OT Capability Uplift – Enablers, Data and Systems

Regulatory Business Case (RBC) 2024-29

30 November 2023

Version 2

PowerWater

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1. Summary

This business case provides for Operational Technology Capability Uplift Project (OTCU Project) expenditure on three interdependent elements designed to elevate Power and Water's operational technology (OT) to assist in meeting licence conditions and challenges with managing a more complex network with current data and tools.

This business case has been prepared to support the 2024-29 Revised Regulatory Proposal. It replaces the business case prepared in January 2023.

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 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.

1.1 Identified need

Power and Water's OT is a secure computing environment that helps monitor, operate and control transmission network assets and some distribution network assets. It is essentially the suite of control room tools used to keep the network functioning securely and to respond to issues.

Power and Water's primary OT system, the Energy Management System (EMS), is limited in its capabilities, particularly in respect of distribution system management. The EMS was designed as a transmission network management tool, with wider system control functions. It does not provide distribution management functions or visibility. This means Power and Water to rely on manual processes to manage the distribution system.

Power and Water is currently the only Australian electricity utility still using pin boards to manage the operational status of the distribution network. It does not have any standard distribution supervisory control and data acquisition (SCADA) system, and it does not have an outage management system (OMS) or distribution management system (DMS).

These are tools adopted by most other Australian distribution utilities. The NT network is smaller in scale and therefore may not yet require an OT solution as sophisticated as in other jurisdictions. However, Power and Water's current OT capabilities are no longer commensurate with the sophistication of the power system, and the expectations of customers.

Until recently, manual processes have sufficed. Power and Water has been innovative in the use of the EMS since its implementation in 2008 to provide some basic status indication of critical switching, but the requirements of a modern distribution system have stretched beyond the limits of what can be done with the EMS.

Over the past decade the network has grown and become more complex. The volume of intermittent renewable power sources – both in front of and behind the meter – has increased. The network has to accommodate two-way flows, and customers continue to want to connect new loads, new generation, and new distributed energy resources.

The biggest limitation of the current OT is visibility. The lack of visibility (i.e. how the network is performing and where new assets are being deployed) exposes the network to very high safety risks. These risks include the potential for manual network processes to result in a safety incident at times of unknown or uncertain states of the network or loss of protection on long distribution lines.

Under its licence obligations and the provision of the NT NER, Power and Water is required to operate under a safety management and mitigation plan, which reflects good industry practice in relation to the safety management of the electricity infrastructure owned or operated by Power and Water. This applies to both the regulated and non-regulated networks.

To meet these obligations, Power and Water is required to have an accurate record of the type, location and status of its network for planning, operation and maintenance purposes. This includes a Geographic Information System (**GIS**), and complimentary distribution system operation tools to ensure that information is available to assist operational decision making and timely and accurate information to customers. Historically, the accuracy of these functions has been low risk and highly predictable, meaning systems could also be simple. This is increasingly not the case, and will only become more dynamic and unpredictable with changes to power flows and system strength, and to varying degrees in different parts of the network.

The current GIS will be three years past vendor support by the end of the next regulatory period. Power and Water is therefore using the end-of-life GIS upgrade as the platform and catalyst to uplift associated OT.

This business case has been prepared in accordance with the OT roadmap, to progress the highest priority issues associated with obsolescence risk, inconsistent quality and robustness of operational data, and OT operating practices that are no longer fit for purpose. A targeted approach is required to progressively uplift OT capability, consistent with the feedback from customers to prioritise some projects and/or to fast-track investment to improve future service delivery and reduce potential issues and costs.

1.2 Options analysis

The table below summarises the options that were considered to uplift Power and Water's OT capability.

Table 1.1 Summary of credible options

Option No.	Option name	Description
1	Base Case	Continue operating with the current systems and platforms with no upgrade. This is not sustainable as it exposes the organisation to an unacceptable level of risk and is not considered a credible option

Option No.	Option name	Description
2	GIS Upgrade	Upgrade the GIS (and required Utility Network model)
3	GIS Upgrade and Data Improvement Projects/Base DMS	Implement essential enhancements for safety, technical, reliability and operational reasons covering: • GIS Upgrade and Utility Network model • Data Quality Improvements • Base DMS
4	GIS Upgrade and New Consolidated ADMS Platform	Implement a completely new platform with all AEMS/DMS/OMS capabilities in place, delivered within one RCP. This will include the GIS upgrade and data improvements.

1.3 High level assessment of options

A high level comparison of the options and the issues they address in the identified need is depicted in the table below.

Table 1.2 High level assessment of options

Assessment metrics	Option 1	Option 2	Option 3	Option 4
Totex ($m, real FY22) – 24-29 RCP	n/a	**5.5**	**19.5**	**60-70**
Meets customer expectations	○	◑	◕	◕
Aligns with Asset Objectives	○	◑	◕	◕
Technical Viability	○	●	●	○
Deliverability	n/a	●	●	○
Preferred	No	No	Yes	No
Ranking	n/a	2	1	3

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

Key conclusions from the high level review are that:

- Option 1 is not credible as it would leave Power and Water without a supported GIS before the end of the next regulatory period.

- Option 4 was not believed to be technically feasible due to the scale of effort, risk and cost to re-platform. The resource effort would require multiple years of implementation and would put at risk the need to address some of the current challenges as early as possible.

The analysis of options has therefore concentrated on a comparison between Option 2 (GIS Upgrade only) and Option 3 (GIS upgrade and Data Improvement projects/Base DMS), with Option 3 preferred.

The scope of Option 3 is broken down into 3 sub-categories of expenditure:

1. Mitigate obsolescence risk in critical operational systems – through upgrading of the GIS to a supported version.
2. Address inconsistent quality and robustness of operational data - Rectify issues with data and allow multiple platforms to operate off the same accurate and complete data set to maintain the safety and reliability of our network.
3. Updating / upgrading of OT operating practices that are not fit for purpose - Power and Water are the only Australian electricity utility still using pin boards to manage the operational status of the network and the only utility without a DMS/OMS. These limitations restrict Power and Water's ability to deliver on targets for development of the network, maintaining reliability standards and technical and safety compliance. The limitation also restrict Power and Water's ability to support the NT Renewable Energy (RE) targets and broader decarbonisation targets.

1.4 Cost benefit assessment (CBA)

The first sub-category of expenditure is a replacement for the current critical GIS and no CBA has been developed. Power and Water is required to have an accurate record of the type, location and status of its network for planning, operation and maintenance purposes. Operating with a supported GIS (which has a much lower risk of unavailability) is essential to continuing to deliver against Power and Water's licence conditions.

The second and third sub-categories of expenditure collectively enhance Power and Water's OT capability and a CBA has been produced.

The CBA reviewed the incremental costs and benefits of the data improvement and Base DMS functionality proposed in the preferred Option 3. The costs and benefits of the GIS Upgrade (and associated elements) have not been included as these are needed to maintain the level of risks faced by Power and Water and are common to both Option 2 and 3. The CBA outcome is based on an NPV calculation over the next 15 years, was a positive NPV of $7.4 million and a BCR of 1.43.

Table 1.3 Summary of costs and benefits

Category	Net present value
Net present cost	$17.4 million
Net present benefits	$24.8 million
Net present value	$7.4 million

Implementing this option is consistent with the Capital Expenditure Objectives as it will assist to maintain the reliability of the network, whereas without the proposed investment reliability would decline. These projects are also consistent with the National Electricity Objective as they promote efficient investment in the reliability of the supply of electricity and are therefore in the long term interest of consumers. The proposed investment also provides a foundational platform that can be built upon to enable additional functionality to further benefit consumers.

1.5 Recommendation

It is recommended that Option 3 – GIS Upgrade and Data Improvements/Base DMS project is progressed at an estimated cost of $19.5 million ($ real 2021/22) in the next regulatory control period.

This option will enable Power and Water to remain compliant with its licence conditions and technical codes. This option is consistent with the capital expenditure objectives to maintain reliability/safety and the National Electricity Objective through being in the long term interest of consumers.

2. Identified need

This section provides the background and context to this business case with a breakdown of the need for the recommended project including the risks of current operations and potential efficiency gains.

2.1 Legacy, out of support systems introducing obsolescence risk

2.1.1 Current state of GIS

ESRI ArcGIS is the core system used in Power and Water, with the Schneider ArcFM extension used to provide network connectivity modelling and tools for specific utility needs. The solution also comprises ArcFM Web, a user facing web based platform for viewing, interrogating, reporting and completing business workflows associated with GIS network data.

The original ESRI system was implemented as part of the Asset Management Capability project in 2013. The ESRI and Maximo custom code interface was replaced with specific middleware in 2021. This decoupled the two systems to allow the independent upgrade of the GIS from the existing ESRI ArcMap, which was completed in 2022.

The current version of ESRI and ArcFM uses a structured connectivity model known as a geometric network (GN) model. ESRI has used the GN model since the 1990s. ESRI has now developed a new network model known as the Utility Network (UN) to make use of improved modelling and database concepts.

