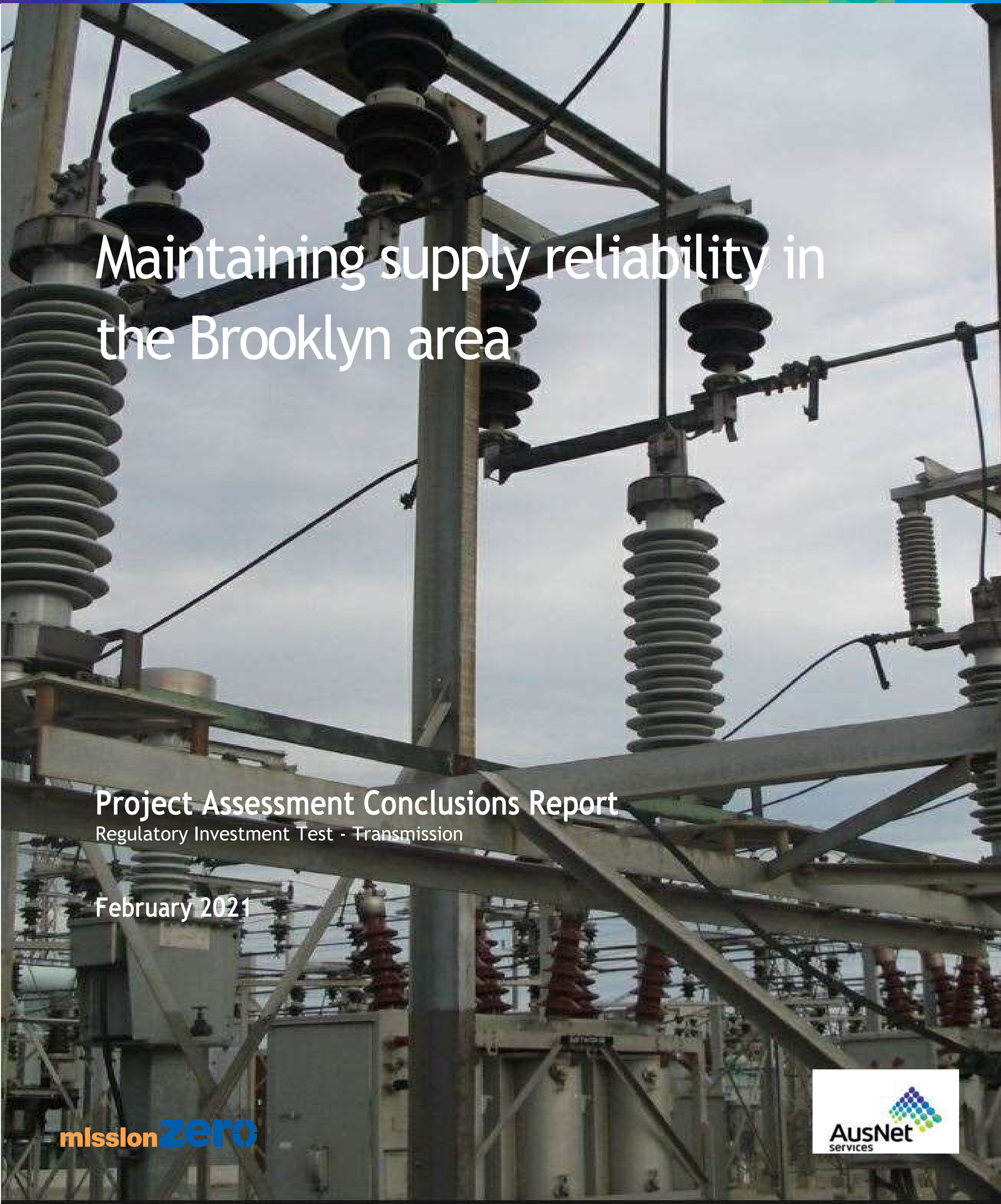

Maintaining supply reliability in the Brooklyn area

Project Assessment Conclusions Report

Regulatory Investment Test - Transmission

February 2021

mission zero

AusNet services

Important notice

Purpose

AusNet Services has prepared this document to provide information about potential limitations in the Victoria transmission network and options that could address these limitations.

Disclaimer

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Executive summary

AusNet Services undertook this Regulatory Investment Test for Transmission (RIT-T) to evaluate options to maintain supply reliability in the Brooklyn area. The options investigated in this RIT-T are intended to mitigate the risk of an asset failure at Brooklyn Terminal Station (BLTS).

The Project Specification Consultation Report (PSCR), which represents the first step in the RIT-T process in accordance with clause 5.16 of the National Electricity Rules (NER) and section 4.2 of the RIT-T Application Guidelines was published in November 2020. AusNet Services is exempted from preparing a Project Assessment Draft Report (PADR) as per NER clause 5.16.4(z1) as the project cost is less than $43 Million. Publication of this Project Assessment Conclusions Report (PACR) represents the final step of the RIT-T process.

BLTS is owned and operated by AusNet Services and is located approximately 10 km west from Melbourne's CBD. It was commissioned in the early 1960's and serves as the main transmission connection point for distribution of electricity to approximately 56,650 customers via 220/66 kV transformers and approximately 7,530 customers via 220/22 kV transformers. Peak demand of the BLTS 66 kV load during the summer of 2019/20 reached 234.0 MW.

The condition of some of the 66 kV circuit breakers at BLTS has deteriorated to a level where there is a material risk of asset failure, which could have an impact on electricity supply reliability, safety, environment, and emergency replacement costs. The RIT-T analysis shows that it is no longer economical to continue to provide supply with the existing 66 kV assets at BLTS as the asset failure risk has increased to a level where investment to replace the selected assets presents a more economical option based on the value that consumers place on supply reliability (VCR).

No non-network proposals were received during the RIT-T PSCR consultation phase.

The preferred option to address the asset failure risk at BLTS is an integrated replacement of selected 66 kV switchgear.

