It is more reasonable to compare the outcomes of Frontier's studies with the benefits of the third Heywood transformer alone, and only this element of Option 1b.

ElectraNet and AEMO have not considered the benefits of the third transformer by itself. The benefits can be inferred by the difference in benefits between Options 1a and 4, which differ only in the installation of the Heywood transformer. The difference in benefits between the two is $39.4 million. The capacitor banks (forming part of the scope of Options 1 and 4) would alleviate the voltage stability constraints sufficiently to provide a limit on the interconnector greater than 460 MW under a broad range of operating conditions. The capacitor banks would not be sufficient to provide a firm 650 MW limit on the interconnector.

[1] Excluding the cost of the 500 kV bus tie.

This reduces the utilisation of the third Heywood transformer when compared with Option 1b. For this reason, the third transformer is a marginal investment in Option 1a. Series compensation delivers a 650 MW capability across the interconnector under a greater range of operating conditions. The third Heywood transformer experiences greater utilisation and hence delivers sufficient benefits to warrant investment in Option 1b. ElectraNet and AEMO agree with Frontier that the gross market benefits of the third Heywood transformer can be inferred as approximately $93 million, more than twice the cost of the transformer.

A key reason for the difference between the benefits calculation, is - as stated above – the absence of intra-regional congestion modelling by Frontier. The inclusion of this congestion influences the investment patterns. By changing the investment pattern, significant differences in the operating benefits may emerge. In this scenario, the shifting of biomass from New South Wales to south eastern South Australia, whilst not generating significant benefits itself, facilitates operating cost savings by displacing more expensive South Australian generation rather than relatively cheaper NSW generation. It is reasonable to conclude the reduction in congestion due to the augmentation may be a significant factor in shifting biomass from NSW to south eastern South Australia given this does not happen in the Frontier model.

The RIT-T study endeavoured to model the network at a level of fidelity that captures the material aspects of the power system's operation. Intra-regional constraint equations are one of a range of material aspects that require due consideration in order to accurately determine the market benefits of the credible options considered. ElectraNet and AEMO consider that sufficient information has been provided to understand the benefits that have been reported. ElectraNet and AEMO do not consider that the sensitivity of the results to intra-regional constraints that are not solved as part of the credible options is relevant. This analysis has not been undertaken by ElectraNet and AEMO.

In attachment B, ElectraNet and AEMO have provided for the revised central scenario hourly flow duration curves for all options between 2013-14 and 2039-40. Also provided are annual histogram distributions of binding constraints on the Heywood interconnector for the base case and Option 1b.

1.2. Network modelling – Thermal constraints

At times of high import into South Australia and under high load conditions, the 132 kV network in parallel with the 275 kV network between South East and Tailem Bend is a limiting factor on imports from Victoria.

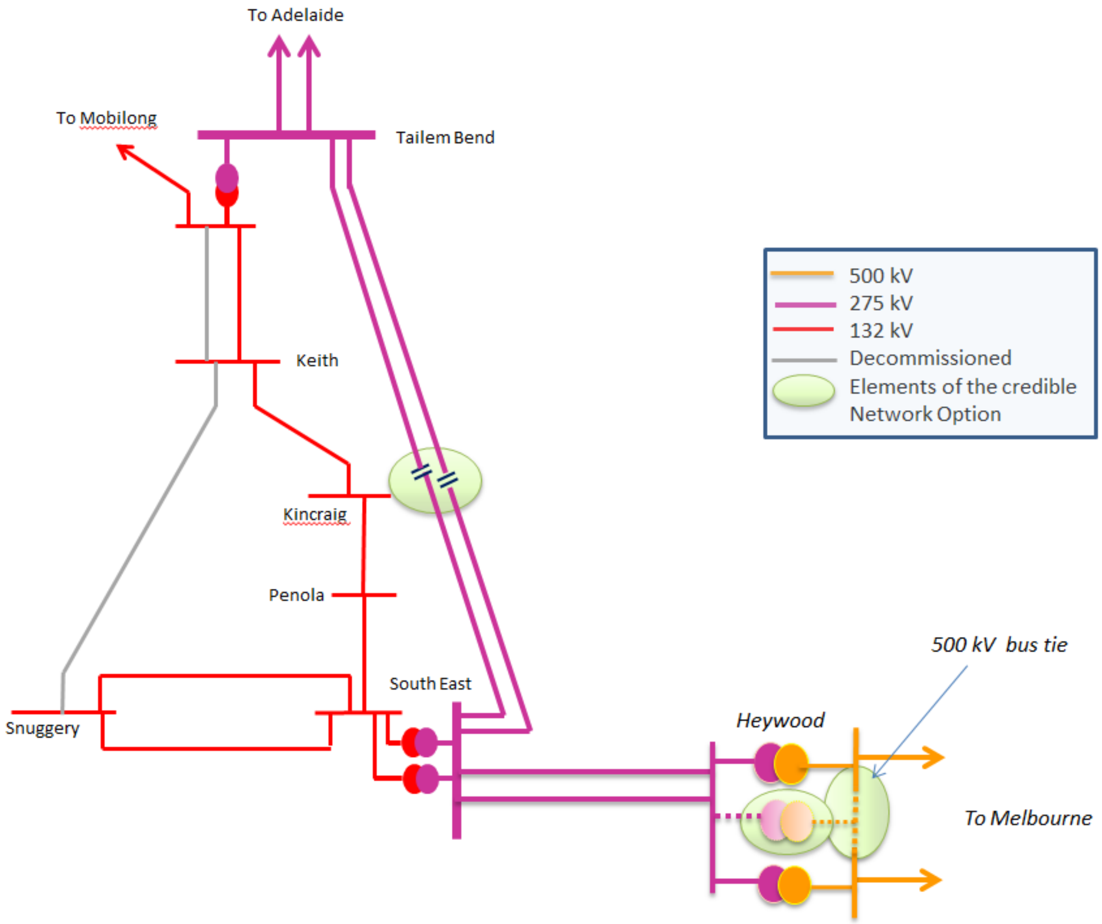
Specifically, the loss of a 275 kV line can overload the parallel 132 kV lines. This constraint has bound for 17.7 hours in 2011. It may be noted that, whilst this constraint has historically impacted on the market for a relatively small number of hours, its influence was correlated with peak demand conditions and had large market impacts. In 2011 estimates of the market impact of this constraint were $544,809/MWh. More recently, with the changing demand profile, this constraint is increasing in both frequency and severity at off peak times.

This section presents a number of load flow studies to explore the impact of the reconfiguration of the 132 kV south east network. All the load flows discussed are based on system snapshots and therefore do not capture the impact of all system operating conditions that may arise in the operation of the power system. Such detailed information is captured by market modelling with the use of constraint equations.

Figure 1 shows the proposed network augmentations related to the Heywood Interconnector RIT-T preferred option. A number of plant and protection limitations on the 275 and 132 kV networks in the South East region of South Australia will also be addressed as part of Otion 1b. This is included in the load flow studies.

Power flow drawings indicate MW flows and % of rating for each line and transformer.

Figure 1 : Proposed Network Augmentations



With the increase in Heywood interconnector transfer capacity from 460 to 650 MW, the intra-regional thermal constraints will increase in significance if not addressed. Table 1 shows the comparison of the thermal Heywood import capability before and after the proposed network augmentation. Estimates of the impact of constraints on Heywood interconnector flows are based on peak demand conditions unless otherwise stated. The 132 kV thermal limits will be more limiting on flows across Heywood under lower demand conditions.

Table 1: comparison of thermal constraints for import into South Australia

Configuration	Thermal Limit (MW)	Reason
Existing	**420 to 490***	Overloading of weak Snuggery-Keith and Keith-Tailem Bend lines on loss of either the 275 kV lines or loss of the parallel 132 kV line
Proposed	**600 to 650**	Overload of 275 kV line from South East to Tailem Bend on loss of parallel circuit; Loss of Tailem Bend to Tungkillo line may overload the Tailem Bend to Mobilong 132 kV line

** The current limit depends on a number of parameters and hence a wide range*

It may be noted that the weak 132 kV lines in the existing arrangements (shown on Figure 1 in grey) will limit the interconnector import capability to about the existing capability. The proposed augmentation will increase that capability to the new desired capability of 650 MW.

