

# OPTIONS EVALUATION REPORT (OER)

Continuation of Supply to the ACT

OER-9031 Revision 2.0



**Ellipse project description:** P0001054 - Second Supply to the ACT - Stockdill Dr Switching Station  
**TRIM file:** MF1495

**Project reason:** Reliability - To meet connection point reliability requirements

**Project category:** Prescribed – Augmentation

## Approvals

Author	James Tin	Network & Connection Analysis Engineer
Endorsed	Vincent Ong	Network & Connection Analysis Manager
	Azil Khan	Investment Analysis Manager
	Garrie Chubb	Investment Support Manager
Approved	Andrew Kingsmill	Manager/Network Planning
Date submitted for approval	9 January 2017	

## EXECUTIVE SUMMARY

TransGrid's supply to the Australian Capital Territory (ACT) is required to meet the technical code requirements as per its [Utility Services Licence](#) obligations and the [Utilities \(Technical Regulation\) \(Electricity Transmission Supply Code\) 2016](#). The Code stipulates:

Code Section 4.1.1 – TransGrid (and its successors)

- (1) *TransGrid must plan, design, construct, test, commission, maintain, operate and manage its electricity transmission networks and geographically separate connection points that supply customers in the ACT and that will operate at 66 kV and above, whether or not those networks and connection points are in the ACT, to achieve the following:*
  - (a) *the provision of two or more geographically separate connection points operated at 132 kV and above to supply electricity to the ACT 132 kV network;*
  - (b) *at all times provide continuous electricity supply at maximum demand to the ACT 132 kV and 66 kV network throughout and following a single credible contingency event;*
  - (c) *until 31 December 2020, provide electricity supply at 30 MVA to the ACT 132 kV or 66 kV network within one hour following a single special contingency event and 375 MVA within 48 hours of this event; and*
  - (d) *from 31 December 2020, provide continuous electricity supply at 375 MVA to the ACT 132 kV network immediately following a single special contingency event and agreed maximum demand within 48 hours of this event.*

A range of options were assessed against the base case option on a balance of technical and economic factors in the Options Screening Report (OSR-DCN335). The options considered to address the identified need are shown in the table below.

Note there are no Options A to C, the options considered commence at Option D. Also there was an Options numbering change adopted for this OER, hence the equivalent OSR numbering is shown in brackets.

**Table 1 - Options Considered**

Option	Description	Assessment	TransGrid CAPEX (\$m)	ActewAGL CAPEX (\$m)	Financial NPV (\$m)*	Economic NPV (\$m)*	Rank
<b>Base case</b>	'Do Nothing'	Not technically feasible. Does not meet Code requirements.	N/A	N/A	N/A	N/A	-
<b>D (OSR 1A)</b>	Stockdill 330 kV Switching Station: Turning in Line 01 with Capacitors at Stockdill and in the ActewAGL Network <i>ActewAGL to update Gilmore to Theodore line corridor and install capacitors at Woden and Bruce</i>  <i>* plus cost of operating CANB No.2 and No.3 Tx</i>	Technically feasible. However difficult to implement due to limited capacitor sites in the ActewAGL network. Significant reinvestment required after year 2024 to maintain Code compliance.	47.306	14.8	-44.92	588.11	5
<b>E (OSR 1B)</b>	Stockdill 330 kV Switching Station: Turning in Line 01 and Line 07, with Capacitors at Williamsdale 132 kV <i>ActewAGL to update Gilmore to Theodore line corridor</i>  <i>* plus cost of operating CANB No.2 and No.3 Tx</i>	Technically feasible. Meets Code requirements. Significant reinvestment required after year 2025 to maintain Code compliance.	59.706	10.9	-40.49	582.54	7

Option	Description	Assessment	TransGrid CAPEX (\$m)	ActewAGL CAPEX (\$m)	Financial NPV (\$m)*	Economic NPV (\$m)*	Rank
<b>F</b> <b>(OSR 2A)</b>	Stockdill 330/132 kV Substation: Turning in Line 01 with Capacitors at Williamsdale <i>ActewAGL to tail-end Line A-1 to Stockdill transformer</i> <i>* <u>plus</u> cost of operating CANB No.2 and No.3 Tx</i> <i>* <u>less</u> cost of replacing CANB No.2 Tx</i>	Technically feasible. Meets Code requirements.	47.006	4.475	-35.51	597.51	2
<b>G</b> <b>(OSR 2B)</b>	Stockdill 330/132 kV Substation: Turning in Line 01 and Line 07 <i>ActewAGL to tail-end Line A-1 to Stockdill transformer</i> <i>* <u>plus</u> cost of operating CANB No.2 and No.3 Tx</i> <i>* <u>less</u> cost of replacing CANB No.2 Tx</i>	Technically feasible. Meets Code requirements.	53.406	15.375	-47.27	585.76	6
<b>H</b> <b>(OSR 3A)</b>	Stockdill 330 kV Switching Station: Turning in Line 01 with Capacitors at Williamsdale. Operate Line 9 at 132 kV on contingency event. <i>ActewAGL to update Gilmore to Theodore line corridor</i> <i>* <u>plus</u> cost of operating CANB No.2 and No.3 Tx</i>	Technically feasible. Meets Code requirements. Significant reinvestment required after year 2030 to maintain Code compliance.	49.106	14.8	-44.74	588.29	4
<b>I</b> <b>(OSR 4A)</b>	Stockdill 330/132 kV Substation: Turning in Line 01. Operate Line 9 at 132 kV on contingency event. <i>ActewAGL to tail-end Line A-1 to Stockdill transformer</i> <i>* <u>plus</u> cost of operating CANB No.2 and No.3 Tx</i> <i>* <u>less</u> cost of replacing CANB No.2 Tx</i>	Technically feasible. Meets Code requirements.	45.606	4.475	-35.8	597.22	3
<b>J</b> <b>(OSR 4A)</b>	Stockdill 330/132 kV Substation: Turning in Line 01 Utilising Line 3C Structures. Operate Line 9 at 132 kV on contingency event. <i>ActewAGL to tail-end Line A-1 to Stockdill transformer</i> <i>* <u>plus</u> cost of operating CANB No.2 and No.3 Tx</i> <i>* <u>less</u> cost of replacing CANB No.2 Tx</i>	Technically feasible. Meets Code requirements.	40.606	4.475	-31.55	601.48	1

\* NPV calculations include any re-investments during the 30 year assessment period. See 4.1.1.

Notes:

1. The operational cost (OPEX) is expected to be similar between the options and is not a determining factor in the ranking of the options.
2. Economic NPV is at standard discount rate (10%) and includes any potential future re-investments.
3. No non-network options were identified.

4. Any change from the original Wallaroo option is considered a negotiated augmentation and is not included in this analysis.
5. The ActewAGL component of work is assumed to be completed in the last year of the works program and is reflected in the NPV calculations.

Option J is identified as the preferred option for detailed scoping. It requires developing Stockdill as a 330/132 kV substation, turning in Line 01 and operating Line 9 at 132 kV following a special contingency event (Canberra failure). This option meets the Code requirements, is technically preferred on a balance of operation and expandability, and has the lowest capital cost and highest Net Present Value. The inclusion of a single Stockdill transformer, tee'd onto Line A-1, provides the additional network benefit of allowing the future Canberra transformer requirement to be reduced to 2 transformers, eliminating the need to replace the No.2 unit as per the current Canberra Piecemeal Replacement Project.

## 1. NEED/OPPORTUNITY

TransGrids' supply to the Australian Capital Territory (ACT) is required to meet the technical code requirements as per its [Utility Services Licence](#) obligations and the [Utilities \(Technical Regulation\) \(Electricity Transmission Supply Code\) 2016](#) (the Code) stipulates:

Code Section 4.1.1 – TransGrid (and its successors)

- (1) *TransGrid must plan, design, construct, test, commission, maintain, operate and manage its electricity transmission networks and geographically separate connection points that supply customers in the ACT and that will operate at 66 kV and above, whether or not those networks and connection points are in the ACT, to achieve the following:*
  - (a) *the provision of two or more geographically separate connection points operated at 132 kV and above to supply electricity to the ACT 132 kV network;*
  - (b) *at all times provide continuous electricity supply at maximum demand to the ACT 132 kV and 66 kV network throughout and following a single credible contingency event;*
  - (c) *until 31 December 2020, provide electricity supply at 30 MVA to the ACT 132 kV or 66 kV network within one hour following a single special contingency event and 375 MVA within 48 hours of this event; and*
  - (d) *from 31 December 2020, provide continuous electricity supply at 375 MVA to the ACT 132 kV network immediately following a single special contingency event and agreed maximum demand within 48 hours of this event.*

### Current Compliance with the Code

The present electricity supply to the ACT complies with the Code.

- |                    |  |
|--------------------|--|
| <b>4.1.1(1)(a)</b> | Canberra and Williamsdale 330/132 kV substations provides 132 kV supplies to the ACT. The two sites are set 43 km apart and are geographically separate.   |
| <b>4.1.1(1)(b)</b> | The present ACT supply arrangement is able to sustain the loss of any one element without impacting on the continuous electricity supply at <i>maximum demand</i> .  |
| <b>4.1.1(1)(c)</b> | The present ACT supply arrangement is able to provide electricity supply at 30 MVA to the ACT 132 kV or 66 kV network within one hour following a single special contingency event and 375 MVA within 48 hours of this event.  |
| <b>4.1.1(1)(d)</b> | The present ACT supply arrangement is not capable of supplying 375 MVA to the ACT 132 kV network immediately following the loss of Stockdill substation. Furthermore, the present arrangement cannot supply maximum demand within 48 hours of a special contingency event. |

The present supply arrangement is therefore not compliant with the Code after 31 December 2020.

## 1.1 Original Wallaroo Supply Concept

The original supply concept (documented in the joint 'Final Report' for the *Development of the Southern Supply to the ACT*) was to develop a 330 kV switching station in the Wallaroo area, rerouting and extending Line 3C Canberra to Williamsdale to form a Wallaroo to Williamsdale circuit. This arrangement would result in two 330 kV supplies to the ACT from Canberra and Williamsdale independent of each other.