Changes to inputs since PSCR publication

In December 2020, AEMO published the 2020 Transmission Connection Point Forecast for Victoria. The 2020 demand forecast for Brooklyn Terminal Station is slightly higher than the 2019 forecast. A discount rate of 4.8% was used for the central scenario as per the AEMO draft 2021 Inputs Assumptions and Scenarios Report (IASR)[1], which is slightly higher than the 4.68% discount rate that was used for the PSCR. These updates do not change the preferred option but results in a slight advancement of the project economical timing.

Credible options considered

AusNet Services did not receive any proposals for non-network solutions and did not identify a credible, economical non-network solution for the identified need at BLTS.

AusNet Services assessed two credible network options and concluded that both options will deliver higher net present benefits through improved supply reliability to customers in the Brooklyn supply area compared with keeping the existing assets in service:

[1] Australian Energy Market Commission, Draft IASR, available at https://www.aemo.com.au/consultations/current-and-closed-consultations/2021-planning-and-forecasting-consultation-on-inputs-assumptions-and-scenarios

Table 1 - Summary of credible network options

Option	Description	Indicative capital cost ($million)	PV (Base case $million)
Option 1: Integrated Replacement	Replace fifteen 66 kV circuit breakers and associated switchgear as well as secondary assets that are in poor condition.	15.5	18.8
Option 2: Integrated Replacement deferred by five years	Same as Option 1.	15.5	20.7

Options evaluation and conclusion

All the network options evaluated are like-for-like replacements and will have no material impact on wholesale market cost. No market simulation studies have therefore been conducted for this RIT-T. Scenario analysis as used in AEMO's Integrated System Plan (ISP) is therefore not required.

The robustness of the ranking and optimal timing of options have been investigated through sensitivity analysis that involve variations of assumptions around the values used in the base case.

AusNet Services' cost-benefit evaluation confirms that Integrated replacement (Option 1) is the most economic option as it provides the highest present value of net economic benefits as illustrated by the results of the sensitivity analysis in Figure 1.

This option will not only maintain supply reliability in the Brooklyn area, but also mitigates safety, environmental, and emergency replacement risks at BLTS.

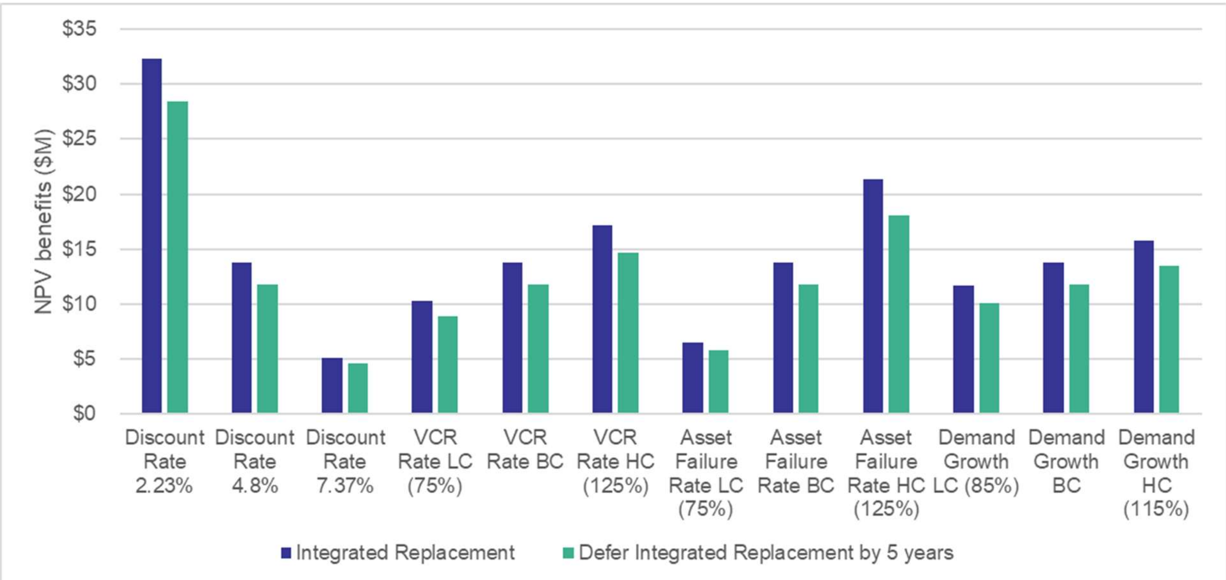

Figure 1 - Option Selection and sensitivity analysis

The optimal timing of Option 1 is as soon as possible as supported by the sensitivity analysis. However, to allow for construction and equipment lead time, this option is expected to be commissioned in 2023/24.

AusNet Services concludes that Option 1: Integrated Replacement is the most economical and the preferred option to address the identified need and for it to be implemented by 2023/24.

The proponent of this project is AusNet Services.

Next steps

In accordance with clause 5.16B of the NER, within 30 days of the date of publication of this PACR, any party disputing the conclusion made in this PACR could give notice of the dispute in writing setting out the grounds for the dispute (the dispute notice) to the AER. If there are no dispute notices within 30 days of the date of publication of this PACR, AusNet Services expects to implement the preferred option.

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Figures

Tables

1. Introduction

AusNet Services initiated this Regulatory Investment Test for Transmission (RIT-T) to evaluate options to maintain supply reliability in the Brooklyn area, in response to the deterioration of assets at Brooklyn Terminal Station (BLTS).

The Project Specification Consultation Report (PSCR) was published in November 2020 in accordance with clause 5.16 of the National Electricity Rules (NER)[2] and section 4.2 of the RIT-T Application Guidelines.[3] In accordance with the NER clause 5.16.4(z1), AusNet Services is exempted from producing a Project Assessment Draft Report (PADR) as;

- No technically and economically feasible network or non-network option was received during the PSCR consultation;
- the preferred option (Option 1) has a capital cost of less than $43 million and addresses the identified need and is also the most economically option;
- all credible options will not have a material class of market benefits specified in clause 5.15A.2(b)(4) except for those specified in NER clause 5.15A.2(b)(4)(ii), and 5.15A.2(b)(4)(iii); and
- this project has the benefit of NER clause 5.16.4(z1)

Publication of this Project Assessment Conclusions Report (PACR) represents the final step in the RIT-T process[4].

