Investment Evaluation Summary (IES)

Project Details:

Project Name:	Boyer T13 & T14 supply transformers - replacement
Project ID:	01698
Business Segment:	Transmission
Thread:	Transmission Substations
CAPEX/OPEX:	CAPEX
Service Classification:	Prescribed
Scope Type:	D
Work Category Code:	RENSB
Work Category Description:	Substations
Preferred Option Description:	Replace existing Boyer supply transformers (BY-T13 and BY-T14) in the 2019-24 regulatory period.
Preferred Option Estimate (Dollars $2016/2017):	$5,357,028

	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29
Unit ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Volume	0.00	0.00	0.00	0.05	0.65	0.30	0.00	0.00	0.00	0.00
Estimate ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total ($)	$0	$0	$0	$267,851	$3,482,068	$1,607,108	$0	$0	$0	$0

Governance:

Works Initiator:	Michael Verrier	Date:	04/11/2018
Team Leader Endorsed:	Darryl Munro	Date:	06/11/2018
Leader Endorsed:	Nicole Eastoe	Date:	20/11/2018
General Manager Approved:	Wayne Tucker	Date:	22/11/2018

Related Documents:

Description	URL
Boyer T13 and t14 Condition Assessment report	http://reclink/R0000344974
NPV analysis	http://reclink /R0001198240#NPV_V3_Boyer_T13_T14_TXs.xlsm
Power Transformers AMP	http://reclink/R0000032667
Estimate L1 for new transformers	http://reclink/R0000681175
National Electricity Rules (NER)	http://www.aemc.gov.au/Energy-Rules/National-electricity-rules/Current-Rules
TasNetworks Business Plan 2017-18	http://reclink/R0000779008
TasNetworks Risk Management Framework	http://Reclink/R0000238142
TasNetworks Transformation Roadmap 2025	http://Reclink/R0000764285
TasNetworks Corporate Plan - Planning period: 2017-18	http://reclink/R0000745475
Power Transformer movement details	http://reclink/R0000279578

Section 1 (Gated Investment Step 1)

1. Overview

1.1 Background

Boyer Substation supplies a single major industrial customer. Boyer transformers BY-T13 and BY-T14 are critical assets at this substation.

Transformers BY-T13 and BY-T14 at Boyer Substation are manufactured by Tyree with dual secondary windings each of 31.5 MVA (total 63 MVA). The units operate at 110/6.6-6.6 kV. The units were manufactured in 1988 and have been installed and in operation at Boyer Substation ever since.

The dual secondary windings of BY-T13 and BY-T14 are cross connected across four 6.6 kV busbars. The busbars supply a total load of 86 MVA within the Norske Skog plant.

These units are operating approximately 70 per cent of the name plate rating for most of the year. In the event that one transformer is removed from service the in-service transformer runs at full rating with some reduction of load from the customer due to the limited transformer capacity.

The solid insulation deteriorates at a faster rate when operating continuously at higher temperature and the 45 years design life as defined by Sinclair Knight Merz cannot be expected as reported by SKM in its Asset Valuation for Financial Reporting Purposes prepared in July 2013.

1.2 Investment Need

The customer is one of TasNetworks top 4 major Industrial customers and is dependant on a reliable and secure supply from Boyer Substation.

Renewal drivers

1.2.1 Design

Transformers BY-T13 and BY-T14 at Boyer Substation are manufactured by Tyree with dual secondary windings each of 31.5 MVA (total 63 MVA). The units operate at 110/6.6-6.6 kV. The units were manufactured in 1988.

The units are each 29 years old and has not yet reached their economic life based on Sinclair Knight Mertz "*Assessment of Proposed Regulatory Asset Lives* " report prepared in August 2013 (R192773), which specifies that the economic life of a transformer is 45 years.

TasNetworks Power Transforner AMP aligns to this Sinclair Knight Mertz report and specifies that the economic life of a transformer is 45 years and service life up to 60 years. Replacement of Boyer supply transformers BY-T13 and BY-T14 is proposed earlier than is typically expected due to their higher service duty resulting from an industrial load and accelerated declining asset condition.

