OPTIONS EVALUATION REPORT (OER)

FY24-28 CT Renewal Program

OER- N2347 revision 1.0

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

Project reason: Capability - Asset Replacement for end of life condition
Project category: Prescribed - Asset Renewal Strategies

Approvals

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Change history

Revision	Date	Amendment
0	01/11/2021	Initial version
1	10/11/2021	Minor wording updates

Executive summary

Current transformers (CTs) approaching end of life present an increased risk of failure, causing unplanned network outages, with potential catastrophic failure resulting in safety and environmental hazards. CTs are typically installed in a set of three in a switch bay and are considered for replacement under a single project as the most cost effective solution. There are 105 CT replacement projects (307 units) will be approaching end of life by 2027/28 and are considered to mitigate the identified risk within the 2023 – 2028 regulatory period.

The assessment of the options considered to address this identified need appears in Table 1. The result is that 47 current transformer projects (139 units) have been selected to be included in the program based on the option meeting following criteria:

- Meets the need,
- Is technically feasible,
- Has a positive net present value,
- Provides the highest net present value of each option evaluated, and
- The optimal project timing is earlier than the end of the 2023 – 2028 regulatory period.
- Not part of dead tank CB replacement program

The remaining 58 current transformer projects (168 units) evaluated do not meet this criteria and are not recommended to be replaced under this need. The option evaluation summary for the recommended 47 current transformer replacement projects (139 units) is shown in Table 1.

Table 1 - Evaluated options ($ million)

Option	Description	Direct capital cost	Network and corporate overheads	Total capital cost[1]	Weighted NPV	Rank
Option A	Replace with conventional current transformer	$6.10	$1.85	$7.96	$62.99	1

It is recommended to proceed with implementing the replacement program comprising 47 CT replacement projects (139 units) with a total program cost of $7.96 million. The detailed breakdown of option evaluation for each project is provided in Appendix B.

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

1. Need/opportunity

Current transformers (CTs) are high voltage equipment whose purpose on the network is to transform main system current levels to the range that is useable by secondary systems equipment. This is essential for the control, protection and revenue metering of the high voltage network. CTs can be categorised based on their construction type as follows:

- Oil filled 'live head' CTs where the primary conductor is a simple bar, with the secondary toroid installed around the bar at the level of the high voltage conductors.
- Oil filled 'hairpin' type CTs where the primary conductor is formed into a hairpin shape to allow it to be brought down into the tank located at the base of the unit. The insulation system is complex and is similar to an insulated bushing that has been bent.
- Post type SF6 gas insulated CTs.
- Toroidal CTs such as those installed on dead tank circuit breakers or GIS. These rely on the primary insulation provided by the equipment on which they are installed.
- Non-conventional current transformers or Optical fibre CTs in Transgrid' network works on Faraday effect utilising light to transform current and eliminates need of oil or SF6 insulation compared to conventional CTs. Their use on network is still under trial stage, which is being executed under need 1578.

As oil insulated CTs age the following condition issues become apparent:

- Degradation of the high voltage oil and paper insulation system due to electrical stress. This is the key factor leading to the end of the asset's life.
- Oil leaks and increase of due to degradation of seals and outer housing
- Corrosion due to weathering

Oil filled CTs have the highest risk of explosive failure. An explosive failure may also result in the risk of injury to people, collateral damage and outages of nearby services due to the porcelain insulator being ejected from the failed asset. There are no SF6 insulated CTs, toroidal CTs or non-conventional CTs considered for replacement under this CT renewal need.

The management of the risks associated with the failure of oil filled CTs are considered in this need. The existing in-service oil filled current transformer population has been assessed through application of the Network Asset Risk Assessment Methodology as follows:

- Current transformer health index scores are calculated based on condition data including age and condition monitoring data and type issues.
- Health index scores are mapped to an effective age.
- Current transformers are assigned an individual probability of failure based on its individual effective age.
- Consequences of a current transformer failure and the likelihood of the consequences occurring are calculated based on network criticality, public and worker safety risk exposure, environmental risk and financial risk for each asset.
- The consequence and probability of failure are combined to determine the annual economic risk cost for each current transformer for use in the evaluation for the renewal of current transformers in each bay.
- Each project comprise current transformers selected in this bay for the need, total project cost comprises of all CTs replacements in a bay.

There are 307 current transformers forecast to be nearing end of life by the end of the 2023-2028 Regulatory Period and have been included in this option evaluation for consideration of replacement. Each asset is evaluated with other CTs in the bay to determine if either of the options should implemented in the 2023-2028 regulatory period.

The key economic benefits associated with addressing this need are summarised as:

- Reduction of risk valued as direct impact to Transgrid and consumers including:

- Impact of expected unserved energy;
- Safety and environmental hazards associated with a catastrophic failure.

2. Related needs/opportunities

CTs considered for renewal under this need N2347 are also assessed for consideration of replacement with a DTCB N2345 CB renewal program. Both these needs have been reconciled to ensure there is no duplication in the final replacement programs in 2023 – 2028 regulatory period.