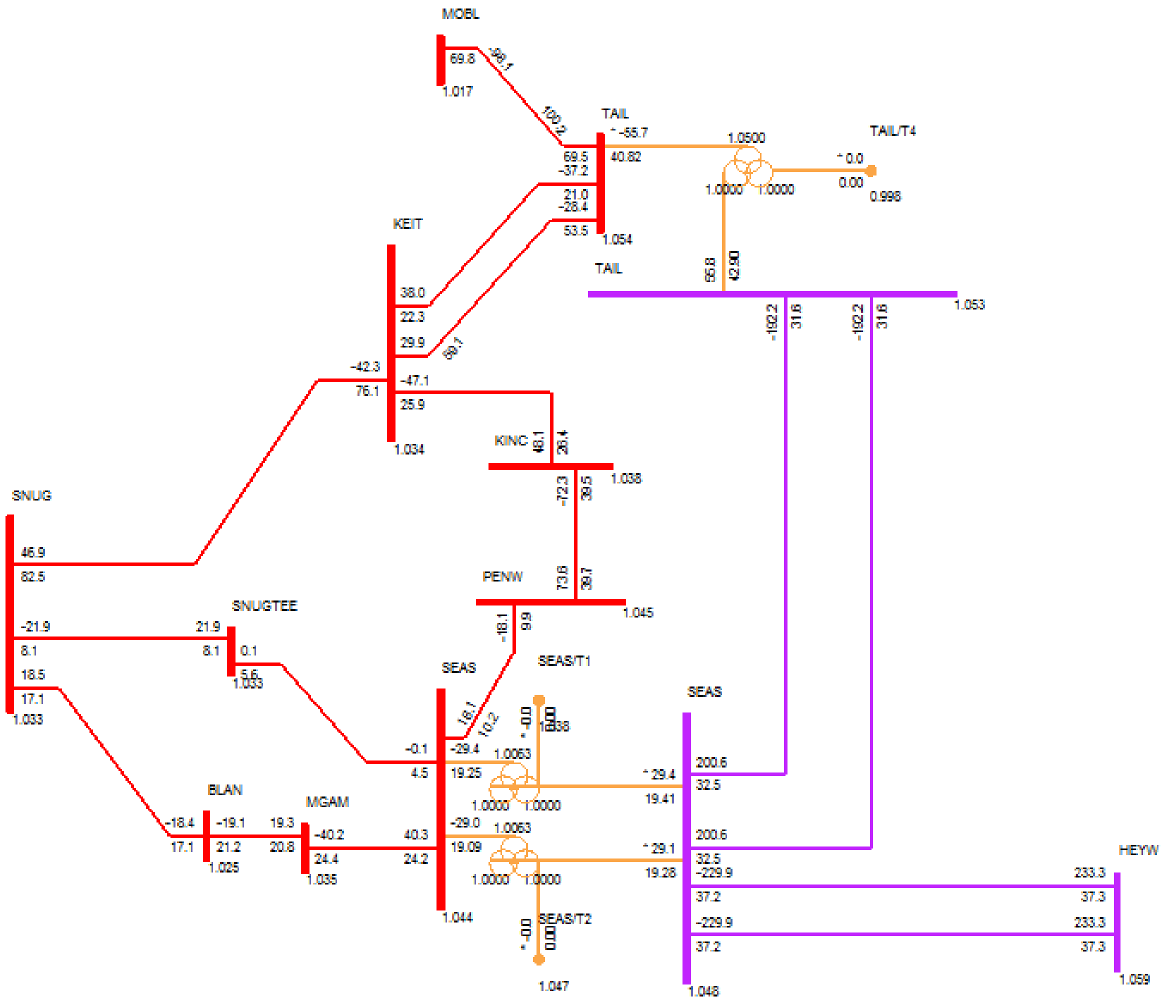
GDF Suez has raised the issue of the impact of the proposed network augmentation on the ability of its generators to access the market. The following figures demonstrate that the augmentation improves network access.

Load flows shown represent peak load conditions in South Australia with maximum import via the Heywood interconnector. All conventional generators in the south east region are operating at maximum output, wind farms are operating at 8% of installed capacity.

Figures 2 and 3 show load flows assuming imports of 460 MW from Victoria at peak load times on the network capability in the South East region. The load flows consider system normal conditions with all elements in service and the consideration of the worst case contingency (N-1).

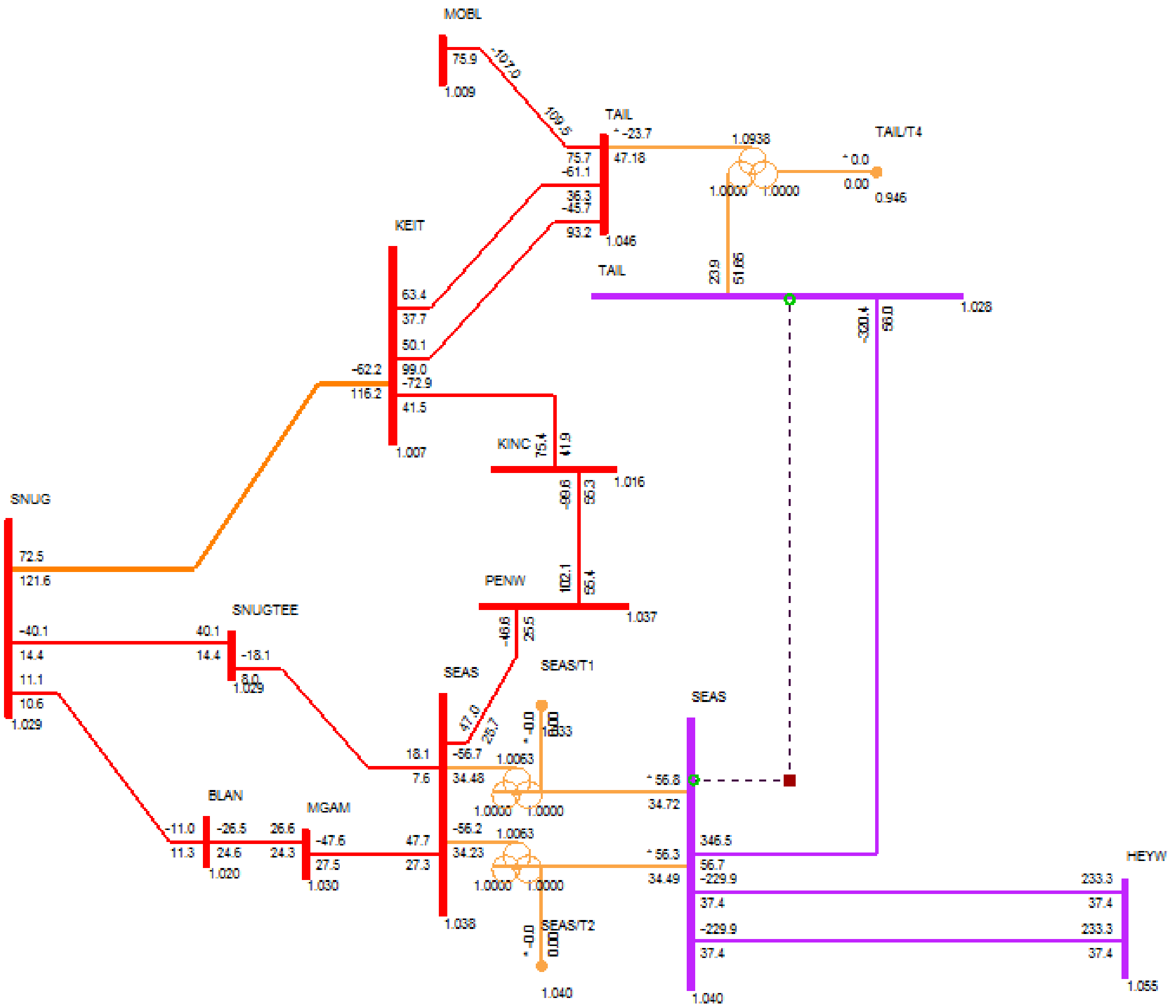
Lines in orange indicate an overload of that element. Dashed lines indicate the worst case contingency. Transformers are in yellow.

Figure 2: Existing system with 460 MW import (system Normal)



In Figure 2, no contingencies are considered and all lines are within limits.

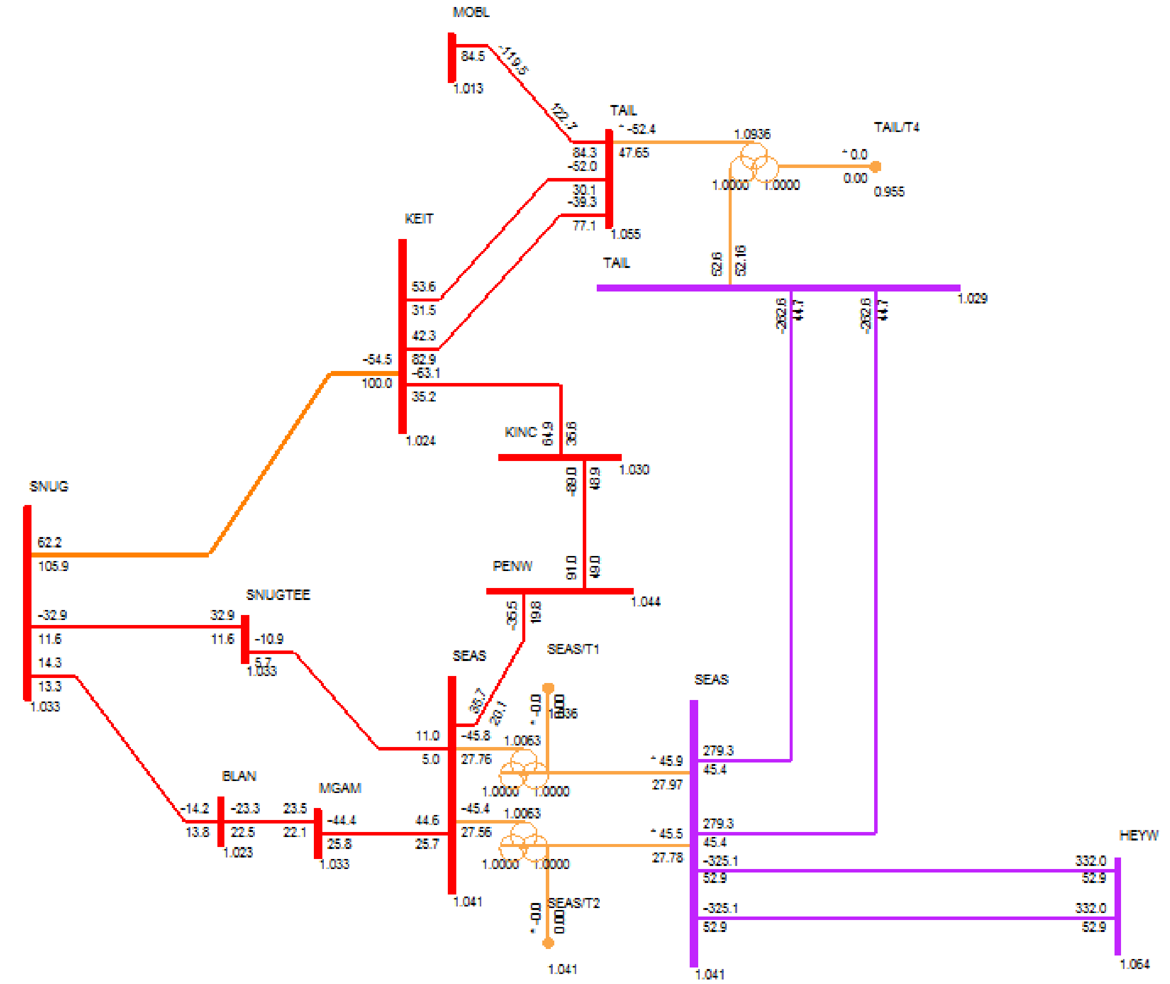
Figure 3: Existing system with 460 MW import (N-1)



In this load flow – with the consideration of the loss of the South East to Tailem Bend 275 kV line, there is a **22**% overload of the Snuggery-Keith 132 kV line. Constraints will prevent the interconnector and/or generators in the south east from reaching this dispatch pattern due to the overload.