1.2.2 Condition

The condition assessment report produced for BY-T3 and T14 was based on key asset management considerations, including technical, design, reliability, condition, maintenance history and requirements, safety and environment issues.

The report has identified that BY-T3 and T14 transformers:

- are critical to the security of electricity supply to the customer connected at Boyer Substation;
- have been in service for 29 years with no major failures reported to date;
- are in acceptable physical condition as oil leaks repaired when opportunity arises;
- are showing signs of gradual paper degradation which is evident by the increase in furan levels from 0.0 ppm to 0.310 ppm for T13 from 1998 to 2015, respectively, and 0.01 ppm to 0.906 ppm for T14 from 2005 to 2015, respectively, based on oil analysis;
- have marginal interfacial tension which indicates the presence of contamination;
- have marginal oil quality index which indicates the beginning of sludge formation inside the tank.

It is noted that the transformers at Boyer Substation are the most heavily loaded in the Network and as such are expected to age at a faster rate that those at other substations. It is also noted that the degree of polymisation of the insulating paper iis deteriorating at a rate faster than onther supply transformers in the network potentially necessitating replacement before economic life is achieved.

It is noted in the CIGRE technical bulletin "Transformer Reliability Survey", prepared by working group A2.37 and published in December 2015 that the major contributors for transformer failures are related to winding, bushings and tap changers.

1.2.3 Condition based risk management (CBRM)

A CBRM assessment has been undertaken as the degree of polymerization of the paper insulation values are trending low and disolved gas analysis results showing issues with arcing and heating.

1.2.4 Defects records

With reference to TasNetworks defects register, there have been 29 defects recorded for BY-T13 and T14 between 2003 and 2017. The majority of defects have been related to oil leaks.

1.2.5 Alignment to asset management plan

The Power Transformer Asset Management Plan (AMP) highlights that to maintain or improve present levels of risk and fault performance in the fleet is for a targeted intervention replacement regime to be utilised. This regime also aligns with an ongoing replacement of approximately 1.6 per cent of the asset population per annum. Replacement of the BY-T13 and BY-T14 aligns with this philosophy.

1.3 Customer Needs or Impact

TasNetworks continues to undertake consumer engagement as part of business as usual and through the voice of the customer program. This engagement seeks in depth feedback on specific issues relating to:

- How it prices impact on its services;
- Current and future consumer energy use;
- Outage experiences (frequency and duration) and expectations;
- Communication expectations;
- STPIS expectations (reliability standards and incentive payments); and
- Increasing understanding of the electricity industry and TasNetworks.

Consumers have identified safety, restoration of faults/emergencies and supply reliability as the highest performing services offered by TasNetworks.

Consumers also identified that into the future they believe that affordability, green, communicative, innovative, efficient and reliable services must be provided by TasNetworks.

This project specifically addresses the requirements of consumers in the areas of safety and supply reliability.

1.4 Regulatory Considerations

This project is required to achieve the following capital expenditure objectives in alignment with NER 6A.6.7 (Transmission) as outlined in table 1.

Table 1 Capital expenditure objectives relevant to this project.

This project is required to achieve the following capital expenditure objectives:	Yes/No
• Meet or manage the expected demand for prescribed services.	Yes
• Comply with all applicable regulatory obligations associated with the provision of prescribed services.	Yes
• Maintain the quality, reliability and security of supply of prescribed services.	Yes
• Maintain the reliability and security of the system through the supply of prescribed services.	Yes
• Maintain the safety of the system through the supply of prescribed services.	Yes

2. Project Objectives

Replace exisiting Boyer supply transformers (BY-T13 and BY-T14)

The objective of this proposal is to replace exisiting Boyer supply transformers (BY-T13 and BY-T14) to:

- Contribute to the achievement of the capital expenditure objectives identified in the NER;
- Provide a safe, secure and reliable electricity supply to the major industrial customer connected to Boyer Substation by replacing assets that are in poor condition;
- Achieve life-cycle cost savings due to reduced operations and maintenance requirements; and
- Align with strategic asset management plans.

