OPTIONS EVALUATION REPORT (OER)

Supply to Sydney Inner Metropolitan Area and CBD

OER DCN43 revision 5.0

TransGrid

Ellipse project description:
TRIM file: MF1241

Project reason: Reliability - To meet overall network reliability requirements
Project category: Prescribed - Augmentation

Approvals

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Executive summary

A reliable electricity supply to the Inner Sydney area (which includes the Sydney CBD and a number of inner suburbs) is of crucial importance, both to customers and businesses located in these areas, as well as more broadly to New South Wales, due to the importance of this area in contributing to the wider economy.

Key elements of the current electricity transmission networks supplying the Inner Sydney area are aging. In particular, there are a number of oil-filled cables that have been in operation since the 1960s and 1970s and have recently identified issues with their backfill and bedding material, which is compromising their operating performance. As a consequence, TransGrid and Ausgrid have both had to downgrade the capacity that these cables can provide in recent years.

These aging oil-filled cables are at a stage in their technical life where they are associated with an increasing risk of failure. When a failure occurs the cable is required to be out of service for lengthy periods to enable repairs, generally up to 3 months but can be longer for difficult locations. This increases the chances that these network elements are out of service when failure of another network element occurs, which may result in unserved energy. Electricity consumers in Inner Sydney are therefore becoming increasingly vulnerable in terms of the expected level of disruption to their electricity supply.

In addition, peak demand in the Inner Sydney area is forecast to increase on the back of renewed economic activity, as confirmed by committed new customer connections, as well as a large increase in future demand from anticipated customer connections. This increases the amount of energy that may be disrupted as a consequence of increasing capacity constraints.

This Options Evaluation Report analyses 6 network options that have been assessed as technically feasible.

Table 1

Option	Indicative capital cost ($2016 real)	Indicative O&M cost ($2016 real)
Option 1: install two 330 kV cables in stages, retire Cable 41 and decommission Ausgrid cables in two stages	$332 million	2 per cent of new capex + $12 million in Ausgrid decommissioning costs
Option 2: operate Cable 41 at 132 kV, install two 330 kV cables in stages and decommission Ausgrid cables in two stages	$340 million	2 per cent of new capex + $12 million in Ausgrid decommissioning costs
Option 3: install two 330 kV cables at once, retire Cable 41 and decommission Ausgrid cables in one stage	$312 million	2 per cent of new capex + $12 million in Ausgrid decommissioning costs
Option 4: remediate Cable 41, install two 330 kV cables in stages and decommission Ausgrid cables in one stage	$455 million	2 per cent of new capex + $12 million in Ausgrid decommissioning costs
Option 5: remediate Cable 41, install two 330 kV cables at once (initially operating at 132 kV) and decommission Ausgrid cables in two stages	$450 million	2 per cent of new capex + $12 million in Ausgrid decommissioning costs
Option 6: remediate Cable 41, install two 330 kV cables at once and decommission Ausgrid cables in one stage	$436 million	2 per cent of new capex + $12 million in Ausgrid decommissioning costs

Non-network options:

TransGrid and Ausgrid consider that there is potential for non-network options (such as embedded generation and demand response) to defer the time at which network investment would be required.

These options within Inner Sydney include:

> Embedded generation;

> Energy power storage, which inject power into the grid when required; and

> Voluntary curtailment of load.

TransGrid and Ausgrid have estimated the approximate level of network support required to provide the minimum amount of reduced estimated unserved energy to defer the network investment. These requirements, detailed in the Table below, are based upon availability of network support for an entire year.

Year	Minimum network support required
2022/23	60 MW
2023/24	90 MW
2024/25	150 MW

In addition, TransGrid and Ausgrid will be seeking submissions during the RIT-T process for potential non-network solutions. Any non-network option raised through the Expression of Interest process and considered to be technically and commercially feasible will be assessed as part of the RIT-T process (during PADR stage).

Preferred Option

The preferred option will be determined through the RIT-T process based on detailed network analysis, cost/ benefit analysis, technical and economic feasibility.

Non network options have been canvassed through the PSCR published on 11 October 2016. While a non-network solution may be feasible in differing the project for one year, it is unlikely that the demand reduction required for deferring the project further could be achieved.

Following the RIT-T, a complete Options Evaluation Report will be issued. The preferred network solution is likely to be Option 3, as this meets the requirements of the need, has the lowest capital cost and has a high NPV.

1. Need

As explained in NOS DCN43, the supply capacity to the Sydney inner metropolitan network is decreasing due to a number of reasons. This results in a forecast shortfall in the capability of the network to supply the Sydney inner metropolitan area load to the standard of reliability as required by the Transmission Network Design and Reliability Standard for NSW. This Options Evaluation Report evaluates the technically feasible network solutions.

2. Related needs

Ausgrid committed program of cable retirements.

3. Options

3.1 Base case

For the 'do nothing' case, the following are expected to increase the amount of unserved energy, environmental and financial risk in the future:

1. The deteriorating condition of aging oil-filled cables in the existing network and the de-rating of the 330 kV Cable 41 by TransGrid (in 2011 and 2016) and the de-rating of a number of 132 kV cables by Ausgrid (beginning in 2012).
2. Ausgrid's planned retirement of three oil-filled cables in Inner Sydney in the next two years.
3. The age-related deteriorating condition of a further eight additional oil-filled Ausgrid cables in the Inner Sydney area.
4. Forecast increases in peak demand due to renewed economic activity within Inner Sydney.

