Distribution and Transmission Annual Planning Report

December 2024

Ausgrid

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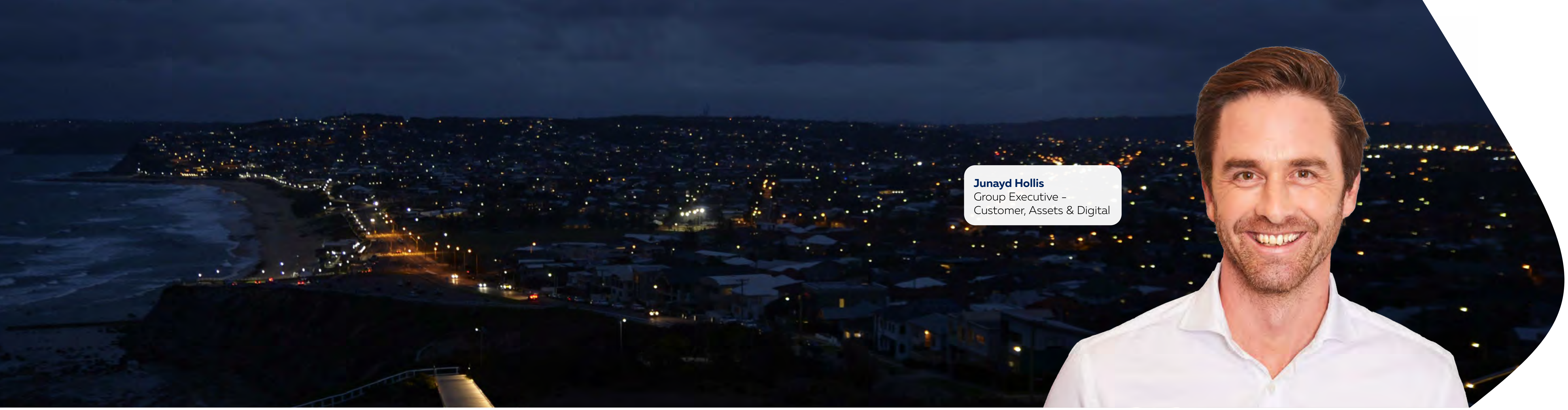


Message from Junayd Hollis

Like many electricity networks around the globe, Ausgrid is redefining its role in the transition to a sustainable future. We have an obligation to protect the long-term interests of our customers and the communities we serve. The role we now play is more important than ever as we help balance the cost of living with Australia's decarbonisation ambitions. Our purpose is to make electricity accessible for all, and our vision is for our communities to have the power in a resilient, affordable and sustainable future.

This vision aligns with our customers priorities for more:

- Reliable electricity – so customers can live their lives with certainty that Ausgrid is there to power their needs;
- Affordable electricity – with customers having the power to choose when and how they use electricity to manage their bills; and
- Renewable electricity – to protect our planet now and into the future.

In 2024, customer energy resource (CER) adoption continued to increase, including rooftop solar systems, battery installations and electric vehicles uptake in our network area. CER gives customers options to generate, store and supply renewable energy back to the grid.

We have also seen a sharp increase in the activity associated with the connection of grid generation and storage projects including Ausgrid's own community battery investments. Community batteries can help customers without rooftop solar access to the benefits that CER provides, by storing excess generation and supplying it back when needed.

Electric vehicle (EV) adoption is also increasing, replacing fossil fuels with higher electricity demand. EV charging infrastructure is being deployed, giving customers access to purchase an EV where home charging is not an option.

Over the past year, in delivering to our purpose and vision, Ausgrid has:

- Been selected as the preferred network operator by the NSW Government to build, operate and maintain the Hunter Central Coast Renewable Energy Zone (HCC REZ) network infrastructure, to allow 1 GW of renewable generation to connect to the grid and supply clean energy to the community.
- Supported the approval to connect a 135MW Solar Farm to the Muswellbrook 132kV network. This will be the first renewable generation of this scale to be connected directly to our network.
- Developed tools to provide information about the hosting capacity of the network to our customers, to enable them to make better energy investment decisions.
- Commissioned three Stand Alone Power Systems (SAPS) in the Upper Hunter network, to improve reliability, resilience and reduce costs for customers. Next year, Ausgrid is continuing SAPS trials across the region with interested landowners.
- Continued our community battery program, with support from the Australian Renewable Energy Agency (ARENA), to transition from 250kW Battery Energy Storage Systems (BESS) to 4.99MW units co-located at local substations.
- Received the final decision for our regulatory proposal from the Australian Energy Regulator (AER) covering the 2024-29 period. This decision determines our revenue for the next five years to cover operating costs and investments to upgrade the network, maintain its reliability and improve accessibility.
- Obtained AER's acceptance of our first contingent project, which is a significant augmentation proposed in the Macquarie Park network. If trigger events are met, the project will be added to our regulatory determination.

Our 2024 Distribution and Transmission Annual Planning Report Summary

The Distribution and Transmission Annual Planning Report (DTAPR) has been divided into two documents: a summary, focusing on our strategies, accomplishments, and challenges; and the extended DTAPR document, which outlines our 2024 annual planning review and delineates our obligations as a Distribution and Transmission Network Service Provider in the National Electricity Market.

Looking at the forward planning period, we continue to explore opportunities in:

- Making it faster, easier and cheaper to connect to our network,
- Supporting the connection of additional renewables and storage,
- Enhancing network resilience
- Continuing to trial and implement innovative technologies on our network,

We will pursue these opportunities while continuing to focus on affordability in light of cost-of-living pressures. We see electrification as the pathway to resilient, affordable and sustainable future.

This report provides an overview of our plans and strategies for the forward planning period. If you have enquiries, please reach out to us at assetinvestment@ausgrid.com.au.

Junayd Hollis
Group Executive - Customer, Assets and Digital

About Ausgrid

Ausgrid is operated under a long-term lease via a partnership between the NSW Government and AustralianSuper, APG Asset Management and IFM Investors where 49.6% of interest and share are held by the NSW Government.

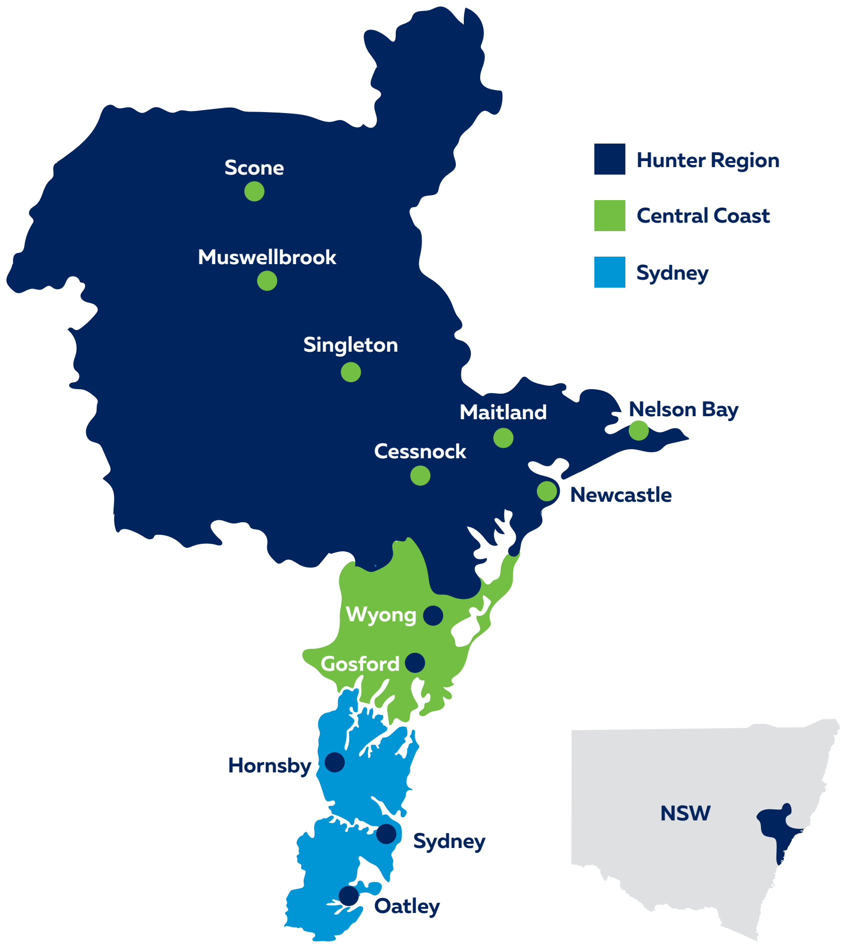
Ausgrid owns and operates the network of substations, powerlines, underground cables and power poles that deliver power to communities across large parts of Greater Sydney, the Central Coast and the Hunter. Ausgrid's network is a shared asset that empowers our customers and their communities today and has done for over a century.

Our core business is to provide distribution network services to our customers. Each day we build, operate and maintain the distribution network with a focus on providing a safe, reliable, affordable and sustainable energy supply. The wide range of services we provide is illustrated on the next page.

We're investing now for a future where renewables play a dominant role in the power mix and households and businesses can generate their own energy and sell it back to the grid. The grid has a pivotal role in supporting customers during this energy transformation. We are committed to working with our customers and stakeholders to realise this lower carbon future sooner and at the lowest possible cost for all customers.

Our Network & Customers

We provide an essential service to over four million customers including urban residents and businesses in Sydney, Australia's largest city, and those in rural areas across the Central Coast and Hunter Valley. Our customers also consist of councils, telecommunication providers and developers. We service critical infrastructure within our network footprint, including schools and hospitals.



Our Network and Customers

- **4m** Australians
- **20%** of Australia's GDP
- **1.5m** Homes
- **200k** Businesses
- **1,238** Schools
- **105** Hospitals
- **1.8m** Customers
- **22,275km²** Area

Ausgrid network covers 22,275 km² made up of large and small substations connected through high and low voltage powerlines, underground cables, tunnels and power poles, including

Dual function subtransmission system

132kV transmission assets operated in parallel to and in support of the main transmission system

Subtransmission system

33kV, 66kV and 132kV assets

High voltage (HV) distribution system

Predominantly 11kV, with some 5kV, 22kV and 33kV and 12.7kV Single Earth Wire Return assets

Low voltage (LV) distribution system

400V assets (230V single phase)

Operating Environment

Ausgrid is regulated by statutory and legislative requirements, including Work Health and Safety (**WH&S**), environmental, competition, industrial, consumer protection and information laws, National Electricity Law (**NEL**), National Electricity Rules (**NER**) and the NSW Electricity Supply Act 1995 (**ESA**). We must also comply with the conditions of our NSW DNSP licence (under the ESA) and Security of Critical Infrastructure Act 2018.

The NEL and NER regulate the NEM, and the National Energy Customer Framework. Ausgrid operates in the NEM as both a DNSP and TNSP. The National Electricity Objective (**NEO**), was amended in late 2023 to include an emissions reduction component, and as stated in the NEL is to:

> "Promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to:
>
> (a) price, quality, safety, reliability and security of supply of electricity; and
>
> (b) the reliability, safety and security of the national electricity system; and
>
> (c) the achievement of targets set by a participating jurisdiction –
>
> (i) for reducing Australia's greenhouse gas emissions; or
>
> (ii) that are likely to contribute to reducing Australia's greenhouse gas emissions."

We meet these obligations with investments that address our customers' requirements for safe, affordable, reliable and sustainable network services.

We manage compliance with these laws and regulations through our internal codes and policies and a common control framework. This control framework comprises plans, policies, procedures, delegations, instruction and training, audit and risk management.

Our Purpose

Making electricity accessible for all.

Our Vision

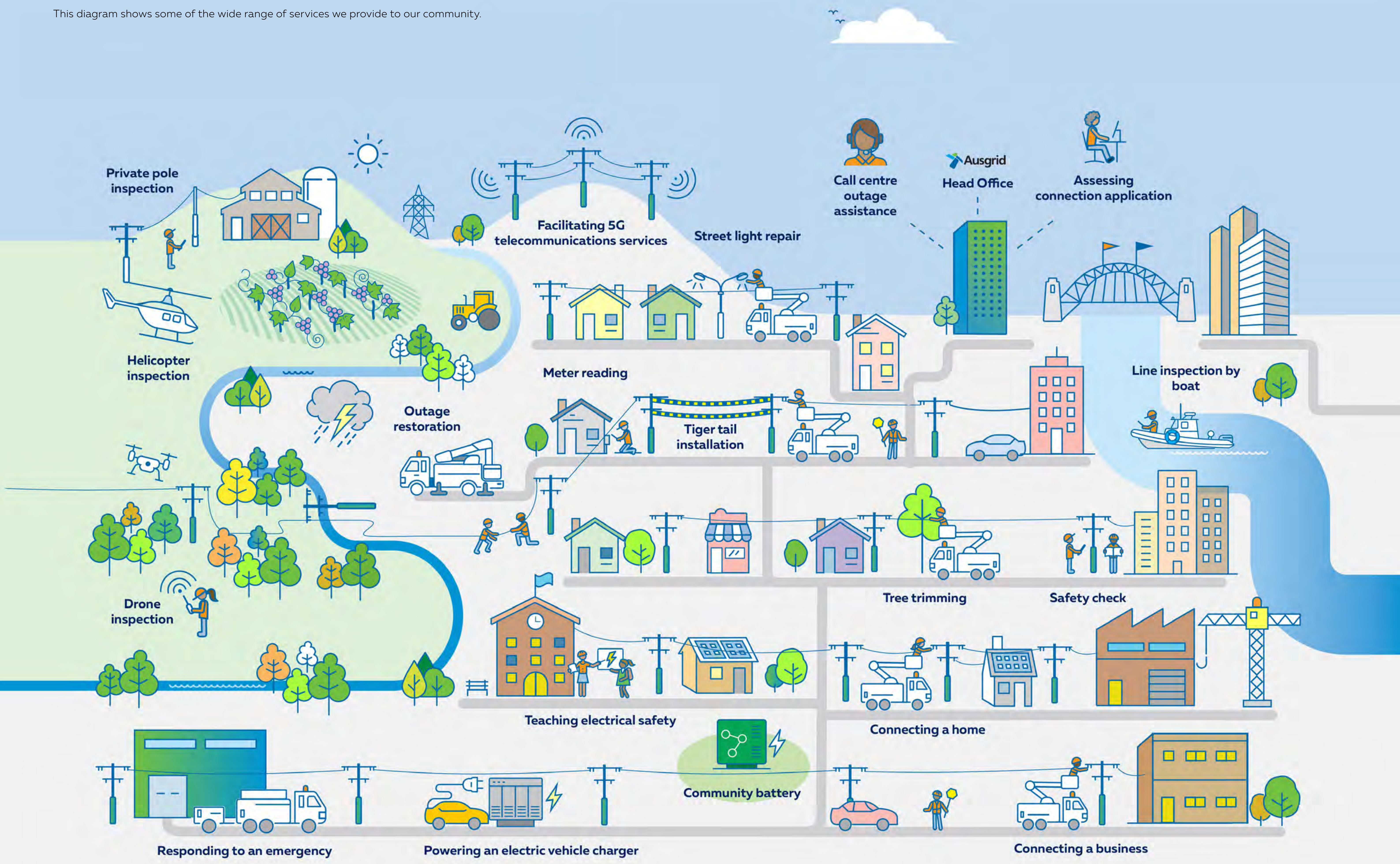
For our communities to have the power in a resilient, affordable and sustainable future.

Our Values

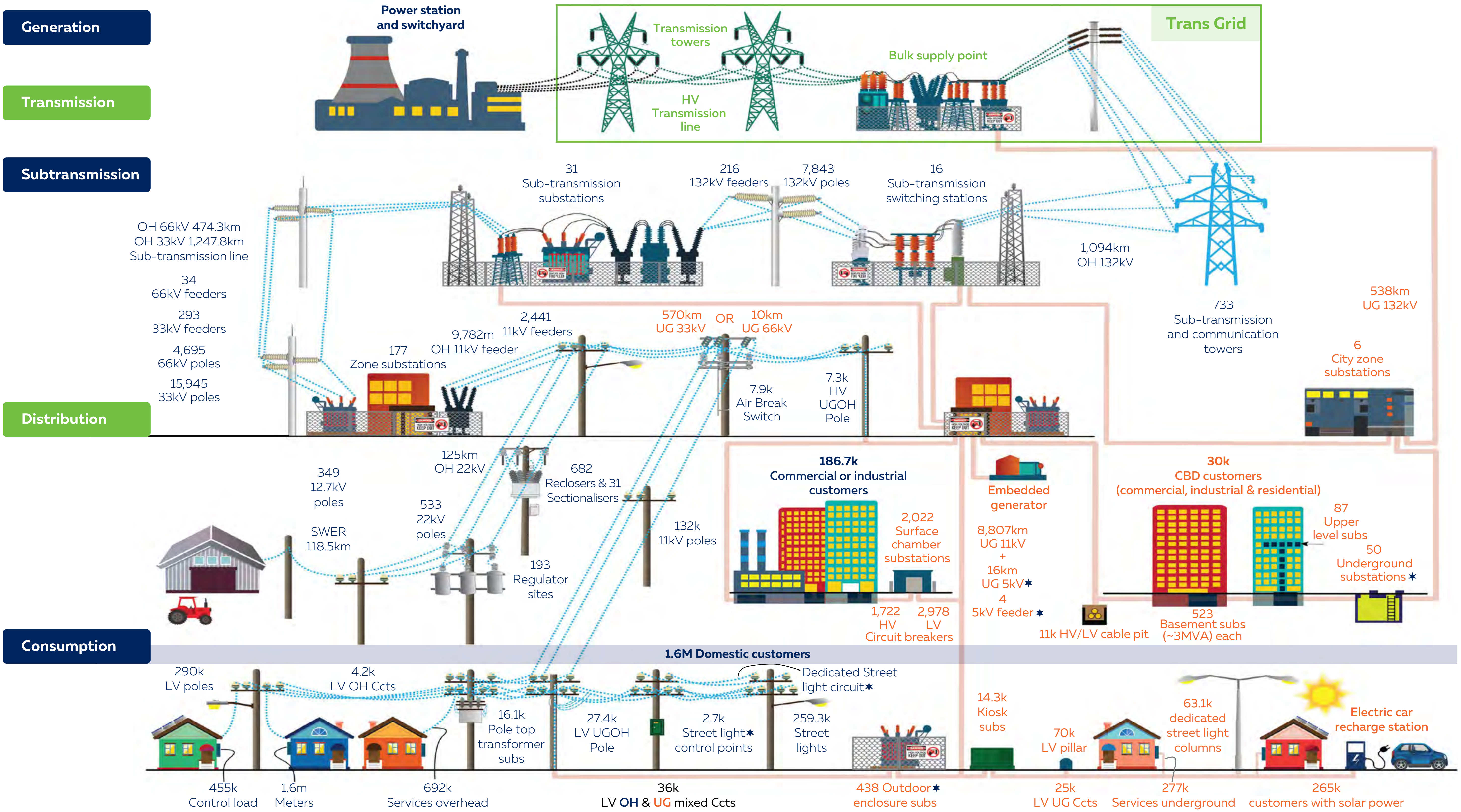
- Work safe, live safe
- Customer-focused
- Commercially minded
- Collaborative
- Honest and accountable
- Respect

Our Role in the Community

This diagram shows some of the wide range of services we provide to our community.



State of the Network

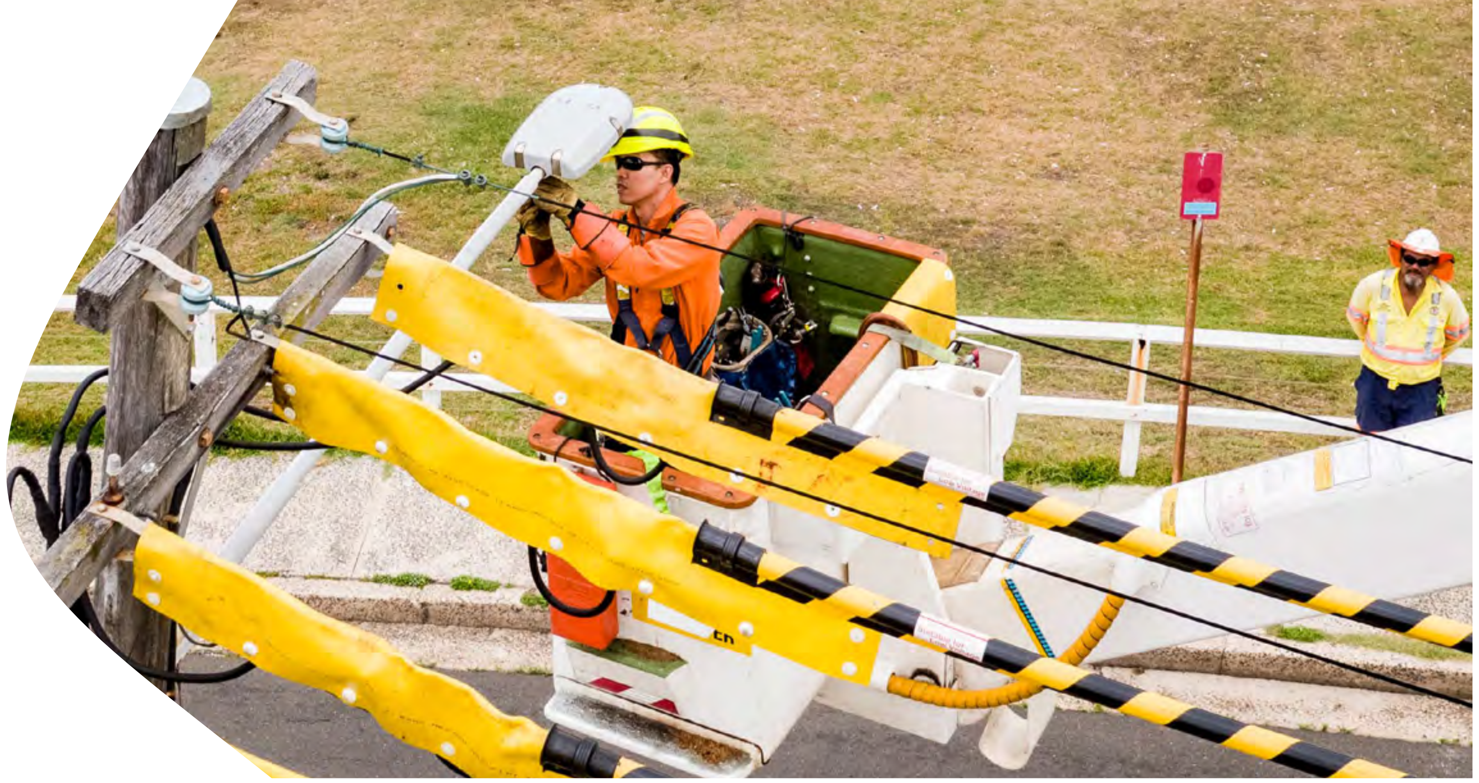


Legend

Ausgrid ········ Overhead Supply ▬ Underground Supply

Other Network Asset Statistics	2022/23
Dual function (Transmission) System – 132kV (km)	889
Low Voltage Overhead (km)	13,133
Low Voltage Underground (km)	7,052
Streetlighting Overhead (km)	3,420
Streetlighting Underground (km)	1,173

Note: Asset counts and lengths do not include private assets.



Purpose of the Distribution and Transmission Annual Planning Report

This DTAPR complies with National Electricity Rules (**NER**) clause 5.13.2 Distribution Annual Planning Report (**DAPR**) and clause 5.12.2 Transmission Annual Planning Report (**TAPR**), utilising Version 214 of the NER. Ausgrid has prepared this DTAPR with a five-year forward planning horizon, reflecting the outcomes of the annual planning review of Ausgrid's electricity network since the December 2023 DTAPR publication.

The purpose of this document is to inform Registered Participants, stakeholder groups and interested parties of the identified future network needs, the committed and proposed solutions to these needs and the potential opportunities for non-network solutions, particularly for large investments where the Regulatory Investment Test for Distribution (**RIT-D**) applies.

Ausgrid's DTAPR aligns with the NER Schedule S5.8 DAPR to:

- Provide transparency to Ausgrid's decision making processes and assist non-network providers, other Network Service Providers and connection applicants to make efficient investment decisions;
- Promote efficient investment decisions in the electricity market;
- Include information on the planning process encompassing forecasting, identification of network limitations, and the development of potential credible options to address these limitations;
- Present the results of Ausgrid's annual planning review, including joint planning with other Network Service Providers, covering a minimum five year forward planning period for distribution assets;
- Offer third parties the opportunity to offer alternative proposals to the identified network needs, including non-network solutions such as demand management or embedded generation;
- Provide network capacity, load forecasts and hosting capacity for embedded generation for sub-transmission lines, zone substations and transmission-distribution connection points, and any 11kV primary distribution feeders which are constrained or are forecast to be constrained within the next two years; and
- Provide information on Ausgrid's demand management activities and actions taken to promote non-network initiatives each year, including plans for demand management and embedded generation over the forward planning period.

Distribution and Transmission Annual Planning Review and Reporting

Ausgrid owns, develops, operates and maintains transmission dual function assets in NSW that are operated in parallel with Transgrid's network, and perform a transmission function by supporting the main NSW transmission network. Ausgrid is therefore also registered as a TNSP and is required to publish a TAPR covering our dual function assets. The NER permit Ausgrid to publish its TAPR as part of the DAPR to align the publication of both reports each year.

Reporting of both planning reviews have been merged into one document. The information that the NER requires Ausgrid to report for both distribution and transmission is covered throughout the various sections of the DTAPR.

Significant Changes from Previous DTAPR

For the past three years, Ausgrid introduced several developments including a new online portal displaying Ausgrid's network interactively. The DTAPR summary which focuses on Ausgrid's strategies, accomplishments throughout the year, and opportunities as a distribution network service provider has also been included separately this year. This summary has been graphically enhanced for readability purposes. The summary document contains the first chapter "Network Growth and Opportunities" amongst the Foreword and About Ausgrid. The structure of the main DTAPR document remains unchanged from last year, except for rearrangement of chapters.

This year information regarding the hosting capacity has been included in the mapping portal as well as system strength data to comply with 5.12.2 (c)(13) and S5.8(q).

In addition, the associated data files mainly remain unchanged, with some structure/graphical enhancements to the Substation Capacity and Demand Forecast, Dual Function Asset 10-year Demand Forecast, Generator Export and Hosting Capacity, and System Limitation template, to assist with readability.

System Limitations Template – Online Data

Since 2017 Ausgrid has published online data in the format prescribed by the Australian Energy Regulator (AER) in a Distribution System Limitation Template.

Following the release of the TAPR guidelines in December 2018, we have populated a Transmission System Limitation Template, and this is included again this year.

Online data associated with the 2024 DTAPR, as well as the document itself, is accessible via Ausgrid's website at www.ausgrid.com.au/DTAPR.

Guide To This Document

We are the custodians of a network that connects communities and empowers the lives of our 1.8 million customers, and have done so for over a century. Ausgrid operates as both a transmission and a distribution network service provider. Our network is made up of approximately 30,000 substations connected through high and low voltage power lines, underground cables, tunnels and power poles. Our operations include infrastructure construction, maintenance and operation, customer connections, street lighting and telecommunications. We are increasingly involved in supporting the transition to a net zero economy through the connection of renewable energy to the grid, by the electrification of loads such as transport via electric vehicles and by supporting the NSW Government's Electricity Infrastructure Roadmap through the development of renewable energy zones.

The DAPR section of this document covers a five year forward planning period, while the TAPR section covers a ten year forward planning period, from December 2024. Our 2024 DTAPR document is accessible via Ausgrid's website www.ausgrid.com.au/DTAPR, with the supporting data at our new online portal located at https://dtapr.ausgrid.com.au.

This data has been structured to enable you to easily target the key locations and come to us with solutions that more readily meet the needs of our customers and grid.

Chapter 1: Network Growth and Opportunities

We continue to explore opportunities in:

- Increasing opportunities to connect
- Leveraging impact of renewable energy and storage
- Reducing cost of living pressures
- Enhancing network resilience
- Advancement through innovation.

Chapter 2: Network Demand and Limitations

This section details the location of identified system limitations and the dual function assets in the network. It also displays the system total maximum demand forecast, discusses frequency control load, load shedding, stability and primary distribution feeder limitations.

Chapter 3: Network Performance

A review of the network from a reliability and quality of supply perspective is reported here. The results are compared against specific targets set in the Licence Conditions given to Ausgrid. This comparison also includes the Service Target Performance Incentive Scheme (STPIS), which is set by the Australian Energy Regulator (AER) as part of its regulatory determination for Ausgrid.

A forecast of the network reliability performance is also provided in this chapter.

Chapter 4: Asset Management

Ausgrid's approach to manage its network assets is described here, including a description of the risk management strategies applied to the asset categories that require the most significant investments in the forward planning period. This section also discusses distribution network losses.

Chapter 5: Non-Network Opportunities

Ausgrid welcomes and encourages feedback from market participants and alternative proposals to address identified network limitations by means of demand management options.

This section also provides information about demand management and embedded generation activities in progress and for the forward planning period.

Chapter 6: Network Investments

In consideration of network limitations identified during the planning process, credible network options have been identified to:

- Address the deteriorating condition of network assets.
- Connect customers, including customer driven network augmentations.
- Implement reliability correction actions.
- Deliver improvements in automation/control systems.

Network investments that will be the subject of a RIT-D in the forward planning period will be reported here.

Chapter 7: IT & Communications

A description of the key Information Technology and Communication Systems supporting Ausgrid's business is provided in this chapter, including details of the strategies and investments in progress as well as those proposed for the forward planning period.

Chapter 8: Planning Coordination

Joint Planning is carried out with peer Network Service providers including Transgrid, Endeavour Energy and Essential Energy. Activities conducted with all these entities are reported, providing an overview of the decisions/actions in each case.

Appendix

Ausgrid's approach to network planning and forecasting methodology are described here. This section describes the approach taken, the assumptions considered in the forecast, and the factors having a material impact on the network. Consideration is also given to emerging trends, such as growth in solar installations, future battery installations and electric vehicle uptake. A Glossary is also included.

1. Network Growth and Opportunities

1.1 Enabling Connections: Increasing Opportunities to Connect

1.1.1 Load Growth

The demand for load is changing as customers look to electrify. A key contributor to this change is the adoption of electric vehicles, replacing traditional fossil fuels with increased demand for electricity. The adoption of EVs and the roll-out of EV charging infrastructure must be met with available network capacity.

Additionally, the data centre market is experiencing significant growth, driven by the rise of hyperscale cloud services and the rapid development of artificial intelligence technologies. Ausgrid, is uniquely positioned to support this growth and is working closely with data centre developers to understand their emerging needs.

Ausgrid currently supports 52 dedicated data centres across its network area. These facilities range in scale from 5 MVA to nearly 200MVA, providing essential infrastructure to meet the rising demand for data storage and processing capabilities. As the digital economy grows, the need for reliable and scalable data centre facilities has become increasingly critical.

In 2024, Ausgrid has seen a surge in interest from new data centre operators. With over 50 new enquiries and applications, the prospective capacity from these developments totals more than 7000MW, reflecting the strong demand for data centre infrastructure, driven by the expansion of digital services and the growing importance of cloud computing.

Ausgrid is meeting this rapid market growth through a range of strategic initiatives aimed at ensuring an efficient integration of new customer capacity:

The Connections Excellence Program: This program is designed to deliver a faster, more efficient, and better value connections experience for data centre customers

Proactive Customer Engagement: Engaging directly with customers and industry stakeholders allows Ausgrid to understand market needs and tailor its services to build strong relationships and facilitate smoother project development

Strategic Network Planning: Ausgrid employs strategic, innovative, and holistic network planning practices to enhance the integration of new data centres into the current network, ensuring that the network remains robust and adaptable to future demands

Encouraging Industry Investment: To support sustainable growth, Ausgrid promotes investment in areas where distribution network capacity is readily available, or where there is potential for grid scale renewable energy developments

Investment in Infrastructure: To accommodate the increased load and ensure reliability, Ausgrid is investing in new distribution network assets and major substation developments

1.1.2 Hosting Capacity

The electricity industry is undergoing a significant transformation, with a shift towards an energy mix dominated by renewable energy resources. Solar generation, energy storage and other distribution energy resources are integrating into Ausgrid's network at a rapid pace. Additionally, customer loads such as electric vehicles and data centres have seen considerable growth in recent years.

One critical aspect of the network's preparedness for the energy transformation, is whether the network has the available capacity for connecting both new loads and generation resources without requiring substantial infrastructure investment, collectively referred to here as 'hosting capacity'.

However, the precise amount of additional load and generation the network can accommodate is often unclear. To address this, Ausgrid conducts hosting capacity analysis to determine the maximum amount of load and generation that can be connected to the network without compromising its performance or firm rating.

Hosting capacity analysis serves as a key process for understanding the limits of the network. Its primary objective is to calculate the maximum size of coincident load or generation that can be added to the network without impacting reliability, efficiency, or safety. The insights from these studies are essential for supporting new connections and maintaining network performance but also for guiding future investments.

Hosting capacity information is made available publicly, allowing to make better informed choices with regard to existing network capacity. By offering this level of transparency, Ausgrid helps its customers align their strategies with the network's current and future capabilities. We want customers to talk to us about potential future capacity and to hear from those who are considering connecting loads or generation resources on our network.

The hosting capacity information is a snapshot in time reflecting the network status at present based on the maximum load on the network. Ausgrid has recently began offering dynamic connections for customers that are flexible with their network usage and therefore could take advantage low load periods.

If you believe your needs are suitable for a dynamic connection, we encourage you to reach out to us at ausgrid.com.au. 'Getting Connected', as a good place to start for further information on how to get connected to the network.

