Investment Evaluation Summary (IES)

Project Details:

Project Name:	Replacement of HV Ground Mounted Distribution Substations - Non Oil-Filled
Project ID:	00703
Thread:	Ground Mounted Substations
CAPEX/OPEX:	CAPEX
Service Classification:	Standard Control
Scope Type:	A
Work Category Code:	REGMS
Work Category Description:	Replace Ground Mtd Sub
Preferred Option Description:	Consistent replacement strategy
Preferred Option Estimate (Nominal Dollars):	$14,300,000

	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Unit ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Volume	10	10	10	5	5	5	5	6	6	6
Estimate ($)										
Total ($)	$2,100,000	$2,100,000	$2,100,000	$1,050,000	$1,050,000	$1,050,000	$1,050,000	$1,260,000	$1,260,000	$1,260,000

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 can result in significant disruption of supply has the potential to cause harm to both operational personnel and the public.

To manage these risks, the assets at the substations are replaced prior to an asset failure occuring. The asset replacement could be either partial replacement, or complete replacement of the substation.

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 224 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. To address this switchgear a replacement program exists for substations that contain oil-filled switchgear.

Asset replacement of other types of switchgear is also necessary due to the switchgear being deemed to be at end of life due (poor condition) or due to operational deficiencies e.g. single phase switching under fault conditions. To address the risk complete replacement of the substation occurs.

Figure 1 shows the consequences of a HV switchgear failure that had the potential to cause harm.

Figure 1 - Epoxy spouts contained inside of RGB switchgear that has failed due to moisture and dust ingress

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.

Where the replacement of the substation is the most appropriate solution to address the risk of deficiency it is undertaken under the REGMS program.

The rate of replacement has been developed with target of removing high voltage switchgear from service prior to it reaching 50 years of age because the risk of failures greatly increase above this age..

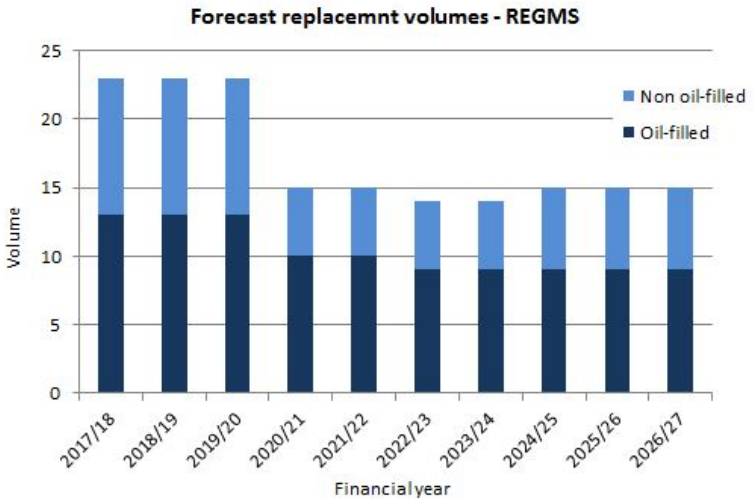

Figure 3 - Forecasted replacement volumes for REGMS split between oil and non-oil filled switchgear

Figure 3 shows the recommended REGMS replacement volumes for the 10 year period starting in 2017/18.

The replacement strategy is related to the REHSW replacement program as they are both targeting high risk 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/renew ground mounted substations containing oil-filled 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

The following section details the business risks specific to this project, as identified in TasNetworks Risk Management Framework. High voltage switchgear can fail catastrophically resulting in a significant safety risk to operators and the public is at risk. Due to multiple types of switchgear there are several drivers for this program.

The switchgear is installed in a variety of enclosures types and they are: chain wire fence, building, kiosk, padmount and vault types. The greatest risk to the public is from the switchgear installed in the chain wire fence type substations as they do not provide protection from fire and limited protection from projectiles.

The switchgear types replaced under this program consist of:

Hazemeyer MD4 switchgear

There are currently 80 substations on the network that contain Hazemeyer MD4 switchgear. They are typically contained inside of padmounts or building type substations. Operating restrictions were enforced on this type of switchgear in 2010 due to the risks of single phase switching under fault conditions presenting a high safety risk to operators. The Hazemeyer units also have a secondary issue of longer reconnect times for customers because the fault-finding operations taking longer due to the ban on live switching. This type of switchgear is only replaced where the risks deem it necessary.

Brown Boveri RGB24 switchgear

The design of these units allows dirt and moisture to build up in the epoxy spout at the rear of them, which over causes the failure of the insulation in the switchgear resulting in an flashover and failure of the unit. . As of April 2014 there were three recorded cases of this type of failure. There is also anecdotal evidence that there have been more that have failed in this manner. There are issues other than the ingress of moisture and dirt concerning these units and due to these faults an additional three incidents have occurred. The most recent being a cable failure inside the switchgear cubicle resulting in the loss of the switchgear.

