Investment Evaluation Summary (IES)

Project Details:

Project Name:	Replacement of High Voltage Switchgear in Ground Mounted Distribution Substations - Oil-Filled
Project ID:	00704
Thread:	Ground Mounted Substations
CAPEX/OPEX:	CAPEX
Service Classification:	Standard Control
Scope Type:	A
Work Category Code:	REHSW
Work Category Description:	Replace Ground Mtd HV Switchgear
Preferred Option Description:	Increased replacement of asset type with identified risks to a manageable level
Preferred Option Estimate (Nominal Dollars):	$10,640,000

	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Unit ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Volume	7	7	7	5	5	5	5	5	5	5
Estimate ($)										
Total ($)	$1,330,000	$1,330,000	$1,330,000	$950,000	$950,000	$950,000	$950,000	$950,000	$950,000	$950,000

Governance:

Project Initiator:	Michael Healy	**Date:**	27/03/2015
Thread Approved:	David Ellis	**Date:**	02/11/2015
Project Approver:	David Ellis	**Date:**	02/11/2015

Document Details:

Version Number:	1

Related Documents:

Description	URL
REGMS and REHSW replacement strategy	http://projectzone.tnad.tasnetworks.com.au/business-projects/nis-program/DD17SAM/Deliverables/Ground%20Mounted%20Substations/Ground%20MTD%20Subs%20Supporting%20Documents/REGMS_%2B_REHSW_Replacement_Strategy_Spreadsheet.xlsx

Section 1 (Gated Investment Step 1)

1. Background

TasNetworks owns and maintains 1892 high voltage ground mounted distribution substations on its network. These substations comprise the following construction types:

- Fence type
- Steel or fibreglass padmount (kiosk)
- Brick kiosk
- Building
- Vault integrated

Within these substations there are approximately twenty different makes and models of high voltage switchgear. The substations are supplied at both 11kV and 22 kV and range in size from 300kVA to 4500kVA.

These substations are actively managed and receive routine inspections and maintenance to maximise their service life. Many older substations were installed in the early 1960's and are near the end of their service life.

1.1 Investment Need

Failure of the assets within the substations, particularly the high voltage switchgear network can result in significant disruption of supply has the potential to cause harm to both operational staff and the public.

To manage these risks, the assets at the substations are replaced prior to asset failure occurs. Asset replacement would consist of only the replacement of the high voltage switchgear.

The majority of the substations installed prior to 1990 use oil as the insulating medium in the high voltage switchgear. This type of switchgear is used at 245 of the older ground mounted substations. If failure occurs it presents a greater risk than other types of switchgear because the oil can become a fuel source making failures more dangerous for both operational personnel and operators and the public.

Eight of the last ten high voltage switchgear failures on the network were with switchgear that contained oil filled circuit breakers. In each instance the switchgear has been in service for more than 50 years.

To manage this risk an asset replacement program for oil filled switchgear was initiated in 2010. Even though this type of switchgear has been proactively managed it still presents a significant risk to the business due to the significant amount of it still remaining on the network.

Other non-oil filled switchgear that poses a notable safety and performance risk due to poor design or condition is also being actively replaced.

The risks attributed to the concerning failure modes of the switchgear types are briefly detailed below.

- Oil-filled switchgear in fence and padmount type substations due to catastrophic failure poses a safety risk to the public due to exposure;
- Oil-filled switchgear in enclosures having a high risk of catastrophic failure and oil fuelling a substation fire;
- Gas insulated units having operating restrictions due to operational safety issues, this is due to single phase switching under fault conditions;
- Gas insulated units having insulation failure and subsequent flashovers due to a poorly designed epoxy spout.

Figure 1 shows the consequences of a switchgear termination failure. The cable terminations are made from cast iron and the insulation medium is pitch/tar. The failed components, which was disseminated throughout the chain fence enclosure due to an internal fault.

