Replacement Expenditure (Repex) Modelling

An Overview | January 2021
2023-27 Revenue Proposal

Background

We have adopted a hybrid approach to forecast capital expenditure for the 2023-27 regulatory period. This builds on the experience, input and feedback gained during our previous revenue determination process. For our Revenue Proposal we have developed project-specific, bottom-up supporting justification and cost estimates for over 70% of our total forecast capital expenditure. The balance of our forecast capital expenditure is forecast using top-down methods. We refer to this as the Hybrid+ approach.

Top-down methods rely on historical information to establish predictive models and trends for future investment needs. These methods are well suited to forecast periodic reinvestment in existing transmission assets.

Reinvestment is expenditure primarily undertaken due to end of asset life, asset obsolescence and asset safety or reliability requirements.

We adapted the AER's Replacement Expenditure (Repex) Model to be the primary forecasting tool for reinvestment expenditure for the 2018-22 regulatory period. We have continued to apply the Repex Model for the 2023-27 regulatory period but have used it to complement the bottom-up forecasts and not as the primary forecasting tool. Approximately 20% of our total forecast reinvestment capital expenditure has been forecast using the Repex Model.

What is the Repex Model?

In broad terms, the Repex Model analyses the historical pattern of reinvestment in different transmission assets to derive quantities of each asset to be replaced on an annual basis. A unit rate (reflecting the typical cost of replacing that asset) is applied to each quantity of asset to derive an overall forecast of annual reinvestment expenditure.

The Repex Model is a statistical model that forecasts quantities of assets to be replaced. As a statistical model, the assets are considered as populations rather than individuals. For each population of a particular asset type (e.g. steel transmission towers) the key parameter for forecasting asset replacements across the population is the mean replacement life.

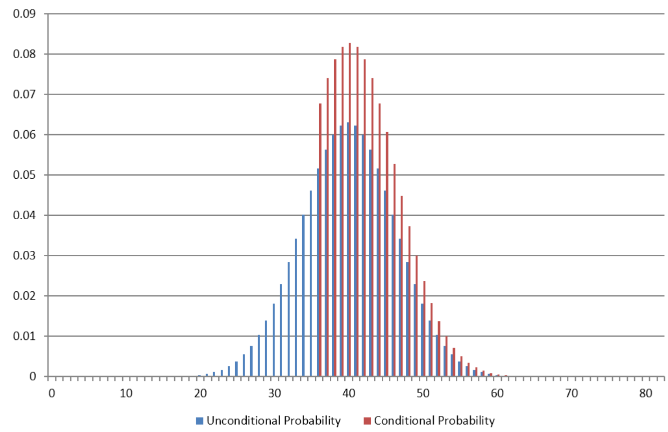
The mean replacement life reflects the average age at which the assets in a population will require replacement.

The model then uses the ages of individual assets within the population, together with the statistical distribution around the mean replacement age, as a proxy for the many factors that drive individual asset replacements.

Repex Model Algorithm

Given the Repex Model operates on an asset age profile that reflects the ages of the assets that are in service, some assets are known to have already survived to a given age. Therefore the standard unconditional probability distribution is transformed into a conditional probability distribution. Conditional probability means the probability that an asset will be replaced at age X, given that it is already Y years old. Conceptually, the unused probability up to Y years of age is redistributed into the future years.

An example of the difference between unconditional and conditional probabilities for a normal distribution is shown below.



The unconditional probability is shown for a newly installed asset with a mean replacement life of 40 years. The conditional probability is shown for an existing asset with the same mean replacement life (40 years) that has already reached 35 years of age.

For each asset type of each age, a conditional probability function is calculated by the model and applied to the relevant populations.

The forecast replacement quantity in each year of the forecast is then calculated by multiplying the quantity of assets of a particular age in that forecast year by the appropriate probability taken from the conditional probability function. This is illustrated in the diagram on page three.

Our Repex Model

We have taken the AER's base Repex Model and enhanced the modelling approach to better reflect our actual asset management approach and be suitable for the Hybrid+ forecasting approach.

Some of our key enhancements are:

- Use of two separate models – one for calibrating mean replacement lives and one for forecasting replacement quantities. This allows the forecasting model to better account for changes in the aggregate age of the network over time.
- Use of the Repex Model to forecast both asset replacement (e.g. substation switchgear and secondary systems assets) and asset life extensions (e.g. transmission lines) – collectively referred to as reinvestment.
- Disaggregating transmission towers into different corrosion zones. This recognises that reinvestment needs for these assets are driven almost entirely by the rate of corrosion of tower steel components.
- Removal of assets from the age profile that are already accounted for in our bottom-up forecasts, to ensure there is no double-counting of reinvestment expenditure.
- Removal of assets from the age profile where there is no enduring need. Removing these assets from the model ensures they do not contribute to the forecast.
- Limiting historic replacement quantities used for model calibration to the purely condition-based drivers. This ensures that previous replacements triggered by the needs of an expanding network, such as fault-level drivers, do not influence the forecast reinvestments in an environment of little or no network expansion.

Unit Rates

Unit rates have been developed for each asset category in the Repex Model. Each rate reflects the expected actual cost of replacing a single unit within an asset category within the scope of a typical project, using an efficient project delivery methodology.

The unit rates are based on our standard project cost data (informed by historical actual expenditure and contemporary cost data from recent tender processes) and have been subject to internal and external benchmarking review.

