Attachment 5.06

Weighted average value at risk analysis

January 2015

Ausgrid revised regulatory proposal attachment

1 Introduction

The ability to understand network health at a system level has been a challenging issue for Ausgrid and for the industry in general as network asset fleets age and significant replacement expenditure are forecast. Various methods have been used and developed over time, generally relating to the age of assets and the likelihood that they may need to be replaced. While Ausgrid has approached the need for replacement, at the asset category level, as being driven by condition information and failure history, rather than simple "standard age" approaches, the age of assets relative to their typical effective life is a reasonable proxy for high-level analysis and indicators.

As we have identified various shortcomings of the metrics available and in use at Ausgrid, we have sought to develop a high level metric that is:

- A relatively accurate reflection of the asset health and need for renewal investment;
- Simple to calculate from available data;
- Simple to understand; and
- Able to be tracked over time and projected forward under different scenarios.

The result of recent work is the "Weighted Asset Value at Risk" approach, which is described in this document.

2 Network health indicators

Ausgrid has reasonably good information about its major asset classes, including date of installation. While this is not perfect, and has been estimated in some cases, it forms a reasonable base for the assessment of the major asset categories. We are unable to deal with a very large number of smaller assets, but these are of less concern in an asset renewal strategy. Currently, reasonable quality asset age profiles are available for:

- underground cables;
- poles;
- overhead conductors;
- service lines;
- transformers; and
- switchgear.

Together these elements comprise about half of the total value of our asset base.

2.1 Average asset age

The simplest measures of asset health we have employed are simple averages of asset age. In some documents we have quoted increasing asset average age as a signal that our asset base is in need of increased investment. The difficulty with simple averages is that the metric is dominated by large numbers of less valuable assets, like poles. Because there are about 500,000 poles, the metric tends toward a measure of pole age only.

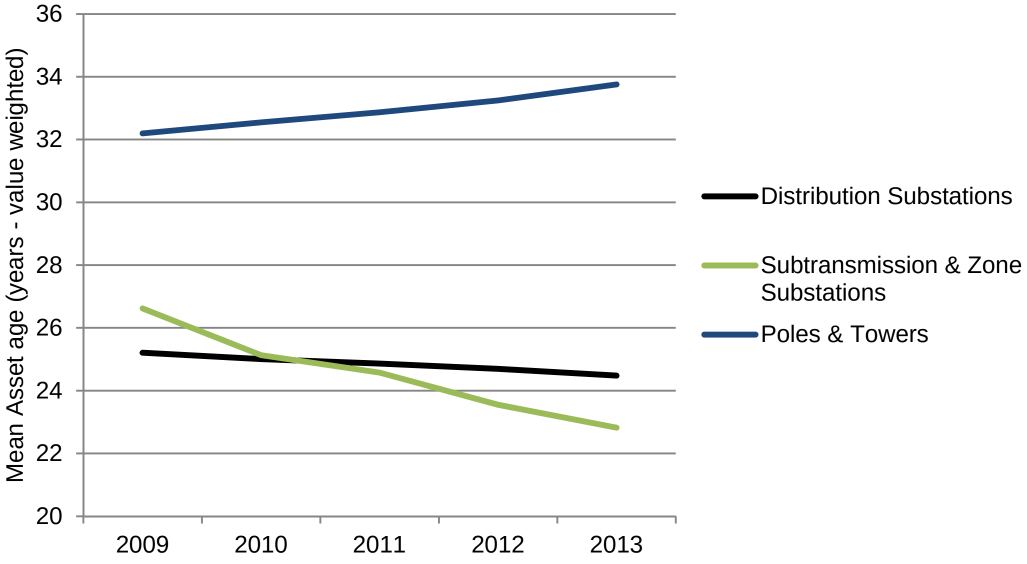
In addition, this approach takes no account of the fact that assets may have different expected lifetimes. Some underground cable technologies have expected lifetimes in excess of 60 years, while electronic equipment might have an expected life as short as 15 years. A simple average age metric does not provide a means to assess multiple asset classes within a single metric.

