Nuttall Consulting

Regulation and business strategy

AER repex modelling

Assessing Power and Water Corporation's replacement forecast

A report to Power and Water Corporation

Confidential final

25 January 2018

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Executive Summary

Introduction

Nuttall consulting has been engaged by Power and Water Corporation (PWC) to undertake an assessment of its replacement expenditure (repex) forecast. This assessment must use the predictive model that the Australian Energy Regulator (AER) has indicated it will use as part of its assessment process. This model is called the AER repex model. The assessment must also follow the method the AER has used to assess repex forecasts using this model in its recent round of decisions.

In accordance with this method, we have used data reported in PWC's Reset Regulatory Information Notices (RIN) to prepare this model. This preparation has been supported by other data provided by PWC and other comments and advice provided during the course of a number of meetings with relevant PWC personnel.

We have used various AER documents to guide our assessment approach, including its expenditure assessment guideline, its repex model manual, and most importantly, its recent decisions.

In accordance with the AER's assessment approach, we have assessed PWC's forecast over the five-year period commencing at the start of PWC's next regulatory period (2019/20 to 2023/24) using model parameters calibrated to the last five years of PWC's reported data (2012/13 to 2016/17).

We have assessed approximately $100 million (69%) of PWC's repex forecast using this model[1].

Assessment findings

Our assessment, using the AER's repex model and the method the AER has applied previously, supports PWC's repex forecast.

PWC's forecast over the five-year assessment period is significantly below all the key studies considered by the AER, ranging between 68% and 79% of the repex model study forecasts. These results suggest that the assessed component of PWC's repex forecast ($100.5 million) would be significantly below the AER's alternative estimate, which was estimated by us to be $127.9 million[2].

These results are shown in Figure E1 below, which indicates PWC's historical and forecast repex compared to the three key assessment study forecasts produced by the AER repex model.

Providing further support to these findings, our studies also indicate that, in aggregate:

- the asset unit costs that underpin PWC's repex forecast are lower than its historical unit costs and the AER's intercompany benchmark unit costs
- the asset lives that underpin PWC's repex forecast are longer than its historical lives.

[1] The remaining repex forecast is associated with repex in asset groups not covered by the AER's assessment.

[2] This assumes the AER will produce this estimate using a similar approach to how it has used the model in its recent decisions

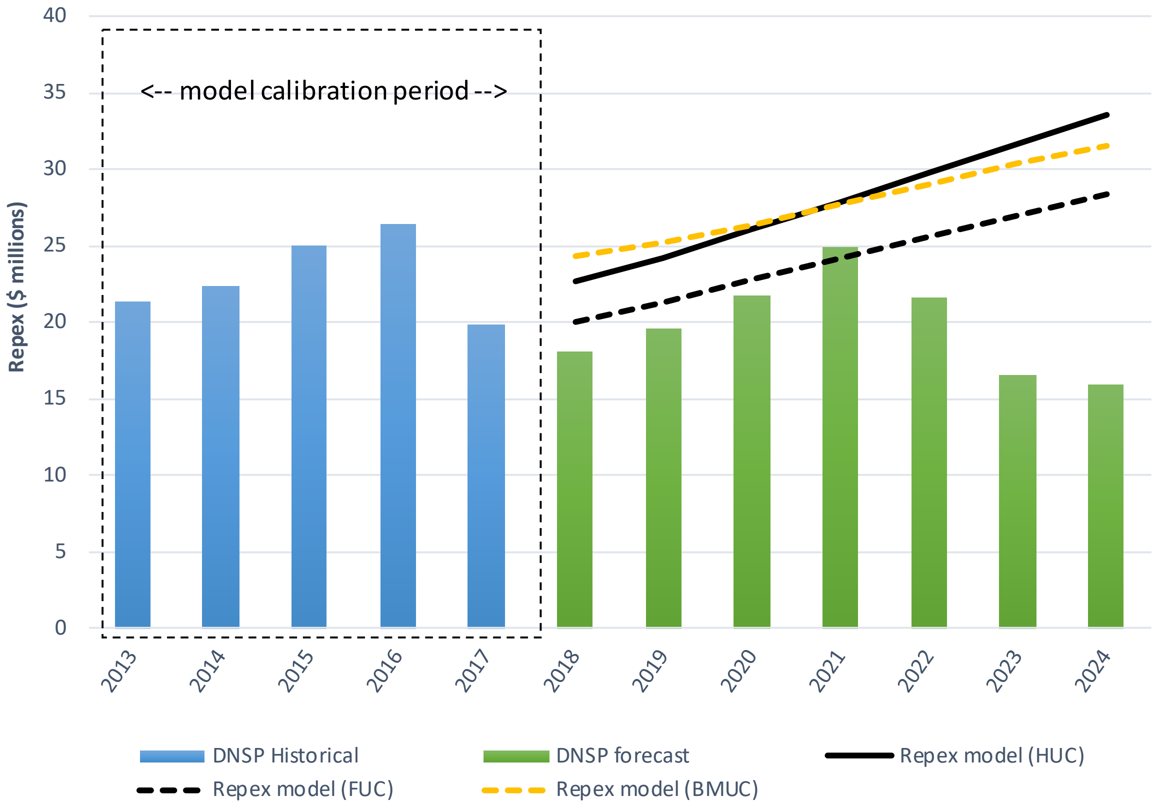

Figure E1 – Assessment results summary

1 Introduction

1.1 Background and scope

Power and Water Corporation (PWC) has engaged us, Nuttall Consulting, to assist in its preparations for its next regulatory determination by the Australian Energy Regulator (AER). This determination will cover the five-year period from 1 July 2019 to 30 June 2024.

