# OPTIONS EVALUATION REPORT (OER)

Making the Grid More Flexible – to Improve Reverse Power Flow Regulation

OER-1423 Revision 0

**Ellipse project no(s): P0008195**
**TRIM file: [TRIM No]**

**Project reason:** Capability - Improved Asset Management
**Project category:** Prescribed - Augmentation

**Approvals**

| | | |
|---|---|---|
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| **Approved** | Nalin Pahalawaththa | Manager/Power System Analysis |
| **Date submitted for approval** | 25 November 2016 | |

# 1. Need/opportunity

TransGrid has an obligation under the National Electricity Rules (NER) to ensure voltage levels at customer connections points are controlled to an agreed supply point voltage. Generally, this is achieved through the transformer's Automatic Voltage Regulation (AVR) to a level determined by local area constraints in conjunction with the customers.

As referred to in NOS-1421, at present the standard transformer AVR function blocks are confirgured to prevent AVR under reverse power flow, resulting in very poor voltage regulation when embedded generation is generating. This situation is currently being experienced at the following TransGrid substations: Dapto, Munyang, Marulan, Wagga, Williamsdale and Yass.

# 2. Related needs/opportunities

Nil

# 3. Options

**Base case**

The base case is to maintain the present AVR Function Blocks at Dapto, Munyang, Marulan, Wagga, Williamsdale and Yass, and operate the transformer AVR in manual mode when embedded generation is generating.

The cost of the base case is estimated as below:

Cost to the Market =Time spent by System Operators in manually adjusting AVRs
= 20%[1] of Time transformer[2] flows are in the reverse direction
= 20% x (2074+1219+129+2579+11+3264) hrs/year
= 20% 9276 hrs/year
= 1855 hrs/year

Using a System Operator time value of $100/hr[3],

The estimated risk cost per year of the Base case = $1855 *100/year = $0.19 million

**Option A – Modify AVR Function Blocks**

This option is to modify the AVR function blocks to allow reverse power flow control so that the transformers at Dapto, Marulan, Munyang, Wagga, Williamsdale, and Yass can operate their OLTC in automatic mode when embedded generation is generating. This would involve:

- Update and function test the program logic of the Bay Controllers (BCON) on the transformer bays in the TransGrid test laboratory;
- Update and commission the updated software logic on the BCON of the transformer bays at Dapto, Marulan, Munyang, Wagga, Williamsdale, and Yass;

[1] Typical factor of time System Operators spend on monitoring and adjusting AVRs manually during reverse power flows – Based on information from TransGrid Control Room

[2] Dapto, Marulan, Munyang, Wagga, Williamsdale and Yass transformer flows from 1/6/2015 to 1/6/2016 were considered in the annual estimate (data downloaded from AEMO OPDMS)

[3] Based on Average System Operator value

- Update functional specification documentations/manuals; and
- Arrange for 'Warning' labels to be put on relevant secondary systems panels.

This option has been assessed for feasibility in OFS-1421A Rev 2. The estimated un-escalated capital cost of the option is $0.1 M ± 25% in 2016-17 AUD.

The post-project risk cost of Option A is assessed to be $ 0 per year since there will not be any System Operator involvement during reverse power flows due to the presence of automatic voltage regulation actions.

**Option B – Reconnect Generators to Substation Primary Busbars**

This option is to upgrade the generator transformers and transmission lines in order to terminate on the substation primary busbar. This will eliminate the reverse power flow as the source of the power will be on the same side as the transformer primary windings.

It is anticipated that the cost to implement this option will be orders of magnitude larger than the cost to implement Option A, with no additional tangible benefit. For this reason, Option B is deemed to be neither economically nor financially viable.

**Non-network Solutions**

No feasible non-network solutions have been identified to address this Need.

# 4. Evaluation

## 4.1 Technical evaluation

Both the Base Case and Option A are technically feasible. However, as seen below, implementing the Base Case (i.e. do nothing) would generate a risk cost of $0.19 million per year, for every year that the Need is not addressed.

In contrast, implementation of Option A would reduce the risk cost to $0 per year.