These CTs also considered for either renewal or removal due to network augmentation or replacement projects under other needs as detailed below. These needs have been reconciled to ensure there is no duplication in the final replacement programs in 2023 – 2028 regulatory period.

- 2145 Southern NSW - Improve voltage control - Kemps Creek SVC and reactor bay
- N2404 Inverell and Panorama transformer renewals - associated switch bay works
- N2421 Molong No1 Transformer Renewal – associated switch bay works
- N2424 Tenterfield Transformer Renewals – associated switch bay works

3. Options

3.1 Base case

Under the 'Base Case' no renewal strategy is implemented for the assets evaluated under this need. This is a 'run to fail' scenario and will lead to an increase in the identified risks under this need, the eventual failure of the assets and the realisation of the expected consequences. This case shall only be considered as a last resort should no option be deemed viable through the NPV evaluation process.

3.2 Options evaluated

Option A — Replace with conventional CT [NOSA N2347, OFS N2347A]

This option considers the replacement of an existing post current transformer with a new oil filled or SF6 insulated CT. At lower voltages resin cast insulated CTs or toroidal CTs are also acceptable. Of the 107 CT replacement projects (313 units) in this need all are evaluated under Option A. Option A fully addresses the identified need by installation of a new current transformer with very low probability of failure and associated risk cost.

The replacement costs under Option A for each project within this program are included in Appendix B, with an expected duration of 1 year for each project. Replacement work may include the following:

- High voltage and civil design work
- Secondary system design work
- Plant procurement and transportation
- Civil work (e.g.: footing replacement or modifications as required)
- Site work and commissioning

3.3 Options considered and not progressed

The following options were considered but not progressed:

Table 2 - Other options considered

Option	Reason for not progressing
Non-conventional CTs	The trial for non-conventional CTs (e.g. fibre optic based measuring technologies) are underway under existing need 1578. The trial is demonstrating that the replacement costs with this technology is much higher than conventional CTs and therefore it is not economically feasible to include as part of this replacement program.
Replacement in conjunction with CB replacement	This option has been considered under the Circuit Breaker renewal program (N2345).
Increased maintenance or inspections	The condition issues have already been identified and cannot be rectified through increased maintenance or inspections, and therefore are not technically feasible to address the need.
Elimination of all associated risk	This can only be achieved by retiring the assets, which is not technically feasible due to the requirement to maintain the existing network reliability.
Non-network solutions	It is not technically feasible for non-network solutions to provide the functionality of the equipment under this need.

4. Evaluation

4.1 Commercial evaluation methodology

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

Assumptions for each scenario are set out in the table below.

Table 3- Scenario assumptions

Parameter	Central scenario	Lower bound scenario	Higher bound scenario
Discount rate	4.8%	7.37%	2.23%
Capital cost	100%	125%	75%
Operating expenditure benefit	Not applicable in this need		
Risk cost benefit	100%	75%	125%
Other benefits	Not applicable in this need		
Scenario weighting	**50%**	**25%**	**25%**

Parameters used in this commercial evaluation:

Table 4 - Commercial evaluation parameters

Parameter	Parameter Description	Value used for this evaluation
Discount year	Year that dollar values are discounted to	2020/21
Base year	The year that dollar value outputs are expressed in real terms	2020/21
Period of analysis	Number of years included in economic analysis with remaining capital value included as terminal value at the end of the analysis period.	25 years
ALARP disproportionality	Multiplier of the environmental and safety related risk cost included in NPV analysis to demonstrate implementation of obligation to reduce to ALARP.	Refer to section 4.3 for details.

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

4.2 Commercial evaluation results

The commercial evaluation of the technically feasible options is set out in Table 5, showing 47 current transformer projects (139 units) where the highest ranked option for each evaluated project:

- Meets the need,
- Is technically feasible,
- Has a positive net present value,
- Provides the highest net present value of each option evaluated,
- Optimal project timing is earlier than the end of the 2023 – 2028 regulatory period.

58 current transformer projects (168 units) evaluated do not meet this criteria and so are not included. Further details appear in Appendix A.

Table 5 - Commercial evaluation ($ million)

Option	Capital Cost PV	Central scenario NPV	Lower bound scenario NPV	Higher bound scenario NPV	Weighted NPV	Ranking
Option A	5.73	48.16	19.32	106.61	55.56	1

4.3 ALARP evaluation

TransGrid manages and mitigates bushfire and safety risk to ensure they are below risk tolerance levels or 'As Low As Reasonably Practicable' ('ALARP'), in accordance with the regulation obligations and TransGrid's business risk appetite. Under the Electricity Supply (Safety and Network Management) Regulation 2014 Section 5 'A network operator must take all reasonable steps to ensure that the design, construction, commissioning, operation and decommissioning of its network (or any part of its network) is safe.' TransGrid maintains an Electricity Network Safety Management System (ENSMS) to meet this obligation.[2]

[2] TransGrid's ENSMS follows the International Organization for Standardization's ISO31000 risk management framework which requires following hierarchy of hazard mitigation approach

In its Network Risk Assessment Methodology, under the ALARP test with the application of a gross disproportionate factor[3], the weighted benefits are expected to exceed the cost. TransGrid's analysis concludes that the costs are less than the weighted benefits from mitigating bushfire and safety risks. The proposed investment will enable TransGrid to continue to manage and operate this part of the network to a safety and risk mitigation level of ALARP.

