PowerWater

Power and Water Corporation

Preliminary Business Case – Category B

PRD33125

Replace Centre Yard Zone Substation

Proposed:

Jim McKay
A/Chief Engineer
Power Networks
Date: 6/2/2018

Approved:

Michael Thomson
Chief Executive & Chair
Investment Review Committee
Date: 23/02/2018

Endorsed:

Djuna Pollard
Executive General Manager
Power Networks
Date: 15/2/2018

Refer to email
D2018/72353

Finance Review
Date: 06/02/2018

Refer to email
D2018/59601

PMO QA
Date: 08/02/2018

1 RECOMMENDATION

It is recommended that the Chief Executive approve project PRD33125 Replace Centreyard Zone substation for an estimated cost of [redacted] and a corresponding completion date of June 2022.

Approval is sought for expenditure of up to $0.2M of the total forecast expenditure to undertake the necessary work to proceed to the next approval gateway (Business Case Approval), including:

- Site selection, site survey, geotechnical investigation and earth grid assessment for the new micro substation;
- Detailed design; and
- A competitive tender with a detailed cost estimate and a firm price.

Since the approval of the BNI, the cost estimate has been adjusted from [redacted] to reflect a more efficient design and corresponding reduced scope of works.

Furthermore it should be noted that the project has a 95% likelihood of being delivered between [redacted].

2 PROJECT SUMMARY

Project Title:	Replace Centre Yard Zone Substation		
Project No./Ref No:	PRD33125	**SAP Ref:**	
Anticipated Delivery Start Date:	Jul 2021	**Anticipated Delivery End Date:**	Jun 2022
Business Unit:	Power Networks		
Project Owner (GM):	Djuna Pollard	**Phone No:**	8985 8431
Contact Officer:	Peter Kwong	**Phone No:**	8924 5060
Date of Submission:	23/02/18	**File Ref No:**	D2017/394625
Submission Number:		**Priority Score:**	/100
Primary Driver:	Renewal	**Secondary Driver:**	Service Improvement
Project Classification:	Capital Category A		

2.1 Prior Approvals

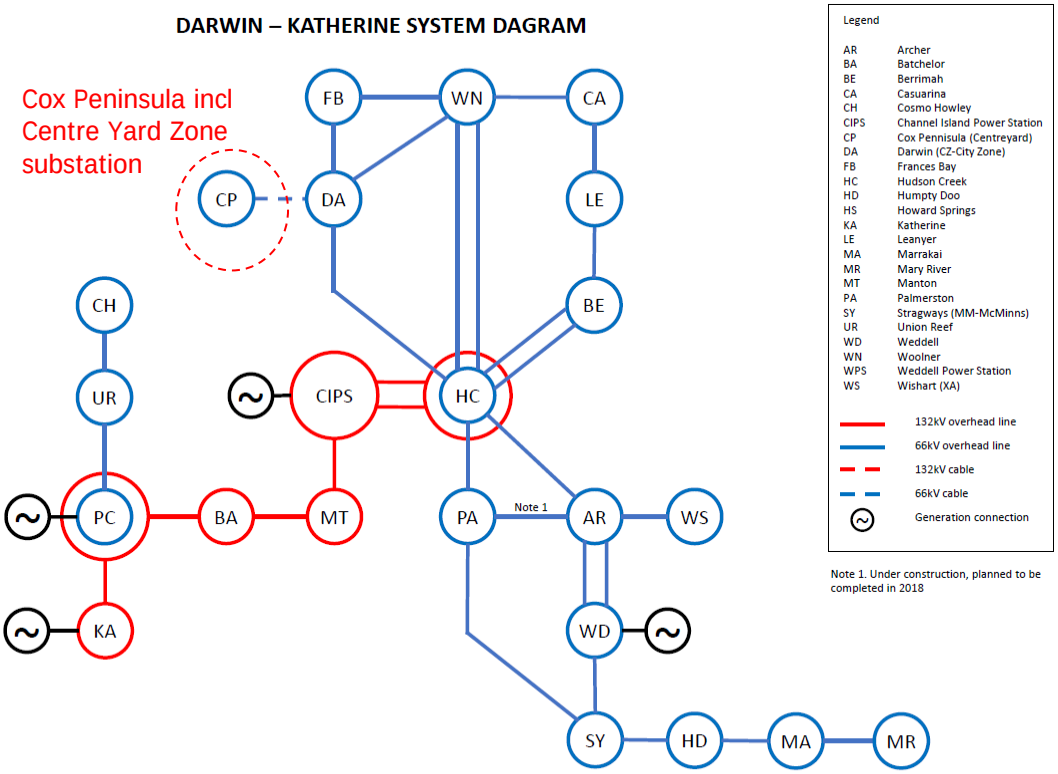
Document Type	Sub Number	Approved By	Date	Capex Value

3 INVESTMENT NEED

3.1 Background

Centre Yard Zone Substation is a 66/11kV 2x 0.5MVA rural substation located in Cox Peninsula. The substation is fed from Darwin Zone Substation by a 66kV undersea cable of approximately 8km in length, with sections of 66kV overhead line at each end.

