EnergyCo
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NSW GOVERNMENT

NSW Network Infrastructure Strategy

A 20-year strategy to transform the NSW electricity network

May 2023

The Energy Corporation of NSW (EnergyCo) is part of the **Treasury Cluster**

Acknowledgment of Country

We acknowledge that Aboriginal and Torres Strait Islander peoples are the First Peoples and Traditional Custodians of Australia, and the oldest continuing culture in human history.

We pay respect to Elders past and present and commit to respecting the lands we walk on, and the communities we walk with.

We celebrate the deep and enduring connection of Aboriginal and Torres Strait Islander peoples to Country and acknowledge their continuing custodianship of the land, seas and sky.

We acknowledge the ongoing stewardship of Aboriginal and Torres Strait Islander peoples, and the important contribution they make to our communities and economies.

We reflect on the continuing impact of government policies and practices, and recognise our responsibility to work together with and for Aboriginal and Torres Strait Islander peoples, families and communities, towards improved economic, social and cultural outcomes.

Artwork:
Regeneration by Josie Rose

James Hay
Chief Executive, EnergyCo

Preface

Every day, NSW households, businesses and communities are helping to transform our electricity system, reduce emissions and put downward pressure on energy bills.

Modernising our electricity system is not only essential for clean, reliable and affordable energy across NSW. It is enabling new industries that rely on that energy at the scale NSW can offer. It is safeguarding and reviving traditional industries with new sustainable fuels. Most importantly, it is opening diverse, high-paying and sustainable job opportunities across our regional communities.

NSW has a clear Roadmap for this modernisation, guiding investment in new wind and solar generation, and its supporting storage, firming and network infrastructure. That investment will power homes, schools, hospitals and businesses right across our State.

As part of that Roadmap, the Energy Corporation of NSW (EnergyCo) has defined roles under the *Energy and Utilities Administration Act 1987* and the *Electricity Infrastructure Investment Act 2020*, and has been appointed as Infrastructure Planner for the five NSW Renewable Energy Zones (REZs) as well as the Waratah Super Battery project and Hunter Transmission Project.

In these roles, EnergyCo is opening the opportunities of a modern electricity system for all stakeholders. It will work with AEMO, Transgrid and distribution network service providers to practically coordinate network infrastructure with NSW's generation, storage and firming infrastructure, and oversee the delivery of REZs. It will work to foster support in local communities by minimising impacts and maximising benefits. And it will support investors to build vital infrastructure for NSW at lowest cost to energy consumers.

The NSW Network Infrastructure Strategy (the "Strategy") is a new and valuable contribution that sets out the clearest plan yet for NSW's network infrastructure, outlining the modernisation projects needed and their proposed timing. It is just one part of a coordinated planning process for our energy system, spanning both NSW and the broader National Electricity Market.

In developing the Strategy, EnergyCo has collaborated with AEMO Services Ltd in its role as the Consumer Trustee on detailed modelling to forecast NSW's future network needs, and with communities and industry to set the guiding principles needed to balance commercial and community concerns.

Thank you to all those have contributed to this Strategy, in particular those who provided such valuable feedback on the Draft Strategy.

I commend the Strategy to NSW's vibrant energy industry, to our strong regional communities, and to the Consumer Trustee as it prepares its final 2023 Infrastructure Investment Objectives report – the next formal step in refining NSW's energy Roadmap.

I look forward to continuing to work with you to deliver NSW's energy future.

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About EnergyCo

The Energy Corporation of NSW (EnergyCo) is a statutory authority established under the *Energy and Utilities Administration Act 1987*, under which it may act to investigate, plan, coordinate and promote energy infrastructure development in NSW.

EnergyCo has been appointed Infrastructure Planner under section 63 of the *Electricity Infrastructure Investment Act 2020* (the EII Act), for NSW's five Renewable Energy Zones (REZs) and for two priority transmission infrastructure projects (PTIPs, the Waratah Super Battery Project and the Hunter Transmission Project).

This role pursues the EII Act's twin goals of clean, reliable and affordable electricity for NSW consumers as well as economic and social benefits for local and First Nations communities.

EnergyCo's primary statutory function is "to investigate, plan, coordinate and carry out the planning and design" of generation infrastructure as well as the construction and operation of storage and network infrastructure.

As Infrastructure Planner, EnergyCo acts in three ways for the practical coordination of transmission with generation and firming infrastructure:

- plans and procures major network infrastructure projects to unlock additional network capacity across the state
- designs and manages network access schemes to ensure new generators can get connected and stay connected
- coordinates local community engagement to support joined-up delivery of major infrastructure and benefits

EnergyCo also supports emerging technologies (pumped hydro, long-duration storage) through grants programs.

In these roles, EnergyCo works in close collaboration with the Australian Energy Market Operator, AEMO Services as the Consumer Trustee, Transgrid as the system operator and jurisdictional planning body, and the distribution network service providers.

This work can only be successful if there is effective engagement with and between relevant stakeholders. EnergyCo therefore leads community and industry engagement to support the delivery of REZs and PTIPs, and to deliver tangible benefits for local communities and First Nations Peoples, and to promote local development opportunities.

Bodangora Wind Farm near Wellington, NSW.

Executive Summary

Our energy system is rapidly modernising

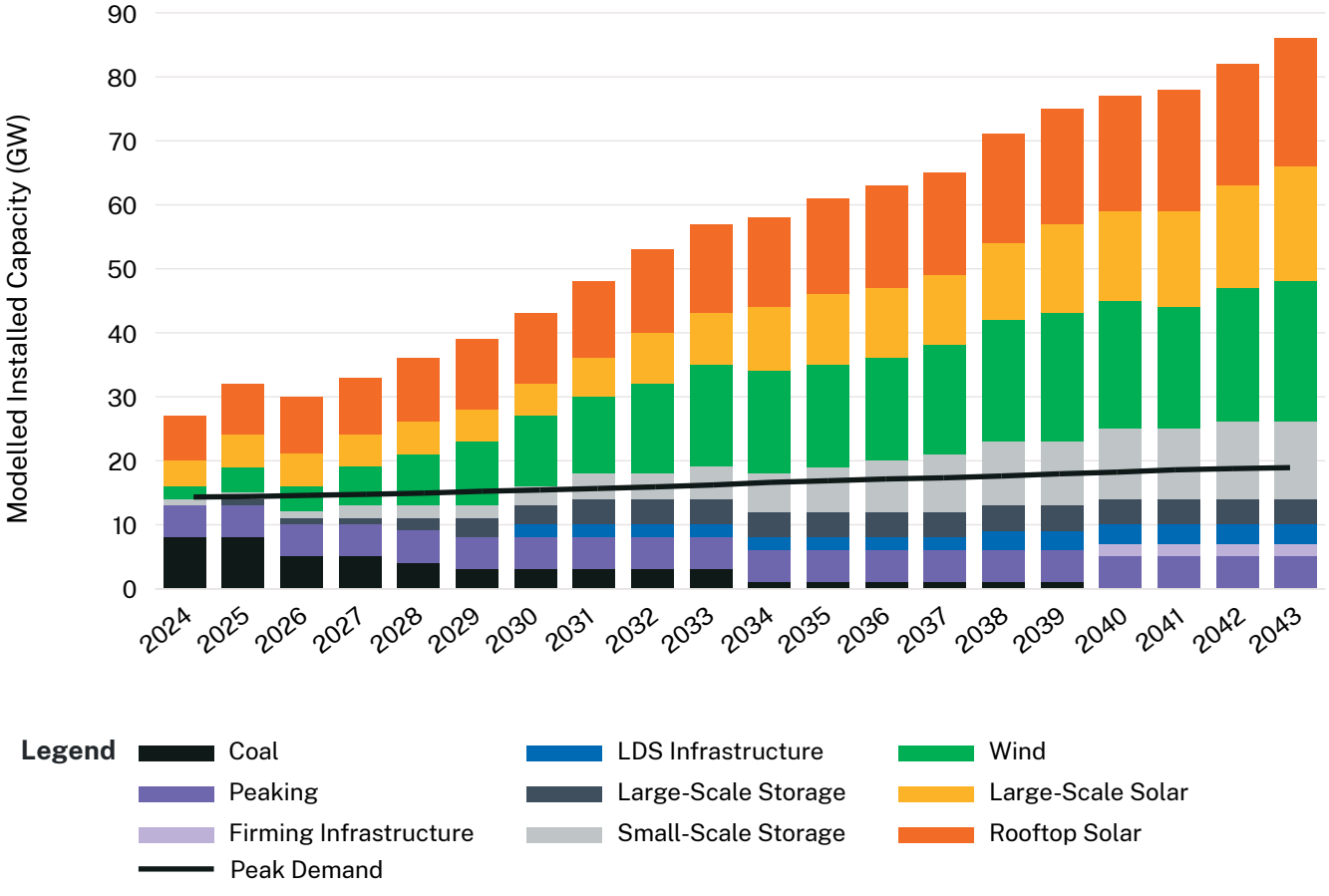
The NSW energy system is being completely modernised to help the state halve emissions by 2030 and reach net zero by 2050. The modernisation will deliver clean, reliable and affordable energy across NSW, enable new industries that can rely on that energy, revive traditional industries with new sustainable fuels, and open diverse, high-quality job opportunities across our regional communities.

The nature, scale and speed of this transformation present inherent challenges. The first is the switch from fossil fuel generation to renewables, supported by additional storage, firming and network capacity. The second is a near-doubling of NSW demand for electricity by 2050 so that our transport, industry, office and homes can switch away from gas, petrol and other fuels.[1]

These challenges must be met at speed. NSW's five coal-fired power stations are ageing and becoming less reliable, with four set to retire by 2033, removing more than half NSW's annual electricity supply. The NSW power system must be ready to deliver equivalent amounts of electricity from firmed renewable sources well before these coal plants retire.

The speed and scale of this challenge is set out in Figure 1 and in the Consumer Trustee's Draft 2023 Infrastructure Investment Objectives Report (IIO Report). NSW will need to replace 8.3 GW of capacity from ageing coal-fired power stations. By 2040, the power system is forecast to comprise 34 GW of grid-scale renewable capacity and 13 GW of large-scale storage and firming capacity. This is on top of significant investment by NSW households and businesses in distributed technologies including 18 GW of rooftop solar and 11 GW of small-scale batteries. See Appendix A and the Draft 2023 IIO Report for further information on the results of the economic analysis undertaken by the Consumer Trustee.

Figure 1: Forecast expansion of new NSW generation storage and firming capacity
AEMO Services Ltd modelling of the Strategy/IIO *Central* Scenario



NSW is in a strong position to secure this clean, affordable and reliable electricity. We have abundant high-quality renewable energy resources, a skilled and experienced workforce, an open market for the world's best products and services, and keen interest from those able to finance and build the state's new electricity infrastructure.

To accelerate the modernisation, the *Electricity Infrastructure Investment Act 2020* (EII Act) requires a minimum 12 GW of generation and 2 GW of long-duration storage to be constructed by 2030. The Act has overall objectives to minimise costs to NSW electricity consumers and meet the NSW energy security target and reliability standard. As well, the Act seeks to foster local community support for electricity investment and to support employment, including for First Nations Peoples.

While EnergyCo is leading delivery of the first five REZs and two PTIPs, Transgrid is continuing to lead delivery of five other critical network projects in NSW under the Australian Energy Market Operator's (AEMO) Integrated System Plan.[2]

This reflects the scale of the transformation underway and highlights the need for coordinated energy system planning, supported by this Strategy.

A Strategy for the practical coordination of NSW network infrastructure

The Network Infrastructure Strategy is a strategy for the practical coordination of NSW network infrastructure to connect new generation, firming and storage in NSW's five Renewable Energy Zones (REZs), and otherwise to assist NSW meet the EII Act objectives.

The Strategy proposes Network Infrastructure Options with a total capacity of 14 GW to be delivered as soon as practicable over the next decade (by 2033), and further options to be considered for delivery beyond that.

The Consumer Trustee independently considers these options in preparing its Infrastructure Investment Objectives Report (IIO Report), which sets a 20-year development pathway for NSW's generation, firming and long-duration storage infrastructure.

In this way, the Strategy and the IIO Report complement each other in the coordinated development of electricity infrastructure in the long-term interests of NSW's electricity consumers, quality of life and competitive industry.

This Executive Summary outlines the 'Deliver Now' and future options of the NSW Network Infrastructure Strategy, how they were selected, their potential benefits, and the engagement with all stakeholders needed to manage risks and secure those benefits.

Carcoar Lake with windfarm, Blayney, NSW.

The Strategy has been developed through analysis and engagement

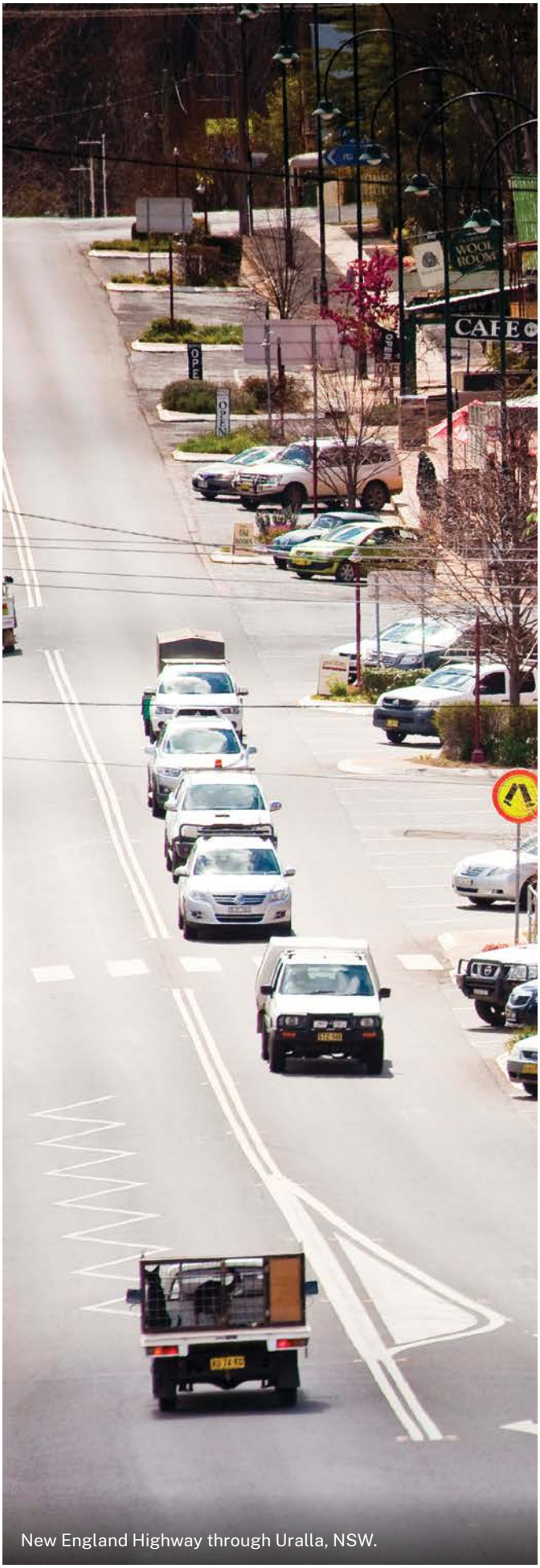
Over 55 potential options for upgrading the network were considered in developing a Network Infrastructure Strategy that balances the needs for flexibility and for investor and community certainty. In brief, the process was to:

1. Identify network options that may deliver access to REZ generation and storage and provide future optionality.
2. Estimate the construction cost and delivery schedule for each option.
3. Draw on economic analysis by the Consumer Trustee to optimise the timing of network infrastructure build with generation and storage build, under three scenarios:
   - *Central* where the power system develops in line with the inputs and assumptions for AEMO's Step Change scenario in the 2022 Integrated Systems Plan.
   - *Transmission Delay* where large projects (with capital cost above $1 billion) are delayed, for example, due to global supply chain disruptions.
   - *Coal Exit by 2030 and Strong Electrification*, a single scenario in which all coal-fired power stations in NSW close by 2030, earlier than currently anticipated, with transport, industry, households switching to electricity, and new hydrogen electrolysers adding to demand.
4. Apply principles agreed with stakeholders (affordability, reliability, flexibility, innovation, local community support and timeliness) to propose the Network Infrastructure Strategy. These principles ensure that the options benefit NSW electricity consumers, prepare the network for market trends and future shocks, and minimise community and landholder impacts.

These steps are detailed in Part 4 of this strategy.

The Strategy also explores new technologies such as offshore wind, long distance high-voltage direct current transmission and hydrogen. These technologies, their commerciality and potential will be explored in more detail in future editions.

Likewise, market modelling for the Strategy has taken into account demand-side factors including rooftop solar, energy efficiency, EV uptake and distributed batteries consistent with the scenarios above. Their potential value to electricity consumers as larger-scale projects ramp up may warrant further investigation.



New England Highway through Uralla, NSW.

The Strategy proposes options to *Deliver Now* and, if needed, in the future

The Strategy proposes options that add between 14 GW and 24 GW of network capacity over the next 20 years, depending on the modelled scenario. These are set out below as:

- the network capacity to be added in each REZ, in the three categories of *Deliver Now, Secure Now* and *Plan for the Future* (Table 1)
- downstream projects to support the NSW network (Table 2), and
- a timeline for the delivery of both sets of projects over the next 20 years (Figure 2).

High-level descriptions of each option follow below, with Part 1 giving guidance on their need, location and timing.

As Infrastructure Planner, EnergyCo will further develop the design of each option, through detailed stakeholder engagement, before recommending a network solution to the Consumer Trustee for authorisation. All major network projects are subject to the NSW planning and environmental assessment process.

Investment in the options would support a secure and well-managed energy transformation for NSW, maximising benefits to electricity consumers and minimising community and landholder impacts. This would represent about 5% of wholesale electricity costs over the next 20 years, which could unlock up to four times the value in generation, storage and firming infrastructure.

Table 1: REZ network capacity increases to be delivered by Network Infrastructure Options

	Deliver Now for secure and affordable energy	**Secure Now** for resilience against early coal closures	**Plan for the Future** to enable strong future electrification
Total REZ network capacity added	**14 GW**	**3.6 GW**	**6.4 GW**
Central-West Orana	4.5 GW	2.3 GW	3.5 GW
New England	6 GW	0.8 GW	1.5 GW
South West[a]	2.5 GW	-	-
Hunter-Central Coast	1 GW	0.5 GW	1.5 GW
Illawarra		Not modelled[b]	
Construction cost preliminary estimates[c]	**$7.8 billion**	**$1.5 billion**	**$3.0 billion**

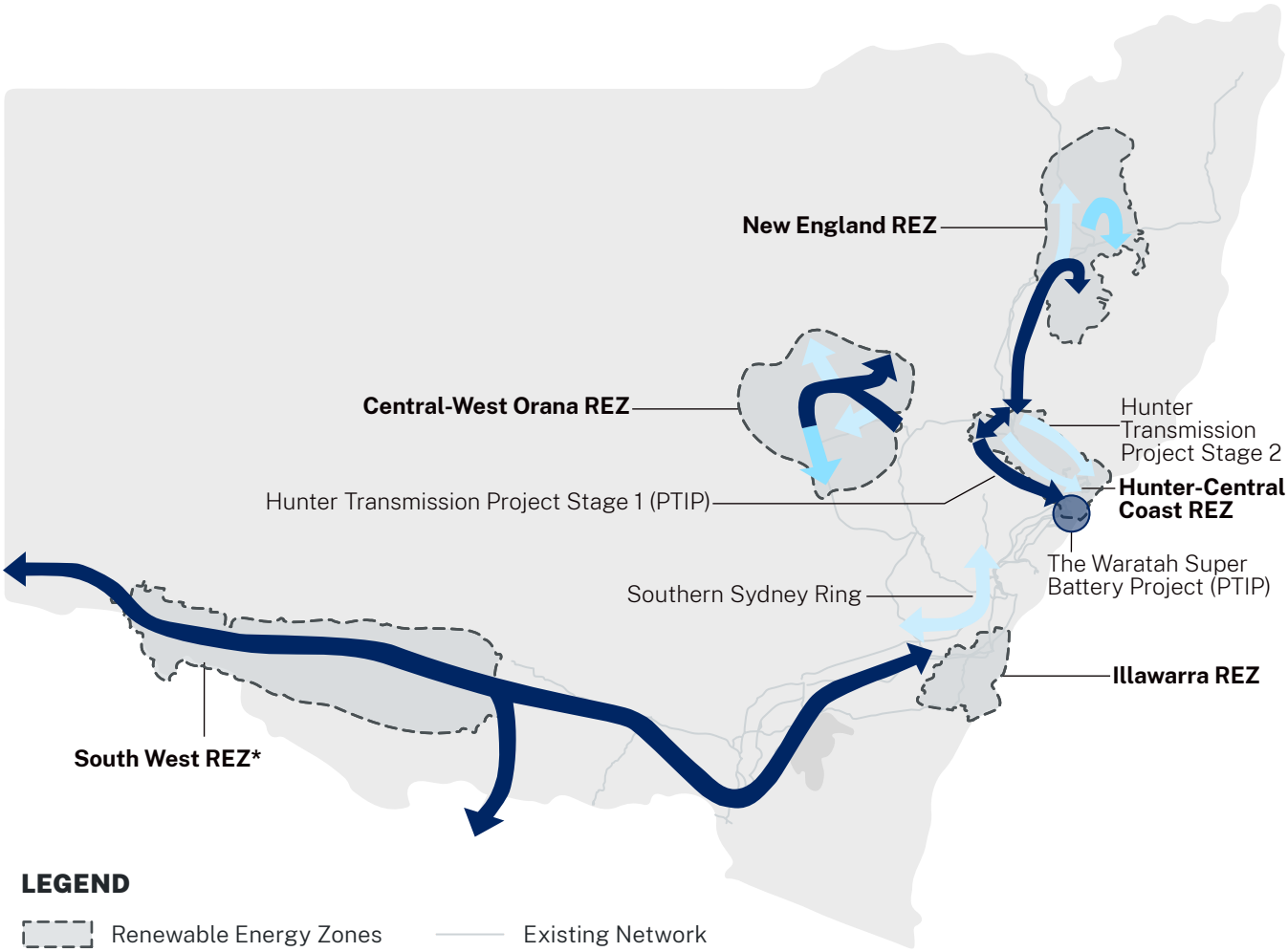
Notes to this table are set out in the equivalent Table 3 on page 24 below.

Table 2: Key downstream network augmentations to meet Energy Security Target and to support REZ development

	Deliver Now for secure and affordable energy	**Secure Now** for resilience against early coal closures	**Plan for the Future** to enable strong future electrification
Total downstream network capacity added	**5.9 GW**	-	**10.5 GW**
Hunter Transmission Project (PTIP)	5 GW	-	6 GW[a]
The Waratah Super Battery Project (PTIP)	0.9 GW[c]	-	-
Southern Sydney Ring[d] (TBC)	-	-	4.5 GW[e]
Construction cost preliminary estimates[b]	**$1.9 billion**	-	**$4 billion**

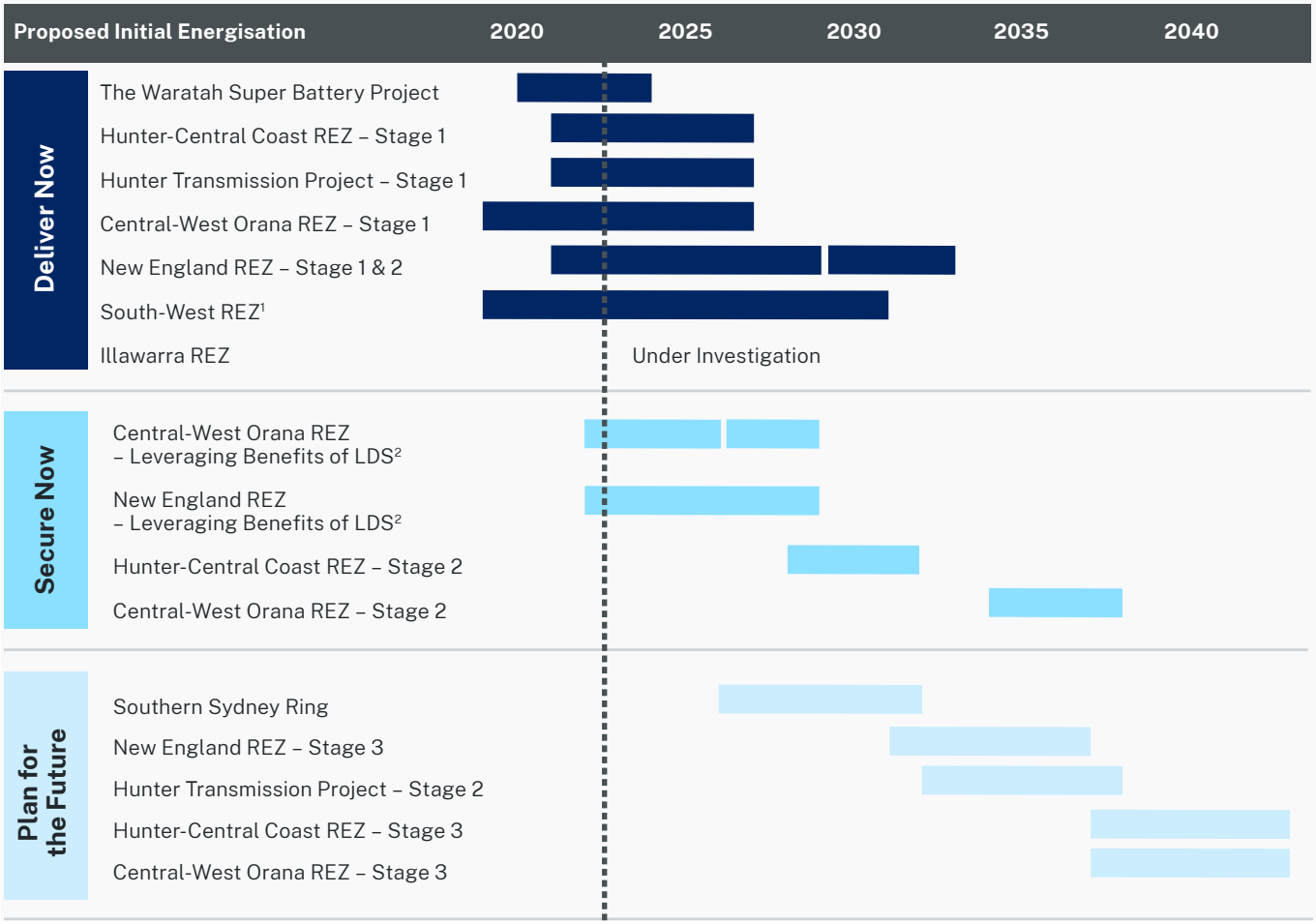
Notes to this table are set out in the equivalent Table 4 on page 24 below.

Figure 2: Reference map of NSW network infrastructure and REZs



*Network infrastructure delivered through Transgrid's ISP projects EnergyConnect, HumeLink and VNI West

Figure 3: Proposed timeline for Network Infrastructure Options



[1] Network augmentations creating this capacity are being delivered under the National Electricity Rules framework, in line with the timing outlined

[2] Long-duration storage

Deliver Now: progress as quickly as possible for delivery by 2033 at the latest

These options are required in the near-term to support grid-scale generation and storage in REZs and maintain supply of electricity as coal-fired plants close. They are 'no regret' options as they benefit electricity consumers under all modelled scenarios. While some of the options included as *Deliver Now* have been updated for the latest project information since the modelling was undertaken, they are largely similar and achieve comparable outcome to the modelling exercise. Delivering them within a decade (by 2033) is a priority, working closely with communities to manage impacts and maximise benefits and opportunities.

