# OPTIONS EVALUATION REPORT (OER)

Maintain Voltage in Greater Sydney Area

OER- N2584 revision 4.0

TransGrid

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

**Project reason:** Reliability - To meet connection point reliability requirements
**Project category:** Prescribed - Augmentation-Sub Sys

## Approvals

| | | |
|---|---|---|
| **Author** | Gang Cao | Senior Planning Engineer |
| **Reviewed** | Mike Tamp | Senior Engineer (Contract), Network Planning & Operations |
| | Jesse Steinfeld | Future Grid Planning Manager |
| **Endorsed** | Kevin Hinkley | Manager Customer Planning |
| **Approved** | John Howland | Acting Head of Network Planning |
| **Date submitted for approval** | 22 December 2021 | |

## Change history

| Revision | Date | Amendment |
|---|---|---|
| 0 | 27/08/2021 | Initial Issue |
| 1-2 | 6/10/2021 | Revision to address HoustonKemp comments (error in system duplicated approval) |
| 3 | 1/11/2021 | Revision to address Cutler Merz comments |
| 4 | 23/12/2021 | Update to wording |

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# Executive summary

The electricity network supplying Inner Sydney comprises of hundreds of kilometres of high voltage underground cables. This characteristic, combined with an increasing penetration of Distributed Energy Resources (DER) such as rooftop solar PV systems, is causing significant reverse reactive power flow into Transgrid's network of up to hundreds of MVAr in some locations. This consequently contributes to increased voltage levels on the network supplying Sydney which can have a detrimental impact on customers' equipment and secure operation of the network.

To respond to these pressures on the Inner Sydney supply network, reactive power management utilising shunt reactors (or equivalent) is expected to be required within the next five years. This is required to ensure adequate voltage regulation of the network by maintaining voltage levels within regulatory requirements, protecting security of supply to Inner Sydney as increasing levels of DER technologies enter the grid.

The Transgrid assessment of the network options considered to address the need/opportunity appears in Table 1.

**Table 1 - Evaluated options**

| Option | Description | Direct capital cost ($m) | Network and corporate overheads ($m) | Total capital cost[1] ($m) | Weighted NPV (PV, $m) | Rank |
|---|---|---|---|---|---|---|
| Option A | Install a new 100 MVAr shunt reactor at Beaconsfield 132 kV busbar | $8.56m | $0.92 | $9.48 | $3.58m | 1 |

The preferred option is Option A, as this meets the requirements of the need and is the only technically and economically feasible option available to Transgrid.

The final preferred option will be determined through joint planning with Ausgrid as well as through the RIT-T process based on detailed network analysis, cost/benefit analysis, and the assessment of technical and economic feasibility of the network and non-network options.

[1] Total capital cost is the sum of the direct capital cost and network and corporate overheads. Total capital cost is used in this OER for all analysis.

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# 1. Need/opportunity

The Inner Sydney electricity network is unique in NSW due to the hundreds of kilometres of underground high voltage cables servicing the area. The Inner Sydney area is also experiencing rapid uptake and increasing penetration of DER which is placing new pressures on Ausgrid's distribution network. This is mostly being seen in the form of rooftop solar PV systems, but electric vehicles are increasingly entering the network. In combination, these characteristics are contributing to increased voltage levels and significant reverse reactive power flow into Transgrid's network, of up to hundreds of MVAr in some locations. This can have a detrimental impact on customers' equipment and the secure operation of the network.

Ausgrid is currently receiving complaints of high voltages in their network, with Transgrid required to reduce voltage set points at various sites in order to deal with the issue, as there is insufficient bucking voltage range and reactive support in the distribution network. Reactive support through the provision of shunt reactors (or equivalent) is likely to be required within the next five years as demand during the day is decreasing due to the aforementioned uptake of PV solar, to ensure the Inner Sydney network remains within adequate voltage regulations.

The specific regulatory compliance need for this project is to ensure that voltage levels are maintained within connection point voltage regulation requirements under NER S5.1.4 through the management of excess reverse reactive power flows back into Transgrid's network.

Also, following the installation of Cable 46 under the Powering Sydney's Future project, the outage of lines 1C/1F or cables 43/44 can lead to high voltages at Rookwood Road and Beaconsfield 330/132 kV Substations during maintenance outages.

In addition to ensuring Transgrid remains compliant with voltage standards, voltage regulation for Inner Sydney will provide the following benefits:

> Accommodate increasing penetration of DER without compromising power quality and system security;
> Reduces network losses within the distribution network;
> Improved network operability and security; and
> Improved voltage regulation during the maintenance outage of lines 1C/1F, and cables 43/44.