This document describes:

- the identified need that AusNet Services is seeking to address;
- credible network options that address the identified need;
- a summary of the submissions received, if any;
- the assessment approach and assumptions that AusNet Services employed for this RIT-T as well as the specific categories of market benefits that are unlikely to be material;
- the results of the option evaluation; and
- the most economical option.

The need for investment to address asset failure risks from the deteriorating assets at BLTS is included in AusNet Services' 2022 to 2027 revenue proposal[5]. This investment need is also presented in AusNet Services Asset Renewal Plan that is published as part of AEMO's 2020 Victorian Transmission Annual Planning Report (VAPR)[6].

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[2] Australian Energy Market Commission, *"National Electricity Rule version 156,"* available at https://www.aemc.gov.au/regulation/energy-rules/national-electricity-rules/current

[3] Australian Energy Regulator, *"Application guidelines Regulatory investment test for transmission,"* available at AER - Regulatory investment test for transmission application guidelines - 25 August 2020.pdf

[4] A RIT-T process will assess the economic efficiency and technical feasibility of proposed network and non-network options.

[5] Australian Energy Regulator, "AusNet Services – Determination 2022-2027", p.100 and 104 of Revenue Proposal, available at AusNet Services - Determination 2022-27 | Australian Energy Regulator (aer.gov.au)

[6] Australian Energy Market Operator, *"Victorian Annual Planning Report,"* available at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Victorian-transmission-network-service-provider-role/Victorian-Annual-Planning-Report

2. Identified need

The role of BLTS in providing electricity supply services and the condition of key assets are discussed in this section. Quantification of the risk costs associated with the deterioration of these assets, and the need for the investments are also presented.

2.1. Electricity Supply to the Brooklyn area

BLTS is owned and operated by AusNet Services and is located approximately 10 km west of Melbourne's CBD. Since it was commissioned in the early 1960's, BLTS has served the inner western residential area of Melbourne, commercial areas on the Western side of the Yarra River, a steel mill induction furnace at Laverton and sewerage pumping stations.[7]

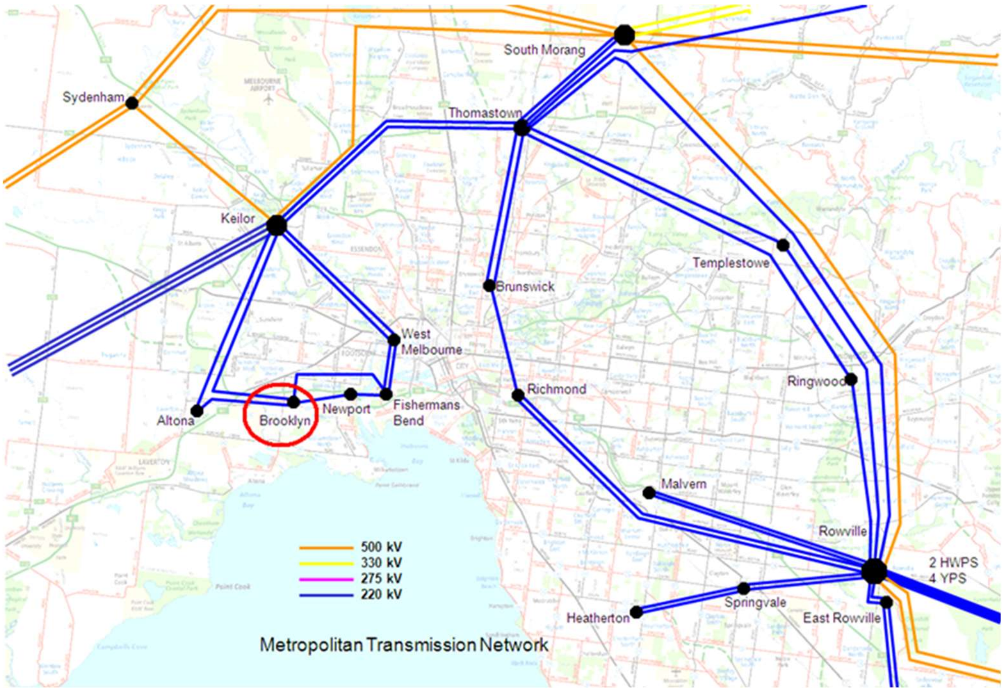

Figure 2 – Metropolitan transmission network and Brooklyn Terminal Station

Electricity demand

Approximately 56,650 customers are supplied from the 220/66 kV transformers. The load composition at BLTS 66 kV consists of 62.25% commercial, 19.42% residential, 18.26% industrial and a very small amount of agricultural customers as illustrated in Table 2.

Table 2 - Demand composition at BLTS

Customer type	Share of consumption (%) - 66 kV
Commercial	62.25%
Residential	19.42%
Industrial	18.26%
Agricultural	0.07%

[7] Distribution of electricity to relevant communities is supported by Powercor and Jemena.

Customer type	Share of consumption (%) - 66 kV
Total	100%

During the summer of 2019/20 the 66 kV peak demand reached 234.0 MW.

