# OPTIONS EVALUATION REPORT (OER)

Armidale CAP transfer tripping scheme

OER 000000001557 revision 3.0

**Ellipse project description:**
**TRIM file: [TRIM No]**

**Project reason:** Economic Efficiency - Network developments to achieve market benefits
**Project category:** Prescribed - NCIPAP

**Approvals**

| Author | Connie Liang | Connection Planning Engineer |
|---|---|---|
| Reviewed | Jahan Peiris | Network Modelling & Performance Manager |
| | Hoang Tong | Operations Analysis Manager |
| Endorsed | Garrie Chubb | Investment Support Manager |
| | John Howland | Manager/Portfolio Management |
| Approved | Andrew Kingsmill | Manager/Power System Analysis |
| Date submitted for approval | 2 August 2016 | |

# 1. Need/opportunity

It is necessary to switch out the Armidale 132kV capacitors during planned outages of an Armidale 330/132kV transformer. This is to cater for a trip of the remaining in-service transformer and to avoid potential overvoltages in the 132kV subsystem.

During periods of high interchange on QNI, the unavailability of these capacitors can impose market constraints due to the voltage stability limit.

Relieving the constraint will not only benefits the market in the form of increased competition but also benefits the consumers, by reducing the price of electricity. The importance of reducing the price of electricity, through NCIPAP or other means, is outlined in the National Electricity Objective (NEO) "…*to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to – price, quality, safety, reliability, and security of supply of electricity; and the reliability, safety and security of the national electricity system…*"[1].

The AER also considered that "*… the NCIPAP as submitted to the AER should be an identification of the limits that, if addressed, would resolve the existing limitations on the transmission circuit or injection point and benefit wholesale market outcomes, benefit consumers or defer the need for major network investment…*",[2] and has not limited the benefits only to be market economic benefits, but encompassed benefits to consumers which arguably will include reduction in price of electricity.

Addressing the above constraint, will (a) reduce the price of electricity across the constraint (b) reduce the total cost of generation in NEM and (c) increase market competition.

# 2. Related needs/opportunities

None

# 3. Options

## 3.1 Base case

The base case is to 'do nothing', that is, continue to switch out capacitor banks at Armidale during outages of an Armidale 330/132 kV transformer, which may impose market constraints.

The unavailability of these capacitors during an Armidale transformer outage can reduce the NSW import limit on QNI by about 85 MW and NSW export limit on QNI by about 145 MW (refer NOS 1557 and Operating Manual 525 for more details).

The market impact due to unavailability of the Armidale capacitor banks is estimated using following assumptions:

Outage rate of an Armidale transformer[3] = 0.21/year

Average Transformer outage duration[4] = 84.2 hours/outage

No. of 330/132 kV transformers at Armidale = 2

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[1]  National Electricity Law

[2]  AER Final Decision, Electricity transmission network service providers, Service Target Performance Incentive Scheme, Dec 2012

[3]  Based on the TransGrid Historical Outage Statistics -  Refer file "Reliability Analysis - Final Summary.xlsx" in PDGS

[4]  50th percentile value from TransGrid Historical Outage Statistics -  Refer file "Reliability Analysis - Final Summary.xlsx" in PDGS

Probability of NSW importing from QLD during a transformer outage[5] = 80%

Market impact due to NSW import limit binding[6] = \$16/MWh

Probability of NSW exporting to QLD during a transformer outage[7] = 20%

Market impact due to NSW export limit binding[8] = \$25/MWh

Probability of NSW import limit binding[9] = 15%

Probability of NSW export limit binding[10] = 75%

Market impact = (No. of transformers at Armidale) * (Outage rate of a transformer) * [{(Probability of NSW importing) * (Probability of NSW import limit binding) * (Market impact due to NSW import limit binding) * (MW reduction in NSW import on QNI)} + {(Probability of NSW exporting) * (Probability of NSW export limit binding) * (Market impact due to NSW export limit binding) * (MW reduction in NSW export on QNI)}] * (Outage duration)

Market impact = (2*0.21)*[{0.8*0.15*16*85} + {0.20*0.75*25*145)]*84.2 = 0.42*[164+544]* 84.2

Market impact = \$0.03 million/year

## 3.2 Option A – Armidale Capacitor Transfer Tripping Scheme (OFR1557, OFS1557)

The market impact associated with a transformer outage could be alleviated with the aid of a local tripping scheme at Armidale. This scheme would be armed onsite during planned transformer outages and would trip any in-service Armidale 132kV capacitors immediately following a trip of the adjacent in-service transformer.