However, subsequent to the Final Report the Wallaroo-area was set aside for other developments and became unavailable to site the new 330 kV switching station.

## 1.2 Present Stockdill Supply Concept

An alternative site was proposed in the Stockdill-area south of the NSW/ACT border, approximately 2.7km south of Canberra 330/132 kV Substation. Options for the configuration of Stockdill and the supply arrangements were investigated and are assessed below.

# 2. RELATED NEEDS/OPPORTUNITIES

---

## 2.1 West Belconnen Land Development Opportunities in the ACT

The suburb of West Belconnen is proposed to be developed with a focus on housing, employment, community spaces, and nature conservation. The land use will be largely residential with a commercial hub near its centre.

Canberra substation is situated on the eastern edge of the West Belconnen development. 330 kV lines enter from the north (Line 6), north-west (Line 9), west (Line 01 and Line 07) and south (Line 3C). All lines enter through the substation's western aspect and lines cut through large portions of the proposed residential area. If in the process of rearranging supply to the ACT the lines can be deviated to free up additional areas for development, secondary benefits for the ACT government can be realised. Any additional costs over and above the requirement to meet the Code will be non-prescribed costs recoverable from the ACT Government.

## 2.2 ActewAGL Strathnairn (formerly West Belconnen) Zone Substation Development

- > NOS-1443 – 132 kV Connection of ActewAGLs' proposed West Belconnen ZS.

ActewAGL is proposing to establish a new Strathnairn (formerly West Belconnen) 132 kV zone substation between the present Canberra and Woden substations. The new zone substation will be located near or adjacent to the existing Canberra substation and is expected to be established by 2020.

## 2.3 Canberra Piecemeal Replacement

- > PSS-DCN238 – Canberra Substation Condition

Canberra substation was constructed in 1967. Augmentations over its service life have seen the extension of the 330 kV busbar (1973); extension of the 132kV busbar (1980); installation of transformers No 1 (1987) and No 4 (2002); and installation of 132kV capacitor banks No 1 (1980), No 2 (1992) and No 3 (2003).

Condition assessment of the substation identified a scope of work required by existing policies, including:

- > Replacement of the No.2 transformer;
- > Replacement of secondary systems;
- > Remediate switchyard surface, and
- > Increase spill oil tank capacity.
- > The No.3 transformer will be removed, leaving three transformers, in positions No.1, 2, and 4<sup>1</sup>.

---

<sup>1</sup> Under the preferred Option J Canberra substation only requires two transformers. The No.2 unit can be retired at the end of life.

### 3. OPTIONS CONSIDERED

---

#### 3.1 BASE CASE

The base case option is to maintain the existing ACT supply arrangement, and operate the Canberra 330 kV bypass on the occurrence of a special contingency event.

The ACT is supplied at 132 kV from Canberra and Williamsdale 330/132 kV substations. However, Williamsdale is supplied at 330 kV from Canberra substation such that on loss of Canberra substation, the supply to Williamsdale is interrupted as is the supply to the ACT.

A 330 kV bypass of Canberra substation is available within 48-hours of outage of the Canberra 330 kV busbar. The 330 kV supply from Yass (Line 9) can then bypass the Canberra 330 kV busbar and connect onto Line 3C to resume supply to Williamsdale and to the ACT, however is not able to provide maximum demand due to voltage constraints.

No work is required by the DNSP (ActewAGL) for this option.

##### **Commercial Feasibility**

The base case is commercially not feasible as it would be a non-compliance of a Technical Code which is part of the Utility Services Licence obligations, and as such is a condition of the TransGrid lease. The commercial cost of non-compliance is un-priced but would be approaching the value of the lease of TransGrid.

##### **Technical Feasibility**

The base case is not technically feasible as it does not comply with the requirements set out in the Code.

##### **3.1.1 Cost**

The base case is a no-cost option.

##### **3.1.2 Market Benefits**

The base case has a large negative impact on the market based on the perceived risk of a special contingency event<sup>2</sup>.

The loss of a connection point (i.e. Canberra substation) would result in:

- > Service interruptions to reliability valued at \$101,170,000. This includes:
  - > The total loss of the entire ACT load for 48 hours during which the Line 3C emergency bypass of Canberra would be put in place after which 350 MW of supply is restored, and
  - > Following two years of limited supply during which works to restore/rebuild Canberra substation would take place.
- > Detrimental media coverage, and
- > Poor customer exposure.

The total base case risk cost is \$101,253,300 p.a.

*The unserved energy is considered over the full restoration period as there are presently no emergency response plans or arrangements in place to setup temporary supplies and/or network rearrangements to reinforce supply following a special contingency event occurring.*

---

<sup>2</sup> *Special Contingency* – the unexpected disconnection of all or multiple elements at a single geographic location for an extended period of time and includes the loss of supply to connection points. – Utilities (Technical Regulation) ACT 2014



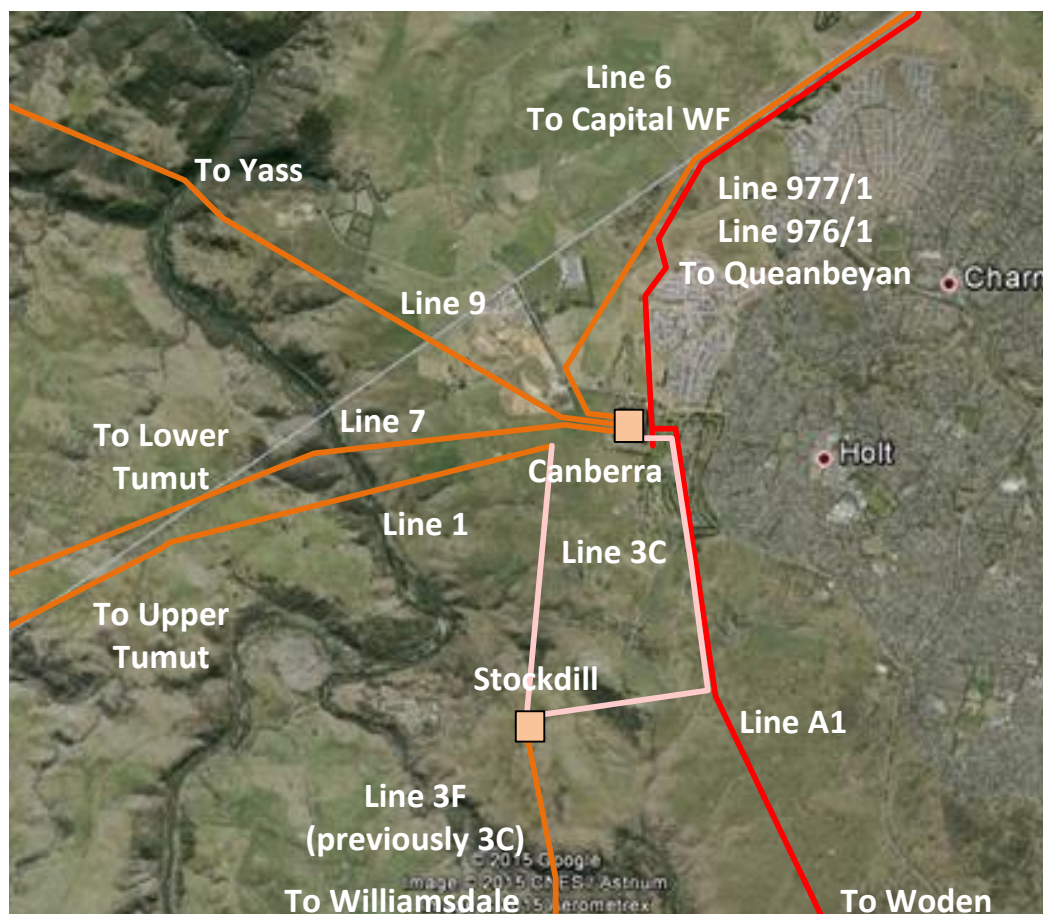
### 3.2 OPTION D – Stockdill 330 kV Switching Station: Turning in Line 01 with Capacitors at Stockdill and in the ActewAGL Network

Ref. doc. – OFR-9031D, OFS-9031D

This option is to develop Stockdill as a 330 kV switching station, installing capacitors at Stockdill and in the ActewAGL 132 kV network. The new switching station would be supplied from Upper Tumut by Line 01, and connected to Williamsdale by turning in existing Line 3C to form a new Line 3F. A new double circuit 330 kV Line 3C, strung only on one side, would be constructed between Stockdill and Canberra.

ActewAGL would upgrade the existing 132 kV Gilmore to Theodore transmission corridor (comprised of two single circuit lines) to match the rating of the Williamsdale to Theodore transmission line.

Figure 1: Supply Arrangement with Option D



#### 3.2.1 Commercial Feasibility

This option is commercially feasible.

#### 3.2.2 Technical Feasibility

This option is technically feasibility as it meets the requirements set out in the Code.

#### 3.2.3 Cost

This option has a capital expenditure of \$61.4 million. The cost is shared between TransGrid and ActewAGL, \$46.6 million and \$14.8 million, respectively.

Refer to OFS-9031D – October 2016.

### Related Costs

TransGrid will expend a further \$706k (as part of a separate project) to refurbish the No.3 Canberra transformer in order to continue to operate the No.2 and No.3 Canberra transformers until the establishment of Stockdill substation is completed, at the which point the two transformers will be decommissioned and scraped.

*Refer to Asset Management Instruction (AMI) DCN-238 – Canberra Substation Condition Rev.1 – 2 September 2016.*

#### **3.2.4 Market Benefits**

This option would result in significant market benefit based on the reduction in the perceived risk of a special contingency event.

Following the loss of a connection point (i.e. Canberra substation), this option would see a reduction in the consequence through:

- > Reduction of unserved energy to zero
- > Reduction in detrimental media cover, and
- > Reduction in poor customer exposure.

The total post-option risk is \$82,976 p.a., a risk cost reduction of \$101,170,324 p.a. over the base case.

