AusNet Electricity Services Pty Ltd

Contingent Project Application – Tranche 2

Bushfire Mitigation

PUBLIC VERSION

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About AusNet Services

AusNet Services is a major energy network business that owns and operates key regulated electricity transmission and electricity and gas distribution assets located in Victoria, Australia. These assets include:

- A 6,574 kilometre electricity transmission network that services all electricity consumers across Victoria;
- An electricity distribution network delivering electricity to approximately 730,000 customers in an area of more than 80,000 square kilometres of eastern Victoria; and
- A gas distribution network delivering gas to approximately 572,000 customer supply points in an area of more than 60,000 square kilometres in central and western Victoria.

AusNet Services' purpose is 'to provide our customers with superior network and energy solutions.' The AusNet Services company values are:

- We work safely
- We do what's right
- We're one team
- We deliver

For more information visit: www.ausnetservices.com.au

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1 Executive summary

1.1 Overview

This project is a world first rollout of Rapid Earth Fault Current Limiters (**REFCL**) technology in a manner to deliver considerable bushfire mitigation benefits to Victoria and our customers. A reduction in bushfire risk will improve the safety of the community and is an objective we fully support. The bushfire mitigation regulations (the **Regulations**)[1], which were amended in 2016, set challenging performance standards (the Required Capacity) for 22 of AusNet Services zone substations and their associated networks.[2] These new standards can only be met by installing REFCLs, which have not previously been implemented for bushfire reduction anywhere in the world. The project is time-critical because the Regulations set establishment dates. Additionally, in the *Electricity Safety Amendment (Bushfire Mitigation Civil Penalties Scheme) Act 2017* (the **Act**), the Victorian Government has reinforced the importance of timely delivery by introducing significant financial penalties if these dates are not met.[3]

The REFCL Program is to be delivered in three Tranches to align with compliance dates of 1 May 2019, 1 May 2021 and 1 May 2023, as set out in the Regulations.

AusNet Services submitted its Tranche 1 contingent project application on 31 March 2017 and the Australian Energy Regulator (**AER**) made its final decision on 21 August 2017. Construction work on Tranche 1 is well progressed with REFCLs now installed at three zone substations and construction work commenced at all remaining zone substations. An update on the Tranche 1 Program is set out in section 5.

1.2 Tranche 2 contingent project application

This document is AusNet Services' contingent project application in relation to Tranche 2 of the REFCL Program and provides a detailed explanation of the necessary expenditure requirements to undertake the second Tranche. AusNet Services considers capital expenditure (**capex**) of $140.2 million and operational expenditure (**opex**) of $4.4 million is the prudent and efficient costs of undertaking this program of works. This application explains the measures AusNet Services has taken to ensure the project scope and costings comply with the prudency and efficiency requirements in the National Electricity Rules (**Rules**).

Importantly, the technology being installed continues to benefit from ongoing research and development, hence AusNet Services has been able to identify and incorporate lessons from the first Tranche of activities in this Tranche 2 application. Compared to the Tranche 1 contingent project application, we have an enhanced understanding of the technical challenges of implementing this Program and a more detailed understanding of the costs.

The characteristics of the zone substations vary between the two Tranches. Tranche 1 focused on the highest risk zone substations, which were generally of a rural nature. Whereas, the Tranche 2 zone substations are of a peri-urban nature and generally in the north-eastern fringe of Melbourne. This difference in the characteristics of the networks emanating from the Tranche

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1 *Electricity Safety (Bushfire Mitigation) Regulations 2013* as amended on 1 May 2016 by the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016*

2 *Electricity Safety (Bushfire Mitigation) Regulations 2013*

3 *Electricity Safety Amendment (Bushfire Mitigation Civil Penalties Scheme) Act 2017*

2 Zone substations gives rise to a number of different features and challenges compared to those faced in Tranche 1, particularly:

- Most Tranche 2 zone substations require two Ground Fault Neutralisers (**GFNs**) to be installed, whereas the majority of zone substations in Tranche 1 only required one GFN. This need for multiple GFNs is driven by the electrical size of the of the network (capacitance) connected to each zone substation and the technical requirements of the GFNs that limit the capacitive size of network that can be connected whilst meeting the Required Capacity.
- There are more High Voltage (**HV**) customers in Tranche 2, where there are 27 HV customer connection points in Tranche 2 compared to 12 in Tranche 1. However, these HV connection points are generally smaller in size a smaller (3 MVA) isolating substation solution will be implemented for these customers. We also anticipate using customer hardening solutions for a larger proportion of customers compared to Tranche 1.
- There is significantly more underground feeder cable supplied by the relevant zone substations. This has necessitated additional testing and hardening works. This underground cable also increases the capacitance of the network, which is a key driver of the need for multiple GFNs.

AusNet Services is actively managing the costs of this Program to ensure it is delivered in a prudent and efficient manner. AusNet Services anticipates submitting a number of exemption requests to Energy Safe Victoria (**ESV**), which will seek to ensure that the necessary safety benefits are achieved while minimising required expenditure. Since the Tranche 1 contingent project determination, clarification has been obtained from ESV regarding the exemption request process as well as its expectations regarding the initial and annual compliance testing regime.

Due to the unique and challenging nature of this Program, cooperation with Powercor Australia (**Powercor**), which is also subject to the same Regulations, has delivered substantial benefits. These include promoting a shared understanding of the technology and its operation on the network, together with efficient practice, particularly in relation to compliance testing. It has also facilitated a deeper understanding of the capabilities of REFCL technology and the challenges in modifying current distribution networks to achieve the benefits of bushfire risk reduction.

AusNet Services is confident the expenditure forecasts in this application comply with the requirements of the Rules. Accordingly, those expenditure forecasts should be accepted by the AER for the purpose of amending the 2016-20 revenue determination to enable AusNet Services to recover the cost of this contingent project.

1.3 Summary of expenditure and revenue requirements

The amended revenue requirements reflect the expenditure forecasts set out in Table 1 below.

Table 1: Expenditure summary ($m, 2015)

	2016	2017	2018	2019	2020	Total
Capital Expenditure	-	-	19.6	76.8	43.8	140.2
Operating Expenditure	-	-	0.0	2.1	2.3	4.4

Source: AusNet Services

Table 2 shows the building block elements that comprise the incremental revenue requirement for the contingent project over the 2016-20 regulatory control period.

Table 2: Contingent project revenue requirement, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020	Total
Return on capital	-	-	-	1.4	6.5	8.1
Regulatory depreciation	-	-	-	2.6	4.6	7.3
Operating expenditure	-	-	-	2.3	2.6	5.0
Revenue adjustments	-	-	-	-	-	-
Net tax allowance	-	-	-	0.5	0.7	1.1
Annual revenue requirement (unsmoothed)	-	-	-	6.9	14.4	21.4
Annual revenue requirement (smoothed)		-	-	10.3	10.9	21.2

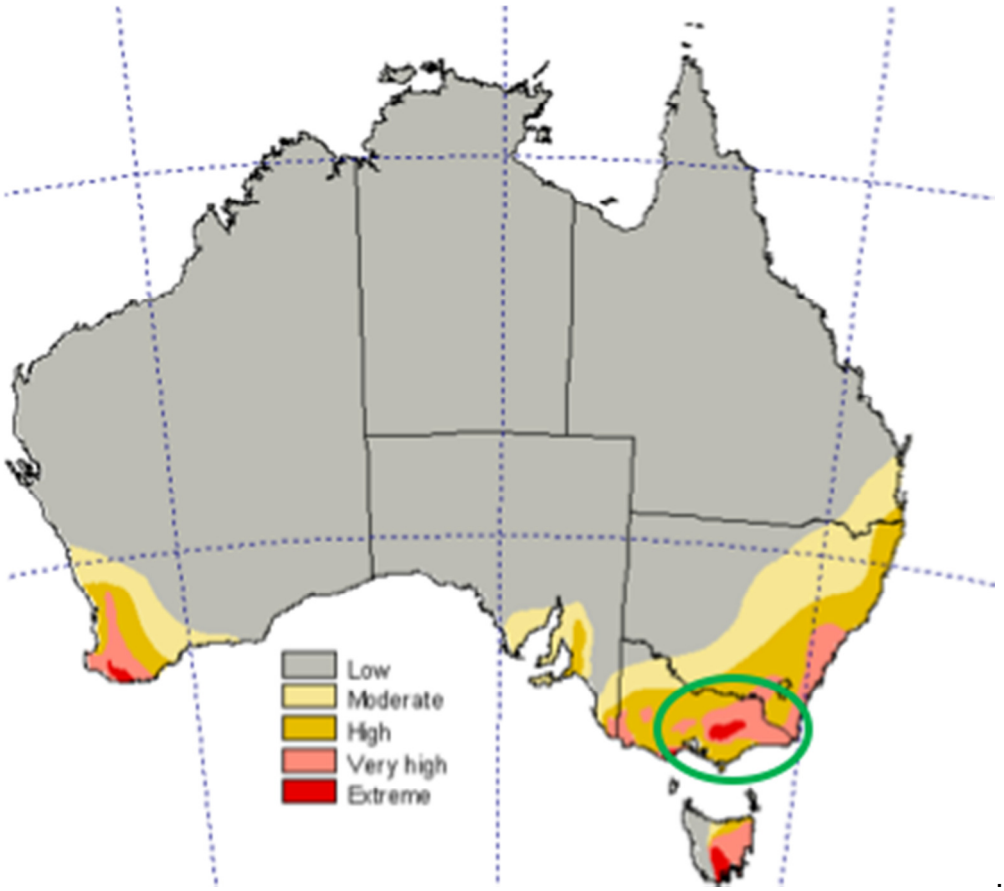
Source: AusNet Services PTRM

2 Background and regulatory framework

2.1 Bushfire risk

AusNet Services' network operates in a geographical location which is exposed to extreme bushfire risk. These conditions warrant significant investment to mitigate the bushfire risk.

Figure 1: AusNet Services' extreme bushfire risk



Following the 2009 bushfires, the Victorian Bushfire Royal Commission (**VBRC**) was established and the recommendations made by the VBRC drove changes to the Regulatory Regime (as described below) that ultimately have led to the roll-out of the REFCL technology.

2.2 Regulatory Regime

The AusNet Services REFCL roll-out Program is necessary to comply with the bushfire safety obligations imposed by the Victorian Government (**Government**) and is governed by a number of regulatory instruments. The regulatory framework has evolved and has become increasingly prescriptive over time and strict penalties for non-compliance have been introduced.

Each of the key regulatory instruments is described below.

2.2.1 Victorian Bushfire Royal Commission

The 2009 VBRC made several recommendations with respect to fires originating from electricity networks. Recommendation 27 called for new technology that delivered greatly reduced bushfire risk, being applied to all overhead conductors (Single Wire Earth Return (SWER) and 22kV powerlines) in high bushfire risk areas. The VBRC also suggested an expert taskforce be established to advise on the best means of achieving the intent of this recommendation. The Powerline Bushfire Safety Taskforce (PBST) was established for this purpose.

2.2.2 Powerline Bushfire Safety Taskforce

The PBST made its report to Government in September 2011. The Taskforce recommended the risk of powerlines starting bushfires could be reduced by:

- Installing fault suppression equipment known as Rapid Earth Fault Current Limiters (REFCLs) on selected 22 kV powerlines to reduce the risk of polyphase powerlines starting fires by automatically reducing the electric current in some types of powerline faults;
- Installing remotely controlled Automatic Circuit Reclosers (ACRs) on SWER lines to reduce the risk of SWER lines starting fires by enabling the devices to be set remotely so that they turn off those powerlines quickly when faults occur; and
- Putting powerlines underground or insulating conductors in the areas of highest bushfire risk.

The Taskforce also indicated the need for further research and development, noting REFCLs had not previously been used for bushfire suppression. In December 2011, the Government accepted the Taskforce's recommendations and established the Powerline Bushfire Safety Program to determine the optimal method for deploying REFCLs for bushfire prevention. This included further investigation of the optimal approach, which included trials of REFCL technology at both Frankston South and Kilmore South zone substations.

2.2.3 REFCL – Regulatory impact statement

A Regulatory Impact Statement (RIS) was prepared by the consulting firm, ACIL Allen, on behalf of the Victorian Department of Economic Development, Jobs, Transport and Resources,[4] on the Government's proposal to mandate new fault suppression standards through the *Electricity Safety (Bushfire Mitigation) Regulations 2013*. The RIS assessment incorporated a detailed cost-benefit analysis indicating that the estimated costs of deploying REFCLs would be more than outweighed by the reliability and bushfire risk reduction benefits.

The RIS recommended the installation of REFCLs at 45 zone substation across Victoria of which 22 substations form part of AusNet Services' network.

2.2.4 Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016

Following the completion of the RIS process, the Government made the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016* which amend the *Electrical Safety (Bushfire Mitigation) Regulations 2013*.

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[4] ACIL Allen Consulting, *Regulatory Impact Statement – Bushfire Mitigation Regulations Amendment*, 17 November 2015. Available at http://www.acilallen.com.au/cms_files/ACILAllen_BushfireMitigationRIS_2015.pdf

The effect of the amended Regulations was to place three obligations on AusNet Services:

- To install REFCLs (or equivalent technology) at specified zone substations;
- Each electric line, within the Electric Line Construction Area, with a nominal voltage of between 1 kV and 22 kV that is constructed, or is wholly or substantially replaced, is to be a covered or underground electric line; and
- To Install an Automatic Circuit Recloser on each SWER line.

Specifically, the amended Regulations required that each polyphase electric line originating from the 45 specified zone substations must have the following capability in the event of a phase to ground fault:

a) reduce the voltage on the faulted conductor in relation to the station earth when measured at the corresponding zone substation for high impedance faults to 250 volts within 2 seconds; and

b) reduce the voltage on the faulted conductor in relation to the station earth when measured at the corresponding zone substation for low impedance faults to —

(i) 1,900 volts within 85 milliseconds; and

(ii) 750 volts within 500 milliseconds; and

(iii) 250 volts within 2 seconds; and

c) during diagnostic tests for high impedance faults, limit —

(i) fault current to 0.5 amps or less; and

(ii) the thermal energy on the electric line to a maximum I^2t value of 0.1. [5]

The practical effect of the amendment is to impose an obligation on AusNet Services to install REFCLs (or equivalent technology) at its specified zone substations.

The Regulations use a scoring system to establish milestones for completing the required works. Each zone substation is attributed a point score from 1 to 5, with the highest value attributed to those zone substations where fire mitigation measures would provide the greatest benefit.

AusNet Services is required to complete the works necessary in order to accumulate:

- 30 points by 1 May 2019;
- 55 points by 1 May 2021; and
- 63 points by 1 May 2023.

In total, the Regulations require AusNet Services to install REFCL devices at 22 zone substations by 1 May 2023.

2.2.5 Electricity Safety Amendment (Bushfire Mitigation Civil Penalties Scheme) Act 2017

The Victorian Government subsequently introduced the *Electricity Safety Amendment (Bushfire Mitigation Civil Penalties Scheme) Act 2017* (**Amendment Act**). This Amendment Act amended the *Electricity Safety Act 1998* (Vic) (**ESA**) to provide for significant financial penalties if AusNet Services fails to achieve the number of points prescribed by the Regulations by the applicable deadline.

[5] Other performance requirements are also specified in the definition of 'required capacity' in the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016*.

The penalties legislation prescribes a penalty of $2,000,000 per point that AusNet Services falls short. Each zone substation is assigned a number of points (up to 5) depending on the degree of bushfire risk. Accordingly, penalties of up to $10 million per zone substation can apply if AusNet Services fails to achieve the Required Capacity by the prescribed dates. Additionally, a daily penalty of $5,500 can be applied for each day AusNet Services remains non-compliant.

These are significant financial penalties AusNet Services could incur, if it fails to meet its obligations. Additionally, this Amendment Act:

- Requires AusNet Services to prepare annual compliance reporting and associated independent audit; and
- Empowers ESV to request audits and information.

2.2.6 Electricity Safety (Bushfire Mitigation Duties) Regulations 2017

The *Electricity Safety (Bushfire Mitigation Duties) Regulations 2017* supports the amendments made to the ESA by prescribing:

- The performance ability that every polyphase electric line originating from a prescribed zone substation is required to have;
- The zone substations at which the required capacity is to be installed; and
- The points allocated to each substation for the purpose of meeting the milestones for installation.

2.2.7 Energy Safe Victoria's Administration Policy

Energy Safe Victoria (**ESV**) has prepared a policy[6], outlining how it intends to administer its audit and information gathering powers to ensure that appropriate regulatory oversight and assurance is achieved. The policy also outlines the penalty scheme associated with failing to comply with the additional bushfire mitigation duties. The topics covered include:

- The exemption request process;
- The modification of later dates and periods for compliance;
- Information notices; and
- Audit by ESV.

2.2.8 Exemptions and extensions

The *Electricity Safety Amendment (Bushfire Mitigation Civil Penalties Scheme) Act 2017* allows for exemptions or extensions to be granted in relation to certain obligations set out in the ESA and the Regulations. In September 2017, ESV clarified their expectations for applications for an exemption. The ESV has outlined a rigorous set of requirements for any exemption request including:[7]

6 Electricity Safety Amendment (Bushfire Mitigation Civil Penalties Scheme) Act 2017 – Energy Safe Victoria's Administration Policy

7 Process for the Administration of Exemption Requests, Powerpoint Presentation, ESV, September 2017.

- Risk demonstrated to be equivalent or reduced compared to the risk without the exemption;
- ESV will be informed by the Risk Reduction Model;
- Safety outcome must be maintained or enhanced compared to strict compliance; and
- Application must be specific (no blanket exemptions) and set out:
    - Zone substation and feeders highest level;
    - Design philosophy to be applied; and
    - Specific technologies to be deployed.

AusNet Services anticipates submitting a number of exemption requests to ESV. These are intended to ensure a cost effective delivery of the REFCL Program whilst still achieving the safety improvements necessary to mitigate bushfire risk. If AusNet Services' exemption requests are not approved, there is a material risk that the required capacity will not be achieved within the work proposed as part of this contingent project application. For example, we will seek to isolate an amount of cable connected to the Bairnsdale zone substation, which reduces the risk a 3rd GFN would be required and thus reduces the cost.

