Distribution Annual Planning Report

2020 DAPR

December 2020

Endeavour Energy

Disclaimer

Endeavour Energy is registered as a Distribution Network Service Provider. This Distribution Annual Planning Report (DAPR) has been prepared and published by Endeavour Energy under clause 5.13.2 of the National Electricity Rules. Its purpose is to notify Registered Participants and Interested Parties of the results of Endeavour Energy's distribution network annual planning review and it should only be used for that purpose.

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1. Executive Summary

Endeavour Energy is a Distribution Network Service Provider serving some of Australia's largest and fastest growing regional economies.

Endeavour Energy is responsible for the safe, reliable and efficient supply of electricity to more than 1 million customers or 2.5 million people in households and businesses across Sydney's Greater West, the Blue Mountains, Southern Highlands, Illawarra and the South Coast.

Due to rapid industry changes, we are transitioning from a traditional 'poles and wires' business to a customer-centred distributed services operator where energy flows in two directions and smart meters, batteries and solar generation enable customers to generate, store and sell back electricity into the grid as we move to a clean energy future.

With an estimated regulatory asset value of $6.5 billion, our network spans more than 25,000 square kilometres and is made up of more than 429,000 power poles, 205,000 streetlights, 204 major substations (includes zone substations, transmission substations and bulk supply points) and more than 32,000 distribution substations connected by over 50,000 kilometres of underground and overhead cables.

The focus of Endeavour Energy is to deliver a safe, reliable and affordable electricity supply to our residential and business customers.

Endeavour Energy is subject to the National Electricity Law (NEL) and National Electricity Rules (NER) which regulate the National Electricity Market. Endeavour Energy is also subject to the statutory and other legal requirements applied to all businesses in NSW. Endeavour Energy operates in the National Electricity Market (NEM) as a licenced distribution network service provider (DNSP).

The distributors licence conditions, including the network Reliability and Performance Licence Conditions are imposed by the NSW Minister for Energy. The Independent Pricing and Regulatory Tribunal (IPART - Electricity) is responsible for administering licensing within the energy industry and monitoring compliance with licence requirements on request from the Minister of Energy. The Australian Energy Regulator (AER) is the relevant economic regulator that ultimately adjudges and sets Endeavour Energy's network revenue and network service pricing within each regulatory control period, and this to meet the National Electricity Objectives for economically efficient operation of the business.

This Distribution Annual Planning Report (DAPR) has been prepared to comply with National Electricity Rules (NER) clause 5.13.2. It reflects the outcomes of the annual planning review of Endeavour Energy's network. Information required for the DAPR is located within this document and the DAPR mapping portal available on https://dapr.endeavourenergy.com.au. The aim of the document and the portal is to inform network participants and stakeholder groups of the proposed development of Endeavour Energy's network, including potential opportunities for non-network solutions particularly for investments where the AER Regulatory Investment Test for Distribution (RIT-D) applies.

Endeavour Energy has adopted an Asset Owner-Asset Manager-Service Provider model to deliver its asset management strategy and achieve its corporate objectives. The plans for the distribution network developed to implement the asset management strategy are developed in accordance with the asset management

Executive Summary

philosophy to achieve the corporate objectives. They are directed and coordinated and through the operation of the Asset Management Committee and the Investment Management Committee.

This Distribution Annual Planning Report outlines the latest plans developed through application of Endeavour Energy's planning processes in accordance with its asset management strategy. This planning supports Endeavour Energy's broader corporate strategy to be amongst the best performing networks in Australia as measured by safety, engagement, customer and financial performance metrics.

Key features of the planning outcomes are:

- Continued strategic focus on asset renewal, prioritised and optimised on the basis of asset condition and network risk, and integrated with growth-related investment needs;
- Demand growth, primarily concentrated in North-West and South-West Sydney which are expected to accommodate over 480,000 new dwellings and land for employment for around 1,000,000 new residents over the next 25 to 30 years, for which Endeavour Energy is planning to provide up-stream supply infrastructure;
- Joint planning with TransGrid for the provision of supply for the proposed Western Sydney Aerotropolis at Badgerys Creek;
- Continued dependence on demand management strategies to defer planned network augmentations where it is economically viable and practicable to do so;
- Management of reliability performance levels with targeted reliability improvement works where justified to meet licence condition obligations;
- A total of an estimated 20 network-need driven projects in the next five years that require the application of the "RIT-D" regulatory test, including consideration of non-network solutions;
- There are at least 3 network-need driven project in the next five years that do not meet the RIT-D criteria but will also include the consideration of non-network solutions;
- The identification of 170 high-voltage distribution feeders that are currently at or above maximum planned loading level, that require monitoring, remediation through augmentation, load transfers or load reductions, or combination of responses; and
- Ongoing growth in the connection of embedded solar-photovoltaic energy generation technologies and the integration of these and other emerging end-use demand management technologies with Endeavour Energy's distribution and reticulation networks.

This Distribution Annual Planning Report provides the market with an understanding of the various investment programs and projects being undertaken by Endeavour Energy to fulfil its obligation as a licensed DNSP in the National Electricity Market. It provides a snapshot of the investment expected over the next five-year period. The details contained in this report will change over time as the consideration of new information in the planning process continues to inform planning outcomes in accordance with Endeavour Energy's corporate objectives.

Introduction

2. Introduction

Endeavour Energy is a Distribution Network Service Provider serving some of Australia's largest and fastest growing regional economies. Endeavour Energy is a registered electricity Distribution Network Service Provider (DNSP) that owns, develops, operates and maintains electricity distribution assets in NSW, and is subject to the National Electricity Law and National Electricity Rules administered by the Australian Energy Regulator.

The National Electricity Rules require all registered DNSPs to:

- Conduct an annual planning review and publish a Distribution Annual Planning Report (DAPR);
- Conduct economic assessments of potential project options under the Regulatory Investment Test - Distribution (RIT-D); and
- Implement a Demand Side Engagement Strategy to consult with and engage non-network providers in the development and evaluation of potential solutions to identified network needs.

The annual planning review includes the planning for all assets and activities carried out by Endeavour Energy 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 annual planning review is to identify possible future issues that could negatively affect the performance of the distribution network to enable DNSPs to plan for and adequately address such issues in an appropriate timeframe. This DAPR reflects the outcomes of Endeavour Energy's 2020 annual planning review.

Endeavour Energy is required to prepare and publish a DAPR that is compliant with the requirements of National Electricity Rules Schedule S5.8 Distribution Annual Reporting Requirements to:

- Provide transparency to Endeavour Energy's decision-making processes and provide a level playing field for all stakeholders in the national electricity market in terms of attracting investment and promoting efficient decisions;
- Include information associated with all parts of the planning process including forecasting demand, identification of network needs and the development of credible options to address network limitations;
- To give third parties the opportunity to offer alternative proposals to alleviate constraints. These proposals may include non-network options such as demand management or embedded generation solutions;
- Set out the results of Endeavour Energy's annual planning review, including joint planning, covering a minimum five year forward planning period for distribution assets;
- Inform registered participants and interested parties of the annual planning review outcomes including asset retirement and network capacity needs for sub-transmission lines, zone substations and transmission-distribution connection points and any primary distribution feeder capacity needs that exist or are expected to emerge within the next two years;

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- Provide information on Endeavour Energy'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; and
- Assist non-network providers, TNSPs, other DNSPs and connection applicants to make efficient investment decisions.

The DAPR covers a minimum five year forward planning period for distribution network sub-transmission assets.

2.1 About Endeavour Energy

Endeavour Energy distributes affordable, safe and reliable electricity to 2.5 million people or more than one million connected customers in homes and businesses across Sydney's Greater West, the Blue Mountains, Southern Highlands, the Illawarra and the South Coast. Our area includes Sydney's second airport, its surrounding Aerotropolis, and the NSW Government's priority land release areas in Sydney's North West and South West.

Over the next 20 years, these areas will be home to communities similar in size to Wollongong and Canberra. The population of Western Sydney is expected to increase by 900,000 over this time and we expect more than 20,000 new customers will connect to the network each year.

Due to rapid industry changes, we are transitioning from a traditional 'poles and wires' business to a customer-centred distributed services operator where energy flows in two directions and smart meters, batteries and solar generation enable customers to generate, store and sell back electricity into the grid as we move to a clean energy future.

We're also partnering with government, universities and energy innovators to find new ways to optimise the use of network services to unlock value for customers.

Introduction

2.2 Endeavour Energy's Network

In 2019/20, Endeavour Energy's network supplied 16,511 GWh of electricity to 1,049,165 network-connected customers. Endeavour Energy's distribution area is shown in Figure 1 below.Most of Endeavour Energy's supply of electricity is taken from the generation source through TransGrid's transmission network at 132kV and 66kV. Once the energy is transferred into Endeavour Energy's network, the voltage is transformed through 24 sub-transmission and 165 zone substations and distributed to customers through a 22kV, 11kV or 12.7kV high voltage network. Distribution substations further reduce the voltage to supply customers with a 230V nominal low voltage supply in accordance with Australian Standards.

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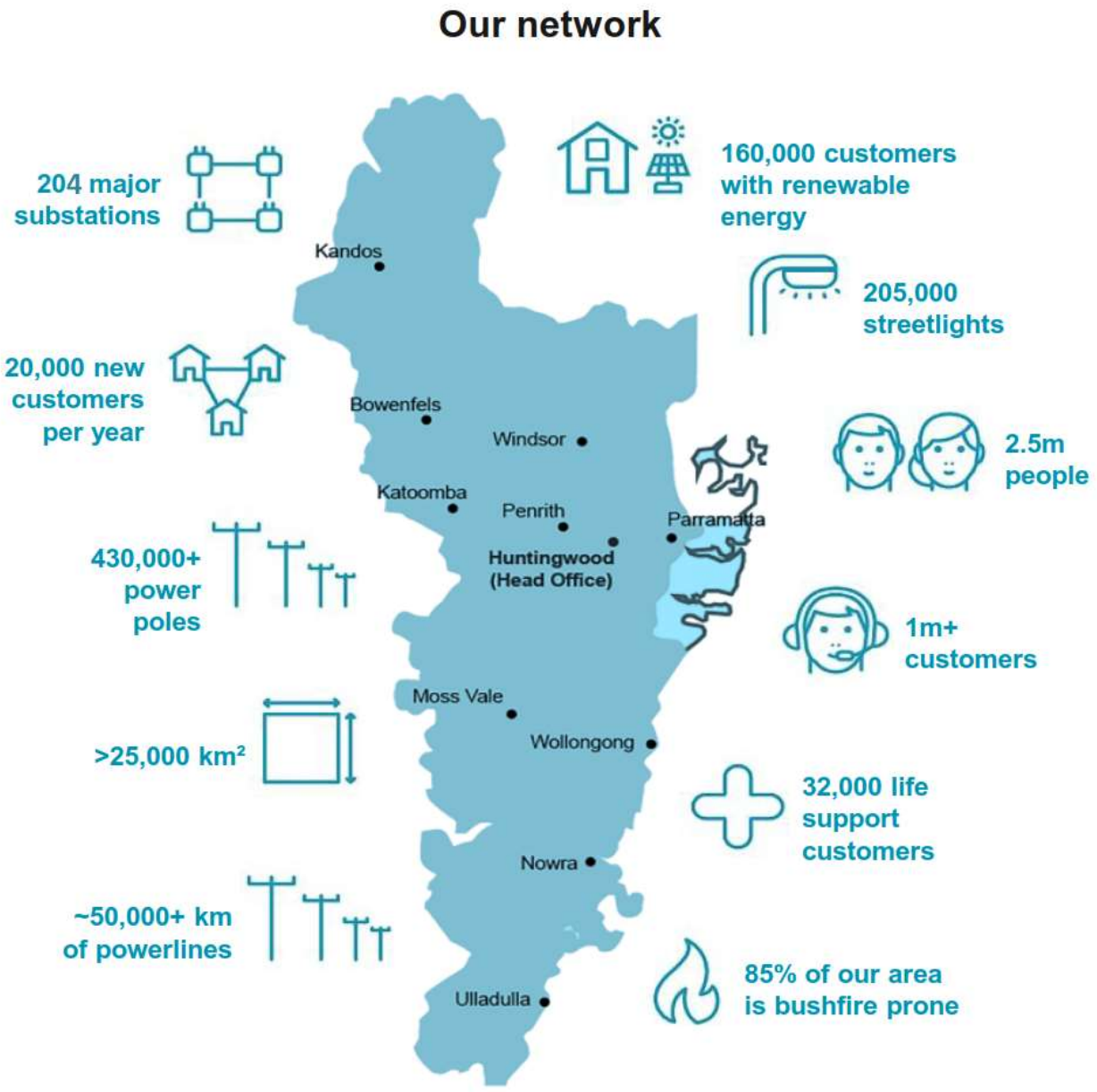
Figure 1: Endeavour Energy's network area showing regional areas



Endeavour Energy's distribution network includes:

- A sub-transmission system of 132kV, 66kV and 33kV assets;
- A high voltage distribution system of 22kV, 11kV and 12.7kV SWER assets;

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- A low voltage distribution system of 400V and 230V assets; and
- Over 50,000 km of overhead lines and underground cables.

The elements that make up a traditional one-way electricity network are shown in Figure 2. The elements owned and operated by Endeavour Energy are highlighted in dark grey. The transmission network (owned and operated by TransGrid) is located between the output of the Power Station and the Bulk Supply Point. The distribution network generally commences at the output of the Bulk Supply Point and includes Endeavour Energy's entire network to the connection point at the customer's premises. A summary of Endeavour Energy's network and other statistics is given in Table 1.

Figure 2: Traditional, one-way network with Endeavour Energy assets shown in dark grey

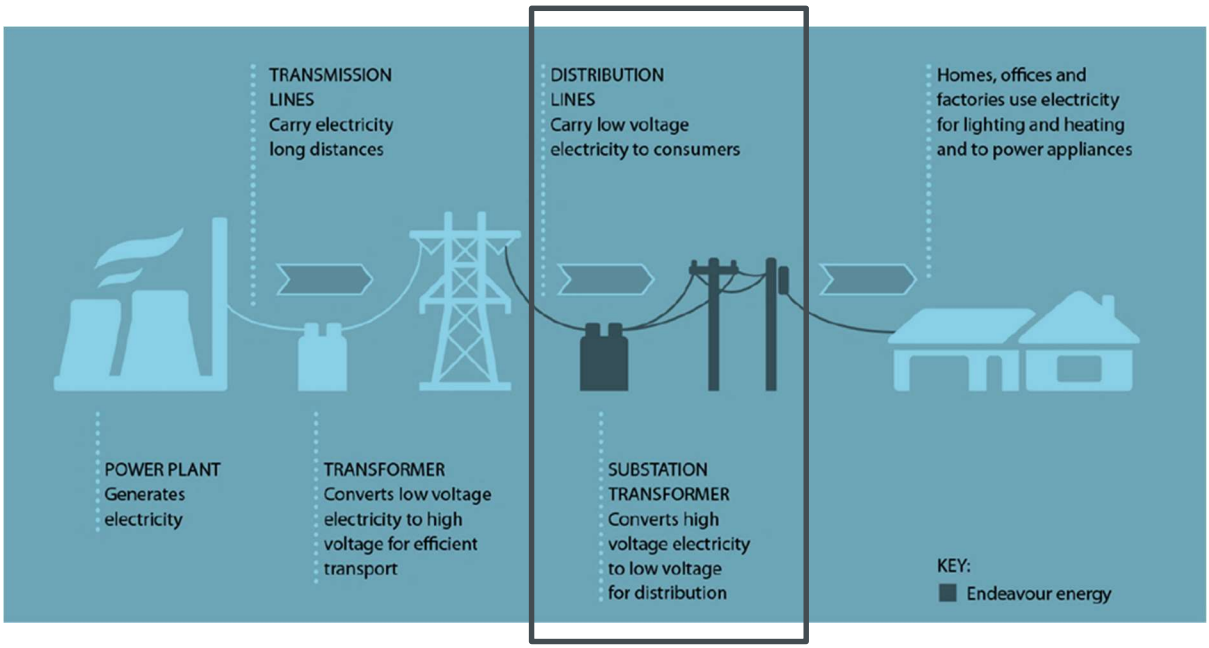

Table 1: Endeavour Energy statistics as at 30 June 2020

Statistic	Number
Distribution Customer Numbers (total)	1,049,165
Maximum Demand (aggregated system MW)	4,056
Feeder Numbers CBD	0
Feeder Numbers Urban	1,242

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Statistic	Number
Feeder Numbers Short Rural	430
Feeder Numbers Long Rural	1
Energy Received by Distribution Network to Year End (GWh)	15,139
Energy Distributed to Year End (Residential) (GWh)	5,740
Energy Distributed to Year End (Non-Residential Including un-metered supplies) (GWh)	10,772
Energy Distributed to Year End (GWh)	16,511
System Losses (%)	4.30
Transmission Substation (Number)	24
Zone Substation (Number)	165
Bulk Supply Point (Number)	15
Distribution Substation (Number)	32,951
Sub-Transmission Overhead (km)	3,024
Sub-Transmission Underground (km)	404
High Voltage Overhead (km)	11,256
High Voltage Underground (km)	5,439
Low Voltage Overhead (km)	8,655
Low Voltage Underground (km)	9,946

Our business is changing fast. What was once a network of poles and wires delivering one-way electricity supply to customers is evolving into a two-way system, where our customers can send power to the grid via their own mini generation systems, largely made up of roof top solar and increasingly battery systems. Figure 3 illustrates how the electricity network has evolved from traditional to present time and what the future would look like.

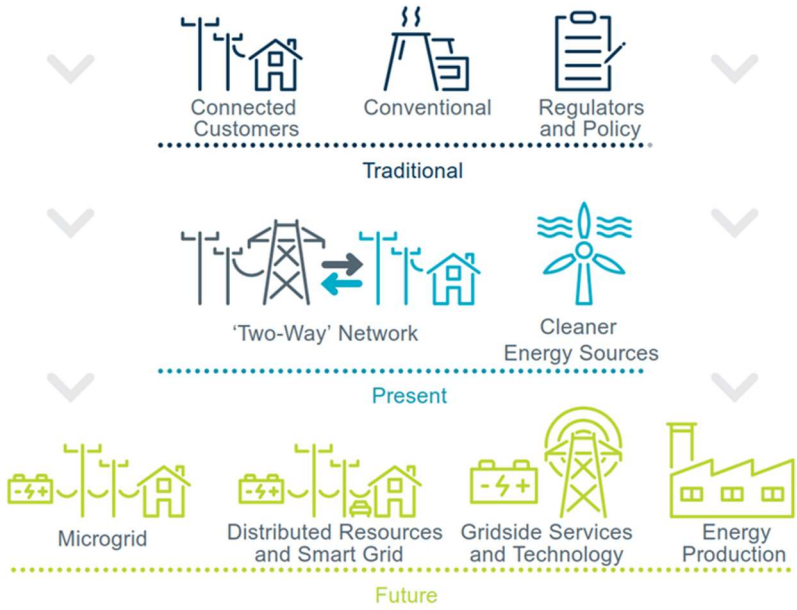
Introduction

There has been enormous growth in solar for Endeavour Energy. In June 2010, there were just 8,557 solar systems on rooftops. Now there are 130,000 connected to the network.

This rapid technological change poses significant opportunities but also challenges for Endeavour Energy to manage the safe and reliable integration of all these distributed energy resources in the network.

If properly managed, solar and storage systems can work together as virtual power plants, reducing the need for investment in poles and wires infrastructure, and ultimately saving customers money on power bills.

Figure 3: Electricity Network Transformation (Two-Way Network)



To help plan for these changes, the electricity and gas industry invited customer advocates and energy industry stakeholders to help the CSIRO map out a plan called the Electricity Network Transformation Roadmap.

Endeavour Energy's leadership chaired the group that designed the Roadmap and is committed to its implementation. Senior managers are working on innovation projects to maximise opportunities presented by this revolution.

2.3 Operating Environment

Endeavour Energy is 50.4 percent owned by an Australian-led consortium of long-term investors in the private sector operating the network under a 99-year lease. The private sector consortium comprises of Australia's Macquarie Infrastructure and Real Assets, AMP Capital on behalf of REST Industry Super, Canada's British Columbia Investment Management Corporation and Qatar Investment Authority.