The existing geometric model will only be supported by the current Power and Water version of ArcMap 10.8.2 and no further releases are available. ArcMap 10.8.2 is no longer generally available to industry and extended support will cease in August 2026. Limited Mature Support relating to phone and chat services will end with the retirement of the system by ESRI in March 2028. This list of current live versions and their retirement dates are shown below:[1]

- ESRI Enterprise software is version 10.9.1 (back-end), released Nov-21, retiring March-28;
- ArcFM 10.8.1a and ArcMap 10.8.2 (GIS editing, analysis tools), released Dec-21, retiring March-28;
- ArcFM Web 4.14 (GIS viewer, released Nov-20, retiring Oct-25.

Any upgrade to GIS therefore requires 3 elements to be upgraded: the GN model to the new Utility Network model; the upgrade of ESRI GIS; and, the upgrade of ArcFM.

2.1.2 Why maintaining a supported GIS capability is essential

The GIS maintains Power and Water network asset specifications, location and connectivity information. It contains the master record for all distributed asset locations and is used to create and update master asset

[1] Refer to Schneider Product Life Cycle Support Policy at https://myarcfm.schneider-electric.com/myarcfm/s/article/Product-Life-Cycle-Support-Policy

data types and specification. This requires the GIS be continuously updated to allow modelling and representation of the network and asset build standards as network equipment and technologies change.

As well as asset data the system is also responsible for maintaining the connectivity model used for modelling the normal state of the network and electrical flow of energy from generators to customer meters via the transmission, distribution and reticulation networks.

The GIS is the central system for many business systems within Power and Water with the provision of network data for:

- Dissemination of spatial data to internal Power and Water network operators, planners and executive, and external stakeholders including the Northern Territory Government, Local Councils, Emergency Services, Before You Dig services, customers and connection proponents;
- Asset Management decision making relating to asset lifecycle, cost and risk modelling;
- Network modelling of connectivity, asset specification and location information to support analytics, interrogation, reporting, planning, maintenance and operations. This includes modelling ratings, capacity planning, basic and negotiated connections, network augmentations, restoration and interface to load flow modelling software Sincal;
- Maintaining relationships between customer Network Meter Identifiers (NMI) and network supply points for Outage notifications, Outage planning, network performance analysis and interrogation, critical customer management; and
- Providing the connectivity information required by Maximo, System Diagrams, Before You Dig, Embedded Generation Database, ArcFM Web and Sincal.

The GIS is the source of information for the following Enterprise systems:

- Maximo – Provides asset location and specification information for distributed assets, such as make, model, size, and rating. GIS is also the source of connectivity information for maintaining assets in hierarchical maintenance models in Maximo based on feeder, circuit source information or componentry specified in GIS;
- Embedded Generation Database – Assessing hosting capacity and network planning;
- Cyclone Response System (CRS) – Provides asset location, specification and connectivity information to CRS for managing emergency response and risk reduction during a declared emergency event using streamlined business processes and inter-agency collaboration;
- Business Intelligence (Tableau) - Provides connectivity and location data for developing location based insights relating to public safety and risk profiling;
- ArcGIS Online – Provide asset location and specification data for remote mobile viewing of network data for operational activities; and
- Financial Management System – Distributed asset data originates from the GIS and provides the source information for asset ownership, asset creation/retirement dates, project information and length of asset.

2.1.3 Updated utility network model for the GIS

A requirement for moving to an in-support version of the GIS is to transition from the geometric network model developed in the 1990's to the utility network model. This is a condition of moving to a supported version of the GIS.

The Utility Network model provides a rich type classification system to help represent every type of utility feature. [2] This assists with specifying network connectivity rules, symbolizing features, tracing, and much more functionality. For example, the utility network model allows definition of structural attachments to generate inventory lists for areas and subnetworks, and assets associated with a common structure (such as a pole).

This supports improvements to safe and reliable operation of the network and provides foundational elements to allow greater use of systems to consider developments in network/system operations, workforce scheduling, asset risk profiling and mobility.

The Utility Network model will assist in consolidating multiple representations of the connectivity model in SCADA, physical pin boards, GIS, load flow software and schematics into one centralised connectivity model. Areas of incomplete data can be resolved in the transition and procedures would be built to better maintain data quality. A centralised model builds the structural base from SCADA models that enables development of DMS and then OMS functionality in later years.

2.1.4 Implication of not upgrading GIS

The GIS is needed to maintain Power and Water network master data and the connectivity model is required to maintain current levels of reliable, safe and cost effective electricity supply to customers.

Power and Water's GIS version will be 3 years outside of extended vendor support by the end of regulatory control period 2024-29. If investment during the 2024-29 regulatory control period does not occur, operational risks include:

- Increased cyber security risks associated with un-authorised access and corruption or loss of network data due to security patches not being updated (after August 2026) to meet modern cyber security threats. This includes the potential increase in frequency of targeted attacks on Power and Water due to the outdated software version.
- Deterioration of network reliability performance as a result of bug fixes being unavailable leading to longer system down times and reduced operational support for outage management and restoration, particularly in emergency and cyclone events.
- Enterprise business systems will no longer be able to integrate with GIS which will result in loss of synchronisation of data between the systems or significant effort being required to manually update data.

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2 https://pro.arcgis.com/en/pro-app/latest/help/data/utility-network/structure-of-a-utility-network.htm

- Public safety risks where information is not readily available or sufficiently accurate for Dial Before You Dig and Look Up and Live services.

2.2 Inconsistent quality and robustness of operational data

2.2.1 Overview of required data improvement

There are several areas of improvement needed to Power and Water's management of data. This includes:

- Data alignment and mapping of data across systems.
- Improvements to quality and completeness of GIS data.
- Provision of SCADA data to distribution network solutions.
- Data governance and data maintenance.

An overview of the needs in each of these areas is provided below. These projects will be essential for maximising the benefits of the GIS upgrade and improving distribution operations.

2.2.2 Data alignment and mapping of data across systems

Power and Water has power utility network data with common network elements and their attributes. replicated in different data systems (GIS, EAM, SCADA etc). Each system holds a combination of attributes that are shared between systems (such as asset name and ID), and attributes that are unique to each system (for example an asset's geospatial references will only be in the GIS system).

When systems become interdependent on each other (as is the case with EMS, GIS and SCADA systems), then it is critical that their underlying data matches. Unfortunately, the underlying data structures and business rules vary from system to system, making this a non-trivial problem with some inconsistency existing between systems.

2.2.3 Improvements to the quality and completeness of GIS data

Accurate data within the GIS is critical and will become increasingly important over time as it becomes the master source for all other systems. The GIS data will be used by other Power and Water systems that have evolved organically through the process of each business area managing their own respective systems, often without knowledge or exposure to how data is managed in other systems. It is essential that users of the data can be confident it is both accurate and complete when they adopt the GIS as the master data source.

2.2.4 Provision of SCADA data to the distribution network solutions

Development of distribution operation tools such as a DMS require these solutions to use the SCADA data that is collected via the EMS. This data will not be in the format expected by the DMS Network Model and therefore can't be easily applied.

2.2.5 Data governance and data maintenance

There is a need to improve the governance and maintenance of data so that improvements in data quality and completeness are retained.

2.3 OT systems and operating practices no longer fit for purpose

2.3.1 Current status

Power and Water's limited OT systems do not currently meet the needs of the business and instead Power and Water relies on operator expertise to try and bridge the gap in capability. There is growing recognition of the need for insights in real-time based on an integrated network model to manage network risks, beyond what is possible with the current manual methods of operation.

The current approach will increasingly pose a risk to safe and reliable operation where the impact of DER and changes to network fault levels and voltages can compromise protection systems, control schemes and power quality compliance. This is in addition to the current high risks associated with paper-based network, permit and access management systems.

There are three main areas where Power and Water's OT tools need improving covering:

- Manual pin boards.
- Switching management process.
- Outages management approach.

An overview of the needs in each of these areas is provided below.

2.3.2 Manual pin boards

One of the key requirements within system control is to move away from the process of manual pin boards recording the real time state of the network, to a situation where this can be done electronically. Power and Water are the only Australian Network business that still use manual pinning and this creates several risks/opportunities. These include:

- Higher probability of a safety risk caused by human error associated with manual processes that can result in times of unknown network state.
- No ability to quickly relocate the control room in a major event.
- High level of resourcing required to reproduce and maintain operating diagrams onto panels including verification of the diagrams and updating pins.
- Delay in restoration of outages as current state of the network is not immediately available to operators and manual checking against pin boards is required.

2.3.3 Manual switching management process

Power and Water continue to operate without a set of operational technology tools to assist with switching management. The manual process for planned switching includes:

- Scheduling of work crews to avoid conflicts with other planned activities on the network.
- Production and dissemination of switching instructions.
- Supervising the execution of the intended work.
- Record keeping.
- Scheduling and managing related ancillary work, such as the revision of operating diagrams.

This manual process is inefficient and more importantly creates a higher risk of a safety incident with a reliance on the skills and knowledge of experienced operators. This is likely to become increasingly important as the network becomes more complex and the number of switching decisions increase.

2.3.4 Outage management approach

Power and Water are the only electricity distribution company in Australia that continue to operate without a recognised outage management system. Maximo provides a very limited capability to capture outage information, but has no connectivity model to support outage location or restoration support. Additional capability is needed to assist with improved customer information, outage analysis, response efficiency and cyclone response support. This would also need to provide accurate data on outages for any future requirements for a STPIS mechanism.

