Project Justification Light Detection and Ranging (LiDAR) Asset Management

Project № PJ1400

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

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1. EXECUTIVE SUMMARY

Project description

This project is called 'Light Detection and Ranging (LiDAR) asset management survey'. The project will utilise LiDAR technology and associated software to perform targeted surveys of the network to identify poles and conductor spans that represent a risk to safety. It will also identify vegetation encroachment issues in high risk areas and update and verify UE's Geographic Information System (GIS) and asset databases.

Project Driver

The driver for this project is UE's statutory obligation to identify and manage risk associated with network assets to a level that is "As Low As Reasonably Practicable" (ALARP).

Benefits

The primary benefits of the project are improving network safety, and mitigating bushfire risk. Specifically, the project will deliver the following benefits:

- Improving network safety by augmenting the current processes relating to audits of physical assets.
- Bushfire risk mitigation by enabling the identification and early rectification of potential asset failure (e.g. clashing conductors) and vegetation encroachment – both of which have the potential to cause a fire start.

In addition to the bushfire and network safety benefits, LiDAR will also deliver capex efficiencies by:

- Increasing planned replacement rather than the more expensive approach of replacement on failure; and
- Minimising the need for physical survey work for some planned distribution works.

The secondary benefits supplement the primary driver for the project, which is risk mitigation in accordance with our ALARP obligations.

Options Analysis

Table 1: Cost and benefits of Options (in present value terms)[1]

Options	PV Costs ($M)	PV benefit ($M)	PVR (Benefit to Cost Ratio)	Net benefit (Benefit minus Cost)	ALARP compliant	Ranking
Reference Case (Status Quo)	0.0	0.0	0.0	0.0	No	3
Option 1 - Perform targeted LiDAR Asset Management Survey	**5.68**	**2.09**	**0.37**	**-3.59**	**Yes**	**1**
Option 2 - Perform LiDAR Asset Management Survey for the entire network	7.50	2.09	0.28	-5.41	Yes	2

[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.

Table 1 shows that the status quo does not satisfy our compliance obligation to identify and manage safety risk to ALARP. In comparing Options 1 and 2, neither option provides an overall net benefit. However, Option 1 is to be preferred as it has a negative net benefit of $3.59M compared to Option 2, which is negative $5.41M

Recommendation

Option 1 is the preferred option. It utilises LiDAR technology to meet our statutory obligations to reduce safety risk to as low as reasonably practicable (ALARP). Specifically, it will improve network safety by augmenting the current audit processes relating to physical assets, and it will mitigate the bushfire risks arising from currently undetected network issues. It will also provide secondary benefits in the form of future capital expenditure efficiencies.

It is recommended that Option 1 (perform targeted LiDAR Asset Management Survey over five years) should proceed.

2. Objectives / Purpose

The objective of the project is to strengthen UE's ability to minimise as low as reasonably practicable (ALARP) the safety and bushfire risks associated with its line and pole assets, in accordance with UE's obligations under sections 83B(1) and 98 of the Electricity Safety Act 1998. It will also enable us to replace assets prior to failure, which is preferred in terms of reduced replacement cost and safety risk.

3. Strategic Alignment and Benefits

3.1 Asset Management Strategy and Strategic Themes Alignment

The project supports the following corporate strategic themes:

- Ensuring regulatory compliance.
- Network safety and environment – by contributing to a safer network.
- Customer service – meeting customer expectations of a safe electricity supply.
- Prudent and efficient asset management and investment – in particular, by enabling an efficient means of detecting possible conductor clashing and vegetation encroachment issues.
- Risk management – by contributing to the reduction of risk of asset damage and bushfires through the proactive identification of issues before they become faults that could also result in bushfires and / or damaged infrastructure.

3.2 National Electricity Rules Expenditure Objectives Alignment

This project is aligned with the National Electricity Rule expenditure objectives, which require UE to comply with all applicable regulatory obligations or requirements associated with the provision of standard control services. It is also consistent with the requirement to maintain safety in accordance with clause 6.5.7(a)(4).

4. Alternative Options Considered

4.1 Background and Identified Options

LiDAR technology can be used to undertake extensive surveys, to measure and identify:

- electricity pole / overhead line spans;
- conductor phase clearances;
- leaning poles;
- vegetation encroachment; and
- conductor and air temperatures.

