PowerWater

Future Network Readiness Plan: 2021-2024

What is the Future Networks Readiness Plan?

The Future Networks Readiness Plan outlines actions and initiatives that we can commence now to ensure Power and Water is in the best position to meet evolving customer needs.

In January 2023, Power and Water will submit our future plans to the Australian Energy Regulator (AER). These plans will include forecast expenditure relating to how Power Water Corporation (Power and Water) intends on preparing its distribution network to meet changing customer needs. The AER will expect these plans to be discussed with customers and supported by business case justifications and economic analysis.

Our investment plans will be informed by the Darwin-Katherine Electricity System Plan[1] which provides clear direction on how the Northern Territory will achieve its 50% renewable energy target by 2030, and importantly Power Water's role in supporting this direction.

Of particular relevance to Power and Water, is the need for transmission investment to support large scale renewable investment, and a new role for the network in providing Essential System Services. The Darwin-Katherine Electricity System Plan also indicates the likely need for network investment to support ongoing customer driven investment in small-scale renewables and battery storage, enable the doubling of small scale renewable generation, and the ability of the distribution network to cater for the uptake of electric vehicles and community batteries.

We recognise that if we are to have clear investment plans which enable the future system to work, we need to have a better understanding regarding the infrastructure, systems, and strategies required to:

- support the establishment of virtual power plants to efficiently coordinate solar, batteries, and customer appliances
- determine the feasibility for deploying community storage and efficiently integrating greater uptake of solar and household batteries on the network
- transition from petrol cars to electric cars without the need for major network upgrades
- better manage network demand to improve the capability of the network to cater for two-way power flows on the network

Our Future Network Readiness Plan sets out how we intend on using funds available through the Demand Management Innovation Allowance (DMIA) to explore innovative ways for fast tracking our preparations. This will integrate with other initiatives we plan to undertake now and into the future. We will also seek to partner with and leverage off other key projects, such as the Alice Springs Future Grid Project, to ensure our work fits into potential total system solutions.

We recognise that initiatives developed through the readiness plan will need to integrate with our broader strategic approach towards integrating small scale renewables, including consideration of the relationships between static export limits in connection contracts and supply agreements, tariff structures, investment in network augmentation and replacement, and investment to alleviate voltage constraints. The insights gained from initiatives under the readiness plan will help to inform and refine our strategic approach towards managing these issues and will enable us to develop expenditure options to engage with customers and stakeholders to better understand their expectations and preferences.

[1] Northern Territory Government, 'Darwin-Katherine Electricity System Plan: Cleaner, more affordable and secure electricity system by 2030,' October 2021.

Why do we need the Readiness Plan?

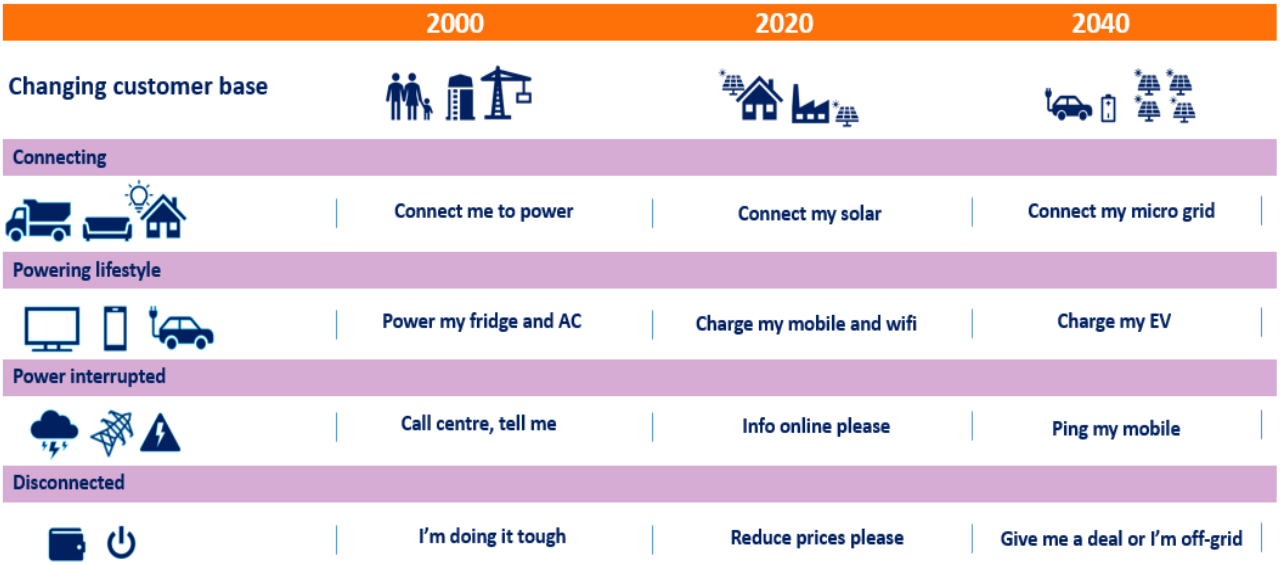
Power and Water's electricity network is currently built and designed to efficiently deliver reliable electricity to Territorian homes, businesses and industries, based on one way flows of electricity from traditional synchronous thermal generators. Our network design and configuration transports energy from centralised generation points at high voltages, with the flow of energy stepped down in voltage across the regulated networks (high voltage to medium voltage to low voltage) to accommodate different customer needs.