2.4 Challenges impacting network resilience

The NT Government Climate Change report[3] indicates an expected decrease in the frequency of tropical cyclones, but an expectation they will be much more intense. This may require the relocation of the control room and a long period of intense activity for System Control to restore the network. With the current operational technology this is likely to have an impact on the resilience of the network.

[3] Northern Territory Government / National Environmental Science Program Earth Systems and Climate Change Hub - Climate Change in the Northern Territory – State of the Science and Climate Change impacts

2.5 Risk analysis

During the 24-29 regulatory control period there will be several risks with the current operational technology environment that are outlined in the risk analysis table below. Potential mitigation strategies are discussed is section 3.6.

Table 2.1 Risk analysis

Risk description	Current risk		
	Likelihood	Consequence	Rating
Unavailable GIS due to system failure – This assumes that the GIS would be unavailable for a period of more than 24 hours with no support to resolve any issues that may have emerged with the system. The risk will increase over time as the period for which the system is unsupported increases.	Likely	Minor	Med
Unavailable GIS due to cyber security attack – This assumes that the GIS would be unavailable for a period of more than 24 hours with no support to resolve the attack. The risk will increase over time as the system would no longer be receiving security upgrades.	Likely	Moderate	High
Unknown network state due to control room relocation - The use of manual pin board exposes us to network status errors when relocating system control to the bunker during emergencies, this could damage the network or our service levels.	Possible	Moderate	Med
Inaccurate asset status leads to an incorrect switching/permitting event – The absence of electronic operating diagrams and a switching solution with built in validation increase the probability of incorrect switching instructions being issued for an asset, with the associated safety hazard. There is also potential to damage network or customer assets if the network response to switching is unexpected and is not visible to operators.	Likely	Major	High
Incident due to loss of key personnel – The current manual network status system relies heavily upon the experience of controllers, which makes on-boarding new staff arduous and the team less resilient to personnel changes. An incident in the control room is more likely should a number of these personnel be unavailable with the current OT working practices.	Likely	Moderate	Med
Declining reliability – Power and Water are facing an increasingly complex network with growing levels of DER and new Connections. The increased complexity and reliance on Manual Pin Board is likely to impact on reliability of supply as outages take longer to assess and resolve using the current tools.	Almost Certain	Moderate	Very High

2.6 Summary

Power and Water's licence conditions issued by the Utilities Commission set out requirements that Power and Water is obligated to meet. In addition to the NT NER, this includes provisions of the System Control

Technical Code and Network Technical Code which describes the technical performance parameters and standards for the power system.

Power and Water is required to operate under safety management and mitigation plans, which reflects good industry practice in relation to the safe management of the electricity infrastructure owned or operated by Power and Water.

To meet these obligations, Power and Water is required to have an accurate and reliable record of the type, location and status of its network for planning, operation and maintenance purposes. Operating with a supported GIS is therefore essential to continuing to deliver against Power and Water's licence conditions. Increasing visibility of network state to manage and anticipate technical compliance risks will also become essential as the traditional and predictable response to demand and switching operations becomes significantly more dynamic as the NT approaches RE targets.

Currently Power and Water is the only utility in Australia that still relies on manual pin boards to manage their outages without access to any operational technology switching management tools. This presents a current safety risk, as it relies on manual processes for the recording of the operational status of the electricity network, and management of switching programs and permitting processes. As Power and Water is facing increasing challenges with DER and growth in number of connections, the impact and risk of relying on manual process is likely to escalate with potential impacts on compliance obligations related to safety, reliability and quality of supply.

The importance of having an integrated network model based on insights in real-time to manage these risks is well-understood by the industry and is becoming more critical in Power and Water's control room today. Enhanced data and improved OT Capability is likely to be essential for safe network operations towards the end of the regulatory period, or early in the following period. Commencing the process of establishing base tools in distribution operations will also provide a platform to allow these to be extended to assist with monitoring of network fault level and protection settings in future should this be deemed prudent and efficient.

This business case has been prepared in accordance with the OT roadmap, to progress elements identified for the 2024-29 regulatory period, relating to:

- Replace legacy, out of support systems.
- Build a robust data platform.
- Implement improved distribution operations.

This business case should be read in conjunction with the overarching direction identified in the OT roadmap for Power and Water.

3. Options description

This section describes the various options that were analysed to address the increasing risk 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, net benefit, and an optimal balance between long term asset risk and short-term asset performance.

3.1 Description of options

Four options have been identified which address the identified need to different degrees. These were:

- **Option 1 – Base case / counterfactual – No Capex Investment –** Maintaining the current systems and platforms. This is not viewed as a sustainable option, but is presented here for completeness
- **Option 2 – GIS Upgrade –** Update the GIS including the Utility Network model required for the upgrade.
- **Option 3 – GIS Upgrade and Data Improvement Projects/Base DMS –** This involved a GIS Upgrade along with improvement in underlying data and base DMS Functionality
- **Option 4 – New consolidated ADMS platform. –** GIS Upgrade and data improvements along with a completely new platform with all AEMS/DMS/OMS capabilities in place, built new from a base data level.

These options are described in the sections below.

3.2 Review of Option 1 – Base Case – No Capex Investment

Whilst a 'do nothing' base case has been included as the counterfactual, Power and Water considers that not taking action (and consequently not having the suitable and reliable OT applications to run the network) is not realistic. This option is likely to result in escalated risks of significant network outages and related safety incident outcomes across our network and would result in unacceptable security and compliance risks.

This option would also not provide any assistance in maintaining reliability or improving efficiency offered by Options 3 and 4. The current functionality also limits Power and Water's ability to deliver on targets for development of the network to facilitate increased penetration of renewable energy or broader decarbonisation targets.

Power and Water considers this option to be non-credible, when considered alongside the other options. Costs for this option have not been developed as it does not meet the business requirements.

3.3 Review of Option 2 – GIS Upgrade

3.3.1 Scope of Option 2

The scope of this option is the list of activities required to upgrade the GIS to ensure that Power and Water continues with a supported critical system. This includes:

- Upgrade the existing ESRI environments to the latest version ESRI Enterprise 11x.
- Upgrade the ArcFM extensions to ArcFM 11x.
- Upgrade the GN model to the Utility Network model required for operation of the supported version of the GIS. This is required as the upgrade to the GIS cannot happen without the transition to the Utility Network model.

These activities are expected to commence in the first year of the RCP and complete by the end of year 2/early year 3 to allow the GIS to remain in support (or at least extended support).

As with Option 1, this option would not provide any data improvements, or DMS functionality, that would assist in maintaining reliability or improving efficiency.

3.3.2 Costs of Option 2

The costs of option 2 in the 24-29 RCP are estimated to be [redacted]. This is split as follows (further detail is provided in Appendix B)

- Capex for GIS Upgrade including UNM is [redacted]
- Opex for GIS Upgrade is [redacted]
- Project Management - [redacted]

There are also additional costs of improving the GIS data set, but these have been included separately in the data improvement projects.

3.3.3 Qualitative Benefits of Option 2

Key qualitative benefits of option 2 are:

- Reduces cyber security risk from operating on an unsupported system (cyber security was a key customer concern).
- Reduced risk of increased downtime of GIS with impact on critical Power and Water systems that rely on GIS data.
- Reduced risk of reliability issues if connectivity data isn't available to operators.
- Reduced public safety risk if information is not available for Dial Before You Dig and Look up and Live services.
- Avoids increased opex cost of maintenance for a system not supported by the vendor.
- Avoids higher future costs for an upgrade (multiple versions) by doing the upgrade in the 24-29 RCP.
- Provides the ability to gain operational improvement from utility network model delivered as part of the GIS upgrade.

3.4 Review of Option 3 – GIS Upgrade and Data Improvement Projects/Base DMS

3.4.1 Scope of option 3

This option builds on the GIS upgrade in Option 2 and has three main elements of scope covering:

- GIS upgrade including utility network model (as per Option 2)
- Data Improvements
- Base DMS Implementation.

The GIS upgrade would complete by half way through the 24-29 regulatory period. The data improvement/Base DMS projects would commence in year 1, but with more intensive effort towards the end of the period to allow completion in this regulatory periopd. Further detail on the scope of each of these projects is provided below.

3.4.2 GIS upgrade including utility network model

This is the same scope as option 2.

3.4.3 Data Improvements

In addition to the utility network model for the GIS there are additional data improvement projects that have been identified by Power and Water as required for the base DMS implementation and to provide additional benefits around data integrity. These initiatives cover:

- Data alignment and mapping following principles of common information model (CIM).
- Improvements to quality and completeness of GIS data.
- SCADA data to the network model.
- Data governance and data maintenance.

The scope of these proposed projects is described below.

Data Alignment and Mapping following principles of CIM

The CIM describes power utility network data in terms of common network elements and their attributes. In populating these attributes, Power and Water have determined that the GIS should be established as the system regarded as the “source of truth” of any attribute. A data alignment exercise is therefore required to ensure that other systems that store the same attribute data are populated from the source of truth.

This alignment requires a mapping exercise for each element and attribute, and to identify secondary repositories of the same elements and attributes that must be kept in sync with the source of truth. It will also require alignment of asset naming conventions across disparate systems, agreement for a process of maintaining data across multiple business areas, and identification of business rules that can be adopted by future systems integrating with elements of the CIM.