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

Asset Name	Risk Category	Risk	Likelihood	Consequence	Risk Rating
Hazemeyer MD4	Safety	Injury or illness that results in multiple fatalities	Unlikely	Severe	**High**
Asea Brown Boveri RGB24	Network Performance	Localised interruption or minor quality of supply issue with temporary inconvenience or disruption	Likely	Minor	**Medium**

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	Asea Brown Boveri RGB24 Localised interruption or minor quality of supply issue with temporary inconvenience or disruption	Likely	Minor	Medium
Safety and People	Hazemeyer MD4 Injury or illness that results in 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 soultion is to replace switchgear types that present a significant business risk (Hazemeyer MD4 and Asea Brown Boveri RGB24) with padmounts substations that use modern vacuum circuit breakers.

The rate at which replacement will occur will initially be ten units per year, for three years. The volume will be reduced to five units per year to provide for steady replacement rates in the REHSW program. This is strategy is shown in figure 4. This approach will allow for strategic replacement, with critical units being replaced first, namely RGB24 and Hazemeyer.

This approach will improve operator safety and maintain network performance. Not proceeding with this option would result in an increase of unplanned failures and safety risk for operators.

5.1 Scope

The scope is to replace ground mounted substations containing oil-filled switchgear with new substations containing vacuum circuit breakers

A prioritised replacement of ground mounted substations will be undertaken based on the individual risk of each substation. The assessment of risk is done in accordance with TasNetworks' Risk Framework.

The replacement of a substation is usually driven by risk associated with the increased probability of an asset failure occurring, particularly the high voltage switchgear 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	2022/23	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27
Volume	10	10	10	5	5	5	5	6	6	6

5.2 Expected outcomes and benefits

The benefits of this option are:

- The safety aspects concerning the gas insulated switchgear are brought from ‘high’ to ‘low’ risk.
- Reduce the number of substations with operational restrictions
- Addresses the unplanned failures due to gas insulated switchgear
- Improve customer reconnect times.
- OPEX will be reduced.

5.3 Regulatory Test

Not applicable

6. Options Analysis

Estimate (in 14/15 dollars)											
Options	**17/18**	**18/19**	**19/20**	**20/21**	**21/22**	**22/23**	**23/24**	**24/25**	**25/26**	**26/27**	**Total**
Option 0	0.21m	0.21m	0.21m	0.21m	0.21m	0.21m	0.21m	0.21m	0.21m	0.20m	**2.10m**
Option 1	0.21m	0.00m	0.00m	0.63m	2.94m	1.47m	1.47m	4.62m	2.73m	1.89m	**16.0m**
Option 2	2.10m	2.10m	2.10m	1.05m	1.05m	1.05m	1.05m	1.26m	1.26m	1.26m	**14.3m**

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

Options 1 and 2 average 1.60m and 1.43m per annum respectively, option 1 fluctuates due to the inconsistency in the age profile. Option 2 which is preferred has a consistently constant CAPEX profile with a focus at the start of the period.

Option 2 aligns with oil-filled switchgear replacements so that delivery is consistent over the 10 year period.

6.1 Option Summary

Option description	
Option 0	Do nothing
Option 1	Continue with the current replacement strategy
Option 2 (preferred)	Consistent replacement strategy

6.2 Summary of Drivers

Option	
Option 0	There are 26 RGB24 units in the network as of 2014/15 and it is expected 8 will remain in 2017/18. The Hazemeyer switchgear is an operational safety issue that is currently being managed by operational restrictions and custom switching tools. To do nothing but maintain the network and let the units run to failure will increase the likelihood of failure due to worsening condition and pose a larger safety risk to operators. It will also increase the number of faults reducing the performance of the network.
Option 1	Replace ground mounted substations with modern padmounts at the current level of replacement. **Advantages** • Deferral of CAPEX • Consistent replacement volumes • Partially addresses safety risk • Partially address performance risk • Reduces the number of substations with operational restrictions **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 the REHSW program 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 • Reduces performance risk to a manageable level • Shift from unplanned to planned outages • Reduces the number of substations with operational restrictions • Reduced fluctuations in replacement volumes **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	$2,100,000
Option 1	$16,000,000
Option 2 (preferred)	$14,300,000

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 substations within fence type enclosures 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 5 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 switchgear replacement program (REHSW).

6.5 Economic analysis

Option	Description	NPV
Option 0	Do nothing	$0
Option 1	Continue with the current replacement strategy	$0
Option 2 (preferred)	Consistent replacement strategy	$0

6.5.1 Quantitative Risk Analysis

Not applicable

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:			