# Revised Proposal

## Attachment 5.13.L.3

## Network Digitisation Business Case

## PUBLIC

January 2019

# Contents

# 1 Executive Summary

This document outlines the case for investment in Network Asset Digitisation. The supporting MS Excel model should be referred to in conjunction with this document as it contains the underlying calculations and assumptions used in the quantification of benefits and expenditure options.

The implementation of the Network Asset Digitisation programme will provide immediate net present value positive outcomes to Ausgrid and customers. The investment also enables Ausgrid to implement transformational activities that will continue to place downward pressure on network prices in the future.

The investment of $11.9m has an expected benefit to cost ratio of 1.8 times based on conservative assumptions of the benefits that can be realised immediately. Five benefits have been identified and quantified:

1. Increased revenue capture from third party assets installed on Ausgrid assets
2. Improving capital efficiency by reducing the effort associated with planning and design activities for volumetric programmes of work
3. Increasing network reliability and reducing network risk (outage, fire-starts, opex) by identifying and prioritising the installation of LV spreaders
4. Reducing capital and operational expenditure associated vegetation encroachments
5. Reducing operational expenditure by optimising vegetation management cycles

This business case comprises the capital cost requirements for Light Detection and Ranging (LiDAR) and high-resolution photography programs from FY20 into the future. The preferred option has net present value expenditure of $21.6m (NPV) over the period 2020-2034, with the net present value of the benefit over that period of $49.4m (NPV).

## 1.1 Background

There are two types of digitisation technology available, LiDAR and high-resolution photography. Whilst LiDAR and photography can be performed independently, Complete Asset Capture is a term used to refer to the use of both LiDAR and high-resolution photography together as a dataset to produce a digital visualisation of the network.

Network Asset Digitisation involves creating a fully digitised virtual network asset world or ‘digital twin’ of the physical network. Recent advances in LiDAR and high-resolution photography have now enabled a digitised virtual network to be created and kept up-to-date at a reasonable cost.

Having an up-to-date digitised virtual network enables the optimisation and efficient execution of routine tasks such as maintenance inspections and planning, network planning and surveying, emergency response, data verification, and asset capture, leading to a reduction in the required operational and capital expenditure.

## 1.2 Current Digitisation Investment

Ausgrid’s existing recurrent network digitisation program involves an annual LiDAR inspection of bushfire prone regions. The primary objective of the annual LiDAR inspection is to identify vegetation encroachments into the clearance envelope, so these can be remediated prior to the commencement of the bushfire danger period. Every three years, the annual LiDAR is supplemented with high resolution photographs of the network assets within these regions to identify asset defects. Ausgrid inspectors conduct an annual visual inspection of network assets in bushfire regions prior to the start of the bushfire season. These activities form part of Ausgrid’s ongoing operational maintenance program.

Ausgrid has recently conducted a one-off aerial LiDAR sweep of parts of the Sydney network using a provider that was able to operate within the Sydney Airport no-fly zone. Ausgrid is planning to commence a ground-based LiDAR and high-resolution photograph trial of 32,000 poles in non-bushfire areas near roadways during FY19.

## 1.3 Options Considered

Ausgrid evaluated and quantified the outcomes for three possible alternative programs:

- **Option 1:** Complete Asset Capture of all remaining network assets near roadways and ongoing LiDAR and high-resolution imagery on a three-yearly cycle
- **Option 2:** Complete Asset Capture of all remaining network assets near roadways with no new recurring program
- **Option 3:** Manual asset capture (where possible) for the remaining network assets during the five-yearly

pole and line inspections. No additional investment in LiDAR or high-resolution photography programs (existing annual LiDAR in bushfire areas will be maintained).

Under option 2, both the expenditure and benefits realised are lower.

Option 3 represents the base case of not performing any additional LiDAR and high-resolution photography beyond the current annual bushfire LiDAR program.

The table below summarises the cost-benefit analysis of the three options ($m):

| | Capex (FY20-24) (FY19 Real $) | Capex (FY20-34) (NPV) | Benefits (FY20-34) (NPV) | NPV |
|---|---:|---:|---:|---:|
| Option 1 | $11.9 | $11.5 | $49.4 | $21.6 |
| Option 2 | $8.9 | $8.4 | $22.2 | $13.3 |
| Option 3 | $10.6 | $23.7 | $12.7 | -$11.0 |

## 1.4 Proposed Program From FY20

Based on the outcome of the NPV analysis, Option 1 is recommended. It involves the expansion of the ground-based LiDAR and high-resolution photography trial to a full recurring program beginning in FY20. Ausgrid proposes to conduct the following digitisation program changes and extensions from FY20 onwards:

| Region | Roadway | Current Program | Proposed Program |
|---|---|---|---|
| Bushfire zones* (excluding Newcastle and Hunter Valley) | Near road | *Annual aerial capture excluding flight restriction areas* | *Annual ground-based capture and three yearly high-resolution photography and* once off Complete Asset Capture.<br>*Flight restriction areas will now be included in LiDAR capture.* |
| Bushfire zones* (Newcastle and Hunter Valley) | Near road | *Annual aerial capture* | Complete Asset Capture in FY20 (ground-based capture with high resolution photographs).<br>*Continue annual aerial capture from FY21.* |
| Bushfire zones* (All) | Not-near road | *Annual aerial capture and three yearly aerial photograph and defect assessment excluding flight restriction areas* | *Continue with current program* |
| Non-bushfire zones | Near road | No existing program except a once-off aerial LiDAR sweep of Sydney | Three yearly ground-based LiDAR and high-resolution photographs and a once off Complete Asset Capture |
| Non-bushfire zones | Not-near road | No existing program except a once-off aerial LiDAR sweep of Sydney | Three yearly aerial LiDAR and photographs |

**Annual bushfire area LiDAR programs have been approved separately as opex programs and associated costs or benefits are not included within the scope of this business case*

The proposed LiDAR programs will provide a complete view of the network as all assets will be captured. The recurring nature of the program will ensure Ausgrid has access to data that is of a reasonable age. Complete Asset Capture data has a useful life of 10 years so will be done at a lower frequency than photographs and defect assessment (three-year data life) and vegetation reports (maximum one-year data life).

