Test Harness

Project № PJ1398

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

The 'Test Harness' project is a pilot scheme to develop the automation of meter testing. Testing is required by the distribution business to validate data and control functionality from / to AMI meters. The project will enable meter control and data flow to be automatically tested for 100 'use cases', which are the most error prone. On successful completion of this pilot scheme, a subsequent project will extend the solution to the remaining use cases.

Project Driver

With 650,000 smart meters in UE's AMI network, the potential scale of testing is very substantial. The current manual testing approach was developed in the old environment of manually read meters, with few meter reads and mechanical technology. The new environment is unrecognisable in terms of its complexity. Updates in meter firmware, software and hardware configurations all require testing.

The manual testing environment is not equipped to maintain the quality, reliability, safety or security of supply of standard control services.

Benefits

The proposed project will deliver capex efficiencies by avoiding the substantial increase in (capitalised) labour that would otherwise be required if manual meter testing continued. The proposed project will also minimise the risk of non-compliant or erroneous meter functionality that can adversely affect the 650,000 meter fleet.

Smart energy products are designed to operate within a multi-vendor, multi-network environment. Here, interoperability testing becomes an essential part of the overall test scheme and therefore before releasing an upgrade or update to a product, regression testing is necessary. If the test process is correctly implemented and the test tools designed well, the distributor is able to save considerable time and cost.

The pilot scheme will focus initially on the most complex 'use cases'. This approach will enable the concept to be tested and refined before being rolled out to the remaining use cases.

Options analysis

This document considers 3 options:

- Reference Case – which is the status quo option;
- Option 1 – Test Harness Pilot with 100 Use Cases; and
- Option 2 – Test Harness Pilot with 1500 Use Cases.

The Reference Case would maintain the current manual testing environment. This option will lead to substantial cost increases over time as additional labour is required to address the growing meter testing requirements.

Option 1 performs a pilot scheme to automate testing for 100 of the most complex and manual error prone use cases. It would seek to develop the test harness pilot, and deliver some quick wins.

Option 2 expands the scope of Option 1 to include 1500 use cases. Essentially, it is more ambitious than Option 1, which means that the costs, benefits and risks are also greater.

Table 1 below shows the option assessment for each of the three options.

Table 1 - Option Assessment (in present value terms)[1]

	"Status Quo" Reference Case	Option 1: Test Harness Pilot with 100 Use Cases	Option 2: Test Harness for 1500 Use Cases
Obligation **Maintain the quality, reliability, safety or security of supply of standard control services**	Not satisfied	Satisfied	Satisfied
Feasible Option	No	Yes	Yes
Present value costs: **Project Capex and Opex ($ 000)**	Refer Section 4.1	883.1	3,782.8
Benefits: **Capex efficiency**	0	Refer Section 4.1	Refer Section 4.1
Present value cost ($ 000)	Refer Section 4.1	883.1	3,782.8

The Reference Case is not a feasible option because it fails to maintain the quality, reliability, safety or security of supply of standard control services. The Reference Case is therefore rejected. Table 1 shows that the cost of Option 1 is substantially lower than Option 2. In addition, Option 1 is a more appropriately scoped pilot scheme to establish automated meter testing.

Recommendation

It is recommended that Option 1 be implemented. This option addresses the problems arising from the current manual testing environment, which is incapable of meeting the requirements of the new smart meter environment. Option 1 is smaller in scale than Option 2, which is appropriate for a pilot scheme. The development of the Test Harness will deliver capex efficiencies and substantially reduce the risk of non-compliant or erroneous meter functionality.

[1] It should be noted that the above table is expressed in present value terms. Therefore, the (undiscounted) forecast capex for Options 1 and 2 exceeds the amounts set out above.

2. Objectives / Purpose

The purpose of this project is to address the increasing costs and risks associated with the current manual testing approach for meters. The project is a pilot scheme that would develop a 'Test Harness' to automate testing. The Test Harness will enable UE to avoid future increases in (capitalised) labour costs that would otherwise be unavoidable if the manual testing approach continued.