The total risk cost (including the cost of the expected unserved energy) is $79, 162m[1,2].

3.2 Option 1: Install two 330 kV cables in stages and retire Cable 41

Option 1 involves ultimately installing two 330 kV 750MVA cable circuits between Rookwood Road and Beaconsfield substations, retiring Cable 41 and retiring the eight Ausgrid oil-filled cables in two stages.

The two cables would be installed and commissioned in two stages[3]:

- Stage 1: build one 330 kV 750MVA cable between Rookwood Rd and Beaconsfield substations, terminate new cable onto existing transformers at Beaconsfield, extend 330 kV GIS at Rookwood Rd, and then retire Cable 41 along with six Ausgrid oil-filled cables (cables 928/3, 929/1, 92C, 92X, 91X/2, 91Y/2); and
- Stage 2: install a second 330 kV 750MVA cable from Rookwood Rd to Beaconsfield, extend 330 kV GIS at Beaconsfield and connect the two 330 kV cables from Rockwood Rd. Stage 2 would also involve extending the 330 kV GIS at Haymarket and converting cable 9S4 from Beaconsfield to Haymarket to 330 kV 750 MVA operation[4]. This allows two additional Ausgrid oil-filled cables to be retired (cables 9S2, 90T/1).

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[1] Summated risk costs of next 30 years.

[2] All costs specified in this OER are real costs

[3] Cost/benefit analysis utilised in identifying the need year for stage 2. That is, stage 2 is to be implemented when the value of unserved energy and risk costs exceed the deferral value of capital costs associated with that stage.

[4] Cable 9S4 is a jointly owned TransGrid / Ausgrid cable currently operated at 132 kV.

Capital costs for this option are estimated to be approximately $332 million in $2016/17, with major cost components shown in the table below. Operating costs include decommissioning costs of cables, as well as annual operating costs associated with new capital costs, which are estimated to be about two per cent of the capital cost.[5]

TransGrid and Ausgrid estimate that the environmental approval and construction timeline for Stage 1 of Option 1 is five years, with commissioning possible during 2022/23. TransGrid and Ausgrid further estimate that the construction timeline for Stage 2 of Option 1 is three years, with commissioning proposed during 2026/27.

Option 1 - Install two 330 kV cables in stages and retire Cable 41

Project description	Cost ($2016 real)	Construction timetable; commissioning date
Stage 1		
Install one 330 kV cable circuit from Rookwood Road to Beaconsfield and provision for a second 330 kV circuit that is to be installed at a later date	$197 million (capex)	5 years, with commissioning possible during 2022/23
Ausgrid decommissioning costs (cables 928/3, 929/1, 92C, 92X, 91X/2, 91Y/2)	$11 million (opex)	
Stage 2		
Install second 330 kV cable circuit from Rookwood Road to Beaconsfield	$118 million (capex)	3 years, with commissioning proposed during 2026/27
Convert cable 9S4 to 330 kV	$17 million (capex)	
Ausgrid decommissioning costs (cables 9S2, 90T/1)	$1 million (opex)	

3.3 Option 2: Operate Cable 41 at 132 kV and install two 330 kV cables in stages

Option 2 involves ultimately installing two 330 kV 750MVA cable circuits between Rookwood Road and Beaconsfield substations, reconfiguring Cable 41 to operate at 132 kV with rating of 170MVA and retiring the eight Ausgrid oil-filled cables in two stages.

The two cables would be installed and commissioned in two stages[6]:

- Stage 1: build one 330 kV cable between Rookwood Rd and Beaconsfield, terminate new cable onto existing transformers at Beaconsfield, extend 330 kV GIS at Rookwood Rd, reconfigure Cable 41 to operate at 132 kV with a rating of 170MVA and retire six Ausgrid oil-filled cables (cables 928/3, 929/1, 92C, 92X, 91X/2, 91Y/2); and
- Stage 2: install a second 330 kV 750MVA cable from Rookwood Rd to Beaconsfield, extend 330 kV GIS at Beaconsfield and connect the two 330 kV cables from Rockwood Rd. Stage 2 would also involve retiring Cable 41 and extending the 330 kV GIS at Haymarket and converting cable 9S4 from Beaconsfield to Haymarket to 330 kV 750 MVA operation and connecting to the 330 kV GIS at Beaconsfield and Haymarket, This allows two additional Ausgrid oil-filled cables to be retired (cables 9S2, 90T/1).

Capital costs for this option are estimated to be approximately $337 million in $2016/17, with major cost components shown in the table below. Operating costs include decommissioning costs of cables, ongoing opex associated with the continued operation of Cable 41 as well as annual operating costs associated with new capital costs, which are estimated to be about two per cent of the capital cost.

