In Meter Capabilities (IMC)

UNITED ENERGY

Project № PJ1386

Project Justification

This document justifies capital expenditure 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

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

Project description

This project will enable “In-Meter Capability” (IMC) applications to be implemented via the Advanced Metering Infrastructure (AMI) network wireless communication without any site visits. A wide range of applications can be installed, each at a modest cost. The project will enable UE to perform analytics and take real-time control actions when necessary, in order to address safety issues, achieve more efficient utilisation of the network and deliver capital expenditure efficiencies.

Project Driver

The key driver for this project is the requirement to satisfy UE’s statutory obligation to minimise as low as reasonably practicable (ALARP) the safety risks arising from its electricity network.

Benefits

The primary benefit of the IMC applications is customer safety. Each year, approximately 94 customers on UE’s network experience neutral integrity issues that result in electrical shocks. This project will expedite neutral integrity detection and subsequent automated action that will help to reduce electric shocks by more than 50%. It will also reduce the risk of fire from customer switchboards and Candling Fuses, in addition to facilitating a more rapid response to ‘live wire down’ faults.

In addition, the IMC will support demand management applications that enable smart appliance control, via the associated meter in-house network. The reduction in demand at peak times is expected to deliver longer term savings in augmentation capex.

Options analysis

Table 1 presents the evaluation of the alternative options. The reference case is not ALARP compliant. The net benefit for Options 1 and 2 relate to assumed capex efficiencies. As already noted, however, these efficiency improvements are not the primary purpose of the project.

Table 1: Option evaluation ($M, expressed in present value (PV) terms)[1]

Options	PV of Costs ($M)	PV Net benefit ($M)	PVR (Benefit to Cost Ratio)	ALARP compliant	Ranking
Reference Case (Status Quo)	0.0	0.0	0.0	No	3
Option 1 - Provide In Meter Capabilities	**1.80**	**2.03**	**1.13**	**Yes**	**1 Recommended**
Option 2 - Provide In Meter Capabilities with Centralised Analytics	8.06	2.03	0.25	Yes	2

Recommendation

- It is recommended that Option 1 should be implemented. It is the lowest cost option that satisfies our ALARP obligations. Furthermore, it is expected to deliver a net benefit, as indicated by a benefit cost ratio of 1.13.

[1] It should be noted that the undiscounted forecast project costs for Option 1 are provided in Table 6 and 7.

2. Objectives / Purpose

The objectives of the IMC project are to take advantage of the underutilised AMI meter capability and expand functionality to provide greater real-time insights of network issues at or near customers' premises. The insights will help shape improvements in network and public safety, and enable UE to comply with its ALARP obligations.

One specific initiative is to use IMC to provide a more effective management of risks associated with neutral integrity at customers' premises. UE customers experience 94 neutral integrity issues per annum that result in electrical shocks. This project will expedite neutral integrity detection and appropriate automated action that will help to reduce the numbers of electric shocks by more than 50%.

A further objective is to enable customers to better manage their energy consumption. Improved customer outcomes can be achieved through smart appliance control via the associated meter in-house network, appliance on-off cycling, and switching appliances between peak and off peak. These capabilities help reduce energy demand and provide spare network capacity, particularly around energy peaks, enabling deferral or avoidance of the need for network augmentation.

3. Strategic Alignment and Benefits

3.1 Asset Management Strategy and Strategic Themes Alignment

This project supports the following key United Energy strategic themes:

- Meet our compliance obligations
- Improve network and public safety and thus mitigate associated risk
- Avoid network augmentation expenditure through better management of customer appliances, particularly during energy consumption peaks.

3.2 National Electricity Rules Expenditure Objectives Alignment

This project contributes to the following National Electricity Rule (NER) Expenditure Objectives:

- Maintain the safety of the distribution system through the delivery of standard control services.

The project will also enable UE to satisfy the capital expenditure objectives in the Rules efficiently and prudently.

4. Alternative Options Considered

4.1 Background and Identified Options

The project options considered in this document seek to extract additional value from the under-utilised AMI network meters by incrementally improving functionality through small incremental capital investments.

The cost of improving the functionality (i.e. adding a ‘use case’) is relatively modest as the required base code can be implemented via the AMI network wireless communication without requiring field visits. Hence the cost incurred is purely that of developing the use case code and associated testing, as the deployment is performed over the network in an automated fashion.

