Replacement Expenditure (Repex) Modelling

An Overview | February 2016

Background

Powerlink has adopted a hybrid approach to forecast capital expenditure for the 2018-22 regulatory period. The hybrid approach involves a mix of top-down and bottom-up forecasting methods. Top-down methods rely on historical information to establish predictive models and trends for future investment needs. These methods are well suited to forecast recurring investment needs such as reinvestment in existing transmission assets.

The AER published a predictive model for Replacement Expenditure (Repex) in 2013. Since that time the model has been applied by the AER in its assessment of replacement expenditure proposed by electricity distribution network businesses.

Powerlink has applied the AER's Repex Model as the primary forecasting tool for reinvestment expenditure for the 2018-22 regulatory period. Powerlink has implemented a range of enhancements to the model to reflect its asset management practices.

What is the Repex Model?

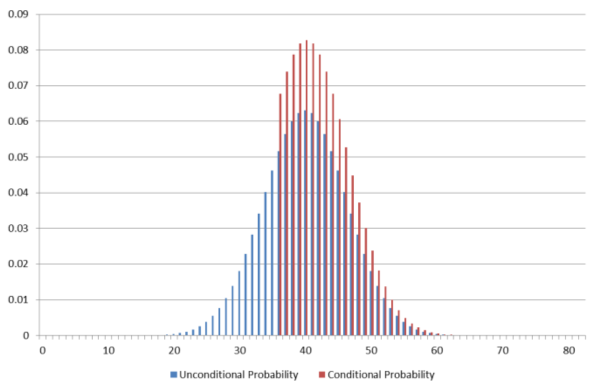
In broad terms, the Repex Model analyses the historical pattern of reinvestment in different transmission assets to derive quantities of each asset to be replaced on an annual basis. A unit rate (reflecting the typical cost of replacing that asset) is applied to each quantity of asset to derive an overall 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 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 simply means the probability that an asset will be replaced at age X, given that it is already Y years old. 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 over the page.

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Powerlink's Repex Model

Powerlink has taken the AER's base Repex Model and enhanced the modelling approach to better reflect Powerlink's actual asset management approach. Some of Powerlink's 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;
- Using the Repex Model to forecast both asset replacement and asset life extensions – collectively referred to as reinvestment;
- Disaggregating transmission towers into different corrosion zones. This recognises that reinvestment needs are driven almost entirely by the rate of corrosion of tower steel components;
- 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; and
- 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 Powerlink's 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 a forecast for a significant portion of Powerlink's overall reinvestment capital expenditure.

A small proportion (approximately 12%) of reinvestment expenditure has been forecast using trend modelling and bottom-up analysis (eg. transformer reinvestment).

Reinvestment represents approximately 83% of Powerlink's total forecast capital expenditure.

For more information about Powerlink's Repex Model, refer to Powerlink's *2018 – 22 Revenue Proposal, Appendix 5.05, Non-Load Driven Network Capital Expenditure Forecasting Methodology*.

For more information about Powerlink's Unit Rates, refer to Powerlink's *2018 – 22 Revenue Proposal, Appendix 7.01 Cost Estimating Methodology*.

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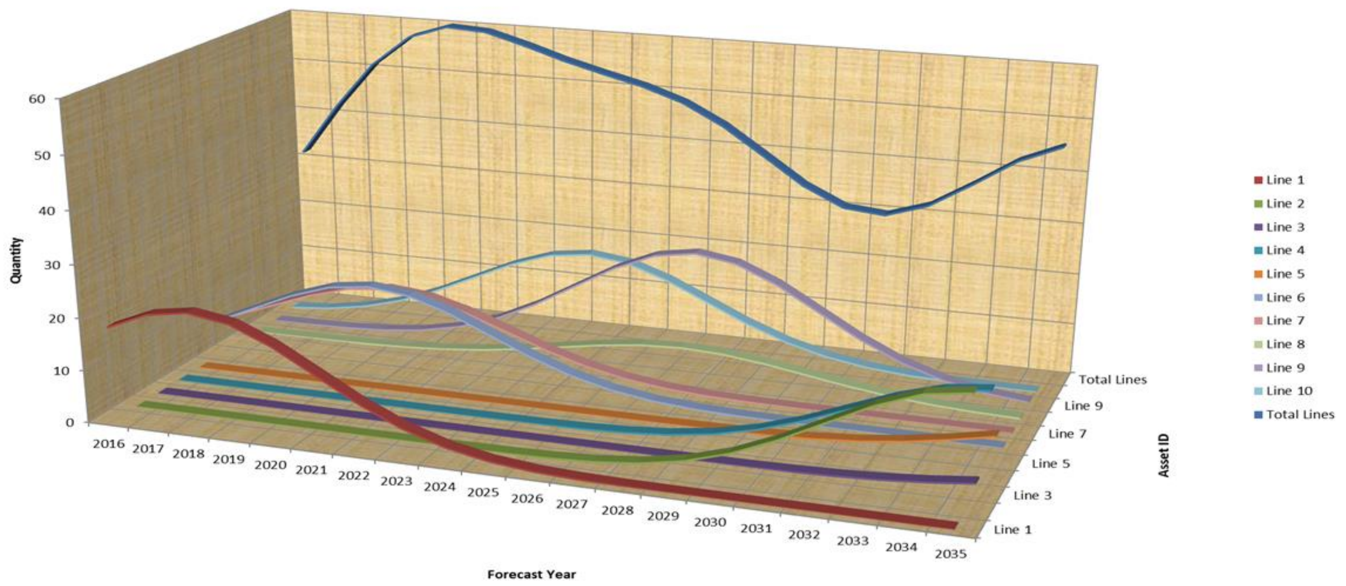

The diagram above illustrates the principles of Repex Modelling. In this example a number of transmission line assets (Line 1 to Line 10) are of the same type and have the same average replacement life. The age of each transmission line is different, so the quantity of structures to be replaced in a 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 2016 and 2018.

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 2018 Forecast Year, 25 structures from Line 1, zero structures from Lines 2 to 5 require replacement and so on. In the 2018 Forecast Year, this results in a total of 55 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.