The data mapping is then followed by a system integration / data alignment exercise. This needs to identify how data is exchanged between systems, and implement a back-end workflow that triggers when the source of truth is updated and cascades the changes through to the secondary data repositories in the other systems. This will avoid the need for the same data to be maintained in multiple disparate systems and prevents data in related systems slowly corrupting over time, which can happen when unaligned business processes change data in each system separately.

The practical need for this improvement in the immediate future is to facilitate integration between EMS, GIS and SCADA, and to make the data flows underlying a DMS (and subsequently future solutions) achievable within the required timeframe. Without the CIM work, a DMS or other future capabilities would need to duplicate data from separate data sources using multiple conventions, a complexity that jeopardises the success of the systems and the necessary risk treatments it brings. Complex integrations are also a significant barrier to future flexibility to develop more efficient solutions to emerging capability requirements to support both the renewables and digitisation of many aspects of network operations.

Data alignment utilising CIM principles is a prudent exercise to be done within the RCP and alongside the required OT uplifts as the data maintenance and data duplication will influence the design, cost and extent of functionality of any tools for distribution operations.

Improvements to the quality and completeness of GIS data

As the CIM is implemented, variations in data between each of the systems (data quality issues) will need to be addressed, with data updated to match the source of truth. This is not always straightforward as the data in each system rarely overlaps perfectly, instead forming more of a Venn diagram with each system having an overlapping view of the truth. This typically leads to the identification of data quality issues such as missing assets, incomplete specialist data, and conflicting data such as the use of different taxonomies, naming conventions and hierarchies.

There are also known gaps identified with elements of the GIS data that need to be refined so it can genuinely be a source of truth for other dependent systems. This will require resources to improve the quality of this data for migration into the GIS (both before and after the upgrade).

SCADA data to the network model

It is expected that future distribution SCADA data will be collected via the EMS, which reflects current operating practices. A project will be needed to provide real-time update of this data from the EMS to the DMS and to map this data accurately to the DMS network model. This should be sufficient to enable both the base DMS enhancement planned for this regulatory period and future enhancements to the DMS that may be commissioned.

Data governance and data maintenance

There are several proposed projects that will deliver more accurate and integrated data models. Once these become available, it is essential they are maintained. This is a small on-going project/activity that would be responsible for data governance and ensuring that data improvements flow through into the required systems.

During this activity, key risks will be identified that may affect ongoing data quality and integrity. Governance processes will then need to be developed to manage those risks with roles identified within existing business teams to support the new processes and responsibilities defined through updated role descriptions.

3.4.4 Base DMS implementation

This option includes base DMS functionality being added during the 24-29 regulatory period to provide electronic operating diagrams and to assist in the creation of switching plans. This is broken down into three main areas:

- Operational network model of the distribution network in DMS.
- Management of the switching process.
- Improvements to outage management.

An overview of the projects in each area are summarised below. This solution would create a no regrets base DMS that could be used to expand functionality in future regulatory control periods.

Operational network model of the distribution network in DMS

In the 24-29 RCP, Power and Water would move to a Base DMS with an electronic version of the operating diagrams. This will display current device state across the network and would utilise the unified network model from the GIS to build a network connectivity model for the Base DMS. The CIM export capability would enable this model to be exported for use in the DMS, recognising that some manipulation of the data is likely to be required.

The DMS would support electronic versions of the current manual pinboard diagrams utilising the underlying connectivity model, which would remove the need for pin boards in the control room. SCADA data would be reflected on the diagrams, where available from feeder circuit breakers and mid-line devices, and operators would manually record any changes to the state of the unmonitored network via the diagrams.

The benefits to Power and Water include:

- Ability to quickly relocate the control room in a major event.
- Reduced effort and resources to reproduce operating diagrams onto panels including verification of the diagrams and updating pins.
- Reduced maintenance of the panel infrastructure and cost of providing space to accommodate pin board infrastructure.
- Faster restoration of outages as current state of the network is immediately available to operators and no manual checking against pin boards is required.

The move to electronic diagrams will also reduce the safety risk caused by human error associated with manual processes that can result in safety incidents at times of unknown network state.

Management of switching process

The second key activity is to implement switching in the DMS. The electronic diagrams would become the basis for developing detailed switching strategies and to automatically maintain the up-to-date network state as switching is undertaken by the control room and field operators. As well as assisting in the drafting and checking of switching instructions the solutions also allow the scheduling of switching work orders and identification of clashes where work orders are not possible due to conflicts of the network state or conflict for resources.

The automation of these processes under a single switching management subsystem has significant benefits in reducing the effort required compared to the current manual processes. The expected end state is an integrated switching system which would provide:

- Standard, consistent format for switching instructions.
- Access to stored switching instructions as a basis for building new switching instructions.
- "Point and click" building of switching instructions from graphic operating diagrams.
- Automatic validation of plant descriptions.
- Visual checking on graphic operating diagrams.
- Step-by-step connectivity checking (assuming a connectivity model is available) on graphic operating diagrams.
- Automatic update of device state in a database upon execution of each switching instruction step in the execution phase i.e. automatic "pinning".
- Automatic logging of Switching Job records for routine reporting requirements.

This set of functions will provide efficiency benefits to Power and Water as well as reduced risk of safety incidents. The importance of this sort of functionality will grow over time as the network becomes more complex and the number of switching decisions increase.

Improvements to outage management

The introduction of the base DMS will provide operators with access to the connectivity model when assessing outages and this will provide more confidence of the likely area affected by a fault and impacted customers. In addition, the assistance the base DMS will provide in writing and checking of switching instructions and removal of the need for manual pinning will facilitate faster resolutions of outages before OMS functionality is developed.

The major improvement to the outage management function will come from the future introduction of an OMS. This could be linked to the DMS or a standalone solution

3.4.5 Costs of Option 3

The estimated totex is $19.51 million over 5 years (FY24 – FY29) with Appendix B providing more details of the cost estimate. The incremental totex over Option 2 is $14.06 million, which is composed of:

- Incremental capex (including PM) - [redacted] million.

- Incremental opex - [redacted] million.

3.4.6 Qualitative benefits of option 3

Key additional qualitative benefits of option 3 compared to option 2 are:

- Improved completeness and accuracy of data for decision making.
- Sharing of consistent data across systems.
- Removal of risks associated with manual pinning.
- Redundancy in the event of a disaster with the ability to relocate control room (reflects feedback from consumer committee).
- Faster restoration of outages with current real time state known by operators without consulting pin boards, and improvements to writing switching instructions.
- Efficiency gains from faster writing and checking of switching instructions.
- Updated SCADA models assisting with renewable energy connections.
- Improved asset management with higher quality of data.

3.5 Review of Option 4 – GIS Upgrade and ADMS

3.5.1 Scope of Option 4

This option also builds on the GIS upgrade in Option 2 and has three main elements of scope with the last project requiring very significant resourcing. The scope is:

- GIS upgrade including utility network model.
- Data Improvements.
- ADMS/AEMS Implementation (Covering full DMS/OMS and advanced applications).

3.5.2 GIS upgrade with utility network model

This is the same scope as Option 2/3.

3.5.3 Data improvements

This is the same scope as Option 3.

3.5.4 ADMS implementation

This is a major undertaking and includes the specification and delivery of an Advanced Distribution Management System (ADMS) during this regulatory period. This would provide ADMS, OMS and advanced application and align Power and Water's OT capability with other leading network Utilities. Key elements that would be delivered include:

- Electronic diagrams (as per Option 3).
- Switching management (as per Option 3).
- Power flow model.
- Outage management capability (full OMS solution with trouble call processing, outage analysis, outage event summary, visualisation and outage restoration management).
- Fault location, isolation and service restoration.
- Field client and establishment of electronic communication from control room.
- Advanced applications (VVO, dynamic rating etc).

Whilst Power and Water are smaller than many other Australian utilities there would be significant resources required for specification, procurement, detailed design, testing and cutover of a project that would require several phases. The challenges for Power and Water in providing sufficient internal resources, essential to getting support for the system, would be substantial.

3.5.5 Costs of Option 4

The estimated totex of the ADMS implementation in the current regulatory period alone is [redacted] million, based upon a market scan[4]. There would also be additional costs to implement the GIS upgrade and data improvements, which are also required bringing the total costs to around [redacted] million.

3.5.6 Qualitative benefits of Option 4

The advantages of this option:

- Would provide a leading ADMS platform and position Power and Water for any future developments
- Deliver all the benefits associated with option 3 including
  - Removal of risks associated with manual pinning.
  - Redundancy in the event of a disaster with the ability to relocate control room (reflects feedback from consumer committee).
  - Faster restoration of outages with current real time state known by .operators without consulting pin boards, and improvement to writing of switching instructions.
  - Efficiency gains from faster writing and checking of switching instructions.
  - Updated SCADA models assisting with renewable energy connections.
  - Improved asset management with higher quality of data.
- Faster restoration using FLISR

[4] *Source: Strada Associates OT Capability review, 2022*

- Further incident reduction and faster restoration with electronic communication between the field and the control room.
- Reduction in capex with less conservative operation of the network due to greater confidence of operators and tools to manage the network (dynamic ratings, volt var optimisation, improved data forecasting).

