5.13.L

Project justifications for operational technology replacement programs

Ausgrid

Content

1 OVERVIEW OF THE OPERATIONAL TECHNOLOGY & INNOVATION PROGRAM

The Operational Technology & Innovation program encompasses Ausgrid's core operational technology requirements for the regulatory period. It comprises five sub-programs, which are outlined below. The total budget is forecast to be $126m for the FY20-24 regulatory period.

- **Program 1 - Advanced Distribution Management System**

  This program covers the ongoing replacement program of Ausgrid's Distribution Network Management System (DNMS) with a commercially available Advanced Distribution Management System (ADMS). This is a transformational project to establish an industry best practice control system to meet changing stakeholder needs and regulations.

- **Program 2 - Network Innovation Program**

  This program covers a range of innovative network technology pilots including expansion of previous trials in order to develop advanced solutions to resolve network needs more efficiently than traditional network investment approaches.

- **Program 3 - Planning and Technology Data Usage**

  This program covers data system enhancements and the acquisition of detailed asset data to enable a higher level of service delivery and improve delivery efficiency over time.

- **Program 4 - Operational Technology Security**

  This program covers mandatory Operational Technology cyber security upgrades and capability enhancements to meet core compliance requirements under Ausgrid's Critical Infrastructure Licence Conditions and federal government guidelines for critical infrastructure.

- **Program 5 – Control System Core Refresh**

  This program covers periodic critical upgrades and refresh of Ausgrid's existing core control system servers, operator work stations and network equipment such as routers, switches, firewalls and operator work stations.

2 PROGRAM 1 – AVDANCED DISTRIBUTION MANAGEMENT SYSTEM

2.1 Program description

The Advanced Distribution Management System (ADMS) program will transform Ausgrid's network management environment by implementing a world class ADMS with more robust, adaptable and effective processes and tools across its operations.

This will reduce the risks associated with current systems and enable Ausgrid to take advantage of future industry and technological developments in order to better serve its customers and stakeholders.

The replacement of the existing system with an ADMS will also permit, over time, the rationalisation and integration of a number of legacy ancillary systems which support operations, planning and design. This will lead to more efficient and effective processes, with commensurate service improvement and reduction in future expenditure requirements. This program continues the implementation of the ADMS first established in the 2014-2019 period.

What is an ADMS?

An ADMS provides an integrated set of tools to remotely monitor and control the network, manage system outages, improve planned and emergency event management, optimise powerflow management, fault location analysis, and fault isolation and restoration capabilities. It also enables integration of distributed energy resources and network optimisation capabilities. An ADMS enables digitised field operations to streamline the day-to-day management of the network, including intelligent field crew dispatch. It is a platform to integrate core, ancillary network and corporate systems to deliver best practice asset management.

2.2 Background

Ausgrid's current Distribution Network Management System (DNMS) is a bespoke vendor and in-house developed hybrid system dating from the 1990s. It incorporates network Supervisory Control and Data Acquisition (SCADA) and visualisation components. The product is obsolete, with limited support, no vendor roadmap for development and elevated risk of failure due to limited knowledge of the underlying software code to resolve issues when data or functionality limitations are encountered.

It also lacks the breadth of functionality required to deliver modern operational management in a modern utility environment, a critical shortcoming considering elevated security risks and the significant leaps in industry best practice enabled by more recent technology. The current system is unable to support the core functions required by modern distribution utilities.

An ADMS is a necessary first step in delivering the services expected by customers and stakeholders in a rapidly changing industry, with increasing levels of distributed generation, customer engagement and concern for energy prices. The need to integrate greater quantities of new and innovative technology is driving the need to have a modern and adaptive control system.

2.3 Needs analysis

Ausgrid commenced implementation of an ADMS in 2017. Whilst our initial assessment at the commencement of the regulatory period was to maintain the existing system and prepare for replacement, change in recent years to customer expectations, product support, regulatory

requirements and emerging security issues required a reassessment of the strategy. Critical risks emerged with the existing system, namely:

- Inadequate cyber security capabilities to manage current and emerging threats to compliance with state and federal legislative requirements;
- Significant risks for legacy software and hardware at end of life and without on-going vendor support; and
- Limited ability to undertake enhancements to the DNMS to leverage and support the transformative changes in the electricity industry such as Distributed Energy Resources (DER), automation and smart metering.

The core features of a modern network management system to address these risks require an integrated application framework which runs with current operating systems and operates on vendor supported hardware. It should also utilise contemporary testing, maintenance and patching processes. This will result in key benefits such as:

- A simplified and modernised Operational Technology environment to comply with our regulatory obligations, including management of escalating cyber security threats to critical infrastructure as required by our Distribution Licence Conditions and anticipated federal legislative requirements;
- Streamlined & standardised industry best practice processes;
- Aligned data between corporate and operational systems to maximise operational and capital delivery efficiencies; and
- An adaptable platform with advanced capability to support the needs of a rapidly changing network and technology landscape as expected from our customers.