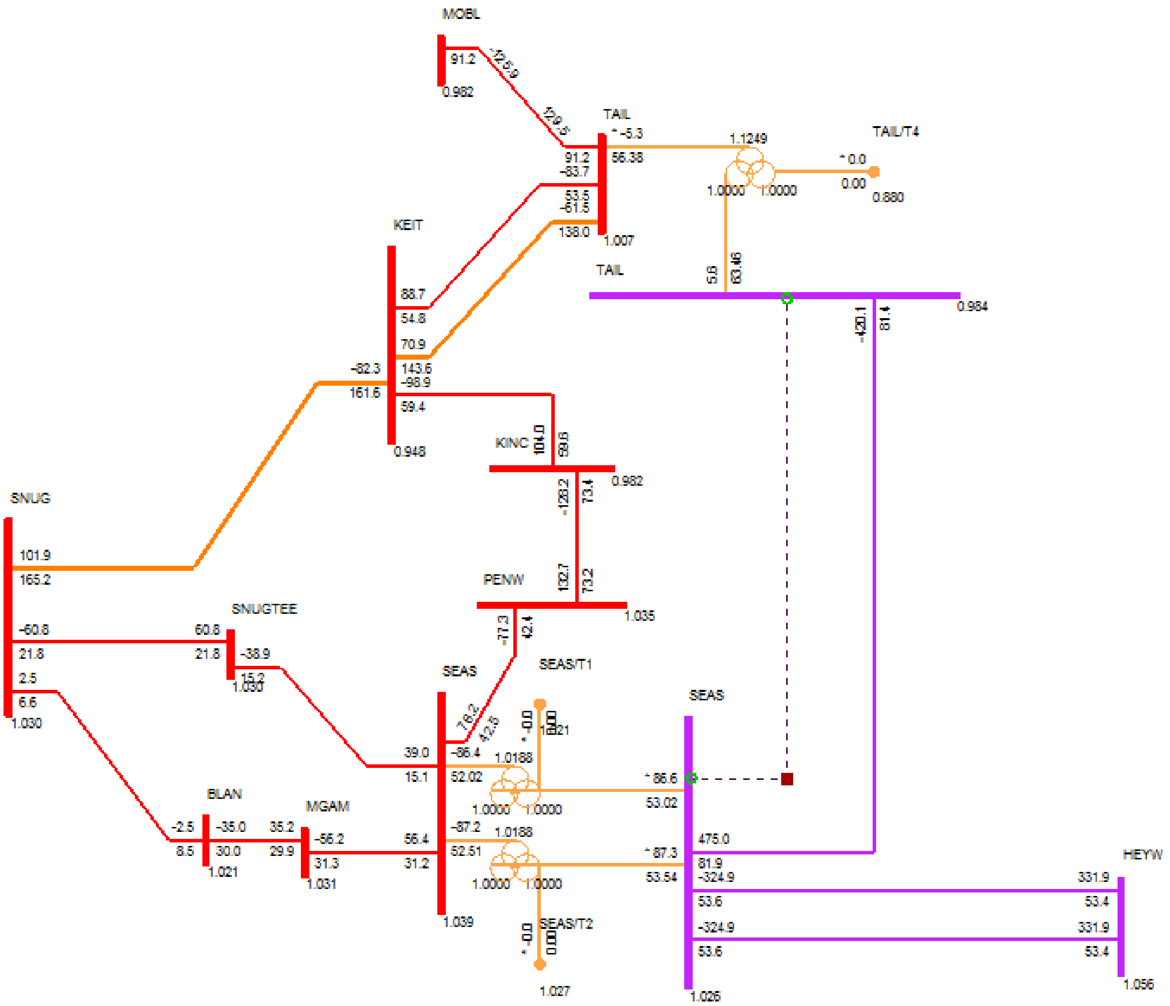
Figures 4 and 5 show load flows and the impact of a contingency at peak load times on the existing network capability in the South East region, with increased interconnector capacity to 650 MW

Figure 4: Existing system with 650 MW import (system Normal)



Under system normal conditions, before consideration of contingencies, there is a 6% overload of the Snuggery-Keith 132 kV line with imports of 650 MW from Heywood.

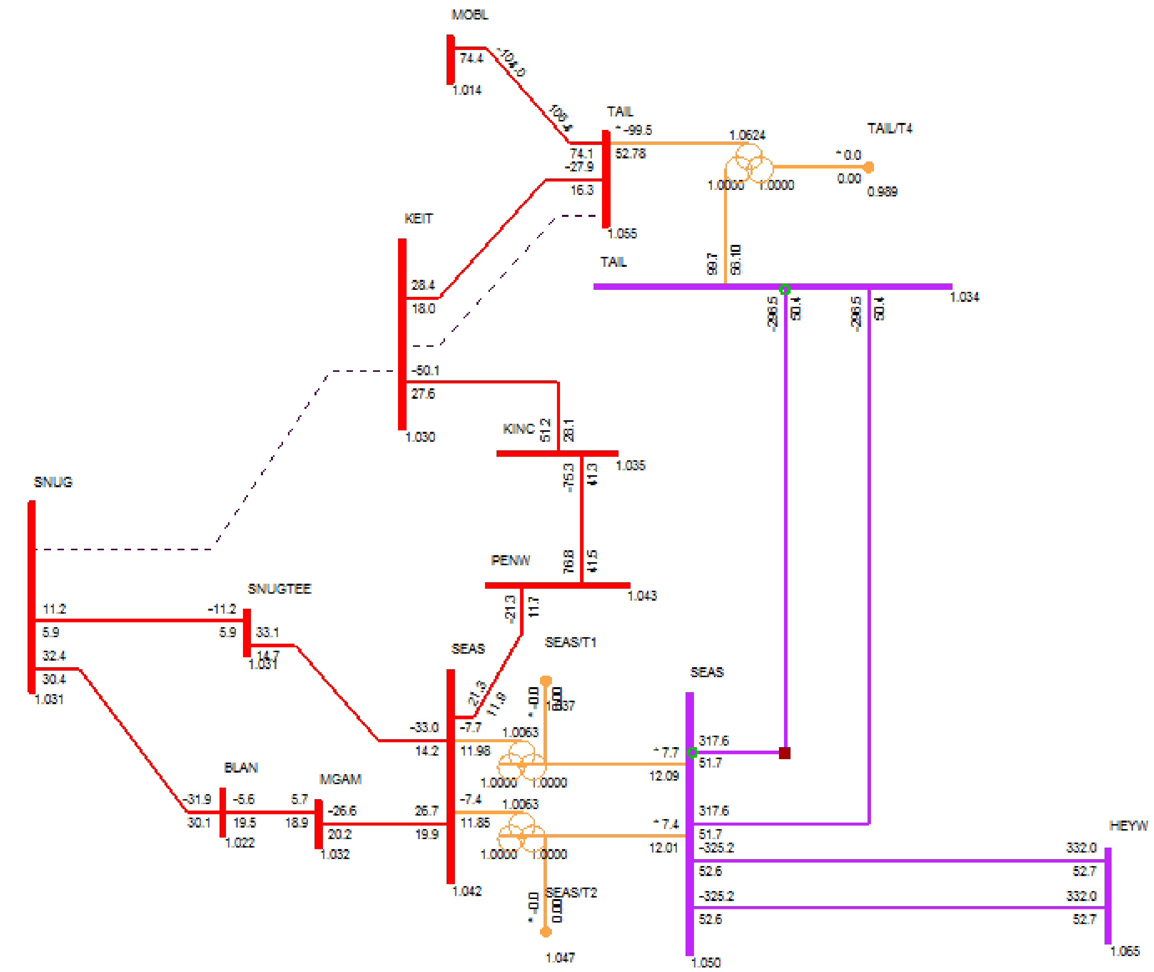
Figure 5: Existing system with 650 MW import (N-1)



There is a **65**% overloading of the on the Snuggery-Keith line and **44**% on the Keith-Tailem Bend#1 line after consideration of flows after a credible contingency on the South East and Tailem Bend 275 kV line.

