Expenditure Justification – Power Quality Maintained

UNITED ENERGY

December 2015

AER Category Expenditure Explanatory Statement

This document describes the expenditure justification for Power Quality Maintained 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 provides the expenditure justification for UE's Power Quality Maintained capital program for the 2016-2020 regulatory control period and should be read in conjunction with supporting document number UE PL 2203 which outlines in detail UE's Power Quality Strategy and Plan.

2. Introduction

This document provides the expenditure justification for UE's Power Quality Maintained capital program for the 2016-2020 regulatory control period. This includes power quality initiatives to prevent deterioration in quality of supply performance predominantly due to uptake of solar photovoltaic (PV) systems and increased use of power electronic appliances. Our expenditure in this area during the 2011-2015 regulatory control period combined with this expenditure justification demonstrate an efficient use of capital to assist in meeting our compliance obligations and our customers' expectations.

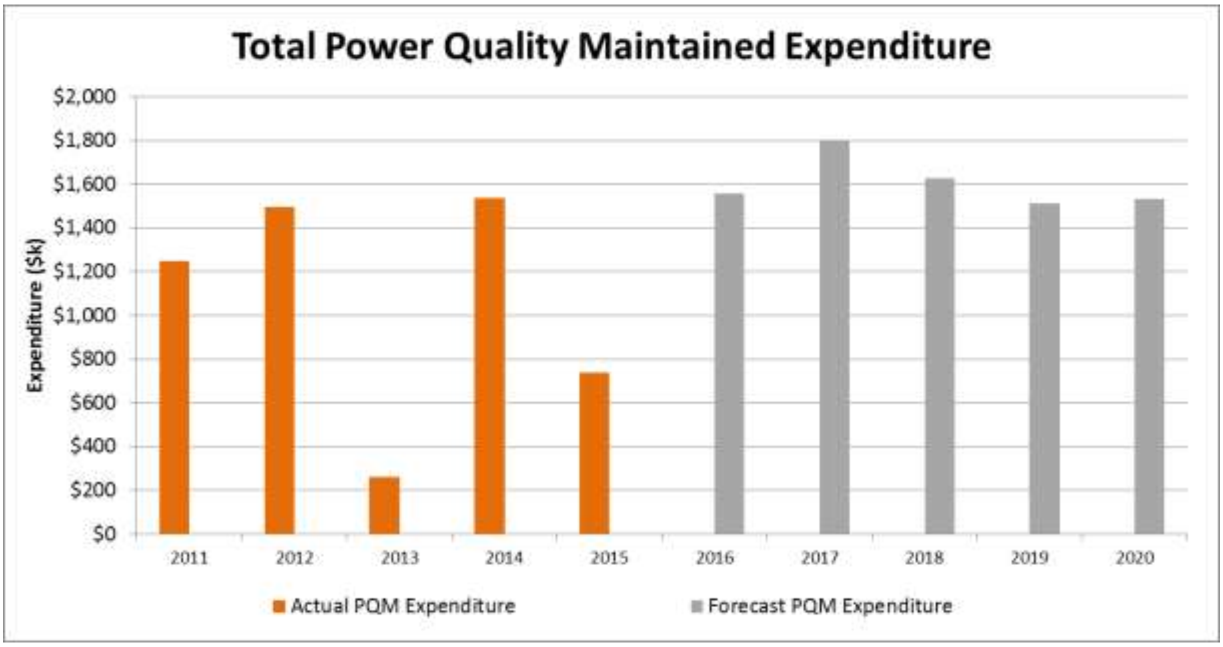
This document provides detail on power quality maintained programs only and sets out the factors driving the need for this expenditure and explains how UE has developed the forecast. UE provides detailed information about the power quality maintained programs in various strategies while evidence and justification is provided in UE PL 2203 "Power Quality Strategy and Plan" for each project or program of works. This document and the principles captured within it are derived from and are consistent with the overall UE Asset Management Policy and Network Performance Strategy.

We have prepared 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. We develop 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.

The forecast associated capital expenditure for Power Quality Maintained discussed herein reconcile directly to the Other asset categories defined in the replacement capex or "repex" templates (table 2.2.1) of the AER's category analysis and reset regulatory information notices[1].

The actual expenditure incurred during the current regulatory period and the expenditure forecast for the forthcoming regulatory period is shown in Figure 1 below. All expenditure is in real 2015 dollars.

Figure 1: Chart of Actual and Forecast Expenditure – Power Quality Maintained ($2015)

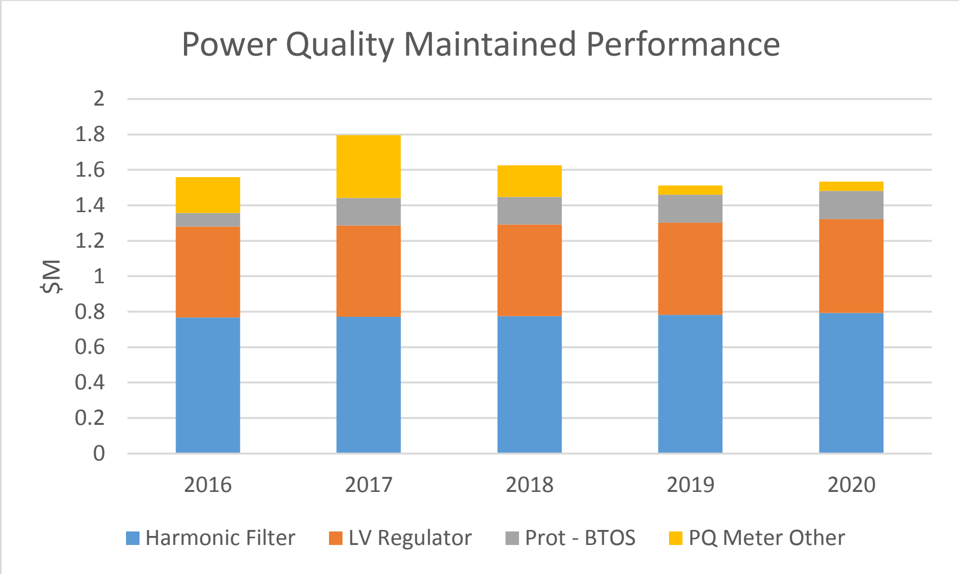


The chart shows forecast expenditure to be higher than the current spend predominantly due to household customers' requirements to connect greater numbers of solar photovoltaics and power electronic appliances to UE's distribution network. This expenditure is required to halt the deteriorating performance in UE's quality of supply performance.