## 2 Purpose of this Document

This document provides a summary of the justification for the capture of a complete digital view of Ausgrid's network and surrounds for the purpose of building a virtualised asset and network world.

The collection of this data will provide a detailed record of Ausgrid's assets, their condition, and location at a point in time for data evaluation and trending analysis. The collected data will enable improved asset management practices and analysis, automation of processes, and image interrogation; and will optimise field-based tasks with increased ability to plan and evaluate work from the office providing a more efficient, effective and valued service to customers.

## 3 Context

### 3.1 Ausgrid's Network

Ausgrid's network extends over an area equal to 22,275 square kilometres consisting of approximately 510,000 network poles supporting approximately 32,000 route kilometres of overhead conductor. The network traverses through CBD, urban and rural environments. Approximately 25% of the overhead network assets fall within a bush fire prone area in both rural and urban areas. 72% of the overhead network resides within 10m of the road corridor and the remaining network extends over private and public land.

The figure below shows the extent of Ausgrid's network.

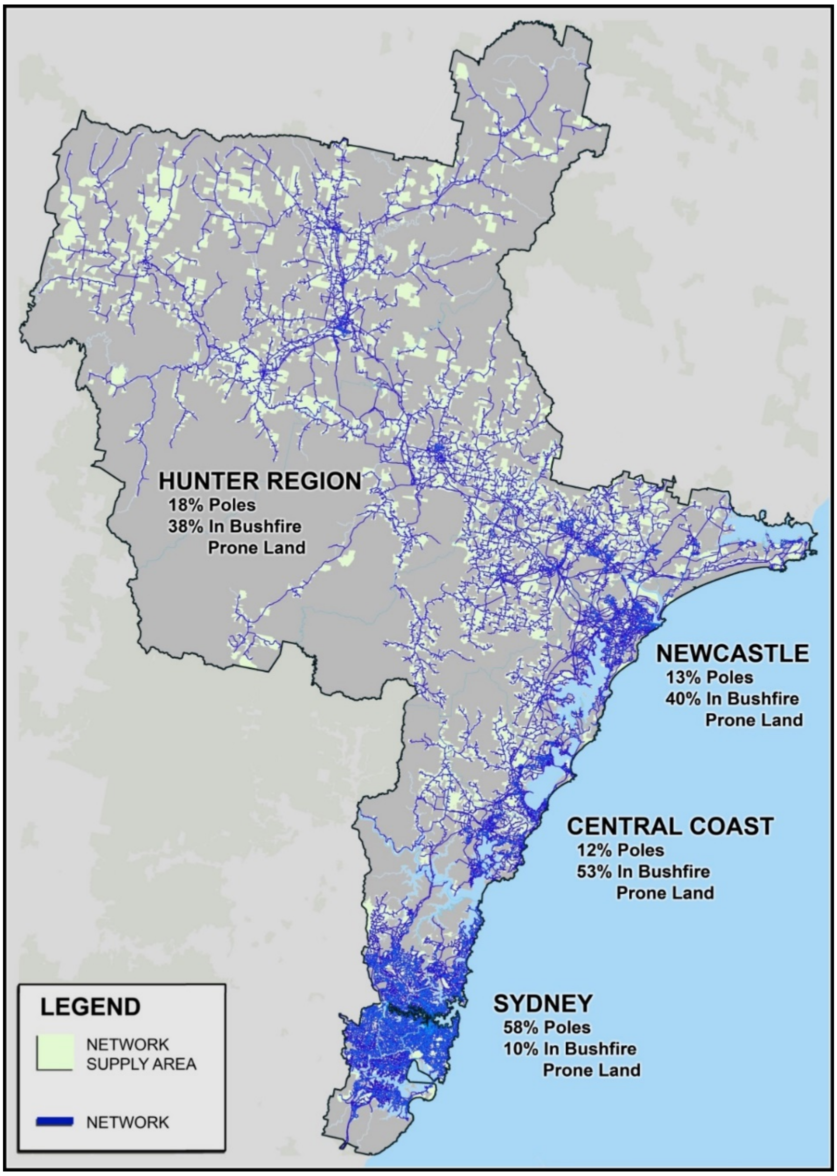


Figure 1. An overview of Ausgrid's network and supply area

## 3.2 Existing Network Asset Data

Ausgrid utilises a large amount of data to efficiently and safely manage its network. Many of the established data sources have been utilised for decades and all the efficiencies that can be driven by the use of this data have been exhausted. To achieve the proposed operating and capital cost efficiencies forecast in the 2019-2024 regulatory period, a range of new and emerging data sources are being proposed.

The primary uses of network asset data are for network augmentation planning, asset replacement planning, coordinating repair and maintenance and emergency response and for reducing risks, in particular managing Ausgrid’s exposure to bushfire risks.

Ausgrid collects a large amount of data through manual processes. This includes asset, site inspection data, and information from asset failures and repairs. The data is collected manually and entered into Ausgrid’s asset systems by Ausgrid employees and contractors. Information requirements over time alter resulting in data gaps across the complete asset class. Due to the cost of manual complete asset data collection programs, data collection is done opportunistically and often only in response to an event such as an asset failure.

Emerging and improving data sources, such as LiDAR, LV network monitoring and smart metering, provide new sources of efficiency that will allow Ausgrid to continue to improve its productivity and manage costs.

## 3.3 Existing LiDAR programs

Ausgrid currently utilises LiDAR data to identify vegetation defects on spans within bush fire areas (25% of its overhead network). This obviates the need for onsite observations and manual assessment in these areas. The LiDAR data is processed by the contract provider and delivered in a suitable format to allow defect notifications to be created automatically within Ausgrid’s asset management systems. This practice commenced as a trial in 2011 and has been conducted annually since as part of the routine maintenance program. Ausgrid now holds seven years of LiDAR data for approximately 25% of its network, but only in bushfire areas.

## 3.4 Existing High Definition Imagery Programs

The capture of high definition photos has recently been introduced as part of routine ground-based inspections to supplement the aerial photography that was introduced in 2013 with the second round of LiDAR capture in bushfire areas. Combining captured photos with recorded metadata, including the inspection task and asset identifier, allows Ausgrid to automatically geo-code photograph locations, link to the inspection task, and asset recorded in its asset management systems.