Finally, average age metrics can mask the actual situation. Age distributions dominated by large number of new assets (perhaps due to growth) can present with a low average age despite the remainder of the asset base being quite old.

2.2 Weighted average asset age

A solution to the issue of different values is to weight the average as by replacement cost. This ensures that high value assets, like underground cables, are represented more correctly within a grouping compared to lower cost assets. Even within an asset class, it can be useful to identify, for example, expensive transmission towers should have more weight in the consideration than simple LV wood poles.

In Ausgrid's May 2014 regulatory proposal, we presented a chart showing how the average age of various asset classes had changed over time. This showed that, over the past five years, our subtransmission and zone substation average age had reduced. At the same time, the average age of distribution substations and changed only slightly, and the average age of poles had increased.

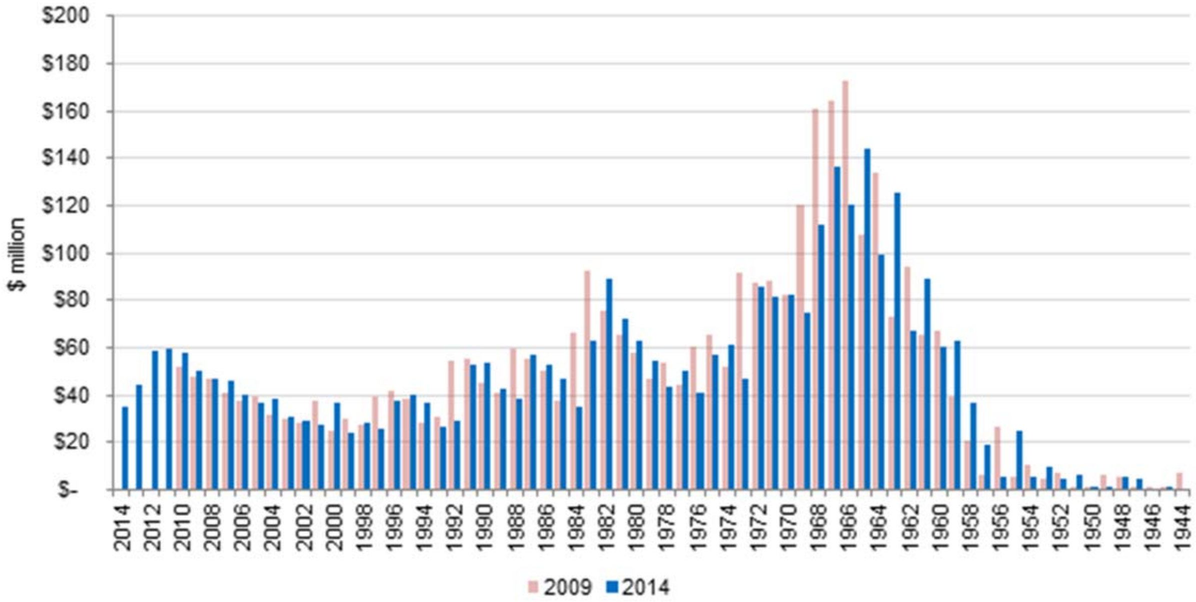


This demonstrates the nature of our investment program over the period. Subtransmission and zone substations have been impacted by a proactive replacement program directed at the assets with the most significant condition issues and greatest failure consequences. The renewal effect of growth driven investments over the period has also contributed. The change in distribution substations, by contrast, is mainly a result of a small replacement program focused on the worst risks and a large impact from adding new assets – the total number of distribution centres has risen by 3-4% per year each year. In the case of poles, the replacement program is based on condition assessment of individual assets leading to replacement or life extension class. The aging profile demonstrates that this approach is enabling the risks associated with these assets to be managed while the overall profile ages. Poles are also a good example of the potential impacts of a distorted asset age distribution. Of our almost 300,000 low voltage poles, 43% were installed before 1968 and are therefore already beyond what would normally be regarded as the 'standard age' of 45 years.

