

**Repex model supporting**

**information**

Asset Management Division

Energex

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Energex Limited (Energex) is a Queensland Government Owned Corporation that builds, owns, operates and maintains the electricity distribution network in the growing region of South East Queensland. Energex provides distribution services to almost 1.4 million domestic and business connections, delivering electricity to a population base of around 3.2 million people.

Energex’s key focus is distributing safe, reliable and affordable electricity in a commercially balanced way that provides value for its customers, manages risk and builds a sustainable future.

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# Introduction

## Background

The AER indicated in its Expenditure Forecast assessment guidelines for electricity distribution and transmission that it intends to use its Repex model to help determine the efficient costs of asset replacement (capital) expenditure over the forthcoming regulatory control period. It is expected that the model will be used to provide a high level assessment in order to identify areas of expenditure that may require more detailed examination.

Planning of replacement expenditure requirements is a core business function performed by Energex and is critical in network planning and asset management. It has developed a rigorous process to develop replacement expenditure requirements on a bottom up project basis, to meet specific network requirements. It is important to note that Energex has not used the Repex model to forecast asset replacement for the forthcoming period, rather it is populated to comply with the AER’s requirements.

## Purpose

The purpose of this document is to provide the information requested by the AER in Reset Regulatory Information Notice (RIN) Schedule 1 Section 6, Replacement Capital Expenditure Modelling. It describes, amongst other matters the methodologies, assumptions and sources of information required to populate the AER’s Repex model.

## Structure

The document is set out in the following main sections:

* Asset categories
* Replacement life statistics
* Replacement unit costs
* Factors affecting replacement expenditure
* Compliance checklist

## Document terminology

Table 1‑1 sets out the definitions used by Energex to clarify any terminology that may differ between that applied by Energex and the AER.

Table ‑ Energex terminology

| Term | Description |
| --- | --- |
| nailed/nailing | a metal support attached to a wood pole to give it extra support and defer replacement – also called staked/staking |
| NFM | Network Facility Management - the main database used by Energex to record and manage asset data and information regarding network outages |
| CBRM | Condition Based Risk Management - engineering models used to forecast asset condition |

## Repex model observations

The use of the Repex model by the AER to assess future replacement expenditure raises several issues. Energex’s observations and concerns regarding the use of the model are discussed below.

### Recalibration using historical replacement volumes and costs

The Repex model uses asset age profile, average replacement age and cost to predict future asset replacement expenditure. The output from the model is then calibrated using five years of historical replacement volumes and costs.

Energex considers that replacement under augmentation projects, that is not included in the Repex model, should also be taken into consideration when calibrating the Repex model. This is because Energex’s asset replacement program has slowly increased over the past five years to current levels of expenditure. The lower levels of replacement expenditure during the first few years were due to end of life assets being replaced as part of the then larger augmentation program.

### Reliance on age data

Optimal timing for asset replacement is not solely reliant on age. Other factors such as safety, environment, changes in defect rates, and obsolesce issues must also be considered. Energex has a number of proactive asset replacement programs driven by emerging issues unrelated to the age of the assets that will not be fully captured in the Repex model.

In particular, Energex’s SCADA, network communications and protection relay replacement programs are driven by the obsolescence of system components and ability of these systems to continue to support a modern power network. The replacement of these assets forms part of a strategic plan that is unrelated to historical replacement rates and therefore difficult to model using Repex.

# Asset categories

## Asset category description

Energex has followed guidance provided in the AER’s Electricity network service providers -Replacement expenditure model handbook (November 2013)[[1]](#footnote-2) regarding asset groups and asset categories.

Energex’s assets have been mapped to the AER’s Repex asset categories as set out in Table 2‑1. Where the assets are adequately described by the Repex asset categories they are noted *as described*.

