Long Term Renewal Capital Expenditure (REPEX) Discussion

Background

This note has been prepared to discuss the long-term renewal capital expenditure (REPEX) forecast for network assets that has been developed to support the upcoming revenue submission to the Australian Energy Regulator (AER). The discussion focuses on the end-to-end forecasting process, including:

- The methodologies employed to develop the REPEX forecast
- A comparison of the REPEX forecast for the different methodologies in the FY2019-2023 period
- Commentary on the long-term REPEX, asset age, and residual life trends

REPEX Forecasting Methodologies

Top-Down Modelling Discussion

In response to criticism from the AER during the last Revenue Reset TransGrid has developed a 30 year REPEX model to support the current revenue proposal. The following three approaches were considered:

- A methodology based on the AER's documented calibrated REPEX model
- A methodology based on the AER's REPEX model without the calibration step
- An enhanced model based on the AER's calibration model modified to address a number of shortcomings.

Evaluation of the three options are described below:

Options 1 – AER's Calibrated REPEX

A review of AER's calibrated REPEX model was undertaken. The following issues were noted:

- A key assumption of the model is that recent replacement expenditure is a reasonable indicator of future replacement. This is not statistically reasonable as it
    - Does not allow for changes in expenditure due to changes in failure rate or the emergence of type issues
    - Cannot consider improved modelling of risk which may change the investment strategy to the benefit of consumers
    - Where low volume exists in an asset class (for example SVC's) it could be expected that no expenditure may occur in some periods, making this underlying assumption invalid.
- The calibration of the model leads to unit replacement values being used which are inconsistent with the values in the bottom up estimating data base , which have been independently benchmarked as reasonable
- Calibration results in unrealistic asset replacement ages that are inconsistent with shared experience of networks around the world.
- Cannot deal with a change in asset strategy such as moving from a historical replacement strategy to a refurbishment approach or vice versa as these changes undermine the key assumption of predictability

The use of a calibrated REPEX model is therefore not endorsed by TransGrid

Option 2 – AER's Uncalibrated REPEX Model

A review of the uncalibrated REPEX model was undertaken, with the following issues noted:

- This model does not take into account where an old asset is to be replaced with a new technology which can have both a different expected age and cost. Examples of this are the replacement of wood poles with a concrete pole, or an electromechanical relay with a microprocessor based unit.
- The model does not allow for partial replacement or refurbishment. For example an SVC control system is a significant replacement cost , but on a different cycle to the primary equipment.
- The model is still not suitable for small volume asset classes as the modelling has limited statistical validity.

The use of the uncalibrated REPEX model is not endorsed by TransGrid. However the general approach and the use of RIN data where possible is a useful building block for an improved model.

Preferred Option TransGrids Top-Down Model

A top-down model was developed to forecast REPEX, asset age, and residual life 30-years into the future based on the AER's uncalibrated model. The model forecasts REPEX according to a renewal unit cost of an asset, and a renewal time (year) that is normally distributed around the mean expected renewal age of an asset. The key inputs to the model are:

- Asset age profile data as per the 2015/16 Category Analysis RIN data and other sources. Asset classes are split into multiple lines of data where significant variation in asset lives exists (e.g coastal vs non coastal transmission lines and electromechanical / solid state / mircroprocessor relays)
- Renewal unit costs that are estimated from TransGrid's benchmarked estimating database (Success)
- Renewal time that is based on the mean expected renewal age from historic asset information and advice from the Asset Managers
- A standard deviation for the renewal time that is the square root of the mean expected renewal age (as per guidance from the AER)
- Significant non high voltage equipment categories have been added, including substation steelwork, buildings, AC / DC distribution and oil containment

The model has been utilised to forecast REPEX for all major asset classes, including:

- Transformer replacement
- Circuit breaker replacement
- Disconnector replacement
- Instrument transformer replacement
- Reactive plant replacement (except SVCs due to their small population)
- Substation steel work refurbishment
- Substation buildings and civil infrastructure refurbishment
- Substation oil containment system refurbishment
- Substation AC/DC system replacement
- Substation battery and charger replacement
- Substation security assets
- Communications terminal equipment replacement
- Control equipment replacement
- Wood and concrete pole replacement (note that all wood poles are replaced by concrete poles)

- Steel transmission tower refurbishment (note that inland and coastal towers have been modelled separately as their mean expected renewal age varies due to the effects of corrosion in coastal areas)
- Overhead conductor replacement
- Protection relay replacement by technology type (note that it has been assumed every two non-microprocessor will be replaced with one microprocessor relay)
- Note that transmission cables and SVC's have not been included in the modelling due to their small population

The model leverages that developed by the AER, and has been enhanced significantly to provide a more accurate estimate of the long-term REPEX forecast.

Bottom-Up Project List

A bottom-up REPEX forecast has been developed for the upcoming revenue period (FY2019-2023) based on a list of individual proposed projects. The list has been developed by identifying the most prominent needs amongst network assets, undertaking a robust risk assessment of the existing and post investment risks, and selecting the preferred option based on a thorough options screening and evaluation process.