Ausgrid have been collecting aerial based high definition images on its poles within bush fire areas since 2013, covering approximately 170,000 poles and 470,000 photos. This has proved to be a successful inspection technique; replacing onsite visual inspections with office-based photo reviews. This process involves comparing the captured photo with a series of example photos in a defect library and/or utilising individual subject matter expertise. This process has been centralised and improves consistency in the way risk is assessed and actioned in the organisation. Additionally, this method links the photo to detailed information recorded about the assets condition.

The high definition imagery is not currently used to capture assets, asset details, or data validation on assets.

# 4 Technology Overview

## 4.1 LiDAR

LiDAR data capture features a 3-dimensional view that allows the measurement between detected data points and analysis of the topological relationships. LiDAR data enables the identification of features such as; vegetation, ground, poles, lines and buildings, as illustrated in Figure 2 and 3. This is an effective means for identifying and monitoring network encroachments and locating the spatial positioning of assets and features without the need to conduct a site visit. Multiple LIDAR scans can be further utilised to undertake change detection in assets and provide the means for analytics regarding assets over a period. This form of data collection is rapid and can be executed on a large scale covering mass areas or along a route or corridor.

Data collected through LiDAR is large and dense, historically requiring specific complex software to read and analyse. Together with data, image and computer processing; LiDAR data providers have recognised this and now offer software packages and tools to access and analyse LiDAR data more efficiently.

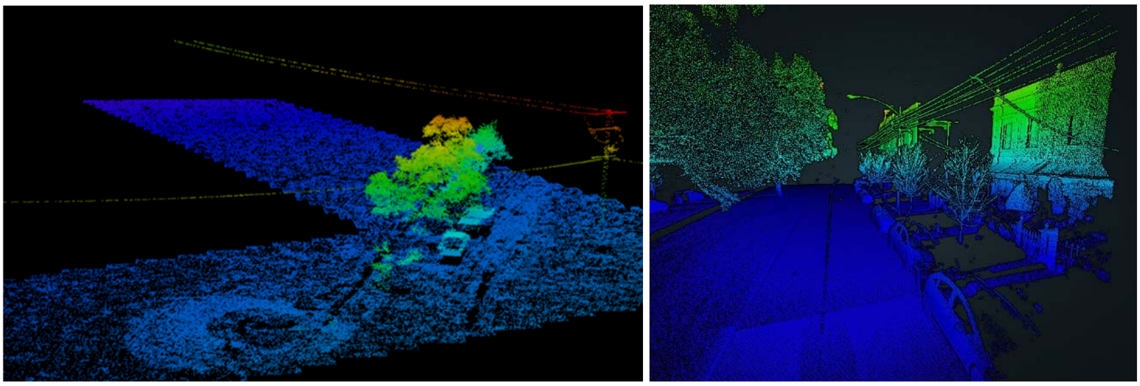

Figure 2. LiDAR data collected via a helicopter (left), and LiDAR data collected via ground vehicle (right).

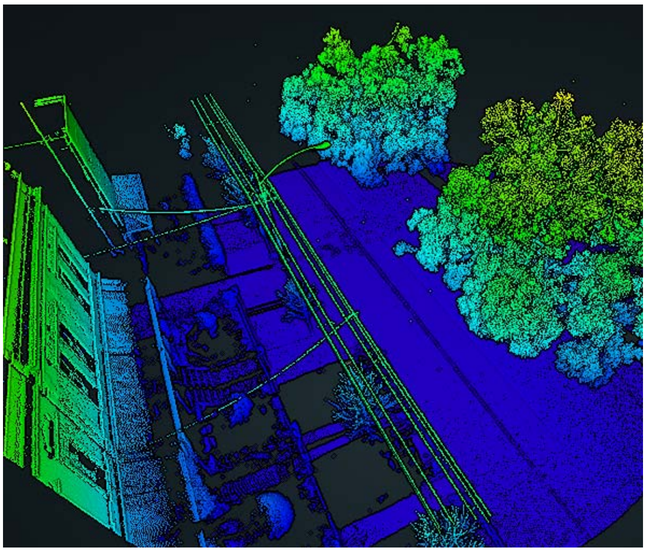

Figure 3. The same data collected as Figure 2 (right) showing distinguishable features, such as lines, services, streetlight, vegetation buildings and ground.

## 4.2 High Definition Imagery

Spatially enabled high definition imagery provides a unique way of capturing information that can be interrogated by a user to extract data and information on assets and their surrounds (e.g. asset condition and proximity to street features). Imagery and photo capture delivers a fully detailed capture method where the capture requirements, or subject does not need to be predefined, enabling a method to capture data required in the future. With the development in advanced image recognition, the extraction of information captured within images has the potential to be automated. This also provides the necessary data to feed into machine learning algorithms to provide automated predictive analytics. Figure 4, below, is an example of high definition image of a pole top.

Figure 4. High definition image of a pole top, which can be reviewed for signs of asset defects.

## 4.3 Complete Asset Capture / Combined LiDAR and High Definition Imagery

LiDAR data and high definition imagery can be combined to provide a more powerful source of information than either dataset on its own. The imagery provides visual context to the underlying LiDAR data and makes the image a 3-dimensional representation rather than 2 dimensional. Features visible in the captured imagery can be measured and analysed as 3 dimensional objects using the LiDAR data collected at the same time.

When combining these two datasets it is advantageous to ensure that both the LiDAR and imagery align not only geographically but in time. This ensures what is being visually represented in the photograph corresponds directly with the underpinning LiDAR data used for analysis and measurement.

The combined datasets can be assessed, currently manually but in future using software and machine learning algorithms, to identify and tag assets with detailed information including material type and pole top configurations. This produces an easy to use and filterable tool for Ausgrid staff to find information about the network. Ausgrid can then easily find particular configurations, such as long LV spans without spreaders, to target for modification.