2.2.9 Victorian Electricity Distribution Code

The Electricity Distribution Code (EDC) specifies, in section 4.2.2, the maximum variations from standard nominal voltage for different voltage levels and durations. It is recognised the operation of the REFCL equipment will result in voltage variations at the HV customer's connection points which exceed the maximum permitted voltage level specified in clause 4.2.2 of the EDC. It is a condition of our Electricity Distribution Licence that AusNet Services comply with all applicable provisions of the EDC. It is therefore important that the EDC be amended to be consistent with our obligations under the Act and the Regulations.

In February 2018, the ESC published a project scope for a review of the voltage standards in the EDC. The ESC expects to make a decision in August 2018.[8] This should provide clarity on the framework to apply to these customers ahead of the AER's decision on this contingent project application.

Notwithstanding the regulatory compliance issues, there are also potentially serious safety and reliability consequences arising from operating the current network outside the allowed limits. HV customers may be exposed to a potentially unsafe electricity supply and any resulting failure of HV customers' equipment during REFCL operation could induce a further fault in the network that has the potential to cause ignition.

AusNet Services is working very closely with our impacted HV customers to identify the most cost effective solution to these safety issues. These solutions comprise a mix of customer hardening solutions (which ensure customers' installations can safely accommodate the elevated voltage during REFCL operation), conversion to a low voltage (LV) connection (where the customer load is sufficiently low) and the installation of isolating transformers on AusNet Services' network close to the customer connection. The proposed solution is determined on a site specific basis after comprehensive consultation with the affected customers. Importantly, where a customer elects to harden its assets, the customer must agree to accept voltage variations at the supply point that are higher than those currently specified in the EDC.

8 ESC, Electricity Distribution Code –Review of voltage standards for bushfire mitigation, project scope, February 2018

2.2.10 Review of Victoria's Electricity and Gas Network Safety Framework

In January 2017, the Minister for Energy, Environment and Climate Change announced an independent review of Victoria's Electricity Network Safety Framework, chaired by Dr Paul Grimes (Grimes Review). An Interim Report was released on 31 October 2017 for public comment, prior to the preparation of the final report.

The Grimes Review notes the cost of the REFCL Program has increased compared to the cost estimates contained in the RIS. The Review indicates that given the more detailed cost information available, the deployment of REFCLs may now have a higher estimated cost than the estimated benefits (though it notes more detailed examination is required).

Accordingly, the Grimes Review proposes that the deployment of REFCL technology to satisfy the *Electricity Safety Act 1998* and the *Electricity Safety (Bushfire Mitigation) Regulations 2013* be subject to review prior to each tranche by an independent expert panel appointed by the Minister, with the first report to be provided once further experience has been gathered with the roll-out of the first tranche.

AusNet Services' submission to the Grimes Review notes some complexities in implementing its recommendation.[9] The key element of our submission is that:

> *Should the Minister adopt the recommendation to review the outcomes of Tranche 1, "stopping the clock" on the remaining Tranches would be the only appropriate way of addressing the issues above.*
>
> *We also reiterate that any decision on this recommendation needs to be both timely and clear so, if necessary, established "stop the clock" processes can be initiated both with the ESV/Minister (project delivery timelines) and the AER (funding).*

If the recommendations were adopted, the Grimes Review could impact AusNet Services' ability to deliver the REFCL Program within the timeframes set out in the Regulations. However, in the absence of a ministerial response to the Grimes Review, AusNet Services continues to pursue our obligations to deliver the REFCL Program according to the prescribed dates.

9 AusNet Services, Review of Victoria's Electricity Network Safety Framework, 27 November 2017

3 Contingent project regulatory requirements

Under the Rules, a distributor may apply to the AER during a regulatory control period to amend a distribution determination that applies to that distributor where a trigger event for a contingent project in relation to that distribution determination has occurred. It is not until the pre-defined trigger event occurs, and the application is made, that the AER undertakes a detailed examination of the efficient costs required to satisfy the capital expenditure factors.

The final form of the 2016 amendments to the Regulations was not settled prior to the AER finalising its 2016-20 Electricity Distribution Price Review (EDPR) for the Victorian distributors. At that time, there was considerable uncertainty regarding the likely costs of meeting the proposed regulations. Accordingly, the AER approved a contingent project to enable AusNet Services to obtain a cost allowance if the regulations were enacted and a project scope completed.

The AER defined three Tranches of projects, each with its own 'trigger event'. AusNet Services considers that the trigger event for Tranche 2 has now been satisfied.

3.1 Trigger event

The AER's final decision set the trigger event for the second Tranche as follows:

Bushfire Mitigation contingent project 2[10]

In circumstances where a new or changed regulatory obligation or requirement (within the meaning given to that term by section 2D of the National Electricity Law) ("relevant regulatory obligation or requirement") in respect of earth fault standards and/or standards for asset construction and replacement in a prescribed area of the State is imposed on AusNet Services during the 2016–20 regulatory control period, the trigger event in respect of bushfire mitigation contingent project 2 occurs when all of the following occur:

1. *AusNet Services has identified the proposed capital works forming a part of the project, which must relate to earth fault standards and/or standards for asset construction and replacement in a prescribed area of the State and which are required for complying with the relevant regulatory obligation or requirement. The proposed capital works must be listed for commencement in the 2016–20 regulatory control period in regulations or legislation, or in a project plan or bushfire mitigation plan, accepted or provisionally accepted or determined by Energy Safe Victoria;*
2. *for each of the proposed capital works forming a part of the project AusNet Services has completed a forecast of capital expenditure required for complying with the relevant regulatory obligation or requirement;*
3. *for each of the proposed capital works forming a part of the project that relate to earth fault standards, AusNet Services has completed a project scope which identifies the scope of the work and proposed costings;*
4. *The AER has made a determination under clause 6.6A.2(e)(1) of the National Electricity Rules in respect of bushfire mitigation contingent project 1."*[11]

[10] Similar provisions apply to the first and third Tranches.

[11] AER, Final Decision, AusNet Services distribution determination 2016 to 2020, Attachment 6 – Capital expenditure May 2016, page 6-126.

3.1.1 Assessment of the Trigger Event

AusNet Services is lodging this contingent project application for Bushfire Mitigation Project 2 as the trigger event has occurred in relation to the introduction of earth fault standards. In particular:

- As previously noted, the Victorian Government has introduced regulations in respect of earth fault standards.
- A revised Bushfire Mitigation Plan was provided to Energy Safe Victoria in April 2018. This revised Bushfire Mitigation Plan, updates the details of the three Tranches and provides additional detail on our compliance program. It also details the required Tranche 2 capital works and their location in accordance with the AER's approved trigger event.[12] A copy of the revised bushfire mitigation plan (**BFM Plan**) is provided to the AER alongside this contingent project application.
- AusNet Services has prepared forecast capital expenditure for Tranche 2, as described in Section 8.
- The capital works for Tranche 2 are fully scoped and costed, as described in the attachments, models and supporting documents.
- The AER made a determination under clause 6.6A.2(e)(1) of the National Electricity Rules in respect of bushfire mitigation contingent project 1 on 21 August 2017.[13]

3.2 Materiality threshold

The Rules[14] require the contingent project application to demonstrate that proposed capital expenditure exceeds either:

- $30 million; or
- 5 per cent of value of the *annual revenue requirement* for the relevant *Distribution Network Service Provider* for the first year of the relevant *regulatory control period*, whichever is the larger amount[15]

AusNet Services' maximum allowed revenue in the first year of the current regulatory period is $586.0 million (real $2015), 5 per cent being $29.3 million. Therefore, the applicable threshold in relation to this contingent project is $30 million, being the larger amount.

As shown in Section 8, the total forecast capital expenditure is $139.7 million (real $2015) in the 2016-2020 regulatory period for this contingent project, and therefore the threshold has been met.

As such AusNet Services is seeking approval of the incremental capital and operating expenditure arising from Tranche 2 of the REFCL Program, which we propose to recover through our distribution network tariffs from 1 January 2019.

12 We consider the previously approved BMP is also satisfies the requirements of this criteria.

13 AER, Final Decision, AusNet Services Contingent Project Installation of Rapid Earth Fault Current Limiters (REFCLs) – Tranche 1, August 2017

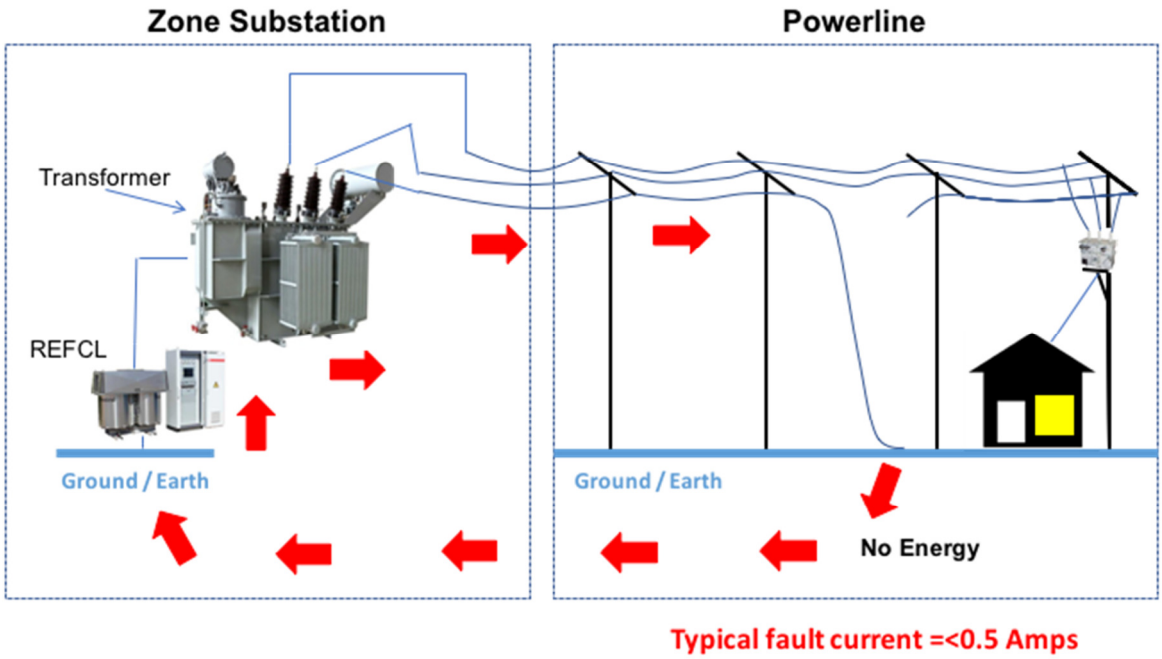
14 Clause 6.6A.2(b)(iv).

15 Clause 6.6A.1(b)(2)(iii).

4 What is REFCL technology?

A REFCL is a type of electricity network protection device, which is designed to minimise the fault current (energy) dissipated from phase to earth (wire to ground) faults on the 22kV network in order to reduce the risk of fire ignition associated with network incidents, as shown below.

Figure 2: How does REFCL technology work?



Source: AusNet Services

There are various types of technology that fall under the REFCL umbrella, however the only type of REFCL currently considered suitable by the Victorian Electric Supply Industry (VESI) for bushfire safety is known as the Ground Fault Neutraliser (GFN), a proprietary product by Swedish Neutral. Presently, the GFN is the only device that can meet the performance criteria of the Regulations.[16]

REFCL technology operating at the required performance standard will minimise the risk of fire ignition associated with phase to ground faults on days of heightened fire danger, such as those experienced on Ash Wednesday and Black Saturday. Based upon a sample period of network fault data, analysis undertaken by the Government and CSIRO predict network fire related incidents associated with the nominated zone substations may be reduced by between 50-55%.

A REFCL operates when a single phase-to-earth fault occurs. Its operation causes the phase to ground voltage of the faulted phase to be reduced to near earth potential (zero volts), thereby working to eliminate the flow of fault current. To achieve this outcome, the REFCL is tuned to the capacitance of the electrical network and a current injected into the transformer neutral that cancels the residual active fault current. This compensation results in phase to ground voltage on the faulted phase reducing to near 0 volts and the fault current being reduced to a very low value. The healthy phases could rise from 12.7kV to 24.2kV, being 22kV plus 10 per cent.

While the REFCL is compensating for a fault, the healthy phases remain energised and customers remain on supply. However, there remains a risk the energised phases may be in an

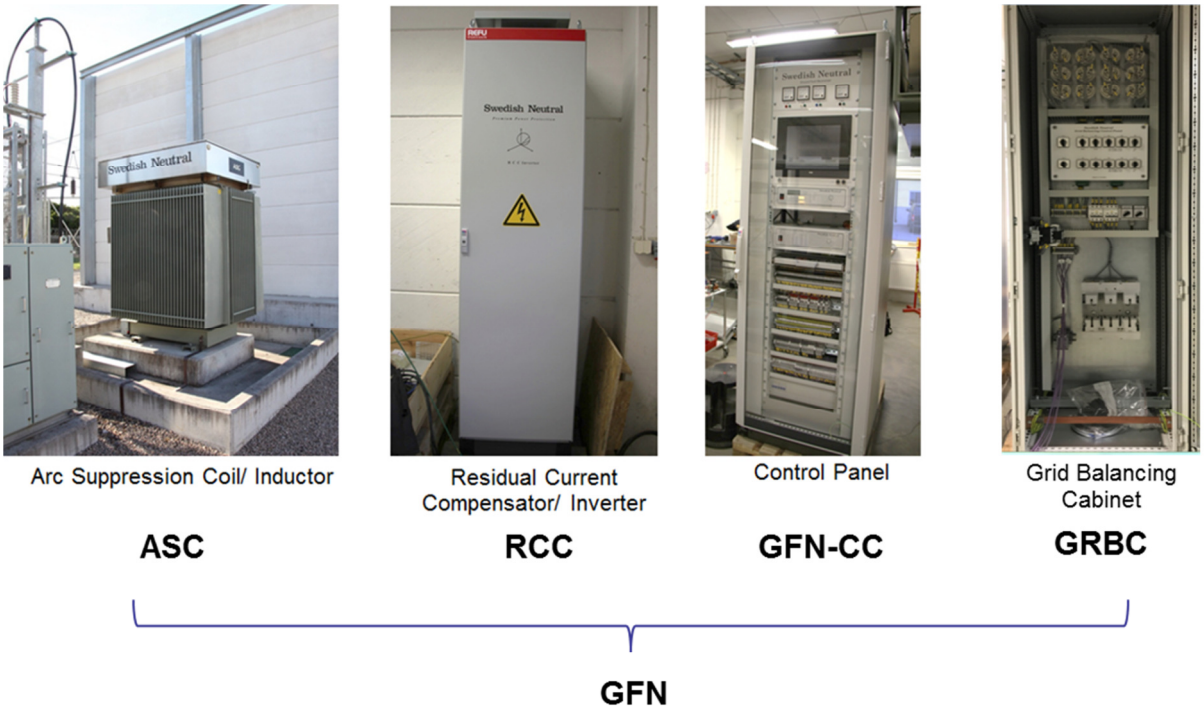
[16] As noted elsewhere in this application, AusNet Services is working with alternative providers to develop alternative solutions.

unsafe condition depending on the nature of the network fault. Accordingly, a maximum compensating period will apply, which may be varied subject to a detailed risk assessment.

The REFCL technology is made up of 4 main components:

- Arc Suppression Coil – also known as a large inductor, which compensates for the leakage current during an earth fault.
- Residual Current Compensator – also referred to as the inverter, which is located in the zone substation control building or switchroom. It is used to reduce fault current by compensating for the active current during an earth fault.
- Control Cubicles, which controls the equipment.
- Grid Balancing Cabinet, which fine tunes capacitive imbalance from the zone substation to achieve better detection sensitivity.

Figure 3: Four components to REFCL technology



Source: AusNet Services

As explained in further detail below, the scope of the required works is much broader than the four components described above. This is because the installation of REFCLs requires a paradigm shift in how our network is designed, operated and maintained. As such, all components of the affected 22kV distribution network need to be reviewed to ensure that the REFCL enabled network continues to operate safely and reliably.

4.1 Alternative technologies

The Regulations prescribe a performance standard that must be met, rather than specifying a particular technological solution. However, in this instance, the mandated performance standard was based on REFCL trials conducted by the Powerline Bushfire Safety Program (PBSP), as explained below:

> *"PBSP conducted a series of world-first trials of Rapid Earth Fault Current Limiter (REFCL) technology for use on electricity networks to reduce fire risks on bare-wire overhead powerlines.*
>
> *[…]*

> *Through this research, the Victorian Government and electricity distribution businesses identified and confirmed new fault detection and suppression standards required to significantly lower the risks that 22kV powerlines will start bushfires in worst bushfire risk conditions. These standards are now in force from the 1 May 2016 commencement of the Electricity Safety (Bushfire Mitigation) Amendment Regulations."* [17]

The Victorian Government also highlighted the superior performance of the REFCL technology in its factsheet 'REFCL – Introducing best knowledge and technology':

> *"In a series of world-first trials, the Victorian Government together with the electricity distribution businesses and research experts demonstrated that REFCLs can suppress arc-induced bushfire ignitions from wire-to-earth faults on 22kV powerlines.*
>
> *The technology was successfully tested under worst-case bushfire conditions, confirming critical fault detection and suppression standards, which are necessary to stop downed powerlines from starting bushfires, and further determining the optimal safety settings of these devices to reduce the risk of powerlines-started fires.*
>
> *The test program demonstrated that REFCLs provide over 10-times better protection than the current best network protection technology.*
>
> *These standards were mandated for 22 kV powerlines proceeding from 45 zone substations by the Government's 1 May 2016 amendments to the Electricity Safety (Bushfire Mitigation) Regulations."*[18]

At the time the Regulations were made, and it remains so, the REFCL technology was the only technology available to meet the performance requirements. In Tranche 1 the AER approved an allowance to assist AusNet Services to explore alternative technologies and manage its sole supplier risk. AusNet Services has been actively working, in conjunction with Powercor, to identify and progress alternative technology.