For Application Form FAQs and supporting resources visit Connection application support or contact the Contestable Connections Team

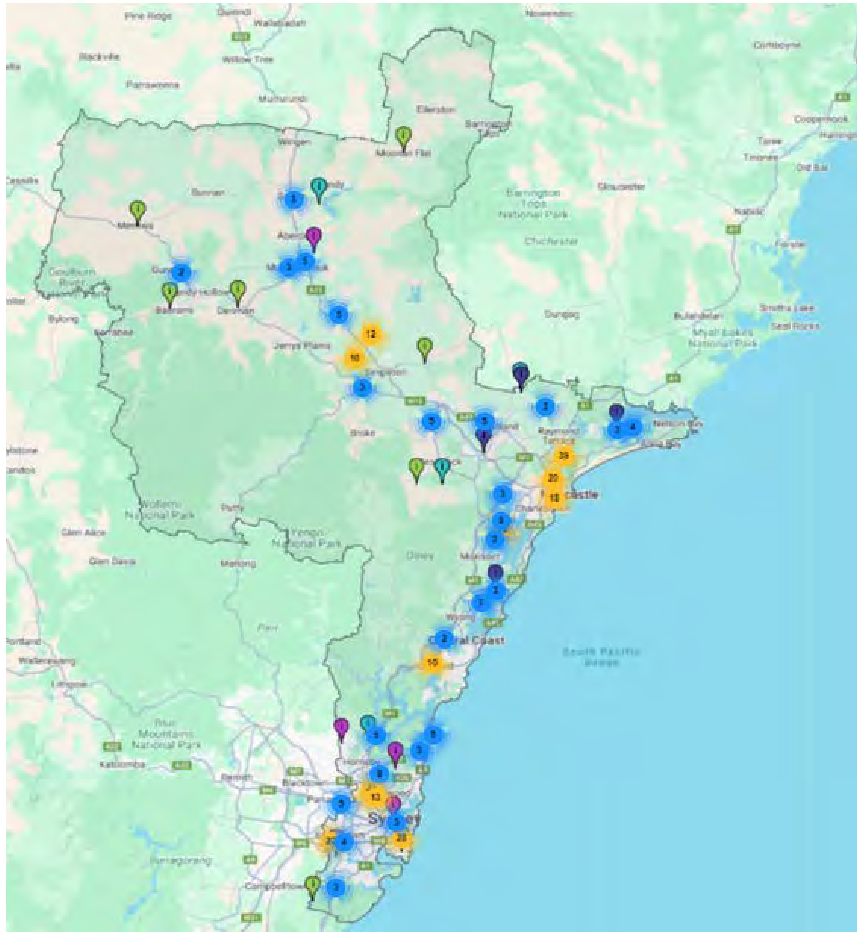
Email: datanorth@ausgrid.com.au

Phone: 02 4399 8099

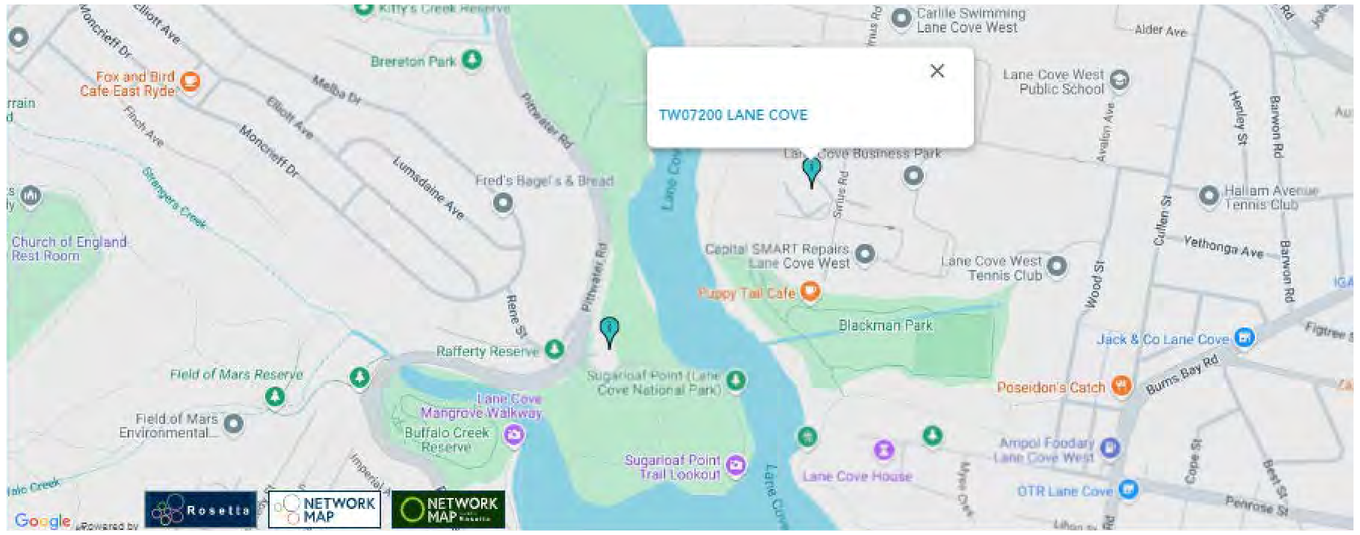
Hosting Capacity Data and Analysis

To effectively manage the network and guide decision making, Ausgrid conducts hosting capacity assessments at two key levels, providing a detailed view of network capabilities:

- **Feeder-level analysis:** Ausgrid performs power flow simulations at sub-transmission feeder level, including contingency analysis, to evaluate the amount of additional capacity each feeder can support.
- **Substation-level analysis:** Simulations are conducted at both the primary and secondary voltage levels of substations to determine the available hosting capacity at these nodes. Substation-level analysis identifies the capacity at points where significant load or generation is likely to be connected.



Ausgrid publishes hosting capacity data on its website, ensuring that network proponents, developers, and other stakeholders can easily access this critical information. By making this data publicly available, Ausgrid empowers stakeholders to make informed decisions regarding their potential investments. This also streamlines the connection application process, allowing Ausgrid to process requests more efficiently and assess new connections in a timely manner.



Report Data for TW07200 LANE COVE

Hosting Capacity

Substation	Voltage	HC Type	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Lane Cove STSS	132.0	Load (MVA)	340.1	340.1	320.1	292.6	252.6	212.6	167.6	0.0	0.0	0.0
Lane Cove STSS	132.0	Generation (MW)	478.9	478.9	487.6	498.9	488.9	488.9	488.9	488.9	488.9	488.9

Note: The network experiences frequent changes due to various factors, including proposed load and generation commitments. These changes can significantly impact the available hosting capacity at a given location. The provided hosting capacities show what is available at a point in time (October 2024). Customer applications based on the available hosting capacity cannot be guaranteed or reserved. Customers must submit an application for connection to undergo detailed investigations into the available hosting capacity and potential physical constrains.

Overview of Ausgrid network as displayed in the mapping portal and hosting capacity map. To view hosting capacity information, please visit Ausgrid - Rosetta Data Portal.

Optimising the Network for Growth and Sustainability

Hosting capacity analysis involves planning for future growth and enhancing the resilience and sustainability of the network. By continuously evaluating the network's capacity to host additional loads and generators, Ausgrid is positioned to:

- **Optimise network use:** Through detailed assessments, Ausgrid can maximise the use of existing infrastructure, deferring costly network upgrades.
- **Support dynamic connections and flexible capacity:** Hosting capacity analysis allows Ausgrid to explore dynamic connections, where full capacity may not be available during certain times and under specific conditions. This flexible approach ensures that the network infrastructure is efficiently utilised, and customers have options to connect their projects even when 100% firm capacity may be limited.
- **Develop long-term planning:** In addition to current capacity assessments, Ausgrid forecasts hosting capacity for future years. This approach allows for better planning and decision making regarding future investments.
- **Deliver strategic investments:** Combined with an understanding of our customers future needs, hosting capacity analysis helps pinpoint potential constraints or bottlenecks that could limit future growth. By identifying these areas early, Ausgrid can prioritise interventions to unlock additional capacity, ensuring that network remains flexible and capable of supporting future energy demands.

Dynamic Nature

It is important to recognise that hosting capacity is not static, it is subject to change based on conditions and ongoing developments across the network. Hosting capacity analysis is conducted based on the best available data and network models as of October every year. Factors such as new load applications, generation proposals, and network commitments can alter the available hosting capacity.

For this reason, the hosting capacity published by Ausgrid should be viewed as indicative only, reflecting the network's status at the time the most recent snapshot was taken.

By leveraging hosting capacity analysis, Ausgrid aims to enhance the network's ability to support a growing number of loads and generations, ultimately contributing to a more sustainable and resilient network.

1.1.3 Electric Vehicles Uptake

Electric Vehicle Forecasts in Ausgrid's Network Area

- EVs in NSW are expected to increase from approximately 66,000 vehicles in 2024 to over 1 million vehicles by 2030 (based on AEMO's Step Change scenario). Around half of these vehicles will be using Ausgrid's network.
- All scenarios assume cost parity (i.e., the full cost of owning and operating a vehicle, without subsidies) between EVs and Internal Combustion Engine Vehicles should happen before 2030.

Increasing EV Charging Infrastructure Uptake in Ausgrid's Network

Ausgrid is leading the industry by providing 'facilities access' agreements to enable charge point operators to lease out space on our assets to deploy their chargers on our kiosks and poles.

With support from the NSW Government, Ausgrid will be connecting 100s more EV chargers in our network. However, this will fall far short of the NSW Government's projected need for 26,000 to 30,000 public AC charging points in NSW.

This is why Ausgrid has been advocating to be able to build, own and maintain (but not sell energy through) 11,000 pole mounted AC chargers on our network. We want to support approximately 30% of NSW residents who do not have access to powered off-street parking.

Ausgrid proposes to maintain these chargers to the same high reliability standards as the rest of our network assets, while providing all charging providers open access to these chargers via a standard electricity tariff. This will expand existing charging providers' networks. This way customers will be able to access AC kerbside charging for similar costs to those able to charge at home.

1.2 Leveraging Impact of Renewables & Storage

1.2.1 Renewable Generation

The Energy Corporation of NSW (**EnergyCo**) is a NSW Government statutory authority responsible for delivering and coordinating investment in Renewable Energy Zones (**REZ**) as part of the State's Electricity Infrastructure Roadmap.

Renewable Energy Zones combine new wind and solar power generation into locations where it can be efficiently stored and transmitted across NSW. Five zones have so far been identified which will deliver a reliable electricity supply to meet the growing demand of power from our regions and cities, one of which is in the Hunter Central Coast area.

In December 2024, EnergyCo announced that they will be working with Ausgrid to deliver the proposed network solution for the HCC REZ. This involves upgrading the existing electricity network to allow new renewable generation to connect to the grid. These enhancements are vital to meeting both our current and future energy needs.

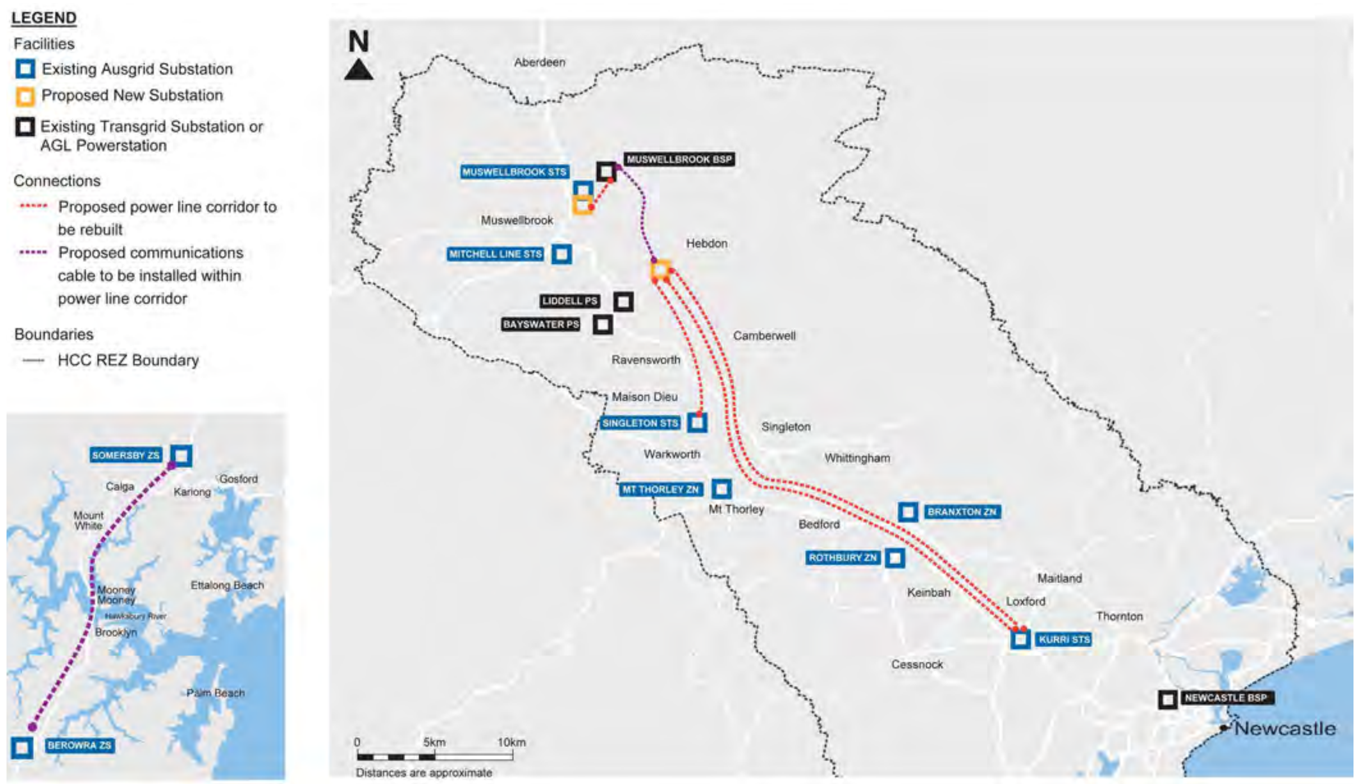
The proposed solution will primarily involve upgrades to existing network infrastructure, and re-use existing corridors. This minimises impacts on surrounding communities and the environment, while delivering the capacity to transfer at least 1 gigawatt of renewable energy.

This will bring significant economic benefits to the region including more jobs, opportunities for local businesses and potential new industries.

The map below shows the areas where Ausgrid's proposed upgrades will occur.

Ausgrid is committed to working alongside EnergyCo and engaging with local councils, landowners, communities, and businesses to ensure the project delivers benefits for all stakeholders.

Proposals have also been submitted to EnergyCo to participate in the 2025 IIOR (Infrastructure Investment Objectives Report) report. The proposals will be evaluated and shortlisted for EnergyCo to make a final determination on which options it would progress with by July 2025.



Ausgrid is continuing work with the NSW government, to identify further opportunities to support large renewable generation in our network. This ongoing work is vital to securing the long-term interest of our customers by providing sustainable and secure sources of generation.

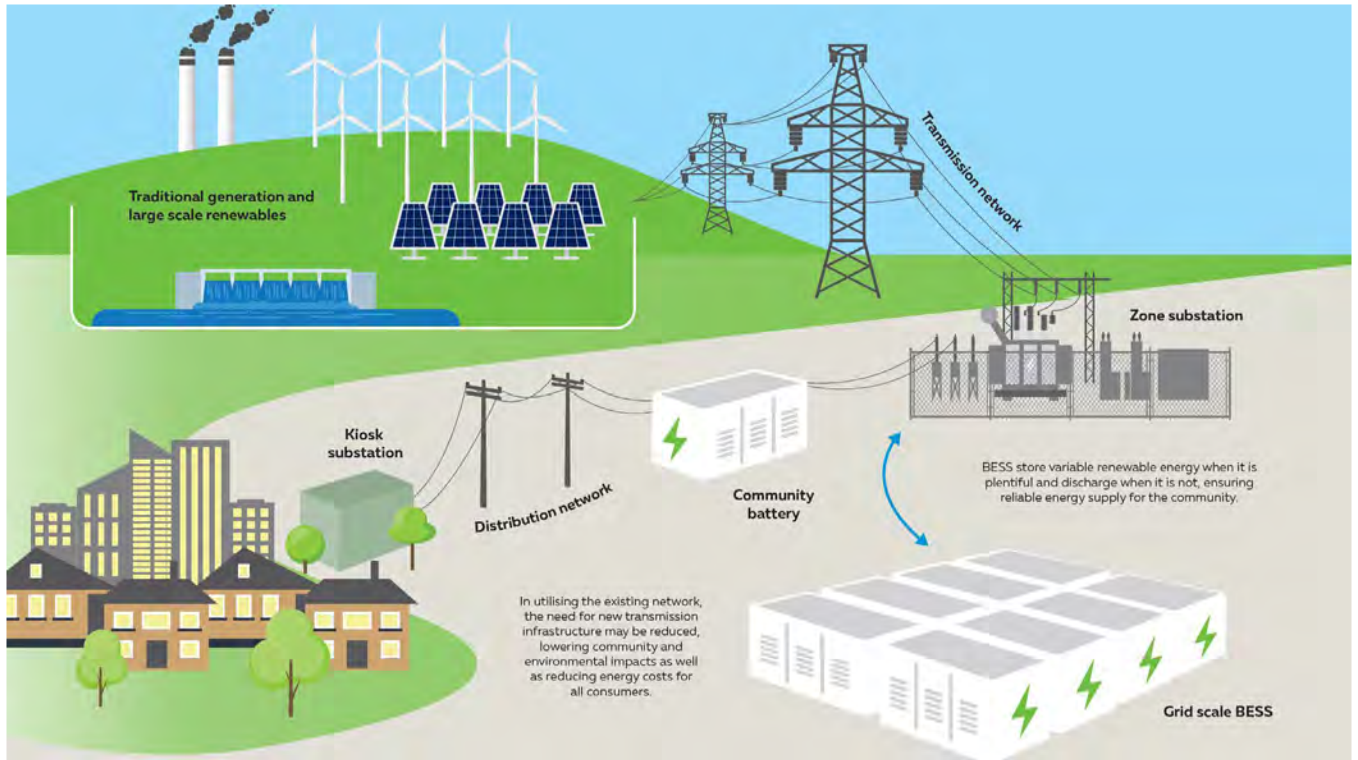
1.2.2 BESS

Ausgrid Group is building a resilient and sustainable energy system by expanding energy storage on the distribution network, increasing the integration of renewable energy and ultimately paving the way for a more sustainable future. Ausgrid Group's ambition is to deliver up to 1.5GW of distribution connected storage to the energy market by 2031.

By better leveraging existing network assets, Ausgrid Group is developing a portfolio of cost-effective BESS to improve network resilience by storing and securing excess generation, allowing access to power during peak periods of demand.

This approach ensures the best outcomes for our customers, the network and our shareholders, and helps deliver a faster, more affordable, and less disruptive transition.

As one of the first DNSPs to connect grid-scale storage to the distribution network, Ausgrid is leading the way in fostering a resilient and equitable energy transition. This initiative challenges the status quo and supports the ongoing integration and adoption of renewable energy, contributing to a sustainable energy future for all.



1.2.3 Community Batteries

Batteries are key to supporting the growth of renewable energy sources. A community battery is a shared solution for a local neighbourhood that allows both that neighbourhood and the wider community to access the multiple benefits batteries can provide.

Community batteries use existing Ausgrid infrastructure to capture and store excess energy produced locally (e.g. rooftop solar) and then releases that energy back to eligible consumers during peak demand times. By enabling more local energy use closer to the end consumer and utilising existing Ausgrid infrastructure, we can enable a faster rollout of energy storage at lower system cost, facilitating the energy transition and enabling more savings for customers.

Key Updates for 2024

- A total of 19 community batteries have been deployed totalling ~2MW / ~4MWh, including nine poletop batteries and 10 ground mounted batteries.
- Ausgrid has been awarded an ARENA grant of $12.6M to deliver an additional 16 batteries totalling 40MW / 85MWh.
- Energy-Storage-as-a-Service (**ESaaS**) has been launched in partnership with two major retailers, enabling an estimated $200 a year in energy bill savings for consumers. More retailers are expected to offer ESaaS in 2025.

The various benefits of community batteries are outlined below:

- Provides residential customers access to stored renewable energy and bill savings.
- Allows customers to access centralised storage without the upfront costs.
- Enables more rooftop solar and electric devices such as electric vehicle chargers to be connected without expensive network upgrades.
- Strengthens the grid and reduces the need to limit (curtail) solar exports. This helps customers maximise their solar investment.
- Helps explore new models that share more electricity produced from solar panels within the local area, including to households without solar panels.
- Creates a positive impact on wholesale electricity prices that can flow through to reduced retail electricity prices.
- Helps to regulate voltage on the network and improves network quality in the local area.
- Reduces reliance on traditional poles and wires investment and helps lower network costs.

ESaaS Overview

The crucial innovation that has enabled consumers to share in the benefits of community batteries is Ausgrid's ESaaS offering.

ESaaS enables eligible customers that live near a community battery to access the benefits of a shared community battery without any upfront cost, saving an estimated $200 per year in energy bills. This approach not only delivers cost savings for consumers, but also improves grid reliability and facilitates greater integration of renewable energy.

Ausgrid partners with energy retailers to offer ESaaS, with two major retailers having launched their products to market. More retailers are expected to offer ESaaS in 2025.

1.2.4 SAPS & Microgrids

Ausgrid is investing in SAPS and microgrids to reduce outage impacts for certain customers in remote locations, as well as reducing risk of fires in bushfire prone areas. SAPS are off grid electricity systems, generally comprised of solar photovoltaic arrays, energy storage and backup diesel generators.

SAPS and microgrids reduce bushfire risk as electricity infrastructure, that could potentially spark igniting a bushfire, is either no longer energised or removed. It is expected that the average cost to supply customers will fall if DNSPs provide SAPS on a permanent basis, leading to a reduction in network charges for the entire customer base. They can also be used by electricity networks as practical solutions to make communities more resilient to extreme weather events and natural disasters as they enable a customer or community to isolate and remain energised in an emergency. This is particularly important for keeping telecommunication towers and fire-fighting equipment (water pumps) operational.

As distribution network's experience more natural disasters such as bushfires, storm events and floods, SAPS can also be utilised in an emergency to replace assets, allowing utilities to effectively provide the updated power solutions for our customers rather than replacing assets like for like.

- SAPS range in sizes but typically comprise a 13kW **PV** system, paired with a 7.5kW BESS & 9kVA backup generator connected to a single customer point of connection.
- 3 x SAPS have been commissioned to date in Mirannie with a further 7 under construction in Ellerston and Mirannie located in the Upper Hunter region of Ausgrid.
- A microgrid may be completely disconnected from the electricity network or it can be connected to the main electricity network with the ability to deenergise the main line for network maintenance or an impending extreme weather event.
- Ausgrid announced the construction of a LV Microgrid in Merriwa in late 2022. Ausgrid's depot in Merriwa was the ideal spot to locate the microgrid given its location on the main street and connected to the same low voltage network as many key small businesses.
- The Merriwa microgrid will supply the petrol station, supermarket, chemist, bakery, CWA hall, IGA supermarket and RSL amongst other small businesses that will be able to continue to service the township during planned and unplanned outages on the local electricity grid.
- Ausgrid has recently completed major construction activities with the installation of a new 500kVA diesel generator, 500kW/1000kWhr BESS and 110kW solar installation along with microgrid control system.
- Final commissioning of the microgrid should be completed by early 2025.

1.2.5 CER Uptake

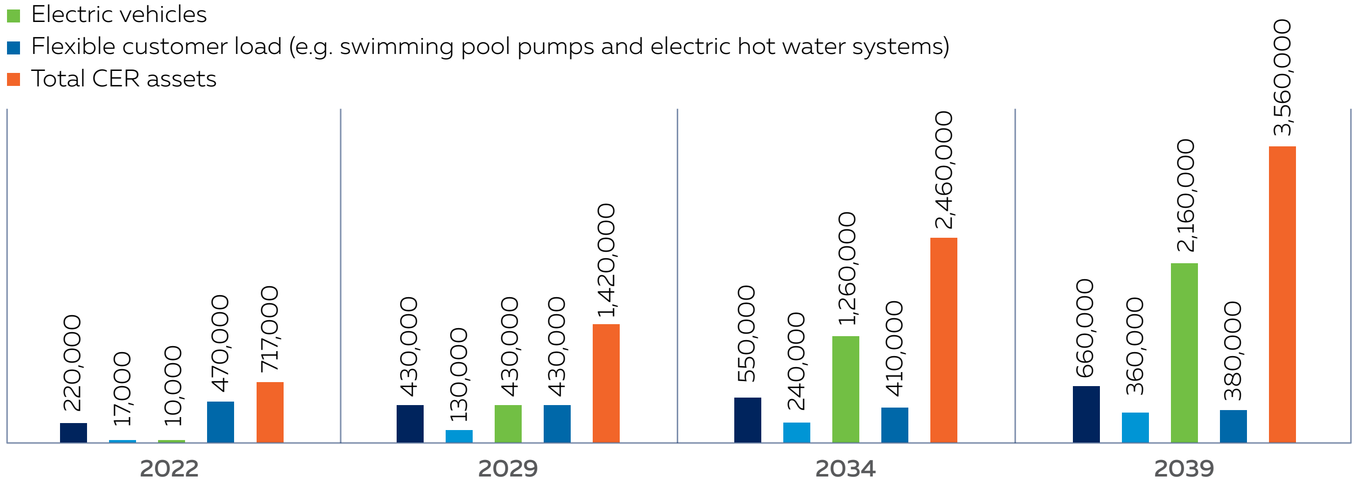
Ausgrid is adapting to a rapidly changing energy landscape including an acceleration of CER, which include behind-the-meter (**BTM**) renewable energy generation, storage, and EVs. The uptake of rooftop solar on our network has consistently exceeded forecasts, with this trend expected to continue. BTM storage, typically paired with rooftop solar, is forecast to grow from 17,000 in 2022 to 130,000 in 2029. EV adoption on our network is also accelerating, with numbers expected to rise from 10,000 in 2022 to 430,000 by 2029.

Updated Forecasts

Ausgrid has updated its forecasts since the 2023 DTAPR for rooftop solar and BTM storage based on the latest inputs and assumptions from the AEMO[1]. The forecast for EVs has also been revised upwards, reflecting recent adoption trends, updated technology pricing, emissions reduction policies, and power pricing forecasts. These updates indicate a significant increase in the number of rooftop solar systems and EVs, while the forecast for BTM batteries has decreased slightly. Overall, the forecast number of CER assets by 2034 has increased to 2.46m (as compared to previous forecast of 2.35m).

CER Adoption

- Rooftop solar system
- Behind-the-meter batteries
- Electric vehicles
- Flexible customer load (e.g. swimming pool pumps and electric hot water systems)
- Total CER assets



What This Means for Ausgrid and Our Customers

Under certain conditions, high levels of CER can push the network beyond its design limits, leading to supply interruptions and curtailment. Successful integration of CER into the network is essential for maximising the value of customers' investments in CER and distributing these benefits across all connected customers.

Due to increasing two-way power flows, Ausgrid must support the integration of CER through efficient investment. Rooftop solar exports can cause network voltages to rise, leading to curtailment where inverters limit their output or trip off. This affects both in-home consumption and exports, with 11% of rooftop solar customers expected to experience some level of curtailment by 2029[2].

EVs increase maximum demand, particularly during times of peak household energy usage. While smart chargers will help to manage this, the majority of residential EVs currently use convenience charging, which typically occurs during peak times. This drives the need for network upgrades to manage capacity constraints and avoid equipment failures.

Managing Network Challenges and Maximising CER Integration

Ausgrid's approach to CER integration includes a range of initiatives to effectively integrate CER, manage the risks and opportunities of the accelerated adoption of CER. Our business strategy prioritises incentives to reduce the need for network augmentation and offers a wide range of network solutions to manage voltage non-compliance and capacity constraints due to increasing CER.

1. AEMO, 2023 - 24 inputs, assumptions and scenarios report, 2023, https://aemo.com.au/en/energy-systems/major-publications/integrated-system -plan-isp/2024-integrated-system-plan-isp/current-inputs-assumptions-and-scenarios

2. Ausgrid, 2023, Att. 5.7: CER Integration Program, https://www.aer.gov.au/system/files/Ausgrid%20-%20Att.%205.7%20-%20CER%20integration%20program%20-%2031%20Jan%202023%20-%20Public.pdf

Key initiatives include:

- **Innovative Pricing Options**
  Simplify tariffs and offer cost-reflective pricing to manage peak demand and reduce costs
- **Coordination and Collaboration**
  Enhance planning data transparency and improve network visibility through increased measurement and data sources
- **Improved Network Visibility and Voltage Management**
  Invest in dynamic voltage management tools and processes to maintain network stability.
- **Transition from Load Control to Flexibility**
  Develop incentives for flexible load and generation, adapting to smart meter adoption
- **Investment in Grid Enhancement**
  Address voltage and thermal constraints to support increasing rooftop solar and EV adoption.

The AER assessed Ausgrid's 2024-29 period regulatory proposal and determined that the requested funding for dealing with EV constraints was not required. Despite this, Ausgrid will continue to assess the needs of our customers and seek efficient methods to maintain reliable power supply, including monitoring and adjustment of our plans as CER uptake and usage patterns evolve.

1.3 Reducing Cost of Living Pressures

1.3.1 Addressing Affordability Challenges in the Energy Transition

Affordability continues to be a challenge during the energy transition, largely due to factors beyond our control, such as:

- Rising costs driven by inflation and increasing interest rates.
- The potential impact of additional investments in transmission and generation costs on energy bills.
- The need to balance achieving net-zero targets with maintaining affordable electricity for all customers.
- The impact on customers that do not have access to rooftop solar, home batteries and EV charging at home.

To maintain downward pressure on prices, Ausgrid will focus on:

- Making adoption of EV possible for more customers, through the availability of EV public charging.
- Making the benefits of CER available to other customers, through the use of community batteries and energy as a service.
- Offering dynamic connections, tariffs and coordinated management of CER, to improve the utilisation of existing infrastructure and reduce the need for network investments.
- Providing greater transparency of available capacity to encourage customers that have the option of where to connect, to locations where capacity is available, reducing the need for greater network investment.

The total revenue approved by the AER in its final decision is expected to result in an average increase of $14 per annum ($ nominal) to the average electricity bill for Ausgrid residential customers over the 2024–29 period. For small business customers, the impact would be an increase on average of $38 per annum ($ nominal).

Amplify Value

- Investing in new grid capacity where it provides the highest net benefit for customers.
- Dynamically managing our grid to unlock the most value out of what has already been build.

Powering Progress

- Improve asset management and resilience strategies.
- Drive technology advancements and operational efficiency.

Stakeholder Synergy

- Foster stakeholder engagement so we understand their priorities and focus on high-value, aligned opportunities.

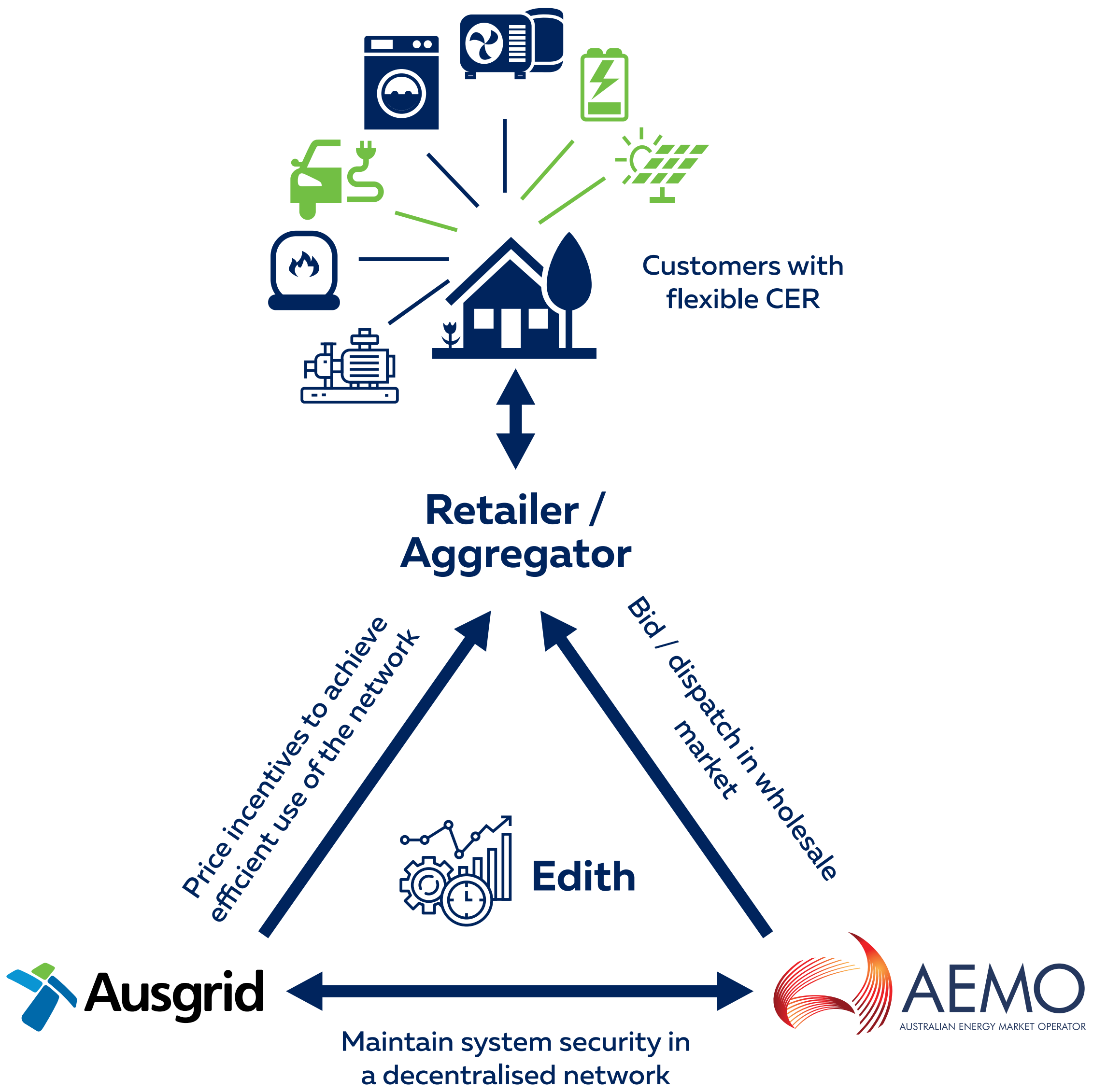
1.3.2 Participation of Customers in Energy Markets

As part of Ausgrid's commitment to innovation, we are developing tariffs that encourage customer participation in energy markets. Traditional network tariffs often create barriers, so Ausgrid aims to support the shift to a two-sided market by introducing more flexible solutions that benefit customers and the network.

Project Edith has successfully demonstrated the dynamic network pricing concept and is now expanding to include over 1,000 participating customers.

The project aims to explore the following:

- Implementing dynamic pricing options for customers with flexible Customer Energy Resources (CER) managed by retailers or aggregators, encouraging load shifting and providing network support during constraints.
- Supporting CER in participating actively in energy markets.
- Adopting a decentralised approach to managing network capacity at a local level.
- Utilising network assets and CER to manage voltage across the network dynamically.
- Providing customised connection agreements for customers who demonstrate significant flexibility in their network usage, rewarding efficient performance.



1.4 Enhancing Network Resilience

Ausgrid's Climate Resilience Program seeks to build resilience that maintains service levels in the face of climate change.

Ausgrid's climate change modelling indicates that our risk from climate related events will grow on average by 1 percent each year. Already, 62 percent of supply outages to customers are caused by climate related weather events.

Ausgrid's approach to build resilience includes a spectrum of resilience solutions that range from investments in the network, improving how we respond during outages, and community-based solutions to help communities be more resilient (see figure below).

Ausgrid also continues to be a proactive participant in the development of the NSW Reconstruction Authority Disaster Adaptation Plans, including assessment of distributor/telco co-dependencies. We are encouraged that the Australian Energy Regulator has recently published a value for network resilience and will continue to advocate for an evolving regulatory landscape to provide more equitable services for customers.