Our network is has reached a pivotal turning point, where it is necessary to refresh and rethink how we plan, design, build, and operate our network. Innovation, rapid changes in technology, and growing concerns over climate change are driving fundamental changes in the Northern Territory Electricity Market, and has revolutionised how customers use and consume electricity.

The last 5 years in particular, has seen a dramatic change in the way customers use (and now produce) electricity to enhance their lifestyle and offset their electricity bill. Figure 1 below, seeks to highlight how customer needs and expectations have changed and evolved over time, and how they are likely to continue to change, driven by new innovations and changes in technology.

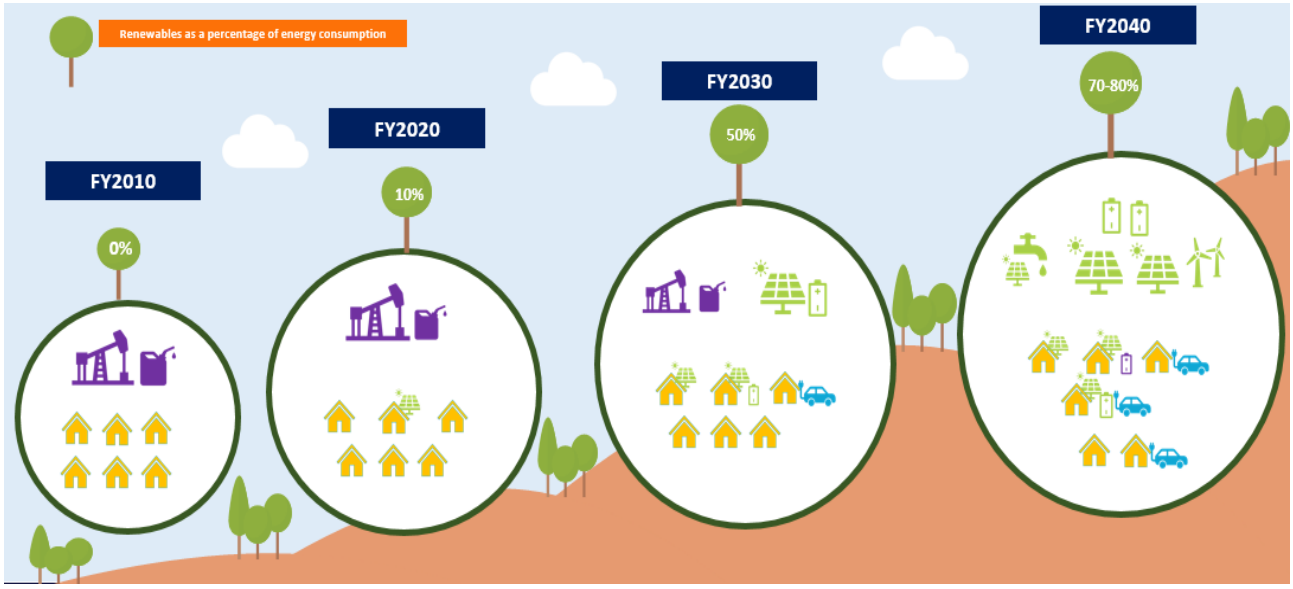
While the focus of today is on how to efficiently integrate more solar energy and transition to greater use of renewable energy, we anticipate that in the future this focus will likely shift to integrating batteries, microgrids and electric vehicle (EV) charging. Customer reliance on electricity is likely to rise and rapidly accelerate over the next decade – driven by de-carbonisation policies set by Government resulting in a combination of increased rooftop solar, the uptake of and household batteries, network digitalisation, and vehicle electrification.

Figure 1 - Evolving customer needs and expectations



The future is likely to see a more rapid transition to renewable generation sources in the Northern Territory as highlighted by Figure 2 below. Like other jurisdictions across Australia and around the world, the Northern Territory is planning to transition to an energy system dominated by renewable generation. This transition is likely to be accelerated in the Northern Territory due to a significant proportion of gas generating units scheduled to be retired by 2026/27, with the Northern Territory Government signalling that these are unlikely to be replaced with fossil-fuel based technologies.

