Operational Technology roadmap

Revised Regulatory Proposal 2024-29

30 November 2023

PowerWater

Contents

1. Executive summary

Based on feedback from our stakeholders, we have developed this roadmap for the improvement of our Operational Technology (OT) systems. The roadmap describes the drivers, priorities and initiatives required to respond to the change that is forecast to impact our operations over the next 10 years. While this roadmap focusses on the OT systems that supports our electricity network services (and specifically our power services business), it is envisaged that a future version will expand the scope to include OT that support our water, gas and sewerage services.

We are living in a period of rapid change in the electricity industry. Our network is being disrupted by global trends from climate change, to distributed energy sources, to electric vehicles and market uncertainty. We also expect to face a myriad of local changes in the Northern Territory in the years ahead, such as the need for a significant replacement of network assets, to meeting the demand needs of a growing population.

Our Future Network Strategy and ICT Strategy both signal large and transformational changes that are impacting our business. Responding to these challenges will require an uplift in the capability of our people and our systems.

Our ultimate objective is to improve our customer's experience including affordability, maintaining reliability and security of supply, playing our part in a sustainable and prosperous Northern Territory, and improving choice and equity. Our customers have told us that they want Power and Water to facilitate and actively support the shift to renewables. Many think we should even go further by leading change on renewables directly.

Our Operational Technology systems are critical as they ensure we continue to meet our safety and compliance obligations and can enhance or detract from the customer's experience of our services. We must balance the need for improvements to these systems against the cost to our customers, and in so doing implement fit for purpose solutions that cater directly to the highest value areas for our customers.

Table 1.1 provides a summary of the initiatives included in this roadmap with greater detail of each initiative and the systems underpinning them provided in this document.

Table 1.1: Indicative timing of initiatives by regulatory period

Focus area	Regulatory period 2019-24	Regulatory period 2024-29	Regulatory period 2029-34
1. Replace legacy, out of support systems	• EMS replacement	• GIS replacement	
2. Develop network visibility and improve hosting capacity	• Network visibility tool	• Increase hosting capacity / DOE	• Increase hosting capacity / DOE
3. Build a robust data platform		• Unified network model • Common information model	• Information model and data quality

Focus area	Regulatory period 2019-24	Regulatory period 2024-29	Regulatory period 2029-34
4. Implement improved distribution operations		• Base DMS • Develop system evolution plan to enhance interaction	• OMS/ADMS • Implement system evolution plan to enhance interaction

This roadmap will continually evolve as the increasing penetration of renewable technologies and growing number of market participants provide both opportunities and challenges for how we run our system.

2. Strategic priorities for OT

2.1 Priority one – Ensuring safety

Power and Water's licence conditions require it to operate both the regulated and non-regulated networks under a safety management and mitigation plan. These obligations require that Power and Water maintain accurate records of the type, location and status of its network for planning, operation and maintenance.

> **In the event of a cyclone or fire we cannot relocate the network status model to our backup control centre. This issue affects resilience to climate change, which** NTG forecasts will bring more severe cyclones and fires in the future

The paper pin board does not allow this, and the current state of the network needs physical verification in the field. This would be resolved through a digital, cloud-based representation of the network, accessible in the field via 4G mobile devices, and remaining always connected from back-up control centres.

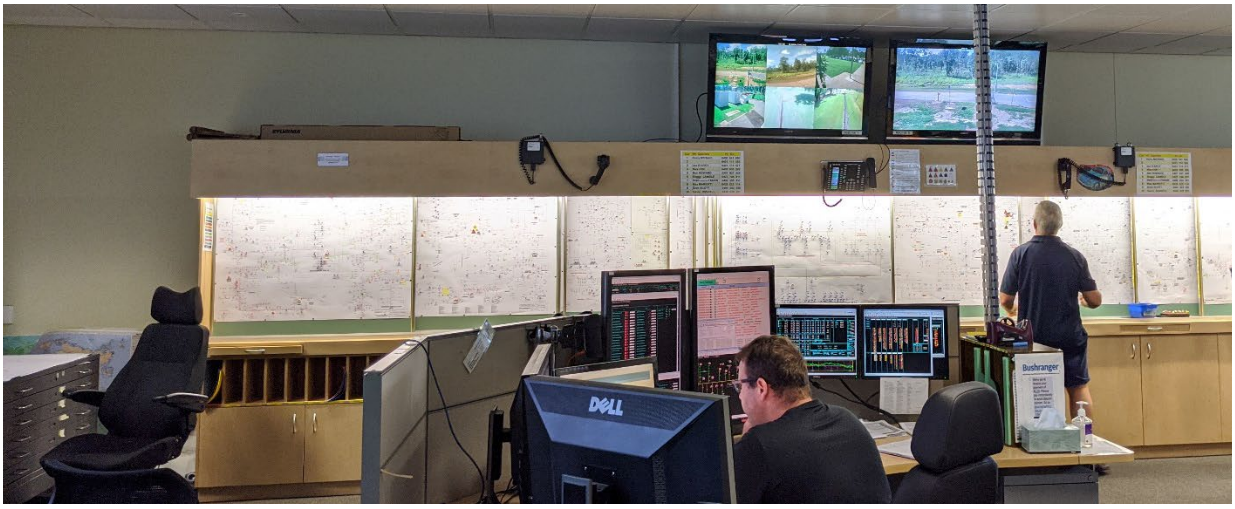
> **Manual Systems create unsustainable safety concerns,** increasing the risk of network status errors, events where two permits are issued against a single asset, and situations where operators in the field open / close incorrect switches.

Unlike the current switching plans that are painstakingly developed in MS Excel, digitalised switching plans can be created from near to real time common asset status information and embedded network rules.

> **Inadequate outage data creates safety risks for operational decision making:** detailed, timely knowledge of the system is not available, and an error on the pin board (such as a pin falling out or being misplaced) can lead to loads being switched that are beyond the switch's capacity, or inadvertent energisation of a fault that could create safety risks to crews and public.

These risks have been managed through the experience and diligence of system controllers, but the level of experience is dropping as older staff retire, the network is getting more complex, and the risk is increasing.

Figure 2.1 – Power and Water pin boards for distribution management



2.2 Priority two – Improving customer outcomes

Our customers care about the reliability of the network, the cost of services, and increasing the proportion of energy generated from renewable sources.

A lack of visibility can lead to poor decisions that affect customers

This includes delays in large restoration events (such as the Alice Springs System Black event in 2019), customer losses due to unintentional trips of Zone Sub Stations, and outages where customers were left offline until 'no power' calls alerted the control room to the error.

A key to unlocking affordability is providing more power to customers while minimising expenditure on new infrastructure

Connection of more distributed energy resources (DER) on to the transmission, distribution and low voltage networks in the coming years, as anticipated in the Future Network Strategy, cannot be adequately monitored and controlled using the paper wall board and manual processes.

A better customer service interface requires an integrated OT environment

Access to data can encourage new and existing customers to use electricity in off peak periods that coincide with low cost solar. A more efficient and better integrated OT environment also allows better customer service interfaces in a market that will include dispatch able battery storage, competitive large scale PV farms and behind the meter control.