- **Central-West Orana (CWO) REZ:** add 4.5 GW of network capacity, with new lines to connect five new substations to the existing network.
- **New England REZ:** add 6 GW of network capacity, with new lines to connect four new substation hubs to the existing network between Bayswater and the Tamworth–Armidale line. This is proposed over two stages of 2.4 GW and 3.6 GW.
- **Hunter-Central Coast (HCC) REZ:** add 1 GW of network capacity, with two new and one upgraded lines to connect new substation hubs to the existing network in the Upper Hunter.
- **South West REZ:** add 2.5 GW of network capacity, through the ISP projects EnergyConnect, HumeLink and the Wagga Wagga to Dinawan section of VNI West.
- **Hunter Transmission Project Stage 1:** add 5 GW of network capacity with a 500 kV double circuit line between Bayswater and Eraring power stations, providing capacity for the CWO, New England and HCC REZs. This project is essential to alleviate downstream network constraints when the total power transmitted from CWO, New England and HCC REZs exceeds 3 GW.
- **The Waratah Super Battery Project:** add 0.9GW of network capacity from a 700MW SIPS scheme provided by a standby battery at the site of the former Munmorah coal-fired power station, and minor upgrades to Transgrid's existing network.

Together, all *Deliver Now* options would constitute approximately 1,200 km of new REZ network infrastructure, with a preliminary construction cost estimate of $7.8 billion (+/- 50% and excluding finance and connection costs).

Secure Now: act now to secure, as likely to be needed in the 2030s

Additional network options are likely be required over the next two decades. They would add resilience in the event of further early coal closures or transmission project delays. Although these projects would not be proposed until future editions of the Strategy, actions should be taken now to secure the ability to deliver these options, if needed, in a timely and cost-effective way.

- **Central-West Orana REZ:** add 2.3 GW of network capacity, by uprating the Merotherie–Elong Elong lines, and by adding a new line to Burrendong via Uungula and upgrading the existing network near Bathurst to leverage the full benefits and ancillary services of long-duration storage (LDS) to benefit the REZ and power system.
- **New England REZ:** add 0.8 GW of network capacity by upgrading an existing line between Armidale and Carrai to leverage the full benefits and ancillary services of LDS to benefit the REZ and power system.
- **Hunter-Central Coast REZ:** add 0.5 GW of network capacity with a new switching station.

The exact timing of these options, including their potential addition to *Deliver Now*, would be assessed by EnergyCo as Infrastructure Planner prior to recommending any project to the Consumer Trustee for authorisation.

Plan for the Future: may be needed in the 2030s to support electrification

These options may be required in the decade after 2033 if there is accelerated electrification of the economy and/or a large-scale hydrogen industry.

- **Central-West Orana REZ:** add 3.5 GW of network capacity with new lines to the north-west of the REZ.
- **New England REZ:** add 1.5 GW of network capacity with a new line to the north-west and further reinforcement of *Deliver Now* infrastructure.
- **Hunter-Central Coast REZ:** add 1.5 GW of network capacity by meshing the Muswellbrook substation with the Tamworth–Liddell line and upgrading the Liddell–Tomago line.
- **Hunter Transmission Project Stage 2:** add 6 GW of network capacity to link Central NSW with Sydney, Newcastle and Wollongong flow path and enable the CWO and New England REZs to operate at their intended capacities.
- **Southern Sydney Ring (SSR):** add 4.5 GW of network capacity, depending on interactions with the Illawarra REZ and Forestry NSW plantations (see Sections 2.4.5).

On the information currently available, these three categories of Network Infrastructure Options are the most likely to ensure clean, reliable and affordable electricity to NSW homes and businesses through the next two decades.

Windmills at Boco Rock Wind Farm, Nimmitabel.

The Strategy supports up-front scale-efficient investment where appropriate

The proposed Network Infrastructure Options aim to support the EII Act infrastructure investment objectives and deliver the declared intended network capacities for each REZ.

EnergyCo's assessment of modelling results and the realities of project delivery suggest that the intended REZ network capacities may be refined and rebalanced to optimise benefits to consumers and communities across NSW. This is in keeping with the Strategy being the latest, but not the final, iteration of NSW coordinated network planning: see Section 2.2.

In the future, the network capacity for the CWO REZ could increase from the intended 3 GW to at least 4.5 GW with just the *Deliver Now* options, and up to approximately 10 GW if all future options were exercised. At the same time, the *Deliver Now* options for the New England REZ would limit its network capacity to 6 GW, down from the intended 8 GW, although additional capacity would be considered for future expansions.

Providing large-scale network options will help:

- reduce inconvenience to local communities by minimising the number of large construction projects, where we expect the network capacity will be used
- leverage economies of scale to help deliver network infrastructure at the lowest unit cost to consumers
- provide flexibility in circumstances where new capacity is needed sooner than anticipated, and
- enable increased competition for Long Term Energy Service Agreements (LTESAs) and access rights, delivering benefits to NSW electricity consumers.

The NSW Government is also exploring options for small-scale distribution network upgrades and storage projects that would complement this Strategy's network options by improving electricity affordability and reliability in the shorter term, while the large-scale REZ and PTIP network projects are being built.

Field in Wellington, NSW.

Benefits from network investment are substantial

The Strategy proposes the network investments required to modernise the NSW energy sector. NSW energy consumers and the broader community will benefit from that investment in many ways, not least by substantially reducing greenhouse gas emissions.

- **Downward pressure on prices.** Well planned and executed network development puts downward pressure on electricity costs by reducing the barriers, risks and ultimate cost of renewable generation and storage. They counter the upward price pressures flowing from global resource and supply chain markets.

  The network investment, together with the other Roadmap mechanisms, is expected to deliver substantial net consumer benefits with a present value of $10.6 billion of 20 years.

  This has been calculated by comparing the *Central* scenario against preliminary No Roadmap modelling, developed independently by the NSW Office of Energy and Climate Change.

- **Regional social and economic benefits.** The Roadmap investments will create thousands of construction and operations jobs for regional communities, in addition to substantial lease payments to landholders and up to $265 million of community enhancement funds to local communities. Downward pressure on electricity prices helps alleviate cost of living pressures, and also improves the competitiveness of regional energy-intensive industries.
- **Insurance against market events.** Comparisons between the modelled scenarios also demonstrate how the timely investment in network infrastructure minimises costs and risks as existing generators retire. If coal-fired power stations retire earlier than expected and without network infrastructure in place, NSW consumers would face a less reliable grid, more expensive firming capacity, and higher electricity prices. Likewise, a delay in the planned delivery major network projects leads to greater reliance on more expensive firming and long-duration storage capacity.

Meaningful engagement with all stakeholders is needed

EnergyCo is committed to thoughtful engagement and collaborative practices when delivering its projects across the State.

Fostering local community support is integral to EnergyCo's approach to network planning and project development. Earning that support requires:

- appropriate respect for host, regional and First Nation communities and the issues they face
- clear principles to guide engagement, informed by studies and strategies to minimise impacts on communities and the environment, and
- a holistic package of programs to share the benefits of energy modernisation across all stakeholders, not just electricity consumers.

The industry collaboration needed to maintain downward pressure on prices against the weight of global markets is noted above. The second area of continuous industry collaboration is in maintaining energy system reliability and security. EnergyCo will continue to collaborate with the Consumer Trustee, AEMO, Transgrid and Network Service Providers to maintain reliability and security throughout the transition. Driving that collaboration are the Energy National Cabinet Reform Committee and dedicated NSW funding initiatives such as the Long Duration Storage Recoverable Grants program (formerly the Pumped Hydro Recoverable Grants Program).

Next steps

The Consumer Trustee considers the Network Infrastructure Options in preparing its Infrastructure Investment Objectives Report (IIO Report), which sets a 20-year development pathway for NSW's generation, firming and long-duration storage infrastructure.

As Infrastructure Planner, EnergyCo will develop the design of each option, with detailed stakeholder engagement, before recommending a network solution to the Consumer Trustee for authorisation.

All major network projects are subject to the NSW planning assessment process, which includes consultation during two further stages:

- environmental impact statements, which evaluate the social, environmental and economic impacts of network infrastructure, and
- development consents and management plans, which sets the conditions to be met during project construction and operation.

EnergyCo looks forward to engaging and working with communities, consumers, the Consumer Trustee and industry on the continued modernisation of NSW's energy system.

Father and children on a walk in Yarriabini National Park.

Feedback and responses on the Draft Strategy

In the Draft Strategy consultation, EnergyCo received 43 submissions from industry, network businesses, community associations, individuals, advocacy groups, local councils, and government bodies. The Final Strategy incorporates this feedback and foreshadows future iterations to continue working to address the issues raised.

The major themes in the submissions indicated:

Overall support for the Strategy as a useful addition to the transmission planning framework to ensure network projects are delivered in a timely and efficient manner to benefit NSW consumers. The 'option-rich' approach to REZ network planning can accommodate diverse future generation needs without burdening communities with multiple rounds of consultation and development on the same portion of network infrastructure. While the Strategy brings together national and state long-term planning frameworks, it could also consider short-term network needs.

Request for further detail around the option-rich approach and how this provides certainty to communities and industry as network development is undertaken. While this detail will be developed throughout the network development process, it is important to clarify how and when stakeholders will have further opportunities to provide input. This detail must be accessible to both industry and communities; direct engagement may allow better understanding for landholders and local communities.

Both communities and industry welcome further engagement throughout the development process. This is relevant for both communities and industry to foster local community support, ensuring greater community and local government voice throughout the planning development process, and for industry to better understand trends in hydrogen, offshore wind, long-duration storage, non-network solutions, the distribution network, demand management and energy usage.

EnergyCo has sought to address as much of this feedback as possible in this Strategy. In particular, it has:

- further clarified how the Strategy complements the IIO Report, with EnergyCo working closely with the Consumer Trustee to align this and future editions of the Strategy and IIO Report
- identified the nature and timing of project options, especially those options that are needed soonest
- clarified how EnergyCo's guiding principles help EnergyCo propose those options, and the Consumer Trustee to select the optimal schedule, and
- set out EnergyCo's approach to ongoing community and industry engagement to ensure the best possible outcomes for host communities and NSW consumers.

The Strategy process is one of several EnergyCo and NSW Government initiatives to facilitate comprehensive engagement between communities and the Roadmap entities. Full details of our approach to engagement are on the EnergyCo website at www.energyco.nsw.gov.au.

Introduction

As set out in the Executive Summary, the modernisation of NSW's energy system requires a backbone of critical network infrastructure.

The Strategy is for the practical coordination of this network infrastructure with NSW's generation, firming and storage infrastructure over the next 20 years, particularly through Renewable Energy Zones (REZs) and Priority Transmission Infrastructure Projects (PTIPs).

The Strategy is set out in this document in four parts:

Part 1 **The 2023 Network Infrastructure Strategy** proposes 14 GW of Network Infrastructure Options to progress as quickly as practicable for delivery over the next decade (by 2033), with further options considered beyond that.

Part 2 **The coordinated development of REZ network infrastructure** is guided by the NSW Roadmap, the EII Act and the Strategy, and by various statutory 'Roadmap entities' including EnergyCo. A range of emerging technologies may be considered in future-proofing NSW's dynamic energy system.

Part 3 **Engagement with community and industry stakeholders** will continue to ensure that NSW's energy transformation delivers affordable, reliable and progressively clean electricity for NSW consumers, and appropriate benefits and minimal impacts for host, regional and First Nations communities.

Part 4 **The Network Infrastructure Options have been selected by EnergyCo** from 55 potential options, drawing on economic analysis by the Consumer Trustee and principles agreed with stakeholders, through a systematic four-step process.

Car on a highway in Wollongong underneath transmission lines.

The Strategy and IIO Report help future-proof NSW's energy needs

The complementary roles of the IIO Report and the Strategy are set out in Box 1 below. Together, they are intended to:

- co-optimise and coordinate the development of all NSW electricity infrastructure in the long-term interests of NSW consumers and communities
- add to guidance, confidence and certainty for investors, consumers and communities on coordinated electricity infrastructure delivery, and
- facilitate meaningful engagement with industry, consumer and community stakeholders on all elements of the pathway.

The Strategy is for the practical coordination of NSW *network* infrastructure, identifying new network options to support the benefits anticipated by the NSW Roadmap. (As Infrastructure Planner, EnergyCo will further assess and refine these and potentially other options before recommending any network project for authorisation.)

The Consumer Trustee considers these options in preparing the Infrastructure Investment Objectives Report (IIO Report), with a development pathway and tender plan to guide investment in NSW *generation*, *firming* and *long-duration storage* infrastructure.

These roles are part of the coordinated planning and delivery of NSW's electricity infrastructure, set out fully in Part 2 below.

Box 1: Complementary roles of the IIO Report and Network Infrastructure Strategy

IIO Report focuses on generation, long-duration storage and firming infrastructure

- Provides a 20-year development pathway for generation, long-duration storage and firming in NSW, including to meet the minimum infrastructure investment objectives as legislated in the EII Act
- Provides a 10-year tender plan for generation, long-duration storage and firming to give effect to the development pathway
- Considers the Strategy as a key input to help co-optimise the development of generation, storage, and network infrastructure, and
- Provides a forecast of wholesale electricity costs and costs for NSW electricity consumers that are due to contributions required to be paid by distribution network service providers under the EII Act.

Network Infrastructure Strategy focuses on network infrastructure

- Provides a 20-year strategy for the coordinated development of network infrastructure to deliver Renewable Energy Zones and other supporting infrastructure to meet the IIO development pathway and broader objectives of the EII Act

  The strategy consists of a proposed development sequence of REZ and PTIP projects embedded in the broader context of ISP projects
- Provides network infrastructure options for consideration in the IIO Report to help co-optimise the development of generation, storage and network infrastructure
- Identifies potential network infrastructure options for recommendation to the Consumer Trustee and/or Minister for Energy, and
- Investigates the extent of NSW's energy resources and opportunities to inform the IIO, joint network planning, industry, communities, and potential government policies.

Box 2: Network infrastructure includes lines, easements and substations

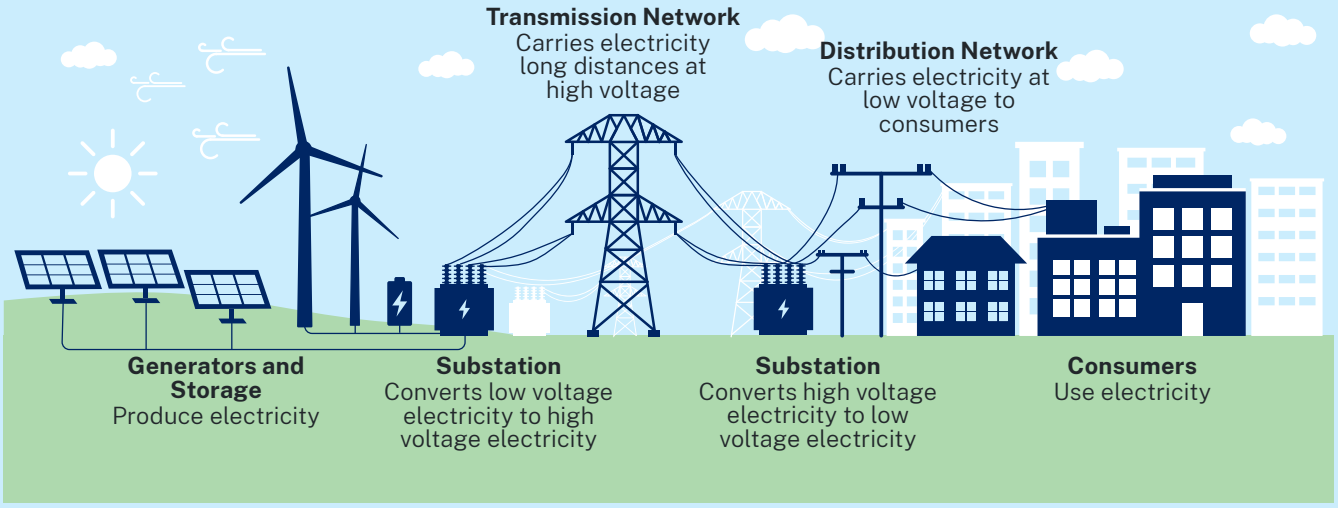
Transmission is the high-capacity backbone infrastructure that transports electricity to NSW consumers. It stretches thousands of kilometres across the state, connecting multiple sources of energy generation and storage to demand centres, so that electricity can be produced, stored and consumed when needed and from the lowest cost sources possible.

Distribution is lower capacity infrastructure that delivers electricity to NSW consumers. In urban areas, distribution network infrastructure is generally local and in regional areas, distribution network infrastructure traverses long distances to deliver electricity to regional towns and localities. The role of distribution infrastructure is changing significantly, from traditionally one-way power flows to multi-directional flows that facilitate integration of small-scale generation.

The major components of a transmission network include:

- **Transmission or distribution are:** towers or poles with metal conductors, or wires, strung between. Transmission towers are typically steel towers 40m to 80m high and spaced around 500m apart (subject to the terrain). They each typically have one or two sets of conductors, and operate at voltages of 132kV, 220kV, 330kV or 500kV, depending on capacity requirements. Distribution towers or poles are typically concrete, steel or wood within 50m height, spaced closer than transmission towers. They each typically have one or two sets of conductors, and operate at voltages up to 132kV.
- **Easements** are held by Network Operators over the land on which transmission is built. Easement corridors provide "right of way" access for construction, operation, maintenance and public safety. They span the entire length of the transmission line and can be up to 70m wide, depending on the line requirements.
- **Substations** are located where lines of different operating voltages connect, and have transformers to step the operating voltage up or down. Substations contain switching, controlling, metering and connection points and other equipment to control the flow of electricity through the network.

Figure 4: Network infrastructure examples



Overhead transmission lines are most common globally as they best balance the considerations of cost, risk, reliability and transfer capacity.

Underground transmission is used in rare cases where it is not feasible to secure a corridor for overhead lines, such as in already developed urban areas or undersea. Underground cables can seem attractive, offering less visual impact than overhead lines. However, underground cables at transmission voltages have significantly higher capital and operating cost, materially longer repair times, lower transfer capacity and often require a similar easement footprint as overhead lines. Underground distribution is more commonly used as these issues are not as prevalent at lower voltages.

Underground cables can be high voltage alternating current (HVAC), similarly to most existing overhead transmission lines, or high voltage direct current (HVDC), similarly to most undersea transmission cables. Where underground cables are used, they are estimated to be many times more expensive than traditional overhead lines, with the cost differential varying significantly with project alignment and scope. The variations are due to the cost of the cable, the higher levels of insulation, the need for additional plant and equipment where lines transition from overhead to underground, including large structures that need to be carefully sited. The digging and additional structures add time to planning and construction, with greater disturbance to the environment during construction, and total costs that are similarly many times greater than overhead lines. If there is a failure on a cable, it is more difficult to find and repair the location and cause, requiring longer outages, and the cables cannot be uprated to increase their capacity.

The costs and benefits of undergrounding were independently assessed for the HumeLink project in NSW. The assessment found that an underground transmission for that project scope would cost more than three times that of the overhead options, with a 2- to 3-year delay in project delivery.[3]

Box 3: Network and Generation Capacity (defining "GW")

Network Capacity and Generation Capacity are two different measures, both measured in gigawatts (GWs), used in the planning and regulation of network infrastructure, including in the EII Act. The terms are not interchangeable, and the use of 'GW' in this document refers to Network Capacity, unless otherwise stated.

- **Network Capacity, also known as transfer or transmission capacity**, is the maximum instantaneous amount of electricity that can be transmitted from one point of a network to another without exceeding its operating constraints. That amount is determined by a number of factors including the network configuration, generator dispatch configuration, ambient temperature, stability limits – so it may vary with seasons, generation output, loads and power system conditions. The Network Capacity of a REZ is therefore the maximum amount of power that can be transmitted from generators in the REZ within the REZ or to the broader network at any point in time.
- **Generation Capacity, also called Installed Renewable Capacity**, is the amount of 'nameplate' renewable generation that is (or can be) connected to a given section of the network. The nameplate capacity of a solar or wind generator is its maximum in ideal conditions, so actual generation is typically less as sun and wind conditions vary. Because of this, the maximum generation capacity of a REZ is typically higher than its network capacity – otherwise the network would have idle capacity in all but ideal generation conditions. When generation within a REZ exceeds the Network Capacity, renewable generation is curtailed. The acceptable level of curtailment within a REZ, termed the Target Transmission Curtailment Level (TTCL) is specific to each Access Scheme and is set to deliver efficient utilisation of the network in the long-term financial interest of consumers.

Part 1: The NSW Network Infrastructure Strategy

1

Aerial view of powerlines at sunset.

The Strategy proposes a schedule of Network Infrastructure Options to enable NSW to meet legislated infrastructure investment objectives,[4] and to deliver clean, affordable and reliable electricity in the long-term interests of NSW consumers and communities.

To do so, EnergyCo has had regard to economic analysis undertaken by the Consumer Trustee for the Draft IIO Report, guiding principles agreed with stakeholders, and the latest project information (see Part 4).

The 2023 Network Infrastructure Strategy proposes 14 GW of Network Infrastructure Options to progress as quickly as practicable for delivery over the next decade (by 2033), with further options considered beyond that.

This Part 1 sets out the components of the NSW Network Infrastructure Strategy:

1.1 an overview of the Network Infrastructure Options and their calculated financial benefits to NSW electricity consumers

1.2 the Network Infrastructure Options proposed for the five Renewable Energy Zones

1.3 the options proposed for the two NSW priority transmission infrastructure projects (PTIPs), and

1.4 the major ISP projects and other projects that complement the NSW options to complete the coordinated planning of NSW's electricity network.

The Consumer Trustee will independently consider the options in the Strategy and may adopt some or all of them in the Final 2023 IIO Report: see Part 2.

The EII Act also requires and EnergyCo is committed to ensure that the delivery of network infrastructure brings economic, employment and social benefits for host and First Nations communities. Development of the Network Infrastructure Options will contribute to those benefits, and the Roadmap also offers a range of regional development, employment, training and social infrastructure opportunities: see Part 3.

Power poles at Ropes Creek greenfield area.

1.1 Overview of the 20-year Network Infrastructure Strategy

This section sets out:

- the 14 to 24 GW of additional network capacity proposed by the Strategy, in three market-responsive categories
- how the proposals align with intended network capacities and favour up-front scale investment where appropriate, and
- the financial and broader social and economic benefits that the network investment is expected to deliver to consumers and communities.

1.1.1 Three categories of options would add 14 to 24 GW of network capacity

The electricity generation projected for NSW over the next 20 years (see Figure 1) would far exceed NSW's existing network capacity. In response, the Strategy proposes adding between 14 GW and 24 GW of network capacity over the next 20 years, depending on the modelled scenario.

This capacity would be delivered by three categories of Network Infrastructure Options, set out in Table 3 and described below it:

- *Deliver Now* options would progress as quickly as possible for delivery by 2033 at the latest, to secure NSW's future energy supply ahead of the announced retirement of coal-fired power stations.
- *Secure Now* options would likely be needed in the 2030s to add further network capacity, and resilience against earlier coal closures and potential delays of other network projects.
- *Plan for the Future* options may be needed in the 2030s to support the economy-wide electrification of transport, industry and domestic appliances needed to reach net zero emissions.

The Strategy also proposes this categorisation for major projects downstream from the REZs to support the NSW network: the Hunter Transmission Project, the Waratah Super Battery Project, and the Southern Sydney Ring ISP project (see Table 4).

These three categories offer high-level guidance on the need, location and timing of the options. As Infrastructure Planner, EnergyCo will develop the design of each option, through detailed stakeholder engagement, before recommending a network solution to the Consumer Trustee for authorisation. All major network projects are subject to the NSW planning assessment process.

Windfarm at Lake George, NSW.

Table 3: REZ network capacity increases to be delivered by Network Infrastructure Options

	Deliver Now for secure and affordable energy	**Secure Now** for resilience against early coal closures	**Plan for the Future** to enable strong future electrification
Total REZ network capacity added	**14 GW**	**3.6 GW**	**6.4 GW**
Central-West Orana	4.5 GW	2.3 GW	3.5 GW
New England	6 GW	0.8 GW	1.5 GW
South West[a]	2.5 GW	-	-
Hunter-Central Coast	1 GW	0.5 GW	1.5 GW
Illawarra	Not modelled[b]		
Construction cost preliminary estimates[c]	**$7.8 billion**	**$1.5 billion**	**$3.0 billion**

a. South West REZ transfer capacity is delivered through ISP projects. The cost has not been included here as this capacity will be delivered through Project EnergyConnect, HumeLink and the Wagga Wagga to Dinawan section of VNI West.

b. Not modelled due to early-stage development of Illawarra REZ at the time of modelling for the Strategy. The Illawarra REZ has an intended network capacity of 1 GW and Network Infrastructure Options will be considered in the next Strategy.

c. Estimates are Class 5b accuracy (i.e. +/- 50%) and for development and construction costs only (excluding finance, generator connection and system strength costs). This provides a comparable basis with estimates for projects under the National Electricity Rules. The total cost for a REZ also includes finance, generator connection and system strength costs at typically an additional 70% to 110% of development and construction costs. Generator and storage proponents that hold access rights will contribute connection and system strength costs. All values are in real 2021 Australian dollars.

Table 4: Key downstream network augmentations to meet Energy Security Targets and to support REZ development

	Deliver Now for secure and affordable energy	**Secure Now** for resilience against early coal closures	**Plan for the Future** to enable strong future electrification
Total downstream network capacity added	**5.9 GW**	-	**10.5 GW**
Hunter Transmission Project (PTIP)	5 GW	-	6 GW[a]
The Waratah Super Battery Project (PTIP)	0.9 GW[c]	-	-
Southern Sydney Ring[d] (TBC)	-	-	4.5 GW[e]
Construction cost preliminary estimates[b]	**$1.9 billion**	-	**$4 billion**

a. This is an indicative capacity that has been derived from early power system analysis studies. More detailed investigation is required to determine scope and timing.

b. Estimates are Class 5b accuracy (i.e. +/- 50%) and for development and construction costs only (excluding finance, generator connection and system strength costs). This provides a comparable basis with estimates for projects under the National Electricity Rules. The total cost for a REZ also includes finance, generator connection and system strength costs at typically an additional 70% to 110% of development and construction costs. Generator and storage proponents that hold access rights will contribute connection and system strength costs. All values are in real 2021 Australian dollars.

c. The Waratah Super Battery Project refer to the BESS component (0.85GW/1.68GWh), a 700MW SIPS scheme and minor upgrades to Transgrid's existing network.

d. The Southern Sydney Ring may be delivered under the National Electricity Rules or under the EII Act.

e. Cost estimates taken from AEMO ISP 2022 – Appendix A5 – A5.4.3 for the Southern Sydney Ring.

Deliver Now: Options to be progressed as quickly as possible for delivery by 2033 at the latest

The *Deliver Now* Options set out in Table 5 below are 'no regret' options, required in all modelled scenarios to support grid-scale generation and storage in REZs, and a reliable and affordable supply of electricity as coal-fired plants close. Approximately 1,200 km of new network infrastructure would be needed by 2033, with construction costs estimated at $7.8 billion (+/- 50%). Delivering these projects is a priority, working closely with communities to manage impacts and maximise benefits.

EnergyCo has set up dedicated project development teams and prepared initial delivery schedules for *Deliver Now* options in four of the five declared REZs[5] and two PTIPs: see Section 3.