Figure 2 – Accelerating to a renewable energy system



At a localised level, the power system is also likely to experience a significant increase in customer installed solar PV to complement large scale generation. This will provide considerable benefits for customers who install their own generation, and for all Territorians, due to the potential for excess solar PV generation to be exported back into the grid and used by other customers.

It is imperative that we change and adapt our network to meet these changes and trends to ensure that Power and Water continues to meet the needs of Territorians and deliver valued services both now and into the future.

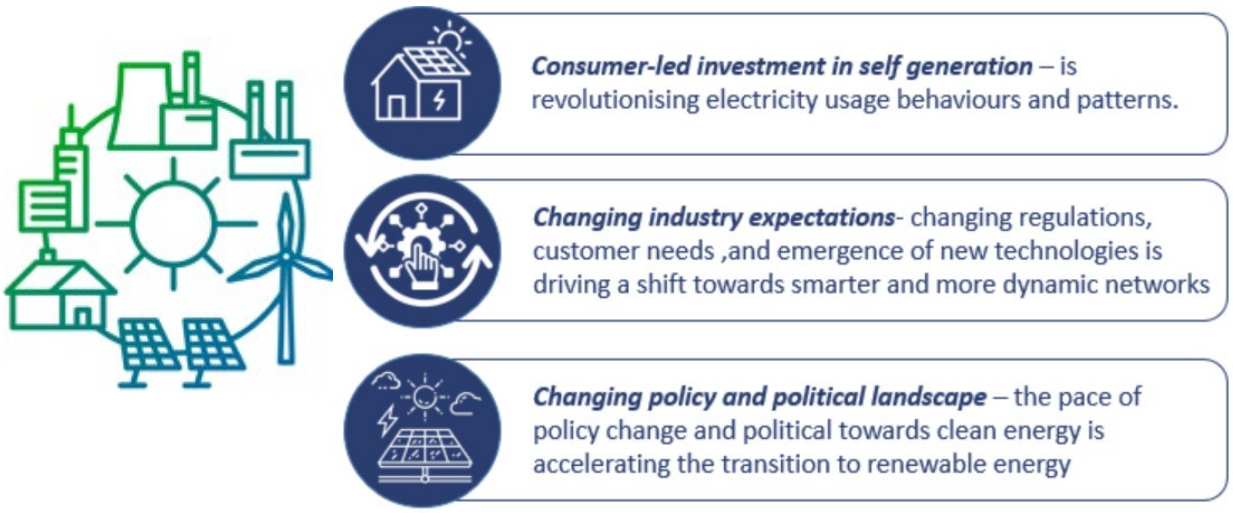
To do this, we need a longer term investment strategy to unlock the benefit of increasing customer installed solar generation in a manner which optimises network infrastructure ability to manage two way electricity flows. Our plans cannot lose sight of other customer driven changes on the horizon and must be flexible and adaptive to accommodate future changes.

Managing customer supply quality and efficiently enabling two way power flows on an evolving power system are challenges that all distribution networks are currently trying to address. However, few networks are faced with the same pace of change which is occurring in the Northern Territory. The agility of our network to adapt will be a key determinant in the Northern Territory's success towards transitioning to a renewables future. Delays in our ability to host increasing capacity of renewable generation will delay necessary investment as well as customer and private sector interest.

What is driving the pace of change?

The Northern Territory energy system is experiencing rapid change, which is being driven by increasing consumer investment in distributed energy resources (DER), changing industry expectations, and changes in the political and policy landscape.

Figure 3 – Key drivers for network change



Each of these drivers is discussed in further detail below.

A consumer-led energy revolution

The Northern Territory power system is becoming more decentralised as more small-scale energy systems connect to the grid. Households and businesses are becoming more interested in the energy transition either because they are taking control of their energy use or adopting new technologies. Nearly one in four dwellings in the Northern Territory currently has a solar PV system[1] and this is likely to rise. Emerging technologies, such as battery storage and electric vehicles are also forecasted to increasingly enter the mix and change the profile for electricity use in the Northern Territory.

As increasing numbers of customers purchase these technologies, our electricity networks must evolve to effectively incorporate two-way flows and make the grid more integrated and dynamic. Without doing so, many benefits from the growth in customer owned solar power will not be unlocked, or if left unmanaged could have a detrimental impact on the way electricity networks function. Electric Vehicles is another technology that will place greater demands on local areas in the network which will need to be planned and managed without compromising the operation of the system and increasing the overall cost for customers.

Power and Water is committed to ensuring that existing and new customers are able to connect, operate, and access the opportunities available from these new technologies.