As part of this engagement, PWC has requested that we:

- develop a model of PWC's replacement capex (repex) using the AER's repex model
- use the model to assess PWC's repex forecast, using an approach based on that used by the AER in its recent determinations
- reconcile the model forecast with PWC's own replacement forecast to identify the parameters within the model driving the differences
- prepare an independent report, which can be used as a supporting document to PWC's building block proposal to the AER, that sets out the forecast and explains how we developed the model and forecast.

This document serves as the report indicated above.

The following definitions are used in this report:

- **Replacement capex** (or **repex**) has the meaning given to it by the AER in its recent advice on how it will conduct expenditure forecast assessments, which broadly covers the non-demand-driven replacement of assets with their modern equivalent asset.
- We use the term **AER repex model** to mean the generic excel workbook that the AER has advised it will use as an assessment technique in its determinations – and the AER calls the repex model.
- We use the term **PWC repex model** to mean the model we have prepared of PWC's network using the AER repex model. The PWC repex model is used here to produce repex forecasts of the PWC network.

In addition, all expenditure and costs shown in this report represent **direct real June 2019 dollars**.

1.2 Nuttall Consulting experience in this task

Nuttall Consulting, using Dr Brian Nuttall (the author of this report), developed the excel workbook that serves as the basis of the AER's repex model and advised the AER on the model's possible roles and application in regulatory determinations.

Moreover, we were engaged by the AER to provide advice that informed the AER's past determinations of the Victorian and Tasmanian Distribution Network Service Providers (DNSPs). As part of these engagements, Dr Nuttall developed repex models and forecasts, using an approach very similar to that described in the AER's repex model documentation (and used here).

1.3 Key information sources

We have used the following information to develop the PWC repex model:

- the AER repex model and AER repex model handbook, published on the AER website
- the AER's most recent decisions where it has used its repex model to assess DNSPs' repex forecasts
- PWC's Reset Regulatory Information Notice (Reset RIN), which will be submitted with its proposal, covering the following data and templates:
    - PWC's historical repex and replacement volumes from 2012/13 to 2016/17, which is in the format of template 2.2 of the Reset RIN
    - PWC's replacement capex forecast, covering the period from 2017/18 to 2023/24, which is in the format of template 2.2 of the Reset RIN
    - PWC's 2016/17 age profile, which is in the format of template 5.2 of the Reset RIN
- AER benchmark asset unit costs and lives, as the AER applied in various recent decisions.

We have also held a number of workshops and telephone meetings with relevant PWC personnel to discuss the model and clarify data requirements.

1.4 Structure

This report is structured as follows:

- In section 2 we review the AER's approach to using its repex model in recent decisions; in particular, how it has used it to determine an "alternative estimate" for the repex forecast of each DNSP. We then explain how we have applied this in our assessment approach.
- In section 3 we summarise and discuss the results of our assessment approach.
- In Appendix A we provide an overview of the AER repex model, summarising how it develops a forecast, its inputs and outputs, and how model parameters can be calibrated to an outcome. We then discuss the methodology we have used to develop the PWC repex model, including the PWC data we have used.

- Finally, in Appendix B we discuss differences at the asset category level between the repex model forecast and PWC's forecast. Here, we also explore the model parameters (i.e. asset lives and unit costs) that are causing these differences.

2 Assessment approach

Our assessment approach is based upon the approach used by the AER in recent decisions.

In this section, we first provide a summary of the AER's approach. We then explain how this has been used for our assessment.

2.1 AER assessment approach

It is important to note that the following represents our understanding of the approach the AER applied, which we have determined from explanations provided in recent AER decisions. We have not confirmed with the AER that this understanding is strictly correct. Furthermore, the AER decisions are unclear on the specific circumstances that the AER may depart from this approach when deciding whether it will accept a DNSP's repex forecast.

In recent decisions, the AER has used its repex model to define an *alternative estimate* for a large component of each DNSP's repex forecast. This component of the DNSP's repex was accepted if it was less than this *alternative estimate*.

Importantly, the estimate represented the **aggregate** repex over the regulatory period being assessed i.e. it was not a year-by-year figure or a figure developed for each asset group or category.

2.1.1 The repex component assessed through the model

The component of the DNSP's repex forecast assessed by the AER using the repex model covered the following asset groups (as defined in RIN Tables 2.2.1 and 5.2.1):

- poles
- overhead conductors
- underground cables
- services
- transformers
- switchgear.

The AER excluded the following from its modelling and assessment:

- all replacement associated with the pole top structure, public lighting and SCADA, protection and control asset groups and the "other" asset group
- other programs within the DNSP's forecast that were defined by the DNSP as not suitable for repex modelling.