Evaluation of the above options has been completed in accordance with As Low As Reasonably Practicable (ALARP) obligations. The Network Safety Risk Reduction is calculated as 6 x Bushfire Risk Reduction + 3 x other Environmental Risks + 3 or 6 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction.

The results of the ALARP evaluation are set out in Table 6. This table shows that 35 of the CT replacement projects are justifiable under the ALARP evaluation.

Table 6 - Reasonably practicable test ($ million)

Option	Network Safety Risk Reduction	Annualised Capex	Reasonably Practicable?[4]
A	0.82	0.45	Y (35 CT projects)

4.4 Preferred option

The list of the projects and options for each of the 107 CT replacement projects (313 units) evaluated are included in Appendix B.

This criteria results in 47 current transformer projects (139 units) that are recommended to be progressed at a total program cost of $7.96 million under this need. Therefore total 139 CTs to be replaced under these projects. Replacement of a current transformer under the preferred option fully meets the need by achieving the risk reduction outlined in Section 3.The remaining 58 current transformer projects (168 units) evaluated do not meet this criteria and are not recommended to be replaced under this need.

Capital and Operating Expenditure

Opex cost benefits associated reduced corrective expenditure has been allowed for in the business case NPV and optimal timing evaluation.

There are no capex to opex trade-offs considered in this evaluation.

Regulatory Investment Test

The program and estimate allows for the appropriate regulatory approvals as required.

5. Optimal Timing

The test for optimal timing of the preferred option has been undertaken. The approach taken is to identify the optimal commissioning year for the preferred option where net benefits (including avoided costs and safety disproportionality tests) of the preferred option exceeds the annualised costs of the option.

The results of optimal timing analysis for each current transformer project within the program is included in Appendix C.

This OER recommends progressing only positive business cases which are optimally time before the end of the 2023-2028 Regulatory Period, hence all projects are evaluated for benefit in the final year of the period.

[3] The values of the disproportionality factors were determined through a review of practises and legal interpretations across multiple industries, with particular reference to the works of the UK Health and Safety Executive. The methodology used to determine the disproportionality factors in this document is in line with the principles and examples presented in the AER Replacement Planning Guidelines and is consistent with TransGrid's Revised Revenue Proposal 2023/24-2027/28.

[4] Reasonably practicable is defined as whether the annualised CAPEX is less than the Network Safety Risk Reduction.

- Evaluation commissioning year: 2027/28
- Commissioning year annual benefit: $3.03 million
- Annualised cost: $0.45 million

6. Recommendation

It is recommended to proceed with implementing the N2347 current transformer replacement program of 47 current transformer projects (139 units) at a total program cost of $7.96 million

An allowance of $2.6 million is included in this program value to progress the program from Decision Gate 1 (DG1) to Decision Gate 2 (DG2).

The list of the 47 current transformer projects (139 units) are included in Appendix C.

Appendix A - Commercial evaluation report

Project Summary : N2347 Program - CTs OER Option A, Rank 1, Optimally Timed, NPV Positive			
Option Rank	*1*	Investment Assessment Period	*25*
Asset Life	*40*	NPV Year	2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $million)	46.83	Annualised CAPEX @ Central Benefit Scenario ($million)	Annualised Capex - Standard (Business Case) 0.45
NPV @ Lower Bound Scenario (PV, $million))	35.37	Network Safety Risk Reduction ($million)	Network Safety Risk Reduction 0.82
NPV @ Higher Bound Scenario (PV, $million)	122.93	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, $ million)	62.99	Optimal Timing	Optimal timing (Business Case) 2028
Cost (Central Scenario)			
Direct Capex ($million)	6.10	Network and Corporate Overheads ($million)	1.85
Total Capex ($million)	7.96	Cost Capex (PV,$million)	5.73
Terminal Value ($million)	2.79	Terminal Value (PV,$million)	0.62
Risk (Central Scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$million)	Reliability Risk (Pre) 46.89	Reliability Risk (Post) 4.89	Pre – Post 42.00
Financial (PV,$million)	Financial Risk (Pre) 0.43	Financial Risk (Post) 0.04	Pre – Post 0.39
Operational/Compliance (PV,$ million)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (PV,$million)	Safety Risk (Pre) 8.34	Safety Risk (Post) 0.83	Pre – Post 7.51
Environmental (PV,$million)	Environmental Risk (Pre) 2.56	Environmental Risk (Post) 0.25	Pre – Post 2.31
Reputational ($million)	Reputational Risk (Pre) 0.87	Reputational Risk (Post) 0.09	Pre – Post 0.78
Total Risk (PV,$million)	Total Risk (Pre) 59.08	Total Risk (Post) 6.11	Pre – Post 52.98
OPEX Benefit (PV,$million)			OPEX Benefit 0.00
Other benefit (PV,$million)			Incremental Net Benefit 0.00
Total Benefit (PV,$million)			Business Case Total Benefit 52.98