Mounting LiDAR sensors on survey vehicles enables data to be collected rapidly and efficiently, by driving alongside power poles, power lines and power line easements.

The data collected is processed using a mobilised Asset Inspection Mapping System incorporating 3D panoramic imagery. Further processing of the data enables desktop-based analysis, feature classification, catenary modelling, and reporting of any clearance violations.

The use of 3D imaging software represents a paradigm shift in the assessment of conductor separation. It promotes faster identification of any problem locations, and thereby enables UE to address undetected safety risks. For instance:

- LiDAR will enable the identification of potential conductor clashing from causes such as slack lines[2].
- LiDAR will also provide proactive gathering of information on SWER lines to avert potential faults in high bushfire areas.
- The AER's disallowance of UE's SWER lines replacement program means that performing LiDAR will be needed to provide vital information that will help identify ground and conductor clearance issues that may lead to bush fires.
- In the absence of LiDAR surveys, additional expenditure would be required to perform regular helicopter patrols of SWER lines to detect issues that could lead to bushfires.
- Information on overhead conductors can be gathered through LiDAR to avert potential faults in high bushfire areas.

The scope of the proposed LiDAR survey project includes associated software that will deliver:

- 3D point cloud of sections of distribution lines
- Laser point cloud viewed over the 3D imagery application
- An application to view laser point cloud as 3D imagery in terms of:
  - Circuit-to-circuit
  - Phase-to-phase
  - Circuit-to-ground, and
  - Cross-arm clearances.

To maximise the safety benefits of LiDAR technology, UE could undertake a LiDAR survey and data analysis of its entire network. As explained below, however, an alternative option would be to stage the completion of the first LiDAR survey with an initial focus on high voltage lines. Based on the learnings from that survey, UE could determine whether to extend the survey to the remainder of the network.

[2] Clashing can be caused by slack conductor spans and loosened pole hardware, but the major cause is the increase in fault currents driven by the addition of transformation capacity in the network and embedded generation.

As already noted, the principal benefit of the LiDAR survey is to enhance UE's ability to improve its safety performance and reduce bushfire risks.

In addition to this primary benefit, the LiDAR survey could also deliver capex efficiencies and reduce physical survey work for all planned distribution works. These secondary benefits may arise if assets are replaced prior to failure, resulting in lower replacement costs and fewer unplanned outages.

The following three options have been evaluated:

Reference Case:	Under the "Reference Case", the status quo is maintained
Option 1:	Perform a targeted LiDAR Asset Management Survey
Option 2:	Perform a complete LiDAR Asset Management Survey

4.2 Reference Case - Status Quo

Under the Reference Case the current processes would remain unchanged, and no additional effort would be made to manage the safety and bushfire risk associated with UE's poles and conductors.

UE considers that the reference case is inconsistent with our obligation to minimise as low as reasonably practicable (ALARP) the hazards and risks arising from our electricity network in accordance with sections 83B(1) and 98 of the Electricity Safety Act 1998.

4.3 Option 1 – Perform a targeted LiDAR Asset Management Survey

Under this option, a targeted LiDAR survey would be undertaken over five years from 2016 to 2020. In the survey, 143,000 poles and associated conductors in the most vulnerable areas would be surveyed. Based on the data and experience gained during the initial survey, the benefits of extending the survey to cover the remaining 66,000 poles and associated conductors can be assessed in 2020.

The capital costs (excluding real labour escalation) of this option are summarised below:

- $5.72 million is required to survey 143,000 poles and associated line spans.
- 3D imagery software and associated training will cost $0.2 million.
- Issue diagnosis and reporting into SAP works management will cost $0.262 million.
- Overheads will cost $0.519 million.
- The total project cost is therefore $6.701 million.

This option has the potential to deliver the following capex efficiencies:

- The targeted LiDAR survey will obviate the need for site surveys costing $260,000 per annum. These site surveys are required prior to the commencement of network projects.
- Capital expenditure efficiencies of $200,000 per annum may be achieved through improvements in asset management. It is noted, however, that these benefits are difficult to estimate and relatively uncertain.

