

# OPTIONS EVALUATION REPORT (OER)



Network Support and Control Ancillary Services  
Southern NSW Absorbing Reactive Power Support

OER 000000001569 revision 2.0

**Ellipse project description:** P0009225 - Provision of NSCAS in Southern NSW  
**TRIM file:** [TRIM No]

**Project reason:** To maintain network security

**Project category:** Prescribed - Augmentation

## Approvals

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<b>Date submitted for approval</b>	8 December 2016	

## 1. Need/Opportunity

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AEMO has procured NSCAS under the two following agreements for the period from 30 June 2013 to 30 June 2019.

- > Agreement for generation support: AEMO has an NSCAS agreement for the provision of VCAS by generation units running as synchronous condensers from 1 July 2013 to 30 June 2018. VCAS costs are based on actual usage of the service, which has been progressively reduced since TransGrid commissioned its first reactor at Yass 330/132 kV substation.
- > Agreement with TransGrid: AEMO has procured 800 MVar absorbing VCAS from TransGrid, primarily using new network assets, including reactors at Murray Switching Station and Yass Substation. Provision of full VCAS service under this agreement commenced from 31 March 2014 and will end by 30 June 2019.

AEMO advised in their 2015 NTNDP that:

*“AEMO has identified an NSCAS gap of about 150 MVar absorbing reactive power capability to manage potential high voltage likely to occur in Kangaroo Valley after the expiry of one of the two existing NSCAS agreements in June 2018. This NSCAS gap was identified on the assumption that the absorbing reactive power capability provided by TransGrid’s existing NSCAS agreement, remains unchanged. “*

In the early morning on 6/9/2015, there was low demand in both Victoria and NSW, and low interconnector flows from Victoria to NSW. After all operational options to suppress the voltage in Southern NSW were exhausted, including dispatching 5 TransGrid reactors at Yass and Murray, AEMO was required to dispatch two of Snowy Hydro’s synchronous condensers (SCOs) units, Tumut 3 G2 and Murray2 G11, to avoid post contingency high voltage violations at Upper Tumut and Kangaroo Valley 330 kV.

TransGrid’s assessment shows that the reactors (6 x 180 MVar 362 kV shunt reactors at Murray and Yass<sup>1</sup>) presently installed and available in the NSW transmission network will be sufficient to meet the identified NSCAS gap beyond 2018 (after the agreement for generation support expires).

There is an opportunity for TransGrid to provide the required absorbing reactive power services from 2019 onwards. At which time the NSCAS assets could be transitioned to the RAB for the NSCAS services to continue as prescribed services, by utilising the 6x 180 MVar 362 kV shunt reactors at Murray and Yass, which will reduce costs to the market.

For details, refer to [NOS-1569](#).

## 2. Related Needs/Opportunities

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Nil.

## 3. Options

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### Base case

The base case is “do nothing”, forcing AEMO to shed load in southern NSW for maintaining network security under low demand in both Victoria and NSW and low interconnector flow from Victoria to NSW (i.e. to maintain network voltages within the operating limits). This will entail, disconnecting all the loads approximately south of Marulan, under light load periods (i.e. when the southern NSW load is approximately 890 MW).

The base case is not considered credible as under the NER, AEMO is required to take necessary actions to mitigate the situation, if it is economical. The options available to AEMO for mitigating high voltages in the area are described in the following two options, A and B.

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<sup>1</sup> It is assumed that 6 x 180 MVar 362 kV shunt reactors at Murray and Yass instead of procured 800 MVar reactors to absorb VCAS after the “Agreement for Generation Support” expires in June 2018.

### Base case risk cost

The risk cost was calculated to be \$136.53 million using TransGrid's Risk Tool (See Appendix A for a summary report). This risk cost has been calculated as follows:

$$VCR \text{ risk cost} = USE \text{ in MWh} * VCR^2$$

$$= (\text{load at risk during light load time} * \text{expected risk hours per year} * VCR) = \left( 890 \text{ MW} * 4 \text{ hrs}^3 * \frac{\$38,350}{\text{MWh}} \right)$$

$$= \$136.53 \text{ million per annum}$$

### **Option A — AEMO constrain “on” the generation in the area (e.g. Snowy)**

To manage the voltages in southern NSW within the operational limits, AEMO has the option of constraining “on” generation in the region, so that generating plant can also provide the absorbing reactive power NSCAS services. This will entail scheduling generation out of generation offer merit order, causing a significant cost to the NEM participants.