Figure 1: System diagram



The Cox Peninsula system[1] consists of a 66/22kV 500kVA micro-sub[2] supplying the Charles point area connected to the 66kV subsea cable, with a tee-connection to the Centre Yard ZSS. In the event of failure of the subsea cable, the back-up supply to the Cox Peninsula is by diesel back-up connected to Centre Yard ZSS.

3.2 Asset details

Two 66kV submarine power cables supplying electricity across the sea bed of Darwin Harbour to Mandorah were originally laid in 1969. The risk of damage

[1] Refer to D2017/322674 – DIAG 13_Aug 2017

[2] Micro substation is a combined transformer / switchgear unit, with protection and controls usually mounted on a skid.

to the cables is high due to the active shipping across the cable route and strong tidal movements resulting high mechanical stresses. One of the cables failed in 1993 and was subsequently repaired.

In 2013, the second submarine cable failed, and it was not repaired due to the high likelihood of repeated failures in the longer term, lower loads in Mandorah, the high cost of specialised skills and the difficulty in assessing the final repair cost. It is estimated that the remaining cable still has a service life of between 10-15 years.

The Centre Yard Zone Substation consists of two Crompton 0.5MVA 66/11kV transformers connected to a single 66kV minimum oil circuit breaker.

The 66kV circuit breaker is an [redacted] unit with known failure modes.

3.3 Management strategy & investigation outcomes

Piecemeal replacement, and replacement on failure, has been undertaken to date as required.

Recent inspection reports have identified issues with continued operation of the power transformers at the site due to moisture levels in the paper insulation, significantly elevating the risk of failure. The 66kV switchgear is also assessed as being in poor condition and at high risk of failure and the secondary systems are obsolete, unsupported by the manufacturer, increasingly difficult to maintain, and have an increasing defect rate.

These items are discussed in further detail in the following section.

3.4 Current and emerging issues

3.4.1 Poor condition 66kV Switchgear

The 66kV circuit breaker is an [redacted] minimum oil unit manufactured in 1976 currently 41 years old. At the end of the next RCP (regulatory control period), the 66kV CB will be 48 years old. There is a history of operational issues with these breakers, especially failures associated with the operating arm.

Industry experience and the maintenance and test results for the PWC circuit breaker at Centre Yard indicates that even with regular maintenance the end-of-life for these assets is at about 40 years:

- This type of circuit breaker has a high failure rate within the electricity industry and PWC has previously experienced multiple failures with its other [redacted] circuit breakers[3];
- The circuit breaker at Centre Yard ZSS is an obsolete model and parts for the remaining units are sourced from old decommissioned circuit breakers. It incurs high maintenance costs due to oil leaks – oil must be drained and replaced regularly. In addition to the frequent oil leaks,

[3] Power and Water Asset Management Plan – Circuit Breakers

test results for the Centre Yard Circuit Breaker shows an increasing level of partial discharge, indicating progressive insulation breakdown.

The poor condition of this circuit breaker increases the risk of explosive failure, posing the risk of fatal injury to PWC personnel working within the substation. The 66 kV circuit breaker is scheduled for replacement within the next RCP.

3.4.2 Poor condition power transformers

The power transformers were manufactured in 1967. Test results from a recent asset condition report[4] indicate that the insulation is severely compromised, with high levels of moisture in the oil. Online tap-changers for both transformers are no longer functional due to anomalies associated with poor dynamic behaviour and drive/control mechanism issues.

Both transformers have had numerous oil leaks repaired at various points on the transformer, parts replaced, and water marks and other deposits removed from bushings.

By 2024, the transformers will be 57 years old. Industry experience is that the typical power transformer operating life is 45-50 years, depending on the operational history and other factors, with only a small percentage of transformers operating beyond 60 years.[5]

PWC has observed a strong correlation between the ageing of power transformers and its Degree of Polymerisation (DP). Ageing paper and reducing DP reduces the ability of the transformer to withstand transients and essentially will determine end of life for a transformer. DP values indicate the tensile strength of the paper is severely reduced; it would be prudent to plan for end of life and manage exposure to fault risk.

From the predictive modelling being developed by PWC as part of the power transformer asset (class) management plan, an effective asset age can be developed based on the measured DP values. Transformer 1 has a DP of approximately 176 and Transformer 2 has a DP of approximately 220. These values equate an effective life for Transformer 1 of 62 years, and for Transformer 2 of 60 years. At the end of the next RCP (2024), the effective life is likely to be increased to approximately 69 and 67 years respectively.

Whilst further maintenance practices will be undertaken to extend the life of these units, the test results for both transformers indicate the insulation is near its end-of-life. Based on common industry benchmarks, the transformers should be replaced within 3-5 years. Due to the low demand at this site and corresponding low criticality of this load the timing of replacement is required by the end of this timeframe.

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[4] Condition Assessment Report for Centre Yard Zone Substation

[5] Power and Water Asset Management Plan – Power Transformers

3.4.3 Secondary Systems

The protection relays are over 19 years old and are no longer supported. The SCADA system is also obsolete and the communications system is designed for low data rates and is incompatible with current SCADA and protection systems.