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

Figure 2 shows the profile of capital expenditure for Power Quality Maintained programs over the next regulatory period (2016-2020). Expenditure is provided in 2015 dollars. A total of $8.024 million of expenditure is forecast for the 2016-2020 regulatory period compared to $5.280 million for the current regulatory period.

Figure 2: Capital Expenditure – Power Quality Maintained Performance ($2015)



This document outlines UE's rationale and basis to support our capital expenditure forecast for Power Quality Maintained. The document demonstrates our quality of supply performance is deteriorating and this is due in large part to the connection of greater numbers of solar photovoltaic panels and power electronic appliances to our network. Our proposed increased expenditure allows us to maintain power quality levels and prevent further deterioration.

3. Background

In this section UE provides material to demonstrate the expenditure is necessary to maintain the quality of supply on our network at its current level of performance and to meet our regulatory, legislative and licence obligations.

The projects and initiatives on Power Quality Maintained by UE within the 2016-2020 regulatory control period address power quality regulatory compliance requirements and halt the deterioration in quality of supply levels on UE's network. Our expenditure levels during the 2011-2015 period demonstrate that we are addressing the identified power quality compliance issues through prudent programs of work. These programmes need to continue into the next period to maintain power quality. Furthermore, an increase in expenditure in some areas is required in response to increasing numbers of installed solar PV systems at customers' premises. Our regulatory obligations are to measure network power quality and to correct power quality where it is not within the codified limits. We do this by targeting power quality programs towards our worst-served customers first where there is an economically prudent case to do so. The section also provides a summary of the need for each of these projects and their relationship to a performance or service obligation of UE.

3.1 Need for the Work

UE has obligations under the Victorian Electricity Distribution Code (the Code) and the National Electricity Rules (the Rules) for quality of supply including an obligation to monitor quality of supply in accordance with the principles applicable to good asset management and to provide information about quality of supply to customers on request.

The key relevant sections of the Code and the Rules relating to power quality are in Section 4 and Schedule 5.1, respectively. In many areas of power quality, the two regulatory requirements overlap and are not consistent, making compliance complex. However, UE strategies are to comply with both stipulated regulatory quality of supply limits at different levels.

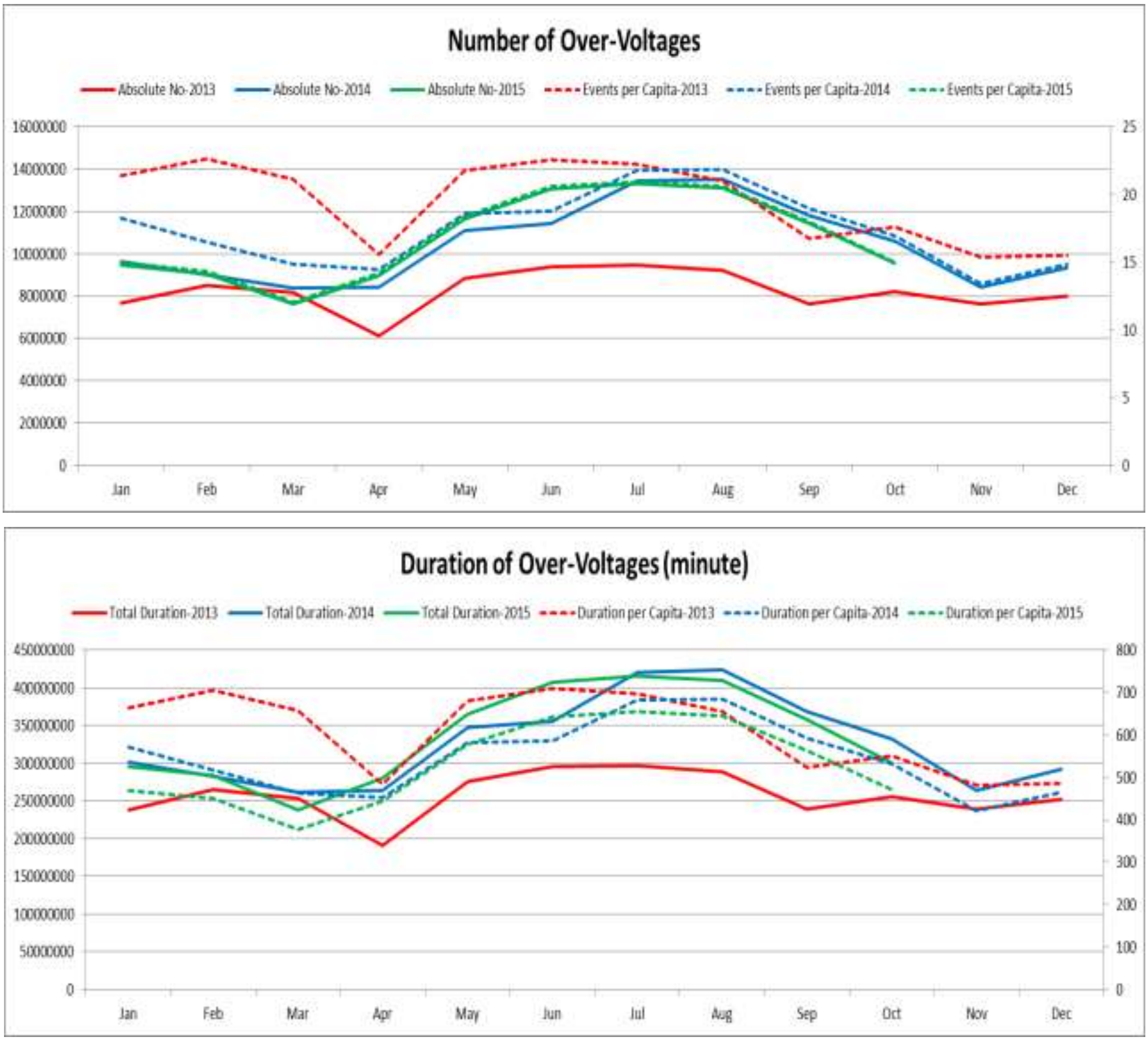
The objective of the power quality programme is to identify and target particular areas of the UE network where known or emerging power quality regulatory compliance issues have been identified, particularly those identified by our recently installed smart meters. Following detailed modelling and analysis of measured data, corrective measures will be applied to enable UE to maintain power quality.