The dates proposed for commissioning of the *Deliver Now* options, together with projects delivered through the national framework, would support the connection of generation and storage infrastructure to meet the EII Act's minimum infrastructure investment objectives for 2030.

The scheduled energisation dates are the current best estimate based on work underway, including that of the ISP projects: see Section 4.3. Initial energisation dates may be optimised as projects mature. For example, CWO and New England REZs have their earliest energisation dates earlier than the modelled entry dates, reflecting most contemporary understanding of the schedule of work. In particular, EnergyCo and the Roadmap entities, in close collaboration with industry, are exploring opportunities to accelerate delivery of these projects to minimise price and reliability risks to consumers if coal generators exit faster than announced.

Some of the energisation dates are slightly earlier than the modelled delivery dates. EnergyCo is proposing this approach to insure against possible delivery delays of REZ network infrastructure projects, modelling imperfections and the risk of earlier retirement of existing generators. It is generally better for a project to be slightly ahead of schedule than to be late, which can lead to costly wholesale electricity price rises.

Table 5: Proposed timing for initial energisations

Projects	Initial Energisation
Waratah Super Battery Project	2025
South West REZ	2026 (PEC), 2028 (HumeLink)
Hunter-Central Coast REZ	2027
Hunter Transmission Project	2027
Central-West Orana REZ	2027/2028
New England REZ	2029

Secure Now: Options for likely delivery in the 2030s

Secure Now options would add further network capacity and provide resilience against early coal closures or the delay of other major network projects. They would be required in the 2030s unless other developments address these needs (such as large-scale offshore wind or a private REZ).

Actions should be taken now to secure the ability to deliver these options in a timely and cost-effective way, with consideration given to minimising the number of large construction projects for local landowners on transmission corridors. Their scale and timing can be refined as market conditions change, including the final design and timing of preceding REZ projects, and revised in future editions of the Strategy. Planning could include strategic procurement of easements and/or property where this would be prudent to enable the options.

Secure Now projects may be re-categorised as *Deliver Now* in the future if that consolidated planning would reduce costs through scale efficiencies and reduce community and landholder impacts.

The exact timing of these options, including their potential addition to *Deliver Now*, would be assessed by EnergyCo as Infrastructure Planner prior to recommending any project to the Consumer Trustee for authorisation.

Plan for the Future: Options for the 2030s, conditional on electrification needs

Plan for the Future options would support the economy-wide electrification of transport, industry and domestic appliances that is needed to achieve net zero emissions. Their timing and scale would depend on the speed and scale of electricity demand. That in turn depends on the evolution of transport and heavy industry technologies, the adoption of rooftop solar and community or household batteries and, in particular, the possibility of a green hydrogen export industry. Economy-wide electrification will significantly impact both large-scale development in and around REZs, and small-scale development outside REZs.

Options in this category would remain at the concept stage until their need is confirmed, while considering the time taken to develop projects and the potential speed of change in market conditions. EnergyCo will continue to consider electricity demand trends and the potential for these options to meet that demand cost-effectively.

1.1.2 Alignment with declared REZ network capacities

The proposed Network Infrastructure Options aim to support the EII Act infrastructure investment objectives as well as the intended network capacities for each REZ.

EnergyCo's assessment of network demand and the realities of project delivery suggest that some declared REZ network capacities could be refined and rebalanced to optimise benefits to consumers and communities across NSW. This is in keeping with the Strategy being the latest, but not the final, iteration of NSW coordinated planning: see Section 2.3.

The Strategy suggests that:

- for the CWO REZ, the *Deliver Now* options would add at least 4.5 GW[6] of network capacity, up from the intended 3 GW, and later up to approximately 10 GW if all future options were exercised, and
- for the New England REZ, the *Deliver Now* options would add 6 GW, down from the intended 8 GW, although more capacity could be added if needed.

The Strategy outlines a plan for REZ and PTIP projects to be developed at scale during the *Deliver Now* period. Building greater network capacity up-front would:

- reduce inconvenience to local communities, as more frequent and incremental REZ development may prolong construction impacts, especially in the greenfield REZs of Central-West Orana and New England
- secure economies of scale that help deliver network infrastructure at the lowest unit cost to consumers
- provide flexibility if new capacity in a REZ is needed sooner than anticipated, due to a coal-fired power station retiring early or delays to transmission or generation projects elsewhere, and
- enable increased competition for LTESAs and access rights in competitive tenders, delivering cost benefits to NSW electricity consumers.

The NSW Government is also exploring options for small-scale distribution network upgrades and storage projects that would complement this Strategy's network options by improving electricity affordability and reliability in the shorter term, while the large-scale REZ and PTIP network projects are being built.

1.1.3 Financial and broader benefits from network investment

The Strategy proposes network investments that are required to modernise the NSW energy sector, investments that will put downward pressure on electricity prices and bring material economic and social benefits to regional communities. The modelling analysis suggests that the financial benefits increase further if coal-fired plants retire earlier than expected, or if major transmission or generation projects are delayed.

Downward pressure on prices

Well planned and executed transmission development will unlock abundant low-cost renewable energy resources and put downward pressure on electricity costs. Actions by EnergyCo and other Roadmap entities will optimise the timing and scale of energy infrastructure development through their planning, stage capital deployment, run highly competitive procurements for generation, storage and network infrastructure, leverage new network, generation, and storage technologies, and enact policies that help reduce finance costs.

This work counters upward price pressures flowing from global markets. The demand for essential components, equipment, skills and labour is forecast to be high, as NSW will be decarbonising its energy system at the same time as all the world's major economies. At the same time, global resource markets and supply chains may be subject to the type of disruptions experienced through the COVID-19 pandemic and the Ukraine War. We are engaging with industry on how to manage these challenges prudently: see Part 3.

Net consumer benefits of $10.6 billion

The network investment, together with the other Roadmap mechanisms, is expected to deliver substantial net consumer benefits with a present value of $10.6 billion of 20 years.

This has been calculated by comparing:

- the Consumer Trustee's modelling of the forecast generation, long-duration storage, firming and network investment required to achieve the legislated targets, across the three modelled scenarios (see Section 4.3), and
- preliminary *No Roadmap modelling*, where the proposed Roadmap network infrastructure are delayed and scaled down, developed independently by the Office of Energy and Climate Change.[7]

The calculated impacts incorporate changes in wholesale electricity costs, top-up payments to firming providers, LTESA costs and transmission investment. The wholesale costs are the costs paid in the market for the electricity provided to customers by utility-scale generation, storage, and firming infrastructure.

In the *Central* scenario, Roadmap-related network construction cost represents about 5% of consumers' wholesale electricity costs over the 20-year modelling horizon. In the No Roadmap Counterfactual scenario, the network construction cost is about 3% over that time frame, i.e. 2 percentage points lower, as transmission development is delayed and reduced. This translates to the *Central* scenario offering a $10.6 billion saving to consumers, in present net value terms.

Regional social and economic benefits

NSW energy consumers and the broader community will benefit from network infrastructure investment in many ways, not least by substantially reducing greenhouse gas emissions.

For regional communities, the Roadmap investments will create thousands of construction and operations jobs. In addition, they will lay the foundation for substantial lease payments to landholders who host generation and network, and provide up to $265 million of community enhancement funds to host local communities by 2042.

Apart from helping to alleviate cost of living pressures, the downward pressure on energy costs will also improve the competitiveness of regional energy-intensive industries, and may enable new export industries or energy-intensive digital industries.

Insurance against market events

Network investment provides insurance against the possibility that generators retire earlier than expected, or that major projects are delayed. Historically, generator exits have been followed by high-price periods for consumers. These benefits are shown by comparing the three scenarios modelled for the Strategy.

Firstly, Figure 5 below compares the outcomes of the *Central* and the *Coal Exit by 2030 with Strong Electrification* scenarios, that is, the value of network infrastructure if coal-fired power stations retire earlier than expected. The columns above the '0' line in Figure 5 show the extent of that increase, and in particular the expensive, additional firming capacity needed before 2030. Unless the additional generation, storage and firming infrastructure can connect to available network infrastructure, NSW consumers would face a less reliable grid, more expensive firming capacity, and even higher electricity prices.

Secondly, Figure 6 below compares the outcomes of the *Central* and *Transmission Delay* scenarios, and shows how a delay in major network projects leads to greater reliance on more expensive firming and long-duration storage capacity. Again, the columns above the '0' line in Figure 6 show the extent of that increase, and in particular the additional firming capacity needed before 2030. This would take the form of higher cost technologies such as gas generation, potentially increasing electricity prices for NSW consumers. Instead, the timely delivery of network infrastructure would protect against this by allowing low-cost renewable energy to connect.

Thirdly, comparing outcomes in the *Central* scenario to those in *Transmission Delay* shows how a delay in major network projects leads to greater reliance on more expensive firming and long-duration storage capacity. Again, the columns above the '0' line in Table 6 show the extent of that increase, and in particular the additional firming capacity needed before 2030. This would take the form of higher cost technologies such as gas generation, potentially increasing electricity prices for NSW consumers. Instead, the timely delivery of network infrastructure would protect against this by allowing low-cost renewable energy to connect.

This analysis confirms that NSW electricity consumers face higher electricity prices without appropriate investment in network infrastructure.

Figure 5: Additional expansion in generation capacity needed in *Coal Exit by 2030 and Strong Electrification* compared with *Central*

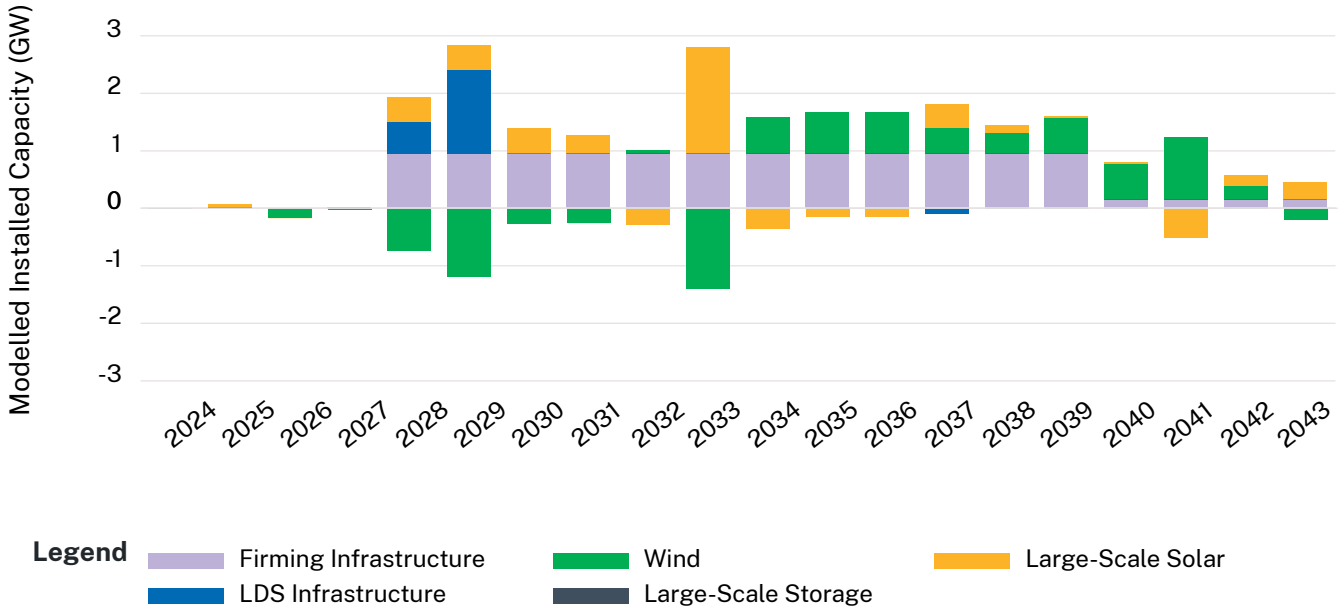
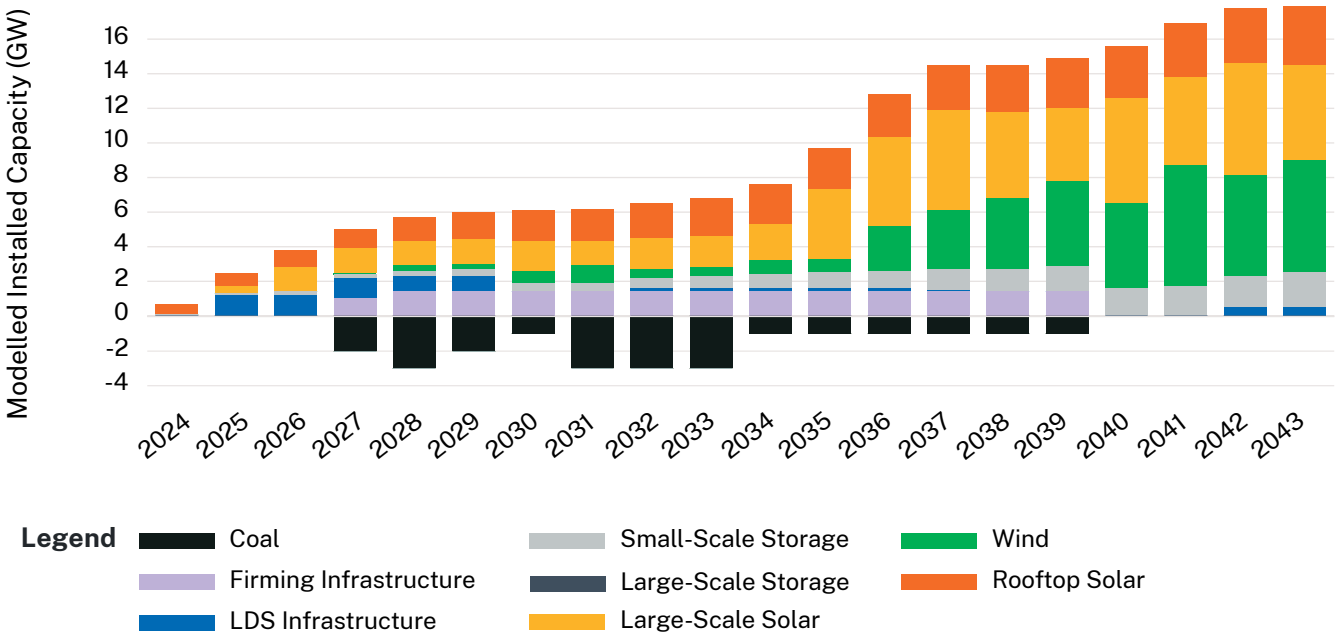


Figure 6: Forecast expansion of NSW generation capacity – comparison between *Transmission Delay* and *Central* scenarios



1.2 Network Infrastructure Options for each REZ

This section sets out the proposed Network Infrastructure Options (options) for four of NSW's five declared REZs. The options are designed to:

- deliver the REZs' intended network capacities
- form the basis for the Infrastructure Planner's recommendation of a network project for authorisation by the Consumer Trustee, and
- guide investors on the expansion of the NSW grid, reflecting current REZ project thinking and their potential development under modelled scenarios.

The options have been selected from the Draft Strategy's list of potential options (see Appendix B), refined further since the modelling process through stakeholder engagement by EnergyCo and each REZ project team, with feedback from communities and other stakeholders on delivery of the projects.

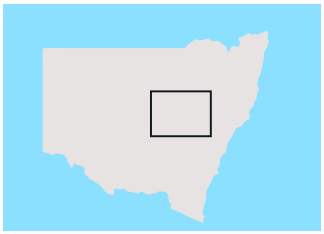
EnergyCo has used guiding principles to assess the options to ensure they deliver holistic benefits to local communities, the electricity network and NSW electricity consumers. Applying these principles will ensure that the options provide:

- Long-term benefit to NSW energy consumers and minimise long-term system costs
- Network benefits and efficient use of network capacity, as provided by pumped hydro and other storage technologies, to maintain a reliable and secure energy supply
- Flexibility to further expand the network as needed, and maintain value across potential future outcomes
- Opportunity for engagement throughout the planning process, and minimise interruptions for local communities throughout project construction
- Efficient and innovative solutions to the development of the network, and
- Ease of delivery, taking in account the practical delivery considerations of each project.

These guiding principles are discussed further in Part 4.

Person on a farm with solar panels.

Central-West Orana REZ



Legend

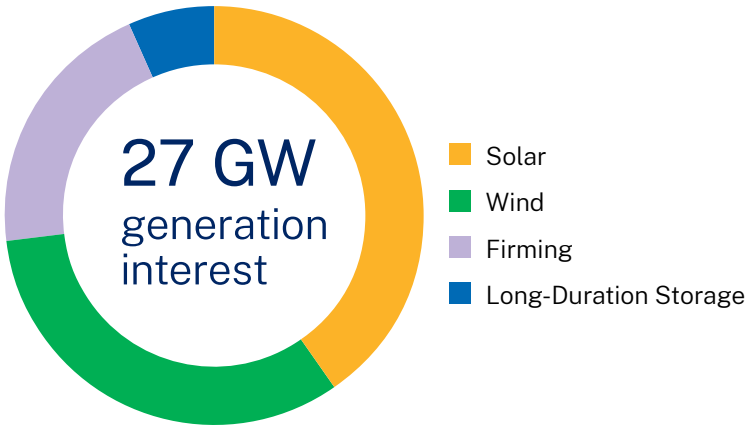
- Major Roads and Highways
- Existing 500 kV Network
- Existing 330 kV Network
- Deliver Now
- Secure Now
- Plan for the Future

3 GW intended network capacity

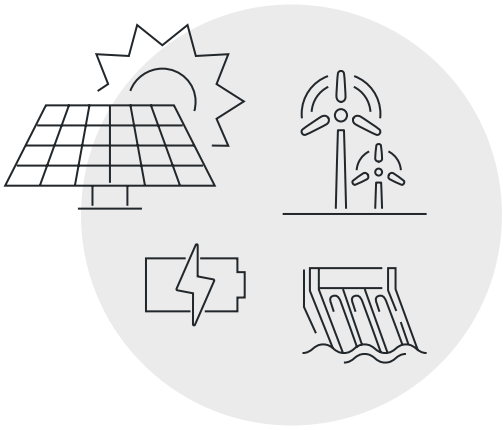
First ranked network operator announced

3,900 construction jobs

REZ Registration of Interest results



Anticipated technologies



REZ development status

1.2.1 Central-West Orana REZ

Central-West Orana is one of two REZs with large generation potential and good access both to quality renewable resources and to the existing electricity network. It was formally declared on 5 November 2021, with an intended network capacity of 3 GW.[8] However, the Consumer Trustee's modelling for this Strategy suggests that significantly more network capacity will be needed than intended in that original REZ declaration.

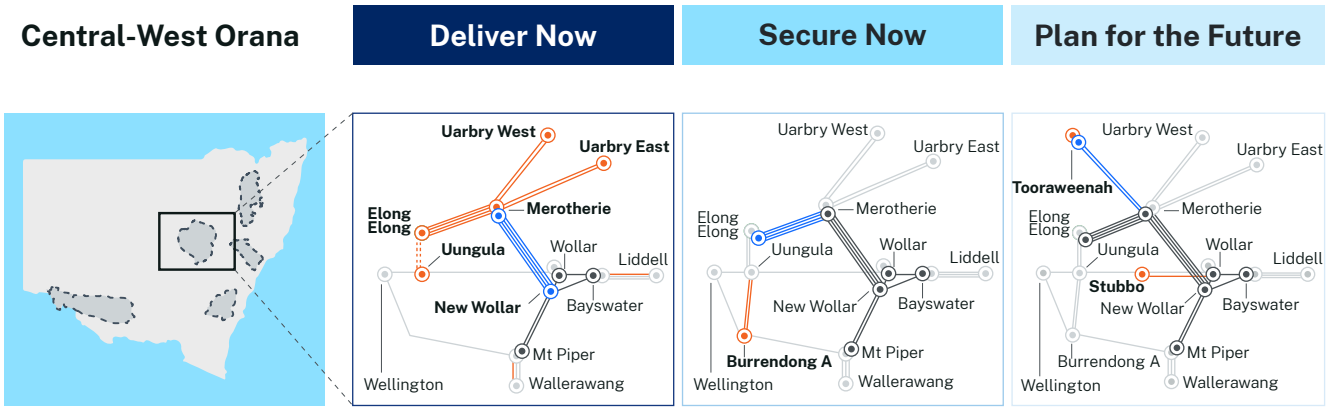
To meet the declared, modelled and potential long-term needs of the CWO REZ, the Strategy proposes the network arrangements laid out in Figure 7:

- **Deliver Now.** 4.5 GW capacity by 2027/2028, delivered by new 500 kV lines connecting a new hub at Merotherie to the existing network at Wollar, with 330 kV extensions to Elong Elong, Uungula and Uarbry West and East, and a possible expansion to Uunugla.
- **Secure Now.** An additional 2.3 GW capacity by 2038, delivered by uprating the Merotherie–Elong Elong lines to 500 kV, with an extension to Burrendong and upgrade in the Mt Piper area (off-map).
- **Plan for the Future.** An additional 3.5 GW capacity if needed, delivered by utilising the Merotherie–Elong Elong line to its full capacity, with extensions to the Gilgandra–Tooraweenah area and Stubbo.

The options proposed would deliver the needed capacity while reducing the number and duration of interruptions to local communities, offering flexibility if new capacity in a REZ is needed sooner than anticipated, and allow for greater competition for access rights through LTESA tenders, bringing delivery and cost benefits to NSW electricity consumers.

The high-level detail and rationale for each of the Network Infrastructure Options are set out below, along with their development status and next steps. Further detail is given in Appendix B.

Figure 7: Central-West Orana REZ indicative network arrangements



LEGEND

- Existing 330 kV circuit
- Existing 500 kV circuit
- New 330 kV circuit
- New 500 kV circuit
- Existing 330 kV substation/ switching station
- Existing 500 kV substation/ switching station
- New 330 kV substation/ switching station
- New 500 kV substation/ switching station

Extra capacity (GW)	4.5	2.3	3.5
Anticipated delivery timing	2027/2028	2029–2038	2043
Construction cost preliminary estimate	$3.2 billion	$0.8 billion	$1.3 billion

Estimates are Class 5b accuracy (i.e. +/- 50%) and for development and construction costs only (excluding finance, generator connection and system strength costs). This provides a comparable basis with estimates for projects under the National Electricity Rules. The total cost for a REZ also includes finance, generator connection and system strength costs at typically an additional 70% to 110% of development and construction costs. Generator and storage proponents that hold access rights will contribute connection and system strength costs. All values are in real 2021 Australian dollars.

Deliver Now network configuration is subject to review and refinement as part of detailed design review, Network Operator tender and the authorisation process.

CWO REZ *Deliver Now*

All modelled scenarios indicate that at least 4 GW network capacity would be needed as early as possible and no later than 2033: see Figure 8 point A.

To meet these requirements, EnergyCo proposes Option 1A, a new transmission spine for the CWO REZ that would add 4.5 GW capacity, delivered by 2027/2028. This option is comprised of:

- two 500 kV double circuits between Wollar and Merotherie, and
- new 330 kV lines to new energy hubs at Elong Elong, Uarbry East and Uarbry West
- Subject to further analysis, CWO REZ may be meshed with Line 79 at Uungula to increase transfer capacity and deliver additional system benefits. Further augmentations to CWO REZ may be revised.

Option 1A replaces Options 1 and 2A from the Draft Strategy, which together delivered only 4 GW. The new Option 1A efficiently delivers additional capacity due to an additional 1,500 MVA transformer that has been added at Elong Elong. The Uarbry East and Uarbry West hubs replace the single Uarbry hub in the Draft Strategy, reflecting constraints identified by local communities and practicalities in adding future capacity, and noting that these two extensions are dependent on access right holders. Further refinements to the CWO REZ scope may occur before EnergyCo, as Infrastructure Planner, makes a recommendation to the Consumer Trustee for authorisation.

Option 1A adds capacity at a cost comparable to the previous Options 1 and 2A from the Draft Strategy and Draft 2023 IIO Report. The resulting overall cost estimate of $3.2 billion is within the ±50% accuracy band. It also better enables future expansions without repeated community and landholder impacts (final Access Fee arrangements will determine how costs related to the two Uarbry hubs may be recovered from energy suppliers).

Note that the previous CWO REZ cost estimates were published by AEMO about 4 years ago as part of the 2020 ISP process. These are now out of date. The underlying project and, as a result, costs have changed for three key reasons. Firstly, EnergyCo had to add an additional double circuit to meet the 'N-1 secure' operating requirement. Secondly, EnergyCo had to move the originally planned transmission corridor to avoid negative impacts on the Merriwa–Cassilis communities and prime agricultural land. And thirdly, EnergyCo increased the overall project size to deliver sufficient hosting capacity pre-2030, create optionality beyond 2030 and share community impacts more evenly between CWO and NE REZ.

To enable CWO REZ to export more than 3 GW to the key demand centre, Stage 1 of the Hunter Transmission Project (HTP) will also have to be in place: see section 1.3 below.

CWO REZ *Secure Now*

The modelling indicates that at least another 1.5 GW of additional network capacity may be needed after 2033, if there is either transmission delay or early coal exits: see Figure 8 point B.

To achieve this and support LDS projects that would deliver broader consumer/network benefits, EnergyCo proposes three options to add 2.3 GW of network capacity at low cost.

- Option 2B would uprate the 330kV lines between the Elong Elong and Merotherie hubs to 500kV, adding 1.5 GW of network capacity and optionality to cater for early coal closures and other uncertainties. Although this option could unlock 3 GW of network capacity, it will be limited to 1.5 GW until a further augmentation is made to the downstream shared network.
- Option 5A would expand the network south from Uungula towards Burrendong to add 0.8 GW network capacity and support up to 500 MW of LDS projects.
- Option: Pumped Hydro Near Bathurst would reinforce the existing line between Bathurst and Mt Piper, supporting up to 325 MW of additional LDS capacity, delivering network security and reliability benefits in the CWO REZ.

As Infrastructure Planner, EnergyCo may consider these *Secure Now* options, and their potential inclusion as *Deliver Now*, as part of the scope for network projects recommended to the Consumer Trustee for authorisation, subject to community, cost and environmental considerations.