3.4.4 Control Building

The control building is a demountable type building and has not been refurbished or modified since the original commissioning of the substation. There is significant floor damage due to termites and it is a safety hazard for operational staff accessing the building.

3.5 Peak demand and capacity forecasts

AEMO's demand forecast for Centre Yard ZSS[6], projects a maximum demand of approximately 210kVA by 2024 [P50], well within the substation firm capacity of 500kVA. There are no identified demand-related drivers for this project.

The substation was established to supply a major customer and since that time the load has decreased significantly from 10MVA to less than 500kVA, for the supply to the local community in Mandorah.

The Network Management Plan (NMP) has confirmed an enduring need for electricity supply to customers in Mandorah, currently supplied from Centre yard substation.

3.6 Risk analysis

Figure 2 shows the current rating, inherent rating (in 2024, i.e. if no action is taken in the interim), and the residual (post-treatment) risk ratings associated with the condition of assets in the Centre Yard ZSS.

(i) *Current rating:* The Current rating (2017) is assessed to be 'High' due to the aggregate safety risk posed to PWC workers by the poor condition of the primary assets in Centre Yard ZSS. The probability of explosive failure of primary plant assets is rated as 'unlikely', but should such an event occur, the consequences could be serious injury to PWC operational personnel (or even a fatality).[7] There would also likely be adverse media attention and temporary disruption to electricity supply.

(ii) *Inherent rating:* If the poor condition assets are not replaced by 2022, the likelihood of explosive failure of primary plant is assessed to increase from 'unlikely' to 'likely'. As a lower criticality site, the number

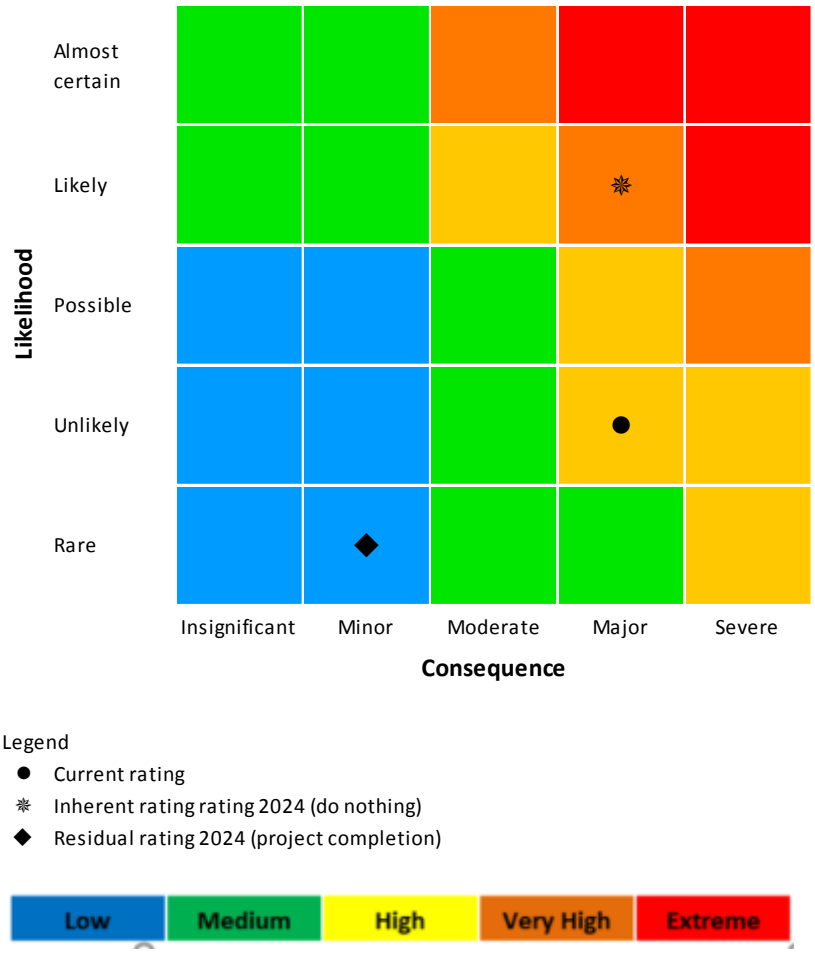
[6] AERReportForPWC_V3

[7] The 66kV circuit breakers, instrument transformers, and power transformer bushings all contain porcelain components which can explode, sending high velocity porcelain shards and oil into the immediate area around the equipment

and frequency of operational personnel onsite would not likely change, and a similar consequence level is incurred. There would likely be prolonged adverse media attention and temporary disruption to electricity supply. The inherent risk rating is therefore 'Very High'.

(iii) *Residual rating:* The proposed project will mitigate the poor condition assets through corrective maintenance. Given the change from a ZSS design to a micro-grid, the exposure level of personnel and the likelihood of explosive failure of primary plant will be reduced to 'rare', and the consequence level to minor. There would likely be adverse media attention and temporary disruption to electricity supply. The residual rating is therefore 'Low'.

Figure 2: Centre Yard ZSS risk assessment[8]



It is Power and Water's current practice to take action on risks that have an inherent rating of 'HIGH' or above. The PBC summarises the proposed response to this impending risk.

