

OPTIONS EVALUATION REPORT (OER)

Capacitors to improve QNI limits

OER- 000000001701 revision 3.0



Ellipse project no(s):

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Project reason: Economic Efficiency - Network developments to achieve market benefits

Project category: Prescribed - NICIPAP

Approvals

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Date submitted for approval	30/11/2016	

Change history

Revision	Date	Amendment
0	November 2016	Initial issue

1. Need/opportunity

According to recent historical performance of the QNI interconnector, NSW export to Queensland is often limited due to the following constraints:

1. N^Q_NIL_B1: Avoid voltage collapse for loss of Kogan Creek generator
2. N^Q_NIL_A: Avoid voltage collapse for trip of Liddell to Muswellbrook (83) line

Both above voltage stability limits can be improved by adding capacitor banks at Armidale or Tamworth.

1. N^Q_NIL_B1: 32 MW per 100 MVar capacitor
2. N^Q_NIL_A: 75 MW per 100 MVar capacitor

2. Related needs/opportunities

None

3. Options

3.1 Base case

The cost to the market each year for the “do nothing” option is valued at \$1.26 million/year. This market impact will be realised as market benefits if either option A, B or C is implemented.

Market impact calculation

The market impact due to this constraint is estimated using following assumptions:

Probability of NSW exporting to QLD¹ = 20%

Market impact due to NSW export limit binding² = \$25/MWh

Probability of NSW export limit binding³ = 75%

Market impact = {(Probability of NSW exporting) * (Probability of NSW export limit binding) * (Market impact due to NSW export limit binding) * (MW increase in NSW export on QNI)} * (duration)

Market impact = $\{0.20 \times 0.75 \times 25 \times 38.4^4\} \times 24 \times 365 = \$144 \times 24 \times 365$ /year

Market impact = \$1.26 million/year

¹ Based on QNI flows from 1 June 2012 to 31 May 2016 – Refer file “nsw-vic-ql-1557.xlsm” in N:\HV System Planning\PUBLIC\NCIPAP\Risk Costs.

² Based on the difference between NSW Black Coal and QLD Gas variable costs – refer page 61 of Jacobs report “Retail electricity price history and projections.pdf” filed in PDGS supporting documents. QLD price is expected to be higher than NSW price in this situation. In addition, it is expected that QLD Gas prices will be setting the dispatch price when QLD is importing from NSW. Hence, Gas prices in QLD and Black Coal prices in NSW were used. Accordingly, Market impact = \$45 - \$20 = \$25/MWh. Note that, the average historical price difference between NSW and QLD is about \$69 when NSW export to QLD – Based on prices from 1 June 2012 to 31 May 2016 when NSW is exporting to QLD – Refer file “nsw-vic-ql-1701.xlsm” in N:\HV System Planning\PUBLIC\NCIPAP\Risk Costs.

³ Based on Historical average number of binding NSW export constraints with the reduction due to Armidale capacitors unavailability applied for the period from 1 June 2012 to 31 May 2016 – Refer file “nsw-vic-ql-1701.xlsm” in N:\HV System Planning\PUBLIC\NCIPAP\Risk Costs

⁴ 38.4 MW increase on QNI has been determined assuming a 120 MVar capacitor installation, this increase is proportional to the size of the capacitor bank, and so the market impact is increased with a larger or more capacitor bank installations.

3.2 Option A – 120 MVar capacitor at Armidale (OSA 1701, OFR 1701A)

This option is to install 120 MVar 330 kV capacitor at Armidale 330/132 kV substation.

The following works to be carried out at Armidale substation for this option to address this need:

- > extension of the switchyard bench
- > provision of a 330 kV capacitor bank switchbay (with point on wave circuit breaker)
- > the provision of 330 kV capacitor bank, and
- > Installation of secondary systems associated with the control and protection of the capacitor bank.

This option is technically feasible and will achieve the 38.4 MW increase on QNI import.

The expected capital cost for this option is \$4.69 million \pm 25% (in un-escalated 2016/17 dollars). The project is expected to be completed in an estimated 23 months from the issue of a Request for Project Scoping (RPS).

