



Revised Proposal

Attachment 5.13.0

Justification for replacement programs

January 2019

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1 REVISED REPLACEMENT PROGRAM OVERVIEW

1.1 Purpose of this document

This document provides a summary of the justification for part of Ausgrid's revised capital programs (excluding major projects) categorised as replacement program expenditure (repx). These programs form part of Ausgrid's overall proposed standard control capital expenditure (capex) for the 2019-24 regulatory period.

The purpose of this document is to provide the AER, its consultants and consumers with a description of the need for the revised capital programs that results in programs that are efficient and prudent as required by Chapter 6 of the National Electricity Rules (NER).

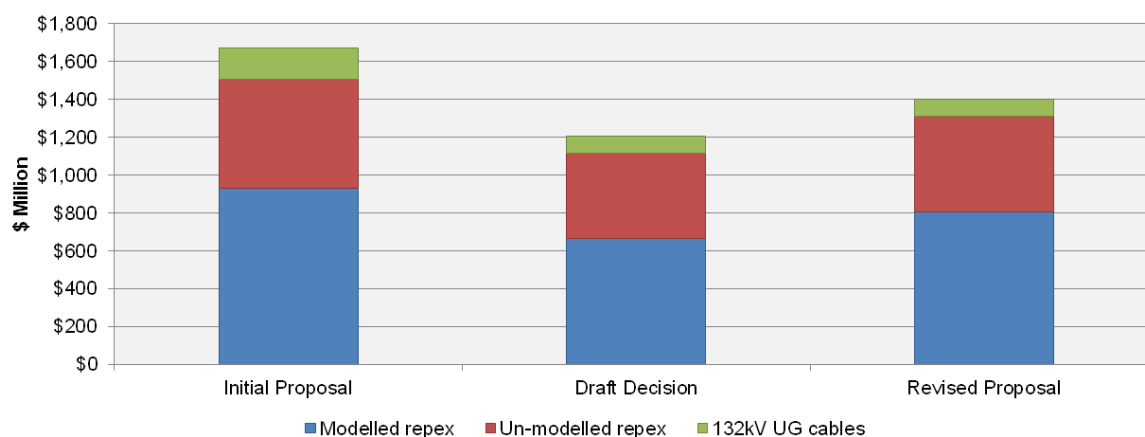
1.2 Changes in revised proposal

Ausgrid's total forecast repx for the 2019-24 regulatory period is \$1,402 million. A breakdown of this compared to the Initial Proposal and the AERs Draft Decision is shown in the table below:

Table 1. Comparison of Ausgrid repx proposals and AER Draft Decision (FY19 Real \$m)

FY19, \$millions	Initial Proposal	Draft Decision	Revised Proposal
Modelled repx	\$930	\$664	\$804
Un-modelled repx	\$578	\$450	\$505
132kV cables	\$165	\$93	\$93
Total	\$1,673	\$1,207	\$1,402

Figure 1. Comparison of Ausgrid repx proposals and AER Draft Decision (FY19 Real \$m)



The modelled and un-modelled repx relate to the Regulatory Investment Notice (RIN) mapping supplied to the AER utilised to undertake REPEX modelling. In providing transparency from the Draft Decision to the Revised Proposal, Ausgrid has maintained the split between modelled and un-modelled replacement in-line with the AERs RIN asset category mapping.

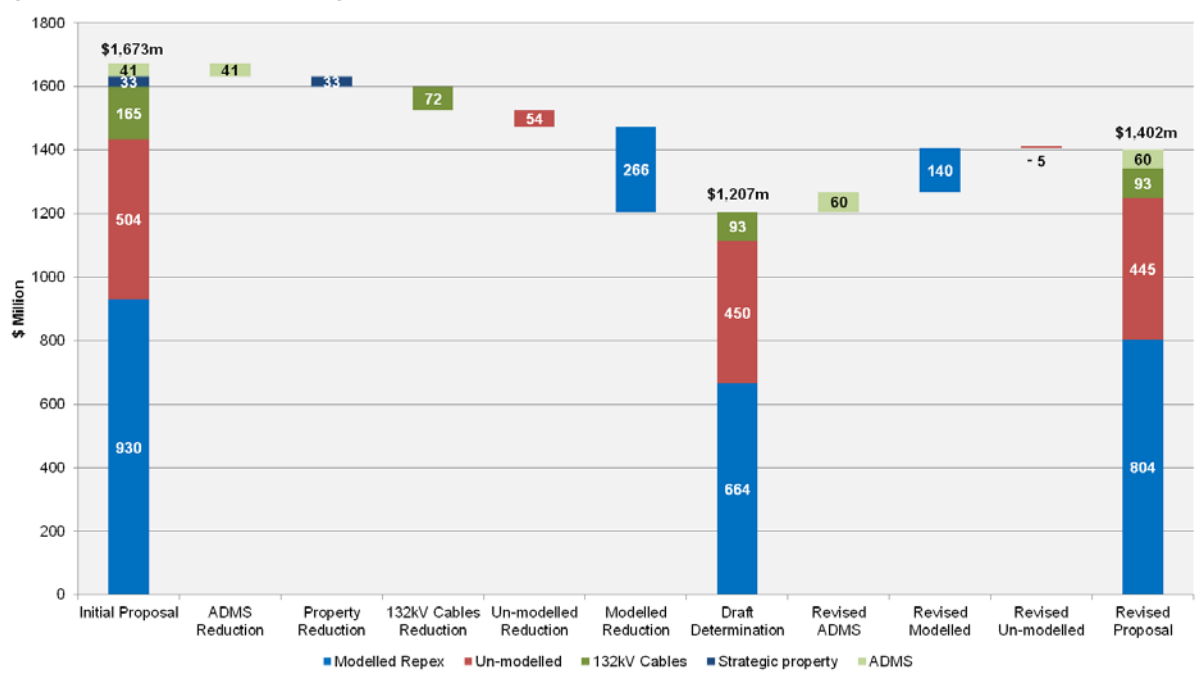
A further breakdown by replacement programs and major projects is shown in the table below:

Table 2. Comparison of Ausgrid repex proposals and AER Draft Decision (FY19 Real \$m)

FY19, \$millions	Programs / Major Projects	Initial Proposal	Draft Decision	Revised Proposal
Modelled	Programs	\$754	-	\$662
	Major Projects	\$176	-	\$142
Modelled Sub-total	-	\$930	\$664	\$804
Un-modelled	Programs	\$382	-	\$342
	Major Projects	\$122	-	\$103
Strategic property*	-	\$33	\$0	\$0
ADMS*	-	\$41	\$0	\$60
Un-modelled Sub-total	-	\$578	\$450	\$505
132kV Cables	-	\$165	\$93	\$93
Total	-	\$1,673	\$1,207	\$1,402

* AER transfers of strategic property and ADMS to Augex and Non-network categories respectively.

Figure 2. Comparison of Ausgrid repex proposals and AER Draft Decision (FY19 Real \$m)



This document only includes replacement captured as programs and does not include major projects replacement which is detailed in Attachment 5.14. Following feedback on its Initial Proposal, Ausgrid has undertaken more detailed cost benefit analysis (CBA) modelling to support its revised replacement forecast.

Ausgrid's Initial Proposal for replacement program expenditure was for \$1,136 million. Ausgrid's revised submission is for \$1,004 million, representing a \$132 million (12%) reduction.

Of the \$754 million included in the original proposal of modelled replacement programs:

- \$723 million (96%) has a rigorous quantified CBA model developed to test the revised forecast (focus on areas of misalignment)
- \$31 million (4%) has not had a model developed for the revised proposal (including pole reinforcement and low voltage overhead mains reactive programs)

Ausgrid has not developed CBA models on its un-modelled replacement programs for its Revised Proposal as the Draft Decision had close alignment with Ausgrid's proposal.

Details of the risks associated with each program are captured in Attachment 5.13 (A – K) of the Initial Proposal. These documents have not been updated to for the revised proposal, however, further detail in this document and additional documents supporting the CBA modelling undertaken by Ausgrid have been produced and included in Attachments 5.13.M.0 (CBA Methodology), 5.13.M.1-19 (CBA Model Summaries), 5.13.M1A-19A (CBA Models), 5.13.M.20 (Independent review of the methodology) and 5.13.M.21 (Independent Review of Input Assumptions).