Table 2.1: Examples of customer benefit

Customer focus	Example of customer benefit
Customer Safety	Better asset record accessibility, leading to better customer safety outcomes for Dial-Before-You-Dig and Look Up and Live services.
Reduced downtime and better outage notifications	New capabilities in field crew location awareness and switching plan creation can improve outage planning and reduce customer down time. Greater confidence in asset status information and records, can improve the accuracy of outage notifications to customers. Improved visibility of critical customers, resulting in reduced likelihood of inadvertent interruption of these customers with life-support systems.
Secure and Reliable Connections with Customer Devices	Accurate connectivity modelling of customer sites on the network will lead to continued delivery of safe and reliable electrical services. Maintaining up to date software packages reduces potential cyber security vulnerabilities, data corruption, or unauthorised access to network data that could lead to service interruption for customers.
Enabling Customer Development	Improved ability to assess and respond to customer connection requests. Allow maximum participation of DER through increase in hosting capacity and dynamic operation of connected devices

2.3 Priority three – Facilitating renewables

Under NTG policy, we expect that 50 per cent of energy consumed will come from renewable generation by 2030.

The transmission network must securely transport renewables to load centres, and the distribution network must be able to manage two-way flows

Approximately 30 per cent will come from large-scale renewables that connect through our transmission network. About 20 per cent is expected to come from roof top solar connected to our smaller customers' houses and exported back into the grid.

Regulated networks in Alice Springs and Darwin are experiencing the issue of minimum demand, risking black out events

Solar penetration is pushing minimum demand toward or below stable operating levels, creating the very high risk of black out events. An upgrade of the OT will enable the necessary digital interface and communication pathways to establish BTM control from the Control Room. When a minimum demand event is forecast, solar customers can be remotely notified, solar inverters can be remotely curtailed and Demand Management capabilities can be remotely activated.

2.4 Priority four – Meeting our compliance obligations

The manual and disconnected nature of our OT systems increase the effort for the Business to meet its compliance obligations.

The network model is at the core of all distribution network management tools. Power and Water has multiple network models that are separately maintained. The effort to build and maintain them is a key issue in all projects.

Utilities have multiple representations of the network model (i.e. one each in GIS, SCADA, OMS, load flow, and schematics). Each of these network representations are maintained separately and updated independently. Several of the key OT functions (e.g. network capacity planning, entry of outages and logs, state estimation, and short circuit analysis) are manual (not automated).

A Common Information Model (CIM) solution shares the same single network model database, which means less effort in data management, less cost in integration and more robust operation.

Compliance relies largely on experienced and disciplined control room operators (rather than systems). The level of reliance is particularly risky. Our control room is the only one in the country still managing the network using pin boards.

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

Ensuring our GIS is supported, available and secured is a key enabler for meeting compliance obligations.

2.5 Priority five – Network and Control Room Resilience and Security

We currently operate with an aged fleet of ICT systems that are not equipped to meet the increase in activity we expect over the next 20 years, while we face a retirement and knowledge retention issue in our control room and with our field operators.

Further, we face resource challenges as a relatively small population that is geographically remote from other places in Australia.

Control Room operational teams will be able to address staff retirement and knowledge retention concerns through an integrated platform that is built with customised rules and limitations. The manual nature of wall boards and their disconnection from EMS, SCADA, GIS and other asset information systems is causing unease around knowledge retention.

The Federal government has introduced legislative changes to improve the cyber security of critical infrastructure. Power and Water must comply.

With the amendments to the security standard under the *Security of Critical Infrastructure Act* ('SOCI Act') there is a heavy requirement to improve ICT and physical security. Developing a strong cybersecurity position is a major priority for protecting our assets.

The GIS and geometric model will need upgrading before end of financial year 2025 to maintain its functional and technical capabilities within PWC.

Our GIS system reaches end-of-life by 2026. This increases cyber security risks (as security patches will no longer be released), and affects network resilience (as bug fixes and operational outage support will no longer be available).

3. Required OT capabilities

The following capabilities are required to bridge the gap to a higher level of OT maturity. They will see Power and Water following in the well-trodden path of Australian and international utilities in implementing technologies, investing in data quality, and developing skills in a younger cohort of staff to manage the system challenges that are forecast, and to mitigate those that are already being experienced.

- **One Network Operating Model:** Power and Water currently have multiple network operating models. To simplify, optimise and de-risk the information flow across all related systems, a single network operating model is required.
- **Common Information Model:** with a single view of an asset across the organisation: to access all the latest data across the various asset systems and data repositories. The strategic outcome is to provide seamless and easy access to systems and data that is required to undertake the day-to-day operations of the business.
- **Situational awareness:** to enable a combination of people, processes and technology to geospatially visualise and analyse information, including improvements to outage management.
- **GIS-based framework:** Standardise and streamline operations through smart use of data while ensuring reliable service, working towards creating a digital geospatial-based framework that spans the entire company from end-to-end
- **Data flow from mobile field workers back to the office:** Current tools enable data to flow one way (from office to the field), but two-way flows are needed to enable digital asset management, digital field work, digital operations and digital customer interaction. This represents the era of the 'Digital and Mobile Utility'
- **Improved information to customers and market participants:** that provides information on the location of outages, field crews, street works, and planned works**.**

Power and Water will incrementally implement an integrated, off-the-shelf platform that develops a 'fit for purpose' OT capability to meet the needs of the network and consumers

Our future capabilities are based on a single network operating model and an enterprise integrated solution, with GIS at the centre of service management, and the DMS module being the key to managing renewables. In the long term, the strategic direction moves towards an integrated set of tools that remotely monitor and control the network, manage system outages, improve management of planned and emergency events, and optimise power-flow management, fault location analysis, fault isolation and restoration capabilities, even in complex scenarios with DER feeds into the network.

4. Operating context

This section provides an overview of our business, discusses feedback from our customers, and addresses the impact of the evolving energy landscape, changes in cyber security, and other trends influencing Power and Water's Operational Technology.

4.1 Overview of our business

Power and Water is a Northern Territory Government ('NTG') Owned Corporation (GOC) operating under the *Government Owned Corporations Act 2001* (GOC Act). As a multi-utility, Power and Water provides a range of electricity, gas, system control, water, and sewerage services. As the Network Service Provider (NSP) for the Northern Territory, Power and Water has responsibility for the three regulated electricity networks in the Northern Territory:

- The northern network, which services about 150,000 people and stretches from Darwin to the south of Katherine including Batchelor, Adelaide River, Pine Creek, Mataranka and Larrimah.
- The Tennant Creek network, which services about 7,000 people in and around Tennant Creek.
- The southern electrical grid, which services the Alice Springs area of approximately 28,000 people.

With our unique, complex operating environment and customer base, Power and Water is transforming into a more efficient, customer-focused and responsive organisation able to meet the needs of our customers and to support the economic growth targets of the NTG.