2.1.2 Defining the alternative estimate

The alternative estimate is determined from a set of model studies. Each study reflects a forecast prepared by the model, using a different set of the model's planning parameters (i.e. asset lives and unit costs).

The AER has considered a large number of studies when assessing each DNSP. However, it has evaluated each study (for each DNSP) in order to accept or reject it as an appropriate basis for defining its alternative estimate. In this way, it has only used three studies to define the estimate for any DNSP, and these three studies have been common across the DNSPs.

All three of these studies use asset lives that are *calibrated* to reflect the last five years of the DNSP's reported replacement volumes (as reported in its RINs). As such, the studies are uniquely defined by variations in the unit cost parameter set used for each study, as follows:

- **Study 1** - historical unit costs – This study uses a set of unit costs that are calibrated to reflect the last five years of the DNSP's replacement expenditure and replacement volumes as reported in its RIN
- **Study 2** - forecast unit costs - This study uses a set of unit costs that are calibrated to reflect the DNSP's replacement expenditure and replacement volume forecasts over its next regulatory period, as reported in its RIN
- **Study 3** - AER's benchmark unit cost – This study uses a set of unit costs that the AER has calculated as the average historical unit costs (as calculated above) across all the NEM DNSPs[3].

Typically, the lowest repex forecast from the studies using the DNSP's historical and forecast unit costs (Study 1 and Study 2) is used to define the alternative estimate for each DNSP.

The AER has applied a more relaxed role for its benchmark unit cost study (Study 3), using this to gauge whether the DNSP's unit costs are reasonably representative of efficient costs. As such, it has typically not used this to define its alternative estimate in circumstances where this study is the lowest, but not by a significant margin. However, as far as we are aware, it has not explicitly defined what such a margin would be, and therefore, we still consider that this is an important study for defining the alternative estimate.

2.2 Our assessment approach

2.2.1 Assessment and calibration period

In accordance with the AER's approach, we have used a five-year assessment period to apply the model. This means that when we calibrated the model's planning parameters (i.e. asset lives and unit costs):

- historical calibrations used data for the years 2012/13 to 2016/17

[3] See the AER's determinations on its website for more information on the methodology the AER applied to derived these benchmarks.

- forecast calibrations used data for the years 2019/20 to 2023/24.

2.2.2 Repex component modelled

We have assessed the same component of PWC's repex forecast that has been assessed by the AER previously using its repex model. For the avoidance of doubt, this assessment allows for the following:

- Modelled asset groups - all repex in the poles, overhead conductor, underground cable, services, transformer and switchgear asset groups are modelled
- Unmodelled asset groups – all repex in the pole top structure, SCADA, protection and control and "other" asset groups are excluded from the model

The modelled component represents $100.5 million (69%) of PWC's repex forecast (2019/20 to 2020/24).

3 Repex forecast assessment

In this section we discuss our assessment of PWC's forecast, using studies defined in the previous section. In keeping with the AER's recent approach, this assessment is focused on the aggregate repex forecast.

3.1 Repex model results

Table 1 summarises the repex model forecasts for the three studies defined in Section 2.1. The table shows the repex model results in comparison to PWC's forecast repex and its historical repex over the 5-year calibration period. The results are provided as a total repex over the periods indicated. The table also shows the breakdown of repex into the various RIN asset groups covered by the AER's assessment.

Table 1 Assessment study results summary ($ millions – Real June 2019)

	actual repex	Forecast repex (2019/20 to 2023/24) - $ millions, Real June 2019			
Asset group	*(2012/13-2016/17)*	*DNSP repex forecast*	repex model (S1 - HUC)	repex model (S2 - FUC)	repex model (S3 - BMUC)
Poles	*8.9*	*20.8*	30.1	12.2	7.7
OH conductors	*2.5*	*5.2*	5.5	9.8	6.8
UG cables	*28.8*	*32.0*	64.2	53.5	72.7
Services	*0.5*	*0.4*	2.0	0.1	0.6
Transformers	*26.1*	*24.9*	19.8	29.5	36.7
Switchgear	*48.2*	*17.1*	27.2	22.9	20.6
Total AER assessed	***114.9***	***100.5***	**148.8**	***127.9***	**145.0**

The profile of PWC's repex compared to the model's forecasts for the three assessment studies is shown further in Figure 1.