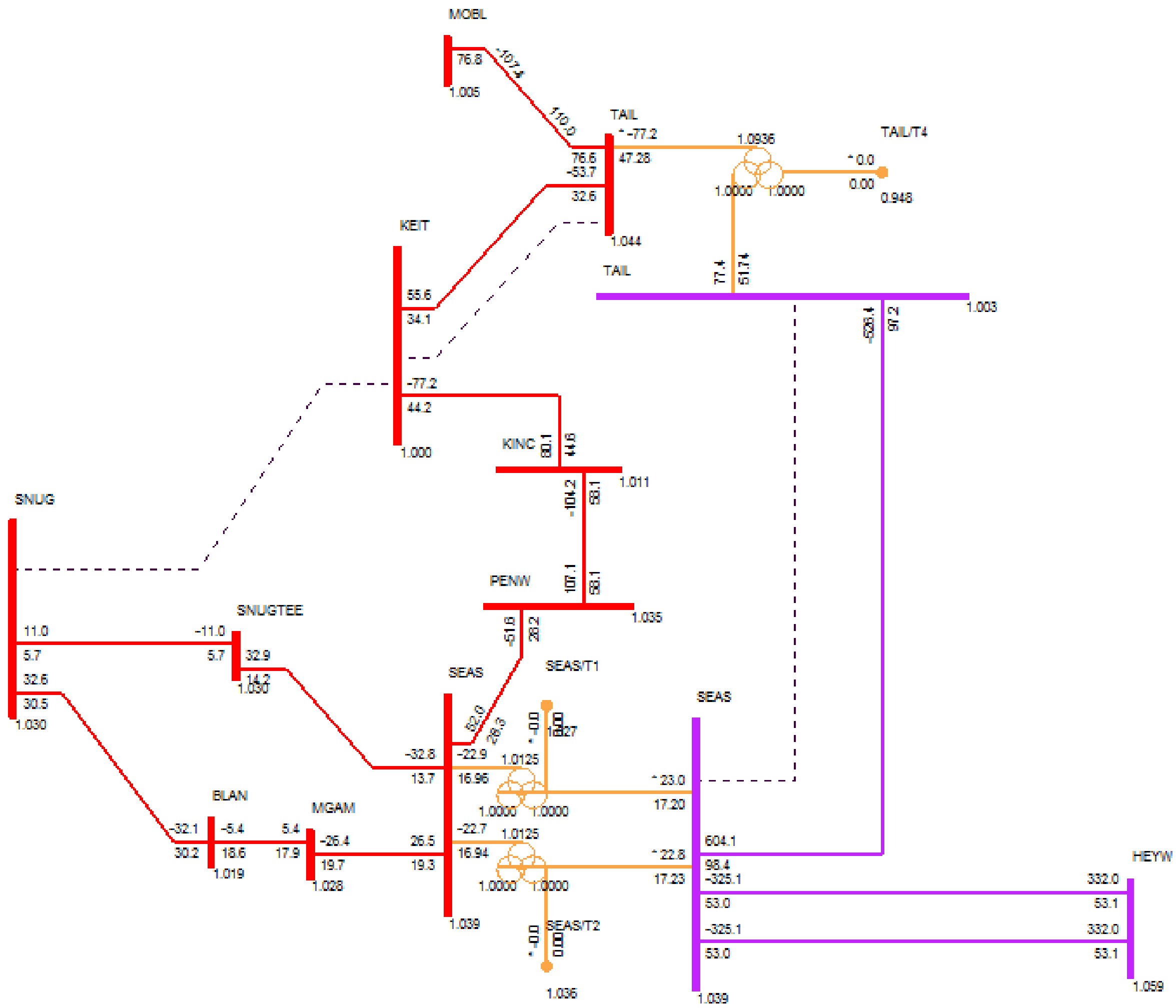
The following load flows show the impact of a contingency at peak load times with the network augmentations as per Otion 1b and increased interconnector capacity of 650 MW. The dashed lines on the 132 kV network between Snuggery to Keith and Keith to Tailem Bend are decommissioned.

Figure 6: Augmented system with 650 MW import (system Normal)



All lines are within limits.

Figure 7: Augmented system with 650 MW import (N-1)



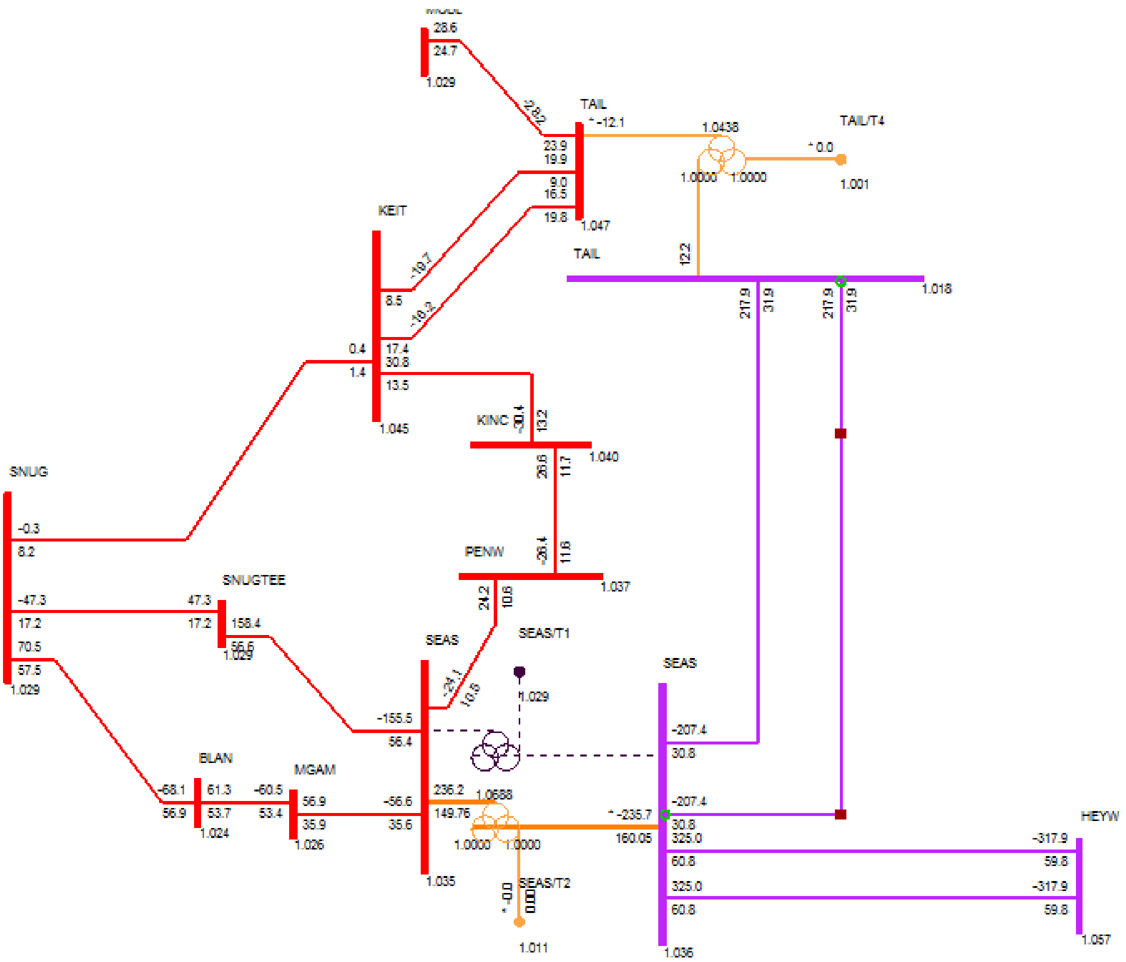
It may be noted that none of the lines are overloaded and therefore no constraints will be applied to the South East generators for high load, high import and low wind generator conditions. This clearly demonstrates that with the proposed network augmentations, the generators in South East will have improved access to the network.

The issue of reduced network access following the proposed augmentation has been raised, due to limitations imposed by the South East transformers under light load and high wind conditions. The following demonstrates that the South East transformer constraint will actually be reduced with the augmentation of the network.

Load Flows shown represent light load conditions in SA with maximum export via the Heywood interconnector. It may be noted that in this snapshot, all OCGTs are off, and wind farms are at 75 to 80% output. Conventional generation elsewhere in SA is turned on to maintain the load-generation balance.

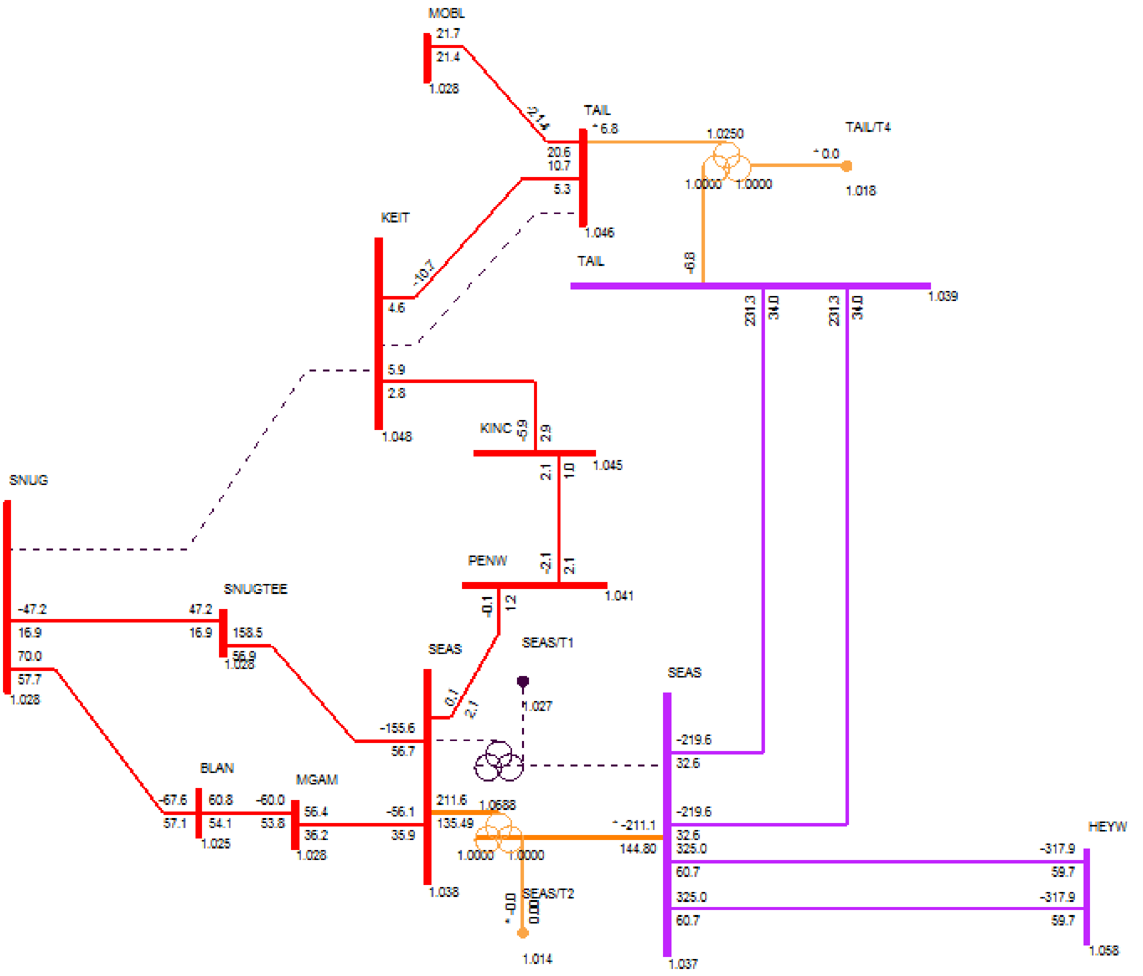
The following load flows show the impact of a contingency – the loss of a South East Transformer during a time of light loading on the network capability.

