Expenditure Justification – ZSS Capacitor Banks, Earthing and Neutral Earthing Resistors

UNITED ENERGY

AER Category Expenditure Explanatory Statement

This document describes the expenditure justification for Zone Substation Capacitor Banks, Earthing assets and NERs on the United Energy network.

REPEX Road Map

1. Asset Replacement – Modelled

a. 6 modelled asset categories

2. Asset Replacement – Modelled & Unmodelled

a. Pole top structures + SCADA/protection

3. Other Repex - Unmodelled

a. ZSS Primary Asset Replacement

(i) CEES - Capacitor Banks + Earth Grid + Neutral Earthing Resistors

(ii) CEES - Buildings

b. Non VBRC Safety Projects

(i) Intelligent Secure Substation Asset Management (ISSAM) – UE PL 2401 e.g.CCTV

c. Operational Technology

(i) OT Safety

- Service Mains Deterioration Field Works – PJ1385
- In Meter Capabilities IMC) – PJ1386
- Light Detection and Ranging (LiDAR) Asset Management – PJ1400
- OT Security – PJ1500
- DNSP Intelligent Network Device – PJ5002

(ii) OT Reliability

- Distribution Fault Anticipation Data Collection and Analytics (DFADCAA) – PJ1599
- Fault Location Identification and Application Development – PJ1600

(iii) OT Other

- Dynamic Rating Monitoring Control Communication (DRMCC) – PJ1413
- Test Harness – PJ1398
- Pilot New and Innovative Technologies – PJ1407

d. Network Reliability Assessment UE PL 2304 – Projects

(i) Automatic Circuit Re-closers (ACRs) and Remote Control Gas Switches (RCGSs)

(ii) Fuse Savers

(iii) Rogue Feeders

(iv) Clashing

(v) Animal Proofing

(vi) Communications Upgrade

e. CEES – Environment

f. CEES – Power Quality Maintained

g. Terminal Station Redevelopment HTS and RTS - UE-DOA-S-17-002 & UEDO-14-003

4. VBRC Projects

a. HV Aerial Bundled Cable Strategic Analysis Plan - UE PL 2053

b. DMA and MTN Zone Substation Rapid Earth Fault Current Limiter (REFCL) Installation

c. Other VBRC projects

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1. Purpose

This document is one of a set of documents that explain and justify the replacement and refurbishment programs, which form part of our capital expenditure (capex) forecast in our building block proposal.

The volumes and capital expenditure discussed in these documents reconcile to the volumes and expenditure set out in the Table 2.2 of the reset Regulatory Information Notices.

This document should be read in conjunction with the suite of Life Cycle Strategies, which provide more detailed technical information on our assets and how United Energy (UE) manages these, and with UE's Expenditure Forecasting Methodology.

2. Introduction

This document provides an explanation of UE's forecast replacement expenditure on the asset classes – Zone Substation Capacitor Banks, Earth Grids and Neutral Earthing Resistors (NERs).

How UE manages these assets are set out in the following documents:

- Zone Substations Capacitor Life Cycle Strategy (Document No UE PL 2022)
- Earthing Inspection and Testing Life Cycle Strategy (Document No UE PL 2016)
- Zone Substation Transformers Life Cycle Strategy (Document No UE PL 2028)