CWO REZ *Plan for the Future*

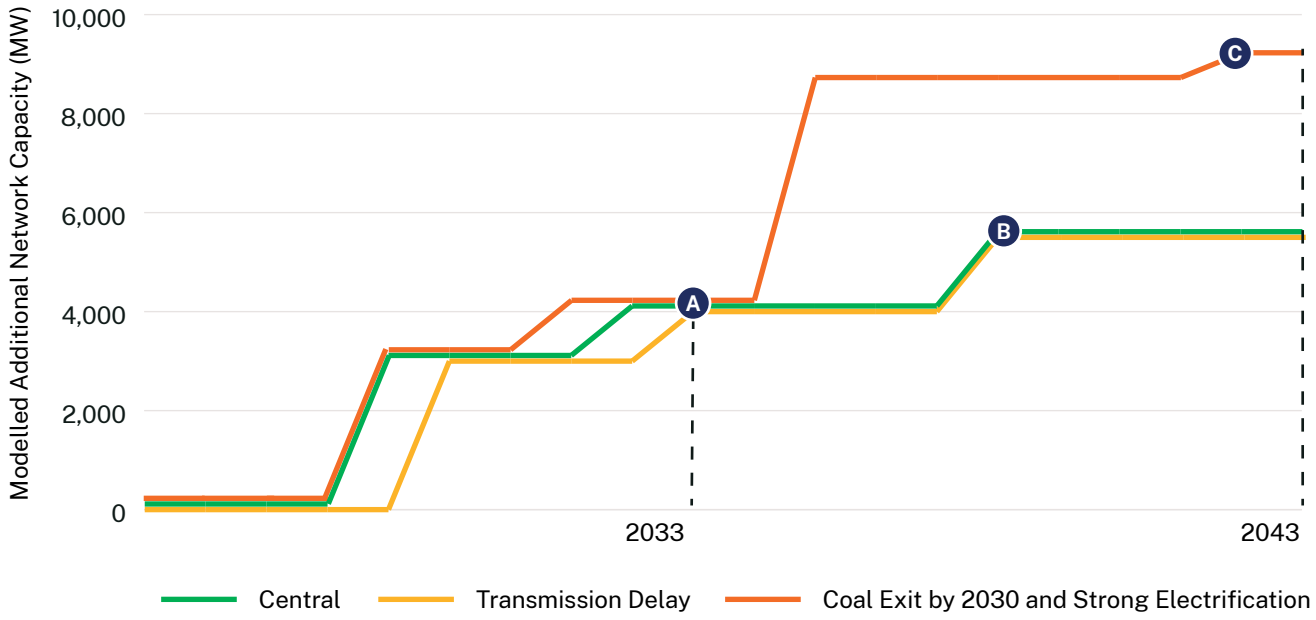
Modelling of the *Coal Exit by 2030 and Strong Electrification* scenario suggests that the CWO REZ may require an increase up to a total 9 GW capacity by 2043 if there is also strong demand from electrification: see Figure 8 point C.

To achieve this if needed, EnergyCo proposes the following options to augment the capacity provided under earlier options:

- actualising the latent 1.5 GW of capacity delivered under Option 2B, with further augmentation downstream in the existing network
- Option 3A, a 500 kV expansion from Merotherie to a new hub in the Gilgandra–Tooraweenah area and adding 1 GW capacity, and
- Option 4, a 330 kV expansion from Wollar to a new hub at Stubbo also adding 1 GW capacity.

If any of these options were implemented to take the CWO REZ network capacity beyond 6 GW, new augmentations downstream in the existing shared network would be required.

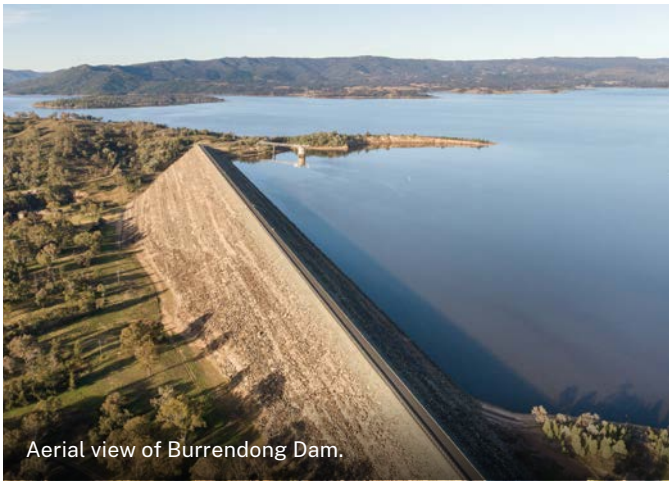
Figure 8: CWO REZ modelled network capacity needs under different scenarios, 2023–43



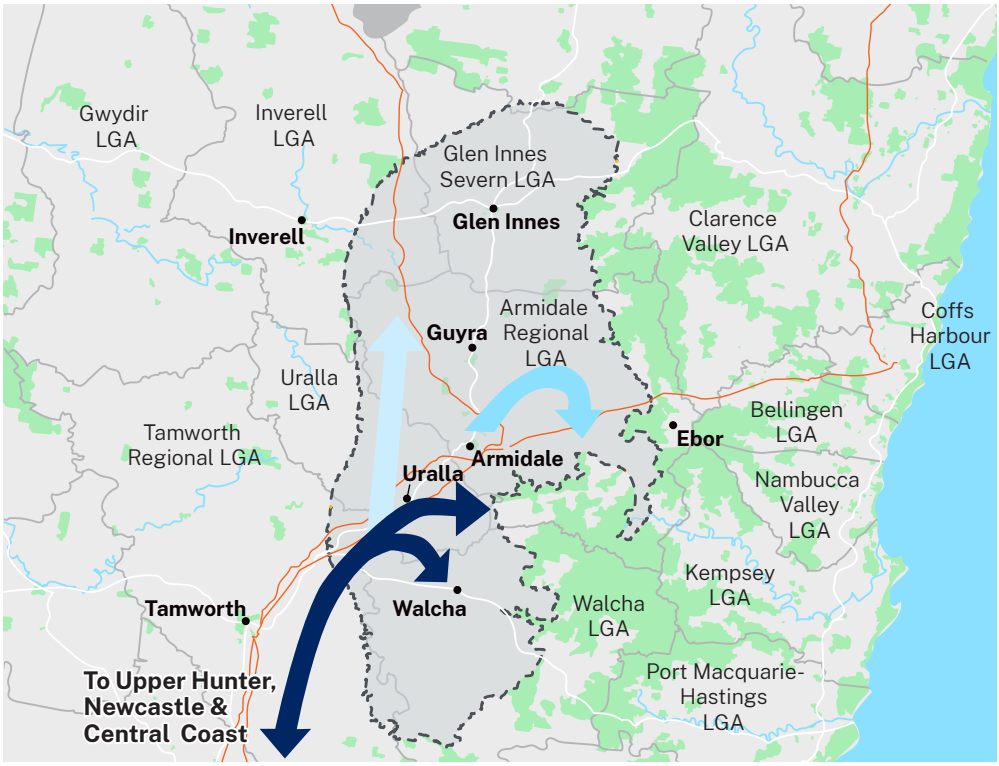
Status and next steps

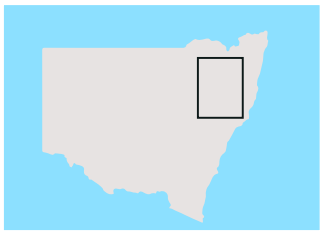
The CWO REZ Access Scheme, setting out how generation and storage projects can be granted access rights to new network infrastructure, commenced on 23 December 2022.[9] The Consumer Trustee is expected to hold competitive tenders for those access rights from 2023 onwards.

EnergyCo, as Infrastructure Planner, is currently conducting a competitive tender for a Network Operator to design, build, finance, operate and maintain the CWO REZ network infrastructure. Based on the current project delivery plan, construction may commence as early as 2025 with a target delivery date of 2027/2028.


Aerial view of Burrendong Dam.

New England REZ





Legend

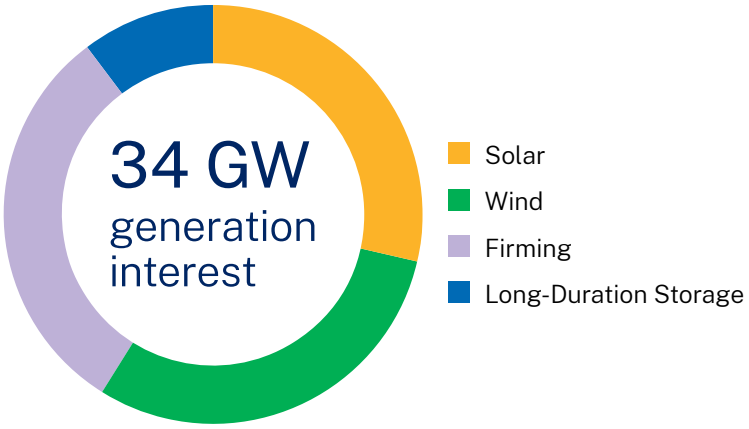
- Major Roads and Highways
- Existing 500 kV Network
- Existing 330 kV Network
- Deliver Now
- Secure Now
- Plan for the Future

8 GW intended network capacity

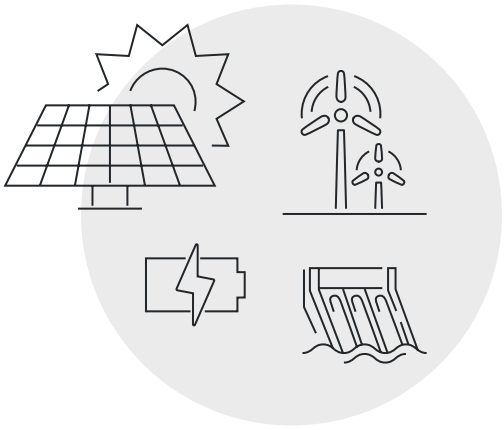
To be delivered in stages

Access scheme in development

REZ Registration of Interest results



Anticipated technologies



REZ development status

1.2.2 New England REZ

New England is the other of two REZs with large generation potential, with good access both to quality renewable resources and to the existing electricity network. It was formally declared on 17 December 2021, with an intended network capacity of 8 GW.[10] A further 2GW of network capacity may be delivered by future augmentations.

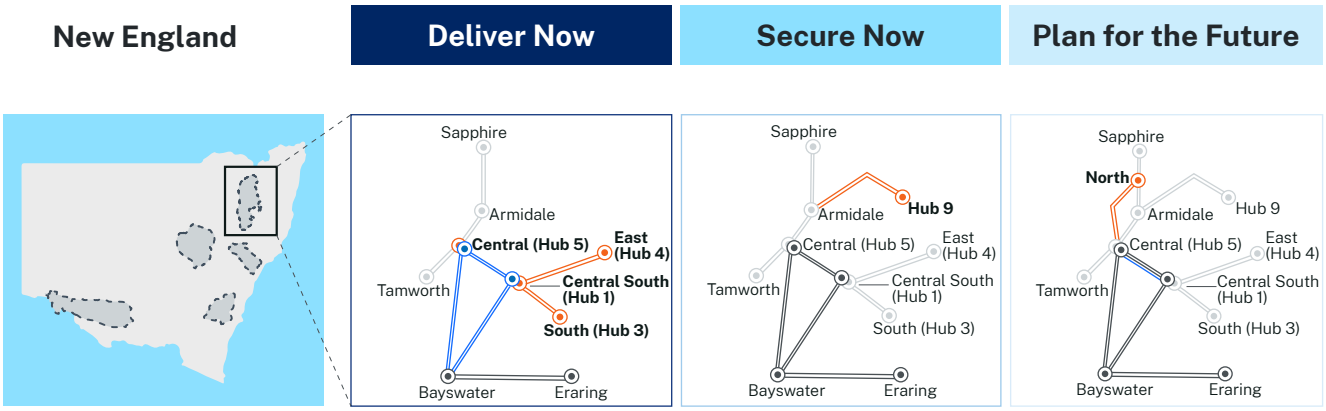
To meet the declared, modelled and potential long-term needs of the New England REZ, the Strategy proposes the network arrangements laid out in Figure 9:

- **Deliver Now.** An additional 6 GW capacity by 2033, delivered by a ring of new 500 kV double circuit lines connecting Bayswater and two new central hubs, and another two 330 kV lines connecting an east and a south hub.
- **Secure Now.** An additional 0.8 GW capacity by 2029 to support long-duration storage in the region, delivered by an upgrade to an existing line between Armidale and Carrai.
- **Plan for the Future.** An additional 1.5 GW capacity if needed to support strong state-wide electrification, delivered by a new 330 kV line running north from the Central hub.

The order of network development of the East, South and North hubs may vary depending on the progress of generation development in each area.

The high-level detail and rationale for these Network Infrastructure Options are set out below, along with their development status and next steps. Further detail is given in Appendix B.

Figure 9: New England REZ indicative network arrangements



LEGEND

Existing 330 kV circuit
Existing 500 kV circuit
New 330 kV circuit
New 500 kV circuit
Existing 330 kV substation/ switching station
Existing 500 kV substation/ switching station
New 330 kV substation/ switching station
New 500 kV substation/ switching station

Extra capacity (GW)	6	0.8	1.5
Anticipated delivery timing	2029 (2.4 GW) and 2031 (3.6 GW)	2029	2037
Construction cost preliminary estimate	$4.2 billion	$0.6 billion	$0.8 billion

Estimates are Class 5b accuracy (i.e. +/- 50%) and for development and construction costs only (excluding finance, generator connection and system strength costs). This provides a comparable basis with estimates for projects under the National Electricity Rules. The total cost for a REZ also includes finance, generator connection and system strength costs at typically an additional 70% to 110% of development and construction costs. Generator and storage proponents that hold access rights will contribute connection and system strength costs. All values are in real 2021 Australian dollars.

New England REZ *Deliver Now*

All modelled scenarios indicate that at least 6 GW more network capacity will be required by 2034: see Figure 10 point C. EnergyCo proposes that the 6 GW be delivered in two stages:

- Option 1 would deliver 2.4 GW of network capacity by 2029. A double circuit line built at 500kV would run from Bayswater to a Central South and then a Central hub; another two 330 kV lines would run from the Central South to an East and a South hub each.
- Option 2B would deliver 3.6 GW more network capacity by 2033. This would be an additional two lines built at 500kV between Bayswater and the Central hub.

This staging would allow consideration of market and delivery issues while the New England REZ is being developed. It is indicative, being dependent on the capacity needed through each planning scenario, and will be confirmed by EnergyCo, as Infrastructure Planner, when making a recommendation to the Consumer Trustee for authorisation.

These options (see Appendix B) have been revised since the Draft Strategy and the Draft IIO 2023. Their project scopes have been refined to reflect practical project delivery, respond to planning constraints and stakeholder engagement, and maintaining network security.

The scope refinements have meant revisions to the line lengths for Options 1 to 2D, with Options 1, 2B and 2D also being modified to reflect the preferred eastern route for the second 500 kV line. Options 3A to 3D in the Draft Strategy are now redundant, as there are no future expansions to the then-proposed Hub 1, and Option 3C is now incorporated into Option 1.

The revised configurations deliver the same added network capacity as proposed in the Draft Strategy, and their revised cost estimations are within the ±50% accuracy band.

New England REZ *Secure Now*

The modelling suggests that no network capacity beyond 6 GW is needed before 2033: see Figure 10 point C. However, the IIO Report highlights the need for additional long-duration storage (LDS) capacity by 2029, and there is potential for LDS capacity in the east and north of the New England REZ.

EnergyCo therefore proposes Option 5A which includes an upgrade to an existing transmission line to 330 kV with associated minor upgrades, connecting a new northeast hub to the existing Tamworth–Armidale line. This project would deliver 0.8 GW of network capacity to unlock up to 0.9 GW of LDS projects, which would help to provide energy security and reliability to the system.

The optimal delivery time of this option would be confirmed by EnergyCo, as Infrastructure Planner, when making a recommendation to the Consumer Trustee for authorisation.

New England REZ *Plan for the Future*

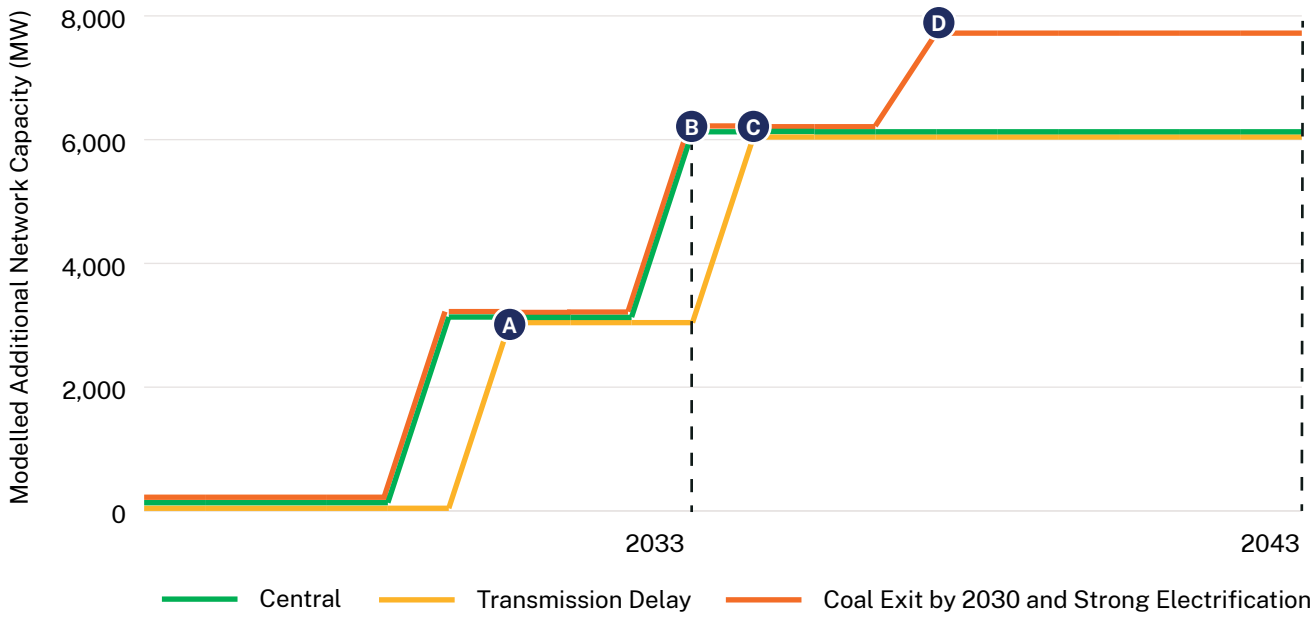
The modelling indicates that 7.5 GW total network capacity may be required in the NE REZ by 2043: see Figure 10 point D.

To achieve this, EnergyCo proposes Option 4D, to add 1.5 GW of network capacity to support additional generation in the northwest of the REZ if strong electrification drives high energy demand. The economic analysis suggested Option 3C (Draft Strategy), however that option is no longer being investigated, and Option 4D adds equivalent capacity, although at different cost.

Modelling indicates that this Plan for the future option may be required by 2037 under a strong electrification scenario. However, this is indicative at this stage and is subject to further REZ and project development, and demand growth.

People sit outside a café, Uralla.

Figure 10: New England REZ modelled network capacity needs under different scenarios, 2023–43

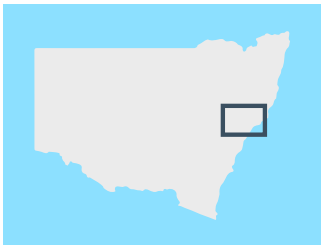


Status and next steps

EnergyCo has commenced preliminary works on the *Deliver Now* options. Further engagement with local communities and stakeholders is being undertaken in the first half of 2023 to help develop the initial scope for the New England REZ (i.e. the 'reference scope'). EnergyCo aims to submit a recommended network solution for the New England REZ for authorisation by the Consumer Trustee in 2024, with the NSW planning assessment process and construction to follow. Infrastructure localities, network capacity and delivery timings shown are currently indicative and subject to detailed REZ specific modelling, stakeholder consultation and design refinement.


New England Highway, Tenterfield to Inverell, NSW.

Hunter-Central Coast REZ



Legend

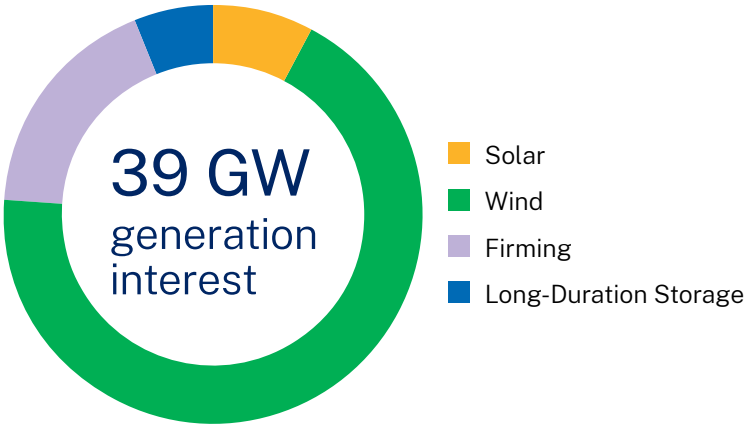
- Major Roads and Highways
- Existing 500 kV Network
- Existing 330 kV Network
- Deliver Now
- Secure Now
- Plan for the Future
- Potential future Commonwealth Offshore Wind Zone

1 GW intended network capacity

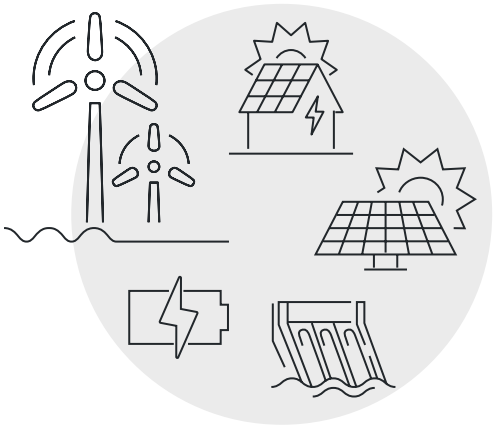
Proposed Hunter offshore renewable energy zone

Clean energy and manufacturing hub

REZ Registration of Interest results



Anticipated technologies



REZ development status

REZ declaration → Access scheme declaration → Network Operator procurement → Network infrastructure authorisation & determination → Planning approvals → Construction → Completion

1.2.3 Hunter-Central Coast REZ

The Hunter-Central Coast REZ is expected to host smaller generation and storage projects as nearby coal-fired powers retire, support future offshore wind development, and become a hub for expanded low-emission industrial development in the region. It would leverage its existing electricity, port and transport infrastructure, as well as a large skilled workforce.

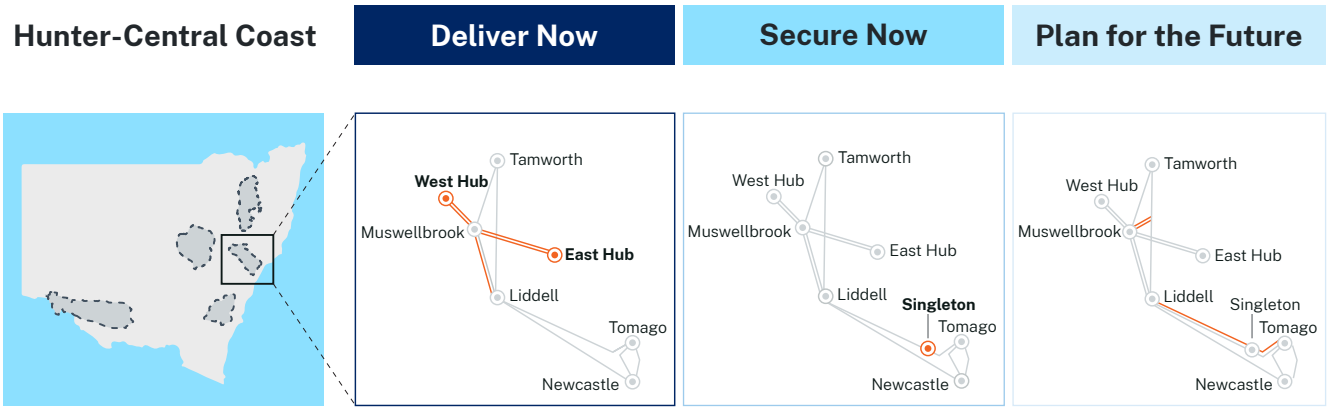
The HCC REZ was formally declared on 9 December 2022, with an intended network capacity of 1 GW.[11] If the forecast growth in demand occurs, modelling suggests it would need just under 3 GW more network capacity by 2043.

To meet the declared, modelled and potential long-term needs of the HCC REZ, the Strategy proposes substantial upgrades to the network, as laid out in Figure 11:

- **Deliver Now.** An additional 1 GW network capacity by 2027, delivered by network upgrades between Muswellbrook and Liddell and new substation hubs to the west and/or east.
- **Secure Now.** An additional 0.5 GW network capacity by 2032, delivered by a 330kV switching station near Singleton.
- **Plan for the Future.** An additional 1.5 GW network capacity by 2042 if needed, delivered by a new 330 kV circuit from Muswellbrook to the existing Tamworth-Liddell line, and rebuilding the Liddell–Tomago line as a double-circuit 330 kV line.

The high-level detail and rationale for these Network Infrastructure Options are set out below, along with their development status and next steps. Further detail is given in Appendix B.

Figure 11: Hunter-Central Coast REZ indicative network arrangements



Extra capacity (GW)	0.95	0.5	1.5
Anticipated delivery timing	2027	2032	2043
Construction cost preliminary estimate	$0.4 billion	$0.05 billion	$1 billion

Estimates are Class 5b accuracy (i.e. +/- 50%) and for development and construction costs only (excluding finance, generator connection and system strength costs). This provides a comparable basis with estimates for projects under the National Electricity Rules. The total cost for a REZ also includes finance, generator connection and system strength costs at typically an additional 70% to 110% of development and construction costs. Generator and storage proponents that hold access rights will contribute connection and system strength costs. All values are in real 2021 Australian dollars.

HCC REZ *Deliver Now*

The modelling suggests that an additional 0.5 GW network capacity would be required under the *Central* scenario, and another 0.45 GW capacity would be required under *Transmission Delay*, both well within the *Deliver Now* timeframe: see Figure 12 point A.

To meet this need, EnergyCo proposes Option 1 (as listed in the Draft Strategy) to deliver 1 GW network capacity by 2027. This option would construct two new double circuits between Muswellbrook and an east and west hub, and one new circuit from Muswellbrook to Liddell. The Muswellbrook substation would be modified to accommodate the new lines and optimise their value to the network.

This option would also provide low-cost insurance for readily-available network expansion if there were unexpected delays in delivering the CWO or New England REZs. In addition, this option provides low-cost capacity to unlock LDS in the region, including a planned 250 MW long-duration storage project.

HCC REZ *Secure Now*

The modelling suggests that a further 0.7 GW network capacity would be needed if greater demand eventuates under the *Transmission Delay* scenario: see Figure 12 point B. As HCC REZ provides essential capacity to support NSW demand, the required network build is very sensitive to potential delays in the CWO and New England REZs during the 2020s.

If additional network capacity were required, EnergyCo proposes Option 3, a new 330kV switching station at Singleton to add 0.5 GW network capacity by 2032. While this option would provide slightly less than the modelled requirement, it would provide significantly more flexibility for future rapid expansions of HCC should they be required in the late 2030s, especially in a high-electrification scenario. Further investigation into the scope of this augmentation is required to determine the full network capacity that could be unlocked.