According to the Australian Energy Market Operator's (AEMO) latest demand forecast[8] published in December 2020, a slight increase in peak demand is forecast for BLTS 66 kV over the ten-year forecast period. Figure 3 shows the 10% probability of exceedance (POE10)[9] and the 50% probability of exceedance (POE50)[10] forecasts for peak demand during summer and winter periods.[11]

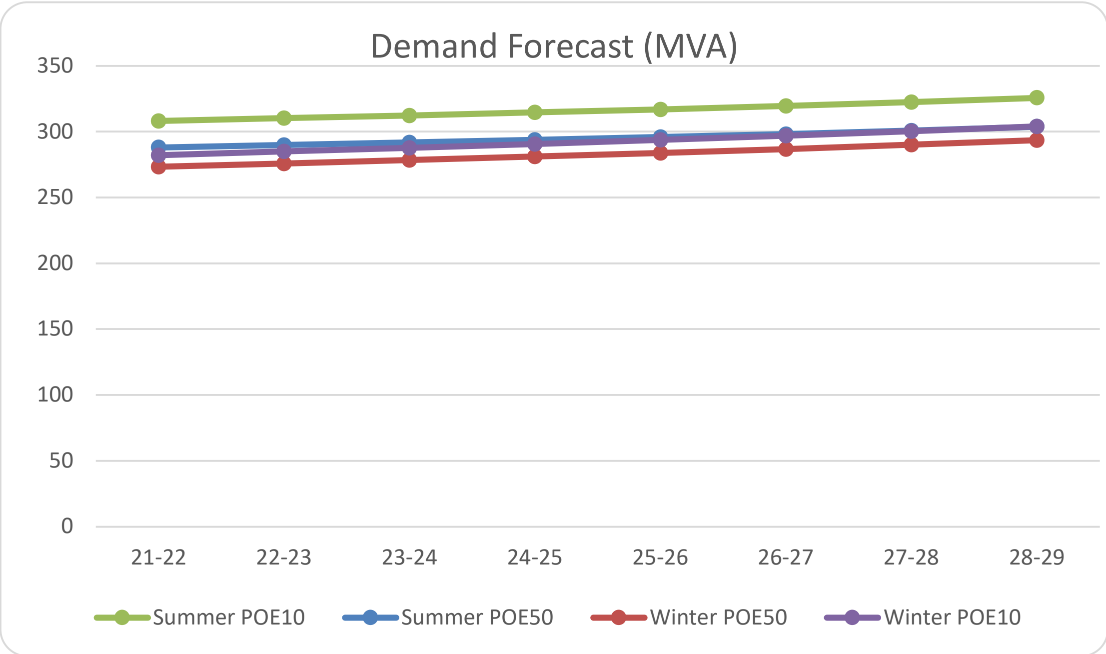

Figure 3 - Demand forecasts for BLTS 66 kV network

AEMO and the relevant Distribution Network Service Providers (DNSPs) recognize there is an ongoing need for electricity supply services to communities in the Brooklyn area as reflected in the official demand forecasts for BLTS 66 kV.

Embedded generation

There are no embedded generators connected to BLTS at 66 kV.

Electricity network

BLTS sources its electricity supply from the Keilor Terminal Station (KTS) and is connected in the western metropolitan 220 kV ring as shown in Figure 2.

The 66 kV switchyard supplies eleven 66 kV feeders (owned by Powercor and Jemena) and a dedicated feeder for a steel mill induction furnace at Laverton as shown in Figure 4. The zone substations

[8] Australian Energy Market Operator (AEMO), *"2020 Transmission Connection Point Forecast for Victoria,"* available at https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/transmission-connection-point-forecasting/victoria

[9] A POE10 forecast indicates a level where there is 10 % likelihood that actual peak demand will be greater.

[10] A POE50 forecast indicates a level where there is 50 % likelihood that actual peak demand will be greater.

[11] Victorian electricity demand is sensitive to ambient temperature. Peak demand forecasts are therefore based on expected demand during extreme temperature that could occur once every ten years (POE10) and during average summer condition that could occur every second year (POE50).

supplied from Brooklyn Terminal Station include Altona (AL), Air Trunk (ATD), Bacchus Marsh (BMH), Smorgans Consolidated Ind (SCI), Toyota (TYA), Laverton North (LVN), Footscray West (FW), Tottenham (TH), Newport (NT) and Yarraville (YVE).