4.2 Technology trends

4.2.1 Cyber security

The Federal government has introduced legislative changes to improve the cyber security of critical infrastructure. With the amendments to the security standard under the *Security of Critical Infrastructure Act* ('SOCI Act') there is a heavy requirement to improve ICT and physical security. Developing a strong cybersecurity position to protect our IT/OT assets is a major priority.

4.2.2 Cloud computing

Northern Territory lags other states in its adoption of cloud computing, and is still yet to take full advantage of wide-spread technology that

- Offers scalable resources for data storage and analytics
- Provides potential redundancy of services with computing resources available outside of NT regions that are otherwise prone to cyclones, bush fires and flooding
- Enables rapid access to platforms and technology that are not readily available through NTG
- Introduces globally recognised top-tier security for infrastructure and services

4.2.3 Field worker mobility

Field worker mobility is a significant and growing trend in utility and transmission companies, driven by advances in technology and the evolving needs of the energy sector. This trend encompasses the use of mobile devices, applications, and technologies to enhance the efficiency, safety, and effectiveness of field workers who maintain, inspect, and repair utility infrastructure.

4.2.4 Analytics, big data and AI:

Energy companies are embracing analytics, big data and artificial intelligence for predictive modelling and decision-making. This includes analysing large volumes of data from smart meters, sensors, and other sources to optimize grid operations, forecast demand, and manage energy flow more efficiently.

4.2.5 Integrating OT with IT

In line with Power and Water's target operating model and utilising the Purdue Model, Power and Water is working towards a converged IT and OT to provide increased security as well as efficiencies in areas such as funding, procurement and project management.

4.2.6 Digitalisation of the network and Internet of Things (IoT)

Advances in technology, enabled by digitalisation, are changing electricity markets. Moreover, they are changing the way customers interact with the energy system and enabling more participants to enter the energy market. Energy services will be bought and sold in more dynamic ways, responding to consumer preferences and price signals, while new digitalisation in consumer technology is helping to maximise their return on behind-the-meter assets with minimal impact on lifestyles.

4.2.7 Communication network upgrades

Upgrading communication networks to support the increasing data flow and connectivity needs of a modern, intelligent grid. This includes adopting faster, more reliable communication technologies like 4G, 5G, and remote mobile internet connections like Starlink.

4.3 Feedback from our customers

We invited industry stakeholders to annual regional People's Panel and to the Future Network Forums in November 2021 and June 2022. That feedback clearly showed that our customers wanted us to facilitate the shift to renewables in the Northern Territory. Some customers – such as our Darwin People's Panel - thought we should go further by leading change on renewables directly. In summary, stakeholders wanted us to:

- Invest more now for a future which enables more solar in the system.
- Facilitate more efficient utilisation of network infrastructure.
- Prioritise affordability for households and businesses.
- Invest appropriately in long term maintenance of the network to ensure continued reliability.
- Maintainability and safety of supply.
- Shift energy production to renewables.
- Enable customer choice.

In addition to this feedback, we also know Customers are changing their network usage behaviours and patterns by increasingly leading investment in their own distributed generation and battery storage options.

- Customer's preferred communication channels have changed, with the growth and uptake of digital platforms by customers (e.g. web, mobile, and enhanced collaboration).
- Customers are becoming more aware of their own demands, thanks to an increasing number of smart meters on the network.

- Electric vehicle uptake is expected to increase - this could lead to demand increases from the distribution network in evenings when solar is unavailable[1].

In response to customer feedback, we changed our investment focus. In addition to network asset replacement, we will invest in our ICT systems, processes, and our people to benefit our customers, improve our asset management capabilities and find alternatives to traditional network solutions.

We will continue to test our approach with consumers as part of our engagement process each year.

4.4 Power and Water's corporate strategic priorities

Power and Water's strategic priorities are expressed in its statement of corporate intent. The Operational Technology Roadmap has been developed to support the following priorities:

- **1. Continue to evolve and implement our Operating Model reforms**. Without a well-functioning business equipped with the necessary tools and training and processes, all our best laid plans are in jeopardy... This work involves the development of systems to meet the compliance requirements of the NT National Electricity Rules**.**
- **5. Renewable energy** is where our future lies. As the electricity network service provider, the Power System Controller, the Market Operator and the provider of electricity in our remote communities, Power and Water must invest in the technology to ensure the electricity system is ready for the opportunities and challenges renewable energy brings.
- **6. Uplifting the standard of service in our remote communities**. As the operator of the water and electricity services in 72 remote communities across the Territory, Power and Water has a responsibility to work closely with government to find better ways of delivering and funding those services.

4.5 Electricity industry trends

Strategic trends are expressed in Power and Water's statement of corporate intent. The Operational Technology Roadmap has been developed in response to the following trends and opportunities:

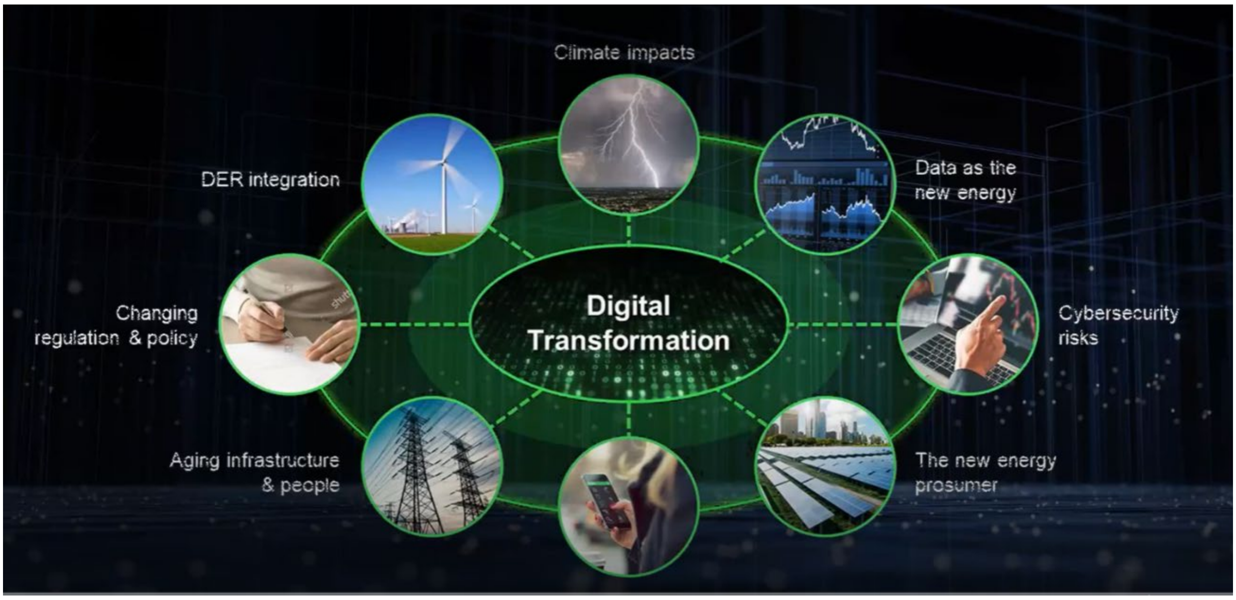
- **Regulation driving higher standards**. Regulation nationally is resulting in greater scrutiny leading to higher standards of performance.
- **Renewables integration into the energy grid**. The NTG has announced a 50 per cent renewable target by 2030. The NT's access to renewables presents an attractive proposition for mass-adoption, but it also poses key challenges to the security and stability of the local grid.
- **Energy storage and grid modernisation**. The growth of battery storage goes hand-in-hand with grid modernisation efforts including the transition to smart grids. Batteries help unlock the full potential of the new intermittent renewable energy generation.
- **Declining energy and water consumption per household.** The standard value offering for traditional utilities is weakening as households increase their energy and water efficiency. Combined with the falling cost of producing solar PV modules and the prevalence of smart technologies, this trend will accelerate moving forward.
- **Evolving customer expectations driving higher standards.** Service standards are increasing across all industry sectors and the NT community will continue to demand high standards from Power and Water.