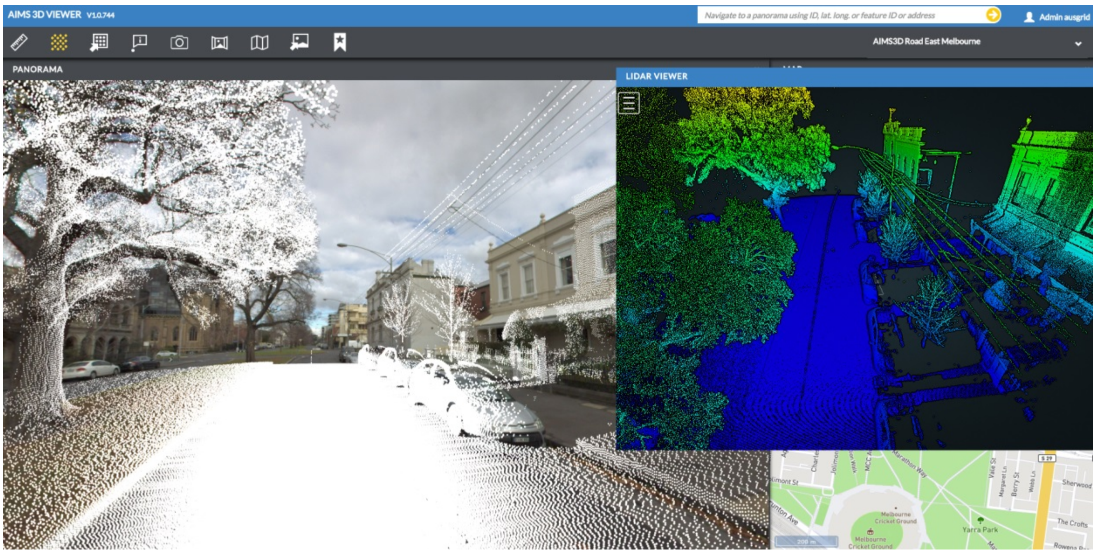


Figure 6. An example of combined LiDAR and High Definition Imagery

# 5 LiDAR Considerations

The section outlines the different methods and technologies that can be used to capture LiDAR data, the challenges affecting the technologies that can be used in Ausgrid's network, data warehousing and other software requirements and the LiDAR data capture providers available in the NSW market.

## 5.1 Capture Technology

LiDAR and imagery can be collected with sensors attached to aircraft and ground-based vehicles. Sensors can also be fixed to stationary mounts to capture the internal configuration of structures such as; buildings, underground pits and substations.

Capture types can be broken into the following five groups:

1. **Aerial grid based area capture** - the area captured covers mass gridded areas capturing everything with a grid style flight schedule. This form of capture can be done at higher altitudes and is predominantly LiDAR focused limiting the opportunity to capture high definition asset imagery.
2. **Aerial based corridor capture** – the area captured is based on a route and the capture area has a limited width usually based on the LiDAR scanners swath width combined with altitude, which can be combined with imagery with only limited alignment.
3. **Aerial based high definition imagery** – this is achieved through targeted high definition photo capture of individual assets, which are geographically referenced.
4. **Ground based corridor coverage** - the area captured is based on a route and limited by vehicle access, however high definition imagery can be captured at the same time providing an integrated view at a single point in time.
5. **Stationary site capture** – the area captured is restricted to a site where multiple placements for a short period can be utilised to provide a single integrated view of the internal and external arrangements of a building or piece of infrastructure at a single point in time.

## 5.2 Capture Challenges

### 5.2.1 Flight Restriction Areas

The Sydney International and Domestic Airport has a flight restriction area around it. The restricted flight area encompasses 225,891 of Ausgrid's poles (44%) and 11,298 route kilometres of overhead network (51%).

Whilst it is possible to perform aerial based acquisition in the flight restriction area, flight times are limited and can be revoked depending on weather conditions and changes in flight paths. These restrictions hinder the ability to carry out efficient and timely capture to achieve Ausgrid's requirements (e.g. for pre-summer bush fire inspections).

### 5.2.2 Network Outside the Road Corridor

The majority of Ausgrid's network is within 10 metres of the road corridor with 72% of the overhead conductors and 88% of poles and streetlight columns.

Ground based acquisition is not suitable for the capture of assets beyond the road corridor. This method of data acquisition is providing a more efficient, and more accurate (due to the proximity to the assets) form of data collection than other LiDAR collection methods. A move towards this approach is likely to provide significant gains where it can be utilised.

## 5.3 Data Warehosing and End-User Software Tools

LiDAR data can be managed by third parties, such as the data provider, or managed in-house within Ausgrid's own databases. Presently, Ausgrid stores all data on its internal network and infrastructure. This approach has been reasonable as only one provider was used, and the amount of data was relatively low due to limited network coverage.

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# 6 Benefits and opportunities

With the proposed roll-out of Complete Asset Capture, and recurring LiDAR and photography, five benefits have been identified that have immediately quantifiable value. These benefits are used as the basis of the cost-benefit analysis / Net Present Value calculation in identifying a preferred option. The benefits are:

1. Increased revenue capture from third party assets installed on Ausgrid assets
2. Improving capital efficiency by reducing the effort associated with planning and design activities for volumetric programmes of work
3. Increasing network reliability and reducing network risk (outage, fire-starts, opex) by identifying and prioritising the installation of LV spreaders
4. Reducing capital and operational expenditure associated vegetation encroachments
5. Reducing operational expenditure by optimising vegetation management cycles

| Benefit and Opportunity | DATA / INFORMATION REQUIREMENTS | | | |
|---|---|---|---|---|
| | LiDAR Capture | Reoccurring LiDAR Capture | HD Imagery | Complete Asset Capture |
| 1 Increased revenue capture from third party assets installed on Ausgrid assets | ✗ | ✗ | ✓ | ✓ |
| 2 Improving capital efficiency by reducing the effort associated with planning and design activities for volumetric programmes of work | ✗ | ✗ | ✓ | ✓ |
| 3 Increasing network reliability and reducing network risk (outage, fire-starts, opex) by identifying and prioritising the installation of LV spreaders | ✓ | ✗ | ✓ | ✓ |
| 4 Reducing capital and operational expenditure associated vegetation encroachments | ✓ | ✓ | ✗ | ✗ |
| 5 Reducing operational expenditure by optimising vegetation management cycles | ✗ | ✓ | ✓ | ✓ |

In addition to the immediately realisable benefits, the roll-out also enables Ausgrid to implement future transformational activities. If realised, these opportunities would support further efficiencies and cost reductions; however, they have not been included within the cost-benefit analysis as their value and timing are uncertain.