Appendix B CT Option Evaluation Summary

The table has list of all CT projects (107) assessed and evaluated under this need (N2347) with their outcome. The projects are listed with their weighted NPV values and optimal timing and reasoning for excluding them from this renewal program. The projects with “Yes” in included in final program are recommended to be included in CT renewal program under this need and detailed in Appendix C.

Bay	CT Quantity	Voltage (kV)	Capex	ALARP	Optimal Timing	Total Benefit	Annualised Capex	NPV (weighted)	Included in final program
CMSDPT2D2	3	132	$169,000	Yes	2023/24	$27,993	$9,581	$580,258	No, due to being part of other need
CMSDPT2E2	3	132	$169,000	Yes	2023/24	$26,243	$9,581	$547,859	No, due to being part of other need
CMSDPT2L	3	132	$169,000	Yes	2023/24	$34,015	$9,581	$735,722	Yes
CMSDPT2W	3	132	$169,000	Yes	2023/24	$32,112	$9,581	$677,890	No, due to being part of other need
CMSDPT8E	1	11	$104,000	No	2048/49	$2,831	$5,896	$33,966	No, not optimally timed
CMSKCR1P2	9	330	$304,000	Yes	2023/24	$65,694	$17,234	$1,282,725	No, due to being part of other need
CMSLP12A	3	132	$169,000	No	2045/46	$6,003	$9,581	$83,615	No, not optimally timed
CMSSE12A1	3	132	$169,000	Yes	2023/24	$67,912	$9,581	$1,261,185	Yes
CMSSYN1B2	1	330	$104,000	No	2053/54	$320	$5,896	-$29,696	No, NPV negative
CMSSYS1D1	3	330	$220,000	Yes	2023/24	$28,226	$12,472	$501,343	No, due to being part of other need
CMSSYS1H1	3	330	$220,000	Yes	2023/24	$49,267	$12,472	$881,272	Yes
CMSSYS2L	3	132	$169,000	Yes	2023/24	$37,117	$9,581	$793,804	Yes
CMSSYS2Y	3	132	$169,000	Yes	2023/24	$178,476	$9,581	$4,247,487	Yes

Bay	CT Quantity	Voltage (kV)	Capex	ALARP	Optimal Timing	Total Benefit	Annualised Capex	NPV (weighted)	Included in final program
CMSSYW2B2	3	132	$169,000	Yes	2023/24	$16,992	$9,581	$349,179	Yes
CMSSYW2C2	3	132	$169,000	Yes	2023/24	$84,813	$9,581	$1,962,146	No, due to being part of other need
CMSSYW2D1	3	132	$169,000	Yes	2023/24	$177,185	$9,581	$4,216,312	Yes
CMSSYW2D2	3	132	$169,000	Yes	2023/24	$82,914	$9,581	$1,925,744	Yes
CMSSYW2FA	3	132	$169,000	Yes	2023/24	$103,568	$9,581	$2,440,275	Yes
CMSSYW2P	3	132	$169,000	Yes	2023/24	$126,923	$9,581	$2,702,428	No, due to being part of other need
CMSSYW2YC	3	132	$169,000	Yes	2023/24	$189,769	$9,581	$4,431,822	Yes
CMSVYD2B	3	132	$169,000	Yes	2023/24	$24,347	$9,581	$499,805	No, due to being part of other need
CMSVYD2D	3	132	$169,000	Yes	2023/24	$18,412	$9,581	$383,524	Yes
CMSVYD2G	3	132	$169,000	Yes	2023/24	$26,463	$9,581	$574,061	No, due to being part of other need
CMSVYD2J	3	132	$169,000	Yes	2023/24	$27,144	$9,581	$586,508	No, due to being part of other need
COSBER4C	3	66	$154,000	Yes	2023/24	$111,549	$8,730	$2,500,014	Yes
COSCW24J	3	66	$154,000	No	2023/24	$56,120	$8,730	$1,283,014	Yes
COSCW24L1	3	66	$154,000	No	2023/24	$52,455	$8,730	$1,211,758	Yes
COSFB24B	3	66	$154,000	Yes	2023/24	$117,452	$8,730	$2,694,220	No, due to being part of other need
COSFB24C	3	66	$154,000	Yes	2023/24	$108,145	$8,730	$2,525,586	No, due to being part of other need