[1] *Refer Section 2.4 Customer Expectations, ICT Strategy RCP24-29*

Improving efficiencies and responding to these expectations in an ever-changing environment is a major challenge.

- **Climate change**. Utilities face the highest combined physical risk from climate hazards like water stress, storms and bushfires. Extreme weather events are likely to become more frequent and intense as a result of rising temperatures, increasing the physical and financial impacts. Ensuring the climate resiliency of infrastructure is critical to limiting impacts.

Figure 4.1: Current Utility challenges driven by digital transformation



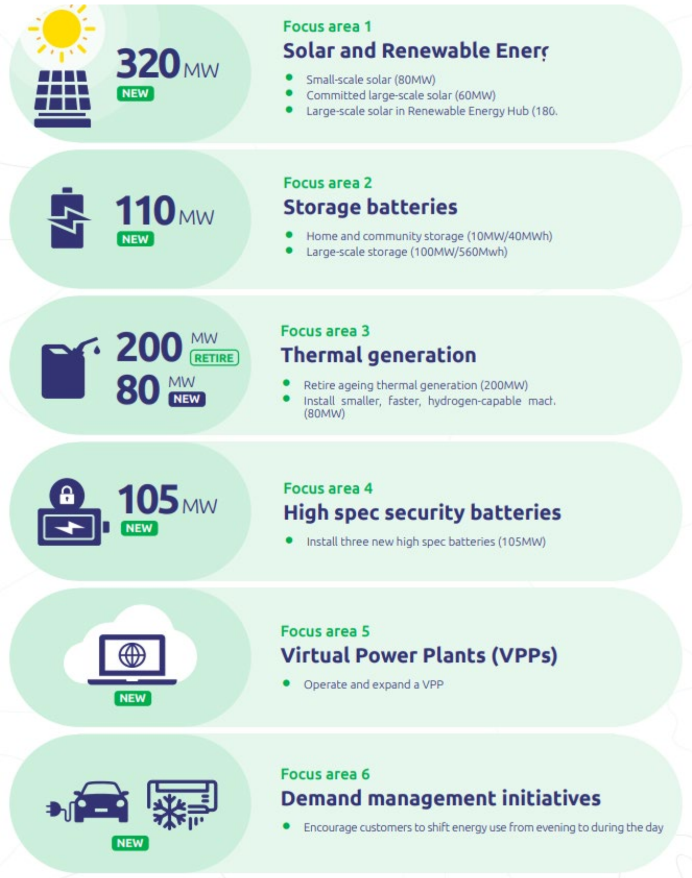
Source: Schneider Electric, 2023

4.6 Darwin-Katherine Electricity System Plan

The Darwin-Katherine Electricity System Plan provides a clear roadmap for how the Northern Territory will transition to a cleaner and more affordable energy future. Importantly, it outlines a range of key initiatives that will enable the Northern Territory to achieve its 50 per cent renewable energy target by 2030.

Investing in the right operational technologies will support the connection of the proposed Renewable Energy Hub, increase small-scale solar, enable virtual power plant capability (VPP), and help develop better ways of managing network demand.

Figure 4.2: Darwin Katherine System Plan focus areas



4.7 CSIRO and ENA Electricity Network Transformation Roadmap

The electricity network transformation roadmap prepared by the ENA and CSIRO recognises that the integrated network played a critical role to realise the full benefits to consumers, and that networks provide a service platform that responds to diverse customer needs. It highlights:

- Active network management – far greater levels of monitoring and control will be required to meet increasingly complex operational needs. This will require flexible systems with open communications and standards to permit new market entrants to participate.
- Network visibility – Third parties will interact with the grid in real time, responding to price signals or operational incentives. Those third parties will require real time access to a data monitoring and communications platform that is affordable, reliable and open.

The Critical Role of the Integrated Grid

The next decade to 2027 is likely to see a step change in the rapid adoption of new energy technologies, driven by falling costs and global carbon abatement measures. This decade provides a limited window of opportunity to reposition Australia's electricity system to deliver efficient outcomes to customers.