TransGrid and Ausgrid estimate that the environmental approval and construction timeline for Stage 1 of Option 2 is five years, with commissioning possible by 2022/23. TransGrid and Ausgrid further estimate that the construction timeline for Stage 2 of Option 2 is three years, with commissioning proposed during 2028/29.

[5] Assuming 2 per cent of capital costs as annual operating costs is industry standard.

[6] Cost/benefit analysis utilised in identifying the need year for stage 2. That is, stage 2 is to be implemented when the value of unserved energy and risk costs exceed the deferral value of capital costs associated with that stage.

Option 2 – Operate Cable 41 at 132 kV and install two 330 kV cables in stages

Project description	Cost ($2016 real)	Construction timetable; commissioning date
Stage 1		
Install one 330 kV cable circuit from Rookwood Road to Beaconsfield and provision for a second 330 kV circuit that is to be installed at a later date.	$194 million (capex)	5 years, with commissioning possible by 2022/23
Operate Cable 41 at 132 kV	$8 million (capex)	
Ausgrid decommissioning costs (cables 928/3, 929/1, 92C, 92X, 91X/2, 91Y/2)	$11 million (opex)	
Stage 2		
Install second 330 kV cable circuit from Rookwood Road to Beaconsfield	$118 million (capex)	3 years, with commissioning proposed during 2028/29
Convert cable 9S4 to 330 kV	$17 million (capex)	
Ausgrid decommissioning costs (cables 9S2, 90T/1)	$1 million (opex)	

3.4 Option 3: Install two 330 kV cables at once and retire Cable 41

Option 3 involves installing two 330 kV 750MVA cable circuits between Rookwood Road and Beaconsfield substations at once, retiring Cable 41 and retiring the eight Ausgrid oil-filled cables at once.

Two 330 kV 750MVA cables would be built between Rookwood Rd and Beaconsfield substations and connected to the extended 330 kV GIS at Rookwood Rd and Beaconsfield substations. Then cable 41 would be retired. Option 3 also involves extending the 330 kV GIS at Haymarket substation and converting cable 9S4 from Beaconsfield to Haymarket substations to 330 kV 750MVA operation. This allows eight Ausgrid oil-filled cables to be retired at the same time.

Capital costs for this option are estimated to be approximately $312 million in $2016/17, with major cost components shown in the table below. Operating costs include decommissioning costs of cables, as well as annual operating costs associated with new capital costs, which are estimated to be about two per cent of the capital cost.

TransGrid and Ausgrid estimate that the construction timeline for Option 3 is five years, with commissioning proposed during 2022/23.

Option 3 – Install two 330 kV cables at once and retire Cable 41

Project description	Cost ($2016 real)	Construction timetable; commissioning date
Install two 330 kV cable circuits from Rookwood Road to Beaconsfield	$295 million (capex)	5 years, with commissioning proposed during 2022/23
Convert cable 9S4 to 330 kV	$17 million (capex)	
Ausgrid decommissioning costs (cables 928/3, 929/1, 92C, 92X, 91X/2, 91Y/2, 9S2, 90T/1)	$12 million (opex)	

3.5 Option 4: Remediate Cable 41 and install two 330 kV cables in stages

Option 4 is to remediate Cable 41 thermal backfill to increase the cyclic rating to approximately 575MVA, ultimately install two 330 kV 750MVA cables between Rookwood Rd to Beaconsfield and retire eight Ausgrid oil-filled cables in one stage.

The option would be conducted in three stages[7]:

- Stage 1: remediate Cable 41 and continue to operate at 330 kV with a rating of 575MVA;

[7] Cost/benefit analysis utilised in identifying the need year for stages 2 and 3. That is, stage 2 is to be implemented when the NPV of value of unserved energy exceeds the capital costs associated with that stage. Similar approach followed for stage 3.

- Stage 2: build one 330 kV 750MVA cable between Rookwood Rd and Beaconsfield and extend the 330 kV GIS at Rookwood Rd and Beaconsfield. Stage 2 would also involve extending the 330 kV GIS at Haymarket and converting cable 9S4 from Beaconsfield to Haymarket to operate at 330 kV with 750 MVA rating. This allows eight Ausgrid oil-filled cables to be retired at once; and
- Stage 3: install a second 330 kV 750MVA cable from Rookwood Rd to Beaconsfield.

Capital costs for this option are estimated to be approximately $455 million in $2016/17, with major cost components shown in the table below. Operating costs include decommissioning costs of cables, ongoing opex associated with the continued operation of Cable 41 as well as annual operating costs associated with new capital costs, which are estimated to be about two per cent of the capital cost.

TransGrid and Ausgrid estimate that the construction timeline for Stage 1 of Option 4 is five years, with commissioning possible by 2022/23. TransGrid and Ausgrid estimate that the construction timeline for Stage 2 of Option 4 is five years, with commissioning proposed during 2024/25. TransGrid and Ausgrid further estimate that the construction timeline for Stage 3 of Option 4 is three years, with commissioning proposed during 2028/29.