Introduction

The remaining 49.6 percent is held by the State of NSW via a corporation constituted under the Electricity Retained Interest Corporations Act 2015.

Endeavour Energy is regulated by statutory and legislative requirements including work health & safety (WH&S), environmental, competition, industrial, consumer protection and information laws, the National Electricity Law Rules, the NSW Electricity Supply Act 1995 and the requirements of its NSW Distribution Network Service Provider licence. Endeavour Energy ensures compliance with these laws and regulations through its internal policies, procedures, work place instructions and industry codes and standards. We operate a common business control framework across these various instruments that allows us to fulfil our obligations through the development and implementation of plans, delegations of authority and associated controls, instruction and training, audits of compliance, and risk identification and management.

In particular, Endeavour Energy's operations are guided by a number of important policies and codes, including a Code of Conduct, a Stakeholder Engagement Framework, our Safety Policy, Environmental Code of Conduct and our Statement of Business Ethics.

Endeavour Energy is managed by a Board of Directors and a Chief Executive Officer (CEO). The business remains focused on:

- Operating efficiently as any comparable distribution network business;
- Maximising the value of the company to shareholders; and
- Balancing commercial, social, environmental and customer expectations.

Endeavour Energy's CEO reports to the Board, which in turn is accountable to shareholders. The Board is responsible for setting the overall strategic direction and performance targets and monitoring the implementation of the strategy by the organisation. The CEO leads the Executive Leadership Team in delivering the approved strategy and achieving the performance targets set by the Board.

Endeavour Energy is subject to the National Electricity Law (NEL) and National Electricity Rules (NER) which regulate the National Electricity Market. Endeavour Energy operates in the National Electricity Market (NEM) as a distribution network provider (DNSP). Endeavour Energy is also required to follow government and regulatory direction.

Within NSW, the Network Reliability and Performance Licence Conditions are imposed by the Minister of Energy. The Independent Pricing and Regulatory Tribunal (IPART - Electricity) is responsible for administering licensing within the energy industry and monitoring compliance with licence requirements on request from the Minister. Safety performance and compliance is also administered by IPART in conjunction with WorkCover NSW. The Australian Energy Regulator (AER) is the economic regulator of the distribution and transmission sectors of the national electricity market under the National Electricity Laws and National Electricity Rules.

Endeavour Energy is a signatory to the Energy Charter, an industry and customer led, world-first, whole-of-sector initiative to address customer expectations. Endeavour Energy works to deliver the five principles of the Energy Charter:

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1. We will put customers at the centre of our business and the energy system
2. We will improve energy affordability for customers
3. We will provide energy safely, sustainably and reliably
4. We will improve the customer experience
5. We will support customers facing vulnerable circumstances

2.3.1 Our Values

Endeavour Energy employees are required to understand and support the Company's corporate values. These five refreshed values and their associated behaviours are the basis for everything the Company does.

Be Safe
- Put safety first. Care. Always.

Work Together
- Listen. Share goals. Work together as one.

Find a Better Way
- Stretch for excellence. Innovate. Challenge ourselves. Create value.

Adapt Quickly
- Be nimble and flexible. Be open to learn. Embrace opportunities.

Own It
- Do what you say and own the impact of what you do. See it through.

Introduction

2.3.2 Our Objectives

Endeavour Energy's purpose is:

"Powering communities for a brighter future."

Our corporate strategy supports the principles of the Energy Charter, and is designed to promote the long-term interests of our customers, shareholders, people and communities by delivering five key strategic goals:

1. ***Safety* and Environment**
   - Establish an organisation-wide culture of safety
   - Establish streamlined systems and processes
2. ***Employee Engagement***
   - Drive performance through clear expectations & performance-oriented mindsets
   - Build leadership capability
3. ***Customer and Communities***
   - Establish easy connection for customers
   - Enhance customer recognition through valued interactions and relationships
4. ***Performance***
   - Optimised work program and risk allocation
   - Improve quality, speed and cost to deliver
5. ***Growth through Innovation***
   - Leverage existing asset base to create value
   - Augment network with smart investments and new technology

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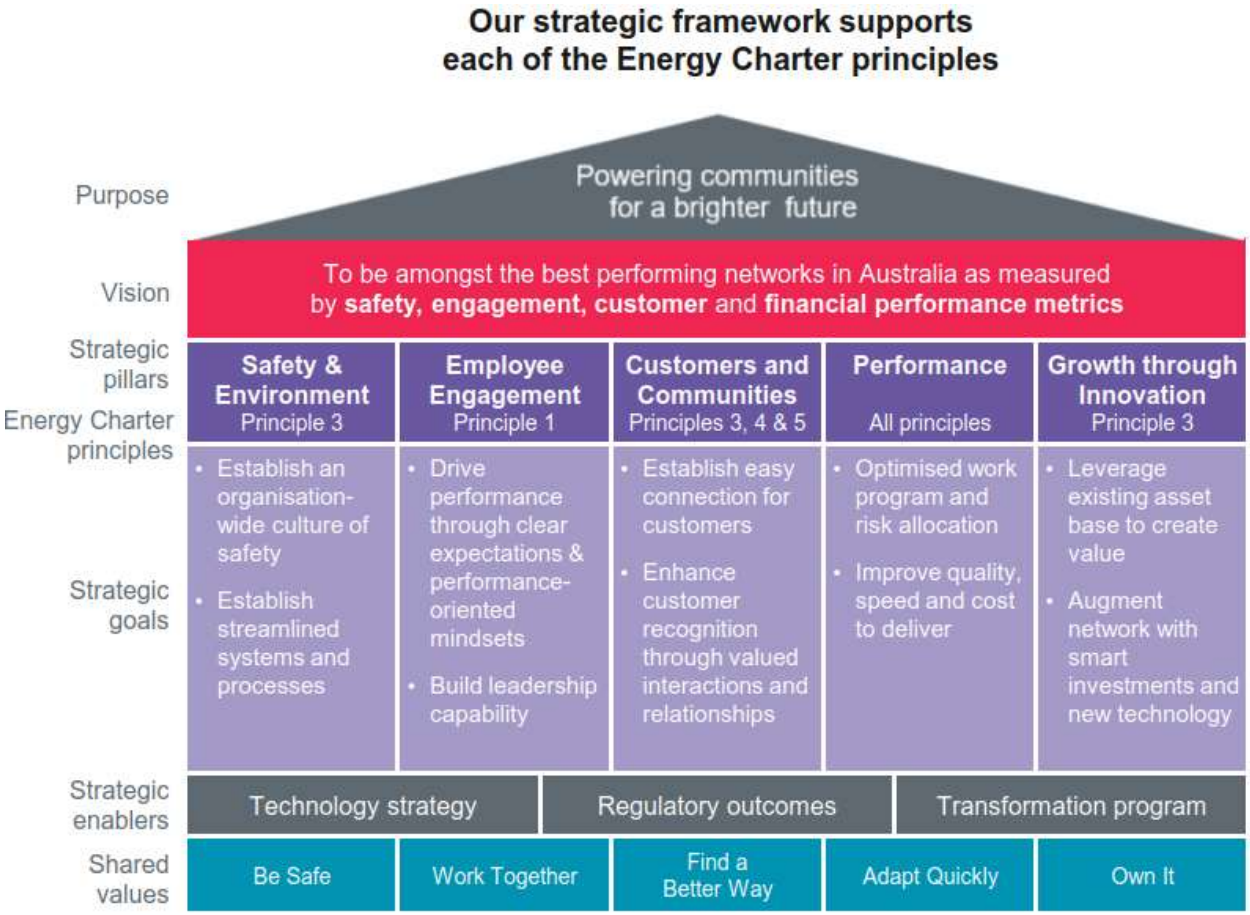
Figure 4: Endeavour Energy's Strategic Framework



Asset Management

3. Asset Management

Endeavour Energy's corporate planning framework is updated annually but takes a multi-year view of the strategic objectives and priorities of the business. As noted in Section 2.0, our strategies are designed to promote the long-term interests of our customers by targeting five key strategic goals:

- *Safety* and Environment
- *Employee Engagement*
- *Customer and Communities*
- *Performance*
- Growth through Innovation

The Company's core business is managing our electrical network assets to achieve the strategic goals noted above. Accordingly, Asset Management is a key focus area, delivering a suite of initiatives in support of priority actions. These priority actions are assigned to senior managers and implemented in the year ahead. The overarching key objectives of our asset management approach are to:

"To deliver the required network performance at least cost"

"Safely and efficiently deliver capital and operating programs"

In response to the challenges outlined above, Endeavour Energy has evolved its asset management approach along the lines of *"Asset Owner – Asset Manager – Service Provider"* business model. This model structure is widely accepted as best practice, and the identification of these roles within the business is central to alignment with the requirements of the ISO 55001 Asset Management Framework.

3.1 Asset Management Philosophy

Endeavour Energy applies a lifecycle approach to managing its network and the assets that comprise it. The lifecycle approach involves two aspects:

- Considering individual assets and asset populations on a whole-of-life basis in order to achieve optimal outcomes across their entire lifecycle e.g. considering how the cost-benefit trade-off between asset management decisions made at the design and procurement stage may later impact the maintenance stage of the asset lifecycle; and
- Considering the network as a whole in all asset management decisions i.e. will the decision made in relation to any individual asset or asset population result in the best outcomes for the network as a whole.

Endeavour Energy's approach captures competing stakeholder requirements in decision making and is supported by a spectrum of continually improving systems and processes.

Asset Management

This approach has been consolidated through the strategically designed structure of our Operations Division. In particular, the embedding and integrating of functions such as Network Planning and Asset Performance with other “more operational” asset management functions allows integration of the whole-of-life asset decision processes. Within the industry at large, these longer-term functions are traditionally considered in isolation, yet through their integration Endeavour Energy has created a more holistic life-cycle management approach with benefits in capital efficiency and investment optimisation.

The Operations Division is directly responsible for developing network and asset plans, proposed investment programs, developing asset standards and management policies, and strategically monitoring and managing network capability and network performance. In addition, the Operations Division is responsible for implementing the various plans thus developed in accordance with the policies and standards set, and undertaking construction, operating, maintenance, renewal and disposal activities in the field in line with these requirements.

3.2 Asset Management Approach

In adopting this operating model, Endeavour Energy is in the best position to meet the challenges of the future. This alignment with contemporary asset management thinking makes clear the distinctions of responsibility and asset management functions between Asset Owner, Asset Manager and Service Provider. The objective of this is to apply leading asset management principles to optimise practices and subsequent outcomes for the network.

This business model requires the Asset Owner to set the vision for the network, whilst the Asset Manager and Service Provider work in unison to deliver on those objectives.

The mechanism by which the Asset Owner receives and provides formal feedback on corporate objectives for the assets and progress in achieving these objectives, as well as setting overall strategic direction, is the Asset Management Committee (AMC). The Asset Manager and the Service Provider coordinate their respective asset management functions through the operation of this committee in line with the requirements of the Asset Owner.

Within Endeavour Energy, the three functional asset management roles are symbiotic, in that the long-standing culture within the company is to operate on a partnership basis. In this respect, the Asset Owner seeks and takes advice from the Asset Manager and Service Provider on strategic issues and performance objectives, whilst the Asset Manager and Service Provider operate collaboratively to ensure the requirements of the Asset Owner are met and delivered through their respective functions.

3.3 Asset Management Strategy

To deliver the desired corporate objectives for asset management, Endeavour Energy develops a Strategic Asset Management Plan (SAMP). This plan provides a framework for aligning Endeavour Energy’s asset management related activities to the corporate plan. It is the alignment, or co-ordination of activities, that realise values from the assets in the delivery of the required outcomes and achievement of the strategic

corporate objectives. The setting of objectives for the network asset management and their prioritisation is undertaken through assessment against the overarching corporate objectives.

The strategy is implemented through the plans and programs in Endeavour Energy's Asset Management System. The planning framework itself is embedded in a range of internal procedures, plans, standards and policy documents, overseen and managed by the AMC. This committee oversees and directs Endeavour Energy's Asset Management Strategy, which is the mechanism by which the overall corporate objectives are achieved.

Endorsement of the funding required to implement agreed plans and programs are captured in the Portfolio Investment Plan (PIP).

Significant resources are devoted to ensuring timely, relevant and thorough data and information is available to support decisions. For example, Endeavour Energy maintains detailed asset age, location and condition data across the Geographic Information System, Field Inspection System, Asset Management System and Outage Management System. Endeavour Energy also monitors the relationship between planned service performance targets and service outcomes in accordance with current regulatory requirements and our own commitment to service delivery.

Endeavour Energy's network investment planning process includes network plans being developed annually. This process culminates in the development of Endeavour Energy's Portfolio Investment Plan (PIP) of required network investments.

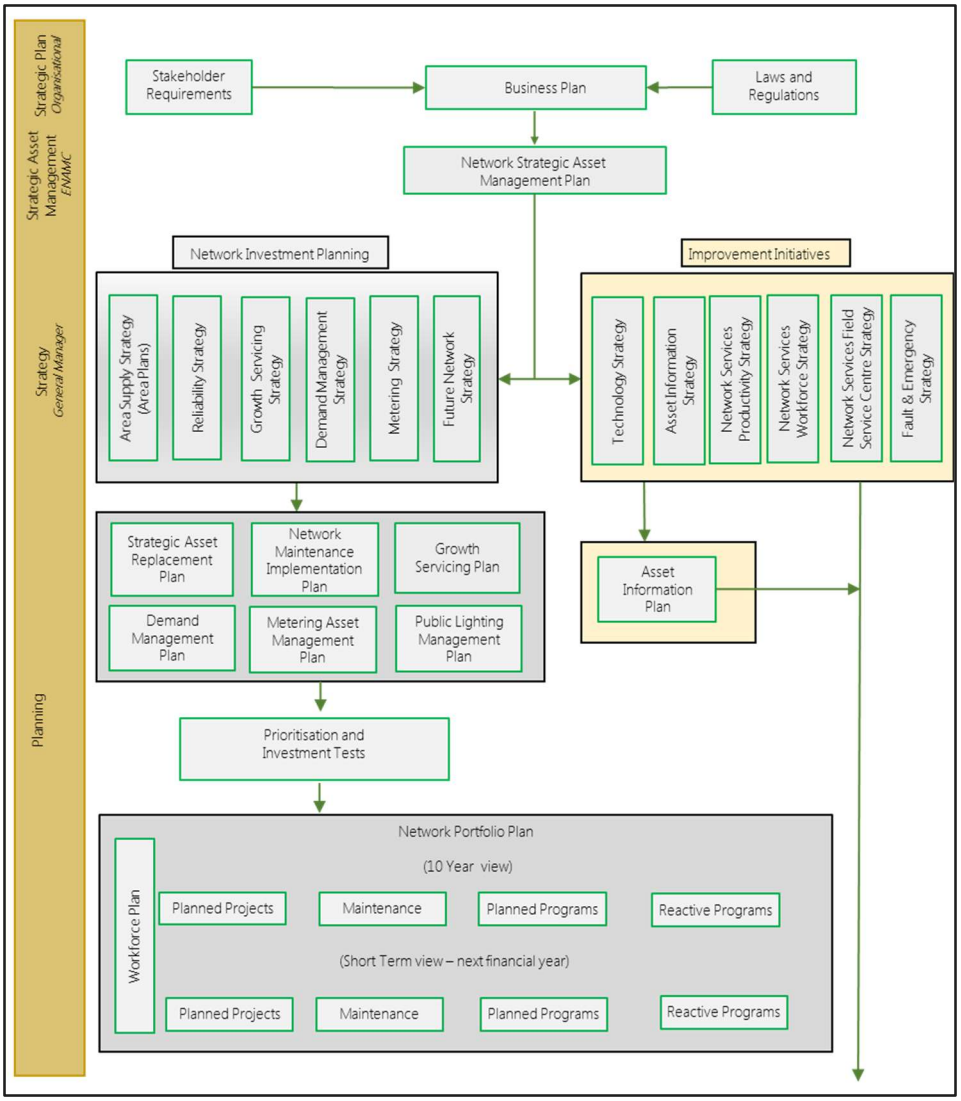
3.4 Asset Management System

To support this process, Endeavour Energy maintains an Asset Management System that provides a framework for effectively managing the network and its assets through the complete asset life cycle of planning, program development, design, construction, operation, maintenance, renewal and disposal in accordance with ISO 55001.

The Asset Management System Document Hierarchy, outlined in Figure 5 below, defines the key documents used to coordinate asset management decision making and ensuring asset management activities are aligned to the organisational objectives.

Asset Management

Figure 5: Asset Management System Document Hierarchy



3.5 Safety

Continuing advances in workplace health and safety are driving a more integrated view of contributing factors to workplace safety and the business's obligation to ensure a safe place of work. In this regard, safety considerations including safety in design are overtly considered in asset management strategies. Furthermore, Endeavour Energy has a specific strategic plan for Safety and Environment that considers the broader safety and environmental initiatives across the business.

Asset Management

3.6 Licence Conditions

NSW Design Reliability and Performance licence conditions were introduced in 2007 and required material capital investment to achieve initial compliance over the 2009-2014 regulatory period. A review of the licence conditions in 2014 removed the “deterministic” supply security requirements of the licence conditions, thus facilitating a transition to more “probabilistic” investment planning approaches.

Endeavour Energy has responded to this challenge through the application of a risk-based assessment of the capability versus demand balance, with a clear understanding of the capabilities of its network assessed against the risk profile of its assets. This has enabled a reduction in capital investment to be achieved over the 2015-2019 regulatory period without an undue increase in network risk.

3.7 Changing Investment Program

The relationship between customer numbers and our total network peak demand is currently weakening. Our system maximum demand is forecast to grow at 2.7% per annum between 2020 and 2029. However, this growth is only occurring in localised areas with the interaction between growth in connections and spatial (locational) demand driving our augmentation expenditure.

Endeavour Energy connected over 20,000 new customers in 2019/20 compared to 10,000 in 2012, and Independent HIA housing construction data shows 29,000 homes commenced construction in the last year. Plans to release large scale greenfield industrial areas are firming, centred around the future Western Sydney Aerotropolis. Therefore, the priority growth areas of Western Sydney will continue to require the provision of substantial amounts of new supply infrastructure, which is a challenge that Endeavour Energy has the demonstrated capability to meet through its various delivery strategies.

The AER determination has confirmed a total capital expenditure allowance of $1.70 billion for the period of July 2019 to June 2024.

Asset renewal is planned on the basis of asset condition and performance criteria. However, a high proportion of aged assets can present a substantial risk to reliability and performance when condition-based or functional failure trends increase, giving rise to coincident asset failures. Endeavour Energy’s focus on risk-based asset management considers these factors and facilitates the development of efficient strategies for mitigating risk that are proportional to the magnitude of the risks posed.

3.8 Resourcing

Endeavour Energy undertakes regular, robust workforce planning to identify future workforce needs and strategies to fulfil those needs. These needs are satisfied through a combination of existing internal resources, apprentice and graduate programs, and market-sourced resources.

Planning Approach

4. Planning Approach

4.1 Annual Planning Review

The NER requires that the annual planning review includes the planning for all assets and activities carried out by Endeavour Energy that would materially affect the performance of its network. This includes planning activities associated with the replacement and refurbishment of assets and negotiated services. The objective of the annual planning review is to identify possible future issues that could negatively affect the performance of the distribution network to enable DNSPs to plan for and adequately address such issues in an appropriate timeframe. This Distribution Annual Planning Report (DAPR) is one of the outcomes the annual planning review and summarises the findings of our planning review processes.

The DAPR provides an insight into the planning process as well as providing information to registered participants and interested parties regarding the nature and location of emerging constraints within Endeavour Energy's sub-transmission and 22kV and 11kV distribution network. The timely identification and publication of emerging network constraints provides an opportunity for the market to identify potential non-network solutions to those constraints and allows Endeavour Energy to develop and implement appropriate and timely solutions.

4.2 Network Planning Process

Endeavour Energy operates in accordance with the legislative and regulatory framework applicable to electricity DNSPs in NSW.

The network planning and development process for the distribution network is carried out in accordance with the National Electricity Rules Chapter 5, Network Connection Access, Planning and Expansion.