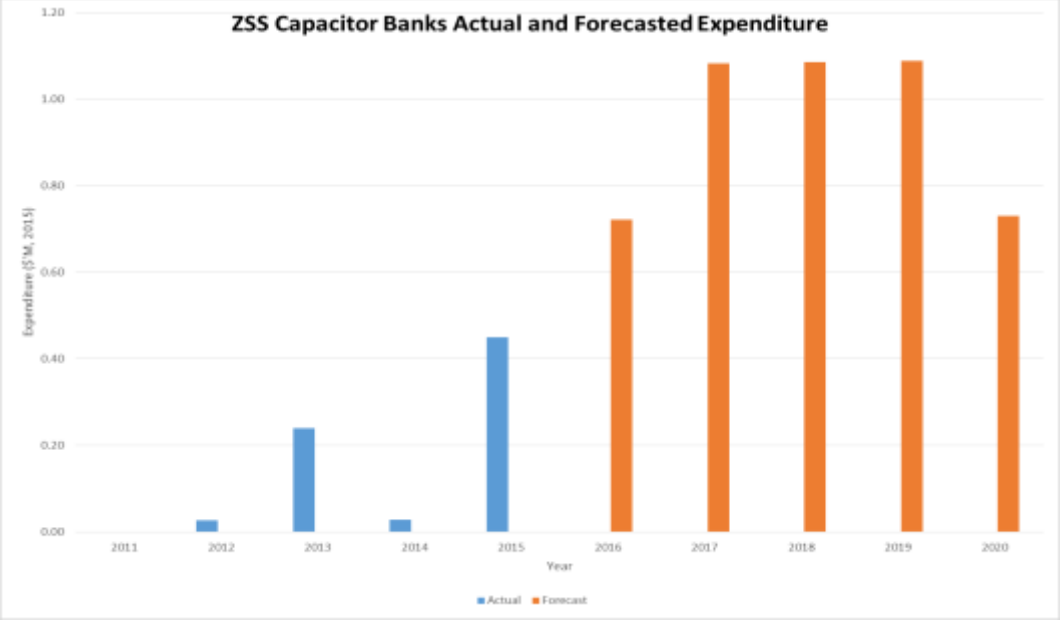
The historical and forecast replacement and refurbishment volumes and associated capital expenditure discussed here reconcile directly to the following asset categories defined in the "repex" templates (table 2.2.1) of the AER's category analysis and reset regulatory information notices[1]:

- ZONE SUBSTATION CAPACITOR BANKS
- ZONE SUBSTATION CIVIL WORKS INC EARTH GRID
- ZONE SUBSTATION NEUTRAL EARTHING RESISTOR

UE prepares volume forecasts for each asset class. These volume forecasts are transformed into expenditure forecasts using either unitised rates or detailed cost estimates for projects. Unitised rates are based on agreed rates from our existing contracts with the service providers Downer and Zinfra. UE develops project cost estimates based on a detailed scope of work. These expenditure forecasts are the base (pre-escalation) forecasts and are reported in the body of this document. This presentation facilitates a comparison with the forecasts developed using the AER's Repex Model.

Figures 1 and 2 below show the profile of replacement capital expenditure (repex) on zone substation capacitor banks and earth grids. They show the actual (and estimated) repex UE has incurred over the current regulatory period (2011 to 2015) and our forecast repex over the next regulatory period (2016-2020). All expenditure is in 2015 dollars.

Figure 1: Capacitor Bank Actual and Forecast Expenditure ($'M, real 2015)

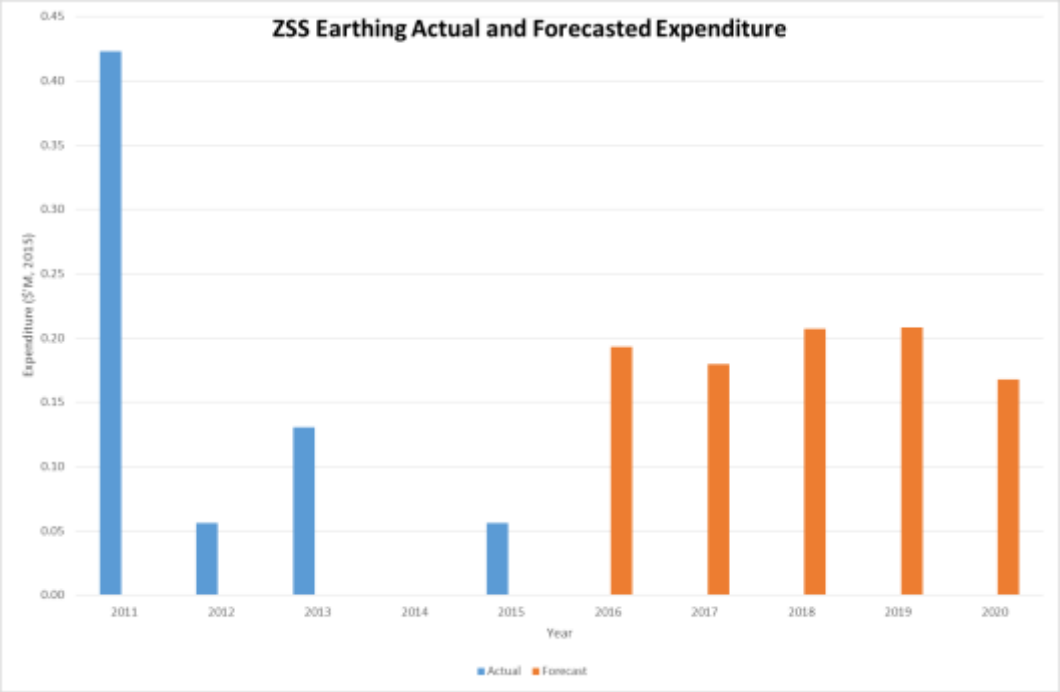


[1] See templates 2.2 and 5.2 in the relevant RIN.