Figure 8: Existing system with 650 MW Export (with contingency of a South East Transformer)



The remaining transformer is overloaded by 60%.

Figure 9: Augmented system with 650 MW Export (with contingency of a South East Transformer)



It may be noted that the remaining transformer remains overloaded, but the overload has reduced to 45%. The impact on generators will hence be reduced. Power flows on the 132 kV network from north to south are reduced after the proposed network augmentation, due to reduced impedance of the 275 kV network. The reduced impedance is from series compensation partially offset by the removal of one of the two 132 kV parallel paths.

No other significant constraints are expected for export out of South Australia, as exports occur at times when conditions allow the use of the highest network ratings.

1.3. Network modelling – voltage stability constraints

Voltage stability constraints limit imports into South Australia across the Heywood interconnector. The limitation is caused by the loss of the largest generating unit within South Australia; this is typically the loss of a Northern Power Station unit[2]. The Northern Power Station is remote from the load centre and the largest generator in South Australia. This constraint has bound for 577 and 1,121 hours in 2011 and 2012 respectively.

Import capability from Victoria will be increased under Otion 1b. The network assessment was based on increasing the Heywood Interconnector transfer capacity for import into South Australia from 460 MW to 650 MW. Table 2 shows the benefits provided by the proposed network configuration, compared to the existing network topology.

Table 2: comparison of voltage stability limits for Import into South Australia

Configuration	Voltage Stability Limit (MW)	Reason
Existing	400 to 500*	Trip of largest generating unit in SA causing a voltage stability issue in the South East region
Proposed	>650	

** The current limit depends on a number of parameters and hence a wide range*

It may be noted that a significant amount of reactive support is provided by the series capacitors in the proposed network augmentation. This provides the significant increase in the voltage stability limits. The series capacitors have additional benefits of increasing both transient and oscillatory stability limits, which will allow a robust interconnector import capability under various operating conditions, including during outages.

Export capability from South Australia will be increased under Otion 1b. The network assessment was based on increasing the Heywood Interconnector transfer capacity for export out of South Australia from 460 MW to 650 MW. Table 3 shows the benefits provided by the proposed network configuration, compared to the existing network topology.

Table 3: comparison of voltage stability limits for export out of South Australia

Configuration	Voltage Stability Limit (MW)	Reason
Existing	**520-570***	Trip of Olympic Dam load at times of light load and high export causes voltage limitations in the South East region
Proposed	**>650**	

** The current limit depends on a number of parameters and hence a wide range*

[2] With Northern off line or at low output, other generators may become the limiting factor.

1.4. Modelling assumptions

Frontier has reviewed the input assumptions to the Heywood interconnector RIT-T and concluded that they are reasonable. Page 28 of the Frontier report identifies some questions in relation to ElectraNet and AEMO's analysis. ElectraNet and AEMO have provided copies of this data in Attachment C.

The fuel cost information was derived from ACIL Tasman consultancy commissioned by AEMO. This only provided fuel cost projections to 2030. In most cases, the modelling extrapolated from the final 10-years of data (from 2020 to 2029) to project fuel cost assumptions for 2030-39.

The exceptions were Swanbank B, Macquarie Generation (Liddell, Bayswater), Gladstone, Eraring Energy, Delta Western, and Delta Coastal (Vales Point, Munmorah) coal, which levelled off and assumed the 2029 cost for the years 2030 to 2039.

The following information is provided in accompanying data files:

1. Flow and limit information across the Heywood interconnector have been provided in attachment B.
2. Fuel cost assumptions used in the modelling to 2039-40 have been provided in attachment C.

2. MEU submission

The Major Energy Users (MEU) expressed concern about market power, particularly within South Australia. ElectraNet and AEMO have gone to significant effort to find a solution that maximises market benefits to all who consume and generate electricity. AEMO and ElectraNet consider the RIT-T process has been effective in delivering an outcome that aligns with consumers best interests. The MEU is supportive of the preferred option.

3. GDF Suez (GDF) Submission

The following sections each address the key concerns raised by GDF Suez in its submission to the AER.

3.1. Consultation process and transparency

Significant effort was made in the PACR to address GDF's concerns regarding increased congestion in the south east (see pages 68-71). In discussions with GDF, it was made clear that ElectraNet and AEMO are expecting that congestion in the south east will be reduced with the reconfiguration of the 132 kV network.

In addition to network option development (including load flow) studies (see Section 3.1 of the PACR), the full set of network constraint equations reflecting the congestion changes was released in December 2012 at the request of stakeholders, one of which was GDF. This information allows stakeholders to perform their own analysis on the potential impacts of the reconfiguration may have on GDF's portfolio. GDF and the market more generally will be kept informed of the progress and potential developments throughout the design and construction phase through the ElectraNet and AEMO Annual Planning Reports and AEMO's NTNDP.

Individual load flow studies were not released at the time as they provide only a snapshot of the network. The constraints can be modelled over a range of operating conditions to demonstrate the reduction of congestion following Option 1b. The constraints were released as a better method to demonstrate the improvement to the network's capability.

ElectraNet and AEMO held two public forums, also meeting with and providing follow-up information to GDF following each of its submissions to clarify concerns raised.

3.2. Identification of options

The Heywood upgrade explored multiple network and non-network options. This included multiple control schemes.

Potential options proposed after the PADR were also considered and only discontinued after careful consideration of the merits of the individual options and the potential for future implementation or investigation into the proposed option. Each option considered is explored in section 4.13 of the PACR.

For example, the South East transformer control scheme was proposed in addition to Option 1b. The addition of this South East transformer control scheme to manage exports from the 132 kV network underwent considerable analysis and was not assessed as economic at the time the PACR was published. ElectraNet and AEMO concluded that this scheme can be assessed separately, without altering the conclusions of the preferred option or biasing any decisions on the additional control scheme that may be made at a later date.

ElectraNet is currently working with SA Power Networks and Kimberly-Clark Australia (KCA) on the connection of new embedded generation in the vicinity of the Snuggery connection point. This is expected to lead to lower future demand in south east of South Australia and increase the cost of constraints.

A review of the analysis into the South East transformer control scheme now indicates there are sufficient benefits created by the control scheme to reasonably conclude that it is beneficial to the long term interests of the NEM should the load in the south east of South Australia fall.

The certainty of the KCA load reduction has increased subsequent to finalising the analysis for the PACR. Under these conditions the PACR findings support a South East transformer control scheme as part of the preferred option. For this reason ElectraNet proposes to include the South East control scheme in the scope of the Heywood Interconnector Upgrade project.

3.3. Non-network options

Non-network options and control schemes were considered on an equivalent basis to network options, including the employment of an independent consultant to evaluate the feasibility and further the design of the control schemes proposed.

The GDF submission indicates that the reasons for the selection of the preferred option are legitimate.

3.4. Modelling and key assumptions

The GDF submission implies that the RIT-T assumptions regarding the RET target were a 'second-guessing' approach.

The modelling assumed the most recent information available at the time. In particular, the RET was modelled based on the current design of the policy. The approach was in fact the opposite of 'second-guessing' in that, in the absence of any update on the target, the current policy was used.

All assumptions were based on AEMO and ElectraNet's understanding at the time they were made. Specific assumptions raised were revised and tested in the fourth scenario. This was discussed on pages 63 and 64 of the PACR.

That the assumptions in relation to Playford and Hazelwood were found to be immaterial to the outcome does not raise questions as to the validity of assumptions made or the transparency of the process.

3.5. Interstate constraints

All material constraints were modelled in the RIT-T. This has been discussed in meetings with stakeholders, in appendix D.5 of the PADR, section 4.16 of the PACR, and the released full set of constraint equations modelled.

3.6. Interactions with the RET and jurisdictional influence

ElectraNet and AEMO will only comment on the diligence applied in ensuring the RIT-T assessment was conducted to an appropriately high standard. Every endeavour was made to ensure that material aspects of the power system's operation were represented to capture relevant classes of market benefits, and that the treatment of credible options was consistent. As a result, no response will be made to the GDF issues raised in relation to the RET and the RIT-T process defined in the Rules, since they are outside the control of either organisation.

GDF has questioned the role of the South Australian government in this RIT-T. ElectraNet and AEMO note that, as per other interested parties who provided submissions, the South Australian Minister for Mineral Resources and Energy is equally an interested party under the NER whose submission was also provided due consideration.