## 6.1 Quantified benefits

### 6.1.1 Additional Revenue Capture

Where a Complete Asset Capture is performed, the data can be used to ensure accurate revenue recovery for third party objects connected to Ausgrid assets. Complete Asset Capture facilitates the correct identification and billing of these third-party assets. Some example of third-party assets includes telecommunication network equipment and use of poles by local authorities.

The data can also be used to identify additional opportunities for suitable assets that can be used by third parties to grow the revenue stream and facilitate the connection process.

Third party assets on condemned poles can also increase maintenance costs and hamper efficient pole replacement works if not known. The LiDAR and photography data can be used to identify these assets prior to maintenance and capital works to improve workforce efficiency.

### 6.1.2 Improved Capex Efficiency

Access to LiDAR and imagery data with Complete Asset Capture will reduce the need for site inspections. This will be most beneficial for replacement programs for high volume assets such as poles.

An office-based analyst will be able to collect most of the required site information using the LiDAR and imagery tools that would traditionally require a site visit. The decrease in travel and inspection time will reduce the capitalised cost of the asset replacement.

Other information in the LiDAR data can be used to select the optimal replacement asset/model/type rather than a basic approach of using a like-for-like or generic replacement to reduce future expenditure requirements.

The benefits from the increased efficiency have been incorporated into Ausgrid's proposed capital program for the FY20-24 regulatory submission. These efficiencies form a minor part of the embedded productivity improvements in Ausgrid's proposed capital program.

### 6.1.3 Identification of Missing LV Spreaders

LV Spreaders are insulated bars that are attached to LV overhead lines to prevent the conductors from touching. During storms and high winds, conductors on lines that do not have spreaders can clash, which can cause sparking and potentially lead to outages and bushfires.

Ausgrid has installed LV Spreaders throughout its network but there are known gaps in their installation. Basic LiDAR is not accurate at identifying LV spreaders due to their small diameter. A Complete Asset Capture will identify all LV Spreaders. Ausgrid can then use the LiDAR data of the conductors to identify bays where the installation of LV Spreaders should be prioritised.

The installation of LV Spreaders will reduce bushfire risk but will incur an additional cost to install the spreader. Due to the high damage to public and private assets as well as the potential for fatalities in large bushfires the risk reduction from an LV Spreader greatly outweighs the installation cost and the remaining risk value contributes to the case for LiDAR with Complete Asset Capture.

### 6.1.4 Reducing Vegetation Caused Outages

Vegetation encroachment into the clearance envelop around overhead conductors can lead to the clashing of mains and powerline failure causing network outages.

Through better vegetation information and improved vegetation management activities in proximity to the powerlines the number of line failures and outages can be reduced.

### 6.1.5 Vegetation Management Transformation

Understanding tree growth rates through trending and species identification, knowledge of specific span by span vegetation trimming frequency history and projections, network construction, tree density per span, council or customer owned trees, all lead to better informed targeted strategies and practises for vegetation management.

The large-scale capture of vegetation clearances at specific points of time provides insight into vegetation management contractor performance and providing audit records.

### 6.1.6 Vegetation Trimming Deferral

In the year that a LiDAR sweep is conducted the vegetation report data can be used to adjust the planned vegetation cycle due to take place in that year. This data is short-lived as the trees will continue to grow and the information will quickly become dated. This benefit is best realised through species identification and recurring LiDAR sweeps aligned to cutting cycles.

The LiDAR data will show where trees that are due to be trimmed have not encroached on the clearance envelope around overhead conductors. These trees can then be removed from the current year trimming cycle and added to a trimming cycle in a later year. The trimming cannot be avoided but it can be deferred and the financing cost of that expenditure that would have been incurred can be avoided and counted as a benefit.

## 6.2 Further Transformational Opportunities

The following opportunities have not been quantified but provide further opportunities for business transformation, greater efficiencies and value to customers.

### 6.2.1 Identification of Hazard Trees

Hazard trees primarily refers to trees that are dying or have died and are now at an elevated risk of falling onto network assets. This could lead to customer outages, electrocution of members of the public or a bushfire.

The identification of hazard trees requires a Complete Asset Capture, which will identify the species of each tree followed by regular recurring LiDAR to determine the growth rate of the tree. Hazard trees will have lower than expected growth rates and may not be growing at all. Software can be used to review all LiDAR data following a recurring LiDAR sweep to quickly identify all hazard trees and prioritise them for removal.

### 6.2.2 Information Partnering

A large-scale data capture program not only captures Ausgrid asset data but also that of other utilities, organisations, and councils or supporting data. LiDAR data captures full terrain models used by councils, surveyors and RMS for road design, flood modelling and drainage. Ground based vehicle imagery capture collects the streetscape and road signage details also of interest to RMS and councils.

### 6.2.3 Standard Constructions – Preassembled Job Packaging & Materials Delivery to Site

"Standard construction" type identification. Identifying the construction configuration on a pole can provide the necessary data to analyse the loading on a pole and automatically assess if it has been constructed to the appropriate design standard. Standard construction information ensures that when it is replaced or augmented it is built to the appropriate design standard, which can be preassembled or "shrink wrapped" for delivery to site for construction without the need for a tailored design works.

An up-to-date digital reflection of the network will support Ausgrid's ability to re-construct the network in the event of a major storm. It provides a view of the network prior to the event so if damage caused, to the network, is so extensive that the construction and configuration is not apparent it can be viewed. Additionally, with detailed asset capture recorded into Ausgrid's Asset Management system, and integration points between the virtual world and GIS; the system can pre-determine the inventory required to repair the network by just defining the damaged area.

### 6.2.4 Design and Planning Transformation

Line spacing between circuits for load and fault level calculations leading to a robust network and improved reliability. Survey data to be used for option route development, built into cost objects to calculate project costs dynamically for optimal network construction.