Figure 1 shows annual expenditure during the current period fluctuating annually. For 2012 and 2014, expenditure was attributed to defective capacitor can replacements across the network. For 2013 and 2015, the marked increase in repex was due to large capacitor bank unit replacements – half a capacitor bank at Heatherton (2013) and an entire unit at Glen Waverley (FY2014/15). The total expenditure over the 2011-15 period was $0.745M.

In 2012, a program for the replacement of capacitor banks aged 50 years or older, prioritised by condition was initiated. Under the program, the first capacitor bank replacement occurs during FY2014/15 with annual replacements being undertaken throughout the 2016-2020 period. This will cause a step increase in repex for the next period as shown in Figure 1. Annual defective capacitor can replacements will continue across the network during the 2016-2020 period as well. This work is forecast to cost $4.758M over the 2016-20 period.

Figure 2: ZSS Earthing Actual and Forecast Expenditure ($'M, real 2015)



Expenditure on earth grid works is moderate with expenditure driven by project work as it occurs. UE carries out an audit of substation earth grids in a 10 yearly cycle. A new cycle is to start in 2015 and work is forecast to be generated from it in the 2016-2020 period.

United Energy is also replacing a single neutral earthing resistor in the forecast period at a cost of $94,900. This is a project that will commence in 2015 and be completed in 2016. Due to the small value of this project and because it will be commenced in the current period, no comment will be provided about it in this document. This expenditure is much lower than the historic expenditure for this asset class, totalling $0.38M from 2011-2015.

The history expenditure for zone substation earth grids and neutral earth resistors was a total of $1.08M over the 2011-2015 period. UE is proposing to largely maintain this level of expenditure, with a total of $1.095M forecast to be spent for these programs in the 2016-2020 regulatory period.

3. Background

In this section, UE provides background material that is relevant to appreciating our preferred forecasting methodologies for these asset classes. This section covers:

- A summary of the asset management practices UE uses in these asset classes, and in particular how UE assesses their conditions and makes replacement decisions.
- A review of the historical expenditure in both assets classes. The findings of this review are important in understanding what has been driving recent changes in their profiles, and in turn, how this affects future needs.
- A review of the performance of zone substation capacitor banks and earth grids over the current period. The findings are important in understanding whether reliability, security and safety have been maintained over the current period, and as such, whether the historical trends are a good guide for our repex requirements to achieve the NER objectives in the next period.
- A review of the accuracy of our previous forecasts methodology that UE developed for our building block proposal for the current period.

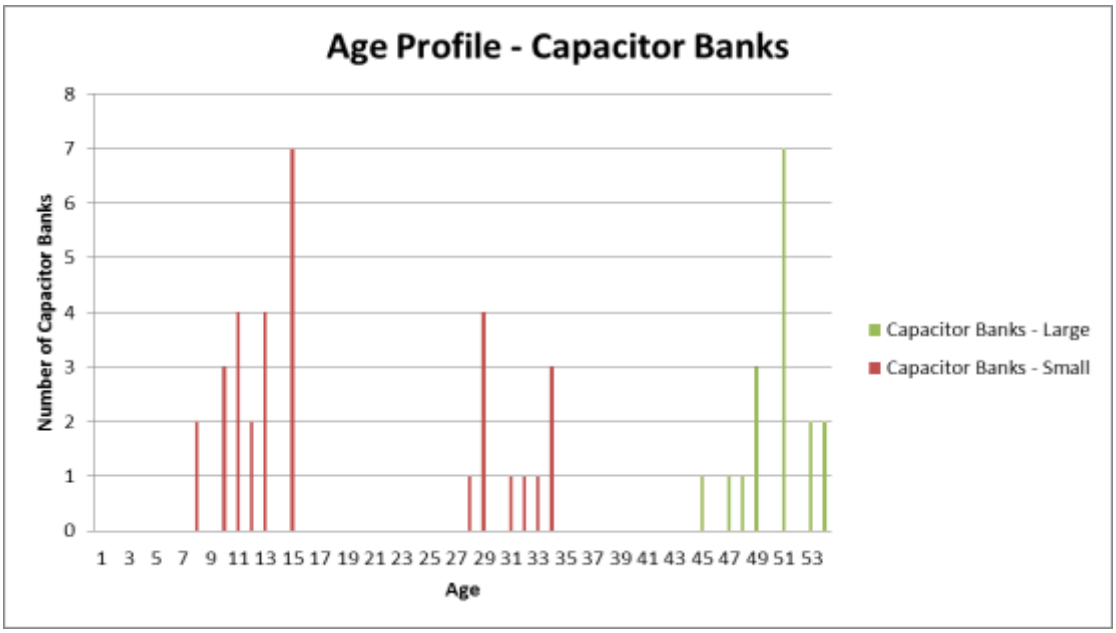
3.1 Management Assets and Replacement Decisions