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Regardless, this workstream:

- Provides a potential back-up solution if problems are experienced with the existing supplier, either in terms of volume delivery, reliability or ability to meet the specifications. This should allow AusNet Services to achieve the specifications if the current technology proves to be unsuitable.
- Helps mitigate against the risk of cost increases from the existing supplier.
- Provides additional alternatives in the longer term when replacement of the current technology becomes necessary.
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[17] Department of Environment, Land, Water and Planning, Investing in new technology, research and development.

[18] Department of Environment, Land, Water and Planning, REFCL – Introducing best knowledge and technology.

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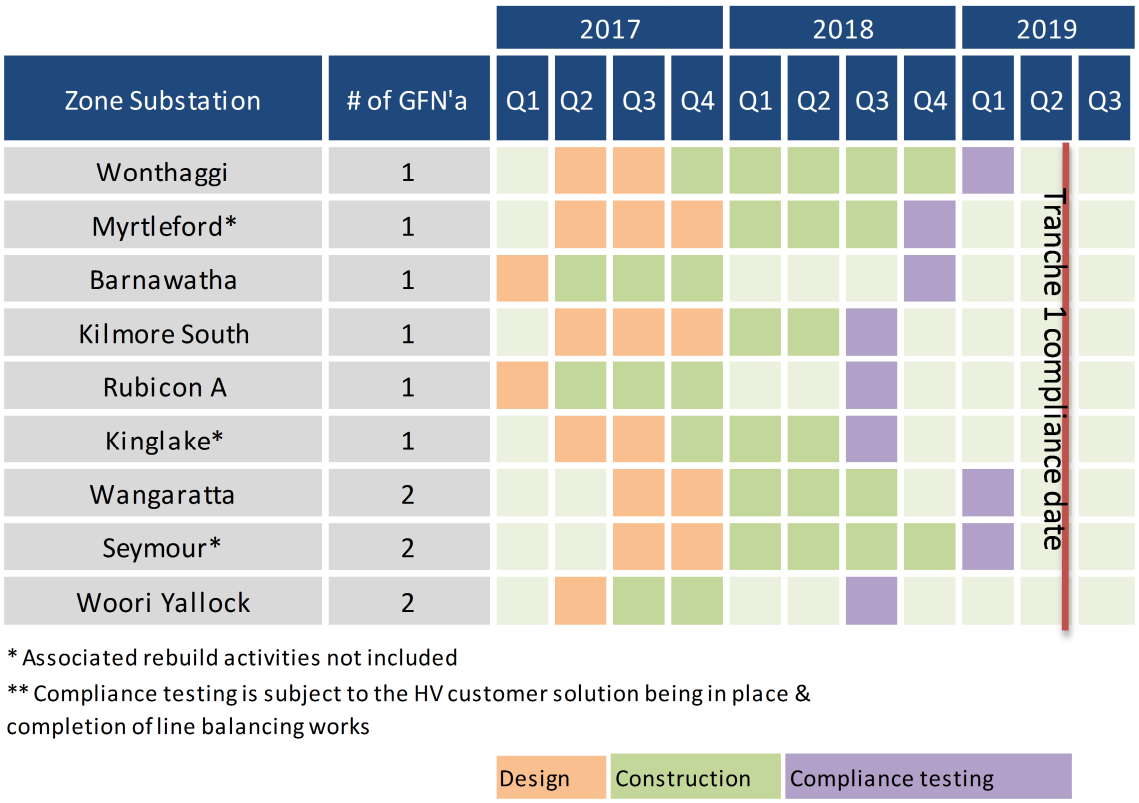
5 Tranche 1 Progress Update

5.1 Overview

As at end March 2018, three zone substations have REFCLs installed and construction works have commenced at all remaining Tranche 1 zone substations.. A progress and forward plan for all zone substations is presented in Figure 4.

Figure 4 Summary of Tranche 1 progress and forward plan



Source: AusNet Services

Tranche 1 is currently on track for completion by the mandatory compliance deadline and our latest financial forecasts indicate we will deliver the Tranche 1 Program in line with the AER's approved allowance, notwithstanding unforeseen delivery issues.

In hindsight, the original Tranche 1 delivery schedule included in the contingent project application was ambitious. The Program experienced a number of delays due to unforeseen complexities in the planning and design phases. The REFCL program involves the deployment of new technologies not previously adopted by other electricity network distributors in Australia and, as such, there has been a significant learning curve in their deployment.

These delays, together with the agreed payment schedules for major equipment and external contractors, have impacted the profile of expenditure, with less expenditure to date compared to the AER allowance. This expenditure underspend will be reversed with higher expenditure than the AER allowance in the remaining Tranche 1 delivery period.

Table 3 Comparison of Tranche 1 expenditure ($m real 2015)

	2016	2017	2018	2019	2020	Total
AER approved Capex forecast	6.9	53.24	39.5	0.12	0.0	99.7
Latest Budget Forecasts	0.0	32.1	46.9	16.1	0.0	95.1
Difference	**-6.8**	**-20.5**	**7.2**	**15.9**	**0.0**	**-4.1**

Source: AusNet Services

5.2 HV customers solutions

A key element of the REFCL Program is implementing solutions for the HV customer sites. In Tranche 1 there are 9 HV customers with a total of 12 HV connection points. Following negotiations with the HV customers, the agreed solutions for the Tranche 1 HV customer connection points are summarised as:

- One connection point is being converted to Low Voltage (**LV**) supply;
- Three connection points are having their HV electrical assets hardened to withstand REFCL operations; and
- Eight connection points will have isolating substation solutions installed to isolate the HV electrical assets from REFCL operations. Isolating substations solutions include an isolating transformer and two automatic circuit reclosers (**ACRs**), noting one of the isolating substations, due to the size of the customers load, requires two isolating substations.

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Table 4 below shows a comparison of our latest forecasts (based on the above HV customer program of works) compared to the expenditure allowance. Our latest forecast for the Tranche 1 HV customers is $9.9 million, which is higher than the $6.9 million allowance. The current forecast expenditure is less than our initially proposed expenditure for HV customers, reflecting savings driven by:

- Strong customer engagement allowing for less costly hardening solutions to be implemented at several sites;

- Modest reductions in the installed cost of an isolation transformer compared to our proposal (noting that these isolation transformer costs are above the approved allowance); and
- A HV customer on a transfer feeder will not be impacted by Tranche 1 REFCL operations. They will be impacted by Tranche 3 REFCL operations.

We also note that expenditure on Tranche 1 to date has been slower than was forecast in early 2016. This reflects the that complexity and novel nature of the project required more time to be spent on early parts of the project than initially expected, delaying expenditure, for example:

- The HV isolating transformers are bespoke pieces of equipment that required new design specifications to be developed before units could be ordered. Whilst this bespoke mature was always known, more allowance for the time required to develop designs should have been made; and
- AusNet Services undertook an extensive vendor selection process to ensure value for money was achieved in this procurement and this process took more time than initially foreseen to finalise.

Detailed design is currently underway for the 5 MVA and 7.5 MVA isolating substations and AusNet Services ordered the first four isolating transformer units, 3 x 5 MVA and 1 x 7.5 MVA, from the manufacturer in January 2018. The remaining isolating transformers for Tranche 1 customers were ordered in March 2018. All isolating substation ACRs were ordered in March 2018.

Table 4 Comparison of Tranche 1 expenditure on HV Customers (m $2015 direct)

	2016	2017	2018	2019	2020	Total
AusNet Services – Tranche 1 Proposal	-	11.8	2.1	-	-	13.8
AER Tranche 1 approved Capex forecast	-	5.8	1.1	-	-	6.9
AusNet Services – Tranche 1 Latest Budget Forecasts	-	0.1	7.4	2.5	-	9.9

Note: All values restated to $2015 for comparison purposes.

Source: AusNet Services

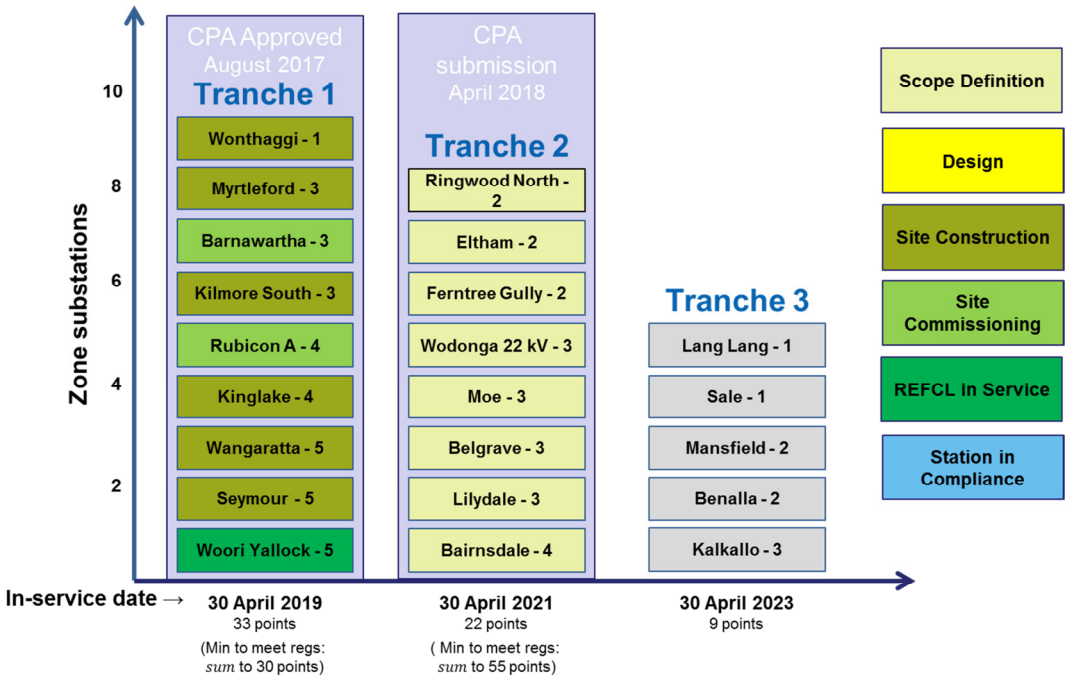
Given that Tranche 2 is a continuation of the REFCLs program which is now well advanced, with construction underway at all Tranche 1 zone substations, there is more certainty around the timing of expenditure that there was in the Tranche 1 CPA.

5.3 Construction update

Whilst the REFCL Program comprises three Tranches, there is considerable overlap and interdependency between the Tranches. As Tranche 1 progresses, we are gaining further insights which improve our performance in each subsequent Tranche.

Figure 5 shows the current status of the three Tranches of the REFCL Program.

Figure 5 REFCL Delivery Schedule



Source: AusNet Services

As previously noted, works are underway at each Tranche 1 zone substation and their respective electricity supply networks.

- A high level snapshot of the current status of the Tranche 1 REFCL Program of works is as follows:
- Woori Yallock (**WYK**): the two REFCLs are in service in tied bus mode. This is due to technical issues with operating in split bus mode (the mode required to reach required capacity). A solution to this technical issue has been identified and steps are being undertaken to address it. Additionally, line balancing works are not yet complete and we will be unable to operate at the required capacity until this work is completed. The one HV customer connection has hardened their HV electrical assets to withstand REFCL operations.
- Barnawartha (**BWA**): the REFCL is installed and was commissioned in November 2017. Required capacity has been demonstrated on a reduced version of the BWA network. However, BWA is not yet in service as line balancing works are being finalised and the installation of isolating substations at two (2) HV customer connection points has not been completed.
- Rubicon A (**RUB A**): the REFCL is installed and was pre commissioned in December 2017. Full commissioning has been deferred until the completion of line balancing works. The three (3) HV connection point solutions are being progressed with two (2) of the HV connection points being hardened to withstand REFCL operations and one HV connection point being isolated from REFCL operations.
- Construction works are underway at the remaining six Tranche 1 zone substations, noting Wonthaggi (**WGI**), Myrtleford (**MYT**), Kinglake (**KLK**) and Seymour (**SMR**) are being progressed concurrently with rebuild activities in addition to REFCL-related activities. For clarity, the rebuild activities were not funded as part of our Tranche 1 contingent project application.

- Line hardening activities for Tranche 1 are well progressed with significant numbers of surge arrestors having been replaced to date.
- Tranche 1 cable testing and replacement activities are in progress, with increased volumes of work than originally anticipated. Additional testing resources are currently being sought to manage this increased work load.
- All Tranche 1 line balancing scope definitions have been completed. At end March 2018, 49% of designs for line balancing works have been completed. Line balancing construction activities are underway, with the initial focus being on the WYK, BWA, RUB A and KLK networks.
- Rectification of the Distribution Feeder Automation (**DFA**) scheme requires the development of new higher sensitivity sectionalisers. AusNet Services has developed a RECFL-compatible design specification for the sectionalisers and are working with suppliers to progress this product.

5.4 Key Learnings

AusNet Services has used its experience from Tranche 1 delivery to date, together with a more detailed assessment of the scope of work, to refine its approach to this Tranche 2 contingent project application. In a number of areas, we have used these learnings to reduce the costs of undertaking components of this REFCL Program. However, our experience has also identified cost increases in other areas.

Key learnings and activities undertaken between Tranche 1 and Tranche 2 include:

- Reducing the scope of the Program through Transfer Feeder Reviews. These reviews have allowed us to remove 12 feeders from the scope of the Tranche 2 Program as they will no longer be used to transfer supply between REFCL and non-REFCL zone substations. This avoids the costs associated with network hardening, balancing, compatible equipment volumes and HV Customers on these transfer feeders.
- Reducing the scope of the surge arrestor replacement program through physical survey of installed equipment. The Tranche 1 application was based on database quantities and subsequent physical survey results identified a reduction in the volumes required. We have been able to use physical survey volumes in this Tranche 2 application ensuring the best available information is used.
- The accuracy of existing current transformers (CTs) limits the capability to accurately determine the faulted feeder at the zone substation and determine sources of imbalance. We are now planning the installation of zero sequence CTs at zone substations in all Tranches.
- We face challenges in servicing HV customer needs whilst installing our REFCL equipment, as this requires a number of planned outages. Note, this is separate from the works required at their premises to either isolate or harden their premises. Temporary generation is required at some customer sites to avoid the planned outages and minimise supply interruptions.
- Achieving balance on individual switchable sections has been proven critical by experiences operating without a balanced network at WYK. This confirms the need for the line balancing work to achieve the required capacity and a reduction in line balancing works does not appear possible.
- Increased costs in relation to cable testing and replacement. As part of the initial Woori Yallock REFCL commissioning, cables failed during initial stress testing. Cable failures were also experienced by Powercor as part of their REFCL commissioning activities. Increased cable testing, both online and offline, has been included in the scope of Tranche 1 delivery activities as well as allowance for cable replacement. These

learnings have been reflected in the Tranche 2 cost estimates. By carrying out more non-destructive testing and cable replacement before stress testing, we expect to reduce the impact on customers during this critical phase of the Program.

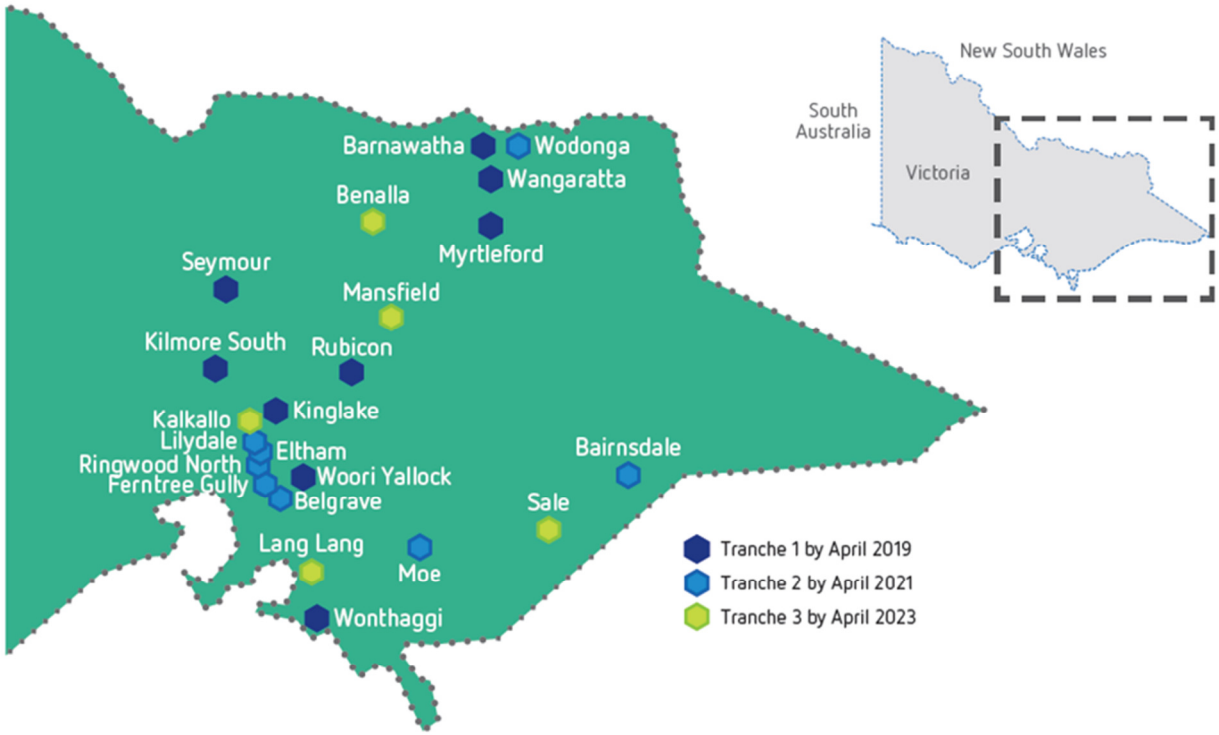
We note we have changed the intended composition of Tranches 2 and 3. We will now progress Wodonga 22kV as part of Tranche 2 and Kalkallo has been moved into Tranche 3. This has been reflected in the latest BFM Plan submitted to the ESV on 20 April 2018.