[8] Based on Power Network's Risk Assessment Guide

4 STRATEGIC ALIGNMENT

This project aligns with the Corporation's key result areas of operational performance and customer centricity, where the goals are to be an efficient provider of services and delivering on customers' expectations.

This project will allow PWC to safely and reliably meet current and future demands for the Cox Peninsula area.

5 TIMING CONSTRAINTS

The project will need to be completed by June 2022 to minimise the risk of interruptions to the supply to Cox Peninsula. Centre Yard Zone Substation is essential for the supply of power to the Mandorah area. It is difficult to predict the remaining life of the existing assets as catastrophic failure can be initiated by a transient external event, such as a through fault. These events are common on overhead networks exposed to the environment, such as trees on lines, lightning, etc.

Condition assessment indicates that the transformers and the 66kV circuit breaker have reached the end of life and should be replaced.

6 EXPECTED BENEFITS

Driver / Objective	Benefit	Current State	Future State
Safety	Reduced risk of injury (including fatality) from explosive failure of primary plant	Elevated level of personnel safety risk due to poor condition of a high proportion of primary assets	Risk of injury to personnel reduced to acceptable levels
Reliability	Increased reliability and reduced maintenance (inspection and repairs)	Risk of asset failure is very high and increasing maintenance costs	Risk of failure is low for new equipment and reduced maintenance costs

7 REQUIREMENTS

The solution selected must resolve the need to allow PWC to supply power to the Cox Peninsula area during credible contingency events and support reliability targets during unplanned events and planned maintenance activity. It is also preferable to minimise impact on existing operational capabilities at both sites during construction (i.e. maintain system security requirements).

PWC will also require compliance with the following:

- Northern Territory Electricity Reform Act;
- Power and Water's Network Licence as issued by the Utilities Commission, and;
- Network Planning Criteria and Electricity Networks (Third Party Access) Code.

8 OPTIONS

8.1 Options Development

A feasibility study considering various options for the Centre Yard Zone Substation Replacement[9] was conducted. This study has been drawn upon in the presentation of options below.

8.1.1 Option 1 – Base case

This option involves no proactive capital expenditure to replace assets assessed as being in poor condition at Centre Yard ZSS.

The advantage of this approach is deferment of capital expenditure to address risks associated with the poor asset condition at Centre Yard ZSS.

However, continuing to operate Centre Yard ZSS beyond 2021/22 is not considered prudent given the risks to personnel safety from explosive failure of the primary plant assets and the increasing risk of disruption to power supplies in case of unavailability of the transformer circuits. This risk will continue to increase with time as the equipment condition continues to deteriorate and the load at risk continues to grow.

The operational costs will also rise over time due to increasing number of planned and unplanned outages as the equipment reaches the end of operational life.

For the purpose of this assessment, it is likely that the transformers will fail in service and require replacement within a solution similar to Option 2 over the evaluation period. Following failure, the site will have reduced security whilst a transformer is procured. Extended supply outages may occur should both transformers, which are of a similar age and condition fail, as the site is not configured for connection of the Nomad transformer.

Option 1 is not considered to be technically or commercially viable.

8.1.2 Option 2 – Replacement of zone substation transformers

This option involves the replacement of the existing 66kV circuit breaker and transformers with new equivalents. The Nomad modular substation will be installed temporary to bypass the zone substation during the upgrade.

Replacement of 66kV CB and 1x transformer at an estimated cost of [redacted]

The scope of work includes:

- Replacement of the 66kV circuit breaker
- Replacement of 1x 500kVA transformer
- The existing transformer bund and oil containment systems will be upgraded to meeting current Australian Standards and environmental requirements.
- Construct a new Nomad connection in the spare transformer bay.

[9] Centre Yard ZSS Options Study Report, PWC Ref: D2017/548347

- The 11kV switchyard will remain unchanged and a 500 kVA generator will be permanently connected to the 11kV bus in case of failure of the remaining 66kV cable.

The advantage of this option is that it costs less than option 4, by utilising the Nomad connection, and more reasonably reflects the design for a small load.

The disadvantages of this option include:

(i) It assumes access to the Nomad substation; and

(ii) It reduces the substation supply to single transformer operation. A transformer failure will result in the transformer being isolated and the Nomad being used. It is expected that the interruption will last at least two days to allow for the initial response to the outage, mobilisation and commissioning of the Nomad. The Nomad may be in service for an extended period of time depending on the severity of the transformer fault; this may influence the reliability of the PWC network elsewhere, by restricting access to the Nomad substation.

8.1.3 Option 3 – Establish new 66/11KV substation

Estimated cost of this option is [redacted]. The scope of work includes:

- New 66/11kVA 0.5 MVA AIS ZSS adjacent to the existing zone substation, to current design standards;
- Retain existing 500KVA diesel genset; and
- Decommission Centre Yard ZSS.

It is planned that the Mandorah load will be connected to the rural 22kV network when the remaining 66KV undersea cable fails.

The advantage of this option is that it establishes a new modern zone substation, and upgrades other items of plant.