Bay	CT Quantity	Voltage (kV)	Capex	ALARP	Optimal Timing	Total Benefit	Annualised Capex	NPV (weighted)	Included in final program
COSFB24N2	3	66	$154,000	Yes	2023/24	$71,812	$8,730	$1,657,405	Yes
COSMPP2L	3	66	$154,000	No	2042/43	$6,912	$8,730	$108,986	No, not optimally timed
COSMTP1C3	3	330	$220,000	Yes	2023/24	$16,104	$12,472	$262,779	Yes
COSMTP1F2	3	330	$220,000	No	2023/24	$13,408	$12,472	$224,009	Yes
COSMTP1F3	3	330	$220,000	No	2023/24	$12,490	$12,472	$207,883	Yes
COSMTP1G5	3	330	$220,000	No	2040/41	$12,012	$12,472	$203,104	No, not optimally timed
COSPKS1B1	3	132	$169,000	Yes	2023/24	$189,617	$9,581	$4,434,636	No, due to being part of other need
COSPKS2B	3	66	$154,000	Yes	2023/24	$82,350	$8,730	$1,874,868	No, due to being part of other need
COSPKS2L	3	66	$154,000	No	2023/24	$9,037	$8,730	$161,027	Yes
COSWL11B2	1	330	$104,000	No	2053/54	$1,541	$5,896	$2,169	No, not optimally timed
NNSKS22M	3	132	$169,000	No	2041/42	$8,577	$9,581	$140,604	No, not optimally timed
NNSKS24D1	1	66	$104,000	No	2053/54	$1,957	$5,896	$8,896	No, not optimally timed
NNSPMQ2B1	3	132	$169,000	No	2023/24	$35,343	$9,581	$776,973	No, due to being part of other need
NNSTRE4K	2	66	$129,000	No	2041/42	$6,422	$7,313	$114,152	No, not optimally timed
NNSTRE4Q	3	66	$154,000	No	2023/24	$10,839	$8,730	$202,730	Yes
NNSTRE4R	3	66	$154,000	Yes	2023/24	$13,459	$8,730	$250,871	Yes

Bay	CT Quantity	Voltage (kV)	Capex	ALARP	Optimal Timing	Total Benefit	Annualised Capex	NPV (weighted)	Included in final program
NNSWRH2Q	3	132	$169,000	No	2023/24	$13,039	$9,581	$253,669	No, due to being part of other need
NNSWRH2V	3	132	$169,000	Yes	2023/24	$14,543	$9,581	$283,524	No, due to being part of other need
NNSWRH2X3	3	132	$169,000	No	2023/24	$12,338	$9,581	$232,920	No, due to being part of other need
NTSAR14J	3	66	$154,000	Yes	2023/24	$27,052	$8,730	$503,290	No, due to being part of other need
NTSGN24A	3	66	$154,000	Yes	2023/24	$35,964	$8,730	$818,957	No, due to being part of other need
NTSGN24B	3	66	$154,000	Yes	2023/24	$59,379	$8,730	$1,218,568	No, due to being part of other need
NTSINV2G2	3	132	$169,000	Yes	2023/24	$70,453	$9,581	$1,630,532	No, due to being part of other need
NTSINV4B	3	66	$154,000	Yes	2023/24	$48,914	$8,730	$1,096,920	No, due to being part of other need
NTSINV4J	3	66	$154,000	No	2023/24	$9,888	$8,730	$175,822	No, due to being part of other need
NTSINV4K	3	66	$154,000	No	2023/24	$10,138	$8,730	$185,989	No, due to being part of other need
NTSLSM2A	3	132	$169,000	Yes	2023/24	$13,776	$9,581	$251,008	No, due to being part of other need
NTSLSM2B	3	132	$169,000	Yes	2023/24	$70,987	$9,581	$1,611,738	No, due to being part of other need
NTSLSM2C	3	132	$169,000	Yes	2023/24	$13,547	$9,581	$249,061	No, due to being part of other need
NTSLSM2D	5	132	$219,000	Yes	2023/24	$30,879	$12,415	$578,754	Yes
NTSLSM2E	3	132	$169,000	Yes	2023/24	$11,331	$9,581	$209,001	Yes
NTSLSM2F	3	132	$169,000	Yes	2023/24	$11,455	$9,581	$211,961	No, due to being part of other need