The scope of works associated with this option includes the following activities for implementation of a transfer tripping scheme with the following functionality:

- Can be armed/disarmed remotely using SCADA

- Monitor the circuit breaker status of the two 330/132 kV transformers and the No.1 and 2 132 kV capacitor banks

- The scheme will be armed during planned transformer outages and would trip any in-service capacitor bank immediately following a trip of the remaining in-service transformer

- This scheme needs to be implemented within control/protection systems locally at Armidale to achieve the desired clearing time (a few cycles after second transformer outage).

The expected capital cost for this option is \$0.20 million ± 25% (in un-escalated 2016/17 dollars). The scope of works included in this option is outlined in OFS-1557A.

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

[6] Based on the difference between NSW and QLD Black Coal variable costs – refer page 61 of Jacobs report "Retail electricity price history and projections.pdf" filed in PDGS supporting documents. NSW price is expected to be higher than QLD price in this situation. Hence, higher range Black Coal prices in NSW and lower range Black Coal prices in QLD were used. Accordingly, Market impact = \$25 - \$9 = \$16.

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

[8] 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-qld-1557.xlsm" in N:\HV System Planning\PUBLIC\NCIPAP\Risk Costs.

[9] Based on Historical average number of binding NSW import 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-qld-1557.xlsm" in N:\HV System Planning\PUBLIC\NCIPAP\Risk Costs

[10] 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-qld-1557.xlsm" in N:\HV System Planning\PUBLIC\NCIPAP\Risk Costs

# 4. Evaluation

Both the base case and Option A are technically feasible.

The commercial evaluation of the technically feasible options is set out in Table 2.

The full financial and economic evaluations are shown in Appendix A.

**Table 1 – Options Comparison**

| Option | Description | Capex ($m) | Opex ($m) | Yearly Post investment risk cost/ benefit (-ve) ($m) | Economic NPV ($m) @10% | Rank |
|---|---|---|---|---|---|---|
| **Base case** | 'Do Nothing' | n/a | n/a | n/a | n/a | 2 |
| **A** | Armidale Capacitor Transfer Tripping Scheme | 0.20 | No additional opex | -0.03 | 0.03 | 1 |

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% and 13% for the upper bound provided in Appendix A.

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

| Discount Rate (%) | Economic NPV ($m) |
|---|---|
| 6.75 | 0.09 |
| 13.00 | -0.01 |

**Preferred Option**

The preferred option is Option A the implementation of the Armidale capacitor transfer tripping scheme as described in OFR1557 and assessed in OFS1557. This option is preferred since it has a positive economic NPV of $0.03 million and provides a market benefit of $0.03 million per year by increasing the availability of the Armidale capacitor banks.

**Capital and operating expenditure**

There is no expected material increase in operating expenditure for the preferred option.

**Payback period**

Expected payback period for Option A is approximately about 6.67 years.

**Regulatory Investment Test**

The RIT-T is not required as the cost of the preferred option is under $6 million. All other network options are considered not economically feasible.

# 5. Recommendation

It is recommended that a NCIPAP project be initiated to implement Option A – Armidale Capacitor Transfer Tripping Scheme in the period 2018-23.