3.1.1. Steady-State Voltage Management

In recent years, there has been unprecedented growth in grid-connected solar PV systems on the UE network, particularly in the residential sector. As the numbers of solar PV systems increases, additional expenditure is necessary to integrate solar PV generation in an optimal manner on UE's network. Solar PV penetration presents a number of challenges for UE primarily because of the customer-initiated connection of inverter-connected generation up to 30kVA (three-phase) and 10kVA single phase. Such customers (predominantly households) do not directly incur upstream connection costs. This means solar PV systems can suddenly appear anywhere across the network and grow at unconstrained rates to form localised clusters of high penetration which have the potential to impact UE's quality of supply performance by pushing up steady state voltage. Solar PV generation is resulting in new levels of uncertainty for our network regarding longer-term system planning.

For example, increasing solar PV installations have an increasing influence on the steady-state over-voltage fluctuation levels observed in the electricity distribution network. The below figures show the over-voltage events which have been captured by the installed Advanced Metering Infrastructure (AMI) devices on the UE distribution network. Based on these figures, on average UE's customers received 204 over-voltage events with duration of 6,552 minutes (more than 109 hours) in 2014.

Figure 3: Historical Over-Voltage Performance 2013-2015



This brings with it a need to investigate localised impacts on steady-state voltage profiles. Our distribution tap change opex programmes are addressing most of these issues, however in areas of the network where customers are experiencing voltage variations at both the high and low end of the regulatory limits, this is not a viable solution. Instead, we are currently installing low-voltage (LV) regulators in the current period and these have been demonstrated to tighten-up the voltage regulation window and provide faster response to sudden changes in voltage. They are facilitating the connection of intermittent renewable generation by smoothing out flicker impacts and when available with remote control functionality can be used as a demand reduction / energy conservation measure by reducing the voltage towards the bottom of the regulatory voltage band. The LV regulator technology has been successfully trialled on the UE distribution network and an opportunity to provide active voltage regulation for customers within regulatory limits.

After assessment of the performance of this trial against the different regulatory stipulated requirements, it is planned to continue to deploy this technology in the 2016-2020 period at locations where the impacts of solar PV systems are most prominent, where it is economically prudent to do so. Our program of works will help to prevent the steady-state voltage performance from deteriorating on our network.

3.1.2. Harmonics Management

Emerging disturbances such as harmonics and voltage fluctuations are becoming more prevalent and this is forecast to continue over the next regulatory period with increasing penetrations of power-electronic appliances and intermittent distributed generation (especially solar PV).

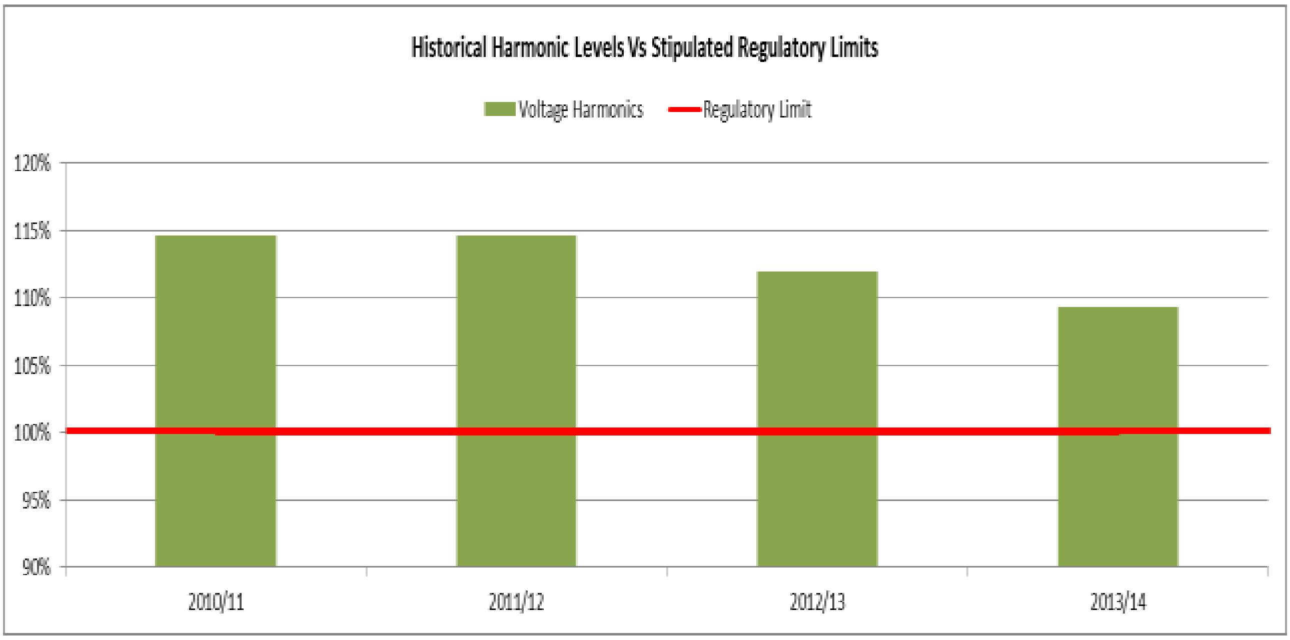
Recent failures of capacitor bank inrush reactors and cans as well as the extraordinary take-up of power-electronic equipment over the last decade including the introduction of compact fluorescent light globes and have triggered the need for a more proactive response to the management of power system harmonics going forward and power quality disturbances more broadly to manage the cost of damage to customer appliances and power system equipment.

UE's program of works for the 2016-2020 regulatory control period plans to maintain the expenditure in the 2011-2015 period by continuing to place emphasis on mitigating voltage harmonic distortion.

Four harmonic filters deployed during the current period have been able to marginally improve the level of voltage harmonic distortion being observed across the network, however we remain non-compliant overall. This initiative has resulted in reduced voltage harmonic distortion and elimination of resonance conditions which can lead to customer and network equipment damage.