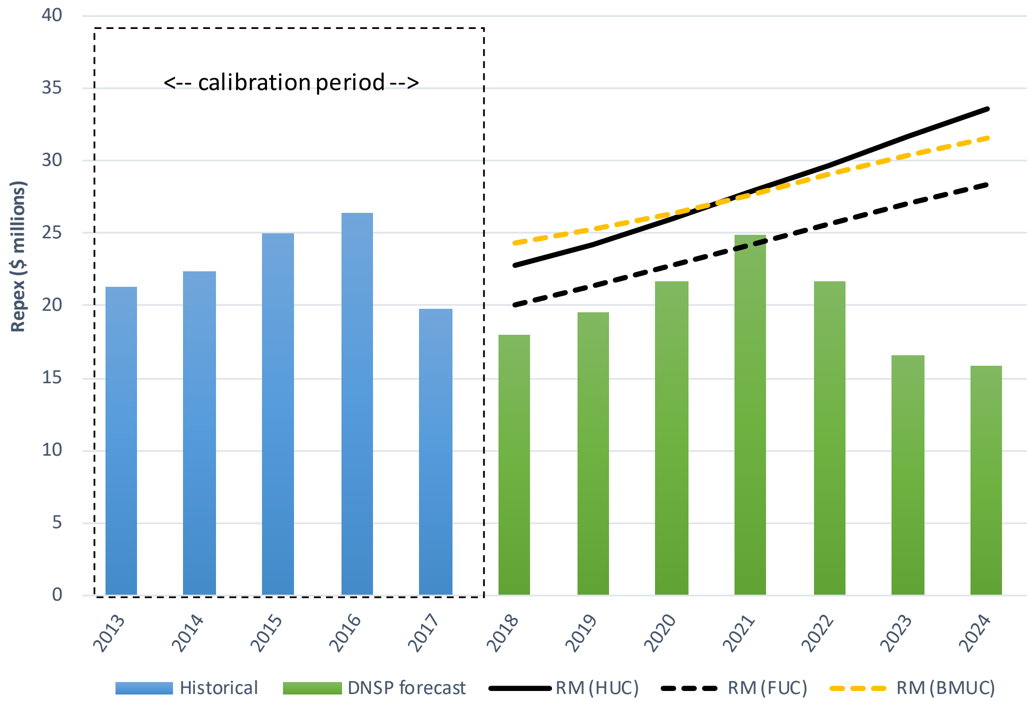

Figure 1 Repex model results – AER studies

3.2 Discussion – AER assessment

The results of this repex model assessment support PWC's forecast.

For all three studies, PWC's repex forecast is below the repex model forecast, with PWC's forecast ranging between 68% and 79% of the study forecasts. These results suggest that the assessed component of PWC's repex forecast ($100.5 million) would be below the AER's alternative estimate, which would be set at $127.9 million by the study using PWC's historical lives and forecast unit costs (assuming the AER produced this estimate using a similar approach to how it has used the model in its previous decisions).

It is also worth noting that the model is predicting the need for an ongoing increase in replacement volumes, at least over the medium term (i.e. the next 10 to 15 years). This result is driven by the relative age of the network compared to the asset lives, whereby the model considers that the majority of the network has not reached the peak of its replacement cycle. The need for this increase is also reflected in PWC's forecast to 2020/21; however, PWC is forecasting a reduction in repex after this time to the end of its next regulatory period.

3.3 Discussion – model parameters

In the recent round of DNSP decisions, the AER has mainly applied its assessment using the repex model at the aggregate level as discussed in the section above. However, the model studies and underlying calibrated parameters can also be used to guide where the AER could have concerns with a forecast, and so for example could investigate these matters via a detailed review.

Therefore, we note some of these key matters here, as they may provide some guidance to PWC on where key risks in its repex forecast could lie, and so, where it may need to ensure its documents provide adequate support.

In Appendix B , we discuss in more detail the variations in unit costs and lives within asset groups.

Note – this discussion only provides a guide to the significant matters as seen through this repex modelling exercise. Therefore, this should not be taken as an exhaustive list of all matters that must be addressed through PWC's repex forecast supporting documents.

Unit costs

The model results support the unit costs PWC has used to prepare its repex forecast.

The lower model study result using PWC's forecast unit costs compared to the study using its historical unit costs ($127.9 million compared to $148.8 million) suggest that the unit costs PWC has used to prepare its repex forecast are, in aggregate, lower than its actual unit costs over the last 5-year period (2012/13 to 2016/17).

Furthermore, the lower model study result using PWC's forecast unit costs compared to the study using the AER's benchmark unit costs ($127.9 million compared to $145.0 million) also suggests that the unit costs PWC has used to prepare its repex forecast are, in aggregate, lower than the benchmark unit costs that the AER has used previously to assess DNSPs' repex forecasts.

As can be seen in Table 1, there are material favourable and unfavourable results at the asset group level. However, the higher forecast unit costs in one asset group (compared to historical unit costs or the AER benchmarks) tend to be offset by lower unit costs in another group. As such, this could be partly reflective of expenditure allocation issues and/or differences in the asset types underlying specific replacement programs. Therefore, these matters would more likely need to be investigated by the AER through its detailed review techniques. Specific differences in unit costs will be discussed in more detail in Appendix B.

Asset lives

The model results support the replacement volumes that underpin PWC's forecast repex.

The significantly higher study result using PWC's forecast unit costs compared to PWC's own forecast suggests that, in aggregate, the asset lives that underpin PWC's forecast volumes are longer than the asset lives that must underpin its historical repex[4].

That said, PWC's forecast lives, in aggregate, appear to be shorter than the AER's benchmarks lives (although, it is important to note that at this point the AER has not used these benchmark lives as primary parameters in its assessment method). This less favourable result however is most significant – in terms of the repex affect – in the 11 kV

[4] That is, given the underlying unit costs assumptions should be the same, any difference in the repex forecast must be due to asset volume differences, and hence difference between historical and forecast asset lives – at the aggregate level.

underground cable category, where PWC's inferred life (49 years) is noticeably shorter than the AER benchmark life (68 years).