Table ‑ Mapping to AER Repex asset categories

| AER asset group | AER asset category | Energex asset category |
| --- | --- | --- |
| "POLES BY:  HIGHEST OPERATING VOLTAGE ; MATERIAL TYPE; STAKING (IF WOOD)" |  |  |
| ˂ = 1 kV; WOOD | \* As described |
| > 1 kV & < = 11 kV; WOOD | \* As described |
| ˃ 11 kV & < = 22 kV; WOOD | \* As described |
| > 22 kV & < = 66 kV; WOOD | \* As described |
| > 66 kV & < = 132 kV; WOOD | \* As described |
| ˂ = 1 kV; CONCRETE | \* As described |
| > 1 kV & < = 11 kV; CONCRETE | \* As described |
| > 22 kV & < = 66 kV; CONCRETE | \* As described |
| > 66 kV & < = 132 kV; CONCRETE | \* As described |
| ˂ = 1 kV; STEEL | \* As described |
| > 1 kV & < = 11 kV; STEEL | \* As described |
| > 22 kV & < = 66 kV; STEEL | \* As described |
| > 66 kV & < = 132 kV; STEEL | \* As described |
| Staked Poles | Nailed ˂ = 1 KV; WOOD |
| Nailed > 1 KV & < = 11 KV; WOOD |
| Nailed > 22 KV & < = 66 KV; WOOD |
| "POLE TOP STRUCTURES BY:  HIGHEST OPERATING VOLTAGE" |  |  |
| ˂ = 1 kV | \* As described |
| > 1 KV & < = 11 KV | \* As described |
| > 11 kV & < = 22 kV | \* As described |
| > 22 KV & < = 66 KV | \* As described |
| > 66 KV & < = 132 KV | \* As described |
| "OVERHEAD CONDUCTORS BY:  HIGHEST OPERATING VOLTAGE; NUMBER OF PHASES (AT HV)" |  |  |
| ˂ = 1 kV | \* As described |
| > 1 kV & < = 11 kV | \* As described |
| ˃ 11 kV & < = 22 kV ; SWER | \* As described |
| > 22 kV & < = 66 kV | \* As described |
| > 66 kV & < = 132 kV | \* As described |
| "UNDERGROUND CABLES BY:  HIGHEST OPERATING VOLTAGE" |  |  |
| ˂ = 1 kV | \* As described |
| > 1 kV & < = 11 kV | \* As described |
| > 22 kV & < = 33 kV | \* As described |
| > 66 kV & < = 132 kV | \* As described |
| "SERVICE LINES BY:  CONNECTION VOLTAGE; CUSTOMER TYPE; CONNECTION COMPLEXITY " |  |  |
| ˂ = 11 kV ; RESIDENTIAL ; SIMPLE TYPE | \* As described |
| ˂ = 11 kV ; COMMERCIAL & INDUSTRIAL ; SIMPLE TYPE | \* As described |
| "TRANSFORMERS BY:  MOUNTING TYPE; HIGHEST OPERATING VOLTAGE ; AMPERE RATING; NUMBER OF PHASES (AT LV)" |  |  |
| POLE MOUNTED ; < = 22kV ; < = 60 kVA ; SINGLE PHASE | \* As described |
| POLE MOUNTED ; < = 22kV ; > 60 kVA AND < = 600 kVA ; SINGLE PHASE | \* As described |
| POLE MOUNTED ; < = 22kV ; < = 60 kVA ; MULTIPLE PHASE | \* As described |
| POLE MOUNTED ; < = 22kV ; > 60 kVA AND < = 600 kVA ; MULTIPLE PHASE | \* As described |
| POLE MOUNTED ; < = 22kV ; > 600 kVA ; MULTIPLE PHASE | \* As described |
| POLE MOUNTED ; > 22 kV ; < = 60 kVA | \* As described |
| POLE MOUNTED ; > 22 kV ; > 60 kVA AND < = 600 kVA | \* As described |
| POLE MOUNTED ; > 22 kV ; > 600 kVA | \* As described |
| KIOSK MOUNTED ; < = 22kV ; < = 60 kVA ; MULTIPLE PHASE | \* As described |
| KIOSK MOUNTED ; < = 22kV ; > 60 kVA AND < = 600 kVA ; MULTIPLE PHASE | \* As described |
| KIOSK MOUNTED ; < = 22kV ; > 600 kVA ; MULTIPLE PHASE | \* As described |
| KIOSK MOUNTED ; > 22 kV ; < = 60 kVA | \* As described |
| KIOSK MOUNTED ; > 22 kV ; > 60 kVA AND < = 600 kVA | \* As described |
| KIOSK MOUNTED ; > 22 kV ; > 600 kVA | \* As described |
| GROUND OUTDOOR / INDOOR CHAMBER MOUNTED ; ˂ 22 kV ; < = 60 kVA ; MULTIPLE PHASE | \* As described |
| GROUND OUTDOOR / INDOOR CHAMBER MOUNTED ; ˂ 22 kV ; > 60 kVA AND < = 600 kVA ; MULTIPLE PHASE | \* As described |
| GROUND OUTDOOR / INDOOR CHAMBER MOUNTED ; ˂ 22 kV ; > 600 kVA ; MULTIPLE PHASE | \* As described |
| GROUND OUTDOOR / INDOOR CHAMBER MOUNTED ; > = 22 kV & < = 33 kV ; < = 15 MVA | \* As described |
| GROUND OUTDOOR / INDOOR CHAMBER MOUNTED ; > = 22 kV & < = 33 kV ; > 15 MVA AND < = 40 MVA | \* As described |
| GROUND OUTDOOR / INDOOR CHAMBER MOUNTED ; > = 22 kV & < = 33 kV ; > 40 MVA | \* As described |
| GROUND OUTDOOR / INDOOR CHAMBER MOUNTED ; > 33 kV & < = 66 kV ; > 15 MVA AND < = 40 MVA | \* As described |
| GROUND OUTDOOR / INDOOR CHAMBER MOUNTED ; > 66 kV & < = 132 kV ; < = 100 MVA | \* As described |
| GROUND OUTDOOR / INDOOR CHAMBER MOUNTED ; > 66 kV & < = 132 kV ; > 100 MVA | \* As described |
| "SWITCHGEAR BY:  HIGHEST OPERATING VOLTAGE ; SWITCH FUNCTION" |  |  |
| ˂ = 11 kV ; SWITCH | The operational switch asset group has been defined as all other switches found within the Energex network, which includes the asset types: airbrake, disk link, link pillar, isolator, switch fuse, dropout, earth switch, fuse switch, sectionaliser, load transfer switch, ring main unit, link pillar and disconnect box. |
| > 11 kV & < = 22 kV ; SWITCH |
| > 22 kV & < = 33 kV ; SWITCH |
| > 33 kV & < = 66 kV ; SWITCH |
| > 66 kV & < = 132 kV ; SWITCH |
| ˂ = 11 kV ; CIRCUIT BREAKER | The circuit breaker asset category has been defined as all circuit breakers and reclosers within the Energex network, excluding circuit breakers that form part of a ring main unit. |
| > 11 kV & < = 22 kV ; CIRCUIT BREAKER |
| > 22 kV & < = 33 kV ; CIRCUIT BREAKER |
| > 33 kV & < = 66 kV ; CIRCUIT BREAKER |
| > 66 kV & < = 132 kV ; CIRCUIT BREAKER |
| "PUBLIC LIGHTING BY:  ASSET TYPE ; LIGHTING OBLIGATION" |  |  |
| LUMINAIRES ; MAJOR ROAD | \* As described |
| LUMINAIRES ; MINOR ROAD | \* As described |
| BRACKETS ; MAJOR ROAD | \* As described |
| BRACKETS ; MINOR ROAD | \* As described |
| LAMPS ; MAJOR ROAD | \* As described |
| LAMPS ; MINOR ROAD | \* As described |
| POLES / COLUMNS ; MAJOR ROAD | \* As described |
| POLES / COLUMNS ; MINOR ROAD | \* As described |
| "SCADA, NETWORK CONTROL AND PROTECTION SYSTEMS BY:  FUNCTION" |  |  |
| FIELD DEVICES | This includes:   * protection relays, * remote terminal units (RTUs)and * intelligent electrical devices (IEDs). |
| LOCAL NETWORK WIRING ASSETS | \* As described |
| COMMUNICATIONS NETWORK ASSETS | This includes:   * Microwave links (links installed), DSS Head ends, * DSS Radios (including repeaters) and Multiplex (including MPLS nodes) |
| MASTER STATION ASSETS | \* As described |
| COMMUNICATIONS LINEAR ASSETS | Includes Copper and fibre optic pilot cables |
| AFLC | \* As described |

### Boundary issues

There are no identified boundary issues between asset categories.