6 Tranche 2 overview

Each of the three Tranches have different characteristics and challenges. This arises due to the different nature of the substations and their respective supply networks progressed in each Tranche.

In Tranche 2, we are installing REFCLs at 8 zone substations. These zone substations are generally described as peri-urban – the area between urban and rural areas. In Tranche 1, the majority of substations were more rural in nature than those being undertaken as part of Tranche 2. Figure 6 below shows the substations that are being undertaken in each Tranche.

Figure 6 REFCL Program Overview



Source: AusNet Services

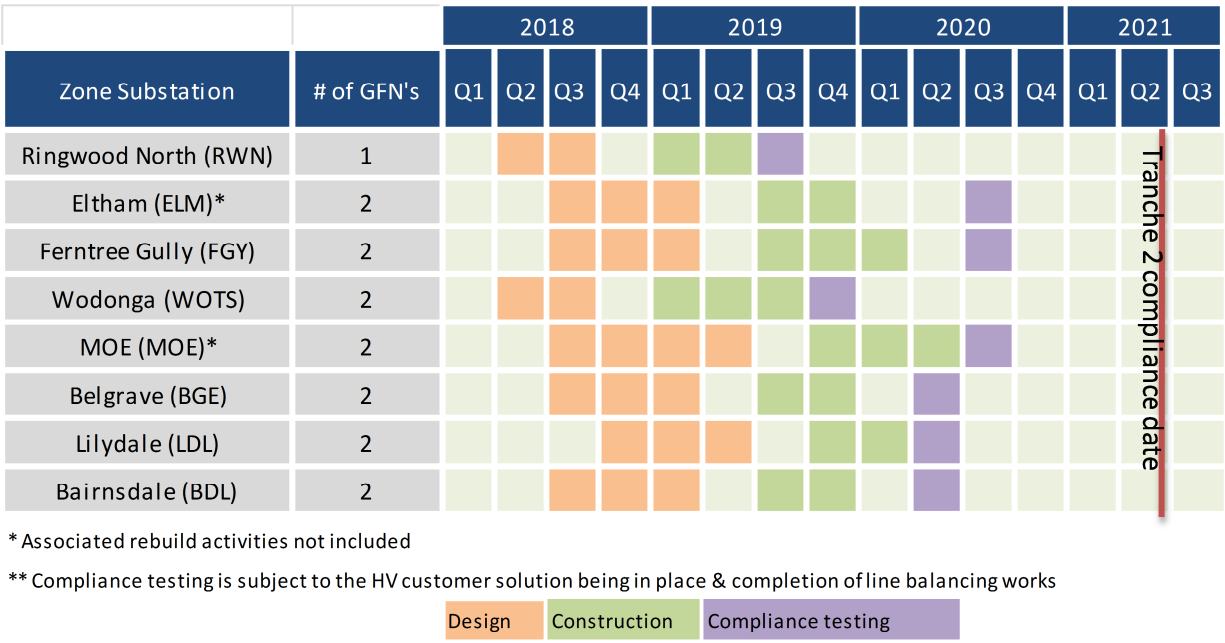
The different locations and characteristics of the zone substations, and their respective supply networks, give rise to several key differences between the Tranche 1 and Tranche 2 contingent project applications:

- 7 out of the 8 Tranche 2 zone substations require 2 GFNs to be installed to meet the required capacity specifications, whereas in Tranche 1, only 3 out of the 9 zone substations required 2 GFNs.
- A greater number of HV customer connection points (27 sites compared to 12). In Tranche 2 we have 12 unique HV customers with a total number of 27 HV connection points. In Tranche 1, the HV customer connection points supplied generally larger industrial customers or generators. In Tranche 2, there are a larger proportion of smaller load HV customer connection points. As such, there is a greater mix in the size and type of solutions required for Tranche 2 HV customers.
- A greater proportion of underground cables emanate from the Tranche 2 zone substations in comparison to Tranche 1. Tranche 1 had a total length of 198 km of underground cable, whereas Tranche 2 has a total length of 426 km of underground cable~~,~~ which was installed in the urban expansion areas. We have experienced cable failures associated with REFCL testing and commissioning activities and, on the basis of

this experience, AusNet Services now considers that a proactive approach is required to identify and repair or replace any critical poor condition cables or insufficiently rated cables prior to operating a REFCL protected network. For Tranche 2 we anticipate needing to proactively replace 18.4 km and complete 159 rectifications and reactively replace 11.6km and complete 122 rectifications across the cable population. We have provided a model demonstrating the relevant assumptions underpinning this forecast.

The proposed delivery schedule for each Tranche 2 zone substation is set out in Figure 7 below.

Figure 7: REFCL Tranche 2 timeline



Key characteristics of each Tranche 2 Zone Substation are set out in Table 5 below.

Table 5 Summary of zone substations

Zone substation	22kV Network Size (km)	Customers	22kV Insulated Network Size (km)	22kV Feeders	22kV Transfer Feeders (to zone substations that will not be fitted with a REFCL in Tranche 1.)	Automatic switchable sections	Single phase km requiring balancing capacitors	HV connection points
RWN	211	18,168	30.8	7	0	43	20.4	0
ELM	407	33,541	45.1	8	2	63	60.2	4
FGY	279	35,874	75.0	10	0	36	1.2	4
WOTS22	1,475	12,049	38.5	6	0	36	633.9	5
MOE	1,600	22,410	20.8	8	1	45	354.7	4
BGE	599	19,309	69.4	6	1	54	181.3	4
LDL	616	21,911	52.4	8	1	46	104.3	5

BDL	1,637	23,829	44.2	8	1	60	555.3	1
Total	**6,827**	**187,091**	**378.2**	**61**	**6**	**383**	**2031.6**	**27**

Source: AusNet Services

6.1 Necessary works

Significant work is required at each zone substation to accommodate the installation of the REFCL equipment. Additionally, the speed and sensitivity at which the REFCLs operate means traditional protection schemes distributed along a feeder will not operate as they normally would, to detect and isolate a faulted section of the network. Further, the operation of the network with REFCL's in service imposes higher electrical stresses on the network.

As a consequence, capital works extend beyond the immediate confines of the zone substation to ensure that the network continues to operate safely and reliably and AusNet Services maintains compliance with its Distribution Code obligations. The REFCL project therefore involves five capital expenditure workstreams, described below:

- **Zone substation works**

  Includes: REFCL installation (being the GFN) and associated equipment within the zone substation. It also includes the replacement of assets that fail during network hardening tests of the relevant high voltage network.

  Reason: In addition to installing the REFCL, additional works are required because the REFCL technology is based on a different earthing philosophy. It is essential that the zone substation operates safety and reliability in the new environment.

- **Network Balancing**

  Includes: Initial desktop and field modelling work followed by: capacitor bank installations, third phase installations and re-phasing long single phase lines.

  Reason: Long single phase (two-wire) spurs teed off three-phase lines can create significant capacitive imbalance. Fire risk reduction relies on minimal capacitive imbalance on switchable sections of the network.

- **Line Hardening**

  Includes: Surge Arrestor and underground cable replacements.

  Reason: When an earth fault occurs, the REFCL response creates increased voltage stresses (compared to without REFCLs) on line equipment connected to un-faulted phases, which can lead to a second fault. In the absence of line hardening, the REFCL installation would increase fire risk and decrease network reliability.

- **Compatible Equipment**

  Includes: Automatic Circuit Reclosers (ACR), Voltage Regulators, sectionalisers and Capacitor Bank replacements.

  Reason: Some widely utilised line equipment cannot be used with REFCLs due to the reduced fault currents. This is separate to line hardening, which is solely concerned with the ability of line equipment to withstand over-voltage events.

- **Distribution Code compliance (HV Customers)**

  Includes: The installation of isolating transformers to isolate HV electrical assets at customers sites from voltage increases or hardening of customer HV electrical assets to withstand REFCL operations.

  Reason: To ensure that AusNet Services maintains compliance with the maximum permissible voltage variations specified in the Victorian Electricity Distribution Code.

Non-compliance with the Code requirements would have unacceptable safety and reliability implications for HV customers and for the network.

In addition to these capital works, the project will also entail expenditure for an incremental increase in AusNet Services' operating expenditure. This contingent project application and attachments provide a detailed explanation of the proposed expenditure. In accordance with the contingent project provisions in the Rules, only the incremental costs associated with the trigger event are included in this contingent project application.

7 Project management process

7.1 Program Governance Framework

An overarching REFCL Program Governance Framework has been established to provide end-to-end program oversight and accountability for the REFCL Program. The Framework aligns with AusNet Services' values and commitment to safety with:

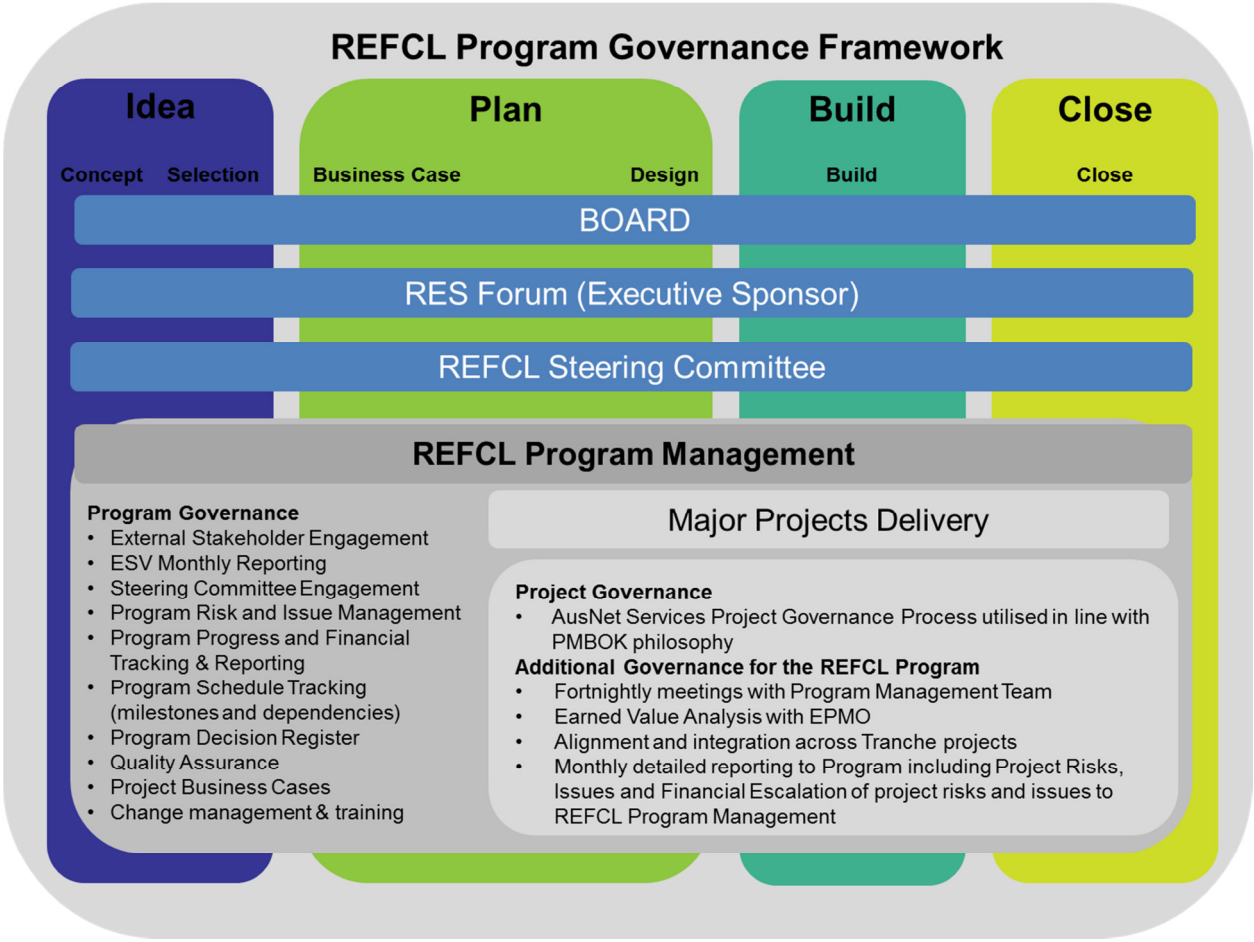
- Clear accountabilities, reporting and robust risk and issue management;
- Sustainable, long term, reliable, economical and workable whole of life designs;
- Delivery as per agreed timelines without compromising reliability and other service standards;
- Integration with the rest of AusNet Services' work program;
- Compliance with required obligations;
- Strong relationships with all stakeholders in order to successfully manage change;
- Development of internal capability in order to facilitate the transition to business as usual (BAU); and
- Use of BAU processes and resources where possible.

Risk management is an important aspect of the Framework, as the REFCL technology has never been operationalised at the performance standard required by the Regulations. The potential exposure is therefore significant and must be proactively managed.

The Program Management team includes a dedicated risk management resource who works proactively with the work stream leaders, project managers and the program management team to identify and assess risks and to develop and monitor risk mitigation measures and controls and to monitor their implementation and effectiveness.

The figure below depicts the REFCL Program Governance Framework.

Figure 8: REFCL Program Governance Framework



Source: AusNet Services

A REFCL Steering Committee was established in early 2016. Its members include key Executive General Managers, General Managers and key program management team representatives.

The Steering Committee is accountable for the successful delivery of a functioning REFCL system across the affected 22 zone substations in AusNet Services 22kV electricity distribution network, in accordance with the regulated schedule and performance criteria.

The Steering Committee:

- Provides strategic and operational direction and support;
- Acts as an escalation point for issue resolution; and
- Actively monitors the Program's critical risks and their mitigations, issues, budget and schedule.

The Steering Committee has met regularly since March 2016.

The REFCL Program Governance Framework provides strong evidence that the REFCL Program is well managed with Program and delivery project risks identified and managed effectively. Further information on our REFCL governance arrangements can be provided to the AER on request.

7.2 Efficient Delivery

AusNet Services' objective is to ensure that the forecast expenditure for this contingent project is prudent and efficient[19]. For the purposes of this contingent project, we consider expenditure is:

- *Prudent* if it is necessary to ensure AusNet Services' compliance with the mandated earth fault standards and mitigates bushfire risk to the maximum extent possible without compromising safety.
- *Efficient* if it delivers the scope of works at the least possible cost to customers, including the expected costs of unserved energy during construction and following the establishment of the REFCL.

To ensure the expenditure forecast for AusNet Services' project scope is expenditure that would be incurred by a prudent and efficient DNSP, a specific cost-benefit analysis is conducted for each workstream which:

- Describes the investment need;
- Identifies the alternative credible engineering options at that location;
- Determines the costs and risks associated with each option; and
- Selects the least cost, prudent option having regard to safety and performance risks.

The cost-benefit assessment described above is consistent with the Regulatory Investment Test for distribution (RIT-D)[20]. In accordance with the RIT-D principles specified in the Rules[21], AusNet Services' cost-benefit analysis:

- Is proportionate to the scale and likely impact of each option; and
- Is applied in a predictable, transparent and consistent manner.

The cost-benefit analysis determines AusNet Services' strategy for each workstream, ensuring that the preferred option will deliver the most prudent and efficient outcome. The possibility of non-network options or operating and capital expenditure substitution are also considered.

AusNet Services is confident our approach ensures the scope of work and the resulting expenditure forecasts are prudent and efficient, in accordance with the capital and operating expenditure criteria in the Rules, which are addressed in Chapters 8 and 9 respectively[22].

7.3 Project cost estimates and unit rates

Project cost estimates are prepared as part of AusNet Services' standard approach to developing, managing and reporting projects and programs of works in accordance with defined project execution procedures and practices. AusNet Services' estimates are founded on the following five key principles:

1. All projects are to be project managed in accordance with AusNet Services' project execution procedures and practices.

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19 Clause 6.6A.2(f)(2) refers to the *capital expenditure criteria*, which refer to the efficient and prudent costs of meeting the *capital expenditure objectives*.

20 The REFCL project is also subject to a separate RIT-D process, although it relies on the costs benefit analysis presented in this contingent project application and supporting documents.

21 Clause 5.17.1(c).

22 Clause 6.6A.2(f).

2. For Business Case investment approval and implementation, P90[23] estimates provide confidence in processes of project priority, affordability and strategic fit. However, the costs presented in this contingent project application are P(50) estimates[24], i.e. expected cost, which excludes project risk and uncertainty covered by management reserve provision in a business case.
3. Estimates are subject to reviews and a sign-off process based on consistent clear lines of responsibility and accountability that will ensure costing standards and controls are applied.
4. Regular system reviews are conducted to encourage and facilitate continuous improvement.
5. Project learnings are shared to increase corporate knowledge.

The unit costs assumed for GFNs reflect a quotation provided by the manufacturer, Swedish Neutral, for the first 7 units of the Tranche 2 GFN order.

Unit rates for other works are primarily based on the rates incurred in recently completed work or where possible, updated based on experience from the Tranche 1 project. These unit rates therefore reflect the efficient costs of delivering similar projects in AusNet Services' network area.

Work is delivered utilising an efficient combination of competitively tendered and internal resources. Pre-qualified panels of design and installation service providers have been established by competitive tender and ensure that providers have the skills and resources to undertake the required work in a safe and competent manner and can comply with works management processes.

Further information on AusNet Services' cost estimating process are provided in the supporting document, *Cost Estimating, Program Delivery & Unit Rates*, which accompanies this contingent project application. AusNet Services' actual unit rates are confidential, and are provided to the AER on that basis.

7.4 Efficient delivery

AusNet Services has implemented a number of initiatives to ensure that the REFCL Program is delivered efficiently, as discussed below.

7.4.1 Standard Designs

AusNet Services utilises a number of standard designs and modular constructions to aid the delivery of zone substation projects. For example, a standard modular 22 kV switchboard has been utilised in zone substation construction and rebuild projects. This switchboard has a number of advantages over the installation of stand-alone switchgear, including the ability to fabricate and fit-out the building off-site in a factory and to readily relocate the switchboard should it no longer be required in its current location.