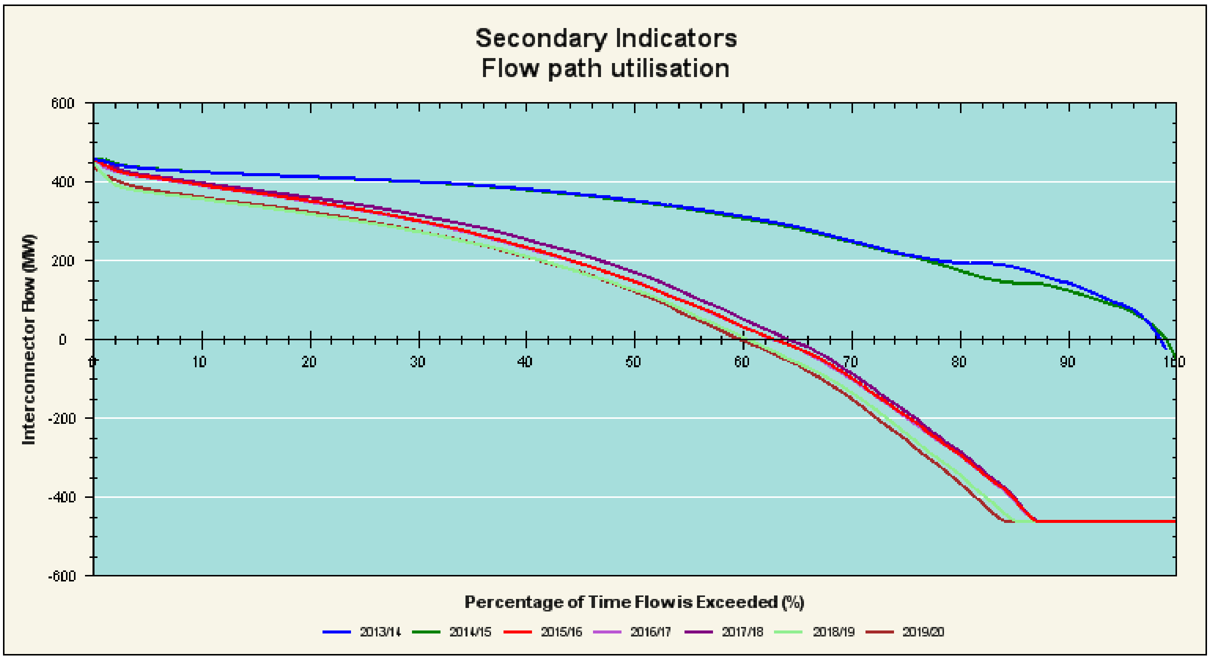
Attachment B: Hourly flow information – Revised Central Scenario

Flow Path Utilisation data

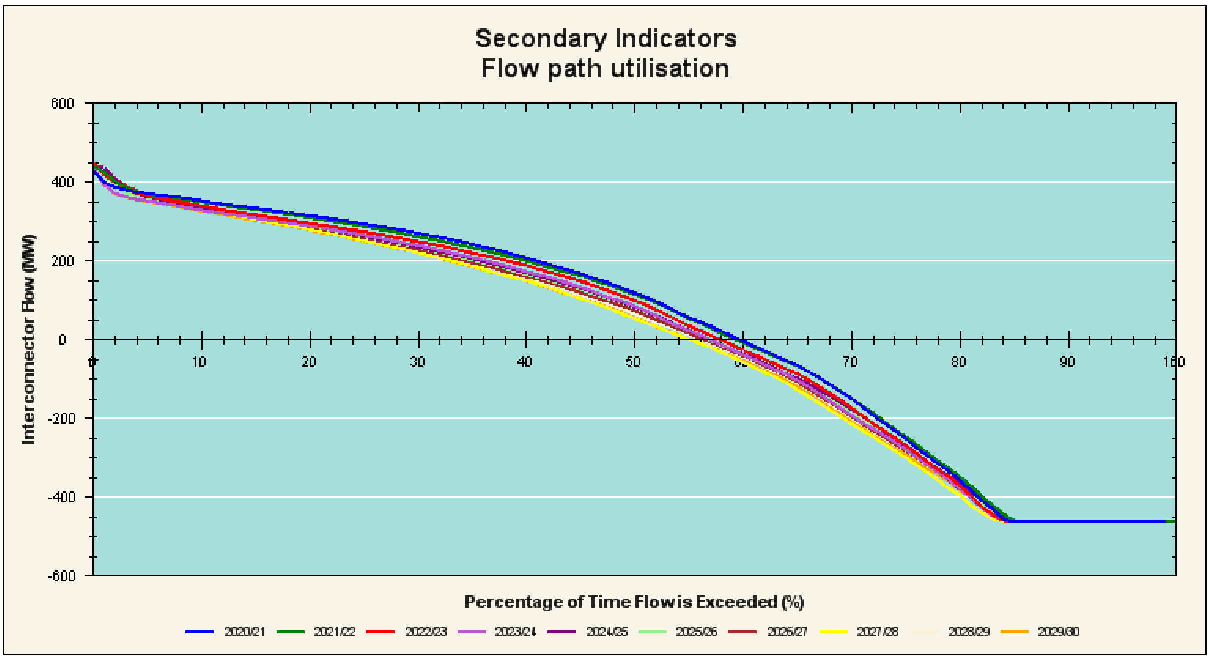
The following graphs present flow duration curves for the Heywood interconnector for Option 1b, and the base case. Multiple years are presented on each graph. Flow duration curves give an indication of the utilisation of the interconnector. Comparisons between the base case and the augmentation give an indication of the increased capacity and the frequency with which it is utilised.

Base case

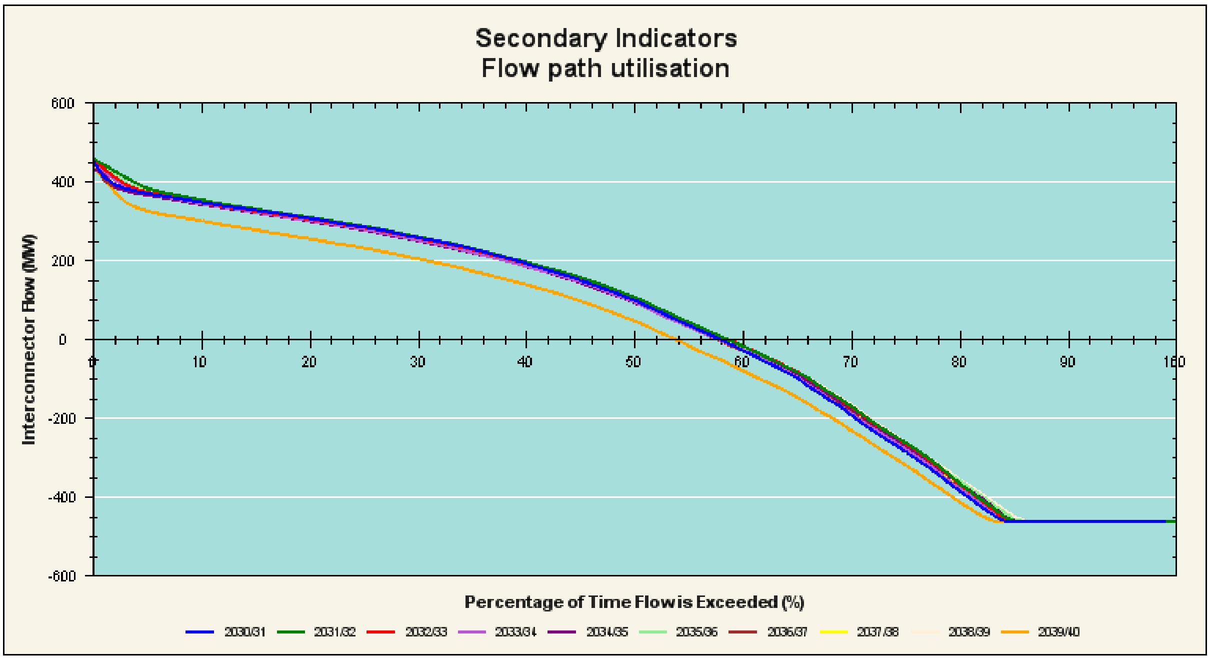
VIC-SA flow path utilisation 2013/14 – 2019/20