Bay	CT Quantity	Voltage (kV)	Capex	ALARP	Optimal Timing	Total Benefit	Annualised Capex	NPV (weighted)	Included in final program
NTSLSM2G	3	132	$169,000	Yes	2023/24	$11,517	$9,581	$213,448	Yes
NTSLSM2H	3	132	$169,000	Yes	2023/24	$171,694	$9,581	$3,985,471	Yes
NTSLSM2J	3	132	$169,000	Yes	2023/24	$71,362	$9,581	$1,621,348	No, due to being part of other need
NTSLSM2K	3	132	$169,000	Yes	2023/24	$68,141	$9,581	$1,565,162	Yes
NTSLSM2L	3	132	$169,000	Yes	2023/24	$68,904	$9,581	$1,583,381	No, due to being part of other need
NTSMRE2A2	3	132	$169,000	Yes	2023/24	$36,252	$9,581	$879,211	Yes
NTSMRE2B2	3	132	$169,000	Yes	2023/24	$36,993	$9,581	$898,448	Yes
NTSMRE2G2	3	132	$169,000	Yes	2023/24	$85,707	$9,581	$1,959,640	Yes
NTSMRE4B	3	66	$154,000	Yes	2023/24	$52,450	$8,730	$1,195,426	Yes
NTSNB24F2	3	66	$154,000	No	2023/24	$10,796	$8,730	$206,216	Yes
NTSNB24G2	3	66	$154,000	No	2023/24	$11,543	$8,730	$219,395	Yes
NTSNB24S	3	66	$154,000	Yes	2023/24	$27,277	$8,730	$603,351	Yes
NTSNB24Z	3	66	$154,000	Yes	2023/24	$12,073	$8,730	$213,708	Yes
NTSTTF2A2	2	132	$144,000	No	2023/24	$10,924	$8,163	$178,857	Yes
NTSTTF2B2	2	132	$144,000	No	2023/24	$11,142	$8,163	$183,476	No, due to being part of other need
SWSALB2B1	3	132	$169,000	Yes	2023/24	$104,486	$9,581	$2,445,330	Yes

Bay	CT Quantity	Voltage (kV)	Capex	ALARP	Optimal Timing	Total Benefit	Annualised Capex	NPV (weighted)	Included in final program
SWSALB2C1	3	132	$169,000	No	2023/24	$9,706	$9,581	$170,100	Yes
SWSBKH7S2	7	22	$254,000	No	2040/41	$12,310	$14,399	$243,596	No, not optimally timed
SWSBKH7T2	7	22	$254,000	No	2040/41	$12,984	$14,399	$261,977	No, not optimally timed
SWSBKH7U	1	22	$104,000	No	2023/24	$10,865	$5,896	$212,637	Yes
SWSDN24H	3	66	$154,000	No	2023/24	$10,800	$8,730	$202,814	Yes
SWSDN28A1	3	11	$154,000	Yes	2023/24	$25,747	$8,730	$451,508	Yes
SWSDN28B1	3	11	$154,000	No	2043/44	$5,911	$8,730	$105,324	No, not optimally timed
SWSDNT1A2	1	330	$170,000	No	2053/54	$1,257	$9,637	-$26,533	No, NPV negative
SWSDNT1B2	1	330	$170,000	No	2053/54	$1,369	$9,637	-$23,389	No, NPV negative
SWSDNT2G	3	132	$169,000	Yes	2023/24	$62,372	$9,581	$1,400,998	Yes
SWSDNT6C	5	33	$204,000	No	2045/46	$6,249	$11,565	$101,215	No, not optimally timed
SWSDNT6D	5	33	$204,000	No	2045/46	$6,249	$11,565	$101,215	No, not optimally timed
SWSJDA1A2	1	330	$170,000	No	2053/54	$1,022	$9,637	-$35,910	No, NPV negative
SWSJDA1B2	1	330	$170,000	No	2053/54	$1,049	$9,637	-$35,216	No, NPV negative
SWSWG12U	3	132	$169,000	Yes	2023/24	$61,924	$9,581	$1,214,127	Yes
SWSWG22B	1	132	$119,000	No	2042/43	$5,442	$6,746	$86,634	No, not optimally timed

Bay	CT Quantity	Voltage (kV)	Capex	ALARP	Optimal Timing	Total Benefit	Annualised Capex	NPV (weighted)	Included in final program
SWSWG22H	3	132	$169,000	Yes	2023/24	$14,414	$9,581	$280,129	Yes
SYSCA12B	3	132	$169,000	Yes	2023/24	$21,504	$9,581	$352,613	Yes
SYSCA12C2	3	132	$169,000	Yes	2023/24	$22,229	$9,581	$398,160	No, due to being part of other need
SYSCA12E	2	132	$144,000	No	2043/44	$6,062	$8,163	$89,660	No, not optimally timed
SYSMRN1F	3	330	$220,000	No	2051/52	$5,080	$12,472	$39,098	No, not optimally timed
SYSMRN1G	3	330	$220,000	No	2052/53	$4,765	$12,472	$31,660	No, not optimally timed
SYSMRN1H	3	330	$220,000	No	2052/53	$4,990	$12,472	$35,593	No, not optimally timed
SYSMRNCFB	2	330	$195,000	Yes	2023/24	$199,820	$11,055	$4,655,082	Yes
SYSMRNCGB	3	330	$220,000	Yes	2023/24	$310,866	$12,472	$7,208,962	Yes
SYSMRNDB2	2	330	$195,000	No	2053/54	$3,744	$11,055	$13,961	No, not optimally timed
SYSMRNDFB	1	330	$170,000	No	2053/54	$3,365	$9,637	$17,084	No, not optimally timed
SYSMRU4J	3	66	$154,000	Yes	2023/24	$78,876	$8,730	$1,861,936	Yes
105 Projects	**307 units**								

Appendix C N2347 CT Replacement Program

The table below list each of the CT replacement projects with details of individual CTs, recommended to progress under this OER.