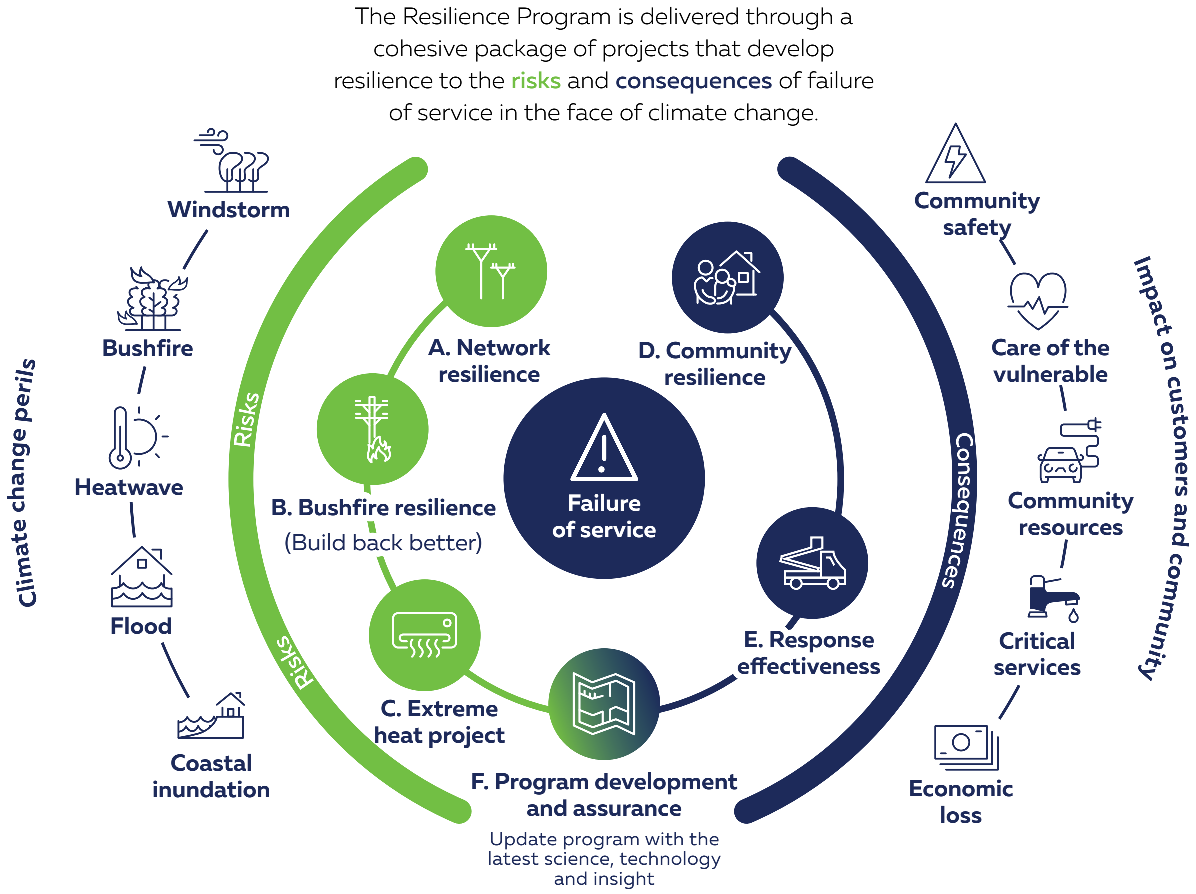
During FY25-29 Ausgrid will invest $52M in network resilience and $6M in non-network solutions including:

Replacement of over 100 km of bare HV conductors with Covered Conductors to mitigate faults caused by vegetation, install an additional 40 Reclosers to prevent outages for customers upstream of a fault, and small sections of HV undergrounding to mitigate windstorm impacts on poor performing HV power lines

Improving resilience of 3000 poles using fire resistant wraps.

Installation of over 600 line fault indicators that will assist the effective deployment of crews during major storms and large incidents.

A suite of customer prioritised initiatives to help withstand the impacts of prolonged outages. A local liaison function will work within vulnerable areas to support blackout planning, targeted communications and education for priority cohorts (e.g. life support customers)



1.5 Advancement Through Innovation

1.5.1 Network Digitisation

Ausgrid's longstanding commitment to innovation continues in 2024. There is an ongoing focus on delivering our digital twin, deploying advanced network technology, drones, as well as new big data platforms supported by artificial intelligence and machine learning to analyse and gain insights on how the network is performing for our customers.

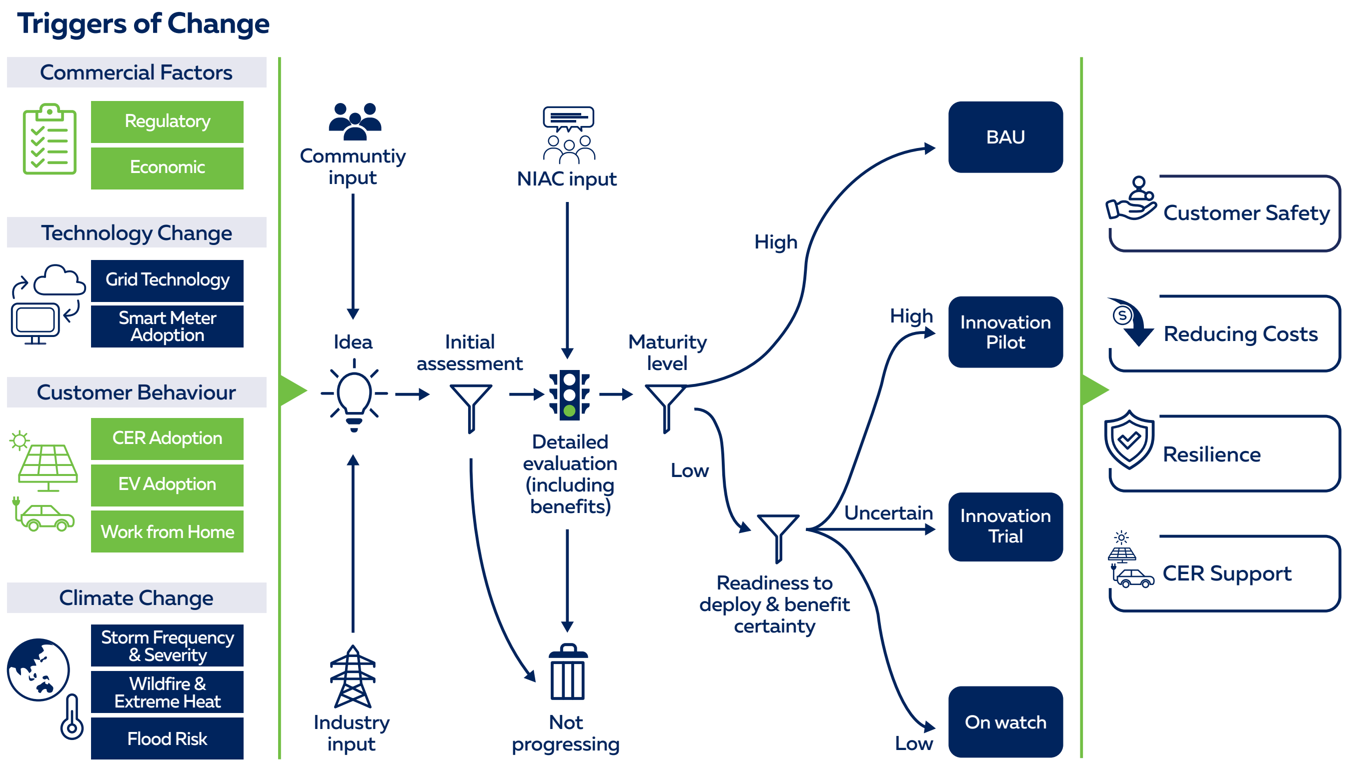
Ausgrid's Network Digitisation Program harnesses spatial, physical and electrical information to improve reliability and affordability for our customers. Key components include:

- Streamlining mass data acquisition of our assets and their environment to develop mutually beneficial outcomes for our customers and other stakeholders. This includes capture of imagery, video and 3D spatial models using Light Detection and Ranging (**LiDAR**) technology.
- Operating a fleet of advanced drones to deliver asset inspections, data capture and operational support, to improve customer reliability and safety particularly through management of bushfire risk in remote areas.
- Deploying our latest digital twin model to deliver analytic insights using artificial intelligence and machine learning to reduce cost and risk across a multitude of use cases, reducing the need for site inspections and identifying potential asset failures or outages.

1.5.2 Innovation

Ausgrid's Network Innovation Program is a suite of research, trials and pilots covering leading edge technologies aimed at better meeting the needs and expectations of our customers in the context of the rapidly evolving electricity sector. The purpose of the program is to test advanced and emerging technologies to efficiently demonstrate the potential of these technologies to deliver significant benefits to our customers and the wider energy market if deployed at scale.

- Projects are grouped into thematic workstreams largely grouped in the following areas e.g. Advanced Voltage Regulation, Network Insights, Fringe of Grid Optimisation, Microgrid Trial, Asset Condition Monitoring, Line Fault Indicators, Dynamic Load Control.
- Advanced Voltage Regulation (**AVR**): 5 x AVR schemes commissioned at various zone substations and data collection commenced, 2 x under frequency load shedding (**UFLS**) blocking schemes commissioned, 3 x Pole Mounted Batteries completed in FY24.
- Network Insights: Distribution Monitoring & Control refurbishments completed with 101 kiosks & 10 chamber substations retrofitted to date, 740 Pole Top monitors installed on LV network.
- Fringe of Grid Optimisation: 3 x SAPS, commissioned with a further 7 under construction.
- LV Microgrid Trial: Microgrid at Merriwa township in Upper Hunter currently under construction.
- Dynamic Load Control: Published revised Customer Supply Standard ES7 Network Price Guide permitting Solar Soak controlled load tariff. Trials underway with participating retailers post July 2024 changes.
- Asset Condition Monitoring: Smart meter data volumes continue to increase enabling analytics platforms to proactively identify "Loss of Neutral" safety events.
- Line Fault Indicators (**LFI**): 7 smart LFI devices now in service with successful connection to Advanced Distribution Management System (**ADMS**).



2. Network Demand and Limitations

2.1 Identified System Limitations

This section is now part of our web-based portal located at https://dtapr.ausgrid.com.au, and should be viewed in conjunction with the rating and demand forecast data files which are available for download from Ausgrid's website at www.ausgrid.com.au/DTAPR, and as outlined in Appendix B.

DNSPs are required to provide information on anticipated system limitations in this Annual Planning Report (refer NER Schedule 5.8, clause (c)). Under the former licence conditions and planning standards, system limitations could be readily identified as constraints, due to the nature of the deterministic approach. However, with the removal of those standards, Ausgrid has adopted a probabilistic planning methodology, based on the AER suggested approach of assessing risk of expected unserved energy (**EUE**) against the value of customer reliability (**VCR**).

In relation to the timing of anticipated system limitations, for the purpose of this Annual Planning Report, the proposed investment date is reported as determined by the cost / benefit analysis as part of the probabilistic planning methodology. Where appropriate, the date is adjusted to consider resourcing and the timing for delivery.

Consideration of remedial action is required when network limitations are identified due to loading, connection of customers, deteriorating condition/performance or reliability. Identified limitations and indicative solutions are listed in the web-based portal, listing the following information:

- Substation – the name of the location, usually a zone or subtransmission substation;
- Feeder – the name of the feeder, indicating the location of the feeder;
- Timing – the identified need date by which a solution is planned to be implemented; and
- System limitation – an identified network need.

2.2 Dual Function Assets

2.2.1 Changes in Dual Function Asset Status

The list of Ausgrid's dual function assets is reviewed periodically and is used as input for preparing Ausgrid's regulatory reporting, regulatory submission and pricing methodology. For the purpose of the regulatory submission, the list of dual function assets is determined based on the forecast load and system configuration as at the beginning of the regulatory period.

Ausgrid's dual function network is defined as those assets with a voltage 66kV and above that are owned by Ausgrid and operate in parallel with and provide material support to the Transgrid transmission network.

These assets may either operate in parallel with the transmission network during normal system conditions, or can be configured so that they operate in parallel during specific system conditions.

An asset is deemed to provide material support to the Transgrid transmission network if:

- there is otherwise limited or no system redundancy within Transgrid's network, or
- investment in the transmission system would be required within the regulatory period if that network asset did not exist, or
- the feeder provides operational support to the transmission network (e.g. to facilitate maintenance of transmission assets or improve security of supply) and the asset provides an effective parallel with the transmission network via a relatively low impedance path.

There have been no changes in dual function asset status since the publication of the December 2023 DTAPR.

2.2.2 Dual Function Connection Points

The NER requires a TNSP to set out planning proposals for dual function connection points.

Ausgrid's joint planning with customers, Transgrid and other NSPs may involve the establishment of new connection points. These augmentations are driven by constraints on the distribution network. However, when the augmentation options are considered in the future, the preferred solution may comprise a mix of dual function and distribution network augmentations.

Planning of new or augmented connections involves consultation between Ausgrid and the connecting party, the determination of technical requirements, and the completion of connection agreements. New connections can result from joint planning with Transgrid, other DNSPs, or be initiated by generators or customers through the application to connect process.

Completed New Dual Function Connection Points

Refer to Section 6.5 of this report.

Proposed Augmentation of Existing Dual Function Connection Points

Ausgrid has identified the need to establish a new 132/33kV subtransmission substation (**STS**) in the Macquarie area due to load growth. Refer to Section 6.1 of this report.

The project to install a third 132/33kV transformer at Macquarie 132/33kV STS due to load growth became committed in 2024.

Committed New Dual Function Connection Points

There are no committed projects for new dual function connection points since the publication of the December 2023 DTAPR.

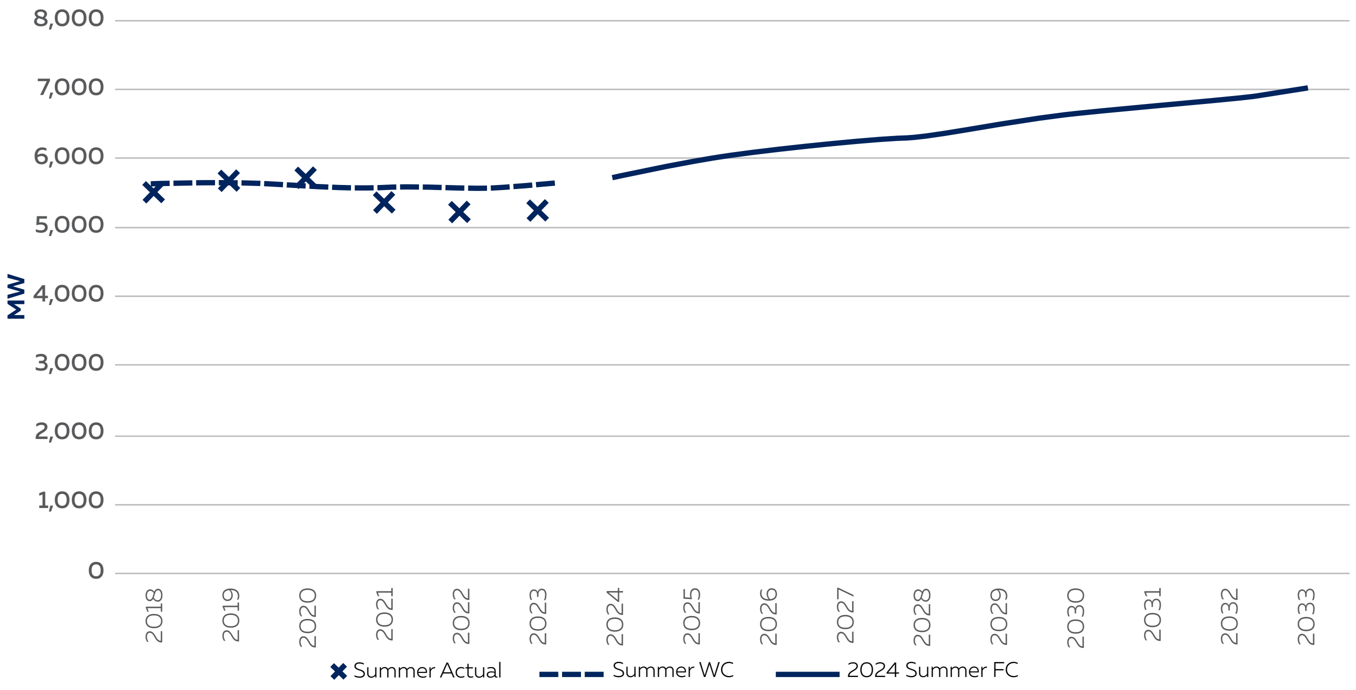
2.2.3 Inter-network Impact

The Augmentation proposals described in this report are reliability projects and do not have a detrimental material inter-network impact.

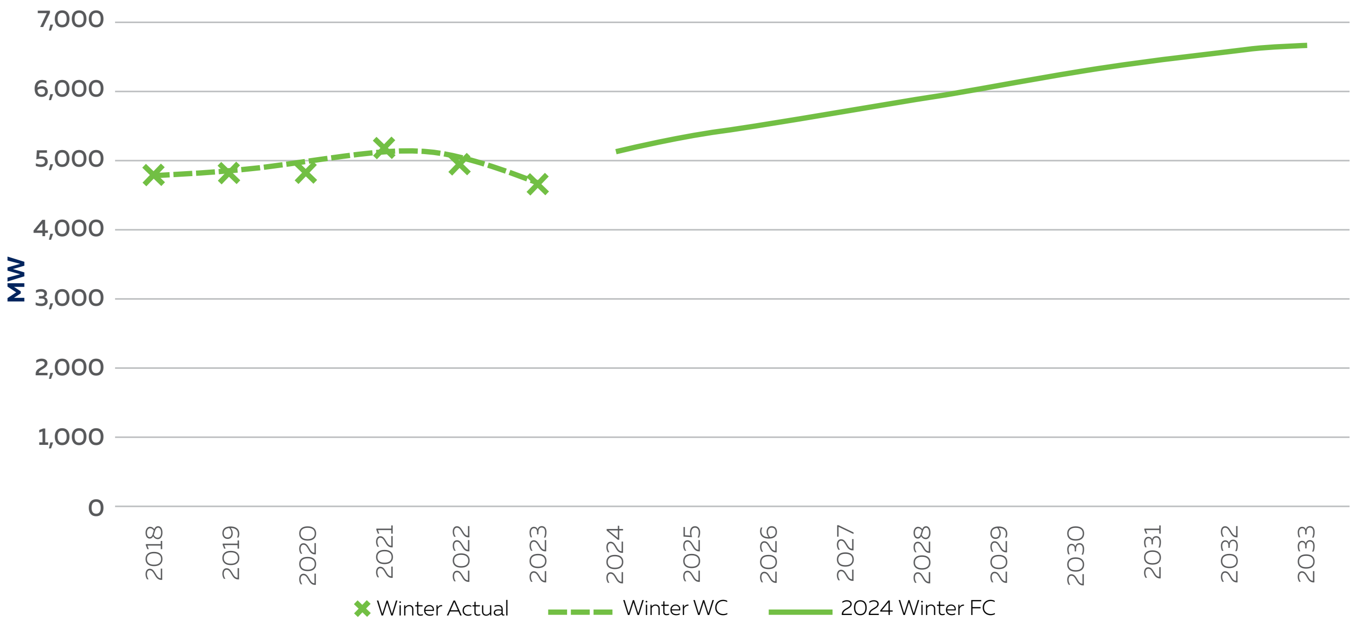
2.3 Ausgrid System Total Maximum Demand Forecasts

The forecast system total summer maximum demand and the system total winter maximum demand is shown below. Each chart displays the actual and weather corrected actual maximum demand to 2022/23 and the 50% Probability of Exceedance (PoE) forecast maximum demand Step Change scenario from 2023/24 in megawatts (MW).

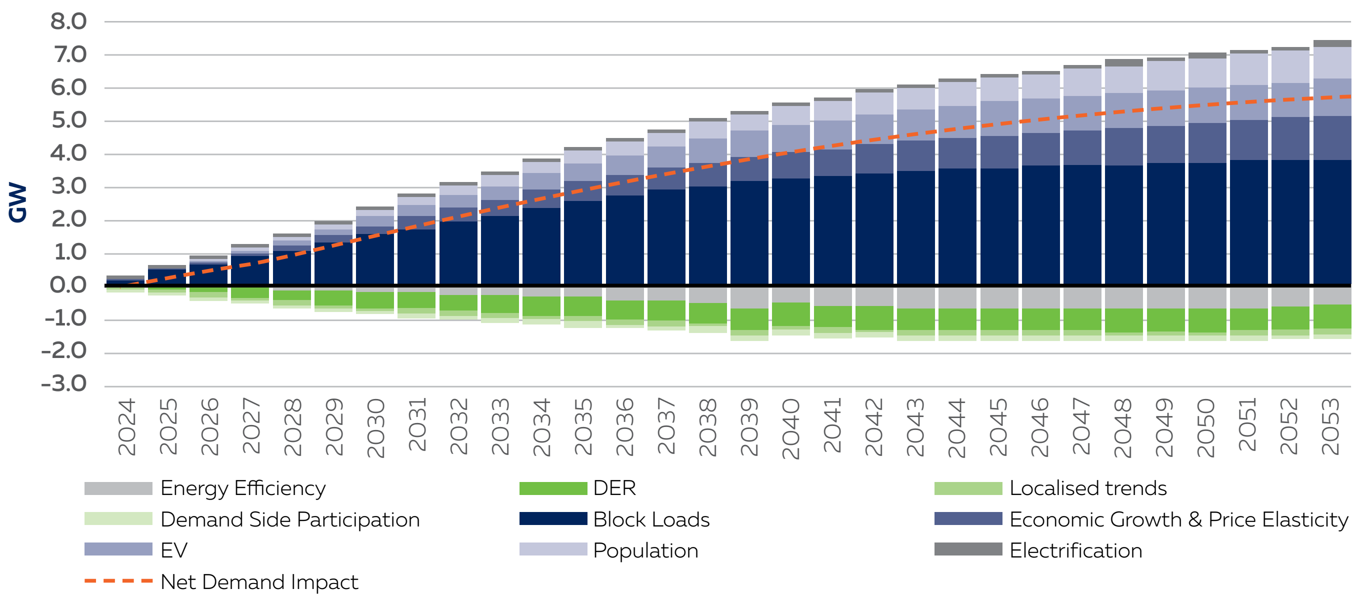
2024 Step Change Maximum Demand Summer



2024 Step Change Maximum Demand Winter



The forecast system total summer maximum demand components are shown below. This chart displays the contribution of each forecast element in each year out of 2053 based on the 50% Probability of Exceedance (PoE) forecast maximum demand Step Change scenario from 2023/24 in megawatts (MW).



2.4 Frequency Control and Load Shedding

Emergency control schemes are designed to make decisions across various scenarios so as to prevent the system from experiencing undesired conditions, particularly to prevent large catastrophic disturbances. As a transmission network service provider, Ausgrid has implemented various control schemes aimed at maintaining system security. Some emergency control schemes that have been implemented or proposed to be implemented are described as below.

- **Network switching and splitting:** To prevent circuits tripping due to thermal overloads as a preventive measure to ensure frequency control within limits, thus maintaining system stability during high-demand periods or network outages.
- **UFLS schemes:** UFLS schemes are widely implemented across most zone and subtransmission substations. They will be implemented on existing substations when an opportunity arises during augmentation or replacement works. Given the rising penetration of photovoltaic, Ausgrid has started enhancing new UFLS schemes with reverse power flow blocking mechanisms to prevent unnecessary load shedding. This improvement addresses the challenges posed by increasing 'behind-the-meter' generation and is also being considered for retrofit at substations experiencing or anticipated to experience reverse power issues. This proactive approach has been integrated into Ausgrid's planning process, and enhancements are implemented wherever feasible.
- **Joint planning:** In collaboration with Transgrid, Ausgrid engages in joint planning efforts to identify and implement load-shedding schemes in alignment with connection agreements. This ensures that load-shedding strategies are coordinated across network boundaries.

2.5 Stability

As per NER S5.1.8, the network service providers are required to plan and operate their network in a manner that supports stable operation of the national grid, following three criteria. Ausgrid coordinates closely with Transgrid as part of joint planning process to ensure power system stability is maintained.

- **Power system synchronism:** To ensure system synchronism, Ausgrid has taken proactive measures to avoid conditions that could disrupt synchronised operation. During this period, no new generators or major system augmentations were commissioned that would impact system synchronism.
- **Adequate damping of power system oscillations:** Ensuring adequate damping is essential to prevent oscillations that could lead to system instability. Ausgrid confirms that no new generators or major augmentations were introduced during this period that would impact the damping of power system oscillations, maintaining stability across the network.
- **Voltage stability criteria:** Voltage stability is critical for reliable operation, requiring that voltage remains within acceptable limits during normal conditions and in the event of the loss of a single network element. Ausgrid conducts regular QV (reactive power vs. voltage) analysis to verify that there is adequate reactive margin at each 132kV bus within the network. The margin criterion specifies that reactive margin, expressed in megavolt-amperes reactive (**MVAr**), should be less than one percent of the maximum fault level (in megavolt-amperes (**MVA**)) at each connection point. Based on the latest QV analysis, Ausgrid has determined that all 132kV buses have sufficient reactive margin, ensuring voltage stability across the network. To address potential reactive power needs, Ausgrid also considers the strategic installation of shunt reactors and capacitors where necessary. The current analysis confirms that reactive margin is adequate, with no immediate need for additional reactive support across Ausgrid network.

2.6 Primary Distribution Feeder Limitations

2.6.1 Maximum Demand and Load Growth

There are three (3) primary distribution feeders that have either exceeded 100% of their normal cyclic rating in the last year, or are forecast to exceed 100% of their normal cyclic rating over the next two years during normal conditions (N-state). In addition there are (111) primary distribution feeders that have either exceeded their rating in the last year, or are forecast to exceed their rating over the next two years during contingency conditions (N-1 state). Projects have been issued to resolve seventeen (17) of these identified issues, and the remaining are under investigation. These are outlined in the 11kV Primary Distribution Feeder Capacity data file which is available for download from Ausgrid's website at www.ausgrid.com.au/DTAPR.

Distribution feeders are proactively planned to remain within their ratings by performing regular assessment of the existing and proposed feeder network. Planning includes annual assessment of network performance; more detailed strategic area studies (for areas with a high level of activity and multiple interrelated risks); and localised assessments, generally triggered by requests for HV connections. Where risk is identified, options for network rearrangement, demand management and augmentation are considered to identify the most economic option to address the risk.

Ausgrid has developed a 'load-at-risk' assessment tool that is able to systematically test contingency (N-1) scenarios to determine the post-contingency utilisation of each primary distribution feeder and the load reduction required to maintain the network within ratings in each case. We then undertake a planning investigation where primary distribution feeders are identified with load at risk.

2.6.2 Provision of Distribution Services for Embedded Generating Units

There are no (0) limitations, current or forecast, identified on HV primary distribution feeders related to the provision of services for embedded generation. At this stage, the limitations associated with provision of embedded generations services on Ausgrid's network are predominately occurring on the LV network.

To identify limitations, Ausgrid determined the existing and forecast growth in demand for embedded generating services by customer segment, and then modelled the demand for services at a customer level during peak and minimum load conditions to identify limitations.

These simulations are computationally intensive as they rely on substantial (often incomplete) data sets that incorporate both HV and LV networks. It takes a number of weeks to collate the data and build each model. A typical network model for an area requires over 5 gigabytes of data and each simulation takes several hours to solve. We are continuing to develop our tools and methodologies for hosting capacity assessments.

3. Network Performance

3.1 Reliability Measures and Standards

Ausgrid seeks to comply with regulatory requirements at reasonable costs, given the condition and utilisation of existing network assets and the funding available to maintain and augment the electricity network.

Under the NSW Reliability and Performance (**R&P**) Licence Conditions for Electricity Distributors[3], Ausgrid is required to comply with specific targets for reliability standards and individual feeder standards. The purpose of the licence conditions is to facilitate the delivery of a safe and reliable supply of electricity. Ausgrid is required to report to the Minister to ensure compliance with the R&P licence conditions.

Under the NER, and the Service Target Performance Incentive Scheme (**STPIS**), Ausgrid is given financial incentives to improve customers' reliability performance compared to historic outcomes over time (as well as penalties if the performance level deteriorates).

Reliability measures used are System Average Interruption Duration Index (**SAIDI**), or minutes off supply for the average customer, and System Average Interruption Frequency Index (**SAIFI**), or number of interruptions experienced by the average customer. The reliability performance is monitored at distribution feeder level for unplanned interruptions (excluding major event days, planned interruptions and circumstances beyond the reasonable control of the electricity distributor).

Until the 30th of June 2024 the individual feeders were categorised as CBD (Sydney CBD), Urban, Short Rural, Long Rural and Low Voltage Stand Alone Power Supplies (**LV SAPS**). This was based on feeder length, load density and connectivity. The Ausgrid distribution network consisted of 57 CBD feeders, 1855 Urban feeders, 462 Short Rural feeders, 5 Long Rural feeders, and 3 LV SAPS. Since the first of July 2024 there is a different form of feeder classification. There are CBD feeders that retain the existing requirements and definition as previously and non-CBD feeders that have SAIDI and SAIFI thresholds that vary and are based on their feeder length. LV SAPS also retain their existing requirements.

Our customers must plan around the possibility that the electricity supply may not always be available and that interruptions could occur without notice, or with notice in accordance with their supply contract.

3. The Minister for Energy established licence conditions for distribution network service providers on 1 August 2005 (revised December 2007, July 2014,for the Ausgrid Operator Partnership ("Ausgrid") on 1 December 2016, and for the operator of a transacted business on 4 December 2017. These were further amended in February 2019, October 2022 and September 2023). See: https://www.ipart.nsw.gov.au/Home/Industries/Energy/Energy-Networks-Safety-Reliability-and-Compliance/Electricity-networks/Licence-Conditions-and-Regulatory-Instruments

3.1.1 Supply Reliability Standards

Average Feeder Category Reliability Standards

The purpose of the R&P licence condition Section 6.1 – "Network Overall Reliability Standards" is to:

Define minimum average reliability performance, by feeder type, for a distribution network service provider across its distribution network and provide a basis against which a distribution network service provider's reliability performance can be assessed.

Average Reliability Standards				
	CBD	Urban	Short Rural	Long Rural
SAIDI	45	80	300	700
SAIFI	0.30	1.20	3.20	6.00

Individual Feeder Standards

The purpose of the R&P licence condition Section 6.2 – "Individual Feeder Standards" is to:

- Specify minimum standards of reliability performance for individual feeders;
- Require a distribution network service provider to focus continually on improving the reliability of its feeders, and
- Enable the reliability performance of feeders to be monitored over time.

Individual Feeder Standards					
	CBD	Urban	Short Rural	Long Rural	LV SAPS
SAIDI	100	350	1000	1400	1817
SAIFI	1.4	4	8	10	9.4

Individual Customer Standards

The purpose of the R&P licence condition Section 6.7 – "Individual Customer Standards" is to:

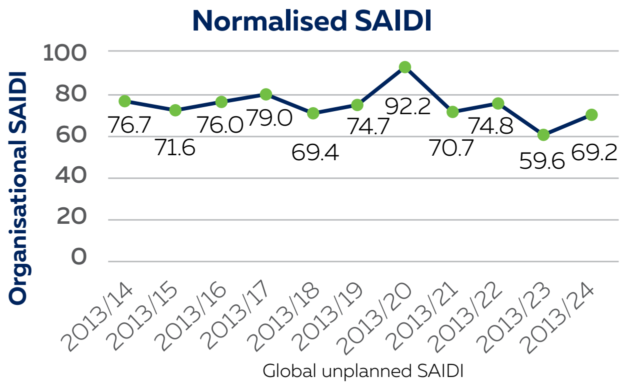
- Specify minimum standards of reliability performance for individual customers;
- Require a distribution network service provider to focus continually on improving the reliability of its customers, and
- Enable the reliability performance of customers to be monitored over time.

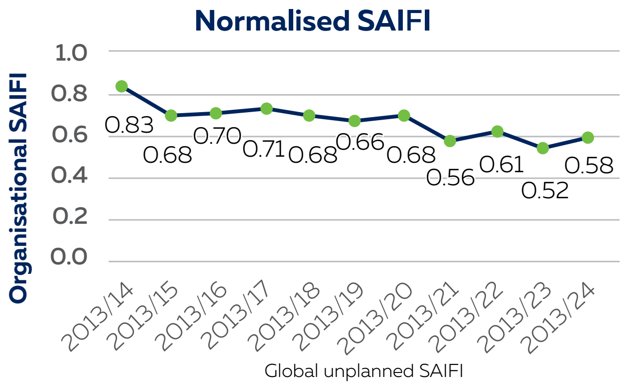
Individual Customer Standards		
	Minutes Interrupted	Number of Interruptions
Metro	350	4
Non-metro	1000	8

3.1.2 Network Supply Reliability Performance in the Preceding Year

SAIDI & SAIFI Performance

The following graphs depict the normalised (i.e. Major Event Days data excluded) SAIDI and SAIFI trends over the period 2013/14 to 2023/24.





Major Event Days

Ausgrid uses the methodology described in IEEE 1366 standard for defining Major Event Days, as outlined in the R&P licence conditions and AER STPIS Definitions.

There were two Major Event Days for 2023/24.

Major Event Days During 2023/24		
Date	Excluded SAIDI	Cause of Major Event Day
30/08/2023	3.01	Storm
06/04/2024	5.10	Storm

Individual Feeder Reliability Performance

As required under the R&P Licence Conditions for Ausgrid, each feeder currently exceeding the Individual Feeder Standard is analysed and an investigation report identifying the causes and, as appropriate, any action required to improve the poor performance is reported in the next quarterly performance report. The majority of feeder exceedances were determined to be random events and action was limited to monitoring ongoing reliability performance. A small number of feeders required remedial actions such as vegetation management and repairs to network assets or capital works.

All required actions were completed in the timeframes required.

Ausgrid has an ongoing reliability management program that targets those feeders that have exceeded the Individual Feeder Standards as outlined in Schedule 3 of the R&P Licence Conditions. The individual feeder performance against the standard is given in the table below.

Individual feeder performance against the standard FY24					
	CBD	Urban	Short Rural	Long Rural	SAPS
Feeders (Total Number)	57	1,855	462	5	3
Feeders that Exceeded the Standard during the Year	5	48	9	1	0
Feeders Not Immediately Investigated	0	0	0	0	0
Feeders Not Subject to a Completed investigation report by the Due Date	0	0	0	0	0
Feeder Not having Identified Operational Actions Completed by Due Date	0	0	0	0	0
Feeders Not having a Project Plan Completed by Due Date	0	0	0	0	0

Feeder Categories Reliability Performance

All feeder category performances were compliant against the NSW R&P Reliability Standards.

Whole organisation and feeder category reliability performance						
12-month period to end of June 2023						
		ORG*	CBD	Urban	Short Rural	Long Rural
SAIDI	Actual	69.15	35.05	57.46	115.95	694.81
	Licence Conditions standard		45	80	300	700
SAIFI	Actual	0.58	0.12	0.51	0.89	3.09
	Licence Conditions standard		0.3	1.20	3.20	6.00

Note: *Refers to the average performance of the organisation overall. This measure does not form part of the licence conditions but is needed to calculate the overall NSW result.

Ausgrid's 2023/24 performance results were within the required levels for all metrics.

Individual Customer Standards Performance

As required under the R&P Licence Conditions for Ausgrid, customers currently exceeding the Individual Customer Standard is analysed and an investigation report identifying the causes and, as appropriate, any action required to improve the poor performance is reported in the next quarterly performance report.

The individual customer performance against the standard is given in the table below.