To deliver the REFCL Program, the standard switchboard has been modified to ensure all the equipment is rated for REFCL operation and to include measuring transformers capable of detecting low fault currents. The use of a pre-assembled switchboard speeds delivery of the REFCL Program because the switchboard utilises a standard design and is assembled off-site by a supplier and delivered complete to site (already fitted with all the components and

[23] A detailed cost estimate that has a 90% confidence factor of not being exceeded by cost at project completion.

[24] The costs presented in this application also exclude the written down value of assets that need to be replaced prior to end of life. While the written down value of these assets are project costs, and included in the business case,

accessories such as air-conditioning). This reduces the design and on-site construction effort leading to more efficient and faster project delivery.

7.4.2 Shared experience

The operation of REFCLs to mitigate bushfire risk has not been undertaken other than in Victoria and so, at the start of the Tranche 1 project, no knowledge relating to the installation or operation of the REFCL existed. AusNet Services and Powercor are both required to achieve the required capacity mandated in the Regulations. The businesses have therefore been sharing information on the installation and operation of their respective units to increase expertise and reduce the probability of unplanned customer interruptions.

In addition, AusNet Services and Powercor have shared the results of tests such as surge arrestor testing to reduce the time and cost of testing a statistically significant sample. A key learning from Tranche 1 has been the need for proactive cable testing and, where necessary, cable replacement. Cable failure data, and cable testing results to date, has been shared between AusNet Services and Powercor.

7.4.3 Leveraging existing contracts and relationships

Delivery of the Program in the required timeframe would not be possible without using existing contracts and relationships. The procurement of equipment relies on established contracts with suppliers and enables the use of standard equipment such as the 22 kV switchboards. Additionally, the pre-qualified service providers (described below) will be used to deliver on-site work.

7.4.4 Resourcing

Our approach is to employ a combination of in-house and outsourced resources to optimise the overall Program costs while meeting the delivery timetable. Additional external resources have been, and will continue to be, engaged to meet the peak workload. These additional resources are not retained when the volume of work reduces, following the completion of the REFCL Program, ensuring that internal resources are always fully occupied.

The establishment of pre-qualified panels of service providers using a competitive process ensures efficient costs and that appropriate quality services are provided. In addition, the cost and time taken to engage resources on a Program is reduced. The use of different labour sources also allows benchmarking comparisons to reduce the risk of cost blowouts, which are not uncommon for large capital projects such the REFCL Program, especially given the untested nature of the technology.

7.5 Change management

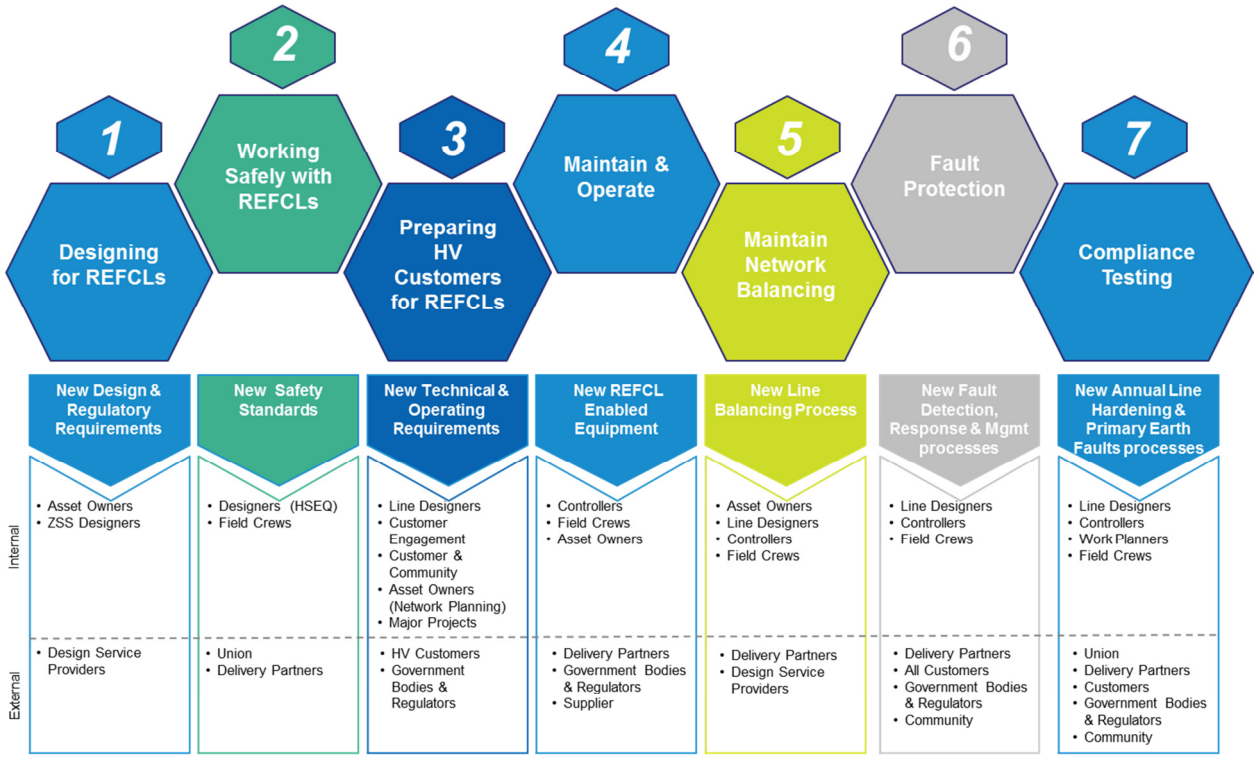
The installation of REFCLs has wide-ranging operational implications across the AusNet Services' electricity distribution business. For example:

- The transition from Low Resistive to Enhanced Resonant Earthing represents a paradigm shift in how we design, maintain and operate our electricity distribution network.
- Safety practices have been enhanced to recognise the network has the potential to operate at higher voltages. As a consequence, live-line workers need Protective Personal Equipment that is rated for these higher voltages.
- Additional planning and resonant earthing protection engineering specialists are required to ensure the network remains in balance. This issue is discussed in further detail in section 9.

- Annual testing is required to ensure the REFCLs operate as intended.

Change management is a fundamental element of the REFCL Program implementation, as illustrated in Figure 9 below.

Figure 9: Change management for implementation of the REFCL Program



Source: AusNet Services

AusNet Services' REFCL Program Change Management Strategy provides the framework to address how we are managing and integrating each of the seven change risks. This includes how we:

- Conduct the overall change management approach for the REFCL Program;
- Optimise audience buy-in;
- Embed the change and ownership;
- Build capability;
- Minimise business disruption; and
- Manage and mitigate change resistance.

This is achieved by using the following strategies:

- Engagement: Involving stakeholders in problem solving and decision making and listening to what they need, and where appropriate, incorporating that into the Program Change in order to increase their commitment to the change.
- Communication: Effectively and consistently sending information to stakeholders to build awareness and understanding of the change.
- Organisation Design / Operating Model: Ensure roles, jobs and teams are aligned to effectively support the new technology and to have clear accountability and ownership.
- Training: Understand what learning and performance support is needed to enable users to confidently perform their job in the new environment to enable knowledge, confidence and adoption.

- Business Readiness: Outline how we intend to prepare the business for the change to enable a successful transition and to enable continuous improvement.
- Measuring Change Effectiveness: Outline how we will measure the effectiveness of the change strategy.

Since November 2016, a dedicated REFCL Program change manager has worked with the REFCL Program team and Business as Usual teams to identify change impact assessments, develop change management initiatives and manage the overall change management work stream.

7.6 Training

A key component of our change management activities is training. Figure 10 provides an overview of the training plan for the REFCL Program.

Figure 10: Training plan for the REFCL Program

Source: AusNet Services

Employees from across AusNet Services, together with external service providers, have been identified as requiring the REFCL induction training either for awareness or because they play a specialist REFCL-related role.

For those resources who perform a specialist REFCL-related role, the training curriculum is targeted depending on the role the resource performs.

To date, over 700 resources have completed the on-line REFCL induction training.

8 Forecast capital expenditure

8.1 Introduction

As noted above, there are five categories of direct capital expenditure in the REFCL installation Program:

- Zone substation works;
- Network balancing;
- Line hardening;
- Compatible equipment; and
- Electricity Distribution Code compliance (HV Customers).

In addition to these five categories, capital expenditure is required for program management expenses incurred in overseeing the project.

The purpose of this section is to provide a high level description of the required work for each of the five categories. Additional detailed information can be found in:

- Functional scopes for each zone substation, which explain the zone substation works in detail.
- The relevant strategy documents, which explain our approach to network balancing, line hardening and compatible equipment.
- The HV customer engagement document, which examines each Tranche 2 HV connection effected by the REFCL Program.
- The Total Cost model, which sets out the volumes and unit rates for work to be carried out on each element of the Program.

A more technical summary of the impact of the REFCL installation on the existing network is provided in the REFCL Equipment Building Block Functional Description, which is provided as a supporting document to this contingent project application.

8.2 Prudent and efficient – satisfying the capital expenditure criteria

AusNet Services recognises that the AER must consider whether the forecast expenditure in relation to this contingent project is prudent and efficient, in accordance with the capital expenditure criteria in the Rules[25], taking into account the capital expenditure factors in the context of the contingent project.

In the context of this project, we consider capital expenditure is:

- Prudent if it is necessary to ensure AusNet Services' compliance with the mandated earth fault standards and mitigates bushfire risk to the maximum extent possible without compromising safety.
- Efficient if it delivers the scope of works at the least possible cost to customers, including the expected costs of unserved energy during construction and following the establishment of the REFCL.

[25] Clause 6.6A.2(f)(2).

As explained in section 7 of this contingent project application, our approach to managing this project ensures that the required works are efficiently scoped and costed. AusNet Services has sought opportunities to reduce the cost of the REFCL Program wherever possible. This is demonstrated by the following work:

- AusNet Services plans to submit an exemption request to ESV relating to a material volume of High capacitance 22kV distribution cable connected to the Bairnsdale (**BDL**) zone substation. This cable supplies an estate in Metung as well as additional polyphase electric lines between the isolation transformer and the connection to the existing network, which will not be REFCL enabled. If the exemption is granted, it removes the need to install a 3rd GFN, distribution transformer and associated equipment at BDL, saving $8-10m without significant change to the fire ignition risk.
- AusNet Services has conducted a comprehensive review of transfer feeders (which are connectable to both a REFCL protected zone substation and a non-REFCL protected zone substation). This process has identified opportunities to change the existing transfer arrangements and hence allowed AusNet Services to remove 12 feeders from the scope of the Program, with no resultant increase in risk or decrease in reliability. In doing so, AusNet Services has avoided the need for works at three HV customer sites and the necessary line hardening and sectionaliser works on these feeders.
- AusNet Services is undertaking an extensive cable testing program to ensure that it identifies and replaces critical cables that are prone to failure. However, we are taking a risk based approach and non-critical cables will not be tested and will be replaced on failure. This is a prudent and efficient approach to managing the risk of failure of these assets.
- AusNet Services engaged a dedicated resource who is responsible for working with HV customers to identify and implement an appropriate solution where over-voltage events may place the HV customer's at risk. This has allowed AusNet Services to propose additional customer hardening works in Tranche 2 and a smaller isolating transformer utilising a kiosk design for these customers. Each HV connection point has been individually assessed and the preferred solution identified based on:
    - site-specific requirements;
    - deliverability by the mandated 1 May 2021 deadline;
    - cost effectiveness; and
    - customer acceptance.

Where additional information has become available from our progress with the Tranche 1 Program, we have incorporated this into the Tranche 2 application. This is reflected in updated unit rates for some items, to better reflect actual costs. The project scope has been developed by considering the alternative engineering solutions that are available to address the identified investment need, while costs are determined using our standard project costing approach.

Project risks have been identified and processes put in place to manage them effectively. We have also examined the change management implications of the project to ensure that the project impacts on the business are properly understood and included in the project costings. In terms of project management, we have a comprehensive program governance arrangement in place.

In summary, AusNet Services is confident that it has adopted a comprehensive and rigorous approach to this project which will ensure that the resulting expenditure forecasts '*reasonably reflect the capital expenditure criteria*' in the Rules, as required by clause 6.6A.2(f)(2).

8.3 RIS Comparison

We have performed a comparison against the Government's RIS.[26] AusNet Services' forecasts for Tranche 2 are substantially more robust than those presented in the RIS, although the comparison is complicated by the significant passage of time, and the analysis and testing that has occurred since the RIS estimates were published in November 2015. Nevertheless, it is important to explain the cost differences.

The benchmarking shows that AusNet Services' median zone substation cost is $12.4 million (real $2015) compared to the RIS average of $6.5 million[27] (real $2015). Table 6 below shows a summary differences in costs compared to the RIS. Note for comparison purposes, the cost of resolving HV customers issues have been excluded.

[26] http://www.acilallen.com.au/cms_files/ACILAllen_BushfireMitigationRIS_2015.pdf

[27] RIS, page 74 and 64.

Table 6: Reasons for cost differences compared to Government RIS ($m, 2015)

	AusNet Services CPA 2 ($2015)[28]	RIS estimate ($2015)	AusNet Services – RIS Submission	Primary reasons for cost differences
Ringwood North	6.3	4.5	6.8	1 GFN – Primarily due to un-costed items and additional line hardening works.
Eltham	12.4	4.6	8.2	The use of 2 GFNs is the primary driver of the price increase, as well as un-costed items and additional line hardening works.
Ferntree Gully	12.6	4.4	6.8	The use of 2 GFNs is the primary driver of the price increase, as well as un-costed items and additional line hardening works.
Wodonga 22kV	15.1	14.3	22.1	The total cost is comparable between the RIS and our application. However, similar issues with un-costed items and additional line hardening works exist at this site.
Moe	14.6	5.5	11.1	The use of 2 GFNs is the primary driver of the price increase, as well as un-costed items and additional line hardening works.
Belgrave	12.7	5.0	8.2	The use of 2 GFNs is the primary driver of the price increase, as well as un-costed items and additional line hardening works.
Lilydale	11.1	5.4	9.6	The use of 2 GFNs is the primary driver of the price increase, as well as un-costed items and additional line hardening works.
Bairnsdale	14.6	8.4	16.7	The use of 2 GFNs is the primary driver of the price increase, as well as un-costed items and additional line hardening works.
Average	**12.4**	**6.5**	**11.2**	

Source: AusNet Services

As noted in the table above, AusNet Services' cost forecasts exceed the RIS estimate principally because the RIS did not assume that two GFNs were necessary for most sites. Additionally (as discussed in section 8.5) AusNet Services has determined that a program of cable replacements is necessary on its network and this has also resulted in additional required expenditure.

There are a number of other costs that were under-estimated or excluded in the RIS associated with necessary zone substation works and network balancing. Specifically, additional zone substations works that were not included in the RIS estimate are:

- Neutral bus switchboard – This is required for effective year-round protection of the network. Balancing bushfire risk reduction with network reliability requires multiple

[28] These costs exclude the Distribution Code compliance (HV Customers) works in order to provide a like-for-like cost comparison with the RIS estimates.

operating modes with differing earthing arrangements. A neutral bus switchboard facilitates these arrangements.

- REFCL backup protection and interface control systems – Protection and control equipment must operate in several earthing fault modes. Additional control systems are required to provide the interface between the GFN and AusNet Services' equipment. New protection devices are also needed to provide an adequate backup for the GFN for the instances of mal-operation.
- Testing the REFCL – As part of the project commissioning it will be necessary to fully test the functionality of the REFCL to ensure that it is capable of operating to meet the Regulations. The capital cost of REFCL installation includes the first instance of insulation and compliance tests to demonstrate the correct operation of the device.
- Community engagement plan - This is required due to the number of outages forecast for the community and the new network insulation tests, which in the short term are expected to produce unfavourable reliability outcomes for customers.

Additional network balancing works omitted from the RIS estimate include:

- Work required to achieve the performance criteria in each automatic switching zone - This involves a combination of additional capital works including adding balancing capacitors and adding a third phase conductor to balance each section. The RIS included phase rotations alone as the only network balancing cost, and this will not achieve the performance required by the Regulations.
- Works needed to maintain balance – These include replacing fuses with solid links where fuse operation will lead to out of balance, potential non-compliance with the Regulations, and possible REFCL mal operation.

8.4 Zone substation works

The following type of work is typical of the investment required at most Tranche 2 zone substations:

- Specification, procurement and installation of a Ground Fault Neutraliser (GFN), including an Arc Suppression Coil (ASC), Residual Current Compensation (RCC), Grid Balancing Cabinet (GBC) and control system.
- Specification, procurement and installation of a neutral bus switchboard. The introduction of the GFN requires a neutral bus which enables different earthing arrangements to be automatically configured. This enables remote earthing and protection scheme selection depending on network and weather conditions.
- Upgrade of the existing station service transformers and changeover boards. This work is required because the alternating current (AC) auxiliary supply requirement dramatically increases due to the GFN installation.
- Testing and potential replacement of cables and equipment incapable of operating at elevated voltages.
- Replacement and extension of existing protection and control equipment with equipment capable of operating in several modes including resonant earthing and traditional earth fault modes. Additional protection and control systems are also required to protect the newly installed REFCL equipment.
- Prior to commissioning the GFN, network hardening tests involve the process of lifting voltages (using the GFN) in a healthy three phase powerline network (phase by phase) to check network readiness for future states of REFCL operation. During this activity, there is an increased likelihood of asset failures. These tests are necessary to ensure the GFN can operate without causing line and station equipment to fail, potentially

resulting in a fire start. We would replace any assets that fail during the testing process, and a forecast cost has been included in the zone substation works.

In addition to the above location specific work may be required. The project scopes set out the zone substation works at each zone substation. A high level summary is set out in Table 7 below.