### **3.3 Option E – Stockdill 330 kV Switching Station: Turning in Line 01 and Line 07, with Capacitors at Williamsdale 132 kV**

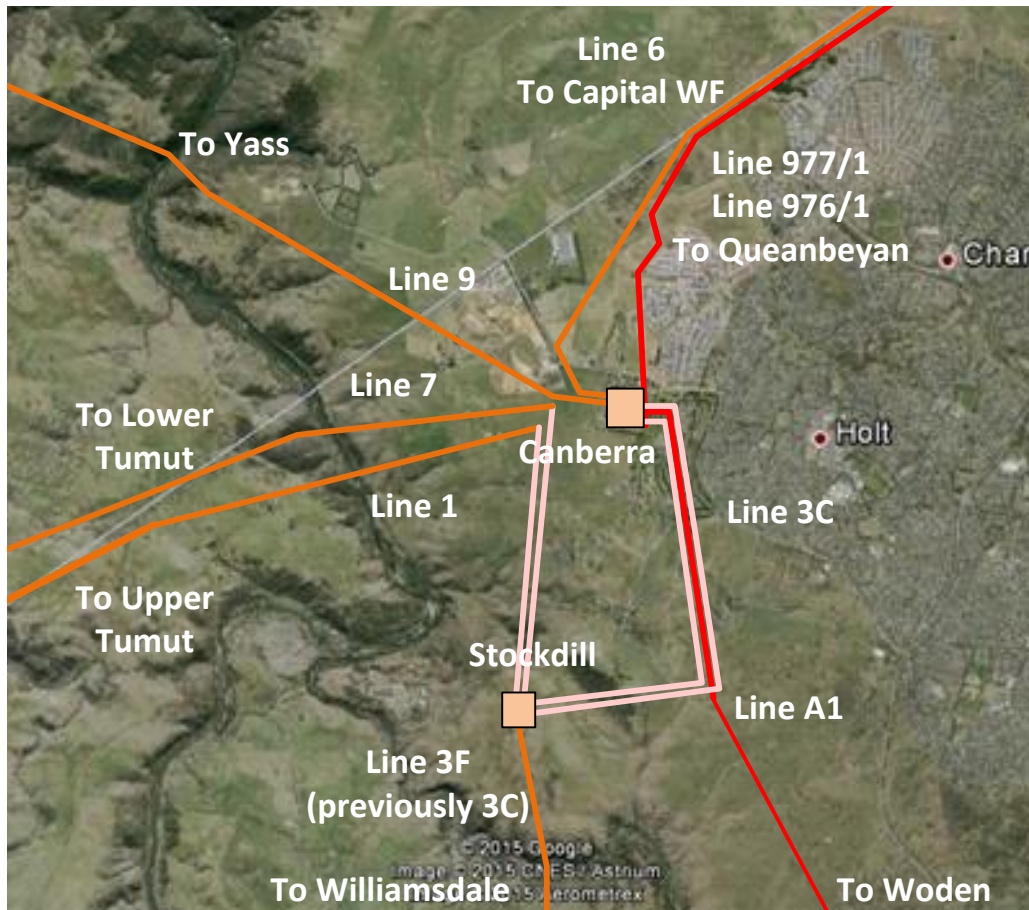
*Ref. doc. – OFR-9031E, OFS-9031E*

This option is to develop Stockdill as a 330 kV switching station and install capacitors at Williamsdale. The new switching station would be supplied from Upper Tumut by Line 01, and Lower Tumut by Line 07. Stockdill switching station would be connected to Williamsdale by turning in existing Line 3C to form the new Line 3F. A new 330 kV double circuit Line 3C would be constructed between Stockdill and Canberra.

ActewAGL would upgrade the existing 132 kV Gilmore to Theodore transmission corridor (comprised of two single circuit lines) to match the rating of the Williamsdale to Theodore transmission line.



**Figure 2: Supply Arrangement with Option E**



### 3.3.1 Commercial Feasibility

This option is commercially feasible.

### 3.3.2 Technical Feasibility

This option is technically feasible as it meets the requirements set out in the Code.

### 3.3.3 Cost

This option has a capital expenditure of \$69.9 million. The cost is shared between TransGrid and ActewAGL, \$59.0 million and \$10.9 million, respectively.

*Refer to OFS-9031E – October 2016.*

#### Related Costs

TransGrid will expend a further \$706k (as part of a separate project) to refurbish the No.3 Canberra transformer in order to continue to operate the No.2 and No.3 Canberra transformers until the establishment of Stockdill substation is completed, at the which point the two transformers will be decommissioned and scrapped.

*Refer to Asset Management Instruction (AMI) DCN-238 – Canberra Substation Condition Rev.1 – 2 September 2016.*

### 3.3.4 Market Benefits

This option would result in significant market benefit based on the reduction in the perceived risk of a special contingency event.

Following the loss of a connection point (i.e. Canberra substation), this option would see a reduction in the consequence through:

- > Reduction of unserved energy to zero
- > Reduction in detrimental media cover, and
- > Reduction in poor customer exposure.

The total post-option risk is \$82,976 p.a., a risk cost reduction of \$101,170,324 p.a. over the base case.

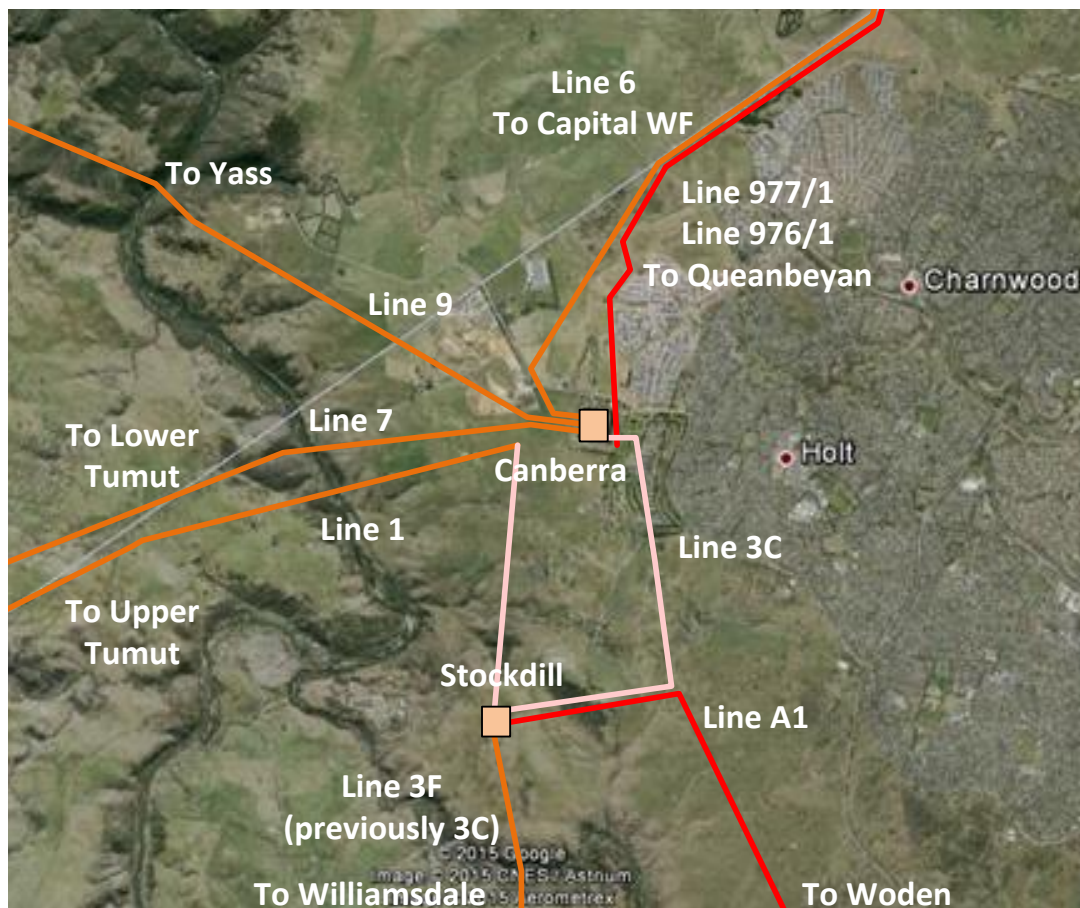
### 3.4 OPTION F – Stockdill 330/132 kV Substation: Turning in Line 01 with Capacitors at Williamsdale

Ref. doc. – OFR-9031F, OFS-9031F

This option is to develop Stockdill as a 330/132 kV substation and install capacitors at Williamsdale. Stockdill substation would be equipped with one 375 MVA transformer tail-ended on to Line A-1 (to Woden) and would be supplied from Upper Tumut by Line 01. The new substation would connect to Williamsdale by turning in existing Line 3C to form the new Line 3F. A new double circuit 330 kV Line 3C, strung only on one side, would be constructed between Stockdill and Canberra.

ActewAGL would turn in Line A-1 into Stockdill substation, tail ending the 132 kV line to the Stockdill 330/132 kV transformer.

Figure 3: Supply Arrangement with Option F



#### 3.4.1 Commercial Feasibility

This option is commercially feasible.

#### 3.4.2 Technical Feasibility

This option is technically feasible as it meets the requirements set out in the Code.

### 3.4.3 Cost

This option has a capital expenditure of \$57.675 million. The cost is shared between TransGrid and ActewAGL, \$53.2 million and \$4.475 million, respectively.

*Refer to OFS-9031F – October 2016.*

#### Related Costs

TransGrid will expend a further \$706k (as part of a separate project) to refurbish the No.3 Canberra transformer in order to continue to operate the No.2 and No.3 Canberra transformers until the establishment of Stockdill substation is completed, at the which point the two transformers will be decommissioned and scraped.

*Refer to Asset Management Instruction (AMI) DCN-238 – Canberra Substation Condition Rev.1 – 2 September 2016.*

### 3.4.4 Market Benefits

This option would result in significant market benefit based on the reduction in the perceived risk of a special contingency event.

Following the loss of a connection point (i.e. Canberra substation), this option would see a reduction in the consequence through:

- > Reduction of unserved energy to zero
- > Reduction in detrimental media cover, and
- > Reduction in poor customer exposure.