Individual Customer performance against the standard during 2023/24		
	Metro	Non Metro
Customers that Exceeded the Standard during the Year	0	0
Customers Not having a Project Plan Completed by Due Date	0	0

3.1.3 STPIS

The AER's distribution STPIS provides a financial incentive for Ausgrid to maintain or improve its reliability and customer service performance over time. As part of the AER final determination for Ausgrid, the AER set elements of the STPIS for the 2019/20 – 2023/24 period including at-risk revenue caps, reliability targets, and customer service targets. The revenue at risk for each regulatory year is capped at 5 percent with a 4.5 percent cap for the reliability of supply component and 0.5 percent cap for the customer service component.

The SAIDI and SAIFI targets set by the AER in their final determination for each feeder category for the reliability component of the STPIS are set out in the tables below[4].

STPIS results – Unplanned SAIDI Targets vs Actuals				
	2022/23		2023/24	
	Target	Actual	Target	Actual
CBD	9.09	11.69	9.09	35.05
Urban	59.91	52.96	59.91	57.46
Short Rural	127.96	91.90	127.96	115.95
Long Rural	496.12	909.32	496.12	694.81

STPIS results – Unplanned SAIFI Targets vs Actuals				
	2022/23		2023/24	
	Target	Actual	Target	Actual
CBD	0.038	0.05	0.038	0.12
Urban	0.603	0.47	0.603	0.51
Short Rural	1.139	0.79	1.139	0.89
Long Rural	2.481	2.04	2.481	3.09

3.1.4 Forecast Of Network Reliability Performance

Ausgrid's Reliability Forecasting System (**RFS**) forecasts the reliability performance of each feeder category based on 5 years of historical performance.

Average minutes of supply interruption per customer per year	
SAIDI	2024/25
System	73
CBD	13
Urban	63
Short Rural	126
Long Rural	887

Average number of network interruptions per customer per year	
SAIFI	2024/25
System	0.59
CBD	0.04
Urban	0.54
Short Rural	0.90
Long Rural	2.44

4. Table extracted from the AER's Final Decision Ausgrid Determination 2019-24 Attachment 10 Table10.2 – Service Target Performance Incentive Scheme.

Where a shortfall in reliability is identified for feeder category performance, improvement methods may include:

- Improvements of individual feeder performance - affecting a sufficient number of individual feeders to influence the category average, or
- Improvements at a sub-transmission level, or
- Improvements with widespread impacts such as operating policy and its implementation, SCADA systems, and the development of intelligent network options.

Project proposals within these three categories are short-listed and the anticipated cost benefit of each option is estimated. The cost estimates are based on standard unit costs and adjusted to reflect, to the extent practicable, the realities of implementing the solution.

3.1.5 Compliance with Network Reliability Standards

Ausgrid monitors feeder outages and records the duration of outage events into the Outage Management System (**OMS**). For reliability reporting purposes, the network performance is measured at the distribution feeder level.

Excluding any excluded events, including planned interruptions and Major Event Days, the recorded outage information provides Ausgrid with the frequency and duration of feeder outages that are used to determine the SAIDI and SAIFI of individual feeders. In turn these individual feeders are grouped into categories, to enable an average SAIDI and SAIFI to be determined for each feeder category (CBD, Urban, Short Rural and Long Rural).

Every quarter Ausgrid submits a report stating the business performance against the overall Reliability, Individual Feeder and Customer Service Standards to Independent Pricing and Regulatory Tribunal (**IPART**) and the Minister administering the Electricity Supply Act 1995 within one month of the end of each quarter.

The report lists performance against the pro-rata SAIDI and SAIFI average standards, along with any reasons for non-compliance and Ausgrid's plans to improve the feeder performance. Similarly, the Individual Feeder document details the date at which a feeder first exceeded the relevant Individual feeder standard and the SAIDI and SAIFI performance for that 12-month period, including details of the remedial action to be taken to improve performance, and the planned date of completion for the action plan. Typical remedial action plans include either operational and/or capital expenditure, or alternatively there is the option of a non-network solution.

Operational work may include works like vegetation maintenance or critical repairs to electrical mains and apparatus. Any identified and reported operational work is due to be completed by the end of the third quarter following the feeder first exceeding the individual feeder standards.

Capital expenditure to improve feeder reliability can be in the form of a network augmentation project involving feeder reclosers or covered overhead mains to prevent or correct some known outage triggers. Any required capital work is to be developed, planned and commenced by the end of the second quarter following the feeder first exceeding the individual feeder standards. Some investigations find that a feeder outage occurred due to a one-off event that is not likely to occur again.

Non-network solutions may include energy storage systems to provide ride-through capability during outages.

3.2 Quality of Supply Standards

Ausgrid's makes best endeavours to provide a service that meets quality of supply standards of our electricity network within available funding, asset conditions and utilisation. Ausgrid's network standard NS 238 Supply Quality[5] sets out Ausgrid's standards for Quality of Supply which customers can expect from Ausgrid's network covering the performance of the network in terms of steady state voltages, voltage unbalance, harmonic distortion, and rapid voltage variation. The quality of supply is determined by the characteristics of connected loads, the network configuration and network events.

Ausgrid does not control the frequency on the electricity supplied through its electricity network, as this standard is set during the electricity generation process. The Australian Energy Market Commission (**AEMC**) establishes standards and regulates the frequency of supply[6] on the national grid.

3.2.1 Voltage Range for Supplied Electricity

Supply voltage is the voltage, from phase to neutral or phase to phase, for electricity that is supplied at a customer's point of supply. Maintaining the steady state supply voltage is important to ensure the customer experience, and the efficiency and stability of the network. When Ausgrid identifies or is notified that the steady state supply voltage is outside the specified target range, Ausgrid will investigate by carrying out relevant measurements on the network in conjunction with the existing network monitoring to determine the remediation necessary. An increase in solar PV installations made steady state voltage the most prominent quality of supply parameter.

Low Voltage Network

Ausgrid's objective for the operation of its network is to maintain a target steady state phase to neutral supply voltage (measured as a ten-minute average) within the range of 216V to 253V at customers' points of supply under normal operating conditions. This range is the nominal voltage range of 230V as defined in the relevant Australian Standard AS 61000.3.100, with a tolerance of +10% / -6% to allow for voltage regulation on the mains between distribution substations and customers' points of supply.

The 99th percentile (V99%) of the 10-minute average voltage readings for a 1-week survey should be less than 253V and the 1st percentile (V1%) should be greater than 216V.

High Voltage Network

Ausgrid's high voltage distribution network operates at several voltage ranges. Accordingly, high voltage customers must obtain from Ausgrid the network operating objective for supply voltage applicable to their location, particularly before proceeding with any project expenditure or commitments.

Applicable Quality of Supply Codes, Standards and Guidelines

Ausgrid relies on the following standards and/or guidelines when setting and assessing network voltage performance:

- Network Standard: NS 238 Supply Quality
- Australian Standards: AS/NZS 60038 and AS 61000.3.100
- NER S5.1a.4 – Power Frequency Voltage
- NSW Service and Installation Rules (**SIR**): Section 1.11.1 refers to AS/NZS 600038 & AS 61000.3.100.

3.2.2 Harmonics and Total Harmonic Distortion

Voltage waveform distortion including harmonic distortion results from the operation of appliances or equipment that draw non-sinusoidal currents from the network. Harmonic distortion can cause the supply voltage to depart from a sine wave in a repetitive manner. Maintaining waveform distortion within acceptable limits is important because it can otherwise cause interference and damage to sensitive customer and network equipment. This form of distortion can also cause light flicker, incorrect operation of ripple control devices (used for off peak electric hot water) and computers, audible noise in television, radio and audio equipment and vibration in induction motors.

Applicable Quality of Supply Codes, Standards and Guidelines

Ausgrid relies on the following standards and/or guidelines when limiting and assessing harmonic performance:

- Network Standard: NS 238 Supply Quality
- Australian Standards: TR IEC 61000.3.6:2012, AS 61000.2.2:2023, AS 61000.3.12:2023, SA/SNZ TR IEC 61000.3.14:2013
- NER S5.1a.6 – Voltage Waveform Distortion
- NSW SIR: Section 1.17.2.1 (b) refers to AS/NZS 61000.3.2, 61000.3.4, 61000.3.12.

3.2.3 Voltage Fluctuations (Flicker) – Applicable Quality of Supply Codes, Standards and Guidelines

Ausgrid relies on the following standards and/or guidelines when limiting and assessing Voltage fluctuations performance:

- Network Standard: NS 238 Supply Quality
- Australian Standards: TR IEC 61000.3.7:2012, AS 61000.2.2:2023, AS 61000.3.12:2023, SA/SNZ TR IEC 61000.3.14:2013
- NER S5.1a.5 – Voltage Fluctuations
- NSW SIR: Section 1.17.2.1 (b) refers to AS/NZS 61000.3.3, 61000.3.5, 61000.3.11.

5. https://www.ausgrid.com.au/-/media/Documents/Technical-Documentation/NS/ns238.pdf
6. https://www.aemc.gov.au/australias-energy-market/market-legislation/electricity-guidelines-and-standards/frequency-0

3.2.4 Voltage Unbalance – Applicable Quality of Supply Codes, Standards and Guidelines

Ausgrid relies on the following standards and/or guidelines when limiting and assessing Voltage Unbalance performance:

- Network Standard: NS 238 Supply Quality
- Australian Standards: TR IEC 61000.3.13:2012, AS 61000.2.2, AS 61000.2.12, SA/SNZ TR IEC 61000.3.14:2013
- NER S5.1a.7 – Voltage Unbalance.

3.3 Quality of Supply Performance for Preceding Year

At Ausgrid, monitoring for supply quality is undertaken by a number of means including review of customer complaints, permanent monitoring at selected locations across the network, power quality data from customer smart meters, and participation in the National Power Quality Compliance Audit conducted by the Australian Power Quality Research Centre (**APQRC**) at the University of Wollongong.

Ausgrid has been actively using power quality data from the smart meters. These measurements are used to assess compliance and proactively manage steady state voltage performance especially in the areas with high solar **PV** density.

3.3.1 Supply Voltage Performance

Distribution substations with Voltage monitoring showed 100% of sites met the V1% limit (216 Volts) and 95% of sites met the V99% limit (253 Volts).

In turn, Smart Meter measurements shows that 6.8% of sites have indices which exceed the limit. However, the percentage of sites with non-compliant indices has trended downward this year, continuing a long-term downward trend.

The high penetration of generation across the network is continue create localised voltage issues generally observed by customers experiencing loss of energy exports due to inverter behaviour as prescribed under AS/NZS 4777. During the reporting period a significant number of complaints were received, approximately half of which are solar related. In most cases these were resolved by either changing the Power Quality response modes of the customer's inverter(s) as specified in AS/NZS 4777.2 or by way of 'tap changes' on the customer's supplying transformer.

3.3.2 Harmonic Content of Supply Voltage Waveform

There were no complaints registered for harmonic issues. Harmonics non-compliance levels across the network including MV and HV remain low with performance this year similar to that of last year.

3.3.3 Voltage Fluctuations (Flicker) Performance

There were several complaints registered as being about flicker. None were confirmed to be flicker or fluctuations within the definition of TR IEC 61000.3.7 standard, but rather light flicker caused by ripple control signals for controlling Off peak Hot Water systems.

3.3.4 Voltage Unbalance Performance

Overall, there are no significant issues, however, unbalance levels are increasing, and this year unbalance is the disturbance of most concern from a compliance perspective. 12.8% of LV sites have indices which exceed the limit and a further 2.7% of sites having indices which are within 10% of the limit. In turn, the MV network is seemingly unaffected with most of the sites are well within the corresponding limits.

3.4 Corrective Action Planned to Meet Quality of Supply Standards

3.4.1 Supply Voltage

The increase in CER including small scale solar and batteries is changing customer awareness of network voltages. Ausgrid's voltage management is moving with this change, bridging the gap between network performance and customer expectations whilst developing an end-to-end voltage management strategy. Ausgrid's voltage management has matured in recent time moving away from a reactive approach with peak demand focus to a more proactive approach with focus over the demand cycle. This maturing has been influenced by the changing use of our network, changing customer energy profile and to a great extent to prepare our network for continued change.

Voltage management has several dimensions including.

- Change underlying network ability to host load and generation: network assets, network performance and modelling
- Making sure connections can operate together: connection policy and customer device settings
- Managing CER behaviour: CER management and tariffs and pricing
- Smart devices to smooth the impact of customers behaviour: static synchronous compensators (**STATCOM)**, community batteries and grid batteries

Our Voltage Management Plan includes a holistic end to end approach considering all levels of our network from our connection with TransGrid through to our low voltage customers. This provides an understanding of options available at all network levels and allows for the most efficient option to be identified. Combined models enable HV voltage regulation to be incorporated in the local low voltage network voltage modelling analysis.

Proactively monitoring voltage data from various sources combined with customer complaint data provides a view of our network voltage health. This data provides feedback into our voltage regulation planning: where emerging and forecast issues are identified we can proactively determine options and implement the most efficient option.

As part of the ongoing work Ausgrid is currently undertaking numerous activities to improve supply quality across the network and deliver network functional compliance:

- Joint Planning with Transgrid, optimising BSP voltage settings.
- Optimising STS, ZS and pole top regulator voltage settings.
- Reviewing and updating distribution substation tap settings.
- Utilising our modelling results to prioritize the proactive replacement of low voltage network conductors with small rating, high impedance and high voltage drop.
- Prioritise the proactive replacement of distribution substations with redundant transformer winding ratios.

3.4.2 Flicker, Harmonic and Unbalance

Ausgrid monitors customer complaints and resolves any supply quality issues as they arise.

4. Asset Management

4.1 Ausgrid's Asset Management Approach

The organisation's vision is for communities to have the power in a resilient, affordable, net-zero future. Our asset management objectives are a key enabler of this vision. These objectives are:

Asset Management Objectives	What does this mean?	How will it be achieved?
Enhancing Safety Protecting people from harm so far as is reasonably practicable.	Applying prudent risk management and prioritisation to eliminate safety hazards 'so far as is reasonably practicable' (SFAIRP) to minimise safety incidents.	Improving safety incident performance, applying risk assessments, measuring and monitoring asset failure trends.
Improving Network Performance Improving the reliability, security and resilience of supply to create a better customer experience and meet our obligations to protect our critical infrastructure.	Enhancing the network's ability to accommodate disruptive technology, meet security and resilience requirements, and anticipate and respond to outages to minimise supply interruptions to customers.	Monitoring SAIDI, SAIFI, CAIDI, STPIS performance against guaranteed service levels and asset failure trends to identify and capture strategic improvement opportunities. Monitor compliance against SOCI requirements.
Delivering Affordability Delivering customer affordability through optimisation of whole of life costs and improved operational performance.	Applying prudent risk management, prioritisation, and cost benefit analysis to make balanced investment decisions that avoid boom/bust investment cycles. Streamlining and enhancing processes and systems to capture delivery efficiencies and productivity gains.	Internal and external benchmarking of capex and opex activities.
Increasing Sustainability Transforming the network through reducing emissions and providing choice and control for customers to more easily access sustainable energy.	Investing on a 'no regrets' basis to facilitate: the adoption of new technology and innovation; customer choice in energy services; and support energy decarbonisation to meet our current and future network needs.	Monitoring of system level performance and Board reporting on the State of the Network.
Making a commercial return Provide dividend certainty through effective and optimised investment that responds to incentives.	Ensures that asset management decisions and activities reflect the need to provide dividend investment in the asset base with a focus on certainty to shareholders through optimised responding to incentives.	Monitoring STPIS, CESS, EBSS and EBITDA performance to identify areas requiring improvement and further focus.

Effective asset management practices will be applied across all levels of the organisation to deliver this vision. In providing services to our customers, we manage, operate and maintain a diverse and expansive electricity network. The following diagram outlines how Ausgrid's asset management system structures our approach to apply a systematic, risk based, whole of life approach, which considers stakeholder requirements, regulatory frameworks and embeds continual improvement and innovation to continue to deliver on our strategic objectives in the context of an ever-changing operating environment.

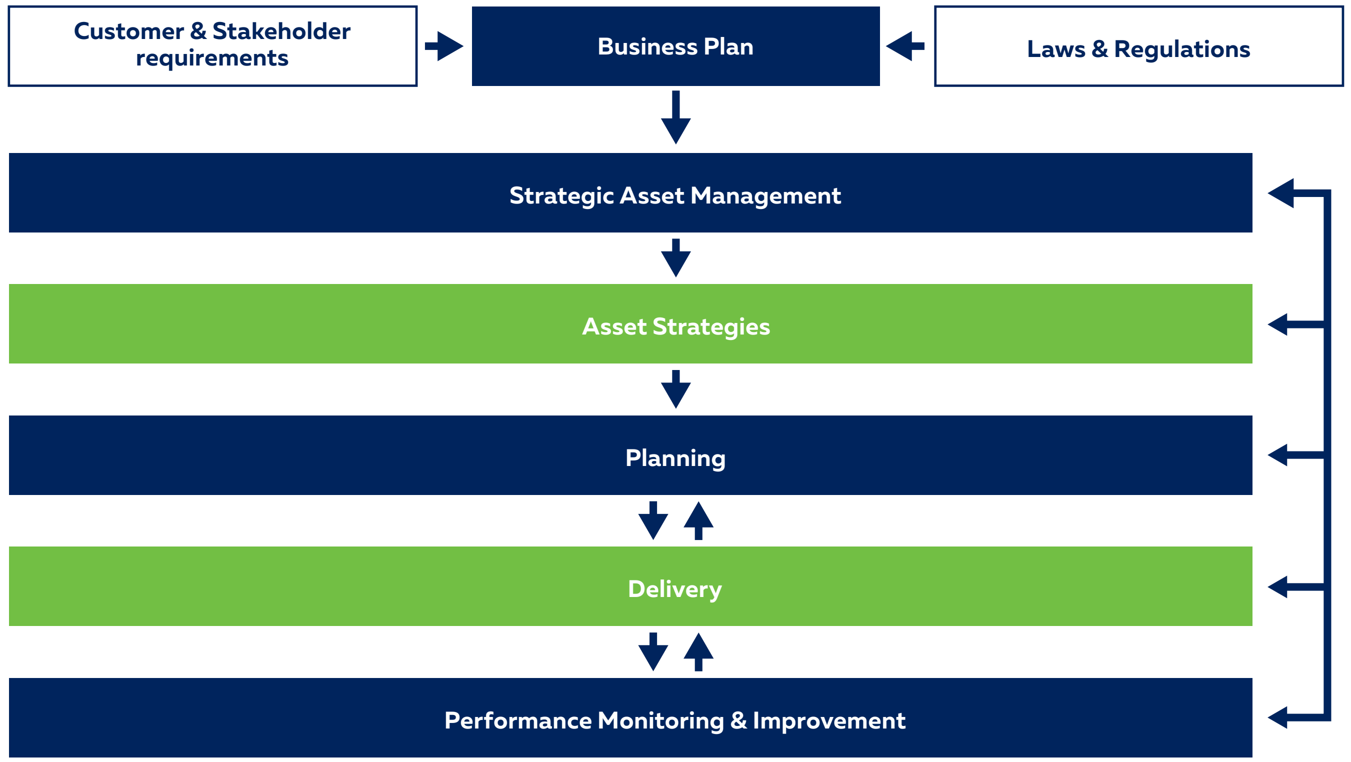


Figure 4-1: Overview of Ausgrid's Asset Management System

This approach also ensures we deliver and align with the NEO and our regulatory and legal requirements, in particular obligations under the WHS Act 2011 and associated regulations, the Electricity Supply (Safety and Network Management) Regulation 2014 (NSW), the NEL and the Electricity Supply Act 1995 (NSW).

Our asset management system, including the strategies, models and processes adopted by Ausgrid, has been certified to conform with the requirements of AS ISO 55001:2014 Asset Management – Management Systems – Requirements in accordance with our Distribution Licence Conditions.

This structured approach to asset management ensures that we continue to deliver on our vision and meet the goals of our customers, shareholders and employees.

4.2 Risk Management Strategies

The asset management objectives captured within the Asset Management System align to the organisation's objectives and risk appetite. Asset decisions are informed through structured risk assessments in accordance with the Risk Management Board Policy and Risk Management Framework. Ausgrid's asset management approach utilises risk management techniques to manage risk within the organisation's Risk Appetite Statement.

Risk management techniques applied to inform asset decision making consistent with the organisation's legislative responsibilities and AS/NZS ISO 31000-2018 Risk Management – Principles and Guidelines for managing risk. Ausgrid applies numerous techniques for managing risk at various scales, leading to various decision pathways across the life cycle of an asset. The asset management system draws on AS/NZS IEC 31010:2020 Risk management — Risk assessment techniques (IEC 31010) to guide a structured approach to decision making. Risk management techniques such as reliability centred maintenance and cost benefit analysis are used to evaluate risks and determine maintenance and investment requirements respectively.

An overview of significant asset class investment strategies is outlined in the following sub-sections.

4.2.1 Sub-transmission Underground Cable Strategy

Ausgrid's sub-transmission cables are an essential part of our supply network. Ausgrid has approximately 1,074km of sub-transmission cables with the majority operating at either 33kV or 132kV and a small number at 66kV. These assets cannot routinely be taken out of service except for brief periods necessitated by the need for maintenance and repair, particularly those which operate at 132kV supplying the inner metropolitan area of Sydney.

There are four cable technology types used for these cables – these are listed below (from oldest to youngest type):

- 166km of self-contained fluid filled (**SCFF**) cables;
- 37km of gas pressure cables;
- 218km of paper insulated, lead covered ('paper lead') cables; and
- 651km of cross-linked polyethylene (**XLPE**) cables.

Approximately 50% of Ausgrid sub-transmission cables operate at 132kV and many of these form the critical backbone of the sub-transmission network. Failure of multiple 132kV cables can have significant impacts upon our customers, particularly in the Sydney CBD and surrounding urban areas.

A risk assessment has been undertaken on our sub-transmission cables using an asset failure probability model and consequence assessment, with timing of any retirement decision based on cost benefit analysis. From the assessment, SCFF and gas pressure cables are approaching end of life and have been forecast for retirement / replacement over the next 15-20 years.

SCFF cables operate at 132kV. Due to the environmental risks posed by these cables, Ausgrid consults with the Environmental Protection Agency (**EPA**) to take reasonable steps and exercise due diligence regarding the management of the environmental risks. The cost benefit analysis takes into consideration:

- The unavailability of individual SCFF cables (failure probability),
- Condition of individual SCFF cables primarily based on their level of fluid leakage and the condition of the cable,
- Network restoration and repair times for failures and defects,
- The environmental risk from individual cables, in particular those crossing major waterways, and
- The unserved energy (customer reliability impacts) which are realised in the event of an asset failure.

Gas pressure cables equate to approximately 3% of Ausgrid sub-transmission cables and they all operate at 33kV. The failure of mechanically fatigued joints, degradation of the cable system resulting in increasing gas leakage rates and the lengthy restoration and repair times, support the retirement of gas pressure cables. As supported by cost benefit analysis, retirement of all remaining gas pressure cables is expected in the next 20 years.

Ausgrid also has a substantial population of paper lead cables which all operate at 33kV. These cables formed the backbone of the sub-transmission network at its inception and remain relatively reliable despite their age, with some sections up to 95 years old. The lifespan of these cables is generally considered to be approximately 80 years; however, individual circuits may be retired prior to reaching this age based on condition (issues related to corrosion of the lead sheath or loss of resistance in the paper insulation) as supported by cost benefit analysis and other network needs.

XLPE cables are the current technology being installed for 33kV, 66kV and 132kV circuits. Ausgrid has been utilising this cable technology for approximately 30 years and is expecting a 60-year operating life. There are currently no plans to retire these assets within the planning horizon.

4.2.2 11kV Switchgear Strategy

Between the late 1930s and the early 1970s Ausgrid progressively installed a large number of compound insulated 11kV switchboards with bulk oil circuit breakers (**OCB**). As technology progressed, air insulated switchboards (non-internal arc classified technology) with bulk OCB became widely available and were installed from the late 1960s until the late 1970s, when vacuum circuit breakers (**VCB**) were introduced. From 2004, internal arc classified switchgear became the accepted industry standard for new installations. This progression of technology has resulted in a corresponding reduction in the risk of catastrophic failure (both likelihood and consequence).
This reduction in risk was traded off against a larger construction footprint in a typical urban style Zone Substation.

In rural and lower loaded areas, outdoor 11kV switchgear (cubicle or recloser style) has generally been used as this is a more economical design than indoor switchgear in those areas. However, due to the increased exposure to local environmental conditions, this type of switchgear has deteriorated over time, leading to more frequent failures and higher maintenance costs.

Risk assessments considering likelihood and consequence have been conducted on 11kV indoor switchgear. Application of cost benefit analysis to the age and condition issues associated with 11kV compound switchboards, confirm that these are approaching end of life. Switchgear risks are considered in conjunction with other planning needs in the local area to determine the optimal replacement timeframes, with consideration given to work bundling opportunities. The cost benefit analysis takes into consideration:

- The unavailability of individual switchboards / switchboard sections,
- Condition of individual components primarily based on maintenance test results,
- Network restoration and repair times for failures and defects,
- The risks from switchboard failures, and
- The unserved energy (customer reliability impacts) which are realised in the event of an asset failure

Oil filled circuit breakers pose an additional risk to safety, reliability and secondary asset damage due to the catastrophic nature in which they can fail. To mitigate this risk and defer retirement of older style air insulated switchboards, 11kV oil filled circuit breakers in zone substations have largely been replaced with vacuum equivalents where practical.

4.2.3 Additional Replacement Programs

Additional key replacement programs include:

- Condition based replacement of poles,
- Replacement of higher risk overhead conductor types,
- Reconfiguration of low voltage streetlight mains (conversion to regular mains supply), and
- Replacement of low voltage underground cable types with conditions/reliability issues.

4.3 Distribution Network Losses

Distribution network losses refer to the difference in energy obtained from the transmission network to that supplied to customers. Ausgrid's distribution network losses as a percentage of total energy for the 2022/23 financial year was 3.25%[7].

Electrical energy losses represent a cost to network service providers and customers, and therefore it is Ausgrid's objective to minimise these losses, while maintaining a safe and reliable electricity supply, at minimum cost to the community. When considering potential network projects under the NER's Regulatory Investment Test for Distribution, Ausgrid must consider changes in electrical energy losses if they are material or may alter the selection of a preferred investment option.

Ausgrid's methodology for calculating losses is published on its website as part of the requirements of the NER to maintain a method for calculating Distribution Loss Factors (**DLF**). This methodology is to utilise the Incremental Transmission Loss Allocation where losses to specific load or generation points are allocated according to its effect on the total losses of the system. The aim of this methodology is to enable the quantification of incremental values of network loss savings in the assessment of proposed network project options, and the quantification of network losses as required under the RIT-D. Additionally, the methodology enables the calculation DLF for Individually Calculated Tariffs (**ICT**) customers and embedded generation systems.

Ausgrid's technical specifications for the assessment of losses for primary plant such as subtransmission transformers, distribution transformers, shunt reactors etc, specify the method of assessing capitalised losses when comparing tender offers from suppliers.

4.4 Obtaining Further Information on Asset Management

Further information on asset management may be obtained from Ausgrid's Asset Management Policy (available on request from the Group Executive – Customer, Assets & Digital), and our Electricity Network Safety Management System (ENSMS) Annual Performance Report available on the Ausgrid website.

7. The distribution network losses are reported at the end of each calendar year, using the previous financial year's accumulated loss data.

5. Non-network Opportunities

5.1 Demand Management

When Ausgrid identifies a network limitation, SAPS and non-network options are considered as an alternative to the preferred network option.

A SAPS alternative means providing customers affected by the identified network limitation an alternative supply source to the electricity grid. A typical SAPS would comprise a renewable energy supply source such as solar, battery storage and a backup generator such as a diesel generator.

The implementation of a non-network alternative is commonly referred to as demand management in that the solution has historically involved the reduction or modification of customer demand for grid supplied electricity. But with rapidly developing alternatives such as advanced solar and battery inverter control, demand management solutions can now include support for voltage unbalance, power factor and harmonics management.

Demand management is an important part of efficient and sustainable network operations; and can help address a network need due to rising customer demand, aging network assets, voltage unbalance or other investment driver. Effective use of demand management reduces the cost to maintain the network and results in lower electricity bills for all customers.

There are a range of demand management or non-network solutions available for use by electricity networks. Examples include:

- Energy efficiency (e.g. replacing lights with more efficient, lower wattage options).
- Demand response (e.g. operating appliances at lower power demand for short periods such as air conditioner load control).
- Operation of embedded generators (including renewable generators).
- Energy storage (e.g. batteries).
- Power factor correction (a form of energy efficiency).
- Load shifting (shifting equipment use from peak to non-peak periods such as off-peak hot water).
- Converting the appliance energy source from electricity to an alternative (e.g. switching from electric to gas heating).
- Voltage management (e.g. operation of customer inverters in voltage support modes).

When a review of a network limitation is initiated, a review of options that includes both network and non-network options is completed. The goal is to identify the solution which offers the highest net benefit and meets the required reliability standards. The solution may be:

Modifications or additions to the existing network (i.e. network solution).

Support of the existing network by others (i.e. non-network or demand management solution).

Blended solutions incorporating network modification or additions and non-network demand management elements (including, though not limited to SAPS and microgrids).

Ausgrid's planning process assesses network needs across different network areas. Solution options are developed by area for all known network needs to allow for comprehensive solutions to address multiple needs.

To ensure a thorough investigation, Ausgrid consults with the community on larger projects about the network requirements and the potential non-network options available.

To determine the right balance, we apply the process depicted in Figure 3.1 following. For projects where the preferred network option cost is greater than $6 million, the RIT-D process is followed. The green boxes denote the reports which are published as part of the RIT-D process.

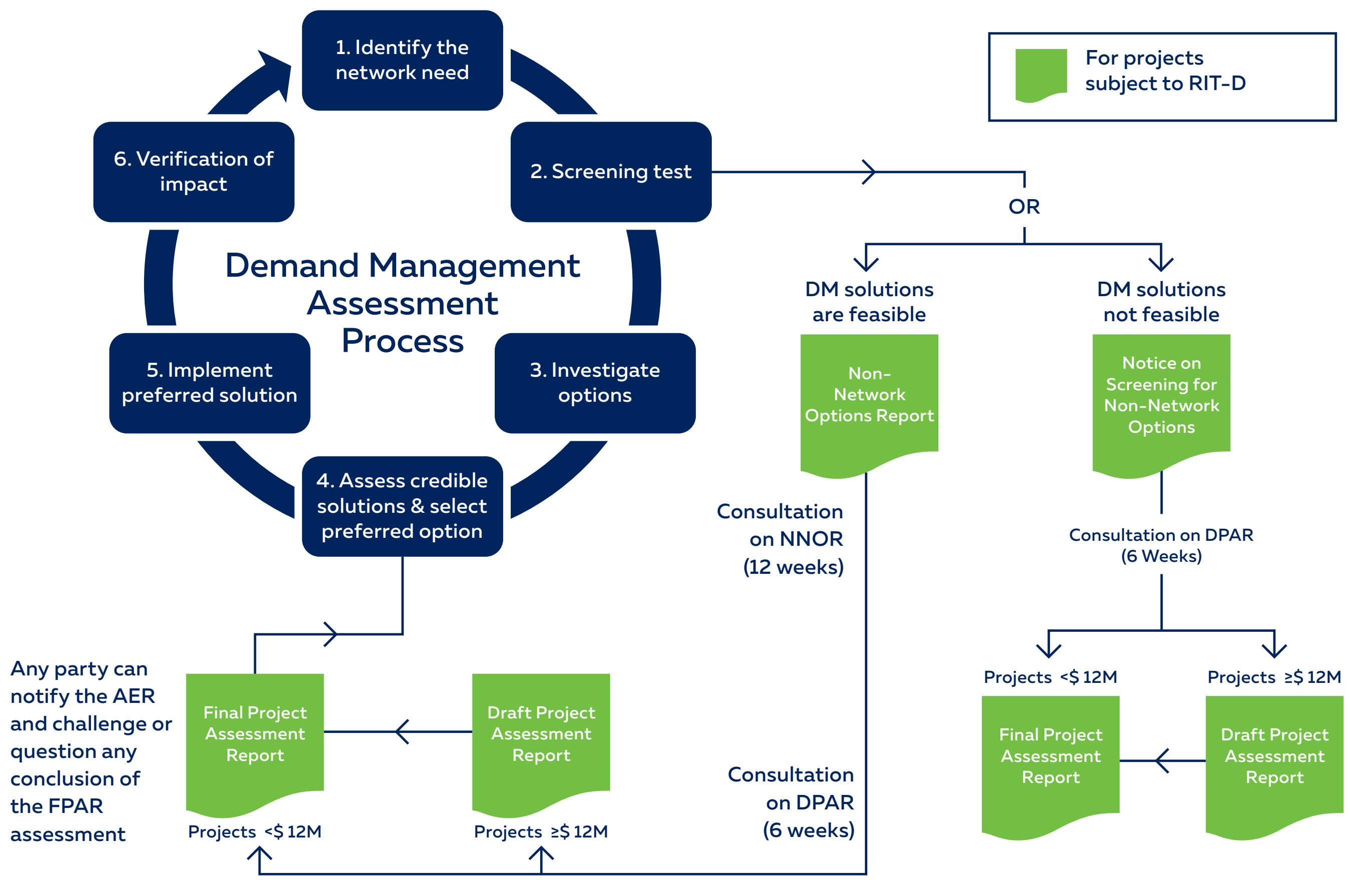
For projects where the preferred network option cost is less than $6 million, Ausgrid applies a similar but simplified process appropriate to the cost of the project.

The RIT-D process is a cost-benefit test that must be applied to all network investment projects where the most expensive credible option costs more than $6 million. It must be applied by network distribution businesses when assessing the economic efficiency of different investment options to select the option with the highest market benefit that address the network needs.

This helps to promote better consistency, transparency and predictability in our planning processes and follows the NER rules under Chapter 5.

The AER published an update to the regulatory investment test for transmission (**RIT-T**) and RIT-D application guidelines in August 2022 which stipulated that DNSPs can connect customers to a SAPS where it may be cheaper, safer and more reliable than connection to the grid. These will become regulated SAPS.

Customers connected to regulated SAPS will receive an equivalent level of customer protections and will pay for their electricity in the same way as grid customers. Both SAPS and grid customers can benefit from lower charges and improved system reliability.



5.2 Demand Management Considerations

5.2.1 Demand Management Considerations FY24

There were 15 major projects in the forward planning period which were considered for SAPS and demand management options. Ausgrid assesses the viability of demand management alternatives for projects that meet minimum threshold costs.

Assessment for non-network solutions has determined that no major projects were identified where it was considered likely that SAPS or demand management would form part of the least cost solution to the need. It should be noted that the level of analysis is of a high level nature and that the assessments for all projects were based upon preliminary assumptions for project costs, unserved energy and other benefits.

A full assessment conducted as part of the RIT-D process, including a request for submissions via the Non-Network Options Report or equivalent, will occur in future for each respective project at the relevant time. Refer to Section 6 of this report for the forward schedule for our RIT-D projects.

5.2.2 Demand Management in the Forward Planning Period

While there are no major network investment projects in the forward planning period that have been identified as likely having SAPS or demand management solutions, there are three areas of localised high growth where demand management solutions may form part of a least cost solution to the needs. Load growth in these areas is being driven by growth in residential demand on hot summer days.

If growth continues, a possible need may arise at which point a planning investigation including assessment for demand management potential solutions will be undertaken.