Endeavour Energy carries out network planning at both a strategic and a project level. Endeavour Energy's investment governance process provides continuous review and ongoing assurance that the Company's capital investment is both prudent and efficient as well as being consistent with the longer term strategic planning objectives.

Endeavour Energy's planning process is designed to identify the most efficient ways of ensuring the network business meets its network performance obligations. The Company places emphasis on the planning and project identification stage, assessing our customer's short term and longer-term supply needs, and coordinating these with asset renewal requirements. We are then able to identify and select the optimal solution to meet those needs in a coordinated, risk-optimised way.

All credible options, including non-network alternatives, are considered in determining how to meet our network performance obligations and the objectives of the National Electricity Law. A robust selection process is implemented that explicitly trades off alternative expenditure options using quantified estimates of credible option costs and benefits to identify the optimum solution to address the identified need.

Planning Approach

In accordance with NER obligations, network investment and non-network options are assessed impartially, using a consistent process for reviewing the costs of each option against the benefits they would deliver. Non-network options are evaluated for the extent to which they can facilitate the deferral of network investment or obviate it altogether. This allows various combinations of non-network solutions and deferred investment options to be assessed.

The first stage of the planning process involves gathering the data required to inform the investment process. This includes:

- Recorded actual electricity demand;
- The preparation of demand forecasts;
- The examination of network capacity limits;
- The assessment of asset condition and asset performance data;
- The forecast of new customer connection requirements; and
- The consideration of applicable statutory and regulatory obligations.

The capability of the network is assessed against key criteria which include:

- Meeting statutory and regulatory requirements relating to the safe operation of the network and to environmental impact;
- Addressing capacity constraints to achieve a level of supply security commensurate with reasonable customer expectations;
- Reliability performance against the reliability performance standards set out in the Licence Conditions;
- Asset condition; and
- Customer connection requirements.

When emerging network limitations are identified, a range of credible options are developed to address the need to ensure that supply security is maintained at a level appropriate to maintain reliability of supply. Options considered include both network and non-network solutions. The costs of these options are compared against the risk costs associated with the base case option of doing nothing.

A review including public consultation with interested stakeholders then selects the most economic option (or options). Each major investment is required to be consistent with Endeavour Energy's longer-term network plans and network standards as well with the National Electricity Objective.

This DAPR document forms part of the public consultation and provides notification of the expected future network requirements. It also indicates the required timeframe to address these needs to allow for appropriate corrective network investment or non-network alternatives or modifications to connection

facilities to be developed and undertaken. Providing visibility of network requirements prior to starting the RIT-D process allows for development of more mature non-network solutions.

Capital investment requirements in the distribution network are forecast in line with network needs and constraints across the network area.

The spatial demand forecast is a critical process which supports the planning and development of the forecast augmentation investment program. The forecasting process is carried out twice a year and is a critical input into the planning process to identify and understand the capacity needs of the network. The summer and winter loading conditions are analysed to provide understanding of the seasonal variations which are important for identifying optimal network solutions.

Losses are considered when comparing credible options. Endeavour Energy complies with RIT-D guidelines and assesses the cost of losses for each option where the losses are materially different between the options. An increase in network losses makes a negative contribution to the market benefits of a credible option, while a decrease in network losses makes a positive contribution.

4.2.1 Probabilistic Planning Approach

Endeavour Energy applies probabilistic planning techniques to assess supply security constraints. Deterministic (N-1) criteria are used only as a trigger for further investigation. The probabilistic planning approach includes:

- An assessment of the likelihood of failure of network elements;
- An assessment of the consequence in the failure event. This includes expected outage duration and expected unserved energy. The unserved energy can be monetised by applying a Value of Customer Reliability (VCR). Safety risks are also assessed and monetised by applying a value of statistical life (VSL);
- Consideration of back-up capacity at other voltage levels (for example HV distribution feeder capacity when analysing zone substation contingencies);
- A sensitivity analysis for key parameters such as load growth, cost, rate of return and discount rate; and
- A determination of economic timing for network augmentation and renewal and the net present value of options based on demand forecasts and the economic benefits provided by each option.

For greenfield development, probabilistic techniques tend to result in a staged approach to provision of supply capacity including the use of distribution feeders, single transformers and temporary and mobile substations being adopted.

Planning Approach

4.3 Approach to Investment Decision Making

Endeavour Energy maintains a Investment Management Framework (IMF) to provide clear guidance and accountability in respect of the development, determination and authorisation of investment in the network. This framework provides the basis for making network investment decisions which include both network and non-network expenditure.

The framework is shown in Figure 6 below.

Figure 6: Network Investment Governance Framework

Network investment decisions made to achieve customer and business objectives will be focused on one or more of five key focus areas of our network strategy of Safety and Environment, Employee Engagement, Customer and Communities, Performance and Growth through Innovation.

4.3.1 Planning and Investing for Growth

Growth in Endeavour Energy's network is being driven principally by new customer connections arising from greenfield development in Sydney's north-west and south-west priority growth areas. Augmenting the network to provide for the growth in demand in these areas at the right time is important to ensure that development can proceed and that significant infrastructure investment by the State Government in water, roads and rail in greenfield areas are not left stranded.

Endeavour Energy evaluates staged options for network augmentation and/or extension in response to developer requests for supply. Further augmentation is undertaken when load growth projections are realised. In some cases, the minimum viable solution may involve a temporary mobile substation that can be moved on to the next greenfield development when its capacity has been outgrown. As the cost and capability of emerging technology solutions improve there is potentially a larger role to play for these technologies in the staged approach of network augmentation. The staged approach to network augmentation provides more optionality for consideration of non-network solutions to meet network needs.

Endeavour Energy has plans in place to utilise mobile or temporary substations where appropriate. The ability to stage investment in infrastructure for growth depends on the rate of growth. In an area which is expected to see a rapid increase in new load (e.g. a large new town centre) a staged option may not be economically efficient. Conversely, an area with a lower projected rate of growth (low-density residential only), the onset of the risk of insufficient capacity can take longer thereby facilitating the exploration of lower-cost operational and non-network options to manage this risk.

In general Endeavour Energy identifies limitations in its network capability against an "N-1" level of supply security at the sub-transmission and zone-substation level, however small or temporary substations (noted

above) may operate in a “non-secure” manner. This approach only serves to identify preferred future network development options should future limitations be unable to be mitigated through operational response (such as load transfer) or demand management initiatives.

The actual investment timing is confirmed through a probabilistic assessment of the network risk and the optimisation of the economic benefits of any proposed development.

Non-network strategies play a significant role in Endeavour Energy’s plans to service the growth in demand, especially in constrained supply areas. Demand management and non-network strategies have a higher likelihood of success in brownfield development locations compared with greenfield release areas due the potential to reduce load from the existing customer base.

4.3.2 Planning and Investing for Asset Renewal

Endeavour Energy takes a risk-based approach to asset renewal planning that matches the investment in the network to the risks posed by individual assets or groups of assets approaching the end of their useful lives.

Risks to the safety of personnel and to the continuity of the electricity supply to our customers as a result of asset failures are quantified and decision is made to retire from service assets which present excessive risk. Assets proposed to be retired are assessed for the ongoing need for the service they provide. Where that service is still required, an assessment is made as to whether that can be provided by a credible non-network solution or whether replacement of the asset is required. Where asset replacement is required the optimum timing of the replacement of the asset is based on the balance between the annualised cost of replacement and the annualised cost of servicing the asset.

Furthermore, the risk to the operational management of the network arising from multiple asset failures occurring during a short period of time is factored into the assessment of whether particular classes of assets should be considered for replacement as they near their end of life or whether they are only replaced after they fail in service.

These considerations lead to an approach where an asset group that has non-catastrophic failure modes and an adequate level of network redundancy are more likely to be renewed in a reactive manner after failure. Other asset groups whose failure modes present safety or unacceptable supply security risks, or where the cost of reactive replacement significantly outweighs the cost of planned replacement, are renewed in a planned manner prior to their failure.

Further, some individual programs and projects within the asset renewal investment program are informed by advanced condition monitoring technology allowing for the targeted and efficient replacement of assets just prior to failure. This technology and the transition to the risk-based economic assessment of the value of each of the elements of our renewal program is resulting in significant reductions in renewal expenditure compared to historic values whilst maintaining risk and performance outcomes.

4.3.3 Planning and Investing for Reliability

Endeavour Energy has adopted a Reliability Strategy of maintaining existing levels of reliability, and rectifying poor-performance outliers that have been identified as per Endeavour Energy's Licence Conditions. Targeted investment leverages new technology such as distribution feeder automation schemes, where analysis shows that these can be a cost-effective way of improving the Company's response to faults.

4.4 Recent Changes to Planned Projects

Significant changes to planned projects compared to the previous DAPR are detailed in Table 2 below.

Table 2: Significant changes to Planned Projects Compared to the Previous DAPR

RIT-D Project	Change	Comments
South Penrith ZS	Project deferred for several years	Due to changes in the demand forecast and the underlying network need in the project location this project has been deferred by several years.
Northern Gateway ZS	New Project identified	Due to recent land use re-zoning and developer plans in the Western Sydney Aerotropolis area, this project has been added to our Identified Network Need RIT-D projects.
West Wollongong Zone Substation 11kV switchboard	Project deferred	In the previous DAPR, it was noted that this project had been cancelled and replaced by a program of replacing the 11kV circuit breaker trucks with vacuum trucks in the existing switchboard. However, the original switchboard replacement project is still under consideration from FY25 pending a further condition assessment and economic evaluation which will determine the most appropriate solution for this substation.

5. Network Performance

5.1 Network Reliability Overview

Reliability of supply is a key measure of the performance of the electrical network. System Average Interruption Duration Index (SAIDI) is the measure of the number of minutes on average that Endeavour Energy's customers are without electricity each year due to unplanned events (but excluding storms and other major event days).

Major Event Days are typically associated with adverse weather conditions and are excludable when reporting normalised reliability results. Figure 7 and Figure 8 shows the total SAIDI and SAIFI trend (includes major event day reliability) as well as normalised SAIDI and SAIFI.

Figure 7: Organisational SAIDI Trend (Total and AER Normalised)

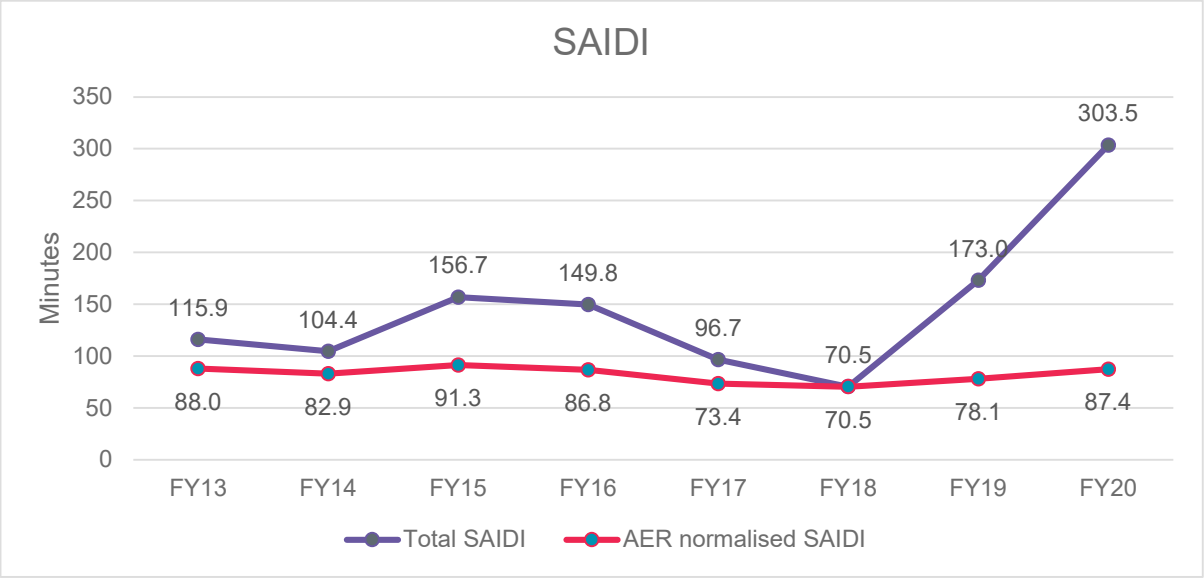
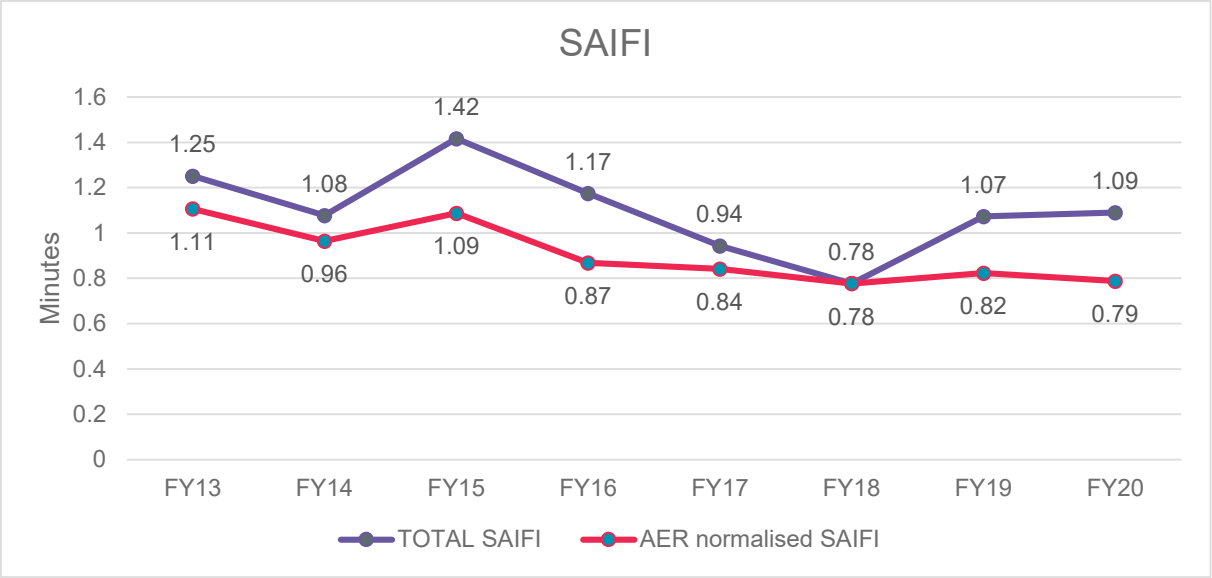


Figure 8: Organisational SAIFI Trend (Total and AER Normalised)



Endeavour Energy's AER normalised SAIDI and SAIFI performance exhibits a stable trend in recent years. The result for FY20 of 87.4 minutes SAIDI was slightly worse that FY19 however this was impacted by several unfavourable bushfire and weather events. Furthermore, in FY20 there were 8 major event days recorded which compares to 8 in FY19.

5.1.1 Trends in Reliability Target Performance

The NSW Minister for Energy first imposed licence conditions for the distribution network service providers on 1 August 2005 covering design planning standards, reliability, individual feeder and customer service standards. The conditions were designed to give guidance to the distributors regarding the performance levels expected by the NSW Government.

The current licence conditions were imposed on 7 July 2017.

Table 3 provides the reliability performance information required by licence conditions 7.3 including:

- Performance against the SAIDI average standards and SAIFI average standards by feeder type, disregarding excluded interruptions; and
- Reasons for any non-compliance by the licence holder with the reliability standards and plans to improve performance.

The data listed in Table 3 is the 'normalised' da ta set i.e. the overall data with 'excluded' interruptions deducted. 'Excluded' interruptions are defined in Schedule 4 of the licence conditions and are primarily outages of less than three-minute duration or outages caused by directed load shedding, planned maintenance, failure of the shared transmission system or 'major event day' outages.

Network Performance

Table 3: Annual Network Reliability Performance

		Whole Network and Feeder Category				
		Network *	CBD +	Urban	Rural Short	Rural Long
Customer numbers (Average over Year to Date)		1,054,075	N/A	748,927	304,833	315
SAIDI	Actual	118.3	N/A	58.1	265.4	969.8
	Standard from Licence Conditions	N/A	N/A	80	300	N/A
SAIFI	Actual	0.81	N/A	0.60	1.33	6.04
	Standard from Licence Conditions	N/A	N/A	1.2	2.8	N/A

* Refers to the average performance of the Endeavour Energy's network overall. This measure does not form part of the licence conditions but is needed to calculate the overall NSW result.

+ The definition of a "CBD" area is a formal technical definition in the Reliability and Performance Standards against which Endeavour Energy is required to report. Key commerce centres at Parramatta, Liverpool, and Penrith which are supplied by Endeavour Energy do not fall into the official "CBD" category and hence there are no statistics against this category.

SAIDI is calculated from the sum of the duration of each sustained customer interruption (measured in minutes), divided by the total number of customers (averaged over the year) of the licence holder.

SAIFI is calculated from the total number of sustained customer interruptions divided by the total number of customers (averaged over the year) of the licence holder.

The Australian Energy Regulator (AER) introduced a Service Target Performance Incentive Scheme (STPIS) for NSW electricity distributors in 2014/15. This scheme encourages continuous improvement in reliability performance by offering financial incentives or penalties based on improvements or deterioration in performance from benchmark levels set in a prior period. From 2019/20 to 2023/24 Endeavour Energy's reliability performance is measured against average performance achieved in the 2013 - 2018 period.

Endeavour Energy has a corporate objective of outperforming the expected target under the AER's STPIS incentive scheme.

- Endeavour Energy invests in targeted reliability improvement works where justified to meet its licence conditions obligations. In addition, Endeavour Energy is leveraging new technology and modernising its network. In 2021, Endeavour Energy will commission an Advanced Distribution Management System (ADMS) which has the capability to perform automated Fault location, Isolation and Service Restoration

(FLISR). This system will leverage available remote operable switches on the distribution network to isolate and restore supply to customers following faults in a faster manner.

5.1.2 Service Target Performance Incentive Scheme

Management of reliability under a STPIS regime requires consideration of desired reliability outcomes as well as the interactions between expenditure and STPIS bonuses or penalties and the overall impact of these on customer prices. Therefore, Endeavour Energy's approach is to focus on improvements to fault response efficiency, asset and defect management practices as well as to leverage modern technology solutions when assets are end of life and require replacement.

The SAIDI and SAIFI unplanned performance results (excluding major events) compared to the STPIS targets for Endeavour Energy are shown in the Table 4: SAIDI and SAIFI STIPIS Targets vs 2019/20 Actuals below.

Table 4: SAIDI and SAIFI STIPIS Targets vs 2019/20 Actuals

Category	SAIDI Actual	SAIDI Target	SAIFI Actual	SAIFI Target
Urban	58.1	60.1	0.598	0.716
Rural	159.3	172.0	1.245	1.493

5.2 Quality of Supply

Quality of supply refers to the performance of the network in terms of steady state voltage, sags and swells, voltage unbalance, harmonic distortion and rapid voltage variation (or flicker).

The quality of supply performance of the network is impacted primarily by the characteristics of customer loads as well as by network events and by the configuration of the network. To manage these impacts, significant customer load applications, particularly commercial/industrial loads and other high voltage customers are formally assessed and provided power quality allocations in accordance with the National Electricity Rules, relevant Australian Standards and ENA Guidelines. Provided customers maintain their emissions within these allocations, the power quality performance of the network can be maintained within established planning levels and the risk of adverse impacts on other customer's equipment is minimised.

There are some loads on Endeavour's network which were connected prior to the implementation of the National Electricity Rules and associated formal power quality allocation processes. These loads can cause planning levels to be exceeded. In such cases, Endeavour Energy assesses the materiality of the performance level on customer equipment and monitors any associated complaints from affected customer that may arise. To date, no significant or widespread complaints have arisen as a result of these legacy loads.

Network Performance

5.2.1 Quality of Supply Standards

Endeavour Energy's technical service standards are published in its Customer Service Standards for Connection Customers (the Customer Service Standards) which has been prepared in accordance with the NSW Electricity Service Standards Code of Practice. The Customer Service Standards include descriptions of the power quality that customers can expect to receive and the disturbances that may occur on the network.