Option 4 – Remediate Cable 41 and install two 330 kV cables in stages

Project description	Cost ($2016 real)	Construction timetable; commissioning date
Stage 1		
Remediate backfill and reinstate the Cable 41 rating to 575MVA	$125 million (capex)	5 years, with commissioning possible by 2022/23
Stage 2		
Install one 330 kV cable circuit from Rookwood Road to Beaconsfield and provision for a second 330 kV circuit that is to be installed at a later date	$241 million (capex)	5 years, with commissioning proposed during 2026/27
Convert cable 9S4 to 330 kV	$17 million (capex)	
Ausgrid decommissioning costs (cables 928/3, 929/1, 92C, 92X, 91X/2, 91Y/2, 9S2, and 90T/1)	$12 million (opex)	
Stage 3		
Install second 330 kV cable circuit from Rookwood Road to Beaconsfield	$72 million (capex)	3 years, with commissioning proposed during 2029/30

3.6 Option 5: Remediate Cable 41 and install two 330 kV cables at once, initially operating at 132 kV

Option 5 is to remediate Cable 41 thermal backfill to increase the cyclic rating to approximately 575MVA, and install two new 330 kV cables between Rookwood Rd and Beaconsfield that would initially operate at 132 kV.

The option would be conducted in three stages[8]:

- Stage 1: remediate Cable 41 and continue to operate at 330 kV with a rating of 575MVA;
- Stage 2: build two 330 kV cables between Rookwood Rd and Beaconsfield and operate at 132 kV with 290 MVA rating, as well as retiring six Ausgrid oil-filled cables (cables 928/3, 929/1, 92C, 92X, 91X/2, 91Y/2); and
- Stage 3: extend the 330 kV GIS at Rookwood Rd and Beaconsfield and convert the cables from Rookwood Rd to Beaconsfield to 330 kV 750 MVA operation. Stage 3 would also involves extending the 330 kV GIS at Haymarket and converting cable 9S4 from Beaconsfield to Haymarket to 330 kV 750 MVA operation. This allows two additional Ausgrid oil-filled cables to be retired (cables 9S2, 90T/1).

Capital costs for this option are estimated to be approximately $450 million in $2016/17, with major cost components shown in the table below. Operating costs include decommissioning costs of cables, ongoing opex

[8] Cost/benefit analysis utilised in identifying the need year for stages 2 and 3. That is, stage 2 is to be implemented when value of unserved energy and risk costs exceed the deferral value of capital costs associated with that stage 2. Similar approach followed for stage 3.

associated with the continued operation of Cable 41 as well as annual operating costs associated with new capital costs, which are estimated to be about two per cent of the capital cost.

TransGrid and Ausgrid estimate that the construction timeline for Stage 1 of Option 5 is five years, with commissioning possible by 2022/23. TransGrid and Ausgrid estimate that the construction timeline for Stage 2 of Option 5 is five years, with commissioning proposed during 2024/25. TransGrid and Ausgrid further estimate that the construction timeline for Stage 3 of Option 5 is three years, with commissioning proposed during 2026/27.

Option 5 – Remediate Cable 41 and install two 330 kV cables at once, initially operating at 132 kV

Project description	Cost ($2016 real)	Construction timetable; commissioning date
Stage 1		
Remediate backfill and reinstate the Cable 41 rating to 575MVA	$125 million (capex)	5 years, with commissioning possible by 2022/23
Stage 2		
Install two 330 kV cable circuits from Rookwood Road to Beaconsfield operating at 132 kV initially	$229 million (capex)	5 years, with commissioning proposed during 2025/26
Ausgrid decommissioning costs (cables 928/3, 929/1, 92C, 92X, 91X/2, 91Y/2)	$11 million (opex)	
Stage 3		
Convert the Rookwood Road to Beaconsfield cables from 132 kV to 330 kV	$79 million (capex)	3 years, with commissioning proposed during 2029/30
Convert cable 9S4 to 330 kV	$17 million (capex)	
Ausgrid decommissioning costs (cables 9S2 and 90T/1)	$1 million (opex)	

3.7 Option 6: Remediate Cable 41 and install two 330 kV cables at once

Option 6 is to remediate Cable 41 thermal backfill to increase the cyclic rating to approximately 575MVA, and install two new 330 kV cables between Rookwood Rd and Beaconsfield.

The option would be conducted in two stages[9]:

- Stage 1: remediate Cable 41 and continue to operate at 330 kV with a rating of 575MVA;
- Stage 2: extend the 330 kV GIS at Rockwood Rd and Beaconsfield and build two 330 kV cables between Rookwood Rd and Beaconsfield. Stage 2 would also involve extending the 330 kV GIS at Haymarket and the conversion of cable 9S4 from Beaconsfield to Haymarket to 330 kV 750 MVA operation. This allows eight Ausgrid oil-filled cables to be retired at once.

Capital costs for this option are estimated to be approximately $436 million in $2016/17, with major cost components shown in the table below. Operating costs include decommissioning costs of cables, ongoing opex associated with the continued operation of Cable 41 as well as annual operating costs associated with new capital costs, which are estimated to be about two per cent of the capital cost.

TransGrid and Ausgrid estimate that the construction timeline for Stage 1 of Option 6 is five years, with commissioning possible by 2022/23. TransGrid and Ausgrid further estimate that the construction timeline for Stage 2 of Option 6 is five years, with commissioning proposed during 2024/25.