Similar to causes of unit cost differences discussed above, the reasons for differences in lives could be reflective of differences in the asset type underlying specific replacement programs. Therefore, these matters would more likely need to be investigated by the AER through its detailed review techniques. Specific differences in asset lives will be discussed in more detail in Appendix B.

3.4 Summary and conclusions

Our application of the AER's assessment method supports the assessable component of PWC's repex forecast. This component of PWC's repex forecast ($100.5 million) is significantly below the three AER assessment studies using the AER's repex model, suggesting that PWC's repex forecast would be below the AER's alternative estimate (should the AER calculate this estimate using the repex model and a similar method it has used recently).

Furthermore, our studies show that, in aggregate:

- the asset unit costs that underpin PWC's repex forecast are lower than its historical unit costs and the AER's intercompany benchmark unit costs
- the asset lives that underpin PWC's repex forecast are longer than its historical lives.

A PWC repex model development

A.1. The AER's repex model

A.1.1. Overview of repex model

The AER repex model is an excel workbook, with a structure, formulas and VBA functions and macros pre-defined in order that it can be used by the AER to develop a network model of a DNSP and use this to prepare repex forecasts. The model is very similar in principle to a model used by the UK energy regulator, Ofgem.

The DNSP's network is constructed within the AER repex model as a series of asset populations. The model uses a probabilistic replacement algorithm to make predictions of replacement needs for this population. The probabilistic replacement algorithm assumes the economic life is normally distributed for any asset population represented within the model. From this, the model predicts future replacement volumes based upon a current age profile for the asset population. This approach is similar to survivor-type models, which are used in various disciplines to model mortality, replacement and reliability.

From an engineering point of view, it is worth noting that although the model relies upon the ages of assets and uses age-based lives, there is no inherent assumption within the model (or its use) that purely age-based replacement strategies are used by the DNSP. The asset life simply reflects the distribution in the life of a population of assets[5] - irrespective of the factors that define the life.

The AER has indicated that it will use this model to make top-down assessments of a DNSP's repex forecast, covering both intra-company and inter-company benchmark forecasts.

A.1.2. AER repex model form, inputs and output

Network specification inputs – asset categories, groups and age profiles

As indicated above, a DNSP's network is defined as a series of distinct asset categories within the repex model. To facilitate analysis and reporting, each asset category is assigned to a smaller set of asset groups. In this regard, a model may use 100 asset categories or more, to improve the accuracy of the analysis, but may use 10 asset groups to provide aggregate forecast for reporting (and benchmarking) purposes.

An age profile must be provided for each asset category used in the model. This age profile represents a snap shot of the ages of the population of assets in that category for the initial year of the model. That is, the age profile is essentially a vector that holds the volume of assets at one-year increments of age.

[5] For example, for many assets, the distribution in the life could result from detailed condition and risk analysis to determine the optimal time to proactively replace each asset. For others, it could be simply the age when each asset fails.

The AER has predefined the asset categories and asset groups that the DNSP should use as the basis of their models. This will be discussed further in A.2.1.

Planning parameters inputs

The model uses three planning parameters to define the approach it uses to predict future replacement needs:

- The replacement life, which is represented as a normal probability distribution is defined by two parameters: its mean life and the standard deviation of the life.

  It is worth noting that the replacement life actually represents the life that an asset is replaced or the life when a life extension may be used, if this is a feasible option. These parameters, via the asset age profile, allow the model to predict the future volume of assets that will need to be replaced (or have their life extended).

- The third parameter reflects the average replacement unit cost.

  That is, the volume forecast multiplied by the replacement unit cost produces the expenditure forecast.

  Importantly, depending on the asset, the replacement cost parameter may represent an actual replacement cost, or a life extension cost, or in some cases a blended cost that represents both.

Model outputs

The model produces various outputs. These outputs provide various measures of the input age profiles, such as average age, average life, total quantity, and total replacement cost (i.e. quantity x replacement unit cost).

The model also produces forecasts (by year over a 20-year period), including replacement volumes, replacement expenditure, average age, and average remaining life.

These various outputs are provided at the asset category, asset group and total network level. When averages are calculated at the asset group or network level, the model uses a weighted average using the replacement cost of each asset category as the weighting.

A.1.3. Model planning parameter calibration

The calibration of a DNSP's model is the critical process that is applied to produce the intra-company benchmark model.

The calibration process concerns deriving the set of planning parameters that reflects historical replacement outcomes (volumes and expenditure) over the calibration period (e.g. the last 5 years)[6].

Assuming the actual volumes and expenditure data is available for each asset category in the model (or a reasonable estimate) then the following process can be used (this process should be in line with the explanation provided in the AER repex model handbook).

[6] It worth noting that a similar process could be applied to calibrate the model to other outcomes, for example the forecast replacement volumes and expenditure.

Replacement unit cost

The replacement unit cost parameter for each asset category is simply the actual expenditure over the calibration period divided by the actual replacement volume over that period.

Life planning parameters

The two life parameters for each asset category need to be set to ensure the model reflects the volume replaced over the calibration period.