Figure 1 - Recent Reyrolle JKSS switchgear with cast iron pitch filled cable terminations failure - 2014

In early 2015 a high voltage switchgear failure in a substation in Perth, Western Australia resulted in two fatalities. TasNetworks has similar equipment to that which failed on its network. As an interim measure to manage the safety risk it has imposed a live switching ban on similar types of switchgear. This unfortunate example shows that these types of switchgear have potential for serious injury or death under fault and that asset replacement must be a priority.

As the oil-filled switchgear in the network presents a safety risk for operators and the public due to catastrophic failure being potentially life threatening. The high safety risk makes the replacement program of oil-filled switchgear a high priority for TasNetworks.

To address the risk complete replacement of only the high voltage switchgear would occur, with the program predominantly targeting the high voltage switchgear installed in building type substations.

Figure 2 – English Electric oil filled switchgear.

The switchgear types targeted by this program are :

- English Electric OLX\;
- Reyrolle LMT;
- Reyrolle JK/JKSS switchgear; and
- Statter.

The forcast rate of replacment is provided in figure 3

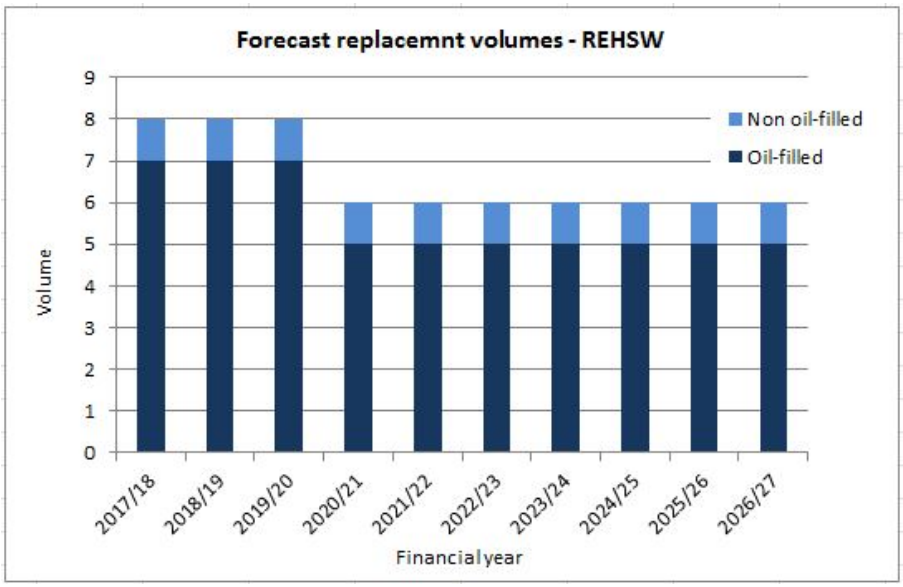

Figure 3: Forecast rate of replacement for HV switchgear

1.2 Customer Needs or Impact

TasNetworks continues to undertake a 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) • Increase

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, restoration of faults/emergencies and supply reliability

1.3 Regulatory Considerations

This project is required to achieve the following capital and operational expenditure objectives as described by the National Electricity Rules section 6.5.7(a) and 6.5.6(a). 6.5.7 (a) Forecast capital expenditure (2) comply with all applicable regulatory obligations or requirements associated with the provision of standard control services; (4) Maintain the safety of the distribution system through the supply of standard control services.

2. Project Objectives

The objective is to replace oil-filled high voltage switchgear to minimise safety risks to operational personnel and the public, and to ensure the current network performance levels are maintained.

3. Strategic Alignment

3.1 Business Objectives

The Asset Management Strategic Objectives are:

- Minimise the cost of asset management to a sustainable level
- No significant safety or environmental incidents.
- Maintain risk such that the residual risk level for all assets risks is “as low as reasonable practical” taking into consideration any expressed or implied duty of care.
- Achieve compliance with relevant legislative, regulative statutory requirements.