There may be additional benefits depending on the scope of ADMS implemented. However, a full ADMS implementation is a challenging project with many utilities taking more than one RCP to implement the full solution even with strong internal resourcing for the project.

3.6 Resolution of risks by option

Several risks have been identified with the current OT environment. The table below outlines how the potential options could assist in resolution of these known risks.

Table 3.1 Risk treatments

Risks	Planned treatments	Options that assist
Unavailable GIS due to system failure	Upgrade the GIS to a modern version within the extended support period	Options 2,3, and 4
Unavailable GIS due to cyber security attack	Upgrade the GIS to a modern version within the extended support period	Options 2,3, and 4
Unknown network state due to control room relocation	Creating a digital control room through data improvements and electronic diagrams. This will allow operational controllers to relocate seamlessly and still operate the network safely as they have a record of the current state.	Option 3 and 4
Inaccurate asset status leads to an incorrect switching/ permitting event	The Base DMS can register and track permits against assets on the digital platform with validation of suggested switching steps. This will reduce the likelihood of these events.	Option 3 and 4
Incident due to loss of key personnel	The electronic operating diagrams and switching management will reduce the reliance on the experience of the key operators and reduces the probability of an incident if they were no longer available.	Option 3 and 4
Declining reliability	Electronic diagrams and switching management in the base DMS will allow faster assessment of current network state and assist in developing switching steps for	Option 3 and 4 Option 4 would allow further

Risks	Planned treatments	Options that assist
	restoration of outages. This should mitigate the impact of more complex network resolution of outages.	improvements in reliability

The table below highlights how the different options can reduce the assessed risk level. It demonstrates how the application of Option 3 and 4 would reduce all the identified risks to a maximum of medium.

Table 3.2 Risk levels after treatment by potential options

Risk description	Base case	Option 2	Option 3	Option 4
Unavailable GIS Due to System Failure	Medium	Low	Low	Low
Unavailable GIS Due to Cyber Security Attack	High	Medium	Medium	Medium
Unknown network state due to Control Room Relocation	Medium	Medium	Medium	Medium
Inaccurate Asset Status leads to an incorrect Switching/ Permitting Event -	High	High	Medium	Medium
Incident due to loss of key staff /key person risk	Medium	Medium	Low	Low
Deteriorating reliability	Very High	Very High	Medium	Medium
Geometric mean outcome	High	Medium	Medium	Medium
Max risk outcome	Very High	Very High	Medium	Medium

3.7 Customer feedback and options assessment

3.7.1 Summary of customer feedback

One of the requirements of the AER's Better Resets Handbook is the need to take in consideration feedback from customers when developing the proposed set of projects for the next RCP. Power and Water have therefore run a series of People's Panel since the original submission to obtain this feedback and ensure this was considered in determining the optimal mix of projects for the next reset period. The feedback from these panels is provided in Appendix A.

Feedback received through customer consultation has demonstrated strong support for system investment beyond the minimum compliance levels. Panellists thought there was a need to prioritise some projects and/or to fast track investment to improve future service delivery and reduce potential issues and costs. There was an expectation that the improvement and oversight of the ICT systems should be a continuous program.

At a more detailed level since the first feedback session in 2021 there has been concern on the need for improved customer communication during outages. Allied to this has been ongoing concern for redundancy for Power and Water's solution in the event of disaster with the length of the longer outages being an issue in the earlier panels. A more recent concern has been the importance of strong cyber security measures and the need for these to be regularly reviewed.

Finally, Power and Water have continued to hear feedback consistent with the first people's panel that our customers want Power and Water to embrace innovation, new technology and transition to a new energy future that is better customer focussed and responsive.

3.7.2 Options assessment for customer feedback

The table below provide an assessment of how each of the options performs against the customer feedback. The feedback is not weighted and some criteria may be considered more important to consumers.

Table 3.3 Customer feedback assessed against options

Feedback/Option	Option 1	Option 2	Option 3	Option 4
Improved future service delivery	No - Will be worse with no supported GIS	No	Improved with base DMS, but may offset the challenges of a more complex network	Improved with ADMS (incremental improvement to Option 3)
Expectation ICT is a continuous project	No	Moves most of required investment to after 2029	Will allow for continuous investments	Major investment just in RCP 24-29
Improved customer communication	No assistance	Improved GIS data but no customer improvement	Data improvements and foundation for OMS which will help, but not delivered in RCP 24-29	OMS will improve customer communication
Redundancy for disasters	No assistance	No assistance	Base DMS will allow relocation of control room	ADMS will allow relocation of control room
Strong cyber security	No assistance	Modern GIS improves cyber security	Modern GIS improves cyber security	Modern GIS improves cyber security
Transition to new energy future	No assistance	No assistance	Some development and foundation for later expansion	Will provide strong platform for any transition
Summary	**Doesn't meet most customer expectation**	**Meets some of customer expectations, but missing on**	**Meets most requirements, but only creates foundation for**	**Meets most requirements, but major investment is in just one RCP and**

		redundancy, improved customer comms and transition to new energy future	**improved customer communication**	**not a continuous project**

3.8 High level options review

A high comparison of the options and the issues they address in the identified need is depicted in the table below.

Table 3.4 Summary of options analysis outcomes

Assessment metrics	Option 1	Option 2	Option 3	Option 4
Totex ($m, real FY22)	n/a	**$5.5m**	**$19.5m**	**$60-70m**
Meets customer expectations	○	◑	◕	◕
Aligns with Asset Objectives	○	◑	◕	◕
Technical Viability	○	●	●	○
Deliverability	n/a	●	●	○
Preferred	No	No	Yes	No
Ranking	n/a	2	1	3

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

Key conclusions from the high level review were:

- Option 1 is not credible as it would leave Power and Water without a supported GIS before the end of the next regulatory period.
- Option 4 is not believed to be technically feasible due to the scale of effort, risk and cost to re-platform. The resource effort would require multiple years of implementation and would put at risk the need to address some of the current challenges as early as possible.

The cost benefit calculation has therefore concentrated on a comparison between option 2 (GIS upgrade only) and Option 3 (GIS upgrade and data improvement projects/Base DMS)

4. Cost benefit analysis

4.1 Modelling approach

This section assesses the incremental benefit of the data improvement projects and base DMS functionality proposed in this business case. The costs and benefits of the GIS upgrade (and associated elements) have not been included as these are needed to maintain the level of risk faced by Power and Water and are common to both Option 2 and 3.

The modelling has assumed that the base DMS functions and data improvements are available from the end of the 24-29 regulatory period. Benefits are therefore captured for the following 2 RCP (10 years). This represents a minimum lifespan for this type of system with systems at other utilities often in operation for longer periods of time.

It is expected that the base DMS will be expanded over time to include additional functionality and therefore facilitate other benefits. At this stage these additional benefits have not been captured, but it should be noted that the foundation work for the base DMS in this period will be an important enabler to the wider set of functions that are likely to be needed in future regulatory periods.

The calculations have assumed a real discount rate of 5.6% based on the draft determination.

4.2 Project costs used in analysis

The project cost of Option 3, excluding the GIS upgrade element, is $11.07 million capex plus $2.9 million opex over Regulatory Period 2024-29. These costs are broken down and outlined in Appendix B.

There are assumed to be on-going opex costs of [redacted] per annum commencing from regulatory period 2029-34 and these have been used in the cost benefit calculations. These costs include:

- On-going data governance and maintenance costs. As the major data improvement project is complete this is estimated at [redacted]
- Support and maintenance costs for base DMS project [redacted]
- Internal support costs (estimated at 1-2 FTE) - [redacted]

These costs assume that the base DMS with the electronic diagrams and switching management is maintained. Any upgrade to a broader solution in future regulatory periods may vary these costs, but this would be assessed in a subsequent business case.

4.3 Project Benefits used in analysis

The project benefits have been broken down into:

- Maintaining reliability.
- Improved operational efficiency.

- Network safety.
- Maintaining compliance.

A separate section on each category of benefit is provided below.

This assessment is focussed on the relatively limited scope of implementation of the base DMS and data enhancements during the 24-29 RCP. The solution also provides a foundation platform that could be expanded (subject to a suitable business case) in future RCPs.

4.3.1 Maintaining reliability and resilience

This category makes up the majority of the benefits and the magnitude reflects the limited OT systems currently available at Power and Water which rely on manual pinning and do not have any switching management support. The increasing level of DER as well as network growth has increased the complexity of the network and makes it difficult for operators to respond to outages and meet the currently achieved SAIDI/SAIFI levels.

In the absence of electronic diagrams and switching management tools, and with an increasingly complex network, it is expected that the level of reliability on the network would decrease over time. Outages would be more frequent (given network growth) and with a larger range of switching options would take longer to assess and restore particularly with the need to check manual pin boards. This complexity and growth is expected to lead to an increase in unserved energy of 2% p/a.

The benefits described below will utilise the intended tools to improve the current mechanisms for restoration and mitigate the potential size of any deterioration in the reliability of the network.

Faster restoration in standard operating conditions (outside a cyclone or major event day).