HCC REZ *Plan for the Future*

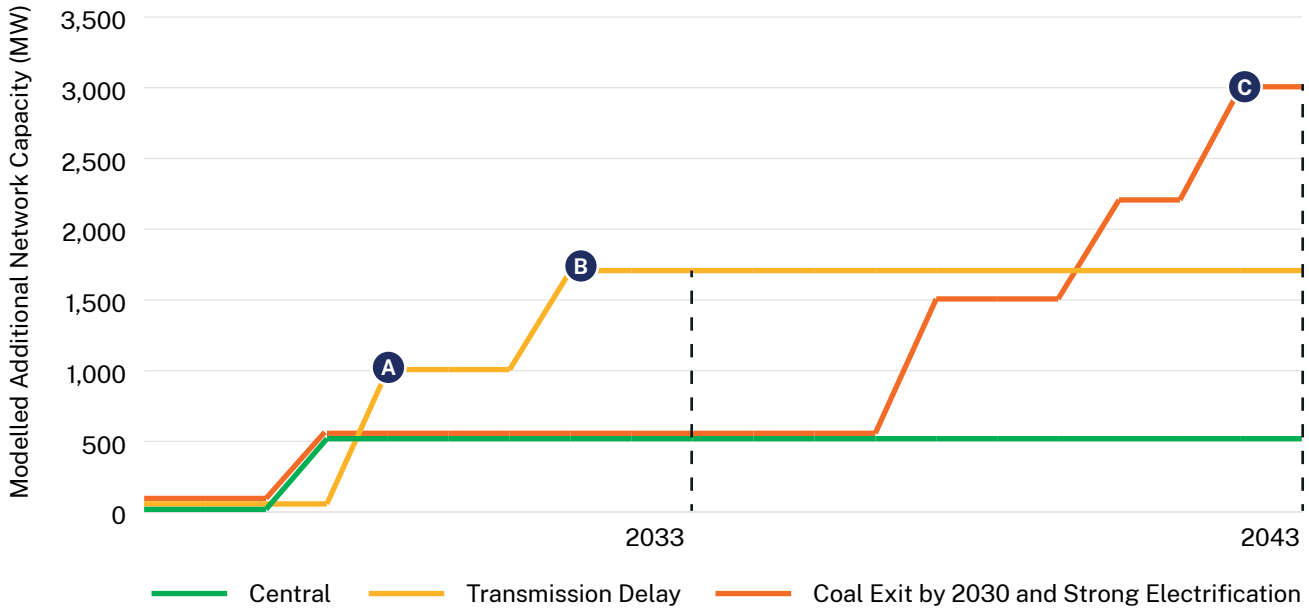
The modelling suggests that a further 1.4 GW network capacity may be needed to prepare the HCC REZ for future demand from industrial electrification or green hydrogen in the *Coal Exit by 2030 and Strong Electrification* scenario: see Figure 9 point C. The Strategy proposes to add that capacity by 2042 if needed, by:

- Option 2 connecting Muswellbrook to the existing Tamworth–Liddell line, and
- Option 4 rebuilding the Liddell–Tomago line to a new double circuit line to increase network capacity (requires Option 3 to be constructed).

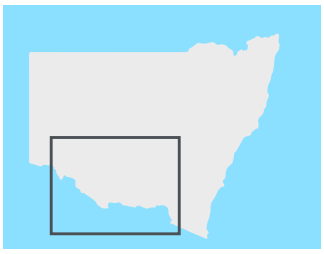
Status and next steps

EnergyCo, Transgrid and Ausgrid have begun joint planning network infrastructure, by considering options within both the transmission and distribution networks. This may result in alternative options to those presented in Figure 11.

Figure 12: Hunter-Central Coast REZ modelled network capacity needs under different scenarios, 2023–43



South West REZ



Legend

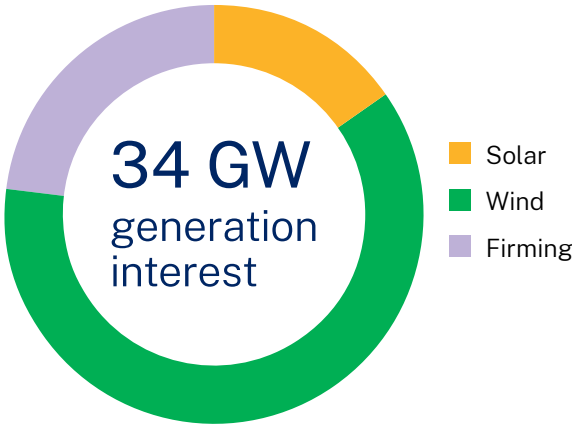
- Major Roads and Highways
- Existing 500 kV Network
- Existing 330 kV Network
- Deliver Now
- Secure Now
- Plan for the Future

2.5 GW intended network capacity

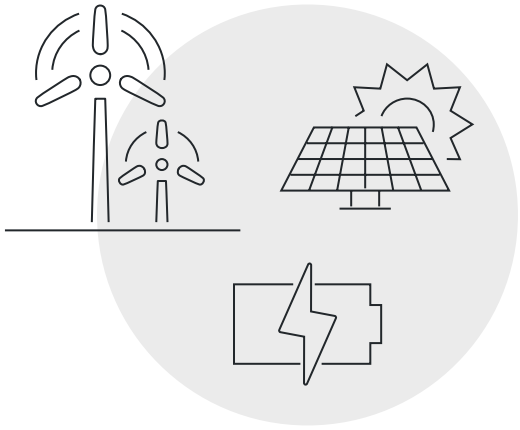
Coordinated with Transgrid's PEC, HumeLink and VNI West

Draft Access Scheme being developed

REZ Registration of Interest results



Anticipated technologies



REZ development status

REZ declaration → Access scheme declaration → Network Operator procurement → Network infrastructure authorisation & determination → Planning approvals → Construction → Completion

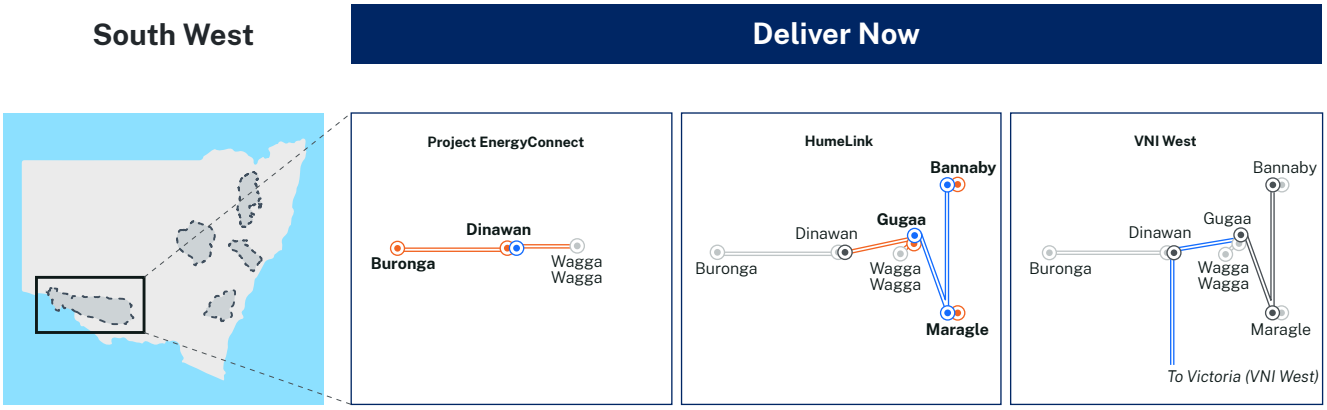
1.2.4 South West REZ

The South West REZ has high-quality renewable energy resources with compatible land uses.

The South West REZ was formally declared on 4 November December 2022, with an intended network capacity of 2.5 GW.[12]

This capacity is planned to be delivered by the three ISP projects: Project EnergyConnect, HumeLink and VNI West: see Figure 13 and section 1.5. These will add the 2.5 GW network capacity needed for the South West REZ by 2033 under all scenarios: see Figure 14.

Figure 13: South West REZ indicative network arrangements



Extra capacity (GW)	0.8	1	Up to 0.9
Anticipated delivery timing	2026	2028	2031
Construction cost preliminary estimate	N/A	N/A	N/A

Estimates are Class 5b accuracy (i.e. +/- 50%) and for development and construction costs only (excluding finance, generator connection and system strength costs). This provides a comparable basis with estimates for projects under the National Electricity Rules. The total cost for a REZ also includes finance, generator connection and system strength costs at typically an additional 70% to 110% of development and construction costs. Generator and storage proponents that hold access rights will contribute connection and system strength costs. All values are in real 2021 Australian dollars.

SW REZ transfer capacity increases achieved through ISP projects, not REZ projects. Cost not included as this capacity will be delivered through PEC, HumeLink and VNI West.

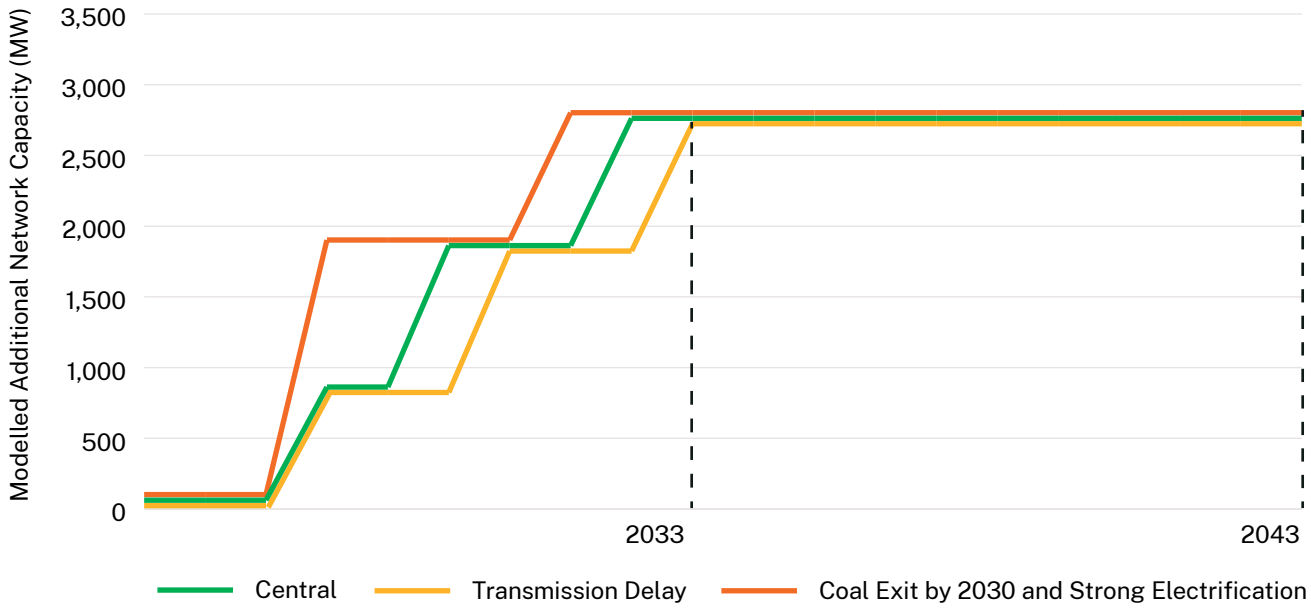
Mustering merino sheep in the west of New South Wales.

South West REZ *Deliver Now*

The planned development in South West REZ comprises:

- as part of Project EnergyConnect, a transmission line between Wagga Wagga and the eastern edge of the REZ at Dinawan, continuing through the REZ to Buronga. The Wagga Wagga to Dinawan section of the line will be constructed at 500 kV by 2026, with an initial 330 kV operation delivering 0.8 GW of network capacity
- additional capacity released when HumeLink is delivered and Project EnergyConnect is connected to Gugaa substation, alleviating downstream constraints, and
- as part of VNI West, uprating the eastern section of the Dinawan–Gugaa line to 500kV by 2031, adding 0.9 GW network capacity and alleviating downstream constraints.

Figure 14: South West REZ modelled network capacity needs under different scenarios, 2023–43



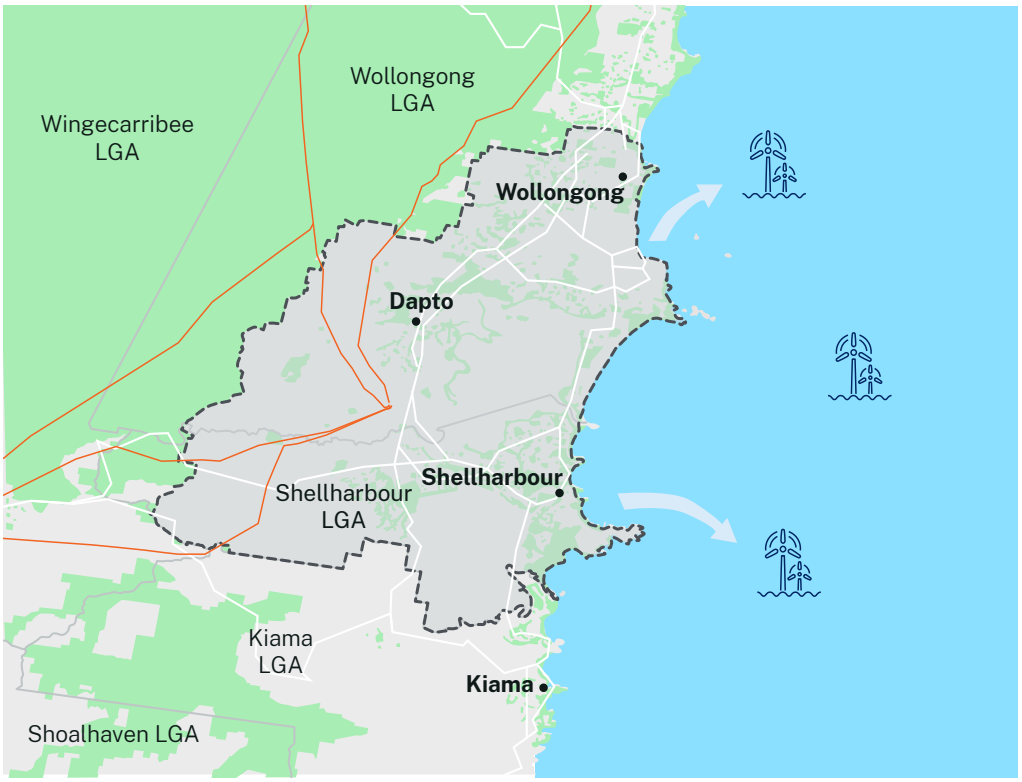
Status and next steps

EnergyCo published a draft Access Scheme for the South West REZ and a Access Scheme Positions Paper in March 2023 for public consultation, responding to the unique network configuration of the South West REZ.

Further investigation may be required on the amount of new generation infrastructure to be built in the South West REZ. The economic analysis for this Strategy suggested the amount would be lower than that suggested by the strong market response to the Registration of Interest process for this REZ, especially for wind projects.

Murrumbidgee River, river red gums near the viewing platform Yanga National Park.

Illawarra REZ



Legend

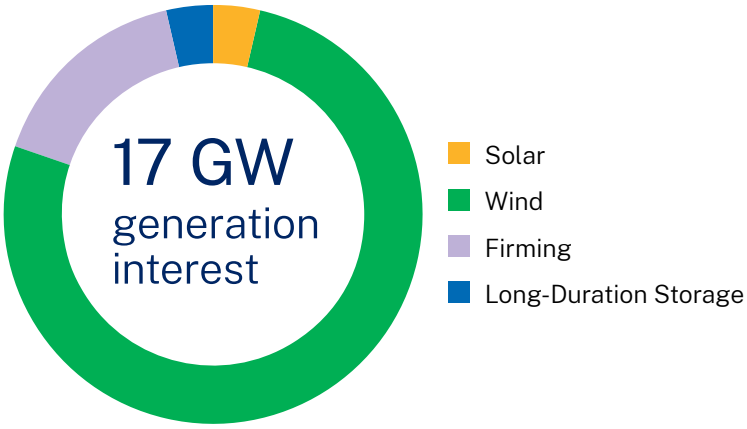
- Major Roads and Highways
- Existing 330 kV Network
- Deliver Now
- Secure Now
- Plan for the Future
- Potential future Commonwealth Offshore Wind Zone

1 GW intended network capacity

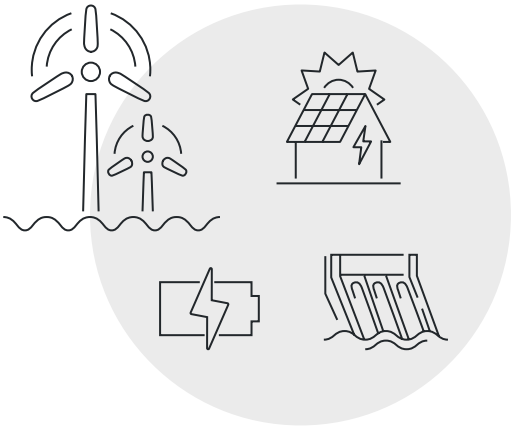
Potential future Commonwealth Offshore Wind Zone

Clean energy and manufacturing hub

REZ Registration of Interest results



Anticipated technologies



REZ development status

REZ declaration

Access scheme declaration

Network Operator procurement

Network infrastructure authorisation & determination

Planning approvals

Construction

Completion

1.2.5 Illawarra REZ

The Illawarra REZ is expected to host smaller generation and storage projects and support future offshore wind development. The region has strong potential for investment in new green hydrogen and steel industries, which would leverage its existing skilled workforce, robust supply chain and established manufacturing plant.

The Illawarra REZ was formally declared on 27 February 2023 with an intended network capacity of 1 GW.[13]

EnergyCo will commence considering the Network Infrastructure Options that would best suit the Illawarra REZ. Planning must take into account the Southern Sydney Ring (part of the 'Sydney Ring' ISP Project), which will likely influence power flows in the REZ. The Southern Sydney Ring may be delivered under the National Energy Rules or the NSW EII Act, depending on how it interacts with any future Illawarra REZ network options.

Detailed joint planning with Transgrid and Endeavour Energy will determine the most practical and cost-effective way to deliver network options, other necessary augmentations to the downstream network, and any dependencies between the Illawarra REZ and Southern Sydney Ring project.

Figure 15: Southern Sydney Ring indicative arrangement

1.3 Priority transmission infrastructure projects

Priority transmission infrastructure projects (PTIPs) under the EII Act are projects located in NSW that are part of an identified ISP project.

There are currently two projects being progressed as PTIPs: the Hunter Transmission Project and the Waratah Super Battery Project. Both are part of the 'Sydney Ring' project, which was an actionable ISP project in the Draft 2022 ISP before Hunter Transmission Project and the Waratah Super Battery Project were transferred to the NSW regulatory framework.

The Minister has appointed EnergyCo as the Infrastructure Planner for both PTIPs.[14] In that role, EnergyCo recommends Network Operators and contractors to carry out the project, either after a competitive procurement process or otherwise.[15] On that recommendation, the Minister may authorise or direct the network operator to carry out the PTIP[16], but only if satisfied that it is appropriate in relation to the NSW Energy Security Target and is in the public interest.

The Network Infrastructure Options in the Draft Strategy included a range of other possible future downstream network upgrades to transfer REZ generation to key load centres. The HTP, WSB and known projects progressing through the National Framework were explicitly included in the model as they are being progressed as PTIPs, however other downstream network options were also co-optimised.

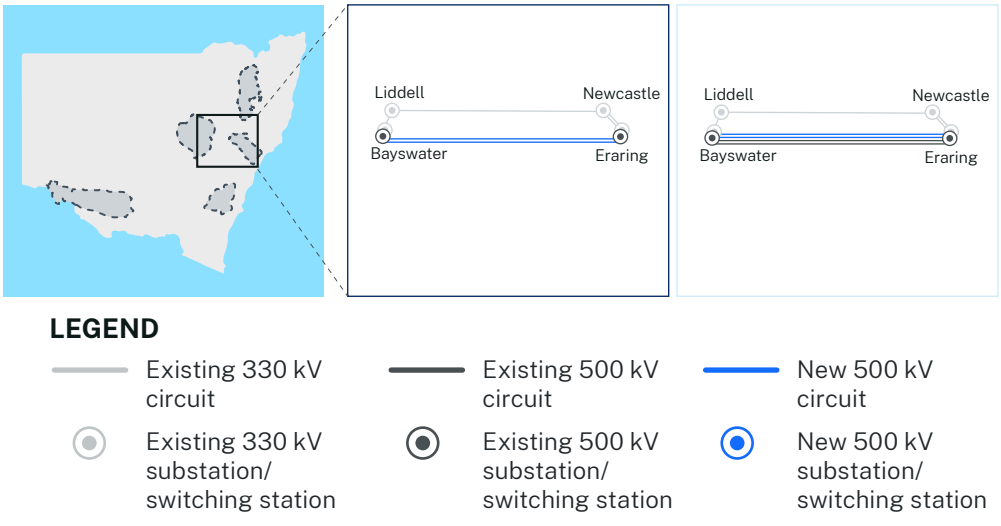
Hunter Transmission Project adds 5 GW of network capacity with potential for more if needed

The HTP is the existing network's first major augmentation to ease congestion for electricity flowing between the CWO, New England and HCC REZs and the demand centres at Sydney, Wollongong and Newcastle. It will provide critical transfer capacity for Roadmap infrastructure and form the backbone of the NSW electricity network for generations to come.

Without the HTP Stage 1, the network would only have enough downstream capacity to support 3 GW of generation output combined from these three REZs. With HTP Stage 1 in place, this could be increased to as much as 8 GW of generation capacity, helping to ensure the security and reliability of NSW's energy supply while supporting the decarbonisation of existing industries (such as Tomago Aluminium) and the growth of emerging technologies (such as hydrogen).

Similarly, without HTP Stage 2, the CWO and New England REZs would be limited to a total of 8 GW of concurrent generation capacity in addition to system security constraints.

Figure 16: HTP indicative network arrangements



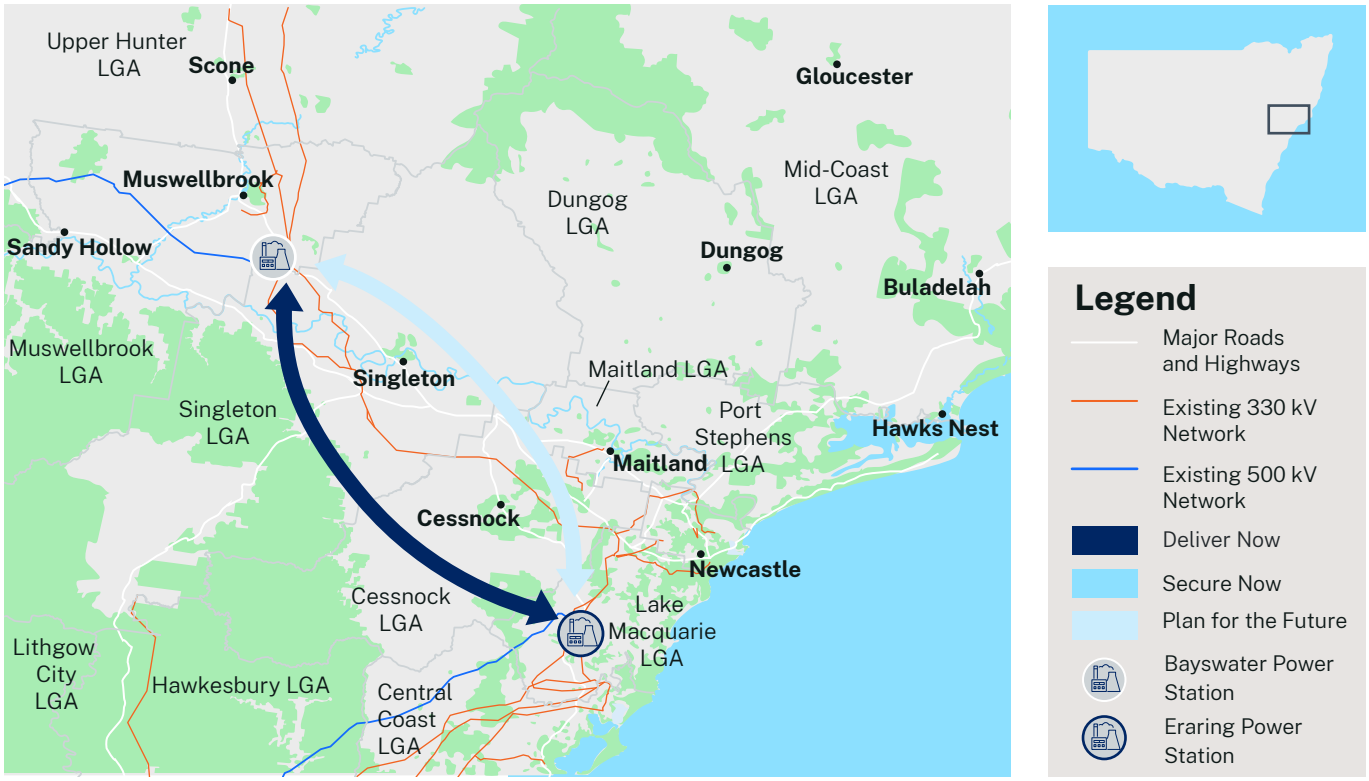
	Deliver Now	Plan for the Future
Extra capacity (GW)	5	6
Anticipated delivery timing	2027	2030s (TBC)
Construction cost preliminary estimate	$1 billion	$1.8 billion

Estimates are Class 5b accuracy (i.e. +/- 50%) and for development and construction costs only (excluding finance, generator connection and system strength costs). This provides a comparable basis with estimates for projects under the National Electricity Rules. The total cost for a REZ also includes finance, generator connection and system strength costs at typically an additional 70% to 110% of development and construction costs. Generator and storage proponents that hold access rights will contribute connection and system strength costs. All values are in real 2021 Australian dollars.

The HTP may be delivered through two separate network projects:

- **HTP Stage 1** is a *Deliver Now* project and a PTIP under the EII Act. It will provide a new 500kV double circuit transmission line from Bayswater Power Station to Eraring Power Station, providing 5 GW of additional transmission capacity in the downstream network. It is scheduled to be complete by mid-2027, and to cost approximately $1 billion. It is currently being expedited to draw on resources available under the Transmission Acceleration Facility (see Box 4 below), and to meet the HTP delivery timeframes.
- **HTP Stage 2** is a *Plan for the Future* project and may be required after 2033 to provide an additional 6 GW of network capacity to unlock further generation capacity from the CWO and New England REZs, at an estimated cost of up to $1.8 billion. Investigation is continuing into the project scope, cost, delivery timeframes, system needs, and land and easement requirements.

Figure 17: HTP Stage 1 and Stage 2 indicative network arrangements



The Waratah Super Battery Project adds 0.9 GW of network capacity

The NSW Government is delivering the Waratah Super Battery (WSB) Project to alleviate constraints on the existing transmission network during periods of high demand. It will have a critical role in the NSW energy system:

- as a System Integrity Protection Scheme (SIPS), a 'shock absorber' in the event of any sudden power surges such as bush fires or lightning strikes
- to ensure NSW continues to have reliable energy supply following the anticipated early closure of the Eraring Power Station in 2025, and
- as a virtual transmission solution to unlock up to 0.9 GW of latent capacity in the existing transmission system, allowing electricity consumers in the Sydney, Newcastle and Wollongong demand centres to access more energy from existing generators.