3.2 Business Initiatives

Strategic and operational performance objectives relevant to this project are derived from TasNetworks 2014 Corporate Plan, approved by the board in 2014. This project is relevant to the following areas of the corporate plan:

- We care for our assets, delivering safe and reliable networks services while transforming our business.
- Safety of our people and the community, while reliably providing network services, is fundamental to the TasNetworks business and remains our immediate priority

The strategic key performance indicators that will be impacted through undertaking this project are as follows:

- Prices for customers – lowest sustainable prices
- Zero harm – significant and reportable incidents
- Sustainable cost reduction – efficient operating and capital expenditure

4. Current Risk Evaluation

To do nothing will not address the safety risks concerning this type of switchgear, a do nothing approach would see assets run to failure, which with the assets catastrophic failure mode means a high operator and public safety risk. There is potential for the risk to increase to ‘Very High’ if the assets are run to failure.

To remain with the current replacement plan will lead to a network with an unmanageable age profile due to sites being erected at a much higher rate in the 1960’s. The lower rate of removal will mean that oil-filled switchgear inside of fence type substations will remain in the system exposing operators and the public to this risk for longer. The likelihood of catastrophic failure causing serious injury or fatality has potential to increase to ‘Possible’, this would result in the risk remaining at ‘High’.

Option 2 is for the switchgear to be replaced consistently for the entire period. It will decrease the public and operator risk from exposure due to the volume of replacement being larger than option 1 to reduce the age and condition profile. This plan coincides with REGMS to reduce the age profile of oil-filled switchgear. This option is forecasted to reduce the

risk to ‘Medium’ as the likelihood is reduced to ‘Rare’.

The business risk associated with these assets has been evaluated by using the TasNetworks Risk Framework.

The level of risk identified was such that a treatment plan is required to reduce the risk down to a manageable level.

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 follows:

Risk Category	Risk	Likelihood	Consequence	Risk Rating
Network Performance	Asset failure resulting in impact to network perfromance and loss of customer supply	Unlikely	Moderate	Medium
Safety and People	Failure of: • English Electric OLX & OLX2 switchgear • Reyrolle LMT switchgear • Reyrolle JK & JKSS switchgear that results in injury or multiple fatalities	Unlikely	Severe	High

Section 1 Approvals (Gated Investment Step 1)

Project Initiator:	Michael Healy	**Date:**	27/03/2015
Line Manager:		**Date:**	
Manager (Network Projects) **or** **Group/Business Manager (Non-network projects):**		**Date:**	
[Send this signed and endorsed summary to the Capital Works Program Coordinator.]			

Actions			
CWP Project Manager commenced initiation:		**Assigned CW Project Manager:**	
PI notified project initiation commenced:		**Actioned by:**	

Section 2 (Gated Investment Step 2)

5. Preferred Option:

The preferred option is to replace the oil filled switchgear that presents a high risk with new switchgear.

The oil-filled switchgear is going to be replaced at a higher rate than the others due to the safety higher safety implications whereas it is planned that the non oil-filled switchgear will be focused on more heavily during the next period.

Replacement would occur when the switchgear presents a significant business risk or has reached end of life. Based on historical experience the switchgear will reach end of life at approximately 50 years of age. The rate of replacement has been developed to achieve this target.

5.1 Scope

The scope is to replace oil-filled high voltage switchgear with new switchgear that contains vacuum circuit breakers.

A prioritised replacement of oil-filled switchgear will be undertaken based on the individual risk of each installation. The assessment of risk is done in accordance with TasNetworks' Risk Framework.

The replacement of a teh switchgear s usually driven by the risk associated with the increased probability of an asset failure occurring and the consequences of the failure e.g. safety risk to operational personnel and the public, network disruption and environmental impact.