AEMO has been of the view that procurement of NSCAS services is cheaper than this option. While the exact cost of NSCAS contracts with AEMO for providing NSCAS services for managing the voltages in the area are not known because of commercial confidentiality, anecdotal evidence suggests that costs would be in the range of approximately \$50-70 million / year. Hence it is assessed here that the cost of option A is \$50 million / year.

Assuming 10% discount rate and 20 years of planning horizon, the economic NPV of the above option is \$736.68 million. It is expected that the risk cost post Option A will be \$0 using TransGrid's Risk Tool.

### **Option B – AEMO procures NSCAS services as per the NSCAS tender procedure**

To manage the voltages in southern NSW within the operational limits, in the past AEMO has been procuring absorbing reactive power NSCAS services from relevant providers usually from the generators in the area.

While the exact cost of NSCAS contracts with AEMO for providing NSCAS services are not known because of the commercial confidentiality, previous experience suggests that the costs would be in the range of approximately \$50-70 million / year. Hence it is being considered here the cost of option B is \$50 million / year.

Assuming 10% discount rate and 20 years of planning horizon, the economic NPV of the above option is \$736.68 million. It is expected that the risk cost post Option B will be \$0 using TransGrid's Risk Tool.

### **Option C – TransGrid procures absorbing reactive power NSCAS services as network support services**

This option is similar to Option B, the only difference is TransGrid procures the services, not AEMO. Therefore the cost of option C is considered to be \$50 million / year.

Assuming 10% discount rate and 20 years of planning horizon, the economic NPV of the above option is \$736.68 million. It is expected that the risk cost post Option C will be \$0 using TransGrid's Risk Tool.

### **Option D – TransGrid to install 6x150 MVar reactors in the southern NSW transmission network as a prescribed transmission service**

In responding to AEMO's identified NSCAS gap in the southern NSW region, TransGrid had analysed the options available, in the form of installing reactors, in the southern transmission network. The analysis has confirmed that the optimum solution is to install 3x150 MVar reactor at Yass and 3x150 MVar reactors at Murray<sup>4</sup>.

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<sup>2</sup> TransGrid's Investment Risk Tool bases the Value of Customer Reliability (VCR) on figures published by AEMO in its Value of Customer Reliability Review - Final Report, September 2014. In this case we use the mixed residential/industrial figure of \$38,350/MWh.

<sup>3</sup> This is assumed that 8 hours restoration time and the work to restore the load will start immediately after the events. Therefore  $8 * 0.5 = 4$  hours restoration hour is used in the calculation.

<sup>4</sup> Note: installation of reactors at the most optimum locations, Kangaroo Valley and Upper Tumut, was not viable due to site restrictions. Murray and Yass were less efficient locations needing more reactive support (i.e. 900 MVar) than the minimum indicative gap identified by AEMO of 800 MVar.

Please see the attached assessment report “NSCAS Absorbing Reactive Power Requirements in Southern NSW – April 2013” for details on solution optimisation.

The cost of transferring the existing 3x150 MVAR reactor at Yass and 3x150 MVAR reactors at Murray from the non-prescribed asset base to the Regulated Asset Base (RAB) is estimated to be the value of these assets, including all associated primary and secondary systems, at the time of transfer.

The estimated value of the assets at the end of financial year 2018-19 is \$26.28 million<sup>5</sup>. This is the value that should be transferred into the RAB.

The annual operating cost is calculated as 2% of the capital cost (total estimated reactor value) escalated at 2.9% per annum. It is expected that the risk cost post Option D will be \$0 using TransGrid’s Risk Tool.

## 4. Evaluation

### 4.1 Technical evaluation

Option A - D are technically feasible as they are able to manage the voltage in southern NSW and they are expected to reduce the risk cost to \$0.

### 4.2 Commercial evaluation

The commercial evaluations of the technically feasible options are set out in Table 1. The full financial and economic evaluations are shown in Appendix A.