The introduction of the base DMS will deliver electronic operating diagrams and management of the switching process to help maintain reliability. This change reduces the time taken to resolve each outage by:

- Removing the requirement to review the pin boards (now done electronically).
- Enabling faster drafting and validation of the switching plans.
- Providing insights from the connectivity model of the likely location of the fault.

The exact impact on the outage restoration time will depend on the complexity of the switching, state of the network and experience of the operators. However, a conservative estimate for standard outage time reduction would be a 5% saving.

This 5% saving has been applied against the current quantity of unserved energy (424 MWh) from the 2023 RIN. This is valued using a weighted VCR of $26.2 per kWh and results in an annual benefit once the system is implemented of $600k per annum.

Faster restoration during a major event day (MED)

As with a standard outage the time taken to resolve each outage during a MED would decrease from:

- Removing of the requirement to review the pin boards (now done electronically).

- Enabling faster drafting and validation of the switching plans.
- Providing insights from the connectivity model of the likely location of the fault.

The exact impact on the outage restoration time will depend on the complexity of the switching, state of the network and experience of the operators. However, given that during a MED the operators are likely to be overloaded, the saving in time for each outage is likely to be larger and a 10% saving has been applied.

The modelling has assumed, based on actual data from recent years, that the average USE on a major event day (excluding cyclones) is 277 MWh with a forecast probability of 60% of a MED each year. This is valued using a weighted VCR of $26.2 per kWh and results in an annual benefit once the system is implemented of nearly $500k per annum.

Faster restoration during a cyclone

One of the major benefits from electronic diagrams and switching management is the increased resilience of the control room to a cyclone and the improved ability to recover. This would be particularly important if the control room had to relocate during the cyclone. Without electronic operating diagrams there would be no up-to-date knowledge of the state of the network as it would not be practical to relocate the pin boards or accurately recreate them.

The electronic operating diagrams would allow the control room to continue operating with the switching management functionality to identify valid switching options for the state of the network. It is expected that collectively this will allow a reduction in the average restoration time of 10% (and potentially much higher if there is a need to validate the state of the network).

The modelling has assumed that the average USE in a cyclone is 6,710 MWh with a forecast probability of a cyclone every eight years based on the last 2 cyclones. This is valued using a weighted VCR of $26.2 per kWh. Despite the infrequency of this event the magnitude of the savings results in an expected annual benefit once the system is implemented of $2,400k per annum.

Avoided Outages through Reduced Switching Incidents

Power and Water have reviewed the annual average unserved energy due to human error on switching incidents and it is relatively low at 2.2 MWh. The move to electronic operating diagrams and switching management will reduce the number of errors, but will not eliminate them. A reduction of 50% has therefore been assumed and this has been valued at the same VCR applied to the other calculations.

This had an annual value of $30k per annum.

Network Resilience Considerations

The cost benefit analysis has considered the resilience of the network during MEDs and cyclone conditions. The modelling has assumed that the frequency and severity of these events continues at the recently observed levels. This is a conservative assumption given the impact of climate changes is likely to lead to less frequent but potentially much larger events.

The AER has published a note on key issues of network resilience (the resilience note) that set out the requirements for approving resilience expenditure. This business case considers resilience as only one of many benefits, although option 3 does meet the three requirements set out in the network resilience note[5] being:

- **Causal relationship between expenditure and increase in extreme weather events:** The NT Government Climate Change report indicates that the intensity of tropical cyclones, will intensify, even if the frequency decreases. The expected unserved energy impacts of any more severe cyclone will be very large regardless of the OT environment, but would be partly limited by the proposed expenditure.
- **Expenditure is required to maintain service levels:** The base DMS will allow the maintenance of an electronic record of the network allowing rapid relocation of the control room. There will also be reduced effort (and therefore faster restoration) in avoiding manual pinning and assistance from switching management tools and the connectivity model. This combination of features will assist in avoiding any further service deterioration due a larger cyclone.
- **Fully informed consumers:** During the customer feedback panels, consumers have provided support for redundancy in the event of disaster.

4.3.2 Improved operational efficiency

Reduced Time to Write and Check Switching Instructions

Currently the control room has a manual process to write switching sheets and permits and to undertake validation and verification tasks. With the proposed solution, Power and Water expect a benefit in terms of reduced effort through automation of the switching instructions process. This will include 'point and click' building of switching instructions from graphic operating diagrams with step by step connectivity checking and access to stored switching instructions as the basis for new switching instructions.

It is estimated that there is currently the equivalent of 4 FTEs involved in the writing and checking of switching instructions in Power and Water. This would be likely to increase over time with a growing and more complex network. It is expected that a saving of [redacted] could be delivered by adoption of the switching management module of the DMS. The modelling applied a conservative view and did not include any benefit for the expected increased workload above the current 4 FTE that would be required with the existing systems.

This would result in an annual benefit of $250k per annum.

Avoided time for pin board updates

There is a time/effort requirement to physically update the pin boards. The modelling has estimated that this would be equivalent to [redacted] across a year, which is valued at the cost of [redacted] per control room FTE. There would also be reduction in office location cost for the pin boards, but these are expected to be relatively low and haven't been valued.

The annual value of the benefit is $25k per annum.

[5] Network Resilience, A note on key issues, Australian Energy Regulator, April 2022

Reduced time for power system modelling

The data improvement projects will improve the accuracy and completeness of the GIS model and create a common information model to facilitate sharing of the data. With a properly maintained and accurate network model, effort that is currently required to update and validate the network models for power system studies will no longer be required. There are a few components to this benefit:

- Internal labour for tasks such as modelling and constraint identification for TDAPR and business as usual tasks.
- Consultant costs for larger studies that are outsourced.
- Accurate input data avoiding the need to rework analysis for incorrect inputs.

The level of studies has increased with the pressure to grow the level of renewable energy on the network with 10 major connections studies required each year based on current financial year progress. This is expected to result in an annual reduction of $50k in consulting fees for studies and a $50k reduction in internal labour for validating models, which gives an annual benefit of $100k.

Drawing verification for pin board

There is currently a significant amount of effort required to verify updated drawings to be put on the pin boards that are then used to manage the network. With a verified and maintained digital network model, this level of effort will be reduced.

There are already activities required to undertake maintenance of the GIS model, which is used as the basis for the DMS model. The effort to keep the future digital model up to date is not additional work, just reallocation of current efforts as a result of implementing a single network model. This results in a net reduction in cost with the new system that is estimated to be realised as a reduction in the cost of the service level agreement with system control.

The modelling is estimated based on [redacted], with the FTE being sufficiently senior to validate the drawings and with an expected cost of [redacted] per year. This gives an annual benefit of $125k.

Reduced cancellations due to network conflicts/inaccurate data

Power and Water currently have around 1800 Network Access Requests (NARs) per year and this number is expected to grow by 2% per annum. It is estimated that around 2% of these NARs may be cancelled close to time due to network conflicts, or inaccurate data. With the focus on data improvements and the base DMS to identify the overlapping network areas it is expected that 25% of the cancellations for network conflicts/inaccurate data can be avoided.

The cost of cancellation is approximately $10k to cover mobilisation of the field crew, time to plan the outage and time to notify customers which all needs to be repeated. This would result in an annual benefit of around $100k per annum.

4.3.3 Network safety

Reduced risk from incorrect switching

The increasing level of DER as well as network growth has increased the complexity of the network and the risk of incorrect switching leading to a safety incident. The introduction of electronic diagrams and switching management should mitigate the safety risks associated with the use of manual pin boards. The risks that can be mitigated include:

- Incorrect switch numbers on switching sheets.
- The possibility to have multiple concurrent permits per asset as a result of not having an integrated permitting system.
- Incorrectly located pins (or accidentally moved).

These issues create some uncertainty with the state of the network. The data improvement project will resolve some of the current data accuracy and completeness issues and the base DMS functionality will provide validation and checking of switching and reducing the numbers of incorrect switching plans. The modelling valued the benefit based on the Risk Quantification Procedure (CONTROL0932).

The benefit is based on historic records showing an average of 1,894 switching events for planned and unplanned outages, with an adjustment factor of 2 to account for switching events without an outage. Examination of the outage records identified that 0.4% of annual switching events had incorrect switching with comments indicating it could have been resolved through an improved management system. The modelling assumed that the annual number of incorrect switching operations could be reduced by 50% with improved data and the introduction of the base DMS.

The annual benefit for this improvement in safety is estimated at $200k per annum.

Reduced risk from ageing workforce

The current processes for system control rely heavily on the skills and experience of the operators. When some of the current workforce retire there is the risk of an experience gap as new employees take time to gain the knowledge required to safely and reliably operate the network.

The introduction of the base DMS will provide an accurate electronic representation of the current state of the network with switching management providing validation of suggested switching options. These tools should reduce the reliance on the experience of personnel in system control and provide more system based validation to avoid incorrect operation. The reduced time to develop switching instructions will also decrease the workload on new operators and therefore reduce safety (and reliability) risks associated with them being overloaded during critical times.

The capability provided by the additional system tools will also reduce the experience level required for new operators and increase the range of personnel that could apply for future positions within the control room. This would increase confidence that the control room staffing levels can be fully maintained at a safe level.