The values included in the supporting documentation of 5.13 for the Initial Proposal were pre RIN allocation. The values included in this attachment are post RIN allocation. The change in approach will enable clear comparison between the proposal and the AERs REPEX outcomes.

1.3 Asset Management System

A robust asset management system has long been embedded in Ausgrid’s network planning, design and operations processes and practices. In September 2018, Ausgrid’s asset management system was certified to *ISO55001 Asset Management System – Requirements*. The ISO55001 certification meets a licence requirement under Ausgrid’s NSW Electricity Distribution Licence Conditions. The certification of our asset management system reinforced the appropriateness of our asset management practices for an electricity network business.

The asset management objectives, as shown in Figure 3, are aligned to our customer expectations and contribute to the achievement of both the National Electricity Objectives (NEO) and the capital expenditure objectives defined in the NER.

Figure 3. Asset Management Objectives

Asset Management Objective	What Does This Mean?
 <p>Keep the network safe for the public, customers, and workers</p>	<p>In practice this means minimising the likelihood of safety incidents associated with network assets or activities by eliminating safety hazards so far as reasonably practicable and where this is not possible reducing risks to ‘as low as reasonably practicable’ (ALARP). This will be measured through safety incident performance, risk assessments, and asset failure trends.</p>
 <p>Maintain current levels of network reliability and security</p>	<p>In practice this means managing the risk of customer interruption while maximising Ausgrid’s ability to restore supply as quickly and safely as possible after an interruption has occurred. This involves identifying constraints or asset issues and taking appropriate proactive action before asset failure occurs or adverse consequences arise. This will be measured through SAIDI and SAIFI, performance against guaranteed service levels, asset failure trends, and value of unserved energy.</p>
 <p>Maintain affordability for customers</p>	<p>Maximising cost efficiency and competitiveness of assets through the use of market tested unit costs and cost benefit analysis to select efficient treatment options. This will be measured through peer benchmarking of capex and opex costs.</p>
 <p>Sustainable expenditure</p>	<p>Optimising the balance between total expenditure and risk through targeted investment and risk prioritisation. This will be measured by analysing system level performance and trends over time.</p>

Certification to ISO55001 provides assurance that the asset management processes used to develop network capex forecasts are reasonable and robust.

The asset management system supports the use of appropriate risk management techniques supported by asset information for considered fact-based decision making. The use of greater cost benefit analysis provides an appropriate balance between risk, cost and performance for Ausgrid’s assets to meet the needs of Ausgrid’s customers and stakeholders.

1.4 Risk Management

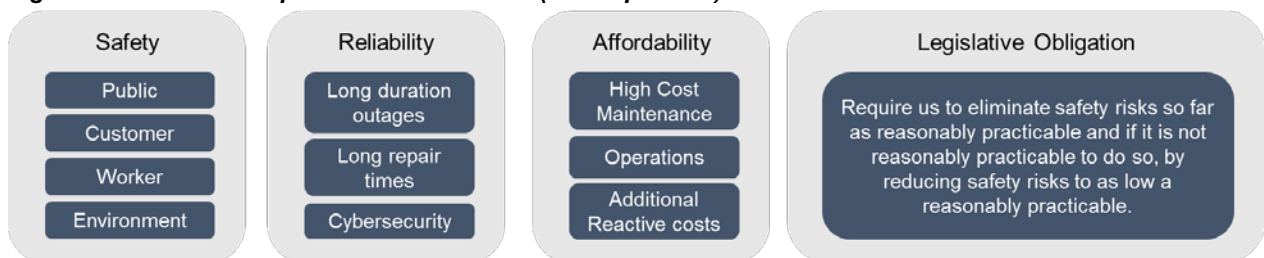
Ausgrid’s asset management system effectively manages the electricity network and related assets through the full asset life cycle. To achieve its required objectives, Ausgrid employs

risk management principles in line with Australian Standards for Risk Management (AS31000) to inform asset maintenance and replacement decisions.

Based on the application of these risk management principles, Ausgrid will eliminate safety hazards ‘so far as is reasonably practicable’ (SFAIRP), however, if it is not reasonably practicable to eliminate safety hazards, they are reduced to ‘as low as reasonably practicable’ (ALARP)¹ in accordance with legislative and regulatory obligations^{2,3}. Other hazards are analysed and evaluated with maintenance strategies to achieve an overall positive balance of risk, cost and performance that meets the needs of Ausgrid's customers and stakeholders and promotes the objectives of the NEO.

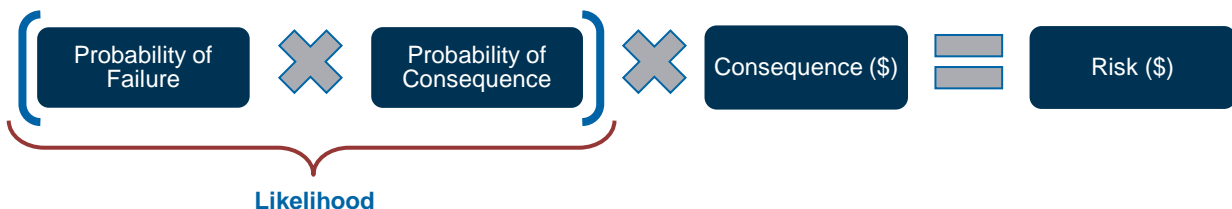
In achieving the objectives described above, Ausgrid’s replacement program is developed to manage the following key risk drivers:

Figure 4. Drivers for replacement investment (consequences)



In applying a risk based approach, Ausgrid considers the likelihood of these drivers being realised and the consequences which arise from their realisation (e.g. after asset failure). This relationship is represented below in the way Ausgrid conducts its cost benefit analysis for managing assets.

Figure 5. Risk Inputs



In assessing the need for planned asset replacement, the avoided risks are considered along with other benefits. These risks and benefits are then evaluated against the cost of undertaking the replacement. This risk based approach determines optimal replacement to maximise benefit to customers. Where replacement is not considered to be cost effective i.e. where the benefits do not exceed the cost, Ausgrid will elect to replace assets reactively.

¹ SFAIRP (so far as is reasonably practicable) and ALARP (as low as reasonably practicable) are complementary safety and risk management concepts. Both require that all reasonably practicable measures are taken to eliminate risk. When risk elimination is not possible, both require that all reasonably practicable measures are taken to reduce risk.

² *Electricity Supply (Safety and Network Management) Regulation 2015* under the *Electricity Supply Act 1995*

³ AS5577-2013, *Electricity network safety management systems*

1.5 Alignment of maintenance and replacement

Ausgrid's maintenance strategies incorporate inspections, testing and condition monitoring of assets to assess their condition and determine potential asset defects which may require rectification.

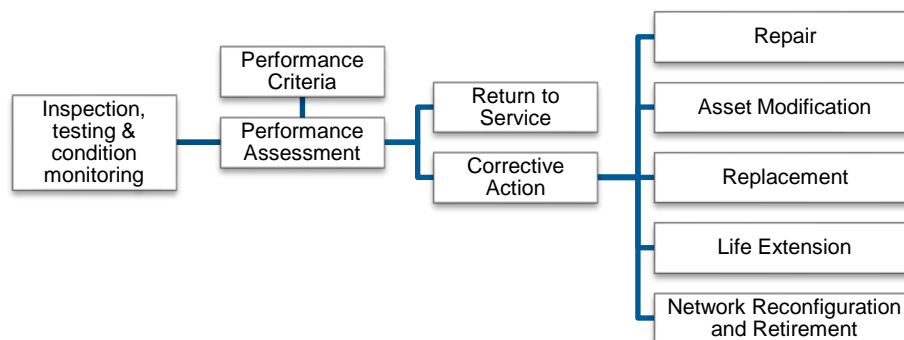
In determining the cost effectiveness and timing for planned maintenance, Ausgrid undertakes Reliability Centred Maintenance (RCM) modelling. RCM compares the asset risk against the cost of performing the maintenance. This comparison utilises cost benefit analysis principles to evaluate and determine the optimal timing to perform maintenance activities based on if and when the maintenance is cost effective.