The total post-option risk is \$82,976 p.a., a risk cost reduction of \$101,170,324 p.a. over the base case.

## 3.5 OPTION G – Stockdill 330/132 kV Substation: Turning in Line 01 and Line 07

*Ref. doc. – OFR-9031G, OFS-9031G*

This option is to develop Stockdill as a 330/132 kV substation. Stockdill substation would be equipped with one 375 MVA transformer tail-ended on to Line A-1 (to Woden) and would be supplied from Upper Tumut by Line 01, and Lower Tumut by Line 07. The new substation would connect to Williamsdale by turning in existing Line 3C to form the new Line 3F. A new double circuit 330 kV Line 3C would be constructed between Stockdill and Canberra.

ActewAGL would turn in Line A-1 into Stockdill substation, tail ending the 132 kV line to the Stockdill 330/132 kV transformer.



**Figure 4: Supply Arrangement with Option G**



### 3.5.1 Commercial Feasibility

This option is commercially feasible.

### 3.5.2 Technical Feasibility

This option is technically feasible as it meets the requirements set out in the Code.

### 3.5.3 Cost

This option has a capital expenditure of \$74.46 million. The cost is shared between TransGrid and ActewAGL, \$59.66 million and \$14.8 million, respectively.

*Refer to OFS-9031G – October 2016.*

#### Related Costs

TransGrid will expend a further \$706k (as part of a separate project) to refurbish the No.3 Canberra transformer in order to continue to operate the No.2 and No.3 Canberra transformers until the establishment of Stockdill substation is completed, at the which point the two transformers will be decommissioned and scrapped.

*Refer to Asset Management Instruction (AMI) DCN-238 – Canberra Substation Condition Rev.1 – 2 September 2016.*

### 3.5.4 Market Benefits

This option would result in significant market benefit based on the reduction in the perceived risk of a special contingency event.

Following the loss of a connection point (i.e. Canberra substation), this option would see a reduction in the consequence through:

- > Reduction of unserved energy to zero
- > Reduction in detrimental media cover, and
- > Reduction in poor customer exposure.

The total post-option risk is \$82,976 p.a., a risk cost reduction of \$101,170,324 p.a. over the base case.

### 3.6 OPTION H – Stockdill 330 kV Switching Station: Turning in Line 01 with Capacitors at Williamsdale. Operate Line 9 at 132 kV on contingency event.

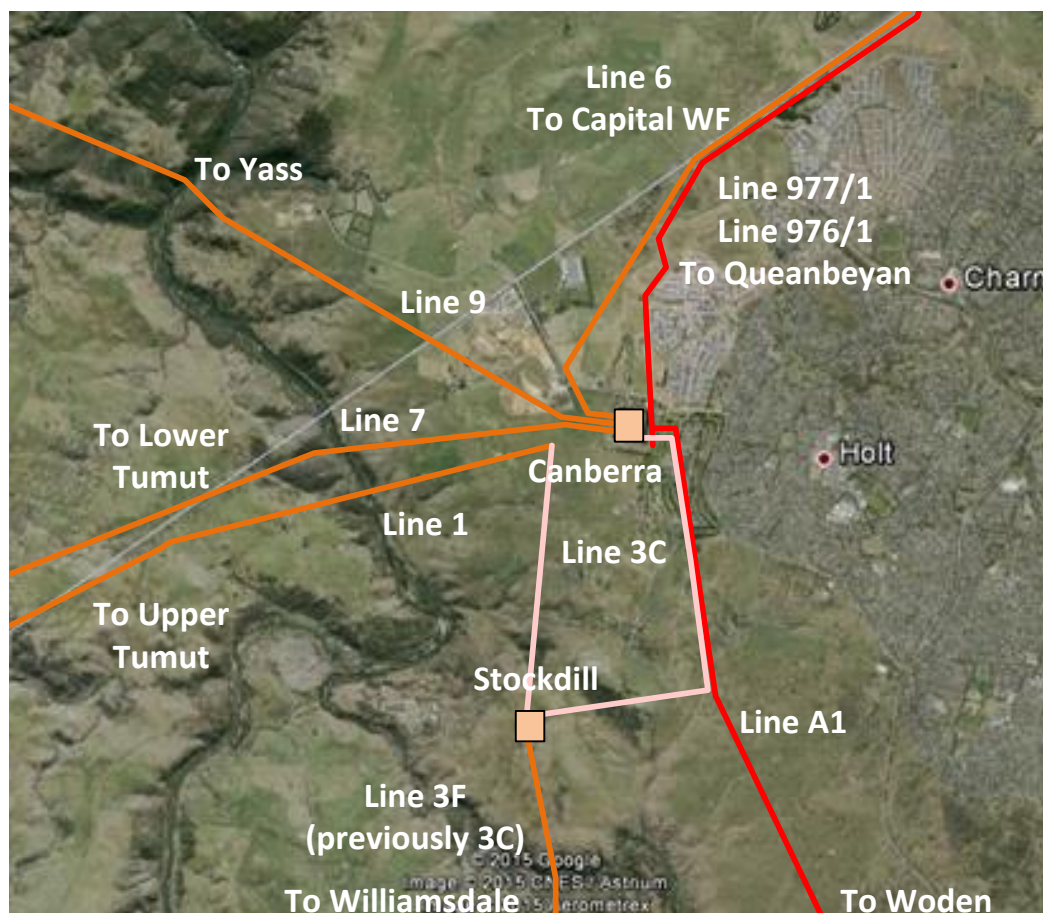
*Ref. doc. – OFR-9031H, OFS-9031H*

This option is to develop Stockdill as a 330 kV switching station and installing capacitors at Williamsdale to provide an initial supply capacity to the ACT on the loss of Canberra substation. The full supply capacity is then restored within 48-hours by converting Line 9 to 132 kV and supplying the ACT from Latham and Gold Creek.

The new switching station would be supplied from Upper Tumut by Line 01, and connect to Williamsdale by turning in existing Line 3C to form a new Line 3F. A new double circuit 330 kV Line 3C, strung only on one side, would be constructed between Stockdill and Canberra.

ActewAGL would upgrade the existing 132 kV Gilmore to Theodore transmission corridor (comprised of two single circuit lines) to match the rating of the Williamsdale to Theodore transmission line.

**Figure 5: Supply Arrangement with Option H**



#### 3.6.1 Commercial Feasibility

This option is commercially feasible.

#### 3.6.2 Technical Feasibility

This option is technically feasible as it meets the requirements set out in the Code.

### 3.6.3 Cost

This option has a capital expenditure of \$63.21 million. The cost is shared between TransGrid and ActewAGL, \$48.4 million and \$14.8 million, respectively.

*Refer to OFS-9031H – October 2016.*

#### Related Costs

TransGrid will expend a further \$706k (as part of a separate project) to refurbish the No.3 Canberra transformer in order to continue to operate the No.2 and No.3 Canberra transformers until the establishment of Stockdill substation is completed, at the which point the two transformers will be decommissioned and scraped.

*Refer to Asset Management Instruction (AMI) DCN-238 – Canberra Substation Condition Rev.1 – 2 September 2016.*

### 3.6.4 Market Benefits

This option would result in significant market benefit based on the reduction in the perceived risk of a special contingency event.

Following the loss of a connection point (i.e. Canberra substation), this option would see a reduction in the consequence through:

- > Reduction of unserved energy to zero
- > Reduction in detrimental media cover, and
- > Reduction in poor customer exposure.

The total post-option risk is \$82,976 p.a., a risk cost reduction of \$101,170,324 p.a. over the base case.

## 3.7 **OPTION I – Stockdill 330/132 kV Substation: Turning in Line 01. Operate Line 9 at 132 kV on contingency event.**

*Ref. doc. – OFR-9031I, OFS-9031I*

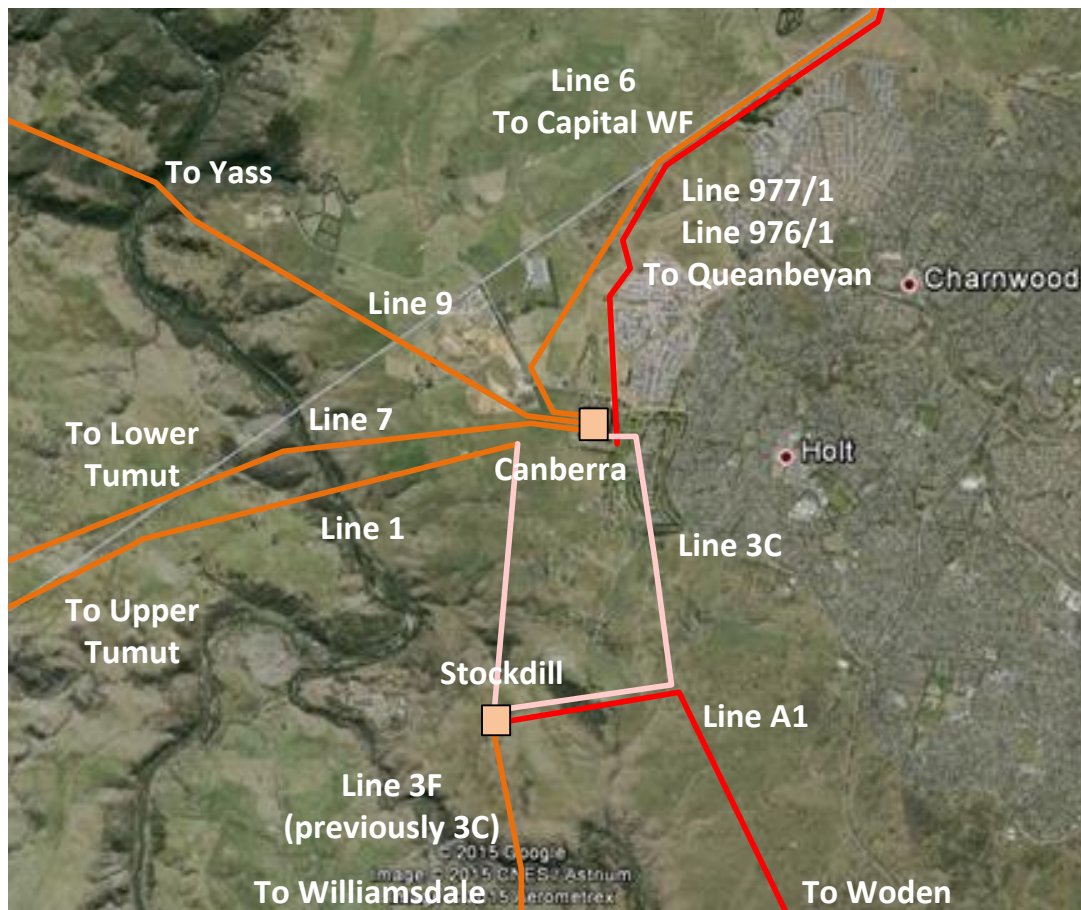
This option is to develop Stockdill as a 330/132 kV substation to provide an initial supply capacity to the ACT on the loss of Canberra substation. The full supply capacity is then restored within 48-hours by converting Line 9 to 132 kV and supplying the ACT from Latham and Gold Creek.