We explained that these effects demonstrated that weighted average age was of limited value as an indicator, which is only really useful at the asset class level, and with a full understanding of the underlying data.

There are two significant shortcomings. The first is that average age metrics do not take into account the different asset life expectancies. The second is that averages will always tend to mask the underlying age profile, which is a problem when the objective is to understand the requirement for renewal expenditure. This can mask the existence of large quantities of assets that are at the end of their life if there are also significant quantities that are very new (a so-called two-humped profile). The effect of growth can be one of the reasons behind this, because while all the added assets will be, by definition, new, even if none of the older assets are replaced, the average age will reduce.

The chart below is a representation of the assets showing the value of pole assets by the year of installation. It compares the situation in 2009 to the situation in 2014. This clearly shows that, while a significant improvement has been made in removing many old assets from service, there is a substantial value in assets still at elevated ages from the rapid development times of the 1960’s and 1970’s. Mapping this asset grouping by average age may lead to an understatement of a looming problem.



2.3 Weighted average remaining life - technical

A solution to the problem of different life expectancies for different assets is to use weighted average remaining life. In this case, the measure responds to the proportion of life left in an asset, rather than the amount consumed. This metric can be estimated by using asset data or by inferring from financial data. Technical weighted average remaining life uses the asset data as its base.

Assets are assessed to determine the remaining life (expectancy minus age) as a proportion of their life expectancy. These results are then weighted by the replacement cost value of the assets and averaged.

This approach resolves the issues of different life expectancies and different values of assets effectively. Where asset age profiles are relatively flat, this can provide a consistent measure that provides valuable insight into the relative health of the network over time.

However, where the asset age profile is not very flat, and has a significant concentration of older assets, this measure can still mask a looming problem.

2.4 Weighted average life – financial

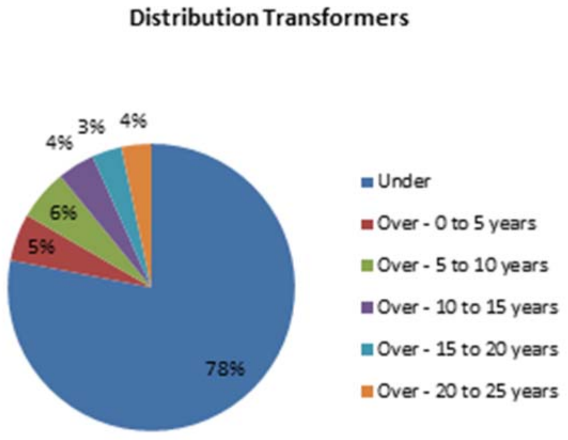
A temptingly simple approach to estimating weighted average remaining life is to use financial depreciation metrics to infer remaining life. Depreciation (straight line) is simply asset value divided by asset life. If one divides the written down asset value by the annual depreciation, the time until the asset is fully depreciated can be derived. Depreciation and written down asset values are commonly aggregated across an entire organisation for financial reporting, so these data inputs are readily available.

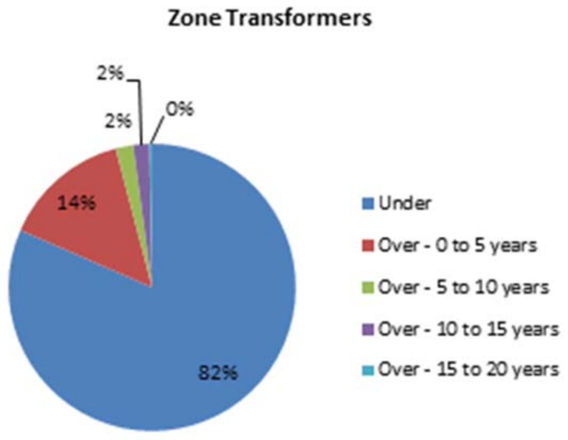
If we assume that depreciation lives are a reasonable representation of expected economic life, and that all assets are replaced once depreciated, the aggregate written down replacement value of an organisation’s assets divided by its total annual depreciation expense should provide a simple way to calculate weighted average remaining life.