Option 6 – Remediate Cable 41 and install two 330 kV cables at once

Project description	Cost ($2016 real)	Construction timetable; commissioning date
Stage 1		

[9] Cost/benefit analysis utilised in identifying the need year for stage 2. That is, stage 2 is to be implemented when the value of unserved energy and risk costs exceed the deferral value of capital costs associated with that stage.

Remediate backfill and reinstate the Cable 41 rating to 575MVA	$125 million (capex)	5 years, with commissioning possible by 2022/23
Stage 2		
Install two 330 kV cable circuits from Rookwood Road to Beaconsfield	$294 million (capex)	5 years, with commissioning proposed during 2026/27
Convert cable 9S4 to 330 kV	$17 million (capex)	
Ausgrid decommissioning costs (cables 928/3, 929/1, 92C, 92X, 91X/2, 91Y/2, 9S2, 90T/1)	$12 million (opex)	

4. Evaluation

4.1 Introduction

A number of benefit categories are considered in evaluating the different options compared to the base case (Do Nothing). These include the reductions in

- Expected unserved energy
- Environmental risks and costs associated with meeting environmental obligations,
- Reputation risk costs associated with continued use of deteriorating oil-filled cables, and
- Costs in operating and maintenance (including costly repairs) associated with continued use of deteriorating oil-filled cables.

4.2 Expected Unserved Energy (EUE)

The cost of Expected Unserved Energy (EUE) should be set equivalent to the annualised cost of the most economical investment required to address the supply constraint for Inner Sydney.

4.2.1 Calculation

The EUE was calculated by tallying selected critical system states that resulted in the inability of the network to service the load. This was performed for half hourly load intervals during a financial year, then scaled by the medium POE 50 maximum demand forecast to evaluate future load. For each system state, the required load curtailment, C(s), was determined based on the network topology, equipment availability, load level and system capacity. Refer Figure 1.

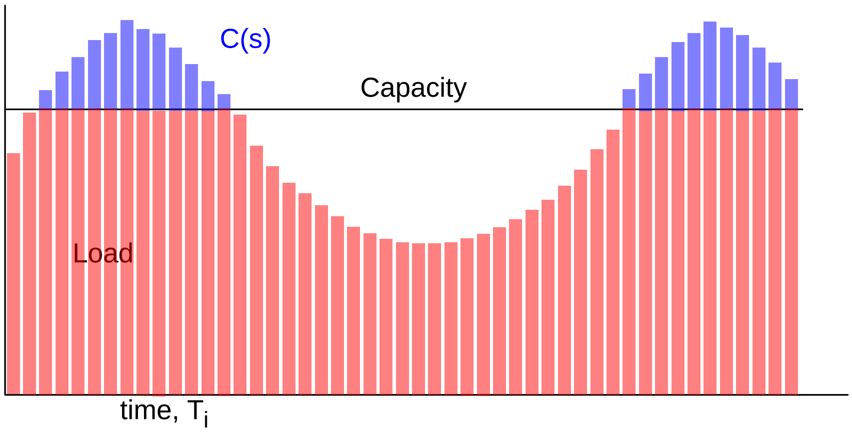


Figure 1 - Expected Unserved Energy

The probability of residing in each state is calculated from the unavailability of each component. Therefore the probability of residing in each state is given by equation

$$P(s) = \prod_{i=1}^{N_d} PF_i \prod_{i=1}^{N-N_d} (1 - PF_i)$$

Where:

N is the total number of components

$\mathrm{N_d}$ is the number of failed components

$\mathrm{PF_i}$ is the unavailability of the ith component

The total annual expected unserved energy for each year is calculated by weighting each system state load curtailment by the probability of residing in that state and the duration of the load level. The EUE is given by equation.

$$EUE = \sum_{i=1}^{NL} \left(\sum_{s \in F_i} P(s) \cdot C(s) \right) \cdot T_i$$

where:

NL is the number of load levels

F_i is the set of all system states with load curtailment

T_i is the time length of the ith load level

4.2.2 Transmission Corridor Capacity

The transmission corridor capacity was calculated such that, in the event of coincident outages beyond (n-1), pre-contingent load shedding would not be employed to satisfy NER requirements of operating in a secure operating state[10]. Instead a secure state would be achieved by developing contingency plans that required manual interventions to manage overloads, and return the system to a secure operating state (for the next most critical contingency). This is similar to the current practice which allows cyclic load shedding (outside Sydney CBD) for short periods of time following a simultaneous outage of a single 330 kV cable and any 132 kV transmission feeder or 330/132 kV transformer, in inner Sydney, until corrective switching is carried out.

This assumption was to maximise the utilisation of the existing network and reduce the likelihood of investing prematurely. It should be noted that advice from Ausgrid's operations staff is that this situation has not occurred in practice and is therefore untested. It has always been possible to maintain a secure operating state without pre-contingent load shedding or the need to rely on contingency plans with manual interventions.