# Appendix A - Financial and Economic Evaluation Reports

| Project_Option Name | 1557 - Option A - Armidale Capacitor Transfer Tripping Scheme | | | | |
|---|---|---|---|---|---|

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

| | | | | | |
|---|---|---|---|---|---|
| NPV @ standard discount rate | 10.00% | $0.03m | NPV / Capital (Ratio) | 0.14 |
| NPV @ upper bound rate | 13.00% | -$0.01m | Pay Back Period (Yrs) | 0.12 Yrs |
| NPV @ lower bound rate (WACC) | 6.75% | $0.09m | IRR% | 12.12% |

### 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% | $0.03m | NPV / Capital (Ratio) | 0.14 |
| NPV @ upper bound rate | 13.00% | -$0.01m | Pay Back Period (Yrs) | 6.67 Yrs |
| NPV @ lower bound rate (WACC) | 6.75% | $0.09m | IRR% | 12.12% |

### Benefits

| Risk cost | As Is | To Be | Benefit | | |
|---|---|---|---|---|---|
| Systems (reliability) | $0.00m | $0.00m | $0.00m | VCR Benefit | $0.00m |
| Financial | $0.00m | $0.00m | $0.00m | ENS Penalty | $0.00m |
| Operational/compliance | $0.00m | $0.00m | $0.00m | All other risk benefits | $0.00m |
| People (safety) | $0.00m | $0.00m | $0.00m | Total Risk benefits | $0.00m |
| Environment | $0.00m | $0.00m | $0.00m | | |
| Reputation | $0.00m | $0.00m | $0.00m | Benefits in the financial NPV* | $0.03m |
| Total Risk benefits | $0.00m | $0.00m | $0.00m | *excludes VCR benefits | |
| Cost savings and other benefits | | | $0.03m | Benefits in the economic NPV** | $0.03m |
| Total Benefits | | | $0.03m | **excludes ENS penalty | |

### Other Financial Drivers

| | | | |
|---|---|---|---|
| Incremental opex cost pa (no depreciation) | $0.00m | Write-off cost | $0.00m |
| Capital - initial $m | -$0.20m | Major Asset Life (Yrs) | 20.00 Yrs |
| Residual Value - initial investment | $0.01m | Re-investment capital | $0.00m |
| Capitalisation period | 3.00 Yrs | Start of the re-investment period | 0.00 Yrs |

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# Attachment 1 – Summary of Preferred Option

| Armidale Capacitor Transfer Tripping Scheme | It is necessary to switch out the Armidale 132kV capacitors during planned outages of an Armidale 330/132kV transformer. This is to cater for a trip of the remaining in-service transformer and to avoid potential overvoltages in the 132kV subsystem. During periods of high interchange on QNI, the unavailability of these capacitors can impose market constraints due to the voltage and transient stability limits. |
|---|---|
| Transmission Circuit / Injection Point | Armidale 330/132 kV Substation |
| Scope of works | Implementation of a transfer tripping scheme for the Armidale 132 kV capacitor banks as per OFR-1557A and OFS-1557A. |
| Reasons to undertake the project | Alleviate QNI import/export constraints due to the unavailability of the Armidale 132 kV capacitor banks |
| Current value of the limit | Market impact due to additional QNI constraints as a result of unavailability of Armidale capacitors during Armidale transformer outages. |
| | Market impact = (No. of transformers at Armidale) * (Outage rate of a transformer) * [{(Probability of NSW importing) * (Probability of NSW import limit binding) * (Market impact due to NSW import limit binding) * (MW reduction in NSW import on QNI)} + {(Probability of NSW exporting) * (Probability of NSW export limit binding) * (Market impact due to NSW export limit binding) * (MW reduction in NSW export on QNI)}] * (Outage duration) |
| | Market impact = $(2*0.21)*[\{0.8*0.15*16*85\} + \{0.20*0.75*25*145\}] *84.2$ |
| | $= 0.42*[164+544]* 84.2$ |
| | Market impact = $0.03 million/year |
| Target limit | Remove market impact due to non-availability of the capacitors during the Armidale transformer outages. Market benefit = $0.03 million/year (based on the historical binding constraints information). |
| Capital Cost | $0.20 million |
| Operating Cost | Nil |
| Market benefits | Market Benefit = $0.03 million per annum |
| Pay-back period | Pay-back period = 6.67 Years |
| Completion date | Over the 2018-23 period |

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