**Table 1: Options Comparison**

Option	Description	Upfront Capex (\$m) <sup>^#</sup>	Total Opex (\$m)	Post-project annual risk cost (\$m)	Financial NPV (\$m)	Economic NPV (\$m)	Rank
Base case	‘Do nothing’	-	-	136.53	-	-	N/A
Option A	AEMO constrain “on” the generation	-	(50.00)	0	(425.68)	736.68	4
Option B	AEMO procures NSCAS services	-	(50.00)	0	(425.68)	736.68	2
Option C	TG procures NSCAS services	-	(50.00)	0	(425.68)	736.68	3
Option D	TG provides NSCAS as a prescribed service	(26.28)	(13.98) <sup>%</sup>	0	(31.73)	1,130.62	1

<sup>^</sup> In un-escalated AUD 2015-16.

<sup>#</sup> Expenditure in 2018-19 period.

<sup>%</sup> Escalated at 2.9% per annum.

The commercial evaluation is based on:

- > A 10% discount, with sensitivities based on TransGrid’s current AER-determined pre-tax real regulatory WACC of 6.75% for the lower bound and 13% for the upper bound.

<sup>5</sup> It is advised by the Finance Team in TransGrid.

- > The applied sensitivity on the discount rate given the following NPVs of the preferred option D:

**Table 2 - Preferred Option**

Option	Description	Economic NPV @ 6.75% (\$m)	Economic NPV @ 13% (\$m)
D	TG provides NSCAS as a prescribed service	1441.55	928.41

### 4.3 ALARP Evaluation

An ALARP assessment is triggered by the following hazard and the disproportionate factor:

- > Unplanned outage of HV equipment → 3 times the safety risk reduction and taking 10% of the reliability risk reduction as being applicable to safety.

However, as this will only produce 30% of the benefit derived in the economic evaluation, a full ALARP evaluation will not produce an alternative preferred option.

The preferred option is therefore Option D, as it improves TransGrid’s risk exposure, and yields the most benefits, as calculated using TransGrid’s NPV Calculation Tool.

### 4.4 Preferred Option

The preferred option is for TransGrid to provide NSCAS as a prescribed service (Option D).

#### Capital and operating expenditure

The yearly incremental operating expenditure of Option A is estimated to be 2% of the upfront capital cost of the option, which equates to \$0.526 million, escalated at a rate of 2.9% per annum.

#### Regulatory Investment Test – Transmission

Option D would be required to be assessed under the RIT-T as the total cost is more than \$6 million.

However, given that TransGrid has already installed the reactors in responding to the AEMO NSCAS tender in 2013, the benefits of consulting on a solution already implemented, following the RIT-T process would be very small and does not warrant the costs. Hence, it is proposed that TransGrid seek agreement with the AER for transferring the installed assets to its regulated asset base (RAB) in 2019, without being required to follow the RIT-T consultation procedure.

## 5. Recommendation

Based on the economic evaluation above, Option D is the preferred option to address the need as it reduces TransGrid’s risk exposure and provides the greatest return on the investment.

It is therefore recommended that:

- > TransGrid continues to provide absorbing reactive power NSCAS services beyond 2019, using the already installed 3x 150 MVar reactor at Yass and 3x 150 MVar reactors at Murray.
- > TransGrid to engage the AER and gain agreement to procure these services as a prescribed transmission service, without the RIT-T process.
- > TransGrid transfer the assets – 3x 150 MVar reactor at Yass and 3x 150 MVar reactors at Murray – to its regulated asset base (RAB) subject to the agreement with AER.

## Appendix A – Financial and Economic Evaluation Reports

Project\_Option Name

Option A - AEMO procures NSCAS

### 1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$425.68m	NPV / Capital (Ratio)	-4256782.86
NPV @ upper bound rate	13.00%	-\$351.24m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	-\$540.15m	IRR%	Not measurable

### 2. Economic Evaluation (includes VCR benefits but excludes tax benefits from non-cash transactions, ENS penalty and overall tax cost)

NPV @ standard discount rate	10.00%	\$736.68m	NPV / Capital (Ratio)	7366785.69
NPV @ upper bound rate	13.00%	\$607.85m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	\$934.79m	IRR%	86529955.58%