[1] See Australian PV Institute, Mapping of Australian Photovoltaic installations, as at October 2021

Changing expectations in the industry

The industry is at the forefront of adapting and evolving to unlock the opportunities presented by renewables. New technologies are being developed to increase the options for consumers to produce, store and use electricity. Consumers are actively influencing these technological advances by becoming more educated and engaged throughout the electricity supply chain and are increasingly making their preferences known.

Rules have recently been changed to ensure owners of solar PV systems have greater access to sell their excess electricity back into the grid[2]. Power and Water needs to be ahead of these reforms and keep pace with new technologies to accommodate the changing needs of electricity customers.

Northern Territory Government's vision for 50% renewable generation by 2030

The Darwin-Katherine Electricity System Plan, provides strategic guidance on the lowest cost pathway for the Northern Territory to achieve its 50% renewable energy target by 2030.

The plan firmly sets the Northern Territory on a path towards significantly decarbonising the power system to provide cleaner and more affordable energy to Territorians, and has direct implications for Power and Water in terms of how the distribution network will support the achievement of this goal.

Figure 4 – The Northern Territory Government's 50% Renewable Energy Target[3]

[2] AEMC, Access, pricing and incentive arrangements for distributed energy resources, Rule determination, 12 August 2021

[3] Northern Territory Government, Darwin-Katherine Electricity System Plan: Cleaner, more affordable and secure energy system by 2030, October 2021, p 6.

Prerequisites for future network planning and expenditure

Our Future Network Readiness Plan (Readiness Plan) seeks to identify key network characteristics and capabilities needed in the immediate term (next 2 years). The outcomes from initiatives outlined in the Readiness Plan will be used to help inform the types of short term investments required during 2024-29 to support the Territory's transition to renewable energy and ensure that we are able to deliver valued services to Territorians now and into the future.

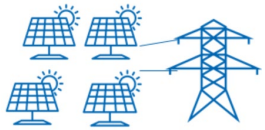
The Darwin-Katherine Electricity System Plan concentrates on providing strategic guidance and recognises the need for co-operation across the supply chain to ensure large scale renewables can be efficiently integrated into the electricity system. While Power and Water expects to play an important role in working with government and stakeholders in fast-tracking transmission investment and enabling grid scale battery connection and integration, our Readiness Plan predominately focuses on the distribution network's role in:

- unlocking small scale renewables
- small scale battery integration
- demand management
- electric vehicle (EV) readiness.

Table 1 below, provides a summary of key focus areas from the Darwin-Katherine Electricity System Plan which have direct implications for Power and Water's distribution network. Focus areas highlighted by red boxes in Table 1 are intended to indicate Darwin-Katherine Electricity System Plan focus areas which the network focus areas listed above are intended to support.

There is an onus on Power and Water to ensure its investment plans for the next regulatory control period (2024-29) includes an appropriate level of investment to deliver the outcomes outlined in the Darwin-Katherine Electricity System Plan. To ensure these plans are appropriately prepared, we believe important work needs to be undertaken now. This is to ensure that our plans are robust, our understanding of the investment need is clear, and our justification on economic and technical grounds for investment is capable of satisfying to customers and the AER that our proposed future network investments are prudent and efficient.

Table 1 - Key implications from the Darwin Katherine System Plan

Darwin-Katherine Electricity System Plan Focus Area[4]	Key Implications for Power and Water		
	Task	**Opportunity**	**Future Network Need**
1) Connecting large renewable hub – 180MW large –scale solar, 100MW large scale  batteries	Work with Northern Territory Government to better understand Power and Water's role in building transmission works to connect the proposed renewable hub to our existing transmission line between Channel Island and Hudson Creek.	Establishment of a dedicated renewable hub means that generators will have access to spare capacity on the existing transmission network, maximising generation potential and has the potential to reduce connection costs to the network.	Establishment of the Renewable Energy Hub by 2025 will require significant implementation given the long lead times for construction and complexity in how to best fund the investment.
2) Increasing small scale renewables - Install 80 MW of small scale solar and 10MW of household batteries 	Developing a strategy to enable Power and Water to activate 80 MW of additional small scale solar and 10MW of household batteries in a manner that is secure for the network.	Facilitating customer choice to install low cost sources of renewable energy that can meet future higher demand without the need for upstream infrastructure such as transmission lines.	Ensuring the network can manage two way flow of electricity securely as the number of small scale renewables increases. Managing minimum demand and other impacts of two way flows on voltage and system strength on the network.
3) High spec security batteries – Install 3 large scale security batteries (105MW) to reduce reliance on thermal generation	Work with Northern Territory Government on the regulatory arrangements, and to provide additional advice on whether any other network issues may arise.	High Spec batteries will mean the network is able to better meet network security and system strength. Further, the plan to install a second battery in 2024 will increase the operating limits of the Darwin-Katherine transmission line, allowing Power and Water to increase the	There is some evidence to suggest batteries can provide inertia, but its capability has not been proven as yet in the Northern Territory. For this reason, some level of risk mitigation may be required if the expected potential does not arise.