Each substation identified for replacement is prioritised based on an assessment against the following criteria:

- Risk to safety i.e. level of exposure e.g. enclosure type, location
- Criticality of the installation
- Condition
- Compliance
- Age

The rate of replacement is as follows:

Financial year	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27
Volume	7	7	7	5	5	5	5	5	5	5

5.2 Expected outcomes and benefits

The benefits of this option are:

- Reduction in safety risk associated with switching from ‘high’ to a manageable level of ‘low’ in a timely manner.
- It maintains the reliability of the network as poor condition assets are replaced.
- Reduces the environmental risk from an oil-filled asset.
- Reduces OPEX expenditure.
- Align with TasNetworks risk framework.

5.3 Regulatory Test

Not applicable

6. Options Analysis

Option 0 is the most cost effective in terms of capital expenditure although there are much larger OPEX costs involved due to the reactive nature of the replacement plan compared to options 1 and 2.

Options 1 - Although the overall expenditure is less than the preferred option (Option 2), the delivery rate would not achieve the required reduction in safety risk.

Option 2 which is preferred has a consistent CAPEX expenditure profile that when combined with the non-oil filled switchgear program produces a consistent delivery rate. This option is the lowest cost option that reduces the safety risk down to a manageable level.

6.1 Option Summary

Option description	
Option 0	Do nothing
Option 1	Continue with the current replacement
Option 2 (preferred)	Increased replacement of asset type with identified risks to a manageable level

6.2 Summary of Drivers

Option	
Option 0	To do nothing will not address the safety risks concerning this type of switchgear, a do nothing approach would see assets run to failure, which with the assets present failure mode of exploding means a high operator and public safety risk.
Option 1	Replace high voltage switchgear with modern vacuum circuit breakers at the current level of replacement. Nominal replacement age of 50 whilst ensuring end of life is reached with condition monitoring. **Advantages** • Deferral of CAPEX • Consistent replacement volumes • Partially addresses safety risk **Disadvantages** • CAPEX required • Age profile will become unmanageable. This option does not fully address the risks previously identified in Section 4.
Option 2 (preferred)	Implement an increased replacement plan that aligns with REGMS replacement plans for a consistent decrease in the age profile of oil-filled switchgear, to reduce the safety risks to operators and the public. **Advantages** • Reduces safety risk to a manageable level • Shift from reactive to proactive • decrease in unplanned outages **Disadvantages** • Largest capital expenditure needed This is the lowest cost option to reduce the business risks to manageable.

6.3 Summary of Costs

Option	Total Cost ($)
Option 0	$1,700,000
Option 1	$8,640,000
Option 2 (preferred)	$10,640,000

6.4 Summary of Risk

If a replacement program did not occur the safety risk for this type of switchgear, with the asset left to run to failure. Letting the assets run to failure could result in catastrophic failures resulting a significant risk to operational personnel and the public.

Continuation of the current rate of replacement plan would led to a network with an unmanageable age profile; this is due to sites being erected at a much higher rate in the 1960's. The lower rate of removal of oil-filled switchgear in substations would result in this higher risk switchgear remaining on the network for an extended period, resulting in operational personnel and the public being exposed to the risk of failure for a longer time.

The preferred program of initially increasing the rate of replacement for 3 years from the 2017/18 financial year before reverting back to the current rate of replacement would reduce the risk to a manageable level and result in a rate of replacement that is achievable for the long term. This plan aligns with the high voltage substation replacement program (REGMS).

6.5 Economic analysis

Option	Description	NPV
Option 0	Do nothing	$0
Option 1	Continue with the current replacement	$0
Option 2 (preferred)	Increased replacement of asset type with identified risks to a manageable level	$0

6.5.1 Quantitative Risk Analysis

Nil

6.5.2 Benchmarking

Other DNSP's also have asset replacement programs for their high voltage switchgear to minimise the safety risk this type of equipment presents to the public and to also maintain network reliability.

6.5.3 Expert findings

Nil

6.5.4 Assumptions

Nil

Section 2 Approvals (Gated Investment Step 2)

Project Initiator:	Michael Healy	**Date:**	27/03/2015
Project Manager:		**Date:**	

Actions			
Submitted for CIRT review:		**Actioned by:**	
CIRT outcome:			