4.2.3 Asset Unavailability

A specific unavailability (expressed as percentage time per year) was applied for each cable considered in the capacity analysis. This was based on the outage duration multiplied by frequency, observed from historical cable failures. The contingency states applied were tested across a range of coincident conditions, ranging from (n-1) to (n-4). The compounded probabilities of most multiple element outages (n-4) and greater were found to produce negligibly small expected unserved energy, and hence were excluded. The equations used were:

$$f = L\lambda(t_2^{\eta} - t_1^{\eta})$$

where:

f is the frequency of failures (i.e. also commonly known as the outage rate)

L is the length of the cable segment

t_1 is the age of the cable segment at the start of the year (years)

t_2 is the age of the cable segment at the end of the year (years)

η is a scale parameter

[10] NER clause 4.2.6 (b)

λ is a scale parameter

$$U = \frac{f * MTTR}{365}$$

where:

U is the cable unavailability

$MTTR$ is the mean time to repair (days/repair)

4.2.4 Value of Customer Reliability (VCR)

The Value of Customer Reliability (VCR) seeks to determine the costs that electricity supply interruptions impose on end-use customers. It is assumed that a customer would be willing to pay a price for increased reliability that is no more (and presumably somewhat less) than the cost they would incur in the event of an interruption to their electricity supply. Separate VCR values were assigned to the energy consumed to reflect the differences between customer load classes within the Inner Metropolitan and Sydney CBD areas

Customer (VCR)	HOUSTONKEMP ($/kwh)	AEMO State Average 2014 ($/kwh)
Inner Metropolitan	$90	$38.35
CBD	$150 - $192 ($170)	$38.35

Value of Customer Reliability

The Houston Kemp VCR[11] values shown above were used for this analysis because the Power Sydney's Future assessment is focussed on prolonged outages and the impact on significant customers such as large financial institutions, NSW Parliament and major public transport assets. In contrast the AEMO VCR values do not address prolonged outages and under estimate VCR values for commercial customers.

The Inner Metropolitan and Sydney CBD areas comprise a combination of industrial, commercial and residential customers, who were assigned different VCR values. In the process of transmission capacity calculation, where the contingency states resulted in load curtailment, blocks of load were shed according to supply priority that were chosen to approximate control room operations. That is, the first 300MW (approximately) of load shedding would be applied to the Inner Metropolitan area (lower VCR customers), then afterwards the Sydney CBD area (higher VCR customers).

4.3 Environmental risks and costs

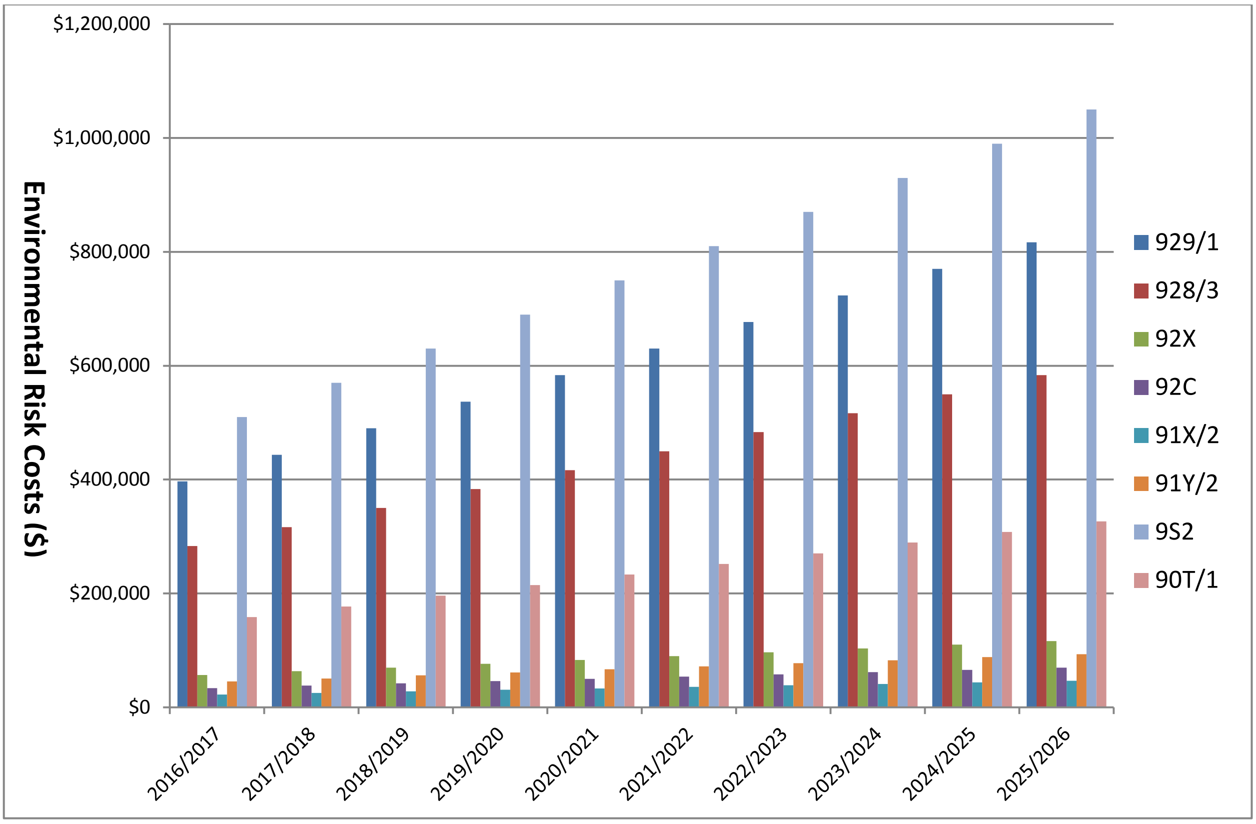
Ausgrid has experienced major leaks from oil filled cables and some Ausgrid cables leak smaller amounts of oil into the environment continuously. Ausgrid has committed to the NSW Environmental Protection Authority (EPA) including an aim to reduce the overall environmental risk by more than 50% for each regulatory period.