The “In-Meter Capability” (IMC) applications will reside on the meter Network Interface Card (NIC) and will utilise meter instantaneous and historical data to perform analytics and take real-time control actions when necessary. The resulting analytics events, alarms and control actions will be stored locally and reported to the master IT Analytics Intelligent Hub (ITAIH) platform.

The following are examples of IMC applications, a significant number of which are safety related:

- Neutral Integrity
- Service impedance degradation
- Voltage fluctuation problem detection
- Active voltage control
- Brown out / fuse blown
- Candling fuse detection
- Customer demand management during critical peaks
- Meter overload detection.

The IMC applications provide real-time analysis and control, which is essential from a safety perspective. In contrast, where analytics are only implemented in the ITAIH platform, there can be up to 4 hours to process all the meter data. This timeframe is unacceptable when issues arise that may endanger the public, employees or contractors, such as degraded Neutral Integrity.

IMC applications will run every 10 seconds as compared to existing 5 minute meter functionality. This will allow finer resolution of events, alarms and actions with the added capability of pre and post event analysis data being available for retrieval on request by ITAIH systems.

The IMC applications have the added advantage that they will continue to operate in the event that the AMI communication network fails. When the AMI communication network is restored, the IMC applications will then report any associated meter changes to the ITAIH. This further enhances the safety, and supply resilience and compliance.

The following options have been evaluated in the context of UE’s current business and its need to manage an increasingly complex distribution network:

- Reference Case: The “Reference Case” will maintain the status quo,
- Option 1: Provide In Meter Capabilities
- Option 2: Provide In Meter Capabilities with Centralised Analytics

4.2 Reference Case - Status Quo

The Reference Case will maintain the status quo. This option is not acceptable from an ALARP perspective because there is a 'reasonably practicable' opportunity to reduce customer exposure to electric shocks and fire risk.

4.3 Option 1 – Provide In Meter Capabilities

Option 1 will provide real-time In Meter Capabilities. As noted in section 3.1, a number of the IMC applications have important safety benefits. It is useful to highlight two examples:

Neutral integrity

Regulation 27(2) of the Electricity Safety (Network Assets) Regulations 1999 requires that:

"*Earthing systems, except common multiple earthed neutral earthing systems, and electrical protection equipment, except fuses, must be inspected and tested at least every 10 years for compliance with regulation 23"*.

Regulation 23 details requirements in relation to earthing and electrical protection

Each year, approximately 90 customers on UE's network experience neutral integrity issues that result in electrical shocks. The introduction of this application (in conjunction with other applications) will reduce electric shocks by more than 50%.

The Neutral Integrity application will run every 10 seconds in the meter communication card and alarm the ITAIH systems when the neutral is degraded or compromised. The higher sampling rate of the data at the meter will increase visibility of neutral deviations in and out of compliance and provide real time alarming to initiate investigation. Action may be taken at the meter to isolate supply automatically if necessary, inform the customer and send a truck to the premise to test and rectify the issue.

With the implementation of smart meters, there is also an opportunity to leverage AMI power quality data to pro-actively identify neutral integrity issues without the need to rely on an on-site test. This automated neutral integrity testing at the meter communications card will enhance the effectiveness of the overall neutral integrity analytics provided on the ITAIH platform.

Candling fuse detection

During fuse operation a level of carbon can develop within the fuse. The carbon can form a high resistance path and still conduct with an ionised glow. Candling Fuses cause heating that may eventually result in damage to the surrounding electrical infrastructure and can cause hot debris to fall to the ground and in some cases start fires. The associated analytics in the ITAIH will detect these issues as they develop, allowing the overall abnormal condition exposure time and risk duration to be reduced.

A number of Candling Fuses are reported annually, causing fires in 2012 and 2014.

The IMC application will detect these safety risks and initiate the necessary action at the customer meter.

These safety initiatives are consistent with UE's ALARP obligations. The application of IMC will also assist in the detection of 'live wire down' and meter overloads, which may result in customer switchboard fires.

It is difficult to quantify the value of these safety benefits, however, the experience of another Victorian distributor demonstrates that using In Meter Capability to expedite Neutral Integrity Detection can be expected to result in reducing electric shocks by more than 50%. This benefit is achieved because faults can be identified and isolated as they occur, before a customer experiences a shock.