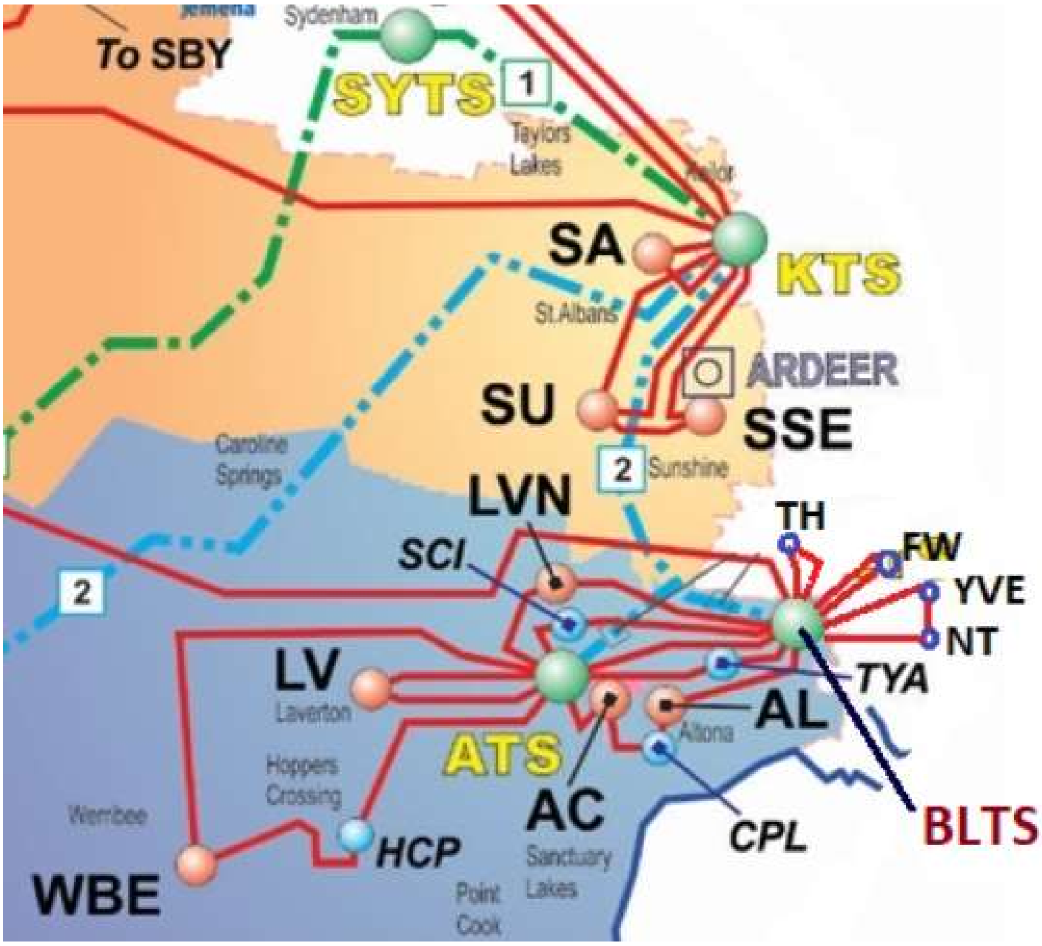

Figure 4 - Distribution network supplied from BLTS

2.2. Asset condition

Several 66 kV primary (circuit breakers and associated switchgear) and secondary (protection and control) assets at BLTS are in poor condition as expected of assets that have been in service for a long time.

AusNet Services classifies asset conditions using scores that range from C1 (initial service condition) to C5 (very poor condition). The latest asset condition assessment for BLTS was conducted in 2019 and reveals some assets at the terminal station are in poor condition (C4) or very poor condition (C5). For the affected assets, the probability of failure is high, and is likely to increase further if no remedial action is taken. Table 3 provides a summary of the condition of relevant major equipment.

Table 3 - Summary of 66 kV major equipment condition scores

Asset class	Condition scores				
	C1	C2	C3	C4	C5
66 kV circuit breakers	1	2		3	13
66 kV current transformers					12
66 kV voltage transformers			9	7	2

66 kV circuit breakers

Sixteen of the nineteen 66 kV circuit breakers, including all four bus tie circuit breakers, are in poor condition or have suffered extreme deterioration and are approaching their end of economic and technical life. This is expected of assets that have been in service for a long time. One of the 66 kV feeder circuit breakers will be replaced by another committed project therefore this RIT-T plan to address the remaining fifteen 66 kV circuit breakers.

With condition scores of C4 and C5, these circuit breakers present challenges due to duty-related deterioration including erosion of arc control devices, bushing oil leakages, and wear of operating mechanisms and drive systems; intensive maintenance; lack of spares and manufacturer support; and lack of oil containment bunding.

66 kV instrument transformers

Several instrument transformers at BLTS are assessed to be in poor or very poor condition (C4 and C5). Management of safety risks from potential explosive failures of instrument transformers is costly due to the need for regular oil sampling and partial discharge condition monitoring.

2.3. Description of the identified need

BLTS provides electricity supply to the inner western residential area of Melbourne, commercial areas on the Western side of the Yarra River, a steel mill induction furnace at Laverton and sewerage pumping stations. AusNet Services expects that the services that BLTS provide will continue to be required as the demand for electricity is forecast to remain approximately at present levels over the next ten-year period. However, the poor and deteriorating condition of some of the components at the terminal station has increased the likelihood of asset failures. Such failures would result in prolonged terminal station outages.

Without remedial action, other than ongoing maintenance practice (business-as-usual), affected assets are expected to deteriorate further and more rapidly. This will increase the probability of failure, resulting in a higher likelihood of electricity supply interruptions, heightened safety risks due to potential explosive failure of the assets, environmental risks from possible oil spillage, collateral damage risks to adjacent plant, and the risk of increased costs resulting from the need for emergency asset replacements and reactive repairs.

Therefore, the 'identified need' this RIT-T intends to address is to maintain supply reliability in the Brooklyn area and to mitigate risks from relevant asset failures.

By implementing the preferred option, AusNet Services will be able to maintain supply reliability in the Brooklyn area and mitigate safety and environmental risks, as required by the NER and Electricity Safety Act 1998[12].

2.3.1. Assumptions

Aside from the failure rates (determined by the condition of the assets) and the likelihood of relevant consequences, AusNet Services has adopted a number of assumptions to quantify the risks associated with asset failure. These assumptions are detailed in the following subsections.

Supply risk costs

Supply risk cost has been calculated from the expected unserved energy at BLTS and AEMO's most

[12] Victorian State Government, Victorian Legislation and Parliamentary Documents, *"Electricity Safety Act 1998,"* available at https://www.legislation.vic.gov.au/in-force/acts/electricity-safety-act-1998/079

recent demand forecast for BLTS[13] and has been monetised at a Value of Customer Reliability (VCR)[14] of $43,550/MWh. The choice of VCR value is based on those published by the AER and the composition of customers supplied by BLTS.

The total supply risk cost is calculated by estimating the impacts of different combinations of relevant forced outages to reliability of supply and weighting them by their probabilities of occurrence.

Safety risk costs

The Electricity Safety Act 1998[15] requires AusNet Services to design, construct, operate, maintain, and decommission its network to minimize hazards and risks to the safety of any person as far as reasonably practicable or until the costs become disproportionate to the benefits from managing those risks.

In implementing this principle for assessing safety risks from explosive asset failures, AusNet Services uses:

- a value of statistical life[16] to estimate the benefits of reducing the risk of death;
- a value of lost time injury[17]; and
- a disproportionality factor[18].

AusNet Services notes this approach, including the use of a disproportionality factor, is consistent with the practice notes[19] provided by the AER.

Financial risk costs

As there is a lasting need for the services that BLTS provides, the failure rate-weighted cost of replacing failed assets (or undertaking reactive maintenance) is included in the assessment.[20]

Environmental risk costs

Environmental risks from plant that contains large volumes of oil, such as Bulk oil circuit breakers, which may be released in an event of asset failure, is valued at $30,000 per event.

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[13] Australian Energy Market Operator (AEMO), *"2020 Transmission Connection Point Forecast for Victoria,"* available at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Transmission-Connection-Point-Forecasting/Victoria

[14] In dollar terms, the Value of Customer Reliability (VCR) represents a customer's willingness to pay for the reliable supply of electricity. The values produced are used as a proxy, and can be applied for use in revenue regulation, planning, and operational purposes in the National Electricity Market (NEM).