The graph below gives the Ausgrid environmental costs for next 10 years based on the present condition of the most deteriorated Ausgrid cables[12]. The methodology adopted is described in Ausgrid Environmental Cost Review report in PDGS supporting documents[13].

[11] HoustonKemp Economists, CBD and Inner Metro VCR estimates, July 2016

[12] Ausgrid Environmental risk costs have been reviewed By WolfPeak

[13] File 20160707 Review - Environmental Risk Assessment SCFF - Final (3)

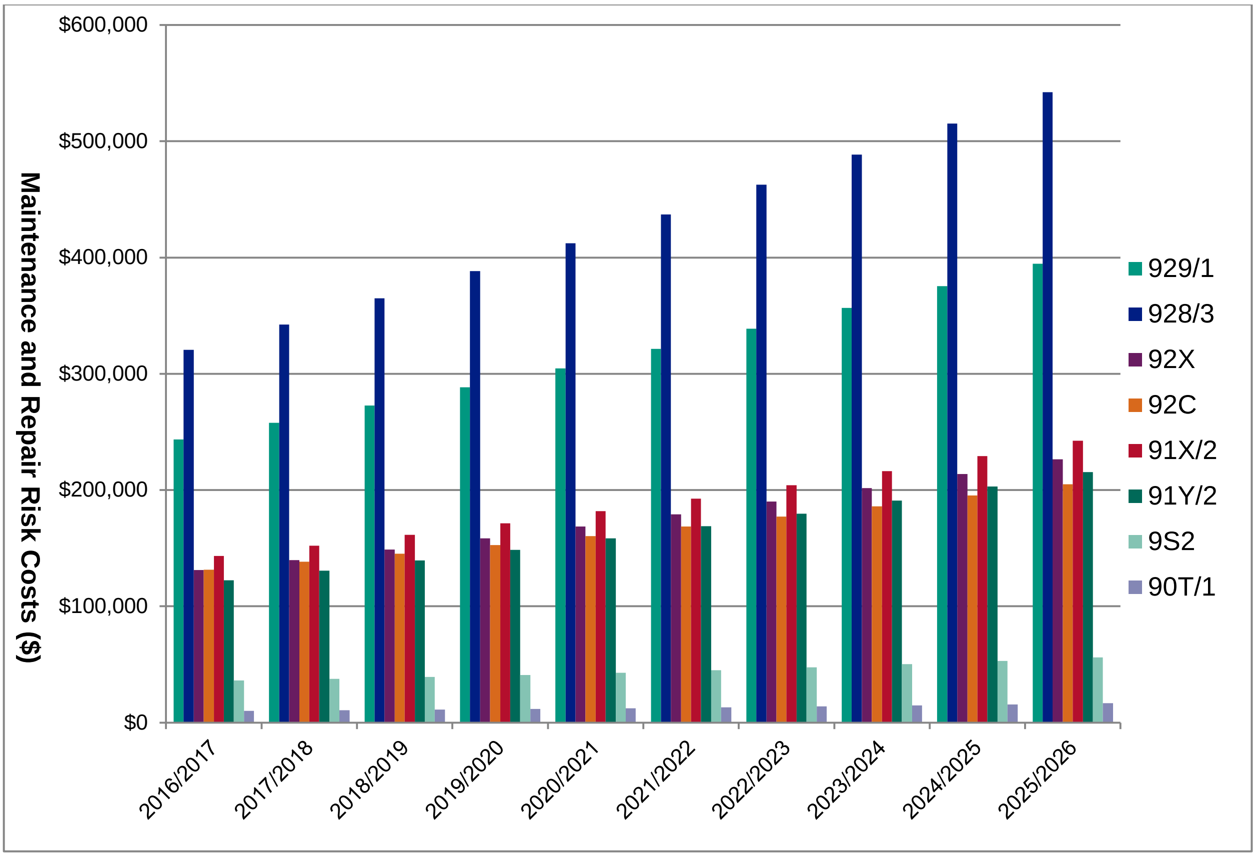


4.4 Costs to maintain the deteriorating cable systems

The electricity industry worldwide has moved away from the installation of oil filled cables with the preferred option now being XLPE cables. Manufacturers have moved away from making or supporting the oil filled cable technology, including jointing kits, and this has also been a driver for the electricity industry to move towards XLPE cable technology.