In addition to achieving these significant safety benefits:

- Implementation of this solution will result in a reduction of electric shocks by more than 50%. This benefit has been delivered by another Victorian DNSP using this approach. The benefit is delivered by identifying Neutral Integrity faults as they occur, before a customer experiences a shock. Importantly we note that our 2011 to 2015 spend on replacing services was $69M, and our 2016 to 2020 spend is proposed to be $34M. So by spending an extra $1.8M (in present value terms), this project can contribute to reducing the network safety risk of shocks by more than 50%, by better targeting our CAPEX spend and applying it before shocks are experienced.

This risk reduction is considered ALARP, as the cost is small in comparison to the replacement CAPEX that addresses this area, whilst the benefit is to reduce the network safety risk of shocks by more than 50%.

- This option enables deferral of augmentation capex by shifting appliances to off peak or cycling the equipment off. This functionality can be provided within the meter with no back office support. For example, subject to customer agreement, prior to a peak period fridges with smart controls can be signalled by the meter prior to reduce temperature by, say, 2 degrees. When the supply peak arrives, the temperature can be eased off by say, 4 degrees, to reduce energy demand during the peak period. Once the supply peak ends, the meter can return the fridge back to its normal condition. Indicative capex efficiencies of $125k in 2020 followed by savings of $250k per annum thereafter are assumed for the purpose of the cost benefit analysis. This equates to a PV benefit of $2.03M.

Either the network safety risk reduction to ALARP or the capital efficiencies generated would independently justify the project.

Option 1 requires total capex of $2.391M.

4.4 Option 2 – Provide In Meter Capabilities with Near Real-time Analytics

Option 2 provides the same functionality as Option 1 provides, but the analytics processing is centralised at the head-end in the IT Analytics Intelligent Hub (ITAIH) platform. This means that meter data for each of the initiatives will need to be accessed at a fast rate (i.e. Near Real Time). Once the analytics are performed, any corrective actions will be sent to the associated meters.

The impact of this extra traffic on the AMI network will degrade the performance of this network. To address this issue, Option 2 will require augmentation of the AMI network access points, repeaters and traffic management as well as incur additional labour costs as part of this option.

The additional equipment and labour costs to perform this near real-time-analytics are shown in Table 2 below.

Table 2: Capital expenditure estimates for Option 2

CAPEX in ($ AUD 1) CAPEX Type: Augmentation	Additional Access Points	Repeaters (Relays) To be Installed
Number of Units Required	534	232
Equipment Unit Cost	$8,398	$2,816
Labour	$1,450	$1,450
Total cost	$5,258,832	$989,712
Traffic management	$446,456	
Additional Head end Hardware, Software and network cost	$3,200,000	
Sub Total Cost	$9,895,000	
Total Project Cost (Including overheads)	$10,701,000	

Option 2 requires capex of $10.701M as shown in Table 2. Option 2 provides a more refined solution than Option 1, as the analytics are centralised. However, it is relatively expensive compared to Option 1 and introduces additional risks in relation to the performance of the AMI network.

4.5 Technical Summary

The table below provides a technical assessment of the Options. Option 3 is excluded from this analysis because it refers to a portfolio of alternative safety projects, each of which will be technically acceptable.

Table 3: Technical Summary

Alternative	Reference Case (Status Quo)	Option 1 – Provide In Meter Capabilities	Option 2 – Provide In Meter Capabilities with Near Real-time Centralised Analytics
Technically Viable	Yes	Yes	Yes
Address Reliability	No	No	No
Enhance Network Flexibility	No	Yes	Yes
Comments	Does not address ALARP.	Technically acceptable. Addresses ALARP.	Technically acceptable, addresses ALARP, but exposes the AMI network to performance risk.

5. Economic Evaluation

5.1 Evaluation of Options

Table 4 presents the evaluation of the alternative options.

Table 4: Option evaluation ($M, expressed in present value (PV) terms)[2]

Options	PV of Costs ($M)	PV Net benefit ($M)	PVR (Benefit to Cost Ratio)	ALARP compliant	Ranking
Reference Case (Status Quo)	0.0	0.0	0.0	No	3
Option 1 - Provide In Meter Capabilities	**1.80**	**2.03**	**1.13**	**Yes**	**1 Recommended**
Option 2 - Provide In Meter Capabilities with Centralised Analytics	8.06	2.03	0.25	Yes	2

Note: PVR measures capital efficiency. If the PVR > 1 then the project / option has a net present value (relative to the reference case) greater than zero, and is therefore economic.