The ENA – CSIRO Electricity Network Transformation Roadmap

In 2017 the CSIRO and the ENA developed a comprehensive roadmap for the electricity system which could deliver 30% lower electricity network charges and net zero carbon emissions by 2050, whilst supporting significant levels of customer owned distributed energy resources. A key element of this roadmap is a pivot to a customer focused and intelligent network – enabled by advanced network management systems to facilitate a distributed energy resources market, network optimisation, and further real time communication and control.

http://www.energynetworks.com.au/electricity-network-transformation-roadmap

2.4 Transformation support

In order to meet the changing needs of our customers and stakeholders, and deliver best practice efficient network operations, Ausgrid is undergoing a significant period of transformation. The ADMS is a core part of this transformation and, as a key foundation system, will ultimately be integrated with a range of initiatives in areas such as field force management and automation, self-healing networks, digital network integration and information management. The full benefits of this integration will not be realised in the FY20-24 period, but have the long term potential to transform service delivery and meet changing customer and stakeholder expectations over the next decade, as articulated in the ENA/CSIRO Electricity Network Transformation Roadmap.

2.5 Options Considered

As part of the initial planning and business case development, Ausgrid considered a range of options, identifying two credible and one non-credible option. The options considered have been summarised below.

Option 1 – Do Nothing

The "Do Nothing" option has been assessed as non-credible. A "Do Nothing" scenario leads to escalating risks associated with operating a legacy control system beyond obsolescence and without appropriate vendor support. This option would result in unacceptable security and compliance risks, embeds operational inefficiencies and does not deliver the service capability that our customers and stakeholders in the transforming electricity market expect us to provide.

With the increasing obsolescence of the system and declining vendor support it is likely that the level of system reliability will decrease. This will have adverse impacts on the visibility and control that operators have on the network, which in turn is likely to lead to an adverse impact on network reliability, performance and potentially safety.

The existing control system was developed by Ausgrid and vendors, commencing in the 1990s. The bespoke nature of this solution means that it is unable to meet ongoing requirements with regards to Ausgrid's critical infrastructure licence conditions. Condition 9 of Ausgrid's critical infrastructure licence conditions requires Ausgrid to follow best industry practice for its control system environment including support, access and security (including cyber security). The vendor supporting the current system has advised Ausgrid that they regard the DNMS as a legacy 'Beta' product and this places hard constraints on what can be achieved. Hence there are no expectations that the current DNMS can enable Ausgrid to continue to achieve full compliance as required by our obligations. The support model for the DNMS determines a practical end of life for the DNMS of 2021.

Option 2 – Develop and Contemporise DNMS to minimum Industry Standard:

This option considered the scenario of retaining the current DNMS and other associated legacy bespoke systems that support the control system environment. The scope of this scenario is to:

- Undertake significant updates to the DNMS to at minimum achieve modern supported operating system and platform environment;
- Undertake significant updates to the DNMS to incorporate minimum modern cyber architecture and security controls to meet basic industry best practices for control system environments;
- Establish minimum appropriate sustainable system support and maintenance arrangements for the existing DNMS code base, including associated bespoke legacy systems

This option excludes enhancements of the DNMS to:

- Develop further core functionality to align with industry trends, as identified in the ENA ENTR Roadmap;
- Enable enhanced business and systems capabilities, including the ability to monitor and detect operational issues;
- Consolidate any other systems that support the control system environment; and

- Implement opportunities to reduce operational expenditure in the long term with more efficient processes and technology.

Option 3 – Replacement of legacy systems with an ADMS

This option considers the scenario of replacing Ausgrid's DNMS and other supporting legacy systems within the control system environment with a commercially available off the shelf ADMS product.

This scenario will enable the simplification and modernisation of the Operational Technology and control system environment to comply with our regulatory obligations, including management of escalating cyber security threats to critical infrastructure as required by our Distribution Licence Conditions and anticipated federal legislative requirements.

This scenario enables Ausgrid to:

- Streamline & standardise to achieve industry best practice processes;
- Align data between corporate and operational systems to maximise operational and capital delivery efficiencies; and
- Implement an adaptable platform with advanced capability to support the needs of a rapidly changing network and customer technology landscape as expected from our stakeholders.

The key advantages and disadvantages of Options 2 and 3 are detailed in the table below.

Table 1. Options considered for network management

	Option 2 – Contemporise DNMS	Option 3 – Replacement of legacy systems with an ADMS
Advantages	None identified	• Reduced risk of non-compliance with Ausgrid's license conditions • Alignment to industry trends, as identified in the ENA ENTR Roadmap • Strong vendor roadmaps aligned with industry trends; • Long-term solution with a supported platform • Reduced support costs and platform risks through a standard implementation • Increased cyber security and ability to detect and respond to threats • Enhanced business and systems capabilities, including the ability to monitor and detect operational issues • Improvements in safety, quality and reliability of the network • Opportunities to reduce operational expenditure in the longer term with more efficient processes and technology

	Option 2 – Contemporise DNMS	Option 3 – Replacement of legacy systems with an ADMS
Disadvantages	• High capital and operating costs fully funded by Ausgrid • Longer time required to meet minimum industry standards and increasing risk of non-compliance with Ausgrid's Critical Infrastructure license conditions • High risk (timing and costs) with uplifting existing system to minimum modern standards • Misaligned with industry best practice regarding use of commercial off the shelf products and system support model • Extremely limited functionality compared with a modern ADMS, including lack of switching Management functionality and integration between OMS and DNMS functions • Increased risk of catastrophic failure of applications due to diminishing support • No improvements in safety, quality and reliability of the network • Compromised ability to monitor and detect operational issues with the DNMS network and application and increased risk of successful cyber-attack due to the inability to apply remedies to newly discovered security issues	• Long implementation timeline means Ausgrid will need to continue to remediate parts of the existing DNMS in parallel with the ADMS implementation program • Migration requires major testing and validation effort • Significant change management effort required including significant control room impacts and corresponding process changes. • Increased capex expenditure over the forecast regulatory period

The project business case provides detailed analysis of the viable options for replacement of the existing DNMS. The assessment of these options determined the preferred approach to be the implementation of a modern ADMS replacing existing legacy systems and commencing in 2017.

2.6 Forecast

Table 2. Advanced Distribution Management System ($,000s)

Program	2020	2021	2022	2023	2024	Total FY20-24
OTI_03.15	**$25,211**	**$3,852**	**$3,735**	**$3,628**	**$4,925**	**$41,351**

3 PROGRAM 2 – NETWORK INNOVATION

3.1 Program description

The Network Innovation program covers a diverse range of innovative network technology pilots which have potential to deliver better value to our customers. Ausgrid has a long history of innovation, and this program builds on this past experience to identify, develop and integrate into core corporate systems and processes a range of new and innovative solutions to both old and emerging problems in a fast-changing industry. It addresses risks related to the sub-optimal use of capital to resolve network constraints, and the failure to meet changing customer service level expectations in line with advances in technology.

3.2 Background

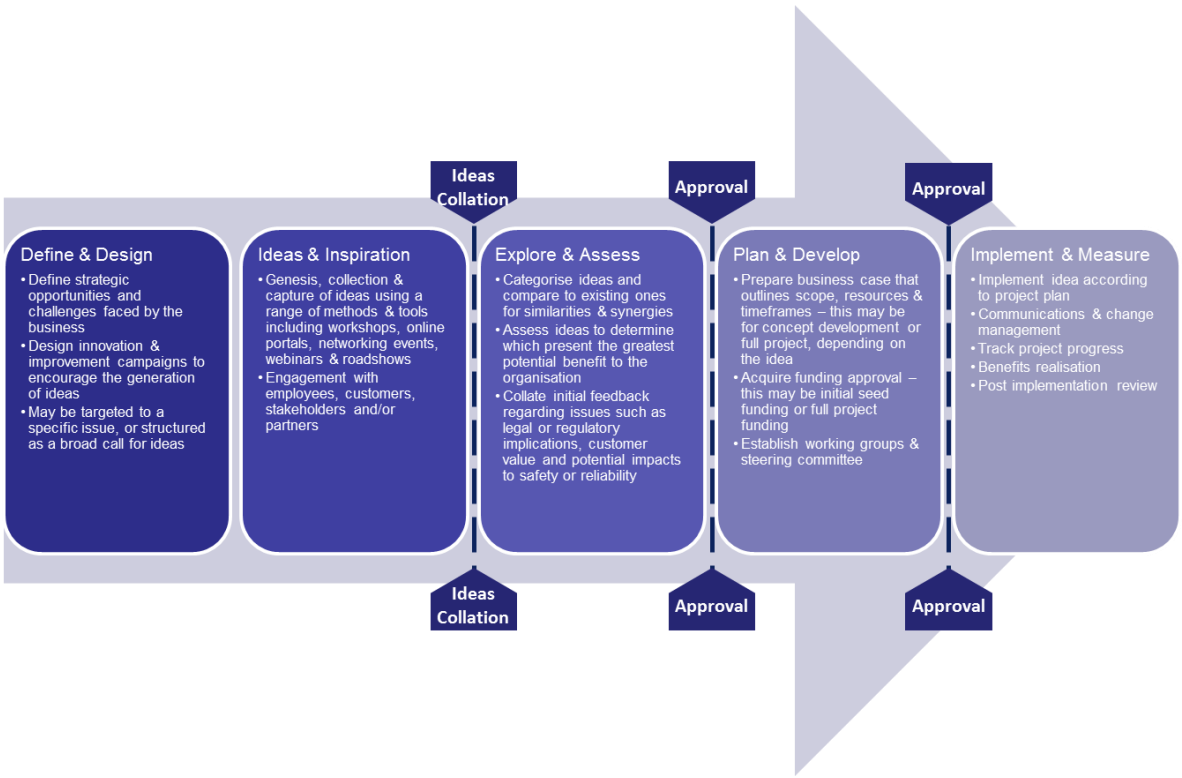
The Australian energy market is currently undergoing a period of unprecedented change. Across the entire national electricity market a substantial proportion of the roles and functions are changing, with significant disruption in the wholesale generation market, on-going asset replacement and renewal in the transmission and distribution networks, and an overhaul of the retail landscape through the Power of Choice regulations. Overlaying these changes are rapid technological advances driving changing consumer expectations about their energy services and providing many opportunities for advanced technology solutions to solve traditional and emerging energy network problems.

Our customers have told us they want to embrace new technology such as renewable generation, batteries, electric vehicles and energy monitoring. They are also eager to ensure that they leverage as much value as possible from their investments through services such as peer-to-peer trading and demand aggregation. The decline in cost of network technology continues to provide opportunities to reduce capital and maintenance expenditure on traditional network “poles and wires” solutions. Ausgrid is committed to expanding the envelope of innovation within the distribution network, and this program encompasses a number of investments in these areas to improve service delivery and maximise the value we deliver to our customers and the market.

3.3 Innovation Framework

The key objective of the Network Innovation Program is to identify innovative technologies capable of providing a better core service to customers at lower cost and more safely than existing methods, or new services that our customers want but that we currently cannot deliver with our existing assets. By their nature, the majority of these technologies are not at the level of maturity that enables accurate and detailed determination of unit costs and overall project costs at early project stages. To ensure optimum outcomes are achieved, Ausgrid utilises an innovation and improvement framework to design, assess, develop and measure the benefits of these programs to deliver greater customer and shareholder value. This framework is shown in Figure 1.

Figure 1. Innovation and improvement framework



It includes a critical assessment of the criteria for success and failure, along with a tolerance for risk appropriate for the level of investment and possible positive outcomes for the customer. Resources and priorities continue to be evaluated across the program to ensure that the core challenges and opportunities are being addressed in the way which maximises value to our customer and stakeholders.

3.4 Advanced Voltage Regulation Pilots

Voltage control is a core element of operating and maintaining an electricity distribution network. Ausgrid's network already comprises on-load tap changing transformers at sub-transmission and zone substations and, in key locations on the subtransmission and high voltage networks, we operate line voltage regulators, reactors and capacitor banks. These devices act to maintain voltages within an acceptable envelope.

Over the last ten years there has been a significant increase in distributed generation, specifically rooftop solar, which has changed load patterns on low voltage networks in ways unforeseen when they were designed decades prior. There are currently over 115,000 homes and businesses with a rooftop solar system in the Ausgrid area and over time, as penetration of these systems increases, control of network voltages within the required thresholds will become increasingly difficult and expensive. As experienced in other Australian networks, power quality issues as a result of high concentrations of distributed generation may also curtail the ability of customers to connect additional systems to our network.

Advances in technology mean that advanced voltage regulation devices, including Static Compensators (STATCOMs), are now cost effective in some situations at the distribution level (see Figure 2). Ausgrid intends to undertake a series of pilot projects of advanced voltage control technology within both our low voltage and high voltage networks, to develop a technically and operationally feasible solution that can be deployed as required to reduce

traditional network expenditure on upgrading assets. This will deliver better customer value in network areas constrained by poor voltage and power quality performance.

Figure 2. Impact of LV STATCOM device on Voltage Profile

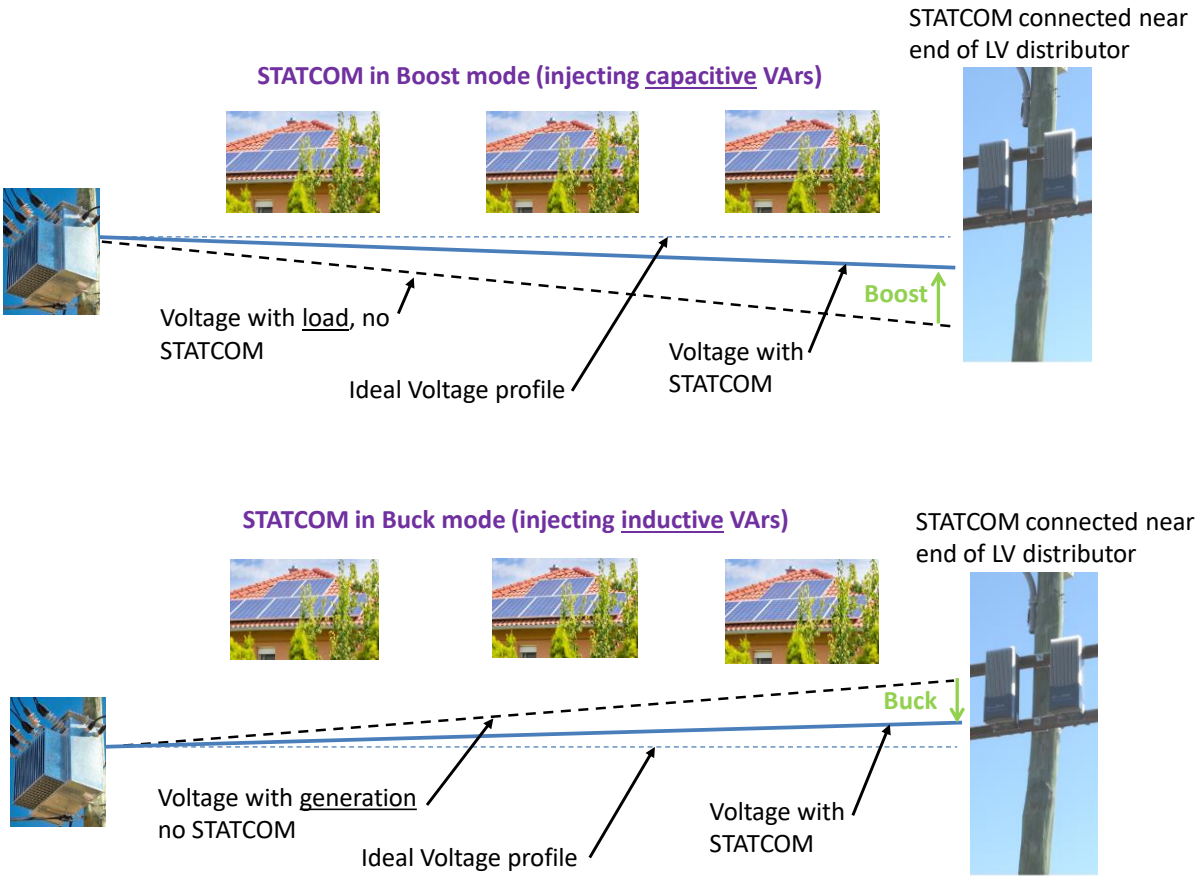


Table 3. Impact of LV STATCOM device on Voltage Profile

Target Customer Benefit	Success Criteria	Total Indicative Timeframe	Indicative Cost FY20-24
Increased capacity to accommodate customer DER resources and reduced network costs	Viability and efficacy of various voltage regulation technologies at increasing network DER capacity	FY18-FY22	$3,100,000

3.5 Network insights

Ausgrid has approximately 5,500 existing online Distribution Monitoring and Control devices (DM&C devices) installed in kiosk style substations across some of our 33,000 distribution substations. This initiative increases the reach of these devices via a retrofit program for the upgrade of existing devices, and the installation of new devices in a number of strategic high capacity surface chamber locations. This initiative will enhance and support the integration of the ADMS into network operations and planning, facilitating self-healing networks initiatives and allowing the network to be dynamically reconfigured to reduce technical constraints that occur due to the roll out of DER. Importantly, it will also give Ausgrid a rich data set to support

any ‘open networks’ information platform made available to our customers, facilitating easier and more cost effective connections, enabling customers to extract greater value from DER, and foster greater levels of innovation in the industry.

The scope of this program covers the installation of approximately 300 new generation substation control and monitoring devices with remote control capability to be retro-fitted into existing distribution substations, as well as development of back-office systems and protocols to facilitate the inclusion of these devices as standard in new substations where beneficial.

Table 4. Key features of new generation substation control and monitoring devices pilots

Target Customer Benefit	Success Criteria	Indicative Timeframe	Indicative Cost FY20-24
Increased capacity to accommodate customer DER resources and better safety, reliability and security of supply	Network insight technology embedded in network design and data on key network locations available for analysis	FY18-FY24+	$10,600,000

3.6 Grid Fringe Optimisation

Over the next regulatory period, Ausgrid plans to investigate, develop and implement a program of projects where micro-grids and stand-alone power system solutions offer more cost-effective alternatives to traditional network expenditure over the long term. Potential drivers of such projects include improving power reliability for customers through providing a back-up supply solution in the case of a power outage, addressing bushfire risks or the reduction of operating and capital expenditure.

This project will include detailed investigation, modelling and identification of future scenarios and network locations where micro-grids or stand-alone power systems are likely to be a more cost-effective than traditional network solutions, now and into the future.

Case Study
Barnard Stand-alone Power System

Working with the National Parks & Wildlife Service, Ausgrid provided a grant to install a stand-alone power system in the Hunter Valley. This enabled us to decommission overhead power lines through bushfire prone land in a National Park, reducing fire risk and saving on the significant future expenditure otherwise required to maintain those assets.

A potential pilot site located in the Upper Hunter region has been identified, where a small number of customers (approx. 60) are fed by over 100km of Single Wire Earth Return (SWER) lines. Development of the detailed business case is underway and consultation with the local community will commence in FY19.

Table 5. Key features of grid fringe optimisation pilots

Target Customer Benefit	Success Criteria	Indicative Timeframe	Indicative Cost FY20-24
Reduced network costs for customers and better safety, reliability and security of supply	Successful and operating demonstration system. A cost-benefit model to quantify the efficiency boundary of the traditional network	FY19-23	$4,800,000

3.7 High Voltage Micro-Grid

Over the next regulatory period, Ausgrid plans to investigate, develop and implement a program of projects where a series of high voltage micro-grid power system solutions offer more cost-effective alternatives to traditional network expenditure over the long term. Potential drivers of such projects include improving power reliability for customers by providing a back-up supply solution in the case of a power outage, addressing bushfire risks and/or the reduction of operating and capital expenditure. We are currently developing a project in a community on the western shore of the Pittwater in Northern Sydney that will result in the implementation of a range of innovative demand management and supply solutions with extensive input from the community.

This project will build on this experience, as well as learnings achieved during the initial phases of the Grid Fringe Optimisation project, for a detailed investigation and demonstration of a major series of connected high voltage micro-grids servicing several hundred customers in a remote area of the Hunter Valley. This will pose a number of technical challenges to ensure such a grid remains connectable to the main high voltage network in the area. A successfully operating micro-grid could provide improved reliability of supply and significantly reduce bushfire risk during high fire danger periods, as well as potentially reducing capital and operating costs over the long term. The potential for specialised micro-grid tariffs will also be examined under this project.

Table 6. Key features of high voltage micro-grid power system pilots

Target Customer Benefit	Success Criteria	Indicative Timeframe	Indicative Cost FY20-24
Reduced network costs for customers and better safety, reliability and security of supply	Successful and operating micro-grid systems which meets customer expectations and allows evaluation of cost, risk and performance benefits of micro-grid.	FY21-FY24+	$17,500,000

3.8 Advanced EV Charging Platform

This initiative examines the ability for Ausgrid's network to interact with multiple electric vehicles (EVs) at a single location. In collaboration with suitable industry partners, this initiative will evaluate the technical parameters and market mechanisms for a suite of EV chargers that can sense the level of charge in vehicle batteries, manage their charge rate and optimise the concurrent charging of individual vehicles to best utilise the available network capacity.

Table 7. Key features of EV charging platform pilots

Target Customer Benefit	Success Criteria	Indicative Timeframe	Indicative Cost FY20-24
Better service experience for EV owners and reduced network costs to facilitate EV charging stations	Development of effective model for deployment of EV charging stations	FY20-FY22	$1,200,000

3.9 Grid battery Pilot

Ausgrid is planning a small number of grid battery pilots to assess the viability of network use cases including the deferral of network augmentation through peak shaving, improving power quality and reliability outcomes, particularly in locations with high PV penetration, and provision of other network support services. A priority of these trials is to demonstrate and evaluate the operating (and partnership) models that can unlock additional value for customers. For example, by providing access to 'virtual partitions' within a community battery, enabled though a cloud based trading platform, giving customers access to the range of value that a battery can deliver without exposing them to the upfront installation cost, and maximising the potential for economies of scale to reduce costs and bring forward adoption of local renewables.

This trial will also seek to learn about appropriate tariff structures to ensure customers using community assets are not at a disadvantage compared to behind-the-meter generation and storage solutions.

Table 8. Key features of grid battery pilots

Target Customer Benefit	Success Criteria	Indicative Timeframe	Indicative Cost FY20-24
Facilitate access to DER for customers who otherwise could not participate in the clean energy transition	Identified benefit to customers from installation of grid batteries. Optimum regulatory and tariff framework identified.	FY20-FY22	$2,000,000

3.10 Portable all-in-one off-grid supply units

This initiative will trial the use of portable, modular off-grid energy supply units that can be deployed rapidly and provide grid quality supply to a customer (or customers) for an extended period without a physical grid connection. There are multiple uses for portable off grid power, and this trial would be expected to test all such cases, including providing additional support during network maintenance, supporting remote and vulnerable customers during extended planned and unplanned outages, or islanding customers to alleviate bush fire risk, or assessing the suitability of permanent 'off-gridding'. This initiative will evaluate the effectiveness of several off the shelf units to deliver improved customer outcomes.

Table 9. Key features of portable off-grid supply pilots

Target Customer Benefit	Success Criteria	Indicative Timeframe	Indicative Cost FY20-24
Reduced network costs for customers and better safety, reliability and security of supply	Improved customer outcomes identified and technology assessed for business as usual adoption	FY20-FY22	$1,000,000

3.11 Self-Healing Network Trials

This project includes expanding trials of automated network reconfiguration capabilities on the network to enable dynamic grid re-configuration for improved customer restoration times, better emergency response and increased overall network capacity through potential time of day reconfiguration and network optimisation.

This type of technology was originally trialled in 2012 and Ausgrid continues to operate a small 'fault detection, isolation and restoration scheme' (FDIR scheme) in the Newcastle area using several high voltage 'IntelliRupter' fault interrupters. This initiative will expand the trial to new sites and evaluate the operation of a number of other devices including those being developed under the Network Insights project. It will evaluate and assist in scoping the requirements for network automation devices following the successful commissioning of the ADMS.

Self-healing network applications ultimately have the potential to provide substantial reliability, capacity and efficiency benefits for the Ausgrid network. These trials would include technologies from multiple manufacturers under various network configurations to ascertain their performance within the Ausgrid network context to ensure that the most cost effective solutions are ultimately adopted.

Table 10. Key features of the automated network devices pilots

Target Customer Benefit	Success Criteria	Indicative Timeframe	Indicative Cost FY20-24
Increased capacity to accommodate customer DER resources and better safety, reliability and security of supply	Operating self-healing network segments with demonstrable benefits to customer reliability, augmentation deferral and DER capacity	FY19-FY23	$600,000

3.12 Dynamic Load Control

Ausgrid operates a significant customer load control system involving nearly 500,000 installations of hot water storage heater control. Advances in technology, including the long term roll-out of smart meters, will provide opportunities to explore more flexible and advanced load control technologies covering a wider range of devices. A number of previous trials over the past five years have explored the potential for control of air conditioners and pool pumps, and Ausgrid is currently migrating existing load control circuitry to smart metering in conjunction with the Power of Choice led smart-meter roll-out. Opportunities also exist to provide better flexibility, value and choice to customers where they live in areas of high network capacity.

Under the Network Innovation Program further pilot projects will continue to build on our past experience gained in this area to identify potential to reduce future capital expenditure by utilising the capability of new smart meters and their ability to individually address customer load control timing.

Table 11. Key features of dynamic load control system pilots

Target Customer Benefit	Success Criteria	Indicative Timeframe	Indicative Cost FY20-24
Increase choice and control of energy and reduced network costs for customers	Robust assessment of customer benefits of a more flexible load control policy and tariffs	FY19-FY22	$600,000

3.13 On-line Asset Condition Monitoring

Ausgrid employs condition based maintenance to manage the majority of our network assets. Generally, this relies on periodic inspections to determine asset condition and respond accordingly, with inspection periods carefully assessed to balance the cost against risk of failure. Technology has been available for some time which provides real-time, control system

integrated monitoring of some asset condition indicators, however has not ultimately been a cost effective substitute to periodic inspections. With advances in technology and the increased capability of the ADMS, the maturity of this technology will be re-assessed.

This project will assess a variety of modern on-line asset condition monitoring technologies available in the market to provide real time assessment of asset condition for critical assets, including integration into the ADMS.