3.1.1. Zone Substation Capacitor Banks

Capacitor banks have been installed at various zone substations throughout the United Energy network in order to correct power factor and thereby improve the utilisation of the capacity of the network. If the capacitor bank fails, other network equipment may become overloaded. If this occurs customer load will be shed.

UE has a total fleet of 53 capacitor banks install in its zone substations. This total is made up of 17 large Ducon mineral oil insulated units and 36 banks of small capacitor cans. Capacitor banks are generally expected to have a long lifespan. The Ducon capacitors and small capacitors banks have average lifespans of 60 and 40 years respectively. The age profile can be seen in the figure below.

Figure 3: Age Profile of ZSS Capacitor Banks



Capacitor banks are non-critical network components; however the consequences of failure can be significant. At best, a failure causes the substation transformation capacity to be marginally reduced during times of peak load; at worst, the above effects are combined with a significant release of PCB-contaminated oil, and plant fire.

The maintenance regime for capacitor banks is time-based, with corrective maintenance undertaken as failures occur. All capacitor banks are maintained on a 4 yearly cycle. In addition, annual thermal surveys of all capacitor banks are also undertaken. Indoor capacitor units are subjected to more maintenance tasks such as cleaning of enclosures, floors and exhaust fans. This is necessary due to the accumulation of dust and debris within the enclosure which are not washed down by rain like outdoor capacitor bank units. Historically on average, UE replaces about 13 capacitor cans per annum due to failure.

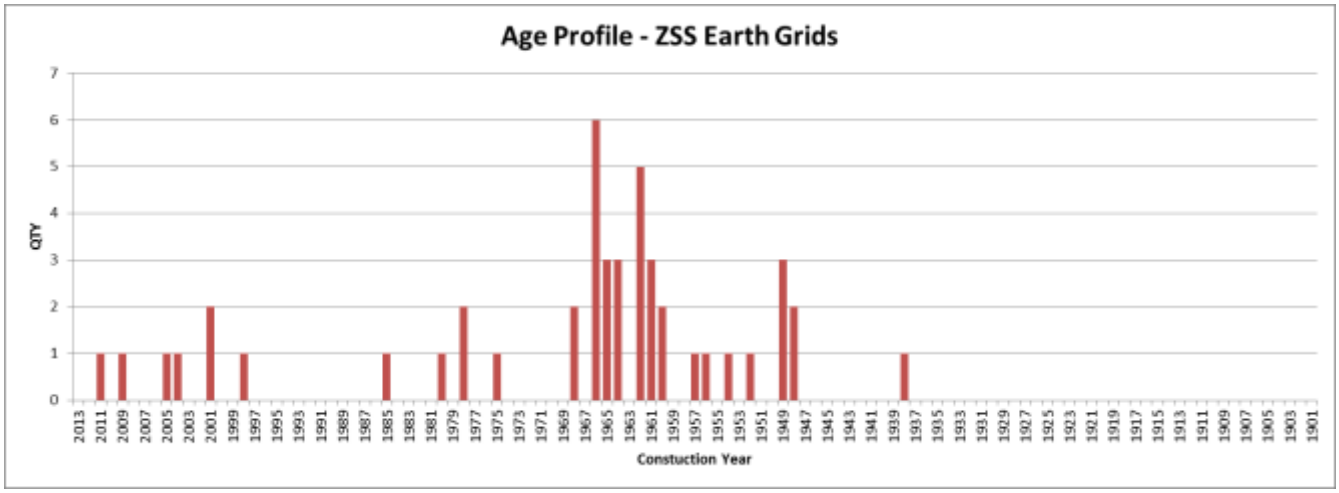
In 2012, UE initiated a program to replace capacitor banks aged 50 years or greater and prioritised by condition. The replacement strategy is based on the average life span of 60 years for large Ducon capacitors and 40 years for small capacitors. A large number of these Ducon capacitors are showing age related degradation problems and need to be replaced in a timely manner before failure. The first unit to be replaced will be undertaken during FY2014/15 with annual replacements continuing into the 2016-2020 period.