The below charts summarise the UE voltage harmonics levels at medium voltage (MV) over the last few years with respect to the regulatory limits. According to these figures, current and emerging harmonics are expected to continue to remain prevalent and noncompliant over the next period. Therefore, it is planned to continue with the current program of installing harmonic filters in areas where high levels of voltage harmonic distortion are worst over the next regulatory period.

Figure 4: Regulatory Voltage Harmonic Performance 2010-2014



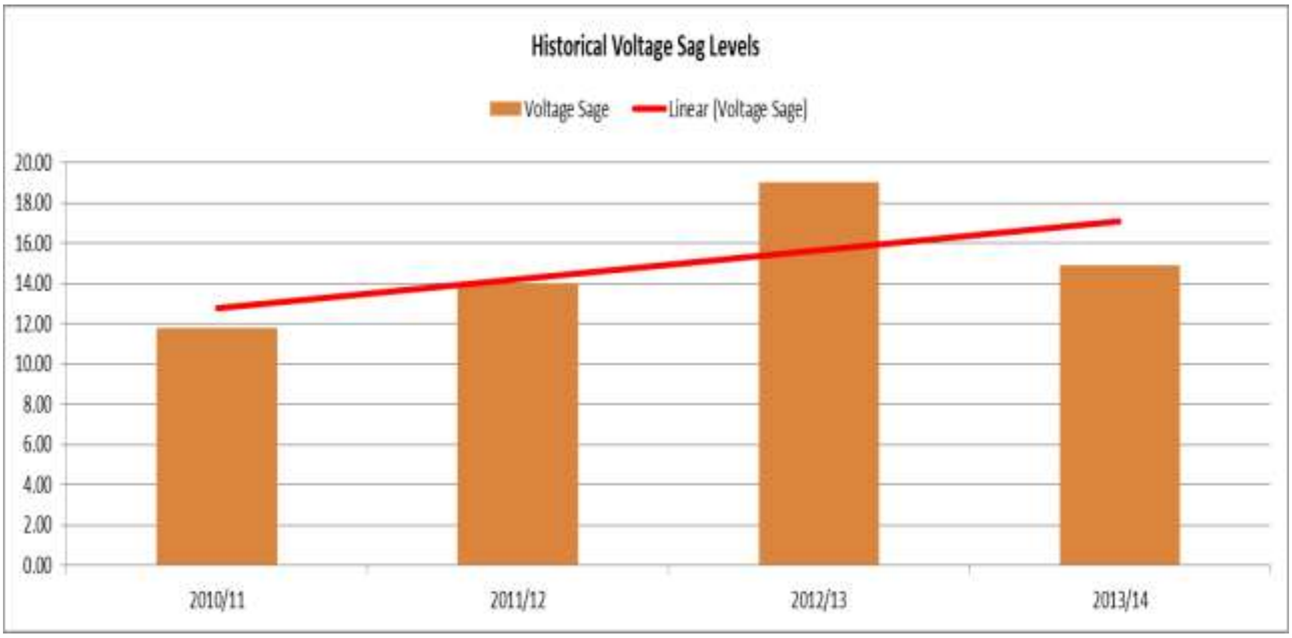
3.1.3. Voltage Sags Management

On the UE distribution network, a fault on any MV distribution feeder results in a voltage sag across all of the MV feeders supplied by the same zone substation. Such voltage sags (also known as reflected faults) can have adverse effects on customers' sensitive equipment. If the sag is long enough or deep enough it can have a similar impact as an interruption. Even voltage sags which are not particularly severe may result in the tripping of a sensitive piece of equipment.

To mitigate such effects and halt the growing number of customers' complaints, UE introduced the bus-tie open scheme (BTOS) back in the early 2000's, initially at a trial site then a subsequent deployment to a number of other sites (totally 13 zone substations). The aim of the BTOS is to maintain the service to our industrial and commercial customers by minimising the risk of critical and costly production downtime caused by reflected voltage sags. The fleet of 13 schemes were installed on our network up until 2011. Since 2011 we have not installed any further schemes.

The below chart summarises the voltage sag performance on the UE distribution network during the current regulatory period. As this chart demonstrates, the voltage sags over the current period have a deteriorating trend. Therefore, it is planned to resurrect the BTOS program and to once again install the BTOS at the zone substations where the sag performance is poor. This program should halt the deteriorating trend in voltage sag performance.

Figure 5: Regulatory Voltage Sag Performance 2010-2014



3.1.4. Power Quality Monitoring

Solving power quality problems can be a time consuming and costly exercise. It can also be a frustrating experience for customers if power quality issues cannot be identified and resolved quickly. Deploying power quality monitoring helps UE to identify the root cause of power quality issues and therefore minimises the cost of solving power quality problems by targeting the right areas, resulting in a more rapid resolution of customer complaints.

The Code requires that UE install permanent power quality monitoring at a select minimum number of sites. For this purpose, power quality analysers are installed at every zone substations as well as at end of the longest feeder for each zone substation. UE has also essentially completed the rollout of smart meters all customers up to 160MWh pa. However, there is still some major power quality monitoring gaps in the network, such as lack of monitoring devices at the transmission connection points and at critical customer connection points. Therefore, it is planned to install power quality analysers at these locations over the next regulatory period to better manage the UE power quality performance and provide improved service to our customers.

3.2 Review of Historical Expenditure

The below table summarises the UE actual expenditure for the 2010-2015 power quality programs. As aforementioned, to halt the deteriorating steady-state voltage and voltage sag trends flat, more emphasis is needed in these areas compared to the current regulatory period. By comparison a similar level of expenditure is needed to keep the voltage harmonic levels compliant.

Table 1: UE Actual Expenditure – Power Quality Maintained 2011-2015

Project	Capital Cost ($k)					
	2011	**2012**	**2013**	**2014**	**2015**	**Total**
Low-Voltage Regulation	0	0	72	247	259	**579**
Harmonic Filters	1,244	1,375	163	788	479	**4,050**
Bus-Tie Open Schemes	0	0	0	0	0	**0**
Power Quality Analysers	0	120	27	501	0	**651**
TOTAL	**1,247**	**1,495**	**263**	**1,536**	**738**	**5,279**

4. Forecast Methodology

This section outlines how UE has forecast the amount of work for power quality maintained.