# 2. Related needs/opportunities

> N2312 – Install third 330/132 kV transformer at Beaconsfield.

Network studies have identified that once Powering Sydney's Future (PSF) Stage 1 is implemented, a third transformer is required at Beaconsfield to prevent overload under worst case modified N-2 contingency.

# 3. Options

## 3.1 Base case

Under the base case, where there is no network development to address the need, the voltage within Ausgrid's distribution network will rise above the 10 percent of the nominal voltage, which is non-compliant with NER S5.1.4. This will force the curtailment of rooftop PV generation during the daytime as high voltages in the network trigger inverters overvoltage protection, especially during lighter load periods, to maintain voltage levels to within regulatory requirements. This will result in increased generation costs in the NEM and higher-cost coal-fired generators will need to be dispatched to supply the load.

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## 3.2 Options evaluated

**Option A** — Install a new 100 MVAr shunt reactor at Beaconsfield 132 kV busbar

Option A will address voltage regulation compliance issues by installing a 100 MVAr shunt reactor at the Beaconsfield 132 kV BSP.

The scope of works includes:

> Installation of a new reactor and all associated equipment, including footing, underground cable, oil containment, fire wall and support steelworks.

The expected commissioning date for this option is 2025/26.

The expected expenditure profile for this option was obtained using the MTWO Estimating System. The estimates in the table below have an uncertainty of ± 25%.

**Table 2 – Option A expected expenditure**

| | Total Project Cost ($M) | 2022/23 ($M) | 2023/24 ($M) | 2024/25 ($M) |
|---|---|---|---|---|
| Estimated Cost – non-escalated ($million 2020-21) | 9.48 | 1.22 | 8 | 0.26 |

It is estimated that an amount up to $0.9 million (included in the project cost) is required to progress the project from DG1 to DG2. This is to cover activities such as site assessments, development of concept design, commencement of project approvals and the early procurement of long lead-time items.

This project is expected to be completed in an estimated 26 months following the approval of DG1.

**Option B** — Non-network solution

This option is to investigate the potential demand management (grid-connected battery) within the area supplied by Beaconsfield and Haymarket BSP to provide reactive support and reduce the voltage level in Ausgrid distribution network.

At this stage, it is not clear whether a demand management solution will be economically viable, and we have not evaluated it in the NPV analysis. However, the least cost network option is likely to exceed $6 million and will be subject to a RIT-T, where an Expression of interest (EOI) is expected to be released calling for non-network solutions. This will enable the viability of a non-network option to be fully assessed.

## 3.3 Options considered and not evaluated or progressed

We considered three other options that were not evaluated or progressed. These options are outlined in the table below.

| Option | Reason for not progressing |
|---|---|
| Option C — Ausgrid to install multiple low voltage reactive support devices in their distribution network at optimised locations. | This option requires no investment from Transgrid. If Ausgrid proposes and implements low voltage reactive support that addresses compliance concerns, Transgrid will not progress this need. Yet there is no certainty that Ausgrid's solution will be implemented. As such, Transgrid must submit a project in the coming regulatory period to address the need. Option C, and other non-network options will be sought as part of the RIT-T. |

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|---|---|
| Option D – install a new 100 MVAr shunt reactor at Haymarket substation | This option is not technically feasible due to the limited space available at Haymarket substation. |
| Option E – install dynamic reactive support plant (SVC or Syncon) at Beaconsfield substation | This option requires a large footprint. It is not technically feasible due to the limited space available at Beaconsfield substation. It is also commercially nonviable due to its significant cost compared with Option A. |

# 4. Evaluation

## 4.1 Commercial evaluation methodology

The economic assessment undertaken for this project includes three scenarios that reflect a central set of assumptions based on current information that is most likely to eventuate (central scenario), a set of assumptions that give rise to a lower bound for net benefits (lower bound scenario), and a set of assumptions that give rise to an upper bound on benefits (higher bound scenario).

Assumptions for each scenario are set out in Table 3 below.

**Table 3 - Evaluation Scenarios**

| Parameter | Central scenario | Lower bound scenario | Higher bound scenario |
|---|---|---|---|
| Discount rate | 4.8% | 7.37% | 2.23% |
| Capital cost | 100% | 125% | 75% |
| Operating expenditure | 100% | 125% | 75% |
| Average NSW Coal-fired generator SRMC[2] | 100% | 70% | 130% |
| Scenario weighting | **50%** | **25%** | **25%** |

Parameters used in this commercial evaluation are given in Table 4 below.