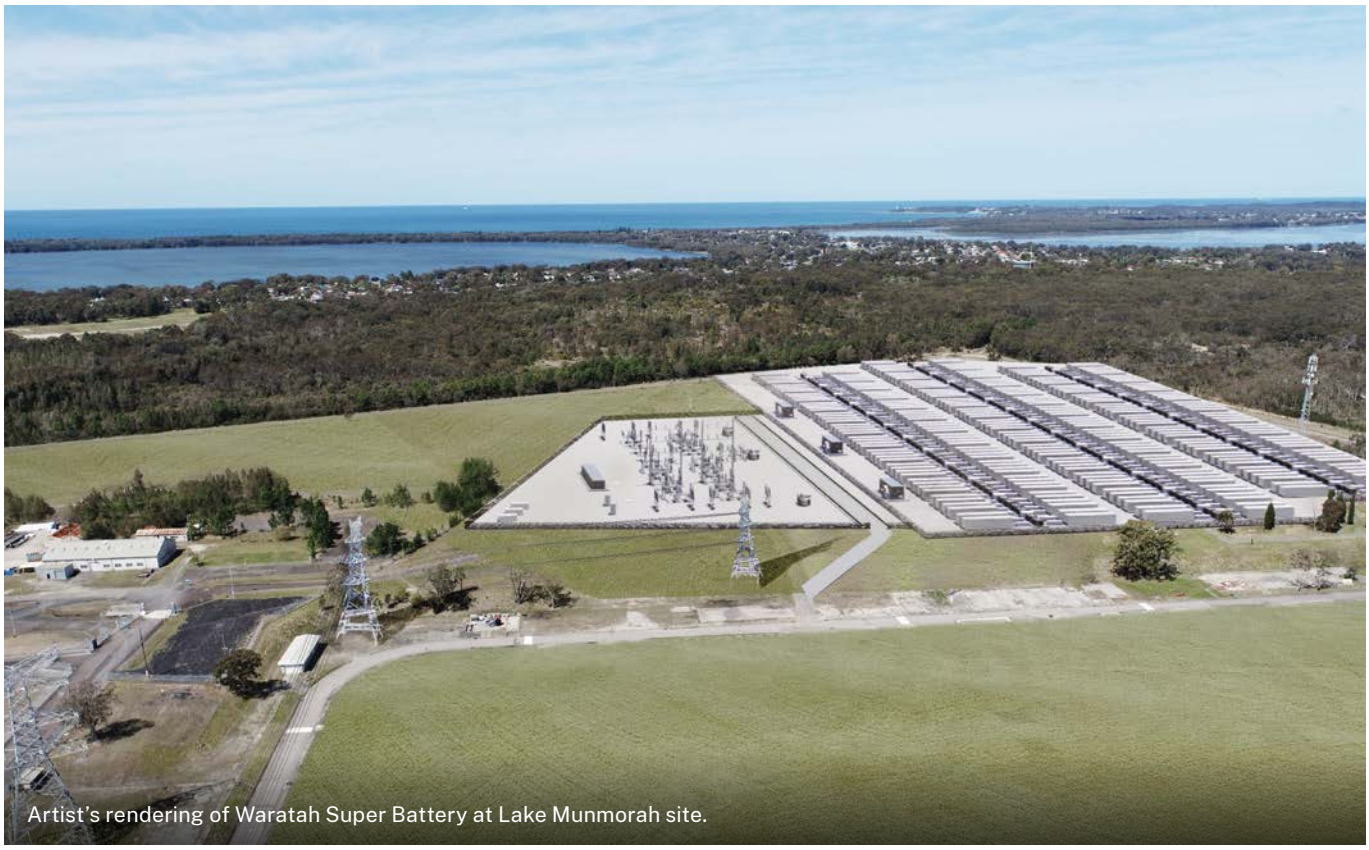
The WSB Project will be delivered by 2025 with an estimated construction cost of $900 million (for the battery and existing minor network upgrades). Its main components are:

- a SIPS Service provided by a Battery Energy Storage System (BESS) located at the former Munmorah coal-fired power station, capable of providing a guaranteed continuous active power capacity of at least 700 MW and a guaranteed useable energy storage capacity of at least 1400 MWh
- paired generation services provided by multiple generators across NSW that are capable of providing technical services to support the SIPS, and
- network augmentations and SIPS Control provided by Transgrid in its role as Network Operator that includes the SCADA, telecommunications, minor augmentations and control scheme equipment required to operate the SIPS.

In its role as Infrastructure Planner, EnergyCo conducted a competitive procurement process and appointed Akaysha Energy as the System Integrity Protection Scheme (SIPS) service provider.[17] On EnergyCo's recommendation, the Minister for Energy directed Transgrid as Network Operator to carry out the WSB project on 14 October 2022[18], and the AER made a contestable revenue determination on December 2022.[19]

Box 4: The NSW Transmission Acceleration Facility

The WSB Project is the first project supported by the Transmission Acceleration Facility – a $1.2 billion recoverable fund to fast-track critical energy infrastructure in the next decade. The Facility is designed to accelerate the construction of REZ network capacity as renewable energy projects replace existing power stations.



Artist's rendering of Waratah Super Battery at Lake Munmorah site.

1.4 Major ISP and other projects

Two further sets of network infrastructure projects are integral to the modernisation of NSW's energy system: ISP Projects delivered under the National Electricity Rules, and proposed additional NSW options to leverage the full benefits and ancillary services from long-duration storage.

ISP Projects

Under the national framework, Transgrid is planning the delivery of major transmission projects across NSW.

- **HumeLink** is a proposed 500 kV transmission project that links Greater Sydney with the Snowy Mountains Hydroelectric Scheme and Project EnergyConnect in southwestern NSW.
- **Project Energy Connect** adds a new 900km transmission line to connect the network infrastructure of South Australia, Victoria and NSW, traversing the South West REZ. Construction began in 2022.
- **VNI West** is a proposed 500 kV interconnector from near Ballarat in Victoria to Dinawan in southwest NSW. It will expand the network capacity between NSW and Victoria, maintaining the reliability of energy supply in both states as coal-fired power stations retire. The project is an actionable ISP project, currently undergoing its Regulatory Investment Test for Transmission.
- **QNI Connect** would add 1 GW network capacity between southern Queensland and northern NSW, following development of the New England REZ Transmission Link. It will expand the network capacity between NSW and Queensland, maintaining the reliability of energy supply in both as coal-fired power stations retire.
- **The Southern Sydney Ring** is a proposed 500 kV double-circuit transmission project reinforcing the network from the Southern Tablelands to Sydney. It will provide network capacity from Southern NSW, Central NSW and the Illawarra REZ to the Sydney, Newcastle and Wollongong load centres.

Workers during set up at Moree Solar Farm.

Additional infrastructure to support long-duration storage projects

To leverage the full benefits of new long-duration storage capacity, the Strategy proposes four additional network options.

2GW of additional LDS capacity required by 2030

The EII Act requires 2 GW of additional long-duration storage (LDS) capacity to be constructed in NSW by 2030. The 2 GW excludes infrastructure committed before 14 November 2019 (such as the Snowy 2.0 project). Established technologies such as pumped hydro could satisfy this need, but given the large need for LDS by 2030, new emerging alternative technologies should also be considered.

As existing generators retire, the right amount of LDS will deliver system reliability and consumer price benefits in two ways:

- by providing much needed firming capacity, and
- by time-shifting excess renewable generation to minimise the need for expensive peaking generation.

If the right LDS technology is placed in a suitable location, it may also deliver additional system strength or inertia services.

Figure 18: Aggregated cumulative long-duration storage capacity in NSW from 2024–42 above committed projects

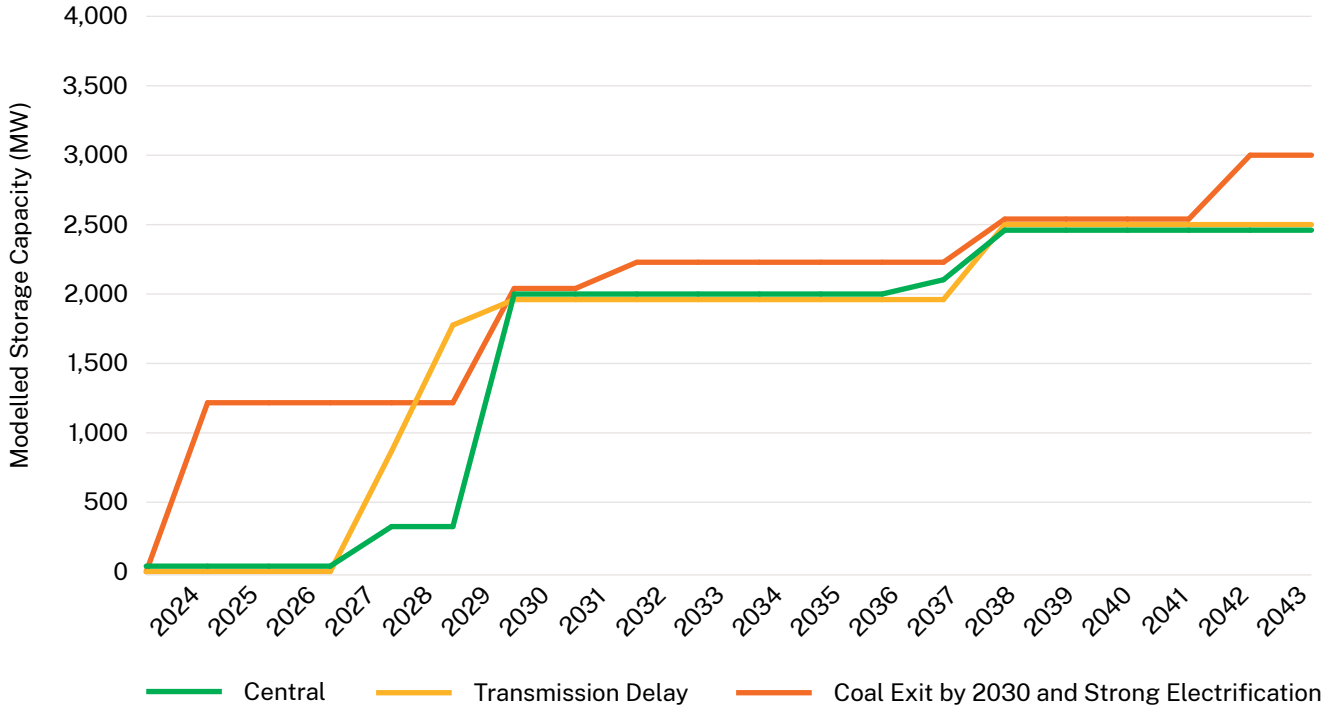


Figure 18 shows the need for LDS capacity for each modelled scenario. Current commissioning estimates for LDS projects indicate new pumped hydro projects might only be available just prior to 2030. Other LDS technologies may be viable before this time but are unlikely to be cost competitive based on current assumptions. To ensure sufficient LDS is available when required to manage coal retirements, EnergyCo believes it is prudent to support the development cost of competitive LDS options that could be deployed in the 2025–30 window.

In the *Central* scenario, NSW would require around 0.3 GW by 2028 and up to 2 GW by 2030 to accommodate the expected closures of the Liddell (2023), Eraring (2025) and Vales Point B (2029) power stations. The *Transmission Delay* scenario follows a similar but moderately faster trajectory, requiring around 0.9 GW by 2028 and 2 GW by 2030.

Conversely, under *No Coal by 2030 with Strong Electrification* scenario, the forecast need for LDS rises faster, with about 1.2 GW required by 2025 before reaching 2 GW by 2030. Meeting the 2025 need would be challenging and likely require all available LDS technologies and project options.

Four network projects proposed to leverage the full benefits of LDS

EnergyCo assessed six potential network options that would leverage the full benefits of pumped hydro projects, including the ability to rely on ancillary services such as system strength. Four of these are proposed as Network Infrastructure Options in the Strategy:

- HCC Option 1 (*Deliver Now*) would leverage benefits of 0.25 GW of LDS capacity
- CWO Option 5A (*Secure Now*) would leverage benefits of up to 0.5 GW LDS capacity
- New England Option 5A (*Secure Now*) would leverage benefits of up to 0.9 GW LDS capacity, and
- the Bathurst Pumped Hydro option (*Secure Now*) would leverage benefits of up to 0.3 GW of LDS capacity near Bathurst and increase system strength for the nearby CWO REZ.

EnergyCo and Transgrid are jointly investigating the scope, feasibility and appropriate regulatory pathways for these projects.

EnergyCo has proposed these *Secure Now* options to assess their feasibility in time to develop them concurrently with pumped hydro projects.

Without starting the necessary work in the near-term to secure these options, NSW may be unable to leverage full benefits from the required LDS capacity when needed in the market to maintain system reliability and place downward pressure on consumer prices.

The corresponding network infrastructure would only be built if the associated pumped hydro projects become commercially viable.

Tumut 3 Power Station.

Part 2: Coordinating NSW electricity infrastructure

2

Moree Solar Farm.

The Roadmap is designed to drive coordinated and integrated investment in large-scale electricity infrastructure, to maintain an affordable, reliable and progressively clean supply for NSW consumers. The EII Act sets the 2030 infrastructure investment objectives and other overall and community objectives, and the processes by which they will be met.

This Part 2 sets out the coordinated planning to future-proof NSW's network infrastructure. It sets out how:

2.1 NSW infrastructure investment is coordinated by the Roadmap Entities (the Consumer Trustee, Regulator and Infrastructure Planner)

2.2 They do so through complementary and iterative planning documents

2.3 Renewable Energy Zones are a primary focus of that planning, and

2.4 The planning takes into account the progressive impacts of a range of emerging technologies and market developments.

In this way, the Strategy will help NSW meet the 2030 infrastructure investment objectives the EII Act's overall and community objectives, and support clean, affordable and reliable electricity for NSW consumers.

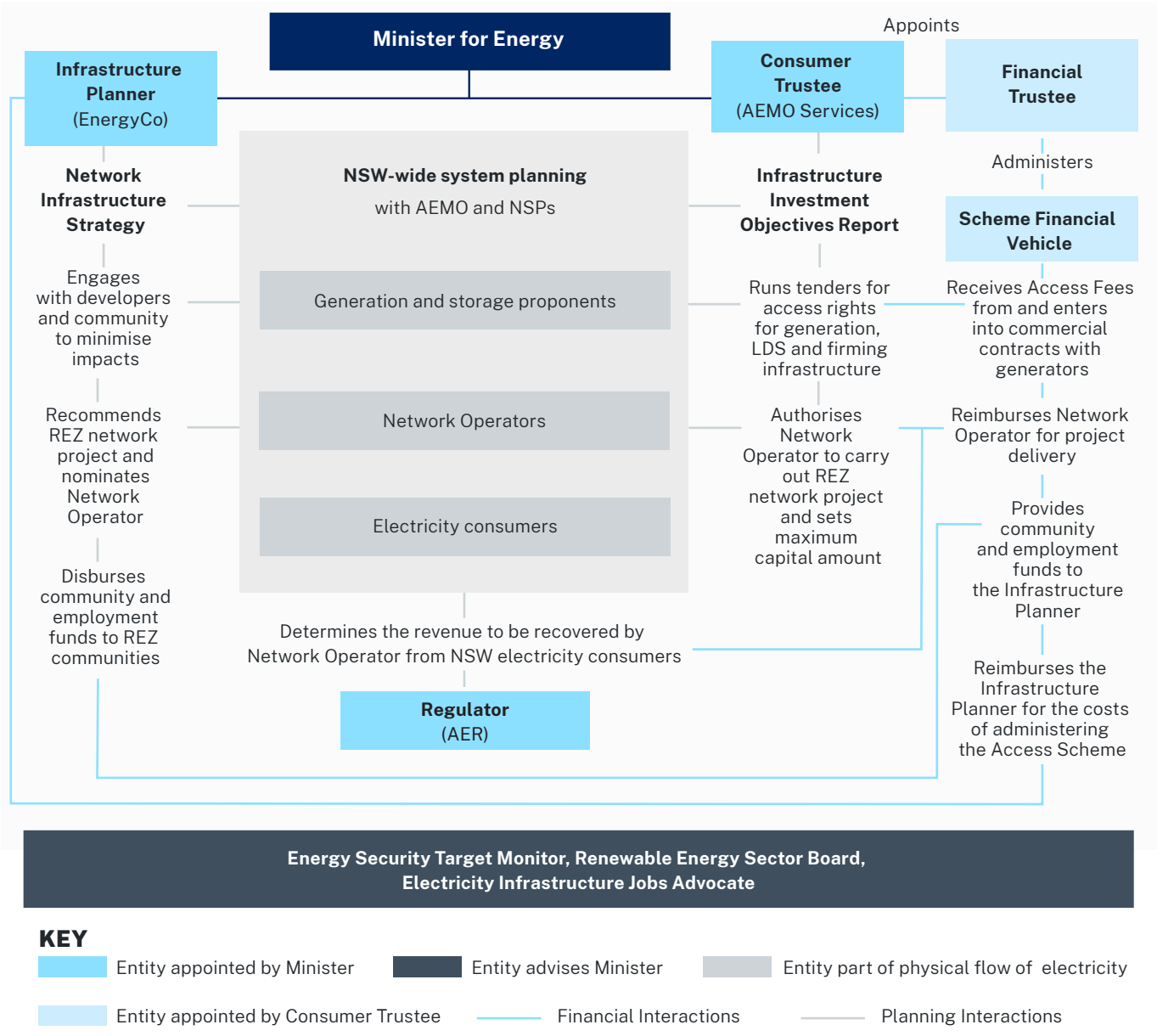
A distribution line in Wollongong.

2.1 ‘Roadmap Entities’ coordinate infrastructure under the EII Act

The *EII Act* sets out the NSW-wide planning framework for coordinated investment in our power system. Under the Act, the Minister for Energy has appointed three statutory bodies with distinct roles to plan for and supervise the delivery of electricity in NSW: see Figure 19.

These three bodies are referred to as Roadmap Entities, both in this Strategy and in other documents produced under the framework. Their roles are described below.

Figure 19: Roadmap Entities in the NSW legislative framework



- **AEMO Services Limited** was appointed as the **Consumer Trustee** in July 2021. The Consumer Trustee acts independently of government and in the long-term financial interests of NSW electricity consumers. It publishes an IIO Report every two years, which sets out a 20-year development pathway for investment in generation, long-duration storage and firming infrastructure and a 10-year plan for how it will conduct competitive tenders for long-term energy services agreements and access rights in REZs.

  The Consumer Trustee also decides whether to authorise network projects recommended by the Infrastructure Planner, enabling the costs of these projects to be recovered from consumers.
- **EnergyCo** has been appointed **Infrastructure Planner** for the five NSW Renewable Energy Zones, as well as for the Hunter Transmission Project and the Waratah Super Battery. Its objective is to ensure this infrastructure is developed in the long-term interest of NSW electricity consumers and communities: see 'About EnergyCo' above.

  EnergyCo publishes this Strategy, leads community engagement, develops access schemes for projects to connect to REZs, and, as Infrastructure Planner, recommends network projects and Network Operators to the Consumer Trustee for authorisation.
- The **Australian Energy Regulator** (AER) was appointed **Regulator** on 12 November 2021. It determines the revenues payable to Network Operators for network infrastructure projects and contributions to the scheme financial vehicle to be recovered from NSW electricity consumers
- The **Scheme Financial Vehicle (SFV)** establishes, maintains and manages payments from the Electricity Infrastructure Fund under the NSW framework, including for LTESAs, access schemes, network revenue allowances, and administration. The SFV also serves as an independent counterparty to LTESA project proponents. The **Financial Trustee** administers the SFV, with **Equity Trustees Limited** appointed to that role by the Consumer Trustee in September 2022 following an open tender process.

The Minister and the statutory bodies also draw on the advice of NSW's Energy Security Target Monitor, the Renewable Energy Sector Board and the Electricity Infrastructure Jobs Advocate.

Sheep farm outside of Glen Innes, NSW.

2.2 Coordinated planning for NSW's network infrastructure

The Electricity Infrastructure Roadmap (the Roadmap), underpinned by the *Electricity Infrastructure Investment Act 2020* (EII Act), provides a coordinated framework for delivering the generation, storage, firming and network infrastructure that NSW needs.

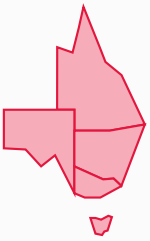
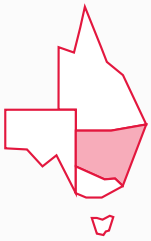
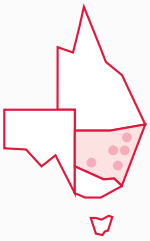
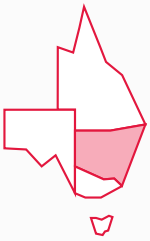
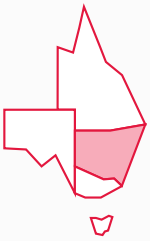
The EII Act has minimum objectives of 12 GW of generation infrastructure and 2 GW of long-duration storage infrastructure to be constructed by 2030. Its overall objective is to construct generation, long-duration storage and firming infrastructure to minimise costs to NSW electricity consumers and meet the NSW energy security target and reliability standard.

Developing NSW's electricity network backbone to support this infrastructure is critical to:

- connect new generation in Renewable Energy Zones (REZs) and unblock network bottlenecks
- keep the grid secure and reliable
- deliver lower electricity prices for households and businesses than would be possible without that network backbone, and
- deliver tangible economic and employment benefits to local communities, while minimising impacts on them.

Given the speed and nature of changes to a complex NSW energy system, a single static plan will not future-proof its infrastructure: see Section 2.4 below. Figure 20 sets out the five layers of complementary, iterative planning documents that coordinate planning for network infrastructure in NSW. It is a continuous process, with each of five planning documents informing the next over a two-year planning cycle. Each document benefits from stakeholder engagement, and is further informed by market developments, including experience from project development and delivery.

Figure 20: Coordinated, iterative planning for NSW transmission projects

Entity	AEMO	AEMO Services Limited	EnergyCo	Transgrid	Ausgrid, Endeavour Energy, Essential Energy
Document	Integrated System Plan	Infrastructure Investment Objectives Report	Network Infrastructure Strategy	Transmission Annual Planning Report	Distribution Annual Planning Reports
Coverage	 NEM	 NSW	 NSW REZs and PTIPs	 NSW	 NSW
Level of detail	National	Generation and storage in NSW	REZ design and downstream augmentation	Existing transmission network and other projects	Existing distribution network and other projects
Time horizon	20 years and beyond	20 years	20 years	10+ years	10 years

High-level planning starts with the ISP, which sets out the NEM's generation, firming, storage and network requirements through to 2050, including several major network projects in this state. NSW is at the centre of the NEM, with transmission lines connecting to Queensland, South Australia, Victoria and on to Tasmania. In all, around half of the ISP's network requirements are located in NSW, linking the most promising areas of renewable energy resources.

In parallel, the Consumer Trustee prepares the IIO Report every two years, with a development pathway and tender plan to guide investment in *generation*, *long-duration storage* and *firming* infrastructure.

Complementing the IIO Report, the Network Infrastructure Strategy is a strategy for the practical coordination of NSW *network* infrastructure with that generation, storage and firming, particularly through NSW's REZs and PTIPs.

Together, the IIO Report and the Strategy serve a similar purpose for NSW as the ISP does for the wider NEM, seeking to co-optimise the development of all electricity infrastructure over 20 years. The IIO Report's economic analysis and development pathway informs each round of the Strategy, along with the guiding principles and latest market and project data.

In turn, these documents complement the Transmission Annual Planning Report, prepared by Transgrid, and the three Distribution Annual Planning Reports prepared by Ausgrid, Endeavour Energy and Essential Energy. These annual plans are set for rolling 10-year periods, with the distribution reports taking the coordinated, iterative planning down to street level in NSW, for the long-term benefit of electricity consumers.

A man in high-visibility clothing surveying.

2.3 Renewable Energy Zones a primary focus of NSW energy planning

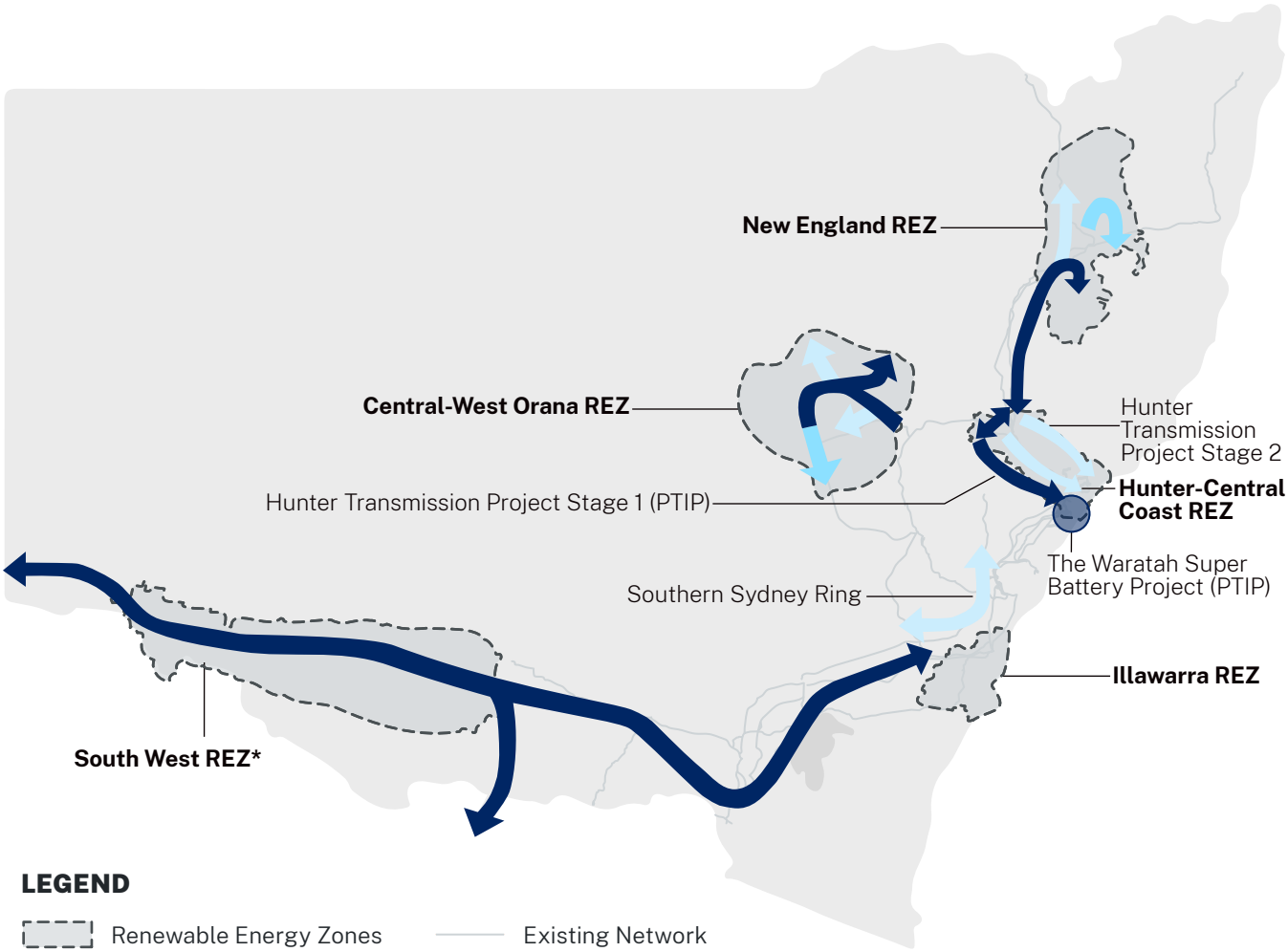
Renewable Energy Zones are a new feature of electricity system planning in NSW (and other states) and are the most cost-effective approach to deliver clean, reliable and affordable energy to NSW household and businesses.

Locating infrastructure in large yet defined areas takes advantage of economies of scale in delivery of infrastructure to access the most reliable and low-cost renewable energy resources, while minimising overall impacts on communities.

These advantages flow through to cost and reliability benefits for NSW electricity consumers, and economic opportunities for host communities. At the same time, REZs must respect existing land uses, biodiversity conservation, and cultural heritage.

The Network Infrastructure Options in the Strategy are designed to support new renewable energy generation and storage capacity in NSW's Renewable Energy Zones. The role of each of the five REZs and the options proposed to enable them are detailed in Section 1.2 above.