Measurement of power quality data for reporting and fault identification and using information from power quality analysers is an on-going business-as-usual activity for UE. Routine analysis and interpretation of network power quality levels to gain an understanding of the UE power quality performance and trends is currently undertaken. The forecasts for power quality performance projects are developed using a bottom up building block approach in the following way:

- The current performance of each of the power quality disturbances and their effect on both UE's customers and distribution network are assessed using measured power quality data and economic evaluation models. This includes the current performance and the trend in performance over the current and following regulatory periods.
- Forecast the changes in customer-connected appliances and equipment (e.g. solar PV) and the corresponding detrimental impact they will have on the grid.
- The most detrimental disturbances which have the largest influences on customers' quality of supply on the UE network are identified and prioritised to be addressed via the lowest lifecycle cost options.
- The worst performing parts of the distribution network are then prioritised to be investigated to identify the root causes of above disturbances and consequently why such parts of the network have a poorer power quality performance than others in order to achieve supply quality compliance.
- The technical and economic effects of the proposed expenditure for the 2016-2020 period on power quality performance are estimated for each power quality disturbance.
- UE has on-going power quality projects and each year business cases are developed for the following year's projects. For each of these projects, the business cases identify the customer saving costs.

5. Forecast Volume of Work

UE is proposing four programs to maintain quality of supply levels:

- A program to install voltage regulators on our LV system;
- A program to install harmonic filters at five zone substations;
- A program to install bus-tie open schemes at five sites; and
- A program to install/upgrade power quality metering at the end of feeders and terminal stations.

A summary of the value of the work programs for UE Power Quality Maintained is reproduced in the table below.

Table 2: Forecast Capex Power Quality Maintained

Projects	2016	2017	2018	2019	2020	Total
Harmonic Filter	$768,026	$771,752	$775,278	$781,927	$793,211	**$3,890,195**
LV Regulator	$512,017	$514,502	$516,852	$521,285	$528,808	**$2,593,463**
Prot - BTOS	$76,661	$154,350	$155,056	$156,385	$158,642	**$701,095**
PQ Meter Other	$201,404	$354,124	$178,448	$52,128	$52,881	**$838,985**
Total	**$1,558,108**	**$1,794,729**	**$1,625,633**	**$1,511,726**	**$1,533,542**	**$8,023,738**

6. Options Analysis & Economic Assessment

The table below illustrates the economic evaluation for each program demonstrating least cost to maintain power quality. The present value of total costs for both Status Quo (Do Nothing) and the Preferred Options are presented.

Table 3: Present Value of Total Costs – Power Quality Maintained

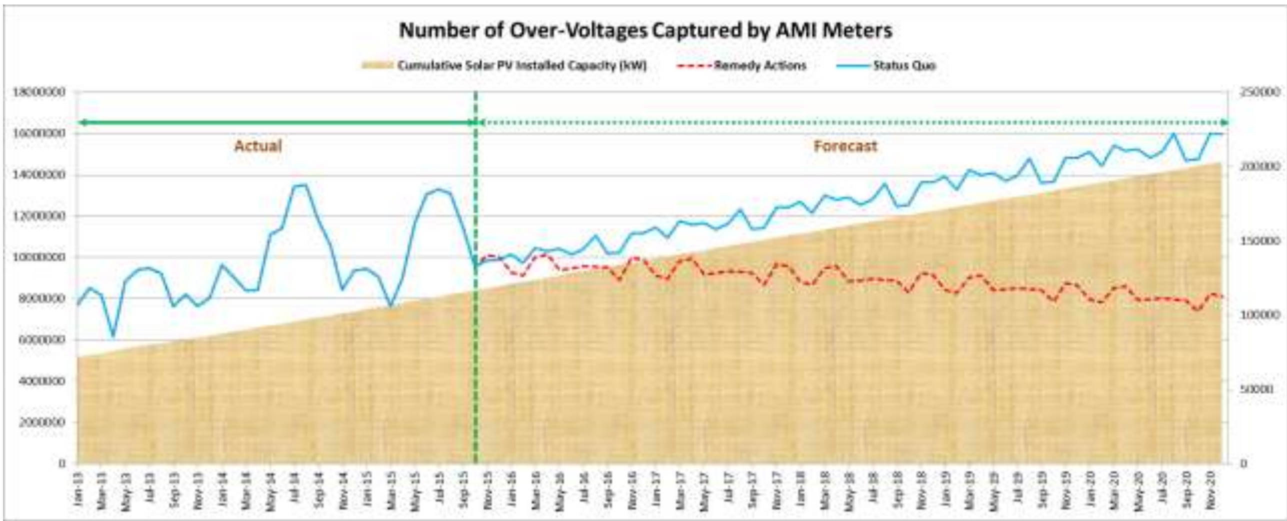
Program	Present Value of Total Costs ($k)[2]	
	Status Quo	Preferred Option
Low-Voltage Regulation	7,742	3,270
Harmonic Filters	22,416	4,581
Bus-Tie Open Schemes	3,917	766
Power Quality Analysers	1,397	839
TOTAL	**27,730**	**9,456**

Since the Preferred Options are the lowest lifecycle cost option, the present values of alternatives are not included in this table - instead they are included in the subsequent tables for each option below. For more information on alternatives considered, refer to UE PL 2203 “Power Quality Strategy and Plan”.

6.1 Low-Voltage Regulation

Among different power quality disturbances, the over-voltage which happens close to the connection point of the inverter has been the most prevalent issue due to installation of solar PV systems on the UE distribution network. The below figures illustrate the forecast and actual number of over-voltages on the UE distribution network. As these figures show, the number of over-voltages will increase if the remedy plans which are described in UE PL 2203 “Power Quality Strategy and Plan” are not taken into action.