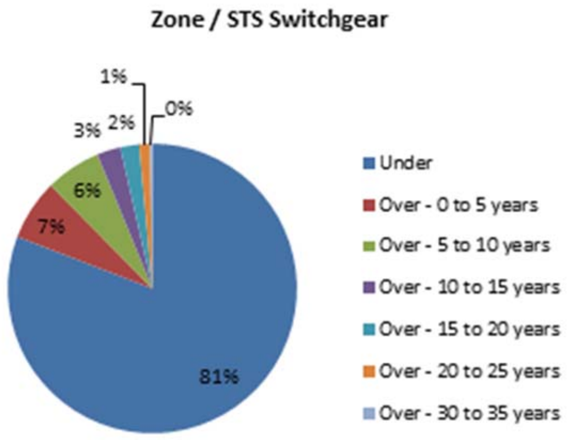
There appear to be several difficulties with this approach. Firstly, in the case of regulated electricity businesses, the written down asset value is usually assumed to be equal to the reported RAB (regulated asset base). RABs have been determined over time for a range of reasons and reset in ways that mean they are not necessarily an accurate representation. Secondly, assets that are fully depreciated, but remain in service are not represented in the calculation, as they have nil or near zero value and no associated depreciation. This effect leads to an overestimation of the average remaining life where there are a large number of assets at or beyond their depreciation life.

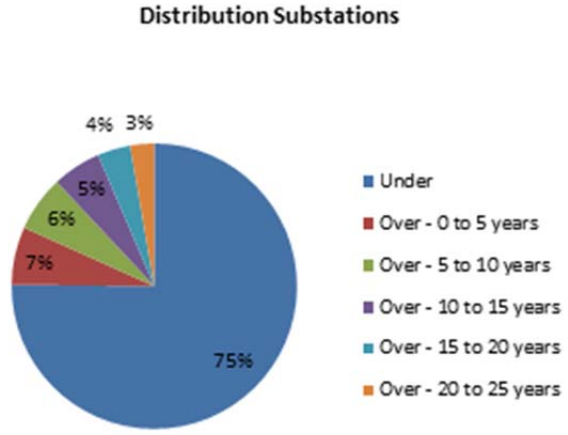
2.5 Proportion of assets above standard age

Another approach that has been used frequently at asset category level is to look at the proportion of assets near or beyond standard life. The charts below show, for a number of asset groups the age profile of the asset bases in relation to the usually assumed life expectancy.









This approach is useful in understanding specific asset classes, and gives a very clear picture of the aging assets that are of most concern. However, it is a static view and not amenable either to aggregating to the system level or to demonstrating how asset ages change over time.

3 Weighted asset value at risk

As a means of addressing the shortcomings of the previously used methods, Ausgrid has developed a more robust approach to providing visibility of network health and the way it moves in response to actual or planned investment. It uses a cumulative normal distribution centred around an assumed end of life for each asset class. This is focusses the metric on those assets that are near (or beyond) their design life and ignores assets that are in the early phase of life.