The new substation would be supplied from Upper Tumut by Line 01, and connected to Williamsdale by turning in the existing Line 3C to form a new Line 3F. A new double circuit 330 kV Line 3C, strung only on one side, would be constructed between Stockdill and Canberra.

ActewAGL would turn in Line A-1 into Stockdill substation, tail ending the 132 kV line to the Stockdill 330/132 kV transformer.



**Figure 6: Supply Arrangement with Option I**



### 3.7.1 Commercial Feasibility

This option is commercially feasible.

### 3.7.2 Technical Feasibility

This option is technically feasible as it meets the requirements set out in the Code.

### 3.7.3 Cost

This option has a capital expenditure of \$56.235 million. The cost is shared between TransGrid and ActewAGL, \$51.76 million and \$4.475 million, respectively.

*Refer to OFS-9031D – October 2016.*

#### Related Costs

TransGrid will expend a further \$706k (as part of a separate project) to refurbish the No.3 Canberra transformer in order to continue to operate the No.2 and No.3 Canberra transformers until the establishment of Stockdill substation is completed, at the which point the two transformers will be decommissioned and scrapped.

*Refer to Asset Management Instruction (AMI) DCN-238 – Canberra Substation Condition Rev.1 – 2 September 2016.*

### 3.7.4 Market Benefits

This option would result in significant market benefit based on the reduction in the perceived risk of a special contingency event.

Following the loss of a connection point (i.e. Canberra substation), this option would see a reduction in the consequence through:

- > Reduction of unserved energy to zero
- > Reduction in detrimental media cover, and
- > Reduction in poor customer exposure.

The total post-option risk is \$82,976 p.a., a risk cost reduction of \$101,170,324 p.a. over the base case.

### 3.8 OPTION J – Stockdill 330/132 kV Substation: Turning in Line 01 Utilising Line 3C Structures. Operate Line 9 at 132 kV on Contingency Event

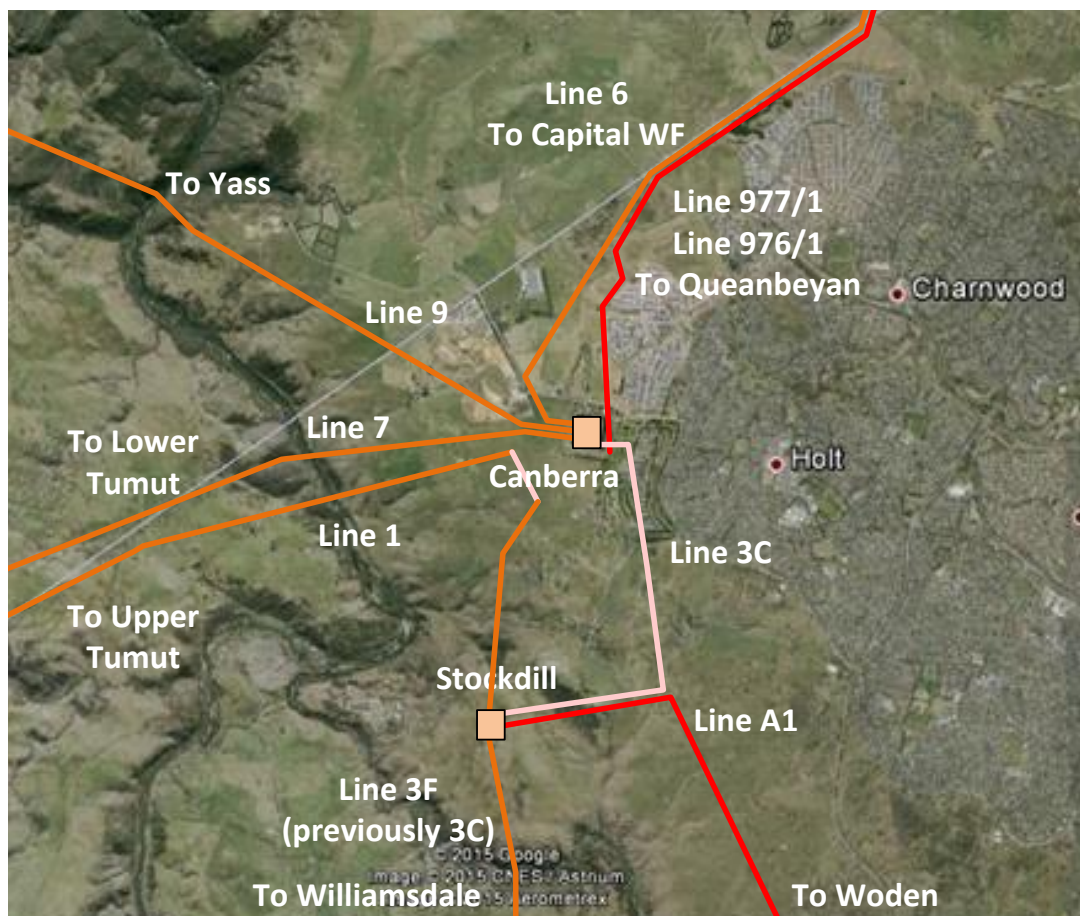
Ref. doc. – OFR-9031J, OFS-9031J

This option is to develop Stockdill as a 330/132 kV substation to provide an initial supply capacity to the ACT on the loss of Canberra substation. The full supply capacity is then restored within 48-hours by converting Line 9 to 132 kV and supplying the ACT from Latham and Gold Creek.

The new substation would be supplied from Upper Tumut by Line 01, and connected to Williamsdale by turning in existing Line 3C to form a new Line 3F. The Line 01 turn-in would utilise the existing Line 3C easement and single circuit structures. A new double circuit 330 kV Line 3C, strung only on one side, would be constructed between Stockdill and Canberra.

ActewAGL would turn in Line A-1 into Stockdill substation, tail ending the 132 kV line to the Stockdill 330/132 kV transformer.

Figure 7: Supply Arrangement with Option J



#### 3.8.1 Commercial Feasibility

This option is commercially feasible.

### 3.8.2 Technical Feasibility

This option is technically feasible as it meets the requirements set out in the Code.

### 3.8.3 Cost

This option has a total base cost of \$50.235 million. The cost is shared between TransGrid and ActewAGL, \$46.8 million and \$4.475 million, respectively. Refer Table 4 for details.

Refer to OFS-9031J – October 2016.

#### Related Costs

TransGrid will expend a further \$706k (as part of a separate project) to refurbish the No.3 Canberra transformer in order to continue to operate the No.2 and No.3 Canberra transformers until the establishment of Stockdill substation is completed, at the which point the two transformers will be decommissioned and scrapped.

Refer to Asset Management Instruction (AMI) DCN-238 – Canberra Substation Condition Rev.1 – 2 September 2016.

### 3.8.4 Market Benefits

This option would result in significant market benefit based on the reduction in the perceived risk of a special contingency event.

Following the loss of a connection point (i.e. Canberra substation), this option would see a reduction in the consequence through:

- > Reduction of unserved energy to zero
- > Reduction in detrimental media cover, and
- > Reduction in poor customer exposure.

The total post-option risk is \$82,976 p.a., a risk cost reduction of \$101,170,324 p.a. over the base case.

## 4. EVALUATION

### 4.1 Technical evaluation

All of the considered options (with the exception of the base case) are technically feasible. A summary of the technical capabilities of each option is shown below.

Table 2 - Technical Evaluation

Option	Description	Supply Capacity:		Supply Adequacy (See Note 1)
		Immediately following the contingency	Within 48-hours following the contingency	
D	Stockdill 330 kV Switching Station: Turning in Line 01 with Capacitors at Stockdill and in the ActewAGL Network  ActewAGL to uprate Gilmore to Theodore line corridor and install capacitors at Woden and Bruce	600 MW (with 240 MVar at Stockdill 330 kV, 120 MVar at Woden, and 120 MVar at Bruce)	Unchanged	Year 2024
E	Stockdill 330 kV Switching Station: Turning in Line 01 and Line 07, with Capacitors at Williamsdale 132 kV  ActewAGL to uprate Gilmore to Theodore line corridor	608 MW (with 240 MVar at Williamsdale 132 kV)	Unchanged	Year 2025

Option	Description	Supply Capacity:		Supply Adequacy
F	Stockdill 330/132 kV Substation: Turning in Line 01 with Capacitors at Williamsdale <i>ActewAGL to tail-end Line A-1 to Stockdill transformer</i>	601 MW  (with 240 MVar at Williamsdale 132 kV)	Unchanged	Year 2024
G	Stockdill 330/132 kV Substation: Turning in Line 01 and Line 07 <i>ActewAGL to tail-end Line A-1 to Stockdill transformer</i>	660 MW	Unchanged	Year 2033
H	Stockdill 330 kV Switching Station: Turning in Line 01 with Capacitors at Williamsdale. Operate Line 9 at 132 kV on contingency event. <i>ActewAGL to uprate Gilmore to Theodore line corridor</i>	443 MW  (with 120 MVar at Williamsdale 132 kV)	640 MW  (with 120 MVar at Williamsdale 132 kV)	Year 2030
I	Stockdill 330/132 kV Substation: Turning in Line 01. Operate Line 9 at 132 kV on contingency event. <i>ActewAGL to tail-end Line A-1 to Stockdill transformer</i>	437 MW	646 MW	Year 2031
J	Stockdill 330/132 kV Substation: Turning in Line 01 Utilising Line 3C Structures. Operate Line 9 at 132 kV on contingency event. <i>ActewAGL to tail-end Line A-1 to Stockdill transformer</i>	437 MW	646 MW	Year 2031

Note 1: Based on T-APR 2015 summer forecast for Canberra and Williamsdale projected for 30 years using 1.2% and 0.7% annual growth respectively.