When opportune UE will also align capacitor bank replacements with other related capex replacement programs/projects e.g. capacitor bank circuit breaker replacements. UE believes this strategy maximises project efficiencies and minimises cost duplication.

3.1.2. Zone Substation Earth Grids

Zone substation earth grids are installed at the time of construction of the zone substation and generally match the installation age. UE has a total of 47 zone substations and the corresponding age profile of their respective earth grids are shown below.

Figure 4: Age Profile of ZSS Earth Grids (2014)



The earth grids in zone substations are considered to be in good condition/performance. Failures are primarily due to third party damage from excavations or vehicles, and changes in ground conditions.

Apart from the 10 year inspection program undertaken as part of UE's ESMS obligations, zone substation earth grids are maintained every 5 years and the following are undertaken.

- A physical integrity inspection of above ground structure connections to the earth grid of all HV and LV equipment
- Sample inspections for corrosion or damage of underground conductors and joints.
- A grid continuity test between the earth grid and high dissipation points such as earth switches and portal earths.

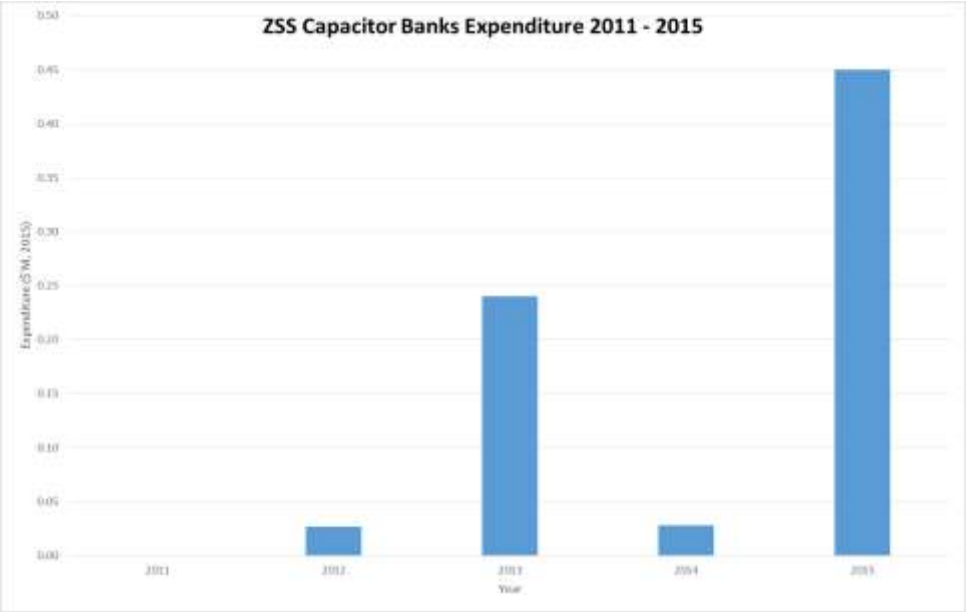
Remedial earth grid augmentation works relating to the 5 year maintenance cycle will be aligned with works identified from the 10 year inspection program. UE believes this strategy maximises project efficiencies and minimises cost duplication.

3.2 Historical Expenditure

3.2.1. Zone Substation Capacitor Banks

Historically, the expenditure on Capacitor Banks is quite low. It fluctuates when large projects are carried out. These have not happened every year in the current period.