VIC-SA flow path utilisation 2020/21 – 2029/30

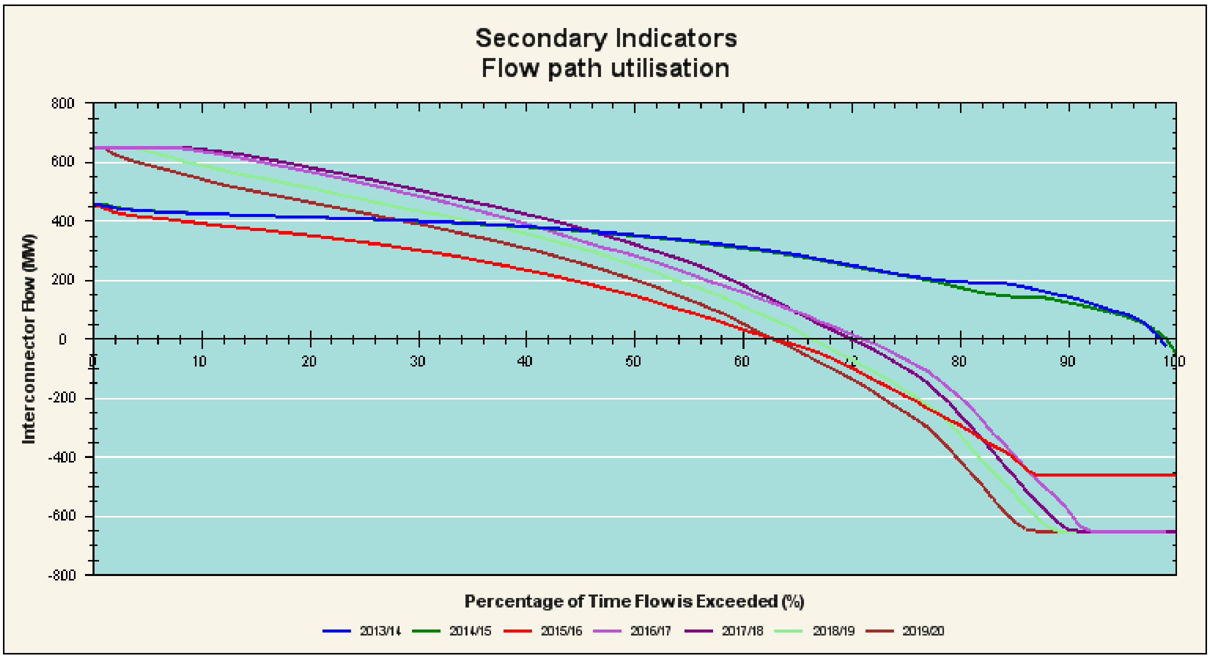


VIC-SA flow path utilisation 2030/31 – 2039/40

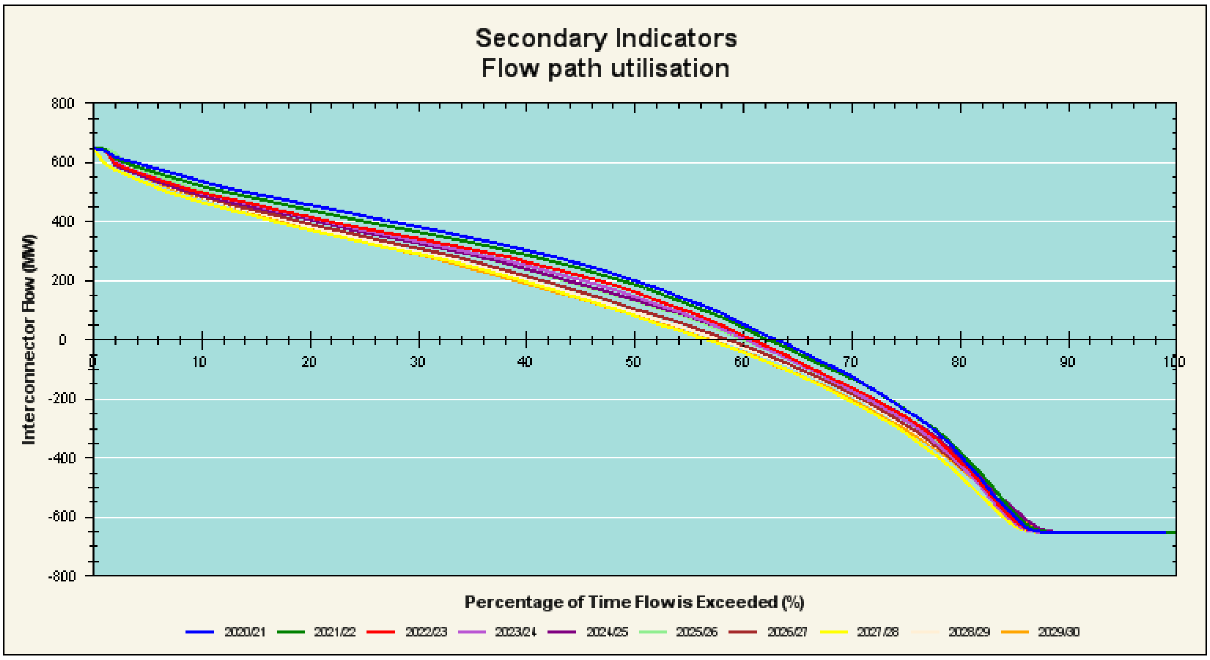


<u>Option 1b: Split132+sc + Heywood transformer</u>

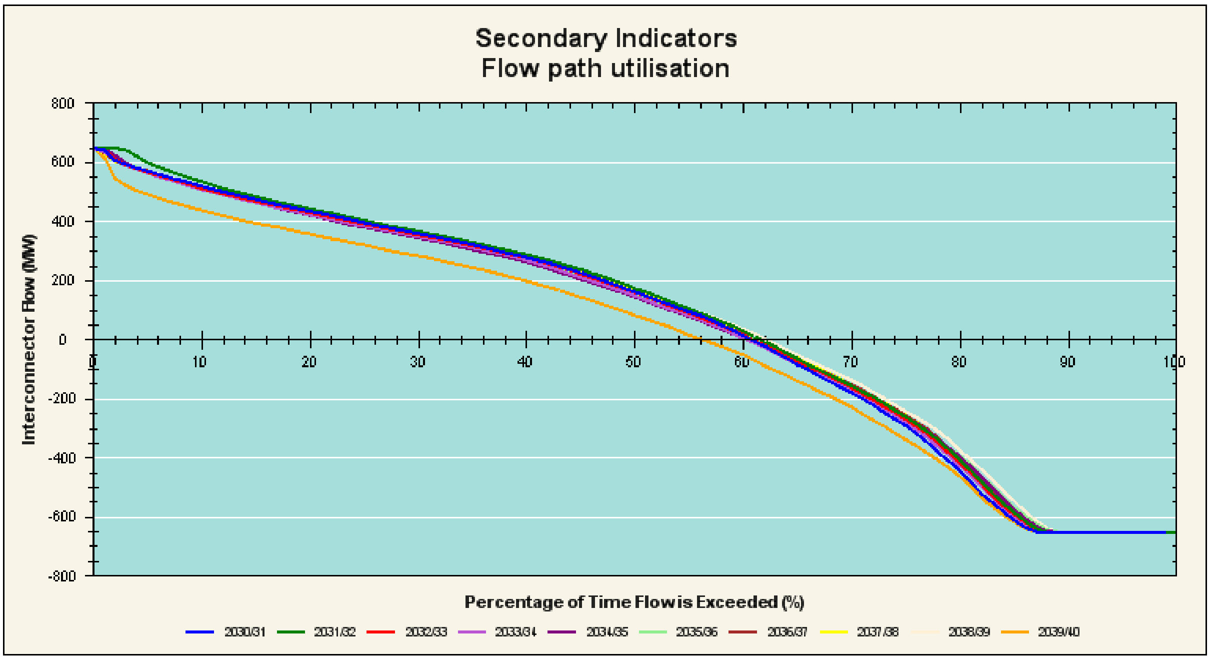
VIC-SA flow path utilisation 2013/14 – 2019/20



VIC-SA flow path utilisation 2020/21 – 2029/30



VIC-SA flow path utilisation 2030/31 – 2039/40

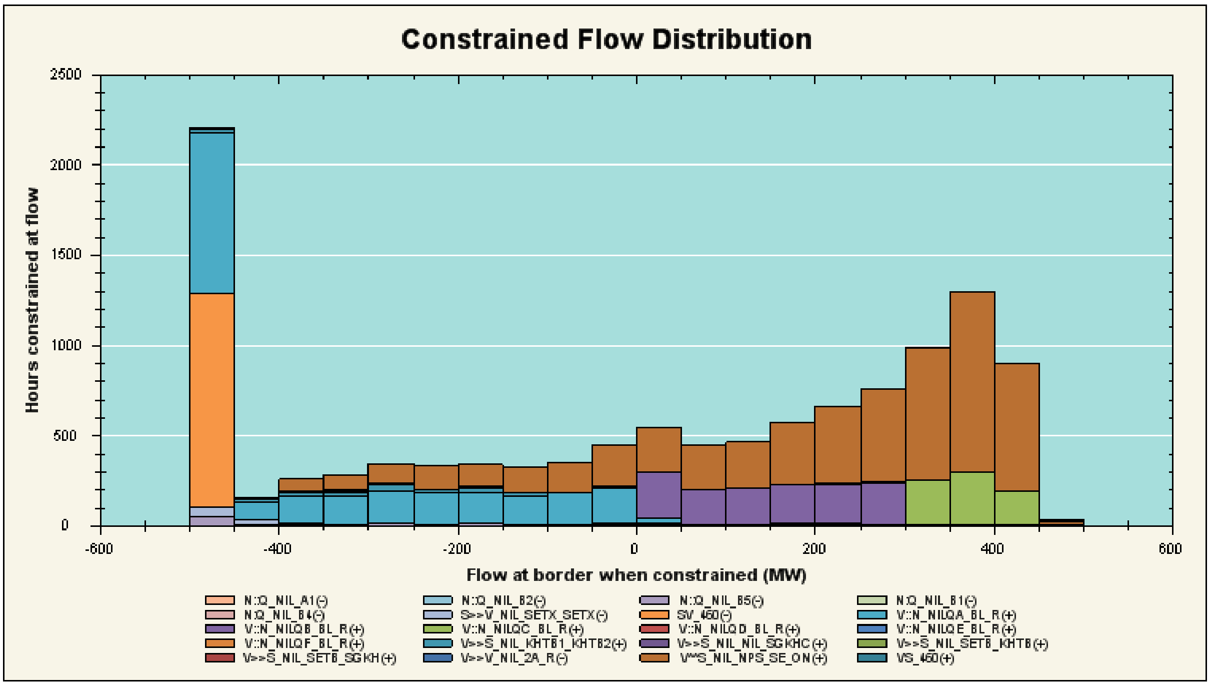


Binding Constraint Distribution data

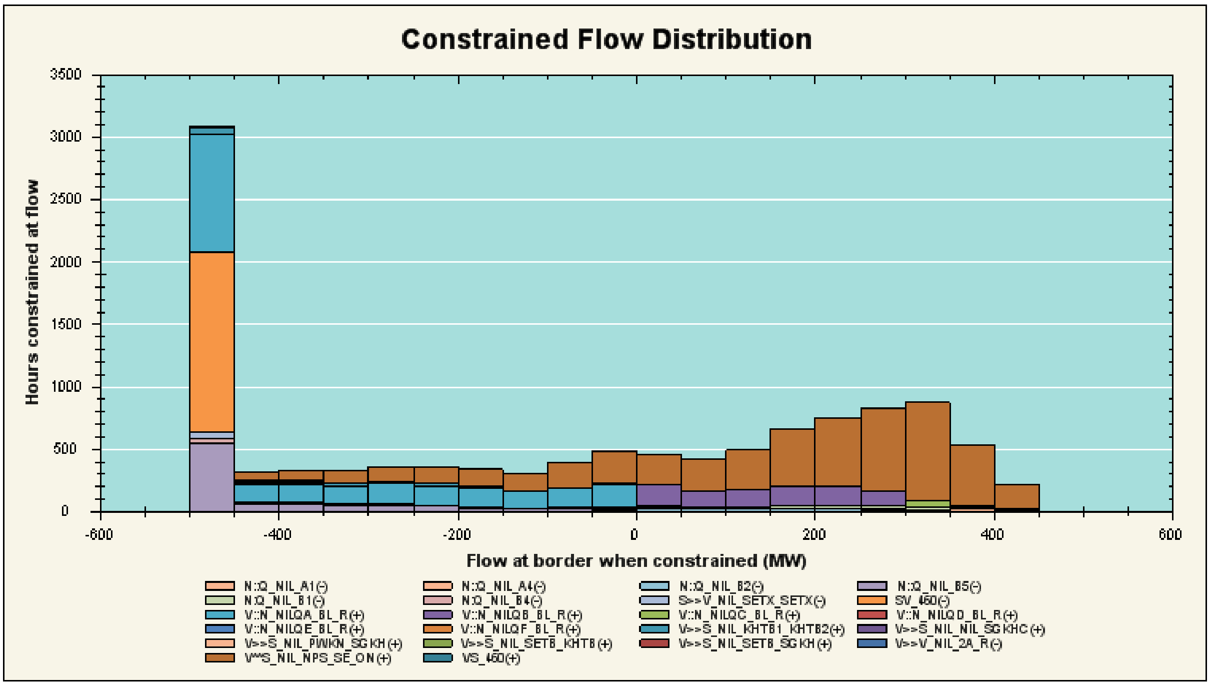
The constraint distributions indicate the range of constraints that are binding and the flows on the interconnector when they bind. Snap shots are presented below for the years 2016-17, 2026-27 and 2036-37. These graphs can be useful to observe the range of conditions that will be relieved following the augmentation.