While these network needs are unlikely to trigger a RIT-D process (due to the likely costs for any preferred network option) , we apply a similar but simplified process appropriate to the cost of the project. Where public consultation forms part of the assessment, non-network option reports will also be published on Ausgrid's website. Those on Ausgrid's Register of Interested Parties will be notified of the publication of any opportunity. You can register your contact details at www.ausgrid.com.au/dm.

5.3 Demand Management Activities in FY24

5.3.1 Demand Management Projects Initiated in FY24

There were no demand management projects initiated in FY24 that were linked to a network investment need.

5.3.2 Demand Management Projects Implemented in FY24

There were no demand management projects implemented in FY24 that were linked to a network investment need.

5.3.3 Demand Management Innovation

As part of our efforts to explore alternative demand management solutions, Ausgrid investigates potential demand management solutions that may offer cost-effective alternatives to traditional network options. These research and development projects are funded through the Demand Management Innovation Allowance Mechanism (**DMIAM**) and approved by the Australian Energy Regulator.

Ausgrid's demand management innovation program is part of our strategic innovation program which aims to explore solutions relating to the risk associated with the retirement/replacement of aged assets (85% of Ausgrid's capital program), emerging technologies such as battery storage and electric vehicles, customer-side alternatives to improving solar hosting capacity, hot water load control and to explore solutions enabled by smart meters and Internet of Things (IoT) automation.

Ausgrid strongly encourages interested parties to engage with us on new and innovative project ideas or proposals that aid the transition to our net zero future. To discuss further please email us at demandmanagement@ausgrid.com.au.

During FY24, Ausgrid progressed seven DMIAM projects. A description of the projects is provided below.

Hot Water Load Control

Through internal analysis, customer engagement, industry collaboration, and field trials, this project aims to explore hot water load control as a demand management (**DM**) solution, benefiting consumers and improving network efficiency.

The key initiatives include:

Appropriate dynamic operating schedules and tariff conditions for managing demand of controlled load hot water	The potential use of hot water load control for voltage management	Regulatory mechanisms that may assist with optimising hot water controlled load

Phase 1 Completed

Involved preparatory work including identifying trial locations, assessing smart meter technology, understanding market models, and conducting customer research on perceptions of load control.

Phase 2 Completed

Involved a trial with 638 residential customers (233 with solar PV) in Sydney, the Central Coast, and the Hunter region.

A metering provider remotely managed customers' controlled load circuits with smart meters, testing the impact of an additional daytime schedule ("solar soak") on shifting energy use from night to day. Following the success of this trial, changes were made to Ausgrid ES7 Price Guide to include daytime window for Controlled Load 1 customers.

Phase 3 Current status

FY24 activities included continued research, stakeholder engagement with retailers and metering providers, participation in the RACE for 2030 SolarShift project, and collaboration on a heat pump hot water trial. Further data and insights will be collected in FY25 to support dynamic appliance control through smart meters.

Peak Time Rebate (Retailer Demand Response)

As part of the Peak Time Rebate (**PTR**) trial, customers were invited to voluntarily reduce their energy usage for 2-3 hours during times of peak demand on the network, with the customers rewarded with energy credits based on their energy reduction. Ausgrid partnered with retailers to implement this project with over 6,000 customers having participated in the trial.

The objective of the trial was to gain an understanding of:

Scale and density of peak demand reduction offered by PTR	Various customer acquisition strategies and the resulting measure of localised PTR customer take-up	Effectiveness of various customer incentives	Customer experience	Reliability and availability of retailer PTR platforms.

Phase 1 Completed

In FY21, trials were conducted with retailers AGL and EnergyAustralia in 24 suburbs across the Lower Hunter, Newcastle West, and Northwest Sydney. These trials confirmed the functionality of PTR platforms and provided insights into customer recruitment and behavior.

Phase 2 Completed

The trial expanded to 44 suburbs and tested automatic demand response. The project concluded in FY24, with activities including analysis of results, stakeholder engagement, and reporting.

Project Conclusion and Next Steps:

The trial ended in FY24. Some of the key lessons from the trial included:

- Opt-in recruitment averaged a 53% participation rate, while opt-out averaged 97%. However, opt-out participants did not show higher energy reductions or engagement.
- 45% of opt-out participants achieved at least 5% energy reduction, with an average reduction of 1.05kW, while opt-in participants averaged 0.85kW reduction.
- Most participants earned credits of $1 to $10 per event.
- 85% of surveyed participants were likely to join future events.

The trial showed promising results, and Ausgrid plans to continue working with retail partners to develop cost-effective demand response solutions for network constraint management.

Community Battery Feasibility Study and Research

This project aimed to develop a feasibility study and model business case for community batteries as a solution for local network constraints.

Objectives of this project included exploring:

Technical, regulatory and commercial aspects of the community battery concept	Customer sentiment towards the concept of a community battery	Opportunities and barriers associated with the Community Battery via a field trial

Phase 1 Completed

Ausgrid developed a feasibility study and a model business case to evaluate community batteries as a solution for local network constraints. The feasibility report is available on Ausgrid's website.

Phase 2 Completed

Customer research was conducted to assess customer perceptions of community batteries and their motivations to participate in a potential trial.

Phase 3 Completed

Over 60 customers participated in a trial involving virtual battery storage across three sites. Customers accessed their energy data through a smart app and received credits averaging $17 per month. Feedback was generally positive, with Net Promoter Scores (**NPS**) between 19-33.

Project Conclusion and Next Steps:

The trial ended in FY24. Some of the key lessons from the trial included:

- Customer Interest: Strong customer interest in community batteries, with financial, environmental, and social benefits seen as key motivators.
- Simplify Offers: Future trials should simplify tariff structures to make them easier for customers to understand.
- Efficient Onboarding: Streamlining the enrolment process is necessary to avoid hardware and participation challenges.
- Fewer Providers: Reducing the number of involved parties will simplify the customer experience.
- Customer Savings: Future trials should monitor and test savings, with the trial showing bill reductions of around 18-20%.

Following the trial, Ausgrid plans to continue rolling out community batteries and explore further customer and grid benefits.

Project Edith Customer Payments

Project Edith aims to explore the effectiveness of dynamic network pricing in influencing CER to help reduce network costs associated with managing minimum and maximum demand, minimise solar curtailment and avoid unnecessary network upgrades. The project involves setting dynamic network prices based on actual conditions at a specific time and location, which provides opportunities for customer agents (aggregator or retailer) to optimise CER based on the dynamic network prices.

The key objectives are to:

- Remove barriers to the participation of customers' energy resources in energy markets through efficient and fair pricing.
- Allocate distribution network capacity in a decentralised manner and incentivise network support from customers' energy resources.
- Identify and inform key areas for implementing this model, share insights and engage with the industry.

Phase 1 Completed

Demonstrated how existing systems could be adapted to implement dynamic pricing to unlock additional value for and from CER.

Phase 2 Current status

In FY24 the project expanded to include over 400 customers and multiple customer agents, providing further opportunities to test the concept at a broader scale. Further information about Project Edith is available on Ausgrid's website.

Barriers to Electrification Study

The project aimed to enhance Ausgrid's understanding of the impact of electrification on decarbonisation and identify customer barriers and opportunities for electricity networks to manage increased electrical loads.

The key objectives are to:

- Identify social, economic, and technical barriers to electrification for different customer segments.
- Understand how electrification pathways can be influenced by policy, social, and economic factors.
- Prioritise future demand-side technology or tariff interventions for integrating new electrical loads.

Phase 1 Completed

An external consultant conducted research to assess electrification pathways and customer barriers. A prioritised list of customer barriers and network opportunities was developed.

Phase 2 Completed

Internal and external engagement with industry and research stakeholders following outcomes of phase 1. Project concluded in FY24 as next steps will advance development of priority initiatives identified during the project.

Project Conclusion and Next Steps:

Based on the lessons, some of the future key focus areas for Ausgrid include:

- Providing customers with clear, simple information on electrification choices.
- Maximising the use of renewable electricity for electric appliances and EVs.
- Trialling new demand-side technologies for greater flexibility.
- Continuing research into demand management, with a focus on electric vehicles, hot water electrification, and energy management systems.
- Longitudinal social research that continues to build understanding of emerging socio-technical trends
- Developing real-world case studies and guidance for overcoming electrification barriers.

These initiatives will help Ausgrid proactively engage with customers and stakeholders, guiding the transition toward electrification and decarbonisation. Ausgrid will continue to collaborate with government, retailers, market participants, and research groups (e.g., Race for 2030 and CSIRO) to support electrification efforts.

C&I Thermal Load Flex

This project aims to assess the effectiveness of thermal load flexibility ("thermal flex") for commercial and industrial (C&I) customers in addressing localised network demand issues on Ausgrid's network. Sites such as supermarkets, shopping centres, and refrigerated distribution centres, with medium to large energy demand, may provide significant load flexibility during peak and minimum demand conditions.

The key objectives are to:

- Assess the quantum and reliability of thermal flex as a demand management solution.
- Evaluate the ability to shape responses for maximum network benefit.
- Investigate customer acquisition strategies and take-up of thermal flex.
- Understand the impact on customer comfort and product requirements.
- Evaluate customer experience, procurement, and operating costs.
- Determine the viability of thermal flex as a business-as-usual (BAU) solution.

Phase 1 Current status

In FY24 initial discussions with market providers and preliminary investigations for demonstration sites were conducted. Key activities for this phase include setting up partnerships, trial agreements, and site selection.

Phase 2

Field trials to test thermal flex effectiveness in line with project goals.

Phase 3

Potential development of thermal flex into a BAU solution based on outcomes of Phases 1 and 2.

Heat Pump Hot Water Systems

The project aims to understand the process of electrifying domestic hot water (**DHW**) systems and installing heat pump hot water (**HPHW**) systems. The project is part of the RACE for 2030 initiative, with partners including the NSW Land and Housing Commission (**LAHC**), NSW Aboriginal Housing Office (**AHO**), UTS, NSW Office of Energy and Climate Change (**OECC**), and Essential Energy.

The key objectives are to:

- Investigate opportunities and barriers for electrifying and upgrading hot water systems.
- Understand the demand impacts of HPHW systems on the network.
- Explore optimal charging schedules to manage peak and off-peak demand.
- Assess compatibility of HPHW systems with controlled load.
- Gather consumer and industry perspectives on energy efficiency and decarbonisation.
- Evaluate energy efficiency, performance, consumer experience, and cost savings of HPHW systems.
- Understand various HPHW technologies and installer practices.

Phase 1	Current status

Replacement of old hot water systems with HPHW systems at approximately 100 social housing properties, with tenants voluntarily participating. Analyse customer experience, financial, environmental and demand impacts of these replacements.

Phase 2

Ongoing monitoring of energy usage data from installed HPHW systems over two years.
This phase aims to assess long-term changes in HPHW performance and tenant hot water usage behavior, providing valuable insights for refining demand management and electrification strategies.

5.4 Forecast Demand Management Projects

Assessment for non-network solutions has determined that no projects were identified where it is was considered likely that demand management will would form part of the least cost solution to the need. This is principally due to the nature of these projects wherein all were related to replacement of aged assets.

Note though that the assessments for all projects were based upon preliminary assumptions for project costs, unserved energy and other benefits. A full assessment conducted as part of the RIT-D process, including a request for submissions via the Non-Network Options Report or equivalent, will occur in future. Refer to Section 6 of this report for the forward schedule for our RIT-D projects. In advance of the need date, a non-network options report will be published on Ausgrid's website at https://www.ausgrid.com.au/ritd.

5.5 Demand Side Engagement

During FY24 Ausgrid continued to inform and engage interested parties over a range of activities to improve demand management outcomes in meeting network needs.

Our main channel of engagement continued to be through our e-newsletters to inform stakeholders about our demand management initiatives, research and other relevant industry information. Past e-newsletters can be viewed on our Keep Informed page at https://www.ausgrid.com.au/Industry/Demand-Management/Demand-management-news.

In addition, we notified members on our demand management engagement register about our assessments on RIT-D projects and invited them to submit comments and proposals during the consultation process. This included notifications for 2 RIT-D project which can be viewed at https://www.ausgrid.com.au/Industry/Regulation/Network-planning/Regulatory-investment-test-projects.

Our engagement activities also included our continuing memberships with the Clean Energy Council and Electric Vehicle Council.

For further information on our demand management programs and activities please contact Ausgrid's Demand Management team at demandmanagement@ausgrid.com.au.

For more information on how Ausgrid investigates and implements non-network solutions, please refer to our Demand Side Engagement Document at https://www.ausgrid.com.au/Industry/Demand-Management/Our-demand-management-strategy.

5.6 Embedded Generator Enquiries and Connection Applications

The following table summarises embedded generation enquiries and applications that Ausgrid received under NER clause 5.3A.5, 5.3A.9, 5A.D.2 and 5A.D.3 during the financial year 2023-24.

Item Description	Quantity
Connection enquiries received under clause 5.3A.5	21
Applications to connect received under clause 5.3A.9	2
Average time taken to complete applications to connect	17 Months*
Connection enquiries received under clause 5A.D.2 in relation to the connection of micro embedded generators or non-registered embedded generators	13
Applications for a connection service under clause 5A.D.3 in relation to the connection of micro embedded generators or non-registered embedded generators	42,747

*Based on one complex connection application.

6. Network Investments

6.1 RIT-D Assessments Completed and in Progress

The following RIT-D have been completed in the preceding year.

Region	Constraint	Project Name	Expected Project Completion	Estimated Cost ($m)	RIT-D completion date
Sydney	Asset Condition	132kV Feeders 9E1 & 9E2 Sydney East-Kuringai STS oil sections replacement	Dec-25	7.8	29/09/2024
	Load Growth	New Wallumatta STS & 132kV Feeders (Contingent Project)	Dec-28	162.3	10/11/2024

A summary is provided to describe the identified need Ausgrid is seeking to address, outline the credible network options considered, explain why other network options were not pursued, identify the proposed preferred option, and explain the reasons for its selection. In addition, the summary includes the corresponding dates in which the different steps of the RIT-D process were completed.

Cost estimates are reported in real dollars. The corresponding reports for this RIT-D assessment are available in Ausgrid's website at the following link: Regulatory investment test projects - Ausgrid

6.1.1 132kV Feeders 9E1 & 9E2 Sydney East-Kuringai STS Oil Sections Replacement

The network in the Upper North Shore area is supplied via 132kV feeders 9E1 and 9E2 from Transgrid's transmission system at Sydney East BSP to Kuringai STS. Feeders 9E1 and 9E2 form an important part of this network, supplying Turramurra, Lindfield, Pymble and St Ives zone substations via a radial 33kV underground network. These feeders are the single source of supply to the Upper North Shore network.

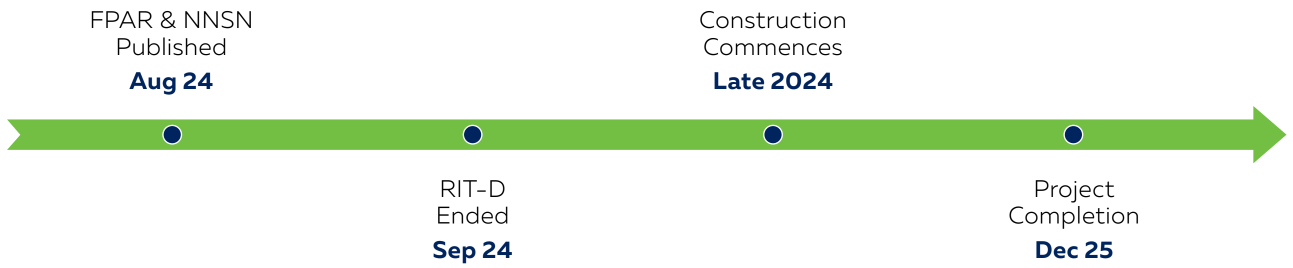
Feeders 9E1 and 9E2 were commissioned in 1980 and consist of underground cable sections (approximately 1km in length) laid in separate trenches from Sydney East BSP to Belrose Transition Point (**TP**), and overhead sections via a 5.5km long double circuit tower line from the Belrose TP to Kuringai STS. The underground feeder sections are of the SCFF type, which are considered an obsolete and outdated technology, and are now reaching the end of their service life. They are becoming less reliable and approaching the point at which their replacement maximises the net benefit for the community. Ausgrid's planning studies indicate that there will be substantial EUE to loads in this area of our network if these cables fail, as well as reactive maintenance costs associated with having to repair and restore service, and environmental risks from oil leaking from the cables. If action is not taken, it is expected that Ausgrid's electricity distribution license reliability and performance standards will be breached.

The table below outlines the network credible options identified, cost for each option in millions of dollars and net present value (**NPV**) in millions of dollars.

Option	Description	Cost ($m)	NPV ($m)
Option1 - Replacement of SCFF sections of feeders 9E1 and 9E2 with XLPE along existing route	Like-for-like replacement of the existing underground SCFF feeder sections with a modern equivalent cable (XLPE) in their existing route configuration, decommissioning the Belrose TP, and decommissioning of the existing SCFF feeder between Sydney East BSP and Belrose TP.	12.5	14.2
Option 2 - Replacement of SCFF sections of feeders 9E1 and 9E2 with predominantly overhead lines	Replacing the underground SCFF feeder sections with predominantly overhead lines along the existing route. This option will improve reliability, reduce unserved energy and decrease operating expenditure over time compared to the base case of maintaining the existing cables.	7.8	18.0

Ausgrid has considered the ability of any non-network or SAPS solutions. An assessment into reducing the risk of EUE has shown that these alternatives are unlikely to cost-effectively address the risk, compared to the two network options presented. This result is driven primarily by the significant amount of EUE that each network option allows to be avoided, compared to the base case, and the cost of non-network or SAPS solutions.

Ausgrid considers Option 1 is the preferred option to satisfy the RIT-D. The project timeframe summary is as displayed.



6.1.2 New Wallumatta STS & 132kV Feeders (Contingent Project)

Macquarie Park is a suburb in Northern Sydney known for being well connected to telecommunications, electrical and transport infrastructure, making it an increasingly popular location for major load customers. Ausgrid has received a lot of interest from new major load customers in the Macquarie Park area in recent years and has subsequently expanded the network to accommodate these loads, by commissioning a new Macquarie STS in July 2021 and adding a third 120 MVA transformer to be commissioned by December 2025. Physical site restrictions mean that new loads cannot be accommodated at the existing STS. This was noted in the 2023 RIT-D we undertook for the third 120 MVA transformer, which stated that further network investment (covered by a separate RIT-D process) would be required to accommodate any additional major loads in the area.1 We have received a further four connection applications from major customers seeking to connect in the Macquarie Park area and have therefore commenced this RIT-D to investigate the options for facilitating these connections. Each of these four applications requests connection from December 2028 and that the connection is provided at 33kV.

The table below outlines the network credible options identified, cost for each option in millions of dollars and **NPV** in millions of dollars.

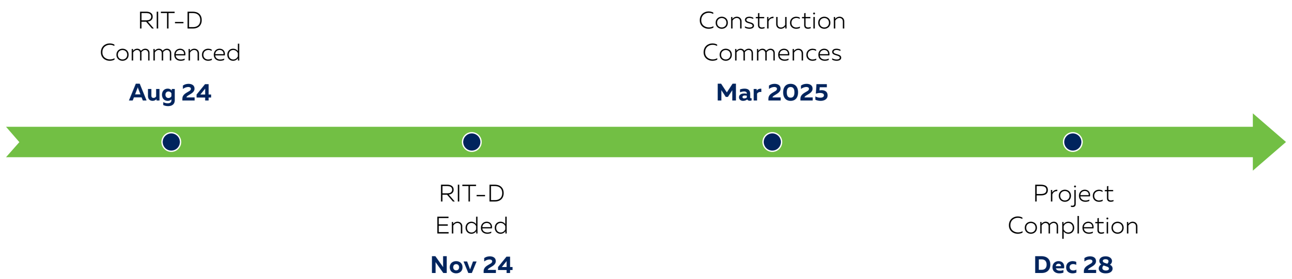
Option	Description	Cost ($m)	NPV ($m)
Option 4 – New 132/33kV STS at 'site 1' tee connected at East Ryde Transition Point to 132kV Feeders 92G & 92J	Acquisition of a property at 'site 1' to construct a Wallumatta 132/33kV STS. Installation of two 132kV feeder connections to tee off from East Ryde Transition Point to Wallumatta STS. This option involves installation of long underground 132kV connections to tee off feeders 92G and 92J.	178.6	1027
Option 5 – New 132/33kV STS at 'site 2' tee connected at East Ryde Transition Point to 132kV Feeders 92G & 92J	Acquisition of a property at 'site 2' to construct a Wallumatta 132/33kV STS. Installation of two 132kV feeder connections to tee off from East Ryde Transition Point to Wallumatta STS. This option involves installation of long underground 132kV connections to tee off feeders 92G and 92J.	162.3	1043
Option 6 – New STS with expanded 132kV busbar at 'site 1' tee connected to 132kV Feeders 92G & 92J	Construction of a new STS with an expanded 132kV busbar at 'site 1', connected via East Ryde Transition Point using tee connections to feeders 92G and 92J. This option is like Option 4, except that 32 circuit breakers are required at the STS (as opposed to 28 under Option 4)	186.1	1023
Option 7 – New STS with expanded 132kV busbar at 'site 2' tee connected to 132kV Feeders 92G & 92J	Construction of a new STS with an expanded 132kV busbar at site 2, connected via East Ryde Transition Point using tee connections to feeders 92G and 92J. The scope of this option involves the same components as Option 6 except that the assumed property acquired is at site 2 (as opposed to site 1).	169.8	1028

Other options considered but not progressed include:

- New 132/33kV STS at site 1 looped into 132kV Feeder 92B Sydney North BSP- Lane Cove STSS
- New 132/33kV STS at site 1 looped into 132kV Feeders 92A & 92B Sydney North BSP - Lane Cove STSS
- New 132kV STSS at 'site 3' and new 132/33kV STS at site 1 looped into 132kV Feeder 92B Sydney North BSP – Lane Cove STSS.

Ausgrid has also considered the ability of any non-network or SAPS solutions to assist in meeting the identified need. These alternatives will not be cost effective due to the magnitude of the load reduction required.

Ausgrid considers that Option 5 is the preferred option that satisfies the RIT-D. A summary of the project timeframe is listed in the following diagram.



6.2 RIT-D Assessments for the Forward Planning Period

This section describes the network investments for which a RIT-D assessment is expected to be initiated within the next five years.

Region	Constraint	Project Name	Expected Project Completion	Estimated Cost ($m)	Indicative RIT-D initiation
Distribution Assets					
Sydney	Asset Condition	Darlinghurst ZS 33kV Feeders 386 & 389 Replacement	Mar-28	7.7	FY26
Sydney		Botany ZS 11kV switchgear replacement	Dec-28	9.0	FY26
Sydney		Willoughby STS 33kV switchgear replacement	Sep-29	42.5	FY26
Hunter		Merewether STS 33kV switchgear replacement	Sep-29	28.9	FY26
Hunter		Blakehurst ZS Decommissioning	Sep-29	24.6	FY27
Sydney		132kV feeder 202 Rozelle STS-Drummoyne ZS replacement	Sep-30	19.6	FY27
Sydney		132kV feeders 203 & 204 Mason Pk STSS-Drummoyne ZS replacement	Sep-30	53.2	FY27
Sydney		Drummoyne ZS 132kV switchgear replacement	Sep-30	17.8	FY27
Sydney		Lidcombe ZS 11kV switchgear replacement (Group 1)	Sep-30	15.5	FY28
Sydney		Leightonfield ZS 11kV switchgear replacement	Sep-30	6.8	FY28
Sydney		Paddington ZS 33kV feeders replacement	Mar-31	11.1	FY29
Sydney		132kV feeder 283/2 Milperra ZS – Revesby ZS	Sep-32	13.2	FY30
Dual Function Assets					
Sydney	Asset Condition	132kV feeders 91A & 91B Beaconsfield BSP to St Peters ZS	Sep-29	20.3	FY27
		132kV feeder 9FF Beaconsfield BSP – Bunnerong STSS oil section replacement	Dec-29	23.5	FY27
	Load Growth	New 132kV Mascot East STSS	Dec-29	31.3	FY27

These network investments are primarily expected to address condition issues identified in several network assets:

- Aged underground subtransmission cables, which have experienced failures and leaks.
- Aged 11kV switchgear installed in several zone substations across the network and 33kV switchgear in subtransmission substations, with insulating materials that can be a fuel source in the event of failure.
- Aged 132kV switchgear at sites with concurrent subtransmission cable replacement works.

These asset condition issues result in growing EUE that justifies replacement investments at proposed dates, with additional benefits in terms of reduction of environmental risks and repair costs.

In addition, there are large customers requesting connections in the Macquarie area, driving the need to augment the subtransmission network.

6.3 Indicative Developments beyond the Planning Period

This section provides an overview of potential network investments in distribution and dual function network assets beyond the 5-year planning period, for which Ausgrid may initiate RIT-D assessments if the criteria are met.

Region	Constraint	Project Name	Expected Project Completion	Estimated Cost ($m)	Indicative RIT-D initiation
Distribution Assets					
Hunter	Asset Condition	Cardiff ZS 11kV switchgear replacement	Sep-33	9.2	2031
Sydney	Asset Condition	Pymble ZS 11kV switchgear replacement	Sep-33	23.4	2031
		Surry Hills ZS 33kV feeders 383, 384 & 385 Replacement	Jun-34	10.5	2031
		Matraville ZS 33kV feeders 313, 318, 324 & 340 Replacement	Jun-34	10.0	2031
		Riverwood ZS 11kV switchgear replacement	Sep-35	11.2	2032
		Miranda ZS 11kV switchgear replacement	Sep-35	13.5	2032
		Campsie ZS 11kV switchgear replacement	Sep-36	31.2	2034
Dual Function Assets					
Sydney	Asset Condition	132kV feeder 9SE Beaconsfield BSP - Green Square ZS Replacement	Jun-34	6.6	2032
		132kV feeder 270 Kingsford ZS - Maroubra ZS Replacement	Jun-34	6.5	2032

Similar to those projects included in the previous section, these network investments are expected to address condition issues identified in aged underground subtransmission cables and 11kV switchgear equipment.

The proposed dates represent the current view of optimal timing for replacement investments, based on the latest available information on these network assets.

6.4 RIT-D Assessments Not Proceeding

Several network needs identified in the preceding DTAPR are now not expected to proceed into network investments and/or require RIT-D assessments in the next five years. These network needs are listed in the table below.

Region	Constraint	Project	Previous Need Date	Reason for cancellation/deferral or RIT-D not proceeding
Sydney	Power Quality	Installation of new Static Compensation at Waratah STS	FY28	Project is no longer required due to closure of steel factory causing the power quality issue
	Load Growth	132kV feeders 92X & 92C, 91X/2 & 91Y/2 Chullora STSS – St Peters ZS/ Marrickville ZS retirement	FY28	The retirement of these oil-filled cables has already been covered by the Powering Sydney's Future RIT-T jointly published with Transgrid in 2017

6.5 Completed Investments

A network investment is considered completed when the project required to address the identified network need is commissioned and in service. The following projects described in the DTPAR 2023 have been completed or cancelled during the preceding year.

Load Area	Completed Network Investments	Reason / comments
Distribution Assets		
Inner West	New Summer Hill 33/11kV ZS and associated 33kV feeders and de-commission Dulwich Hill 33/11kV ZS	Completed
Inner West	Rozelle STS new 33kV switchgear	Completed
Eastern Suburbs	Decommission Darlinghurst 33/11kV ZS – Stage 1	Completed
Sydney CBD	11kV Load Transfers from Dalley St ZS to City North ZS	Completed
Camperdown and Blackwattle Bay	Convert Blackwattle Bay load from 5kV to 11kV and load transfer and decommission 33/5kV Blackwattle Bay ZS	Completed

6.6 Committed Investments

Ausgrid has identified all committed network investments (refurbishments, replacements, or augmentations) with an estimated capital cost of $2 million or more.

Capital cost estimates are shown in nominal dollars and exclude contingency costs.

Load Area	Committed Refurbishment, Replacement or Augmentation Investments	Expected Project Completion	Estimated Cost (nominal $m)
Distribution Assets			
Eastern Suburbs	New 33kV supply to Garden Island and decommission Graving Dock 33/11kV ZS	Feb-25	2.4
Inner West	Lidcombe ZS 11kV Switchgear Replacement & 33kV feeders – Homebush to Lidcombe ZS and Auburn ZS Replacement	Dec-25	38.0
Upper Hunter	Muswellbrook STS refurbishment	Jun-25	5.6
St George	Peakhurst STS 33kV switchgear replacement	Dec-25	25.0
Eastern Suburbs	Surry Hills ZS 11kV switchgear replacement	Jun-25	18.1
Sydney CBD	Decommissioning of City East ZS	Sep-25	44.4
Newcastle Ports	Waratah 132/33kV STS refurbishment	Jun-25	17.0
Camperdown and Blackwattle Bay	Pyrmont STS cable egress enabling works	Mar-25	2.6
Sydney CBD	Decommissioning of Dalley St ZS	Dec-25	12.5
Eastern Suburbs	Sydney Airport ZS 33kV switchgear replacement	Jul-25	7.5
Maitland	Tarro ZS 11kV switchgear replacement	Jun-25	10.7
Inner West	132kV feeders 923 & 924 Strathfield TP-Burwood ZS replacement	Sep-25	13.4
Inner West	Concord ZS 11kV switchgear replacement	Oct-26	20.0
Canterbury and Bankstown	Milperra ZS 11kV switchgear replacement	Dec-27	16.5
Dual Function Assets			
Sydney CBD	Decommissioning of 132kV Feeders Lane Cove STSS – Dalley St ZS	Jun-25	3.1
Eastern Suburbs	132kV feeder 264 Beaconsfield BSP-Kingsford ZS replacement	Jul-25	23.3
	132kV feeders 9SA & 92P replacement & Loop Zetland ZS into feeder 92P	Jul-25	25.6
Carlingford	New Macquarie STS Transformer 3	Dec-25	13.6

6.6.1 New 33kV Supply to Garden Island and Decommission Graving Dock 33/11kV ZS

Key Project Milestones:

Project Initiated **Jan 19**

Project Approved by CEO **May 21**

Project Completion **Dec 23**

Graving Dock ZS No.1 and No. 2 are supplied from Surry Hills 132/33kV STS, via 33kV underground feeders 377 and 378. These feeders are approximately 3km long mostly commissioned in 1946, with a section of approximately 1.3km of feeder 378 commissioned in 1930. Network investments are required due to increases in supply requirements anticipated in the area.

Options Analysis

The only feasible solution, due to the location of the Garden Island Precinct, is to provide 33kV supply to the customer from Surry Hills STS. Other available sources of 33kV supply would require extensive and complex connections to reach the northeast of Sydney CBD.

The project was approved by the Ausgrid Chief Executive Officer on 31/05/2021, at a cost of $2.4 million excluding contingency.

6.6.2 Lidcombe ZS 11kV Switchgear Replacement & 33kV feeders – Homebush to Lidcombe ZS and Auburn ZS Replacement

Key Project Milestones:

11Kv Switchgear

Project Initiated **Sep 14**

Project Approved by Ausgrid Board **Dec 17**

Project Completion **Dec 25**

Feeder Replacement

Project Initiated **Aug 14**

Project Approved by Ausgrid Board **Feb 18**

Project Completion **Dec 25**

Auburn and Lidcombe ZS are 33/11kV substations in Ausgrid's Inner West network, supplied by three 33kV underground feeders, respectively, from Homebush STS, with most sections of the feeders dating back to the 1940s and 1950s. The feeders, comprising 22km of paper-insulated cables and 15km of gas pressure cables, have reached the end of their service lives. Gas pressure cables are prone to leaks, which results in high levels of unavailability due the long time required to locate and repair leaks, while paper-insulated cables have experienced a number of outages in recent years. In addition, the 11kV switchgear at Lidcombe ZS is experiencing increasing condition issues.

If these issues are left unaddressed, the risk of failure and poor availability of these assets will expose customers in the Inner West network area to a network risk that exceeds allowable levels under the applicable reliability standards.

The switchgear replacement project was approved by Ausgrid Board on 14/12/2017, at a total cost of $9.1 million ($6.7 million excluding contingency).

The feeder replacement project was approved by Ausgrid Board on 03/02/2018, at a total cost of $37.2 million ($31.3 million excluding contingency).

Options Analysis

Ausgrid, in collaboration with Endeavour Energy, developed a preferred solution using spare capacity on the Endeavour network after Shell Australia's Clyde oil refinery closure. This joint approach avoids the need to rebuild existing feeders, deferring upstream investments required for continued supply to Auburn and Lidcombe ZS from Homebush STS. Further analysis allowed for deferring the replacement of Group 1 switchgear at Lidcombe ZS, which have been replaced with vacuum trucks, opting instead to replace only Group 2 11kV switchgear now and the rest later. This adjustment reduced the NPC of the enhanced Option 4 to $42.0 million, including $9.1 million for the Group 2 switchgear replacement.

This project experienced significant delays because it is developed in combination with the replacement of 33kV feeders supplying Auburn and Lidcombe zone substations. Extensive community consultation on the feeders and coordination issues with the project that involves the widening of the M4 Motorway (part of the WestConnex development) have caused such delays.

Option 4 is preferred due to its lowest NPC and minimal risk.

These options and their corresponding (PC)in $ million are listed below:

Option	Description	NPC ($m)
1	Replace both Auburn and Lidcombe with a new 132/11kV zone substation	$57.8M
2	Replace 33kV feeders like-for-like and refurbish Lidcombe	$72.5M
3	Replace 33kV feeders from Camellia Substation and reconfigure Lidcombe	$48.5M
4	Replace 33kV feeders from Camellia Substation and reconfigure both substations	$42.0M

Other options were considered but not progressed because they were not feasible from a financial and technical perspective. These included :

- Uprate Auburn and retire Lidcombe
- Auburn 132kV conversion and retire Lidcombe (not feasible)
- Replace Lidcombe with new 132/11kV substation and reconfigure Auburn 33kV feeders
- Replace 33kV feeders from Homebush STS to Auburn and reconfigure Lidcombe

6.6.3 Muswellbrook STS Refurbishment

Key Project Milestones:

Project Initiated **Jul 16**

Project Approved by CEO **Jan 20**

Project Completion **Jun 24**

Condition issues have been identified in the 33kV outdoor switchgear and secondary systems at Muswellbrook STS. In particular, the 33kV Essantee isolators have additional safety risks to personnel involved in switching operations. Furthermore, the 33kV oil filled circuit breakers of this age and type have a history of failures derived from degraded insulation quality. There are extensive condition issues with the existing control and protection, earthing and oil containment systems. There is also an opportunity to retire/reconfigure parts of the 33kV network after recent projects in the area have resulted in disused 33kV feeders and equipment.

Refurbishment of Muswellbrook STS and rearrangement of the Muswellbrook STS 33kV network is the preferred option. The works will involve the retirement of a transformer and decommissioning existing 33kV switchgear and all redundant 33kV equipment at Muswellbrook STS, as well as the rearrangement of the 33kV network by dismantling redundant connections and installing new links required.

The project was approved by the Ausgrid Chief Executive Officer on 9/01/2020, at a cost of $5.6 million excluding contingency.