However, the calculation of the two life planning parameters is more complicated because:

- we have two parameters to determine and typically only one variable (the total volume replaced)
- the replacement volume calculated by the model is dependent on the probabilistic replacement algorithm, and therefore, we need to perform a simulation through the model
- the available age profile represents the end point of the calibration period – not the start or mid-point.

Therefore, the calibration of the life parameters is slightly more involved and involves the following two assumptions.

- First, in the absence of better information, the need to determine the standard deviation is removed by making it dependent on the mean. The AER has advised that it will assume that the standard deviation is taken to be the square root of the mean. We have used this assumption here.
- Second, the mean life is set to ensure that the first year of the forecast produced by the model equals an *adjusted* average annual replacement volume during the calibration period. The adjustment is set to reflect the initial growth rate in the replacement volume that is forecast by the model. This adjustment is necessary to approximate the change due to using the end-point age profile, rather than the profile that reflects the mid-point of the calibration period[7].

  Given the above, and allowing for the 5-year calibration period, the *adjusted* average annual replacement volume is calculated as:

  (1 + x%)^3.(total volume replaced of asset replaced over calibration period) / 5

  where *x*% is the initial forecast growth rate calculated through the model, and the power of 3 is necessary to advance the growth over 3 years i.e. from the mid-point in the calibration period to the first year of the forecast.

[7] It is worth noting that the actual trend in the historical replacement volumes is typically not used as this may be influenced by incentives associated with the regulatory regime.

A.2. PWC repex model

A.2.1. PWC repex model structure set up

Setting up the model structure involves defining the asset categories and asset groups, and populating the PWC model with the relevant age profiles.

Repex model asset categories and age profiles

The PWC network is constructed within the repex model using the asset classifications and PWC's asset age profiles defined in table 5.2.1 of the Reset RIN. That is, each asset category in the PWC repex model corresponds to a line item in table 5.2.1 (i.e. the individual asset categories defined by the AER).

For models used here, PWC has provided a set of age profiles in this format that represent its network in 2016/17.

Repex model asset groups

The asset groups in the model have been defined using the asset groups specified by the AER in table 5.2.1 of the Reset RIN.

A.2.2. Model calibration set up

The calibration of model lives and unit costs is an important element of this modelling exercise. Therefore, for transparency, we explain our method to do this here.

The model calibration set up involves developing the historical data necessary to perform the calibration process (discussed in Section A.1.3). This involves calculating for each asset category in the model (i.e. in table 5.2.1), for the calibration periods (2012/13 to 2016/17):

- historical repex
- historical replacement volumes.

The basis of this data, is the historical replacement volumes and expenditure that PWC has reported in table 2.2.1 of the Reset RIN. This data covers the period from 2008/09 to 2016/17 and across categories that are largely equivalent to table 5.2.1.

The key steps in preparing the table 2.2.1 data set for the calibration process are as follows:

1 **Escalation** - the table 2.2.1 expenditure has been escalated using CPI data (provided by PWC) to place all expenditure on a real June 2019 basis.

2 **2.2.1 to 5.2.1 mapping** - rules have been developed that map the 2.2.1 asset categories (i.e. the asset that was installed) to the 5.2.1 asset categories (i.e. the asset that was retired). In most cases this was considered to be a direct one-to-one mapping using the equivalent asset categories in 2.2.1 and 5.2.1. However, in some circumstances, categories do not map directly or map to multiple categories.

A.2.3. Model calibration process

For each asset category in the PWC model, the calibration process has involved the following steps:

1 Calculate the replacement unit cost as the total historical escalated repex divided by the total historical replacement volumes (using the mapping described above).

2 Determine the mean life that sets the 1st year of the forecast equal to the (unadjusted) average annual historical volume. Excel's goal seek function is used for this purpose.

3 Determine the initial growth rate in the volumes predicted by the model i.e. the growth from the first to the second year of the forecast.

4 Calculate the adjusted average annual historical volume using this growth rate and the formula above.

5 Determine the mean life parameter that sets the 1st year of the forecast equal to the adjusted average annual historical volume. Excel's goal seek function is used for this purpose.

B Assessing forecast differences

In Section 3, we used the PWC repex model to provide an alternative estimate for PWC's repex forecast, using an approach the AER has applied recently.

In this appendix, we use the PWC repex model to identify the asset groups that vary the most between the model and PWC's forecast, and in turn, to determine how the model's lives and unit costs contribute to this variance.

These findings indicate the asset matters that the AER may have the most concern with should it use the repex model for these purposes.

Note on terminology in discussion below

When discussing differences in asset group lives and unit costs, the asset group life or unit cost implied by the discussion is a weighted average across the relevant asset categories calculated through the model. The weightings applied to unit costs are the forecast volumes and the weightings applied to volumes are the forecast unit costs.

We have used a materiality bound of 2% of PWC's assessable repex (i.e. $2.0 million) to identify the asset categories that we consider differences in unit costs or lives are significant enough to highlight below.

It is important to note that the lives we discuss in this section are those associated with producing forecasts using the repex model (i.e. the mean population life, which forms an input parameters of the model). These lives could be different to the lives used by PWC to produce its forecast or for other internal purposes, which should be dependent on the underlying forecasting methodology or purpose. Importantly, the lives discussed here are very unlikely to represent the average age of the assets at the time of their replacement for the assets that either have been replaced over the calibration period or are forecast to be replaced over the next regulatory period. Therefore, PWC, the AER or the AER's advisors should take care when making inferences between these two parameters.