[4] Focus areas are based on the 'Seek Different' scenario in the Darwin-Katherine Electricity System Plan.

Table 1 - Key implications from the Darwin Katherine System Plan

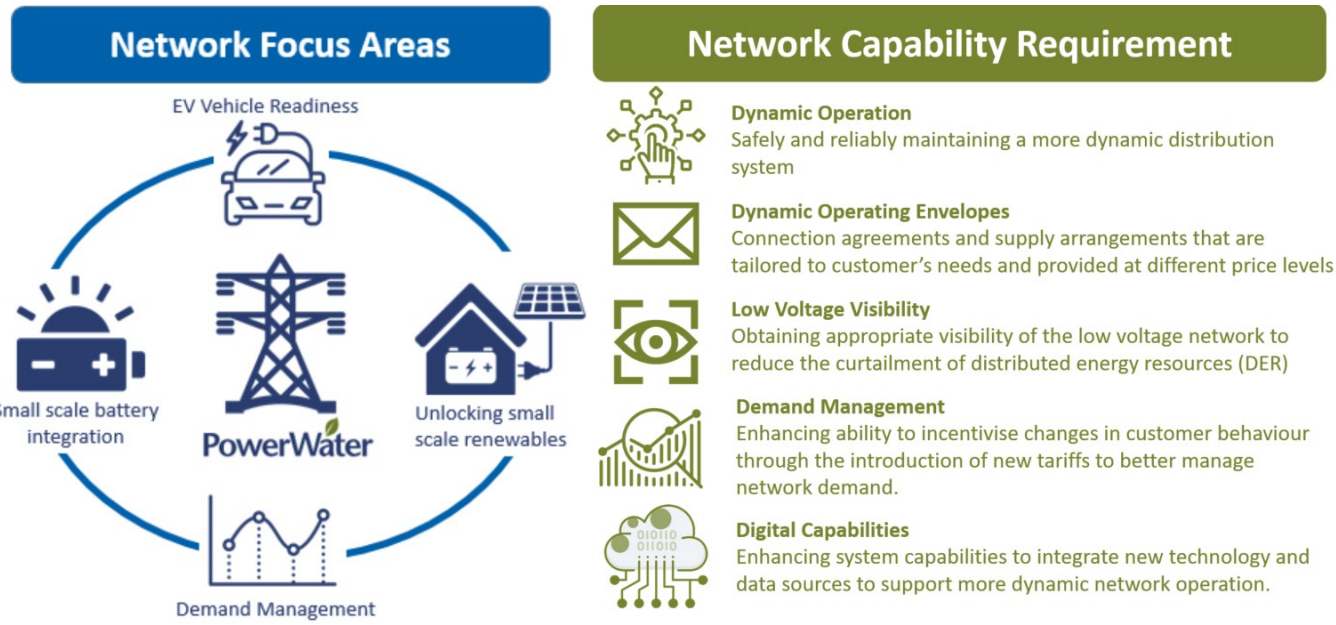
Darwin-Katherine Electricity System Plan Focus Area[4]	Key Implications for Power and Water		
	Task	**Opportunity**	**Future Network Need**
		energy sent out from the committed generators on this line.	
			
4) Develop Virtual Power Plant (VPP) capability –allow for better coordination of solar and batteries 	Work with Northern Territory Government on facilitating the necessary data to support VPP arrangements.	The ability to coordinate small scale solar and batteries, and large loads such as EVs in a way that improves utilisation of the network. This could help with managing minimum demand issues and helping to meet peak demand on the system in the late afternoon and evening period.	The virtual operation of one, or a thousand, small scale power plants requires networks to first understand in near real time any potential constraints that may inhibit actual flows and an agreed approach to how these constraints are communicated. Network requirements will need to be considered when thinking on the best model for a VPP in the Northern Territory, given the relative small scale of the power system.

Table 1 - Key implications from the Darwin Katherine System Plan

Darwin-Katherine Electricity System Plan Focus Area[4]	Key Implications for Power and Water		
	Task	**Opportunity**	**Future Network Need**
5) Develop demand management incentives – The Darwin-Katherine Electricity System Plan identifies the need to encourage customers to shift demand into the middle of the day when low-cost solar generation is at its peak. 	Work with stakeholders on viable demand management activities to shift demand to the middle of the day including network pricing signals that directly incentivise customers to use energy in non-congested periods on the network.	This could help activate more small scale solar in the day (that would have been not used), and would also assist with increasing daytime demand on low demand days. Combined with greater orchestration, this could maximise the efficiency of renewable resources.	This would require incentives including stronger time of day pricing signals, and this would require significant support from our customers and industry stakeholders. New technologies such as electric vehicles may offer part solutions.