3. Strategic Alignment and Benefits

3.1 Asset Management Strategy and Strategic Themes Alignment

This project supports the following key United Energy strategic themes when the Test Harness is deployed widely:

- Maintains network safety, quality of supply, reliability, security and compliance
- Drives capex efficiencies by reducing the costs of implementing software upgrades
- Provides confidence that tests are correctly and consistently repeated
- Enables compliance and test traceability.

3.2 National Electricity Rules Expenditure Objectives Alignment

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

- Maintain the quality, reliability and security of the supply of standard control services.

The project will also enable UE to satisfy the capital expenditure objectives in the Rules efficiently and prudently by avoiding future capex increases.

4. Alternative options considered

4.1 Background and Identified Options

With 650,000 smart meters in UE's AMI network, the potential scale of testing requires an automated approach. UE's existing meter testing environment requires considerable manual effort to alter meter firmware, software and hardware configurations. Currently, approximately two thirds of the time spent for any software change relates to testing.

In the future, the testing requirements will increase as the number of 'use cases' grows as part of the increasingly complex, ever changing AMI environment. Adding manual labour is costly and impractical as the test harness platform becomes the choke point in the manual test scenario. The high volume and frequency of testing required makes the automation of use case testing a necessary development.

Performance testing requires test harnesses and simulators that can handle very large data volumes. AMI meters typically record half hourly meter readings, which produces more than 4000 times the annual meter reads compared to a traditional meter. With 650,000 meters on the network, large scale test tools are required so that the systems correctly interoperate to pass through data and control actions between them.

Scheduling usage of and managing testing environments is critical. Test environment builds must be repeatable and configuration definitions fully documented. For example, each device on the consumer's premises has firmware supported by a specific version of software on the head end. Device firmware and head end software need to align to ensure that testing is performed on vendor supported configurations. This is particularly important when carrying out end to end testing from the source systems to the meters.

The key to a successful automated testing approach is to develop an innovative test harness that will enable UE to test a sample set of meters in a test bed (approximately 150 meters). The test bed replicates all AMI meters in the AMI network and their possible internal and external configurations so that the full suite of tests (over 1500 test use cases) can be carried out in an automated fashion.

The purpose built smart metering test lab replicates the consumer environment and allows realistic and representative tests to be carried out safely and efficiently. In addition to using the test bed for certification tests, using real meters in the lab increases confidence in the test results.

Lab testing has its limitations and so it must be backed up with field trials. Testing in the field increases confidence that systems will work in the real world environment. Field variables such as meter position; low signal coverage; age of the property; household wiring; improperly sized meter enclosures; and wireless network connectivity can result in problems that are not visible in the test harness.

This document considers two pilot scheme options to develop automated testing. In both options, the pilot scheme will design and implement hooks and code to the following systems to enable meter control and data flow to be automatically tested:

- Silver Spring Networks UtilityIQ (UIQ)
- DMS; and
- SCADA.

Once the concept is tested for the more complex and manual error prone use cases, the solution can to be deployed to cover the remaining test use cases. The following options have been evaluated:

- Reference Case: The "Reference Case" will maintain the status quo
- Option 1: Test Harness Pilot with 100 Use Cases
- Option 2: Test Harness Pilot for 1500 Use Cases.

4.2 Reference Case - Status Quo

The Reference Case will maintain the current manual testing processes. It will lead to substantially higher (capitalised) labour costs over time given the inevitable increase in testing requirements in the new smart meter environment.

4.3 Option 1 – Test Harness Pilot with 100 Use Cases

Option 1 will design and implement a Test Harness for automated AMI meter use case testing. These use cases will originate on toolsets that will operate on or through the identified source systems to validate correct data and control functionality from / to AMI meters. The hooks that will be implemented in the source systems will cater initially for a small set of use cases. Successful completion of the pilot will enable this functionality to be extended to other use cases, which is vital in the rapidly evolving and increasingly complex AMI meter environment.

Option 1 is the initial phase that must be undertaken to address the deficiencies in the current manual testing environment. Option 1 minimises the initial capital outlay while getting some quick runs on the board including improving testing speed and consistency, and removing manual errors to use case testing by automating the most complex and most error prone 100 use cases.