[15] Victorian State Government, Victorian Legislation and Parliamentary Documents, *"Electricity Safety Act 1998,"* available at https://www.legislation.vic.gov.au/in-force/acts/electricity-safety-act-1998/079

[16] Department of the Prime Minister and Cabinet, Australian Government, *"Best Practice Regulation Guidance Note: Value of statistical life,"* available at https://www.pmc.gov.au/resource-centre/regulation/best-practice-regulation-guidance-note-value-statistical-life.

[17] Safe Work Australia, "The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community: 2012-13," available at https://www.safeworkaustralia.gov.au/system/files/documents/1702/cost-of-work-related-injury-and-disease-2012-13.docx.pdf

[18] Health and Safety Executive's submission to the1987 Sizewell B Inquiry suggesting that a factor of up to 3 (i.e. costs three times larger than benefits) would apply for risks to workers; for low risks to members of the public a factor of 2, for high risks a factor of 10. The Sizewell B Inquiry was public inquiry conducted between January 1983 and March 1985 into a proposal to construct a nuclear power station in the UK.

[19] Australian Energy Regulator, *"Industry practice application note for asset replacement planning,"* available at https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/industry-practice-application-note-for-asset-replacement-planning

[20] The assets are assumed to have survived and their condition-based age increases throughout the analysis period.

3. Credible network options

AusNet Services considered both network and non-network options to address the identified need caused by the deteriorating assets at BLTS but did not find any suitable non-network solution.

The network options that AusNet Services has identified are presented below.

3.1. Option 1 – Replace selected 66 kV switchgear in an integrated project

Option 1 involves replacement of selected 66 kV circuit breakers and associated switchgear and secondary assets that are in poor condition in a single integrated project. It includes replacement of fifteen 66 kV circuit breakers and associated primary and secondary equipment.

The estimated capital cost of this option is $15.5 million with no material change in operating cost.

AusNet Services' analysis shows that the optimal timing is to deliver a solution as soon as possible. Allowing for construction and equipment lead time, the earliest commissioning date is in 2023/24.

3.2. Option 2 –Integrated replacement deferred by five years

Option 2 defers the replacement of selected 66 kV circuit breakers and associated primary switchgear and secondary equipment by 5 years. During this time poor condition assets would be maintained in a similar manner as the "Business as Usual" option.

The estimated capital cost of this option is $15.5 million with no material change in operating cost and the investment year is 2028/29.

There is no significant change in operation and maintenance cost for this option.

3.3. Options considered and not progressed

Retirement of aging plant: Though it may avoid emergency reactive replacement, environmental, and safety risk costs; retiring selected assets will reduce the terminal station's capacity to supply and will increase supply risk costs. Therefore, any option that reduces the terminal stations' capability is not progressed further.

Refurbishment options do not significantly reduce the risks from asset failure and are therefore not progressed further for this RIT-T.

3.4. Material inter-regional network impact

As the 66 kV supply from BLTS is electrically radial, and the network impact is confined to the Brooklyn area, none of the network options being considered are likely to have a material inter-regional network impact. A 'material inter- regional network impact' is defined in the NER as:

> *"A material impact on another Transmission Network Service Provider's network, which may include (without limitation): (a) the imposition of power transfer constraints within another Transmission Network Service Provider's network; or (b) an adverse impact on the quality of supply in another Transmission Network Service Provider's network."*

4. Assessment approach

Consistent with the RIT-T requirements and practice notes on risk-cost assessment methodology[21], AusNet Services undertook a cost-benefit analysis to evaluate and rank the net economic benefits of the options over a 45-year period.

All options have been assessed against a business-as-usual case where no proactive capital investment to reduce the increasing baseline risk is made.

Optimal timing of an investment option is the year when the annual benefits from implementing the option exceeds the annualised investment cost.

4.1. Sensitivity analysis

The robustness of the investment decision was tested using a range of input assumptions as described in Table 4. The sensitivity analysis involves variation of assumptions from those employed under the base case.

Table 4 - Input assumptions used for the sensitivity studies

Parameter	Lower Bound	Base Case	Higher Bound
Asset failure rate	AusNet Services assessment – 25%	AusNet Services assessment	AusNet Services assessment + 25%
Demand forecast	AEMO 2020 Transmission Connection Point Forecasts - 15%	AEMO 2020 Transmission Connection Point Forecasts	AEMO 2020 Transmission Connection Point Forecasts + 15%
Value of customer reliability	Latest AER VCR figures - 25%	Latest AER VCR figures	Latest AER VCR figures + 25%
Discount rate	2.23% - ENA RIT-T handbook[22]	4.8% - AEMO draft IASR	7.37% - a symmetrical adjustment upwards

4.2. Material classes of market benefits

NER clause 5.15A.2(b)(4) formally sets out the classes of market benefits that must be considered in a RIT-T. AusNet Services estimates that the only class of market benefits that is likely to be material is a change in involuntary load shedding that can be achieved when assets with high failure risk are replaced with new assets. AusNet Services' approach to calculate the benefits of reducing the risk of load shedding is set out in section 2.3.

4.3. Other classes of benefits

Although not formally classified as classes of market benefits under the NER, AusNet Services expects material reduction in: safety risks from potential explosive failure of deteriorated assets,

[21] Australian Energy Regulator, *"Industry practice application note for asset replacement planning,"* available at https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/industry-practice-application-note-for-asset-replacement-planning

[22] Energy Networks Australia (ENA), "RIT-T Economic Assessment Handbook", available at https://www.energynetworks.com.au/resources/fact-sheets/ena-rit-t-handbook-2020/

environmental risks from possible oil spillage, collateral damage risks to adjacent plant, and the risk of increased costs resulting from the need for emergency asset replacements and reactive repairs by implementing any of the options considered in this RIT-T.