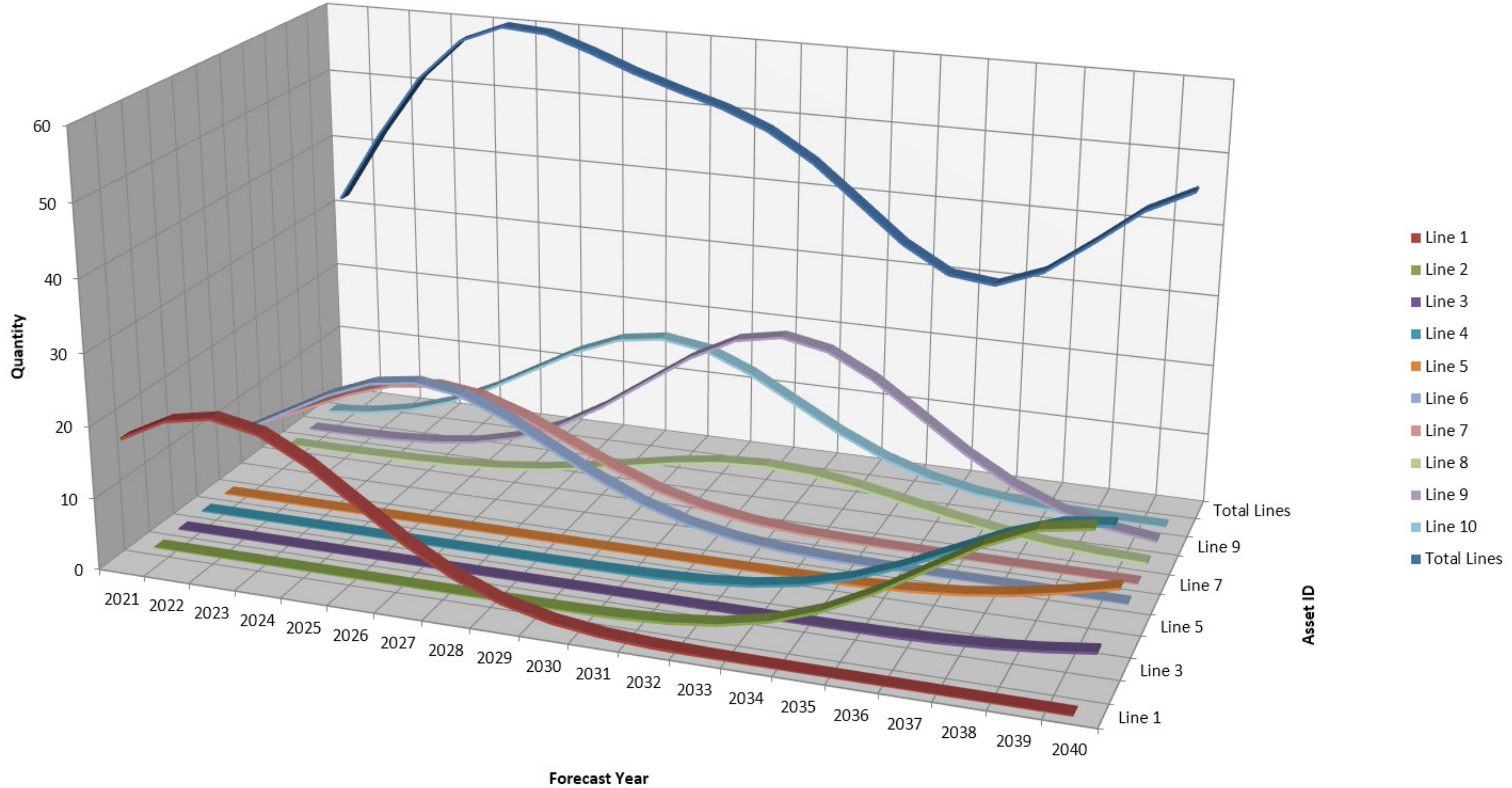
Forecast Reinvestment Expenditure

The application of the Repex Model provides approximately 20% of the forecast reinvestment capital expenditure.

Reinvestment represents approximately 79% of our total forecast capital expenditure for the 2023-27 regulatory period.

For more information about our Repex Model, refer to our *2023-27 Revenue Proposal, Appendix 5.04, Non-Load Driven Network Capital Expenditure Forecasting Methodology.*

For more information about our unit rates, refer to our *2023-27 Revenue Proposal, Appendix 7.03 Cost Estimating Methodology.*



The diagram above illustrates the principles of Repex Modelling. In this example a number of transmission line assets (Line 1 to Line 10) are of the same type and have the same average replacement life. The age of each transmission line is different, so the quantity of structures to be replaced in a particular year for each line is different. For example, Line 1 is the oldest transmission line and has the largest number of structures being replaced in the early years of the forecast between 2021 and 2023.

To derive the total number of structures to be replaced in a given forecast year, the quantity of structures to be replaced from each transmission line are added together. In the 2023 forecast year, 22 structures from Line 1, zero structures from Lines 2 to 5 require replacement and so on. In the 2023 forecast year, this results in a total of 51 structures to be replaced.

For this reason, the replacement quantities derived from the Repex Model do not align with specific projects or complete transmission line assets, but are a sub-set of the total population of all transmission line structures based on a mean asset life and asset age profile.

Note: Data is fictitious and has been generated to illustrate the principles of Repex Modelling. It is not representative of Powerlink's actual Repex Model.