**Table 4 - Commercial Evaluation Parameters**

| Parameter | Parameter Description | Value used for this evaluation |
|---|---|---|
| Discount year | Year that dollar values are discounted to | 2020/21 |
| Base year | The year that dollar value outputs are expressed in real terms | 2020/21 dollars |
| Period of analysis | Number of years included in economic analysis with remaining capital value | 25 Years |

[2] Average NSW Coal-fired generator SRMC is calculated based on the NSW SRMC cost data extracted from AEMO 2020 Inputs and Assumptions Workbook.

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| | | |
|---|---|---|
| | included as terminal value at the end of the analysis period. | |

The capex figures in this OER do not include any real cost escalation.

## 4.2 Commercial evaluation results

The commercial evaluation of the technically feasible options is set out in Table 5. Details appear in Appendix A.

**Table 5 - Commercial evaluation (PV, $ million)**

| Option | Capital Cost PV | OPEX Cost PV | Central scenario NPV | Lower bound scenario NPV | Higher bound scenario NPV | Weighted NPV | Ranking |
|---|---|---|---|---|---|---|---|
| Option A | 8.67 | 2.15 | 2.57 | -5.09 | 14.25 | 3.58 | 1 |

## 4.3 Preferred option

The preferred option is Option A. Under this option, the following investments will be undertaken:

> Install a new 100 MVAr shunt reactor at Beaconsfield 132 kV busbar.

The preferred option was selected because this is the only Transgrid option that meets the identified need and is technically feasible. The base case does not meet the identified need as Transgrid will be non-compliant with regulatory obligations.

**Capital and Operating Expenditure**

The preferred option requires capital expenditure of $9.48 million. Additional operating expenditure of $0.19 million expenditure has been identified for this option.

The base case requires no capital or operating expenditure.

**Regulatory Investment Test**

As the estimated cost of the project is above the Regulatory Investment Test (RIT-T) threshold of $6 million, a RIT-T will be required.

# 5. Optimal Timing

The approach taken is to identify the optimal commissioning year for the preferred option where net benefits (including avoided costs and safety disproportionality tests) of the preferred option exceeds the annualised costs of the option. The commencement year is determined based on the required project disbursement to the meet the commissioning year based on the OFS.

The results of optimal timing analysis is:

> Optimal commissioning year: 2025/26
> Commissioning year annual benefit: $0.87 million
> Annualised cost: $0.517 million

Based on the optimal timing, the project is expected to commence in the 2023-2028 Regulatory Period.

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# 6. Recommendation

At this stage, the preferred network option is Option A – Install a new 100 MVAr shunt reactor at Beaconsfield 132 kV as it is the only technical and economically feasible option available to Transgrid. It is therefore recommended that the project be approved to proceed to a RIT-T assessment, with a view to the preferred option being implemented as soon as practicable from 2025/26.

Based on the options listed in Section 3.2, it is expected that this Project would incur a capital cost of approximately $9.48 million in P50 non-escalated 2020/21 dollars.

The final preferred option, however, will be determined through joint planning and the RIT-T process in conjunction with Ausgrid based on detailed network analysis, market modelling, and technical and economic feasibility.

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# Appendix A Option summaries (repeat for each option)

| **Project Description** | ***Maintain Voltage in Greater Sydney Area*** | | |
|---|---|---|---|
| Option Description | *Option A Install a new 100 MVAr shunt reactor at Beaconsfield 132kV busbar* | | |
| **Project Summary** | | | |
| Option Rank | 1 | Investment Assessment Period | 25 Years |
| Asset Life | 40 | NPV Year | *2021* |
| **Economic Evaluation** | | | |
| NPV @ Central Benefit Scenario (PV, $m) | 2.57 | Annualised CAPEX ($m) | 0.54 |
| NPV @ Lower Bound Scenario (PV, $m) | -5.09 | Network Safety Risk Reduction ($m) | N/A |
| NPV @ Higher Bound Scenario (PV, $m) | 14.25 | ALARP | N/A |
| NPV Weighted (PV, $m) | 3.58 | Optimal Timing | 2025/26 |
| **Cost** | | | |
| Direct Capex ($m) | 8.56 | Network and Corporate Overheads ($m) | 0.92 |
| Total Capex ($m) | 9.48 | Cost Capex (PV,$m) | 8.67 |
| Terminal Value ($m) | 4.5 | Terminal Value (PV,$m) | 1.46 |

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