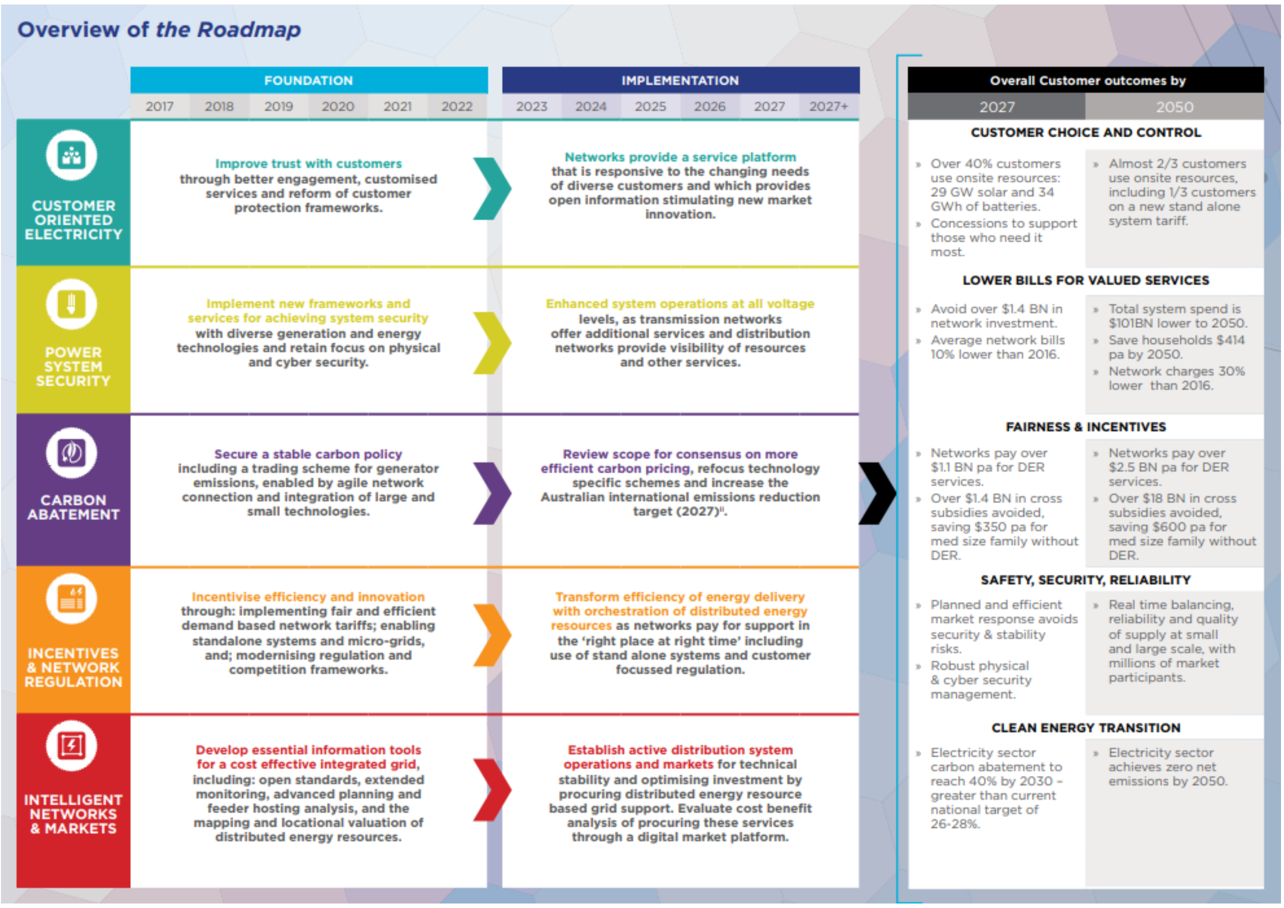
The agility with which networks connect, integrate and incentivise new, lower carbon energy choices will directly influence the cost, fairness, security and reliability of the electricity system for customers. Urgent regulatory and policy changes will be required to maintain power system security, while reducing customer costs by enabling the efficient use of distributed energy resources, stand alone systems and micro-grids. Timely development of technical standards and new platforms will animate new distributed energy resource markets and permit more efficient customer services and participation.

The right balance can be achieved

With a clear Roadmap, Australia's electricity sector can outperform current abatement targets, keep the lights on and deliver lower costs. Australia can increase the levels of both centralised and decentralised renewable and low emission generation sources enabled by transmission and distribution networks. Total system costs can be reduced by over $101 billion through network service platforms enabling distributed energy resources to participate in increasingly dynamic electricity markets. Together, the Roadmap activities can achieve a positive energy future for Australian energy customers enabling choice, lower costs, high security and reliability and a clean electricity system to 2050.

Source: ENA/CSIRO, Electricity Network Transformation Roadmap: Final Report (Summary), April 2017, page 3.

Figure 4.3: Darwin Katherine System Plan focus areas



Source: ENA/CSIRO, Electricity Network Transformation Roadmap: Final Report, April 2017, page v.

5. Focus of immediate OT capability uplift

The following section outlines the systems that are in scope for the uplift of OT capability as it relates to the regulatory period of 1 July 2024 through to June 2029. In a future iteration it is expected that the scope will be expanded to include other systems and initiatives within Power and Water that affect OT.

5.1 Existing systems (in scope)

The following existing systems and their data form the basis of this roadmap.

Table 5.1: Summary of existing systems and status in Roadmap

Existing System	Status in Roadmap
Energy management System (EMS) - Control software used by system operators that interfaces with SCADA to enable monitoring and control of the transmission network, including connected generation. The EMS is used to guide high voltage switching operations in a safe manner.	Software and hardware upgrade project currently in execution. Forecast completion by 2025.
Geographical/Geospatial system ('GIS') – provides a platform for the geospatial representation of the distribution network, including asset nameplate and status information. GIS enables system controllers and field operators to draw a link between assets in our systems / schematics and physical assets out in the field.	**RCP 24 – 29 OT Uplift: To be upgraded through OT Uplift business case.**
SCADA – Physical sensors and controllers deployed on high voltage network devices such as transformers, substations and switches. SCADA enables system operators to monitor and control the distribution network via EMS. SCADA is connected to Pi – a system that visually graphs sensor and time series data.	No change to software. EMS project is upgrading the servers that operate Scada. OT uplift will make use of SCADA data.
Works and Asset Management ('WAMS') – Maximo: a system that enables the planning and scheduling of staff and resources to efficiently maintain assets, plan field work, and manage supplies and materials.	System functionality changes are out of scope **RCP 24-29 – OT Uplift: integrations between WAMS and GIS are in CIM.**

5.2 New systems introduced in RCP 24-29 OT Uplift (in scope)

The following systems / capabilities are planned in the OT Uplift business case.

Table 5.2: Summary of new systems/capability and status in Roadmap

<table>
<tr><th>New System / Capability</th><th>Status in Roadmap</th></tr>
<tr><td>

Base Distribution Management System ('Base DMS') - While the EMS provides monitoring and control of the high voltage transmission network, a DMS deals specifically with the medium voltage distribution network that delivers electricity to homes and businesses. The goal of a DMS is to improve reliability by reducing power outages and minimising outage time, while maintaining acceptable frequency and voltage levels. To achieve this, it typically includes functionality such as switching schedule & safety management, voltage state estimation, fault location isolation and service restoration (FLISR), and dispatch management.

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RCP 24-29 - OT Uplift: Base DMS integrations, data and functionality.

A full DMS includes an outage management system (see OMS), however this is out of scope for RCP 24-29 and will require its own business cases in the future.

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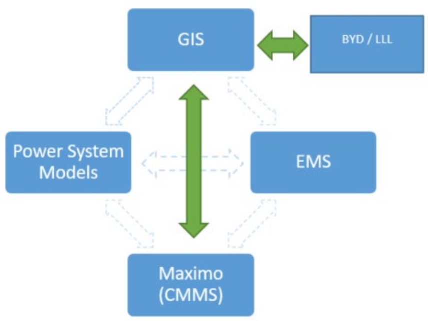
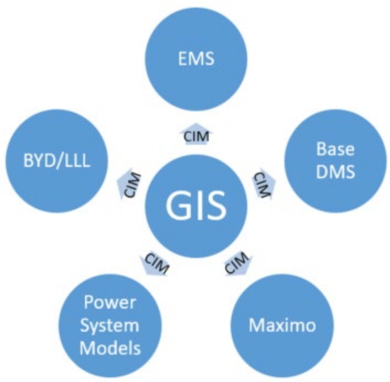
Common Information Model (CIM) – describes power utility network data in terms of common elements and their attributes. The elements related to network assets are replicated in different data systems (GIS, EAM, SCADA etc), with each system holding a combination of attributes that are shared between systems (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 it a non-trivial problem to map them to each other.