Options Analysis

One credible network option has been identified to address asset condition issues at Muswellbrook STS. It involves refurbishing Muswellbrook STS, to retire the 33kV switchgear that is redundant to the network and replace the minimum equipment to maintain 33kV supply in the area, and rearrangement of the Muswellbrook STS 33kV network.

Other options were considered but not progressed because they were not feasible from a financial and technical perspective. These included :

- Retirement of Muswellbrook STS and reconfiguration of the 33kV network in the area;
- The retirement of both Muswellbrook STS and Muswellbrook ZS and transferral of 11kV load to Mitchell Line ZS and Aberdeen ZS, including rearrangement of the 33kV network to provide supply to mine operations and maintain back up supply to Moonan ZS and Rouchel ZS; and
- The establishment of a new Muswellbrook 132/33kV STS.

6.6.4 Peakhurst STS 33kV Switchgear Replacement

Key Project Milestones:

Project Initiated **Nov 16**

Project Approved by CEO **Dec 20**

Project Completion **Jun 24**

St George 33kV subtransmission network is supplied from only one STS, which is located at Peakhurst. Peakhurst STS was commissioned in 1964 and has asset condition and safety concerns stemming from the deteriorating condition of the 33kV switchgear, located in a switchroom building that is non-compliant with contemporary Building Code of Australia (BCA) standards and without adequate segregation in the event of equipment failure. If left unaddressed, the performance of these assets is forecast to continue to decline, leading to increasing safety risks to Ausgrid's staff, customers and the general public, along with increasing risks of exceeding allowable levels under the applicable reliability standards.

The project was approved by Ausgrid Board on 17/12/2018, at a total cost of $26.8 million ($25.0 million excluding contingency).

Options Analysis

Two network options were considered to resolve the issues:

Option	Description	NPV ($m)
1	Replacement of 33kV switchgear in new building	26.5 (with 10% risk)
2	Replacement of 33kV switchgear in existing building	26.6 (with 40% risk)

Option 1 is the preferred option. The estimated costs of each option are similar, however, the cost estimate for Option 2 has much more uncertainty due to the risks and unknowns associated with working in a "brownfield" situation, working around existing live equipment. Option 2 also has increased complexity in staging and longer outage requirements with increased risk of interruptions to customers.

6.6.5 Surry Hills 11kV Switchgear Replacement

Key Project Milestones:

Project Initiated **Jul 11**

Project Approved by Ausgrid Board **Feb 15**

Project Completion **Jun 24**

The project was approved by Ausgrid Board on 25/02/2015, at a total cost of $19.1 million ($18.1 million excluding contingency).

Options Analysis

Three network options were considered to resolve the above issues:

Option	Description	NPV ($m)
1	Retire Surry Hills zone substation via 11kV load transfers to surrounding zone substations	-
2	New Surry Hills zone substation	39.0
3	Replace Surry Hills 11kV switchgear and 33kV feeders	25.0

Option 2 is significantly more expensive than Option 3, and Option 1 is not technically feasible. As a result, the proposal to replace Surry Hills ZS 11kV switchgear and 33kV feeders (Option 3) is shortlisted as the preferred solution.

6.6.6 Decommissioning of City East St ZS

Key Project Milestones:

Project Initiated **Oct 16**

Project Approved by Ausgrid Board **Oct 18**

Project Completion **Sep 24**

Ausgrid's strategic decisions for ensuring reliable supply in the Sydney CBD area arise from the need to address ageing infrastructure at City East and Dalley St ZS's

The project was approved by the Ausgrid Board on 29/10/2018, at a total cost of $44.4 million ($42.4 million excluding contingency).

Options Analysis

Option	Description	NPV ($m)
1	New 132/11kV zone substation and decommission Dalley St and City East substations	165
2	Decommission Dalley St and City East by transferring load to City North and Belmore Park substations	58
3	Refurbish existing City East ZS and decommission Dalley St ZS	115

Strategy 2 has the lowest net present cost and is the preferred option. To capture any differences in the value of the assets remaining at the end of the planning period residual benefits were calculated for each strategy. The present value of residual benefits for Strategies 1 and 3 were $20 million compared to $10 million for Strategy 2. This difference is not material compared to the cost difference of the strategies.

6.6.7 Waratah 132/33kV STS Refurbishment

Key Project Milestones:

Project Initiated **Apr 10**

Project Approved by Ausgrid Board **Mar 16**

Project Completion **Dec 24**

The 33kV industrial busbar at Waratah STS is significantly aged and needs to be retired from service. The 33kV domestic busbar was refurbished in the 1980s but the oil circuit breakers now require replacement. Four out of seven of the 132/33kV transformers are at the end of their service lives.

The project was approved by Ausgrid Board on 30/03/2016, at a total cost of $18.1 million ($ 17.0 million excluding contingency).

Options Analysis

Two network options were considered to resolve the above issues:

Option	Description	PC ($m)
1	Waratah STS supply rearrangement and refurbishment - Disconnect all loads, except major customers, from Waratah domestic busbar. All unused equipment at Waratah STS is to be decommissioned.	19.8
2	Waratah STS replacement - Construct a new 132/33kV substation on a nearby site and decommissioning the existing Waratah STS.	44.3

The preferred option is Option 1 as it is the least cost option. Option2 has more than double the costs without providing a commensurate level of market benefits.

6.6.8 Pyrmont STS 33kV Cable Enabling Works

Key Project Milestones:

Project Initiated **Jul 17**

Project Approved by CEO **Jul 21**

Project Completion **Dec 24**

The existing Pyrmont STS cable corridor is extremely congested due to the high number of cables originating from the site, particularly to the south of the substation. This results in limited space within the roadway to install additional cables.

In anticipation of future major customer connections or replacement projects, additional new 33kV route corridors are required, installed in such way as to avoid any further mutual heating and de-rating of the existing cables, as well as ensuring reliable electricity supply.

Options Analysis

The only feasible solution, due to the location of these major customers, is to enable the provision of 33kV supply from Pyrmont STS. Other available sources of 33kV supply would require extensive and complex connections arrangements.

One of the prospective customers is proceeding with its connection application to receive additional 33kV supply from Pyrmont STS. This triggers an opportunity for efficient delivery of the ducts Ausgrid requires by funding an addition to the scope of the customer funded work. In practical terms this consists of including additional Ausgrid ducts in the customer excavation and sharing the costs in proportion to the number of ducts.

A similar future conduit installation works performed by Ausgrid in the vicinity of Pyrmont STS would be considerably more expensive (i.e. likely to be more than double the costs of the works proposed in this approval), with a higher degree of complexity (i.e. tunnel works) and likely result in Pyrmont STS being underutilised.

The project was approved by the Ausgrid Chief Executive Officer on 23/07/2021, at a cost of $2.6 million excluding contingency.

6.6.9 Decommissioning of Dalley St ZS

Key Project Milestones:

Project Initiated **Aug 20**

Project Approved by Ausgrid Board **Aug 22**

Project Completion **Dec 24**

Refer to Item 6.6.6 above for an explanation of the options analysis, the proposed strategies and the selection of the preferred option.

The project was approved by the Ausgrid Board on 24/08/2022, at a total cost of $13.8 million ($12.5 million excluding contingency).

6.6.10 Ensuring Reliable Supply for the Sydney Airport Network Area

Key Project Milestones:

Project Initiated **Aug 19**

Project Approved by CEO **Sep 20**

Project Completion **Dec 25**

The 33kV switchgear at Sydney Airport is compound insulated with oil-filled circuit breakers, which could lead to failures ranging from single equipment failures to multiple equipment failures impacting the operation of an entire substation. Furthermore, the 33kV oil circuit breakers at Sydney Airport ZS were originally commissioned in 1955 and are now an orphan technology with very limited spare parts availability.

Options Analysis

Replacement of the 33kV switchgear in a new switchroom has been identified as the only option available to address reliability risks based on the outcome of a RIT-D. Condition issues identified in the switchroom buildings have led to the decision to construct a new 33kV switchroom building at the customer's cost to house the new equipment.

The refurbishment of the 33kV switchgear with new equipment in situ (i.e. 'brownfield replacement') was also considered under a staged approach. However, brownfield replacement imposes materially greater safety and schedule risk, arising from work being carried out next to energised equipment.

Ausgrid also considered other options such as the retirement of the 33kV switchgear or the construction of a new 132/11kV zone substation, but these options were not progressed since they were found technically or commercially not credible. In the case of simple retirement, the reliability of supply would be significantly reduced and future developments in Sydney Airport would be limited. In the case of the new substation, the cost would be materially higher than replacing the switchgear, without providing a commensurate increase in benefits.

The scope of this project includes the construction of a new building, installation of new equipment and retirement of the existing 33kV switchgear at Sydney Airport ZS. Demolition of the existing building and site remediation will also occur as a result of the project. The new switchroom design will also support improved fire segregation, contributing to improved safety and reliability.

The project was approved by the Ausgrid Chief Executive Officer on 30/09/2020, at a total cost of $8.4 million ($7.5 million excluding contingency).

6.6.11 Tarro ZS 11kV Switchgear Replacement

Key Project Milestones:

The existing 11 kV switchgear at the Tarro 33/11kV ZS has increasing condition, reliability and safety concerns. If action is not taken, our planning studies expect that there will be substantial unserved energy to loads in this area of our network when the switchgear fails, as well as significant reactive maintenance costs associated with having to repair and restore service. If action is not taken, we expect that our electricity distribution license reliability and performance standards will be breached.

The project was approved by Ausgrid CEO on 6/04/2023, at a total cost of $12 million ($10.7 million excluding contingency).

Options Analysis

Two network options were considered to resolve the above issues:

Option	Description	NPV ($m)
1	Replace the existing 11kV switchgear at Tarro ZS	28.6
2	Build a new zone substation to replace the Tarro ZS	18.2

Option 1 provides the highest NPV and represents the most cost-effective way to address identified risks. In addition it provides the flexibility required to address both the immediate needs of the existing network and the potential needs of future connections in a staged manner, which is a prudent approach considering that such future connections may not materialise. If prospective loads are realised, it is likely that load growth will occur over an extended period, as similar industrial estates in the area are not fully occupied after 10 years.

6.6.12 132kV Feeders 923/2 & 924/2 Mason Park STSS – Burwood ZS

Key Project Milestones:

The underground electricity subtransmission cables supplying the Burwood load area 923 and 924 are part of Ausgrid's Inner West network and include sections of self-contained fluid filled (SCFF) feeders, which are considered an obsolete and outdated technology. They are becoming less reliable and approaching the point where their replacement maximises the net benefit for the community. Ausgrid has identified the need to replace the underground SCFF sections of feeders 923 and 924, which connect the Burwood Zone Substation (ZS) to the Mason Park Subtransmission Switching Station (STSS) via the Strathfield Transition Point (TP).

The project was approved by Ausgrid CEO on 23/12/2022, at a total cost of $14.7 million ($13.4 million excluding contingency).

Options Analysis

Two network options were considered to resolve the above issues:

Option	Description	NPV ($m)
1	Replacement of SCFF feeders along the existing route	43.7
2	Replacement of SCFF using a different route along smaller residential streets	44.7

Option 2 provides the highest NPV and ensures that the Strathfield TP site can be fully decommissioned and made available for disposal. By using the alternate route, Ausgrid will be able to take advantage of conduits installed as part of the WestConnex Motorway project. In addition, removal of 230 metres of overhead lines between the Strathfield TP and Parramatta Road provides amenity improvements and reduced safety risk This option therefore causes the least impact to the community, in addition to the benefits quantified as part of the RIT-D assessment.

6.6.13 Concord ZS 11kV Switchgear Replacement

Key Project Milestones:

The project was approved by Ausgrid Board on 16/08/2021, at a cost of $21.5 million ($20.0 million excluding contingency).

Options Analysis

The existing 11kV switchgear at Concord ZS was commissioned in 1955. Condition based tests on the switchboard have confirmed the asset condition has deteriorated to the point that the risk of failure and associated risk of customer supply interruptions has increased beyond the point where replacement is justified.

Review of the Cost Benefit Analysis (CBA) for the network and non-network options confirmed the preferred option has not changed from the Gate 2 approval (i.e. the replacement of existing switchgear with new switchgear and the build of a new switchroom). Even with the cost increase, this option retains a positive NPV and is the best of the available options.

The credible network options identified to address the asset condition issues at Concord ZS are outlined in the table below.

Option	RIT-D assessment		Gate 3 review	
	Costs ($m real)	Market NPV ($m real)	Costs ($m nominal)	Market NPV ($m real)
1. Maintain the existing 11kV switchgear (i.e. no change)	This option is not viable. Corrective action is required to address the asset condition issue.			
2. Replacement of 11kV switchgear in-situ	16.7	25.9	23.9	7.6
3. Replacement of 11kV switchgear with new switchroom	14.3	28.5	21.5	10.2

The credible network options are the replacement of the 11kV switchgear with new equipment in-situ or a new switchroom to house new equipment. The latter option had the highest market NPV in the initial analysis. The updated assessment (i.e. Gate 3 Final Project Approval) confirms that the installation of a new switchroom to house the new 11kV equipment still has the highest market NPV and therefore maintains its position as the preferred option.

Consideration was given to the establishment of a new substation to replace the existing Concord ZS, of the retirement of Concord ZS via 11kV load transfers to Olympic Park ZS. However, it was found that these options are unfeasible because their costs are significantly higher than the preferred option, without providing significant additional benefits. The new substation or the retirement via load transfers (which would have slightly reduced costs as fewer cables are required due to a reduced load forecast) are sub-optimal options in this case.

6.6.14 Milperra ZS 11kV Switchgear Replacement

Key Project Milestones:

Project Initiated **Sep 21**

Project Approved by Ausgrid Board **Jul 24**

Project Completion **Jun 28**

The compound insulated 11kV switchboard at Milperra ZS is experiencing increasing condition issues. It remains original and failure rates for switchgear are expected to increase with age. If no corrective action is taken, planning studies indicate a significant increase in expected unserved energy, together with increasing safety risks and repair costs. Further, we expect that our electricity distribution license reliability and performance standards will be breached.

The project was approved by Ausgrid Board on 18/07/2024, at a total cost of $17.6 million ($16.5 million excluding contingency).

Options Analysis

One credible network option has been identified to address asset condition issues at Milperra ZS. It involves the replacement of the 11kV switchgear in an extended switchroom and decommissioning of the 11 kV compound insulated switchboard from the site.

Other options were considered but not progressed further because they were found to be technically or economically not feasible:

- Establish a new substation and retire Milperra ZS
- Transfer the 11 kV load to adjacent zone substations
- Replace the 11 kV switchgear by utilising two mobile equipment rooms (MER)
- Replace both the compound and the air insulated switchboard in the scope of the option

6.6.15 Decommissioning of 132kV Feeders Lane Cove STSS – Dalley St ZS

Key Project Milestones:

Project Initiated **Aug 20**

Project Approved by Ausgrid Board **Sep 22**

Project Completion **Sep 24**

The project was approved by Ausgrid Board on 24/08/2022, at a cost of $3.4 million ($3.1 million excluding contingency). This approval was also provided concurrently with the decommissioning of Dalley St ZS (refer to item 2.6.12 above).

Options Analysis

Ausgrid identified a need to address the increasing supply and environmental risks associated with 132kV fluid-filled underground feeders 928/3 and 929/1 between Lane Cove Subtransmission Switching Station (STSS) and Dalley St Zone Substation (ZS). The existing feeders utilise obsolete technology, requiring specialist skills to repair and maintain.

As a result of the implementation of the last step of the strategy in the Sydney CBD load area, Dalley St ZS is to be decommissioned. As such, the 132kV feeders supplying Dalley St ZS have become redundant. Given the condition of these 132kV feeders, there are no other viable alternatives but to retire and decommission these assets.

6.6.16 132KV Feeder 264 Beaconsfield BSP – Kingsford ZS Replacement

Key Project Milestones:

Project Initiated **Aug 21**

Project Approved by Ausgrid Board **Dec 22**

Project Completion **Mar 25**

The 132kV underground Feeder 264, connecting Kingsford Zone Substation (ZS) with TransGrid's Beaconsfield Bulk Supply Point (BSP), is a self-contained fluid-filled (SCFF) feeder, with increasing customer supply, maintenance and environmental risks. Feeder 264 forms part of a ring network that connects Beaconsfield BSP and Bunnerong Subtransmission Switching Station via Kingsford and Maroubra zone substations. The availability of Feeder 264 is critical to supplying these zone substations.

Given the low deferral value available for reducing demand and the scale of load reduction required it was determined that non-network options could not form part of a credible option for this replacement investment.

The project was approved by Ausgrid Board on 7/12/2022, at a total cost of $26.5 million ($23.3 million excluding contingency).

Options Analysis

One credible network option has been identified to address asset condition issues on feeder 264. It involves the replacement of the existing feeder like for like, using modern equivalent technology – Cross Linked Polyethylene (XLPE) cable.

The NPV of this option was $135.7 million.

6.6.17 132kV Feeders 9SA & 92P Beaconsfield BSP to Campbell St ZS/Belmore Park ZS and Loop Zetland ZS into Feeder 92P

Key Project Milestones:

Project Initiated **Sep 21**

Project Approved by Ausgrid Board **Dec 22**

Project Completion **Sep 25**

The underground electricity subtransmission cables supplying the Eastern Suburbs load area include SCFF feeders, which are now considered an outdated technology. They are becoming less reliable and approaching the point at which their replacement maximises the net benefit for the community. Ausgrid has identified the need to mitigate risks associated with 132kV feeders 260 and 261, which run from Beaconsfield Supply Point (BSP) to Zetland Zone Substation (ZS). Ausgrid has also identified 132kV feeders 9SA and 92P as a high priority for replacement with modern technology cables, because of the environmental risks associated with potential oil leaks from these cables. Feeders 9SA and 92P run from the Beaconsfield BSP to Campbell St ZS and Belmore Park ZS respectively. Due to their geographic proximity, addressing concerns associated with feeders 9SA and 92P at the same time as replacing feeders 260 and 261 offers cost efficiencies compared to addressing them in isolation.

The project was approved by Ausgrid Board on 7/12/2022, at a total cost of $29.3 million ($25.9 million excluding contingency).

Options Analysis

Three network options were considered to resolve the above issues:

Option	Description	NPV ($m)
1	Replace the existing feeders 9SA, 92P, 260 and 261 like-for-like using modern equivalent technology.	-0.1
2	Replace SCFF sections of feeders 9SA and 9SP, loop Zetland ZS into feeder 92P and close Zetland 132kV busbar.	5.4
3	Replace SCFF sections of feeders 9SA and 92P, loop Zetland ZS into feeder 92P and defer works on closing Zetland 132kV busbar	6.6

Option 3 provides the highest NPV and represents the most cost- effective way to address identified risks to customers and the environment, noting that works at Zetland ZS can be deferred until FY34. By this time, another transmission path between Beaconsfield and Haymarket BSPs is needed upon retirement of SCFF feeders Commercial in 90T/1 and 9S2, thereby requiring the 132kV bus section circuit breaker at Zetland ZS to be operated normally closed.

6.6.18 New Macquarie STS Transformer 3

Key Project Milestones:

Project Initiated
Sep 22

Project Approved by CEO
Aug 24

Project Completion
Dec 26

Macquarie 132/33kV STS was commissioned in July 2021 to assist with providing supply to three major customers who were ready to connect at the time. Two new connection applications from major customers have since been received. The existing spare capacity at the Macquarie 132/33kV STS is not sufficient to support the connection of these two new loads. These two major customers have both committed to make a direct contribution to the investment, to facilitate the timing of the expansion of the STS being brought forward

If action is not taken, there is a significant and increasing forecast supply risk when the combined demand from new and existing customers is near or close to 100% of requested demand, leading to a shortfall of secured substation capacity under both credible contingencies (i.e., transformer outages) and full availability.

The project was approved by Ausgrid CEO on 14/08/2024, at a total cost of $14.8 million ($13.5 million excluding contingency).

Options Analysis

Three network options were considered to resolve the above issues:

Option	Description	NPV ($m)
1	Install a new transformer in 2029	12.7
2	Install a new transformer in 2026 (with capital contribution)	13.0
3	Install a new transformer in 2026 (without capital contribution)	12.1

Option 2 provides the highest NPV and represents the most cost- effective way to address identified need. It involves installing a third 120 MVA 132/33 kV transformer at the Macquarie 132/33 kV STS. The estimated construction cost of this option includes a direct contribution from the two major customers of $1.3 million, reducing the effective capital cost to $7.4 million. The timing of commissioning for Option 2 is 2025/26. The RIT-D demonstrates that the increase in costs (in present value terms) resulting from the earlier commissioning date is more than offset by the capital contribution that will be made by the two major customers in the central and high demand scenarios as well as on a weighted basis and is effectively equal in the low demand scenario.

7. Information and Communications Technology Systems Investments

7.1 Information, Communication and Technology

Information, Communication and Technology (**ICT**) provides the critical business systems to enable Ausgrid to perform its network operations, which includes undertaking effective asset management planning, and fulfilling regulatory and statutory reporting obligations.

ICT systems are integral to performing functions such as asset lifecycle management, asset operations, customer and market management and financial reporting, with Supervisory Control and Data Acquisition and Network control systems being integral to performing key network activities such as monitoring and managing the electrical network.

ICT also allows Ausgrid to prudently adopt and effectively implement technology that enables Ausgrid to deliver better services to network customers and reduce costs over time. Key ICT systems support the following Ausgrid core business functions:

Domain	Description
Asset Lifecycle Management	Asset management is one of Ausgrid's most critical functions. The asset management business function concerns the management of all physical components of Ausgrid's electrical system across the lifecycle of assets from investment through to retirement/replacement at the component level. It is also tightly integrated with operations and planning at the Network level. The asset management systems are therefore integral to providing services, reliability and quality of supply and protecting the safety of customers, community and employees.
Works Management	Works management refers to the efficient management of Ausgrid's resources in the delivery of services within the Network. It encompasses processes which are tightly associated with the asset management capability described above, scheduling and dispatch, warehousing and mobility.
Market Management and Customer Management	Market management includes all of the processes related to the collection of revenue resulting from the provision of energy distribution services. The main processes in delivering this business capability are metering, revenue management, and network billing. Market management also incorporates network pricing, market transactions, meter data management and financial reporting. Customer management includes functions and processes related to customer interactions, connections and disconnections, as well as the provision of a customer contact centre.
Enterprise Management	Commercial and corporate includes functions necessary for executive control and oversight of normal organisational functions, such as finance, reporting, strategy development and implementation, human resource management, non-system asset management and property management.
IT Management	The effective management of information across Ausgrid has become crucial. The nature of the business dictates that information needs to be collected, managed and analysed in order to provide timely and effective decision support. Information management is also required to satisfy regulatory obligations and core financial and organisational reporting and analysis. Infrastructure provides the backbone to Ausgrid's business capabilities and systems. It includes all of the hardware, communication, operating systems and devices required to support the business.
Asset Operations	System IT provides the core functions regarding provision and development of the **ADMS** and Supervisory Control and Data Acquisition (**SCADA**) systems, core telecommunication networks (MPLS, 4G) and distribution network monitoring and control.

7.1.1 ICT Investment Actual 2023/24 and Forecast

Throughout the year, key applications and infrastructure have been maintained to enable a reliable, scalable and secure computing platform. These include our SAP applications, enterprise content management platform, customer relationship management platform, supporting Ausgrid critical infrastructure licence conditions, metering systems and data centre and telecommunications technologies. Ausgrid has also commenced the migration of applications from data centres to the cloud.

In the development of the forward plan and strategy the following principles were adopted:

- **Simplifying:** simplifying our technology to reduce complexity and remove duplication and legacy;
- **Fit for purpose:** delivering fit-for-purpose solutions with the appropriate security and commercial model;
- **Automation:** where possible, automating to reduce errors and drive consistency;
- **Data Management & Analytics:** improve data quality and access to make better decisions;
- **Cyber Security:** protecting the network and customer information including compliance with laws and the distributor licence conditions, and to be recognised as the leader in cyber security within the Power and Utilities industry.

The table below contains a summary of actual ICT investment in 2023/24 and forecast investment in 2024/25 through to 2028/29.

ICT Investment actual 2023/24 and forecast 2024/25 to 2028/29 (Nominal $) *						
	Actual ($m)	Forecast ($m)				
	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29
Total ICT Capital Investment	103	92	111	116	90	87

*Excludes the Advanced Distribution Management System.

7.2 ADMS

Ausgrid's distribution network is managed using a group of systems where control room staff integrate various information flows and take consequent actions to manage the network, this includes maintaining the security and stability of the network. The ADMS is the core operational management tool in that group of systems, providing an integrated set of tools to monitor and control the network, manage system outages, improve planned and emergency event management, and optimise fault location and restoration processes.

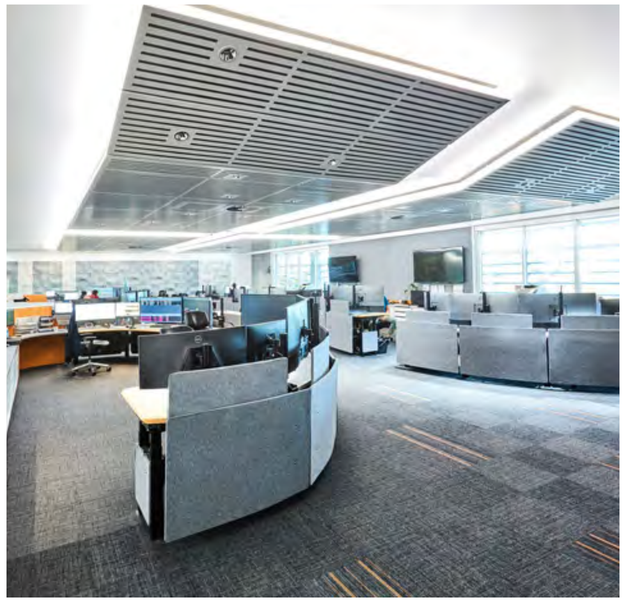
The core ADMS monitoring, and control functionality was implemented in November 2022. The remaining functionality which covers the management of system outages (unplanned and planned) and a group of sophisticated system-management tools, will be implemented over the next few years further replacing existing legacy technologies and providing new capabilities such as Fault Location, Isolation, and Service Restoration (**FLISR**) and integration of Advanced Metering Infrastructure (**AMI**). Once complete, this will enable the continued expansion of features to better manage distributed energy resources in conjunction with a Distributed Energy Resource Management System (**DERMS**) and other developing technologies.

This will allow Ausgrid to provide the services expected by customers and stakeholders in the rapidly changing energy market.

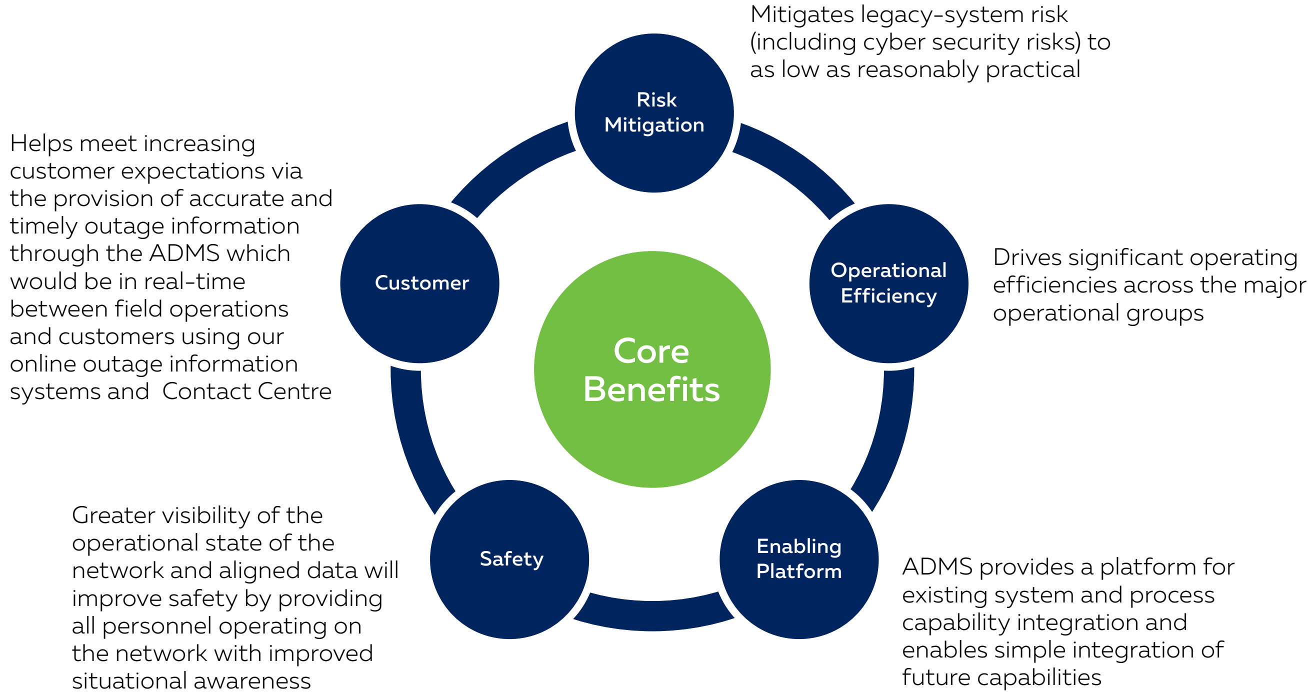
7.2.1 ADMS Benefits

A mature ADMS will deliver benefits to customers with the following improvements to current functionality:

- Management of system outages and restoration works;
- Planned and emergency event management;
- Situational awareness from power-flow analysis;
- Network fault location analysis, automated isolation and restoration capabilities;
- Provision of a platform for the integration of distributed energy resource management systems as well as other corporate systems enabling the Distribution System Operator (DSO) construct;
- An ability to better integrate with Ausgrid's enterprise systems to ensure a consistent real time situational view (that is not dependant on staff entering and updating information in multiple systems); and
- The ability to use digitised switching instructions which would enable non-verbal communications between the control room and field operators.



The core benefits assessed in the business case for the ADMS implementation are described in the following diagram.



7.2.2 ADMS Program Implementation

The overall program is delivered via a phased approach which has been adopted to mitigate the risks of a large technology rollout and to allow the business time to adapt to the ADMS functionality across three phases, each building upon new capability acquired in the prior phase.

Phase	Description	Timing
1	Replacement of legacy distribution management system - this delivers mission-critical monitoring and control functionality (SCADA) – Practically complete	2019 – 2022
2	Modernisation of operations for planned and unplanned work, deployment of additional distribution management applications and establishment of a Low Voltage Network model	2019 – 2025
3	Implementation of Advanced Applications – this delivers Automated Fault Detection and Isolation Restoration and advanced applications to enhance the optimisation of the network, e.g. Distribution Energy Resource Management	2022 - 2026

Each Phase will follow a sequence of 5 stages as outlined below:

Design
- System, process, and business design specifications

→

Build
- Network Model building and testing
- Building of business process
- Work Instructions development
- Train the trainer Sessions

→

Test
- Factory acceptance testing
- Site acceptance testing
- User acceptance testing

→

Deploy
- Development of end-user straining and system support
- ADMS Functionality becomes 'live' and accessible across the business

→

Sustain
- Manage and maintain the implementation
- Embed continuous improvement of the solution

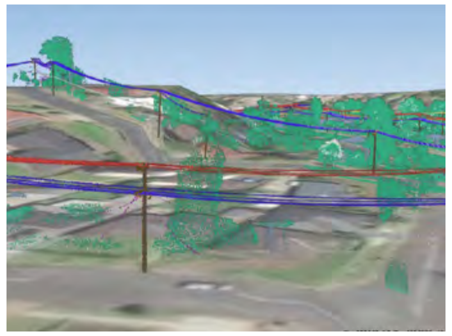
7.3 Network Digitisation Program: Transforming Network Insights

The Network Digitisation Program is at the forefront of providing network insights through cutting-edge technology.

Phase I of the program has focused on delivering innovative solutions to enhance the understanding of Ausgrid's overhead poles and wires network. This phase has utilised drones, helicopters and ground vehicles to capture detailed data, creating a new digital twin of the network. By integrating new data and leveraging artificial intelligence and machine learning algorithms it has provided new insights into the network's performance and condition.

Phase I of the program concludes in 2024 and the program is transitioning into Phase II.

This next phase aims to implement and embed the insights gained from Phase I while expanding the program's scope. Phase II will include the underground network, incorporate more advanced AI analysis, and focus on acquiring and sharing data with customers and other stakeholders more effectively. This holistic approach promises to further enhance the efficiency and reliability of the network, putting downward pressure on prices and improving customer experience into the future.



7.3.1 The Benefits of Ausgrid's Network Digitisation Program

Ausgrid's Network Digitisation Program leverages cutting-edge technologies such as Light Detection and Ranging (**LiDAR**), drone imagery and processing, machine learning and Artificial Intelligence (**ML/AI**) to develop digital twins of our network, providing network wide insights and assisting with asset condition assessments. These advancements enable Ausgrid to gather comprehensive and accurate data at significantly reduced costs, leading to numerous benefits:

Streamlined Internal Design and Work Planning	• Enhanced information availability and validation streamline internal design processes. • Improved planning efficiency ensures that projects are executed more smoothly and effectively.
Automated Design Validation and Construction	• Faster, automated design validation accelerates the construction process. • Efficient asset information exchange benefits Accredited Service Providers (ASPs) and enhances overall project management
Optimised Bushfire and Vegetation Management:	• Advanced technologies optimise bushfire and vegetation management programs. • Improved tree-scapes and vegetation management reduce the risk of bushfires and enhance environmental sustainability.
Enhanced Safety in Design	• Technologies like LiDAR and AI contribute to safer design practices, such as identifying low mains or poles at risk of failure. • Reduced dependency on manned aircraft for bushfire management lowers operational risks and costs, and results in improved environmental outcomes.
Design Optimisation and Major Event Response	• Optimised design processes improve response times and effectiveness during major events. • Reduced vegetation impact enhances the resilience of the network against natural disasters.

7.3.2 Network Digitisation Program Implementation

The Network Digitisation Program has been a transformative initiative. This program has successfully delivered a digital twin of the overhead network and high-resolution pole top drone photography giving unparalleled network insights and advanced design functionalities. This digital twin serves as a virtual replica of the physical network, enabling efficient and high-quality designs and network wide insights.

As Phase I of the Network Digitisation Program wraps up in 2024, the groundwork is being laid for an ambitious Phase II. This next phase will see a significant broadening of scope, including the implementation of new business capabilities and the realisation of enhanced business benefits. Key focus areas will include:

Data Acquisition & Collection

- Building on the successes of Phase I, further integrating AI and ML to derive deeper insights and drive more efficient network management.
- Developing Data Sharing Platforms with customers, councils, utilities and other stakeholders.

Drones & Bushfire Surveillance

- Expanding the range of drone applications to cover more aspects of network inspection and maintenance, including incident response and network construction support.

Digital Twin Enhancements

- Expanding the digital twin concept to include underground networks, providing a holistic view of the entire network infrastructure.

As the program transitions into Phase II, it is poised to deliver even greater value, driving the future of network management with cutting-edge technology and forward-thinking strategies.

The estimated program costs are provided in the table below.

Program cost estimates including contingency & overhead ($m, nominal)					
	FY25	FY26	FY27	FY28	FY29
Network Digitalisation	3.8	4.5	4.2	3.6	4.2

8. Planning Coordination

Joint Planning is carried out with other Network Service Providers, in particular Transgrid, Endeavour Energy and Essential Energy.