Figure 5: Historical Expenditure of ZSS Capacitor Banks



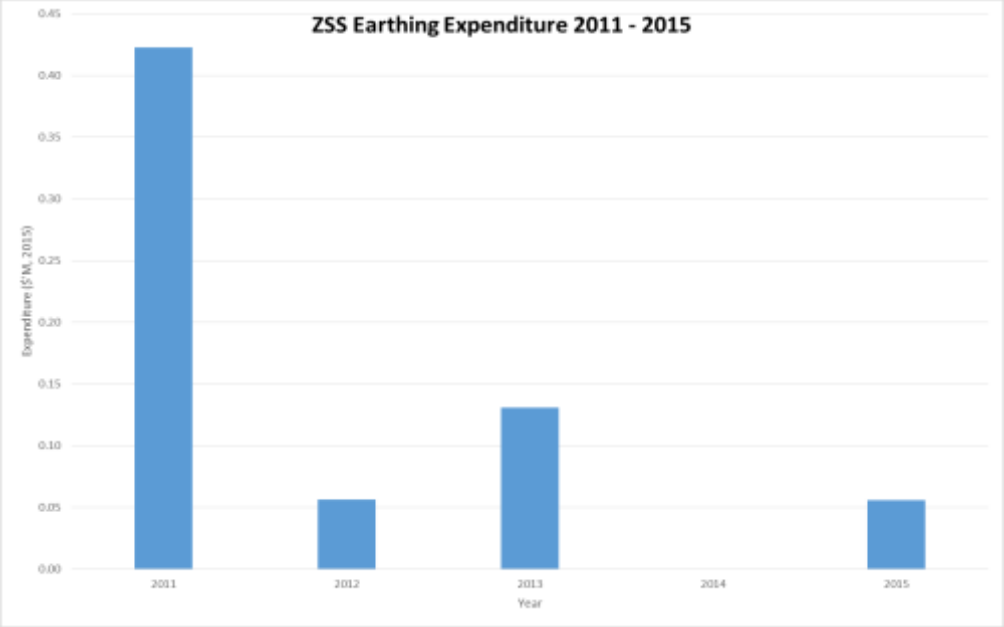
During 2013 and 2015, two capacitor bank replacements were made – half a capacitor bank at Heatherton (2013) and an entire unit at Glen Waverley (FY2014/15). The Glen Waverley replacement is the first Ducon unit to be replaced under the capacitor bank replacement program mentioned in section 2.1.

In 2012 and 2014, no replacement projects were undertaken with expenditure being attributed to defective capacitor can replacements across the network.

3.2.2. Zone Substation Earth Grids

Like capacitor banks, expenditure on zone substation earth grid does not exhibit any trending. Work is carried out on a needs basis and no expenditure has occurred in some years of the current period.

Figure 6: Historical Expenditure of ZSS Earthing Grid



Work that has been undertaken was a result of the 10 year inspection program. UE commenced this inspection program in 2005 and completed the first 10 year cycle in 2014. As the works identified are needs based, no historical trending of expenditure can be developed.

3.2.3. Neutral Earthing Resistors

The expenditure on this asset class totalled $0.38M from 2011-2015, and was driven by a program to replace a particular model of aged NER that was identified to have manufacturing flaws which would lead to in-service failure.

3.3 Review of Historic Asset Performance

UE has conducted a review of the performance of its zone substation capacitor banks and earth grids during the current period. The key purpose of this review is to understand whether the performance of assets has been maintained.

3.3.1. Zone Substation Capacitor Banks

UE reviews the performance of this asset class annually by recording instances of capacitor bank defects and failures across the network. On average, UE experiences three capacitor bank failures and 13 capacitor can defects annually. The primary causes of these failures are;

- internal insulation failures in capacitor cans,
- earth switch corrosion, and
- degradation of can/tanks due to extreme environmental conditions.

Typically, the failure of a capacitor bank does not affect reliability performance statistics like SAIDI and SAIFI.

Ducon Capacitor Banks are the oldest in UE's fleet of capacity banks with an average life span of 60 years. However, all 17 units (aged between 45 to 54 years old) are showing signs of oil leaks with no way of determining oil levels due to their style of construction. In addition, the units are not refurbishable. Should oil levels fall below manufacturer prescribed operational levels, the internal insulation could breakdown resulting in a catastrophic failure of the entire capacitor bank. The oil reservoir could also explode and spill PCB-contaminated oil. Consequently, these Ducon units need to be replaced in a timely manner before failure.

The overall performance of this asset class for the current period (except the Ducon capacitors) is satisfactory. However, UE has identified that the Ducon units are approaching end of life and are displaying age-related degradation issues. To prevent potential failures, UE intends to replace these units during the 2016-2020 period as part of the capacitor bank replacement program.

3.3.2. Zone Substation Earth Grids

UE must maintain the earth grid in its substations in order to provide a safe working environment for its workers.

UE reviews the performance of its earth grids in two ways.