The disadvantages of this option include:

(i) Maintains a ZSS design for a small load, which is likely to provide a higher level of security than required and incur higher maintenance costs;

(ii) Likely to be a more expensive option.

8.1.4 Option 4 – Establish New Micro Substation (Preferred Option)

Estimated base cost of this option is [redacted]. The scope of work includes:

- Establish new 66/22kV 0.5 MVA micro substation;
- Connection for a Nomad substation;
- Retain existing 500KVA diesel genset; and
- Decommission Centre Yard ZSS.

The advantage of this option is that it establishes a new simplified supply arrangement at a lower cost, commensurate with the level of security required for the area, similar to supply options already present in the Cox Peninsula. It will also provide network flexibility if there are significant load growth in the area in the future.

The disadvantages of this option include:

(i) Assume access to the Nomad substation; and

(ii) It would be a non-standard design in the PWC network, and new spares will need to be procured.

8.1.5 Option 5 – Connect Mandorah distribution system to existing rural 22kV network

This option would involve extending the current 22kV rural distribution network to service the Mandorah area. The nearest 22kV feeder is Dundee Beach and it will require a tee-off at switch 380 along Cox Peninsula road. The new distribution line extension will be approximately 21 km.

As the existing distribution system is 11kV, it will require the distribution transformers to be upgraded to 22/0.415 kV. The existing insulators are already rated for 22kV and do not required replacement. The existing Centre Yard Zone Substation and 66KV undersea cable can then be decommissioned.

This option was reviewed in detail in a 2013 planning report[10] and has an estimated cost of [redacted].

The advantage of this option is that it provides for decommissioning of Centre Yard ZSS, and potential failure modes associated with primary plant and associated costs to maintain.

The disadvantages of this option include:

(i) Relies on the overhead distribution network to provide back-up supply to all loads in the Cox Peninsula; and

(ii) It will limit the supply capacity into the area as the existing 22kV feeder is very long and also supplies the Dundee Beach area.

8.1.6 Option 6 - Replace 66kV subsea cable

This option was reviewed in the options study, to supply and install a replacement 66kV subsea cable to supply the Cox Peninsula at an estimated cost of [redacted] (2013). The option study concluded that the option did not meet the required planning criteria[11] and was not considered further.

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[10] D2013/439333 - DRAFT NPR1312 - Extension of McMinns ZSS distribution network to supply Mandorah

[11] D2013/653383 - Network Technical Code and Network Planning Criteria v3.1. Table 14 page 127

This option does not address the stated condition of the substation transformers and therefore not considered technically or commercially feasible.

8.1.7 Option 7 – Non network solution

With a load of less than 500 kVA, it is possible to implement an "off the grid" solution with the use of solar, diesel generators and batteries. The estimated cost of this option is [redacted].

The major advantage of Option 7 is that it would allow the decommissioning of the current Centre Yard ZSS and provide sufficient capacity in the event of failure of the subsea cable.

The disadvantages of Option 7 are:

(i) PWC has not deployed an off the grid solution to the Darwin-Katherine system, and therefore additional time would be required to determine and develop a solution;

(ii) There will be significant operational cost associated with this option, as it is likely that operation of the diesel generators will be required during the wet season; and

(iii) The option is unlikely to be technically (or commercially) viable to address the immediate condition of the substation assets continues to deteriorate, or potential for additional load growth in the area.

PWC will continue to explore the technical and commercial viability of this option by engaging with the market to identify providers of network support services prior to submitting the Business Case for Approval.

In the interim, Option 7 is not considered to be technically or commercially viable.

8.2 Comparative cost analysis

PWC is currently developing a probabilistic risk-cost methodology which, when completed will be used to compare options and confirm the economically optimum time for investment.

Table 2 summarises the results of a comparative cost analysis, the details of which are included in Appendix A. Of the technically viable options, Option 2 – Replace existing substation has the lowest NPC. Costs shown in the table below are base project costs and do not include the risk-adjusted costs (ie. P_{50}).

Table 2: Summary of comparative capital cost analysis

Option	Capital Base Cost ($M)	Net Present Cost ($M)	Comments
1 – Base case (Do nothing)	[redacted]	[redacted]	Not technically feasible

2 – Refurbish existing zone substation with new transformer	[redacted]	[redacted]	
3 – Establish new 66/11kV ZSS	[redacted]	[redacted]	
4 – Establish new 66/11kV Micro-substation	[redacted]	[redacted]	Lowest cost, preferred option
5 – Extend and connect to 22kV network	[redacted]	[redacted]	
6 – Replace 66kV subsea cable	[redacted]	[redacted]	Not technically feasible
7 – Demand management / off-grid solution	[redacted]	[redacted]	High operational costs

8.3 Non-cost attributes

An analysis of the non-cost attributes for each option has been completed using the multi-criteria analysis method. The attributes are selected considering major risks and priorities to achieve Project Objectives. A weighting is allocated to each, totalling 100%. Each attribute is given a score out of 5 (from 1 – Fails to satisfy, to 5 – exceeds requirements); the score is then multiplied by the relevant weighting to give the weighted score that is summarised in the table below.