### Age profile determination

Energex applied a range of assumptions to determine age profile quantities and these are summarised in the following sections. Assumptions can generally be applied across all asset categories of a given asset group so assumptions are listed by asset group. Where assumptions are specific to an asset category this is noted.

#### Poles

The following assumptions were applied to determine pole age profile quantities:

* The pole data does not include assets that are in store or held for spares.
* The pole data has been categorised by the highest voltage at the site. For example if a pole carries 33 kV and 11 kV conductors, then all poles at the site have been allocated as 33 kV poles.
* All poles have a year of commissioning based on the first year the current specification was allocated to the slot in NFM.
* The age of nailed poles is defined as when the pole was nailed, rather than when the pole was first installed.
* Poles that have a material type of plastic (fibreglass) have been excluded.
* Aluminium poles have been combined with steel poles.
* Poles with a dedicated streetlight pole specification and contain a rate 1 or rate 2 streetlight have not been included in the asset group poles, but have been included in the public lighting asset group.
* All poles with no voltage such as cross-street (poles that support a service line across a street) and bollard (poles that support another pole) poles have been allocated to the ≤1 kV category.
* Poles have been allocated based on financial year, i.e. an asset captured in NFM on 5 July 2012 will have a commissioning period of 2012/13.

#### Pole top structures

The following assumptions were applied to determine pole top structure age profile quantities:

* Pole top structures are defined to be cross arms fitted to poles. The following multipliers were applied against the figures calculated for pole assets to determine the quantity of cross arms and their initial ages. Multipliers have been determined from Energex maintenance department based upon field sampling conducted and knowledge of construction types and their application.
* All cross arms on poles installed prior to 1978/79 had been replaced with a consecutive 35 year life span. For example a 1977/78 start date is updated to 2012/13 to indicate that the asset has been replaced.

#### Overhead Conductors

The following assumptions were applied to determine overhead conductors age profile quantities:

* The conductor data does not include conductors that are in store or held for spares.
* Total quantities are reported in kilometres.
* The length of each conductor category is the total conductor route length and not each individual phase conductor length, noting:
* 11 kV routes predominately consist of three conductors, but also include some single phase (two conductors) in the total length.
* Low Voltage (LV) routes predominately consist of four conductors: three phases plus neutral, however the lengths provided include all variations.

#### Underground cables

The following assumptions were applied to determine underground cable age profile quantities:

* The underground cable data does not include cables that are in store or held for spares.
* Total quantities are reported in kilometres.
* The length of each conductor category is the total cable route length and not each individual core length.

#### Service lines

The following assumptions were applied to determine service line age profile quantities:

* Maximum age of a service line of 60 years has been used when estimating the age of the population.
* All LV service lines are a single span making them simple connections.
* All new overhead service line assets are type XLPE.
* A customer may have their own private network beyond a connection point. These assets are not modelled or captured in the database.
* Based on the definitions in the Reset RIN, Energex has only LV service line assets. Where customers require connection at higher voltages and the assets are owned by Energex, they are included in other dedicated asset categories (such as 11 kV overhead conductor) and are not classified as service lines.

#### Transformers

The following assumption was applied to determine transformer age profile quantities:

* The transformer data does not include transformers that are in store or held for spares.

#### Switchgear

The following assumptions were applied to determine switchgear age profile quantities:

* The switchgear data does not include assets that are in store or held for spares.
* The circuit breaker asset category has been defined as all circuit breakers and reclosers within the Energex network, excluding circuit breakers that form part of a ring main unit.
* The operational switch asset group has been defined as all other switches found within the Energex network, which includes the asset types: airbrake, disk link, link pillar, isolator, switch fuse, dropout, earth switch, fuse switch, sectionaliser, load transfer switch, ring main unit, link pillar and disconnect box.

#### Public lighting

The following assumption was applied to determine public lighting age profile quantities:

* The public lighting data does not include assets that are in store or held for spares.

#### SCADA, network control and protection systems

Energex’s database only contains initial commissioning information for intelligent electrical devices (IEDs) and distribution system SCADA (DSS) radios. Subsequent data associated with maintenance swap-outs (i.e. replacements) is not captured due to low cost of the equipment. As a result, this tends to overstate the age of the IED and DSS radio fleet, however, this was not considered a significant issue on the basis that IEDs and DSS radios are typically low cost in nature.

### Main drivers of replacement

The main drivers of replacement for each of the asset groups are shown in Table 2‑2. The drivers of replacement for asset categories are consistent within each asset group.

Table ‑ Main replacement driver

| Asset Group | Main replacement driver |
| --- | --- |
| Poles | Asset condition |
| Pole top structures | Asset condition |
| Overhead conductors | Asset condition |
| Underground cables | Asset condition |
| Service lines | Asset condition |
| Transformers | Asset condition |
| Switchgear | Asset condition |
| Public lighting | Asset condition |
| SCADA, network control | Obsolescence and asset condition |

Public lighting is included in table 2.2.1 of the Reset RIN, it should be noted that Energex manages this asset group as an Alternate Control Service.

Asset condition considers asset metrics including age, environmental factors, inspection and test results and technical engineering risk assessments. Energex uses the following strategies to meet its replacement objectives:

* On condition replacement
* Bulk replacement
* Risk based replacement
* Run to failure

### Explanation replacement unit cost

Replacement unit costs have not been requested by the AER as part of the Reset RIN. Energex assumes that the AER will:

* Calculate replacement unit cost for each asset category using data provided in Table 2.2.1 of the Reset RIN.
* Estimate replacement unit cost for the Repex model using total replacement expenditure divided by the total replacement volumes as per the Repex model calibration instructions[[2]](#footnote-3).

Costs included in historic replacement expenditure provide for a complete replacement of an asset with its modern equivalent except for poles for which Energex undertakes pole nailing as a refurbishment activity to extend asset life. This activity is capitalised and is included as a separate asset category as per directions under clause 5.1.b) of Appendix E of the Reset RIN.

## Proportion of assets replaced

This section provides an estimate of the proportion of assets replaced for each year of the current regulatory control period.

When recording project data, where an augmentation driver exists for projects that include replacement of assets, these projects have been captured as augmentation projects. This means that the level of asset replacement may be obscured due to augmentation projects.