#### 4.1.1 Capacity within the next 30 years

Based on a scaled 30 year projection of the load forecast for Canberra and Williamsdale requires potential reinvestment (see below) to maintain the maximum demand supply within 48-hours of a special contingency event.

The projected 2046 ACT loads are:

Canberra	552 MW
Williamsdale	200 MW

**Table 3 - Potential Reinvestment Options**

Option	Description	Supply Capacity	Potential Reinvestment Option	New Capacity
D	Stockdill 330 kV Switching Station: Turning in Line 01 with Capacitors at Stockdill and in the ActewAGL Network <i>ActewAGL to update Gilmore to Theodore line corridor and install capacitors at Woden and Bruce</i>	600 MW  (with 240 MVar at Stockdill 330 kV, 12 MVar at Woden, and 120 MVar at Bruce)	Install 330/132 kV transformer (\$6.9M) and divert Line 7 (\$0.9M) in year 2024	869 MW
E	Stockdill 330 kV Switching Station: Turning in Line 01 and Line 07, with Capacitors at Williamsdale 132 kV <i>ActewAGL to update Gilmore to Theodore line corridor</i>	608 MW  (with 240 MVar at Williamsdale 132 kV)	Install 330/132 kV transformer (\$6.9M) in year 2025	869 MW



Option	Description	Supply Capacity	Potential Reinvestment Option	New Capacity
F	Stockdill 330/132 kV Substation: Turning in Line 01 with Capacitors at Williamsdale <i>ActewAGL to tail-end Line A-1 to Stockdill transformer</i>	601 MW (with 240 MVar at Williamsdale 132 kV)	Divert Line 7 (\$0.9M) in year 2024	869 MW
G	Stockdill 330/132 kV Substation: Turning in Line 01 and Line 07 <i>ActewAGL to tail-end Line A-1 to Stockdill transformer</i>	660 MW	Install 120 MVar capacitors (\$3.1M) in year 2033	812 MW
H	Stockdill 330 kV Switching Station: Turning in Line 01 with Capacitors at Williamsdale. Operate Line 9 at 132 kV on contingency event. <i>ActewAGL to update Gilmore to Theodore line corridor</i>	640 MW within 48-hours (with 120 MVar at Williamsdale 132 kV)	Install 330/132 kV transformer (\$6.9M) in year 2030	850 MW within 48-hours
I	Stockdill 330/132 kV Substation: Turning in Line 01. Operate Line 9 at 132 kV on contingency event. <i>ActewAGL to tail-end Line A-1 to Stockdill transformer</i>	646 MW within 48-hours	Install 120 MVar capacitors (\$3.1M) in year 2031	850 MW within 48-hours
J	Stockdill 330/132 kV Substation: Turning in Line 01 Utilising Line 3C Structures. Operate Line 9 at 132 kV on contingency event. <i>ActewAGL to tail-end Line A-1 to Stockdill transformer</i>	646 MW within 48-hours	Install 120 MVar capacitors (\$3.1M) in year 2031	850 MW within 48-hours

#### 4.1.2 Option D

Whilst Option D is technically feasible and meets the Code requirements, the limited availability of sites in the ActewAGL network to install 132 kV capacitors makes this option difficult and expensive to implement and limits the capacitors effectiveness. Furthermore, the ActewAGL network presently does not operate any reactive plant.

#### 4.1.3 Options E and F

Options E and F are technically feasible and meets the Code requirements. However, their capacity would only be adequate up until the present 2024/2025 load forecast of 600 MW. Beyond that, significant reinvestment would be required to convert Stockdill into a substation (Option E), or divert a second 330 kV Line into Stockdill substation (Option F).

#### 4.1.4 Options G through J

Options G through J are technically feasible and meet the Code requirements. The options provide sufficient capacity beyond the present 2024 load forecast and would not require reinvestment until 2030 at the earliest.

## 4.2 Economic Evaluation

An economic evaluation of the technically feasible options is set out below.

#### 4.2.1 Associated Secondary Cost/Benefits

The establishment of Stockdill will require four transformers at Canberra to remain in-service, until Stockdill has been established. Once Stockdill has been commissioned, the No.2 and No.3 Canberra transformers can be decommissioned saving the replacement of one Canberra transformer.

The cost associated with the extension of life on the No.2 and No.3 Canberra transformer is estimated to be \$0.706m.

The cost reduction associated with eliminating the need to replace the No.2 Canberra transformer as part of the substation piecemeal replacement is \$6.9m.

With two transformers at Canberra, one at Stockdill, and two at Williamsdale, on outage of any one transformer, four 375 MVA transformers would be available, sufficient to supply the ACT and the surrounding area.

#### 4.2.2 Economic Analysis

The economic analysis for each of the options is shown below:

**Table 4 - Economic Evaluation**

Option	Description	TransGrid CAPEX component (\$m)	ActewAGL CAPEX component (\$m)	TransGrid OPEX (\$m)	Post project risk cost (\$m)	Financial Evaluation (\$m)*	Economic Evaluation (\$m)*	Rank
D	Stockdill 330 kV Switching Station: Turning in Line 01 with Capacitors at Stockdill and in the ActewAGL Network	46.6	14.8					
	ActewAGL to update Gilmore to Theodore line corridor and install capacitors at Woden and Bruce							
	* <u>plus</u> cost of operating CANB No.2 and No.3 Tx	0.706						
	<b>Total</b>	<b>47.306</b>	<b>14.8</b>	<b>Note 1</b>	<b>0.083</b>	<b>-44.92</b>	<b>588.11</b>	<b>5</b>
E	Stockdill 330 kV Switching Station: Turning in Line 01 and Line 07, with Capacitors at Williamsdale 132 kV	59.0	10.9					
	ActewAGL to update Gilmore to Theodore line corridor							
	* <u>plus</u> cost of operating CANB No.2 and No.3 Tx	0.706						
	<b>Total</b>	<b>59.706</b>	<b>10.9</b>	<b>Note 1</b>	<b>0.083</b>	<b>-50.49</b>	<b>582.54</b>	<b>7</b>
F	Stockdill 330/132 kV Substation: Turning in Line 01 with Capacitors at Williamsdale	53.2	4.475					
	ActewAGL to tail-end Line A-1 to Stockdill transformer							
	* <u>plus</u> cost of operating CANB No.2 and No.3 Tx	0.706						
	* <u>less</u> cost of replacing CANB No.2 Tx	-6.9						
	<b>Total</b>	<b>47.006</b>	<b>4.475</b>	<b>Note 1</b>	<b>0.083</b>	<b>-35.51</b>	<b>597.51</b>	<b>2</b>
G	Stockdill 330/132 kV Substation: Turning in Line 01 and Line 07	59.6	15.375					
	ActewAGL to tail-end Line A-1 to Stockdill transformer							
	* <u>plus</u> cost of operating CANB No.2 and No.3 Tx	0.706						
	* <u>less</u> cost of replacing CANB No.2 Tx	-6.9						



Option	Description	TransGrid CAPEX component (\$m)	ActewAGL CAPEX component (\$m)	TransGrid OPEX (\$m)	Post project risk cost (\$m)	Financial Evaluation (\$m)*	Economic Evaluation (\$m)*	Rank
	<b>Total</b>	<b>53.406</b>	<b>15.375</b>	<b>Note 1</b>	<b>0.083</b>	<b>-47.27</b>	<b>585.76</b>	<b>6</b>
H	Stockdill 330 kV Switching Station: Turning in Line 01 with Capacitors at Williamsdale. Operate Line 9 at 132 kV on contingency event. ActewAGL to update Gilmore to Theodore line corridor  * <u>plus</u> cost of operating CANB No.2 and No.3 Tx	48.4  0.706	14.8					
	<b>Total</b>	<b>49.106</b>	<b>14.8</b>	<b>Note 1</b>	<b>0.083</b>	<b>-44.74</b>	<b>588.29</b>	<b>4</b>
I	Stockdill 330/132 kV Substation: Turning in Line 01. Operate Line 9 at 132 kV on contingency event. ActewAGL to tail-end Line A-1 to Stockdill transformer  * <u>plus</u> cost of operating CANB No.2 and No.3 Tx  * <u>less</u> cost of replacing CANB No.2 Tx	51.8  0.706  -6.9	4.475					
	<b>Total</b>	<b>45.606</b>	<b>4.475</b>	<b>Note 1</b>	<b>0.083</b>	<b>-35.8</b>	<b>597.22</b>	<b>3</b>
J	Stockdill 330/132 kV Substation: Turning in Line 01 Utilising Line 3C Structures. Operate Line 9 at 132 kV on contingency event. ActewAGL to tail-end Line A-1 to Stockdill transformer  * <u>plus</u> cost of operating CANB No.2 and No.3 Tx  * <u>less</u> cost of replacing CANB No.2 Tx	46.8  0.706  -6.9	4.475					
	<b>Total</b>	<b>40.606</b>	<b>4.475</b>	<b>Note 1</b>	<b>0.083</b>	<b>-31.55</b>	<b>601.48</b>	<b>1</b>

\* NPV calculations include any re-investments during the 30 year assessment period. See 4.1.1.

Notes:

1. The operational cost (OPEX) is expected to be similar between the options and is not a determining factor in the ranking of the options.
2. Economic NPV is at standard discount rate (10%) and includes any potential future re-investments.
3. No non-network options were identified.
4. Any change from the original Wallaroo option is considered to be non-prescribed and is not included in this analysis.
5. The ActewAGL component of work is assumed to be completed in the last year of the works program and is reflected in the NPV calculations.