Ausgrid utilises this risk based approach to determine maintenance requirements to maintain an assets operational status. Where it is not possible or the condition or configuration of the asset pose an unacceptable risk, determined by cost benefit analysis, corrective action is considered, supported by further quantified risk analysis.

This Condition Based Maintenance (CBM) approach is used to inform corrective maintenance (repairs) or capital replacement requirements. The decision to replace assets requires deliberate consideration of associated risk levels, costs and therefore the benefits provided to customers.

Figure 6 outlines the maintenance process through to assessment and corrective action (treatment). Asset condition monitoring and testing is performed to understand the current condition of assets and the risk they pose. Corrective action is required where risks are not acceptable, otherwise the asset remains or is returned to service. Corrective action may be in the form of repair, replacement, modification/reconfiguration or life extension. These actions are further detailed in the next section.

Figure 6. Condition based maintenance and replacement approach



In-line with the outputs of the RCM (cost benefit analysis), Ausgrid applies a network defect prioritisation framework (NDPF) to inform the appropriate timing of corrective actions based on the likelihood of asset failure from the time of defect identification and based on the probability of adverse consequences. This process also provides the timing (and therefore volumes) of asset replacement for condition based and failure related capital programs to achieve prudent and efficient maintenance and replacement expenditure.

Ausgrid has undertaken cost benefit analysis on the majority (96%) of its proposed modelled replacement programs, except for pole staking and low voltage overhead mains reactive programs, to demonstrate the customer benefit from our replacement program forecast.

1.6 Identifying and assessing the options

Once asset risks are understood, Ausgrid must consider the appropriate risk treatment approach which may include capital or operational expenditure to achieve a 'no regrets' investment program. The selection of the treatment approach considers the evolving network outlook so that Ausgrid does not either over invest in assets which may have reduced utilisation in the foreseeable future, or under invest causing an unreasonable step change in future investment requirements or risk exposure.

This is also consistent with recent changes to the NER in regard to the requirement to apply the Regulatory Investment Test for Distribution (RIT-D) replacement capital expenditure.

Risk treatments as defined for each asset class are described in Attachment 5.13.A-K of the Initial Proposal,. These include the following treatment options:

- Repairs or modifications;
- Life extension (refurbishment or reinforcement);
- Reconfiguration and retirement;
- Replacing like for like;
- Replacing with new technology;
- Installation of new assets or upgrade of existing assets⁴; and
- Network alternatives.

Ausgrid forecasts using the method in which replacement program requirements are identified. Ausgrid defines these approaches in three broad categories detailed in the table below:

⁴ New asset or upgrades are appropriate for replacement where they do not fit the definition of 'Augmentation Expenditure' but are required as part of the ongoing management of the network, such as installation of new fences, fire and oil containment systems.

Table 3. Methods for the identification of replacement needs

Need Identification	Assessment	Forecast Method
Reactive Program		
<p>Generally following asset functional failure.</p> <p>Individual replacements are not known until failures occur or risks are realised.</p>	<p>Reactive treatment is suitable when:</p> <ul style="list-style-type: none"> Asset criticality is low and asset failure is acceptable, or The cost in implementing additional controls outweighs the benefit (CBA not positive), or Asset issues are not cost effective to detect; or To allow for additional risks which arise during the period and are not forecast in other programs. <p>An example is underground cables, where safety, supply security and reliability can be maintained.</p>	<p>Trending of historical reactive expenditure with step changes applied for expected changes in failure rates or impacts from other investments.</p>
Condition Based Program		
<p>Assessment of asset condition against acceptable risk criteria</p> <p>Individual replacements are not known until maintenance is undertaken and evaluated against performance criteria.</p>	<p>Condition based treatment is suitable when:</p> <ul style="list-style-type: none"> The risk mitigation gained (benefits) outweighs the cost, and Risks can be linked to time or asset condition, and Condition based maintenance is technically effective (condition is detectable) and cost effective. <p>An example is poles, where the risks posed may be high, asset deterioration is well understood and can be effectively and efficiently assessed via testing.</p>	<p>Informed by maintenance cycles and forecasted utilising CBA and predictive modelling.</p>
Planned Program		
<p>Assets with known and already unacceptable condition issues.</p> <p>Individual replacements are known and prioritised before the start of the regulatory period.</p>	<p>Planned treatment is suitable when:</p> <ul style="list-style-type: none"> The risk mitigation gained (benefits) outweighs the cost (CBA positive), and Condition based maintenance is not technically effective or cost effective, or Further monitoring of condition does not add value. <p>An example is the replacement of oil filled circuit breakers, where the risks posed by individual assets are already well understood and unacceptable with particular asset condition.</p>	<p>CBA outcomes on individual assets.</p>

1.7 Additional Cost Benefit Analysis

To support the proposed modelled replacement programs, Ausgrid has developed nineteen (19) new Cost Benefit Analysis (CBA) models and will continue to develop and refine these and further models. A list of the replacement program models are shown below with the original proposed forecast requirements and their respective RIN Asset Group:

Table 4. Models mapped to Initial Proposal (FY19 Real \$m)

Model	Approach	Initial Proposal (millions)	RIN Asset Group
Poles	Condition Based	\$156	Poles
Low Voltage CONSAC / HDPE	Planned	\$116	Underground Cables
High Voltage Overhead Lines	Planned	\$47	Overhead Conductors
Low Voltage Overhead Service Lines	Planned	\$55	Service Lines
High Voltage Underground Reactive	Reactive	\$34	Underground Cables
Low Voltage Dedicated Mains*	Planned	\$45	Overhead Lines
Circuit Breakers (excludes switchboards)	Planned	\$51	Switchgear
High Voltage Fuse Switches	Planned	\$50	Switchgear
Distribution Substations (Kiosks and Chambers)	Planned	\$32	Switchgear Transformers Underground Cables
Low Voltage Underground Reactive	Reactive	\$26	Underground Cables
Pole Top Substations	Condition Based	\$20	Overhead Conductors Poles Switchgear Transformers
High Voltage Air Break Switches	Planned	\$16	Switchgear
Major Transformers	Condition Based	\$13	Transformers
Sub-transmission Isolator and Earth Switches	Planned	\$7	Switchgear
High Voltage Underground to Overhead Connection	Planned	\$8	Poles Underground Cables
High Voltage Drop-out Fuses	Planned	\$8	Switchgear
Sub-transmission Towers	Condition Based	\$5	Poles
CBD Distribution Transformers	Planned	\$18	Transformers
High Voltage CBD Isolator and Earth Switches	Planned	\$16	Switchgear
Sub-total	-	\$723	Modelled Repex
Not Modelled for the Revised Proposal: <ul style="list-style-type: none"> • Pole staking (\$6m) • Low Voltage Overhead Low Mains (\$4m) • Low Voltage Overhead Reactive Replacement (\$6m) • Low Voltage Boards (\$1m) • OH Wiring Community Concerns (\$18m) 	Condition Based / Reactive	\$31	Switchgear Transformers Overhead Conductors Poles
Total	-	\$754	Modelled Repex

* Included in the Overhead Conductors RIN Asset Group in the AER's REPEX analysis, however, for the revised regulatory proposal, Ausgrid is recommending that this be treated separately, similar to 132kV cables and supported by the Nuttall analysis described in Attachment 5.15.1.

The models were prioritised for development based on replacement program value and where there is different construction types and risks in a single RIN Asset Category. For example, High Voltage Fuse Switches, High Voltage CBD Isolator and Earth Switches and High Voltage Air Break Switches are in the same RIN Asset Category, however, these have significantly different construction types and risks and have therefore been separated into separate models.

The approach utilised to develop the CBA models, is described in a Methodology Report, in Attachment 5.13.M.0⁵, which details the overall approach. In developing the methodology, the draft best practice application note for asset replacement planning prepared by the AER⁶ was reviewed so that the modelling methodology adopted was consistent with this practice application note. Ausgrid engaged CutlerMerz to support the development of the models and provide independent validation of CBA modelling inputs⁷. This also included a review against industry information for some of the key parameters. This independent validation is provided in Attachment 5.13.M.20.

The CBA modelling monetises asset risk in a ‘do nothing’ scenario in order to evaluate the risk against the potential cost to avoid realising some of these risks and determines the appropriate timing / volume of the assets to be replaced within each model.