3. Strategic Alignment

3.1 Business Objectives

Strategic and operational performance objectives relevant to this project are derived from TasNetworks 2017-18 Corporate Plan, approved by the Board in 2017.

This project is relevant to the following areas of the corporate plan:

- We understand our customers by making them central to all we do;
- We enable our people to deliver value; and
- We manage our assets to deliver safe and reliable services while transforming our business.

3.2 Business Initiatives

The business initiatives reflected in TasNetworks Transformation Roadmap 2025 publication (June 2017) for transition to the future that have synergy with this project are as follows:

- Network and operations productivity: We'll improve how we deliver the field works program, continue to seek cost savings and use productivity targets to drive our business;
- Electricity and telecoms network capability: To meet your energy needs and ensure power system security, we'll invest in the network to make sure it stays in good condition, even while the system grows more complex;
- Predictable and sustainable pricing: To deliver the lowest sustainable prices, we'll transition our pricing to better reflect the way you produce and use electricity; and
- Enabling and harnessing new technologies and services: By investing in technology and customer service, we'll be better able to host the technologies you're embracing.

4. Current Risk Evaluation

The qualitative risk evaluation summarised in section 4.1 below shows the untreated risk associated with a do nothing option. It equates to a worst case scenario of inherent risk associated with a particular asset. A lower level of likelihood and / or consequence may be applied as part of the sensitivity analysis when calculating the total risk cost as part of the quantitative options analysis.

4.1 5x5 Risk Matrix

TasNetworks' business risks are analysed utilising the 5x5 corporate risk matrix, as outlined in TasNetworks Risk Management Framework.

Relevant strategic business risk factors that apply are as follows:

Risk Category	Risk	Likelihood	Consequence	Risk Rating
Customer	Material supply interuption to major industrial customer. Failure in service will result in station not being firm for an extended period until system spare installed.	Unlikely	Moderate	Medium
Environment and Community	Environmental remediation work. No impact beyond Tasnetworks area.	Unlikely	Minor	Low

Financial	Moderate financial impact. Asset has been identified as exceeded expected life and if fails in service will result in un-intended costs to the business in excess of what would be expected for a controlled CAPEX spend.	Unlikely	Moderate	Medium
Network Performance	Localised supply interuption to major industrial customer. Failure in service will result in station not being firm for an extended period until system spare installed.	Unlikely	Moderate	Medium
Regulatory Compliance	No potential to damage relationship with regulator and any breach managed internally.	Unlikely	Minor	Low
Reputation	Some local media attention.	Unlikely	Minor	Low
Safety and People	Risk of injury dependant on asset failure mode and potential industrial action for not adequately maintaining asset. Existing aged assets exhibiting external signs of degradation which introduces risk of failure.	Rare	Severe	Medium

Section 2 (Gated Investment Step 2)

5. Preferred Option:

The preferred option is to replace the existing aged and poor condition supply transformers BY-T13 and BY-T14 at Boyer Substation.

5.1 Scope

Replace exisiting Boyer supply transformers (BY-T13 and BY-T14) due to asset condition. Replace with custom 110/6.6 kV units.

5.2 Expected outcomes and benefits

The outcomes and benefits that are expected to be delivered include:

1. Security and reliability of supply maintained for Major Industrial customer;
2. Adherance to regulatory considerations; and
3. Identified key business risks are addressed.

5.3 Regulatory Test

Not Applicable.

6. Options Analysis

Completion of options analysis has been undertaken using a modified Net Present Value (NPV) tool, to include Risk Cost. Risk Cost represents the expected annual cost of risk events ($ million) associated with the failure of asset. The business as usual case (BAU) base case definition applied in the options analysis is aligned to Australian Energy Regulator (AER) repex planning guideline. The NPV outcomes for all options considered, is relative to the BAU base case. The NPV tool has also been modified to include a Basis of Preparation. This enables increased transparency of the methodology and analysis undertaken, outlining methodology, key inputs, key assumptions. The Risk Cost methodology is represented as below:

Annual asset risk cost = Probability of Asset Failure (PoF) * Asset units (No) * Likelihood of Consequence of Failure (LoC) * Cost of Consequence (CoC).