	Project Objectives			Technical & System Risk			Stakeholder Risk			Env. Risk		Commercial
Criteria	**Reduced Risk Asset Failure**	**Maintain System Security**	**40 Year Design Life**	**Standard Assets**	**Constructability**	**Continuity of Supply**	**Safety**	**Community Impact**	**Approvals**	**Oil Contamination**	**Land Clearing**	**NPV/C**
Weighting (%)	10	10	10	5	5	10	10	5	5	5	5	20
Option 1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.05	0.2	0.05	0.2	1
Option 2	0.4	0.4	0.3	0.2	0.15	0.3	0.4	0.2	0.2	0.15	0.2	0.8
Option 3	0.4	0.4	0.4	0.2	0.2	0.4	0.4	0.2	0.1	0.15	0.15	0.6
Option 4	0.4	0.4	0.4	0.15	0.2	0.3	0.4	0.2	0.2	0.15	0.2	0.8

Option 5	0.4	0.3	0.4	0.2	0.2	0.3	0.4	0.2	0.1	0.2	0.15	0.6
Option 7	0.4	0.3	0.4	0.05	0.1	0.4	0.4	0.2	0.1	0.1	0.1	0.4

8.3.1 Evaluation Summary

Weighted Scores:

Option 1: Deferral	2.40
Option 2: Refurbish existing substation	3.70
Option 3: New substation	3.60
Option 4: New micro substation	3.80
Option 5: Extend 22kV line	3.45
Option6: Off-grid solution	2.95

8.4 Preferred Option

The preferred option (Option 4) is the establishment of a new micro-substation adjacent to the existing Centre Yard substation a single transformer 0.5MVA 66/11kV substation.

This option best fulfils the project objectives of safety and reliability at the same time having minimum impact on system security whilst under construction. It also presents an acceptable level of safety risks during construction.

There is little risk of public opposition to the construction activity associated with this project as it's located in a rural area.

The design of the substation will be to the existing PWC Substation Standards and will be similar in layout to current zone substations. This will maximise constructability and reduce design cost risk.

The will be minimal clearing of the site as there is no significant native vegetation on the PWC owned land. As with other zone substations, power transformers will be installed with current oil containment systems that will prevent hydrocarbon release.

8.4.1 Other Considerations

As stated above, installation of a micro-sub changes the design philosophy at this site. To cater for the event of a single transformer failure, the switchyard will cater for the connection of a Nomad substation. The existing diesel genset will remain on site to cater for a prolonged outage if the undersea cable fails.

It should be noted that Option 1 (deferral) does not include cost of loss load and the monetarisation of risks, including safety and corporate image. It is also likely the average operational cost will increase significantly in the future due to the increased frequency of failures.

9 PROJECT OUTLINE

9.1 Project Description

This project is to replace the existing 66/11kV Centre Yard zone substation at Cox Peninsula. The existing transformers and 66kV switchyard will be replaced with a single transformer, skid mounted micro substation complete with protection and control systems. There will be a hook up point for a portable Nomad substation and the existing diesel genset will continue to be located at the site.

9.1.1 Scope Inclusions

The scope of the project includes:

- Replace existing transformers and 66kV switchyard with a micro substation;
- Modify existing bund and oil separation systems to satisfy the current Australian and PWC standards;
- Modify the 66kV incomer to allow a connection to a portable Nomad substation;
- Modify the 11kV switchyard to allow for existing outgoing feeders and connection for the existing diesel genset.

9.1.2 Scope Exclusions

- 66kV subsea cable
- 11kV distribution network

9.1.3 Assumptions

- The existing load is forecasted to remain flat for the foreseeable future. If there is significant load growth in the area then the options will need to be reviewed.
- The 66kV undersea cable is expected to have a remaining operational life of 10-15 years.

9.1.4 Dependencies

None identified

9.1.5 Key Stakeholders

Name	Title / Business Unit
Internal – Governance Stakeholders	Chief Executive

	Investment Review Committee
	Executive General Manager Power Networks
	Chief Engineer
	Group Manager Service Delivery
Internal – Design Stakeholders	Senior Manager Networks Development and Planning
	Manager Major Projects
	Senior Manager Network Assets
	Manager Protection
External – Authorities	Environmental Protection Authority
	Aboriginal Areas Protection Authority
External - Other	Local Residents
	Ministers
	Utilities Commission
	Australian Energy Regulator

9.2 Capital Cost

A risk adjusted cost estimate (RACE) was conducted on the preferred option based on latest design, scope and cost information.

Based on the analysis, the project has a 90% likelihood of being delivered [redacted] The contingency attributable to risk is calculated as P95 – P50 = $0.48M.The calculated P_{50} risk-adjusted cost is the estimated cost of the project.