The following points should be highlighted from Table 4:

- The Reference Case is not compliant in relation to UE's ALARP obligations. This is because UE is able to reduce the risk of electric shocks and switchboard fires for a comparatively low amount of capital expenditure.
- Options 1 and 2 each deliver benefits of $2.03M in present value terms. This benefit reflects assumed capex efficiency of $125,000 in 2020 and $250,000 per annum thereafter. However, it should be noted that these efficiency gains are broad estimates, which are uncertain to eventuate.
- Option 1 has a benefit to cost ratio of 1.13, which is sufficient to justify the project. However, as noted in section 3.1, the principal purpose of this project is to deliver safety improvements consistent with our ALARP obligations. Therefore, while the assumed capex efficiencies alone would justify the selection of Option 1, the rationale for the project is that it achieves our ALARP obligation at lower cost than Option 2.

2 It should be noted that the undiscounted forecast project costs for Option 1 are provided in Table 6 and 7.

5.2 Benefits Summary

The recommended option, Option 1, will provide the following key benefits:

Table 5: Option 1 Benefits Summary

Option 1 Benefits -> Initiatives ↓	Maintain Quality of Supply	Maintain Network Resilience / Compliance / security / Reliability	Extend asset life	Meeting Customer expectation of a safe and secure electricity supply	Mitigate Risk	Deliver capex efficiency savings	Improved asset information history	Realizing True Capacity by reducing supply peaks	Lower number of planned and unplanned outages	Reduced asset down time
Provide In Meter Capabilities	No	✓	Possible	✓	✓ [1]	✓	✓	✓	Possible	Possible

Where a benefit is shown as 'possible' it indicates a potential secondary benefit that is not the primary driver for the project.

The most significant benefits from Option 1 are summarised below:

- Improve network and public safety and thus mitigate associated risk in accordance with ALARP
- Avoid / defer network augmentation capex expenditure through better management of customer appliances, particularly during energy consumption peaks.

5.3 Optimum timing and capex profile

The project implementation will be prioritised so that safety improvement opportunities, such as neutral integrity, will be implemented first.

The project will commence in 2019 as the related project "IT - PJ12- Network Analytics" needs to be well underway to utilise the associated data. This timing is also appropriate from an internal resourcing perspective.

This project is not expected to require any additional operating expenditure and hence no opex is included in the table below.

Table 6 Option 1 Capital expenditure profile ($'000 real, see note)

	2016	2017	2018	2019	2020	Total
Option 1 - Provide In Meter Capabilities	n/a	n/a	n/a	1,340.7	1,050.7	2,391.4

Note: The capex amounts shown in the table above are undiscounted, and are consistent with the present value costs shown for Option 1 in Tables 1 and 4.

6. Project Financials

The project financials for internal budgeting purposes are detailed below:

Table 7: Project financials - Preferred Option (Option 1)

PROJECT COST	
Year Budgeted	2019 to 2020
Required Service Date	31 Dec 2020
Budgeted Cost ($A excluding GST)	$2,173,000
Business Case Cost ($A excluding GST)	$2,173,000
Business Case Cost + UE overheads ($A excluding GST)	**$2,391,400**

Note: The capex amounts shown in the table above are undiscounted, and are consistent with the present value costs shown for Option 1 in Tables 1 and 4. Additionally these project costs include escalators.

7. Recommendation

Option 1 is recommended at a total capital cost of $2.391M.

This option will deliver important safety improvements consistent with our ALARP obligations. It will also deliver capex efficiencies, which independently justify this project.

APPENDIX A – HIGH LEVEL SCOPE OF WORK

The scope includes:

- Evaluate initiative technological and benefits currency, include any new functionality, remove obsolete functionality, prioritise initiatives and produce the associated business case
- After business case approval, initiate project, identify and obtain resources
- Perform the following:
  - Plan software changes
  - Develop applications and suitably test
  - Initiate any customer programs that will improve and or and impact customer supply
  - Rollout new applications to meters communication cards
  - Commission in to service and validate functionality from a sample set of meters
  - Modify processes and complete all documentation
- Closeout project