The analysis of all options is aligned with the Australian Energy Regulators application note for asset replacement planning, to ensure alignment of our approach. The risk cost categories, likelihood and consequence ratings are aligned with TasNetworks Corporate Risk Framework. The categories can also be mapped to the AER's repex planning guideline

AON, TasNetworks corporate insurer provided Cost of Consequence (CoC) and Likelihood of Consequence (LoC)

data. We have also analysed our assets and sought additional benchmarked data to develop Likelihood of Failure, Likelihood of Consequence and Cost of Consequence when it can be obtained.

The replacement of Boyer Substation transformers BY-T13 and BY-T14 with new transformer (75MVA) in revenue reset period 2019-2024, option 1, is the preferred option. This is the most approriate solution to address the project requirements and has the highest NPV outcome. Replacing with new Supply Transformers is the preferred outcome to provide for best whole of life and supply reliability and security requirements and is the most positive NPV economically.

6.1 Option Summary

Option description	
Option 0	Do nothing and replace on failure.
Option 1 (preferred)	Replace existing Boyer supply transformers (BY-T13 and BY-T14) in the 2019-24 regulatory period.
Option 2	Defer replacement of existing Boyer supply transformers (BY-T13 and BY-T14) until the following 2025-29 regulatory period.
Option 3	Staggered replacement of existing Boyer supply transformers BY-T13 in the 2019-24 regulatory period and BY-T14 in the 2024-29 regulatory period.

6.2 Summary of Drivers

Option	
Option 0	Do nothing and replace on failure. Retain exisiting transformers and review need to increase the maintenance practice frequency. Scope The proposed scope for this option includes: • Maintaining transformer BY-T13 and BY-14 and run to failure. Benefits The benefits for this option are: • No capital expenditure. Drawbacks The drawbacks for this option are: • Higher operational costs; • Adverse impact on transformer availability due to extended and more frequent outage requirements; • increased likelihood of transformer failure; and • Reactive replacement.

Option 1 (preferred)	Replace transformers with new unit in revenue reset 2019-2024 This option includes the replacement of the existing BY-T13 and BY-T14 transformers with new 75 MVA transformers. This option addresses all the condition issues associated with this transformer. Scope The proposed scope for this option includes: • Replacement of transformer BY-T13 and BY-T14 in 2019-2024 revenue reset period. Benefits The benefits for this option are: • Most positive economical outcome from NPV analysis including monetised risk; • Replacement of transformer in declining condition; • Mitigates against a failure of BY-T13 or T14; • Reduction in maintenance costs; and • Planned replacement. Drawbacks The drawbacks for this option are: • High capital cost.
Option 2	Replace transformers with new unit in revenue reset 2024-2029 This option includes the replacement of the existing BY-T13 and BY-T14 transformers with new 75 MVA transformers. This option addresses all the condition issues associated with this transformer. Scope The proposed scope for this option includes: • Replacement of transformers BY-T13 and BY-T14 in 2024-2029 revenue reset period. Benefits The benefits for this option are: • Deferred capital expenditure on replacement of transformers in declining condition. Drawbacks The drawbacks for this option are: • High capital cost;

	• Increased maintenance cost; and • Continue with higher risk of failure as opposed to if new transformer.
Option 3	Staggered replacement of transformers with new units in revenue resets 2019-2024 and 2024-2029 This option includes the replacement of the existing BY-T13 and BY-T14 transformers with new 75 MVA transformers. This option addresses all the condition issues associated with this transformer. Scope The proposed scope for this option includes: • Replacement of transformers BY-T13 in 2019-2024 revenue reset period; and • Replacement of transformers BY-T14 in 2024-2029 revenue reset period. Benefits The benefits for this option are: • Deferred some capital expenditure on replacement of transformer in declining condition. Drawbacks The drawbacks for this option are: • Higher capital cost; • Inefficient use of project resources; • Increased maintenance cost for remaining unit; and • Continue with higher risk of failure compared to replacing both with new transformers.