### Replacements due to asset ageing

Asset replacement volumes due to asset ageing only include assets replaced under replacement projects. These are consistent with expenditure reported against Table 2.2.1 of Reset RIN. The estimate does not include the number of assets that were replaced under augmentation or customer initiated project codes.

Table 2‑3 shows the assets replaced as a percentage of the total asset population. This is reported at the asset group level to average out the variability found when reporting at the asset category level.

Table ‑ Replacements due to asset ageing

| Asset group | Proportion of assets replaced | | | | |
| --- | --- | --- | --- | --- | --- |
| 2010 | 2011 | 2012 | 2013 | 2014 |
| Poles (ea.) | 0.80% | 0.53% | 1.29% | 1.28% | 1.57% |
| Pole top structures (ea.) | 1.09% | 0.66% | 2.11% | 2.10% | 3.06% |
| Overhead conductor (in km) | 0.60% | 0.59% | 1.47% | 1.47% | 2.88% |
| Underground cables (in km) | 0.10% | 0.21% | 0.46% | 0.34% | 0.73% |
| Service lines (ea.) | - | - | - | - | - |
| Transformers (ea.) | 0.69% | 0.30% | 1.44% | 1.42% | 1.80% |
| Switchgear (ea.) | 0.42% | 0.17% | 0.74% | 0.78% | 0.77% |
| Public lighting (ea.) | - | - | - | - | - |
| SCADA, network control and protection systems (ea.) | 0.24% | 0.04% | 0.24% | 0.09% | 0.52% |
| SCADA, Pilot Cable (in km) | 0.003% | 10.16% | 1.24% | 0.31% | 1.43% |

### Replacement due to other factors

Energex has not reported asset replacements due to other factors.

### Replacement due to network augmentation, extension, development

Augmentation projects often include an element of asset replacement. This can be due to:

* A combination of augmentation and asset replacement drivers on a specific asset, such as aged zone substation transformers being upgraded and replaced due to capacity.
* Associated assets also requiring replacement when the main asset is augmented, which occurs for two key reasons:
* to meet the technical specification required for the augmented asset, for example, increasing the capacity of a transformer will require the transformer circuit breaker to carry more current
* to bring forward replacement as part of a major project where the associated assets are in poor condition and financial modelling identified improved efficiency.
* Technical issues that force asset replacement prior to end of life, such as increased fault levels
* Replacement to resolve safety concerns or changes to statutory requirements, such as protection system upgrades.

Table 2‑4 shows an estimate of assets replaced through augmentation projects, which would otherwise have been replaced due to condition, as a percentage of the total asset population. This is reported at the asset group level to average out the variability found when reporting at the asset category level.

Table ‑ Assets replaced through augmentation, extension, development of the network

| Asset group | Proportion of assets replaced | | | | |
| --- | --- | --- | --- | --- | --- |
| 2010 | 2011 | 2012 | 2013 | 2014 |
| Poles (ea.) | 0.18% | 0.18% | 0.18% | 0.18% | 0.33% |
| Pole top structures (ea.) | - | - | - | - | - |
| Overhead conductor (in km) | 0.01% | 0.08% | 0.23% | 0.03% | 0.03% |
| Underground cables (in km) | - | - | - | - | - |
| Service lines (ea.) | - | - | - | - | - |
| Transformers (ea.) | 0.10% | 0.10% | 0.06% | 0.06% | 0.02% |
| Switchgear (ea.) | 0.01% | 0.03% | 0.03% | 0.02% | 0.01% |
| Public lighting (ea.) | - | - | - | - | - |
| SCADA, network control and protection systems (ea.) | 0.50% | 0.37% | 0.22% | 0.35% | 0.25% |
| SCADA, Pilot Cable (in km) | 2.04% | 0.06% | 0.50% | 0.17% | 0.30% |

Energex considers that a component of the total replacement expenditure should be added to the Repex model forecast following calibration to account for difference in the balance between augmentation and replacement expenditure between the current and forthcoming regulatory control periods.

This is important as the Repex model calibrates data inputs to the average actual replacement expenditure for the past five years. Implicit in the calibration methodology is an assumption that the historic levels of augmentation expenditure, and the balance between augmentation and replacement, will remain constant in the forecast period. Energex is forecasting significantly lower augmentation expenditure in the forthcoming regulatory control period. The balance between augmentation and replacement will therefore be very different from the current regulatory control period.

### Additional assets due to other factors

Energex has not reported asset replacements due to other factors.

# Replacement life statistics

## Overview

The AER requires Energex to report replacement life statistics, being the mean economic life and the standard deviation, for all asset categories. The economic life includes when an asset fails in service (sometimes called a functional failure); and when it is replaced due to condition prior to failure (sometimes called a conditional failure).

The following sections describe the data sources, methodology and assumptions used to report replacement life statistics.

### Data sources

A number of sources were used to provide data to estimate replacement life statistics for all asset categories included in the Repex Model. These included:

* NFM - the main database used by Energex to record and manage asset data and information regarding network outages
* CBRM model – engineering models used to forecast asset condition
* Engineering assessments from Energex technical specialists
* Manufacturer’s specifications
* Internal management documentation
* Contracts and customer billing data
* Regulatory lives.

The sources for each asset group are listed in Table 3‑1 below.