## 4.2 Commercial evaluation

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

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

**Table 1 – Options Comparison**

| Option | Description | Total Capex ($m) | Annual Opex / yr ($m) | Annual Post Project Risk Cost ($m) | Financial NPV @ 10% ($m) | Economic NPV @ 10% ($m) | Rank |
|---|---|---|---|---|---|---|---|
| Base case | 'Do nothing' | 0 | 0 | 0.19 | 0 | 0 | 2 |
| A | Modify AVR Function Blocks | 0.1 | 0 | 0 | 1.34 | 1.34 | 1 |

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 provided in Appendix A.
- the applied sensitivities on the discount rate give the following economic NPVs:
- A capital re-investment of $0.061 million is required in 15 years as this is the asset life of secondary systems equipment

| Discount Rate (%) | Economic NPV (2018/19 $m) |
|---|---|
| 6.75 | 1.66 |
| 13.00 | 1.13 |

## 4.3 Preferred Option

The preferred option is therefore Option A, as it improves TransGrid's risk exposure, and yields the most benefits, as calculated using TransGrid's NPV Calculation Tool and Risk Tool (refer Appendix A).

**Capital and operating expenditure**
There is no capital and operating expenditure trade-offs associated with this option.

**Regulatory Investment Test**

No RIT-T is required for this project as the total cost is less than $6 million.

**Net Present Value**

The NPV of this option is $1.34m based on a standard discount rate of 10%.

The pay-back period is less than 1 year.

# 5 Recommendation

Based on the economic evaluation above, Option A is the preferred option to address the Need as it:

- Reduces the operating expenditure associated with manual tap changing of transformers
- Reduces TransGrid's risk exposure and reduces the risk from $0.19m to $0m.

It is therefore recommended that an RPS be completed for the modification for AVR function blocks at Dapto, Marulan, Wagga, Williamsdale and Yass to allow automatic voltage regulation during reverse power flow.

# Appendix A- Financial and Economic Evaluation Reports

| Project_Option Name | Improve Reverse Power Flow Regulation |
|---|---|

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

| | | | | |
|---|---|---|---|---|
| NPV @ standard discount rate | 10.00% | $1.34m | *NPV / Capital (Ratio)* | *13.43* |
| NPV @ upper bound rate | 13.00% | $1.13m | *Pay Back Period (Yrs)* | *Not measurable* |
| NPV @ lower bound rate (WACC) | 6.75% | $1.66m | *IRR%* | *190.00%* |

**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% | $1.34m | *NPV / Capital (Ratio)* | *13.43* |
| NPV @ upper bound rate | 13.00% | $1.13m | *Pay Back Period (Yrs)* | *Not measurable* |
| NPV @ lower bound rate (WACC) | 6.75% | $1.66m | *IRR%* | *190.00%* |

**Benefits**

| Risk cost | As Is | To Be | Benefit |
|---|---|---|---|
| *Systems (reliability)* | *$0.00m* | *$0.00m* | *$0.00m* |
| *Financial* | *$0.19m* | *$0.00m* | *$0.19m* |
| *Operational/compliance* | *$0.00m* | *$0.00m* | *$0.00m* |
| *People (safety)* | *$0.00m* | *$0.00m* | *$0.00m* |
| *Environment* | *$0.00m* | *$0.00m* | *$0.00m* |
| *Reputation* | *$0.00m* | *$0.00m* | *$0.00m* |
| Total Risk benefits | $0.19m | $0.00m | $0.19m |
| Cost savings and other benefits | | | $0.00m |
| Total Benefits | | | $0.19m |

| | |
|---|---|
| *VCR Benefit* | *$0.00m* |
| *ENS Penalty* | *$0.00m* |
| *All other risk benefits* | *$0.19m* |
| Total Risk benefits | $0.19m |
| Benefits in the financial NPV* | $0.19m |
| **excludes VCR benefits* | |
| Benefits in the economic NPV** | $0.19m |
| ***excludes ENS penalty* | |

**Other Financial Drivers**

| | | | |
|---|---|---|---|
| Incremental opex cost pa (no depreciation) | $0.00m | Write-off cost | $0.00m |
| Capital - initial $m | -$0.10m | Major Asset Life (Yrs) | 15.00 Yrs |
| Residual Value - initial investment | $0.00m | Re-investment capital | -$0.06m |
| Capitalisation period | 1.00 Yrs | Start of the re-investment period | 2032-33 |