4.3.4 Maintaining compliance

Connection process timeframe non-compliance

With the transition to renewables and the NT Governments 50% emissions reduction target, Power and Water expect the number of connection applications to increase. The connection process has defined timeframes mandated by the NT NER. The first two stages of applications are relatively straight forward and Power and Water would expect to meet the targeted timescales for compliance. However, the detailed enquiry response step is expected to have approximately 25% non-compliance due to difficulty obtaining the required data and undertaking the relevant studies. The improvement in data accuracy and completeness along with the CIM to allow sharing of the data will assist in undertaking these assessments in the necessary timeframe.

The number of major connections is estimated at 10 annually (based on current financial year progress) and it is expected to have a slow growth rate over time (2% is assumed). The penalties applicable are Tier 3 civil penalties ($188k) and the modelling has allowed for a 10% chance that a non-compliance would attract a penalty.

This results in an annual benefit of around $50k per annum.

4.4 NPV comparison

The table below shows the NPV of the investment in data improvement projects and base DMS over the next three regulatory periods. This is based only on the quantified benefits listed above for the core functionality and data improvements identified for the next RCP.

This NPV comparison is based on the expected case with alternative scenarios assessed in the scenario analysis.

Table 4.1 Summary of costs and benefits of expected scenario

Category	Value
Net present cost	$17.4 million
Net present benefits	$24.8 million
Net present value	$7.4 million
Benefit cost ratio	1.43

4.4.1 Scenario analysis

The table above is based on the prediction of NPV using the central scenario for all the key parameters in the modelling. The modelling also considered 2 other scenarios which were:

- Scenario 2 - Low growth, low risk, low benefit scenario
- Scenario 3 - High growth, high risk and high benefit scenario

This resulted in the following sets of benefits with the weighting outcome based on 50% for scenario 1 and 25% each for scenario 2 and 3.

Table 4.2 Summary of the NPV and BCR for alternative scenarios

Scenario	1	2	3	Weighted Outcome
NPV	$7.4m	$0.9m	$58.5m	$18.6m
BCR	1.43	1.05	4.38	2.07

5. Recommendation

5.1 Justification for investments

The justification for the OT Capability Uplift projects is assessed separately for the GIS upgrade and the data improvement projects/base DMS.

5.1.1 Justification for GIS upgrade

The GIS is a critical system for Power and Water which is used as the master record for all distributed asset locations. It is continuously used to allow modelling and representation of network and asset build standards as network equipment and technologies change. It is the central system for many other systems within Power and Water including Maximo, embedded generation database, emergency response system, Dial Before You Dig, ArcGIS online (field viewing of network data) and financial management systems.

The GIS will be out of extended support by August 2026 (and outside even more limited mature support by 2028). This will increase operational risks associated with:

- Cyber security – There is a risk of corruption, un-authorised access or loss of network data due to security patches not being updated to meet modern threats with a higher frequency of attacks on Power and Water due to software versions.
- Network reliability – Could see a performance reduction as Operational outage support and unavailability of bug fixes lead to longer down times.
- Interfacing of enterprise business systems – This linkage may no longer be supported if the systems are unable to integrate with older versions of GIS.
- Public safety risks – Where information is not readily available from Before You Dig and Look Up and Live Services.

Power and Water is required to have an accurate record of the type, location and status of its network for planning, operation and maintenance purposes. Operating with a supported GIS (which has a much lower risk of unavailability) is essential to continuing to deliver against Power and Water's licence conditions.

The investment in the GIS Upgrade is therefore consistent with the National Electricity Rules Capital Expenditure Objectives as the expenditure is required to maintain the quality, reliability, security of supply of standard control services and maintain safety of the distribution system.

5.1.2 Justification for data improvements and base DMS solution

Power and Water are facing an increasingly complex network with a growing level of DER and connections. Without the addition of new tools in the control room it is expected that reliability of supply will deteriorate as outages take longer to assess and determine switching plans and options for resolution. The introduction of the base DMS will provide OT solutions to offset the expected deterioration from the increased complexity of the network with the electronic operating diagrams and switching management assisting operators to identify resolution options.

The investment has an expected positive NPV of $7.4 million from the quantitative analysis of the expected scenario and a BCR of 1.43. These numbers would be higher if an average of the weighted scenarios was applied as described in section 4.

Implementing this option is consistent with the Capital Expenditure Objectives as it will assist to maintain the reliability of the network, whereas without the proposed investment reliability would decline. These projects are also consistent with the National Electricity Objective as they promote efficient investment in the reliability of the supply of electricity and are therefore in the long term interest of consumers. The proposed investment also provides a foundational platform that can be built upon to enable additional functionality to further benefit consumers.

5.1.3 Customer feedback

Both of the sub-projects align with the feedback provided by customers in the customer consultation process.

This feedback indicated that panellists thought there was a need to prioritise some projects and/or to fast track investment to improve future service delivery and reduce potential issues and costs. There was also an expectation the improvement and oversight of the ICT systems should be a continuous program. This set of requirements would be more aligned with the Option 3 projects, rather than Option 2.

At a more detailed level both projects will assist with the cyber security resilience required. However, only option 3 will assist with the greater resilience to disasters through the ability to relocate the control room. Both options will not address the expectations for improved customer communication, but Option 3 provides an easier pathway for this to be addressed in subsequent years.

The final requirement for Power and Water to embrace innovation, new technology and transition to a new energy future that is better customer focussed and responsive is only achieved by Option 3.

5.2 Recommendations

It is recommended that Option 3 – GIS Upgrade and Data Improvements/Base DMS project is progressed at an estimated cost of $19.5 million ($ real 2021/22) in the next regulatory control period.

This option will enable Power and Water to remain compliant with its licence conditions and technical codes. This option is consistent with the capital expenditure objectives to maintain reliability/safety and the National Electricity Objective through being in the long term interest of consumers.

6. Delivery and annual expenditure

6.1 Delivery approach

Projects are delivered using a mixture of Waterfall project management aligned to PRINCE2 and Agile project management. Power and Water's operational service delivery is aligned to the industry standard Information Technology Infrastructure Library (ITIL) framework. Power and Water has established the Operating Model Program team which, in conjunction with ICT, is the delivery arm for OMP initiatives[6].

ICT recognises that procurement and associated contract negotiations can be on the critical path and has ensured that the time for this step of each project has been adequately accounted for when developing the Regulatory Proposal[7].

6.1.1 Project structure

The project management structure will be appropriate for a project of this size. Establishment of a delivery team will include a Program Manager who has extensive experience in software build-up and operation.

In the preliminary cost estimate, resources have been allowed for the following project management type functions:

- Project and contract management (including scope, cost, and schedule management)
- Integration management
- Documentation management
- User acceptance
- Change management

6.2 Expenditure profile

Table 6. shows a summary of the expenditure requirements for the 2024-29 regulatory period.

Table 6.1 Forecast annual capital and operational expenditure ($m, real 2021/22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	3.1	3.6	3.1	3.4	2.4	15.5
Opex	0.6	1.1	0.7	0.8	0.8	4.0
Total	**3.7**	**4.7**	**3.7**	**4.2**	**3.1**	**19.5**

[6] *Refer Section 6.3 Delivery Model, ICT Strategy, RCP24-29*
[7] *Refer Section 6.4 Delivery Strategy, ICT Strategy, RCP24-29*

The forecast expenditure for the next regulatory control period allocated to Standard Control Services as per the CAM is outlined in Table 6..

Table 6.2 Forecast annual capital and operational expenditure – allocated to SCS ($m, real 2021/22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	3.1	3.6	3.1	3.4	2.4	15.5
Opex	0.6	1.1	0.7	0.8	0.8	4.0
Total	**3.7**	**4.7**	**3.7**	**4.2**	**3.1**	**19.5**

The forecast operating expenditure for the next regulatory control period allocated to recurrent and non-recurrent categories is outlined in Table 6..

Table 6.3 Forecast annual operating expenditure – recurrent and non-recurrent

Item	FY25	FY26	FY27	FY28	FY29
Recurrent	16%	15%	23%	32%	32%
Non-recurrent	**84%**	**85%**	**77%**	**68%**	**68%**

In the table above:

(1) Recurrent expenditure relates to ongoing licence fees
(2) Non-recurrent expenditure relates to data migration and data cleansing activities, that under Power and Water's capitalisation policy is expensed.

Appendix A – Customer feedback

Approach

One of the requirements of the AER's Better Resets Handbook is the need to take in consideration feedback from customers when developing the proposed set of projects for the next RCP. Power and Water have therefore run a series of People's Panel since the original submission to obtain this feedback and ensure this was considered in determining the optimal mix of projects for the next reset period.

May People's Panel

The May People's Panels (May Panels) were in-person all-day sessions attended by approximately six participants at each Panel. The forum was also observed by members of the AER Consumer Challenge Panel, a consumer engagement challenge group, who provide advice to the AER on our engagement program.