Table ‑ Replacement life statistics information sources

| Asset Group | Variable | Source |
| --- | --- | --- |
| Poles | wood | Engineering assessment |
| steel and concrete | Engineering assessment |
| nailed (if wood) | Engineering assessment |
| Pole top structures | all | Engineering assessment |
| Overhead conductors | ≤1 kV | Engineering assessment |
| >1 kV and ≤22 kV | Energex CBRM – 11 kV conductors v3.0 and engineering assessment |
| >22 kV and ≤66 kV | Energex CBRM – 33 kV feeders v2.0 |
| >66 kV and ≤132 kV | Energex CBRM - 110 132 kV feeders v2.0 |
| Underground cables | ≤1 kV | Engineering assessment |
| >1 kV and ≤22 kV | Engineering assessment |
| >22 kV and ≤66 kV | EGX CBRM – 33 kV gas cables v3.0 EGX CBRM – 33 kV oil filled cables v3.0 EGX CBRM – 33 kV solid cables v3.0 |
| >66 kV and ≤132 kV | Energex CBRM – 110 kV oil filled cables v3.0 Energex CBRM – 110 kV solid cables v3.0 |
| Service lines | all | Regulatory life |
| Transformers | pole mounted - all | Energex CBRM - pole mounted TX v3.0/ Engineering assessment |
| kiosk mounted - all | Energex CBRM - ground and pad mounted TX v3.0 and Engineering assessment |
| ground indoor/outdoor chamber mounted ≤22 kV | Energex CBRM - ground and pad mounted TX v3.0 and Engineering assessment |
| ground indoor/outdoor chamber mounted >22 kV and ≤66 kV | EGX CBRM 33 kV TX v3.1 |
| ground indoor/outdoor chamber mounted >66 kV and ≤132 kV | EGX CBRM 110.132 kV TX v3.1 |
| Switchgear | circuit breaker ≤22 kV | EGX CBRM 11 kV CB v3.3 Energex CBRM - reclosers v3.0 |
| circuit breaker >22 kV and ≤66 kV | EGX CBRM 33kV CB v3.2 |
| circuit breaker >66 kV and ≤132 kV | EGX CBRM 110.132kV CB v3.1 |
| operational switch ≤22 kV | Energex CBRM - sectionalisers v3.0 and engineering assessment Energex CBRM - load transfers switches v3.0 and engineering assessment Energex CBRM – Ring main units v3.0 and engineering assessment Energex CBRM - Air break switches v3.0 and engineering assessment |
| operational switch >22 kV and ≤66 kV | Engineering assessment |
| operational switch >66 kV and ≤132 kV | Engineering assessment |
| Public lighting | luminaries | Manufacturer’s specification |
| brackets and poles | Network asset management documentation |
| lamps | Public lighting maintenance contract and customer billing data |
| SCADA network control and protection systems | all | Engineering assessments |

### Methodology

For all assets modelled using a CBRM model, the mean life was extracted from the CBRM model.

CBRM enables asset lives to be expressed based on attributes of assets combined with the operating environment and condition assessment data. The input values used in the CBRM models were developed through workshops with key stakeholders taking account of factors such as original specification, manufacturer, operational experience, obsolescence, maintenance issues and operating conditions such as duty or proximity to coast.

The values for the average asset lives used in the CBRM models are calibrated against historic asset failures and replacements. The standard deviation is approximated by the square root of the mean[[3]](#footnote-4).

For assets not modelled using CBRM, engineering assessment using other techniques were undertaken. These assessments included reviews of actual asset age extracted from asset failure records, manufacturer’s specification and Energex’s regulatory asset lives. The standard deviation was either calculated from the data set or approximated by the square root of the mean.

### Assumptions

Energex applied the following assumptions to obtain replacement life statistics:

* Standard deviation of economic life is approximated by the square root of the mean in accordance with the AER Replacement expenditure model handbook.
* The economic life of ≤22 kV wood poles is assumed to be the same as 11 kV wood poles.
* The economic life of LV steel poles is assumed to be the same as 11 kV steel poles
* The economic life of single wire earth return (SWER) conductors is assumed to be the same as 11 kV conductors.
* The economic life of low LV cables (≤1 kV) is assumed to be the same as 11 kV cables.
* The economic life of poles with unknown voltage has been included with LV poles.
* The economic life of pole mounted single phase transformers is assumed to be the same as multi-phase pole mounted transformers.
* The economic life of ground mounted and indoor chamber mounted transformers >33 kV and ≤66 kV is assumed to be the same as 33 kV ground mounted and indoor chamber mounted transformers.
* The economic life of >11 kV and ≤22 kV circuit breakers and switches is assumed to be the same as11 kV circuit breakers and switches respectively.
* The economic life of >33 kV and ≤66 kV circuit breakers and switches is assumed to be the same as 33 kV circuit breakers and switches respectively.
* Steel poles include steel mono poles and steel lattice towers.

## Relationship to historic replacement lives

The replacement lives used were developed through workshops with key stakeholders, taking account of factors such as original specification, manufacturer, operational experience, obsolescence, maintenance issues and operating conditions.

Therefore, the replacement life statistics for each asset group have a strong relationship with historical replacement lives within the Energex environment.

## Views on probability distribution used in Repex

### Appropriateness of a normal distribution

Due to the general nature of the Repex model Energex does not consider that there is any reason to depart from the normal distribution.

### Typical age when “wear out” phase becomes evident

Energex does not define a “wear out” phase for any asset classes. When forecasting asset replacement requirements Energex considers a number of strategies based on a risk based approach that allows activities to be planned to achieve the desired levels of quality and reliability of supply, safety, and environmental performance.

### Skewness of the distribution

Due to the general nature of the Repex model Energex does not consider that there is any reason to depart from the normal distribution (i.e. by using a skewed normal distribution).

### Process applied to verify the parameters

To verify that replacement life statistics against Regulatory Template 5.2 of the Reset RIN were a reasonable estimate of the life for each asset category, Energex conducted a peer review of values reported to ensure suitability of values for the AER’s Repex model.

It is important to note that Energex does not apply probability distributions when forecasting asset replacement requirements for business as usual purposes. Instead it applies a strategic, risk based approach allowing planning activities to achieve the desired levels of quality and reliability of supply, safety, and environmental performance.

# Replacement unit costs

## Overview

*Replacement unit costs* have not been requested by the AER through the Reset RIN, however the AER’s Repex model requires a *replacement unit cost* for each Asset ID specified in the Repex model. Energex therefore discusses the derivation of replacement unit costs on the basis of assumptions regarding how the AER will derive this information.

The italicised term *replacement unit costs* refers specifically to the unit costs derived by the AER (on the basis of information provided by Energex) as an input into its Repex model. This is to distinguish these costs from Energex’s project or program estimates.

The derivation of asset lives is not relevant to the discussion of cost data.

### Methodology, data sources and assumptions

Energex assumes that the AER will calculate *replacement unit costs* for each asset category using data provided in Table 2.2.1 of the Reset RIN Regulatory Template. Energex assumes that the *replacement unit cost* for the Repex model will be estimated by total replacement expenditure divided the total replacement volumes as per the Repex model calibration instructions[[4]](#footnote-5).