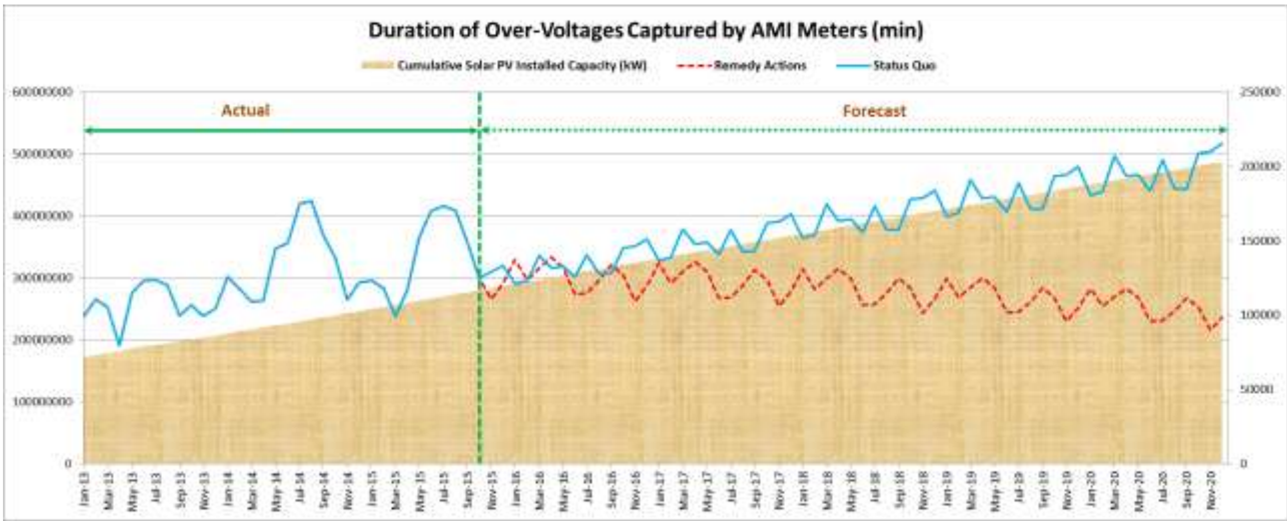
Figure 6: Actual and Forecast Number of Over-Voltages 2013-2020



Not only the number of over-voltages is expected to increase, but also the duration of such events will be increasing in case no remedy actions are taken in consideration over the next five years due to increases in the use of solar PV systems.

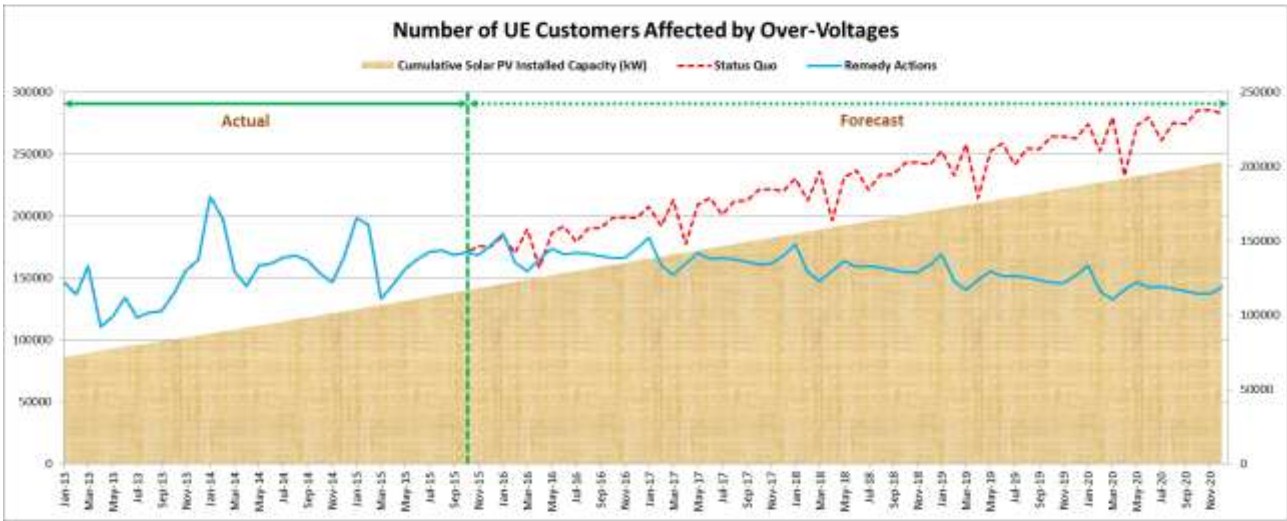
[2] For programs undertaken over 6 years from financial year 2015/16 to 2020/21. This period includes the 5 year regulatory period 2016-2020 in its entirety.

Figure 7: Actual and Forecast Duration of Over-Voltages (minute) 2013-2020



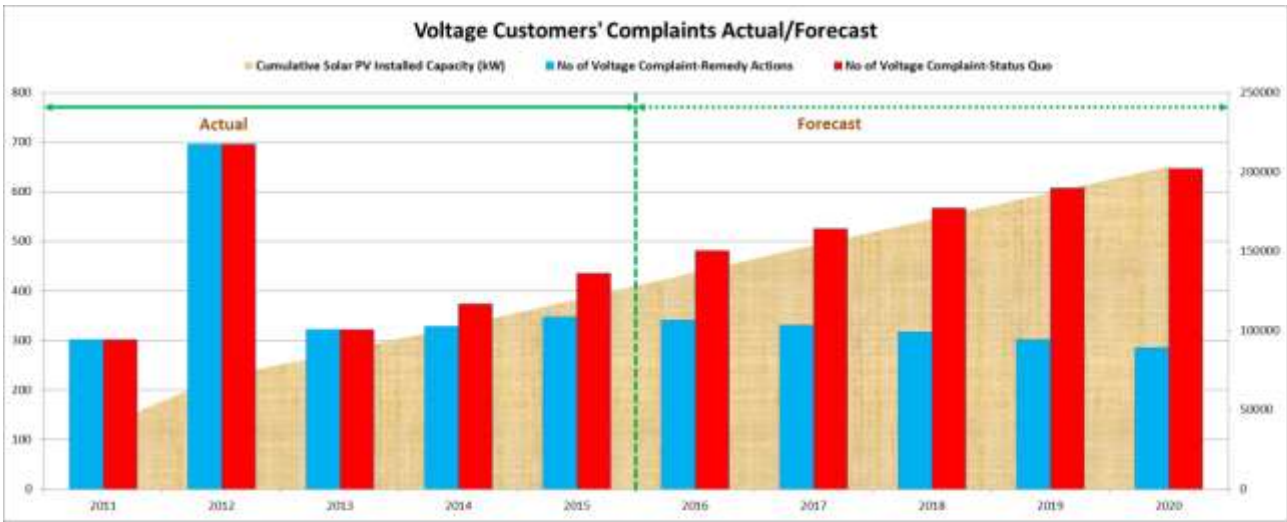
Since more solar PV systems are forecast to be installed over the next five years, these over-voltages become severe when either the load supplied by the solar PV system is low or a large solar PV system is connected to a weak network with high impedance. Consequently, the inverter switches off because of tripping the over-voltage protection and exporting power to the distribution network stops and no income can be generated from Feed-in-Tariffs. The below figures show the actual and forecast customers impacted by over-voltages.