Comparison of the Top-Down and Bottom-Up Forecasts

A comparison of the REPEX forecast from the two methodologies for the upcoming revenue period (FY2019-2023) has been undertaken, and the results of the analysis are presented in Table 1 (nominal dollars). The REPEX forecasts vary consistently between top down and bottom up except in the case of the substation security asset category. Bottom modelling predicts a higher replacement cost due to risk based factors , and additional non modelled components in this asset class.

Overall the top-down modelling provides assurance that the bottom-up forecast (which is the basis for the upcoming revenue proposal to the AER) is reasonable, and not an over or under estimate of the funding required to meet the needs of the network.

Table 1: Bottom-Up and Top-Down REPEX Forecast Comparison for FY2019-2023

Category	Top-Down REPEX Forecast	Bottom-Up REPEX Forecast
Substation Equipment	$299M	$245M
Substation Civil Infrastructure	$62M	$47M
Substation AC/DC Systems	$43M	$33M
Secondary Systems Equipment	$187M	$162M
Transmission Line Assets	$290M	$221M
Security Assets	$11M	$36M
Total	$893M	$708M

The total difference between the two forecasts is approximately 20%. Note that as the same unit prices are used in both the top-down and bottom-up forecasting methods, the outputs (REPEX and implicitly the renewal quantities) of both methodologies are directly comparable.

Excluded from the bottom up forecast are projects required to address emerging risks that are not condition driven, do not have sufficient data to infer an expected life or capture both benefits and risk. These are ad-hoc, unpredictable and not estimated using the REPEX model. The projects in the unmodelled category in the bottom up build total $155M and include:

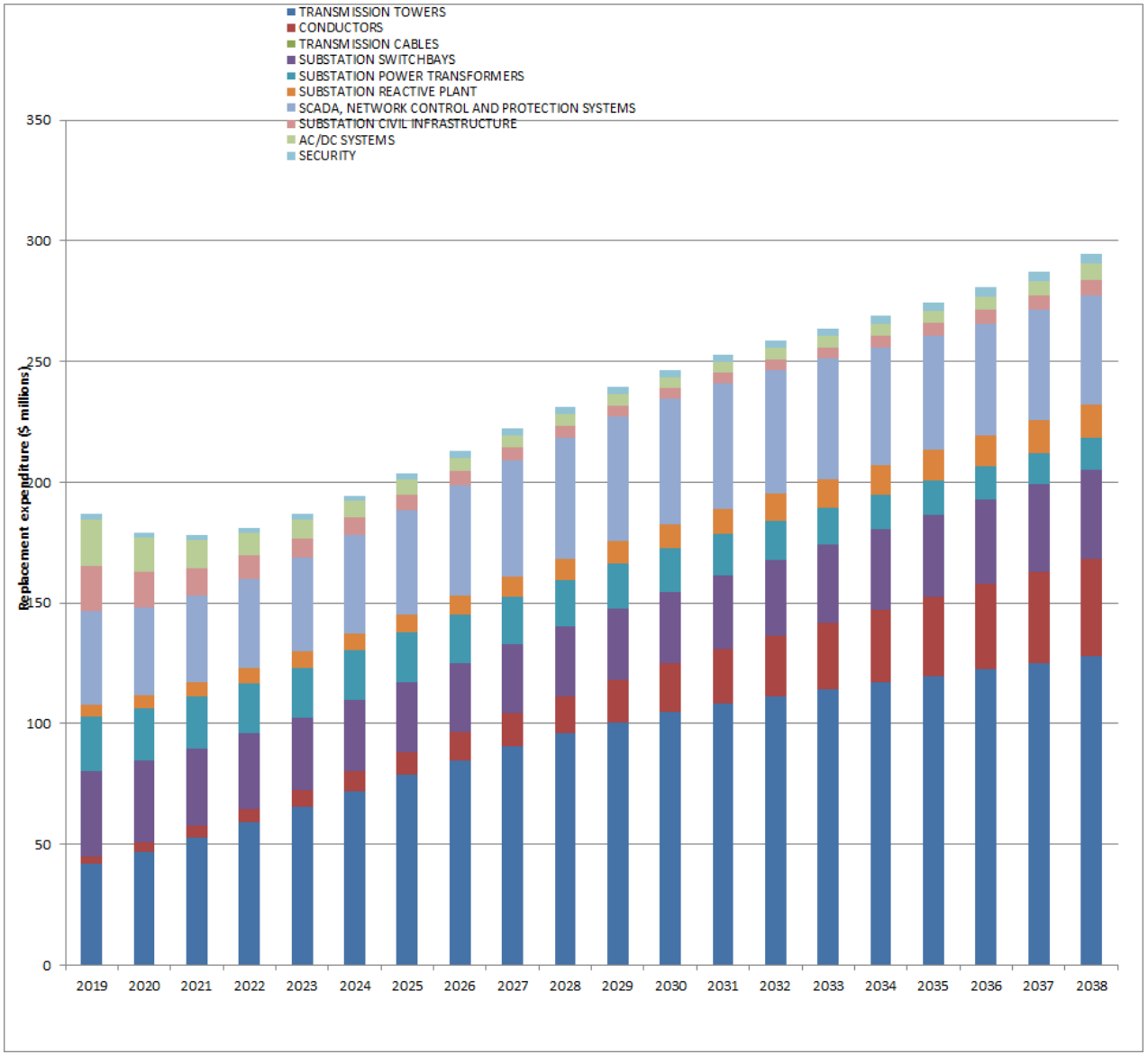
- $36M to upgrade communications infrastructure equipment to provide improved remote monitoring and control benefits
- $16M to renew SVC control systems
- $102M to remediate transmission line structures with harmful asbestos paint and poor condition grillage foundations

These projects are not included in comparison of the top-down forecast to enable a valid comparison with the bottom up results.