Figure 7. CBA Evaluation



Ausgrid engaged Frontier Economics⁸ to provide an independent review of the appropriateness of the methodology and recommendations for modelling improvements which were incorporated into the final modelling methodology and reflect the appropriateness of the modelling methodology.

1.8 CBA Option Analysis

The volume of recommended replacements and repairs are included in each of the CBA models. These volumes are determined by the percentage of predicted failures which will require replacement of the asset i.e. cannot be repaired. Repairs are included in the CBA as a cost which could be avoided (benefit) from planned replacement.

The volume of predicted failures and subsequent replacements (where there is no planned replacement) is also used to determine a base case reactive replacement forecast. The model forecasts reactive replacements where the CBA outcomes do not support the planned replacement of assets predicted to fail during the period. The reactive forecast in the CBA models also supports Ausgrid’s condition based programs as condition issues are recorded as predicted failures in the modelling. In the case of assets such as poles and major transformers, Ausgrid has a rigorous condition monitoring regime (including inspection, servicing and testing) which is able to detect imminent failures. When found, Ausgrid is able

⁵ Ausgrid – Attachment 5.13.M.0 Repex program CBA modelling methodology

⁶ AER, Draft Industry practice application note – Asset replacement planning, September 2018

⁷ 5.13.M.20 CutlerMerz independent validation assumptions / parameters report for Repex program CBA models

⁸ 5.13.M.21 Frontier Economics independent review of the repex CBA methodology

to intervene before failure and replace the asset before the risks are realised, maximising the benefit to customers by avoiding the realisation of risks while maximising the life of the asset.

1.9 Analysis Outcomes

The outcomes from the CBA modelling are summarised in the table below. Overall the models suggest an increase in replacement program investment relative to the Initial Proposal.

Table 5. CBA modelling Summary (FY19 Real \$m)

Model	Initial Proposal (\$m)	Model Outcomes (\$m)
Poles	\$156	\$144
Low Voltage CONSAC / HDPE	\$116	\$104
High Voltage Overhead Lines	\$47	\$59
Low Voltage Overhead Service Lines	\$55	\$60
High Voltage Underground Cable Reactive	\$34	\$46
Low Voltage Dedicated Mains	\$45	\$72
Circuit Breakers (excludes switchboards)	\$51	\$43
High Voltage Fuse Switches	\$50	\$46
Distribution Substations	\$32	\$27
Low Voltage Underground Cable Reactive	\$26	\$25
Pole Top Substations	\$20	\$23
High Voltage Air Break Switches	\$16	\$19
Major Transformers	\$13	\$21
Sub-transmission Isolator and Earth Switches	\$7	\$10
High Voltage Underground to Overhead Connection	\$8	\$15
High Voltage Drop-out Fuses	\$8	\$26
Sub-transmission Towers	\$5	\$8
CBD Distribution Transformers	\$18	\$7
High Voltage CBD Isolator and Earth Switches	\$16	\$2
Sub-total	\$723	\$756
Not Modelled for the Revised Proposal*	\$31	n/a
Total	\$754	\$756

* Including pole staking and reactive LV overhead programs.

From the analysis the following CBA models have confirmed a reactive strategy aligned to current practices:

- **Poles** – The CBA modelling suggests a reactive replacement approach (base case) where pole staking is not possible. This aligns to Ausgrid's current approach and suggests that there is no additional sub-set of the asset class which requires planned replacement in the next regulatory period. Ausgrid intend to continue its condition monitoring program to identify pole staking or replacement needs before asset failure. This maintenance approach has historically been effective in mitigating risks and aligns to the CBA outcomes.

- **Pole Top Substations** – Replacement of these assets is generally informed by the condition of the pole supporting the substation. The CBA modelling supports a condition based approach aligned to current practice.
- **Major Transformers** – Ausgrid’s current approach is to monitor the condition of major transformers and only action repairs or replacement following a conditional or functional failure of the asset. The decision to repair or to replace is then determined after failure based on the cost trade-off for these options. The CBA modelling supports a reactive replacement approach which is consistent with the current condition based approach.
- **High Voltage Underground Cable Reactive** – This model covers funding for reactive replacement of high voltage underground cables as per Ausgrid’s existing strategy. There is currently no sub-set of this asset class that is posing an unacceptable risk and therefore no need for a planned replacement program.
- **Low Voltage Underground Cable Reactive** – Similar to high voltage, this model covers reactive replacement of low voltage cable. This excludes CONSAC and HDPE cables which have been separated into their own model due to their unique risks.

The following program was revised to a reactive strategy as a result of the CBA outcomes:

- **High Voltage CBD Isolators and Earth Switches** – Ausgrid had previously proposed a planned replacement program for these assets. Further informed by the CBA outcomes, Ausgrid’s revised proposal for this asset is to undertake reactive replacement only. The current model does not account for second order failures. The effects of Ausgrid’s triplex network significantly reduces the risk posed by these assets within the current modelling. Future refinement of the CBA modelling will have greater account of the reliability impacts and may support a planned approach in future planning cycles.

1.10 Testing and sensitivity analysis

In determining the proposed replacement program forecast, Ausgrid undertook sensitivity analysis on each model and top down testing of the model outcomes.

One of the key factors that was tested by Ausgrid was the disproportionate factors applied to both safety and fire consequences. In-line with industry good practice and in meeting its requirements to mitigate risk so far as is reasonable practicable, Ausgrid has applied grossly disproportionate factors to safety and fire consequences. In quantitative analysis, these factors are used to demonstrate that the risk is not significantly higher, “grossly disproportionate” than the cost to mitigate, and as a result, tests the reasonable practicability of the investment. Further information of the grossly disproportionate values used are contained within the CBA Methodology Report provided in Attachment 5.13.M.0. In undertaking sensitivity analysis, Ausgrid has applied a range of grossly disproportionate values to test the potential impact on each model.

Ausgrid also qualitatively reviewed the outcomes of each model against the asset issues common on the network and across the industry to test the appropriateness of the CBA outcomes and considered these outcomes relative to the AER’s repex modelling results.

The annual CBA outcomes were reviewed against potential network access and resource constraints in delivering the program. An adjusted forecast based on a uniform annual replacement volume, supports a more sustainable investment approach, and still removes risk by the end of the regulatory period where there is value to customers in-line with model outcomes.

Finally, Ausgrid has considered where there could be further option value in deferring investment beyond the point at which it becomes cost benefit positive. These include additional unforeseen options, synergies with other programs or changes in network needs.

1.11 Un-modelled Replacement

As previously stated, consistent with the Draft Decision, Ausgrid Revised Proposal has considered its replacement forecast in terms of modelled and un-modelled replacement. Un-modelled replacement represents those items that have been excluded from the AER's REPEX analysis.

Ausgrid has considered the feedback provided by the AER on its un-modelled replacement program forecast and has revised its forecast. The original proposal included \$382 million of un-modelled high volume low value replacement programs. Ausgrid's revised proposal is for \$342 million, which represents a reduction of \$40 million. This excludes Major Project un-modelled replacement, which when included increases the total proposed un-modelled replacement to \$445 million (excluding the proposed ADMS program).