Figure 8: Actual and Forecast Number of the UE Customers with Over-Voltage Issues



A direct impact of such over-voltages is the increasing number of customers' complaints which are summarised below. For example, between January 2012 and May 2014 UE paid over $900,000 in customer claims for damage to equipment and property due to incidents which could be attributed to the power distribution network. As such, customer claims represent a significant cost to the business.

Figure 9: Actual and Forecast Number of Customers' Voltage Complaints



Therefore, with the introduction of AMI, UE has better knowledge of the quality of supply issues on the LV network. Some LV systems have been identified as operating beyond the limits specified in the Distribution Code and a new program of work has been initiated and will be continued in the forecast period, to install electronic LV regulator equipment to provide localised LV regulation so that the networks comply with the Code.

Self-automated LV regulation units are being installed which will solve the common utility problems of flicker and voltage excursions. UE plans to install LV regulators at 60 sites at a rate of completing 10 sites every year over the 2016-2020 regulatory control periods. Installation will commence at the 10 worst performing. The site selection is carried out based on the analysis of data from AMI meters as described in UE PL 2203 "Power Quality Strategy and Plan".

The techno-economic feasibility of the following options is evaluated for these projects of which each option is compared to the recommended option:

- Option 1 – Status Quo: Continue to breach the Code and suffer from deteriorating quality of supply;
- Option 2 – Preferred: Install LV regulators at the middle of each problematic LV circuit and tap down the transformer;
- Option 3 – Alternative #1: Install new distribution substations and reconfigure the LV networks;
- Option 4 – Alternative #2: Install storage units on the customers' premises;
- Option 5 – Alternative #3: Upgrade the existing distribution substations with larger transformers; and
- Option 6 – Alternative #4: Adjust the distribution transformer tap settings.

The Preferred Option which is to install the LV regulators is recommended as the lowest lifecycle cost option that addresses the Code compliance and customer complaint issues.

The techno-economic aspects of the Status Quo and the other options proposed to solve the steady-state voltage issues are summarised in the below table.

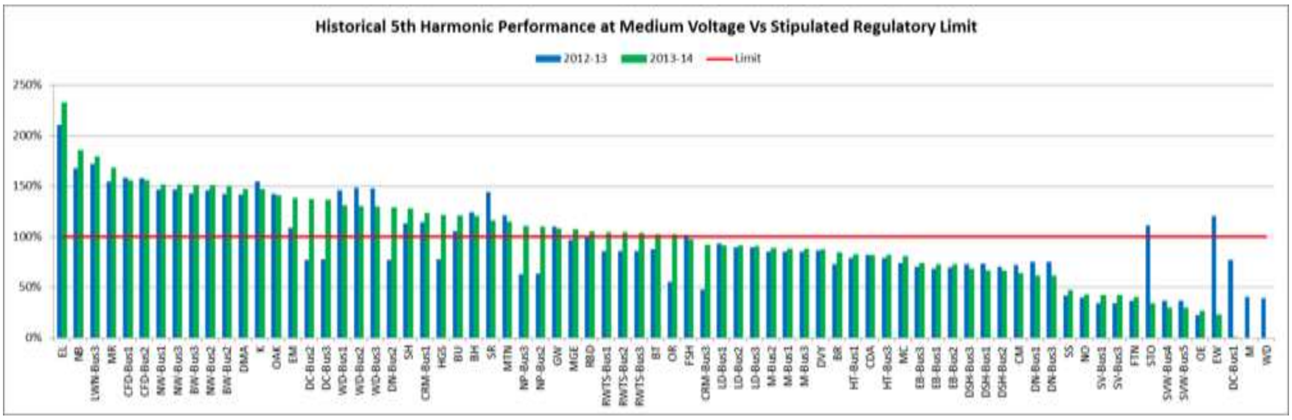
Table 4: Techno-Economic Summary of Different Options for Low-Voltage Regulators[3]

Option	Economic Ranking	Regulatory Compliant	Technically Viable	Address Steady-State Voltage Disturbances	PV Costs
Status Quo	2	No	Yes	No	$7,742k
Preferred	**1**	**Yes**	**Yes**	**Yes**	**$3,270k**
Alternative #1	3	Yes	Yes	Yes	$9,450k
Alternative #2	4	Yes	Yes	Yes	$11,200k
Alternative #3	N/A	No	Yes	No	N/A
Alternative #4	N/A	No	Yes	No	N/A

6.2 Harmonic Filters

UE has been monitoring the performance of its zone substations and observed that within the 2013-2014FY 26 zone substations had voltage harmonic levels above the Code limits as summarised in the below figures.

Figure 10: MV Voltage Harmonic Performance 2010-2014



UE has begun a program to install harmonic filters to address this problem. We have already completed installation of harmonic filters at four zone substations and currently installing a harmonic filter at a further zone substation. The installation of these harmonic filters has been successful at reducing the voltage and current harmonic levels at these particular zone substations to within Code limits. However, there remain a number of zone substations where we remain non-compliant.

UE plans to install additional harmonic filters at the six worst harmonic performing sites over the 2016-2020 regulatory period to manage the harmonic levels.

The techno-economic feasibility of the following options is evaluated for these projects of which each option is compared to the recommended option:

- Option 1 – Status Quo: Continue to breach the Code;
- Option 2 – Preferred: Install the 5th harmonic filters at the nominated zone substations;
- Option 3 – Alternative #1: Leave the zone substation capacitor banks switched in-service all of the time;
- Option 4 – Alternative #2: Rebuild the existing capacitor banks as harmonic filters; and
- Option 5 – Alternative #3: Switch on all pole-mounted capacitor banks overnight/weekends to move the harmonic resonance point below the 5th harmonic.

[3] Refer to Table 42 in supporting document number UE PL 2203.

The Preferred Option which is to install the 5th harmonic filters is recommended as the lowest lifecycle cost option that addresses the Code compliance and customer complaint issues.