4.4 Option 2 – Perform a LiDAR Asset Management Survey for UE's entire network

Under this option, a complete LiDAR survey would be undertaken for UE's entire network (comprising 209,000 poles and associated conductor spans) over five years from 2016 to 2020.

The capital costs (excluding real labour escalation) of this option are summarised below:

- $8.36 million is required to survey 209,000 poles and associated line spans.
- 3D imagery software and associated training will cost $0.2 million.

- Issue diagnosis and reporting into SAP works management will cost $0.382 million.
- Overheads will cost $0.733 million.
- The total project cost is therefore $9.675 million.

Capex efficiency benefits of Option 2 are similar to, but larger than those for Option 1, reflecting the increased number of poles and line spans surveyed. The following benefits have been estimated:

- As noted in relation to Option 1, a LiDAR survey covering the entire network would avoid the need for site surveys costing $340,000 per annum.
- Capital expenditure efficiencies of $274,000 per annum may arise from improved asset management. As already noted in relation to Option 1, these benefits are difficult to estimate and relatively uncertain.

4.5 Technical Summary

Table 2: Technical Summary

Alternative	Reference Case -Status Quo	Option 1 - Perform targeted LiDAR Asset Management Survey	Option 2 - Perform LiDAR Asset Management Survey for the entire network
Technically Viable	Yes	Yes	Yes
Addresses Reliability	No	Small contribution to maintaining reliability due to proactive detection of potential faults.	Small contribution to maintaining reliability due to proactive detection of potential faults.
Enhances Network Flexibility	No	Yes	Yes
Comments	Technically acceptable but does not minimise safety risks including bushfire risks to as low as reasonably practicable.	Technically acceptable. Contributes to UE's minimisation of safety risks including bushfire risks to as low as reasonably practicable. Targets most vulnerable areas.	Technically acceptable. Contributes to UE's minimisation of safety risks including bushfire risks to as low as reasonably practicable. Covers entire network.

5. Economic Evaluation

5.1 Evaluation of Options

The table below provides a summary of the cost and benefits of Options 1 and 2 relative to the Reference Case.

Table 3: Cost and benefits of Options (in present value terms)

	"Status Quo" Reference Case	Option 1 - Perform targeted LiDAR Asset Management Survey	Option 2 - Perform LiDAR Asset Management Survey for the entire network
Obligation **Minimise risk**	Not satisfied	Satisfied	Satisfied
Feasible Option	No	Yes	Yes
PV Costs: **Project Capex ($ 000)**	0	5,678.4	7,497.2
PV Benefits: **Capex efficiencies ($ 000)** **Bushfire risk reduction ($ 000)**	0 0	1,788.3 300.0	1,788.3 300.0
PV Total Benefits ($ 000)	0	2,088.3	2,088.3
PV Net Cost ($ 000)	0	3,590.1	5,408.9

Note: PV Net Cost = PV of Project Capex minus PV of Capex efficiency benefits.

As noted in section 4.2, UE considers that the reference case is inconsistent with our statutory obligations to manage safety risk to as low as reasonably practicable (ALARP). Accordingly, we must evaluate Options 1 and 2 in accordance with these statutory obligations.

Determining whether risks have been reduced to ALARP involves an assessment of the risk, and an assessment of the sacrifice (in money, time and effort) involved in taking measures to further reduce that risk, and a comparison of the two.

The basis on which the comparison is made involves the test of ‘gross disproportion’. Under this test, if a measure is practicable and it cannot be shown that the cost of the measure is grossly disproportionate to the benefit gained, then the measure is considered 'reasonably practicable' and should be implemented.

Applying these criteria, we have determined that Option 1, which has a present value net cost of $3.59 million, is the preferred option because:

- It focuses the initial LiDAR survey effort on the highest risk areas of the network.
- It involves lower expenditure than Option 2 (which has a present value net cost of $5.41 million).
- It involves a lower level of project completion and delivery risk than Option 2.
- It enables us to assess in 2020 the benefits of proceeding to complete the LiDAR survey for the entire network, based on the experience and data obtained in the 2016 to 2020 period.