Finally, we have developed the benchmark unit costs and lives we discuss below from AER repex model files that the AER has published with recent decisions. These may not represent its latest benchmarks or those it could subsequently develop to use to assess PWC's repex.

B.1. Underground cables

PWC's repex forecast for the underground cable asset group is the most significant of the asset groups normally assessed by the AER, accounting for $32 million (32%) of PWC's repex forecast in the asset groups normally assessed by the AER.

PWC's repex forecast for the underground cable asset group is $21.4 million lower than the forecast predicted by the repex model's alternative estimate. This difference represents the most significant component making up the difference between PWC's forecast and the models alternative estimate. The much lower PWC forecast is driven by both favourable unit costs and lives.

In aggregate, PWC's forecast unit costs are similar to its historical unit costs and lower than the AER benchmarks. The most material asset categories driving this result are as follows.

impact on result	asset category	unit cost ($'000) forecast	historical	AER benchmark
favourable	UG cables - < = 1 kV	250.8	439.7	243.8
unfavourable	UG cables - > 1 kV & < = 11 kV	495.0	386.5	673.4

In aggregate, PWC's forecast lives are longer than its historical lives but shorter than the AER benchmarks. The most material asset categories driving this result are as follows.

impact on result	asset category	Life (years) forecast	historical	AER benchmark
unfavourable	UG cables - < = 1 kV	56.0	64.0	67.9
unfavourable	UG cables - > 1 kV & < = 11 kV	48.6	45.0	67.5
favourable	UG cables - Pillar	47.4	40.6	40.6

It is worth noting that the differences in lives for the 11 kV cable category are the most significant in driving the difference between the model and PWC's repex forecast for this asset group.

B.1.1. Transformers

PWC's repex forecast for the transformer asset group accounts for $24.9 million (25%) of PWC's repex forecast of the asset groups normally assessed by the AER.

PWC's repex forecast for the transformer asset group is $4.5 million lower than the forecast predicted by the repex model's alternative estimate. This reduction is driven by favourable unit costs, which offset the effects of unfavourable lives.

In aggregate, PWC's forecast unit costs are lower than its historical unit costs and the AER's benchmark unit costs. The most material asset categories driving these results are as follows.

impact on result	asset category	unit cost ($'000) forecast	historical	AER benchmark
favourable	Transformers - Pole Mounted ; < = 22kV ; > 60 kVA and < = 600 kVA ; Multiple Phase	16.5	12.4	27.2
favourable	Transformers - Kiosk Mounted ; < = 22kV ; > 60 kVA and < = 600 kVA ; Single Phase	10.6	69.3	72.8
unfavourable	Transformers - Kiosk Mounted ; < = 22kV ; > 60 kVA and < = 600 kVA ; Multiple Phase	77.5	69.3	39.4

unfavourable	Transformers - Ground Outdoor / Indoor Chamber Mounted; > 33 kV & < = 66 kV ; < = 15 MVA	1452.1	252.8	1364.6
favourable	Transformers - Ground Outdoor / Indoor Chamber Mounted; > 33 kV & < = 66 kV ; > 15 MVA and < = 40 MVA	247.1	680.4	1923.4
favourable	Transformers - Ground Outdoor / Indoor Chamber Mounted; > 66 kV & < = 132 kV ; < = 100 MVA	469.0	360.8	3446.9

The favourable unit cost of the "*Transformers - Kiosk Mounted ; < = 22kV ; > 60 kVA and < = 600 kVA ; Single Phase*" asset category is the most significant in driving the difference between the model and PWC's repex forecast for this asset group.

In aggregate, PWC's forecast lives are similar to its historical lives, but shorter than the AER benchmarks. The most material asset categories driving this result are as follows.

impact on result	asset category	Life (years)		
		forecast	historical	AER benchmark
unfavourable	Transformers - Pole Mounted ; < = 22kV ; > 60 kVA and < = 600 kVA ; Multiple Phase	32.1	39.6	53.2
favourable	Transformers - Kiosk Mounted ; < = 22kV ; < = 60 kVA ; Single Phase	44.4	42.9	40.0
unfavourable	Transformers - Kiosk Mounted ; < = 22kV ; > 60 kVA and < = 600 kVA ; Single Phase	44.4	42.9	40.0
unfavourable	Transformers - Kiosk Mounted ; < = 22kV ; > 60 kVA and < = 600 kVA ; Multiple Phase	44.4	42.9	50.7

B.1.2. Poles

PWC's repex forecast for the pole asset group accounts for $20.8 million (21%) of PWC's repex forecast in the asset groups normally assessed by the AER.

PWC's repex forecast for the poles asset group is $8.9 million higher than the forecast predicted by the repex model's alternative estimate. This represents the only asset group where PWC's forecast is materially higher than the repex model's estimate. This increase is driven by shorter forecast lives compared to PWC's historical lives.