### 6.2.5 Refined Maintenance Schedules and Packages

More accurate and reliable asset data allows for a finer level of asset grouping and tailored maintenance programs, resulting in better risk management and delivery efficiencies.

### 6.2.6 Asset Life Extension

Improvements in asset condition and configuration assessments leading to improved asset strategies including life extensions and targeted repairs. For example:

- Pole top loading analysis can potentially result in longer life of poles, and deferment of CAPEX. This includes utilising improved service wire length and positioning.
- Replacement of missing pole caps extends the life of a pole and therefore leads to a reduction in CAPEX.
- Identification of further opportunities to substitute pole reinforcement works rather than replacement.

### 6.2.7 Targeted Service Wire Replacements

The capture of this information with updates to Ausgrid's systems is required for more accurate analysis which leads to accurate AER reporting and greater efficiency in replacement strategies with specific asset targeting.

### 6.2.8 Network Augmentation / Replacement (UG/CCT/ABC)

Potential for construction type changes to further improve energy supply services. For example, open wire replacement allowing for reduced vegetation clearances and therefore, longer cycle vegetation contracts and lower operational costs attributed to vegetation management.

### 6.2.9 Asset Data

As part of Ausgrid's normal operations, potential and emerging risks are identified through observations, incidents or asset failures. With a complete network capture of LiDAR and high definition imagery these risks can be quickly and clearly understood and actioned with an appropriate informed and prioritised approach.

Examples include:

- Investigations into ad-hoc asset failures. Having a detailed view of the asset prior to failure can help to investigate the failure cause and therefore the appropriate standard change or mitigation works to prevent or predict the reoccurrence of a similar incidence.
- Identification of redundant assets and network, including the network construction so replacement can be prioritised based on risk. For example, LV mains supplying replaced public lighting.
- UGOH replacements.
- Identification of LV parallels left on the network in their abnormal state.
- Identification of private poles (not in bush fire prone areas). Private poles within bush fire prone areas have been captured as part of pre-summer bush fire season inspections, however areas outside of bush fire areas have not.
- Switch location and switch number verification supporting data requirements of an ADMS.

# 7 Options

The objective of the LiDAR program is to:

1. Rapidly capture detailed asset data.
2. Provide the framework to manage the growing volume of asset data.
3. Provide the flexibility to link and integrate with existing and future business systems.
4. Provide analytical tools and access to network asset data and information.
5. Enable opportunities for further transformation initiatives.

The options presented below meet these objectives to varying degrees. The analysis includes a full cost benefit assessment which values the benefits associated with each objective to provide confidence that the preferred option is beneficial to customers.

The cost-benefit analysis includes both financial and non-financial benefits. Non-financial benefits include improvements in public and worker safety, reduced outage frequency and length and reduced bushfire risk. The detailed assumptions underlying the cost-benefit analysis are contained within the model and in Appendix A – Cost-Benefit Analysis Methodology.

The final decision is made by selecting the option with the highest NPV as the preferred option. If no option has a positive NPV, there will be no change to Ausgrid's existing approach.

## 7.1 Options Summary

Ausgrid evaluated and quantified the outcomes for three possible LiDAR programs:

- **Option 1:** Complete Asset Capture of all remaining network assets near roadways and ongoing LiDAR and high-resolution imagery on a three-yearly cycle
- **Option 2:** Complete Asset Capture of all remaining network assets near roadways with no new recurring program
- **Option 3:** Manual asset capture (where possible for the remaining network assets during the five-yearly pole and line inspections. No additional investment in LiDAR or high-resolution photography programs (existing annual LiDAR in bushfire areas will be maintained).

Under Option 2, both the expenditure and benefits realised are lower.

Option 3 represents the base case of not performing any additional LiDAR and high-resolution photography beyond the current annual bushfire LiDAR program.

The table below summarises the cost-benefit analysis of the three options ($m):

| | Capex (FY20-24) (FY19 Real $) | Capex (FY20-34) (NPV) | Benefits (FY20-34) (NPV) | NPV |
|---|---|---|---|---|
| Option 1 | $11.9 | $11.5 | $49.4 | $21.6 |
| Option 2 | $8.9 | $8.4 | $22.2 | $13.3 |
| Option 3 | $10.6 | $23.7 | $12.7 | -$11.0 |

## 7.2 Option 1 – Full LiDAR Program

### 7.2.1 Description

This option involves the widespread use of LiDAR to manage Ausgrid's network from FY20 onwards. This option includes:

- A once off Full Asset Capture of all network assets near roadways including in bushfire areas
- A three-yearly cycle for LiDAR sweeps in non-bushfire areas using ground-based LiDAR and high resolution photography with defect assessment near roadways and corridor following aerial LiDAR with photographs and defect assessment away from roadways

- A complete extract and provision of all captured information
- [redacted]

This option will ensure the entirety of Ausgrid's network is captured by LiDAR and as much as possible with existing technologies is digitised in a Full Asset Capture.

The advantages of this option are that it provides the maximum amount of data so that all LiDAR benefits will be realised by the network. This includes benefits to operating and capital costs of maintaining the network and reduction in safety, outage and bushfire risks.

### 7.2.2 Costs

This option has a capital cost of $11.9m (FY19 Real $) within the FY20-24 period, with ongoing operational costs outside the FY20-24 period and the increases not included in the revised regulatory proposal. There is a capital cost of $11.5m (NPV) within FY20-34 period.

### 7.2.3 Benefits

This option has the quantified benefits of $49.4m (NPV) within the FY20-34 period. The benefits are delivered from increased revenue capture from third-party assets, improved capital efficiency, reduction in risk and outages with targeted LV spreader installations, reduced capital and operation expenditure associated with vegetation encroachments, and reducing operational expenditure by optimising vegetation management cycles.

### 7.2.4 NPV

This option has an NPV of $21.6m within the FY20-34 period.

## 7.3 Option 2 – Limited LiDAR Program

### 7.3.1 Description

This option involves the widespread use of LiDAR to manage Ausgrid's network from FY20 onwards. This option includes:

- A once off Full Asset Capture of all network assets near roadways including in bushfire areas
- A complete extract and provision of all captured information
- [redacted]

This option will ensure the entirety of Ausgrid's network is captured by LiDAR and as much as possible with existing technologies is digitised in a Full Asset Capture.