8.1 Process & Methodology

8.1.1 Transgrid

Ausgrid plans its transmission network jointly with Transgrid as the Ausgrid 132kV dual function network provides support to Transgrid's 330kV network. In carrying out joint planning Transgrid and Ausgrid:

- Meet regularly, at least 4 times per year;
- Record minutes and decisions;
- Prepare work plans and monitor progress;
- Assess augmentation options on the basis of least cost to the community;
- Initiate projects within each organisation following the normal approval processes; and
- Jointly consider demand management as an option.

Ausgrid and Transgrid have established a Joint Planning Committee structure which comprises a steering committee and a joint planning sub-committee to coordinate the planning activities of Ausgrid and Transgrid in accordance with the joint planning requirements of the NER. Under the agreed terms of reference, there are quarterly meetings of the sub-committee and bi-annual steering committee meetings. Members include relevant planning, operations, design and project development staff. The key considerations of the joint planning committees are specified in the joint planning charter. Committee activities and deliverables are managed through an agreed work plan, with decisions documented in approved Joint Planning Reports for major milestones.

From 1 July 2018, Transgrid and Ausgrid are required to comply with the "NSW Electricity Transmission Reliability and Performance Standard 2017". This standard requires the NSW electricity transmission network to be designed and planned to a certain level of redundancy and level of EUE. This is a significant change from the former deterministic assessment of the network.

8.1.2 Other DNSPs

Ausgrid follows the same principles when joint planning with Endeavour Energy and Essential Energy. However, due to the limited number of network dependencies between the organisations, joint planning meetings may only take place once per year, or less, unless a particular issue has been identified and needs to be progressed and monitored.

Joint planning meetings may be initiated by any party to discuss planning issues, identified network needs and proposed solutions near adjoining network boundaries that are likely to affect either party. The joint planning meetings are also the forum used to discuss proposed changes on the network that may have a material impact on either DNSPs network.

8.2 Joint Planning Completed in 2024

8.2.1 Transgrid

Sydney Inner Metropolitan Transmission Load Area

Existing and future constraints on the Sydney Inner Metropolitan transmission network are centred on two critical areas:

- Transmission supply into Beaconsfield BSP from Bulk Supply Points at the edge of the city, Sydney South, Sydney North, and Rookwood Rd BSP. This is known as Transmission Corridor 1 (**TC1**).
- Transmission supply into Haymarket BSP and surrounding Ausgrid 132kV zone substations from Sydney South BSP (Cable 42) and Ausgrid 132kV connections from Beaconsfield BSP and the meshed 132kV network. This is known as Transmission Corridor 2 (**TC2**).

Both transmission corridors operate as meshed systems of 330kV and 132kV circuits, with significant interdependencies between both corridors. Both have limitations due to the age and condition of existing circuits, including significant reduction in capacity of cables where in-situ conditions are not adequate to support design ratings. The Inner Metropolitan Area Joint Planning strategy must resolve issues on both corridors.

After extensive consultation from 2014 through the RIT-T, Transgrid's 2018-2023 regulatory submission and numerous other forums, Transgrid began construction in 2020 on the first stage of the preferred strategy for Powering Sydney's Future. This strategy consists of:

- A combination of non-network solutions to manage the risk of unserved energy before the network option can be commissioned;
- Installing two 330kV cables in two stages, with commissioning of the first cable in time for the 2022/23 summer;
- Operating 330kV Cable 41 at 132kV from 2022/23; and
- Decommissioning Ausgrid's cables in two stages.

Commissioning of the first stage was completed in June 2022. This includes the first 330kV cable and operating 330kV cable 41 at 132kV. Decommissioning of the first stage of Ausgrid's cables was completed in 2023. Early development work is now starting on the second stage of this project.

Other Transmission Load Areas

Transgrid's Sydney East 330/132kV BSP was commissioned in 1974. The substation is a major interconnection point in the Transgrid 330kV network and is the sole source of supply to Ausgrid's substations in Sydney's Northern Beaches and North Shore areas. A condition assessment of Sydney East BSP identified that the Secondary Systems require replacement, requiring Ausgrid to carry out works on the Ausgrid end of the impacted feeders. On TransGrid's request, Ausgrid is facilitating the required protection replacement works on all affected Ausgrid feeders. Protection upgrades are expected to coincide with Transgrid's program of works at Sydney East BSP which are scheduled for completion by 2027/28.

Voltage Planning

Transgrid and Ausgrid initiated a voltage specific joint planning stream in 2020. The voltage specific planning stream provides for a BSP to LV customer planning approach for our whole network whilst aligning with the upstream Transgrid voltage requirements. This has provided efficient solutions in improving voltage issues and DER hosting capacity. This work has continued in 2024.

Embedded Generation Planning

A number of large embedded generator and Battery Energy Storage System connections to the Ausgrid network has and may require joint planning and assessment with Transgrid.

8.2.2 Endeavour Energy

A joint planning meeting with Endeavour Energy was held in June this year. The focus of discussion was mainly on the below topics as given below:

- Connections of major loads like data centres, EV charging hubs etc. with focus on allocation and prioritisation of the network capacity considering flexible connection arrangements.
- Conduct analysis of feeder 926/927 supply to Endeavour Energy owned Carlingford transmission substation.
- Treatment of Invertor Based Load (**IBL**) and generator connections assessment in particular modelling architecture, wide area model studies and system strength.
- Update Connection Agreement Databook to include existing and proposed Inter distributor supply and cross border arrangements.
- Forecast methodology inclusive of Distributed Energy Resources (DER)

8.2.3 Essential Energy

A joint planning meeting with Essential Energy was held in October this year. The connection points were reviewed and the ownership of assets at each connection point was confirmed, with the intention of updating the connection agreement.

Essential Energy raised concerns about load growth at Clarence Town which may require an increase to the export/import capacity at two connection points. Ausgrid will review the capacity of all connection points related to Brandy Hill zone substation, particularly with the emergence of multiple BESS to be connected to the 11kV network (up to 6 over a number of years). A joint planning meeting is planned for early next year after the completion of the summer peak period, to discuss the Brandy Hill connection points for Clarence Town.

8.3 Planned Joint Network Investments

8.3.1 Transgrid

Planned future network investments, excluding committed projects, discussed at Transgrid - Ausgrid joint planning meetings in the preceding year include:

- The shunt reactor at Sydney East BSP has been identified for replacement due to asset condition issues. It is essential to manage the voltage and power factor at Sydney East BSP
- The Ausgrid network is experiencing high voltages and leading power factor for an increasing proportion of the year. One of the potential solutions may require installation of a new shunt reactor at Beaconsfield BSP. Investigations will continue in 2024.

8.3.2 Endeavour Energy

There is currently a project to supply Ausgrid's Auburn and Lidcombe zone substations from Endeavour Energy's Camellia Transmission Substation.

8.3.3 Essential Energy

There were no jointly planned network investments with Essential Energy in the preceding year.

8.4 Additional Information

Further information on Transgrid and Ausgrid's completed joint planning and joint network investment can be found in Transgrid's Transmission Annual Planning Report. It is published on their website as well as AEMO's website. Further information on completed Ausgrid and other DNSP joint planning and joint network investments may be found in other section of this report.

Where a proposed future project satisfies the requirements for a RIT-T or RIT-D project, the identification of non-network options, the consultation on potential credible options and their economic assessment will be published in accordance with the NER.

Appendix A: How We Plan the Network

A.1 Ausgrid and the DTAPR

A.1.1 Distribution Network

The NER (Version 214) require that the annual planning review includes the planning for all assets and activities carried out by Ausgrid that would materially affect the performance of its network. This includes planning activities associated with replacement and refurbishment of assets and negotiated services. The objective of the distribution annual planning review is to identify possible future issues over a minimum five-year planning horizon that could negatively affect the performance of the distribution network to enable DNSPs to plan for and adequately address such issues in a sufficient timeframe.

This document provides information to Registered Participants and interested parties on the nature and location of emerging constraints on Ausgrid's subtransmission and 11kV distribution network assets, commonly referred to as the distribution network. The timely identification and publication of emerging network constraints allows the market to identify potential non-network options and Ausgrid to develop and implement appropriate and timely solutions.

A.1.2 Transmission Network

The NER require network service providers, who own and operate dual function assets to register as TNSPs by virtue of the definition of 'TNSP' in the rules. Certain parts of the rules treat dual function assets in the same way as other subtransmission assets. However, for the purposes of the transmission annual planning review and reporting, dual function assets are treated as transmission assets requiring a TAPR. For the purposes of economic evaluation and consultation with Registered Participants and Interested Parties, dual function assets are treated as distribution network assets and are subject to the same economic evaluation test.

Ausgrid's dual function network is defined as those assets with a voltage of 66kV and above that are owned by Ausgrid, and operate in parallel with and provide material support to the Transgrid transmission network. These assets may either operate in parallel with the transmission network during normal system conditions or can be configured so that they operate in parallel during specific system conditions.[8]

An asset is deemed to provide material support to Transgrid's transmission network if:

- There is otherwise limited or no system redundancy within the transmission network, or
- Investment in the transmission system would be required within the regulatory period if that network asset did not exist, or
- The feeder provides operational support to the transmission network (e.g. to facilitate maintenance of transmission assets or improve security of supply) and the asset provides an effective parallel with the transmission network via a relatively low impedance path.

Ausgrid reviews the function of its dual function assets periodically to determine if they continue to provide material support to Transgrid's transmission network. This review is used as input for preparing Ausgrid's regulatory reporting, the regulatory submission, and pricing methodology. For the purpose of AER Revenue Determination submissions, the list of dual function assets is determined based on the forecast load and the system configuration as at the beginning of the regulatory period.

A.2 Ausgrid's Planning Approach

The network planning and development process for both the distribution and transmission networks is carried out in accordance with the **NER** Chapter 5, Part D, Network Planning and Expansion. Planning for distribution and subtransmission assets is carried out in accordance with NER 5.13.1 - Distribution annual planning review and NER 5.12.1 - Transmission annual planning review for dual function assets.

A.2.1 Investment Objectives and Decision Criteria

Ausgrid's investment objectives are set to comply with the NER and the NSW Licence conditions for a DNSP, to ensure the safety of the people and improve the efficiency of the business

8. Network Planning Standard NIS433: Classification of Dual-Function Assets

The following table, taken from Ausgrid's Asset Management Strategy, provides a summary of Asset Management objectives:

Enhancing Safety
Protecting people from harm so far as reasonably practicable

Improving Network Performance
Improving the reliability, security and resilience of supply to create a better customer experience.

Delivering Affordability
Delivering customer affordability through efficient optimisation of whole of life costs and improved operational performance.

Increasing Sustainability
Transforming the network through reducing emissions and providing choice and control for customers to more easily access sustainable energy.

Making a commercial return
Provide dividend certainty through effective and optimised investment that responds to incentives.

These investment objectives are supported by the development and delivery of investments which efficiently achieve the key network performance outcomes outlined below:

Customer Connection
Connect customers to the network so that they can receive electricity supply, or supply energy to others.

Resilience & Reliability
Deliver network performance (resilience and reliability) that is equitable across customers and only to a level that customers are prepared to pay for.

Capacity
Deliver a system that can supply forecast customer demand for and supply of electricity.

Fault Level
Fault currents which are within a range which allows network and customer equipment to operate correctly and safely.

Voltage
Maintain the operating voltage within specified limits to support customer behind the meter activities including DER.

Power Quality
Provide supply that allows customers to successfully operate their equipment in the same network as others

System Stability
Facilitate the stable operation of the national electricity market (NEM)

Network Planning Process

Ausgrid follows a structured planning process that can be summarised by the following diagram from our Network Investment Policy. The planning phase involves identifying the investment needs and risks based on the probability and consequence of adverse events; developing one or more options to address these needs; assessing costs and benefits associated with those options under various scenarios to select the preferred option and initiating the preferred option.

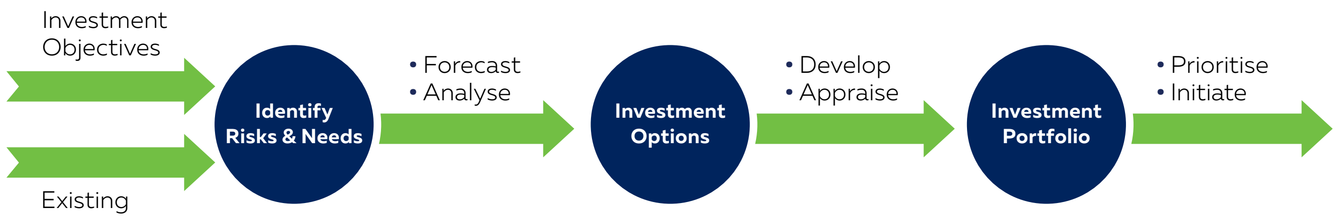


Figure A-1: Ausgrid planning process

The timeframe and complexity of this process varies according to network level, risk profile, and the project scale and intent. Accordingly, Ausgrid organises its planning activities by distinct investment categories. This approach allows Ausgrid to adopt a level of analysis and justification that is commensurate with the costs, risks and obligations associated with each investment category discussed below:

	Area Plan Strategies	• Consider the development requirements of interconnected areas over a 20 year investment window to capture synergies between projects and drivers. • Detailed analysis considering a number of alternatives is typical. • Often consider alternative network architectures
	Distribution Network	• Investments to provide for the evolving needs of our existing customers and connection of new small customers. • High volume of low-medium value investments with largely standard solutions that are initiated reactively once network constraints are identified (i.e. demand growth, voltage, supply quality and fault duty requirements) • Up to 6 year planning horizon
	Customer Connections	• Direct investment to connect customers. • These investments are initiated by customer applications for a connection • Larger customers are responsible for connection costs and thus determine efficient level of investment
	Reliability Planning	• Investments to address gaps in reliability performance • Proactive investment responding to forecasts of reliability performance. • Reactive investment determined through an assessment of reliability outcomes based on actual performance.
	Replacement	• Lifecycle management of existing infrastructure considering asset performance, risks and costs to determine when to maintain, renew, replace or retire those assets. • Investment is either to meet specific obligations and standards; or justified based on an assessment of cost and benefits, in terms of risk mitigated.

The following tools have been implemented to assist Ausgrid in making prudent, cost-effective investment decisions:

1. Governance Framework

The Governance Framework provides guidance and accountability for the planning, development, endorsement, and approval of network investments. It defines how Ausgrid plans and invests in its network.

The governance framework is comprised by the following stages

I. **Policies and standards** are used to define the technical requirements for any future changes to the network and therefore drive the nature and size of network investments.

II. **Long-term plans and strategies** provide a long term view of the network and outline a 5-10 year program of works required to meet known asset performance requirements, new large connections, infrastructure standard compliance gaps and likely capacity constraints. Sub-transmission area plans are used to identify needs/constraints up to 20 years in advance and allow investment decisions to be made in the short term to enable the lowest cost solutions to be delivered over the long term.

III. A resource strategy is developed in the form of **program delivery models**. They consider resource requirements by work program or job type, current utilisation rates and productivity targets.

IV. The integration of these guidelines makes possible the development of a **Portfolio Investment Plan (PIP)**, which is updated on annual basis and approved via a Gate process. At **Gate 1**, investments are reviewed and approved by Ausgrid's Board at the portfolio level. Once approved, the PIP becomes the baseline for the annual budget/Management Business Plan (MBP) and for the regulatory proposal (in years when a proposal is submitted to the AER).

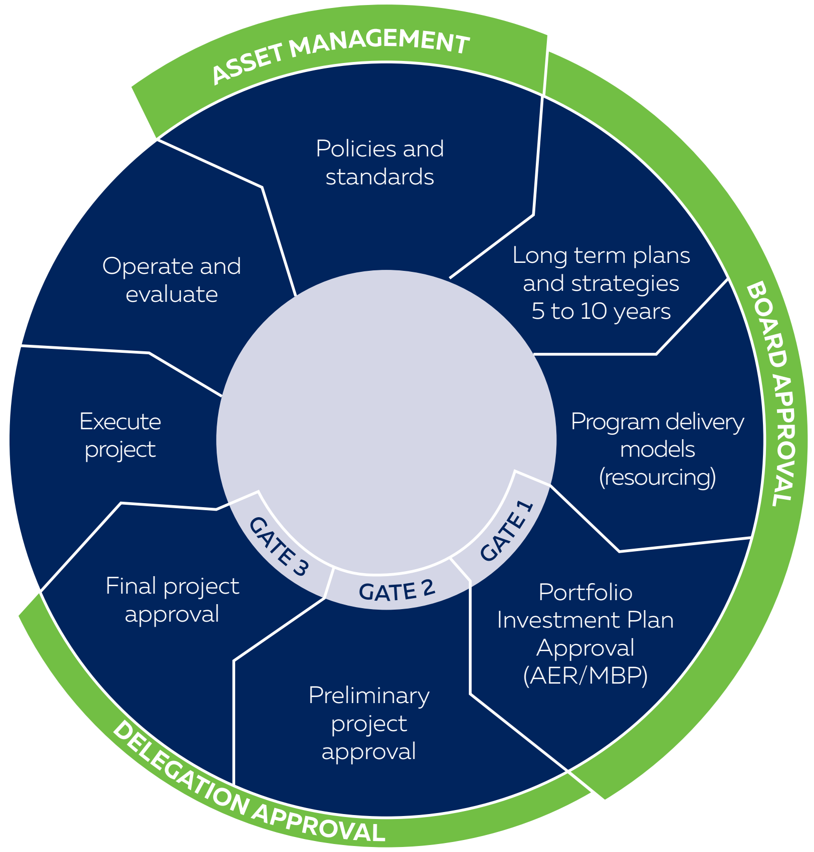
V. At **Gate 2**, **preliminary approval** is provided for investments at the project and program level. The focus is placed on assessing the network need for the program/project, prior to proceeding to the detailed estimate stage. Preliminary funds can be authorised to enable completion of design work, place orders for long lead time standard equipment and seek market consultation for externally delivered works.

VI. At **Gate 3**, **final approval** is provided for investments. The governance focuses on testing the efficiency of the delivery model and confirming the project/program timing, risk and cash flows. Investment approvals are obtained in accordance with applicable delegations and sub delegations of authority.

VII. After that, **project and program execution** can be initiated. Delivery is monitored for each individual project or program and milestones are reviewed on monthly basis. Variations can be raised if delivery and risk outcomes cannot be achieved within existing approval limits.

VIII. Once investments are completed, the resulting assets are commissioned and ready to **operate**. Projects must have a formal close-out. Post-implementation reviews are required to **evaluate** performance and provide feedback/lessons learnt for similar investments in the future.

These stages are illustrated in the diagram below, representing the governance lifecycle:



2. Cost Benefit Analysis (CBA) / Options Analysis

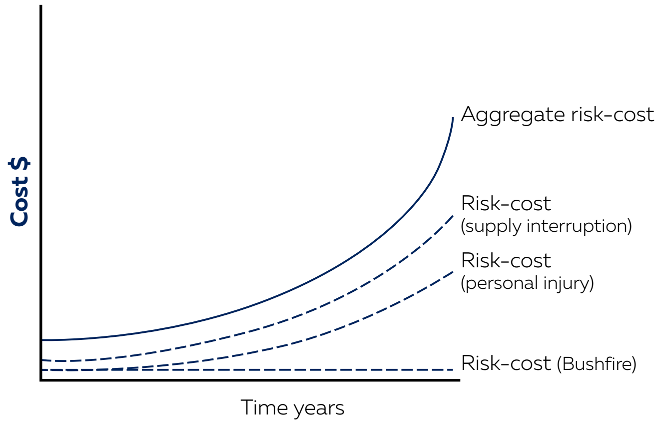
CBA is an investment decision support tool that measures the benefits of an action minus the costs of taking that action. It typically involves tangible 'cash' metrics such as capex invested or operational costs saved as a result of the decision to pursue a project, and often includes intangible benefits and costs, such as reduced supply, environmental or safety risks, with a dollar value assigned to the intangible items to make them comparable with the tangible financial components on a common basis.

Capex, ongoing opex, savings in future capex and opex are tangible elements that can usually be estimated with a reasonable degree of accuracy. They are typically modelled as direct cash flows in the CBA.

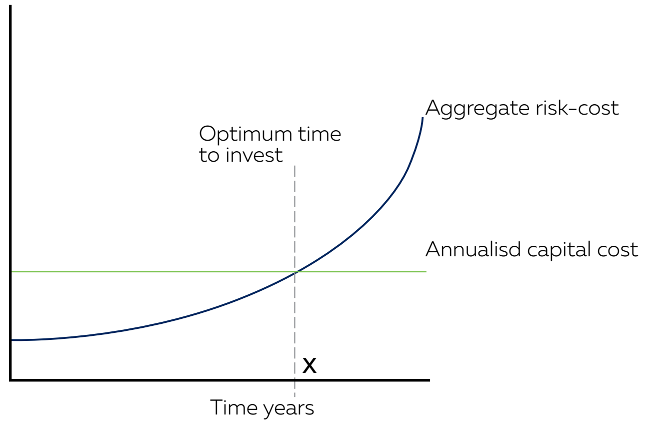
Loss of supply (i.e. unserved energy), safety and environmental risks are typically unknown and can only be included on a probabilistic basis – i.e. the likelihood of an event in any given future year is multiplied by the monetised risk cost associated with that event occurring. If an investment is implemented to avoid these risks, they will become benefits from a customer perspective and modelled as indirect cash flows in the CBA.

At the point where the annual benefit to society of an investment exceeds the costs customers will incur under the regulatory framework if the investment is made, the investment is considered justified and should proceed.

If the condition/capacity of a network is expected to deteriorate over time then the probability of failure increases. Resulting risks can be monetised and aggregated as an annualised risk-cost.

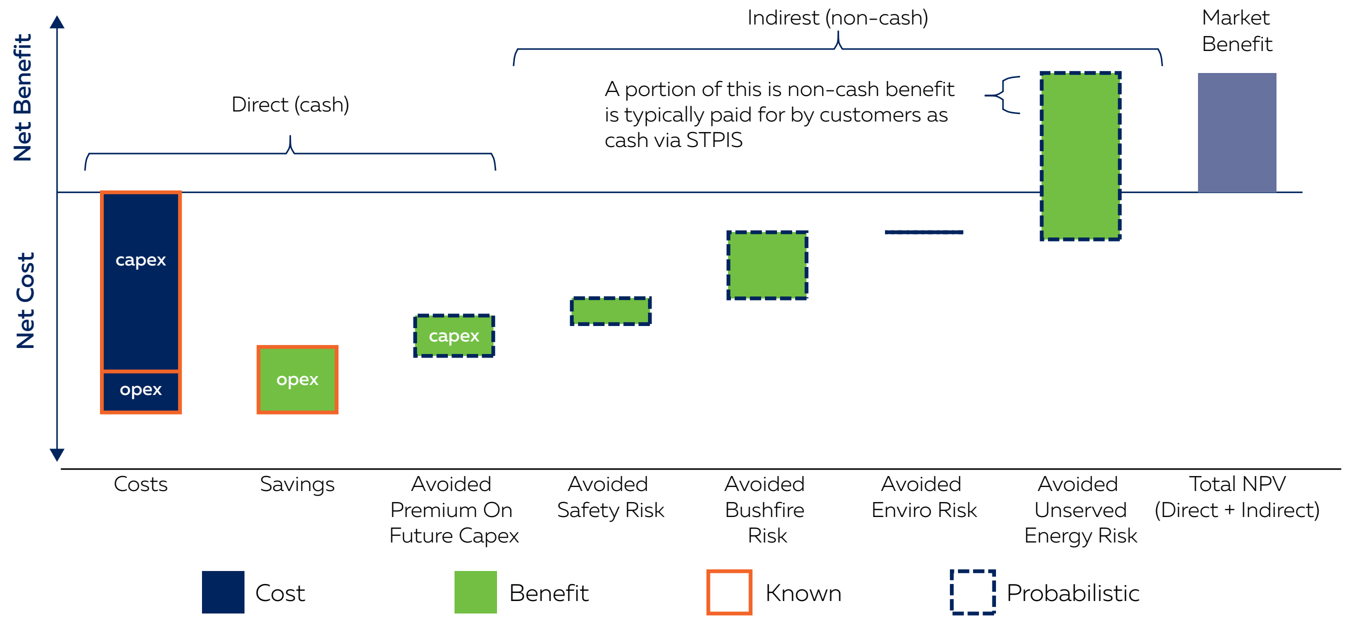


Optimal investment timing is identified when the aggregate risk-cost exceeds the annualised cost of the investment required to mitigate the risk.



The AER published guidelines with details on what they expect network businesses to include when using CBA to justify a capital investment.

In most network investments, the costs and benefits span multiple years. Therefore, a present value approach is applied to ensure future benefits can be compared on a like for like basis with expenditure now. Where future costs and benefits are discounted at or above the current regulated cost of capital, the CBA is implicitly comparing the option of making an investment against the opportunity of having the cash available for other purposes.



The CBA needs to identify the option that "maximises the net economic benefit across the Market". As a result, costs and benefits must be assessed in aggregate across all market participants, including those that "consume, generate, and transport electricity".

CBA is useful to assess the relative value of different investment options.

An investment option showing a positive NPV is not enough to justify a decision to go ahead with such investment. It should be assessed against other investment options that could also manage/mitigate the identified risks, to determine which option has the highest NPV.

The investment option with the highest market NPV (i.e. the most favourable to the overall community) should be the preferred option.

3. Capex Prioritisation/Optimisation

The outcomes of CBA applied to projects and programs (i.e. NPV results, Benefit/Cost ratios) are used as input information to rank and prioritise capital expenditure across the network investment portfolio.

Consideration is also given to the contribution made by projects/programs to support customer outcomes, corporate strategy and network performance targets, along with their ability to mitigate/reduce identified risks (i.e. workplace and public safety, environment, loss of supply, financial, etc) on the network.

A.2.3 Network Area Plans

Area Plans relate to major investments in the network and considers all of Ausgrid's obligations (irrespective of network type, voltage or investment drivers). The majority of investments within the Area Plans are subtransmission investments due to the greater interconnectivity of the network at this level and because these investments are generally complex and high in value.

To ensure Ausgrid's investment is prudent and efficient, our planning of major investments in the network:

- Is based on meeting the requirements of geographic areas, defined on the basis that they represent discrete electrical areas and with relative independence from network interconnections;
- Considers Ausgrid's obligations under the NER and other applicable regulatory instruments in a holistic manner; and
- Considers identified needs over a twenty-year planning horizon to allow for the development of a long term strategy that addresses various drivers and minimises long term cost.

Projects that comprise the preferred strategy for each Area Plan are determined by a probabilistic planning approach. This approach assesses cost and benefit, based on the risk of EUE and the VCR, with the preferred strategy entered in the Major Project List (Project List). Each project initiated is based on this list and on the expected project lead times, and in accordance with Ausgrid's Investment Initiation Standard. The Project List records the identified system limitation and need date, the required completion date and the estimated cost for each project.

The Area Plans are reviewed as significant changes to network needs are identified. In order to optimise project implementations, the timing of major projects is reviewed annually as new information and forecasts become available. Within the area plan cycle, major changes are captured in Area Plan Addendums or Planning Reports. The Project List also forms the basis of the economic assessment, consultation and reporting requirement under the RIT-D.

Appendix B: Demand Forecast

B.1 Data Tables Online

In keeping advice from the AER, that data should be made accessible in a format that can been readily interrogated, forecast and related data tables are published online and can be accessed via Ausgrid's website at www.ausgrid.com.au/DTAPR.

Table definitions for the 'Substation capacity and demand forecast' table and the 'Dual Function asset 10-year demand forecast' table located on Ausgrid's website are as follows:

Substation capacity and demand forecast table definitions

Heading Label	Description
Area Plan	An area as defined by Ausgrid used to describe a collection of substations of similar geographical region
Substation	Name of the substation. Details on the primary and secondary voltages of the substation included in the name to differentiate some locations of similar naming convention
Substation Type	Denotes either Zone Substation (ZS) or Subtransmission Substation (STS)
Total Capacity (MVA)	Maximum load able to be carried by the substation with all elements in service. A summer and winter Total Capacity value is provided
Firm Capacity (MVA)	Load able to be carried by the substation with the largest rated element out of service. A summer and winter Firm Capacity is provided
Load Transfer Capacity (MVA)	Amount of load that can be restored in the event of a whole zone outage by switching the distribution network. The transfer capacity assumes that a single zone is rendered out of service and the rest of the network is in system normal configuration. A summer and winter Transfer Capacity is provided
95% Peak Load Exceeded (hrs/yr)	The number of 15 minute occurrences that exceeded the 95th percentile value of maximum demand was summed and divided by four to determine the "hours within 95% of peak" value. A summer and winter 95% Peak Load exceeded value is provided
Embedded Generation - Solar PV (MW)	The Solar PV capacity by zone substation is consistent with the information used in the forecast and is current as at 31 March 2022 and 31 August 2022 for summer and winter respectively and includes all known systems. The solar generation capacity is based on information gathered from the application for connection forms completed at the time of applying for a solar installation and recorded in the Distributed Energy Resources Register
Embedded Generation - Other (MW)	Embedded generation "Other" includes all known diesel, landfill biogas, coal seam methane, natural gas including tri-generation and co-generation, hydro and mini hydro, coal washery, and waste heat recovery generating units known to Ausgrid. Not all of these units export to the grid as they are not capable of operating in parallel with the Ausgrid network and are intended for standby operation in island mode.
Actual Load (MVA)	Recorded peak demand for the substation. A summer and winter actual is provided. The actual loads are provided for the three years with the most recent year analysed being summer 2021/22 and winter 2022.
Actual Load (PF)	Recorded power factor for the substation at time of peak load. The value is compensated and takes into account the actual switching of capacitors at the substation at time of peak load. A summer and winter actual is provided
Forecast Load (MVA)	POE50 planning forecast peak demand in MVA for each respective forecast year for the substation. A summer and winter forecast is provided with the forecast starting from Summer 2022/23 and winter 2023.
Forecast Load (PF)	Forecasted power factor as calculated from POE50 planning forecast for each respective forecast year for the substation. The value is compensated and takes into account the forecasted switching of capacitors at the substation for any given forecast year. A summer and winter forecast is provided

Dual Function asset 10 year demand forecast table definitions

Heading Label	Description
Substation	Name of the substation. Details on the primary and secondary voltages of the substation included in the name to differentiate some locations of similar naming convention
Substation Type	Denotes either Zone Substation (ZS) or Subtransmission Substation (STS)
Substation Actual MW	Recorded peak demand in MW for the substation. A summer and winter actual is provided
Substation Actual MVAr	Recorded peak reactive load for the substation. The value is compensated and takes into account the actual switching of capacitors at the substation at time of peak load. A summer and winter actual is provided
Substation Forecast MW	POE50 medium scenario planning forecast peak demand in MW for each respective forecast year for the substation. A summer and winter actual is provided
Substation Forecast MVAr	POE50 medium scenario planning forecast peak reactive load in MVAr for each respective forecast year for the substation. The value is compensated and takes into account the forecasted switching of capacitors at the substation for any given forecast year. A summer and winter actual is provided

B.2 Zone and Subtransmission Load Forecasting Methodology

This section describes the maximum demand planning forecasting methodology (the forecast) used by Ausgrid for zone substations and subtransmission substations.

The forecasts of peak demand are prepared at the zone substation level and at the subtransmission substation level. These spatial forecasts form a key input into the planning of Ausgrid's capital expenditure program.

The underlying forecast is constructed from two primary components; a near term forecast that is based on the statistically derived trend line of the weather corrected historical customer electricity demand, and a medium to long term forecast that is based on a system level econometric model. This recognises the need for the forecast model to consider the short-term trend and long-term macro econometric factors.

Both components are adjusted for out of trend impacts from embedded generation, energy storage, electric vehicles and energy efficiency. Adjustments to the forecast are also made at a spatial level to account for planned new large customer connections and planned changes to the network architecture such as load transfers. The forecast is prepared seasonally for summer and winter.

In recent years Ausgrid, along with AEMO, have adopted a more scenario-based approach to forecasting given the level of uncertainty. For the current forecast Ausgrid has developed forecasts based on the three AEMO Integrated System Plan (**ISP**) 2024 scenarios: Progressive Change, Step Change and Green Energy Exports (a proxy for a Strong Electrification scenario). An additional scenario testing the sensitivity of the Step Change Demand impacts to CER orchestration assumptions is also used for planning purposes. Step change has been identified as the most likely option in the 2024 ISP published by AEMO in June 2024. Subsequently Ausgrid has adopted Step Change forecast as the most likely scenario on which to apply planning models and expenditure forecasts.

B.2.1 Spatial Trend Component of Forecast

The near-term component of the forecast is based upon the local historical trend in total customer demand from both grid supplied electricity and customer embedded generation. The process for deriving the local substation forecast is as follows:

a. Raw metered electricity demand data is obtained for zone substations and subtransmission substations for 7 years at 15min intervals.

b. 10 years of weather data is obtained from the Bureau of Meteorology for weather stations across Ausgrid's network area. Each zone and subtransmission substation is assigned a representative Bureau of Meteorology weather station.

c. Network configuration data is obtained from Ausgrid's planning and customer connections groups.

d. The metered grid supplied electricity demand data is cleansed to remove abnormal loads (generally resulting from temporary network switching and abnormal configurations). This prevents abnormally switched loads from distorting historical trends.

e. The total customer electricity demand is then weather corrected based on the variable of "average ambient temperature" and subjected to Monte Carlo simulation analysis. This enables calculation of probability of exceedance (POE) levels.

f. Embedded generation demand for all 30 min intervals is modelled from a representative sample of customer interval meter data (gross metered systems) for customer solar power systems. The historical non-dispatchable embedded generation (30 min intervals) at each zone substation is derived from the embedded generation demand model and historical customer connection information. The embedded generation is then added to the weather corrected grid supplied electricity demand data to derive the customer electricity demand.

g. Maximum demand impacts from historical block loads are then identified from planning information and actual network system meter data for the historical time series. These block loads comprise all customer connections which result in a step change in demand at the zone substation. The basis for including or excluding block loads is described in section B.2.3 below. These step changes to maximum demand are then reversed from the customer electricity demand data to derive the underlying customer electricity demand data series.

h. By excluding step changes due to larger, lumpy customer loads and including the electricity supplied by customer generation, a more stable underlying trend of customer demand is revealed.

i. Regression of the resultant data series calculates the underlying rate of growth using a line of best fit at each zone and subtransmission substation. Any step changes in demand (solar, historical block loads and load transfers) are then reinserted to arrive at the starting point.

j. This local substation trend forms the basis for the first 2 years and is a component of years 3 and 4 of the forecast.