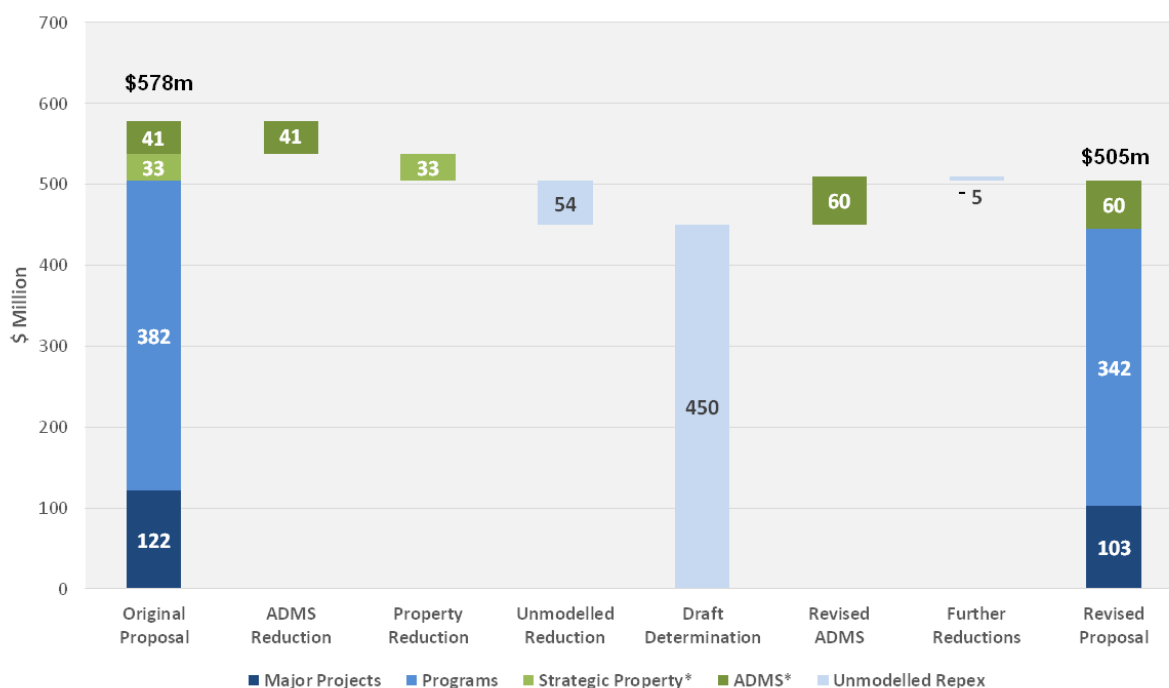
Overall, the revised forecast for un-modelled replacement is \$445 million. This is lower than Ausgrid's original proposal of \$504 million (excluding subsequent transfers of \$74m of ADMS and Strategic Property transferred by the AER to Non-network and Augex categories respectively), and lower than the AER's Draft Decision of \$450 million.

Key changes to the un-modelled programs in the revised proposal include:

- A reduction in the SCADA, Control and Protection RIN Group of over \$13 million predominately due a revised timeline for the 3G roll-off and a reduction in relay replacements considering the potential for future synergies;
- A reduction in Oil Containment upgrades by \$20 million considering potential future alternative solutions;
- A reduction in Distribution Substation Civil upgrades by \$5 million considering the potential for further synergies to be identified with adjacent works;
- A reduction in Tower Refurbishments by \$5 million through deferral into the next regulatory period; and
- A number of minor increases related to reactive program forecast updates.

The updated forecasts have greater consideration for historical expenditure in these programs.

Figure 8. Un-modelled Repex – Initial Proposal, Draft Decision & Revised Proposal (FY19 Real \$m)



* AER transfers of strategic property and ADMS to Augex and Non-network categories respectively.

1.12 Proposed Investment

Ausgrid’s proposed replacement program forecast expenditure has reduced from \$1,136 million to \$1,004 million in the revised proposal. This represents a \$132 million reduction (12%) from the Initial Proposal.

The table below shows the preferred investment related to each model and compared to the cost benefit model outcomes:

Table 6. CBA modelling Summary (FY19 Real \$m)

Model	Initial Proposal	Model Outcomes	Revised Proposal (Change from Model Outcomes)*	
Poles	\$156	\$144	\$138	↓
Low Voltage CONSAC / HDPE	\$116	\$104	\$95	↓
High Voltage Overhead Lines	\$47	\$59	\$51	↓
Low Voltage Overhead Service Lines	\$55	\$60	\$49	↓
High Voltage Underground Cable Reactive	\$34	\$46	\$43	↓
Low Voltage Dedicated Mains	\$45	\$72	\$43	↓
Circuit Breakers (excludes switchboards)	\$51	\$43	\$43	↔
High Voltage Fuse Switches	\$50	\$46	\$36	↓
Distribution Substations	\$32	\$27	\$24	↓
Low Voltage Underground Cable Reactive	\$26	\$25	\$26	↔
Pole Top Substations	\$20	\$23	\$22	↔

Model	Initial Proposal	Model Outcomes	Revised Proposal (Change from Model Outcomes)*	
High Voltage Air Break Switches	\$16	\$19	\$15	↓
Major Transformers	\$13	\$21	\$17	↓
Sub-transmission Isolator and Earth Switches	\$7	\$10	\$9	↔
High Voltage Underground to Overhead Connection	\$8	\$15	\$6	↓
High Voltage Drop-out Fuses	\$8	\$26	\$7	↓
Sub-transmission Towers	\$5	\$8	\$8	↔
CBD Distribution Transformers	\$18	\$7	\$4	↓
High Voltage CBD Isolator and Earth Switches	\$16	\$2	\$2	↔
Sub-total	\$723	\$756	\$639	↓
Not Modelled for the Revised Proposal	\$31	-	\$23	↓
Modelled Total	\$754	\$756	\$662	↓
Un-modelled	\$382	-	\$342	↓
Total	\$1,136	-	\$1,004	↓

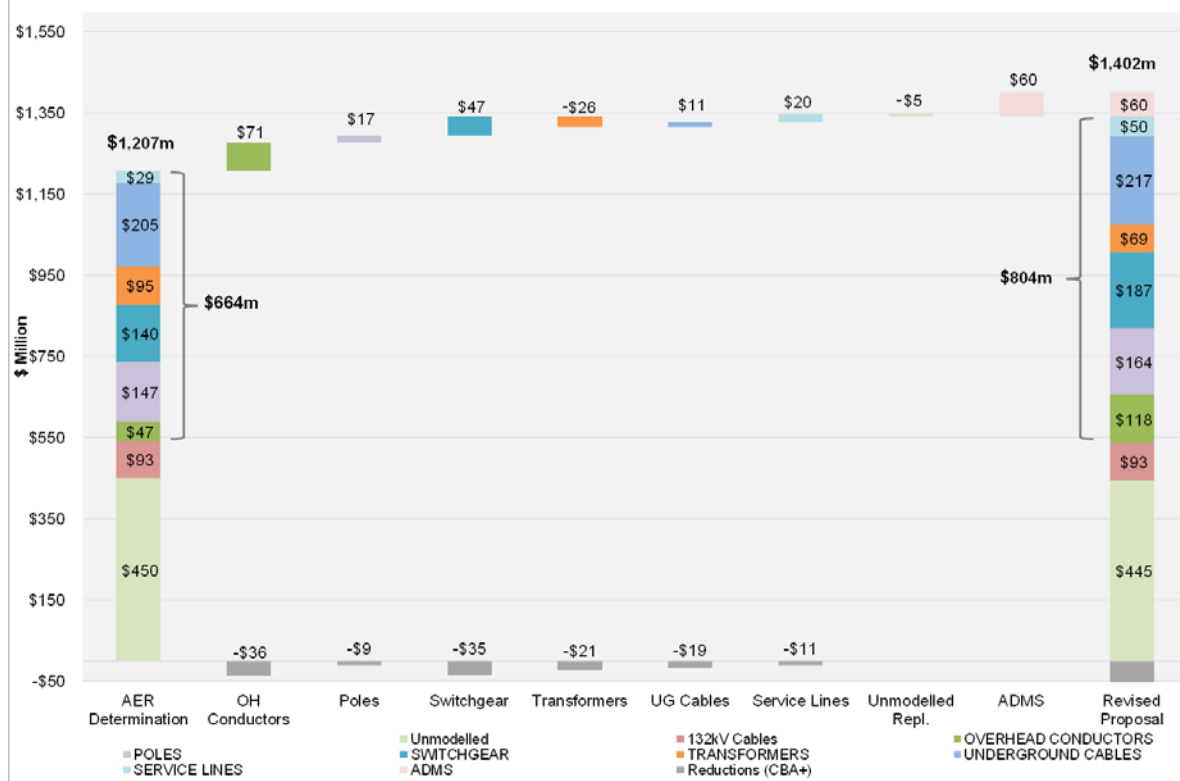
*Due to rounding, values within \$1 million of model outcomes are considered to be equal.

The CBA modelling was utilised to test the reasonableness of the forecast program including sensitivity to model parameters. Ausgrid also applied top-down pressure on its forecast expenditure based on considered feedback from customer stakeholders and the AER. In all cases the revised proposal is lower than or equal to the outcomes supported by the CBA models. The AERs REPEX model outcomes, with consideration of some key issues identified below was also considered to test and apply top-down pressure on the proposal.