6.3 Summary of Costs

Option	Total Cost ($)
Option 0	$0
Option 1 (preferred)	$5,357,028
Option 2	$5,357,028
Option 3	$5,815,257

6.4 Summary of Risk

Option 0: Do Nothing and replace on failure.

Identified risks predominately to customers, financial, network performance and safety increase further over time as the asset condition deteriorates further.

Option 1: Replace existing Boyer supply transformers (BY-T13 and BY-T14) in the 2019-24 regulatory period

Reliability of supply maintained for the long term. Risks to customer, financial, Network performance and safety reduced to 'Low'.

Option 2: Defer replacement of existing Boyer supply transformers (BY-T13 and BY-T14) until the following 2025-29 regulatory period.

The deferment of the replacement would result in an increased exposure to a failure.

With the asset failure likelihood increasing due to condition degradation, the risks to customers, financial, network performance and safety continue as per do nothing option for greater period of time.

Option 3: Staggered replacement of transformers with new units in revenue resets 2019-2024 and 2024-2029

The deferment of the replacement of one transformer would result in continued increased exposure to a failure on the remaining transformer until it is replaced.

With the asset failure likelihood increasing due to condition degradation, the risks to customers, financial, network performance and safety continue as per do nothing option for greater period of time.

6.5 Economic analysis

Option	Description	NPV
Option 0	Do nothing and replace on failure.	-$17,644,576
Option 1 (preferred)	Replace existing Boyer supply transformers (BY-T13 and BY-T14) in the 2019-24 regulatory period.	$5,732,178
Option 2	Defer replacement of existing Boyer supply transformers (BY-T13 and BY-T14) until the following 2025-29 regulatory period.	-$1,237,234
Option 3	Staggered replacement of existing Boyer supply transformers BY-T13 in the 2019-24 regulatory period and BY-T14 in the 2024-29 regulatory period.	-$463,604

6.5.1 Quantitative Risk Analysis

A quantitative risk analysis has been completed including the cost of risk as described in section 6 above. The most positive option has been selected as the preferred option.

As well a quantitative risk analysis was completed using TasNetworks CBRM tool. The CBRM tool was used to identify the highest risk and prioriity power transformers in TasNetworks fleet. The results highlighted the expected end of life period and associated risk to the network. BY-T13 and BY-T14 were identifed as two of several transformers approaching end of life.

6.5.2 Benchmarking

TasNetworks participates in various formal benchmarking forums with the aim to benchmark asset management practices against international and national transmission companies. Key benchmarking forums include:

- International Transmission Operations & Maintenance Study (ITOMS); and
- Transmission survey, which provides information to the Electricity Supply Association of Australia (ESAA) for its annual Electricity Gas Australia report.

In addition, TasNetworks works closely with transmission companies in other key industry forums, such as CIGRE (International Council on Large Electric Systems), to compare asset management practices and performance.

ITOMS provides a means to benchmark asset class averages (maintenance cost & service levels) between related utilities from around the world. There is a strong need to ensure capital expenditure, maintenance processes and procedures are continually reviewed to ensure optimum financial and service benefits and minimal fault outages.

The completion of this project is expected to ensure TasNetworks continues to meet it benchmarking obligations and any improvement initiatives related to those benchmarking results.

6.5.3 Expert findings

Not Applicable.

6.5.4 Assumptions

New transformers rating to be reviewed but for now assumed to be 75 MVA.

Project work assumption includes that along with new transformers some work may be required on exisiting bund and oil containment, Transformer bay switchgear and conductors and protection.

Unserved energy and/or network penalties used in NPV:

1. Use average energy through line or transformer;
2. Apply failure rate, typically for transmission transformer assets assume to be 0.5 per cent for aged and one tenth of this or 0.05 per cent for new.