Today – Only 1 system integration – all other processes are manual



Tomorrow – all integrations become systemised, reducing human error and improving timely data flows



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RCP 24-29 - OT Uplift: Data mapping, followed by a system integration & data alignment exercise.

This will identify the means by which data is exchanged between systems and implement workflows cascade changes from the source of truth through to secondary data repositories in other systems.

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5.3 Possible future systems (Out of scope)

The following systems may or may not be included in a future roadmap. If included in a future version of the roadmap then they will require their own business cases. They are mentioned here because the roadmap must remain cognisant that they may be implemented in the future.

Table 5.3: Summary of possible future systems/capability and status in Roadmap

New System / Capability	Status in Roadmap
Advanced Distribution Management System ('ADMS') - An ADMS encompasses all functionalities of a traditional DMS but adds advanced features like integration with Distributed Energy Resource Management Systems (DERMS), which manage the flow of energy from various distributed energy resources (like solar panels, wind turbines, and energy storage systems), and supports more advanced analytics, grid optimization, and demand response management. These systems are designed to handle more complex grid environments and support the integration of renewable energy sources.	Out of scope
Outage Management System ('Distribution OMS') – Enables a rapid and safe response to network faults by combining outage reports from customers with a connectivity model of the distribution network that has the location of protective devices. Using the connectivity model, an OMS can help predict the location of outages and plan restoration activities. Power and Water has installed Inter-Control Centre Communications Protocol (ICCP), which can be utilised to feed SCADA information into an OMS with limited additional investment in the future. *Note: Distribution outage management differs from participant / generation outage management, which would form a function of a future dispatch engine. Dispatch OMS is to assist Power and Water with outages in its own network, while Generation OMS is to assist with balancing forecast energy generation against demand.*	Out of scope
Dispatch Engine (DE) – An energy market system that balances supply and demand in real-time by dispatching additional generation when required, ensuring the reliability and efficiency of the power system and facilitating the introduction of more participants onto the energy network. DEs often includes matching supply and demand, economic dispatch, merit order, network constraints, and real-time and day-ahead markets.	Out of scope
Low Voltage monitoring equipment – Combined with smart meters provide an opportunity for greater visibility of behind-the-meter (BTM) energy generation. Communications is typically via GSM 4G, fibre optic cabling or RF.	Out of scope

6. Focus areas and initiatives of the Roadmap

The following section outlines the broader focus areas and initiatives that relate to the current version of the Roadmap. In a future iteration it is expected that the scope will be expanded to include other systems and initiatives within Power and Water that affect OT.

We have adopted four key focus areas

1. Replace legacy, out of support systems
2. Develop network visibility and improve hosting capacity
3. Build a robust data platform
4. Implement improved distribution operations

For each of these focus areas, there are multiple initiatives as detailed below.

6.1 Focus area 1 – Replace legacy, out of support systems

6.1.1 EMS replacement / upgrade

The EMS hardware and software projects are delivering an upgrade to the newer AEMS platform by GE. Primarily on a risk- and efficiency-basis, a direct upgrade to a modularised platform which also offers OT capabilities is favourable to Power and Water. PWC obtains a range of benefits such as:

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

This roadmap is dependent on the delivery of the EMS Upgrade, as it affects assumptions on the timing, hardware and integration of other initiatives, particularly on the common information model, and other data-enablers.

6.1.2 GIS replacement / upgrade

The GIS is needed to maintain PWC network master data and the connectivity model to maintain current levels of reliable, safe and cost effective electricity supply to customers. The vendor will no longer provide upgrades, software patches or hotfixes past extended support ending 2026. Our GIS version will be 3 years outside of extended vendor support by the end of regulatory control period 2024-29. Risks include:

- Increased Cyber security risks associated with the corruption, un-authorised access, or loss of network data due to security not being updated to meet modern cyber security threats.
- Risk of network reliability service performance reduction as bug fixes and operational outage support are unavailable, leading to longer down times.
- Interfacing enterprise business systems no longer able to integrate with GIS.
- Public safety risks where information not readily available for Dial-Before-You-Dig and Look up and Live services.

Consequently the GIS and supporting services will need upgrading before end of financial year 2026 to maintain its functional and technical capabilities within PWC.

NOTE – The latest versions of GIS require a migration from the geometric model to a unified model. This is an initiative covered in Focus Area 3

6.2 Focus area 2 – Network visibility and hosting capacity

In Australia, there is a lot of interest in the development of Dynamic Operating Envelopes (DOE) to support distribution network operations. ARENA, the Australian Renewable Energy Agency, has set up a formal work stream[2] to understand the issues that DNSPs are facing and to develop principles for DOE engines.

Similarly, network service providers are developing capabilities to improve the information on the operation of the electricity distribution network, and connected customer devices including DER. This ultimately extends to functions described as a Distribution System Operator (DSO).

We will look for opportunities to improve our understanding and experience with the changing complexity of our network, including the role of DER and consumer preferences. This includes participation in the Alice Springs Future Grid project.

6.2.1 Network visibility

Power and Water will invest in building capability for network visibility tools to support decision making, business cases and strategy development.

- **Smart Meter Data -** Initially utilising manual data transfer functions, GridQube will implement a Time Series Data Store and Graphical Interface to enable Power & Water employees to easily access Smart Meter Data including where available, Solar Export.
- **Low Voltage SCADA -** Front of field device installs for remote control and monitoring of LV field devices
- **Network Visibility – State Estimation Engine.** Our network model data will be imported into a Network Model Store. This electrical model of the network will be combined with 'meter data' to enable the following:
  - (i) Capacity Constrained Optimisation (CCO) engine – The rules associated with DOE
  - (ii) Constraint Analysis (CA) engine – manages physical and operational constraints of the network
  - (iii) Distribution System State Estimation Engine (DSSE) – determines the underlying network output (performance) utilising a wide variety of "incomplete" data from the network

6.2.2 DER integration management to improve hosting capacity

These functions will assist our ability to safely integrate greater DER into our network. DER integration will involve implementation of Dynamic Operating Envelopes (DOEs) to provide greater flexibility in how to enable customers to participate in a DOE-based network management scheme and allow for the maximum technically feasible allocations. DOEs will be targeted to maximise the additional export (generation) and import (load) the network can accept at any one time without breaching any of the specified technical and operational limits.

This will require close working relationship with consumers and the industry to understand expectations and preferences to ensure a safe, reliable and secure electricity network.

[2] https://arena.gov.au/knowledge-bank/deip-dynamic-operating-envelopes-workstream-national-regulatory-and-policy-design-issues/

6.3 Focus area 3 – Build a robust data platform

6.3.1 Upgrade from Geometric model to Unified Network model

Upgrading GIS also requires a transition from the geometric network model developed in the 1990's to the Utility Network model. The existing geometric model will only be supported by the current PWC version of ArcMap 10.8.2 and no further releases. ArcMap 10.8.2 is no longer generally available to industry, and extended support will cease in 2026.

The Utility Network model provides a rich type classification system to help represent every type of utility feature. [3] This assists with specifying network connectivity rules, symbolizing features, tracing, and much more functionality.