We are aware that the existing state and capability of our electricity network is not 'fit-for-purpose' for achieving these objectives and responding to key market and customer drivers. Figure 5 below, highlights the key capabilities and knowledge that we need to build over the coming years to inform the least cost and 'no regrets' investment pathway for delivering the objectives of the Darwin-Katherine Electricity System Plan and ensuring that we continue to meet the needs and expectations of our customers.

Figure 5 – Power and Water's Future Network Focus and Network Capability Requirements



Leveraging our existing capability

Power and Water's progress towards developing future network readiness

There are a number of existing initiatives that Power and Water has facilitated or contributed to that help to support our future network capability. To date, work has primarily focused on undertaking modelling analysis to understand future impacts on the network and through the Alice Springs Future Grid project[5]. The Alice Springs Future Grid project in particular acts as a significant opportunity for Power and Water to collaborate and leverage off key findings.

The Alice Springs Future Gird project is a two-year initiative to enhance renewable energy capability developed in the Alice Springs network and shared to other grids and jurisdictions. Projects and sub-projects target a transition towards a robust, dynamic and renewable future grid with a focus on:

- modelling and future grid capability
- microgrid feasibility and trialing
- distributed energy resource (DER) integration and capability to deliver services either through community solutions or orchestration and aggregation

[5] More information on the Alice Springs Future Grid project can be found by accessing the following link: https://alicespringsfuturegrid.com.au/about

Although existing initiatives will assist Power and Water in building its capability and future network readiness, there is more that needs to be done to establish the necessary network characteristics and capabilities to enable Power and Water to transition towards becoming an enabling platform capable of adapting and responding to external changes and supporting the Northern Territory's transition to a cleaner and more affordable energy future.

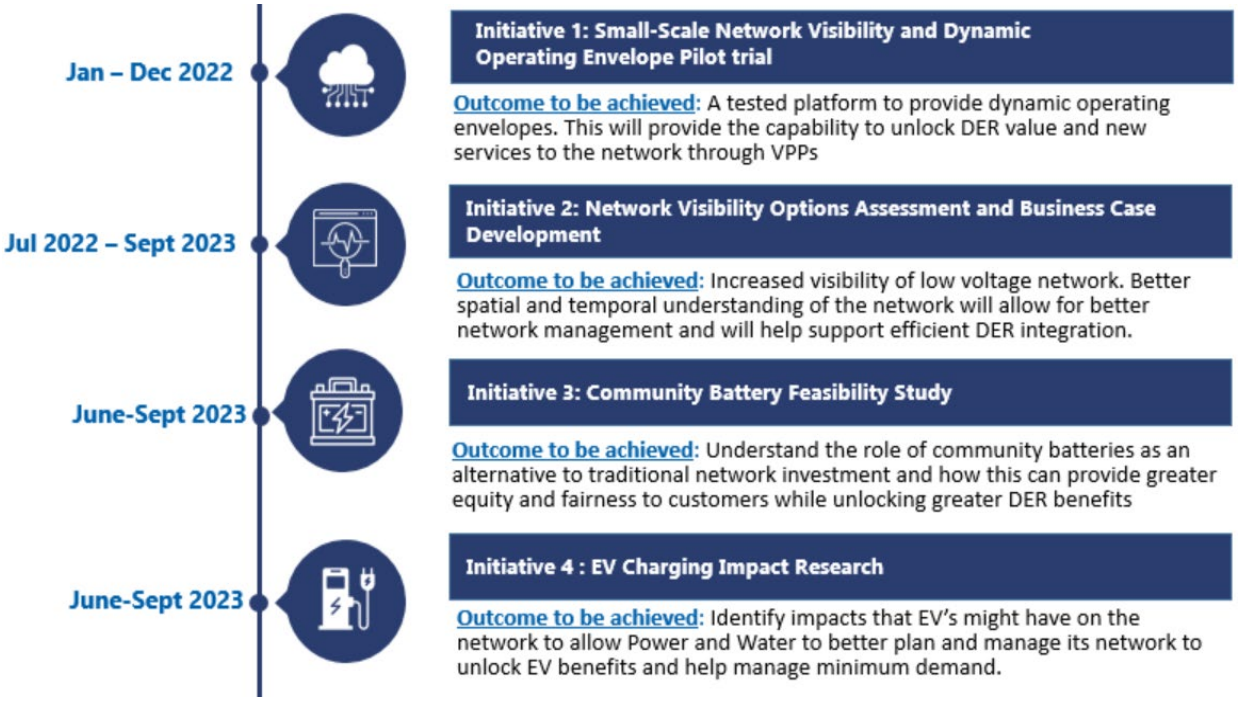
Readiness initiatives

In the immediate short term, Power and Water has initially identified four initiatives which we will seek to fund under DMIA arrangements. These include:

- a Small-Scale Network Visibility and Dynamic Operating Envelopes (DOE) Pilot Trial;
- Network Visibility Options Assessment;
- Community Battery Feasibility Study; and
- EV Charging Impact Research

These initiatives will support other strategies around metering, demand management and tariff reform in providing the right settings to support the efficient integration of DER and better manage network demand.