### Double counting

Replacement project expenditure was apportioned to each of the AER’s asset categories based on the project material cost. As the expenditure was apportioned from actual project expenditure there was no possibility of double counting.

### Variability in replacement unit costs

The AER requires Energex to report asset age profiles, replacement volumes and expenditure according to defined asset groups and asset categories. As a result, there can be variation between the replacement costs of assets within the specified groups which depends on the homogeneity of the assets and replacement scope of work is for a particular asset group.

The key asset and project unit costs affected by large variations are:

* Brownfield developments, particularly power transformer projects, which have a unique scope and where costs can be driven by factors such as ground condition, site location, availability of space at site and modern equivalent assets with different footprints and functionality.
* Pole top structures, as due to significant variance in in complexity within the same asset category.
* Where controlled substances, such as polychlorinated biphenyls (PCBs) in oil, are found causing an increase to the cost of asset disposal.
* Fibre Cable installation unit costs can vary significantly between projects where bundling is possible with other replacement works (Overhead Earth Wire replacement) compared to direct installation of the cable. This can also impact many of the low cost assets replacement activities.

### Relationship to historic costs

Energex assumes that the *replacement unit cost* for the Repex model will be estimated by total historical replacement expenditure divided the total historical replacement volumes as per the Repex model calibration instructions[[5]](#footnote-6).

### Verification process

The replacement volumes and expenditure that will be used by the AER to calculate the *replacement unit cost* are subject to audit under the Reset RIN and will be verified through this process.

Importantly, Energex does not use the calculated repex *replacement unit costs* as part of its replacement expenditure forecast methodology. Instead, Energex’s replacement program is forecast based on specific asset requirements, costed through a combination of comparative and standard cost estimating methodologies to underpin the estimation process for individual projects. Energex uses an estimating program that is part of the Ellipse Enterprise Resource Planning (ERP) package.

Energex standard designs for substations, overhead power lines and underground cables are the building blocks used for the construction of the network. Foundation or base individual components known as compatible units (e.g. circuit breakers, busbars, units of work) are combined to form standard assemblies/estimates (e.g. transformer bays), which in turn are built up into standard network building blocks (e.g. zone substations). This approach ensures all labour, material and contract work is included in compatible units and standard estimates. Where required, a project scope is developed by selecting the appropriate building blocks or compatible units to deliver the required network solution and the project estimate is developed from the standard estimates of the associated elements.

Project estimates are developed and refined at key stages in the planning, design and construction process the estimate of each project will be refined throughout its lifecycle. The key estimates used by Energex are as follows:

* Strategic estimates represent the initial determination of what the project may cost and are prepared based on minimal scoping for the purpose of program of works prioritisation and development.
* Preferred option estimates are produced with greater accuracy reflecting the more detailed scoping of the chosen network solution, used for prioritisation/inclusion in the program of work. This estimate is also used for RIT-D purposes.
* Approval estimates are developed from detailed planning analysis of individual network limitations used for formal approval of capital expenditure. Project approval estimates are used to forecast capital requirements typically in the zero to three year timeframe.
* A Total Out-Turn Cost estimate is produced following the detailed design for an approved project.

Once completed, Energex’s detailed asset replacement expenditure forecast was allocated to each of the asset categories reported in Table 2.2.1 of the Reset RIN based on material cost.

Energex engaged AECOM to provide advice and review unit rates used by Energex to develop the capital expenditure programs to ensure these are reasonable and reflect prudent and efficient operations (refer to Regulatory Proposal Appendix 22).

# Factors affecting replacement expenditure

## Overview

The following sections describe factors that have changed network replacement expenditure requirements over the current regulatory control period, or are expected to affect replacement requirements in the forthcoming regulatory control period. These factors are expected to result in higher replacement volumes and/or increased unit costs and affect the suitability of using the Repex model to forecast replacement requirements.

## Statutory requirements

The Energex Distribution Authority was amended in 2014 to establish a safety net standard for planning the network to manage the risk of high impact low probability events. The updated standard, in conjunction with moderation in demand growth resulted in fewer forecast augmentation based projects in the forthcoming regulatory control period. Therefore, fewer assets will be replaced as part of augmentation projects, with the majority expected to be captured under the replacement category.

This will result in a small increase in the level of replacement from its current level, as discussed in Section 2.2.

## Internal planning and asset management

Energex introduced CBRM modelling for high value assets in 2008. This approach enabled Energex to take a more condition and risk based approach to asset replacement, as opposed to a purely age based replacement program.

CBRM modelling generally enables asset lives to be extended however there are cases where asset condition and risk assessment results in the early retirement of assets compared to the economic mean life.

## Asset factors

There are a number of continuing and emerging issues affecting the need for expenditure in certain assets categories. The following sections set out the key issues, resulting in the greatest expenditure impacts.

### 33 kV power transformers

Energex has a number of 33/11 kV transformers installed during the 1960s and 1970s fitted with a Fuller type tap changer identified as having a high risk of failure. The majority of the internal shafts where constructed from wood and due to age and moisture build up in them they become weak and break. This can lead to potential catastrophic failure. Refurbishment of these tap changers is no longer an option as spare parts are no longer manufactured. Energex has a proactive program to replace these transformers.

The replacement of these transformers has been prioritised based on a risk assessment and is anticipated to result in the replacement of 22 out of a population of 58 assets.

### 33 kV circuit breakers

Energex identified issues with the following circuit breakers:

* GEC type JB424,
* Emailed type 345GC and
* AEI type LG1C44 type

These assets are 33 kV bulk oil filled outdoor circuit breakers, the majority of which were installed from the 1950s to 1970s.

These circuit breakers were found to have deteriorated bushing insulation, primary contact wear; difficulty in achieving correct mechanism adjustments; and reliability issues. Spare parts are no longer manufactured and components cannot be retrieved from recovered plant due to poor condition.

The replacement of these circuit breakers has been prioritised based on a risk assessment and is anticipated to result in the replacement of 257 out of a population of 309 assets.

### 11 kV circuit breakers

A risk assessment for oil circuit breakers, particularly in high density areas under manual switching operations (no remote control), identified high risk plant. In 97 substations for commercial and industrial customers, the majority of which were installed from the early 1950s to late 1970s, existing 11 kV circuit breakers require an operator to trip or close.