### Benefits

Risk cost	As Is	To Be	Benefit		
<i>Systems (reliability)</i>	\$136.53m	\$0.00m	\$136.53m	VCR Benefit	\$136.53m
<i>Financial</i>	\$0.00m	\$0.00m	\$0.00m	ENS Penalty	\$0.00m
<i>Operational/compliance</i>	\$0.00m	\$0.00m	\$0.00m	All other risk benefits	\$0.00m
<i>People (safety)</i>	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$136.53m
<i>Environment</i>	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.00m
<i>Reputation</i>	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Total Risk benefits	\$136.53m	\$0.00m	\$136.53m	Benefits in the economic NPV**	\$136.53m
Cost savings and other benefits			\$0.00m	**excludes ENS penalty	
Total Benefits			\$136.53m		

### Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$50.00m	Write-off cost	\$0.00m
Capital - initial \$m	-\$0.00m	Major Asset Life (Yrs)	20.00 Yrs
Residual Value - initial investment	\$0.00m	Re-investment capital	\$0.00m
Capitalisation period	1.00 Yrs	Start of the re-investment period	0.00 Yrs

**1. Financial Evaluation** (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$425.68m	NPV / Capital (Ratio)	-4256782.86
NPV @ upper bound rate	13.00%	-\$351.24m	Pay Back Period (Yrs)	Not measurable
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**2. Economic Evaluation** (includes VCR benefits but excludes tax benefits from non-cash transactions, ENS penalty and overall tax cost)

NPV @ standard discount rate	10.00%	\$736.68m	NPV / Capital (Ratio)	7366785.69
NPV @ upper bound rate	13.00%	\$607.85m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	\$934.79m	IRR%	86529955.58%

**Benefits**

Risk cost	As Is	To Be	Benefit	VCR Benefit	
<i>Systems (reliability)</i>	\$136.53m	\$0.00m	\$136.53m	<i>ENS Penalty</i>	\$0.00m
<i>Financial</i>	\$0.00m	\$0.00m	\$0.00m	<i>All other risk benefits</i>	\$0.00m
<i>Operational/compliance</i>	\$0.00m	\$0.00m	\$0.00m	<b>Total Risk benefits</b>	\$136.53m
<i>People (safety)</i>	\$0.00m	\$0.00m	\$0.00m	<b>Benefits in the financial NPV*</b>	\$0.00m
<i>Environment</i>	\$0.00m	\$0.00m	\$0.00m	<i>*excludes VCR benefits</i>	
<i>Reputation</i>	\$0.00m	\$0.00m	\$0.00m	<b>Benefits in the economic NPV**</b>	\$136.53m
<b>Total Risk benefits</b>	\$136.53m	\$0.00m	\$136.53m	<i>**excludes ENS penalty</i>	
<b>Cost savings and other benefits</b>			\$0.00m		
<b>Total Benefits</b>			\$136.53m		

**Other Financial Drivers**

Incremental opex cost pa (no depreciation)	-\$50.00m	Write-off cost	\$0.00m
Capital - initial \$m	-\$0.00m	Major Asset Life (Yrs)	20.00 Yrs
Residual Value - initial investment	\$0.00m	Re-investment capital	\$0.00m
Capitalisation period	1.00 Yrs	Start of the re-investment period	0.00 Yrs

**1. Financial Evaluation** (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$425.68m	NPV / Capital (Ratio)	-4256782.86
NPV @ upper bound rate	13.00%	-\$351.24m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	-\$540.15m	IRR%	Not measurable

**2. Economic Evaluation** (includes VCR benefits but excludes tax benefits from non-cash transactions, ENS penalty and overall tax cost)

NPV @ standard discount rate	10.00%	\$736.68m	NPV / Capital (Ratio)	7366785.69
NPV @ upper bound rate	13.00%	\$607.85m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	\$934.79m	IRR%	86529955.58%