Figure 6 – Overview of readiness initiatives and timing



Next steps

We intend on rolling-out our Readiness Plan over the next few years. Customers and interested parties will be able to engage throughout the process either through accessing documents published online for knowledge sharing purposes, or through targeted and facilitated engagement. Insights gained from these readiness initiatives will be used to help inform our future network expenditure requirements. More information on the engagement process will be available early to mid-next year.

Initiative1: Small-Scale Network Visibility and Dynamic Operating Envelope Pilot Trial

Objective

Power and Water will assess the capability of its current systems to interface with available data sources. Working with technology partners, we will integrate these data sets and attempt to convert this into a near real time operating state of the network.

Description

Initial work will be undertaken to establish a proof of concept using small samples of data. If successful this will be expanded into a whole of network congestion and capacity assessment study which will identify early black spots of available data and data quality issues.

This work will help to identify the future focus of data acquisition as well as focus for congestion and constraint management.

We aim to work with a range of stakeholders and business partners to test the interoperability of real time visibility with future market interfaces. This project will integrate with market based work being trialled in the Alice Springs Future Grid.

Outcomes to be achieved

Achieve a better understanding of system capabilities and limitations in integrating data to provide near real time visibility of the state of the network to allow for more dynamic network operation and support network orchestration.

This work will help to inform what expenditure and solutions may require further exploration to expand network visibility and dynamic operating capability across the network more broadly to support the efficient integration and ability to aggregate small scale renewable energy to unlock the full value and benefits from these investments.

What is network visibility and why is it important?

A key to unlocking greater levels of small scale renewable generation lies in improving the accuracy of locating where and local generation causes potential problems for the safe and secure operation of the network.

Right now, Power and Water can't see the two-way flows of energy at the street level. And even if it could see the two way flows of energy, it cannot respond in real time if the two-way flows started disturbing reliable and safe energy supply up and down the street.

To avoid supply problems, across the network we constrain the amount of energy that can be exported from a solar system when it firsts connects – what is called a static limit. We apply this everywhere, but in some areas the static limits are becoming smaller.

We recognise that this is not sustainable long term, because as more solar is connected the risk of congestion increases, decreasing limits. Because we don't know exactly where and when the real problems are, we set these limits across the network, meaning that currently there are lost opportunities for more solar to be exported.

If Power and Water improves its visibility of the network capabilities and capacities in real time, it can limit its constraints to the locations and times that it knows problems will occur.

- ***Darwin-Katherine Electricity System Plan:*** *Focus Areas 2 and 4*
- ***Network Focus Area****: Unlocking small scale renewables and integrating small scale batteries*
- ***Network Capability Requirement****: Dynamic operation, dynamic operating envelopes, low voltage visibility and digital capability*

Initiative 2: Network Visibility Options Assessment and Business Case Development

Objective

If the pilot phase of initiative 1 proves successful, Power and Water will assess the performance of the network in real-time to inform more customer outcome use cases.

Description

We expect the potential use cases to include a more detailed understanding of the state of the low voltage network to support future renewable expansion, and priority areas for investment including improving data quality, export management (including community battery), demand management and EV charging capacity.

Work undertaken will be used to inform business case development and investment plans for the next regulatory control period, as well as potential pilots and trials over the next 2-5 years. During the initial phases of this initiative Power and Water intends on undertaking the following work:

1. Assess the current state of all data available to determine any gaps, identify potential errors, and improve overall data quality. This will be used to improve the accuracy and validity of Power and Water's future network visibility capability, as well as for planning and forecasting purposes.
2. Assess capability requirements to ensure that any future system can effectively integrate with other systems so that new data and technology can support network orchestration.
3. Develop a clear description of the network and its components to better support business case development for better network visibility and enable economic analysis of different investment options.
4. Perform an options analysis to determine the best approach to implementing network visibility across Power and Water. The assessment of each option will quantify potential use cases, including the potential to alleviate minimum demand issues at the low voltage level and provide capability for DOE and controlling DER assets.

Outcomes to be achieved

A better spatial and temporal understanding of the network will support more efficient integration of renewables and adoption of new technology. This will allow Power and Water to better manage and plan its network. Key learnings and insight from this work will be used to:

- help inform future network expenditure needs
- options analysis to identify the 'no regrets' investment required to support greater uptake of renewables at the least cost to customers
- the development of robust business cases for undertaking the investment which satisfies customer and AER expectations.