<u>Base case</u>

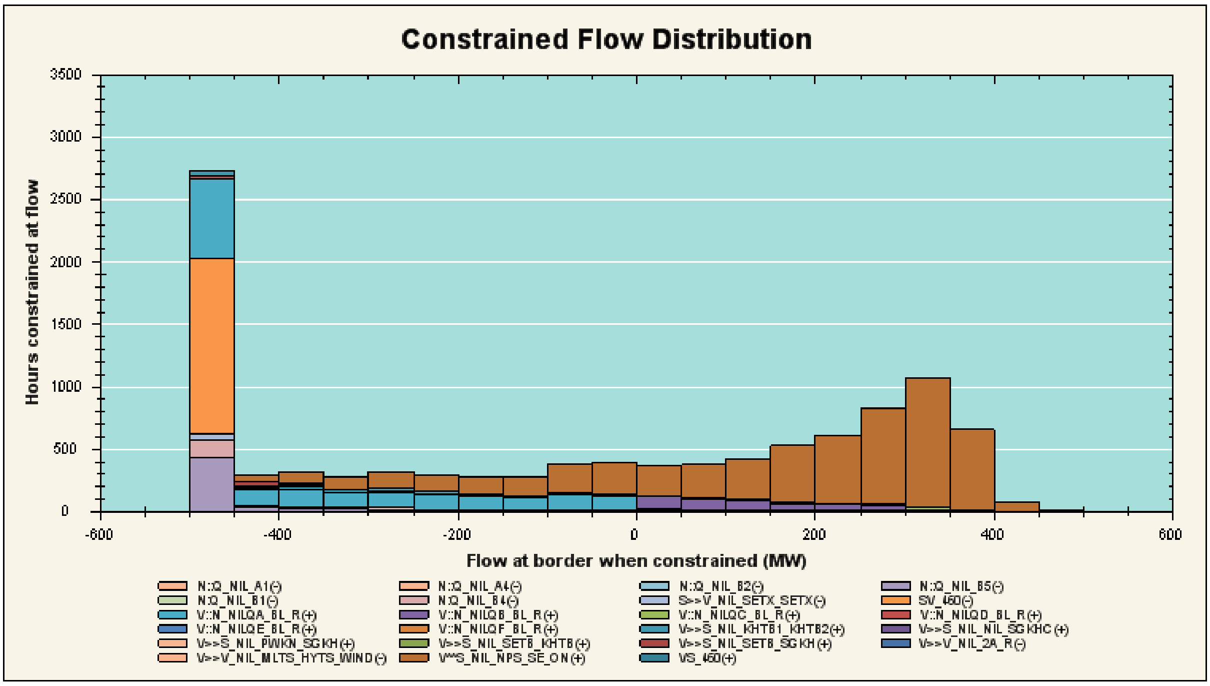
VIC-SA binding constraint distribution 2016/17



VIC-SA binding constraint distribution 2026/27

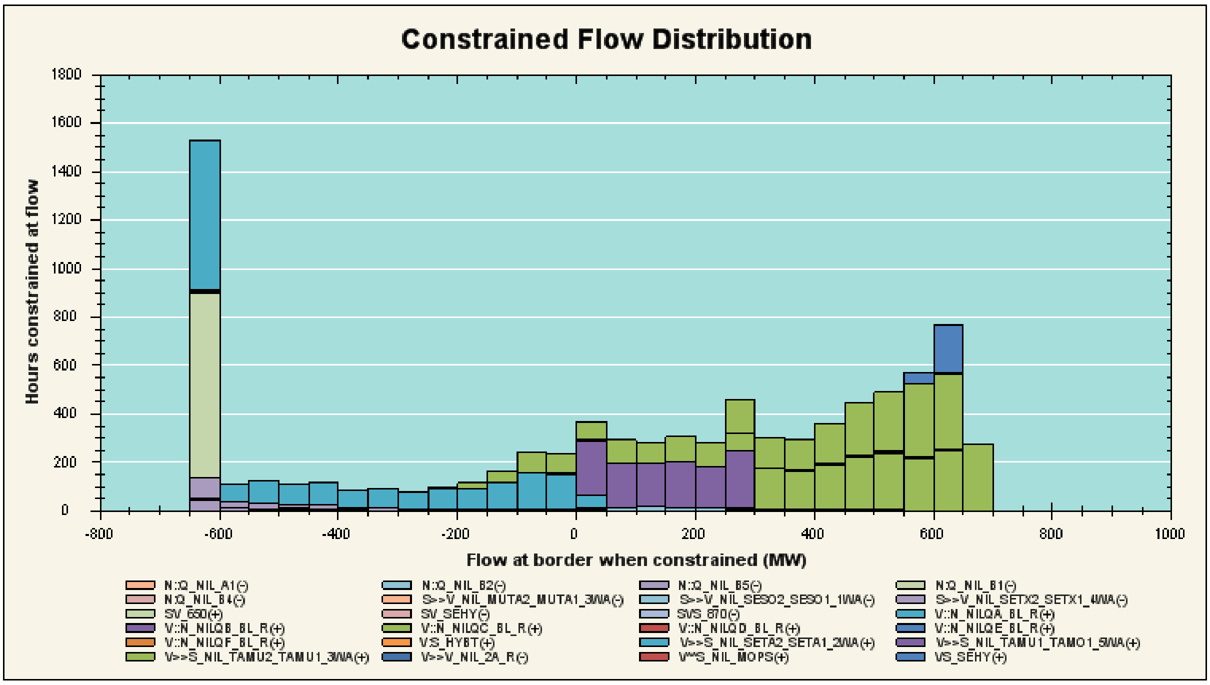


VIC-SA binding constraint distribution 2036/37

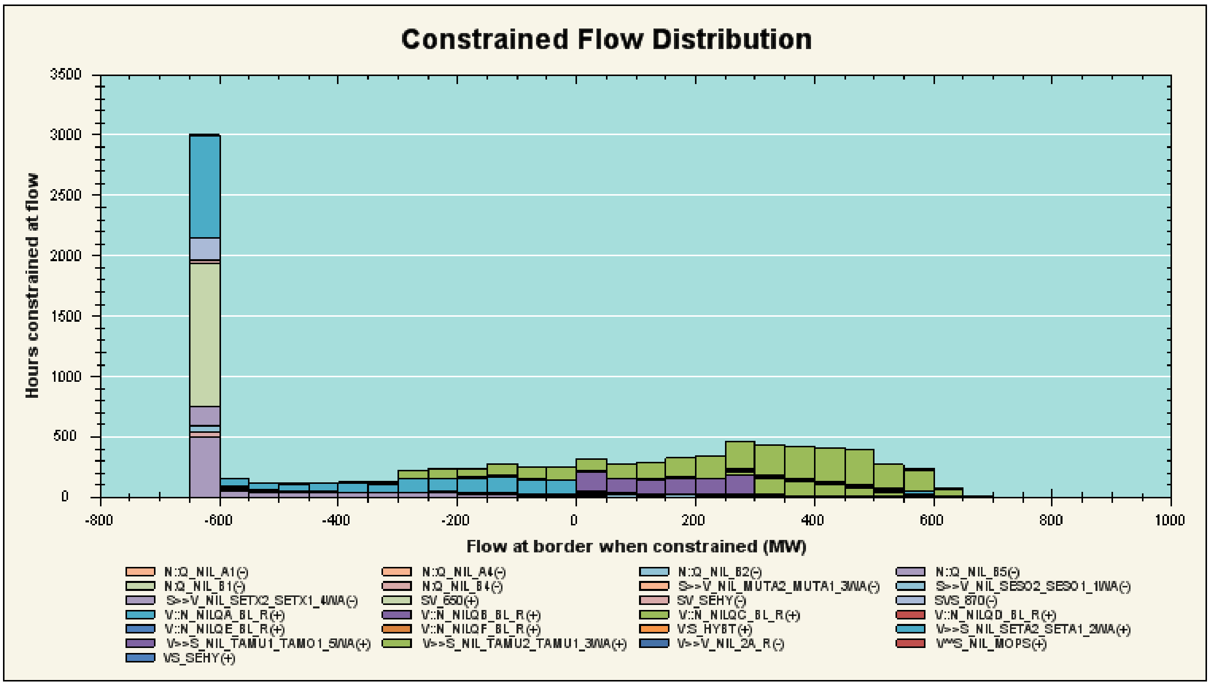


Option 1b: Split132+sc + Heywood transformer

VIC-SA binding constraint distribution 2016/17



VIC-SA binding constraint distribution 2026/27



VIC-SA binding constraint distribution 2036/37