A copy of the Customer Service Standards for Connection Customers can be downloaded from the Endeavour Energy website.

Endeavour Energy's adopts limits for power quality parameters as per the planning levels in the AS/NZ61000 series of standards as referred to in the national electricity rules. Emissions allocations are provided to larger customers on a site-specific basis upon receipt of a connection application.

5.2.2 Quality of Supply Corrective Action

Endeavour Energy's power quality monitoring and rectification process resulted in all substantive issues relating to identified power quality non-compliances being addressed in the 2019/20 year. Outstanding matters pertain to incidents where non-compliances were unable to be clearly identified and/or validated.

5.2.3 Compliance Processes

Endeavour Energy is required to design, maintain and operate its network in a cost-effective manner to provide reliable power supply to its connected customers. The objectives of power quality fall within this overall framework.

Power quality issues are frequently related to specific loads connected to the network. In order to appropriately manage these effects, Endeavour Energy places requirements on connected customers to ensure that power quality is maintained. These requirements are stated in Company Policy 9.6.1 – Network Connection, the Customer Service Standards for Connected Customers and the Service and Installation Rules of NSW. Customers are advised of these requirements by reference to the Customer Service Standards for Connected Customers and the Service and Installation Rules of NSW.

5.2.4 Power Quality Surveying

Endeavour Energy takes part in the annual national Power Quality Compliance Audit (PQCA) run annually by the Australian Power Quality and Reliability Centre (APQRC). This audit uses data from power quality monitors in Endeavour Energy's substations and from available smart meters on customer's switchboards to assess the Company's performance and compliance levels compared to accepted limits (such as the planning levels).

Endeavour Energy has supplied data for the 19/20 PQCA from sites at low voltage (LV) as per Figure 9 and Figure 10 below.

Network Performance

Figure 9: Number of Sites Per Power Quality Parameter (LV)

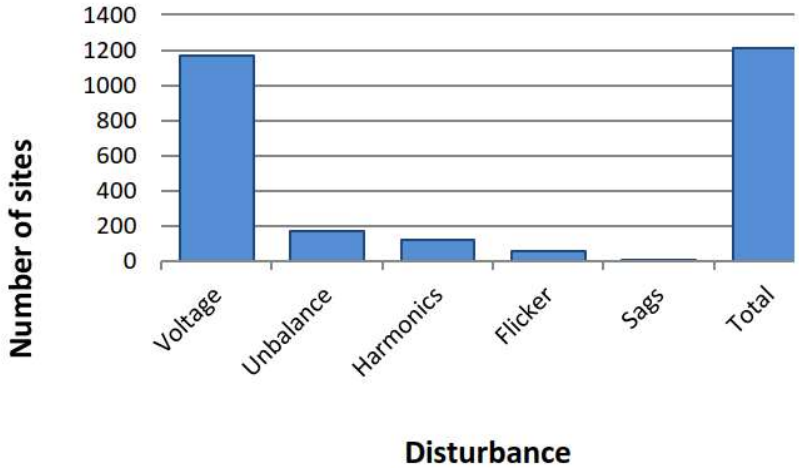
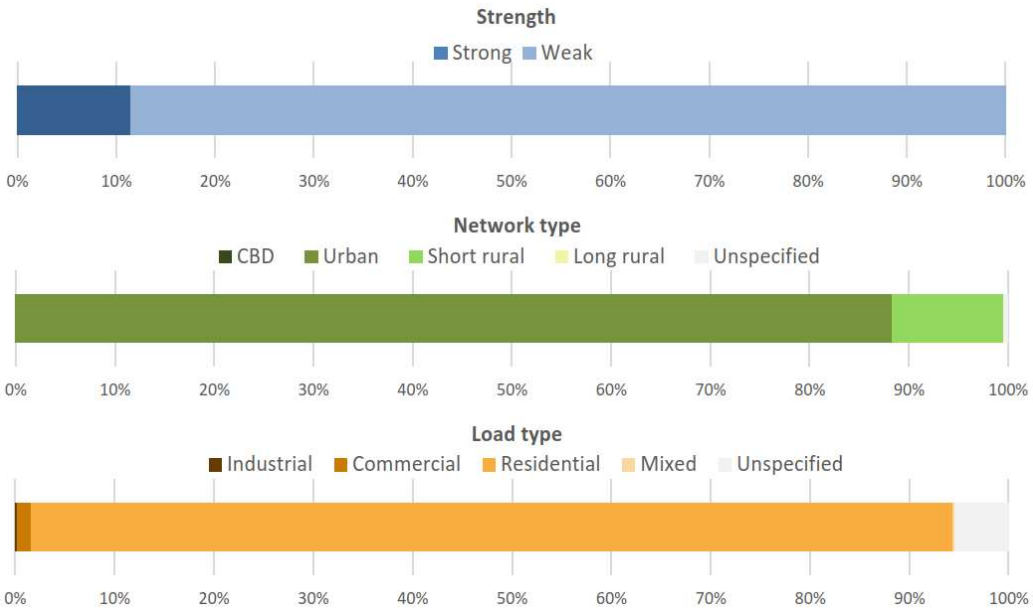


Figure 10: Distribution of the classification of relative electrical strength of sites (LV) based on the relative fault level at the measurement point compared to the distribution transformer



Endeavour Energy has supplied data for the 19/20 PQCA from sites at medium voltage (MV 22kV and 11kV – also called “HV” in this document) as per Figure 11 and Figure 12 below.

Network Performance

Figure 11: Number of Sites Per Power Quality Parameter (HV)

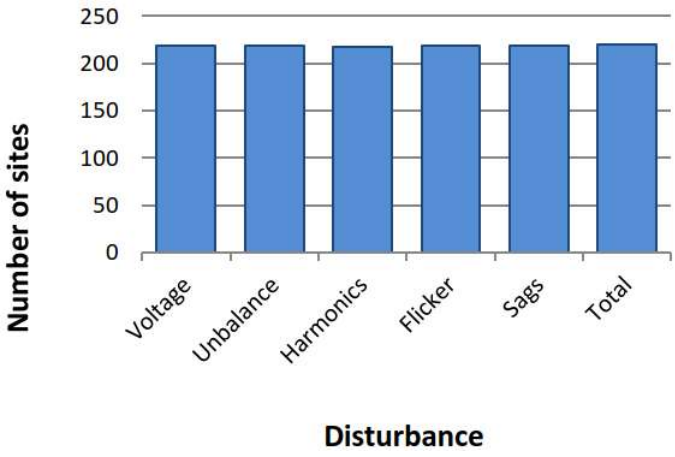
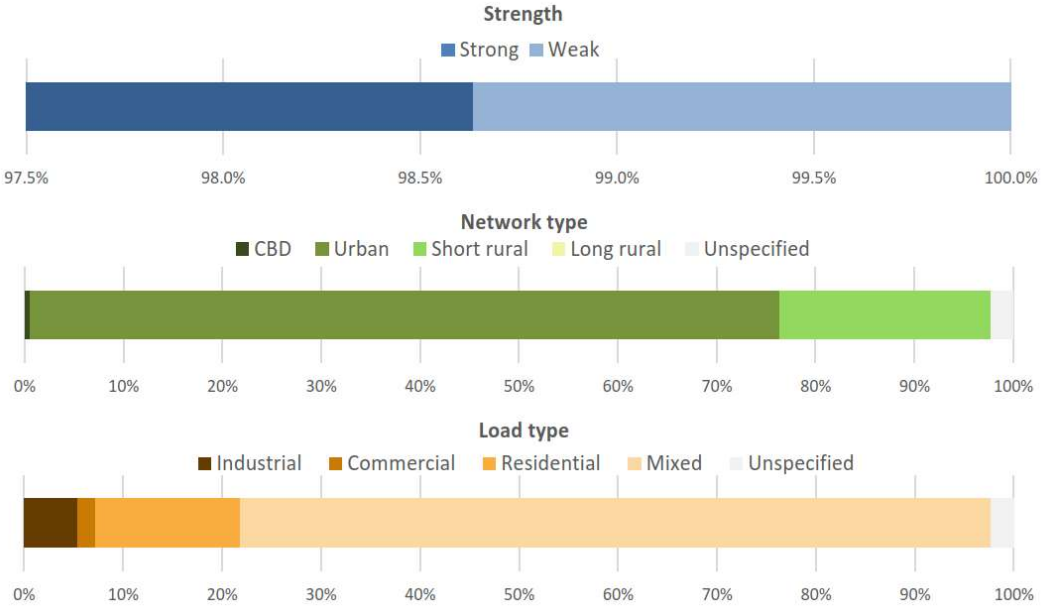


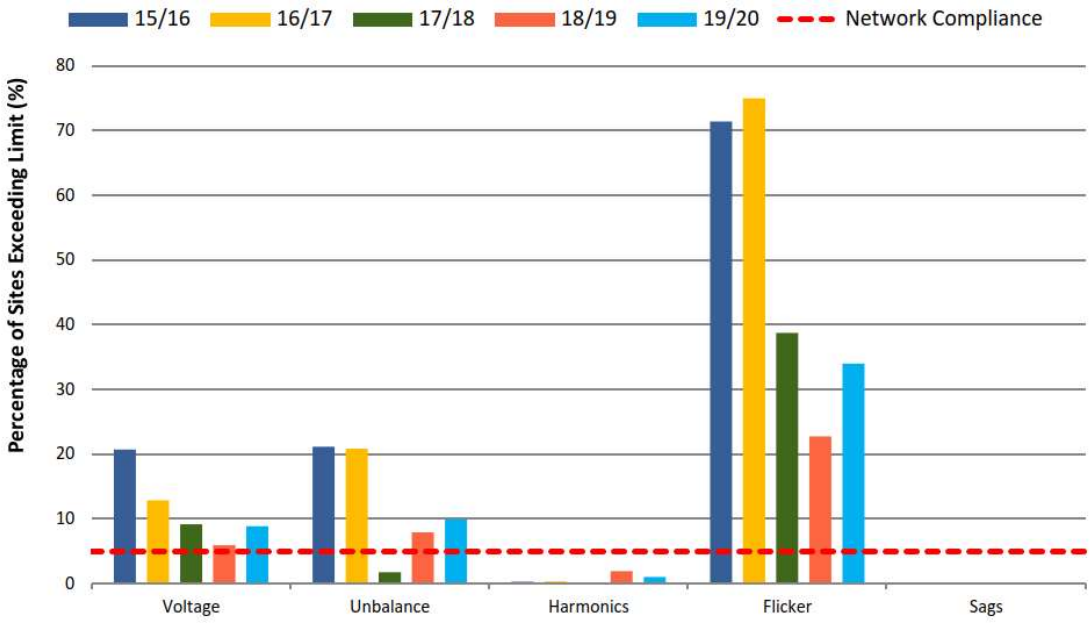
Figure 12: Distribution of the classification of relative electrical strength of sites (HV) based on the relative fault level at the measurement point compared to the zone substation



The results of the Power Quality Compliance Audit of Endeavour Energy's network in 2019/20 for the low voltage network are shown in Figure 13 and for the medium voltage network in Figure 14.

Network Performance

Figure 13: Power Quality – Measured LV Network Compliance

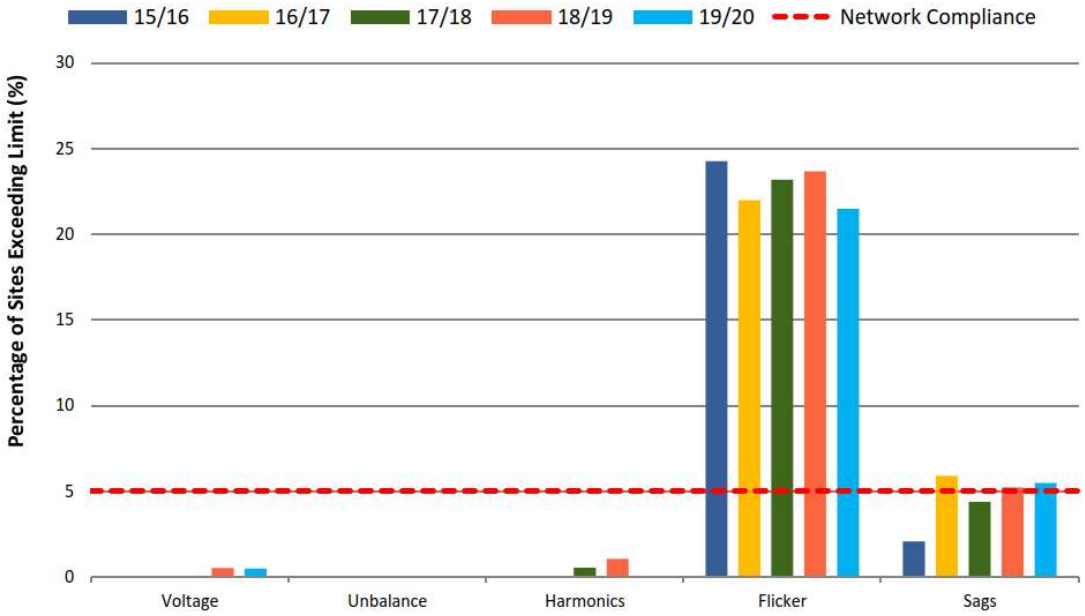


Endeavour Energy's steady state voltage V99 (upper limit) performance exceeded the compliance limits for some 8% of sites in 2019/20. After a continued improvement trend, the voltage compliance deteriorated likely due to significant uptake in solar PV. Results year on year are also affected by available measurement data which does not stay consistent every year. Endeavour Energy continues to pursue cost effective approaches to lowering voltage levels to better align with the allowable voltage range. These approaches include the adjustment of voltage float settings at zone substations and the re-tapping of distribution transformers where appropriate. Over a third of zone substations have had target voltage adjustments to date, primarily during 2015/16 and 2017/18. This is expected to continue to significantly improve voltage compliance levels and continues to allow for greater levels of distributed PV and battery systems to be accommodated on the network.

Flicker on Endeavour Energy's network is primarily influence by large fluctuating loads such as a large arc-furnace located in Western Sydney. Historically however, these high flicker levels have not led to any significant customer complaints relating to perceptible light flicker or other disturbance of equipment. Furthermore, due to very limited measurement points of flicker on the LV network the above historical results are not considered representative of network wide performance.

Harmonics (THD) and voltage sags are both within accepted network compliance limits.

Figure 14: Power Quality – Measured MV Network Compliance



Endeavour Energy's performance at the medium voltage level (also referred to as "HV") is compliant for voltage, unbalance and harmonic distortion (THD).

Flicker exceed limits at 21% of sites, however, as noted above, these results are influenced by a large arc-furnace load in Western Sydney. These flicker levels have not led to any significant customer complaints in the past.

5.3 Other Factors Affecting Network Performance

5.3.1 Fault Levels

Fault levels in the network are controlled primarily by managing the number of network elements (lines and transformers as well as local generation) which are in service in parallel at any given time. Fault levels across the network are studied on a regular basis, including during planning for the establishment of new or augmented or redeveloped network elements and for the connection of new load or generation. These studies inform the management of network configuration to ensure that the fault ratings of the affected network element are not exceeded. Alternatively, these studies identify the requirement to upgrade elements to appropriate fault ratings.

Further, Endeavour Energy participates in regular joint planning exercises with TransGrid to ensure that any effect on Endeavour Energy's network by changes in the fault level within TransGrid's network are understood allowing solutions to be developed in an efficient and timely manner.

The majority of new generation connecting to Endeavour Energy's network in recent years has been rooftop solar photovoltaics (PV) connected through an inverter. Solar PV does not contribute to fault currents beyond the rating of the inverter and therefore does not generally contribute to fault rating exceedance of network equipment. Furthermore, detailed assessment of the impacts of embedded synchronous generation is undertaken as a matter of course as part of the connection process.

5.3.2 Voltage Levels

Voltage levels are managed primarily through appropriate network design and operational configuration.

The voltages within the sub-transmission and HV distribution networks are managed by local control routines in the SCADA systems controlling the on-load tap-changers on the transformers in transmission and zone substation. Taps on distribution transformers are fixed at levels selected on the basis of typical voltage drops on the type of LV network being supplied as well as the HV distribution feeder regulation and supplying zone substation voltage regulation characteristics.

In certain situations, load growth in weaker parts of the network can lead to complaints of low voltage. This has traditionally been resolved by adjusting the distribution transformer tap setting to the upper end of the voltage range.

In recent years however, the proliferation of solar PV has reduced daytime demand significantly and, in some cases, reversed power flows which has contributed to voltages outside of the standard range. As a result, complaints of high voltage have now become more significant that complaints of low voltage.

Endeavour Energy is actively managing this issue through the assessment of clustered customer complaints data, available smart meter data and load flow voltage studies to better align zone substation target voltage and distribution transformer tap settings to improve voltage compliance and improve voltage headroom to accommodate solar PV. In addition to this, Endeavour Energy has completed a trial of low voltage static compensator (STATCOM) technology as a lower cost flexible alternative to LV network augmentation in certain scenarios to improve voltage compliance and solar hosting capacity.

5.3.3 Power System Security

Power system security requirements are defined in the National Electricity Rules. The need to comply with these requirements may result in a need to invest in the network. Examples of these requirements include obligations to implement under-frequency load shedding, to operate within prescribed limits for the 132kV network and to comply with critical clearance times to maintain power system stability.

Where these issues arise, they are managed through the joint planning process with TransGrid, outlined in Section 7.1

5.3.4 Ageing and Potentially Unreliable Assets

There are a numerous projects and programs that are being undertaken or are proposed to be undertaken during the forward planning period that retire assets that have reached the end of their serviceable life. Details of these projects and programs are provided in Section 9.6.

Demand Forecasts For The Forward Planning Period

6. Demand Forecasts For The Forward Planning Period

The Endeavour Energy transmission and zone substation peak demand forecasts are provided in the DAPR Mapping Portal https://dapr.endeavourenergy.com.au, covering the peak demand forecast by season for the 2020 – 2024 period. The peak demand forecasts provide Endeavour Energy with the basis for identifying network limitations and commencing the RIT-D process to identify and evaluate the credible network and non-network options to address those limitations. They also feed into the Portfolio Investment Plan (PIP) which documents the capital and operating investment expected to be required for a rolling ten-year period.

Growth in peak demand is a key driver of network-capability related capital investment. In the previous decade the growth in demand was fundamentally driven by an increase in residential, commercial and industrial development areas within the priority growth areas of Western Sydney and the Illawarra. It may also be a driver for asset renewal investment.

In recent years the penetration of air-conditioning appears to have reached saturation point in some areas of our network. As a consequence, peak demand growth from existing connections no longer presents a significant driver of network expenditure. Furthermore, demand in recent years has seen a decline due to the effect of energy efficiency measures, the roll-out of roof-mounted photovoltaic systems and reductions in the demand from large industrial customers. It is further expected the energy efficiency measures and the installation of photovoltaic systems, coupled with the forecast increase in battery installations, will continue to influence a reduction in demand over the forecast horizon for established areas.