Following a risk assessment process, substations with manual controlled circuit breakers were prioritised such that 45 substations are planned to be completed by 2014/15 and the remaining 52 substations will be completed in the forthcoming regulatory control period.

### SCADA, network control and protection systems

Energex is replacing certain Protection, Telecommunications and SCADA equipment with modern technologies, resulting in variability to anticipated units and unit rates. In particular the Protection Relay replacement programs resulted in a significant numbers of assets that previously had a 45 year life time now nearing end of life at only 15-20 years. This has resulted in a large unit count to be replaced compared with historic replacement volumes.

In the current AER period, large amounts of SCADA, network control and protection systems works were completed under larger augmentation projects resulting, in artificially low historic replacement units in table 2.2.1 of the Reset RIN.

Similarly, synergies that were achieved in the current AER period by bundling certain SCADA, network control and protection systems work with other substation projects will not be available in the forthcoming period, resulting in unit price increases.

## External factors

There are no external factors relating to asset replacement that will affect Energex in the forthcoming regulatory control period.

## New technology

All assets that are captured by asset replacement categories are replaced with their modern equivalent and the modern equivalent is used to determine the replacement unit cost.

The main types of assets affected by this type of replacement are:

* Plesioochronous Digital Hierarchy (PDH) multiplex equipment, which is being replaced with Multi Protocol Label Switching (MPLS) equipment, and is anticipated to result in the installation of 262 modern equivalent assets.
* Copper pilot cables which are replaced with fibre optic cabling, and is anticipated to result in the installation of 314 km modern equivalent assets.
* Electro mechanic protection relays which are replaced with numerical / digital protection relays, and is anticipated to result in the replacement of 2000 modern equivalent assets.

Energex has not identified non-network technology impacting the need for replacement expenditure.

## Other significant matters

There are no other significant matters relating to asset replacement activity reported in table 2.2.1 of the Reset RIN that will affect Energex in the next forthcoming regulatory control period.

# Additional Energex replacement expenditure items

The AER has stated that the Repex model is aimed at modelling non-demand driven replacement of an asset with its modern equivalent, where the timing of the need can be directly or implicitly linked to the age of the asset.

This statement acknowledges that there are factors other than condition that trigger the need for asset replacement and that age cannot always be a good proxy for condition. In addition, the AER notes that DNSPs apply a number of alternative techniques and the Repex model does not replace those techniques.[[6]](#footnote-7)

The following programs set out in Table 6‑1 have not been included in table 2.2.1 of the Reset RIN due to:

* Asset replacement not being directly or implicitly linked to the age of the asset
* affected assets not being included in the AER’s Repex categories.

Table ‑ – Unmodelled programs not included in Repex model

|  |  |  |
| --- | --- | --- |
| Unmodelled Programs | Description | Driver |
| Protection Schemes | Bus zone protection at locations where high fault levels exist, bus schemes are not present, bus faults are currently cleared via low speed overcurrent protection, transformer ended feeders without diverse communications and 11kV feeders without under frequency load shed control. | Replacement of existing aged protection schemes where they unable to meet current operating standards |
| Asset Replacement | 132/110kV Insulators Replacement | Replacements identified through planned inspections of overhead 132kV and 110kV network. |
| Planned Substation Battery Replacement | Planned replacement of the entire substation battery bank every five years. This was determined through a joint Powerlink/Energex engineering assessment and has been ongoing for several years. |
| 110kV CVTs Replacement | The outcome of a failure investigation by Powerlink on these CVTs was to replace all assets greater than 20 years old before they catastrophically fail with a potential safety risk to personnel as the bushing material is porcelain. |
| Overhead Earth Wire (OHEW) Replacement | Replacements identified through planned inspections of overhead earth wires on the 132kV and 110kV network |
| Replace Cable Terminations | Where high risk and “end of life” Cable Terminations exist, the cable needs to be replaced feeding the Ground Transformer. |
| Asset Management Requested Refurbishment | This program is for minor non-specific network components that are encountered during normal works and are identified by Asset managers as at "End of Life". |
| Non-age Related Replacement | Non-age related circuit breaker replacement | Premature degradation of specific types of modern circuit breakers due to partial discharge. |
| Neutral Earth Resistor (NER) Replacement | The time required to maintain a NER is longer than what is allowed for the NER to be out of service. This was determined by a risk assessment safety driver. |
| Andelect ring main unit Replacement | Replacement driver is based on two known issues: the first is frequent oil leak attributed to the failure of the bottom tank gasket and other issue is the tendency for coupled units (SDAF and SDAF3) to fail in the coupling chamber. |
| Specific air break switch replacement | Insulators of the switches have pin corrosion which has led to numerous insulators with hairline cracks failing when the switch is operated. |
| Reactive Work Program | Capital replacement of plant which fails in service, requiring quick turnaround. | Provision of fast-tracked capital replacement of critical system assets which fail in service where there are no applicable alternative options and repair is not economical. |
| Life Extension Trials & Condition Monitoring | Transformer Moisture Rectification | Increasing moisture levels in some of the Energex transformer fleet. If this is not rectified the insulation will age exponentially leading to a reduction in useful life or failure of the internal windings. |
| Regenerative Breather Installation | Increasing moisture developing in the new tap changers. If not addressed assets will catastrophically fail as the clearances within are less than in older unit. |
| Air Conditioning | A small quantity of observed degrading sites with HS Eclipse switchgear that are at risk of failure. As the Partial Discharge is very sensitive to the environment, studies have shown that a reduction in the substation humidity by employing A/C can substantially reduce the risk of PD occurring and hence the risk of a catastrophic failure. |
| Condition Monitoring | Better assessment of equipment condition such that it is replaced just before failure or that it is better to run to failure,. |
| Distribution power quality monitoring - pole mounted transformer | Energex has a responsibility to provide a reliable supply of electricity to its customers with acceptable supply quality. This program enables the monitoring of the network to provide input into reporting systems, network analysis and remediation programs. |
| SCADA System | OTE environment and services migration | Implementation of the replacement Environment and Services Migration from existing arrangement to the OTE environment. |
| SCADA Development | This program includes initiatives to keep the existing arrangements operating and to commence the work to transition to a commercial system. |
| SCADA Feature Rollout | In order to meet the evolving needs of the distribution network, improvements to SCADA and Automation system software will need to be deployed. |
| Trunked Mobile Radio (TMR) replacement | This project caters for the need to pay for a replacement network to meet Energex requirements. |

# RIN Schedule 1 checklist

Table 7‑1 sets out the requirements and relevant reference for each of the Submission RIN Schedule 1 clauses relating to Repex modelling.