- ***Darwin-Katherine Electricity System Plan:*** *Focus Areas 2, 4, and 5*
- ***Network Focus Area****: Unlocking small scale renewables, integrating small scale batteries, demand management and EV readiness*
- ***Network Capability Requirement****: Dynamic operation, dynamic operating envelopes, low voltage visibility and digital capability*

Initiative 3: Community Battery Feasibility Study

Objective

This initiative will provide a better understanding of the feasibility for community scale batteries to deliver network and non-network services to enable Power and Water to more efficiently manage two-way flows of electricity on its network.

Description

Community batteries have the potential to play a significant role in addressing key challenges associated with the Northern Territory transitioning towards the greater uptake of renewable energy. In particular, we envisage that community batteries will play a significant role in managing the security and reliability of the Northern Territory power system while reducing network costs.

Through uncovering the various benefits of community batteries, where they can be best placed in the network, and how to operate the battery to achieve the optimal outcomes available, Power and Water can take the next step towards harnessing the potential of community batteries to provide the most benefits to customers and contribute towards a more efficient, reliable and secure power system.

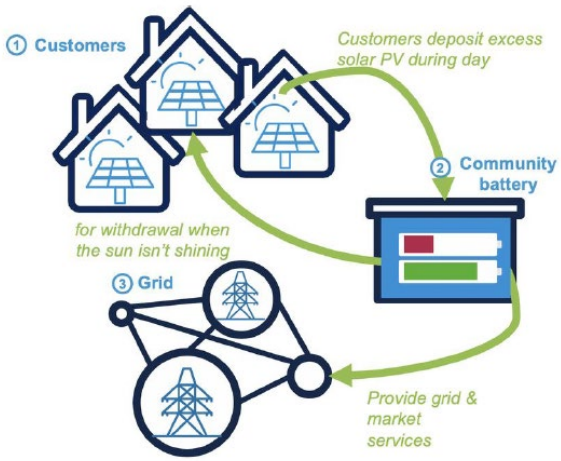
Outcomes to be achieved

Key learnings and insights gained from this initiative will be used to determine whether there is a positive business case for deploying community batteries to support more dynamic network operation and as an alternative to investment in traditional network solutions for addressing network issues and constraints.

The potential of community batteries in supporting the NT power system

Community batteries are a shared battery solution located in a local neighbourhood which allow customers and the wider community to share in the multiple benefits that batteries can provide. They can encourage greater solar uptake by making access to battery storage more equitable and accessible for all customers, particularly those who aren't currently able to install their own battery, while also enabling customers without solar systems to also benefit.

Community batteries can also offer a flexible alternative to traditional poles and wires investment, potentially reduce peak demand and provide power security and reliability, helping to place downward pressure on electricity prices.



- ***Darwin-Katherine Electricity System Plan:*** *Focus Areas 2, 4, and 5*
- ***Network Focus Area****: Unlocking small scale renewables and integrating small scale batteries, and demand management*
- ***Network Capability Requirement****: Dynamic operation, dynamic operating envelopes, low voltage visibility and digital capability*

Initiative 4: EV Charing Impact Research

Objective

Although EVs have the potential to cause significant impacts onto the power system, Power and Water is taking a proactive and coordinated approach towards the seamless integration of EVs onto the Northern Territory electricity system.

Description

This project will determine where and when any localised network issues which may arise from EV charging, including both home and workplace charging. From this, Power and Water will be able to identify and develop potential options to mitigate these impacts and unlock additional opportunities from integrating this new technology onto its network.

Outcomes to be achieved

Key learning and insights from this initiative will enable Power and Water to better plan and manage the impact of EV loads to minimise the need for costly network investment to accommodate and facilitate the integration of this new type of technology on our network.

Learnings from initiative will help Power and Water to identify optimal locations on its network for public charging stations, and understand how incentivising workplace charging could be used to help address minimum demand issues and will be used to inform the development of an EV strategy.

Unlocking the benefits of electric vehicles

EVs will become increasingly prominent in the Power and Water network in the short-term future as the cost of EVs decline, fuel range improves, and overseas car manufacturers transition away from conventional combustion.

As adoption of EVs in the Northern Territory increases, the Power and Water electricity network will be profoundly impacted by residential and commercial EV charging behaviour which will increase the cost of the network if left unmanaged. However, we recognise that EVs also have the power to change the profile for electricity use similar to that of batteries. As such, EVs presents both opportunities and challenges for the Northern Territory power system and electricity network.

- ***Darwin-Katherine Electricity System Plan:*** *Focus Area 5*
- ***Network Focus Area****: Demand management*
- ***Network Capability Requirement****: Dynamic operation, dynamic operating envelopes, low voltage visibility and digital capability*