B.2.2 System Level Econometric Model Component of Forecast

The medium to long term component of the forecast is based upon a system level econometric model. The econometric model is derived from key drivers at the local and system total level for both residential and non-residential elements. The process for deriving the econometric component of the forecast is as follows:

a. The residential and non-residential components of the econometric model include both price and income response elements. The residential component includes drivers for the change in real retail residential electricity prices and the change in real average household disposable income. The non-residential component includes drivers for the change in real retail non-residential electricity prices and the change in NSW Gross Value Added Services. The residential component also includes impacts from any forecast changes in population growth.

b. Forecast variation in real retail residential electricity prices, real average household disposable income, real retail non-residential electricity prices and NSW Gross Value Added Services are obtained. For the 2024 forecast, this data was obtained from the Australian Energy Market Operator (AEMO) and is the data used for AEMO's 2024 ISP.

c. Due to the collinearity of the historical customer price response with historical impacts from energy efficiency improvement, the model is based upon the total 'electricity services' to customers. The 'electricity services' includes the total metered demand (grid supply), the historical demand impacts from embedded generation and the historical demand impacts from Commonwealth and New South Wales government energy efficiency programs.

d. The total metered electricity demand (grid supply) is obtained for all 30 min intervals from the bulk supply point meter data for Ausgrid's network.

e. From the interval metered data for over 900,000 customers and the total system metered electricity demand data from the bulk supply point meters, a regression model is used to calculate the separate metered electricity demand for residential customers and non-residential customers.

f. The historical demand impacts from non-dispatchable embedded generation are obtained as per item f in the description of the spatial trend forecast above. These are allocated separately for residential and non-residential customers.

g. The historical and forecast demand impacts from Commonwealth and New South Wales government energy efficiency programs are obtained for four key programs:

   i. The Minimum Energy Performance Standards (MEPS) program which sets national minimum energy performance standards for electrical appliances such as air conditioners, motors, televisions and refrigerators;

   ii. The Building Code of Australia (BCA) which sets minimum energy performance standards for buildings; and

   iii. The NSW Energy Savings Scheme (ESS) which encourages customers to invest in energy efficiency improvements in their homes and businesses.

   iv. The Peak Demand Reduction Scheme (PDRS) introduced by NSW Government to incentivise households and businesses to reduce their consumption during peak demand hours through a certificate scheme.

   Ausgrid obtains the historical and forecast demand impacts for these energy efficiency programs principally from external expert advice. The demand impacts are allocated separately for residential and non-residential customers. The peak demand contribution is derived from the seasonal daily load factor on day of system peak.

h. The historical 'electricity services' for residential customers and the 'electricity services' for non-residential customers are then regressed against the separate independent variables of price and income. The econometric model determines the elasticities for both income and price for each of the residential and non-residential customer sectors.

i. Following derivation of the econometric elasticities, historical embedded generation and energy efficiency impacts are reversed out to return to the starting point. This process excludes effects likely to pollute the relationship between grid supplied electricity demand and the price and income variables. The forecasted demand impacts due to changes in price and income over time is derived by the application of the most recent econometric elasticities to econometric forecasts for future electricity price and income supplied by AEMO and as used in AEMO's 2024 ISP.

j. Impacts due to new block loads, embedded generation, battery storage systems, energy efficiency, and electric vehicle take-up by customers are included as post model adjustments to the econometric model.

k. The impacts from household energy (battery) storage and rooftop solar, or distributed energy resources (DER), in the 2024 maximum demand forecast are based upon a model originally developed from external consultancy advice. The model calculates annual electricity bill savings for thousands of sample load profiles divided into representative customer types (agents) by energy consumption bands to derive likely uptake rates for DER across the Ausgrid network. In conjunction with modelled price paths for rooftop solar and batteries and future consumption and feed-in tariffs, an ROI is calculated for each representative agent over time, which in turn drives the uptake of DER. Output is reconciled to Ausgrid's share of AEMO's 2024 ISP forecast of PV and battery storage. Spatial allocation of the DER is based on the current allocation of the representative customer types across the Ausgrid network area and their respective DER projections from the model, aggregated to the zone substation level. Initial DER forecast years blend from historical DER trends to model outcomes over a 5 year period

l. The impact from electric vehicles (EV) has been guided by information obtained from AEMO and external consultancy advice, supplemented by knowledge obtained from Ausgrid's involvement in EV charging trials and EV owner customer surveys. Demand impacts are derived using 5 charging typology types (Bus, Fleet, Residential, Carpark, and DC fast charge) which are allocated spatially using "points of interest" data along with NSW vehicle registration data for electric vehicles obtained from NSW Roads and Maritime Services, the 2021 ABS vehicle census by postcode data, ABS 2016 census LGA income statistics.

m. The residential component includes impacts from forecast changes in population growth based upon data from the NSW Department of Planning and ABS population projections. The population projections data from the NSW Department of Planning extracted from 2022.

n. The impact from Electrification of residential gas appliances is considered by studying the current trends on the prevalence of gas appliances in new builds, as well as existing residential gas use by LGA.

o. Each component is allocated at a zone substation level. Allocation of embedded generation and energy storage is based upon the current penetration of rooftop solar and DER model outputs and though the agent-based model as per item k. Allocation of energy efficiency impacts is based upon each substation's share of annual metered electricity volume. Allocation of impacts due to population changes is based upon the 2022 NSW Department of Planning data and Ausgrid GIS systems to align with NSW government planning policies.

p. This econometric model forms the basis for years five and beyond of the forecast for each substation and a component of years 3 and 4 of the forecast.

B.2.3 Assumptions Applied to Substation Load Forecasts

Endeavour Supplied Substations

There are three Ausgrid zone substations not supplied from within Ausgrid's network but supplied from Endeavour Energy at 66kV and 33kV. These zone substations are Epping 66/11kV, Leightonfield 33/11kV and Hunters Hill 66/11kV. Demand from these zone substations is included in the aggregate data.

Note, in 2018 a project was committed which will see 2 more zone substations to be supplied from Endeavour Energy at 33kV. These projects continue to progress to supply both Auburn 33/11kV and Lidcombe 33/11kV zone substations from Camelia STS in the Endeavour network area. Demand from these zone substations will remain as being included in the aggregate data.

Customer Negotiated Capacity

Where a customer has negotiated a higher standard of service than the default planning standard and the agreed financial terms have been met, the substation load forecast is adjusted accordingly so that this capacity is reserved for that customer.

If a customer has negotiated a lower standard of service (e.g. to reduce their costs), this is generally not incorporated into the forecast. Generally, these requests are considered during network planning, or inherent in the connection of the customer.

Embedded Generation

The historical load data includes the impact of downstream embedded generation that was generating at the time of peak, consequently, the forecast includes the impact of non-dispatchable small scale generation such as rooftop solar installations.

Where a generator has a material impact on peak load that is not accurately reflected in the historical data and information is available about generator output and reliability, the forecast is adjusted to reflect the expected impact of the generator, taking into account:

- The historical reliability of the generator and expectations about its future reliability, including weather dependency where relevant;
- When the generator was installed and whether it is a temporary or permanent installation;
- Contractual obligations for Ausgrid to provide backup or standby supply to a site; and
- Network support agreements with the generator.

Larger generators that are relied on for network support are generally included as a negative block load. In determining whether a generator is 'large', Ausgrid uses the same approach as is used for block loads and transfers.

Capacitors for Power Factor Correction

Reactive compensation for locations with known capacitor installations is modelled according to the following guidelines:

- Growth rates are applied to the uncompensated MVAr component of load prior to switching in Ausgrid capacitors. In other words, growth rates are not applied to capacitors.
- The amount of reactive compensation for forecast years is applied according to the nameplate step size and maximum available MVAr capacity and the application of 2 adjustment factors, the voltage adjustment factor and the operational adjustment factor.
- The voltage adjustment factor calculated at 0.84 accounts for the difference between the nameplate rated voltage and the operational voltage at the corresponding substation. The voltage adjustment is the square of the ratio of nominal operational secondary voltage at the substation over the nameplate rated voltage of the capacity i.e. $(11/12kV)^2$ or $(33/36kV)^2$.

The operational factor accounts for the fact that capacitors are not necessarily switched in to maximise power factor. In determining the operational factor, historical patterns of capacitor switching are used.

Weather Correction

Historical loads are weather corrected, to enable statistical trend line calculation of growth rates and the determination of probabilistic forecast loads. The weather correction factor is the percentage difference between the weather corrected and actual load in the most recent historical year. This correction factor can be negative, positive or zero.

Weather correction is applied according to the following rules:

- Maximum demands are weather corrected with a probability of exceedance of 50% (POE50) which forms the basis for planning decision-making.
- Each substation uses 10 years of Bureau of Meteorology (BOM) data from the geographically closest BOM weather station;
- Ambient temperature is used; and
- Weather correction is applied using a Monte-Carlo simulation method to determine the POE50 maximum demand. The simulation incorporates non-working days to model the effect of substations that can peak on a non-workday.

Exceptions of Weather Correction

Weather correction is not applied to zone substations or subtransmission substations where the load does not exhibit weather dependency for that season, or where the load exhibits weather dependency that does not follow the general trend expected for that season based on an examination of the seasonal load versus temperature relationship. Weather correction is not applied to dedicated large customer loads (connected at the subtransmission level).

Rate of Growth

The rate of growth, which may be negative, is calculated according to the following process:

- The historical block loads, load transfers, and small-scale solar generation are adjusted out of the historical weather corrected loads to reveal the underlying trend;
- The weather corrected and adjusted trends are reviewed by an expert panel to consider factors that could influence the growth rates, such as Local Government Plans; and
- A growth rate of zero is applied to dedicated customer loads (connected at the subtransmission level).

Block Load Transfers

Block loads for customer connections greater than a predefined threshold (as described below) are included after the application of underlying growth rates which specifically exclude these often large and lumpy changes in customer demand. A block load or transfer can result in either an increase or decrease in the forecast load (e.g. load can be transferred to or from a zone substation).

This approach to block loads has been adopted as there is a need to distinguish between natural load growth and growth arising from these larger customer connections. Large individual customer connections at a spatial level is often sporadic in nature and including such loads in the trend can lead to an over or under forecast of demand for the network asset. Removing these changes in demand for the calculation of the trend ensure that we capture the underlying trend.

Depending on the nature of block loads activity, some block loads may be individually small or there may be numerous block spot loads occurring around the same time at a given substation. To account for these possibilities, the sum of block loads for each year for each zone substation is compared to a threshold of 50A (approximately 1MVA @ 11kV). Where the sum is less than the threshold, the growth is considered to be organic and not included as a block load adjustment in the forecast.

Block loads are differentiated to account for the differing nature of these customer connections. The block load categories are late stage 11kV block loads, early stage 11kV block loads and major customer connection block loads. Scaling factors are derived from a detailed analysis of actual historical customer demand and connection data which are then applied to the requested capacity.

A summary of the block load categories is as follows:

Category	Description	Scaling Factor
Early-stage 11kV	General 11kV connections which have applied for connection	0.31
Late-stage 11kV	General 11kV connections which have received connection design approval	0.51
Major Customers	33kV+ connections or unique industry 11kV connections (e.g. rail)	based on industry

The higher resultant scaling factor for late stage 11kV block loads has been determined from detailed analysis of historical block load data and reflects the higher probability for a connection proceeding when a connection has progressed to this stage. As the 11kV scaling factors are derived from actual customer connection data and the actual resultant demand at the local 11kV panel and at the time of 11kV panel peak for real customer connections, they incorporate coincidence with peak, probability of proceeding and any industry-specific scaling factors in the case of major customer connections.

Major customer connections have a representative scaling factor applied that varies depending on the industry type and expected customer future demand profile. Where available, actual demand data from existing customers by industry type is used to derive coincidence factors. A further probabilistic factor is applied to reflect the probability of occurrence and oversizing to derive an overall scaling factor for each individual major customer connection.

B.2.4 Explanation of Substation Forecast Outcome

The 2024 forecast is higher than the 2023 forecast over the entire 10 year forecast period driven largely by a significant increase in customer connection activity, in particular within the data centre sector. . Overall demand rises consistently over the forecast period as demand drivers that increase demand such as Block Loads and EV uptake outweigh those that apply downward pressure to demand such as PV/Battery uptake and energy efficiency. Whilst demand drivers that lead to lower demand are higher in magnitude, they are unable to entirely offset the change in demand impacts projected from increased customer connection activity and growth in EV uptake in the near term.

Summer maximum demand is expected to remain higher than winter for at least the next 10 years, however the gap between summer (higher) and winter (lower) forecasts is expected to narrow. Factors which contribute to this narrowing include the downward pressure from PV being largely absent at the time of the winter peak, combined with the fact that electrical demand reduction and energy efficiency targets have been more strongly focused on summer day loads such as air-conditioning.

DER including PV and batteries places material downward pressure on projections, however the forecast impact of energy efficiency has the largest downward impact. Electric vehicle adoption places moderate upward pressure on demand to 2030 but is expected to accelerate post 2030.

Macroeconomic income and price factors, which drive existing customer decisions affecting electricity consumption are a significant source of growth to 2033 in the data used for the 2024 forecast.

Block loads, which capture large new connections (typically >1MW up to 100+ MW) to the Ausgrid network, are also a dominant factor placing upward pressure on maximum demand growth consistent with the previous years.

The overall volume of large customer connection (block load) activity continues to be at high levels, and this has a significant impact on the 2024 forecast at a local spatial level. High-density residential development activity remains at elevated levels in the forecast, with significant investment in road and rail transport infrastructure required to service this population growth continuing through to the end of the forecast period. Rapid growth in data centre developments, large customers, and generator connection activity remains at a rate not seen in over a decade.

The 2024 forecast update includes continued improvements to forecast components an update to the spatial allocation of demand impacts due to population growth. As previous years, it also includes revision of the latest available relevant data sources, particularly in the application of customer connection activity.

For the 2024 forecast, at the spatial level, around 61% of zones in summer and 87% of zones in winter are expected to experience growth in maximum demand over the next 5 years to 2028 (based on compound annual growth). This is an decrease from 78% of zones in summer and increase from 84% of zones in winter expected to experience growth to 2027 in the 2023 forecast. Overall growth for the 2024 forecast in Summer is 2.1% over the same five-year period (0.8% 2023) and 3.3% in winter (2.0% 2023). This implies the drivers of demand growth when applied spatially, concentrate to particular localities and is uneven across the network.

B.3 Transmission – Distribution Connection Point Load Forecast

Ausgrid prepares an annual transmission distribution connection point forecast which is provided to Transgrid in February each year as part of the annual planning review and load forecast information provisions of the NER. A forecast of future loads over a ten year forward planning period is prepared for each dual function subtransmission substation connected to the Transgrid transmission network. These load forecasts are presented in www.ausgrid.com.au/DTAPR.

As part of the annual load forecast development Ausgrid provides Transgrid with the "132kV Transgrid Report" which provides an input for their power system load flow modelling of the Ausgrid network. It contains MW, MVAr and uncompensated power factor data per year for the most recent actual year and 10 forecast years for each:

- 132kV connection point (subtransmission substations, 132/11kV zone substations and 132kV customers); and
- Zone substation supplied from other DNSPs, such as Epping, Leightonfield, and Hunters Hill, irrespective of supply voltage.

B.4 Subtransmission Feeder Load Forecasts

Ausgrid undertakes an annual review of subtransmission feeder capacity constraints ("the feeder load forecast") using load-flow analysis to simulate credible network contingencies. Initial analysis is conducted using network load-flow models for a forward looking 20-year period, based on:

- A 50% POE Planning Spatial Demand Step Change Forecast, including committed spot loads and uncommitted spot loads by applying a probability;
- Committed network developments and load transfers, and
- Line and cable cyclic normal and long-term emergency ratings.

The results of this analysis form an input into the Area Planning process and the Annual Capital Review process. During these processes, a cost benefit analysis based on a probabilistic criteria is undertaken in order to maximise the economic benefit of investment to relieve identified constraints.

B.5 Primary Distribution Feeder Load Forecasts

Ausgrid's primary distribution feeder forecast contains peak and minimum load values that are determined seasonally and adjusted to account for temperature variation and abnormal switching on the distribution network.

The summer and winter load scenarios are determined based on interval load data for the primary distribution feeders, zone substation interval data, customer meter data, customer connection information, and weather. This data is used to identify and exclude abnormal system states, and to estimate how this load is likely to be allocated across the network, to determine the expected load on the network during normal system conditions.

Zone substation forecast load rate of growth (ROG) and known network changes (spot loads and transfers) are then applied to estimate the demand on each feeder for the forward planning period (generally 6 years).

This forecast data is combined with network connectivity data to construct network models that can be used to simulate different scenarios to identify system limitations.

B.5.1 Load Transfer Capacities of Zone Substations

Load transfer capacity is the amount of load that can be restored in the event of a whole zone outage by switching the distribution network. The transfer capacities presented in the distribution demand forecast table as described in Section B.1 assume that a single zone is rendered out of service and the rest of the network is in system normal configuration.

Load transfers are generally considered to be a temporary solution, as transferring load to neighbouring zone substations will increase the utilisation of the destination zone and feeders. This restricts the operability of the network as the remaining distribution network is more highly utilised than planned and further restoration of subsequent contingencies may not be possible.

Transfer capacities presented in this document are based on the configuration of the HV network. Installation of additional HV interconnection and transfer capacity is typically a further consideration where it might provide a cost-effective alternative to other capital investment associated with zone substations or the subtransmission network.

Load transfer impacts are assessed on a case-by-case basis (typically in a load flow program) to ensure that the overall impact of load transfers does not overload assets in the distribution network.

Additionally, a load transfer alters the configuration of the distribution network, which may impact the capacity of subsequence load transfers. Therefore, the presented transfer capacities assume that no other load transfers have occurred.

This forecast data is combined with network connectivity data to construct network models that can be used to simulate different scenarios to identify system limitations.

B.6 Other Factors Having Material Impact on the Network

B.6.1 Fault Levels

Fault level management of the network is a critical consideration given the ongoing expansion of network infrastructure and the increasing connection of both loads and generators. However, with the proposed decommissioning of synchronous generators, fault levels across the network are expected to decrease, which pose new challenges. Careful and proactive management of fault levels is essential to maintain network stability and ensure the safety and reliability of the system.

In Sydney metropolitan area, the fault levels have been increased over the years, and to compensate this Transgrid has installed 50kA rated switchgear at Beaconsfield BSP during its condition driven replacement given that in some operating arrangements fault levels exceeded 40kA. AS such, Ausgrid is now installing equipment with this same fault rating in all new developments in the area. Nearby existing substations with 40kA rated switchgear, under certain operating scenarios, operate very close to their limits and this restricts some network configurations. There are numerous open points on the 132kV meshed transmission system due to these fault level limitations. These open points create more complicated switching arrangements and limit network flexibility.

The installation of the Kurri open cycle gas turbines (**OCGT**) by Snowy Hydro connected at 132kV in the Newcastle BSP load area has necessitated maintenance of additional open points in the 132kV network to manage the fault level to within equipment ratings at Newcastle BSP during periods of OCGT generation.

132kV series reactors have been installed by Transgrid at Rookwood Rd BSP in part to limit fault level contribution (along with power flow control). In addition to these reactors open points were created on the 132kV network to restrict fault levels to below equipment ratings.

For a number of 132/33kV STS refurbishments changes have been made in the standard arrangement for neutral earthing due to review of Ausgrid network standards. This results in individual transformer neutral earthing reactors being installed in place of a common neutral earthing resistor.

The HV Network Reinforcement program includes managing fault level constraints in the HV network. These include both high and low fault level constraints. HV feeders that have high fault levels may result in damage to customer and network equipment during faults. HV feeders with low fault levels may have protection systems that cannot see or discriminate between fault locations which may lead to increased clearing times or excessive customers being interrupted. Typical solutions to these constraints include network augmentation, modifying protection settings or altering the network configuration.

B.6.2 Voltage Levels

Network power flow is continuing to transition from a traditional one-way flow towards a two-way flow. A major contributor to this change up till now is the increase in CER, in-particular the large number of "behind the meter" solar generating plants now connected to the Ausgrid distribution network. These solar generating plants can have a significant impact on network voltages, especially during periods of high solar generation. To effectively manage voltage across network, we have adopted a comprehensive and holistic strategy that extends from BSP's to LV customers, ensuring efficient voltage management.

Voltage levels at our BSP's, STS's and zones are coordinated by local regulation schemes that are continually optimised where possible to enable transition in power flow, and where required localised network voltages are managed by traditional network options such as customer load balancing, transformer tap changes and network upgrades. These traditional options are complimented by innovative technology trials such as community batteries, STATCOMs and Advanced Voltage Control methods. Additionally, there are also network areas that require tailored approaches to address unique voltage-related challenges, ensuring the stability and reliability of the electrical network.

The meshed inner-metropolitan network is supplied by two large radial 330kV cables with very high charging capacitance. The inner-metropolitan network is also comprised of a number of long 132kV cables with significant cable charging. This means capacitor banks are required during cable outages to replace this lost reactive support, however during low load conditions shunt reactors are required to reduce voltages. One of these cables also has a series reactor with bypass capabilities for power flow and fault level control. Capacitor banks are located at Beaconsfield BSP, Peakhurst STS and Bunnerong STS and shunt reactors at Mason Park STSS, Rookwood Rd BSP, Beaconsfield BSP and Haymarket to help manage the voltage on the 132kV meshed network.

The meshed network connected to Muswellbrook BSP is supplied from three 132kV overhead feeders and spans a significant distance to Singleton 132kV STS. Under system abnormal conditions of the 132kV subsystem and high network loading, network voltages can drop below 0.9pu at Singleton 132kV STS. Closing of the normally open 132kV interconnector to Newcastle BSP will assist in maintaining system voltages during these conditions, however the use of this interconnector is frequently constrained by abnormal local 330kV network configuration and during periods of Kurri OCGT generation. Voltage control to manage 11kV network voltages is done at zone substations using tap changing transformers and where necessary capacitor banks.

B.6.3 Other Power System Security Requirements

Ausgrid's under frequency load shedding capabilities are assessed on a bi-annual basis to ensure compliance with NER requirements. Projects are created where compliance is no longer met due to network topology rearrangements or at the request of AEMO. Refer to 6.4 Frequency control and load shedding for more details.

B.6.4 Quality of Supply

Ausgrid endeavours to provide quality of supply to customers that is necessary to operate their equipment. In general, this is achieved by operating Ausgrid's network, and requiring customers to operate their electrical installations, consistent with power quality requirements set out in the NER, NSW SIR and Ausgrid's Network Standard NS238. Ausgrid investigates supply quality issues as they arise, including supply voltage, harmonics, and flicker. At Ausgrid, supply quality is monitored through permanent monitors at a selection of sites across the network at different voltage levels. Temporary supply quality monitors are installed at customer premises to investigate specific supply quality issues and complaints.

B.6.5 Embedded Generation

Ausgrid has published on its website, guidance for proponents seeking to connect an embedded generating system under Chapter 5A or Chapter 5 of the NER. The information includes guidelines, Network Standards, Electrical Standards and proforma contracts, and Connection Application forms. A register of completed generator connections is also maintained in accordance with the NER requirements.

Ausgrid provides basic connection offer services for inverter coupled micro embedded generator units up to 200kW where augmentation of the network is not required. All other embedded generating units are offered a negotiated template connection offer consistent with Chapter 5A for units that are not registered with AEMO and Chapter 5 in the case of Registered Generators of the Rules.

Amendments to the NER, which commenced on 18 December 2021 require all grid connected inverters to comply with the new version of AS/NZS 4777.2 which was released in December 2020. To complement the NER amendments, Ausgrid in December 2021 revised our Network Standard NS194 which sets out technical requirements for connection of generators.

Ausgrid continues to work with industry partners including the Clean Energy Council, ENA, AEMO and other DNSP's to better understand the current and future network impacts of embedded generation and the emerging battery storage market and its implications within Chapter 5A of the Rules. This includes the standardisation of the power quality settings published in AS/NZS 4777.2:2020 which will allow for improved compliance and potentially increase embedded generation hosting capacities.

Ausgrid has experienced an increase in the number of customers applying to connect embedded generation. This is commensurate with the industry as a whole and the push to Net Zero. This has also led to an increase in generation proposals proceeding to the application stage.

B.7 Additional Notes

B.7.1 ISP

The ISP is a whole-of-system plan that provides an integrated roadmap for the efficient development of the NEM. AEMO published the first ISP in 2018 and it has endeavoured to update every two years under the functions of NER to maintain and improve system security of NEM transmission grid. It provides an actionable roadmap for eastern Australia's power system to optimise consumer benefits and provides an overview of the current state and potential future development of the NEM transmission grid.

The ISP includes a review of the:

- Optimal development path needed for Australia's energy system
- Identification of forecast constraints on the national transmission flow paths
- Whole-of-system plan to maximise net market benefits, and
- Least-regret future scenario modelling, detailed engineering analysis and cost benefit analysis.

The current is 2024 ISP. Key features of the current ISP 2024 include three key areas:

1. The ISP is a roadmap through the energy transition
2. An optimal development path for reliability and affordability
3. Delivering the optimal development path

It has focused on following key outcomes when delivering the ISP 2024.

- Supplying affordable and reliable electricity to customers in the NEM, while supporting Australia's net zero ambitions,
- Increasing the firming capacity of alternative energy sources including utility-scale batteries, hydro storage, gas-fired generation, and smart behind the meter "virtual power plants" (**VPPs**),
- Coal power stations are rapidly retiring, and supporting generation and storage investments in the optimal development path,
- Supporting the transmission projects in the optimal development path
- Establishment of Renewable Energy Zones to efficiently connect renewables

A copy of the current ISP 2024 is available on AEMO's website at https://www.aemo.com.au.

B.7.2 NSW Responsibility

In the ISP, network augmentation proposals by TNSPs that affect national transmission flow paths are taken into account by AEMO in the development of conceptual augmentation options and market development scenarios.

Transgrid is the Jurisdictional Planning Body (**JPB**) for NSW in the NEM. In this role Transgrid:

- Represents the NSW jurisdiction on the Inter-Regional Planning Committee (**IRPC**); and
- Provides jurisdictional information to the IRPC to enable it to assist AEMO in producing its annual Statement of Opportunities (**SOO**) and the ISP.

Accordingly, Transgrid is responsible for providing information concerning transmission developments in NSW which may affect the power transfer capacity of national transmission flow paths. Further details are available on Transgrid's website at https://www.transgrid.com.au

In addition to ISP, the NSW government has initiated an Electricity Infrastructure Roadmap (the Roadmap) which sets out the NSW Government's vision to coordinate investment in electricity transmission, generation, storage and firming infrastructure and transform the NSW electricity system into one that is cheap, clean and reliable. EnergyCo is a statutory authority and is responsible for leading the delivery of REZs as part of the Roadmap. As part of this, the State's first REZ in the Central-West Orana regions is in the development phase. Further details are available on EnergCo's website at https://www.energyco.nsw.gov.au.

Appendix C: Distribution Services for Embedded Generating Units

A recent new requirement to provide forecast use of distribution services and hosting capacity assessments for zone substations, sub-transmission lines and transmission-distribution connection points is included in this year's report. We are continuing to review and develop our tools and methodologies for these assessments, and to improve the availability and accuracy of data and results.

The assessment results are outlined in the online Generator Export and Hosting Capacity data file which is available for download from Ausgrid's website at www.ausgrid.com.au/DTAPR.

C.1 Zone Substations

Ausgrid has considered the "use of distribution services by embedded generation units" as the total capacity collectively used by all individual customers to export their excess generation to the low voltage network at the time of maximum total export.

A comparison of three years historical data measuring aggregated exported energy and total installed distributed solar panel capacity was undertaken to examine potential predictive relationships. Analysis showed a strong correlation at all locations between the installed distributed solar capacity and their maximum export to the grid with an R^2>0.9. Given the strong correlation, Ausgrid's methodology for predicting distribution services by embedded generation units utilises forecasted total installed solar capacity and predicts the maximum aggregate export to the grid in each zone substation by applying this relationship.

The forecast PV capacity for each zone substation for the years 2022 to 2027 is extracted from the same DER model used in the maximum demand process and the average historical relationship between the installed capacity and the maximum export is applied to estimate the maximum export (MW). The forecasted installed PV capacity aligns with AEMO's Step Change scenario from AEMO's ISP 2024, applied in the Ausgrid area.

It should be noted that future changes in the consumption volume and pattern including the impact of EV, electrification, energy efficiency, modified tariffs and other sources of change can potentially have an impact on the above relationship. The impact of EVs in particular may be significant on both maximum and minimum demand in future years with increased potential for customers to charge their EVs behind the meter and therefore reduce their export ratio.

However, Ausgrid assumes for the purposes of this forecast that the number of EVs and their use pattern over the next five years will not be sufficient to significantly impact the maximum export on balance with the current trend of average PV system install size increasing. That is, the estimated current export to installed capacity ratio evident in the historical data will not significantly change due to these two competing factors during the forecast period.

C.2 Subtransmission Feeders

Ausgrid has identified that some zones are experiencing reverse power flows but no system limitations of subtransmission feeders have been identified at this stage. As such, the subtransmission feeders that are supplying these substations and are experiencing reverse power flows have not been reported at this stage.

However, there are situations where embedded generators are connected to the subtransmission network which are exporting power to the subtransmission network causing power flows through subtransmission feeders. While no system limitations have been identified as a result of these embedded generators at this stage, it is appropriate that the details of power flows on the subtransmission network and peak generation values are provided which may possibly be useful information to stakeholders.

Note that the simplistic analysis is undertaken using Ausgrid's peak power flow model which represents only one snapshot in time. The values presented in the table may vary during lighter loads and/or different operating conditions of the network.

C.3 Transmission-Distribution Connection Points

Refer to Appendix C.2 above.

C.4 Subtransmission Network Hosting Capacity

The hosting capacity is the amount of generation that can be added to the subtransmission network without requiring additional network investment in the network. The hosting capacity depends on a number of network parameters and limitations, including:

- Overvoltage
- Overloads including subtransmission line and transformers,
- Fault level,
- Frequency,
- Protection,
- Power quality

At this early stage of the analysis, the primary boundaries considered in finding hosting capacity are overloading, overvoltage, and fault level limitations. Typically, it is required that the power generated is able to supply both network load and losses, that the generators produce power under specified active and reactive power limits. This ensures the bus voltages are within recommended values and that there is no overloading of the subtransmission lines and transformers.

Hosting capacity is calculated at each substation connection point and subtransmission line at n (total capacity) and n-1 (firm capacity) network security levels. The approach used for the calculation of hosting capacity at subtransmission level is as follows.

- Choose performance indices: overvoltage, overloading and fault levels.
- Determine acceptable limits of those performance indices.
- Connect a generator at the substation connection point or subtransmission line.
- Vary the size of the generator and calculate the performance indices using power flow analysis and fault level analysis.
- Find the boundaries of the generator size which is the hosting capacity at that connection point.

It should be noted that the hosting capacity is dependant on the local load where the generator is connected as there is opportunity to consume the generator load at local level without violating performance indices at upstream levels. Thus, to obtain a prudent level of hosting capacity, the minimum load level (scaling the relevant loads down) where possible is applied when calculating the hosting capacity.

The hosting capacity presented in this report is only for general guidance and would not represent the optimum hosting capacity as a number of assumptions were made during the analysis given the limited time and resources to complete detail analysis at each and every location. This is a rapid method for obtaining an initial estimation of hosting capacities. It is proponent's responsibility to use this information with care and due diligence. The proponent must consult Ausgrid for detailed analysis of available capacity that suits a range of operating conditions at the interested location if required which ensures a more conservative and robust result can be determined for hosting capacity.

Appendix D: Glossary

ADMS	Advanced Distribution Management System
AER	Australian Energy Regulator
AEMC	The Australian Energy Market Commission is the rule maker and developer for Australian energy markets
AEMO	Australian Energy Market Operator
Asset Condition	Refers to an asset being identified as having condition issues or approaching the end of service life, and cost benefit analysis has been applied to identify an optimum solution and its timing.
BESS	Battery Energy Storage Systems
Capacity	Indicates there is a projected network capacity shortfall on the basis of expected unserved energy, and cost benefit analysis has been applied to identify an optimum solution and its timing
CBM	Condition Based Maintenance
CER	Customer Energy Resources
DER	Distributed Energy Resources
DLF	Distribution Loss Factor
DPAR	Draft Project Assessment Report
DTAPR	Distribution and Transmission Annual Planning Report prepared by a Distribution Network Service Provider under the National Electricity Rules
DNSP	A Distribution Network Service Provider who engages in the activity of owning, controlling, or operating a distribution system, such as Endeavour Energy, Ausgrid and Essential Energy
Dual Function Asset	Any part of a network owned, operated or controlled by a Distribution Network Service Provider which operates between 66kV and 220kV and which operates in parallel, and provides support, to the higher voltage transmission network and is an asset which forms part of a network that is predominantly a distribution network
EnergyCo	The Energy Corporation of NSW (EnergyCo) is a statutory authority established under the Energy and Utilities Administration Act 1987 and is responsible for leading the delivery of Renewable Energy Zones (REZs) as part of the NSW Government's Electricity Infrastructure Roadmap (the Roadmap)
ENSMS	Electricity Network Safety Management System
ESA	NSW Electricity Supply Act 1995
EUE	Expected Unserved Energy
EVCI	Electric Vehicle Charging Infrastructure
FMECA	Failure Mode Effects and Criticality Analysis

FPAR	Final Project Assessment Report
GJ gigajoule	One gigajoule = 1000 megajoules. A joule is the basic unit of energy used in the gas industry equal to the work done when a current of one ampere is passed through a resistance of one ohm for one second
GWh gigawatt hour	One GWh = 1000 megawatt hours or one million kilowatt hours
HV high voltage	Consists of 11kV and 22kV distribution assets
JPB	Jurisdictional Planning Body
LV low voltage	Consists of 400V and 230V distribution assets
kV kilovolt	One kV = 1000 volts
kW kilowatt	One kW = 1000 watts
kWh kilowatt hour	The standard unit of energy which represents the consumption of electrical energy at the rate of one kilowatt for one hour
MRA	Maintenance Requirements Analysis
MVA	(unit of electrical power) Mega Volt Amp
MVAr	MVA (reactive). Where quoted as part of a demand forecast, it is assumed that capacitors are in service.
MW megawatt	One MW = 1000 kW or one million watts
MWh megawatt hour	One MWh = 1000 kilowatt hours
N capacity	The capacity of a network (or sub-section of network) with all elements in service.
N-1 capacity	The capacity of a network (or sub-section of network) following a failure of a single critical element.
NEL	National Electricity Law
NER	National Electricity Rules
NTFP	National Transmission Flow Path
NTNDP	National Transmission Network Development Plan
OCB	Oil Circuit Breaker
POE 50	In this document, refers to a demand forecast with a 50% probability of being exceeded (i.e. 1 in 2 years)
Primary distribution feeder	Distribution line connecting a subtransmission asset to either other distribution lines that are not subtransmission lines, or to distribution assets that are not subtransmission assets

pf	Power Factor
RCM	Reliability Centred Maintenance
REZ	Renewable Energy Zones
RIT-D	Regulatory Investment Test for Distribution
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAPS	Stand Alone Power System
SCFF Cables	Self-Contained Fluid Filled Cables
SFAIRP	So Far As Is Reasonably Practicable
SOO	Statement of Opportunities
STPIS	Service Target Performance Incentive Scheme
STS	Subtransmission Substation
Subtransmission	Any part of the power system which operates to deliver electricity from the higher voltage transmission system to the distribution network and which may form part of the distribution network, including zone substations
Subtransmission system	Consists of 132kV, 66kV and 33kV assets, including dual function assets
TNSP	Transmission Network Service Provider
V volt	A volt is the unit of potential or electrical pressure
VCB	Vacuum Circuit Breaker
VCR	Value of Customer Reliability
W watt	A measurement of the power present when a current of one ampere flows under a potential of one volt
XLPE	Cross-linked Polyethylene
ZS	Zone substation

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