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.

The upgrade keeps the graphics more or less as they are today and adds in the new elements, such as terminals, needed for the UN and any future ADMS integration to function inside the ArcFM framework. Benefits include:

Reduce/avoid increased maintenance costs associated with un-supported software;

Reduce interoperability risks associated with unsupported interfaces between core enterprise business systems.

Reduce impact on our ability to deliver essential services to Territorians through safe, reliable, cost effective and secure electricity supply.

6.3.2 Data Alignment and Mapping applying a Common Information Model (CIM)

The Common Information Model (CIM) describes power utility network data in terms of common network elements and their attributes. The elements related to network assets are replicated in different data systems (GIS, EAM, SCADA etc), with each system holding 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.

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

Power and Water have determined that the GIS should be established as the one 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 data attribute are populated from the source of truth.

This alignment requires a mapping exercise to determine the best source of truth 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 the means by which 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.

6.3.3 Information and data management & governance

Until data quality is successfully addressed, asset data represents a high operational and corporate risk. It is envisioned that asset and information management will continue as a focussed initiative for several years, to ensure that an end to end process is implemented and appropriate data quality governance and controls are in place and effective.

This includes a framework that defines the key controls of training, standards, policies, QA/QC, processes, accountabilities and the required organisational reform. Power and Water can use a data governance framework to support data uniformity across multiple operational platforms, reducing inefficiencies in handling and field safety risks from overlooked data or erroneous interpretation.

6.4 Focus area 4 – Implement improved distribution operations

6.4.1 Distribution management

The importance of maintaining the network operating models does not appear to be well understood. This ultimately comes back to relying on operator skill and experience. The 'single point of failure' in the network operation and outage management functions is the operator decisions/presumptions around data. A greater level of sophistication for managing the changing state of our electricity network in an increasingly complex system is required.

Penalties around outage times are expected in the near future (as they have been introduced for the East Coast DNSPs). Operators currently manually enter outages and record data, which requires a greater level of automation.

6.4.2 Develop system evolution plan to enhance interaction

Each of the system upgrades/enhancements will require a minimum level of integration, particularly in relation to sharing of data. For example, the DOE will begin on the periphery of the network, due to the algorithms working from BTM data. However, as the capabilities of DOE are better realised across the distribution and perhaps transmission networks, particularly around DER sites, DOE will need greater integration with other OT systems.

Once greater vendor information becomes available, and the minimum requirements can be determined for Power and Water a more comprehensive OT evolution and systems integration plan can be developed. This will consider the role of functions such as OMS/ADMS into the future evolution plan.

6.5 Indicative timing

The indicative timing is provided in the table below, organised by regulatory period. Specific investments are subject to their own business case, with scope and timing to be determined as a part of the normal project governance process.

Table 6.1: Indicative timing of initiatives by regulatory period

Focus area	Regulatory period 2019-24	Regulatory period 2024-29	Regulatory period 2029-34
5. Replace legacy, out of support systems	• EMS replacement	• GIS replacement	•
6. Develop network visibility and improve hosting capacity	• Network visibility tool	• Increase hosting capacity / DOE	• Increase hosting capacity / DOE
7. Build a robust data platform		• Unified network model • Common information model	• Information model and data quality
8. Implement improved distribution operations		• Base DMS • Develop system evolution plan to enhance interaction	• OMS/ADMS • Implement system evolution plan to enhance interaction

The above does not include business as usual activities associated with data updating, cleansing and other related improvement projects.

7. The OT challenge

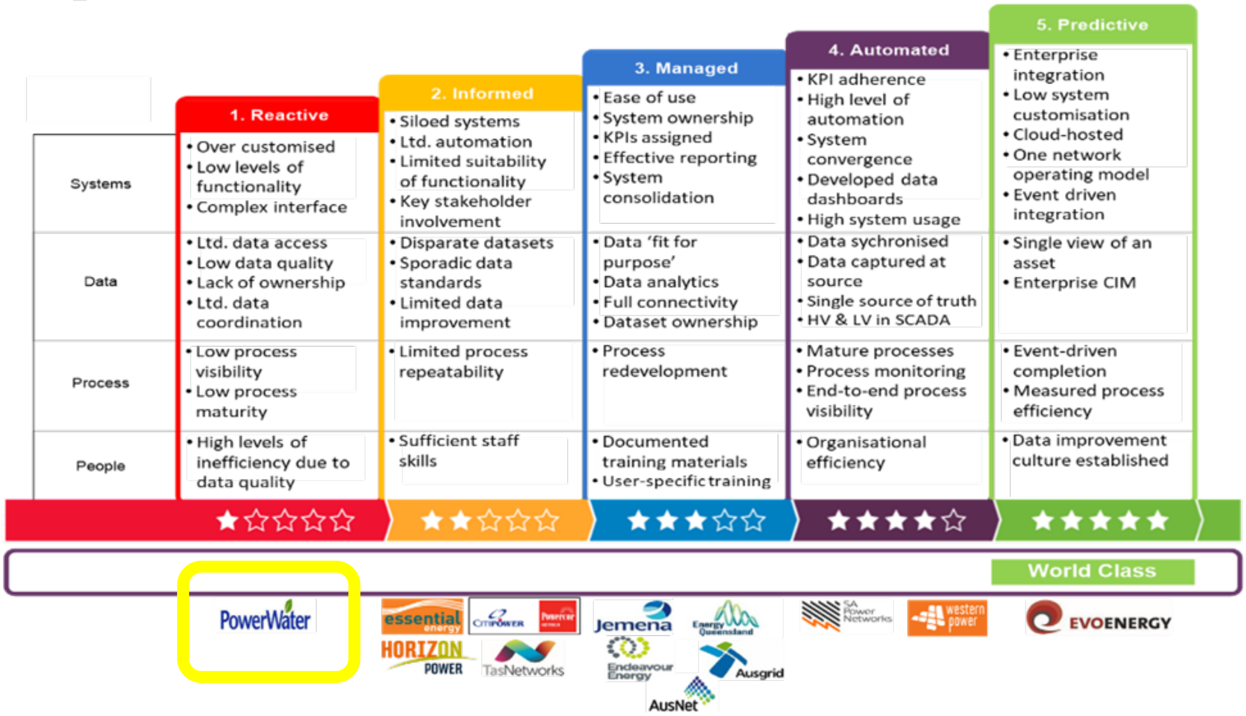
Power and Water are the last to establish a network management system, and the only Australian electricity utility still using pin boards. We do not have any standard distribution SCADA system, OMS and lack confidence in the data that supports the current systems.

7.1 PWC suffers from a lack of integration

Underlying this is the insufficient extent, accuracy and completeness of operational data. Not having a solid OT information platform also constrains the business from embarking on other initiatives such as effectively managing renewables or Electric Vehicles (EVs). In using the Carnegie Mellon University model to assess the maturity of the OT systems and asset data, PWC is currently rated as being 1.0 out of 5.0 and trails all the other Tier 1 Australian utilities.