Table 7 Summary of works required (ZSS)

	GFN (including neutral bus)	Battery Set	Auxiliary Transformer	22Kv Capacitor Banks	Cables zone substation (meters)	Total Cost $000 2015 direct
RWN	1	0	2	0	850	4,255
ELM	2	0	2	2	1,650	7,981
FGY	2	0	2	2	2,690	8,555
WOTS22	2	0	2	2	785	6,947
MOE	2	1	2	1	1,210	8,243
BGE	2	1	2	2	900	7,660
LDL	2	0	2	2	1,290	7,485
BDL	2	0	2	1	1,030	6,957
Total	**15**	**2**	**16**	**12**	**10,405**	**58,084**

Source: AusNet Services

To demonstrate the efficiency and prudency of our proposed expenditure, we have regard to available benchmark information. Attachment 24 shows a comparison of the proposed unit rates against the Tranche 1 application. Generally, the cost differences have arisen because we have used quoted rates from Tranche 1 works (whereas we used budgeted costs in the Tranche 1 application) or have progressed further in understanding the necessary solutions. In Attachment 24 we have provided an explanation where there has been a material change in the cost forecasts between the Tranche 1 application and the Tranche 2 application.

8.5 Network balancing

In order to meet the performance standards in the Regulations, capacitive balance must be achieved and maintained. Capacitive imbalance will negatively affect REFCL performance because:

1. It increases residual earth fault current, i.e. fire ignition risk; and
2. It increases the standing level of neutral voltage, i.e. it constrains fault detection sensitivity.

As fire risk reduction relies on low residual fault current, capacitive imbalance can pose a risk to fire safety and so must be managed. In Victoria, long single phase (two-wire) spurs teed off three-phase lines can create significant capacitive imbalance.

In broad terms, the potential actions to balance network capacitance include:

- Two-wire spur lines must be connected to the three phase network in a way that limits capacitive imbalance, i.e. the phases to which each spur line is connected must be selected for capacitive balance, not just load balance.
- Balancing capacitance can be added by installing pole-mounted capacitors along feeders, e.g. on the third phase at a tee-off pole where a long two-wire spur leaves a feeder.
- Improved fault detection algorithms with increased tolerance to imbalance also have a potential role in addressing the potential impact of imbalance.

To satisfy the legislated performance criteria the network leakage current will need to be at a minimum under normal operating conditions. The leakage current required will vary site to site however the target is less than 0.1A. Our approach is to achieve this outcome through a combination of:

- Performing single-phase spur and distribution substation phase transpositions;
- Installing a balancing capacitor bank at the beginning of single phase spur sections;
- Installing LV balancing capacitor banks on the three-phase backbone; and
- In a small number of cases adding a third conductor to the beginning of a single-phase spur section and converting that section to three-phase.

As explained in our Network Balancing Strategy, we tested three alternative options before selecting the preferred approach, which is the lowest cost solution. The volume of work is site specific, dependant on total 22kV line length and the degree that it is out of balance. AusNet Services approach to network balancing is set out in its Network Balancing Strategy. Having applied this strategy, we have identified the volumes and costs of works required for network balancing as set out in Table 8 below.

Table 8 Summary of works required

	Phase Transpositions.	Single Phase Balancing Caps.	Three Phase Balancing Caps.	Unbound Third Phase	Install Third Phase of conductor	Fuse replacement with solid links	Phase Plate Correction	Total Cost $000 2015 direct
RWN	9	0	5	0	5	8	51	734
ELM	15	1	17	2	24	21	74	1,853
FGY	0	0	12	0	0	7	48	1,181
WOTS22	191	7	29	0	1	45	42	3,141
MOE	56	8	22	1	9	38	54	2,467
BGE	22	11	20	3	38	34	61	2,617
LDL	8	2	10	5	10	15	56	1,302
BDL	93	5	30	2	18	34	69	2,986
Total	**394**	**34**	**145**	**13**	**105**	**202**	**455**	**16,281**

Source: AusNet Services

We note in its decision on our Tranche 1 application, the AER accepted that AusNet Services' "approach is in accordance with industry norms for complex capital works and is reasonable."[29] Regardless, to demonstrate the efficiency and prudency of our proposed expenditure, we have regard to available benchmark information. Attachment 24 shows a comparison of the proposed unit rates against the Tranche 1 application and this shows that our unit rates are unchanged compared to Tranche 1 costs. Tranche 1 unit costs were based on the cost of undertaking similar programs of work and these remain appropriate for Tranche 2.

We note our proposed costs for the network balancing program are higher than the estimate provided in the RIS. Significant increase in the scope and cost for network balancing has occurred reflecting improved understanding following the Woori Yallock REFCL commissioning. This has led to better understanding of the work required to meet and maintain the prescribed sensitivity criteria in the Regulations. The RIS detailed phase rotations alone as the only network balancing cost, which will not achieve the required performance criteria of the Regulations.

8.6 Line hardening

When an earth fault occurs on a REFCL-protected network, over-voltage on un-faulted phases occurs and can lead to failure of equipment installed on the network. Such equipment failure constitutes a second earth fault on the network, termed a 'cross-country fault' because it is usually remote from the initial fault and always occurs on one of the un-faulted phases.

REFCLs can only deal with multiple earth faults if they all occur on a single phase. With a cross-country fault, the network has two phase-to-earth faults at different locations and high currents will flow in both fault locations. To minimise the risks arising from cross-country faults, equipment that is liable to fail under REFCL voltages must be replaced. This Program covers two key pieces of equipment: surge arrestors and cables.

8.6.1 Surge Arrestors

Powercor and AusNet Services jointly conducted tests to determine whether some existing types of surge arrestors are capable of withstanding 24.2kV. Testing has concluded that two particular types of line surge arrestors that make up 60% of the population of AusNet Services' line surge arrestor fleet do not need replacing as they are capable of withstanding the increased voltages associated with the operation of a REFCL

AusNet Services' Tranche 2 total line surge arrestor population is 25,825 units. Out of this population 8,356 units at 3,497 sites, need to be replaced to withstand over-voltage events. This is 32.4% of the surge arrestor population and is less than the overall proportion of 40% that must be replaced. This lower percentage is due to the specific types of surge arrestors installed at the Tranche 2 sites. The costs of replacing surge arrestors in relation to each zone substation installation will depend on the number and type of surge arrestors at that location. In aggregate (across all three Tranches) 40 per cent of the population of surge arrestors will be replaced.

[29] AER, Final Decision, REFCL Tranche 1 Application, pg 46

Table 9 Summary of capital expenditure requirements

	Unacceptable Surge Arrestor Sites Requiring Replacement	Unacceptable Surge Arrestor Units Requiring Replacement	Costs $000s 2015 direct
RWN	142	339	316
ELM	219	523	487
FGY	129	308	287
WOTS22	917	2,191	2,041
MOE	790	1,888	1,758
BGE	262	626	583
LDL	224	535	498
BDL	814	1,945	1,811
Total	**3497**	**8,356**	**7,782**

Source: AusNet Services

To demonstrate the efficiency and prudency of our proposed expenditure, we have regard to available benchmark information. Attachment 24 shows a comparison of the proposed unit rates against the Tranche 1 application and the unit rate is unchanged compared to Tranche 1 costs. Tranche 1 unit costs were based on the cost of undertaking similar programs of work and these remain appropriate for Tranche 2.

We note the RIS prepared in 2015, provided the variation in the quantities for surge arrestors units (referred to as 'Feeder Lightning Arrestors'). The RIS estimate forecast[30] 0 - 8,224 surge arrestor units per zone substation requiring replacement at $1,000 each. AusNet Services' replacement program is for 1,044 surge arrestor units per zone substation requiring replacement at $940 per unit. We have reduced volumes compared to the RIS at a considerable saving. This outcome provides further assurance that AusNet Services' cost forecasts are prudent and efficient.

8.6.2 Cable Replacement

As noted above, the REFCLs increase the risk that 22kV cables may fail, as they will experience elevated phase-to ground-voltages when a REFCL operates. AusNet Services experienced cable failures of this kind when testing at the Woori Yallock zone substation and understand that Powercor also experienced cable failures. On the basis of this experience, AusNet Services now considers that a proactive approach is required to identify and repair or replace critical poor condition or insufficiently rated cables prior to operating a REFCL protected network.

AusNet Services considered several options and developed the following approach to dealing with this issue:

[30] Regulatory Impact Statement, Bushfire Mitigation Regulations Amendment, ACIL ALLEN Consulting, Table 14, Page 69. It should be noted that the RIS costs are expressed in $2015 while our costs are expressed in $2016. Strictly speaking, for comparison purposes the RIS costs are approximately 1.5 per cent higher than indicated here.

1. Desktop and field identification of critical cable types and population currently on the network; and
2. Targeted on-line and off-line testing to confirm if the cables cannot withstand elevated voltages.
    - On-line tests ranging from visual inspection, spot Partial Discharge (PD) measurements using on-line PD measurement devices and non-invasive inspection methods (RF scanners, Ultrasonic and Corona cameras)
    - Off-line tests ranging from sheath integrity, Dielectric Spectroscopy (DS), Dielectric Dissipation Factor (DDF) and Capacitance, Partial Discharge (PD) and High Voltage (HV) withstand.

Targeted testing ensures all critical feeder cables in a REFCL protected network are appropriately rated and with a sound condition score minimising the risk of failure during REFCL operation. Based on this approach AusNet Services has proposed a program of:

- proactive cable repair and replacement; and;
- reactive cable repair and replacement

Cables that are identified as being unable to sustain REFCL operation will be either repaired or replaced using a proactive replacement program prior to commissioning the REFCLs. However, not all cables will be tested and testing may fail to identify some cables that could fail under REFCL operation. Accordingly, we anticipate some cables will need to be repaired or replaced on a reactive basis. We are confident that the assumptions underpinning this forecast reflect the prudent and efficient costs of undertaking this cable replacement program.

Table 10 Summary of capital expenditure requirements – Cable Replacement

	On-line Tests	Off-line Tests	Repairs	Replacement (m)	Costs $000s 2015 direct
RWN	84	25	10	1073	735
ELM	194	56	22	2248	1,603
FGY	182	88	35	3242	2,422
WOTS22	105	70	28	2599	1,923
MOE	75	31	12	1332	961
BGE	115	30	12	3967	1,530
LDL	146	42	17	2333	1,368
BDL	135	57	23	1597	1,460
Reactive Cable Replacement*		38	31	2902	1,709
Total	**1,036**	**437**	**190**	**21,293**	**13,710**

*Note: this only includes the reactive cable replacement in the 2016-2020 regulatory period. As noted below this program continues into the 2021-25 regulatory period.

Source: AusNet Services

This expenditure was not included in either the RIS or our Tranche 1 application. As such there is no relevant benchmarking data provided for comparison.

8.6.3 ACR at site of customer hardening

To ensure AusNet Services can detect faults and safely operate its network, we will install an ACR at each HV customers site, where they undertake asset hardening works (as opposed to AusNet Services installing an isolating transformer). The ACR will be owned and operated by AusNet Services and so is distinct from opex incurred on the customers' premises. The ACR is necessary to ensure faults on the customer's premises can be detected and isolated. This is critical for our staff when patrolling lines to identify faults. We consider this is prudent and efficient expenditure and necessary to enable an overall cheaper solution to be implemented at these customers sites. The cost of installing new ACRs has been based on recent network experience.

Table 11 Summary of capital expenditure requirements

	HV customers undertaking line hardening	Costs $000s 2015 direct
RWN	0	-
ELM	3	240
FGY	3	240
WOTS22	0	-
MOE	1	80
BGE	1	80
LDL	0	-
BDL	0	-
Total	**8**	**640**

Source: AusNet Services

8.6.4 Line Surveys

AusNet Services is commencing survey works of all lines that will be connected to zone substations progressed as part of the remainder of the REFCL Program. This is proceeding concurrently with work at the Tranche 2 zone substations due to the efficiencies that arise from doing this as a Program across all sites. This will reduce the cost of implementation and we consider that it is a prudent and efficient approach to managing this Program.

8.7 Compatible equipment

Some network equipment is not compatible with REFCL operation and must be upgraded or replaced with equipment that is compatible. This is a separate issue to the network hardening testing, described in section 8.4 above, which is solely concerned with the capability of the equipment to withstand the increased voltage. In contrast, incompatible equipment can prevent

correct REFCL operation, prevents the operation of the DFA scheme, or may produce dangerous network conditions with a REFCL in service.

Automatic circuit reclosers (**ACRs**) and sectionalisers will need to be replaced or altered due to their incompatibility with REFCLs. Unlike in Tranche 1, there are no voltage regulators that need to be upgraded in Tranche 2.

8.7.1 Automatic Circuit Reclosers (ACRs)

A significant issue arises in relation to existing earth fault protections, which are non-directional. The devices act when they detect earth fault current flow without information on its direction, i.e. whether the fault is 'upstream' or 'downstream' of them. This is not a problem in non-REFCL networks, since all earth fault currents flow only one way – from the zone substation to the fault.

With a REFCL in service, however, earth fault current flows back into the zone substation from un-faulted feeders before a portion (the uncompensated residual current) flows out along the faulted feeder to the fault. Using non-directional feeder earth fault relays with a REFCL in service will lead to tripping of healthy feeders or whole groups of feeders.

To address this issue, AusNet Services will replace or upgrade unsuitable ACRs on feeders connected to REFCLs with new ACRs that have reverse power flow capability. In addition, the new ACRs have more sensitive earth fault detection capability to assist in locating faults when a REFCL operates.

AusNet Services' Automatic Circuit Recloser Strategy provides further information on the rationale for the planned scope of work and the alternative options that were considered.

Table 12 Summary of works required

	Units requiring upgrade	Units requiring replacement	Costs $000s 2015 direct
RWN	6	1	299
ELM	3	6	495
FGY	3	0	118
WOTS22	2	15	1,019
MOE	12	11	1,163
BGE	4	2	283
LDL	7	3	464
BDL	5	19	1,389
Total	**42**	**57**	**5,231**

Source: AusNet Services

Attachment 24 shows a comparison of the proposed unit rates against the Tranche 1 application and the unit rate is unchanged compared to Tranche 1 costs. Tranche 1 unit costs were based

on the cost of undertaking similar programs of work and these remain appropriate for Tranche 2..

We note the RIS provided the variation in costing for automatic circuit reclosers (referred to as 'Polyphase ACR upgrades'). The RIS estimate forecast[31], 0 - 18 upgrades per zone substation at $70,000 each upgrade. Both the proposed volumes and unit rates are lower than those contained in the RIS. Importantly, AusNet Services' forecasts are fully substantiated having regard to the actual conditions at each zone substation whereas the RIS estimate adopted a broader estimating approach that was unavoidably less comprehensive.

8.7.2 Sectionalisers

Our existing 22kV feeder fault treatment scheme, Distribution Feeder Automation (DFA) involves a combination of sectionalising switches, ACR operations plus the use of adjacent feeders to supply feeder sections downstream of a faulted section. The DFA philosophy and technology developed by AusNet Services is unique and plays an important role in maintaining network reliability. The introduction of REFCLs affects the operation of DFA, such that each 'automated switching zone' in a DFA scheme must be both capacitively balanced and able to detect faults (this capability is impacted by the much lower fault currents as a result of the installation of REFCLs). The existing sectionalisers are unable to detect the low fault current and as such, need to be upgraded to restore the DFA functionality. Additionally, the DFA algorithm operating within the SCADA system is not compatible with REFCL technology, and needs to be rewritten.

The use of DFA significantly increases the number of automated switching zones, which is a feeder section delineated by sectionalising switches. As a consequence, AusNet Services' total network balancing and switch upgrade costs are affected by AusNet Services' historic investment decision to implement DFA in order to maintain reliability. The decision to install DFA was efficient, as is the need to undertake the additional work to address the capacitive imbalance that results from the REFCL Program.

Unless DFA capability is rectified, customers will suffer a degradation in reliability outcomes as a result of the REFCL Program. We note in assessing our Tranche 1 application the AER considered whether it was appropriate to approve expenditure to restore the DFA scheme, the AER found:[32]

> *As the DNSP is under an obligation to maintain reliability, it follows that where a requirement to install equipment which reduces a current service level is imposed on a DNSP, it is a valid project cost to take corrective action to counter that effect.*

Further, the AER noted:[33]

> *the forecast STPIS impact is considerably greater than the cost of the proposed modifications. As such, we consider it would be cost-effective to accept the $7.0 million (real, $2016) [$7.2 million ($nominal)] capital allowance that AusNet Services has identified. We believe this approach is consistent with the incentives on AusNet Services under the STPIS.*

We agree with the AER's findings in relation to our Tranche 1 CPA. For Tranche 2 AusNet Services has again modelled the impact of installing the REFCLs on its STPIS (assuming that the DFA functionality is not restored). This modelling demonstrates an anticipated STPIS

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[31] Regulatory Impact Statement, Bushfire Mitigation Regulations Amendment, ACIL ALLEN Consulting, Table 14, Page 69. It should be noted that the RIS costs are expressed in $2015 while our costs are expressed in $2016. Strictly speaking, for comparison purposes the RIS costs are approximately 1.5 per cent higher than indicated here.

[32] AER final decision, pg 60

[33] AER final decision, pg 61

penalty of $19 million over five years. This is higher than the proposed cost of rectifying the DFA scheme and so we consider rectifying the DFA scheme is the prudent and efficient course of action. This issue is specific to AusNet Services' network, reflecting the substantial investments in DFA that have been made to achieve current levels of reliability.

This contingent project application includes the investment costs of rectifying the DFA in order to avoid this degradation in reliability. This includes the following work:

- Replacement of sectionalisers - these are switches designed to interrupt load current, but not fault current. Similarly to the ACRs (which are designed to interrupt fault current) these sectionalisers which do not have the requisite detection sensitivity to support the DFA scheme when a REFCL is in operation and will need to be replaced; and
- DFA algorithm design - the DFA algorithm interprets real time network status data and devises the switching sequence to isolate a faulted switching zone and restore supply to the maximum number of customers achievable, typically within a period of 1 minute.

We note these upgraded sectionalisers are a new technology, being produced specifically for AusNet Services. AusNet Services has progressed to a proof of concept stage with one supplier and we are confident that we will be able to source sectionalisers with the requisite sensitivity to allow for the restoration of the DFA scheme.