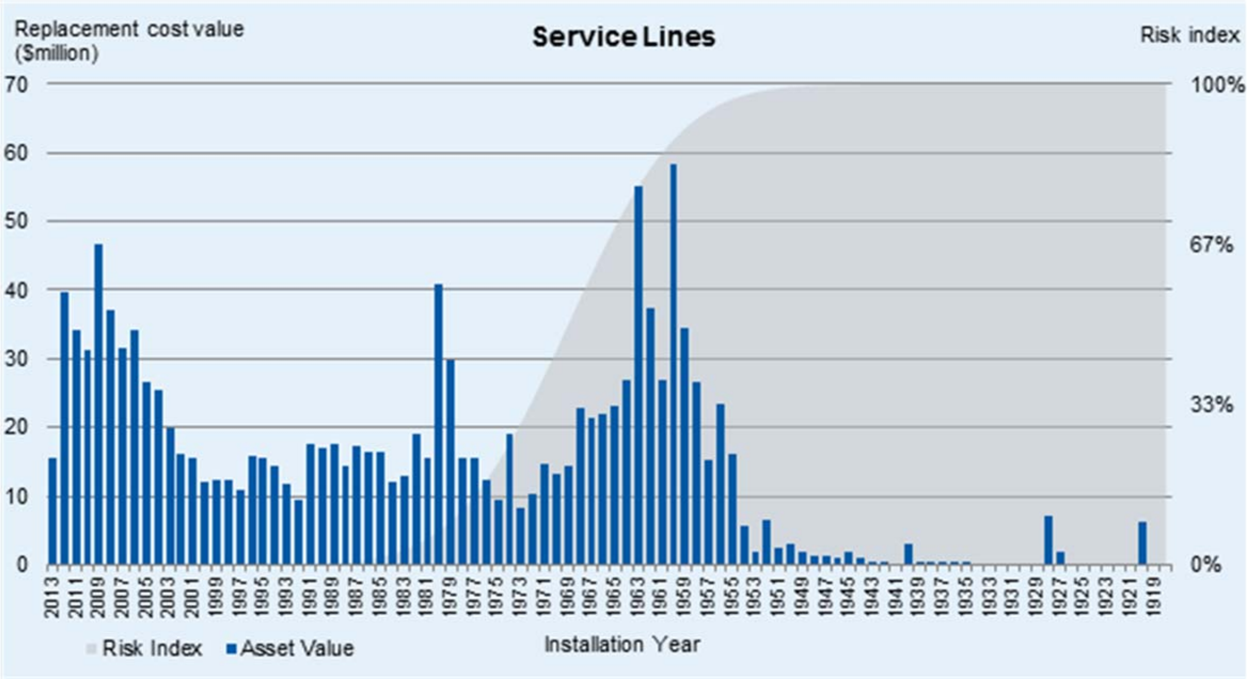
The first assumption is that age is a reasonable proxy for the likelihood of assets within a homogenous category requiring replacement. An assumed typical lifetime is required. This can be standard accounting lives, observed life at failure, industry standard averages or any other reasonable method. A standard deviation around this end of life is also required. Again this can be established by a number of approaches. A default option is to use the approach embodied in the AER's REPEX model, that the standard deviation is equal to the square root of the life.

Based on these factors a "risk index" is established as the cumulative normal distribution using the lifetime as the mean and the established standard deviation.

The other input is a value weighted profile of the asset category by year of installation. Value is based on current replacement cost (as this would be the cost incurred if replacement was required).

An example of these elements is shown in the chart below. To derive the weighted asset value at risk, the value of assets in each year is multiplied by the risk index and the results summed.

Weighted Asset Value at Risk



For the any year, the same calculation is performed, with the risk index moving forward or backward to reflect the change in age.

The results can be used at the category level, or summed to provide a measure of overall network health across a number of asset classes.

A historical trace can be developed by calculating the weighted value at risk based on the assets in place in that year and the relevant risk index. Mapping the change in value at risk over several years provides a view of whether the replacement program is maintaining or improving, or if asset health is deteriorating.