Ausgrid is proposing a reduction in pole replacement and has increased the proposed volume of pole staking to mitigate the residual risks of this change. Pole staking is a lower cost solution to extend the life of a pole and defer replacement by approximately 15 years. Ausgrid will be seeking opportunities to improve the staking to replacement ratio by substituting more replacement with staking, to defer investment and achieve greater value for customers.

These outcomes were combined with major projects replacement to develop the total replacement forecast. The changes included in the revised proposal, relative to the Draft Decision, and supported by cost benefit modelling are summarised in the figure below.

Figure 9. Draft Decision to Revised Proposal FY20-24 (FY19 Real \$m)



Subsequent to the Draft Decision Ausgrid has considered the outcomes of the CBA modelling, the review of adjusted AER’s REPEX model outcomes, feedback from customers and the top down pressure applied from internal governance processes. Ausgrid asserts that its revised forecast represents prudent and efficient investment that provides ongoing value to customers.

1.13 AER REPEX Model Comparison

Ausgrid recognises, as identified in its Initial Proposal, the AER’s REPEX model as a useful tool for benchmarking replacement capital requirements. As such, Ausgrid have been working closely with the AER and modelling experts on the REPEX model and results. Through review of the Draft Decision REPEX model outcomes, a number of key areas where the REPEX analysis is producing unusual results have been identified and discussed with the AER. A summary report has been prepared by Nuttall Consulting and is included in Attachment 5.15.1⁹ highlighting six areas where the REPEX outcomes may require closer examination due to these unique circumstances. Included in the Nuttall Consulting report is the following asset category related items:

- **LV overhead conductors (OVERHEAD CONDUCTORS - <= 1 KV)**

In this asset category, Ausgrid has proposed a new program to reconfigure the low voltage network and remove low voltage dedicated mains. This program has a lower unit rate and a higher forecast volume than historical and benchmark low voltage overhead mains replacement. As this program is unique to Ausgrid, both REPEX scenarios considered by the AER produce unusual results. Due to the difficulty in benchmarking, Ausgrid supports the examination of this program outside of the REPEX model and has developed a specific CBA model. This model supports the continuation of this program.

⁹ Ausgrid – Attachment 5.15.1 – Nuttall Consulting supplementary repex review – January 2019

- **LV underground cables (UNDERGROUND CABLES - < = 1 KV)**

Based on Ausgrid's Initial Proposal, this asset category is achieving longer comparative lives than the median DNSP. The average unit rates for LV underground cable replacement is higher than the median based on Ausgrid's unique network circumstances. Benchmarking of unit rates across all DNSPs for underground cable replacements will overlook key differences such as trenching and reinstatement costs. Ausgrid supports the review of unit rates for underground cables with consideration of cable types and the impact of their location.

- **11kV switches (SWITCHGEAR - < = 11 KV ; SWITCH)**

This RIN asset category includes a broad range of asset construction types at varying unit rates particularly considering the differences between overhead and underground networks. This makes benchmarking across all DNSPs difficult without some consideration of network topology. Ausgrid proposal includes a high number of underground network related high voltage switches skewing benchmarking of unit rates when compared to a predominately overhead network. Ausgrid has developed several CBA models to test its forecast in this RIN asset category. These models support the programs through a more applicable analysis approach. The repex model will require further benchmark data at a more granular level to provide a suitable comparative test.

- **11kV fuses (SWITCHGEAR - < = 11 KV ; FUSE)**

Similar to 11kV switches, differences in network design will affect the unit rates and produce unusual results. Further to the comments from Nuttall Consulting, Ausgrid is also seeking a step change in this category from historical volumes due to known type faults creating unforeseen risks. This is supported with a CBA for high voltage drop-out fuses.

- **11kV circuit breakers (SWITCHGEAR - < = 11 KV ; CIRCUIT BREAKER)**

This RIN category includes distribution substation, zone substation, outdoor and indoor circuit breaker construction types. Brownfield replacements particularly in zone substations can include significant additional civil costs and load transfers to adjacent sites, which are highly influenced by the assets location and network design. Ausgrid would support considering these larger "major project" replacements outside of the REPEX model.

- **Ground mounted transformers (multiple RIN Asset Categories)**

These categories are dominated by the replacement of CBD underground transformers. The style and location of these transformers makes benchmarking difficult. Ausgrid has undertaken a CBA for this asset category and is proposing a reduction in replacement based on a reactive strategy and the robust 11kV triplex arrangement in its CBD network. Further model improvements are expected in the next planning cycle to verify or revise these analyses and modelled outcomes.

Additional to the items identified by Nuttall Consulting, Ausgrid has also raised concerns with the AER over the unit rates and volumes applied to service lines. The AER's REPEX model analysis utilises benchmarking across the industry, Ausgrid historical and Ausgrid forecast unit rates. Ausgrid's unit rates continue to benchmark extremely well.

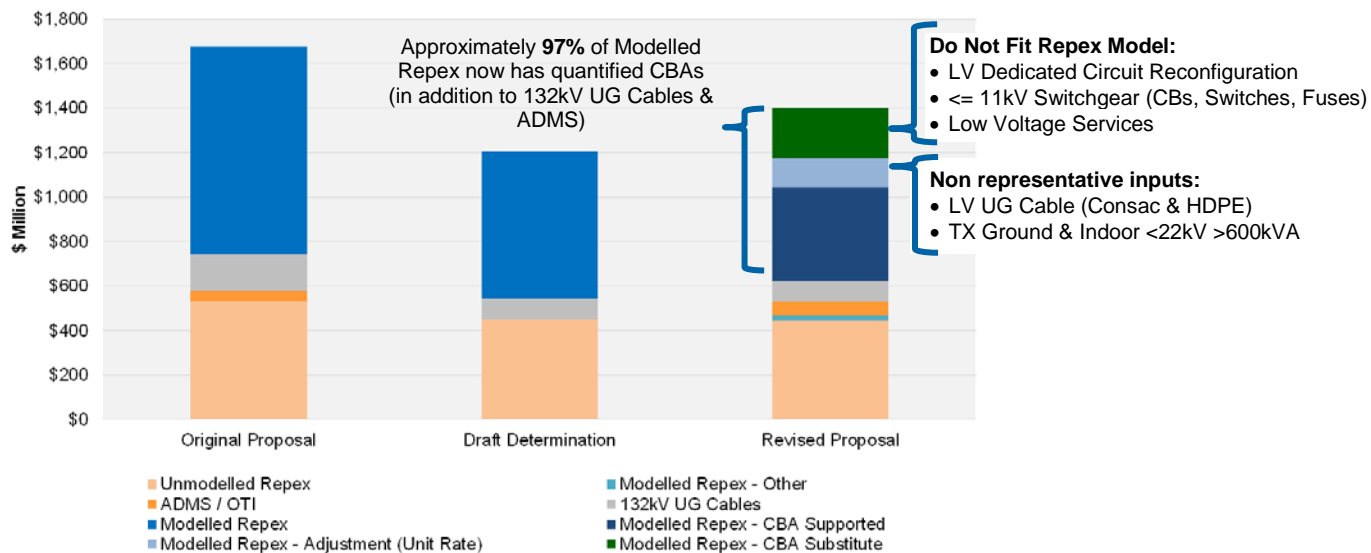
- **LV Residential Service Lines (SERVICE LINES <= 11kV; Residential; Simple Type)**

Following an IPART required audit of the Electricity Network Safety Management System (ENSMS) in 2017, the need for additional modelling to target replacements on a site-specific basis was identified. This has resulted in a less 'production line' approach to address a greater quantum of risk. While Ausgrid continues to achieve extremely strong benchmark comparative unit rates, this change in strategy to address the last of the high risk assets has led to increased travel and setup requirements and increased the unit rates. The change in approach has also led Ausgrid to revise its replacement volumes informed by a greater

understanding of the risk posed to customers and the community from bare and PVC service lines. This revised forecast is further supported by the CBA modelling undertaken for service lines.

Figure 10 below provides a summary of the CBA modelling undertaken and the impact upon the revised proposal and how this revised proposal relates to the modelled replex asset categories. Approximately 97% of Modelled Repex now has quantified CBAs, in addition to CBAs that have been provided for the 132kV UG Cables & ADMS program.