The cost to maintain the deteriorating cables has increased because the availability of the exact replacement cable and spare parts are becoming more difficult or expensive to source as manufacturers no longer or unwilling to make the oil filled cables and spare parts, and they are manufactured as ‘one off’ items and usually at a premium cost.

The graph below gives the forecast Ausgrid cable maintenance and repair costs for next 10 years based on the present condition of the most deteriorated Ausgrid cables.



4.5 Capital and operating expenditure

The yearly incremental operating expenditure is estimated to be as indicated in the Table in section 4.6 for each option. This is estimated as 2% of the capital cost.

4.6 Options Evaluation

The options are evaluated based on the costs and benefits. The benefit of each option comprises:

- The reduction of expected unserved energy,
- The reduction of environmental and reputation risk costs, and
- The reduction of repair and maintenance costs

The costs of each option include:

- The distributed CAPEX costs, terminal value of new cable assets are calculated based on the service life of 40 years.
- OPEX costs (cable decommissioning costs, operating costs related to the new assets).

The net present value of benefit for each year is calculated based on the discount rate of 8% (real pre-tax) which is derived from the nominal 10% rate applied in the rest of the program. The real discount rate used in the analysis is applied to the real cashflows, consistent with the Grid Australia's guide on RIT-T cost benefit analysis. The analysis period for the NPV is 30 years.

The summated costs and NPV benefit of the technically feasible options for next 30 years are given in the table below.

Option	Description	Capex ($m)	Decommission costs ($m)	Post project risk cost ($m)	Summated NPV ($m)[14]	Rank
Base case	Do nothing	-		$79,162		-
1	Install two 330 kV cables in stages, retire Cable 41 and decommission Ausgrid cables in two stages	$332	$12	$3,256	$10,935	3
2	Operate Cable 41 at 132 kV, install two 330 kV cables in stages and decommission Ausgrid cables in two stages	$337	$12	$3,263	$10,941	2
3	Install two 330 kV cables at once, retire Cable 41 and decommission Ausgrid cables in one stage	$312	$12	$3,220	$10,941	1
4	Remediate Cable 41, install two 330 kV cables in stages and decommission Ausgrid cables in one stage	$455	$12	$3,627	$10,868[15]	5
5	Remediate Cable 41, install two 330 kV cables at once (initially operating at 132 kV) and decommission Ausgrid cables in two stages	$450	$12	$3,607	$10,868	6
6	Remediate Cable 41, install two 330 kV cables at once and decommission Ausgrid cables in one stage	$436	$12	$3,615	$10,877	4

Sensitivity analysis of the preferred option under different discount rates is conducted and results are shown in table below. Option 2 will be the preferred option when discount rate is above 8.00% otherwise Option 3 will always be the preferred option.

Discount Rate	4.75%	6.13%	8.00%	10.00%
Preferred Option	Option 3	Option 3	Option 3	Option 2
Need Year	2020/2021	2021/2022	2022/2023	2021/2022

The sensitivity analysis for different load growths show that the different demand scenarios will not affect the preferred option but the need year will change depending on the growth rate.

[14] NPV is calculated for next 30 years and terminal values of new cables are calculated based on the asset life of 40 years.

[15] 41 service life will be extended to 60 years after 41 backfill remediation.

Demand Growth Scenarios	Preferred Option[16]	Need Year
High Growth	Option 3	2021/2022
Medium Growth	Option 3	2022/2023
Low Growth	Option 3	2023/2024

TransGrid and Ausgrid have estimated the approximate level of network support required to provide the minimum amount of reduced estimated unserved energy to defer the network investment. These requirements, detailed in the Table below, are based upon availability of network support for an entire year.

Year	Minimum network support required
2022/2023	60MW
2023/2024	90MW
2024/2025	150MW

The non-network options can be used to defer the project for the first need year depend on the costs of the non-network solutions. However it is unlikely that the non-network options can be used to defer the project further years based on the TransGrid experience in previously DM activity.

Although the cable 41 remediation options (option 4 – 6) have higher network capability, due to the age and the remaining service life of the cable, the benefit of remediation 41 to 575MVA, in terms of the Expected Unserved Energy, is not enough to justify the extra remediation costs compared with other options.

The preferred network option is likely to be Option 3, as this has the lowest capital cost, and the highest NPV.

4.7 Regulatory Investment Test

The RIT-T is currently in progress, the Project Specification Consultation Report (PSCR) has been released in October 2016. Submissions on the PSCR are due on or before 13 January 2017. A Project Assessment Draft Report (PADR), including full option analysis, is expected to be published by the end of March 2017.

5. Recommendation

The preferred option will be determined through the RIT-T process based on detailed network analysis, market modelling, technical and economic feasibility. Following the RIT-T, a complete Options Evaluation Report will be issued. However, the preferred network option is Option 3 – Install two 330 kV cables at once[17], retire cable 41 and decommission Ausgrid cables in one stage. Based on the options listed in Section 4.2, it is expected that this Project would incur a capital cost of approximately $312 million in 2016-17 dollars (based on the estimated capital cost for Option 3 given above).

[16] Based on the discount rate of 8.00%.

[17] Installation of two cables at once will reduce the community impact and disruptions which will be significant if the cables are installed in two stages.