The advantages of this option are that it provides a full capture of the network so that many LiDAR benefits will be realised by the network. This includes benefits to operating and capital costs of maintaining the network and reduction in safety, outage and bushfire risks.

However, as this option does not include recurring LiDAR sweeps outside of the bushfire areas some benefits will not be realised. This includes future vegetation encroachment information and vegetation growth rate information would allow for better targeting of Ausgrid's vegetation management spending and help with the identification of hazard trees to mitigate future network risks.

### 7.3.2 Costs

This option has a Capital cost of $8.9m (FY19 Real $) within the FY20-24 period. There is a capital cost of $22.2m (NPV) within FY20-34 period.

### 7.3.3 Benefits

This option has the quantified benefits of $22.2m (NPV) within the FY20-34 period. The benefits are delivered from improved capital efficiency, reduction in risk and outages with targeted LV spreader installations, a reduction in capital and operation expenditure associated with vegetation encroachments limited to FY22 without reoccurring benefits. Increased revenue capture from third-party assets identified in the base year data collection, however growth of third party installations are not discovered.

This option does not provide the information required to realise the benefits for optimising vegetation management cycles from calculated vegetation growth rates.

### 7.3.4 NPV

This option has an NPV of $13.3m within the FY20-34 period.

## 7.4 Option 3 – No Additional LiDAR or Imagery Investment

### 7.4.1 Description

This option represents the discontinuation of all LiDAR or high-definition image collection activities on Ausgrid's network. Asset data collection in this option will be manually collected at the time of Ausgrid's pole and line inspections on a fiver yearly cycle.

The use of annual LiDAR sweeps in bushfire areas will continue as these programs have already been approved as opex programs and are not within the scope of this business case.

If this option is selected it may have implications for the proposed capital expenditure efficiency factor applied to Ausgrid's capital programs for the FY19-24 planning period.

### 7.4.2 Costs

This option has a Capital cost of $10.6m (FY19 Real $) within the FY20-24 period. There is a capital cost of $12.6m (NPV) within FY20-34 period. The cost is a result of manually collecting the data and associated logistics and administration.

### 7.4.3 Benefits

This option has the quantified benefits of $12.7m (NPV) within the FY20-34 period. The benefits of this option are limited by the less effective data collection method and are realised over a longer period due to the delay in the information availability, caused by a longer collection cycle.

### 7.4.4 NPV

This option has a negative NPV of -$11.0m.

# 8 Proposal

Ausgrid proposes to allocate $11.9m (FY19 Real $) in Capital funds during the planning period from FY20 to FY24 to implement Option 1: Full LiDAR Program.

This option is proposed as it has a positive NPV and its NPV is higher than the NPV of all other options. The options that have been assessed have included all credible options that produce a comprehensive range of benefits and there are no possible options that were not assessed that would reasonably be expected to perform better than the recommended option.

# 9 Appendix A – Cost-Benefit Analysis Methodology

## 9.1 Methodology

Ausgrid has quantified the costs and benefits of alternative network digitisation options to determine the option that maximises the net benefit over time in present value terms.

Ausgrid has modelled the net present value of costs and benefits of three alternative credible investment options. The alternate options use different network digitisation technologies or timing of the use of these technologies. The underlying driver of both the costs and benefits used in this is the number of poles captured by a particular digitisation technology at a point in time.

All costs and benefits are discounted to FY19 dollars using a 3.9% discount rate. The forecast period covers FY20 through FY34 for a total of 15 years.

Costs are applied per pole captured and digitised based on the number of poles proposed to be covered by each option on an annual basis.

The modelling underlying the business case considered six sources of potential benefit:

- Additional revenue capture
- Improved capex efficiency
- Identification of missing LV spreaders
- Reducing vegetation caused outages
- Vegetation management transformation
- Vegetation trimming deferral

The benefits captured by these categories include reductions in operating expenditure, capital expenditure, fire risk and unserved energy risk and increased revenue. In some cases, the benefits are partly offset by additional costs outside of the network digitisation program that would be required to realise the benefits, such as additional vegetation trimming costs. These are counted as a reduction to the benefit and not as an increase to the capital or operating expenditure values for the Network Digitisation program.

## 9.2 Assumptions

The sections below outline the assumptions for capital costs, operating costs and benefits.

### 9.2.1 Cost Assumptions

Costs of services have been obtained from each LiDAR service provider, either through requests for quotation or as actual costs charged for existing or historical LiDAR services.

To ensure consistency over time, as some quotes are older than others, all prices have been adjusted using Ausgrid's standard CPI adjustment factor to equivalent 2018/19 dollars.

Data management and analytics costs are added on top of all other costs at a rate of 15% of all other expenditure incurred during each year. As these costs are dependent on the volume of data received it is considered reasonable to apply this as a percentage of the expenditure on data collection (which is closely related to the volume of data received) during each year.

| Provider | Service | Unit Rate ($ FY19) |
|---|---|---|
| [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] |
| | [redacted] | [redacted] |
| | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] |

[redacted]

No cost escalators have been applied in the modelling over the forecast period.

The methods used for allocating costs between capital and operating expenditure are discussed below.

#### 9.2.1.1 Capital Cost Allocation Assumptions

Capital costs are calculated as follows:

- The first time a pole is captured the entire cost (including LiDAR, vegetation reports, imagery, complete asset capture and defect assessment of the data) is counted as capital costs as the information contributes to the establishment of a long lived data asset for the network
- The second time a pole is captured 50% of the cost is counted as capital costs as data that requires two captures (i.e. growth rates of vegetation) is considered an asset to the network.
- During the second, third and fourth LiDAR capture cycles (if applicable to the option), additional poles equal to 2% of the known poles at the start of the cycle are assumed to be found. This is based on findings from existing LiDAR programs. All LiDAR costs are per pole so additional poles that are found increase the cost of procuring the data from the provider. The entire cost for these additional poles is counted as capital costs (as 50% the second time these poles are captured)
- In bushfire areas, where complete asset capture is done the additional cost for this service is counted as capital expenditure. The remaining costs (LiDAR, vegetation reports, etc.) are covered by other programs and are not within the scope of this business case so are not included in any expenditure category)
- Capitalised data management and analytics costs are 15% of all other capital costs

### 9.2.2 Operating Cost Allocation Assumptions

Operating costs are allocated as follows:

- The second time a pole is captured 50% of the cost is counted as operating costs
- From the third capture onwards, all LiDAR capture costs are counted as operating costs
- Operating costs for data management and analytics are 15% of all other operating costs
- [redacted]

### 9.2.3 Benefit Assumptions

The benefit assumptions are outlined by benefit source in the sub-sections below.