Figure 21: Reference map of NSW network infrastructure and REZs



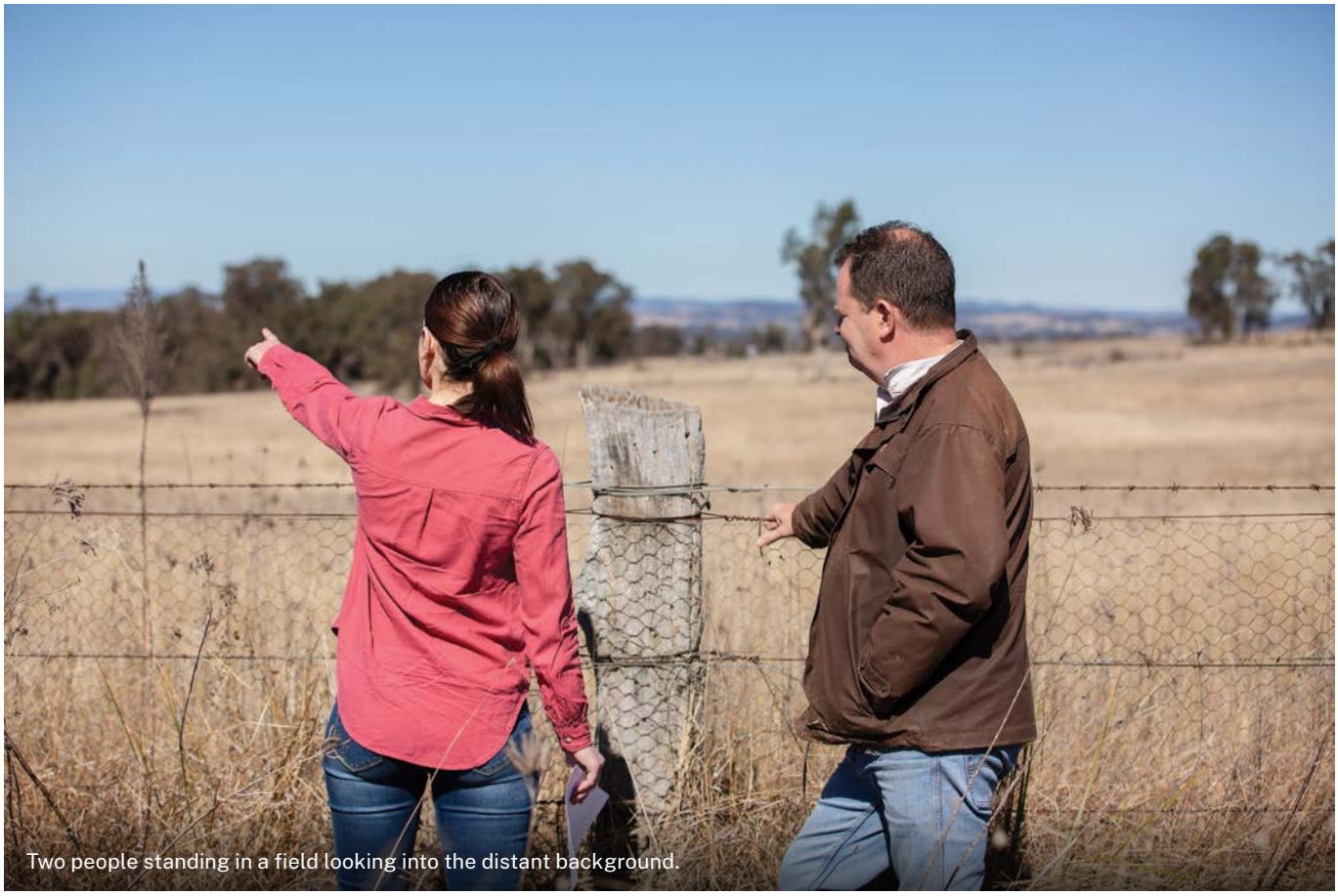
*Network infrastructure delivered through Transgrid's ISP projects EnergyConnect, HumeLink and VNI West

The switch from fossil fuel generation to renewable generation requires additional storage, firming capacity and ancillary services, all of which lead to a much more dynamic and complex power system. Electrifying industry, homes and transport further increases complexity. New technologies such as hydrogen, novel long-duration storage technologies and offshore wind continue to emerge, each of which may feature in the development pathway in the future.

Given the speed and nature of these changes, a single static plan will not future-proof NSW's energy system. The planning must be coordinated and systematic, but also iterative to take into account industry developments as they occur. Each release of an ISP, Network Infrastructure Strategy, IIO Report or Transmission Annual Planning Report contributes to that planning.

The development pathway outlined in the Strategy does not bind either the Infrastructure Planner or the Consumer Trustee in their decisions. Rather, it provides a coordinated strategic context for the decisions.

As Infrastructure Planner, EnergyCo develops the design of each option, with detailed stakeholder engagement, before recommending a network solution to the Consumer Trustee for authorisation. Projects will continue to be assessed and refined to ensure they benefit NSW consumers and host, regional and First Nations communities. All major network projects are subject to the NSW planning assessment process.



Two people standing in a field looking into the distant background.

2.4 Impacts from emerging technologies and market developments

NSW's complex energy system is becoming even more complex. The switch from fossil fuel generation to renewable generation requires additional storage, firming capacity and ancillary services, all of which lead to a much more dynamic power system. Electrifying industry, homes and transport further increases that complexity.

New technologies such as offshore wind, green hydrogen and novel long-duration storage continue to emerge, alongside opportunities in the distribution network and land managed by the Forestry Corporation of NSW. Different emerging technologies will have different roles in the NSW's future energy system, with differing needs from network infrastructure. For example:

- at-scale development of offshore wind would require offshore network development, and may reduce the need for onshore network development
- long-duration storage may decrease or increase the need for network infrastructure depending on its location
- a large-scale, grid-connected hydrogen export industry would significantly increase the need for generation and network infrastructure, and
- smart asset management technologies, including use of artificial intelligence, can release latent capacity in existing networks.

These and other developments are explored below. EnergyCo will continue to assess the developments as they mature, both through the Strategy and otherwise, to assist the coordinated, iterative planning of all Roadmap entities. This includes EnergyCo's considerations of these developments informing future iterations of the IIO Report. As mentioned, each release of an ISP, Network Infrastructure Strategy, IIO Report or Annual Planning Report contributes to the planning needed to account for these developments, in conjunction with other policies and programs the NSW Government may put in place.

2.4.1 Offshore wind

Oceans have strong and reliable wind resources, often time diverse to those on land, even if those resources are currently more expensive to access, particularly using floating technologies: see Box 5 below.[20] Offshore wind turbines are heavily deployed overseas, particularly in the North Sea off both the United Kingdom and Scandinavia, which have limited land availability for onshore wind. There, shared offshore-to-grid transmission helps lower connection costs, mitigate environmental impacts, and reduce planning assessment timeframes.

Given the potential benefits of offshore wind, the technology and enabling frameworks have potential for NSW, and the industry is expected to invest in projects at a significant scale. We have a long coastline and stable continental shelf, although deep waters would require the more expensive floating platform turbines. Offshore wind could bring large renewable energy generation directly into the major load centres on NSW's east coast, diversify NSW's renewable resources and reduce the need to upgrade onshore transmission.

The development of offshore renewable energy infrastructure, including these connections, is the focus of the *Offshore Electricity Infrastructure Act 2021 (Cth)*. Three separate processes are underway to explore offshore wind's potential for NSW:

- From February 2023 to April 2023, the Australian Government opened consultation on the impacts of potential offshore renewable energy, including offshore wind, in the Pacific Ocean near the Hunter region. This consultation is conducted under *Offshore Electricity Infrastructure Act 2021 (Cth)*, for which the Hunter is a priority region.
- In 2022, EnergyCo ran Registration of Interest processes for the Hunter-Central Coast and Illawarra REZs. Eight submissions totaling 12.9 GW for the Illawarra REZ and seven submissions totaling 24.5 GW for the Hunter-Central Coast REZ are now being reviewed.

Under NSW's coordinated framework for electricity infrastructure, planning for offshore wind would be integrated through the Strategy, including interfacing undersea transmission cables to the onshore grid to transfer electricity to demand centres.

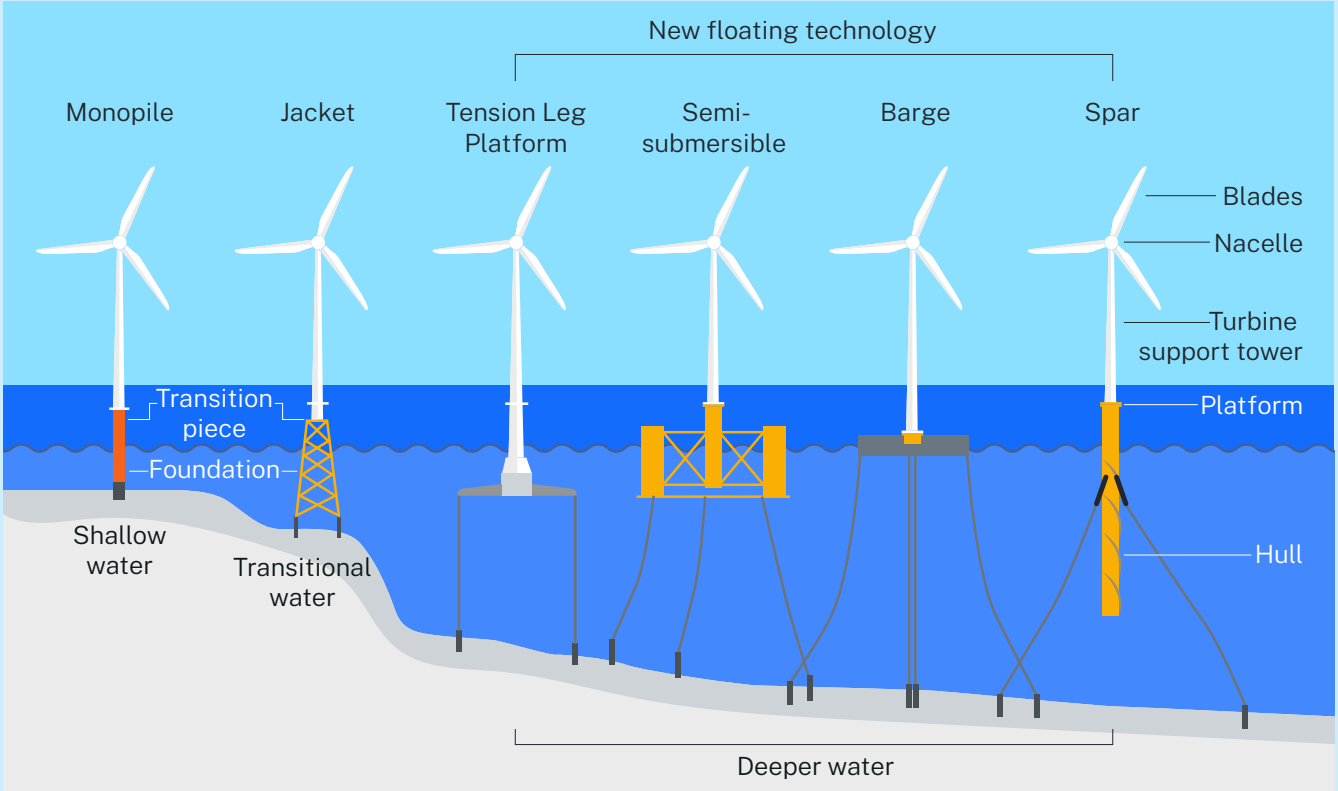
As offshore wind technology matures, EnergyCo will closely monitor its development and the NSW Government will continue to work with the Commonwealth in its planning and delivery as part of NSW's generation mix.

Box 5: Offshore wind energy technologies

While offshore wind technologies vary to suit different conditions, there are two main types:

- **Fixed turbines**, the most common types, built on either monopile or 'jacket' foundations on a suitable area of seabed floor in depths up to 50–60m, depending on conditions.
- **Floating turbines**, in deeper waters, sitting on a floating structure that is stabilised and moored in place by anchors. The typical designs for anchoring the surface structure include spar-buoy, semi-submersible and tension leg platforms. These turbines are generally more complex and expensive than fixed turbines, and commercial development is less advanced. Floating platform variants are considered novel compared to fixed turbines and are currently undergoing practical testing and design evolution.

Figure 22: Offshore wind turbine structures



Wind turbines at sea.

2.4.2 Green hydrogen

The 2021 NSW Hydrogen Strategy sets out a vision and plan to develop a commercial green hydrogen industry. 'Green hydrogen' means hydrogen produced from renewable energy sources into its various carrier forms: gas, ammonia, liquid hydrogen, and liquid organic hydrogen carriers: see Box 6 below.

Not only is green hydrogen critical for NSW to achieve net zero emissions by 2050, but it would support domestic industrial growth and may underpin a globally competitive export industry at a scale to rival our current coal export industry. The NSW Government's coordinated energy system planning will continue to review the appropriate and achievable scale of a hydrogen export industry, including the extent of solar and wind resources needed to support it.

The NSW Hydrogen Strategy provides around $3 billion in financial incentives to reduce the cost of green hydrogen and unlock new demand for it. The initial target is 700 MW electrolyser capacity of production by 2030, which would create up to 10,000 jobs and increase gross state product by over $600 million each year. The NSW Government's Hydrogen Hub Initiative has $150 million in grants available for that production, with the ten projects already shortlisted for funding having potential to exceed the 2030 capacity target.

EnergyCo will continue to explore the hydrogen opportunity, especially in relation to the Illawarra and Hunter-Central Coast REZs and their respective Hydrogen Hubs. There may also be scope to form additional 'H2-REZs' that focus purely on electricity production for green hydrogen production.

These would demand significant amounts of clean, affordable electricity, and the infrastructure required to support it, including emerging technologies such as offshore wind. EnergyCo will continue to consider these factors in developing future editions of this Strategy and as an input to a proposed masterplan for the development of NSW Hydrogen Infrastructure.

Box 6: Green hydrogen technologies

Hydrogen (H) is the most common chemical element in our universe. Different types of 'electrolysers' are used to break down water molecules into hydrogen and oxygen, including polymer electrolyte membranes (PEM), alkaline water electrolysis and solid oxide electrolyser cells.

Hydrogen can be used to store or transport energy (as hydrogen or ammonia, the two options for exporting renewable energy), or to displace fossil fuels in a variety of applications. These include electricity generation (through a gas turbine), fuel-cells for cars, trucks and public transport (such as the hydrogen buses being trialled on the Central Coast), chemical production (ammonia for fertiliser), or industrial feedstock (green steel or alumina).

Produced hydrogen is called 'green' if the electrolysers are powered by renewable energy only, so that both its production and use are effectively emissions-free. Other forms or colours of produced hydrogen are not. 'Black or brown' hydrogen is produced by drawing on black or brown coal; 'grey' or 'blue' hydrogen is produced from natural gas (CH_4) through a different 'steam reforming' process; and 'blue' hydrogen may also refer to hydrogen produced from fossil fuels in combination with carbon capture and storage.

Portside factories, Port Kembla.

2.4.3 Long-duration energy storage

Different forms of LDS help to 'time-shift' electricity and provide 24/7 reliability of supply as renewable energy replaces traditional sources in the NSW generation mix. Under the EII Act, LDS is defined as being capable of dispatching for at least eight hours.

The technologies include pumped hydro schemes, advanced compressed air energy storage, gravitational storage, battery energy storage systems, flow batteries and thermal storage including concentrated solar thermal systems: see Box 7 below.

The NSW Government is supporting the development of these technologies through the Long Duration Storage Recoverable Grants program (formerly the Pumped Hydro Recoverable Grants program). EnergyCo has awarded grants to the early stage and detailed feasibility studies of six projects across NSW, with a combined capacity of over 2.5 GW.

These initiatives complement the Consumer Trustee's competitive tenders for LDS LTESAs, and reduce risk for investors financing LDS projects. The inaugural tender in Q4 2022 sought around 600 MW of LDS capacity.

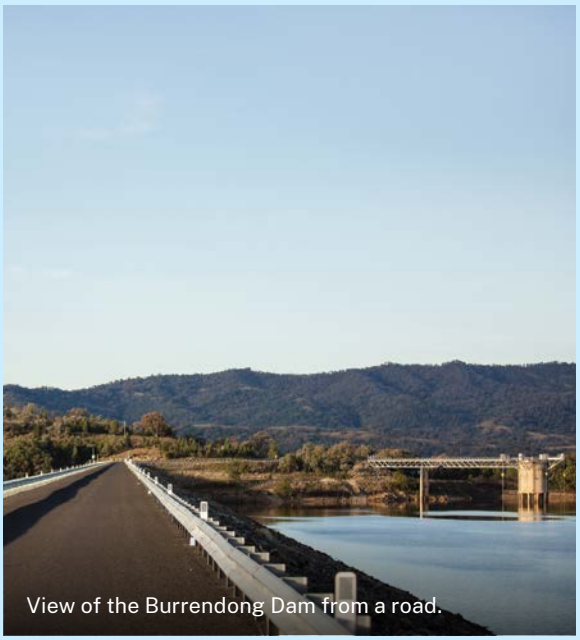
Cataract Dam.

Box 7: Long-duration storage technologies

Pumped hydro energy storage (PHES) is the most mature LDS technology. Conventional PHES uses electricity from the grid to pump water from a lower to an upper reservoir. It does so when there is strong solar or wind electricity supply ideally in periods of off-peak energy demand. When electricity demand is high, the water is released and flows through a hydro-electric turbine to produce electricity.

Under the Pumped Hydro Recoverable Grants Program, a total of $51.84 million has been awarded to support pre-investment activities for six projects, with a combined capacity of 2.5 GW:

- 335 MW Lake Lyell PHES
- 600 MW Oven Mountain PHES
- 235 MW Shoalhaven Hydro Expansion
- 325 MW Central West Pumped Hydro
- 250 MW Muswellbrook Pumped Hydro
- 810 MW Phoenix Pumped Hydro



View of the Burrendong Dam from a road.

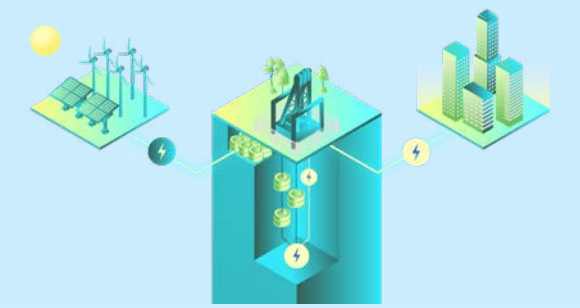
Advanced compressed air energy storage (A-CAES) is similar to pumped hydro, but instead of pumping water to an upper reservoir, it compresses air into deep underground "rock caverns" during periods of excess electricity supply. When electricity is later required, the rock cavern is flooded with water, and gravitational force pushes the compressed air back to the surface and through an expansion turbine to generate electricity.

The Silver City Energy Storage Project in Broken Hill is planning a 200 MW A-CAES facility, able to discharge for up to 8 hours at a time, to provide flexible grid support services and energy for local consumers. It was recently awarded $45 million in funding from the Australian Renewable Energy Agency.

A graphic representation of the Hydrostor compressed air energy storage project, planned near Broken Hill.

Gravitational storage uses similar principles as PHES and A-CAES, using available energy to raise a large mass by crane or pulley. An alternative implementation of this technology hydraulically pumps water into a chamber underneath the mass. When electricity demand is high, the weight is lowered, reversing the motor of the pulley or crane, or by forcing the water through a turbine to generate electricity for the grid.

This technology is currently being explored in NSW, with a pre-feasibility study underway to demonstrate the potential use of the technology in a former mineshaft.



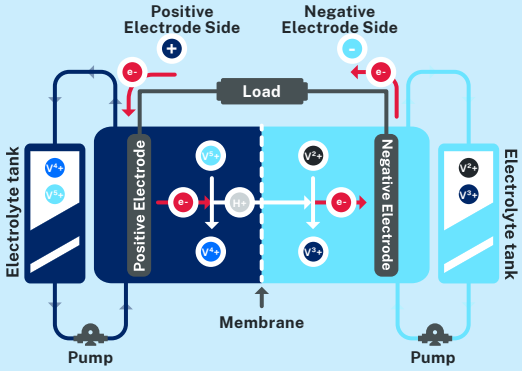
Graphic representation of a gravitational storage system, storing energy in weights raised and lowered in an underground shaft.

Battery energy storage systems (BESS) typically use **lithium-ion batteries** which are charged from the grid and later discharged when electricity demand is high. This technology is scalable and flexible and is suited to a number of applications of different sizes and durations. Batteries are fast to respond to system needs, reacting on a millisecond-second scale to provide energy and ancillary system services.


Modern Container battery energy storage system.

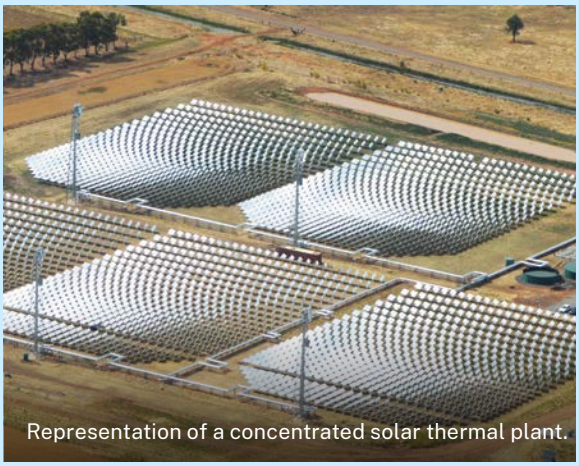
Flow batteries are another form of BESS. A typical battery has an electrolyte solution and the positive and negative electrodes in the same cell. A flow battery stores the electrolyte solution in separate tanks and pumps it through a smaller electrode cell. In this way, the energy stored in the electrolyte tank (kWh) is decoupled from the cell's power output (kW). To add storage duration, a flow battery can add more or larger electrolyte tanks, while lithium-ion batteries would add complete electrode cells. Flow batteries are able to respond to demand as quickly as lithium-ion batteries, but they degrade more slowly and have a longer lifecycle.

Figure 23: Diagram of a discharging vanadium flow battery



Concentrated solar thermal is a form of thermal energy storage. Concentrated solar systems use mirrors to reflect and concentrate the sun's energy which is captured as heat, stored, then used to produce cost-effective heat and power when it is needed. It is ideally suited to hot, dry locations.

Australian company Vast Solar's CSP v3.0 technology has been proven at its 1.1 MW, grid-synchronised demonstration plant in Forbes, NSW, and is set for deployment at scale across Australia and around the world. The company's modular design, utilising sodium heat transfer technology, provides consumers with a solution to the challenge of intermittent renewable energy through dispatchable power and heat.


Representation of a concentrated solar thermal plant.

MGA thermal is a novel form of thermal energy storage developed locally by MGA Thermal Pty Ltd with University of Newcastle. Miscibility Gap Alloy (MGA) thermal energy storage systems use proprietary MGA blocks to store energy as heat, which can be later discharged as industrial process heat or used to drive a turbine. The technology has many advantages including simultaneous charge and discharge, small size, continuous dispatch of energy, and compatibility with existing industrial systems.


Miscibility Gap Alloy blocks.

2.4.4 Distribution network opportunities

The increasing use of residential rooftop solar, batteries and electric vehicles is rapidly changing the amount and timing of electricity demand on distribution networks. Network Service Providers are continually evaluating minor, low-cost upgrades to make better use of their existing network capacity. Such efforts leverage existing assets and deliver tangible benefits for NSW electricity consumers, and complement larger transmission options.

Small-scale consumer energy resources (CER) such as household and community batteries and rooftop solar are located in distribution networks, and typically but not always on the consumer side of the electricity meter. Their use is growing strongly in NSW as consumers embrace new technologies to contribute to climate change action and take control of their energy bills. As a result, a broadening range of CER services are being offered to consumers, including those of retailers, aggregators and virtual power plants (VPPs) that use 'smart' technologies to aggregate and orchestrate local CER.

NSPs for both transmission and distribution networks are responding with cost-effective minor upgrades to specific lines or substations to unlock latent capacity, and optimising the network with technology innovation: see Box 8 below. As well they must consider how rooftop PV is shifting peak demand from daylight hours to later in the evening, and how their output is more than offset by increasing demand from domestic and commercial EVs and electrification of domestic appliances and industrial processes.

EnergyCo is taking account of these developments in its Strategy planning, in particular through demand forecasting for the modelling exercise. Distribution system investments complement the larger transmission options that are the focus of the Strategy. They may offer an additional solution to bridge the 2025–2030 period when existing generators are already exiting at scale, but large-scale generation, storage and infrastructure projects are only starting to deliver their benefits. Additional consumer benefits could be obtained by accelerating the deployment of distributed PV, VPP and other CER, enabled with targeted minor distribution network augmentations.

Box 8: Network design software technologies

As they are responsible for 40,000 km of NEM transmission and distribution lines, Network Service Providers have innovative network and system design tools to plan, build, maintain and optimise their networks.

The creation of "digital twins" of the physical network is becoming increasingly common. These virtual representations allow for testing of the network under a variety of possible situations, helping identify opportunities for efficiency, safety and system security improvements. Contemporary digital twin models can incorporate environmental and technical constraint data in carrying out simulations.

By applying these technologies, some existing network infrastructure in NSW can be used more efficiently and greater levels of CER can be supported within the distribution networks, thereby overall reducing the need for new network assets.

2.4.5 Forestry Corporation NSW

In 2021, the *Forestry Act 2012* was amended to allow renewable energy infrastructure within the 225,000 hectares of State forest pine plantations. Some of these are near existing network infrastructure, opening up new opportunities for generation to connect to new parts of the grid previously difficult to access.

The Forestry Corporation has begun to identify potential for renewable energy projects within pine plantations near Oberon, Sunny Corner, Orange and Bondo. The Corporation is shortlisting renewable energy providers to provide formal proposals to best understand compatible development opportunities.

The scale, timing and location of this potential generation development could influence the planning and operational parameters of NSW's REZs, as the currently identified plantations are near existing REZs or important downstream network pathways. EnergyCo will closely work with Forestry Corporation to ensure coordinated development of the two programs of work – ensuring the best outcome for NSW electricity consumers.

More information on the Forestry Corporation program can be found on their website.

Part 3: Engagement with communities and industry

3

Armidale Post Office, Armidale, NSW.

EnergyCo leads engagement with community and industry to support the delivery of REZs and PTIPs across NSW. Working with communities and industry helps ensure that new transmission infrastructure is developed in the right place, at the right time, to deliver clean, reliable and affordable energy to the households and businesses of NSW.

Effective community engagement helps deliver better energy system outcomes, maximise benefits for regional and First Nations communities that host new energy infrastructure and minimise the impacts of network development as far as practicable.

Effective industry engagement helps ensure the delivery of new NSW transmission in a supply-constrained world, maintaining security and reliability through the power system's modernisation.

This section sets out:

3.1 the opportunities for consultation and engagement through state-wide, REZ and project planning

3.2 the need to balance energy market and community considerations, and

3.3 the challenges facing the energy sector in delivering the NSW energy transformation, and the collaborative strategies being taken to address them.

Effective, inclusive engagement will remain central to EnergyCo's approach to network development.

3.1 Opportunities for consultation and engagement

NSW's energy development is systematically coordinated by the Minister, the Consumer Trustee, EnergyCo and the Network Operators: see Section 2.1. Although their consultation and engagement with communities is continual, there is a particular focus at three levels of planning:

- NSW's major state-wide planning documents, including this Strategy and the IIO Report
- the development stages of each REZ, and
- the development stages of each project that contributes to NSW's energy transformation.