### 4.3 Compliance with ACT Licence Obligations

TransGrid holds a [Utility Services Licence](#) in the ACT under the *Utilities Act 2000* (ACT) which outlines the conditions under which the licence is maintained. Violation of any of the conditions of the licence may result in its revocation, including violation of the Code.

## 4.4 Preferred Option

The preferred Option J is to develop Stockdill as a 330/132 kV substation, turning in Line 01. On loss of either Canberra or Williamsdale substations, Line 9 would be converted to 132 kV operation within 48-hours. This arrangement has a supply capacity up to 646 MW, sufficient to supply the ACT peak demand up to year 2031.

Stockdill would be supplied from Line 01 Upper Tumut, and connected to Williamsdale by turning in existing Line 3C to form new Line 3F. The Line 01 turn-in would utilise the existing Line 3C easement and single circuit structures. A new double circuit 330 kV Line 3C, strung on one side, would be constructed between Stockdill and Canberra.

Stockdill substation will be equipped with one 375 MVA 330/132 kV transformer (asset spare) transferred from Newcastle substation. ActewAGL would then tee onto Line A-1 from Woden to the transformer at 132 kV.

Immediately following the critical outage of Canberra substation, the ACT load is supplied from Williamsdale (lines 97F, 97H) and from Stockdill (Line A-1).

To reduce the loading on the Williamsdale transformer, Line 979 is closed at Guthega, and Line 978 and Line 97D are taken out of service to transfer the Cooma load from Williamsdale to Murray.

To reduce the subsequent loading on Line 97G/3, the Bega load on Cooma is reduced with the possibility of opening Line 974 and Line 97R. Spring Flat would be automated as part of this option to remotely change over the Queanbeyan and Fyshwick supply to Yass (from Canberra). The rating limitation on Line 976 (due to protection and secondary systems) at Queanbeyan would be removed as part of this option.

Stockdill and Williamsdale substations can only supply a portion of the ACT load following the loss of Canberra substation. To support the full load, Line 9 is converted for 132 kV operation by bypassing the 330 kV switchyard at Yass to connect to Line 970 from Burrinjuck. At the Canberra end of Line 9, the 330 kV switchyard is bypassed by connecting Line 9 to line A-2 to supply the ActewAGL Latham zone substation.

With Line 9 operating at 132 kV, the ActewAGL network is split at Bruce and Molonglo to restore full supply capacity. This arrangement can supply up to 646 MW, adequate up until year 2031, and can be incrementally increased by installing reactive support.

This option allows Canberra substation to be reduced in size by reducing the number of transformers from four to two. This will allow the two older 400 MVA units to be retired at the end of their serviceable life.

Beyond 2031, a 120 MVar capacitor can be installed at Williamsdale 132 kV to increase supply capacity to 850 MW within 48-hours (i.e. with Line 9 operating at 132 kV), sufficient to supply the ACT peak demand well beyond 2046 (i.e. 30+ years).

### Capital and Operating Expenditure

There is no capital and operating expenditure trade-offs associated with this option. The cost associated with the operation and maintenance of the new asset (Stockdill substation) is not expected to materially impact on the selection of the option.

### Special Contingency Event Considerations

The loss of Canberra substation in a special contingency event is considered to be a 1 in a 1000 year event with a total VCR risk of \$101.17 million a year. The preferred option would realise a positive economic cumulative benefit in the first year of operation (2020) for a wide range of event likelihoods and consequences compared to the base case 'do nothing' option.

Note in 2030, it is planned that 120 MVar of capacitors could be installed at Williamsdale 132 kV for \$3.1m to meet the projected load driven need in 2031. This need will be reviewed over time to confirm the timing of the investment decision.

**Table 5: Expected Benefits over 30 years**

(\$m)	2017 <sup>^</sup>	2018 <sup>^</sup>	2019 <sup>^</sup>	2020 <sup>^</sup>	2021-29	2030	2031-46
On-going benefits*					101.2 (per year)	101.2	101.2 (per year)
TransGrid capital investment	-1.306 <sup>A</sup>	-2.5	-11.4	-25.0 <sup>B</sup>			
ActewAGL capital investment				-4.475			
TransGrid reinvestment						-3.1 <sup>C</sup>	
<b>Cumulative benefits</b>	-1.306	-3.8	-15.2	-44.681	867.5 (at 2029)	965.6	2,584.8 (at 2046)

\* With respect to the base case

<sup>^</sup> Pre-project risk cost not considered

<sup>A</sup> Includes expenditure of \$706k for the refurbishment of the Canberra No.3 TX

<sup>B</sup> Includes cost savings of \$6.9m from not replacing one Canberra TX

<sup>C</sup> Installation of a 120 MVar capacitor at Stockdill 132 kV to increase supply capacity

### Regulatory Investment Test

The Stockdill development is a variation on the Wallaroo project for which a Regulatory Test has been completed. Components of work associated with establishing a Wallaroo equivalent 330 kV switching station and associated line works are considered to be prescribed work for which the Regulatory Test has been approved. Components of work in addition to this, such as additional line diversions (if required), are considered as non-regulated and will be negotiated with the ACT government. It is anticipated that no RIT-T will be required.

### Prescribed Cost

The TransGrid prescribed cost is the preferred option total project cost (\$46.76 million) less the previous Wallaroo line works (\$8.33 million). The cost of the Line 3C and Line 9 augmentations for Wallaroo, as detailed in OFS-9031J Rev.1 is \$5.08 million and \$3.25 million.

The TransGrid prescribed cost for this project is therefore \$38.43 million.

### Risk Benefit Sensitivity

The risk cost reduction from the base case is calculated by the pre-option risk cost less the post-option risk cost. The risk benefit is sensitive to variations in the probability of failure (PoF), and the Value of Customer Reliability (VCR). A range of PoFs and VCRs are presented below.

**Table 6: Expected Risk Benefits for a range of VCRs**

Probability of Failure	1/500	1/1000	1/1500	1/2000	1/2500
<b>VCR:</b> \$/kWh					
<b>\$20</b>	\$105.4M	\$52.7M	\$35.1M	\$26.3M	\$21.0M
<b>\$38</b>	\$200.4M	\$100.2M	\$66.7M	\$50.0M	\$40.0M
<b>\$50</b>	\$263.7M	\$131.8M	\$87.9M	\$65.9M	\$52.7M
<b>\$100</b>	\$527.5M	\$263.7M	\$175.8M	\$131.8M	\$105.4M

<b>\$200</b>	\$1,055.1M	\$527.5M	\$351.7M	\$263.7M	\$211.0M
--------------	------------	----------	----------	----------	----------

*Highlighted is the assumed probability and VCR.*

The risk benefit is also sensitive to the repair and restoration time which is the driver for a major risk cost component: interruption to electricity services.

**Table 7: Sensitivity of Risk Benefits for a range of Repair Times (VCR: \$100/kWh)**

Probability of Failure	1/500	1/1000	1/1500	1/2000	1/2500
<b>Repair/Restoration Time:</b>					
<b>1 month</b>	\$21.9M	\$10.9M	\$7.2M	\$5.4M	\$4.3M
<b>3 months</b>	\$65.9M	\$32.9M	\$21.9M	\$16.4M	\$13.1M
<b>6 months</b>	\$131.8M	\$65.9M	\$43.9M	\$32.9M	\$26.3M
<b>1 year</b>	\$263.7M	\$131.8M	\$87.9M	\$65.9M	\$52.7M
<b>2 years</b>	\$527.5M	\$263.7M	\$175.8M	\$131.8M	\$105.4M

*Highlighted is the assumed probability and repair/restoration time.*

## 5. RECOMMENDATION

It is recommended that Option J – Stockdill 330/132 kV Substation: Turning in Line 01 Utilising Line 3C Structures and operating Line 9 at 132 kV on contingency, be scoped in detailed.

The TransGrid prescribed cost for this project is \$38.4 million, as detailed in Section 4.4 – Prescribed Cost.

## ATTACHMENT 1 – Net Present Value Calculation Coversheets

**OPTION D: Stockdill 330 kV Switching Station: Turning in Line 01 with Capacitors at Stockdill and in the ActewAGL Network**

Project_Option Name			Continuation of Supply to the ACT		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	-\$44.92m	NPV / Capital (Ratio)	-0.72	
NPV @ upper bound rate	13.00%	-\$41.17m	Pay Back Period (Yrs)	Not measurable	
NPV @ lower bound rate (WACC)	6.75%	-\$48.22m	IRR%	-2.77%	
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%	\$588.11m	NPV / Capital (Ratio)	9.47	
NPV @ upper bound rate	13.00%	\$416.24m	Pay Back Period (Yrs)	Not measurable	
NPV @ lower bound rate (WACC)	6.75%	\$894.75m	IRR%	111.86%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$101.17m
Systems (reliability)	\$101.25m	\$0.08m	\$101.17m	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	\$101.17m
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	\$101.25m	\$0.08m	\$101.17m	Benefits in the financial NPV*	\$0.00m
Cost savings and other benefits			\$0.00m		
Total Benefits			\$101.17m	Benefits in the economic NPV**	\$101.17m
				**excludes ENS penalty	
Other Financial Drivers					
Incremental opex cost pa (no depreciation)		\$0.00m	Write-off cost	\$0.00m	
Capital - initial \$m		-\$62.11m	Major Asset Life (Yrs)	50.00 Yrs	
Residual Value - initial investment		\$29.47m	Re-investment capital	-\$7.80m	
Capitalisation period		4.00 Yrs	Start of the re-investment period	2024-25	

**Note:** The *Capital – initial \$m* (Other Financial Drivers) is made up of TransGrids' and ActewAGLs' CAPEX component cost and any associated costs and cost savings, as detailed in Table 4.