9.2.1 Base Capital Cost

[redacted]

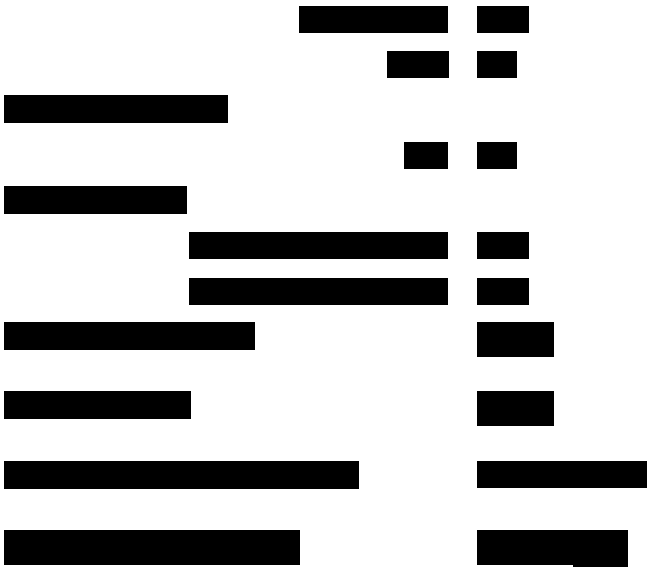

Table 1 – Base Capital Cost Estimate

9.2.2 Risk and Contingency

The current estimate has been developed largely based on PWC and consultant estimates considering previous experience with similar works. The contingency amount, calculated as the P95 value minus the expected P50 value, is currently $ 0.48M.

9.3 Estimated Operating Cost Impact

Ongoing costs of the new substation are related to operation and maintenance as detailed below. It is expected there will be a saving in operating cost due to lower maintenance costs associated with the new equipment.

Item	Annual Incremental Cost
Planned Maintenance	38,259
Preventative Maintenance	31,993
Unplanned Maintenance	2,253
TOTAL	72,505

Table 2 – Estimated Operating Cost Impact

9.4 Project Milestones

Project Phase (end)	Investment Planning	Project Development	Commitment	Implementation	Review
Original Plan (BNI)	07/2017	03/2021	06/2021	06/2022	09/2022

Current Forecast	07/2017	03/2021	06/2021	06/2022	09/2022
Actual Completion	07/2017				

10 RISK MANAGEMENT AND COMPLIANCE

A preliminary risk register has been established to address project risk. This is included in Appendix B. This register will form the basis of the Project Risk Register into the project delivery phase. The register will be regularly reviewed and updated as required to ensure all identified risks are managed as the project progresses.

10.1 Legal Issues

There are no expected legal issues regarding this project.

10.2 Stakeholder and Approval Issues

There are no expected stakeholder and approval issues regarding this project.

10.3 Environment and Sustainability Issues

All replacement or upgrade work will take place entirely within PWC owned zone substations. Decommissioned assets, such as protection relays, will be disposed of appropriately in accordance with good environmental practice.

10.4 Technical and System Issues

The existing 66kV switchyard will be taken out of service with the use of a Nomad modular substation. However, for all construction work adjacent to energised high voltage equipment, PWC has policies and procedures that must be adhered to, such as the Power and Water Access to Apparatus Rules and Access to High Voltage Apparatus Procedure.

Change over from existing to new 66kV micro substation will involve short term line outages to affect the transfer. These outages will be scheduled away from peak periods and in detail to minimise system security risk in close consultation with System Control.

11 PROJECT IMPLEMENTATION

This project is to be managed by the Power Networks' Major Projects group. It is planned that the project will be delivered using the "Design and Construct" methodology through an external contractor.

Testing and commissioning will be managed by Power Networks' Test and Protection group.

It is expected that the majority of electrical equipment will be procured through the Design & Construct contract, with detailed specifications from PWC.

11.1.1 Resourcing Requirements (to next gateway)

Resource Type/Role	How Many?	Internal/ External?	Anticipated Start Date	Duration Required	Allocation (% time or # hrs/days/ wks/mths)
Project Manager	1	Internal	Jan 2021	6 months	10%
Planning Engineer	1	Internal	Jan 2021	6 months	10%
Design Engineer	1	External	Jan 2021	6 months	50%

12 FINANCIAL IMPACT

12.1 Funding Arrangements

The capital expenditure for this project will need to be approved by the AER's 2019-24 Network Price Determination, which is recovered through standard control network tariffs.

Based on the most up to date information, the project cost estimate has been revised to [redacted] The revised cost is based on the estimated costs provided in the concept design and additional estimates for internal PWC expenditure.

12.2 Capital Expenditure

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]			[redacted]			[redacted]
[redacted]			[redacted]			[redacted]

12.3 Incremental Operating Expenditure

An operating expenditure of approximately $72,505 per annum is expected for the maintenance of the new transformer and switchboard extension. Upon completion of the project, the operation cost of the new transformer will be included in the operational budget and forecasted in regulatory processes.

APPENDIX A

DETAILED FINANCIAL ANALYSIS

Introduction

The purpose of this Appendix is to provide details of the options analysis for Replace Centre Yard Zone Substation.

Table A1 below outlines the estimated capital expenditure for options 1, 2, 3, 4, 5 and 7. The operational cost of option 5 is less as there will be no new zone substation and the existing 22kV line will be extended. Option 7 is higher as there will be significant fuel and labour costs. This is reflected in the operational cash flows below.

Commercial analysis of Option 1 (deferral) was not undertaken as it is not considered to be a viable alternative due to the risk of major outages as a result of equipment failure. Option 6 (replace subsea cable) was not undertaken as well as it is not a technically feasible solution.