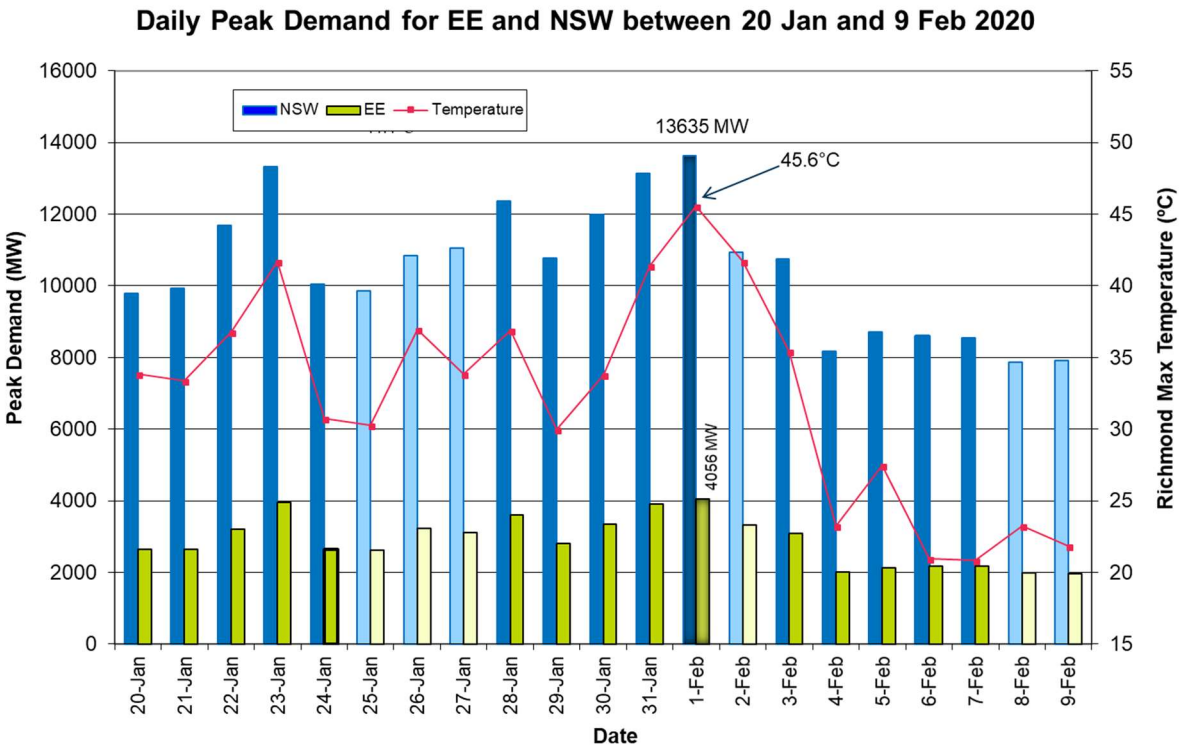
Demand growth is primarily concentrated in North-West and South-West Sectors of Western Sydney. Widely regarded as the fastest-growing corridor in the state, priority growth areas in Western Sydney are expected to accommodate up to 480,000 new dwellings and land for employment for around 1,000,000 new residents over the next 25 to 30 years. Strong economic growth is expected in the growth centres over the forecast period, with a series of major transport, health and education projects planned for the region. Development of Sydney's second airport at Badgerys Creek has commenced and will drive further demand growth in the years to come. The North West Rail Link has also created new high density residential and commercial development in the North-West Growth Sector.

The Endeavour Energy Network total demands for the 2020 summer peaked at 4,056 MW at 17:30 pm on 1 Feb 2020 (Saturday) while the maximum temperature at Richmond recorded 45.6 ºC on that day. This was the second highest daily maximum temperature recorded at Richmond for the 2019/20 summer. The hottest day for the summer was on 4 January 2020 (Saturday). The maximum temperature reached 46.6^{O}C with the peak demand reaching 3,570 MW.

Figure 15 shows the time series of the daily maximum temperatures at Richmond and the peak demands on the Endeavour Energy network and NSW during the 2020 summer peak demand period. The maximum NSW daily peak demand for the 2019/20 summer occurred on the second hottest day of 1 Feb 2020.

Demand Forecasts For The Forward Planning Period

Figure 15: Daily Peak Demand for Endeavour Energy and NSW Between 20 Jan and 9 Feb 2020



Note: Peak demand during non-working days are shown in lighter colours.

6.1 Forecasting Methodology

Peak demand forecasts are prepared for both the summer and winter season. Summer is defined as the five-month period between November and March while winter consists of the four-month period from May to August. The forecast method is based on a bottom-up approach and provides maximum MVA, MW and MVAr loads and the power factor expected for the summer and winter peak periods.

The forecasts are prepared for each zone substation and major customer substation, each transmission substation and TransGrid's Bulk Supply Points (BSPs) that supply the Endeavour Energy network. The total Endeavour Energy network peak demand is also forecast.

The forecasts consider planned load transfers, expected spot loads, land release developments and re-developments in the area under consideration. Loads supplied by generation embedded in the network are also incorporated into the calculation of the maximum demand forecasts.

Historical and forecast peak demands at the Endeavour Energy total, bulk supply point, transmission substation and zone substation levels are corrected to normalised figures that represent a specific weather

condition. Temperature Corrected Maximum Demand (TCMD) is the estimate of the likely peak demand that could be expected in the reference conditions with 10% and 50% Probability of Exceedance (PoE).

Weather correction is applied to the peak demands at substations where there is a strong relationship between demand and temperature. Summer demands at zone substations in the Blue Mountains and demands of all high voltage customers are not subject to any weather normalisation. However, the Blue Mountains substations are subject to weather normalisation for winter peak demands.

A weather normalisation methodology based on a simulation approach is used to normalise peak demand forecasts for Endeavour Energy's network area. Two reference weather stations are employed for temperature correction of the maximum demand for summer. A weather station at Nowra is used for the South Coast area which covers the Dapto BSP Region and the Richmond weather station is used for the remainder of the network. The temperature correction method utilises two steps:

- Development and updating of a regression model for estimating the relationship between demand, weather and periodic pattern (calendar effects) of demand; and
- Simulation of the demand using multi-years of historical weather data to produce 10% and 50% normalised demand values.

For the summer peak, the regression model uses the most recent six years of daily maximum demand and temperature values to determine the relationship between demand, weather and periodic patterns of demand. Various input parameters are employed in the model. Day-of-the-week variables account for the difference between the daily peak by day of the week and by workday/non-workday. A set of holiday variables are included to describe the load reductions associated with holiday periods. Separate variables are used for special days such as: New Year's Day, Australia Day, and Christmas Day. In addition, a school holiday variable captures the reduced loads which occur in residential Western Sydney during the school holiday period in December and January and the commensurate increase in demand seen in some south coast zone substations during the same period. Monthly and bi-monthly variables capture the key seasonal demand variations. Year variables describe the changes in base load level for each year. Previous hot day effect variables are also included to explain the impacts of successive hot days on the daily peak demand.

From the regression model, daily demands are estimated using 24 years of daily weather data available from the reference weather stations. Annual seasonal maximum demands are derived from the calculated daily demands. The 10% and 50% demand values are computed from the distribution of annual seasonal maximum demands to give the 10% and 50% PoE TCMD values. The TCMD values for the latest year are the starting points for the peak demand forecasts.

The peak demand forecast considers the growth or decline from the existing customers as well as the new customer connections. The forecasting process has two major steps:

- Incorporating the network planner's inputs into the base level forecast.

The inputs include new developments planned to occur (lot releases), new load increases expected from customer applications (spot loads) and information regarding the transfer of load between zone or sub-transmission substations (load transfers).

- Applying post model adjustments (PMA).

PMAs are applied to each year of the forecast for each zone substation based on the zone substation's residential, commercial and industrial customer mix and its peak demand for the season. PMAs are designed and used to capture future changes in the peak demand resulting from solar generation, battery energy storage, electric vehicles and from different state and national energy policies/programs, such as the Minimum Energy Performance Standards (MEPS), NSW Energy Savings Scheme (ESS) and changes to the building code.

The final forecasts for all zone substations are reviewed for consistency with expected demand growth based on local knowledge of load transfers, embedded generation, proposed spot-loads and lot release information.

The forecast at transmission substations and bulk supply points is based on the rolled-up zone substation forecast and calculated using the corresponding historical diversity factors.

The diversity factor is considered to be the ratio between the summation of the individual peak demands of the lower level substations and compared to the measured peak demand of the higher-level substation for the same period.

6.2 Forecast Input Information Sources

Demand and temperature data is sourced from Endeavour Energy's Network Load History (NLH) and Historian databases. Data from the SCADA system is used as a substitute where gaps existed in the metering data available from NLH or Historian. Where neither metering nor SCADA data is available, the measured current flow read from the current transformers on individual circuit breakers are used.

6.3 Assumptions Applied to Forecasts

The following probability of exceedance (PoE) parameters have been adopted:

- 1 in 10-year event (corresponding to 10% PoE); and
- 1 in 2-year event (corresponding to 50% PoE).

A 10% PoE figure is estimated to be exceeded once in every ten seasons on average whilst a 50% PoE figure is likely to be exceeded every two years on average.

The installed and firm capacity of each substation and the capacity of the sub-transmission system are shown in the forecast tables are indicated by a single figure. This figure is the summer rating for the sub-transmission system and each substation.

The determination of the load transfer capability for each substation involves the analysis of individual distribution feeders and their ability to carry additional load after network switching occurs. Consequently,

this is only performed for substations that are experiencing limitations and may need to be offloaded. The analysis involves determining the load that could potentially be transferred away from the constrained network on a permanent basis.

6.4 Demand Forecast

The capacity, forecast demand and any network limitation on each of the transmission and zone substations on the Endeavour Energy network and on the associated sub-transmission networks are listed in the DAPR Mapping Portal https://dapr.endeavourenergy.com.au. The RIT-D level identified network needs are summarised in Table 6 and Table 7 in the DAPR report.

Limitations are referenced to the design level of supply security at each substation. In general Endeavour Energy assesses its network capability on the basis of providing an "N-1" level of supply security at the sub-transmission and zone-substation level, however small or temporary substations may operate in a non-secure manner and these are marked as limited to N. Generally, these have maximum demands of less than 10 MVA. This approach serves to identify preferred future network development options should future limitations be unable to be mitigated through Demand Management initiatives. The actual investment timing is confirmed through a probabilistic assessment of the network risk and the optimisation of the economic benefits of any proposed development.

The substation total (installed) capacity is the maximum load able to be carried by the substation with all elements in service. The secure capacity of a substation is the capacity with one major element (such as a power transformer or sub-transmission feeder) out of service. This is often referred to as its "Firm" or N-1 rating.

Transmission substations are considered to be constrained when the load exceeds the secure capacity. Suburban zone substations are considered to be constrained when the demand exceeds the firm capacity which is the trigger point for commencing investigations for cost-effective options to address the limitation. The exception are substations whose rating is limited by underground feeders or where exceeding secure capacity will result in the thermal rating of apparatus being exceeded in its normal configuration. In these situations, the load may not exceed the secure capacity of the substation for any period of time.

The voltage levels of Endeavour Energy's sub-transmission substations (termed "Transmission substations") are nominally 132kV on the primary and either 66kV or 33kV on the secondary. The voltage levels of Endeavour Energy zone substations are nominally 132kV, 66kV or 33kV on the primary and 22kV or 11kV on the secondary.

The forecast is prepared following the end of each peak season. The zone substation rating changes have only been included where the associated project(s) which are influencing the rating have been given approval and are committed at the date of preparation of the forecast.

The forecast power factor readings correspond to the power factor at time of peak load. A dash in this field indicates that the particular transformer was either not commissioned at the time of measurement or is normally unloaded.

Demand Forecasts For The Forward Planning Period

Forecast demands for the sub-transmission feeder network are based on its 'N' rating, summer or winter, and the 'N-1' loading, that is, the worst condition load that would appear on the feeder with an adjacent feeder out of service compared to the thermal rating of the smallest conductor or cable on that feeder.

The '95% Peak Load Exceeded (hours)' figure in the Transformer Rating and Substation Details table represents the number of hours the load is above the 95% level of actual peak demand. It is an indication of how peaky the load profile is which is important for designing an effective non-network option.

The 'Actual (MVA)' figure that appears in the summer and winter demand forecast tables is not temperature corrected. It is the actual recorded load. The forecast loads are based on temperature corrected actuals.

The 'Embedded Generation' figure that appears in the Transformer Rating and Substation Details table provides the estimated aggregate level of embedded generation connection to the network supplied from that substation. It includes residential and commercial PV and customer generation. Customer details are withheld for privacy reasons.

The summer 2020 refers to the 2019/20 summer.

The transmission-distribution connection points are termed Bulk Supply Points (BSP) and are owned by TransGrid, the NSW transmission company.

Endeavour Energy evaluates the capability of its sub-transmission network on the basis of load flows modelling different contingencies and network operating configurations. The sub-transmission forecast tables in this document are desktop estimates derived from zone substation load forecasts and are based on an assumed operating configuration and on the present-day network. The loads presented are indicative of the load on the stated feeder in the event of the most likely contingency. Hence, the sub-transmission forecast tables should therefore be treated as indicative loading data in the event of a credible contingency event.

6.5 Analysis and Explanation of Forecast Changes

There have been minor changes occurring within the customer groups that has an effect on demand on the network and the demand forecast. These include:

- An increase in the projects for residential lot releases in greenfield priority growth areas. More details can be found in the Endeavour Energy Growth Servicing Plan available on our website https://www.endeavourenergy.com.au;
- An increased focus on redevelopment of existing areas especially along rail corridors; and
- The Western Sydney Aerotropolis showing increased load growth from 2021 onwards.

Certain areas in the priority growth areas have accelerated their lot release projections as well as densities resulting in increased levels of demand growth. However, all lot release projections are diversified to account for the lag in housing development.

Demand Forecasts For The Forward Planning Period

A review of established industrial areas has identified a stabilisation in the decline in demand in those areas. This trend will be closely monitored over the coming years to determine if growth in demand in these established industrial areas re-emerges.

7. Planning Coordination

7.1 Joint Planning with TransGrid

Joint planning is carried with TransGrid on a biannual basis or as required. Agreed actions are minuted and action plans developed by each company as required.

Areas where network limitations and/or network developments affect the electricity networks of Endeavour Energy jointly with TransGrid are discussed below.

7.1.1 Process and Methodology

Endeavour Energy confers with TransGrid on technical matters relating to Endeavour Energy's connections with TransGrid at bulk supply points (TransGrid connection points). These matters include:

- Forecast loads for all BSPs supplying Endeavour Energy's network;
- Supply capability at all BSPs supplying Endeavour Energy's network;
- Exchange of system modelling data;
- Coordination of loading requirements on individual BSPs and across other BSPs;
- New BSP requirements and connection arrangements;
- Coordination of communication, protection and control requirements; and
- Coordination of other operational requirements.

Clause 5.14.1 of the NER sets out the planning process and consultation requirements and includes requirements on forecasting, annual reviews, regulatory tests and consultations. The principal inputs to the planning process are:

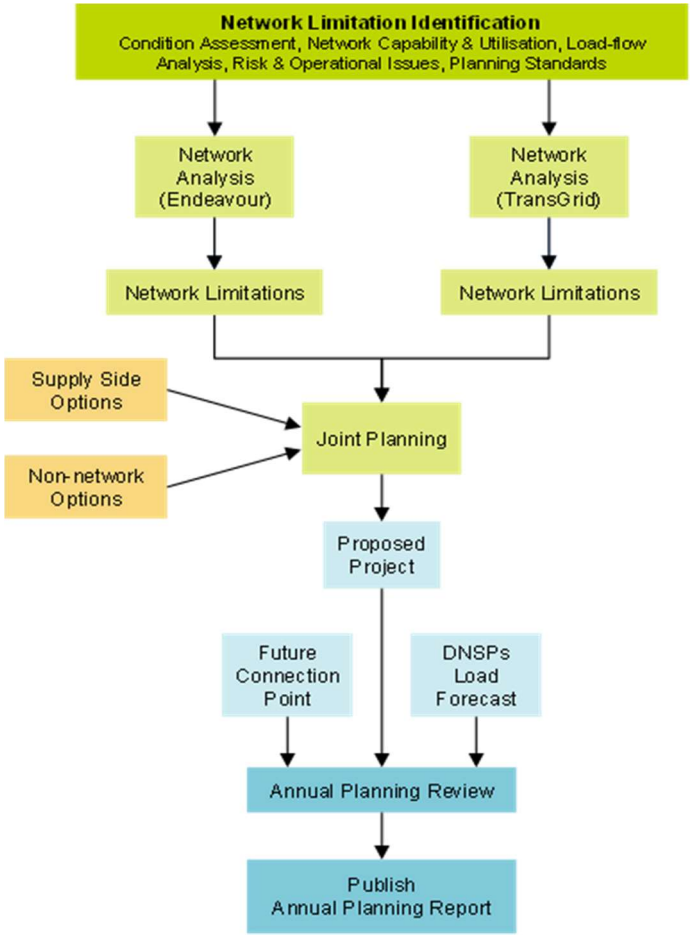
- DNSP supply point load forecasts;
- Review of network capacity and utilisation;
- Planning criteria and indicators;
- Condition, operational and risk assessments;
- Transmission network load-flow analysis; and

Identified Network Needs

- TransGrid planning reviews.

The relationship between the various elements in the planning process is shown in Figure 16.

Figure 16: Joint planning process with TransGrid



Note that Endeavour Energy does not have any assets that are classed as “dual function assets” under the NER.

7.1.2 Overview of Bulk Supply Investments

7.1.2.1 Vineyard 132kV Switchbay (Box Hill Supply)

A project requiring a switchbay at Vineyard Bulk Supply Point for supply to Box Hill is required by 2022.

7.1.2.2 Macarthur 66kV Switchbay (Menangle Park Supply)

A 66kV switchbay required at Macarthur Bulk Supply Point has been built by TransGrid to supply the proposed Menangle Park Zone substation.

7.1.2.3 Macarthur 66kV Switchbay (Mt Gilead Supply)

A 66kV switchbay will be required at Macarthur Bulk Supply Point to supply the proposed Mt Gilead Zone Substation by 2025. The project is development driven.

7.1.2.4 Sydney West Switchbay for South Erskine Park Zone Substation

Endeavour Energy has submitted a formal request for provision of one 132kV switchbay at Sydney West Bulk Supply Point to connect the proposed South Erskine Park Zone Substation which is under construction.

7.1.2.5 Sydney West Switchbay for Large Customer Supplies

Endeavour Energy has submitted a formal request for provision of two further 132kV switchbays at Sydney West Bulk Supply Point to facilitate connections to a number of large customers.

7.1.2.6 Macarthur 66kV BSP Augment

RIT consultation for the second Macarthur 330 kV/66 kV transformer has now been completed by TransGrid. This is an existing constraint and it is expected that TransGrid will deliver on this project by 2022.

7.1.2.7 Bulk Supply Point for Western Sydney Priority Growth Area

Joint Planning discussions are underway with TransGrid to determine the feasibility of a bulk supply point to service the Aerotropolis development area. A solution under consideration is turning the existing TransGrid 500/330 kV substation into a 132kV bulk supply point. The timing for this will be determined by future load growth on existing bulk supply points. Joint planning has determined that the timing for the new bulk supply point is likely to be within both TransGrid's and Endeavour Energy's next regulatory periods.

7.1.2.8 Other Future Investments

Discussions are continuing with TransGrid in relation to:

- Timing for the augmentation of Macarthur 132kV BSP with the augmentation of a second 330/132kV transformer. A joint planning project will be developed when this is required; and
- Joint Planning investigations are underway with TransGrid to recommence the deferred Tomerong Bulk Supply point project due to emerging constraints in the South Coast supply network. Joint Planning investigations are underway to address constraints on TransGrid's network under certain outage scenarios that will impose voltage constraints at Vineyard Bulk Supply Point.

Endeavour Energy and TransGrid have formalised the joint planning arrangements between the two companies. The joint planning arrangements have been expanded to include an executive steering committee as well as the current working group.

Identified Network Needs

7.2 Joint Planning with Other DNSPs

Joint planning between Endeavour Energy and Ausgrid and Endeavour Energy and Essential Energy follow the same principles as applied to the joint planning process with TransGrid. However, due to the limited number of dependencies between the companies' networks, joint planning meetings are generally conducted on a needs basis.

7.2.1 Process and Methodology

Formal joint planning meetings between the planning groups of the companies form the basis of the joint planning process as per the planning process with TransGrid.

7.2.2 Joint DNSP Planning Completed in Preceding Year

Endeavour Energy did not conduct formal joint planning meetings with Ausgrid during the year. However, planning was conducted in relation to a joint planning project which is in the process of connecting two of Ausgrid's zone substations to Endeavour Energy's Camellia sub-transmission substation.

Endeavour Energy conducted joint planning with Essential Energy in relation to a proposed 132kV feeder renewal project. The 132kV feeder provides supply to Essential Energy's network in the far South Coast.

Endeavour Energy commenced joint planning with Sydney Trains mainly in relation to supply issues in the Blue Mountains area.