- Firstly, UE records instances of earth grid failures and defects. During the previous two reset periods, there were only 22 recorded failures and defects on UE's earth grids. The primary causes were due to third party damage from excavations and conductor corrosion. There were no recorded incidents relating to electrical safety.
- Secondly, UE commenced a 10 year inspection program of all its zone substation earth grids in 2005 as part of its ESMS obligations. Works identified as part of the audit findings have been undertaken over the last two reset periods. UE will be starting on the second 10 year inspection in 2015 and has forecasted minimal augmentation works as a result of the satisfactory condition of its earth grids post remedial works.

Overall, UE is satisfied with the asset performance in the current period, indicating that the level of expenditure on this asset class is appropriate.

3.4 Review of Previous Forecasting Methodology

UE has conducted a review of the forecasting methodology UE used to prepare the capital expenditure forecast in our previous proposal to the AER, to confirm that the methodology is suitable for the forecast period.

3.4.1. Zone Substation Capacitor Banks

UE's forecast for the current regulatory period was developed by using a combination of:

- historical trending - using existing failures/defect data records to make budgetary allowance for the replacement of capacitor cans.
- Identification of capacitor banks to be replaced on condition.

3.4.2. Zone Substation Earth Grids

UE's forecast for the current regulatory period was based on the expenditure of replacement/augmentation works identified from the first half (2005 to 2009) of the 10 year inspection program.

4. Forecast Methodology

4.1 Zone Substation Capacitor Banks

For the capacitor banks replacement program, UE has identified the capacitor banks for replacement by condition. The forecasted capacitor banks replacements for the 2016-2020 period are discussed in section 4.

A scope of work document (SOW) has been produced by the Engineering team for the program and a corresponding costing estimate by the estimating team. The program costing estimate has been verified by both teams and the program business case developed.

4.2 Zone Substation Earth Grids

UE has based its forecast for earth grid works on the outcomes of its previous Earthing Reviews carried out in 2005.

The new review has not yet been carried out so the scope of works is not accurately known. However, if the review does find problems, they will need to be rectified as there will be a safety risk for UE personnel.

UE has forecast an amount of $200k per year for these works. This will allow for such works as:

- replacement of part of an earth grid that may be corroded
- a small extension of the earth grid
- designing and implementing an earth grid solution

UE believe that major problems with earth grids have been addressed in the first review and do not anticipate large expenditure in the forecast period.

5. UE's Forecast Expenditure

A summary of the Capex expenditure relating to both ZSS capacitor bank and earth grid replacement works are presented below.

Table 1: UE Forecast Capex Expenditure

	2016 ($,000)	2017 ($,000)	2018 ($,000)	2019 ($,000)	2020 ($,000)	Total ($,000)
ZSS Capacitor Banks	723	1,089	1,096	1,105	746	4,758
ZSS Earth Grids	194	181	209	211	171	966
ZSS Neutral Earthing Resistor	95					95

5.1 Capacitor Bank Replacement Program

In keeping with the age-profile of its fleet of capacitors, UE will be replacing five Ducon Capacitor Banks over the 2016-2020 period. These are presented in Table 2 below. The Ducon units have been identified by age i.e. all five units are over 50 years old and prioritised by condition. In addition, all of these capacitor banks are critical for load management and to enable UE to meet power factor obligations under the Electricity Distribution Code.

Future capacitor bank replacements will be undertaken in the following reset period (2021-2025) in accordance with the age-profile of this asset class.

Table 2: Ducon Capacitor Bank Replacements

Ducon Capacitor Bank	Proposed Replacement Year
DC #1 Capacitor Bank	2016
OR #1 Capacitor Bank	2017
M #3 Capacitor Bank	2018
SV #3 Capacitor Bank	2019
DN #1 Capacitor Bank	2020

The total forecast expenditure is $4.71M compared with $0.8M for the current period. The increase is due to the capacitor replacement program. UE believes it continues to manage this asset class well and is confident the forecast is suitable for the 2016-2020 period.

5.2 ZSS Earth Grid Replacement Program

For the 2016-2020 period, the zone substation earth grids to be inspected as part of the second 10 year inspection program are presented below. Replacement/augmentation works will be undertaken after completion of the audits at the various locations.

Table 3: ZSS Earth Grid Inspection Locations

ZSS Earth Gird Second 10 Year Inspection Program – Audit ZSS Locations	Year
OAK; SR; MR; EM; BR; FTN	2016
BT; BU; CM; BH; NW; M	2017
OR; BW; CFD; SS; LD; CRM; DN	2018
DC; EB; NO; HT; SV; SVW; SW; FSH	2019
MGE; DSH; NP; HGS; RBD; MC; STO	2020

$0.96M of expenditure has been forecasted for the 2016-2020 period. This compares with a spend in excess of $3.0M for the first half of the first 10 year inspection program.