In order to make the required improvement so PWC has a sufficient degree of automation and can for example manage renewables, PWC requires a rating of at least 3, with a plan to move towards 4.

Figure 7.1: Maturity of OT systems and asset data – benchmarking with Australian DNSPs



Power and Water's currently low score is based primarily on its predominance of manual systems, limited data quality and accessibility, and low process maturity. The reliance on manual systems, creating significant risks through dependencies on key resources, and through a lack of timely and quality information on the state of the network.

The pictures below of Power and Water's control room show the reliance on printouts of network schematics and pins to represent the distribution network.

Figure 7.2 – Power and Water pin boards for distribution management

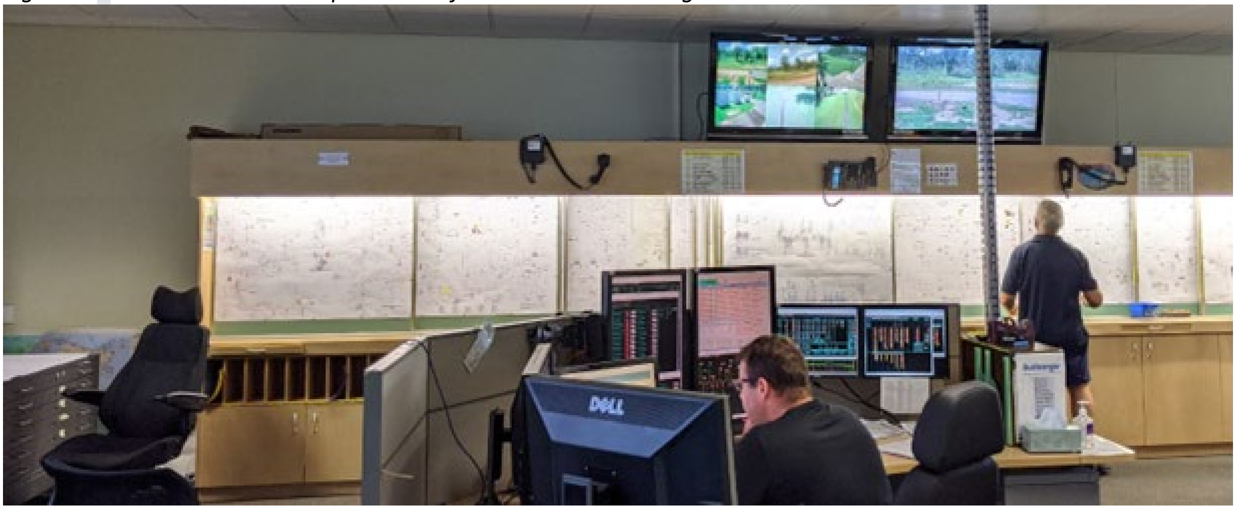
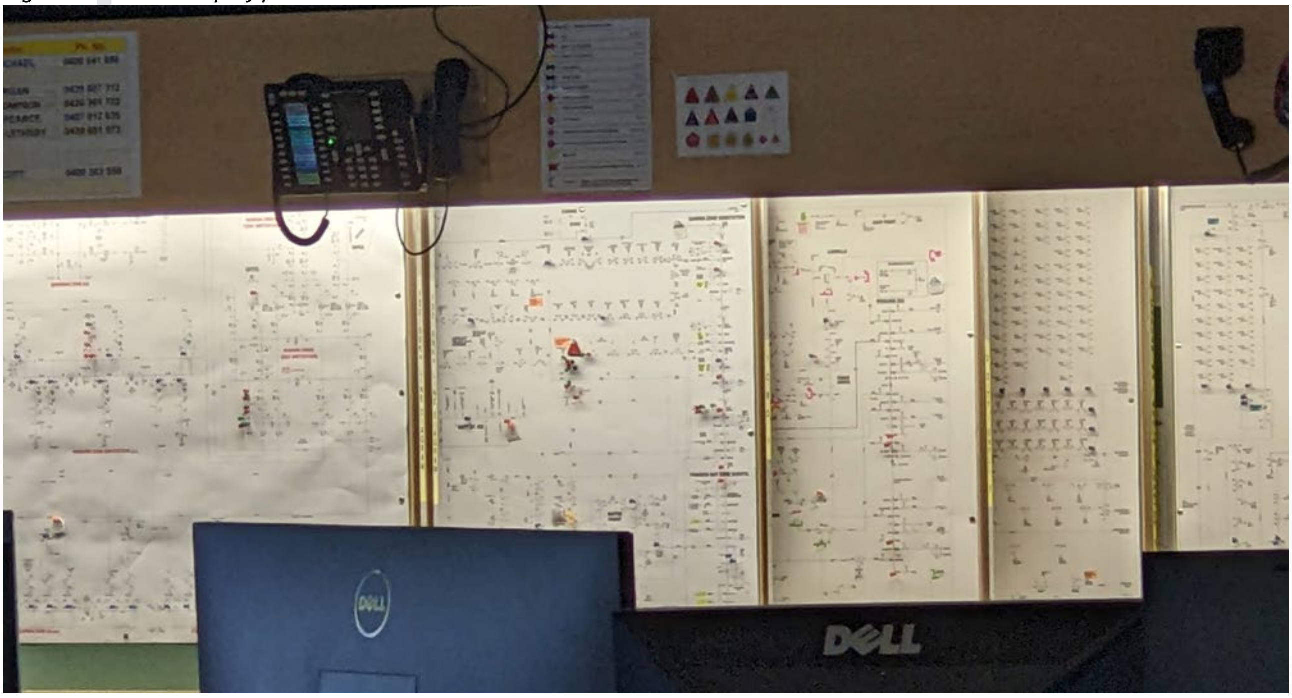


Figure 7.3 – Close-up of pin boards



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

7.2 Challenges from recent projects

The general perception is that PWC has system problems, however it primarily has data problems. If these were resolved it would make a significant difference to many PWC projects and BAU. The data problems affect network operations data, asset data, outage management data, customer data and some GIS data.

- PWC has received a reprimand from the Utilities Commission for its lack of outage information (i.e. such as reliable restoration times), and is the only Australian utility not to have an Outage Management System.

- PWC does not have a SCADA-controlled Low Voltage network, limiting distribution visibility
- Connective Network Model – could not achieve close to real time network configuration and status synchronised with the GIS System, including all switch and active devices.
- Customer Connection – insufficient maintenance of customer connection to the network model derived from RMS and Maximo and not ensuring customer information was correct and complete.
- Not ensuring the GIS system and underlying data was at a standard suitable for an OMS. This included issues such as pre-build and maintenance of switch status and open points.
- PWC has no effective way of managing the network beyond the meter as is increasingly required.
- OT and asset data is often not 'fit for purpose' (i.e. inaccurate, incomplete, duplicated, not easily accessible & not timely).
- PWC does not have a 'populated' enterprise data model (i.e. so assets are named & numbered differently in different systems).

These challenges must be kept in mind when planning and budgeting future implementation initiatives.

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