Table ‑ – Compliance checklist

|  |  |  |
| --- | --- | --- |
| RIN Clause | Description | Section Reference |
| 6.1(a)(i)(A) | In relation to information provided in regulatory templates 2.2 and with respect to the AER’s repex model, provide in relation to individual asset categories set out in the regulatory templates, provide in a separate document a description of the asset category, including:  …the assets included and any boundary issues (i.e. with other asset categories) | 2.1 |
| 6.1(a)(i)(B) | …an explanation of how these matters have been accounted for in determining quantities in the age profile | 2.1.2 |
| 6.1(a)(i)(C) | …an explanation of the main drivers for replacement (e.g. condition) | 2.1.3 |
| 6.1(a)(i)(D) | …an explanation of whether the replacement unit cost provides for a complete replacement of the asset, or some other activity, including an extension of the asset’s life (e.g. pole staking) and whether the costs of this extension or other activity are capitalised or not. | 2.1.4 |
| 6.1(a)(ii)(A) | In relation to information provided in regulatory templates 2.2 and with respect to the AER’s repex model, provide in relation to individual asset categories set out in the regulatory templates, provide in a separate document an estimate of the proportion of assets replaced for each year of the current regulatory control period, due to:  … aging of existing assets (e.g. condition, obsolesce, etc.) that should be largely captured by this form of replacement modelling | 2.2.1 |
| 6.1(a)(ii)(B) | …replacements due to other factors (and a description of those factors) | 2.2.2 |
| 6.1(a)(ii)(C) | …additional assets due to the augmentation, extension, development of the network | 2.2.3 |
| 6.1(a)(ii)(D) | …additional assets due to other factors (and a description of those factors) | 2.2.4 |
| 6.1(b)(i) | In relation to information provided in regulatory templates 2.2 and with respect to the AER’s repex model, provide justification for the replacement life statistics provided (the mean and standard deviation), including the methodology, data sources and assumptions used to derive the statistics | 3.1 |
| 6.1(b)(ii) | In relation to information provided in regulatory templates 2.2 and with respect to the AER’s repex model, provide justification for the replacement life statistics provided (the mean and standard deviation), including the relationship to historical replacement lives for that asset category | 3.2 |
| 6.1(b)(iii)(A) | In relation to information provided in regulatory templates 2.2 and with respect to the AER’s repex model, provide justification for the replacement life statistics provided (the mean and standard deviation), including Energex’s views on the most appropriate probability distribution to simulate the replacement needs of that asset category, including matters such as:  …the appropriateness of the normal distribution or another distribution (e.g. the Weibull distribution) | 3.3.1 |
| 6.1(b)(iii)(B) | …the typical age when the “wear out” phase becomes evident | 3.3.2 |
| 6.1(b)(iii)(C) | …the “skewness” of the distribution | 3.3.3 |
| 6.1(b)(iii)(D) | …the process applied to verify that the parameters are a reasonable estimate of the life for the asset category. | 3.3.4 |
| 6.1(c)(i) | In relation to information provided in regulatory templates 2.2 and with respect to the AER’s repex model, provide the derivation of replacement unit costs and asset lives, including any internal documentation or analysis or independent benchmarking that justifies or supports its cost data. This information must include:  … the methodology, data sources and assumptions used to derive the cost data | 4.1.1 |
| 6.1(c)(ii) | … the possibility of double-counting costs in the estimate, and the process applied to ensure this is appropriately accounted for | 4.1.2 |
| 6.1(c)(iii) | … the variability in the unit costs between individual asset replacements, and the main drivers of the variability | 4.1.3 |
| 6.1(c)(iv) | … the relationship of the unit cost, and its derivation, to historical replacement costs for that asset category (this should clearly differentiate and quantify any assumed cost difference due to labour/material price changes and other factors) | 4.1.4 |
| 6.1(c)(v) | …the process applied to verify that the parameter is a reasonable estimate of the unit cost for the asset category; | 4.1.5 |
| 6.1(d)(i) | In relation to information provided in regulatory templates 2.2 and with respect to the AER’s repex model, provide for the previous, current and forthcoming regulatory control periods, explain the drivers or factors that have changed network replacement expenditure requirements. Separately identify and quantify the relative effect of each of the following matters on network replacement expenditure requirements, where they have changed network replacement expenditure requirements:  … rules, codes, license conditions, statutory requirements;  The information provided in response to the above requests should at least distinguish between the asset categories defined above. | 5.2 |
| 6.1(d)(ii) | ...internal planning and asset management approaches; | 5.3 |
| 6.1(d)(iii) | …measurable asset factors that affect the need for expenditure in this category (e.g. age profiles, risk profiles, condition trend, etc.). Identify and quantify individual factors | 5.4 |
| 6.1(d)(iv) | …the external factors that can be forecast and the outcome measured (e.g. demand growth, customer numbers) that affect the need for expenditure in this category. Identify and quantify individual factors, covering the forecasts and the outcome (external factors to be discussed here do not relate to changing obligations which are covered in paragraph 4) | 5.5 |
| 6.1(d)(v) | …technology/solutions to address needs, covering:  (A) network; and  (B) non-network. | 5.6 |
| 6.1(d)(vi) | …any other significant matters. | 5.7 |

1. AER Replacement expenditure model handbook, November 2013 [↑](#footnote-ref-2)
2. AER Replacement expenditure model handbook, November 2013, page 20 [↑](#footnote-ref-3)
3. AER Replacement expenditure model handbook, November 2013, page 18 [↑](#footnote-ref-4)
4. AER Replacement expenditure model handbook, November 2013, page 20 [↑](#footnote-ref-5)
5. AER Replacement expenditure model handbook, November 2013, page 20 [↑](#footnote-ref-6)
6. AER guide to the Repex model, November 2013, Section 2 [↑](#footnote-ref-7)