7.2.3 Planned DNSP Joint Network Investments

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

7.3 Demand Management Process

The National Electricity Rules (NER) requires Distribution Network Service Providers (DNSP) to investigate non-network options by utilising a thorough consultation process as part of the planning for major network investments. The NER requires a Regulatory Investment Test for Distribution (RIT-D) process to be used in identifying the most cost-effective solution to address the network need for all projects where the highest cost credible option exceeds $6 million. These network investment projects are classified as RIT-D projects. This provides the opportunity for all interested parties and the community to submit options, ideas and comments allowing for the development of cost effective demand management and other system support non-network options.

Endeavour Energy conducts a planning review of the network on an annual basis to identify emerging network limitations and to identify opportunities for non-network solutions which could effectively manage demand and defer or avoid network investment created by demand growth or network asset retirement.

As part of the RIT-D process, the timing of the network limitation and the level of demand reduction required to address the limitation as well as credible options are assessed.

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Network options are developed to determine if the estimated cost of the highest cost credible option is above $6 million in which case the project is classified as a RIT-D project. The network limitation is then screened to identify if a non-network option is feasible. If a non-network option is deemed feasible then a non-network option investigation consultation process is conducted. The goal of this process is to obtain all alternative options and to identify the most cost-effective solution that meets the required standards for network security and reliability.

The non-network option investigation process is comprised of six separate stages:

- A planning review to identify the emerging network limitations and credible network options;
- Screening for feasible non-network options;
- Issue of a Non-Network Options Report as part of the community consultation process to obtain proposals for alternative options from interested parties where a demand management approach appears to be feasible;
- Evaluation of submissions to identify the most cost-effective credible non-network option;
- A RIT-D evaluation on all credible options to identify the most cost-effective option or combination of options; and
- Negotiations with proponents of the successful proposal to implement the program if a non-network option is identified as the most cost-effective option.

All parties registered on Endeavour Energy's register of interested parties are notified when a Screening Report or a Non-Network Options Report is issued.

Identified Network Needs

8. Identified Network Needs

A key element of the planning process is the determination of network limitations through:

- Network analysis using the latest demand forecasts to identify upcoming network capacity or supply security limitations; and
- Asset condition or performance assessments to identify assets approaching their end-of-life.

The Replacement Expenditure Planning Arrangements rule change, commencing 1 January 2018, requires DNSPs to evaluate retirement and de-rating projects using the RIT-D process together with augmentation projects.

The process identifies whether a corrective action is required to address the network need. A network need is declared to be a 'RIT-D project' if there is sufficient evidence that the network need will be realised within the time required to initiate corrective action. If action is required, the RIT-D process is initiated if the most expensive feasible remediation option exceeds the RIT-D trigger threshold (currently $6 million). Endeavour Energy will then proceed with a RIT-D process to determine the most cost-effective solution to address the network limitation.

Projects that do not meet the RIT-D criteria also undergo analysis to identify credible network and non-network options using a similar but less formal process.

Those projects identified as being subject to the RIT-D process are outlined in Table 6 and Table 7 given in Section 8.2.

The National Electricity Rules requires DNSPs to investigate non-network options through a market-based approach as detailed in the RIT-D investigation process. This forms an integral part of Endeavour Energy's planning process for major network investment proposals. This process provides opportunity for interested parties and the community to submit concepts and ideas for the development of cost-effective demand management and other non-network system support options.

The RIT-D process requires a 'screening test' to be performed for all RIT-D projects to determine if a non-network option is feasible and should be investigated further. If the screening test determines that a non-network option is feasible, Endeavour Energy will conduct a detailed investigation to determine the objective and targets for a non-network option to be successful and publish this information in a Non-Network Options Report. The publication of this report forms part of the procurement process whereby Endeavour Energy invites interested stakeholders to make submissions for non-network options to be evaluated against network options. It also provides instructions on how to make a submission.

Whilst not required under the National Electricity Rules, non-network option investigations are also conducted for selected projects that do not meet the RIT-D trigger threshold. An alternative demand management investigation process (such as an in-house investigation) may be adopted to identify a suitable non-network option for these projects, or the formal RIT-D process may be used if considered appropriate. An in-house demand management investigation is generally adopted where there are a few major customers within the constraint area that could provide the demand reduction required to cost effectively defer or avoid the identified network need.

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Projects that do not meet the RIT-D criteria and that will be investigated for non-network options are listed in Table 9.

Future network limitations have also been identified as those that are beyond the 5-year planning horizon. They may also be heavily dependent on forecast load growth and the proposed greenfield development proceeding before the network limitation is realised. These limitations will be investigated when demand growth and network limitations are more certain and may develop into RIT-D projects if the RIT-D criteria are met. Future needs are listed in Table 11.

Details of projects which Endeavour Energy expects to commence within the next 5 years are discussed in Section 8.2. Projects that do not meet the RIT-D criteria are discussed in Section 8.3 and future projects are discussed in Section 8.4.

8.1 Notes on Indicative Network Solutions

The following notes shown in Table 5 below provide an explanation of the terms used in the Identified System Limitations tables in Sections 8.2, 8.3 and 8.4 below.

Table 5: Terms Used in Identified Network Needs

Term	Definition
Critical Season	The season of most critical peak demand (summer or winter) in terms of network limitation.
Existing Capacity (firm)	The firm capacity that the network element can supply with one element of redundancy available. In the case of the 11kV network it is the firm capacity whilst preserving the appropriate level of backup.
Demand Forecast	The following year forecast of peak demand for the most critical season.
Capacity Limitation Rating Reached	Indicates that the load at risk has reached unacceptable limits being either cyclic or emergency rating exceeded or the expected energy at risk is above acceptable limits in the following year.
Need Date	Indicates when both the firm rating of the network supplying the load (F) and its corresponding capacity limitation rating (C) is exceeded.
RIT-D Start Date	The year in which Endeavour Energy anticipates options investigation to commence. Investment decisions can take up to 3 years to finalise agreements and regulatory approvals. Given this, RIT-D start is timed to meet capacity limitations.
Load Transfer Potential	The load in MVA that could potentially be transferred away from the constrained network, through the existing network, on a permanent basis. This analysis is performed for constrained assets only.

Identified Network Needs

Term	Definition
Required Load Reduction	The required level of load reduction to achieve a one-year deferral of the network limitation.
Potential Solutions	The currently identified credible options to resolve the network limitation including network and non-network solutions (subject to public consultation or a feasibility review).
Asset Retirement	The removal of an asset from service due to the asset reaching its end of life or a condition where the asset can no longer service the network due to performance or safety risks.

8.2 RIT-D Investigations

This section presents the RIT-D augmentation and replacement projects in the 5-year planning horizon that Endeavour Energy will investigate. Endeavour Energy reviews its network needs annually and the dates shown below may be adjusted from year to year as the underlying customer demand and network need change over time..

Listed in Table 6 are the identified Augmentation RIT-D projects and Table 7 details the Retirement or De-Rating RIT-D Projects. A screening test is required for each of these projects to determine the potential for non-network solutions. Where the capacity limitation date has already been reached the project has a risk adjusted optimal timing economic analysis for a later network option.

Table 6: Identified Network Need – Augmentation RIT-D Projects

RIT-D Project Name	Critical Season	Existing Capacity (firm) (MVA)	2021/22 Demand Forecast (MVA)	Capacity Limitation Rating Reached	Limitation Date	RIT-D Start Date	Load Transfer Potential (MVA)	Required Load Reduction (MVA)	Potential Solutions
Southern Macarthur 66kV PR113	S	60.0	95.0	Yes	(F) Nov 18 (C) Nov 18	Feb 2021	0	35.0	1. DM 2. New Feeder
Box Hill ZS PR713	S	23.0	20.0	No	(F) Nov 23 (C) Nov 23	Feb 2020	0	7.6	1. DM 2. New ZS
Aerotropolis 132kV Supply PR741	S	7.0	3.0	No	(F) Nov 23 (C) Nov 23	Nov 2020	7.0	10.0	1. DM 2. New Feeder

Identified Network Needs

RIT-D Project Name	Critical Season	Existing Capacity (firm) (MVA)	2021/22 Demand Forecast (MVA)	Capacity Limitation Rating Reached	Limitation Date	RIT-D Start Date	Load Transfer Potential (MVA)	Required Load Reduction (MVA)	Potential Solutions
Westmead ZS PR754	S	35.0	27.0	No	(F) Nov 23 (C) Nov 23	Nov 2020	0	8.0	1. DM 2. Augment ZS
Science Park ZS PR723	S	8.0*	15.0	No	(F) Nov 23 (C) Nov 23	Nov 2020	2.0	5.0	1. DM 2. New ZS
Aerotropolis ZS PR439	S	2.0	0	No	(F) Nov 23 (C) Nov 23	Feb 2021	0	5.0	1. DM 2. New ZS
West Dapto ZS PR620	S	5.0*	7.0	No	(F) Nov 23 (C) Nov 23	Feb 2021	0	5.0	1. DM 2. New ZS
Riverstone East ZS PR700	S	95.0*	86.0	No	(F) Nov 24 (C) Nov 24	Nov 2021	0	15.0	1. DM 2. New ZS
Northern Gateway ZS PR790	S	2.0	3.0	No	(F) Nov 25 (C) Nov 25	Jul 2022	0	16.0	1. DM 2. New ZS
Western Sydney Employment Lands PR728	S	8.0	4.0	No	(F) Nov 25 (C) Nov 25	Oct 2021	0	5.0	1. DM 2. New ZS
North Bomaderry ZS/TS PR742	S	3.0*	1.0	No	(F) Nov 26 (C) Nov 26	Feb 2023	0	5.0	1. DM 2. New ZS

* Based on the existing distribution system back- up capacity.

Identified Network Needs

Table 7: Identified Network Need – Retirement or Derating projects

RIT-D Project Name	Existing Capacity (firm) (MVA)	2021 Demand Forecast (MVA)	Retirement or De-Rating Date	Original Retirement or De-Rating Date	RIT-D Start Date	Retirement or De-Rating Details
Carlingford TS	360.0	200.0	2023	2022	Feb 2021	End of life of the control building and associated protection and control equipment.
Parramatta area 132kV oil insulated cables	NA	NA	2025	2028	Feb 2022	End of life of multiple aged oil filled cables 9J8, 22U, 22W, 226, 228 and 233.
Steel Towers on 33kV Feeder 7028	44.4	21.2	2023	2023	Feb 2021	Engineering assessment in progress on optimal timing and possible replacement options.

Table 8 provides detail of the RIT-D process timeline for each augmentation and retirement/de-rating project. Additional details for these RIT-D projects are provided in the DAPR Mapping Portal https://dapr.endeavourenergy.com.au.

Details are provided for each identified project including the constraint driver and the areas where demand reduction opportunities may exist. The time frame over which a non-network investigation and program implementation would be expected to operate to successfully address the network limitation is provided.

If a screening test identifies that a non-network option is feasible then Endeavour Energy will issue a Non-Network Options Report. All registered participants on Endeavour Energy's register of interested parties will be notified of the release of the document.

If a screening test identifies that non-network options are not feasible, Endeavour Energy will publish a notice of the screening result on its website and all registered participants will be notified.

Table 8: RIT-D Projects Timetable

RIT-D Project Name	Constraint Driver	Timetable		Constraint
RIT-D Augmentation Projects				
Southern Macarthur 66kV PR113	Major customer development and residential load growth exceeding capacity of transmission feeder under outage conditions. (Summer seasonal constraint only)	Investigate Results Decision	Feb 2021 Aug2021 Oct 2021	Nov 2018

Identified Network Needs

RIT-D Project Name	Constraint Driver	Timetable		Constraint
Box Hill ZS PR713	New residential release area - Development dependent project	Investigate Results Decision	Feb 2020 Dec 2020 Jan 2021	Nov 2023
Aerotropolis 132kV Supply PR741	Airport and major Customer development and new industrial release areas - Development dependent project	Investigate Results Decision	Jun 2020 May 2021 Jul 2021	Nov 2023
Westmead ZS PR754	Large major customer and associated health services and accommodation	Investigate Results Decision	Oct 2020 May 2021 Jul 2021	Nov 2023
Science Park ZS PR723	New industrial release area in close proximity to the airport - Development dependent project	Investigate Results Decision	Nov 2020 Apr 2021 Jul 2021	Nov 2023
Aerotropolis ZS PR439	Airport and major customer development and new industrial release areas - Development dependent project	Investigate Results Decision	Feb 2021 Jul 2021 Sep 2021	Nov 2023
West Dapto ZS PR620	New residential and commercial release area - Development dependent project	Investigate Results Decision	Feb 2021 Jun 2021 Aug 2021	Nov 2023
Riverstone East ZS PR700	New residential release area - Development dependent project	Investigate Results Decision	Jul 2021 Mar 2022 Jul 2022	Nov 2024
Maryland ZS PR423	New residential and industrial release areas - Development dependent project	Investigate Results Decision	Nov 2023 Mar 2023 Jul 2023	Nov 2026
Northern Gateway ZS PR790	New precinct in the Western Sydney Aerotropolis including residential, commercial and industrial zoning – Development dependent project	Investigate Results Decision	Jul 2022 Mar 2023 Jun 2023	Nov 2025
Western Sydney Employment Lands PR728	New Industrial release area in close proximity to the Airport - Development dependent project	Investigate Results Decision	Oct 2021 Mar 2022 Jul 2022	Nov 2025
North Bomaderry ZS/TS PR742	New residential and commercial release area - Development dependent project	Investigate Results Decision	Feb 2023 Sep 2023 Nov 2023	Nov 2026

Identified Network Needs

RIT-D Project Name	Constraint Driver	Timetable		Constraint
Berrima Junction ZS PR778	New industrial development exceeding the capacity of the existing single transformer ZS - Development dependent project	Investigate Results Decision	Jul 2022 Mar 2023 Jul 2023	Nov 2026
South Penrith ZS PR677	Major customer developments, CBD and residential medium density housing related load growth	Investigate Results Decision	Nov 2022 May 2023 Jul 2023	Nov 2026
Mt Gilead ZS PR724	New residential release area - Development dependent project	Investigate Results Decision	Oct 2022 Mar 2023 Jul 2023	Nov 2026
Catherine Park ZS PR748	New residential release area - Development dependent project	Investigate Results Decision	Nov 2023 May 2024 Jul 2024	Nov 2027
Termeil ZS PR744	Load growth in a rural coastal community driven by holiday season summer load.	Investigate Results Decision	Nov 2026 Mar 2027 Jul 2027	Nov 2030
RIT-D Retirement or De-Rating Projects				
Carlingford TS	End of life of the control building and associated protection and control equipment.	Investigate Results Decision	Feb 2021 Jul 2021 Sep 2021	Nov 2023
Parramatta area 132kV oil insulated cables TM028	End-of-life Replacement of aged oil filled cables supplying parts of the Parramatta area.	Investigate Results Decision	Feb 2022 Jul 2022 Sep 2022	Nov 2024
Steel Towers 33kV Feeder 7028	End-of-life Replacement of aged and corroded steel towers and conductors	Investigate Results Decision	Feb 2021 Jul 2021 Sep 2021	Nov 2023
West Wollongong ZS	End of life of the 11kV busbar and equipment.	Investigate Results Decision	May 2022 Sep 2022 Dec 2022	Nov 2026

Identified Network Needs

8.3 Projects That Do Not Meet the RIT-D Criteria

Endeavour Energy also seeks to investigate non-network options for network needs that are below the RIT-D trigger threshold of $6 million[1], to determine if a non-network option is feasible. These are shown in Table 9.

If a non-network investigation identifies that a demand management option is feasible for a project below the RIT-D threshold, Endeavour Energy may issue a public tender document to provide interested stakeholders and service providers the opportunity to submit proposals to address the need. All registered participants on Endeavour Energy's database of interested parties will be notified when a tender document is issued.

Alternatively, an in-house demand management investigation may be conducted to identify a suitable non-network option where it is identified that one customer or a small number of customers are able to provide sufficient demand reduction to defer or avoid network augmentation or asset replacement. The implementation of a non-network solution in these instances is negotiated directly between Endeavour Energy and the relevant customer(s). The dates associated with these projects are shown in Table 10. Endeavour Energy reviews its demand forecast annually and the dates shown below may be adjusted accordingly. For each identified constraint, details of the limitation and possible demand reduction opportunities are discussed in the DAPR Mapping Portal https://dapr.endeavourenergy.com.au.

[1]In accordance with NER cl. 5.15.3(d)(1) as amended.

Table 9: Identified Network Needs – Projects That Do Not Meet The RIT-D Criteria

RIT-D Project Name	Critical Season	Existing Capacity (firm) (MVA)	2021/22 Demand Forecast (MVA)	Capacity Limitation Rating Reached	Limitation Date	Start Date	Load Transfer Potential (MVA)	Required Load Reduction (MVA)	Potential Solutions
Augmentation Projects (Not meeting RIT-D Criteria)									
Marsden Park (Stage 2)	S	10.0	12.1	No	(F) Nov 20 (C) Nov 20	Nov 2021	0	5.0	1. DM 2. ZS augmentation
Cheriton Avenue ZS	S	45.0	32.1	No	(F) Nov 27 (C) Nov 27	Nov 2023	0	5.0	1. DM 2. ZS augmentation

Table 10: Investigation Timetable – Projects That Do Not Meet The RIT-D Criteria

Project Name	Constraint Driver	Timetable	Constraint
Marsden Park (Stage 2) PR698	Single transformer Zone Substation with load at risk in the event of transformer outage (planned & unplanned)	Investigate Nov 2020 Results Jul 2021 Decision Sep 2021	Nov 2020
Cheriton Avenue ZS PR729	Zone substation load due to exceed firm capacity in the next few years.	Investigate Nov 2023 Results Mar 2024 Decision Jul 2024	Nov 2027

8.4 Future Network Needs

Our future network needs are defined as occurring beyond the 5-year planning period and where there is uncertainty regarding the timing of the need. Such network needs may become RIT-D projects if the criteria are met and when the need is more certain due to load applications and/or subdivisions being submitted or when asset condition and end-of-life actors become more evident.

In the early stages of development applications, the proposed timing is often not firm, but the need date is estimated based on the best available information. These identified future network limitations are shown in Table 11.

Table 11: Future Network Needs

Project Name	Description	Estimated Constraint Date*
Austral ZS - PR745	New residential release area – Development dependent project	Nov 2026
Box Hill ZS (Stage 2) – PR797	New residential release area - Development dependent project	Nov 2026
Macarthur BSP Connection Works PR800	Augmentation to the connection to the BSP	Nov 2026
Nepean ZS Augmentation - PR749	New residential release area – Development dependent project	Nov 2027
Culburra Beach ZS - PR444	New residential release area – Development dependent project	Nov 2027

Identified Network Needs

Project Name	Description	Estimated Constraint Date*
Calderwood ZS (Augmentation) - PR782	New residential release area – Development dependent project	Nov 2027
Menangle Park ZS (Augmentation) PR779	New residential release area – Development dependent project (Augmentation to existing interim ZS)	Nov 2027
Tomerong BSP Connection Works PR801	Augmentation to the connection to the BSP	Nov 2027
South Gilead - PR739	New residential release area – Development dependent project	Nov 2028
Western Sydney University Employment Lands - PR746	New industrial release area – Development dependent project	Nov 2028
Collimore Park ZS - PR081	New residential and commercial release area – Development dependent project	Nov 2028
Holsworthy ZS - PR170	New residential release area – Development dependent project	Nov 2028
Bringelly ZS Augmentation - PR733	New residential release area – Development dependent project	Nov 2029
Glenfield ZS – PR768	New residential release area – Development dependent project	Nov 2029
East Wollongong ZS - PR781	New residential and commercial development – Development dependent project	Nov 2029
Second Westmead ZS – PR784	New residential and commercial development – Development dependent project	Nov 2029
Eschol Park ZS - PR190	New residential release area – Development dependent project	Nov 2030
Kemps Creek BSP Connection Works - PR752	New release area across all sectors – Development dependent project	Nov 2030
Avondale ZS - PR653	New residential release area – Development dependent project	Nov 2030

Identified Network Needs

Project Name	Description	Estimated Constraint Date*
Catherine Fields North ZS - PR435	New residential release area – Development dependent project	Nov 2030
Penrith Lakes ZS – PR249	New residential and commercial release area – Development dependent project	Nov 2030
North Rossmore ZS - PR431	New residential release area – Development dependent project	Nov 2030
Rossmore ZS - PR433	New residential release area – Development dependent project	Nov 2030

* Our RIT-D process typically commences 3 years prior to constraint date to allow sufficient time to develop economic network options and conduct the screening for non-network options including an allowance for market engagement procurement of economically efficient non-network options.