The purpose of the May Panels were to:

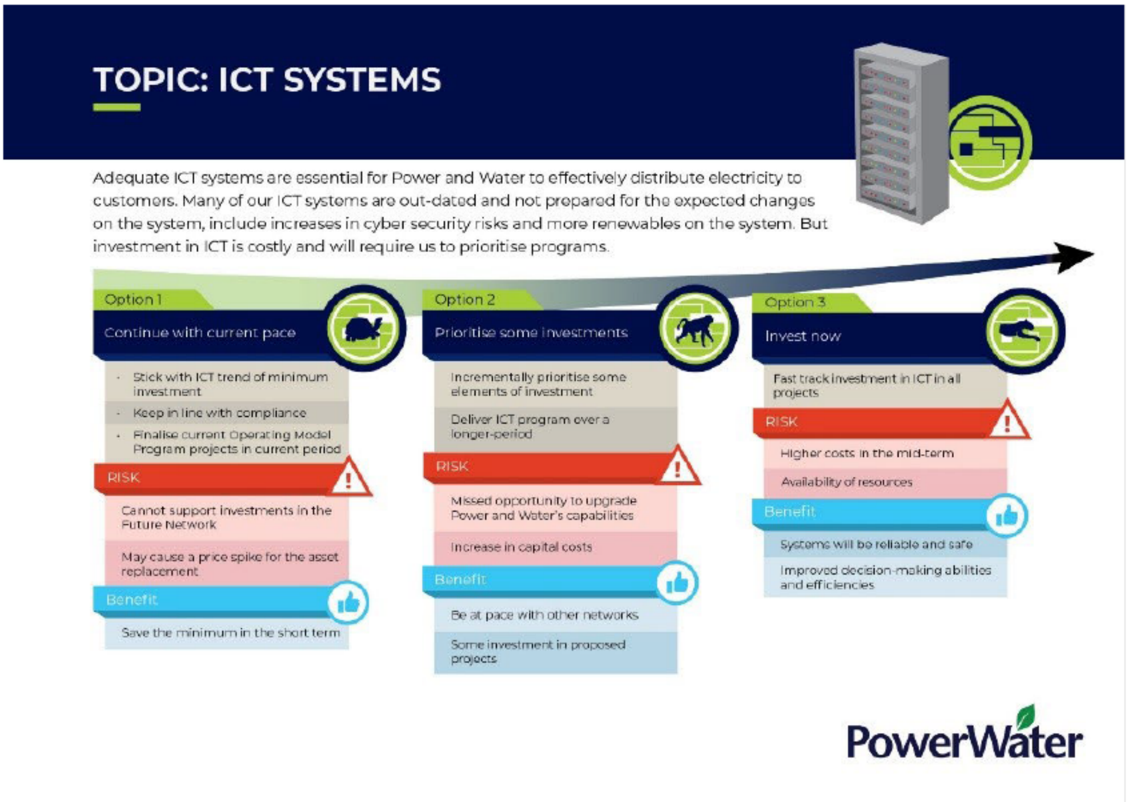
- Obtain feedback on how customer preferences were reflected in our forecasts
- Deep dive into specific topics and programs including the single site consolidation project, proposed Information and Communications Technology (ICT) expenditure, the future network program, the proposed contingent projects and alternative control services
- Discuss and test future engagement opportunities.

This session focused on demonstrating how technology has evolved over time and why Power and Water needs to invest to upgrade our systems. Panellists undertook an exercise of 'designing' a 2000 versus 2020 house by allocating a series of technologies to the relevant periods. Posters showing the changing IT world were also used to demonstrate how the current technology capabilities will not be fit for the future and need to be upgraded to improve operations. Panellists were presented with the three key areas of capability that Power and Water are looking to upgrade including:

- **Cyber security** to protect customer data and prevent the network being compromised by any cyberattacks
- **Information Technology** relating to corporate and administrative systems which help support business practices and align with relevant regulations
- **Operating Technology systems** relating to network operations to allow visibility of the network and appropriate asset management.

The May Panels considered ICT to be critically important for a business to operate efficiently and agreed that Power and Water should be investing to keep systems up to date. Following discussion on these investments, panellists were asked to vote on which option to pursue and indicate which projects should be prioritised if this expenditure had to be reduced following AER feedback.

Figure A.1 Need for ICT solutions



The majority of the panellists were largely supportive of Option 2 to prioritise some of the projects or Option 3 to fast-track investment now to improve future service delivery and reduce potential issues and costs.. They also suggested that greater investment now could be attractive to industry and customers when considering whether to invest in the Northern Territory compared to other states if the costs are more reasonable than eastern networks. Alternatively, one of the Panel members explained that Power and Water could wait a bit longer for technology that is still in development before fully investing.

Figure A.2 Darwin May Panel allocating different ICT technologies to 2000 versus 2020

August People's Panel

The August 2023 session was held online and combined participants from the Darwin and Alice Springs People's Panels.

An independent facilitator coordinated the conversation and feedback from the Panels.

The participant representation was expanded from prior People's Panels to include four new participants across Tennant Creek, Katherine and Alice Springs.

The objectives of this Panel were to Inform and:

- Provide an update in approach for some of the key projects and programs for the Revised Regulatory Proposal.
- Test outcomes from the May 2023 People's Panels to ensure these align with participants' views.
- Discuss the future of the Peoples' Panels, including what topics the Panels wanted to cover in future.

At the May 2023 Peoples' Panels, participants were provided with a summary of our ICT investments and were asked to prioritise these investments based on their perceived level of importance. The results of this exercise can be found in the May 2023 summary report.

At the August 2023 Peoples' Panels, participants were provided with an update on the Operating Technology (OT) Capability Uplift, Cloud Migration projects and Cyber Security. We also re-tested the scope of our proposed cyber security program with our customers.

Panellists provided the following feedback:

- Improvement and oversight of ICT systems should be a continuous program
- Power and Water need to have redundancies in the event of disaster
- More details should be provided around the security of customer information
- Strong cyber security measures are important and should be regularly reviewed.

October 2023

In October 2023, Power and Water met with the People's Panel for the sixth time during the reset process. The purpose and objective of the session was to provide a summary of the AER draft decision, to seek the panellists' feedback on refined scopes that Power and Water have been working on since the IRP submission and, to obtain and test views on Power and Water's direction and speed of key investments.

The way in which Power and Water achieved our objectives for our ICT expenditure, including the OTCU Project, is through Market Stalls. The purpose of the Market Stalls was for a Power and Water person to explain the refined scope from the IRP to the RRP submission from both a capex and opex point of view.

Customers showed substantial support with these three investments and recognised the benefits to both Power and Water and customers such as easier outage and issue response rate, greater security of information and cost savings from migrating to cloud storage.

Many also recognised that ICT is a key enabler of unlocking renewables and expressed support to drive this.

Many of these views were consistent with Power and Water's first People's Panel in November 2021, where customers stated that they wanted Power and water to embrace innovation, new technology and transition to a new energy future that is better customer focussed and responsive. This also included key criticisms from customers around overcoming key challenges such as long outages particular during Cyclone Marcus and the need for better customer communication.

Summary

Feedback received through customer consultation has demonstrated strong support for system investment beyond the minimum compliance levels. Panellists thought there was a need to prioritise some projects and/or to fast track investment to improve future service delivery and reduce potential issues and costs. There was an expectation the improvement and oversight of the ICT systems should be a continuous program.

At a more detailed level since the first feedback session in 2021 there has been concern on the need for improved customer communication during outages. Allied to this has been ongoing concern for redundancy for Power and Water's solution in the event of disaster with the length of the longer outages being an issue in the earlier panels. A more recent concern has been the importance of strong cyber security measures and the need for these to be regularly reviewed.

Finally, Power and Water have continued to hear feedback consistent with the first people's panel that our customers want Power and Water to embrace innovation, new technology and transition to a new energy future that is better customer focussed and responsive.

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Appendix B – Cost estimate

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 – e.g., 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.

Specific sources of cost estimates have included:

- Power and Water Corporation Vendor market scan for Smart energy systems in Oceania, ADMS/DERMS/EMS, EYGM Limited 2022.
- Vendor engagement workshops [IPS-Energy Aust Pacific, Schneider Electric, General Electric].
- ADMS implementation SME consultant.
- Esri SME and Consultant workshop (labour build up).

- Consultation with Power and Water finance team SME.

The cost estimates are preliminary and have been derived from the initial needs assessment. A breakdown is provided in the tables below.

Table B.1 Proposed capex for the next RCP, $million FY22

Activity	2024/25	2025/26	2026/27	2027/28	2028/29	Total RCP
GIS Upgrade Project						
GIS Costs	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Unified Network Model	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
PM Allocation to GIS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Data Improvements						
Data Improvement Projects	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
PM Allocation	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Dist Ops/Base DMS						
DMS Cost	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
PM Allocation	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
TOTAL	3,085,000	3,634,000	3,050,000	3,400,000	2,350,000	15,519,000

Table B.2 Proposed opex for the next RCP, $million FY22

Activity	2024/25	2025/26	2026/27	2027/28	2028/29	Total RCP
GIS Upgrade						
GIS Data Migration	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
ArcFM Cost	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Other Data Improvements						
GIS Data Corrections	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Activity	2024/25	2025/26	2026/27	2027/28	2028/29	Total RCP
Data Governance and Data Maintenance	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Dist Ops Improvements						
DMS Cost	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
TOTAL	640,000	1,058,967	698,967	798,967	798,967	3,995,868

Power and Water Corporation

55 Mitchell Street, Darwin NT 0800

Phone 1800 245 092

powerwater.com.au