The estimated number of switches requiring change and total costs to rectify the DFA schemes to ensure reliability is maintained are set out in Table 13 below.

Table 13: Forecast Reliability expenditure and units requirements, ($m, $2015 direct)

	2016	2017	2018	2019	2020	Cost $000s 2015 direct
Forecast no. of switches	-	-	-	120	195	15,411

Source: AusNet Services

8.8 Distribution Code compliance (HV Customers)

The operation of a REFCL following a single phase fault will lead to a temporary increase in voltage levels on the healthy phases. The increases that may occur at HV customers' supply points exceed the variations currently permitted by the Electricity Distribution Code (**EDC**). In the absence of agreement from customers to install isolating transformers, or undertaking hardening works on their network, HV customers may be exposed to a potentially unsafe and unreliable electricity supply. Any resulting failure of HV customer's equipment during REFCL operation would induce a cross country fault negating any fire mitigation effect on the phase affected by the first fault as the REFCL attempted to compensate for the second fault. This situation may result in a fire ignition at the site of the first fault.

Such outcomes would not be prudent, efficient or acceptable from a safety perspective. Given the potential impacts of REFCL operations on HV customers supplied by REFCL-enabled feeders, AusNet Services created a dedicated REFCL Program HV customer lead role. The purpose of the role is to identify, and negotiate, the appropriate solution for each HV customer in relation to the REFCL implementation. Each HV customer site is unique in terms of the nature and condition of the HV electrical assets, the site location and the appropriate solution required to meet the required regulatory deadlines.

As noted in Section 2 above, the ESC is reviewing the EDC. A decision by the ESC is expected around August 2018 and we will work with the AER to incorporate the impact of any changes into its contingent project decision. For the purpose of this application, we note that the Victorian Government HV Customer Assistance Package (HCAP) availability and eligibility criteria has not

been finalised. As such, we assume that AusNet Services will be required to fund the cost of all work to protect HV customers' assets from over-voltage events caused by REFCL operations.

AusNet Services has worked closely with our Tranche 2 HV customers to determine the appropriate engineering solution to protect their HV electrical assets. The three (3) technically acceptable engineering solutions for HV customers impacted by REFCL operations are:

- Conversion to low voltage (LV);
- Primary assets hardening with Automatic Circuit Reclosers (ACRs); or
- Installation of an isolating substation.

Once the nature and condition of the HV electrical assets is determined, an assessment is undertaken to confirm which of the three available engineering solutions is the least cost viable option. This assessment includes:

- Site-specific requirements: reflecting the cost and complexity of undertaking different approaches at the site.
- Deliverability: the engineering solution must be in place prior to the Tranche 2, 1 May 2021, legislated deadline; and
- Acceptability: under the current EDC, a connection agreement variation must be executed with the HV customer for an asset hardening solution to be viable.

Where an isolating substation is the selected solution, the required isolating transformers will be sourced from one of two suppliers. This follows a formal tender process conducted in 2017 for the Tranche 1 sites and review of Tranche 2 requirements.

The smallest size of isolating transformer to be installed is a 3 MVA solution. This isolating transformer was too small for Tranche 1 customers and not developed by AusNet Services as part of the first Tranche. This 3 MVA isolating transformer, will be a containerised 'kiosk style' ensuring the isolating transformer is 'self-bunded' and includes switchgear and protection equipment. This smaller size significantly reduces the cost of installing isolating transformers. The isolating transformers for larger customers (5MVA and above) are not kiosk style and require more significant installation works including a fenced compound.

A summary of the works required at each zone substation are set out in Table 14 below.

Table 14 Summary of works required

	Sites requiring isolation transformer	Sites requiring customer hardening	Alternative solution (i.e. LV conversion)	Cost $000s 2015 direct[34]
RWN	0	0	0	-
ELM	1	3	0	971
FGY	1	3	0	971
WOTS22	5	0	0	3,676
MOE	3	1	0	2,540
BGE	3	1	0	2,525
LDL	5	0	0	3,917
BDL	0	0	1	-
Total	**18**	**8**	**1**	14,599

Source: AusNet Services

Detailed information on each of the HV customers, including descriptions of the customer assets and the expected solution can be found in Attachment 21. As noted above, the 3 MVA solution (which accounts for 15 of the 18 isolating transformers required in Tranche 2) has driven a reduction in the average cost of isolating transformers for Tranche 2. Additional, our revised forecast represents increased forecasting certainty over our Tranche 1 application, as we now have costs based on quoted unit rates for the larger isolating transformers.

8.9 Program management costs

Consistent with the CPA1, AusNet Services has incurred costs developing this regulatory proposal and will incur further costs related to the proposal during the AER review. Costs associated with the development of the application include drafting of the proposal and attachments and reviewing the technical supporting information, project management, corporate including legal review of matters relating to the submission, and providing further information and detail to the AER during the review process.

In addition, some tools and test equipment need to be replaced. The introduction of the REFCL devices imposes higher voltage conditions on existing installed lines infrastructure. Where in the past equipment had to be designed to withstand phase-to-ground voltages up to 12.7kV, REFCL networks need to be able to withstand 24.2 kV. Some of the tools and equipment that AusNet Services uses for operating and maintaining the network are not rated to handle the higher voltages. It is therefore not safe to continue using this equipment for operations and maintenance activities.

8.10 Capital Expenditure in the 2021-25 Regulatory Control Period

Clause 6.5.7 (f) of the NER describes how capital expenditure for a contingent project, which is expected to be incurred in a subsequent regulatory period, is to be treated. These provisions

[34] This is the total of the capex involved in HV customer solutions. The opex required for hardening solutions is detailed in Section 9 below.

are operative where the AER determines under clause 6.6A.2(e)(1)(iii) that the likely completion date for a contingent project is a date which occurs in the immediately following regulatory control period.

AusNet Services is required to complete the Tranche 2 zone substations by 1 May 2021. This is 4 months into the subsequent regulatory period. Whilst AusNet Services is endeavouring to have the REFCLs commissioned well prior to this date, it is expected that some capital expenditure will be incurred in the 2021-25 regulatory control period. In particular, the reactive cable replacement program in regards to the Tranche 2 sites is likely to continue into the subsequent regulatory period.

Accordingly, we consider the AER should determine in accordance with clause 6.6A.2(e)(1)(iii) that the likely completion date for a contingent project is a date which occurs in the immediately following regulatory control period.

A forecast of the capital expenditure in the 2021-25 regulatory period is set out in Table 17 below.

Table 15: Capex in subsequent regulatory period

	2021	2022	2023	2024	2025	Total $000s 2015 direct
Capex in subsequent regulatory period	2,094	1,709	1,709	-	-	5,512

Source: AusNet Services

8.11 Summary of forecasts

Table 16 below summarises our capital expenditure for each of the five workstreams.

Table 16: Summary of Direct capital expenditure requirements ($000s 2015, direct)

	2016	2017	2018	2019	2020	Total
Zone Substations	-	-	7,018	39,229	11,452	57,699
Network Balancing	-	-	3,051	7,605	5,625	16,281
Line Hardening	-	-	2,668	10,072	8,752	21,492
HV customers	-	-	3,992	7,787	2,820	14,599
Compatible Equipment	-	-	1,454	8,309	10,879	20,642
Other	-	-	719	810	2,131	3,660
Total	-	-	18,902	73,813	41,658	134,373

Source: AusNet Services

9 Forecast incremental operating expenditure

9.1 Expenditure categories and drivers

In addition to the capital works described in chapter 1, AusNet Services will incur incremental operating expenditure as a result of the installation of REFCLs, requiring additional specialist planning resources and resources to deliver the following activities:

- **HV customers – hardening solutions**

  Where we undertake customer hardening solutions, this expenditure is recognised as operating expenditure. As discussed above, we will undertake customer hardening solutions wherever this is the least cost viable solution, we secure agreement from customers and safety and bushfire risk can be appropriately managed. Based on preliminary discussions with affected customers, we expect to reach agreement with some customers to undertake customer hardening solutions and so have included the cost of these hardening solutions in this contingent project application.

- **Annual testing**

  Annual tests take the form of Primary Earth Fault Testing and Insulation Testing at each site. The first of these tests will be performed as part of the capital installation project for that site. However, annual testing is an on-going operating cost, and has been included in the forecast incremental operating expenditure.

- **Network Balancing**

  This involves monitoring capacitive balance and initiating corrective action where balance is outside range. Forecasting capacitive balance is necessary to ensure that material changes to the network (such as conductor replacement or retirement, and changes in loads or generation) are known in sufficient time to rebalance the network.

- **Fault response and analysis**

  It is expected the time spent on fault response and analysis will increase due to the complexities of the resonant earthing network. A small incremental operating expenditure allowance has been included to address this new activity. This is additional to the allowance provided in the Tranche 1 application, because each Tranche increases the number of REFCLs installed and the requirement for additional analysis on effected feeders.

- **Equipment maintenance**

  Following the installation of the REFCL devices, routine maintenance is required, similar to any other plant and equipment in the zone substation. A small incremental cost has been included in the forecast operating expenditure to perform this routine maintenance.

- **Line equipment purchases**

  The introduction of the REFCL devices imposes higher voltage conditions on existing installed lines infrastructure. Some of the equipment that AusNet Services uses for operating and maintaining the network is not rated to handle these higher voltages. Many of these items are capitalised, but insulated hard covers do not meet the unit cost requirements for capitalization. Therefore the cost of these items has been included as an incremental operating cost.

- **Alternative technologies and vendors**

  Currently, there is only one supplier of GFNs which offers the technology that is able to comply with the performance standards specified in the Regulations. A sole supplier model is not desirable because it inevitably exposes AusNet Services and our customers to increased risk in terms of performance, delivery and costs.

To mitigate this risk, it is prudent and efficient to engage other suppliers and work with them to develop an alternative, compliant product. To that end, AusNet Services committed resources to engage with alternative suppliers to explore alternatives technologies that have the potential to comply with the mandated performance requirements. [C-I-C
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]

9.2 Forecasting efficient and prudent operating expenditure

AusNet Services has adopted a 'bottom up' forecasting approach for each of the activities described in section 9.1. The objective of the forecasting method is to determine the efficient and prudent incremental operating expenditure associated with each activity.

AusNet Services has adopted 'global' assumptions in relation to the REFCL installation timetable and labour rates, which apply across each of the operating expenditure activities. The labour rates are consistent with the rates adopted by the AER in its 2016-20 EDPR Final Decision. AusNet Services is not seeking to amend these rates or the rate of escalation during the current regulatory control period.

In addition to these global assumptions, AusNet Services has developed specific assumptions regarding the resource requirements for each activity. These assumptions are explained in the relevant supporting documents. In each case, the resource requirements reflect AusNet Services' estimate of the efficient and prudent level of activity.

The AER must accept AusNet Services' operating expenditure forecast if it is satisfied that the forecast reasonably reflects the operating expenditure criteria in the Rules[35], taking into account the expenditure factors in the context of the contingent project. The application of the expenditure factors to this contingent project is discussed in Section 10. For the reasons outlined in the REFCL Program *Operational Requirements* supporting document, AusNet Services considers that the application of its forecasting methodology produces operating expenditure forecasts that comply with the Rules requirements.

9.3 Summary of forecasts

The annual incremental operating expenditure is set out in Table 17 below.

35 Clause 6.6A.2(f)(2).

Table 17: Forecast incremental operational costs, $000's, $2015

	2016	2017	2018	2019	2020	Total
Fault response & analysis	-	-		24	97	122
Operating, maintenance and testing instructions	-	-		-	5	5
Routine maintenance of zone substation assets	-	-		-	9	9
Network Balancing	-	-		18	79	97
Annual Testing	-	-			144	144
HV Customers	-	-		1,032	1,121	2,153
WOTS - (Transmission Charges)	-	-			11	11
Live line equipment purchases	-	-		117	350	467
Training & Change Management	-	-				-
Regulation & Code Changes	-	-	25	-	-	25
Alternative technologies and vendors	-	-		943	443	1,387
Total	-	-	25	2,135	2,260	4,420

Source: AusNet Services

As shown in the above table, in relation to the REFCL devices installed in Tranche 2 of the REFCL Program, incremental operating expenditure of $2.1 million is required in 2018, increasing to $2.3 million in 2020. Opex related to HV customer solutions is the largest opex item, however these opex solutions are cheaper than the alternative of installing an isolating transformer and should be viewed in that context. The operating expenditure for Tranche 2 is all incremental to the operating expenditure already included in Tranche 1.

For the reasons outlined in section 9.1, each of the operating expenditure activities is required in order to ensure that the network operates safely and reliably during REFCL implementation and the subsequent operation of REFCL equipment.

10 Expenditure factors to be considered by the AER

The Rules require the AER to consider a number of operating and capital expenditure factors in its assessment of the forecast expenditure in the contingent project application. These expenditure factors include:

- The substitution possibilities between operating and capital expenditure;
- Whether the expenditure forecast is consistent with any incentive schemes that apply to the distributor;
- The extent the expenditure forecast is referable to arrangements with a person other than the distributor that do not reflect arm's length terms; and

- The extent the distributor has considered, and made provision for, efficient and prudent non-network alternatives.

The following paragraphs comment on each of these factors in turn.

10.1.1 Substitution possibilities between operating and capital expenditure

The capital works are driven by an obligation to comply with new performance standards that apply to each polyphase electric line originating from a list of specified zone substations. As explained in section 4, the installation of REFCL technology is the only feasible method that is capable of complying with the Regulations. At this highest level, there are no substitution possibilities in relation to the proposed project.

However, feasible alternative options are available in determining the strategies for the particular workstreams (such as network balancing) and the scope of the station works as we move beyond the immediate task of installing the GFNs. In some instances, the feasible options include different mixes of operating and capital expenditure, and therefore reflect substitution possibilities.

The HV customer engagement document sets out the proposed solutions to HV customers and AusNet Services is proposing to undertake a mix of opex and capex solutions. The selection between the capex or opex solution has been made on the basis of the relative cost of each solution, whilst also considering the deliverability and likelihood of customer acceptance.

The incremental operating expenditure activities in relation to the contingent project application are discussed in Section 1 and the supporting document, *Operational Requirements*. The nature of many of these activities (such as testing, document updates and reporting) is such that there are no substitution opportunities between operating and capital expenditure.

10.1.2 Consistency with the incentive schemes – reliability impacts

The impact of REFCL installation on network reliability was examined in the AER's final decision on the Tranche 1 Contingent Project Application. The Victorian Government queried whether modification of the DFA system is a valid project cost to be included in this application. This issue is considered in more detail above. The operation of the other economic regulatory regime incentive schemes are unaffected by the contingent project. The implications of REFCL operation on the Victorian Government F-Factor Scheme has been accounted for through the F-Factor Scheme Order in Council gazetted on 22 December 2016. This amends the target ignition risk units for financial year 2019/20.

10.1.3 Related parties

The AER is required to consider the extent the expenditure forecast is referable to arrangements with a person other than the distributor that do not reflect arm's length terms. AusNet Services' related party arrangements were described in detail in Appendix 1C of the Regulatory Proposal for the 2016-20 period. AusNet Services confirms that there are no related party margins in the capital expenditure forecasts presented in this contingent project application.

10.1.4 Non-network alternatives

As discussed in section 7, AusNet Services has considered non-network alternatives in relation to addressing the higher voltage variations at HV customers' supply points. AusNet Services' Contingent Project Application for Tranche 2 has a mix of HV isolating transformers and customer hardening works (which is a non-network solution). This demonstrates that non-network alternatives have been examined and adopted when appropriate.

The nature of the other capital expenditure workstreams – being station works, network balancing, line hardening and compatible equipment – is such that there are limited opportunities for non-network alternatives. In particular, much of the work is focused on ensuring that AusNet Services' network is capable of continuing to provide safe and reliable distribution services with REFCLs in service. Inevitably, the issues to be resolved necessitate capital works in relation to AusNet Services' network assets, rather than non-network solutions.

11 Accelerated Depreciation of Retired Assets

AusNet Services proposes to accelerate depreciation of certain network assets that will be removed from service over the current regulatory period. The nature of the assets and asset classes is such that they will be replaced ahead of the end of their expected economic and/or technical lives. The AER has recently approved AusNet Services' proposal to accelerate depreciation of certain high bushfire risk assets which have been, or are forecast to be replaced as part of our safety programs and approved this approach in our Tranche 1 contingent project application.[36]

AusNet Services' proposal to apply accelerated depreciation to the identified assets under this contingent project application accurately reflects changes to the remaining economic lives of those assets. Accordingly, AusNet Services' proposal conforms to the requirement in NER clause 6.5.5(b)(1)[37].

The methodology undertaken by AusNet Services to determine the proposed accelerated depreciation is similar to our approach used in the 2016-20 EDPR proposal and Tranche 1 contingent project application. For this contingent project application AusNet Services has used the following methodology:

1. Identify assets that are to be removed in the current period (2016-20).
2. Estimate opening RAB value of relevant asset classes (as at January 2015).
3. Determine portion of asset class to be accelerated (i.e. proportion removed from asset base).
4. Roll forward the estimated 2015 opening RAB values to 2017 using a nominal RAB roll forward approach.

Step 1 – Identify assets

The assets considered in AusNet Services' accelerated depreciation proposal include:

- Protection Relays within Zone Substations
- Surge Arrestors;
- Automatic Circuit Reclosers (ACRs);
- Sectionalisers; and
- 22kV HV overhead cables

The proposed protection relay replacements form part of protection and control systems replacement and extension works within zone substations as outlined in section 8.4. The proposed surge arrestor replacement program and proactive 22kV cable replacement program each form part of the Line hardening outlined in sections 8.6. ACR replacements and sectionaliser replacements are under compatible equipment investments in section 8.7.

Step 2 – Estimate RAB value of identified asset class

[36] AER - Final decision, AusNet distribution determination - Attachment 5 - Regulatory depreciation - May 2016, p.5-13

[37] NER clause 6.5.5(b)(1) requires that "the schedules must depreciate using a profile that reflects the nature of the assets or category of assets over the economic life of that asset or category of assets".