Figure 10. Initial Proposal, Draft Decision and Revised Proposal FY20-24 (FY19 Real \$m)

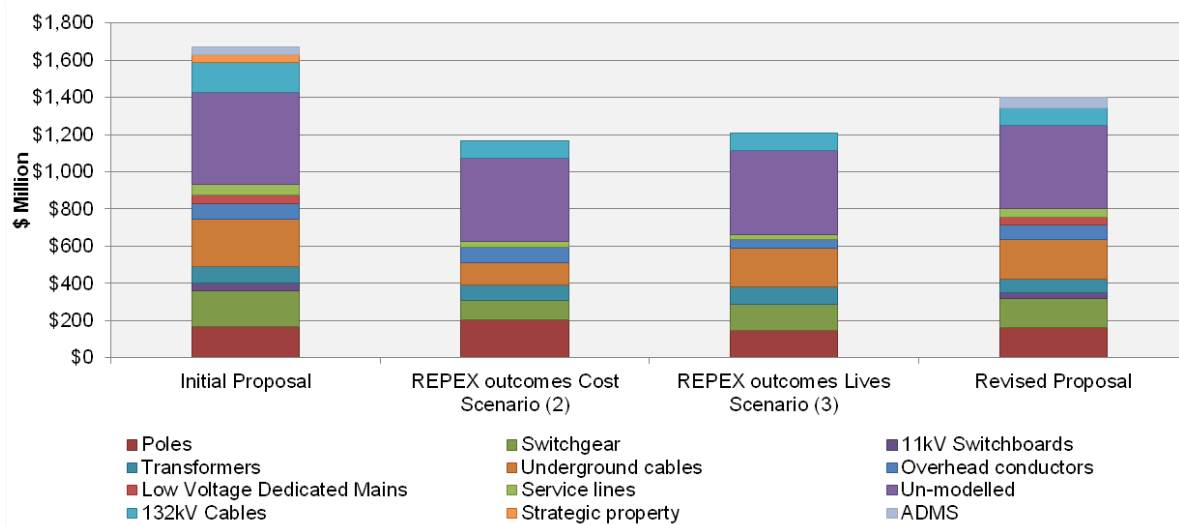


A comparison between the total replacement expenditure in the revised forecast and the two AER REPEX model outcome scenarios preferred by the AER is shown in the table below:

Table 7. Comparison of Ausgrid replex proposals and AER REPEX model outcomes (FY19 Real \$m)

RIN Asset Group	Initial Proposal	REPEX Outcomes Cost Scenario (2)	REPEX Outcomes Lives Scenario (3) Draft Decision	Revised Proposal
Poles	\$168	\$205	\$147	\$164
Switchgear	\$189	\$105	\$140	\$153
- 11kV Switchboards	\$41	-	-	\$35
Transformers	\$91	\$79	\$95	\$69
Underground cables	\$256	\$119	\$205	\$217
Overhead conductors	\$83	\$86	\$47	\$75
- Low Voltage Dedicated Mains	\$45	-	-	\$43
Service lines	\$56	\$29	\$29	\$50
Modelled Total	\$930	\$624	\$664	\$804
Un-modelled	\$504	\$450	\$450	\$445
132kV Cables	\$165	\$93	\$93	\$93
Strategic property	\$33	\$0	\$0	\$0
ADMS	\$41	\$0	\$0	\$60
Total	\$1,673	\$1,167	\$1,207	\$1,402

Figure 11. Comparison of Ausgrid repex proposals and AER REPEX model outcomes (FY19 Real \$m)



As can be seen from above, Ausgrid has reduced its un-modelled expenditure forecast and 132kV cable replacements to be in-line with the AERs Draft Decision. The increases in modelled replacement expenditure, low voltage dedicated circuit reconfiguration and ADMS programs from the REPEX outcomes are all supported by CBA modelling.

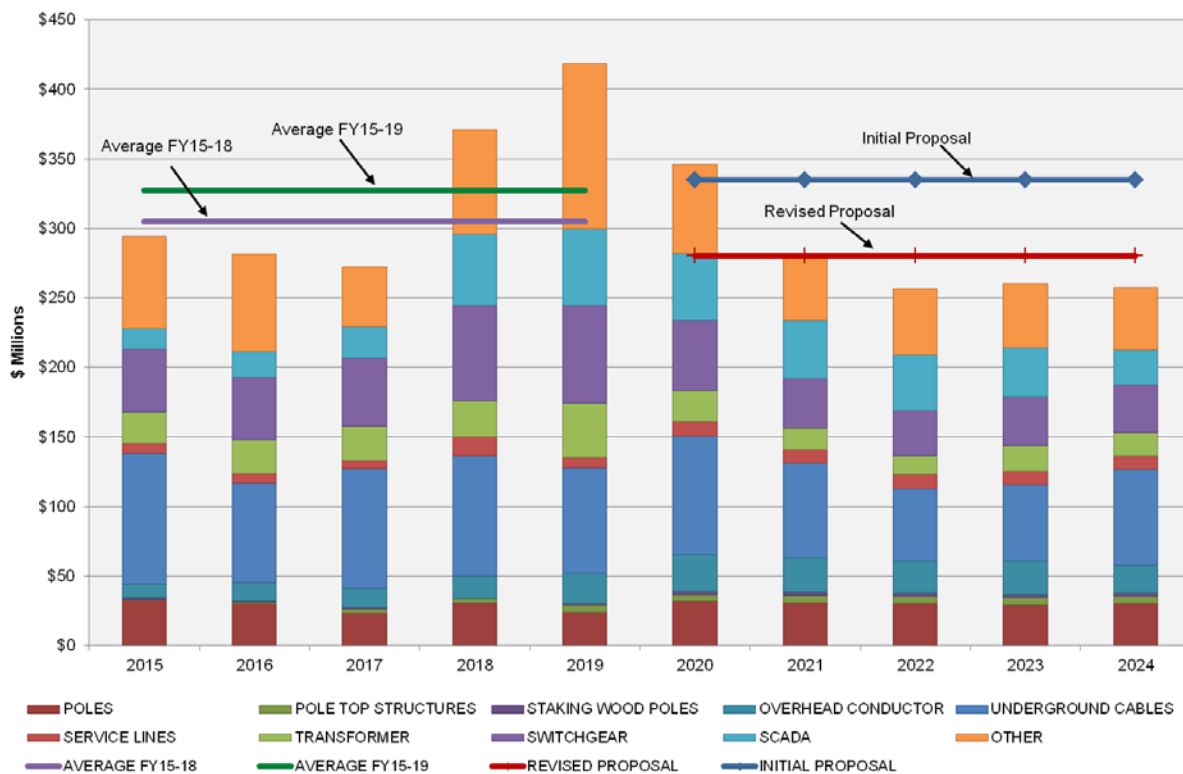
Given due consideration of the points raised above, Ausgrid considers the revised forecast to be reasonable compared to the AERs REPEX model outcomes, and to be prudent and efficient.

1.14 Top-down checks

The figure below shows the historical and forecast replacement expenditure from the current (2015 – 2019) regulatory period to the 2020 – 2024 regulatory period including replacement programs and major projects. The average summary lines included in the chart highlight the average annual expenditure for the following four items:

- Current period – Actual expenditure (FY15-18)
- Current period – Actual expenditure (FY15-18) and Forecast expenditure (FY19)
- Forecast expenditure (FY20-24) – Initial Proposal
- Forecast expenditure (FY20-24) – Revised Proposal

Figure 12. Annual Repex Expenditure Profile Comparison By RIN Asset Group (FY19 Real \$m)



The above chart demonstrates the average annual forecast in the revised proposal is lower than historical expenditure and substantially lower than the Initial Proposal.