**Benefits**

Risk cost	As Is	To Be	Benefit	VCR Benefit	
<i>Systems (reliability)</i>	\$136.53m	\$0.00m	\$136.53m	ENS Penalty	\$0.00m
<i>Financial</i>	\$0.00m	\$0.00m	\$0.00m	All other risk benefits	\$0.00m
<i>Operational/compliance</i>	\$0.00m	\$0.00m	\$0.00m	<b>Total Risk benefits</b>	<b>\$136.53m</b>
<i>People (safety)</i>	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.00m
<i>Environment</i>	\$0.00m	\$0.00m	\$0.00m	<i>*excludes VCR benefits</i>	
<i>Reputation</i>	\$0.00m	\$0.00m	\$0.00m	Benefits in the economic NPV**	\$136.53m
<b>Total Risk benefits</b>	<b>\$136.53m</b>	<b>\$0.00m</b>	<b>\$136.53m</b>	<i>**excludes ENS penalty</i>	
Cost savings and other benefits			\$0.00m		
<b>Total Benefits</b>			<b>\$136.53m</b>		

**Other Financial Drivers**

Incremental opex cost pa (no depreciation)	-\$50.00m	Write-off cost	\$0.00m
Capital - initial \$m	-\$0.00m	Major Asset Life (Yrs)	20.00 Yrs
Residual Value - initial investment	\$0.00m	Re-investment capital	\$0.00m
Capitalisation period	1.00 Yrs	Start of the re-investment period	0.00 Yrs

**1. Financial Evaluation** (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$31.73m	NPV / Capital (Ratio)	-1.21
NPV @ upper bound rate	13.00%	-\$30.68m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	-\$33.38m	IRR%	Not measurable

**2. Economic Evaluation** (includes VCR benefits but excludes tax benefits from non-cash transactions, ENS penalty and overall tax cost)

NPV @ standard discount rate	10.00%	\$1,130.62m	NPV / Capital (Ratio)	43.02
NPV @ upper bound rate	13.00%	\$928.41m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	\$1,441.55m	IRR%	517.51%

**Benefits**

Risk cost	As Is	To Be	Benefit		
<i>Systems (reliability)</i>	\$136.53m	\$0.00m	\$136.53m	VCR Benefit	\$136.53m
<i>Financial</i>	\$0.00m	\$0.00m	\$0.00m	ENS Penalty	\$0.00m
<i>Operational/compliance</i>	\$0.00m	\$0.00m	\$0.00m	All other risk benefits	\$0.00m
<i>People (safety)</i>	\$0.00m	\$0.00m	\$0.00m	<b>Total Risk benefits</b>	<b>\$136.53m</b>
<i>Environment</i>	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.00m
<i>Reputation</i>	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
<b>Total Risk benefits</b>	<b>\$136.53m</b>	<b>\$0.00m</b>	<b>\$136.53m</b>	Benefits in the economic NPV**	<b>\$136.53m</b>
Cost savings and other benefits			\$0.00m	**excludes ENS penalty	
<b>Total Benefits</b>			<b>\$136.53m</b>		

**Other Financial Drivers**

Incremental opex cost pa (no depreciation)	-\$0.53m	Write-off cost	\$0.00m
Capital - initial \$m	-\$26.28m	Major Asset Life (Yrs)	20.00 Yrs
Residual Value - initial investment	\$0.00m	Re-investment capital	\$0.00m
Capitalisation period	1.00 Yrs	Start of the re-investment period	0.00 Yrs

# Attachment 1 - Base Case Risk Cost Summary



## Current Option Assessment - Risk Summary

Project Name: Network Support and Control Ancillary Services

Option Name: 1569 - Base Case - 'Do Nothing'

Option Assessment Name: 1569 - Option 1 - Assessment 1

Rev Reset Period: Next (2018-23)

Major Component	No.	Minor Component	Sel. Hazardous Event	LoC x CoF (\$M)	Failure Mechanism	NoxLoC xCoF (\$M)	PoF (Yr 1)	Total Risk (\$M)	Risk (\$M) (Rel)	Risk (\$M) (Op)	Risk (\$M) (Fin)	Risk (\$M) (Peo)	Risk (\$M) (Env)	Risk (\$M) (Rep)
NSCAS Reactors at Murray and Yass (Oil Filled)	1	Winding and Core	Unplanned Outage - HV (NSCAS Reactors at Murray and Yass (Oil Filled))	\$136.53	Failure	\$136.53	100.00%	\$136.53	\$136.53					
				\$136.53		\$136.53		\$136.53	\$136.53					

Total VCR Risk: \$136.53

Total ENS Risk:

