OT Capability Uplift – Enablers, Data and Systems

Regulatory Business Case (RBC) 2024-29

PowerWater

Contents

PowerWater

1. Summary

This business case has been prepared to support the 2024-29 Regulatory Proposal. The business case demonstrates that Power and Water has undertaken appropriate analysis of the need and identified a full suite of credible options that will resolve the need, to ensure that Power and Water continues to meet the National Electricity Objectives and manage the network prudently and efficiently.

The proposed expenditure identified in this business case will undergo further assessment and scrutiny through Power and Water's normal governance processes prior to implementation and delivery.

This business case addresses the risks from near obsolescence and not-fit-for purpose operational technology capability and environment to support the needs of the network and customers.

1.1 Business need

This business case provides for the Operational Technology Capability Uplift Project ('OTCU Project') expenditure on three interdependent elem67ents designed to elevate Power and Water's operational technology ('OT') from near obsolescence and not-fit-for purpose:

- Addressing data, data quality and data governance gaps.
- Introduction of contemporary operational technology.
- Building internal resource skills and capacity to manage the OT.

The target state is a contemporary, integrated suite of systems, enabled by a sufficiently complete and accessible set of standing and real-time data, and sufficient trained staff to operate and leverage the capabilities. With contemporary tools, adequate data, and the right staff, Power and Water can effectively manage the network despite the rapidly changing landscape of distributed and large scale energy resources, less synchronous machines, and electric vehicles.

The capabilities and supporting systems and data being proposed are often referred to collectively as advanced distribution management system ('ADMS'), and notwithstanding that some aspects of these capabilities may be being addressed by other initiatives outside this business case such as the EMS upgrade, an ADMS typically comprises of:

- Distribution SCADA – delivering the functionality required for network monitoring and control of Power and Water's distribution network, noting that the control aspects will be limited during the next regulatory control period ('next RCP', which spans 2024-2029)
- Distribution Management System ('DMS') - a combination of advanced network applications and analytics providing operators with the analytical tools to make informed decisions and manage the network effectively (e.g. state estimation, fault location isolation and service restoration (FLISR), and dispatch management)
- Outage management ('OMS') – provides a platform for operational decision support and a system that can be used simultaneously by multiple users, integrating information about customers, system status, and resources
- Distributed energy resource management ('DERMS') – to help reduce voltage excursions and increase hosting capacity in networks with high distributed energy resource ('DER') penetration, noting that the full functionality of DERMS will not be introduced until the subsequent RCP.
- Works and Asset Management ('WAMS') and integration – a system which makes optimum use of all resources to promote safety and enhance operations.

Whilst the focus is on fit-for-purpose electricity distribution management capabilities, the scope of the project supports improved network planning and operations across generation, transmission, distribution, and NTESMO (NT Energy System and Market Operator) – it is therefore not a ADMS implementation project, but also a project to coordinate and address foundational elements and enablers to support ADMS/ADMS functionality overall.

1.1.1 Lack of Operational capability to manage the network

Power and Water needs the appropriate tools, data and people to effectively manage the expected growth and impact of renewable energy sources connecting to the grid, which add enormous operational complexity to network management. However, Power and Water's capabilities for managing the distribution network are not suitable for this paradigm – they are almost completely manual, creating significant risks through dependencies on key resources, and through a lack of timely and quality information on the state of the network.

Following a path that all other Australian electricity distribution utilities have been on for many years, Power and Water requires platforms which support the full range of capabilities typically offered by advanced energy management systems (AEMS) and advanced distribution management system (ADMS) platforms (i.e. EMS, DMS, OMS, DERMS, and WAMS). Network operation and automation via these technologies are needed to improve Power and Water's ability to meet its obligations across generation, transmission, and distribution.

1.1.2 AEMS project is a separate dependent project

The proposed OT Capability Uplift Project is dependent upon the related AEMS project which is building upon a project completed recently to upgrade the GE EMS (and supporting software and hardware) to the supported version. The extension of this work which will span the remainder of the current regulatory control period (RCP) and the first two years of next regulatory control period (i.e. 2024-29) involves cross-grading from the current out-of-support product, GE e-Terra, to GE's AEMS platform. This cross-grade is technically an upgrade in the sense it is a migration to the current GE product, enabling the equivalent licenced features within the legacy e-Terra implementation. This new platform provides the modular baseline required to enable additional components to support ADMS functionality, including DMS, DERMS and OMS.

1.2 Options analysis

The table below summarises the credible options that have been considered to lift Power and Water's OT capability and the results of the options comparison.

Table 1 Summary of credible options

Option No.	Option name	Description	Recommended
1	Integrated point solutions	Multiple platforms with integration between them. Implement additional modules and bespoke components to meet needs not met by either platform, or where both platforms are required to integrate with a third platform for advanced functionality (e.g. state estimation, fault location isolation and service restoration (FLISR), and dispatch management).	No

2	New consolidated platform	Completely new platform with all AEMS/DMS/OMS/DERMS capabilities in place, from the ground up.	No
3	Upgrade, extend & integrate EMS platform	Staged, capability based upgrade of existing EMS platform with managed integration for advance point solutions.	Yes

The benefits of the OTCU Project have not yet been quantified. Therefore a cost-benefit analysis has not been undertaken as yet and the NPV for each option is not yet available.

1.3 Recommendation

Despite the current absence of a cost-benefit analysis, given that

Option 3 (Phase-based upgrade, extend & integrate the EMS platform) is recommended at a total cost of $35.7 million (real 2021/22) in the 2024-29 regulatory period. This option is technically viable, deliverable, and the least-cost approach.

A 'doing nothing' approach will not enable Power and Water to cope with the increasing complexity of managing the evolving distribution system using the current obsolete and largely manual systems, and was not considered credible. In the next RCP (i.e. 2024-29) the project expenditure is primarily directed to building distribution management capabilities, improving network data quality and data management, and staff capability.

Table 2 shows a summary of the expenditure requirements for the 2024-29 regulatory period.

Table 2 Forecast annual capital and operational expenditure ($m, real 2021/22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	4.50	4.50	3.00	4.50	4.50	21.00
Opex	3.15	3.15	2.10	3.15	3.15	14.70
Total	**7.65**	**7.65**	**5.10**	**7.65**	**7.65**	**35.70**

The forecast expenditure for the next regulatory control period allocated to Standard Control Services as per the CAM is outlined in Table 3.

Table 3 Forecast annual capital and operational expenditure – allocated to SCS ($m, real 2021/22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	4.08	4.08	2.72	4.08	4.08	19.04
Opex	3.15	3.15	2.10	3.15	3.15	14.70
Total	**7.23**	**7.23**	**4.82**	**7.23**	**7.23**	**33.74**

The forecast expenditure for the next regulatory control period allocated to recurrent and non-recurrent categories is outlined in Table 4.

Table 4 Forecast annual capital expenditure – recurrent and non-recurrent

Item	FY25	FY26	FY27	FY28	FY29
Recurrent	-	-	-	-	-
Non-recurrent	100%	100%	100%	100%	100%

2 Identified need

This section provides the background and context to this business case, identifies the issues that are posing increasing risks to Power and Water and its customers, describes the current mitigation program and its delivery status, and provides a risk assessment of the inherent risk if no investment is undertaken.

2.1 Background

Network management is becoming more challenging daily as the trend of DER growth (particularly residential solar PVs/inverters and large-scale solar farms) and the progressive but inexorable retirement of synchronous machines and their system-stabilising inertia continues.[1]

> Australia's energy ecosystem is rapidly transforming towards a decentralised, two-way power system, as increasing numbers of households and businesses invest in solar photovoltaic (PV) generation and energy storage capabilities. (AEMO)

The Northern Territory Government's (NTG) 50% renewable target by 2030 will continue to underpin the reshaping of the energy system in the Territory. In this section the impacts of the evolving energy landscape and, to a lesser extent, but still importantly, the cyber security landscape, are discussed in the context of Power and Water's operational technology – which in summary is not fit-for-purpose today, let alone for the short-to-medium future.

Power and Water's distribution network needs to be progressively more dynamic, therefore Power and Water's capabilities to manage the network safely and efficiently need to rapidly improve.

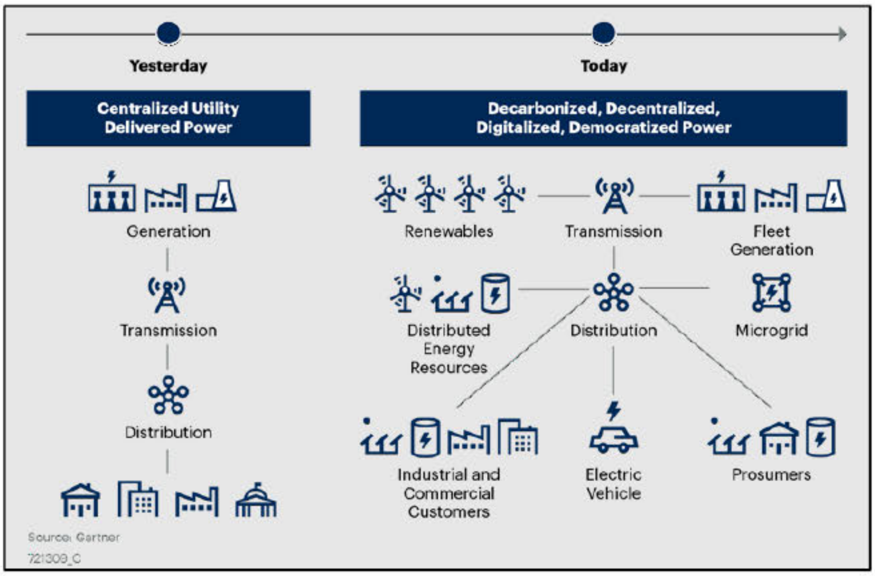
2.2 Strategic Network Business Drivers

2.2.1 Growth and Demand of Renewables

The primary investment driver for improving operational technology capability is the requirement for Power and Water to effectively (prudently, and efficiently) manage the expected growth and impact of renewables connecting to the grid. The figure below illustrates the old and new network operating models:

[1] Territory Generation's planned retirement of six large generators at the Channel Island power station (CIPS) and three generators at the Katherine power station (KPS); these retirements are partially offset by currently committed generation and battery investments, including six solar generators, the new gas-fired Channel Island generator (CIPS 10) and Hudson Creek power station (HCPS), and the Darwin BESS.

Figure 1 – The current and superseded system models



As observed by the Utilities Commission in its NTEOR:[2]

> *'The Territory's electricity supply industry is undergoing a rapid transformation. This is primarily due to the displacement of synchronous gas and diesel generation by asynchronous distributed solar photovoltaic (PV) systems on residential and commercial premises (distributed PV) and large-scale solar PV systems that are in the process of connecting to the Darwin-Katherine network. As the Commission has consistently acknowledged, this transformation is particularly challenging given the Territory's power systems are small, isolated, lacking in diversity of renewable energy technologies and without supporting market frameworks.*
>
> *The 2020 NTEOR made it clear urgent attention was needed to mitigate emerging risks and ultimately protect the long-term interests of Territory electricity consumers.'*

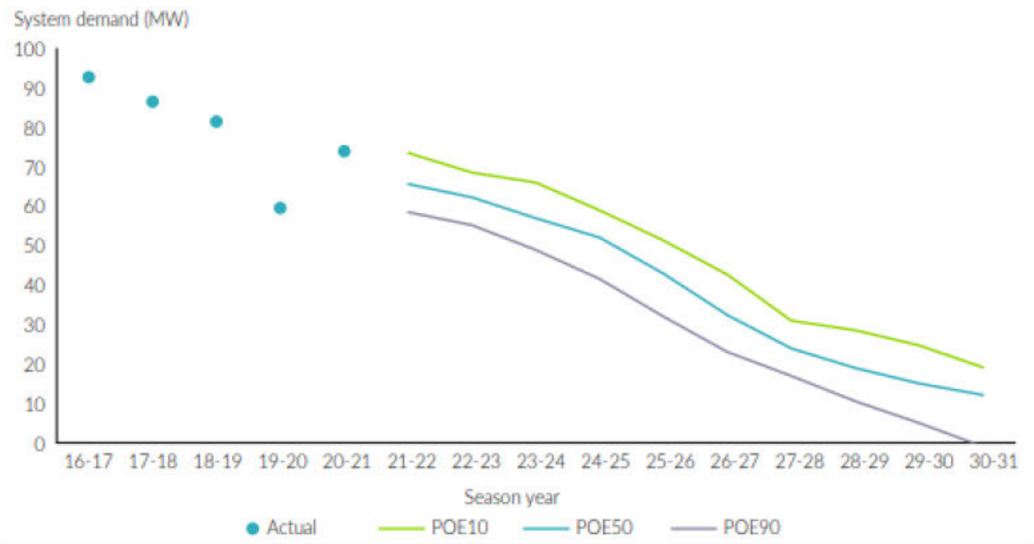
In addition to the NTG's renewable energy target, growth is underpinned by the affordability of solar photovoltaic (PV) panels/inverters (the unit cost has fallen 85% from a decade ago), and a new 40+ gigawatt solar farm is in development (by Sun Cable, north of Alice Springs, which would be the world's largest solar farm). Together with the inexorable growth of electric vehicles on the network, they are impacting the energy flows across the network, peak demand, and minimum demand. Again, the Utilities Commission notes that:[3]

> *'The Commission's assessment forecasts system security challenges as a result of falling minimum demand, primarily as a result of increasing household and commercial distributed PV systems. Licensees have advised these challenges are already apparent in Alice Springs, and they are forecast to start as early as 2023-24 in Darwin-Katherine.'*

The figure below shows the minimum demand outlook for Darwin, which shows a consistently declining minimum load to well below the 60MW threshold apparent in the Commission's analysis.

[2] Utilities Commission, *Northern Territory Electricity Outlook Report 2021,* page v
[3] *Ibid, page v*

Figure 2 – Historical and forecast minimum system demand for the Darwin node



The challenges of minimum demand include:[4]

- Voltage management – it can be increasingly challenging to manage network voltages
- Unintended disconnection of distributed solar –when exposed to power system disturbances, affecting network limits, frequency control, and other aspects of power system operation
- Minimum demand thresholds –sufficient demand is required to operate the minimum generating units to provide voltage and frequency control services under normal conditions
- Emergency frequency control schemes – under-frequency load shedding, an important 'last resort' mechanism for frequency control, is less effective for managing severe disturbances
- System restart – a minimum quantity of stable load is required to restart the large synchronous units that enable system restoration after a major blackout.

The operational complexity requires the operational technology offered by off-the-shelf advanced energy management systems (AEMS, for transmission levels)[5] and distribution system related technologies.

2.2.2 Power and Water's current level of OT capability is inadequate

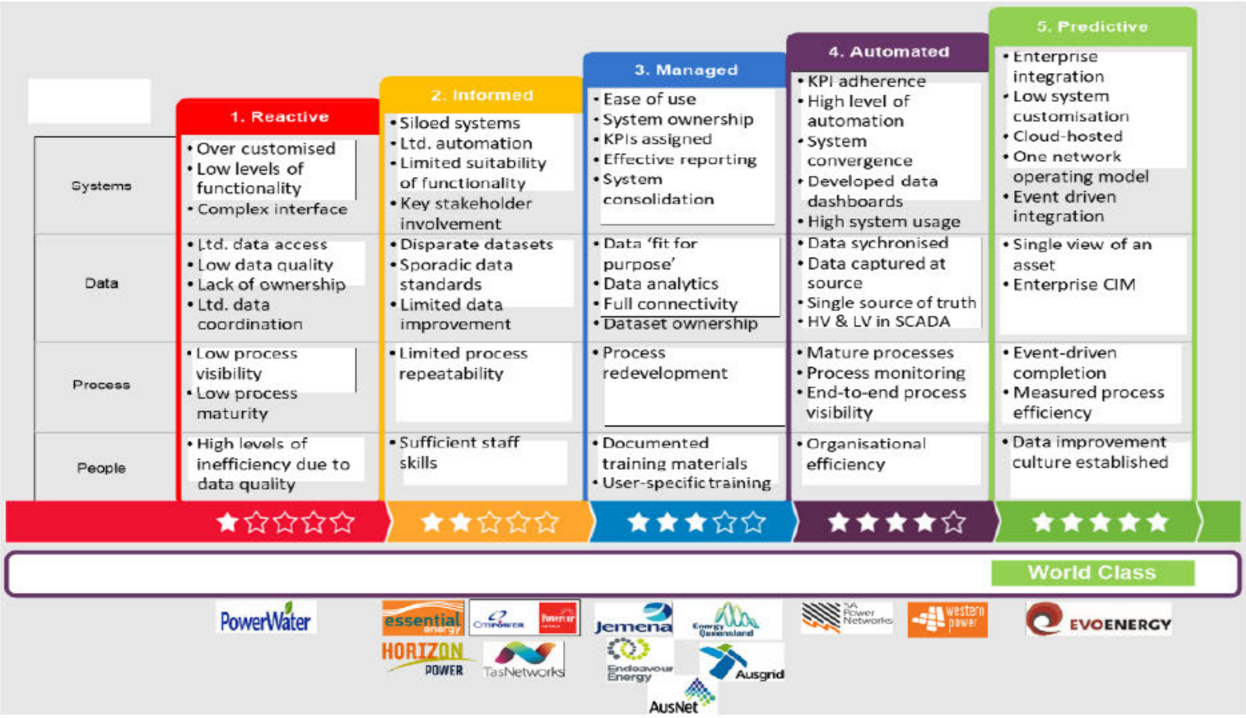
New requirements have highlighted the need to for integration between its key OT systems. Compounding this issue, is the insufficient extent, accuracy and completeness of some operational data. Not having a solid OT information platform constrains the business from effectively managing renewables.

Applying the Carnegie Mellon University model to assess the maturity of the OT systems and asset data, Power and Water is rated as 1.0 (out of 5.0) and trails all the other Australian utilities in related capabilities. Power and Water's currently low score is based primarily on its predominance of manual systems, limited data quality and accessibility, and low process maturity. The reliance on manual systems, creating significant risks through dependencies on key resources, and through a lack of timely and quality information on the state of the network.

[4] AEMO.com.au, *Energy explained: Minimum operational demand*

[5] Which, as discussed in more detail below, Power and Water is developing through an active project and a planned extension to the GE EMS

Figure 3 – Maturity of OT systems and asset data – benchmarking with Australian DNSPs



Source: Strada Associates OT Capability review, 2022

As evidence, the pictures below of Power and Water's control room show the reliance on printouts of network schematics and pins to represent the distribution network. Every other utility in Australia has an electronic representation of its distribution network.

Figure 4 – Power and Water pin boards for distribution management

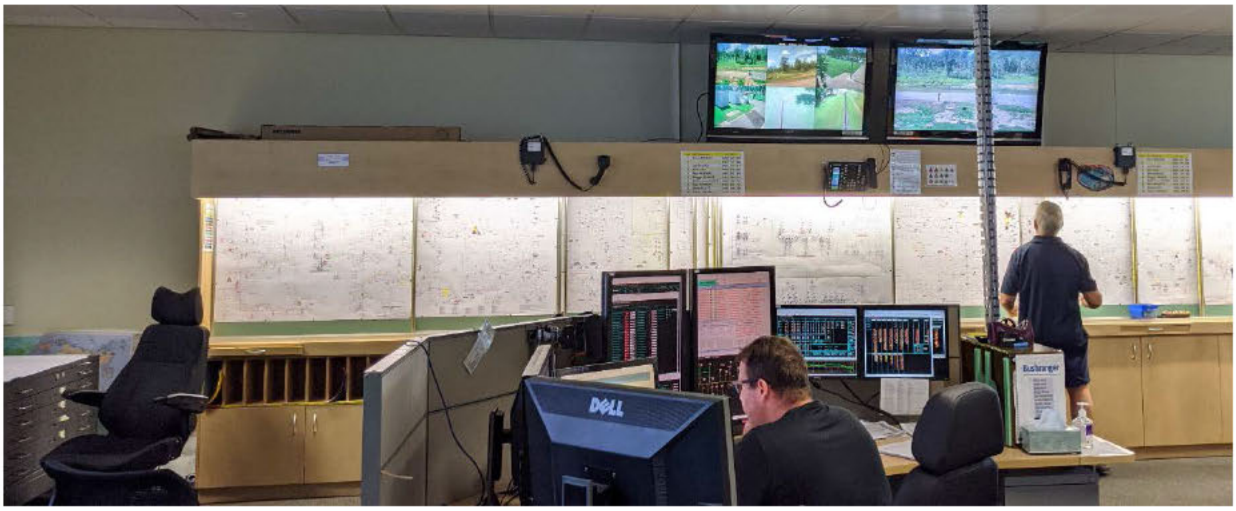
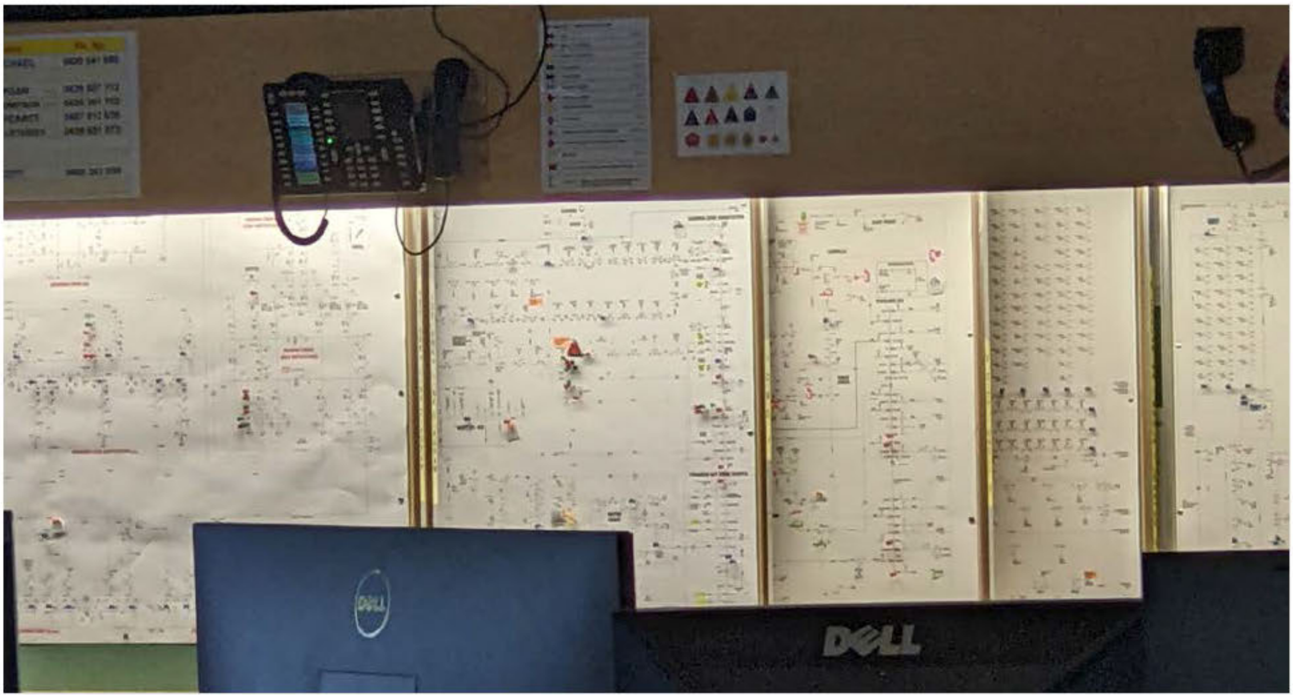


Figure 5 – Close-up of pin boards



2.2.3 Cyber security maturity of OT technology

Power and Water's current cyber security maturity level has been assessed at a Security Profile of [redacted][6] The combination of the increased cyber threat landscape, the obligations under the amended Security of Critical Infrastructure Act ('SOCI Act') and associated Bills, and Power and Water's current cyber security maturity level, makes it clear that Power and Water's overall IT and OT cyber security posture is well short of the required level.

A separate business case has been developed to embed the practices necessary to achieve the Australian Energy Sector Framework's Security Profile 2 level of cyber security maturity. However, achieving the required cyber security posture will depend heavily on Power and water's platforms, systems, and applications more generally being fully supported by the respective vendors to ensure they are each able to withstand cyber-attacks to the extent practicable.

The implications for Power and Water's OT capability is that part of the decision -making for system/vendor selection will be cyber security capability. However, this requirement will not be assessed in detail until the procurement phase of the project lifecycle.

2.2.4 IT/OT Integration

In line with PWC's target operating model and utilising the Purdue Model (see figure below), Power and Water is working towards a converged and federated accountability model which will inform sourcing as well as technical integration and operational management aspects across IT and OT, to provide both security as well as efficiencies.

As part of the scope of this project, an updated integration strategy and roadmap for IT and OT will be produced to inform practical and sustainable architectural designs to support prudent and efficient system designs and

[6] As assessed against the AESCSF

support and service models, whilst ensuring compliance with security obligations and demonstrable alignment to applicable security and regulatory frameworks, such as the AESCSF and the SOCI act.

2.2.5 Risk analysis

Network operation and automation via OTU-related technologies will significantly improve Power and Water's ability to meet its obligations across transmission, distribution and market operating capabilities. The implementation of OTU solutions will address these aspects, and some underlying enterprise risks, including those shown in the table below.

Figure 6 – Purdue-aligned layers for technology management

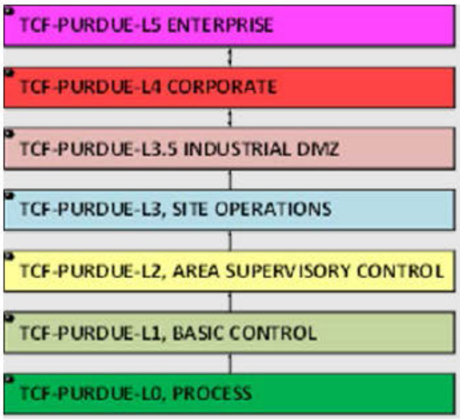
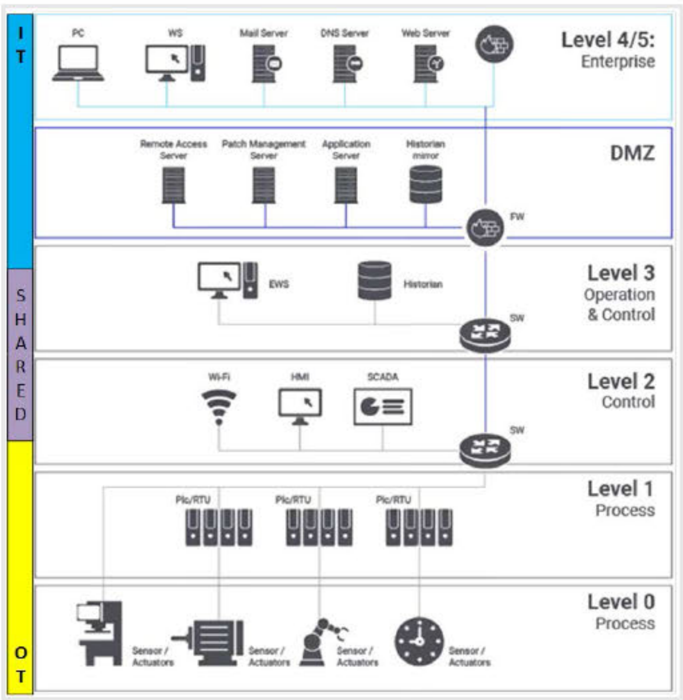


Figure 7 - Standard Purdue Model highlighting accountabilities across IT and OT



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2.3 Industry responses to similar challenges

Power and Water is not alone in facing these OT challenges, but is one of the last, if not the last, Australian DNSPs to make the necessary investment in its OT, data, and personnel skills to respond to the challenges of managing today's electricity system.

One positive from the lagging position is that it provides Power and Water with the opportunity to leverage of the maturing vendors solutions in the market and from the successes and lessons learned from peer utilities from their OT capability uplift journeys. Appendix C provides a summary of such lessons that have and/or will be incorporated into the project development and implementation.

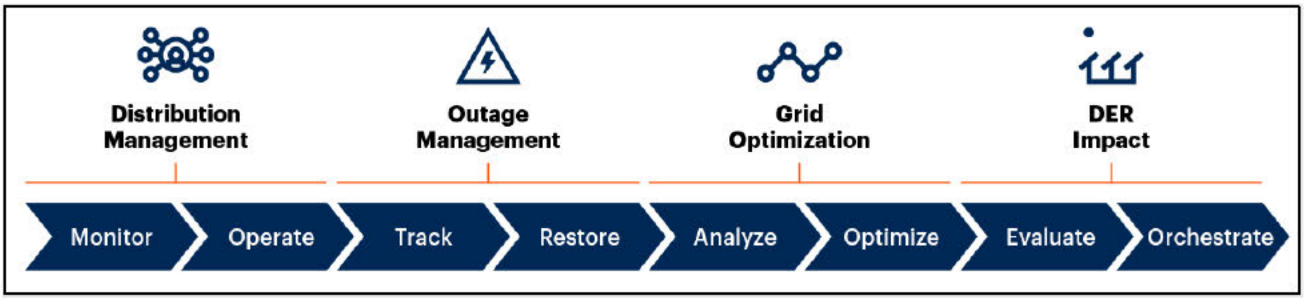
2.3.1 Vendor offerings

At the core of the OTCU project is enhancement of Power and water's distribution management capabilities, with the majority of the functionality to be delivered throughout the next RCP involving what is referred to in the industry is Advanced Distribution Management System (ADMS).

'An advanced distribution management system (ADMS) is the software platform that supports the full suite of distribution management and optimization. An ADMS includes functions that automate outage restoration and optimize the performance of the distribution grid. ADMS functions being developed for electric utilities include fault location, isolation and restoration; volt/volt-ampere reactive optimization; conservation through voltage reduction; peak demand management; and support for microgrids and electric vehicles.' Gartner definition

ADMS solutions are offered by numerous vendors, including Oracle, NREL, GE, Hitachi Energy, ETAP, Schneider Electric, and ABB. The ADMS functional scope is illustrated in the diagram below.

Figure 8 – ADMS functional scope



Source: Gartner, DER-Distributed Energy Resources, 733294-C

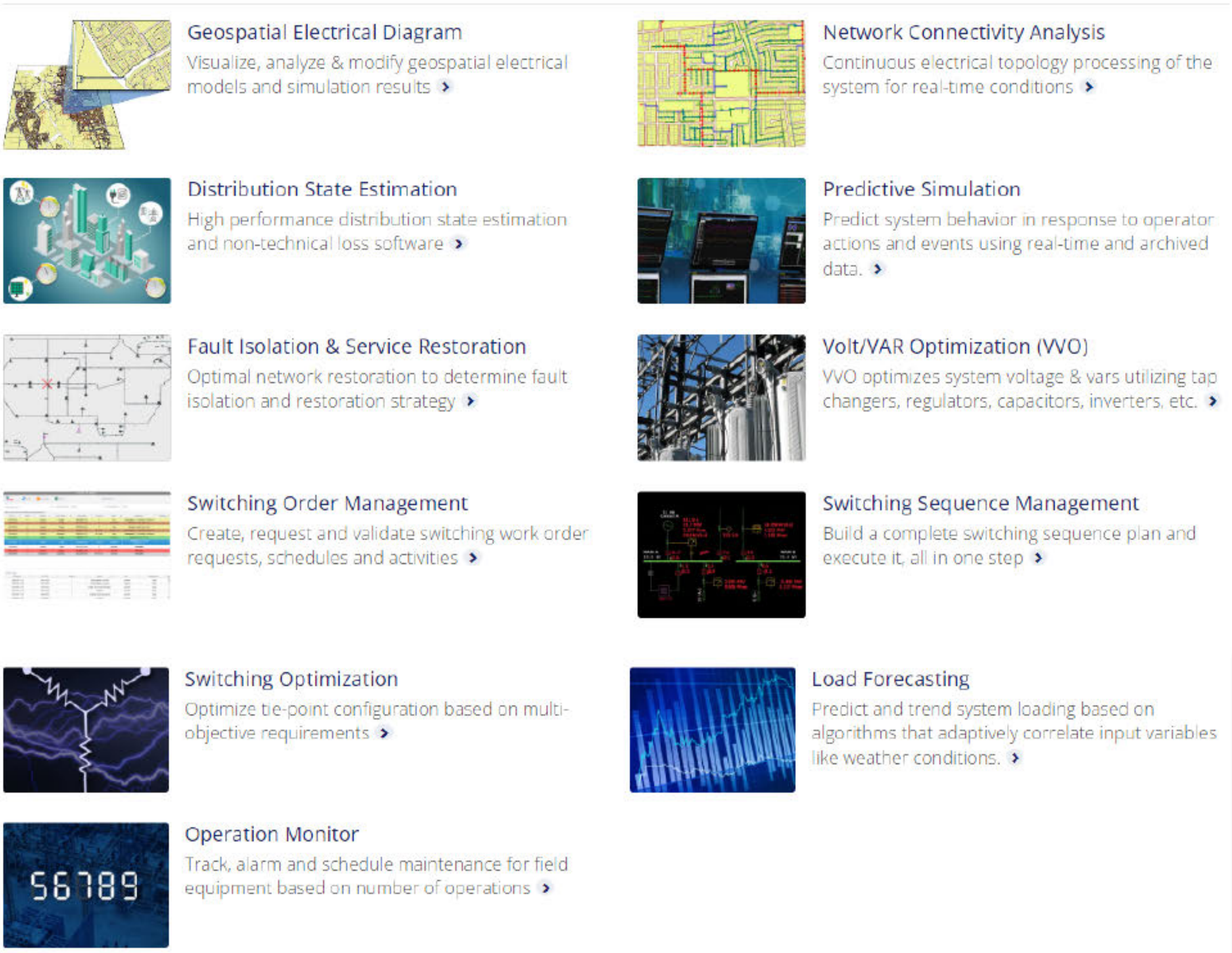
Some vendors' offerings identify DERMS[7] as a separate set of functionality and some, like GE, encompass DERMS within its ADMS suit, as illustrated in the quote from its web site below:

GE's DER-aware ADMS moves beyond the traditional bounds of SCADA, DMS and OMS and provides software for the safe and secure management and orchestration of the distribution grid. Our solutions deliver reliability, productivity, and efficiency through a modular architecture, adaptive algorithms, predictive analytics, and a brilliant user experience. GE's ADMS software supports our customers' journey towards predictive and autonomous operations, and an optimized distribution grid that accelerates the energy transition.

To illustrate the functionality offered off-the-shelf by vendors, ETAP refers to its ADMS as 'an intelligent geospatial (GIS) based distribution network solution that proactively reduces peak demand, optimizes network assets, while assisting distribution networks deliver electricity more efficiently, reliably, securely, and economically'. Its web site refers to each of the applications (modules) shown in the figure below.

[7] Distribution Energy Management System – a software solution that helps utilities organise, control and optimise DERs and other consumer assets operating within their distribution system to maximise the DERs' economic benefits while also improving grid reliability and service quality (EY Report – Smart Energy Systems in Oceania)

Figure 9 – ETAP's DMS modules



Source: etap.com

Oracle's web site includes a case study from United Energy in Victoria, which outlines the returns on investment in the Oracle ADMS.

2.3.2 Case study (United Energy, Victoria)[8]

United Energy (UE) launched its distribution automation initiative in 2018with an '*approach to smart grid technology, network reliability, and performance-based rate making with the support of its regulators.*' Recent successes include implementing the following ADMS features:

1. FLISR (fault location, isolation and system restoration) deployment – 10x ROI over 5 years
2. Network control mobility (via OMA) - integrated control center and field for improved safety and efficiency; 3.2xROI over 5 years
3. Power flow and feeder load management – 3.5xROI over 5 years

"The benefits we've seen from FLISR have been tremendous. Since implementing FLISR five years ago, we've seen a 10x return on investment."

Adam Gellie
General Manager for Service Delivery, United Energy

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[8] Oracle, Australia's United Energy mines deep ADMS value – Case study, https://www.oracle.com/a/ocom/docs/industries/utilities/utilities-united-energy-case-study.pdf

4. Fault location analysis (FLA) and suggested switching – 8.1xROI

2.4 Power and Water's OT strategic objective

Power and Water needs to follow in the well-trodden path of Australian and international utilities in implementing technologies, adequate data quality, and adequate skills to manage the system management challenges that are already being experienced. When based on single network operating model, such a system is the basis of an enterprise integrated solution, with its DMS module being the key to managing renewables. It is to provide an integrated set of tools that remotely monitor and control the network, manage system outages, improve planned and emergency event management, and optimise power-flow management, fault location analysis, fault isolation and restoration capabilities, even in complex scenarios with DER feeds into the network.

OT strategic objective

The strategic objective is to achieve a maturity level of at least 4.0 'Automated' (per the Carnegie Mellon-based maturity model)

2.5 OT capability uplift strategy development

2.5.1 Research and assessment

Cognisant of the risk analysis, the need to upgrade Power and Water's OT capability, and the approach by other DNSPs to address similar risks, several studies were undertaken in 2021/22 to help prepare the initial scope and plan for implementing DMS technologies and the integration with (i) work underway in developing Power and Water's transmission OT capability (i.e. the Energy Management System EMS project) and with NT energy market development (NTEM). The scope and findings of the studies are summarised below:

- OTU System and data readiness: an initial body of work to review and identify system capabilities and information quality and completeness to deliver DMS, OMS, DERMS and an integration GIS, WAMS and Common Information Model across all of them. This involves analysis of historical initiatives across these capabilities, as well as the current state of information and systems, and planned bodies of work which may impact them. This work formed the foundations upon which this business case was developed.
- BIS Research – Market Analysis Procurement: a market analysis of products and vendors in the energy space, including the size, market presence, acquisitions, strategic direction and more. Informed the EY analysis work detailed below.
- BIS Research – Future Direction: A further analysis of vendors and products, focussed on their future direction, strategic acquisitions, and areas of investment. Informed the EY analysis work detailed below.
- EY EMS & ADMS Vendor Analysis: an Australasian market scan of historical, current and planned platforms across utilities, the migration/upgrade paths they took, including sizing and indicative spend, as well as recommendations on approach, lessons learned by other utilities, and details on market presence by across utilities with ADMS capabilities in place.
- EMS & ADMS Landscape & Future Roadmap: Based on all of the above, a high level dependency roadmap for solutions and projects delivering them, based on current and planned systems across PWC from generation to transmission, NTESMO, distribution and DERMS, and trading/optimisation capabilities.

In summary, Power and Water has undertaken market research via several channels, including a spot audit of the current systems and data in place via technical and face-to-face audits and interviews, review and analysis of published market research on utilities and platforms in the energy space, and a Big-4 lead synthesis of the market research and Australasian utility market (TNSP and DNSP). This resulted in an initial roadmap to highlight a possible approach to structuring and delivering the required capabilities, which has in turn has informed this business case. Power and Water built the structure of the business case and the required systems, processes and data based on vendors involved with successful implementations of comparable capabilities at other TNSP and DNSPs, including a whole of implementation reference being ActewAGL.

2.5.2 EMS Upgrade project

The EMS Upgrade project has undertaken commercial activities to determine that the most prudent path forward is to upgrade to the newer AEMS platform by the same vendor, GE. Primarily on a risk- and efficiency-basis, a direct upgrade to a modularised platform which also offers OTU capabilities is favourable to Power and Water. PWC obtains a range of benefits such as:

- Reduced training overhead
- Re-use of data
- Minimised breaking of technical dependencies
- Ability to maintain and enhance the existing hardware platforms.

Whilst this business case is not dependent specifically on a GE-based AEMS platform, should the EMS upgrade project change direction and re-platform with a new vendor (for example), the individual projects within the OTU initiative would have to be refactored from a timing, hardware and integration assumption perspective. This business case and the structure of the proposed initiatives will be able to accommodate such a shift, but it would add overhead and complexity, particularly on the common information model, and other data-enablers.

2.5.3 OT Capability uplift strategy

Taking into account Power and Water's starting point, gap analysis, strategic objective, and Power and Water's capabilities, Power and Water's OT Capability Uplift strategy is shown below.

OT capability uplift strategy

The strategy is to incrementally implement an integrated, off-the-shelf platform that supports the full suite of distribution, transmission and generation automation and management capabilities.

In the interest of prudency and efficiency, Power and Water has a published standard to prioritise 're-use, before buy and before build'. At the time of writing, this means the adoption and utilisation of the GE AEMS/ADMS functionality looks to be the most practical and deliverable platform for much of the required capability uplift. Note that one of the design goals for the OT Capability Uplift project overall is to meet obligations in the near time, whilst affording a relatively straight forward transition to more coherent and centralised tooling as the market products mature in this space. DERMS in particular is challenging at the moment, as mature reference sites utilising well-tested and mature product offerings are not sufficiently abundant to inform decision-making. Product acquisitions by vendors in the AEMS/ADMS space are still relatively new, making platforms not yet coherent and compelling, holistically. This business case allows PWC to manage the risk associated with the current state of the market,

2.6 Required OT capability

The result of the reviews referred to above, cognisant of the EMS and EMS Upgrade projects and the requirements of the iNTEM and NTEM requirements, resulted in the following capabilities or functionalities being assessed as required to bridge the gap to 4.0 level OT maturity:

Single view of an asset across the organisation - being able to access all the latest data across the various asset systems and data repositories. The strategic outcome is to provide seamless and easy access to systems and data that is required to undertake the day-to-day operations of The Business. A 'single view' does not mean a 'single system' but a single interface, referred to as an OT Common Information Model (CIM).

The concept of a single view is underpinned by the following principles:

- Single points of truth;
- Support specialist views;
- Streamlined processes and information within systems and across systems;
- Spreadsheets and databases used for analysis do not become transactional and dependent for operations or BAU.

Real-time outage management model - having one real-time model that is generated from the GIS and drives the operations and outage management. This revolves around having the situational awareness to enable a combination of people, processes and technology to geospatially visualise and analyse information. This involves relating assets and incidents (e.g. inspection locations, pipe burst locations, etc), by location/coordinates. This provides the ability to rapidly evaluate history and present circumstances even as they are changing with a focus on analysing data that is relevant to a particular decision across space and time

Real-time public facing portal - having a public facing portal that in real-time provides information on the location of outages, field crews, street works, planned works, etc

Asset performance and maintenance linked to levels of service - defined levels of service can be used to define the required asset performance and maintenance work. As a function of the defined level of service, every asset management decision and 'trigger' point needs to be defined for all asset classes and the asset information needs identified so that a robust and flexible framework is available to deliver the full complement of analysis and reporting requirements. The objective is to have consistent and accessible asset data across Power and Water

Digital Utility - Power and Water is facing increased pressure to standardise and streamline operations while ensuring reliable service. In a highly connected, data-driven and service-centric new era, simply continuing to adopt more technology is not sufficient. The business needs to transform and understand the value of asset data. Power and Water needs to be working towards creating a digital geospatial-based framework that spans the entire company from end-to-end

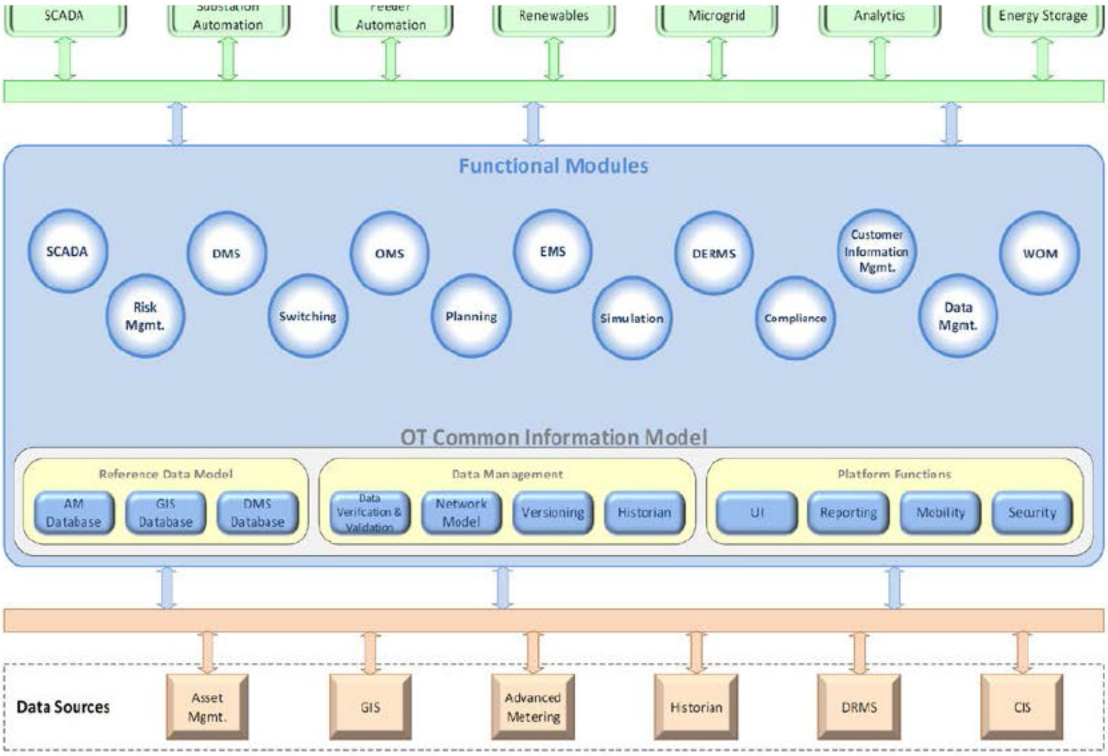
Front-office, back-office and operations - need to be fully integrated so that data flows in from the field and across The Business in a seamless manner. This seamlessness would enable it to transform its current electronic, hardcopy, duplicated, incomplete and often disparate datasets into a geospatial single point-of-entry, through which internal decision-makers, business partners, suppliers, customers and others can access business information. Pursuing digital transformation across the value chain is critical to achieving digital asset management, digital field work, digital operations and digital customer interaction. This represents the era of the 'Digital Utility'

Customer notification app - where customers or the public can use their phones to record asset failures and submit them to Power and Water for rectification

One Network Operating Model Across All OT Systems – to simplify, optimise and de-risk the information flow across all related systems, a single network operating model is required.

Conceptually, the overall need can be address via this option with solution coverage shown in the figure below, representing the target state for EMS, DMS, OMS, DERMS, WAMS and related/supporting systems and capabilities. Note that each functional module below may be present in multiple applications, and each of those may in fact be used in support of multiple business capabilities. Part of the approach within the business case is to minimise the number of applications and modules required to provide the capabilities across AEMS/ADMS.

Figure 10 – Conceptual Target State for Network Operation ETAP's DMS modules



Source: Strada Associates ADMS readiness review 2021

As illustrated in the figure below, the functionality in the diagram above spans several component of the energy system value chain.

Figure 11 – OTCU project impacts several aspects of the energy sector value chain

2.7 Summary

Power and Water's OT capability and environment is not fit for purpose.

Power and Water, has determined that the target state is a contemporary, integrated suite of systems, enabled by a sufficiently complete and accessible set of standing and real-time data, and sufficient trained staff to operate and leverage the capabilities. With contemporary tools, adequate data, and the right staff, Power and Water can effectively manage the network despite the rapidly changing landscape of distributed and large-scale energy resources, less synchronous machines, and electric vehicles.

The capabilities and supporting systems and data being proposed are often referred to collectively as advanced distribution management system ('ADMS'), and notwithstanding that some aspects of these capabilities may be being addressed by other initiatives outside this business case such as the EMS upgrade, an ADMS typically comprises of:

- Distribution SCADA – delivering the functionality required for network monitoring and control of Power and Water's distribution network, noting that the control aspects will be limited during the next regulatory control period ('next RCP', which spans 2024-2029)
- Distribution Management System ('DMS') - a combination of advanced network applications and analytics providing operators with the analytical tools to make informed decisions and manage the network effectively (e.g. state estimation, fault location isolation and service restoration (FLISR), and dispatch management)
- Outage management ('OMS') – provides a platform for operational decision support and a system that can be used simultaneously by multiple users, integrating information about customers, system status, and resources
- Distributed energy resource management ('DERMS') – to help reduce voltage excursions and increase hosting capacity in networks with high distributed energy resource ('DER') penetration, noting that the full functionality of DERMS will not be introduced until the subsequent RCP.
- Works and Asset Management ('WAMS') and integration – a system which makes optimum use of all resources to promote safety and enhance operations.

Whilst the focus is on fit-for-purpose electricity distribution management capabilities, the scope of the project supports improved network planning and operations across generation, transmission, distribution, and NTESMO (NT Energy System and Market Operator) – it is therefore not just an ADMS implementation project, but also a project to coordinate and address foundational elements and enablers to support ADMS/ADMS functionality overall.

3 Options analysis

This section describes the options that were analysed to address the increasing risks and need and to identify the recommended option. The options are analysed based on ability to address the identified needs, prudency and efficiency, commercial and technical feasibility, deliverability, benefits and an optimal balance between long term asset risk and short-term asset performance.

3.1 Comparison of credible options

Credible options are identified as options that address the identified need, are technically feasible and can be implemented within the required timeframe. The following options have been identified:

- Option 1 – Integrated Point Solutions. This option proposes multiple platforms with integration between them. Implement additional modules and bespoke components to meet needs not met by either platform, or where both platforms are required to integrate with a third platform for advanced functionality (e.g. state estimation, fault location isolation and service restoration (FLISR), and dispatch management).
- Option 2 – New consolidated Platform. This option proposes a completely new platform with all AEMS/DMS/OMS/DERMS capabilities in place, from the ground up.
- Option 3 – Upgrade, Extend & Integrate EMS Platform. This option proposes a staged, capability based upgrade of existing EMS platform with managed integration for advance point solutions.

A comparison of the three identified credible options and the issues they address in the identified need is depicted in Table 6. These options are described and assessed in detail in the sections below.

Table 6 Summary of options analysis outcomes

Assessment metrics	Option 1 –	Option 2 –	Option 3 –
NPV ($m, real FY22)[9]	-35.10 to –43.87	-52.65 to -70.20	-31.32
BCR[10]	n/a	n/a	n/a
Totex ($m, real FY22)	40-50	60-80	35.7
Meets customer expectations	◑	◑	◕
Aligns with Asset Objectives	◑	◑	◕
Technical Viability	◑	○	●
Deliverability	◑	○	●
Preferred	✗	✗	✓
Ranking	2	3	1

● Fully addresses the issue ◕ Adequately addresses the issue ◑ Partially addresses the issue ○ Does not address the issue

[9] Provisional NPV assuming there are no quantified benefits. Benefit Areas, and anticipated net benefit are articulated further below however have not yet been quantified. Key areas of benefit will include compliance/obligations, efficiencies and labour savings

[10] Not yet available.

3.1.1 Option 1 – Integrated Point Solutions

This option is based on introduction of multiple products and multiple vendors.

The advantage of this option is simplicity of implementation of discrete functionality; smaller projects are generally easier to implement.

However, there are many disadvantages with Option 1:

- Effort: this approach defers effort to the data, integration and operational management aspects, increasing opex proportionally. This option is also a well-documented anti-pattern from an integration and operational point of view, which becomes unsustainable due to the sheer number of vendors, applications, integrations and data sources to manage.
- Cost: the estimated effort described above results in a considerably higher totex of $40-$50 million, with a significant portion of that being operational expenditure/headcount, than estimated for the preferred Option 3.
- Risk:
  - Cyber security risk - the critical infrastructure legislation (i.e. SOCI Act amendments and associated Bills) makes this option extremely unattractive overall due to the amount of configuration and reconfiguration and the overall risk footprint associated with this approach. More vendors, more patching, wider footprint of exposure.
  - Delivery risk – each subsequent project which requires to integrate or consume data from prior solutions built this way have additional and non-linear increases in complexity and cost
  - Operational risk – management overhead will increase for each application adopted and integrated in this way.

For these reasons, Option 1 is not recommended.

3.1.2 Option 2 - New Consolidated Platform

This option is based on building a completely new implementation from the ground up, using either the same or different vendor.

The advantage of this option is the opportunity to implement exactly what is needed and only what is needed, without exhaustive current-state analysis and data migration. There is also the opportunity to select a platform which is more heavily integrated with other key technologies (GIS, WAMS) across PWC, by choosing vendors who have strategic relationships with other major players and have built interoperability between their platforms, reducing the complexity of integration, data management and operational support.

However, this option is not technically feasible because the scale of effort, risk and cost to re-platform is comparably prohibitive at an estimated totex of $60-$80 million. Further Power and Water would not have the capacity to support a completely new implementation and manage day-to-day operations in parallel, even if the project was developed using a blended/hybrid resourcing model (i.e. as proposed for Option 3). It is therefore very unlikely that the project would be delivered successfully, or, if it was, the ramifications to business-as-usual activities would be unacceptable.

This option is not recommended.

3.1.3 Option 3 – Upgrade, Extend and Integrate EMS Platform

This Option is based on staged, capability-based upgrade of existing EMS platform with managed integration for advance point solutions. The estimated capex is $25-30 million over 10 years (FY23 – FY33).

Refer to Appendix A for a bottom-up build of the preliminary cost estimate, and Appendix B for the Key assumptions.

Scope

Its scope includes the uplift and introduction of platforms to support improved network planning and operations across generation, transmission, distribution, and NTESMO over the 2024-29 regulatory period and beyond, but with the expenditure in this business case being focussed on the regulated distribution capabilities, and the enablers (particularly relating to data quality and data management).

This Option therefore provides full coverage for all elements required to meet DMS, OMS and DERMS related capabilities, including peripheral supporting systems such as the EMS and GIS. It further includes the development of a single integrated and capability-based plan for all energy related technology initiatives to ensure Power and Water can quantify expenditure and credible options that will resolve the needs with an appropriate sequencing, resourcing and scoping (avoid duplication).

Foundational capability for commissioning DERMS will be provided in the next RCP, however full DERMS implementation is currently planned for the following RCP (I.e. 2029-2034)

The advantages of this option are: maximising the existing investment including infrastructure, and minimising the expense of data migration, re-platforming and training.

The disadvantages of this option are: dependencies to manage with the EMS upgrade project, and other NTEM-related works, as well as a more thorough and time-consuming current state and target state analysis (e.g. compared to a new implementation).

Scope exclusions

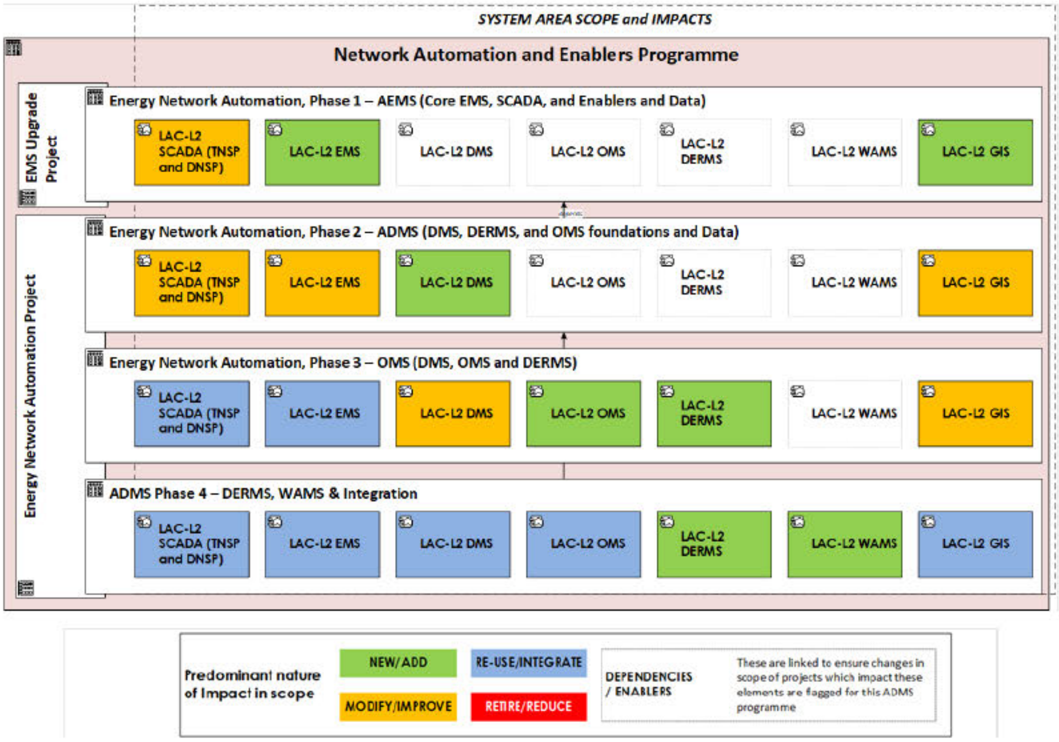
This business case does not include the cost associated with the AEMS project, which this option is dependent upon (as discussed in more detail below). The AEMS project provides the foundational platform (GE AEMS) and because of its importance to this project is recognised as Phase 1 in the project scoping plan shown in the figure below.

This business case does not include any scope or costings for data remediation work which may be identified through scoped activities.

Project design strategy

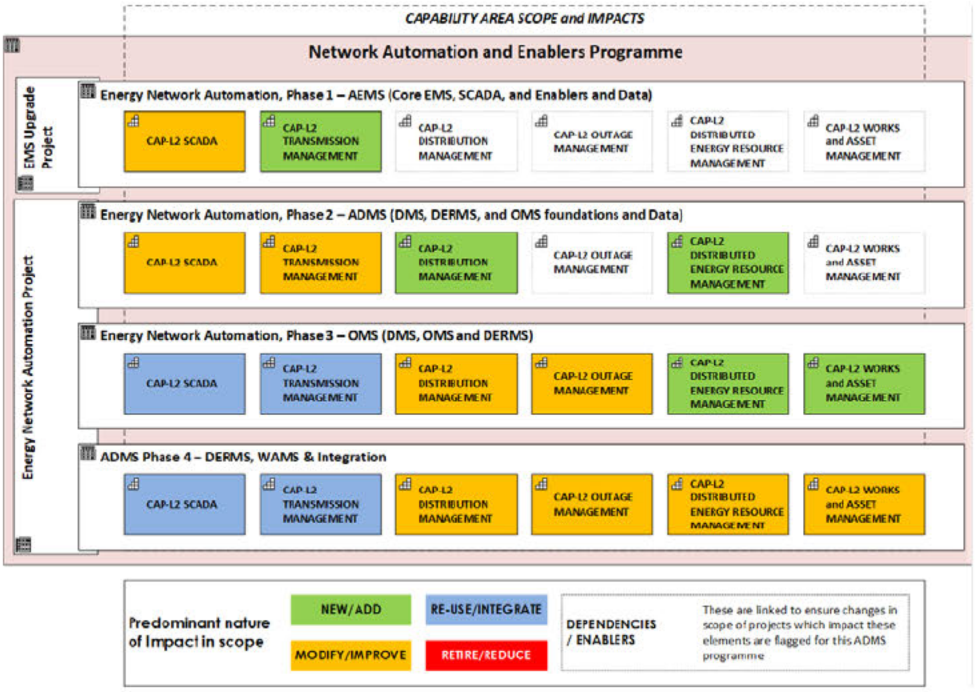
The figure shows the project being delivered/managed in four phases, with Phases 2 and 3 being the focus in the next RCP. The strategy of phasing delivery and (i) re-using or modifying existing capabilities, and, where necessary, (ii) adding new capability is clear from this figure.

Figure 12 – System development plan for the AEMS and OTCU projects (new, modify, re-use, retire)



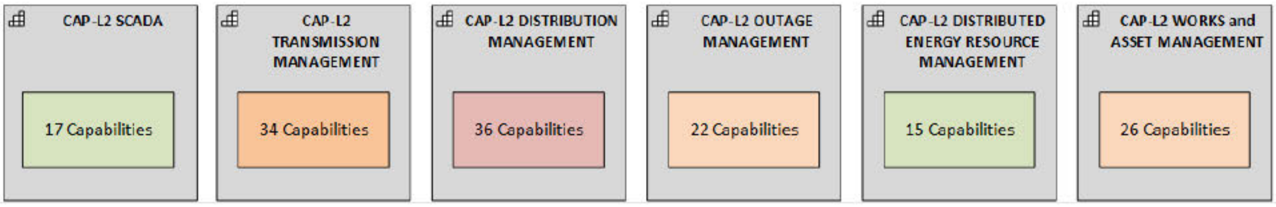
The figure below provides a similar perspective – the capabilities that will be progressively developed from the AEMS and OTCU projects.

Figure 13 - Scope and impact (new, modify, re-use, retire) across capabilities per phase



The figure below shows a heatmap of the effort attributable to the capabilities designated in the figure above, with distribution management (per the introduction of DMS) the most impacted area.

Figure 14 – Heatmap of Scale of capabilities impacted across Power and Water's capability areas



Initiatives

The initiatives underpinning these phases are:

- Data Governance
- Populate OTU CIM
- Customer Connectivity Modelling Remediation
- Implement Esri Utility Network Model (UNM)
- Develop LV SCADA Network
- Implement Distribution SCADA
- Complete GIS Connectivity
- Implement DMS
- Key Business Process Redevelopment
- Implement OMS
- Implement DERMS
- OTU/Maximo Integration

Each of these initiatives are described in greater detail in Appendix D.

This is the recommended option.

3.2 Non-credible options

Our analysis also identified a single option found to be non-credible, as described below and was not taken through to detail analysis for the reasons provided.

3.2.1 Do nothing – does not address the need

The current network and supporting systems are not unable to support the required functionality. Business as usual and incremental improvements for point capabilities will neither meet the need, nor be deliverable with the existing technologies and data in the current state.

4 Recommendation

Option 3 – Upgrade, Extend and Integrate the EMS Platform, at an estimated total cost of $35.7 million (real 2021/22) for the 2024-29 regulatory period is recommended.

The full project scope will provide functionality across transmission, NTESMO and distribution and is planned to commence in FY23 and conclude in FY33. The project will be delivered in four phases, with the scope of this business case and cost covering phases 2-4. Phase 1 (AEMS, core EMS, SCADA, data) covered by a separate business case.

The estimated capex is $21 million (real 2021/22) for the next regulatory period, with the focus on building distribution management capabilities.

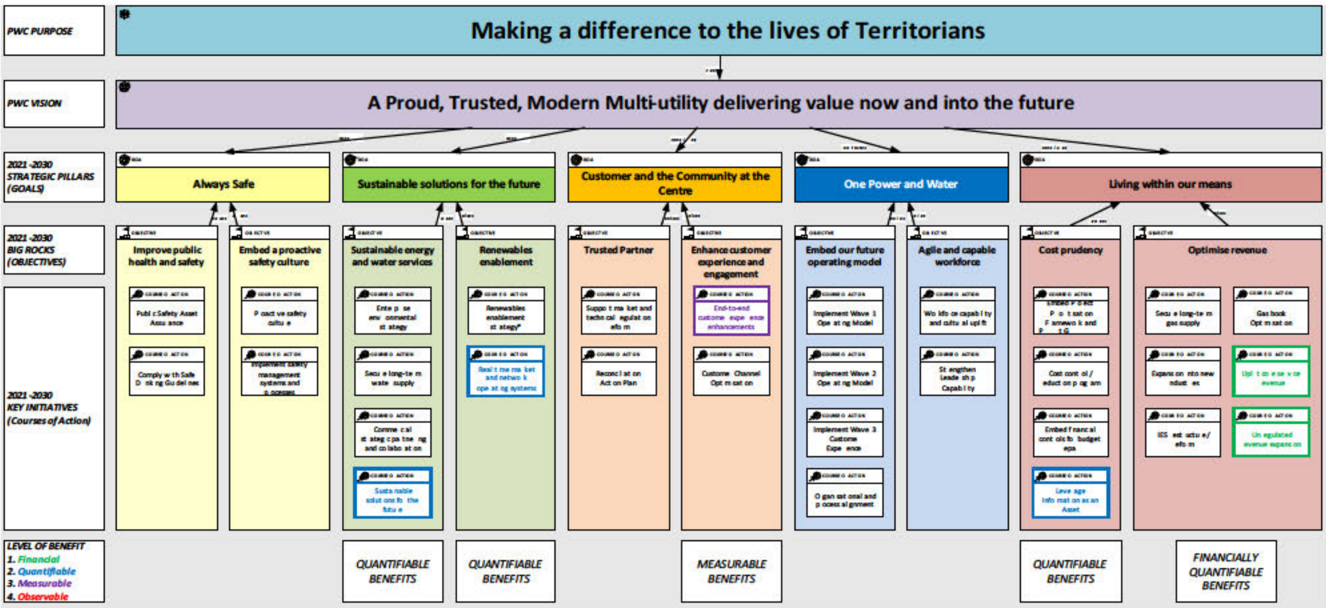
The proposed program is consistent with the National Electricity Rules Capital Expenditure Objectives as the expenditure is required to maintain the quality, reliability, and security of supply of standard control services and maintain the safety of the distribution system, as well as to meet renewables targets.

4.1 Strategic alignment

The figure below shows the strategy map for Power and Water. There are five 'strategic pillars. And the OTCU Project contributes to three of them:

- Sustainable solutions for the future - Real-time market and operating system to help with renewables enablement
- Customer and the community at the centre - End-to-end customer experience enhancements to enhance customers' experience and engagement
- Living within our means - Leverage information as an asset to assist with efficiencies, and cyber and information security risk mitigation.

Figure 15 - Strategic Impact Map for Business Case – rudimentary due to OTU business case being in initiation phase only



PowerWater

4.2 Dependent projects[11]

This project assumes that the planning, scoping and sequencing of work continues in the current regulatory period in advance of the final business case being developed and approved to commenced in the next regulatory period. Specific project dependencies are shown in the table below.

- 'Bidirectional' means that the projects are dependent on each other.
- 'Upstream' means that the OTCU Project is dependent on the project identified in the first column.
- 'Downstream' means that the project identified in the first column is dependent in some way on the OTCU Project.

Table 7 Project interdependencies

Project	Complexity & Potential Impact	Dependency Direction	Dependency/Constraint details if known
Cyber Security Project	5 - EXTREME	Bidirectional	Extreme dependency – could dramatically change scope of OTU.
EMS – Energy Management System	5 - EXTREME	Upstream	Approaching end of supported life and does not support required functionality to meet future, confirmed capability and demand requirements.
Meter to Cash/Transformation	5 - EXTREME	Upstream	Various technical and resourcing inter-dependencies.
NTEM-MMS	5 - EXTREME	Bidirectional	A range of capabilities which will leverage and/or integrate with OTU capabilities.
WAMS implementation	5 - EXTREME	Bidirectional	Shared dependencies on data, data structures, network models, asset hierarchies and more.
Field Mobility implementation	4 - HIGH	Bidirectional	Tied to WAMS and EMS and DMS.
FMS – Finance Management System	4 - HIGH	Downstream	Tied to outcomes and platforms for OTU, WAMS.
NTEM-MMS (Extensions)	4 - HIGH	Downstream	A range of capabilities which will leverage and/or integrate with OTU functions.

[11] The full nature of the dependencies and sequencing will be determined as part of the integrated plan developed through the next phase of this business case's internal development.

NTEM-Settlements	3 - MODERATE	Upstream	Various technical and resourcing inter-dependencies.
Market Interaction enablement	2 - LOW	Upstream	Rules and regulations that feed into multiple projects that are inter-dependent with OTU scope.

4.3 Expected benefits

At this stage, we can identify likely areas of benefit, but not quantify them. Once individual business cases are developed, with options and selections made each case will have clear benefits defined per the categories shown in the table below.

Table 8 Expected benefits – indicative only

Area of Benefit (context in brackets)	Nature of benefit	Possible benefit offset
Increased accuracy, precision and currency of DMS state data (Crew management, dispatch, outage resolution, network state analysis, network protection, DOE)	FLISR Labour, efficiency saving	Increase in control room labour to manage DMS and DMS Data Increase in data maintenance labour for the CIM and CIM-dependent systems
Reduction in labour for maintenance of multiple representations and data formats for the network (EMS, GIS, WAMS, DMS, OMS, DERMS all running a single, coherent model with single 'view' of assets)	Labour, efficiency saving	Increase in GIS data to maintain
Compliance & Obligations	Compliance Metrics	
Renewables Targets	Position against targets	
Event driven AEMS/DMS through modern system and data architecture (Automation, analytics, data accuracy and precision)	Labour, efficiency saving	

4.4 Deliverability

Sequencing and structure of the initiatives have been informed by an approach considering cost, scale, requirement, risk, resourcing and interdependencies. Whilst the initiatives presented here define the approximate scope and sequence, Power and Water will be analysing and structuring specific projects to be delivered in a way to:

- coordinate to a single, capability-based plan covering all energy-related initiatives;
- minimise resource and technical contention;
- size each initiative as small as practicable, without introducing excessive management overhead;
- deliver to milestones based on operational capability vs application or technical deliverables.

4.5 Customer considerations

As required by the AER's Better Resets Handbook, in developing this program Power and Water has taken into consideration feedback from its customers.

Feedback received through customer consultation undertaken at the time of writing this PBC, has demonstrated strong support amongst the community for appropriate expenditure to enable long term maintenance of the network to ensure continued reliability, maintainability and safety of supply.

4.6 Expenditure profile

Table 9 shows a summary of the expenditure requirements for the 2024-29 regulatory period.

Table 9 Forecast annual capital and operational expenditure ($m, real 2021/22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	4.50	4.50	3.00	4.50	4.50	21.00
Opex	3.15	3.15	2.10	3.15	3.15	14.70
Total	**7.65**	**7.65**	**5.10**	**7.65**	**7.65**	**35.70**

The forecast expenditure for the next regulatory control period allocated to Standard Control Services as per the CAM is outlined in Table 10.

Table 10 Forecast annual capital and operational expenditure – allocated to SCS ($m, real 2021/22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	4.08	4.08	2.72	4.08	4.08	19.04
Opex	3.15	3.15	2.10	3.15	3.15	14.70
Total	**7.23**	**7.23**	**4.82**	**7.23**	**7.23**	**33.74**

The forecast expenditure for the next regulatory control period allocated to recurrent and non-recurrent categories is outlined in Table 11.

Table 11 Forecast annual capital expenditure – recurrent and non-recurrent

Item	FY25	FY26	FY27	FY28	FY29
Recurrent	-	-	-	-	-
Non-recurrent	100%	100%	100%	100%	100%

4.7 Scope of work

Phase 1 of the project is not in scope of this business case because it is being managed under a separate project

- Modify/improve T & D SCADA
- Implement EMS
- Implement new GIS

Within the OTCU scope, the required system and data oriented initiatives aligned to the drivers include:

Phase 2

- Modify/improve Transmission and Distribution SCADA;
- Modify/improve EMS
- Implement DMS
- Modify/improve GIS

Phase 3

- Implement OMS
- Implement DERMS Foundations[12]
- Re-use/integrate Transmission and Distribution SCADA
- Re-use/integrate EMS
- Modify/improve DMS
- Modify/improve GIS

Phase 4

- Re-use/integrate transmission and distribution SCADA
- Re-use/integrate EMS
- Re-use/integrate DMS
- Re-use/integrate OMS
- Re-use/integrate GIS
- Add DERMS
- Add WAMS

The project structure will be commensurate with a project of this size. As can be seen from the preliminary cost estimate, resources have been allowed for the following functions:

- Project management (including scope, cost, and schedule management)
- Contract management
- Integration management

[12] DERMS is separate and complementary to implementation of a DOE solution

- Documentation management
- User acceptance
- Change management

Appendix A. Cost estimation

A combination of consultancy, vendor and internal costing methods have been used to estimate scope, scale and costs of the initiatives. Overall, the element used include:

- Individual work packages have been sized according to vendor information, Big-4 consultancies' market and vendor scans, and via a consultancy involved in costing and delivering similar initiatives for other utilities.
- For fixed products or services indicative figures have been sought from vendors – eg ESRI Australia have provided the indicative costs for their Esri Utility Network Model to act as the master network model
- For resourcing/labour elements, standard internal rates tables have been applied to the indicative sizing estimates determined as outlined above
    - Vendor - Single
    - Vendor - Multiple
    - Internal Labour - SME/s
    - External Contractor/s
    - Internal Labour - SME/s
    - Blended
- For capex/opex allocations, three principles featured most prominently in the estimations:
    - What can be capitalised: Power and Water's rules on the treatment of spend categories and phase of project (i.e. all costs before final business case are ruled operational expense by default)
    - Percentage based estimates of what portion of each investment is ongoing operational cost.
    - Right-size initiatives and close projects early: Given the overall scale of the proposed projects and other projects in flight, and Power and Water's historical success with smaller, targeted investments, the structure of this proposal's projects are forecast to result in a higher percentage opex allocation than if they were stand-alone as a means of getting projects within the size of historically successful initiatives, and to get projects closed with core capabilities in place whilst using business as usual activities to complete the enhancements.

The cost estimates are preliminary and have been derived from the initial needs assessment and span multiple regulatory periods. The interdependencies, sequencing, resourcing, schedule and costings are being developed as part of the internal preliminary and final business case through to March 2023 and will continue to be refined through that process.

Table 12 Preliminary cost estimate for total project ($, Real FY22)

Item	[redacted]
SYSTEM	
System design	[redacted]
Purchase/implement/train for Transmission SCADA & EMS	[redacted]
Purchase/implement/train for Distribution SCADA & DMS	[redacted]

Purchase/implement/train OMS & DERMS	[redacted]
System integration (e.g. Maximo, Gentrack & GIS)	[redacted]
Vendor travel/accommodation	[redacted]
Additional applications	[redacted]
DATA	
Customer connectivity modelling remediation	[redacted]
Develop LV SCADA network	[redacted]
Implement Esri Utility Model (electricity & water)	[redacted]
Other data projects (new capture to support additional capabilities and system functionality)	[redacted]
PERSONNEL	
Program Mgr.	[redacted]
Enterprise Architect	[redacted]
Real-Time PM	[redacted]
OMS PM	[redacted]
GIS PM	[redacted]
Integration Manager	[redacted]
Change Manager	[redacted]
Key OT Bus. Pro. Redevelopment	[redacted]
Post Imp. Support	[redacted]
Training Manager	[redacted]
User Documentation	[redacted]
ICT Staff – Populate OT OTU CIM	[redacted]
ICT Staff – Data Governance	[redacted]
Real-Time SME	[redacted]
Utility Model PM	[redacted]
Bus. Control Room Rep.	[redacted]
Bus. Asset Mgmt Rep.	[redacted]
Bus. Outage Mgmt Rep.	[redacted]
Bus. DERMS Rep.	[redacted]
Network Data Improvement PM	[redacted]
Travel/accommodation	[redacted]

Risk and Contingency (20%)	[redacted]
Total	[redacted]

Table 13 Additional Ongoing costs ($, Real FY22)

Item	Total
Annual Maintenance	
Transmission SCADA & EMS	[redacted]
Distribution SCADA & DMS	[redacted]
OMS	[redacted]
DERMS	[redacted]
Additional modules	[redacted]
Application Development	
Unspecified	[redacted]
Additional Staff (including Corporate overheads)	
Control Room Staff (to maintain LV) x 1	[redacted]
Control Room Staff to operate x 1	[redacted]
Totals	[redacted]

Appendix B. Key Assumptions

Costings have partially been informed and sized in line with findings contained in EY's vendor market scan from 2022. Internal project business cases will be structured, sized and costed in line with the elements shown in the figures below as a guideline.

Figure 16 - Cost Profile: Sourced EY Report - Vendor Market Scan for Smart Energy Systems in Oceania

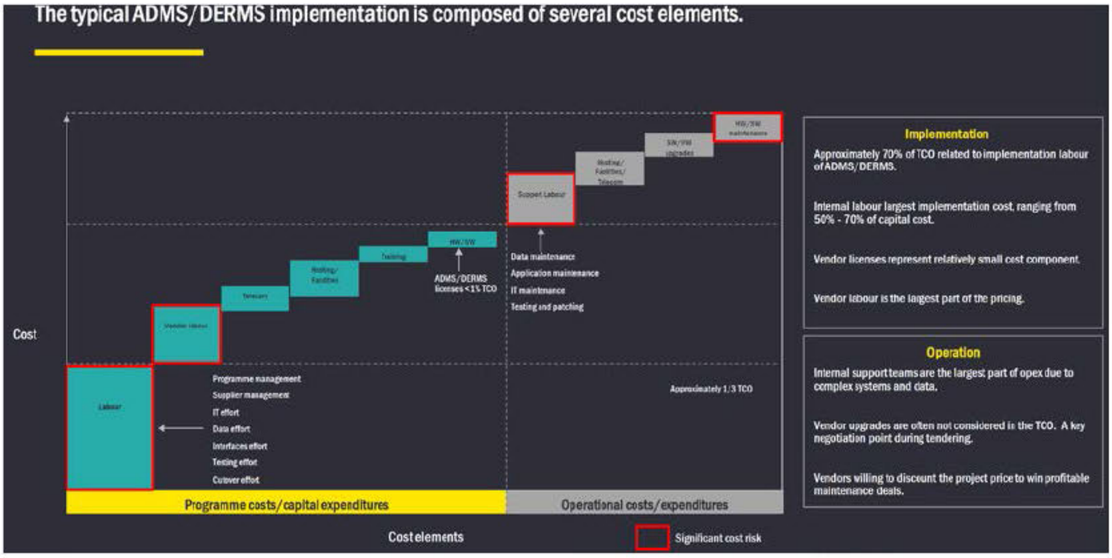
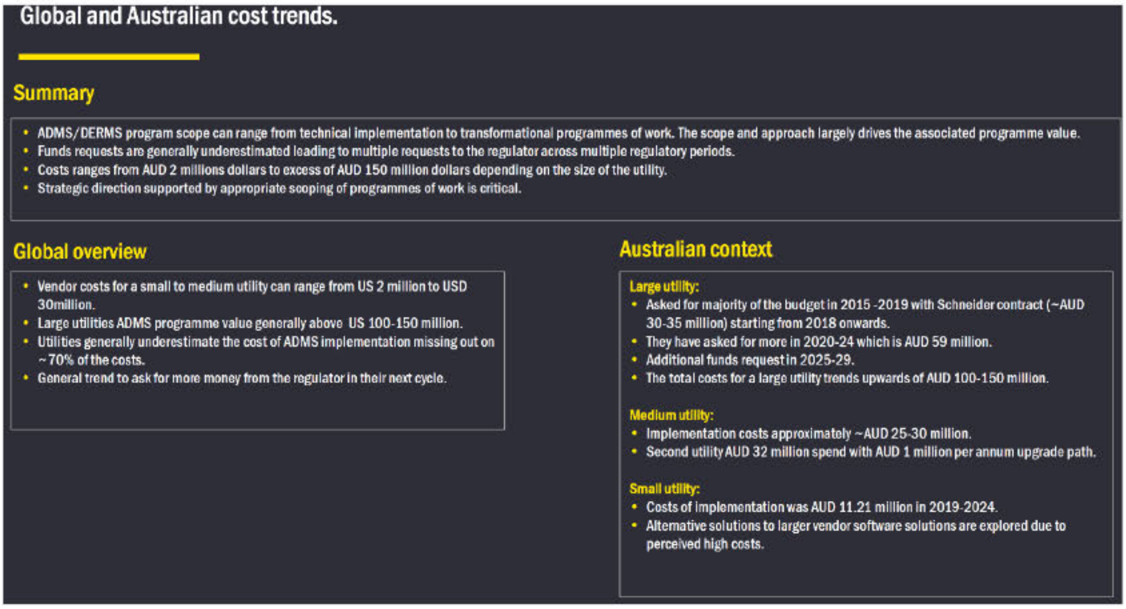
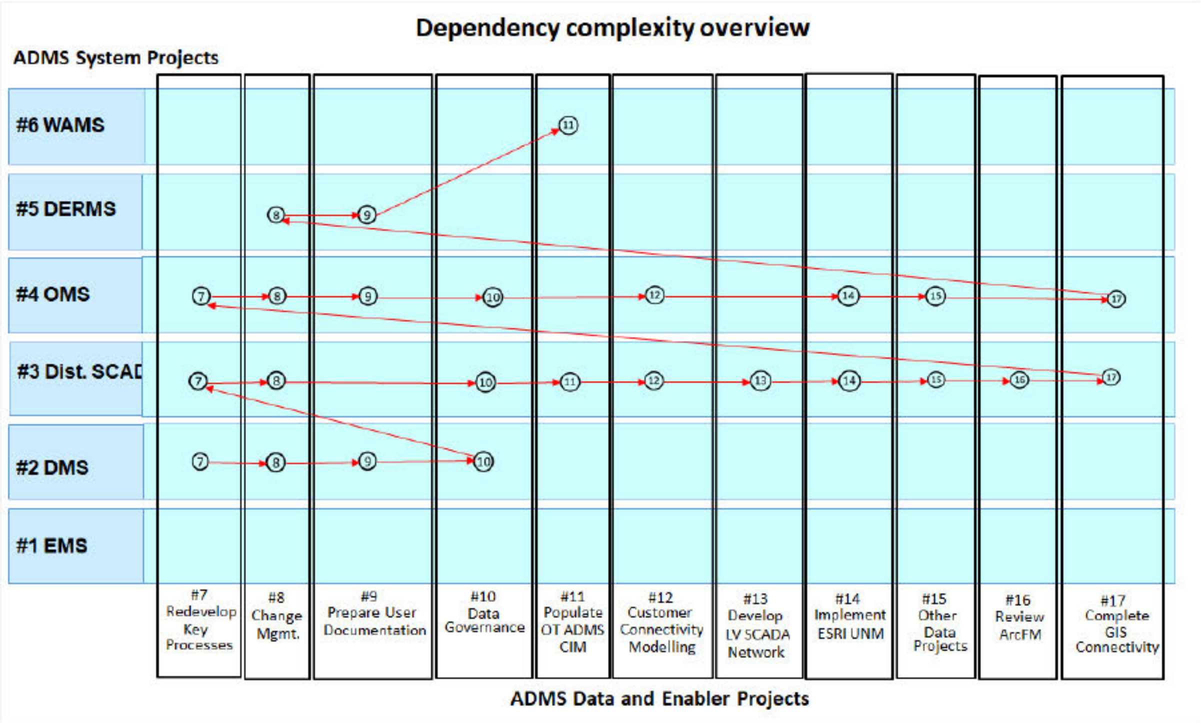


Figure 17 - Trends informing approach: Sourced EY Report - Vendor Market Scan for Smart Energy Systems in Oceania



The dependency view below shows the number of data and enabler projects that each system depends upon, and the overall direction and sequence of dependency. Internal projects will be structured based on the capabilities required to deliver each system (in the numbered sequence shown from 1 to 6), and the specific data and enablers needed.

Figure 18 - Dependencies will also inform how the projects are scoped and sized for delivery



Appendix C. Key Lessons Learnt and Findings

During high level discovery sessions to inform this initiative's scope, a range of interviews and technical discovery work was undertaken to ensure Power and Water could learn from past experience with projects in similar areas, as well as industry and Big4 Consultancies. These lessons and findings are presented as context to demonstrate transparency, and the analytical and pragmatic approach used to ensure a business case is based on prudency, efficiency, deliverability and reality.

C.1 Network Operating Model

Key OT systems are not currently meeting the needs of the Business. The Business has been able to rely almost solely on operator expertise to date, although this will not be possible in the future once batteries/solar farms connect.

The core of all of the distribution network management tools is the network model. The effort required to build and maintain this model is one of the key issues in all distribution network management projects and is virtually the same regardless of the brand of tool being implemented. Power and Water's Network Operating Model is not 'fit for purpose' to meet the current or future challenges. An OTU solution shares the same single network model database, which means less effort in data management, less cost in integration build and testing and more robust operation.

Utilities have multiple representations of the network model (i.e. one each in GIS, SCADA, OMS, load flow, schematics, etc). Each of these network representations are maintained separately and updated independently. An ADMS consolidates these representations down to one and usually held in the GIS. Several of the key OT functions (e.g. network capacity planning, entry of outages and logs, state estimation, short circuit analysis, etc) are manual (not automated) and so largely rely on the Control Room Operators. This level of reliance is particularly risky. The Power and Water Control Room is the only one in the country to still manage the network using Pin Boards.

Given the ageing systems in the Control Room, Power and Water has a system problem but just as importantly, a data problem (i.e. missing field data, incomplete data, multiple OT data models, inconsistent asset naming & numbering, etc).

C.2 Asset Hierarchy

There is little governance around the entry and naming of asset data. The structure of an asset hierarchy needs to be finalised down to the Minimum Maintainable Unit (MMI) and mutually agreed across the key parties. It is understood that there is a team in Power Services currently working on this.

C.3 Data Accessibility

Accessibility to data is frequently constrained by the interface, the core system, dataset versioning, etc. It is an essential component in having a robust asset information management foundation. It is only when users have confidence in the data they are accessing will some of the extensive inefficiencies around searching for the required data be significantly reduced.

C.4 Data Quality

Compared with most utility companies, the quality of Power and Water's asset and operational data is low and is considerably below that of the other Australian electricity companies. This in part has been due to a lack of effective information management. Moving forward the objective is to work towards having consistent and accessible data across the Business. Data needs to be entered the same way no matter who captures or enters it, no matter where they are, or when it is. The achievement of data being 'fit for purpose' supports the concept of having a single view of an asset where users have ready access to all required asset data residing in the asset systems.

The following is a summary of the key data issues:

- Data quality is insufficient (i.e. there are unpopulated fields, incorrect entries, duplicated data, missing data, etc);
- Lack of data standards and no monitoring of KPI adherence;
- Assets are named and numbered differently across the company's primary systems;
- Some data is not being captured consistently across the company;

Until data quality is successfully addressed, asset data will not be 'fit for purpose' and represents a high operational and corporate risk. It also results in the same data having to be recaptured.

C.5 Field Capture

It is essential that Power and Water works towards data being 'Fit for purpose.' This involves dispatching suitably qualified staff into the field to record the required data (e.g. phasing). This first of all involves agreeing with the various key business areas on what data is required and what is realistic to capture. This also includes defining the need for outage data in the IES communities as it is essential that there is only one field capture project to collect whatever is required.

The following are a range of issues that highlight the need to further resolve the required capture of data in the field.

- Some EMS substation data collection may be required;
- The type of required capture depends on the level Power and Water requires and whether remote communities are to be included in the DMS (i.e. given the high cost of travel to the Communities if field verification is required);
- In visiting some sites, almost none of the U/G cables could be verified because if the cable markings could not be seen, it was near impossible to validate without intrusive work, requiring an outage. O/H was able to be sourced from drawings and via desktop investigation;
- Assets in Alice Springs should have been verified already as part of the pole replacement project;
- Undertaking field checks only for feeder backbones and transferring the links in between feeders, could be an option;
- The data can be assumed on the spur lines, as the feeder capacities are not affected by spur lines;

- Capturing the phase of existing meters (e.g. for a new MDMS or upgraded RMS) could be quite difficult, particularly where there is a 3-phase service line feeding a 3-phase service point that houses many single-phase meters (i.e. typical commercial or residential apartment blocks). Although some equipment can inject a signal into a line that can be detected downstream, it is necessary to get to the back of each meter and that entails isolating all three phases (i.e. causing an outage for the entire block) and having to open the board to gain access to the rear of the meter panel. This could be prohibitively expensive;
- The need to model the zone substation equipment in the OTU ADMS needs to be confirmed. As the purpose of an OTU is to model the distribution feeders, it is mandatory that Power and Water models up to the feeder head circuit breaker. If this is correct, then it may not be required to model any transmission assets or zone substation devices in the OTU (i.e. leaving the EMS to model that equipment). This would reduce the work needed to fix connectivity issues in the GIS if transmission is excluded;
- The data (i.e. attributes) required by an OTU needs to be defined, as there is a considerable amount missing from the distribution cables, conductors and devices in the GIS. This came up in the Alstom pilot;
- The asset hierarchy needs to be finalised.

C.6 Phasing Information

Although it is acknowledged that having phasing information is preferable, some Power and Water staff do not consider the effort and expense to be worthwhile for current requirements. The following are the types of analysis that is possible through having phasing details, in support of emerging requirements:

- State estimation and load flow per phase including violation report/alarms (e.g. overloads, over-voltages, etc);
- Outage management information per phase – having information regarding which customer is on which phase, receiving trouble calls from those customers will make outage location predication more accurate;
- Having more precise network topology necessary for comprehensive load balancing of the network and giving required information for ADMS applications to mitigate phase disbalance;
- Informing the DERMS module with the precise information on which phase each DER asset is on (i.e. used for calculating the hosting capacity and network flexibility for new DER customer connections).

C.7 Process Redevelopment

Given the number of required data and data improvement initiatives are ongoing, the required supporting processes need to be redeveloped in line with a single, coherent enterprise capability model.

C.8 Implementation

It is essential that projects are strictly managed in-line with the standard Project Management Guidelines. In order to effect improvement, Power and Water needs an over-arching role responsible for the ongoing monitoring of the various system implementations across the company.

C.9 Internal Stakeholder Engagement

It is essential that a coordinated approach is adopted to reach a mutual understanding.

C.10 Infield Monitoring

An OTU does not necessarily require extensive monitoring equipment in the field, its simulation environment can provide valuable network monitoring and control. For example EvoEnergy does not monitor every distribution transformer, they monitor several key substations/reclosers on each feeder. Their Planning Team then uses the ADMS simulation environment for network augmentation and extension. Therefore it is not expected that Power and Water will require additional monitoring equipment in the field for an ADMS.

C.11 Personnel

Appointment of an OUT Coordinator is required to:

- Investigate/plan/initiate pre-OTU Program data projects;
- Prepare OTU PBC/Business Case;
- Maintain liaison with EMS;
- Coordinate OUT activities.

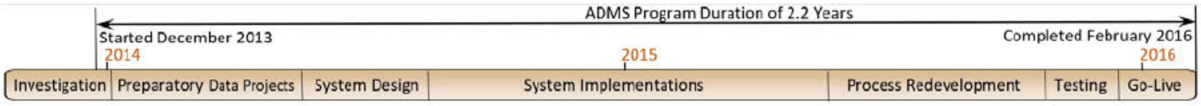
C.12 ADMS - Case Study Overview

A successfully implemented ADMS such as that of EvoEnergy has now been live for 6+ years and has:

- One network operational model;
- One centralised source of connectivity;
- A single source of truth for operational and asset data;
- Data that is fit for purpose;
- Integration between the core OT systems;
- Real-time outage management;
- A full LV model in SCADA;
- All required phasing details;
- Automated design;
- Unit assemblies (i.e. composites), and more.

Operationally EvoEnergy is the leading utility in the country, has been for some years and is the only utility to have a fully complete ADMS. Collectively what they have achieved in the OT space represents that of a 'Digital Utility.'

Power and Water also has the opportunity of achieving this if it has a similar vision for its operational network. The key point of note that comes out of the EvoEnergy ADMS Program is that implementing the systems was not the difficult part, the complexity and risk all came down to how well the data aspects were planned and handled.



AusGrid has recently completed their first phase ADMS implementation, and discussions are underway with Power and Water on key lessons and findings on this set of projects.

C.13 Enterprise Coordination Of Business Functions Via Capabilities

Business Units need to work together to coordinate common business functions (e.g. four areas of the business areas have an involvement with DER, however only one area of The Business is preparing the DER Integration Strategy). It is essential that Power and Water develops an enterprise-wide framework within which projects and programs are planned.

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Appendix E. Operational system elements

E.1 Distribution Management System

DMSs are designed to achieve the following:

- Reduce the duration of outages
- Improve the speed and accuracy of outage predictions.
- Reduce crew patrol and drive times through improved outage locating.
- Improve the operational efficiency
- Determine the crew resources necessary to achieve restoration objectives.
- Effectively utilize resources between operating regions.
- Determine when best to schedule mutual aid crews.
- Increased customer satisfaction
- A DMS incorporates IVR and other mobile technologies, through which there is an improved outage communications for customer calls.
- Provide customers with more accurate estimated restoration times.
- Improve service reliability by tracking all customers affected by an outage, determining electrical configurations of every device on every feeder, and compiling details about each restoration process.

DMS functions include:

- Network visualization and support tools
- Applications for analytical and remedial action
- Utility planning tools
- System protection schemes.

The various sub functions of the above include:

- Network Connectivity Analysis (NCA)
- Switching Schedule & Safety Management
- State Estimation (SE)
- Load Flow Applications (LFA)
- Volt-VAR Control (VVC)
- Load Shedding Application (LSA)
- Fault Management & System Restoration (FMSR)
- Load Balancing via Feeder Reconfiguration (LBFR)
- Distribution Load Forecasting (DLF).

E.2 Outage Management System

OMS are designed to achieve the following:

- Reduce GSL payments (especially through logging partial restorations);

- Improve System Average Interruption Duration Index (SAIDI) performance.
- Improving situational awareness and control for system operation, in turn:
- Allowing the visualisation of the current network state concurrently from multiple locations.
- Returning power to customers more quickly after planned or unplanned outages as a consequence of:
    - Improving the efficiency of the field workforce by reducing the scope of outage patrols (through the tie-in between electrical equipment and geographic location);
    - Improving the provision of planned and unplanned outage information;
    - Improving the capabilities for customer planned outage identification.
- Providing the capability to enable Distribution Network Analysis Functions in future
- FLISR and CIM improvements (e.g. via automatic feeder reconfiguration and automatic fault restoration).

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