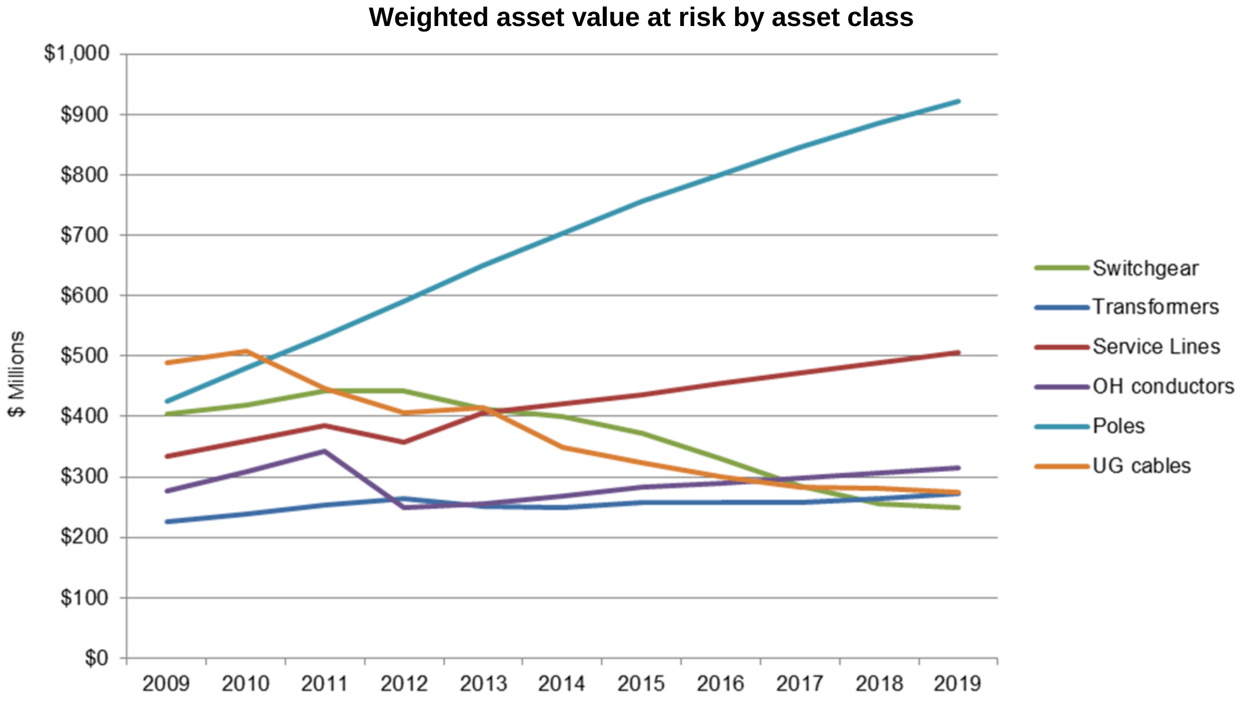
To project forward, there are two options. The first assumes no foreknowledge of the exact targets of the replacement program or which assets will fail. In this case the assumption is that the replacement expenditure (which establishes a group of assets equal to the forecast expenditure in the current year) retires assets in the at-risk region in proportion to their risk index. A higher expenditure will retire more of the assets at risk, a lower expenditure will leave more in place. This can be repeated for as many years as desired to provide a simple forward view of the effect of various expenditure scenarios.

The second requires a knowledge of which assets will be proactively replaced in order to remove those from the base and insert new assets in their place. The remainder of forecast replacement expenditure (typically reactive replacements) can be estimated using the method above.

A no-spend scenario is simple to construct to see what would happen to the value at risk in the absence of replacement expenditure.

3.1 Segment level weighted asset value at risk analysis

Considering the asset classes mentioned above, the results for each asset class, based on available history and the projected expenditure in our revised regulatory proposal are shown in the chart below.



Some of the sudden changes in the historical data point to the likelihood of some data inaccuracy, or changes of definition in previous years. However, it would be clear from this analysis that we would be concerned to ensure that the replacement rate for poles was checked and we ensured that our risk exposure was being managed appropriately. We would also have some concern about service wires. On the other hand, we would be comfortable that our risk exposure in transformers and overhead conductors was stable.