4.4. Classes of market benefits that are not material

AusNet Services estimated that the following classes of market benefits are unlikely to be material for any of the options considered in this RIT-T:

- Changes in fuel consumption arising through different patterns of generation dispatch - as the network is sufficiently radial to the extent that asset failures cannot be remediated by re-dispatch of generation and the wholesale market impact is expected to be the same for all options.
- Changes in costs for parties, other than the RIT-T proponent – there is no other known investment, either generation or transmission, that will be affected by any option considered.
- Changes in ancillary services costs – the options are not expected to impact on the demand for and supply of ancillary services.
- Change in network losses –while changes in network losses are considered in the assessment, they are estimated to be small and unlikely to be a material class of market benefits for any of the credible options.
- Competition benefits – there is no competing generation affected by the limitations and risks being addressed by the options considered for this RIT-T.
- Option value – as the need for and timing of any investment option is driven by asset deterioration, there is no need to incorporate flexibility in response to uncertainty around any other factor.

5. Results of options assessment

This section presents the results of the economic cost benefit analysis and the economical timing of the preferred option.

All options assessed will deliver a reduction in the following risks: involuntary load shedding, safety, environmental, collateral and emergency asset replacement.

The total risk cost reduction, presented in Figure 5, outweighs the investment cost for all options under all scenarios where input variables are varied one at a time.

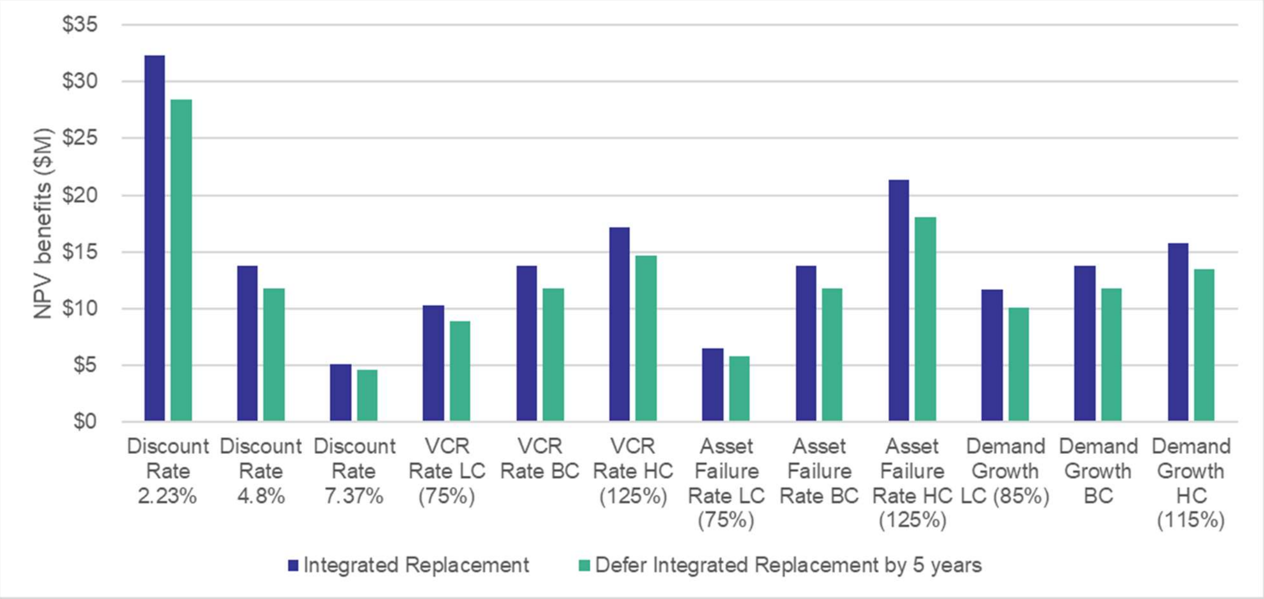

Figure 5 - Sensitivity of net economic benefits with respect to variation of key parameters

5.1. Preferred option

Option 1 – Integrated Replacement – delivers the highest net benefit for all the scenarios considered and is therefore the preferred option.

5.2. Optimal timing of the preferred option

This section describes the optimal timing of the preferred option for different assumptions of key variables. Figure 6 shows that the economical time for the preferred option is as soon as possible for the base case assumptions.