Table A1 – Estimated Capital & Operating Expenditure

Option	Capex – Base Costs ($M)	Opex – Base Costs ($000's)
Option 1 – Base case, do nothing	[redacted]	$117 (from 2022/23)
Option 2 – Refurbish existing zone substation with new transformer	[redacted]	$72 (from 2022/23)
Option 3 – Establish new 66/11kV ZSS	[redacted]	$72 (from 2022/23)
Option 4 – Establish new 66/11kV Micro-substation	[redacted]	$72 (from 2022/23)
Option 5 – Extend and connect to 22kV network	[redacted]	$20 (from 2022/23)
Option 7 – Demand management / off-grid solution	[redacted]	$162 (from 2023/24)

Assumptions

In modelling the options, technical, economic and cost parameters were included. The technical and cost data was provided by Power Networks and the economic data was sourced from Pricing and Economic Analysis (PEA). Base cost capital expenditure was based on the consultant's feasibility study.

In the assumptions, all costs exclude GST or other government charges.

The common variables employed in the Discounted Cash Flow (DCF) model are presented in Table A2 below. These variables are consistent with the 2019-24 Regulatory Proposal to the AER and are considered appropriate for use in the detailed commercial analysis.

Table A2 – Common Variables

Variables	
Nominal Pre-Tax WACC	6.96%

CPI – 2017/18	2.42%
CPI after 2017/18	2.42%
Time Horizon of Project	40 years

Option 1 - Deferral

Commercial analysis of Option 1 (deferral) is not considered to be a viable alternative due to the risk of major outages as a result of equipment failure. There is not capital expenditure and it is assumed that the average OPEX of the last 3 years of $117,106 will continue into the future. The likelihood of increased opex costs and loss of energy costs were not taken into account.

Option 2 – Refurbish existing zone substation with new transformer

The analysis for this option includes capital expenditure of [redacted] is estimated to be the base cost. Ongoing annual OPEX of $72,505 is also included for the duration of the project life.

Option 3 – Establish new 66/11kV ZSS

The analysis for this option includes capital expenditure [redacted] is estimated to be the base cost. Ongoing annual OPEX of $72,505 is also included for the duration of the project life.

Option 4 – Establish new 66/11kV Micro-substation

The analysis for this option includes capital expenditure of [redacted] is estimated to be the base cost. Ongoing annual OPEX of $72,505 is also included for the duration of the project life.

Option 5 – Extend and connect to 22kV network

The analysis for this option includes capital expenditure of [redacted] is estimated to be the base cost. Ongoing annual OPEX of $20,000 is also included for the duration of the project life.

Option 6 – Replace subsea cable

Commercial analysis of Option 6 (replace subsea cable) was not undertaken as it is not considered to be a viable alternative as it is not a technically feasible solution.

Option 7 – Demand management / off-grid solution

The analysis for this option includes capital expenditure of [redacted] is estimated to be the base cost. Ongoing annual OPEX of $162,930 is also included for the duration of the project life.

Least cost analysis

Based on the DCF analysis undertaken, the least cost option is Option 1 (Do nothing). However, this option is not considered to be a viable alternative due to the risk of major outages as a result of equipment failure. This is summarised in Table A3 below.

Table A3 – Net Present Cost of Options

Option	NPC ($M)
Option 1 – Do nothing	[redacted]
Option 2 – Refurbish existing zone substation with new transformer	[redacted]
Option 3 – Establish new 66/11kV ZSS	[redacted]
Option 4 – Establish new 66/11kV Micro-substation	[redacted]
Option 5 – Extend and connect to 22kV network	[redacted]
Option 7 – Demand management / off-grid solution	[redacted]

Tariff cover

This project capex (2021/22 expenditure) will be submitted as part of the 2019 Regulatory Proposal to the AER. The AER's Final Determination will provide the approved level of net capital expenditure for the 2019-24 period. In so far as the Regulated Networks annual capital expenditure program remains at this level (or lower), Networks will earn a guaranteed rate of return through standard control service charges until the commencement of the next regulatory control period in 2024-25.

APPENDIX B

DETAILED RISK REGISTER

Refer:

PRD33125 Risk Analysis Replace Centre Yard Zone Substation

PWC Ref: D2017/479899

APPENDIX C

SUMMARY PROJECT PROGRAM

Task	*Baseline*			*2021*				*2022*			
	Plan Start	*Plan Duration*	*Percent Complete*	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*
Options Study	Jul 17	6 wks	100%								
Concept Design	Jan 21	6 wks	50%								
Planning and Permits	Mar 21	10 wks									
Detailed Design	Jul 21	10 wks									
Procurement	Aug 21	10 wks									
Civil Construction	Sep 21	8 wks									
Primary Electrical Construction	Sep 21	16 wks									
Secondary Electrical Construction	Jan 22	16 wks									
Commissioning and Energisation	Apr 22	8 wks									
Cutover Existing Services	Jun 22	2 wks									

APPENDIX D

CONDITION ASSESSMENT REPORT

Refer:

Cox Peninsular CPZSS Condition Assessment

PWC Ref: D2018/64695