In aggregate, PWC's forecast unit costs are lower than its historical unit costs, but higher than the AER benchmarks. The most material asset categories driving this result are as follows.

impact on result	asset category	unit cost ($'000)		
		forecast	historical	AER benchmark
favourable	Poles - < = 1 kV; Steel	15.9	39.8	9.1
favourable	Poles - > 1 kV & < = 11 kV; Steel	15.8	57.9	8.5
unfavourable	Poles - > 11 kV & < = 22 kV; Steel	17.2	19.6	10.0
favourable	Poles - > 22 kV & < = 66 kV; Steel	13.9	71.3	18.7
favourable	Poles - > 66 kV & < = 132 kV; Steel	22.2	64.1	18.9

With regard to PWC's higher unit costs compared to the AER benchmarks, we consider that at this stage some caution should be placed on the significance of this result. As we understand matters, PWC steel construction poles are unlikely to be equivalent to the type of steel poles that are represented by the AER's benchmark. Therefore, this matter may need to be investigated with the AER if this difference becomes an important factor in the AER's considerations.

In aggregate, PWC's forecast lives are shorter than its historical lives, but longer than the AER benchmarks. The most material asset categories driving this result are as follows.

impact on result	asset category	Life (years) forecast	historical	AER benchmark
favourable	Poles - < = 1 kV; Steel	66.0	66.4	57.4
favourable	Poles - > 1 kV & < = 11 kV; Steel	61.2	63.3	51.5
unfavourable	Poles - > 11 kV & < = 22 kV; Steel	63.9	67.3	53.5
unfavourable	Poles - > 66 kV & < = 132 kV; Steel	40.5	54.5	50.0

It is worth noting that the likely difference in steel construction type may also be affecting PWC more favourable pole lives compared to the AER benchmarks.

B.1.1. Switchgear

PWC's repex forecast for the switchgear asset group accounts for $17.1 million (17%) of PWC's repex forecast in the asset groups normally assessed by the AER.

PWC's repex forecast for the switchgear asset group is $5.8 million lower than the forecast predicted by the repex model's alternative estimate. This lower forecast is due to both favourable unit costs and asset lives.

In aggregate, PWC's forecast unit costs are lower than its historical unit costs and the AER's benchmark unit costs. The most material asset categories driving these results are as follows.

impact on result	asset category	unit cost ($'000) forecast	historical	AER benchmark
unfavourable	Switchgear - < = 11 kV ; Switch	26.1	24.2	11.4
favourable	Switchgear - < = 11 kV ; Circuit Breaker	31.4	102.9	106.8
favourable	Switchgear - > 11 kV & < = 22 kV ; Circuit Breaker	66.1	274.8	98.4
favourable	Switchgear - > 33 kV & < = 66 kV ; Circuit Breaker	86.7	317.7	158.4

In aggregate, PWC's forecast lives are longer than its historical lives, but shorter than the AER benchmarks. The most material asset categories driving this result are as follows.

impact on result	asset category	Life (years) forecast	historical	AER benchmark
unfavourable	Switchgear - < = 11 kV ; Switch	48.4	44.3	63.2
favourable	Switchgear - > 11 kV & < = 22 kV ; Switch	52.6	47.1	59.5

B.1.1. Overhead conductors

PWC's repex forecast for the overhead conductor asset group accounts for $5.2 million (5%) of PWC's repex forecast in the asset groups normally assessed by the AER.

PWC's repex forecast for the overhead conductor asset group is $4.6 million lower than the forecast predicted by the repex model's alternative estimate. This increase is driven by favourable forecast lives.

In aggregate, PWC's forecast unit costs are higher than its historical unit costs and higher than the AER benchmarks. That said, given this asset group only represents a small portion of PWC's repex forecast, no asset categories in this group are above the 2% materiality threshold set for this analysis. The most material asset category is as follows, which caused a 1.9% difference.

impact on result	asset category	unit cost ($'000) forecast	historical	AER benchmark
unfavourable	OH conductors - > 11 kV & < = 22 kV ; Multiple-Phase	68.6	26.8	64.5

In aggregate, PWC's forecast lives are longer than its historical lives and the AER benchmarks. The most material asset categories driving this result are as follows.

impact on result	asset category	Life (years) forecast	historical	AER benchmark
unfavourable	OH conductors - > 11 kV & < = 22 kV ; Multiple-Phase	64.0	59.2	70.7
favourable	OH conductors - > 66 kV & < = 132 kV	60.2	72.2	50.0

B.1.2. Services

PWC's repex forecast for the services asset group is the least significant of the asset groups normally assessed by the AER, accounting for only $0.4 million (0.4%) of PWC's repex forecast. It concerns a single asset category: *< = 11 kV ; Residential ; Simple Type.*

PWC's repex forecast for the services asset group is $0.3 million higher than the forecast predicted by the repex model's alternative estimate. This represents a large increase from the model's forecast of $0.07 million, but this difference is largely immaterial on the overall results.

The increase is driven by PWC's forecast life being much shorter than its historical life. Its forecast life is also shorter than the AER's benchmark life. PWC's forecast unit cost is more favourable, being lower than both its historical unit cost and the AER benchmark. However, the positive effect of this lower unit cost is not sufficient to offset the negative effect on volumes of the unfavourable life.