8.5 Impact on Transmission – Distribution Connection Points

Table 12 details constraints in the network which impact on the capacity of transmission – distribution connection points.

Table 12: Transmission – Distribution Connection Point Constraints

Network Constraint	Constraint Date	Impact on Transmission-Distribution Connection Point
The two Nepean TS 132/66kV transformers are overloaded for an outage on the single 330/66 kV transformer at Macarthur BSP.	Existing	This constraint limits the firm capacity of the 66kV system supplied from the single 330/66kV transformer at Macarthur BSP. This project is addressed by the project known a 'Southern Macarthur 66kV Network.
Under certain outage scenarios, TransGrid has modelled voltage issues and possible voltage collapse at Vineyard Bulk Supply Point	2023	Possible voltage collapse at Vineyard BSP for an outage of one TransGrid feeder to Vineyard BSP.
Connection of additional load overloads Feeder 9L1 and Macarthur 330/132KV transformer in contingency situations.	2026	Macarthur 330/132kV transformer will be overloaded.
Connection of major customers and additional load to Sydney West Bulk Supply Point will cause Sydney West BSP to exceed firm capacity in future	2027	Firm capacity at Sydney West exceeded, followed by installed capacity exceeded 3-4 years later.

Identified Network Needs

8.6 Primary Distribution Feeders

For any primary distribution feeders for which Endeavour Energy has prepared forecasts of maximum demands and which are currently experiencing an overload situation, or are forecast to experience an overload within the next two years, Endeavour Energy must set out:

- The location of the primary distribution feeder;
- The extent to which demand exceeds, or is forecast to exceed, 100% of the normal cyclic rating (240A) of the feeder (or a lesser percentage of the cyclic rating of the feeder where maximum utilisation factors[2] are employed), under normal conditions during summer and/or winter periods;
- The types of potential solutions that may address the constraint or forecast constraint; and
- Where an estimated reduction in forecast demand would defer the constraint for a period of 12 months, including:
  - An estimate of the year and month in which the constraint is forecast to occur;
  - A summary of the location of relevant connection points at which the estimated reduction in forecast demand would defer the constraint; and
  - The estimated reduction in demand required to defer the forecast constraint.

Options that are considered for all forecast constraints include:

- Non-network solutions;
- Augmenting the network;
- Rearranging the network by switching and load transfers; and
- Monitoring the situation if the forecast constraint is not significant.

Details of Endeavour Energy's primary distribution feeders which are currently overloaded can be located in the DAPR mapping portal https://dapr.endeavourenergy.com.au.

[2] Endeavour Energy employs a utilisation factor of 80% for the distribution feeder cables exiting a zone substation to allow 20% of the thermal rating of the feeder to be available for transfer of load from an adjacent feeder under first level emergency conditions.

Identified Network Needs

8.7 Other Network Issues Impacting Identified Network Needs

Endeavour Energy faces several challenges and opportunities in relation to managing network assets in the face of changing demands on those assets. The key issues in the short-term include the assessment of asset ratings and the impact of rooftop solar photo-voltaic installations whilst longer term issues include energy storage systems and the increasing use of electric vehicles. These issues are being addressed through network investigations, participation in industry committees, trialling new technology and through the development of appropriate network connection and management standards.

Each of these emerging issues are further discussed below.

8.7.1 Asset Ratings

Endeavour Energy investigates potential cyclic or emergency rating of assets to identify the actual capacity of the network and to accurately forecast the emergence of constraints. This ensures optimal utilisation of existing network assets and presents opportunities for deferral of investment in augmentation of the network.

8.7.2 Solar Photovoltaic (PV) Generation

The growth in embedded photovoltaic generation has continued steadily since 2010 despite reductions in feed-in tariffs and continues to challenge the performance of the distribution network.

Endeavour Energy continues to monitor the impacts of solar panels which, in some areas, have materially reduced peak demand. PV generation has little impact on peak demand in those areas of the network where demand peaks later in the day. However, it reduces the duration of the peak and improves the thermal capacity of some parts of the network during the day.

PV systems also impact the quality of supply. Traditionally, distribution networks were designed to accommodate voltage drops arising from the flow of power in one direction, from the high voltage system through to the low voltage system and connected customers. However, the large volumes of rooftop solar PV connected at customer's premises in some locations results in power flows in the reverse direction from the LV to HV at times of peak solar generation and overall low system demand. This reverse power flow situation is often not predictable and can lead to both voltage rise and voltage drop situations in various parts of the network having to be managed simultaneously to ensure voltage at the customer's premises remains within statutory limits.

8.7.3 Future Impacts of Battery Energy Storage Systems

It is expected that there will be an increasing trend of PV customers installing battery energy storage systems to optimise the generation output from their PVs for their internal consumption.

This may result in a reduction in high voltage complaints as the exporting of energy from customers with PV installations reduces during periods of low system demand. It is also likely to result in a reduction in the level of peak demand on the network as batteries allow customers to shift their solar generation to better match their electricity consumption profile and to make use of time-of-use tariffs to reduce their overall electricity consumption charges.

A residential battery energy storage system trial completed in 2019 demonstrated that battery systems provide opportunities for Endeavour Energy to utilise stored energy during critical peak times to defer investment in the augmentation of the network. Several battery systems can be aggregated into a single or multiple virtual power plants (VPP) in order to deliver the network capacity required. The capacity from the VPP can be dispatched using third party aggregation platforms.

8.7.4 Electric Vehicles

Electric Vehicles (EV) are an emerging technology with potential for significant impact on the electricity network both due to the very large demand when the vehicles are being recharged and also for the potential for the batteries in the vehicles to be used to support the electricity network during periods of peak network demand.

Endeavour Energy is a member of the Australian Standards Electric Vehicle Committee which is developing standards for the connection of EVs to the electricity network and for the associated charging/discharging control systems. The committee is also exploring strategies for vesting the control of the charging and discharging of EV batteries with the DNSP for load management purposes. Such an approach will require regulations and technical standards to be developed that balance the need to maintain network security with customer's needs and enable different providers to offer controlled EV charging services.

Network pricing signals will also play a key role in encouraging efficient EV charging behaviour by customers and influencing the take up of demand side participation products.

Endeavour has assisted the NSW Department of Planning, Industry and Environment in the development of an EV charging infrastructure map to support the objectives laid out in the NSW Electric and Hybrid Vehicle Plan. The objective of the map is to inform the market about potential locations for EV fast charging infrastructure. Preferred locations include those with adequate network capacity for fast charging stations.

Endeavour is a DNSP partner in a large scale electric vehicle trial led by a retailer and funded by the Australian Renewable Energy Agency (ARENA). The trial aims to assess the value of EV charging orchestration using managed smart chargers installed in participants' homes. Two emerging EV orchestration technologies that have significant commercial potential, Vehicle-to-Grid (V2G) and Vehicle Application Programming Interface (API) integration, will also be assessed as part of the trial.

8.8 Embedded Generation Connections

Our non-network option consultation process will provide an opportunity for embedded generation proposals to be submitted and considered for each constrained location. Endeavour Energy has deployed a 1.5 MWh grid scale Battery Energy Storage System to supply customers at West Dapto ZS. More details on the grid connected battery are provided in Section 9.2.2.

During the 2019/20 financial year we received 347 applications for non-micro embedded generator connections and 35,763 micro embedded generator connection applications. We had an average turnaround time for micro embedded generator applications of less than 1 day.

Identified Network Needs

At the end of the 2019/20 year there was a total of 155,466 PV generators connected to Endeavour Energy's network with a total combined capacity of over 807 MW.

There were no significant issues recorded as arising from the connection of these generators to Endeavour Energy's network.

Endeavour Energy received four large embedded generation connection applications and enquiries in the 2019/20 financial year.

9. Network Investments

9.1 Demand Management Activities in the Preceding Year

9.1.1 Screening for Non-Network Options

The purpose of the screening for non-network options is to determine if investment in network augmentation or replacement to address a network need has an opportunity of being deferred or avoided by a non-network option. Screening includes investigating the feasibility of initiatives that reduce the demand on that part of the network by the required amount and at the appropriate time of day or that provide an alternative source of energy that addresses the need.

When screening for non-network options Endeavour Energy considers the following:

- Any measure or program targeted at reducing peak demand, including:
  - Improvement to or additions of automatic control schemes such as direct load control and air conditioner cycling;
  - Energy efficiency programs that target appliances that contribute to peak demand;
  - The installation of smart meters to accommodate a demand response program;
  - Existing load transfer capacity;
  - Installation of technology capable of reducing peak demand; and
  - Load curtailment, load shifting or demand response
- Increased local or distributed generation/supply options including:
  - Capacity for standby power from existing or new embedded generation;
  - Capacity of micro embedded generation; and
  - Capacity of energy storage systems.

Endeavour Energy understands that credible solutions may include a variety of different measures combined to form one integrated program when determining whether a non-network option could constitute or be part of a credible option.

In evaluating the feasibility of a non-network option, the analysis focuses on the following areas:

- The ability to address the identified need in terms of the level and timing of demand reduction;
- Commercially feasibility;
- Technical feasibility; and
- Implementation timeframe to meet the network need.

9.1.2 Screening Tests

The network limitations screened for non-network options during 2020 are shown in Table 13 below.

Table 13: Screening Test Results

Network Connection Point	Constrained Area	Summary of Constraint	Screening Test Result	Notice date
Southern Macarthur 66kV Network	Southern Macarthur 66kV supply area	Major customer activities and residential load growth	DM Feasible issue Non-Network Options Report	June 2021
Aerotropolis 132kV Supply	Large Western Sydney Airport spot load and associated employment lands.	Airport and major Customer development and new industrial release areas	DM not feasible, Non-Network Options Report not required	June 2021
Science Park ZS	Driven by residential and industrial development	New industrial release area in close proximity to the airport	DM Feasible issue Non-Network Options Report	September 2021
Westmead ZS	Major Customer Development	Large Major Customer and associated services and accommodation	DM Feasible issue Non-Network Options Report	September 2021

9.1.3 Screening Test Result Details

9.1.3.1 Southern Macarthur 66kV Network

The Southern Macarthur area is supplied by two 66kV feeders, one from Nepean TS and the other from Macarthur BSP. The area is dominated by major customer loads and contains several townships and adjoining residential and rural areas. There are several embedded generators in the areas that have decreased their output and coupled with residential load growth, the load at risk is exceeding acceptable limits on outage of one 66kV feeder.

Non-network option screening identified that non-network options may be feasible and consequently a Non-network Options Report will be issued in 2021.

9.1.3.2 Aerotropolis 132kV Supply

The Western Sydney Airport and the surrounding development precincts including areas zoned for industrial use will present a large demand to the existing network in the area which is mainly a rural residential design with low density of demand. The airport will also be served by the metro rail line that will contribute to the network need in the area surrounding the airport. While our planning process for this project is not yet completed, the early results show that non-network options would not be feasible and full details on this screening report will be issued in 2021.

9.1.3.3 Science Park ZS

The proposed Western Sydney Science Park network demand and feasible network and non-network options will be further clarified in 2021. Endeavour is likely to issue a non-network options report for this network need in 2021.

9.1.3.4 Westmead ZS

The demand growth in the Westmead area from major customer developments in the hospital and allied health services area is being assessed and network options are being explored and evaluated. At this stage, we have determined that non-network options may be feasible and plan to issue a non-network options report for this project in 2021.

9.2 Details of Implemented Non-Network Programs

Endeavour has undertaken several demand management activities during 2019/20, both programs and trials. These include:

- Oakdale Industrial Development Area Demand Management Program;
- Grid connected battery (demand management initiative);
- Digital Customer Engagement Platform (DCEP) Trial;
- Albion Park ZS Off-Peak Load Control; and
- Stand Alone Power Supply investigations and trials.

These are summarised below.

9.2.1 Oakdale Industrial Development Area Demand Management Program

A demand management program was implemented in the Oakdale Industrial Development Area in 2019. The program is based on conducting energy audits at industrial customers within the target area to identify peak demand reducing initiatives. A customer financial incentive payment is available to customers who implement the approved initiative and is based on the level of reduction achieved. The service provider was identified through the tendering process of issuing the Non-Network Options Report.

The program will operate for four years from 2019/20 to 2022/23. The objective of the program is to defer the construction of South Erskine Park ZS by one year.

During 2019/20, there were a total of 13 energy audits completed with approximately 2MVA of total demand reduction opportunities identified. An opportunity that is currently being explored is to work with aggregators to deliver the demand reduction required in the area.

9.2.2 Grid Connected Battery

A grid connected battery was installed at Dapto to offload Kembla Grange ZS and supply the development area of West Dapto. Endeavour Energy has deployed a grid scale Battery Energy Storage System to supply customers at West Dapto. The BESS has 1.5MWh storage capacity and 500 KVA peak demand output and is connected at 11kV to the distribution network. The system is programmed to reduce peak demand by charging at times of low demand and discharging during the local network load peak.

While the official non-network option investigation for West Dapto ZS is planned to commence in 2021, the opportunity was taken to install this initiative early as a proof of concept and to supply the initial stages of development. This project will assist in deferring construction of a new zone substation for one or more years. As the price of battery storage reduces, it is possible to install more storage to provide a longer deferral period. Endeavour Energy may consider deploying this type of system elsewhere when a suitable opportunity is identified.

9.2.3 Digital Customer Engagement Platform (DCEP) Trial

Endeavour Energy has implemented trials of residential demand management (DM) programs and found that the major challenge in implementing successful programs is recruiting the correct customers onto programs and constantly communicating with participants to keep them engaged and interested. Obtaining sufficient take-up for a program in a cost-effective manner has been difficult to date. Communication with customers and providing feedback has also been a challenge.

Through the introduction of new communications technology and social media, access to residential customers has become easier and more cost-effective. In 2019/20, Endeavour Energy implemented a Digital Customer Engagement Platform (DCEP) trial. The DCEP will be utilised to manage Endeavour Energy's portfolio of residential DM programs including voluntary demand reduction, air conditioning control and battery energy storage DR program. These DM programs have been successfully implemented and have achieved the desired demand reduction. The DCEP brings all these programs together under one umbrella to enable more efficient program management and deliver all the above-mentioned services in one system.

The focus of the trial is on creating a positive customer experience by making it easy for customers to register and participate in the program and having access to an easy to use mobile application and web portal. Gamification strategies is also being investigated to test customer behavioural response where participants undertake challenges that result in reduction in energy consumption and peak demand. The application sends regular information to participants to ensure continual engagement through interactive social-based techniques.

Endeavour is working with local councils to help promote the program and assist in customer recruitment. Currently, there are 1,200 customers who signed up for the program. The DCEP trial will be completed on 31st March 2021 and an evaluation report will be available in July 2021.

9.2.4 Albion Park ZS Off-Peak Load Control

The Albion Park ZS Off-Peak Load Control system has reached its capacity. An approach to the market for non-network options identified a cost-effective option of replacing all customer load control relays and basic

meter with a smart meter that has load control functionality. The meter replacements commenced in November 2020 with completion expected by February 2021. Around 30% of the target 2,900 meters have been replaced as of early December 2020.

9.2.5 Stand Alone Power Supply Investigation and Trial

Endeavour Energy is monitoring the development of national regulation changes that may make standalone power supplies an economically feasible alternative to network augmentation and replacement and also to improve customer reliability and quality of supply in certain network areas. Endeavour Energy is in the process of investigating the feasibility of SAPS in relation to emergency response in rural and remote locations impacted by bushfires and storms and also for end-of-life network asset replacement alternatives following economic evaluation. Endeavour Energy expects to report further on these investigations and trials in the future including providing project details and opportunities in the DAPR.

9.3 Promotion of Non-Network Options

The promotion of non-network options occurs predominantly through the public consultation process which includes the issuing of the following reports:

- Non-Network Options Report;
- Draft Project Assessment Report; and
- Final Project Assessment Report.

Listed below are the actions taken to promote non-network proposals from the preceding year.

9.3.1 Summary of Non-network Options Reports

The network needs where a Non-network Options Report was issued during 2019/20 are shown below in Table 14.

Table 14: Non-network options reports

Network Connection Point	Constraint Area	Summary of Constraint	Non-Network Options Issue Date	Timing of Constraint	Est. Load Reduction (MVA)	Defer Years
Box Hill ZS	New residential area	Distribution network capacity	April 2020	Nov 2023	7.6 or	1 or 2
Albion Park ZS	Albion Park ZS supply area	Distribution network capacity	July 2019	Nov 2020	6.0	Permanent

9.3.2 Summary of Draft Project Assessment Reports

The Draft Project Assessment Reports (DPAR) that were issued from June 2018 to December 2020 in accordance with the RIT-D cost thresholds are detailed in Table 15 below.

Table 15: Draft Project Assessment Reports

Network Connection Point	Constrained Area	Summary of Constraint	Status	Notice Date
Menangle Park development area	New release residential & commercial areas	Distribution network capacity	Issued	Dec 2018
Calderwood development area	New release residential & commercial areas	Distribution network capacity	Issued	Nov 2019
South Erskine Park ZS	Oakdale new industrial release areas	Distribution network capacity	Issued	Dec 2019

9.3.3 Summary of Final Project Assessment Reports

The Final Project Assessment Reports (FPAR) that were issued from June 2018 to December 2020 in accordance with the RIT-D cost thresholds are detailed in Table 16 below.

Table 16: Final Project Assessment Reports

Network Connection Point	Constrained Area	Summary of Constraint	Status	Notice Date
South Leppington ZS	New release residential & commercial areas	Distribution network capacity	Issued	July 2018
Menangle Park ZS	New release residential & commercial areas	Distribution network capacity	Issued	Mar 2019
Calderwood ZS	New release residential & commercial areas	Distribution network capacity	Issued	Mar 2020
South Erskine Park ZS	Oakdale new industrial release areas	Distribution network capacity	Issued	Mar 2020
Sussex Inlet ZS	End-of-life asset retirement	Asset retirement	Issued	Sep 2020

9.3.3.1 South Leppington ZS

The South Leppington Zone Substation Final Project Assessment Report was issued in July 2018. The reports detailed the network development plans resulting from the new release areas. It also details the result of the non-network screening test that found demand management not to be feasible in this greenfield development area due to the weak existing network and the high demand growth rate as well as the low potential for demand reduction. The assessment results conclude the following:

- The preferred option involves the development of a 2 x 45 MVA transformer zone substation with a permanent control building and a single 132kV sub transmission feeder;
- The estimated cost of the preferred option is $25.3 million;
- The net economic benefit of this option is $51.2 million over a 15-year evaluation period;
- This investment is required by 2021/22; and
- The estimated capital expenditure of $25.3 million is part of the overall approved capital program and consequently will have no effect of connections charge or distribution use of system charges.

9.3.3.2 Menangle Park ZS

The Menangle Park ZS Draft Project Assessment Report was issued in December 2018 and the Final Project Assessment Report was issued in March 2019. The report detailed the network development plans resulting from the new release areas. It also details the result of the non-network screening test and the subsequent Non-Network Options Report that was issued in April 2018. The assessment results conclude the following:

- No submissions were received from the Non-Network Options Report;
- The preferred option involves the development of a single transformer mobile zone substation with a single 66kV subtransmission feeder from Macarthur BSP;
- The estimated cost of the preferred option is $5.0 million;
- The net economic benefit of this option is $350 million over a 15-year evaluation period;
- This option is required by 2021/22; and
- The estimated capital expenditure of $5.0 million is part of the overall approved capital program and consequently will have no effect of connections charge or distribution use of system charges.

9.3.3.3 Calderwood ZS

The Calderwood ZS Draft Project Assessment Report was issued in November 2019 and the Final Project Assessment Report was issued in March 2020. The report detailed the network development plans resulting from the new release areas. It also details the result of the non-network screening test and the subsequent Non-Network Options Report that was issued in July 2018. The assessment results conclude the following:

- No submissions were received from the Non-Network Options Report;
- The preferred option involves the establishment of a single transformer mobile zone substation with a 33kV feeder from Mt Terry Transmission Substation;
- The estimated cost of the preferred option is $4.3 million;
- Based on current forecasts and optimal economic timing this option is required by 2021/22; and
- The preferred option refers to a permanent ZS to be established in 2026, depending on demand forecasts and will likely require an additional RIT-D consultation process.