Bay	Bay Description	Equipment Number	Capex	NPV (Weighted)	ALARP	Optimal Timing
CMSDPT2L	98Y SPRINGHILL 132KV FEEDER	CT-EC00010139 CT -EC00010145 CT-EC00010168	$169,000	$733,687	Yes	2023/24
CMSSE12A1	NO1 TRANSFORMER 132KV A BUS CB BAY	CT-A02007/4 CT -A02007/5 CT-A02007/6	$169,000	$1,259,150	Yes	2023/24
CMSSYS1H1	11 DAPTO 330KV FEEDER BAY	CT-BESS61/3 CT -BESS61/6 CT-H70734/1	$220,000	$878,623	Yes	2023/24
CMSSYS2L	916 KURNELL T CRONULLA 132KV FEEDER BAY	CT-EC00003341 CT -EC00003342 CT-EC00003343	$169,000	$791,769	Yes	2023/24
CMSSYS2Y	NO2 132KV CAPACITOR BANK	CT-EC00022719 CT -EC00022748 CT-EC00022751	$169,000	$4,245,452	Yes	2023/24
CMSSYW2B2	NO2 TRANSFORMER 132KV B BUS CB BAY	CT-EC00023554 CT -EC00023555 CT-EC00023556	$169,000	$347,144	Yes	2023/24
CMSSYW2D1	NO4 TRANSFORMER 132KV A BUS CB BAY	CT-EC00022806 CT -EC00022807 CT-EC00022808	$169,000	$4,214,277	Yes	2023/24
CMSSYW2D2	NO4 TRANSFORMER 132KV B BUS CB BAY	CT-EC00022810 CT -EC00022811 CT-ETA1337	$169,000	$1,923,709	Yes	2023/24
CMSSYW2FA	NO2 132KV CAPACITOR BANK	CT-EC00023737 CT -EC00023738 CT-EC00023739	$169,000	$2,438,240	Yes	2023/24
CMSSYW2YC	NO5 132KV CAPACITOR BANK	CT-EC00022717 CT -EC00022747 CT-EC00022750	$169,000	$4,429,786	Yes	2023/24
CMSVYD2D	9JA ROUSE HILL 132KV FEEDER BAY	CT-EC00022778 CT -EC00022787 CT-EC00022788	$169,000	$381,489	Yes	2023/24
COSBER4C	NO3 TRANSFORMER 66KV CB BAY	CT-EC00024746 CT -EC00024750 CT-EC00024753	$154,000	$2,498,160	Yes	2023/24
COSCW24J	866 COWRA TOWN 66KV FEEDER BAY	CT-EC00023428 CT -EC00023429 CT-EC00023430	$154,000	$1,281,159	No	2023/24
COSCW24L1	863 CANOWINDRA 66KV CB BAY	CT-ETA2501 CT -ETA2502 CT-ETA2503	$154,000	$1,209,903	No	2023/24
COSFB24N2	89H WEST JEMALONG 66KV FEEDER BAY	CT-EC00023611 CT -EC00023613 CT-EC00023615	$154,000	$1,655,550	Yes	2023/24
COSMTP1C3	330KV #3 TRANSFORMER MAIN BUS CB BAY	CT-EC00022836 CT -EC00022837 CT-EC00022838	$220,000	$260,130	Yes	2023/24