TransGrid CAPEX component:	\$46.6m
ActewAGL CAPEX component:	\$14.8m
Associated cost –	
Cost of operating CANB Tx	\$0.706m
<b>TOTAL</b>	<b>\$62.11m</b>

**OPTION E: Stockdill 330 kV Switching Station: Turning in Line 01 and Line 07, with Capacitors at Williamsdale 132 kV**

Project_Option Name			Continuation of Supply to the ACT	
1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	-\$50.49m	NPV / Capital (Ratio)	-0.72
NPV @ upper bound rate	13.00%	-\$46.45m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	-\$53.98m	IRR%	-2.76%
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%	\$582.54m	NPV / Capital (Ratio)	8.25
NPV @ upper bound rate	13.00%	\$410.96m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	\$889.00m	IRR%	97.63%
Benefits				
Risk cost	As Is	To Be	Benefit	VCR Benefit
Systems (reliability)	\$101.25m	\$0.08m	\$101.17m	ENS Penalty
Financial	\$0.00m	\$0.00m	\$0.00m	All other risk benefits
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits
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	\$101.25m	\$0.08m	\$101.17m	Benefits in the financial NPV*
Cost savings and other benefits			\$0.00m	*excludes VCR benefits
Total Benefits			\$101.17m	Benefits in the economic NPV**
				**excludes ENS penalty
Other Financial Drivers				
Incremental opex cost pa (no depreciation)			\$0.00m	Write-off cost
Capital - initial \$m			-\$70.61m	Major Asset Life (Yrs)
Residual Value - initial investment			\$33.55m	Re-investment capital
Capitalisation period			4.00 Yrs	Start of the re-investment period
				2025-26

**Note:** The *Capital – initial \$m* (Other Financial Drivers) is made up of TransGrids' and ActewAGLs' CAPEX component cost and any associated costs and cost savings, as detailed in Table 4.

TransGrid CAPEX component:	\$59.0m
ActewAGL CAPEX component:	\$10.9m
Associated cost –	
Cost of operating CANB Tx	\$0.706m
<b>TOTAL</b>	<b>\$70.61m</b>



**OPTION F: Stockdill 330/132 kV Substation: Turning in Line 01 with Capacitors at Williamsdale**

Project_Option Name			Continuation of Supply to the ACT		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	-\$35.51m	NPV / Capital (Ratio)	-0.69	
NPV @ upper bound rate	13.00%	-\$32.88m	Pay Back Period (Yrs)	Not measurable	
NPV @ lower bound rate (WACC)	6.75%	-\$37.69m	IRR%	-2.79%	
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%	\$597.51m	NPV / Capital (Ratio)	11.61	
NPV @ upper bound rate	13.00%	\$424.53m	Pay Back Period (Yrs)	Not measurable	
NPV @ lower bound rate (WACC)	6.75%	\$905.29m	IRR%	117.29%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$101.17m
Systems (reliability)	\$101.25m	\$0.08m	\$101.17m	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	\$101.17m
People (safety)	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.00m
Environment	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Reputation	\$0.00m	\$0.00m	\$0.00m	Benefits in the economic NPV**	\$101.17m
Total Risk benefits	\$101.25m	\$0.08m	\$101.17m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$101.17m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m			-\$51.48m	Major Asset Life (Yrs)	50.00 Yrs
Residual Value - initial investment			\$24.37m	Re-investment capital	-\$0.90m
Capitalisation period			4.00 Yrs	Start of the re-investment period	2024-25

**Note:** The *Capital – initial \$m* (Other Financial Drivers) is made up of TransGrids' and ActewAGLs' CAPEX component cost and any associated costs and cost savings, as detailed in Table 4.

TransGrid CAPEX component:	\$53.2m
ActewAGL CAPEX component:	\$4.475m
Associated cost –	
Cost of operating CANB Tx	\$0.706m
less Cost of replacing CANB Tx	-\$6.9m
<b>TOTAL</b>	<b>\$51.48m</b>

**OPTION G: Stockdill 330/132 kV Substation: Turning in Line 01 and Line 07**

Project\_Option Name

Continuation of Supply to the ACT

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$47.27m	NPV / Capital (Ratio)	-0.69
NPV @ upper bound rate	13.00%	-\$43.68m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	-\$50.30m	IRR%	-2.77%

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%	\$585.76m	NPV / Capital (Ratio)	8.52
NPV @ upper bound rate	13.00%	\$413.73m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	\$892.68m	IRR%	99.28%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$101.17m
Systems (reliability)	\$101.25m	\$0.08m	\$101.17m	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	\$101.17m
People (safety)	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.00m
Environment	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Reputation	\$0.00m	\$0.00m	\$0.00m	Benefits in the economic NPV**	\$101.17m
Total Risk benefits	\$101.25m	\$0.08m	\$101.17m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$101.17m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m	-\$68.78m	Major Asset Life (Yrs)	50.00 Yrs
Residual Value - initial investment	\$32.68m	Re-investment capital	-\$3.10m
Capitalisation period	4.00 Yrs	Start of the re-investment period	2033-34

**Note:** The *Capital – initial \$m* (Other Financial Drivers) is made up of TransGrids' and ActewAGLs' CAPEX component cost and any associated costs and cost savings, as detailed in Table 4.

TransGrid CAPEX component:	\$59.6m
ActewAGL CAPEX component:	\$15.375m
Associated cost –	
Cost of operating CANB Tx	\$0.706m
less Cost of replacing CANB Tx	-\$6.9m
<b>TOTAL</b>	<b>\$68.78m</b>

**OPTION H: Stockdill 330 kV Switching Station: Turning in Line 01 with Capacitors at Williamsdale. Operate Line 9 at 132 kV on contingency event**

Project\_Option Name

Continuation of Supply to the ACT

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$44.74m	NPV / Capital (Ratio)	-0.70
NPV @ upper bound rate	13.00%	-\$41.11m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	-\$47.94m	IRR%	-2.76%

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%	\$588.29m	NPV / Capital (Ratio)	9.21
NPV @ upper bound rate	13.00%	\$416.29m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	\$895.04m	IRR%	106.54%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$101.17m
Systems (reliability)	\$101.25m	\$0.08m	\$101.17m	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	\$101.17m
People (safety)	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.00m
Environment	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Reputation	\$0.00m	\$0.00m	\$0.00m	Benefits in the economic NPV**	\$101.17m
Total Risk benefits	\$101.25m	\$0.08m	\$101.17m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$101.17m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m	-\$63.91m	Major Asset Life (Yrs)	50.00 Yrs
Residual Value - initial investment	\$30.34m	Re-investment capital	-\$6.90m
Capitalisation period	4.00 Yrs	Start of the re-investment period	2030-31

**Note:** The *Capital – initial \$m* (Other Financial Drivers) is made up of TransGrids' and ActewAGLs' CAPEX component cost and any associated costs and cost savings, as detailed in Table 4.

TransGrid CAPEX component:	\$48.4m
ActewAGL CAPEX component:	\$14.8m
Associated cost –	
Cost of operating CANB Tx	\$0.706m
<b>TOTAL</b>	<b>\$63.91m</b>

**OPTION I: Stockdill 330/132 kV Substation: Turning in Line 01. Operate Line 9 at 132 kV on contingency event**

Project\_Option Name

Continuation of Supply to the ACT

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$35.80m	NPV / Capital (Ratio)	-0.71
NPV @ upper bound rate	13.00%	-\$33.33m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	-\$37.81m	IRR%	-2.75%

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%	\$597.22m	NPV / Capital (Ratio)	11.93
NPV @ upper bound rate	13.00%	\$424.07m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	\$905.17m	IRR%	100.44%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$101.17m
Systems (reliability)	\$101.25m	\$0.08m	\$101.17m	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	\$101.17m
People (safety)	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.00m
Environment	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Reputation	\$0.00m	\$0.00m	\$0.00m	Benefits in the economic NPV**	\$101.17m
Total Risk benefits	\$101.25m	\$0.08m	\$101.17m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$101.17m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m	-\$50.08m	Major Asset Life (Yrs)	50.00 Yrs
Residual Value - initial investment	\$23.70m	Re-investment capital	-\$3.10m
Capitalisation period	4.00 Yrs	Start of the re-investment period	2031-32

**Note:** The *Capital – initial \$m* (Other Financial Drivers) is made up of TransGrids' and ActewAGLs' CAPEX component cost and any associated costs and cost savings, as detailed in Table 4.

TransGrid CAPEX component:	\$51.8m
ActewAGL CAPEX component:	\$4.475m
Associated cost –	
Cost of operating CANB Tx	\$0.706m
less Cost of replacing CANB Tx	-\$6.9m
<b>TOTAL</b>	<b>\$50.08m</b>

**OPTION J: Stockdill 330/132 kV Substation: Turning in Line 01 Utilising Line 3C Structures. Operate Line 9 at 132 kV on contingency event**

Project_Option Name			Continuation of Supply to the ACT		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	-\$31.55m	NPV / Capital (Ratio)	-0.70	
NPV @ upper bound rate	13.00%	-\$29.17m	Pay Back Period (Yrs)	Not measurable	
NPV @ lower bound rate (WACC)	6.75%	-\$33.57m	IRR%	-2.77%	
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%	\$601.48m	NPV / Capital (Ratio)	13.34	
NPV @ upper bound rate	13.00%	\$428.23m	Pay Back Period (Yrs)	Not measurable	
NPV @ lower bound rate (WACC)	6.75%	\$909.41m	IRR%	123.04%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$101.17m
Systems (reliability)	\$101.25m	\$0.08m	\$101.17m	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	\$101.17m
People (safety)	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.00m
Environment	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Reputation	\$0.00m	\$0.00m	\$0.00m	Benefits in the economic NPV**	\$101.17m
Total Risk benefits	\$101.25m	\$0.08m	\$101.17m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$101.17m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m			-\$45.08m	Major Asset Life (Yrs)	50.00 Yrs
Residual Value - initial investment			\$21.30m	Re-investment capital	-\$3.10m
Capitalisation period			4.00 Yrs	Start of the re-investment period	2031-32

**Note:** The *Capital – initial \$m* (Other Financial Drivers) is made up of TransGrids' and ActewAGLs' CAPEX component cost and any associated costs and cost savings, as detailed in Table 4.

TransGrid CAPEX component:	\$46.8m
ActewAGL CAPEX component:	\$4.475m
Associated cost –	
Cost of operating CANB Tx	\$0.706m
less Cost of replacing CANB Tx	-\$6.9m
<b>TOTAL</b>	<b>\$45.08m</b>