9.3.3.4 South Erskine Park ZS

The South Erskine Park ZS Draft Project Assessment Report was issued in December 2019 and the Final Project Assessment Report was issued in March 2020. The report detailed the network development plans resulting from the new release areas. It also details the result of the non-network screening test and the subsequent Non-Network Options Report that was issued in 2018. The assessment results conclude the following:

- One submission was received from the Non-Network Options Report;
- The preferred option involves the establishment of a two-transformer zone substation with two 132kV feeders from Sydney West Bulk Supply Point (one via Mamre ZS). The project will be deferred by one year by the implementation of a demand management program;
- The estimated cost of the preferred option is $26.6 million;
- The net economic benefit of this option is $350 million over a 15-year evaluation period;
- This option is required by 2022/23 including the 1-year deferral provided by the demand management program. The DM program is expected to operate up to 2022 to support the deferral.

9.3.3.5 Sussex Inlet ZS

At Sussex Inlet ZS, the 11kV outdoor busbar has reached its end-of-life and further repair or maintenance is not cost effective. A project has been developed to replace this equipment. Not replacing this equipment will cause the entire substation to be retired. Investigations were conducted into the feasibility of either providing sufficient demand reduction to allow the retirement of the Sussex Inlet ZS or provide alternative sources of supply to cater for the existing and future demand.

The peak demand on Sussex Inlet ZS is currently 8 MVA with predominantly residential customers in the township of Sussex Inlet and rural customers in the surrounding area. Permanent demand reduction initiatives were investigated as well as alternative sources of electricity. Three scenarios of embedded generation were investigated being:

Generation connected at a single point effectively replacing the zone substation;

Generation distributed at multiple locations in the low voltage network; and
Generation behind the meter at each customer premises.

The results of the analysis found that the present value of costs of the scenarios range from $72 million to $294 million which far exceeds the cost of the network option being $8.8 million. Consequently, the screening for non-network options identified that a non-network option was not feasible. The screening report was published in April 2018. The Final Project Assessment report was issued in September 2020.

9.4 Plans for Demand Management

Endeavour Energy produces a demand management plan that includes all identified network needs that are subject to a non-network options investigation and potentially the release of a Non-Network Options Report. The principal factor affecting the investigation timetable is the forecast load growth or the asset retirement timeframe. In many situations the load growth is driven by spot load applications and projected new release development areas whereas retirements are driven by the condition and performance of the network assets in question. Endeavour Energy closely monitors the level of demand that appears on the network and the condition of assets identified for retirement to ensure network needs are accurately forecast and solutions implemented in a timely manner.

Details of the network limitations that are currently RIT-D projects or those not meeting the RIT-D criteria and will be screened or investigated for non-network options during 2020 has been detailed above in Table 6 to Table 10. This information is also included in the DAPR Mapping Portal: https://dapr.endeavourenergy.com.au.

9.5 RIT-D Projects Completed or In Progress

9.5.1 Projects in Progress

Table 17 below provides a summary of the RIT-D projects which are currently in progress. Refer to Section 9.3 for more information.

Table 17: RIT-D Projects in Progress – Summary

RIT-D Project	RIT-D Status	Cost of Preferred Option ($M)	Construction Timetable	Credible Options
Southern Macarthur 66kV Network	Screening - Complete NNOR - TBI	9.2	2022/23-2024/25	1. Demand Management 2. New 66kV Feeder
Box Hill ZS	Screening - Complete NNOR – Complete DPAR – In Progress	24.9	2018/19-2023/24	1. Demand Management 2. New Zone Substation
Aerotropolis 132kV Supply	Screening – In Progress	71.5	2021/22-2024/25	1. New 132kV Feeder
Science Park ZS	Screening – In Progress	20.6	2021/22-2023/24	3. Demand Management 4. New Zone Substation
Westmead ZS	Screening – In Progress	9.5	2021/22-2022/23	1. Demand Management 2. New Zone Substation

NNOR – Non-Network Options Report

DPAR – Draft Project Assessment Report

TBI – To be issued

9.5.2 Projects Completed

The consultation process for projects where a Final Project Assessment Report was issued in the preceding year is considered to be complete. These projects are detailed in Table 18. Refer to Section 9.3 for more information.

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Table 18: RIT-D Projects Completed – Summary

RIT-D Project	Cost of Preferred Option ($m)	Construction Timetable	Credible Options	Net economic Benefit ($m)
Menangle Park ZS	5.0	2020/21-2022/23	Single transformer mobile ZS and a single 66kV subtransmission feeder	350
South Leppington ZS	25.3	2020/21-2022/23	2 x 45 MVA transformer ZS and a single 132kV subtransmission feeder	51.2
Marayong ZS	17.3	2019/20-2022/23	New 33/11 kV ZS with 3 x 25 MVA transformers	13.5
Sussex Inlet ZS	8.8	2018/19-2019/20	New 33/11 kV ZS with 3 x 25 MVA transformers	2.3
South Erskine Park (Southpipe-Oakdale West)	26.6	2019/20-2022/23	Demand management program followed by new 132/22kV ZS with 2 x 45MVA transformers	103.0
Calderwood ZS	4.3	2020/21-2021/22	Establishment of a single transformer 33/11kV mobile zone substation	49.0
Albion Park ZS AFIC	0.6	2020	Demand Management in the form off-peak load control	1.5

9.6 Asset Retirements and Potential Regulatory Investment Tests

9.6.1 Asset Retirements (Project Based)

Endeavour Energy has a range of project based planned asset retirements which will result in a system limitation or de-rating. Table 19 below summarises these planned asset retirements for the forward planning period. Some of these needs may be addressed by options that are yet to be determined and which could trigger the requirement to undertake a RIT-D assessment.

Table 19: Asset Retirements (Project Based)

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
RTM028	132kV oil insulated cable	Guildford/Merrylands/ Parramatta	Sheath oil leaks and dissolved gas levels indicating end of life of the cables: 9J8, 22U, 22W, 226, 228, 233.	2024/25	N/A
RTM030	33kV Feeder 7028 on 132kV steel towers	Bellambi/Helensburgh	Corrosion of towers and conductors with risk of failure Safety risk for the public and electricity workers	2022/23	N/A
RTM134	Wollongong - Port Kembla copper pilot cables	Wollongong – Port Kembla	Increased experience of failures at joint boxes leading to failures of the high speed 33kV feeder protection schemes	2028/29	N/A

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
			Risk to public safety due to slow clearing of feeder faults		
RTS167	Carlingford Transmission Substation control building replacement	Carlingford	Failure of roof of control building Deterioration of protection and control services Asbestos contamination of control building Risk of loss of protection and control of the substation WH&S risks	2022/23	N/A

9.6.2 Asset Retirements (Program Based)

The following list of programs will result in the retirement of various asset types across the Endeavour Energy network. The rationale for the retirement for some asset classes is defined by an economic evaluation in a case for investment and for other asset classes by Endeavour Energy Standards which set out conditions and health indices used to determine the need for the retirement of those assets.

Network Investments

Table 20: Asset Retirements (Program Based)

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
RAU004	Substation SCADA Remote Terminal Units	Zone and sub-transmission substations	Increasing likelihood of failures leading to loss of control of the substation Reliability risk	2020/21 - 2029/30	
RDS005	Distribution poles	Across the network	Inspection and test criteria indicating risk of failure Safety risk to the public Reliability risk	2020/21 - 2029/30	
RDS006	LV CONSAC distribution cables	Across the network	Failures of joints in pillars and columns and of the CONSAC cable Shock hazards to the public and electricity workers	2020/21 - 2029/30	
RDS007	LV service wires	Across the network	Deterioration of insulation	2020/21 - 2029/30	

Network Investments

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
			Safety risks to public and electricity workers		
RDS011	HV distribution steel mains	Bushfire prone areas	Corrosion of steel conductor indicating failure risk Risk of initiating a bushfire Safety risks for the public and electricity workers	2020/21 - 2029/30	
RDS014	LV underground cable network	Across the network	Failures of in-ground joints Shock hazards to customers and electricity workers	2022/23 - 2029/30	
RDS301	Distribution ground substations	Across the network	Poor condition of the substation assets Safety risks due to exposure of conductors and inadequate clearances	2020/21 - 2029/30	
RDS302	Distribution transformers	Distribution substations across the network	Poor condition of transformer due to cracked bushings, oil leaks and corrosion	2020/21 - 2029/30	

Network Investments

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
			Risk to safety, environment and reliability		
RDS307	MD4 epoxy switchgear	Distribution substations across the network	Discharge over surface of resin Risk of flash-over and substation fire Safety risk to the public and electricity workers	2020/21 - 2029/30	
RDS315	Low voltage switchgear	Distribution substations across the network	Insulation deterioration leading to arc-flash incidents Safety risk to electricity workers	2020/21 - 2029/30	
RDS405	Air break switch	Across the network	Failure of switchgear resulting in inability to be operated Safety risks to electricity workers and the public	2020/21 - 2029/30	
RDS414	Copper distribution mains	Across the network	Corrosion of conductor and fatigue of material indicates risk of conductor failure	2021/22 - 2029/30	

Network Investments

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
			Safety risk to the public and electricity workers		
RDS415	LV mains	Across the network	Deterioration of insulation Safety risk to public and electricity workers	2021/22 - 2029/30	
RDS417	Distribution access track reconstruction	Across the network	Access tracks in deteriorated condition which are unsafe for use Safety, reliability and environmental risks	2020/21 - 2029/30	
RPS008	Substation electro-mechanical, electronic and early numerical protection relays	Zone and sub-transmission substations	Increased risk of malfunction Reliability risk Safety risk to the public	2020/21 - 2029/30	
RTM012	Sub-transmission poles	Across the network	Failure of inspection and test criteria with risk of failure	2020/21 - 2029/30	

Network Investments

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
			Safety risk to the public Reliability risk		
RTM014	Renewal of 33kV and 66kV gas and oil filled cables	Carlingford and Outer Harbour	Poor oil and paper condition indicating end of life Reliability risk	2025/26 - 2029/30	
RTM015	Sub-transmission steel towers	Across the network	Corrosion of steel structures indicating risk of failure Safety and reliability risk	2021/22 - 2029/30	
RTM171	Corroded overhead steel earthwires	Across the network	Corrosion of steel earthwire indicating risk of failure Bushfire start risk Safety risk to the public Reliability risk	2023/24 - 2029/30	

Network Investments

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
RTM174	Hardex earthwires	Across the network	Risk of burn-down during faults Safety risk due to the public due to slow clearing of faults and due to conductors down	2021/22 - 2029/30	
RTS004	132kV circuit breakers	Zone and sub-transmission substations	Poor diagnostic test results and defect history indicating destructive failure risk Reliability and safety risk	2021/22 - 2029/30	
RTS005	33kV circuit breakers	Zone and sub-transmission substations	Poor diagnostic test results and defect history indicating destructive failure risk Reliability and safety risk	2022/23 - 2029/30	
RTS007	11kV circuit breakers	Zone and sub-transmission substations	Poor diagnostic test results and defect history indicating destructive failure risk Reliability and safety risk	2021/22 - 2022/23	

Network Investments

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
RTS008	Substation batteries	Zone and sub-transmission substations	Deteriorating test results Risk of failure and loss of protection systems at the substation Reliability risk as substation is remotely switched off until battery is replaced and control restored	2020/21 - 2029/30	
RTS009	Auxiliary switchgear	Zone and sub-transmission substations	Risk of catastrophic failure Reliability and safety risk	2022/23 - 2028/29	
RTS015	Surge arresters	Zone and sub-transmission substations	Breakdown of seals on porcelain housing, moisture ingress leading to failure Reliability and safety risk	2020/21 - 2029/30	
RTS016	VT and CTs	Zone and sub-transmission substations	Oil leaks, degradation of seals, corrosion leading to risk of destructive failure	2022/23 - 2029/30	

Network Investments

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
			Reliability and safety risk		
RTS055	66kV circuit breakers	Zone and sub-transmission substations	Poor diagnostic test results and defect history indicating destructive failure risk Reliability and safety risk	2022/23 - 2029/30	
RTS086	Busbars, disconnectors and/or support structures	Zone and sub-transmission substations	Corrosion of reinforcing steel and cracking of support insulators indicate risk of failure Reliability and safety risk	2020/21 - 2029/30	
RTS173	11kV oil circuit breaker trucks	Zone substations	Risk of failure to clear faults leading to catastrophic failure Reliability risk Safety risk for electricity workers	2020/21 - 2029/30	

Network Investments

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
RTS600	Power transformers	Zone and sub-transmission substations	Poor paper insulation, bushing and tap changer condition, oil condition indicates risk of failure Reliability risk	2021/22 - 2029/30	
RTS700	11kV zone substation switchboards	Zone substations	Risk of failure to clear faults leading to catastrophic failure Reliability risk Safety risk for electricity workers Safety risks for workers in the cable basement due to failure of deteriorated paper cable terminations	2021/22 - 2029/30	

Network Investments

9.7 Urgent and Unforeseen Investments

There are currently no issues which are sufficiently urgent or unforeseen that they have not been able to be addressed through the normal investment planning process.

However, during 2020 Endeavour Energy's network sustained substantial damage caused by bushfires and an east coast low storm. Endeavour Energy conducted substantial fault and emergency repair to recover from these events.

Table 21: Urgent and Unforeseen Network Issues

Project Number	Project Name	Description Purpose	Estimated Cost ($m)	Approval Date	Completion Date	Alternative Options
Nil entry						

9.8 Information Technology Investment

Table 22 provides information on the investment in information technology systems within the network for the preceding year and that proposed for the forward planning period.

Table 22: Information Technology Program

Project Name	Period	Description
Optimus Program	2018/2019 onwards	This program includes a refresh and consolidation of 40 information systems including the ERP and Billing platforms, rationalisation of applications, improving data and reshaping operations and processes. The establishment of a modern technology platform will improve productivity and safety outcomes.
Security Improvement Program	2018/19 – 2019/20	The Security Improvement Program includes several key initiatives to improve Endeavour Energy's overall information security posture to achieve ISO27000 certification and to ensure compliance with Critical Infrastructure Licence Conditions.
Advanced Distribution Management System (ADMS)	2018/19 onwards	This program aims to provide Endeavour Energy with an Advanced Distribution Management System to provide an end to end integrated real-time view of the entire distribution network. The program will replace the company's existing OMS system and enable efficiencies and safety improvements in field operations. Additionally, through the greater understanding and control of the Endeavour Energy network this program will enable customers to take up smart technologies and renewable sources of energy.

Network Investments

Project Name	Period	Description
Lights Up Program	2019/20	The Lights Up program has delivered enhanced software, new hardware and improved customer-support technology. The program delivered tools such as Office365 and Windows 10 and refreshed network and infrastructure hardware to support Optimus and ADMS programs.

Appendices

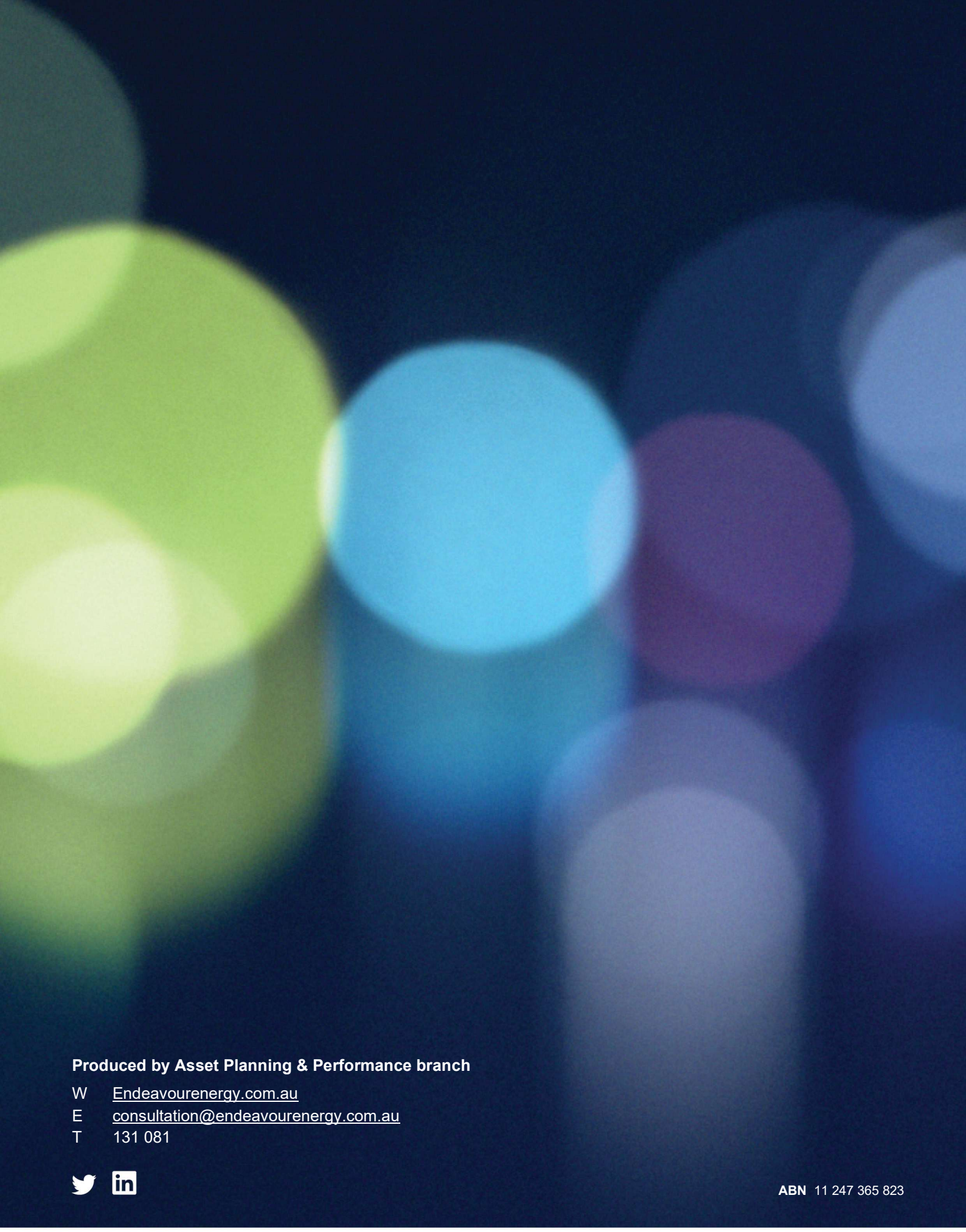
Appendices

Appendix A: Glossary

Abbreviation/Phrase	Definition
AEMC	The Australian Energy Market Commission is the rule maker and developer for Australian energy markets
AER	Australian Energy Regulator
DAPR	Distribution Annual Planning Report prepared by a Distribution Network Service Provider under clause 5.13.2 of 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
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 22kV, 12.7kV and 11 kV distribution assets (also referred to as medium voltage in some sections of this report)
HVC	High voltage customer
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
LV low voltage	Consists of 400V and 230 volt distribution assets
Major Event Day	Any day that exceeds a daily SAIDI threshold
MW megawatt	One MW = 1000 kW or one million watts
MWh megawatt hour	One MWh = 1000 kilowatt hours
NER	National Electricity Rules

Appendices

Abbreviation/Phrase	Definition
Primary distribution feeder	Distribution line connecting a sub-transmission asset to either other distribution lines that are not sub-transmission lines, or to distribution assets that are not sub-transmission assets. An example is the first distribution feeder out of a zone substation
RIT-D	Regulatory Investment Test for Distribution
Sub-transmission	Any part of the electricity network which operates to deliver electricity from the transmission system to the distribution network and which may form part of the distribution network, including zone substations
Sub-transmission system	Consists of 132kV, 66 kV and 33 kV assets
V volt	A volt is the unit of potential or electrical pressure
W watt	A measurement of the power present when a current of one ampere flows under a potential of one volt



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