3.3 Option B – 120 MVar capacitor at Tamworth (OSA 1701, OFR 1701B)

This option is to install 120 MVar 330 kV capacitor at Tamworth 330/132 kV substation.

The following works to be carried out at Tamworth substation for this option to address this need:

- > extension of the switchyard bench
- > Installation of overhead strung busbar extension
- > provision of a 330 kV capacitor bank switchbay (with point on wave circuit breaker)
- > the provision of 330 kV capacitor bank and
- > Installation of secondary systems associated with the control and protection of the capacitor bank.

This option is technically feasible and will achieve the 38.4 MW increase on QNI import.

The expected capital cost for this option is \$5.05 million \pm 25% (in un-escalated 2016/17 dollars). The project is expected to be completed in an estimated 23 months from the issue of a Request for Project Scoping (RPS).

3.4 Option C – 120 MVar capacitor at Tamworth and 120 MVar capacitor at Armidale

This option is to install 120 MVar 330 kV capacitor at Tamworth 330/132 kV substation and a 120 MVar 330 kV capacitor at Armidale 330/132 kV substation. This option is considered to be not technically or operationally feasible due to excessive capacitive reactance added in the area leading to overvoltage conditions. This option is therefore not evaluated any further.

The following works to be carried out for this option to address this need:

Armidale 330/132 kV Substation:

- > extension of the switchyard bench
- > provision of a 330 kV capacitor bank switchbay (with point on wave circuit breaker)
- > the provision of 330 kV capacitor bank, and
- > Installation of secondary systems associated with the control and protection of the capacitor bank.

Tamworth 330/132 kV Substation:

- > extension of the switchyard bench
- > Installation of overhead strung busbar extension
- > provision of a 330 kV capacitor bank switchbay (with point on wave circuit breaker)
- > the provision of 330 kV capacitor bank, and

- > Installation of secondary systems associated with the control and protection of the capacitor bank.

This option may achieve a 76.8 MW increase on QNI import.

The expected capital cost for this option, based on the costing for Option A and B is \$9.74 million \pm 25% (in un-escalated 2016/17 dollars)

4. Evaluation

All the options (base case, options A, and B) are technically feasible. Option C is not technically feasible.

The commercial evaluation of the technically feasible options is set out in Table 1.

The full financial and economic evaluations are shown in Attachment 1.

Table 1 – Commercial evaluation

Option	Description	Total capex (\$m)	Annual opex (\$m)	Annual market benefit (\$m)	Economic NPV @ 10%	Rank
Base case	Do nothing	0	n/a	0	n/a	3
A	120 MVar capacitor at Armidale	4.69	0.09	-1.26	4.77	1
B	120 MVar capacitor at Tamworth	5.05	0.1	-1.26	4.39	2

The commercial evaluation is based on:

- > A 10% discount rate, 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, is provided in Attachment 1.

The applied sensitivities on the discount rate give the following economic NPVs:

Discount Rate (%)	Option A (NPV 2018/19 \$m)	Option B (NPV 2018/19 \$m)
6.75	8.31	7.90
13.00	2.78	2.43

4.1 Preferred option

The preferred option is Option A – 120 MVar Capacitor Bank at Armidale, as described in OSA 1701 and assessed in OFS 1701A. This option is preferred since it has a positive economic NPV of \$4.77 million and provides a market benefit of \$1.26 million per year by removing the interconnector constraint and increasing the NSW import on QNI.

A summary of the preferred option can be found in Attachment 2.

4.2 Payback period

Expected payback period for Option A is 4.04 years.

4.3 Capital and operating expenditure

There is no expected material increase in operating expenditure for the preferred option over and above the 2% expected operating expenditure related to installing additional plant in the network.

4.4 Regulatory Investment Test

The RIT-T is not required as the cost of the preferred option is under \$6 million.

5. Recommendation

It is recommended that a NCIPAP project be initiated to implement Option A – 120 MVar Capacitor Bank at Armidale in the period 2019-23.