The present value cost of Option 1 is estimated to be $0.88M.

4.4 Option 2 – Test Harness for 1500 Use Cases

Option 2 extends the scope of Option 1 to include an additional 1400 use cases. Automating the additional use case testing will allow changes to be brought to market faster and minimise manual errors.

The present value cost of Option 2 is estimated to be $3.8M.

5. Economic Evaluation

5.1 Evaluation of Options

The table below provides a summary of the evaluation of the options.

Table 2 - Option Assessment (in present value terms)[2]

	"Status Quo" Reference Case	Option 1: Test Harness Pilot with 100 Use Cases	Option 2: Test Harness for 1500 Use Cases
Obligation **Maintain the quality, reliability, safety or security of supply of standard control services**	Not satisfied	Satisfied	Satisfied
Feasible Option	No	Yes	Yes
Present value costs: **Project Capex and Opex ($ 000)**	See Note 1	883.1	3,782.8
Benefits: **Capex efficiency**	0	See Note 2	See Note 2
Present value cost ($ 000)	See Note 1	883.1	3,782.8

Notes:

1. Based on current projections, the present value costs for the Reference Case is $5.2M in present value terms, which reflects the existing costs of manual testing. It should be noted, however, that manual testing is not a feasible option. In this regard, the inclusion of a cost estimate for the Reference Case in this table would be misleading.

2. The automation of meter testing is expected to deliver capex efficiencies by avoiding the (capitalised) labour associated with the Reference Case. As noted above, these savings are likely to be significant given the required increase in labour in a manual testing environment (which is ultimately unsustainable). It should also be noted that the costs presented for Options 1 and 2 only reflect the costs of the pilot scheme. The costs of Options 1 and 2, therefore, are not comparable to the Reference Case costs of $5.2M explained above.

   Given the above observations, it is not appropriate to estimate the capex efficiencies attributable to Options 1 and 2.

For the reasons already explained, the Reference Case is not a feasible option and is therefore rejected.

Table 1 shows that the cost of Option 1 is substantially lower than Option 2. In addition, Option 1 is a more appropriately scoped pilot scheme to establish automated meter testing.

[2] It should be noted that the above table is expressed in present value terms. Therefore, the (undiscounted) forecast capex for Options 1 and 2 exceeds the amounts set out above.

5.2 Description of benefits

The key benefits from Option 1 are:

- Reduced reliance on manual labour
- Improved efficiency and sustainability
- Lower risk of AMI meter non-compliance and / or incorrect functionality
- Brings AMI meter functionality changes and new software releases to market faster
- Maintains accuracy and consistency of safety standards for any AMI meters functionality changes
- Maintains network and public safety
- Provides full automated audit trail of testing and test results
- Reduces labour costs when modifying AMI meters software as a result of additional automated testing
- Reduces time to test
- Reduces human errors.

5.3 Optimum timing and expenditure profile

The proposed expenditure profile in Table 4 below reflects the scope of the pilot scheme.

Table 4: Option 1 Estimated Annual Cash Flow (Preferred Option Project CAPEX Only)

CAPEX in ($'000) CAPEX type: AUGEX Year -> Initiatives ↓	2016	2017	2018	2019	2020	Total
Option 1: Test Harness Pilot with 100 Use Cases	561	406				966.6

Note: The amounts shown in the table above are undiscounted, and are consistent with the present value costs shown for Option 1 in Tables 1 and 2.

6. Project Financials

The project financials for internal budgeting purposes are detailed below.

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

PROJECT CAPITAL COST	
Year Budgeted	2016 to 2020
Required Service Date	31 Dec 2020
Budgeted Cost ($A excluding GST)	$895,000
Business Case Cost ($A excluding GST)	$895,000
Business Case Cost + UE overheads ($A excluding GST)	$966,600

Note: The amounts shown in the table above are undiscounted, and are consistent with the present value costs shown for Option 1 in Tables 1 and 2.

7. Recommendation

It is recommended that Option 1 at a capital cost of $966,600 be implemented. The establishment of a pilot scheme to automate meter testing is a prudent and efficient response to address the issues arising from the existing manual meter testing environment, which is no longer fit for purpose.