As in the case with capacitor banks replacements, UE believes it continues to manage this asset class well and is confident the forecast is suitable for the 2016-2020 period.

6. Validation of Forecast

6.1 Costing Methodology

For our capacitor bank replacement projects (Ducon capacitor banks) scope of work (SOW) documents have been produced by our Asset Management team. These have been costed by or estimating group who have developed a database of current zone substation asset costs, installation costs and commissioning costs.

For earth grid works, a similar process will be undertaken once SOW have been developed following the inspection program. Until then, a moderate amount has been allocated as the works are not expected to be extensive.

Where applicable, comparisons with historical expenditure are provided to demonstrate that expenditure for these asset classes are reasonable and not excessive. On the other hand, comparisons with the AER Repex model are not appropriate as the model is based on historical replacements and expenditures. The nature of replacement work for both these asset classes is needs / project based and their respective project SOWs vary significantly from project to project. As such the AER Repex model is not applicable as a validation tool for forecast expenditure.

6.2 Comparison with Historical Expenditure

6.2.1. Zone Substation Capacitor Banks

Historical expenditure has been on replacements of individual capacitor cans and half a capacitor bank unit rather than whole capacitor banks. As such, historical expenditure such as used by the AER repex model cannot be used to validate the replacements of the capacitor banks for this forecast period.

6.2.2. Zone Substation Earth Grids

As the 2016-2020 period is aligned with the second 10 year inspection program for zone substation earth grids, a comparison with historical expenditure is useful in demonstrating that the forecast expenditure is reasonable.

For the first 10 year inspection program, UE spent in excess of $4.5M ($3.0M during the first 5 years and $1.5M during the second 5 years) in replacement / augmentation earth grid works across all its zone substations. More significant works were required to be undertaken during the first 5 years of the inspection program as compared with the second 5 years. This was attributed to the nature of works i.e. needs based and varying from site to site, resulting in expenditure that was not consistent over the 10 years. UE is satisfied with the condition of its earth grids - post remedial works. As a result, UE does not expect the second 10 year inspection program to have as much replacement / augmentation works. UE believes that the significant defects have already been addressed in the first inspection program. Consequently, spend on the program will be much lower.

This is indeed consistent with the 2016-2020 forecast. $0.96M of repex has been forecasted as compared with a spend in excess of $3.0M for the first half of the first 10 year inspection program. This comparison demonstrates that our forecast expenditure is reasonable.

UE believes that the explanations above provide strong support that our preferred forecasting methodology for both asset classes is fit-for-purpose.

7. Summary and Conclusion

In this document, UE has explained how it has prepared the forecast of the replacement and refurbishment capital expenditure for zone substation capacitor bank and earth grid replacements.

UE believe that this document and its supporting references provide a compelling justification that the AER should accept that these program-level forecasts should form part of our capital expenditure forecast in our building block proposal.

In summary, the AER can be confident that these forecasts (at the asset class level) are in accordance with the NER capital expenditure criteria and objectives because:

- The existing problem with deteriorating capacitor banks needs to addressed through the capacitor bank replacement program.
- The forecast for zone substation capacitor banks uses the most appropriate methodology.
    - For capacitor banks, UE's methodology was developed by using a combination of historical trending – using existing failures/defect data records to forecast budgetary allowance and estimates for specific projects justified by the condition of the assets.
    - To develop our estimates we have used a bottom-up building block approach; identifying programs/projects, developing SOW and obtaining estimates.
    - Our forecast expenditure of $4.71M is prudent and efficient, being required to maintain network reliability and safety obligations. UE believes it continues to show prudence and efficiencies in asset management by replacing only the oldest capacitors in its fleet.
- The forecast for zone substation earth grids uses the most appropriate methodology.
    - For earth grids, UE's methodology was based on the cost of replacement / augmentation works outcomes from the first 10 year inspection program of all its zone substation earth grids – this program was undertaken in 2005 as part of UE's ESMS obligations.
    - Our forecast of $0.96M of expenditure for the 2016-2020 period compares with a spend in excess of $3.0M for the first half and $1.5M for the second half (overlapping with the current period) of the first 10 year inspection program. We have estimated a lower value because we believe that the significant defects were addressed in the first audit process.
    - UE believes it forecast expenditure is reasonable showing prudence and efficiencies in management of this asset class.