5.2 Benefits Summary

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

Table 4: Option 1 Benefits Summary

Option 1 Benefits -> Initiatives ↓	Contributes to UE's ability to manage safety and bushfire risk to as low as reasonably practicable	Improve network safety by augmenting the current audit process	Meeting customer expectations of a safe and secure electricity supply	Reduce costs through capital efficiency; consistent with prudent network investment	Prevent / reduce asset failure and / or extend asset life (by planned asset replacement)	Increase effectiveness and efficiency of vegetation management	Mitigate risk including bush fire and reputation damage
Perform Targeted LiDAR Asset Management Survey	✓	✓	✓	✓	✓	✓	✓

The targeted LiDAR Asset Management Survey will directly provide benefits (1) and (2) below and will be the enabler for providing the benefits listed in (3).

1. The targeted LiDAR survey contributes to UE's ability to manage safety and bushfire risk to ALARP, and will lead to reduced asset damage and associated costs.
2. The targeted LiDAR survey may improve efficiency of asset management, and enable capital expenditure efficiencies to be achieved.
3. Once the issues identified by the targeted LiDAR survey are rectified via separate projects / programs, the following benefits are expected to be realised:
    a) Improved asset management decisions, based on planned asset replacement and associated expenditure reduction.
    b) Helps meet customer expectations of safe and secure electrical supply
    c) Better vegetation management
    d) Reduced number of unplanned outages and reduced asset down times.

5.3 Optimum timing and capex profile

The work associated with Option 1 will be spread over the five year period commencing in 2016.

The proposed capital expenditure to implement Option 1 is summarised in the table below.

Table 5: Option 1 Estimated Annual Cash Flow

CAPEX Forecast ($'000)	2016	2017	2018	2019	2020	Total
Option 1: Perform targeted LiDAR Asset Management Survey (i.e. For 143,000 Poles and associated conductors)	1,829.6	1,322.8	1,136.4	1,326.5	1,146.6	6,761.8

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 3.

A breakdown of the project costs is provided in the table below.

Table 6: Break down of project capital expenditure (excluding labour escalation) for Option 1

LiDAR survey cost per pole / line span ($)	40
Number of Poles and associated line spans to be surveyed	143,000
Cost to survey the stated poles & line spans ($M)	5.72
Software and training costs ($M)	0.200
Issue diagnosis and reporting into SAP ($M)	0.262
Overhead ($M)	0.519
Total cost ($M)	6.701

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 3.

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	2016 to 2020
Required Service Date	31 Dec 2020
Budgeted Cost ($A excluding GST)	$6,146,000
Business Case Cost ($A excluding GST)	$6,146,000
Business Case Cost + UE overheads ($A excluding GST)	$6,761,800

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 3.

7. Recommendation

In relation to risks and hazards associated with UE's poles and associated conductors, Option 1 is the least cost option that satisfies UE's statutory obligation to minimise as far as reasonably practicable the safety risks, including bushfire danger, arising from those assets. Option 1 also delivers capex efficiencies by replacing more assets prior to failure.

Option 1 is the preferred option because it is approximately $1.8 million lower in present value terms than the next best option (Option 2). It is noted that the reference case is not feasible, because it fails to minimise safety risks in accordance with ALARP.

It is therefore recommended that Option 1 (perform targeted LiDAR Asset Management Survey over five years) should proceed at a total project capital cost (undiscounted) of $6.762 million.

8. APPENDIX A – HIGH LEVEL SCOPE OF WORK

The scope of works is provided below:

- Engage a part time project lead / manager
- Engage a reputable Light Detection and Ranging (LiDAR) service provider utilising LiDAR technology mounted on vehicles to perform the following bush fire mitigation site surveys that will include but not be limited to measuring and identifying:
  - Electricity pole / overhead line spans
  - Conductor phase clearances
  - Leaning poles
  - Vegetation encroachment to poles and wires including that from council lands
  - Conductor and air temperatures
- Purchase 3D imagery software and perform training
- Progressively obtain the following from the LiDAR services provider:
  - 3D point cloud of sections of distribution lines
  - Laser point cloud viewed over the 3D imagery application.
  - Several reports detailing clearances of a range of assets including**:**
    - Circuit-to-circuit
    - Phase-to-phase
    - Circuit-to-ground
    - Cross-arm clearances
- Project lead / manager to progressively feed issue summary in to SAP works program.
- Project close out and post-implementation review by 31/12/2020.