AusNet Services has relied on data within its 2015 Repex Model[38] to establish each asset class's share of the total RAB value. The Repex model contains Electricity Distribution system assets including Network SCADA assets and does not contain IT or Non Network assets. The proportion obtained from the Repex model for each asset class was then separately applied to the 2015 opening RAB values[39] (excluding assets not modelled in the Repex model, such as IT assets) to derive estimated 2015 opening RAB values for each asset class.

In the case of surge arrestors and protection relays the respective shares of total RAB value were determined using the current replacement unit rate multiplied by total volume multiplied by an average remaining life factor (average remaining life / standard life). This depreciated replacement value was then divided into the total depreciated replacement value for all asset classes consistent with the approach used for the other assets identified in step 1 above. The Repex model does not separately track surge arrestors or protection relay systems in zone substations. Instead, they are either incorporated within an aggregated benchmark asset category or allocated across multiple benchmark categories. Therefore this alternate approach was used and is considered management's best estimate of the 2015 opening RAB values.

Step 3 – Determine proportion of identified RAB value to be depreciated

The portion of the asset class that is to be included in the accelerated depreciation proposal is calculated based on forecast replacement volumes included in this contingent project application, as a share of the total volume of assets in each asset class as at January 2015.

The total volume of assets within the identified asset classes are obtained from the 2015 Repex model. In the case of surge arrestors the total volume was taken from AusNet Services' 2016 RIN in lieu of available data within the Repex model. As noted in step 2 above, surge arrestors and protection relays are not captured in a single benchmark asset category within the Repex model, rather they are spread across multiple categories.

Step 4 - Roll forward the estimated 2015 opening RAB values to 2019

Since our approach described above established the opening RAB values as at January 2015 there is a requirement to roll forward the RAB values to January 2019, to align with the REFCL Tranche 2 Program delivery schedule which will see the replacement of identified assets commencing in2019. AusNet Services has applied the AER's standard nominal RAB roll forward approach to establish the 2017 opening RAB values[40].

AusNet Services therefore proposes to accelerate depreciation over the remaining two years of the current regulatory period (2019-20). To facilitate this in the Proposed Amended Post Tax Revenue Model ("PTRM") we have established a new asset class 'Accelerated Depr - Distr assets (Contingent Project 2)'.

This allows for the opening RAB transfers between 'Distribution system assets' and the new accelerated depreciation assets class. Since the opening RAB transfers do not occur until 2019 we have reflected these transfers within our Amended Year by Year tracking model[41] which is a supporting attachment to this contingent project application.

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38 2015 Repex Model owned and maintained by the Regulatory & Network Strategy team within AusNet Services.

39 Opening RAB values obtained from the AER Final Decision Roll Forward Model, May 2016.

40 Using forecast inflation contained in the AER Final Decision PTRM.

41 AusNet Services' Amended RAB Depreciation model. The PTRM depreciation schedule for the opening RAB has been updated accordingly.

In summary, AusNet Services' proposed accelerated depreciation allowance is $5.13 million ($Nominal) as shown in **Error! Reference source not found.** below.

Table 18: Proposed Accelerated Depreciation Allowance ($m, nominal)

	2016	2017	2018	2019	2020	Total
Accelerated Depreciation	-	-	-	$2.50	$2.62	$5.13

Source: AusNet Services

Incremental revenue requirement

11.1 Introduction

This section presents information on the incremental revenue requirement of the contingent project described in this application. We have used the post-tax building block approach outlined in NER 6.5.4, and the AER's post-tax revenue model to calculate the incremental revenue requirement. Information that explains and substantiates the forecast incremental capital and operating expenditure has been set out in sections 8 and 9.

The building block formula applied in each year of the regulatory control period is:

MAR = return on capital + return of capital + opex + revenue adjustments + tax

= (WACC x RAB) + D + opex + revenue adjustments + tax

where:

MAR = Maximum allowed revenue

WACC = Post tax nominal weighted average cost of capital

RAB = Regulatory Asset Base

D = Economic depreciation (nominal depreciation minus indexation of the RAB)

Opex = Operating and maintenance expenditure

Revenue adjustments = efficiency benefit sharing scheme carry-overs, forecast DMIA, 2010 S-factor scheme close out and shared asset adjustments

Tax = Cost of corporate income tax of the regulated business

The sections below set out further information on each building block component of the incremental revenue requirement. Details regarding the total incremental revenue allowance and the amended revenue determination to enable recovery of the contingent project costs are provided at the conclusion of this section.

11.2 Regulated asset base and depreciation

The forecast RAB in relation to the contingent project is set out in the table below. These values incorporate the capital expenditure plans set out in section 1, and the forecast depreciation over the period.

Table 19: Contingent Project Regulatory Asset Base ($m, nominal)

	2016	2017	2018	2019	2020
Contingent project Opening RAB	-	2	2	23	106
Contingent project capital expenditure[42]	2	-	21	85	50
CPI indexation on opening RAB	-	0	0	1	2
Contingent project depreciation	-	- 0	- 0	- 3	- 7
Contingent project Closing RAB	2	2	23	106	151

Source: AusNet Services PTRM.

The regulatory depreciation in relation to this contingent project has been calculated using the straight-line depreciation method and the standard asset lives approved by the AER in its final decision for the 2016-20 regulatory period. Full details of this calculation are provided in the updated PTRM which is submitted as part of this contingent project application.

For completeness, Table 20 below shows the derivation of the regulatory asset base (RAB) for the 2016-20 period, sourced from the AER's Final Determination PTRM model and updated for the 2017 cost of debt in accordance with the Final Determination WACC requirements and the Tranche 1 REFCL Program.

Table 20: AER's Final Decision Regulatory Asset Base 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Opening RAB	3,442	3,683	4,022	4,315	4,575
Capital expenditure	345	427	387	354	342
CPI indexation on opening RAB	80	86	93	100	106
Straight-line depreciation	- 184	- 174	- 187	- 195	- 208
Closing RAB	3,683	4,022	4,315	4,575	4,816

Source: AusNet Services PTRM.

Table 21 below shows the amended RAB for the 2016-20 period, which reflects the summation of the values set out in Table 19 and Table 20.

[42] Note: the capital expenditure reported in 2016 reflects the change in equity raising costs over the regulatory period.

Table 21: AusNet Services' Amended Regulatory Asset Base 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Amended Opening RAB	3,442	3,685	4,024	4,338	4,680
Amended Capital expenditure	346	427	409	440	392
CPI indexation on opening RAB	80	86	93	101	109
Amended Straight-line depreciation	- 184	- 174	- 187	- 198	- 215
Amended Closing RAB	3,685	4,024	4,338	4,680	4,967

Source: AusNet Services PTRM.

11.3 Return on capital

The return on capital in relation to the contingent project has been calculated by applying the AER's estimated post-tax nominal vanilla WACC to the regulatory asset base, in accordance with the AER's 2016-2020 EDPR Final Decision. This calculation is shown in the table below.

Table 22: Return on capital for contingent project, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Contingent project RAB for revenue calculation purposes	2	2	23	106	151
WACC (percent per annum)[43]	6.31%	6.27%	6.24%	6.18%	6.18%
Contingent project return on capital	-	-	-	1	7

Source: AusNet Services PTRM.

For completeness, Table 23 below shows the return on capital for the 2016-20 period, as set out in the AER's Final Determination, updated to include its decision on Tranche 1 of the REFCL CPA and updates to the annual WACC allowance.

Table 23: AER's Final Decision Return on capital, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
RAB for revenue calculation purposes	3,683	4,022	4,315	4,575	4,816
WACC (percent per annum)[44]	6.31%	6.27%	6.24%	6.18%	6.18%
Return on capital	217	231	251	267	283

Source: AusNet Services PTRM.

43 Updated annually for return on debt.

44 Updated annually for return on debt.

Table 24 below shows the amended return on capital for the 2016-20 period, which reflects the summation of the values set out in Table 22 and Table 23.

Table 24: AusNet Services' Amended return on capital, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Amended RAB for revenue calculation purposes	3,685	4,024	4,338	4,680	4,967
WACC (percent per annum)[45]	6.31%	6.27%	6.24%	6.18%	6.18%
Amended return on capital	217	231	251	268	289

Source: AusNet Services PTRM.

11.4 Tax allowance

The calculation of estimated corporate income tax attributable to the contingent project has been undertaken in accordance with the provisions set out in clause 6.5.3 of the NER. The estimated tax allowance is shown in the table below.

Table 25: Estimated cost of corporate tax for contingent project, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Tax payable	-	0	0	1	1
Less value of imputation credits	-	- 0	- 0	- 0	- 0
Net corporate income tax allowance	-	0	0	0	0

Source: AusNet Services PTRM.

For completeness, Table 26 below shows the corporate tax allowance for the 2016-20 period, as set out in the AER's Final Determination updated to include its decision on Tranche 1 of the REFCL CPA.

Table 26: AER's Final Decision on corporate tax allowance, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Tax payable	55	45	46	47	46
Less value of imputation credits	- 22	- 18	- 18	- 19	- 18
Net corporate income tax allowance	33	27	28	28	28

Source: AusNet Services PTRM.

Table 27 below shows the amended tax allowance for the 2016-20 period, which reflects the summation of the values set out in Table 25 and Table 26.

[45] Updated annually for return on debt.

Table 27: AusNet Services' Amended corporate tax allowance, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Tax payable	55	45	46	48	46
Less value of imputation credits	- 22	- 18	- 19	- 19	- 19
Amended net corporate income tax allowance	33	27	28	29	28

Source: AusNet Services PTRM.

11.5 Incremental operating expenditure

AusNet Services' operating expenditure forecasts for this contingent project are described in section 1 of this proposal.

The table below shows the operating expenditure allowance for the 2016-20 period set out in the AER's Final Determination updated to include its decision on Tranche 1 of the REFCL CPA. Also shown is the amended operating expenditure allowance for the 2016 period, which is the sum of the AER's Final Determination allowance and the incremental operating expenditure for the contingent project.

Table 28: Amended operating expenditure allowance, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Contingent project operating expenditure	-	-	0.0	2.3	2.6
Opex allowance, AER Final Determination (updated)	228.5	238.1	249.4	260.0	271.5
Revised operating expenditure allowance	228.5	238.1	249.5	262.3	274.1

Source: AusNet Services

11.6 Incremental revenue allowance

The table below shows the building block elements that comprise the incremental revenue requirement for the contingent project over the 2016-20 period.

Table 29: Contingent project revenue requirement, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020	Total
Return on capital	-	-	-	1.4	6.5	8.1
Regulatory depreciation	-	-	-	2.6	4.6	7.3
Operating expenditure	-	-	-	2.3	2.6	5.0
Revenue adjustments	-	-	-	-	-	-
Net tax allowance	-	-	-	0.5	0.7	1.1
Annual revenue requirement (unsmoothed)	-	-	-	6.9	14.4	21.4
Annual revenue requirement (smoothed)	-	-	-	10.3	10.9	21.2

Source: AusNet Services

11.7 Revised revenue determination

Table 30 below shows the revenue allowance and X factors for the 2016-20 period sourced from the AER's Final Determination and updated to include its decision on Tranche 1 of the REFCL CPA. Accordingly, the 2017 X Factor has been updated to determine the smoothed revenue requirement.

Table 30: AER Final Determination revenue requirement, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020	Total
Return on capital	217.3	230.8	251.0	266.8	282.8	1,248.6
Regulatory depreciation	103.8	88.5	93.9	94.8	101.7	482.7
Operating expenditure	230.3	240.0	251.5	262.2	273.9	1,258.0
Revenue adjustments	5.3	- 6.4	- 3.6	16.1	0.1	11.6
Net tax allowance	33.2	27.1	27.8	28.6	27.8	144.6
Annual revenue requirement (unsmoothed)	590.0	580.1	620.6	668.6	686.3	3,145.6
Annual expected revenue (smoothed)	586.0	597.9	623.0	650.9	686.0	3,143.9
X factor[46]	8.27%	0.30%	-1.84%	-2.50%	-3.00%	

[46] The X factors from 2018 to 2020 will be revised to reflect the annual return on debt update. Under the CPI–X framework, the X factor measures the real rate of change in annual expected revenue from one year to the next.

Table 31 below shows our amended revenue requirement, which includes the contingent project Tranche 2 revenue requirement.

Table 31: Amended revenue requirement, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020	Total
Return on capital	217.3	230.9	251.1	268.2	289.4	1,256.8
Regulatory depreciation	103.8	88.5	93.9	97.4	106.3	490.0
Operating expenditure	230.3	240.0	251.6	264.6	276.5	1,263.0
Revenue adjustments	5.3	-6.4	-3.6	16.1	0.1	11.6
Net tax allowance	33.2	27.1	27.8	29.1	28.5	145.7
Annual revenue requirement (unsmoothed)	590.0	580.2	620.6	675.5	700.7	3,167.0
Annual expected revenue (smoothed)	586.0	597.9	623.0	661.3	696.9	3,165.1
X factor[47]	8.27%	0.30%	-1.84%	-3.73%	-3.00%	

[47] The X factors from 2018 to 2020 will be revised to reflect the annual return on debt update. Under the CPI–X framework, the X factor measures the real rate of change in annual expected revenue from one year to the next.

12 List of supporting documents

The following documents are provided as attachments to this document.

Table 32 Attachment List

Attachment	Title
Attachment 1-8	8 x Functional Scopes – One for each ZSS
Attachment 9	REFCL Program - Equipment Building Block Functional Description Issue 2
Attachment 10	REFCL Program Network Balancing Strategy Issue 2
Attachment 11	REFCL Program Hardening Strategy – Stations
Attachment 12	REFCL Program Hardening Strategy - Lines
Attachment 13	REFCL Program Automatic Circuit Recloser (ACR) Strategy
Attachment 14	REFCL Program Line Voltage Regulator Strategy
Attachment 15	REFCL Program Distribution Feeder Automation (DFA) Strategy
Attachment 16	REFCL Program Operating modes
Attachment 17	REFCL Program - Arc Suppression Coil Sizing Policy Issue 2
Attachment 18	REFCL Program HV Customer Policy
Attachment 19	REFCL Program Operational Requirements
Attachment 20	REFCL Program Cost estimating, Unit Rates & Program Delivery
Attachment 21	Bushfire Mitigation Plan
Attachment 22	REFCL Program T2 HV Customer Engagement Overview v1.0
Attachment 23	REFCL Program T2 HV Customers – Detailed
Attachment 24	Capex – Unit Rate Comparison

Table 33 Model List

Attachment	Title
Attachment 25	Expenditure build-up model (Tranche 2)
Attachment 26	Amended PTRM
Attachment 27	Amended depreciation model
Attachment 28	HV Customer Model
Attachment 29	Cables Model
Attachment 30	DFA reliability model

13 Compliance Checklist

This document and the accompanying supporting documents provide the following information in accordance with the National Electricity Rules[48]:

[48] NER, clause 6.6A.2(b).

Table 34 Compliance Checklist

Rule provision	Requirement	Relevant section
Part C: Building block determinations for standard control services		
6.6A	Contingent Projects	
6.6A.2(a)	Subject to paragraph (b), a Distribution Network Service Provider may, during a regulatory control period, apply to the AER to amend a distribution determination that applies to that Distribution Network Service Provider where a trigger event for a contingent project in relation to that distribution determination has occurred.	Noted
6.6A.2(b)	An application referred to in paragraph (a):	Noted
6.6A.2(b)(1)	must not be made within 90 business days prior to the end of a regulatory year;	Noted
6.6A.2(b)(2)	subject to subparagraph (1), must be made as soon as practicable after the occurrence of the trigger event;	Noted
6.6A.2(b)(3)	must contain the following information:	Noted
6.6A.2(b)(3)(i)	an explanation that substantiates the occurrence of the trigger event;	Section 3.1
6.6A.2(b)(3)(ii)	a forecast of the total capital expenditure for the contingent project;	Section 8.11
6.6A.2(b)(3)(ii)	a forecast of the capital and incremental operating expenditure, for each remaining regulatory year which the Distribution Network Service Provider considers is reasonably required for the purpose of undertaking the contingent project;	Section 9.3

Rule provision	Requirement	Relevant section
Part C: Building block determinations for standard control services		
6.6A	Contingent Projects	
6.6A.2(b)(3)(iv)	how the forecast of the total capital expenditure for the contingent project meets the threshold as referred to in clause 6.6A.1(b)(2)(iii);	Section 3.2
6.6A.2(b)(3)(v)	the intended date for commencing the contingent project (which must be during the regulatory control period);	Section 6
6.6A.2(b)(3)(vi)	the anticipated date for completing the contingent project (which may be after the end of the regulatory control period);	Section 8.9
6.6A.2(b)(3)(vii)	an estimate of the incremental revenue which the Distribution Network Service Provider considers is likely to be required to be earned in each remaining regulatory year of the regulatory control period as a result of the contingent project being undertaken as described in subparagraph (iii); and	Section 11
6.6A.2(b)(4)	the estimate referred to in subparagraph (3)(vii) must be calculated:	Noted
6.6A.2(b)(4)(i)	in accordance with the requirements of the post-tax revenue model referred to in clause 6.4.1;	Section 11
6.6A.2(b)(4)(ii)	in accordance with the requirements of the roll forward model referred to in clause 6.5.1(b);	Section 11
6.6A.2(b)(4)(iii)	using the allowed rate of return for that Distribution Network Service Provider for the regulatory control period as determined in accordance	Section 11

Rule provision	Requirement	Relevant section
Part C: Building block determinations for standard control services		
6.6A	Contingent Projects	
	with clause 6.5.2;	
6.6A.2(b)(4)(iv)	in accordance with the requirements for depreciation referred to in clause 6.5.5; and	Section 11
6.6A.2(b)(4)(v)	on the basis of the capital expenditure and incremental operating expenditure referred to in subparagraph (3)(iii).	Section 11
6.6A.2(i)	A Distribution Network Service Provider must provide the AER with such additional information as the AER requires for the purpose of making a decision on an application made by that Distribution Network Service Provider under paragraph (a) within the time specified by the AER in a notice provided to the Distribution Network Service Provider by the AER for that purpose.	Noted

Source: AusNet Services