The techno-economic aspects of the Status Quo and the other options proposed to solve the voltage harmonic issues are summarised in the below table.

Table 5: Techno-Economic Summary of Different Options for Harmonic Filters[4]

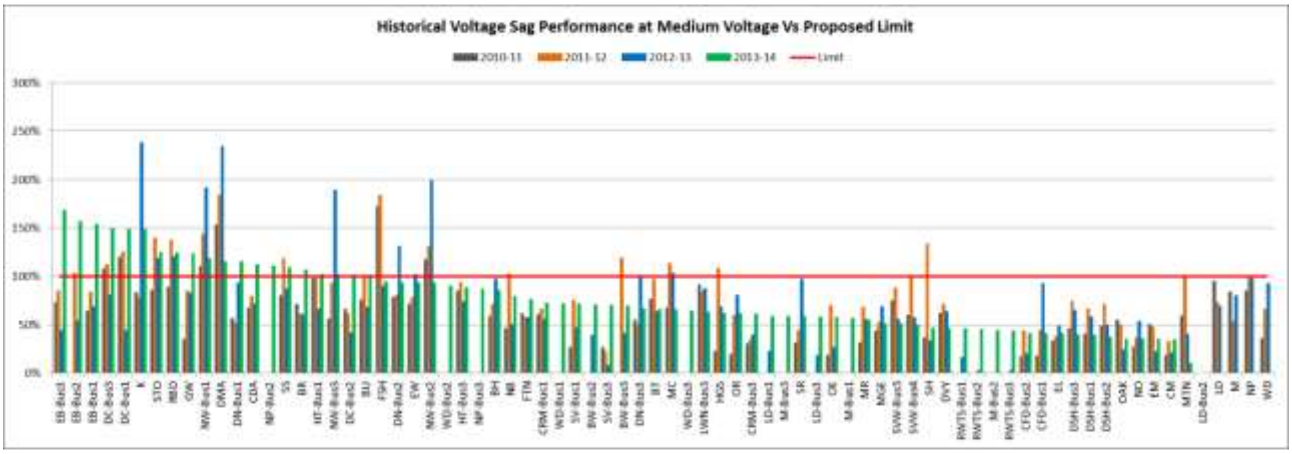
Option	Economic Ranking	Regulatory Compliant	Technically Viable	Address Harmonic Disturbances	Network Power Factor Flexibility	PV Costs
Status Quo	2	No	Yes	No	No	$22,416k
Preferred	**1**	**Yes**	**Yes**	**Yes**	**Yes**	**$4,581k**
Alternative #1	N/A	Yes	No	Yes	No	N/A
Alternative #2	N/A	Yes	Yes	Yes	No	N/A
Alternative #3	N/A	Yes	No	Yes	No	N/A

6.3 Bus-Tie Open Schemes (BTOS)

BTOSs are an innovative approach used by UE to improve quality of supply. Whilst the BTOS does not reduce the number of faults on the network, it does limit the severity of voltage sags created by the faults on the MV network.

UE has already installed the BTOS at 13 zone substations with great effect. UE plans to install the BTOS at one zone substation annually over the next 2016-2020 regulatory period. The performance of voltage sags for UE's zone substations is shown below[5].

Figure 11: MV Voltage Sag Performance 2010-2014



The techno-economic feasibility of the following options is evaluated for these projects of which each option is compared to the recommended option:

- Option 1 – Status Quo: Deteriorating performance;
- Option 2 – Preferred: Install BTOS for the below zone substations;
- Option 3 – Alternative #1: Install real-time power quality enhancement system on the customers' premises; and
- Option 4 – Alternative #2: Install uninterrupted power supplies (UPS's) on the customers' premises.

[4] Refer to Table 82 in supporting document number UE PL 2203.
[5] For voltage sags, the limit of 10 which is proposed by UE is considered in this document.

The Preferred Option which is to install the BTOS's is recommended as the lowest lifecycle cost option that addresses the Code compliance and customer complaint issues.

The techno-economic aspects of the Status Quo and the other options proposed to solve the voltage sag issues are summarised in the below table.

Table 6: Technic-Economic Summary of Different Options for Bus-Tie Open Schemes[6]

Option	Economic Ranking	Regulatory Compliant	Technically Viable	Address Voltage Sag Disturbances	PV Costs
Status Quo	4	No	Yes	No	$3,917k
Preferred	**1**	**Yes**	**Yes**	**Yes**	**$766k**
Alternative #1	3	Yes	Yes	Yes	$1500k
Alternative #2	2	Yes	Yes	Yes	$1250k

6.4 Power Quality Analysers

As aforementioned, there are still some gaps with respect to power quality monitoring. UE plans to install power quality analysers at ends of three critical MV feeders every year over the next regulatory period of 2016-2020.

The techno-economic feasibility of the following options is evaluated for these projects of which each option is compared to the recommended option:

- Option 1 – Status Quo: Do nothing;
- Option 2 – Preferred: Install power quality analysers; and
- Option 3 – Alternative #1: Rent power quality monitoring devices in order perform the measurements.

The Preferred Option which is to install the power quality analysers is recommended as the lowest lifecycle cost option that addresses the Code compliance and customer complaint issues.

The technic-economic aspects of the Status Quo and the other options proposed to solve the power quality monitoring issues are summarised in the below table.

Table 7: Technic-Economic Summary of Different Options for Power Quality Analysers[7]

Option	Economic Ranking	Regulatory Compliant	Technically Viable	Address Power Quality Monitoring Issues	PV Costs
Status Quo	2	No	Yes	No	$1,397k
Preferred	**1**	**Yes**	**Yes**	**Yes**	**$839k**
Alternative #1	3	Yes	Yes	Yes	$4,315k

[6] Refer to Table 57 in supporting document number UE PL 2203.
[7] Refer to Table 5, 9, 10 and 14 in supporting document number UE PL 2203.

7. Summary and Conclusion

In this document, UE has explained how it has prepared the forecast for our projects to maintain our quality of supply and meet our obligations with regards to the power quality.

UE believe that this document and its supporting references provide a compelling justification that the AER should accept our forecast expenditure.

In summary, the AER can be confident that this forecast is in accordance with the Rules capital expenditure criteria and objectives because it maintains power quality at least cost, preventing further deterioration in quality of supply levels despite forecast increases in customer demand for solar PV connections and electronic appliance use.