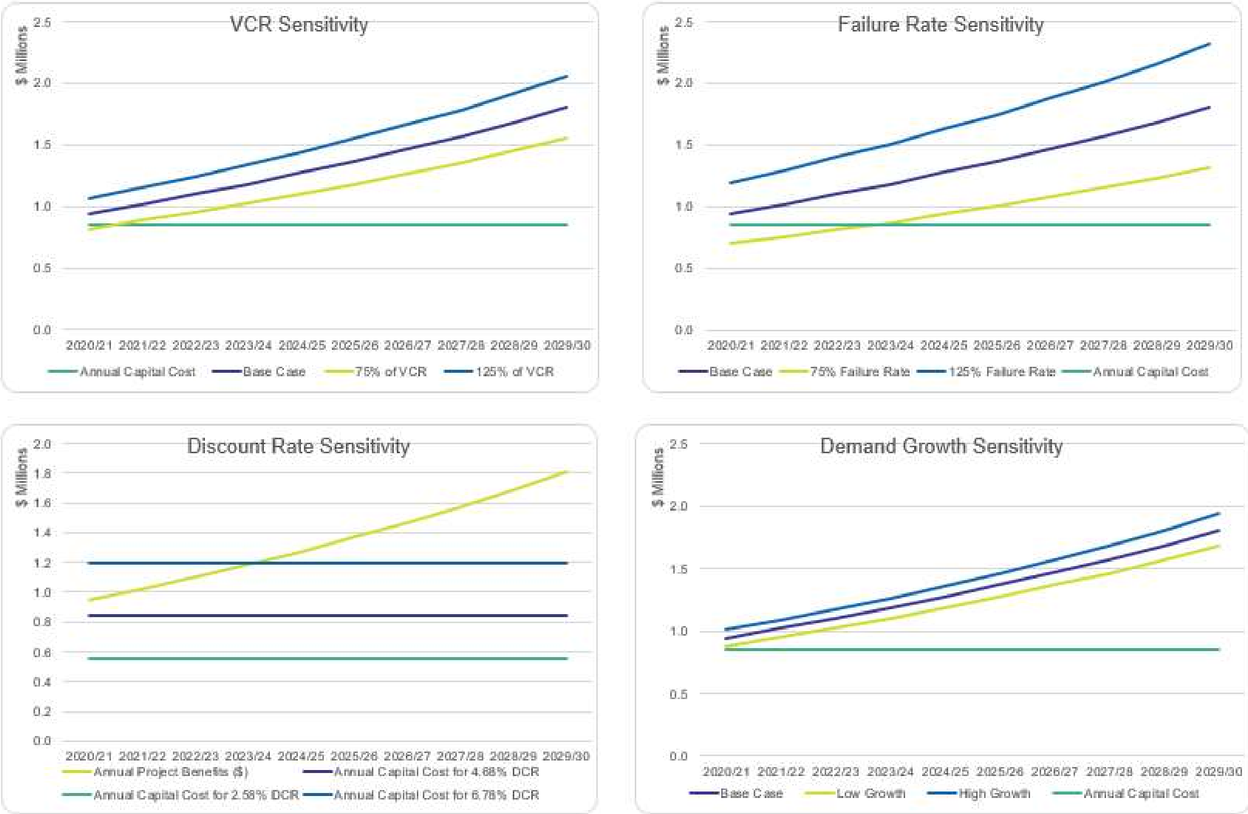

Figure 6 - Sensitivity of the optimal timing with respect to variation of key parameters

6. Conclusion of the RIT-T

Amongst the options considered in this RIT-T, Option 1 - Integrated Replacement is the most economical option to maintain supply reliability in the Brooklyn supply area and to manage safety, environmental, collateral and emergency replacement risks at BLTS.

This preferred option involves replacement of fifteen 66 kV circuit breakers and associated primary and secondary equipment in a single integrated project.

The estimated capital cost of this option is $15.5 million.

The preferred option is economical to proceed as soon as possible. However, to allow for construction and equipment lead time, this option is expected to be commissioned in 2023/24.

Appendix A - RIT-T assessment and consultation process

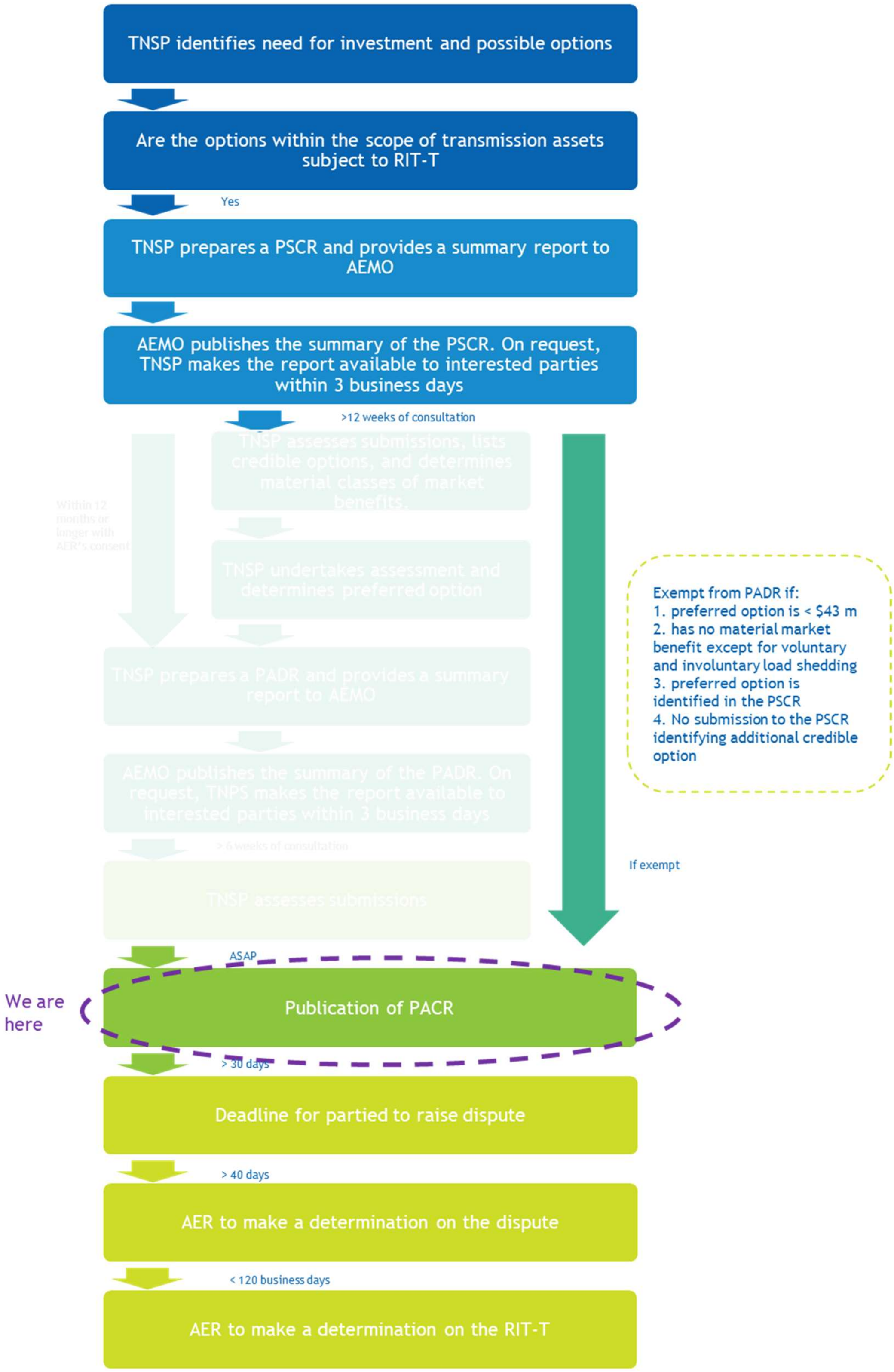

Figure 7 - RIT-T Process