Table 12. Key features of on-line asset condition monitoring devices pilots

Target Customer Benefit	Success Criteria	Indicative Timeframe	Indicative Cost FY20-24
Reduced network costs for customers and better safety, reliability and security of supply	Proven efficacy of on-line condition monitoring for network deployment	FY19-FY22	$600,000

3.14 Advanced Line Fault Indicator Trials and Deployment

Line Fault Indicators provide a visible indicator for field crews to quickly identify network faults, particularly in the dark or during adverse weather. Modern line fault indicators can communicate directly with the ADMS, to provide system operators with more information about network issues before crews are dispatched. They also provide real-time performance indication of network flows and thus support a better understanding of network capacity, particularly in long and diverse overhead networks. This project involves an examination of modern line fault indicator technology and a targeted deployment to network locations to quantify the operational benefits achievable.

Table 13. Key features of line fault indicator pilots

Target Customer Benefit	Success Criteria	Indicative Timeframe	Indicative Cost FY20-24
Reduced network costs for customers and better safety, reliability and security of supply	Deployed and operating fleet of devices integrated into operational systems, with quantified benefits	FY18-FY24	$600,000

3.15 Forecast

The overall forecast for this program is shown in the table below.

Table 14. Network Innovation Program Forecast ($,000s)

Program	2020	2021	2022	2023	2024	Total FY20-24
OTI_03.19	$8,487	$8,488	$8,526	$8,578	$8,617	$42,695

4 PROGRAM 3 – PLANNING & TECHNOLOGY DATA USAGE

4.1 Program description

This program will drive enhancements of asset data and systems to safely and effectively optimise usage of network assets. This will be done by improving data integration from various information systems, the capture of new asset data, and systematically upgrading business processes and systems to better utilise this data. It will improve capital delivery efficiency and address risks relating to sub-optimal capital expenditure due to inadequate or insufficient asset and performance information.

4.2 Background

Ausgrid undertakes design, planning and analysis under modelled and forecast conditions for its electrical network infrastructure. We also capture spatial data and high resolution imagery of our assets utilising aerial patrols with Light Detection and Ranging (LiDAR) equipment. Where this data is under-utilised in business processes, assumptions are made regarding key modelling and forecasting parameters. Greater integration of data into the core asset management decision making processes will enable more efficient standards and designs, planning, ratings and maintenance decisions and processes, leading to better value for our customers.

4.3 Network Digitisation Project

Ausgrid has been undertaking helicopter based aerial photography and LiDAR analysis of the network since 2012 to manage bushfire risk in rural areas, covering approximately 25% of our overhead network. We are commencing a program over FY17 and FY18 to further digitise the network using LiDAR across urban areas of the network using fixed wing aircraft. In the FY20-24 period we intend to capture significantly more asset data via ground based LiDAR and high definition photography services.

Detailed asset data supports advanced analytics, the development and enhancement of mature asset management strategies, and underpins efficient and effective operational activities for the organisation. Advanced data collection technologies provide the means to rapidly capture a greater level of detail on assets and their surrounds. This data can then be analysed, in some cases automatically, reducing the need for traditional manual data collection methods.

What is LiDAR?

Light Detection and Ranging (LiDAR) is a technology using laser light targeted at an area looking to be analysed. It measures the timing and reflectivity of the surface being targeted to determine the exact positioning of objects and surrounds. The GPS synchronisation and use of this technology over a large area enables the construction of a 3D model of the area.

The market availability of applications to host and analyse LiDAR and other large datasets has grown in recent years. These applications have reached the stage of maturity where they are capable of processing the large data volumes, converting this information into digital virtual environments. They have easy to use interface tools for end users to fully utilise these datasets for decision making.

A fully digitised virtual network asset world is a strategic opportunity which will provide the foundation for transformational change in the way Ausgrid executes routine tasks such as maintenance inspections, network planning and surveying, data verification, and asset

capture. It forms the backbone for future technology advancements and development such as augmented reality, location based services, virtualised digital networks, big data analytics, spatial data and context awareness, machine learning, and image processing and pixel recognition.

A project business case has been developed to create a digitised virtual world of the Ausgrid network, integrating current practice and leveraging further technology advances to increase capital delivery efficiency by understanding exact configuration of assets and improving risk prioritisation methods for effective capital delivery.

Table 15. Key features of the network digitisation project

Target Customer Benefit	Success Criteria	Indicative Timeframe	Indicative Cost FY20-24
Reduced network costs for customers and better safety, reliability and security of supply	Ongoing delivery efficiency improvements from improved access to accurate information and more effective capital prioritisation	FY19-FY24	$11,950,000

4.4 Connection Maps for EV Charging and Embedded Generation

Ausgrid intends to invest in a web-based system to provide information for the competitive market on optimum areas to connect new services to the network, including electric vehicles (EV) and embedded generation.

The purpose is to better facilitate the market led roll-out of these types of energy services. This will deliver better value to our stakeholders and the energy market in general. This project is expected to be low cost, but high value by bringing together key network connections data in a form which will help market proponents navigate the connections process in a more streamlined way.

Table 16. Key features of connection maps project

Target Customer Benefit	Success Criteria	Indicative Timeframe	Indicative Cost FY20-24
Increased visibility to communities of areas that can accommodate DER, including EVs	Increased uptake of DER in areas requiring limited or no network augmentation in a timely manner	FY19-FY23	$400,000

4.5 Forecast

Table 17. Planning & Technology Data Usage Forecast ($,000s)

Program	2020	2021	2022	2023	2024	Total FY20-24
OTI_03.12	$2,446	$2,461	$2,445	$2,482	$2,514	$12,348

5 PROGRAM 4 – OPERATIONAL TECHNOLOGY SECURITY

5.1 Program description

This program enhances Ausgrid's control system security position to comply with NSW Distributors Licence, specifically the Critical Infrastructure Licence Conditions, and broader Federal Government Cyber security guidelines. It addresses the significant complexity associated with maintaining cyber-security on critical control system network infrastructure.