Figure 2 and 3 show the future expenditure predicted by the model and the age trend through RP2. These figures support the bottom spend being reasonable as:

- Expenditure over the next three regulatory periods is expected to increase each period. This is consistent with the RP0 – current RP to RP 2 trend.
- Average age is increasing to the end of RP2 showing that TransGrid is not replacing purely on age, but is moderating the expenditure on a risk basis
- Deferral of expenditure form RP2 to RP3 will result in increasing pressures on sustainability.

Figure 1: Top-Down REPEX Forecast



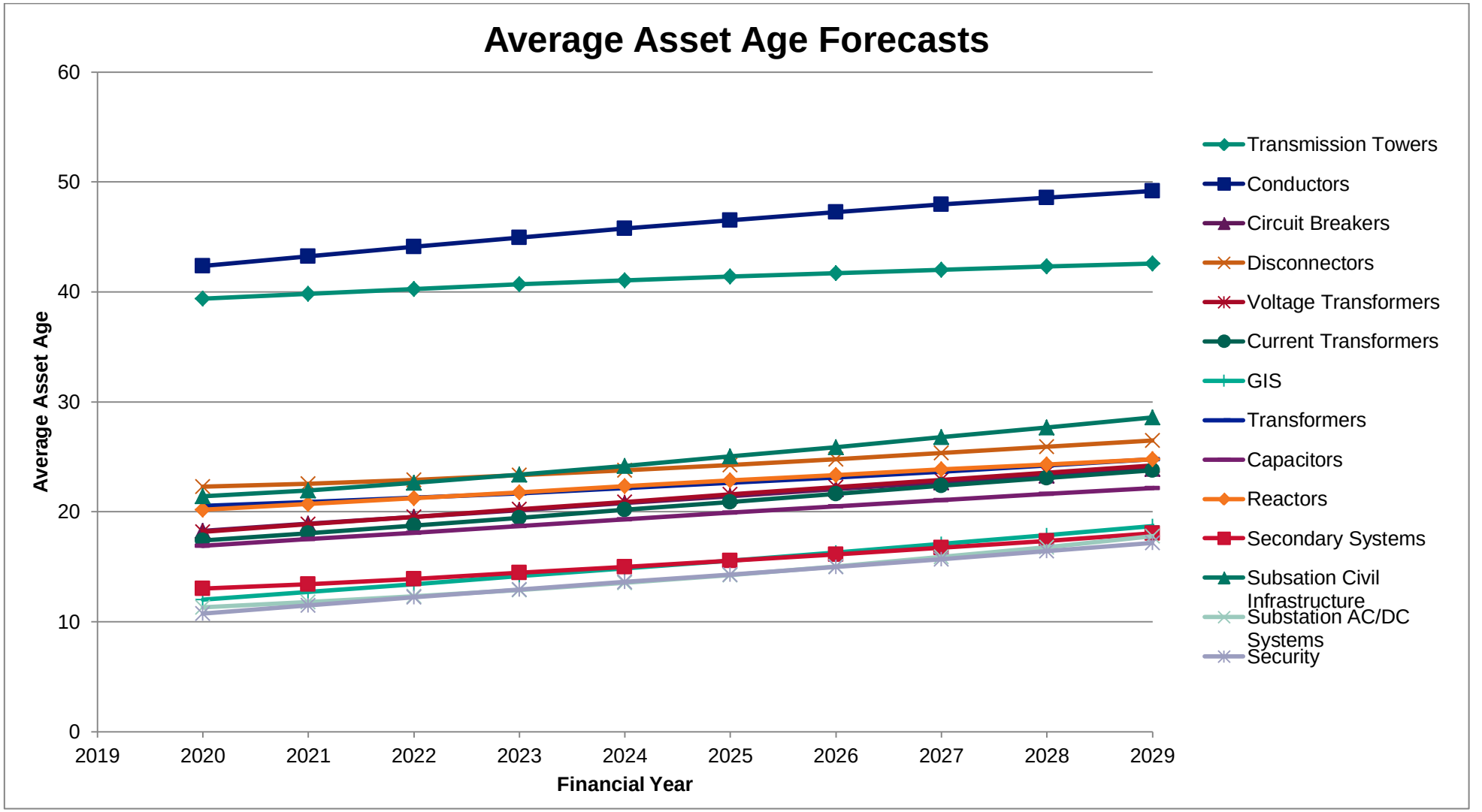


Figure 2: Top-Down Average Age Forecast