Ausgrid has identified other benefits beyond those included below. However, to simplify the modelling and to produce a conservative assessment of the total benefits available, Ausgrid opted to only quantify the six major benefits presented here. The total benefits of the options is therefore likely to be higher than produced by the modelling used for this business case.

#### 9.2.3.1 Additional Revenue Capture

Additional revenue capture requires a complete asset capture to identify all objects attached to network assets. The benefit can also be achieved with a manual inspection program specifically targeting this with an assumed effectiveness of 60% relative to LiDAR.

[redacted]

[redacted]

#### 9.2.3.2 Improved Capex Efficiency

Improved capex efficiency requires a complete asset capture to identify all objects connected to network assets, detailed network asset type information and clearances to nearby network and/or non-network objects. The benefit can also be achieved with a manual inspection of pole top configurations with an assumed effectiveness of 50%.

The information collected through LiDAR is used to avoid a percentage of manual inspections when doing asset replacements. Ausgrid has conservatively limited the scope of this benefit to the annual pole and cross arm replacement programs.

Ausgrid estimates that, where LiDAR data has been collected, 0.2 site inspections per asset replacement can be avoided (one site visit per 5 replacements). Standard practice is to have 2 site inspections for each replacement so the reduction in site visits is a conservative 10%. The avoided cost per site visit is $158.77, which was obtained form Ausgrid's historical data for such inspections.

#### 9.2.3.3 Identification of Missing LV Spreaders

Identification of LV Spreaders requires a complete asset capture as LiDAR alone has been found to miss some LV Spreaders due to their small size. The benefit can also be achieved with a manual inspection program specifically targeting this with an assumed effectiveness of 60% relative to LiDAR.

Ausgrid has estimated that there are 31,815 LV Spreaders that have not been installed on the network based on known number of LV spans, procurement and warehouse information and an assumption that 10% of spans without spreaders require them. The model assumes that these missing spreaders are spread evenly across the network and are not biased towards or away from the parts of the network that will be included in a complete asset capture.

Ausgrid calculated the cost of each additional spreader as $442 using information on LV Spreaders installed between July 2017 and September 2018.

For each additional spreader installed, there are three sources of benefits. These are:

1. Avoidance of fire risk due to clashing lines during high winds
2. Avoidance of outages due to lines clashing or contacting nearby assets causing a fuse to trip at the distribution substation
3. Avoidance of repair costs due to damage caused by lines clashing or contacting nearby assets

Fire risk was calculated from Ausgrid's historical fire start data which shows 8 fires caused by LV lines clashing over a five year period, or 1.6 events per year. This was multiplied by Ausgrid's standard fire risk value (used in replacement expenditure risk modelling) including grossly disproportionate factors. This risk was spread equally over all poles in the network to determine the benefit captured by the LiDAR complete asset capture program.

Outages risk was calculated assuming that an outage would result in the loss of a low voltage distribution feeder for four hours with an average of 50 customers affected and average load of Ausgrid customers of 0.63kW/hr. Ausgrid estimated that 0.5% of the spans without an LV Spreader (and among the 10% assumed to require an LV Spreader) would cause an outage each year. A VCR of $40/kWh was used to value the avoided risk.

Repair costs were calculated by assuming that each failure that caused an outage would incur $2,000 of repair costs.

#### 9.2.3.4 Reducing Vegetation Caused Outages

Reducing vegetation caused outages requires at least two LiDAR captures to determine the growth rate of vegetation. Half of the benefit is assumed to be obtained after the second capture and the full benefit after a third capture. This is because the additional information from the third capture increases the business' confidence in the growth rate data.

Outages risk was calculated assuming that an outage would result in the loss of a low voltage distribution feeder for four hours with an average of 50 customers affected and average load of Ausgrid customers of 0.63kW/hr. Ausgrid estimated that 4.0% of the spans without vegetation growth rate data would be at risk of an outage each year due to encroaching vegetation. Of these, Ausgrid assumed 0.5% would result in an outage each year. A VCR of $40/kWh was used to value the avoided risk.

This benefit will incur additional vegetation management costs to benefit from the growth rate information by bringing forward or increasing the frequency of some vegetation management.

#### 9.2.3.5 Vegetation Management Transformation

Vegetation management transformation requires a LiDAR capture each year to better target Ausgrid's vegetation management program. If the assets are only captured during a multi-year cycle benefits are only gained from the poles captured in the current year. The benefit can also be achieved with a manual inspection program specifically targeting this with an assumed effectiveness of 60% relative to LiDAR.

Vegetation management produces capital cost benefits from the reduction in repair costs due to failures of service mains due to vegetation and operating cost benefits from the reduction in vegetation management costs around overhead mains. Both benefits have been estimated at $400/affected span.

Ausgrid estimates that vegetation management transformation will avoid 1% of service mains failures in areas of the network included with a LiDAR capture.

Ausgrid estimates that vegetation management transformation will avoid 1% of trees targeted for trimming per annum in areas of the network included with a LiDAR capture.

#### 9.2.3.6 Vegetation Trimming Deferral

Vegetation trimming deferral requires at least two LiDAR captures to determine the growth rate of vegetation. Half of the benefit is assumed to be obtained after the second capture and the full benefit after a third capture. This is because the additional information from the third capture increases the business' confidence in the growth rate data.

Ausgrid has estimated that, where the LiDAR data is available, 2% of trimmings can be deferred. This equates to a 2% reduction in the related $46m vegetation management program, adjusted for the portion of the network captured by the required level of LiDAR.