Attachment 1 – Financial and economic report

Project_Option Name

Need 1701 - Option A - 330 kV Capacitor at Armidale

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	\$4.77m	NPV / Capital (Ratio)	1.02
NPV @ upper bound rate	13.00%	\$2.78m	Pay Back Period (Yrs)	0.22 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$8.31m	IRR%	21.98%

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%	\$4.77m	NPV / Capital (Ratio)	1.02
NPV @ upper bound rate	13.00%	\$2.78m	Pay Back Period (Yrs)	4.04 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$8.31m	IRR%	21.98%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$0.00m
Systems (reliability)	\$0.00m	\$0.00m	\$0.00m	ENS Penalty	\$0.00m
Financial	\$0.00m	\$0.00m	\$0.00m	All other risk benefits	\$0.00m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$0.00m
People (safety)	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$1.26m
Environment	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Reputation	\$0.00m	\$0.00m	\$0.00m	Benefits in the economic NPV**	\$1.26m
Total Risk benefits	\$0.00m	\$0.00m	\$0.00m	**excludes ENS penalty	
Cost savings and other benefits			\$1.26m		
Total Benefits			\$1.26m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.09m	Write-off cost	\$0.00m
Capital - initial \$m	-\$4.69m	Major Asset Life (Yrs)	40.00 Yrs
Residual Value - initial investment	\$1.41m	Re-investment capital	\$0.00m
Capitalisation period	2.00 Yrs	Start of the re-investment period	0.00 Yrs

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	\$4.39m	NPV / Capital (Ratio)	0.87
NPV @ upper bound rate	13.00%	\$2.43m	Pay Back Period (Yrs)	0.20 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$7.90m	IRR%	20.37%

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%	\$4.39m	NPV / Capital (Ratio)	0.87
NPV @ upper bound rate	13.00%	\$2.43m	Pay Back Period (Yrs)	4.38 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$7.90m	IRR%	20.37%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$0.00m
Systems (reliability)	\$0.00m	\$0.00m	\$0.00m	ENS Penalty	\$0.00m
Financial	\$0.00m	\$0.00m	\$0.00m	All other risk benefits	\$0.00m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$0.00m
People (safety)	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$1.26m
Environment	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Reputation	\$0.00m	\$0.00m	\$0.00m	Benefits in the economic NPV**	\$1.26m
Total Risk benefits	\$0.00m	\$0.00m	\$0.00m	**excludes ENS penalty	
Cost savings and other benefits			\$1.26m		
Total Benefits			\$1.26m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.10m	Write-off cost	\$0.00m
Capital - initial \$m	-\$5.05m	Major Asset Life (Yrs)	40.00 Yrs
Residual Value - initial investment	\$1.52m	Re-investment capital	\$0.00m
Capitalisation period	2.00 Yrs	Start of the re-investment period	0.00 Yrs

Attachment 2 – Summary of Preferred Option

QNI Constraint	<p>According to recent historical performance of the QNI interconnector, NSW export to Queensland is often limited due to the following constraints:</p> <ol style="list-style-type: none"> 1. N^Q_NIL_B1: Avoid voltage collapse for loss of Kogan Creek generator 2. N^Q_NIL_A: Avoid voltage collapse for trip of Liddell to Muswellbrook (83) line <p>Both above voltage stability limits can be improved by adding capacitor banks at Armidale or Tamworth.</p>
Transmission Circuit / Injection Point	Armidale/Tamworth 330/132 kV Substation
Scope of works	Installation of 330 kV 120 MVar capacitor bank at Armidale as per OSA-1701 and OFS-1701A.
Reasons to undertake the project	Relieve voltage stability limits that cause constraints on NSW export to Queensland, increase QNI capability
Current value of the limit	<p>N^Q_NIL_B1: 850 MW</p> <p>N^Q_NIL_A: 300 MW</p>
Target limit	<p>Improves the voltage stability limits that constrain QNI at certain times.</p> <p>N^Q_NIL_B1: 888 MW</p> <p>N^Q_NIL_A: 338 MW</p>
Priority project improvement target	Increase transfer limits on QNI
Capital Cost	\$4.69 million
Operating Cost	\$94k per annum
Market benefits	Market Benefit = \$1.26 million per annum
Pay-back period	Pay-back period = 4.04 Years
Completion date	Over the 2019-23 period