The forecast reduction in exposure for underground cables and switchgear would prompt us to ensure that we were reducing risk cost effectively and that the program did not represent over-servicing.

All these trends accord with our strategies for replacement.

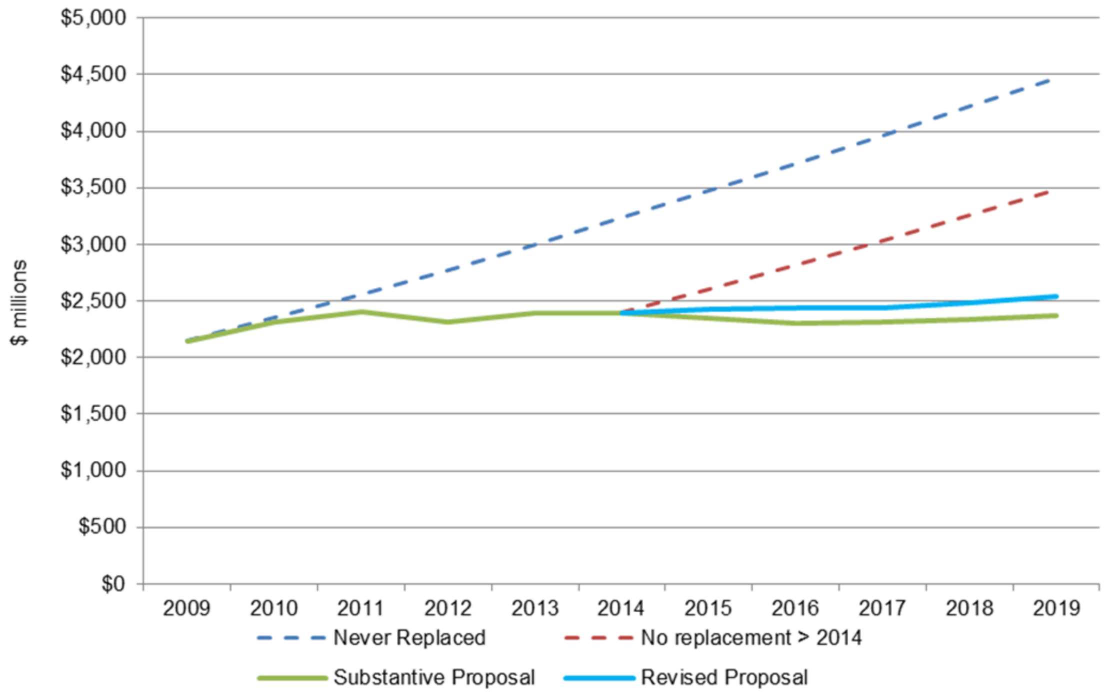
3.2 System wide view

Using the same approach, we have mapped a high-level approximation for the movement in asset health of the collective system comprising these major asset classes:

- over the past five years,
- if over the past five years and if the future there was no replacement
- over the five years from 2014 no proactive investment was undertaken, and
- the impact of the replacement program in our substantive and revised proposals.

While this only includes the major assets classes it shows a high level measure of network asset health. Ausgrid has not relied upon this analysis to develop its expenditure forecasts however the trajectory provides a level of assurance that the proposed program is proportionate and appropriate.

System wide weighted asset value at risk ($ million)



4 Conclusion

Weighted average value at risk analysis as described in this report provides a simple to administer method for providing a high-level tool that can be used instead of average age or weighted average remaining life analysis to assess the relative asset health under a range of investment scenarios.

It is superior to the previously used metrics in that it focusses the attention on the assets that are oldest and therefore most at risk of failure if not replaced. Because it is denominated as value at risk in dollars, it also provides some sense of the level of relative benefit from investment of particular.