5.2 Background

On 1 December 2016, additional licence conditions were imposed on Ausgrid by the NSW State Government to ensure critical infrastructure security systems were in place. The conditions related to Critical Infrastructure were subsequently revised and re-issued on 5 December 2017. Furthermore, the Federal Government has drafted a Security of Critical Infrastructure Bill, which seeks to manage the complex and evolving national security risks associated with Critical Infrastructure, including many of Ausgrid's assets. This, in coordination with the formation of the Australian Government Critical Infrastructure Centre, will drive Ausgrid's security requirements for the management of its Operational Technology and Secondary Systems. This will result in systems and practices that are capable of addressing evolving cyber security risks and ensure alignment with industry best practice for control systems.

Ausgrid must invest in a number of systems to increase the resilience of the Operational Technology and associated Secondary Systems which provide protection, control and monitoring of the electrical network.

5.3 Cyber Security

A number of Operational Technology and Secondary System enhancements are needed to ensure Ausgrid's control systems remain aligned with industry best practice as required under the critical infrastructure licence conditions. These broadly relate to isolation of the control system environment from the corporate environment, communication encryption and other security strategies recommended by relevant Industry standards such as IEC 62443 Industrial Communication Networks - Network and System Security and National Institute for Standards and Technology (NIST) SP800-82 Guide to Industrial Control Systems (ICS) Security and where applicable applying security strategies recommended by the Australian Signals Directorate (ASD).

5.4 Operational Technology Off-line Environment

The operational technology systems provide protection, monitoring and control of the network consist of Intelligent Electronic Devices (IEDs) including relays, Remote Terminal Units (RTUs), Human Machine Interfaces (HMIs), routers and switches.

Relays, RTUs, HMIs, routers and switches are procured from a variety of vendors, to avoid common mode failure and also from the increased availability in variety of auxiliary telemetry devices. These devices are dependent on Ausgrid's communications network to provide protection communications for increasingly sophisticated schemes as well as to enable SCADA control and monitoring capabilities.

This project covers the upgrade of Ausgrid's operational technology off-line test environment to ensure Ausgrid has a representative off-line system that can be used to undertake appropriate integration testing of technologies, changes to system such as security patches and updates. This enables Ausgrid to align with industry best practices, including compliance with the new critical infrastructure licence conditions.

5.5 Modem Encryption

Ausgrid has undertaken an assessment of the options to include end-to-end encryption for communications over third party wireless networks for the population of existing and future modems. Ausgrid proposes to undertake a program of works to implement end-to-end encryption for its population of modems based on OpenVPN.

5.6 Forecast

Table 18. Operational Technology Security Forecast ($,000s)

Program	2020	2021	2022	2023	2024	Total FY20-24
OTI_03.16	$449	$447	$447	$448	$448	$2,240

6 PROGRAM 5 – CONTROL SYSTEM CORE REFRESH

6.1 Program description

This program funds periodic critical upgrades and refresh of Ausgrid's existing core control system severs, operator work stations and network equipment such as routers, switches, firewalls and operator work stations.

6.2 Background

Ausgrid's control system environment consists of field devices, communications and control systems. These control systems are driven and managed by software that resides on hardware provided by a system severs, operator work stations and network equipment such as routers, switches and firewalls and other associated supporting equipment that comprise the core control system.

Ausgrid's core control system dates from the 1990s. This program covers defined enhancements or replacements of systems components which comprise this core control system, based on risk assessments that consider end of life equipment and technology obsolescence or additional functionality requirements to meet core regulated business needs.

This program replaces the previous systems maintenance program (OTI_03.04) and forecasts a significant reduction in on-going expenditure in this area compared to the current regulatory period, due largely to recent or proposed investment in major system upgrades or replacements such as the ADMS (OTI_03.15) and the operational technology off-line environment (within OTI_03.16).

6.3 Requirements

This program covers the enhancement and replacement of severs, operator work stations, network equipment, other associated supporting equipment that comprise the core control system. This equipment needs to be regularly refreshed based on a risk based assessment of their end of life and technical obsolescence.

As required by critical infrastructure licence conditions, Ausgrid must use best industry practice for electricity network control systems, and ensure that operation and control of its distribution system, including all associated infrastructure, can only be accessed, operated and controlled from within Australia.

As part of applying industry best practice for a control system to meet this objective, it is critical that this supporting equipment that comprises the core control system is refreshed based on a risk based assessment. This enables the management of equipment end of life and technology obsolescence in conjunction with available vendor support arrangements, for example maintaining servers and workstations on currently supported operating systems version releases.

The expenditure under this program covers maintenance and integration activities for remaining control systems infrastructure before, during and after the transition to the ADMS over the 2019-24 regulatory period.

The reduction in expenditure from the current regulatory period is an outcome of the significant upgrade works associated with the ADMS and other investments in secondary system security facilities.

6.4 Forecast

Table 19. Control System Core Refresh Forecast ($,000s)

Program	2020	2021	2022	2023	2024	Total FY20-24
OTI_03.17	$518	$342	$343	$-	$-	$1,203
OTI_03.18*	$449	$447	$447	$448	$448	$2,240

* Under previous OTI_03.04 program