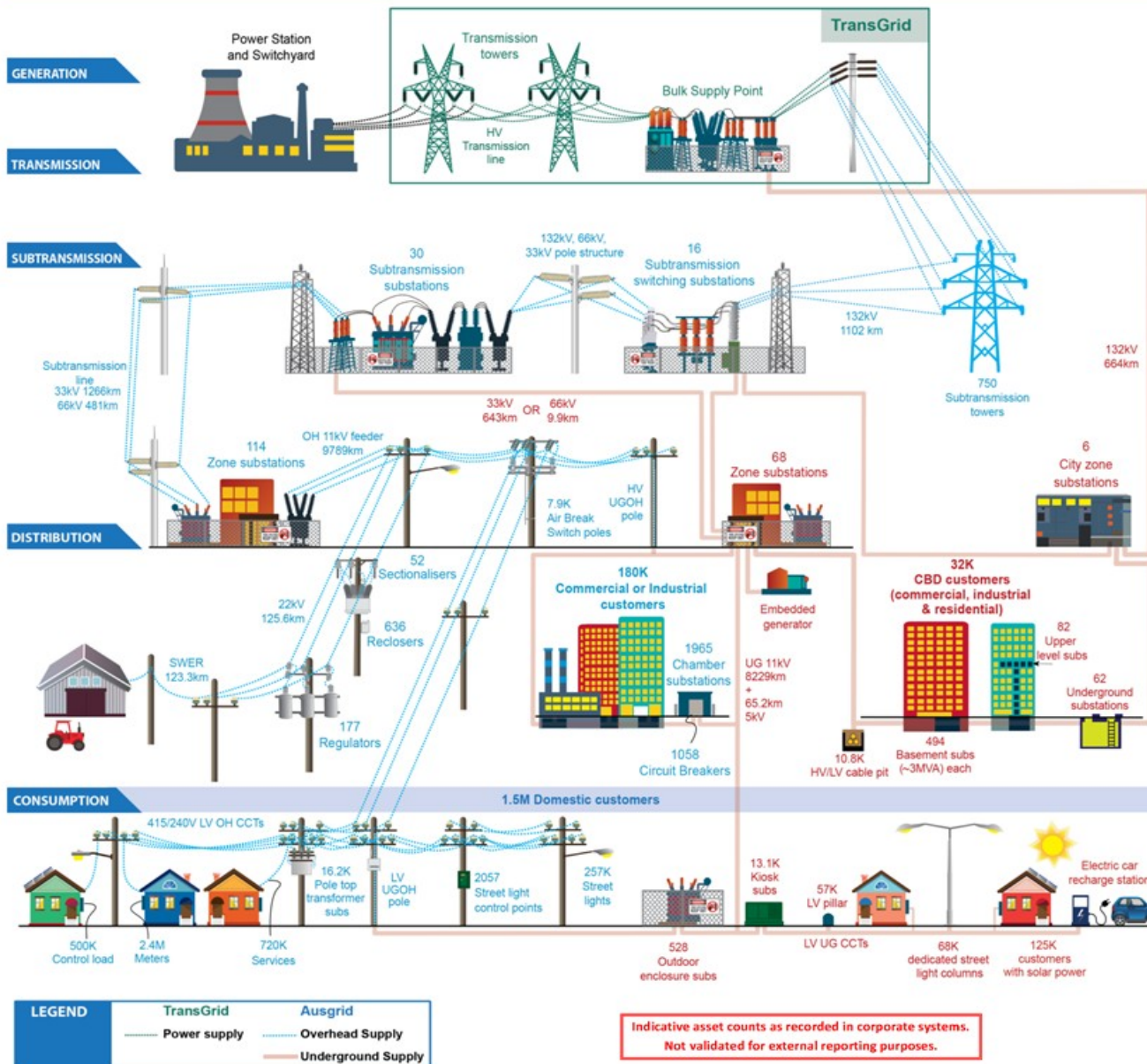
Figure 13 shows the current Ausgrid state of the network summary, which highlights the complexity and increasing age of the asset base. The state of the network also identifies specific sub-sets of asset groups such as steel mains, low voltage dedicated mains, Consac and HDPE and 132kV circuits where Ausgrid has programs in place to address risks associated with these sub-sets of assets. The percentage over standard life provides an additional check of potentially emerging asset condition issues and is often preferred to other indicators like average age which can be biased by new assets. There is a high percentage of assets over standard life for a large number of asset groups which further supports the prudence of Ausgrid’s proposed investment.

As part of ongoing feedback and interaction with customer groups and the AER, Ausgrid is proposing a forecast that is striving to achieve maximum benefit for customers while maintaining downward pressure on expenditure and subsequently prices to customers.

Figure 13. Ausgrid State of the Network Summary

State of the Network

February 2018



Asset Category	Average Age	Std Life	% over Std Life	Qty	Units of M	Bushfire %
Overhead						
132 kV OH ccts	37.1	45	46.8%	1,102	km	66%
33 & 66 kV OH ccts	34.4	45	43.7%	1,716	km	56%
11/22 kV OH ccts	35.1	45	39.8%	10,038	km	61%
- Steel/ACSR/Quince	41.0	45	47.1%	2,211	km	73%
LV OH ccts	43.4	45	59.0%	13,074	km	21%
LV OH dedicated ccts - lighting	51.9	45	79.7%	6,081	km	11%
Poles	36.2	45	42.3%	446,505	No	27%
Services Overhead	28.4	35	40.2%	720,016	No	17%
Underground						
132 kV UG ccts - oil	43.7	45	36.4%	359	km	5%
132 kV UG ccts - other	7.7	45	3.7%	305	km	4%
66 kV UG ccts	4.0	45	1.1%	10	km	57%
33 kV UG ccts - gas	51.0	45	81.9%	108	km	1%
33 kV UG ccts - other	40.9	45	53.1%	535	km	9%
5/11 kV UG ccts	32.3	60	9.7%	8,294	km	14%
LV UG ccts	27.6	60	4.6%	6,163	km	22%
- CONSAC	43.6	60	2.5%	712	km	10%
- HDPE	53.1	60	18.6%	139	km	4%
LV UG dedicated ccts - lighting	47.5	60	57.9%	1,270	km	13%
LV pillars	23.4	60	0.0%	57,383	No	34%
Services Underground	29.2	60	5.7%	232,057	No	32%
Substations - ZN & TS						
Sub-transmission Substation	42.7	60	15.2%	46	No	33%
Zone(ZN) Substation	38.1	60	14.3%	182	No	30%
City ZN Substation	28.9	60	0.0%	6	No	0%
132 kV CBs ZN & TS	8.6	45	1.2%	603	No	19%
66 kV CBs ZN & TS	7.7	45	0.0%	139	No	32%
33 kV CBs ZN & TS	23.9	45	30.6%	924	No	24%
5/11 kV CBs ZN	15.5	45	11.1%	4,003	No	17%
5/11 kV Switchboards ZN	30.7	45	34.8%	5,425	No	17%
Sub-transmission Transformers	29.1	50	6.7%	85	No	21%
132/11 kV ZN Transformers	16.5	50	8.5%	180	No	17%
66/11 kV ZN Transformers	25.8	50	10.0%	44	No	32%
33/11 kV ZN Transformers	32.1	50	27.1%	260	No	26%
Other (incl. Asset Intangibles)	0.0	-	-	-	-	0%
Distribution Centres - DC						
- Pole Substation	31.0	40	32.1%	16,222	No	56%
- Kiosk Substation	22.5	40	18.5%	13,128	No	15%
- Outdoor Enclosure Substations	40.9	40	54.1%	528	No	6%
- Chamber Substations	34.8	40	39.1%	2,603	No	3%
5/11 kV CBs DC	29.9	45	26.3%	2,460	No	3%
5/11 kV Switchboards DC	55.0	45	65.5%	847	No	0%
Distribution Centre Transformers	25.2	45	14.4%	34,110	No	32%
Meters						
Three Phase Meters (Types 5 & 6)	11.0	25	-	210,178	No	-
Single Phase Meters (Types 5 & 6)	26.5	25	-	2,123M	No	-
Streetlights						
Lights & Brackets (Incl. Connections)	35.9	20	16.2%	257,678	No	16%
Light Poles & Columns	28.7	45	29.7%	65,225	No	22%

Notes
 1. Average Age from Asset Investment Outcomes (AIO) Dashboard and GIS extracts as at early February 2018.
 2. Standard Life from NSW Treasury Guidelines 2002.
 3. Distribution Substation numbers include control points.
 4. Zone Substation supply is nominated as overhead if one or more supply feeders is overhead.
 5. STS and ZN Transformers extract from AIO Dashboard as at early February 2018.