Bay	Bay Description	Equipment Number	Capex	NPV (Weighted)	ALARP	Optimal Timing
COSMTP1F2	330KV 70 WALLERAWANG MAIN BUS CB BAY	CT-EC00022839 CT -EC00022840 CT-EC00022841	$220,000	$221,360	No	2023/24
COSMTP1F3	330KV BAY F BAY COUPLER CB BAY	CT-EC00022842 CT -EC00022843 CT-EC00022844	$220,000	$205,234	No	2023/24
COSPKS2L	89L PARKES 66 - 66KV FEEDER BAY	CT-EC00023203 CT -EC00023204 CT-EC00023206	$154,000	$159,173	No	2023/24
NNSTRE4Q	NO4 66KV CAPACITOR	CT-EC00007914 CT -EC00008031 CT-EC00008039	$154,000	$200,875	No	2023/24
NNSTRE4R	NO5 66KV CAPACITOR	CT-EC00006361 CT -EC00006362 CT-EC00006363	$154,000	$249,017	Yes	2023/24
NTSLSM2D	NO1 STATIC VAR COMPENSATOR BAY 132KV	CT-ETA8884 CT-ETA8886 CT-ETA8887 CT -ETA8888 CT-ETA8891	$219,000	$576,116	Yes	2023/24
NTSLSM2E	9W1 LISMORE 132KV FEEDER	CT-EC00023664 CT -EC00023665 CT-EC00023666	$169,000	$206,966	Yes	2023/24
NTSLSM2G	NO1 132KV CAPACITOR	CT-EC00023670 CT -EC00023671 CT-EC00023672	$169,000	$211,413	Yes	2023/24
NTSLSM2H	NO1-2 132KV BUS SECTION CB 4102	CT-EC00023685 CT -EC00023686 CT-EC00023687	$169,000	$3,983,436	Yes	2023/24
NTSLSM2K	9U8 LISMORE 132KV FEEDER	CT-EC00023676 CT -EC00023677 CT-EC00023678	$169,000	$1,563,127	Yes	2023/24
NTSMRE2A2	NO1 TRANSFORMER 132KV TRANSFORMER BAY	CT-EC00006940 CT -EC00006941 CT-EC00006942	$169,000	$877,176	Yes	2023/24
NTSMRE2B2	NO2 TRANSFORMER 132KV TRANSFORMER BAY	CT-EC00006943 CT -EC00006944 CT-EC00006945	$169,000	$896,413	Yes	2023/24
NTSMRE2G2	96M NARRABRI 132KV CB BAY	CT-EC00020900 CT -EC00020907 CT-EC00020908	$169,000	$1,957,605	Yes	2023/24
NTSMRE4B	NO2 TRANSFORMER 66KV CB BAY	CT-EC00007956 CT -EC00007986 CT-EC00008076	$154,000	$1,193,571	Yes	2023/24
NTSNB24F2	882 WEE WAA 66KV CB BAY	CT-EC00006855 CT -ETA1821 CT-ETA1822	$154,000	$204,362	No	2023/24
NTSNB24G2	878 BOGGABRI 66KV CB BAY	CT-EC00006871 CT -ETA1818 CT-ETA1819	$154,000	$217,540	No	2023/24
NTSNB24S	861 WALGETT 66KV FEEDER	CT-TG003863 CT -TG003864 CT-TG003865	$154,000	$601,497	Yes	2023/24

Bay	Bay Description	Equipment Number	Capex	NPV (Weighted)	ALARP	Optimal Timing
NTSNB24Z	NO3 66KV CAPACITOR	CT-EC00008287 CT -EC00008288 CT-EC00008289	$154,000	$211,854	Yes	2023/24
NTSTTF2A2	NO1 TRANSFORMER 132KV TRANSFORMER BAY	CT-A08114/1 CT -A08115/1	$144,000	$177,123	No	2023/24
SWSALB2B1	NO2 TRANSFORMER 132KV CB BAY	CT-EC00010059 CT -EC00010100 CT-EC00010117	$169,000	$2,443,294	Yes	2023/24
SWSALB2C1	NO3 TRANSFORMER 132KV CB BAY	CT-EC00005993 CT -EC00009349 CT-EC00010070	$169,000	$168,064	No	2023/24
SWSBKH7U	NO4 22KV CAPACITOR BAY	CT-EC00017699	$104,000	$212,637	No	2023/24
SWSDN24H	NO1 CAPACITOR 66KV BAY	CT-EC00008025 CT -EC00008062 CT-EC00008074	$154,000	$202,814	No	2023/24
SWSDN28A1	NO1 11KV/415V AUX TRANSFORMER BAY	CT-EC00016070 CT -EC00016071 CT-EC00016072	$154,000	$449,653	Yes	2023/24
SWSDNT2G	NO1 CAPACITOR 132KV	CT-EC00002644 CT -EC00005851 CT-EC00005863	$169,000	$1,398,963	Yes	2023/24
SWSWG12U	996 A.N.M. 132KV FEEDER BAY	CT-A07111/1 CT -A07111/2 CT-A07111/3	$169,000	$1,212,092	Yes	2023/24
SWSWG22H	NO1-2 132KV B BUS SECTION	CT-EC00023514 CT -EC00023518 CT-EC00023507	$169,000	$278,094	Yes	2023/24
SYSCA12B	NO2 TRANSFORMER 132KV B BUS CB BAY :	CT-A06575/1 CT -A06575/2 CT-A06575/3	$169,000	$350,578	Yes	2023/24
SYSMRNCFB	4 COLLECTOR WIND FARM 330KV CB BAY	CT-EC00022845 CT -EC00022859	$195,000	$4,652,733	Yes	2023/24
SYSMRNCGB	8 DAPTO 330KV CB BAY	CT-EC00022848 CT -EC00022853 CT-EC00022857	$220,000	$7,206,313	Yes	2023/24
SYSMRU4J	66KV BUS SECTION CB BAY	CT-ETA9223 CT -ETA9224 CT-ETA9225	$154,000	$1,860,082	Yes	2023/24
Total	**47 Projects**		**$7,959,000**			