If a Network Infrastructure Option is to proceed to delivery, there would be three further formal opportunities for stakeholder consultation, in addition to the continuing engagement:

- as EnergyCo develops the design of the option in its role as Infrastructure Planner, before recommending a network solution to the Consumer Trustee for authorisation
- if the project is authorised, an environmental impact statement process to evaluate its social, environmental and economic impacts, and
- finally, the development consent and management plan process, which sets the conditions to be met during project construction and operation.

EnergyCo looks forward to engaging and working with communities, consumers, the Consumer Trustee and industry on the continued modernisation of NSW's energy system.

People walking along the Port Kembla Seawall.

3.2 Balancing energy market and community considerations

Electricity system investment must balance energy market efficiency, consumer costs, and environmental and community impacts. Achieving a reasonable balance calls for:

- appropriate respect for host, regional and First Nations communities and the issues they face
- clear principles to guide engagement, informed by studies and strategies to minimise impacts on communities, and
- a holistic package of programs to share the benefits of the energy transformation across all stakeholders not just energy consumers.

EnergyCo continues to work with communities on each of these elements.

Respect for communities and the issues they face

New transmission infrastructure must be delivered in a way that minimises the impacts on, and maximises the benefits for, the communities and landowners who will host it. This is core to EnergyCo's approach to network planning and project development and fostering local community support is a clear objective of the Roadmap and EII Act.

Through feedback on the Draft Strategy and EnergyCo's other continuing engagement, EnergyCo recognises that the primary community concerns include:

- securing tangible benefits for local communities hosting infrastructure, including lower cost and more reliable local electricity, more reliable local telecommunications, and more local infrastructure and services
- managing demand on local services and infrastructure such as workforce accommodation, skilled workforces, roads and traffic management, telecommunications and waste management, and
- maintaining a strong community voice throughout the planning and development process.

EnergyCo continues to engage with host communities to understand local priorities, inform whole-of-REZ planning and deliver collaborative solutions to address issues and concerns.

Family enjoying the day in the garden.

Principles of community engagement

There are many opportunities for community input and engagement through the lifecycle of a network project: both through formal processes and ongoing collaborative engagement.

Network projects are developed with consideration of a range of technical, environmental, economic and social factors and informed by consultation with landowners and the broader community. This includes gathering local knowledge and understanding community and landholder concerns and preferences to refine a network route.

EnergyCo's approach during all stages of a project is to encourage collaborative, transparent and open consultation to deliver a project which meets the network need to provide reliable and affordable energy supply in a way that secures the best possible outcomes for communities and minimises impacts as far as practicable.

The formal consultation processes in project development include public consultation as part of development applications by EnergyCo for planning approval for network projects under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Engagement by EnergyCo and proponents may also be bound by other NSW standards such as the NSW Large Scale Solar (2017) and Wind (2016) Guidelines, First Nations Guidelines (2020), Undertaking Engagement Guidelines for State Significant Projects (2021), Property Acquisition Standards (2019), and Community Participation Plan (2019).

For more information on our engagement with communities please visit our website, or call EnergyCo at any time: Contact | EnergyCo (nsw.gov.au).

Sharing the benefits of the energy transformation

EnergyCo is also supporting specific NSW Government packages to ensure host communities benefit directly from infrastructure investment in their local area:

- a **Strategic Benefits Payments Scheme** for landowners, which complements existing compensation requirements for easements and recognises the critical supporting role landowners will have in hosting the new transmission infrastructure that will power the state into the future
- **Community Benefit Sharing Schemes** to fund community initiatives within the REZs, including public services or infrastructure, health services, accommodation or housing, local or regional energy programs, environmental programs, parks and recreation infrastructure, education programs or research, arts, cultural and tourism programs, First Nations programs, or other services that benefit the local community. The schemes are funded from access fees paid by energy generation and storage developers who connect to new REZ network infrastructure[21]
- for **local First Nations communities**, formal guidelines set out EnergyCo's expectations for proponents to consult and negotiate, in order to increase employment and income opportunities, and
- **Employment and training programs** to implement the recommendations of the Renewable Energy Sector Board and the Electricity Infrastructure Jobs Advocate, to promote opportunities to maximise employment and training opportunities and the use of local content, goods and services in delivering the NSW Roadmap.

EnergyCo will maintain an open dialogue with the community as projects progress, on these schemes as well as infrastructure project delivery.

3.3 Industry engagement to overcome inherent challenges

The complexity, speed and scale of NSW's energy transformation bring two specific challenges for the energy sector:

- Delivering new electricity infrastructure in a world of supply chain constraints, skills and labour shortages, and competition for scarce resources, and
- Maintaining reliability and security of the network in the face of potential delays to new network projects, existing power stations exiting the market faster than anticipated, and the commissioning of unprecedented amounts of new generation and storage.

These challenges will be met by meaningful engagement and collaboration between all parties with a role or interest in NSW's electricity transformation.

Delivering new electricity infrastructure in a supply-constrained world

NSW is modernising its energy system at the same time as the rest of the world. Annual global investment in clean energy is expected to rise from US$1.3 trillion today to above US$2 trillion by 2030 under current national commitments and would need to double again to US$4 trillion to limit temperature rises to 2°C.[22]

This investment crunch is leading to shortages of large electrical components, shipping capacity, skills and mineral resources. Currently, only a small number of companies and countries supply major electrical components[23], with a factory production 'slot' having to be booked up to 12 months in advance, and shipping to Australia extremely constrained. Australia's large infrastructure pipeline is already leading to workforce shortages,[24] yet NSW's energy infrastructure is forecast to need 14,000 to 22,000 workers over the next 15 years, with the peaks leading up to 2025 and 2030.[25] Electricity infrastructure also requires substantial supplies of materials that are currently in short global supply, especially concrete, steel, copper, aluminium, and rare earth metals.

NSW has a range of initiatives to address these challenges, in coordination with Australian Government initiatives.

- The **Renewable Energy Sector Board**, with industry, union and consumer representatives, advises on strategies to reduce potential supply chain disruptions. The 2022 RESB Plan recommends strengthening the supply chain with locally produced and supplied goods, materials and services, which may leverage strong advantages Australia has in these resources. The plan aligns with the NSW Electricity Infrastructure Jobs Advocate in promoting opportunities for qualified workers and trainees across the energy supply chain.[26]
- The Low Carbon Product and Renewable Manufacturing Funds offer $550m in support for the local manufacture of clean energy materials and fuels, reducing the dependency on overseas supply chains. The Clean Manufacturing Precincts and Hydrogen Hubs in the Hunter and Illawarra regions are at the vanguard of these new industries.
- The National Energy Transition Partnership between the Australian, NSW and other state and territory governments is a national commitment to address supply chain issues. At their December 2022 meeting, Energy Ministers announced a National Clean Energy Supply Chain Action Plan to address supply chain pressures and build national capability.[27]

In addition, EnergyCo will continue to explore the possibilities for greater supply and skills coordination across projects (e.g. the bulk buying of components and materials, or the coordination of training programs across host communities and workforces).

Maintaining reliability and security in a rapidly evolving energy market

The second area of continuous industry collaboration is in maintaining energy system reliability and security. To keep the grid secure and reliable, the power system is carefully managed to balance demand and supply. Balance becomes harder as more renewable energy and storage capacity is connected, as major power stations are withdrawn, as extreme weather events become more common, and as demand continues to grow. Balance is also at risk if there are delays in the delivery of electricity and network infrastructure.

Under the Roadmap, AEMO (as the NSW Energy Security Target Monitor) makes an annual 10-year capacity forecast and sets a target to ensure NSW has sufficient generation capacity to meet demand. The most recent EST Monitor Report[28] indicates a potential breach of the Energy Security Target, in part due to the potential early closure of Eraring Power Station, highlighting the need for additional firming capacity to be delivered promptly.

The Minister subsequently requested the preparation of a **Firming IIO Report**,[29] in which the Consumer Trustee recommended 380MW of new firming capacity in the Sydney-Newcastle-Wollongong sub-region by the end of 2025. In response, a firming LTESA tender round is currently underway, with a further contingent tender for long-duration storage scheduled for Q2 2023.

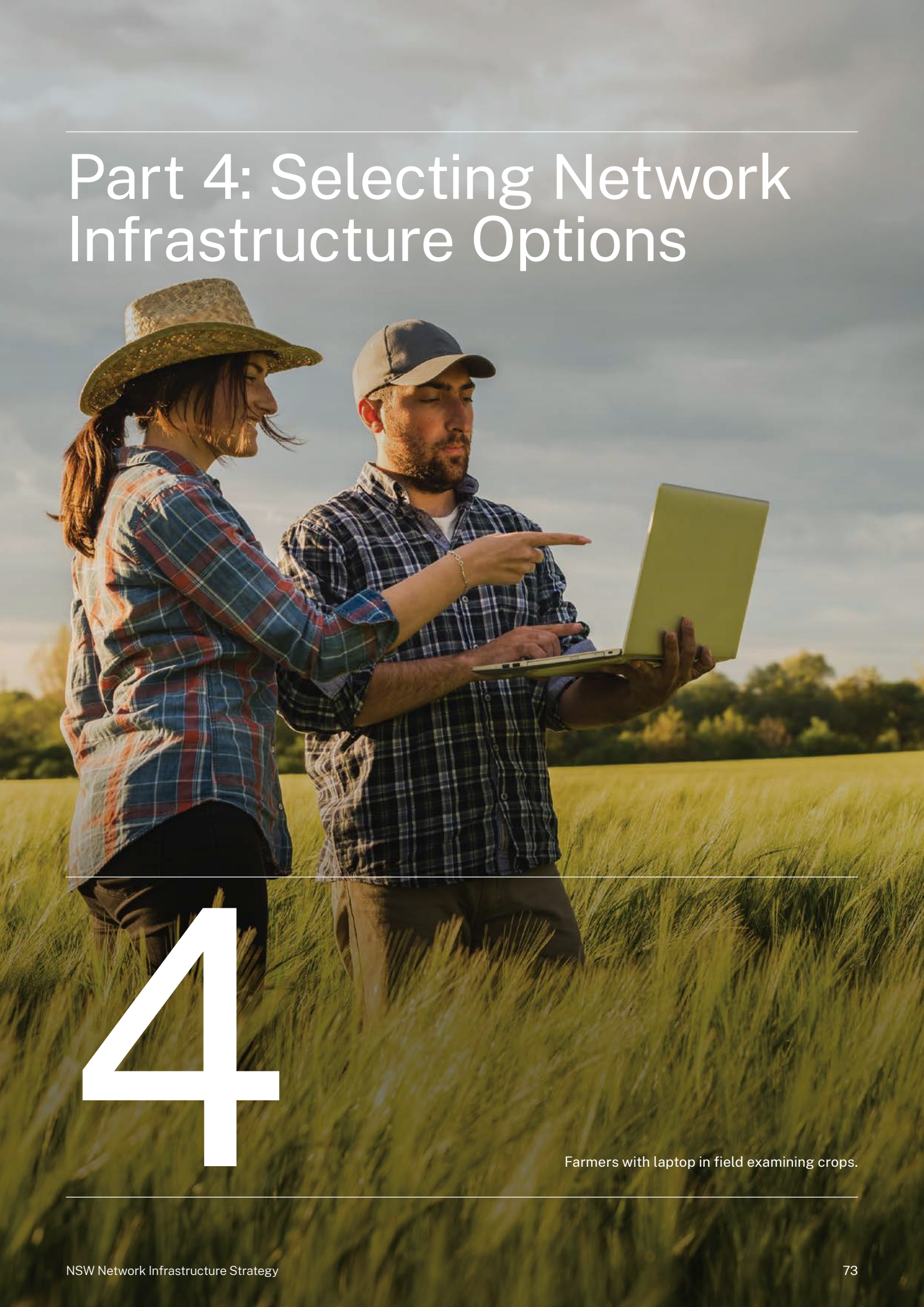
EnergyCo will continue to collaborate with the Consumer Trustee, AEMO, Transgrid and Network Service Providers to maintain reliability and security throughout the transition. AEMO oversees market operation, network, and system security planning in NSW, in accordance with the National Electricity Rules. Transgrid operates the existing high-voltage network in NSW. As new REZ infrastructure connects with the existing network, even closer collaboration is needed to minimise grid disruptions.

A number of NSW and national initiatives are driving that collaboration. Apart from the Waratah Super Battery project mentioned previously, these include:

- the new **Energy and Climate Change Ministerial Council**,[30] in which the Commonwealth and all state and territory governments collaborate on energy, including to support the NSW Roadmap, through initiatives such as the Capacity Investment Scheme, and
- the **Long Duration Storage Recoverable Grants program** (formerly the Pumped Hydro Recoverable Grants program) and other dedicated funding arrangements, to maintain focus on the roles of energy innovation and long-duration storage in maintaining energy security and reliability during REZ development.

Workers during set up at Moree Solar Farm.

Part 4: Selecting Network Infrastructure Options



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Farmers with laptop in field examining crops.

The Network Infrastructure Strategy proposes a portfolio and schedule of Network Infrastructure Options that, as a whole, balances the need for flexibility with the need for greater certainty for investors and communities.

This Part 4 sets out the steps EnergyCo and the Consumer Trustee have taken to identify those options:

4.1 EnergyCo identified 55 potential network infrastructure options that would enable generation and storage projects within REZs and provide future optionality.

4.2 EnergyCo estimated the construction cost and delivery schedule needed to build each option.

4.3 The Consumer Trustee conducted economic analysis to optimise the timing of network infrastructure build with generation and storage infrastructure build.

4.4 EnergyCo considered the Consumer Trustee's economic analysis as well as agreed guiding principles and the latest project information, to propose the Network Infrastructure Strategy.

The guiding principles that EnergyCo agreed with stakeholders are affordability, reliability, flexibility, innovation, fostering local community support and timeliness.

Together with other ISP projects, these Network Infrastructure Options would support the EII Act's 2030 infrastructure minimum and overall investment objectives, and its community objectives, to deliver clean, affordable and reliable electricity in the best long-term interests of NSW consumers and communities.

Figure 24: Overview of steps taken to determine the Network Infrastructure Options

Step	By	Actions	Additional inputs
1 Identify Network Options	EnergyCo	• Undertake engineering analysis to determine which Network Options could meet REZ capacity requirements, expected ISP timings and future NSW system needs • Incorporate community and other stakeholder feedback to make real-world adjustments to the engineering analysis	CT IIO Report AEMO ISP AEMO IASR TAPR/DAPR
2 Estimate option cost and delivery schedule	EnergyCo	• Estimate a standardised, high-level cost and schedule for each Network Option or augmentation	AEMO Transmission Cost Database Market soundings
3 Optimise option schedule	Consumer Trustee	• Undertake modelling to optimise the sequence of network option development across relevant scenarios	
4 Propose option schedule	EnergyCo	• Consider the modelling results, the guiding principles and the latest project information to propose a schedule of network options that would be in the best long-term interests of electricity consumers and communities	Joint planning with AEMO and Transgrid

4.1 Identify a menu of 55 potential network options

EnergyCo first identified potential network options (listed in the Draft Strategy) for connections within REZs and downstream to major load centres. These potential options are at a high-level conceptual stage of development, known as a 'Class 5b' estimate, suitable for this level of planning analysis.

The process, outlined in the Draft Strategy, benefited from feedback from both industry (received in the Registration of Interest processes for each REZ) and host communities and other stakeholders (received during the exhibition of the REZ declaration).

Forty potential options were identified for the first four declared REZs (Central-West Orana, New England, South West and Hunter-Central Coast). Fifteen more downstream options, including the Hunter Transmission Project, were identified for the existing network to support the REZs.

The Illawarra REZ hadn't been declared at the time modelling was undertaken for this Strategy, and its network options will be included in future editions.

4.2 Estimate the cost and delivery schedule for each Network Option

A detailed description of the method for estimating cost and delivery schedules is in Appendix C of the Draft Strategy. The assumptions used for these methods will continue to be updated in consultation with stakeholders and based on insights learned during the delivery of the REZs.

Cost estimations

Initial costs estimates were prepared based on AEMO's Transmission Cost Database and EnergyCo's experience developing the CWO REZ (see the Draft Strategy for further information). Following the completion of modelling, EnergyCo has further refined the network options and their costs as a result of feedback received during industry and community consultations. Appendix A Table 4 provides a detailed comparison of the minor changes made post modelling.

The costs include construction costs only, to a Class 5b accuracy level (i.e., +/- 50%). They include development and construction costs only (excluding finance, generator connection and system strength costs). This provides a comparable basis with estimates for projects under the National Electricity Rules. The total cost for a REZ also includes finance, generator connection and system strength costs at typically an additional 70% to 110% of development and construction costs. Generator and storage proponents that hold access rights will contribute connection and system strength costs. All values are in real 2021 Australian dollars. They are subject to evolving market conditions (including fostering local community support and global supply chain considerations) which may lead to changes in project scope, design and cost estimates.

Delivery schedule estimations

Delivery schedules estimate the earliest time an option could be delivered. In developing the estimates, EnergyCo itemised all activities and timings (from planning to commissioning the infrastructure) from its experience in developing the CWO REZ.

Standard project delivery was estimated at 4 years, with alternatives of 3.75 years to allow for acceleration if required, or 5 years to allow for delays in either approvals or construction. With the timing of some projects dependent on the progress of others, EnergyCo could set milestones within their earliest start and latest delivery.

These delivery dates are now based on the first realistic project schedules developed by EnergyCo. Realistic delivery times are on average about 2 years longer than previous estimates published in the 2022 ISP. EnergyCo's estimates now include sufficient time for community engagement, necessary regulatory and planning approvals and accommodating global supply chain constraints.

4.3 Optimise the Network Options under three future scenarios

EnergyCo next commissioned economic analysis by the Consumer Trustee to optimise the timing of network infrastructure build with generation and storage build. The analysis was performed across three scenarios that represent a range of market conditions. The optimisation incorporated limits on the extent of development that could feasibly be delivered in any one location at the same time, considering supply chain and cumulative impacts to host communities, and timing of other ISP projects.

Three scenarios to cover a range of plausible events

Four scenarios were developed by both parties and adjusted for stakeholder feedback on the Draft Strategy. One scenario was considered very similar to the *Central* scenario and so not included in the modelling for the final Strategy.

The three scenarios ultimately considered are described below. The Strategy does not express a view on the likelihood of these scenarios, but their consideration represents prudent network planning in taking into account plausible market developments.

1. ***Central***, in which there is rapid, coordinated, economy-wide action to transition from fossil fuels to renewable energy to help limit global temperature rise to below 1.8°C, in line with the *Step Change* scenario in the 2022 ISP.

   Network infrastructure would support an increasingly flexible and decentralised grid. Increased renewable penetration would drive down the cost of electricity, increasing the demand from industries that are switching to electricity. Hydrogen plays an increasing role in decarbonising local transport and replacing gas consumption. Wholesale electricity and scheme costs are lower than under *Transmission Delay* and higher than under *Coal Exit by 2030 and Strong Electrification*.

2. ***Transmission Delay***, in which the core assumptions are as in *Central*, but large network projects (with capital cost above $1 billion) are delayed due to development, construction and/or supply chain disruptions.

   The announcement of these delays is inherently uncertain, flowing through to a slower build of new REZ network infrastructure. As both generation and network infrastructure are being developed less efficiently, wholesale and scheme costs rise compared to the *Central* scenario, although emissions are similar.

3. ***Coal Exit by 2030 and Strong Electrification***, in which the ambition to limit global temperature increases to 1.5°C compared with pre-industrial levels. This would see all NSW coal-fired power stations exit the market by 2030, followed by strong growth in demand across the NSW economy from transport, industry and households all switching to electricity, and from new hydrogen electrolysers. New generation and network infrastructure is accelerated, leading to significantly lower wholesale electricity costs and emissions. Additional short-duration batteries support the existing mix of capacity and provide dispatchable capacity to meet the reliability standard.

   This scenario has identical inputs and assumptions as the *Hydrogen Superpower* scenario used in the Draft 2023 IIO Report. However, the new title better signals the implications for network planning in the accelerated withdrawal of coal-fired power stations. Other notable differences to the *Central* scenario include 10% higher operational demand by 2030, higher levels of flexible demand, around 900 MW of additional storage, and utility-scale solar with 50% lower cost by 2030.

The fourth scenario in the Draft 2030 IIO Report, *Early Coal Exit*, uses the same assumptions as *Central*, except that it assumes all Bayswater power station units retire by June 2030 and there is accelerated delivery of some transmission projects. The *Early Coal Exit* scenario was not analysed for this Strategy as in EnergyCo's view the outcomes were not sufficiently different from the *Central* scenario. The Consumer Trustee similarly notes this similarity in out comes between the two scenarios, which they identify as indicating that the *Central* scenario, as the draft development pathway, is resilient.

More information on the inputs, assumptions and scenarios for this modelling is available in Consumer Trustee's Draft 2023 IIO Report.

REZ build limits for solar and wind projects

To help ensure that the modelling results are as realistic as possible in the short-term, EnergyCo identified 'build limits' – the maximum capacity of solar and wind projects that can be brought into operation for ISP subregions[31] within NSW in the next three years.

For 2025 (the potential closure of Eraring Power Station) and 2026 (the indicative delivery time for ISP projects including HumeLink), the build limits were developed from the available knowledge of NSW's existing generation pipeline, the REZ Registration of Interest processes and the NSW Planning Portal, as well as the assumptions of the 2022 ISP.

For 2027 and beyond, the build limits used in the 2022 ISP were applied to all regions. After this time, projects may enter that are not yet known. More information on build limits is given in the Draft Strategy.

ISP project timings

To coordinate NSW development with the National Electricity Market, the modelled scenarios adopt EnergyCo's latest understanding of delivery timing for key ISP projects: see Table 6.

The timings for the *Central* scenario are formed from the latest published dates and knowledge from joint planning with Transgrid and AEMO. Where appropriate, *Transmission Delay* dates incorporated a 1-year delay, and *Coal Exit by 2030 and Strong Electrification* dates were brought forward by 0.25 years, consistent with the schedule adjustments applied for Strategy projects discussed above. These timings do not strictly follow the standard schedules of the Network Infrastructure Options because the projects are delivered by other parties and influenced by other factors.

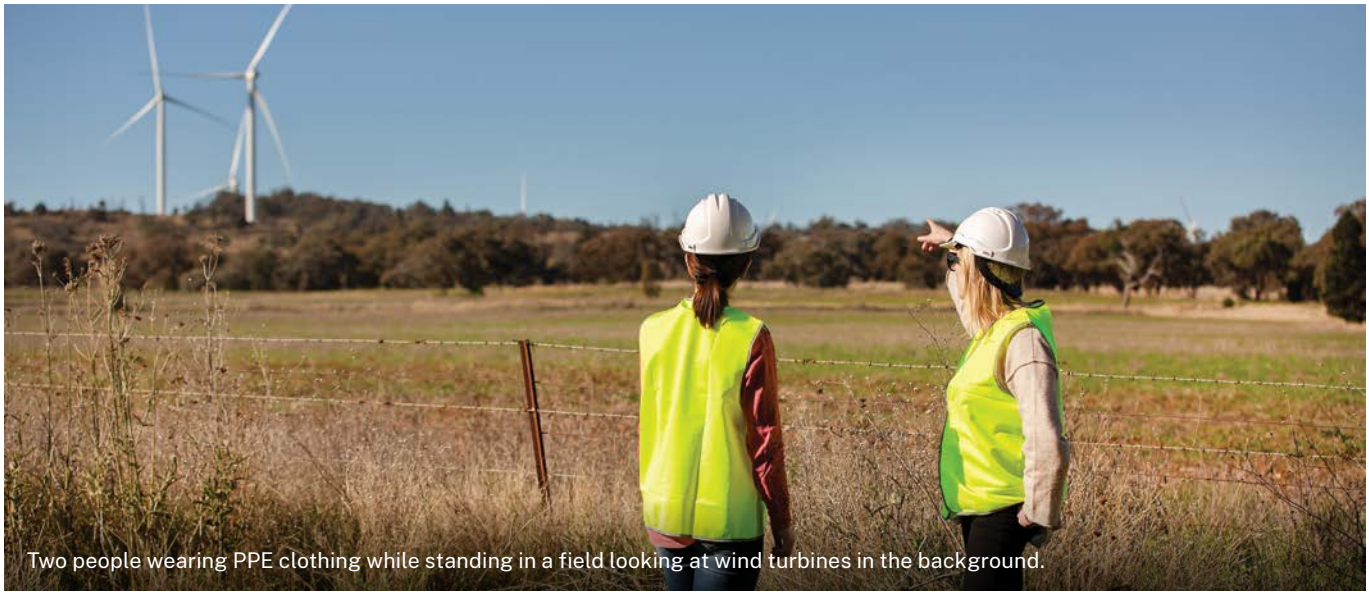
Table 6: Timings for other ISP and storage projects used in modelling

ISP Project	Strategy Scenario		
	Central	***Transmission Delay***	***Coal Exit by 2030 and Strong Electrification***
Project Energy Connect (both stages)[1]	Jun 2026	Jan 2027	Jun 2026
Snowy 2.0[2]	Aug 2028	Feb 2029	Feb 2028
HumeLink[3]	July 2028	Jul 2028	Dec 2026
Hunter Transmission Project (i.e. Sydney Ring North)	Dec 2027	Dec 2028	Sept 2027

1 Project EnergyConnect has the same timing in Central and No Coal by 2030 with Strong Electrification scenarios as this project is committed.

2 The Snowy 2.0 project timing is for full commercial operation of all units, for each scenario. At the time of modelling, EnergyCo assumed that commercial operation of all units which commence in August 2028, representing around an 18-month delay. EnergyCo made this assumption based on informal advice obtained through joint planning processes. Since this time, Snowy Hydro Limited has updated the expected commercial operation of all units to at earliest December 2028 and at latest December 2029, which represent around a 24-month delay. Snowy Hydro Limited, Snowy 2.0 Project Update Snowy Hydro Limited, 3 May 2023.

3 HumeLink project timing under Central scenario is in line with the Step Change scenario in Australian Energy Market Operator (AEMO), 2022 Integrated System Plan, 2022.



Two people wearing PPE clothing while standing in a field looking at wind turbines in the background.

4.4 Apply the guiding principles

The Consumer Trustee's market modelling identified a potential schedule for REZ network infrastructure over the next 20 years, for each of the three future scenarios. The Strategy seeks to ensure that network development balances the interests of electricity consumers and host communities.

EnergyCo has consulted with communities and industry to understand how to balance those interests. The result of that consultation are six guiding principles (Table 7 below) that inform selection of Network Infrastructure Options for economic modelling.

Affordability, reliability and flexibility highlight the need to build a strong, resilient network capable of dealing with future shocks, supporting wholesale market competition and consumer outcomes. Innovation and fostering local community support reflect the need to secure competitive and innovative solutions that meet the needs and expectations of local communities. Timeliness helps ensure that these projects, once selected, are delivered when they are needed in the energy transformation.

Table 7: Guiding principles and their application

Guiding principle	The development process seeks Network Infrastructure Options that...	Secured through the Strategy process by...
Affordability	• minimise long-term system costs, i.e. network cost per MW of generation capacity including downstream augmentations maximise inter-REZ and intra-REZ competition for LTES Agreements • enhance network utilisation • enable emissions reductions of 50 per cent by 2030 and achieve net zero emissions by 2050 at the lowest cost to consumers in line with NSW's Net Zero Plan	Market modelling by the Consumer Trustee
Network benefits and reliability	• create hosting capacity in high quality resource areas • reduce the risks of shortfalls of system strength and other system services • ensure system reliability and security and thus reduce unserved energy risk	Market modelling by the Consumer Trustee
Flexibility	• provide low-cost and quick expansion options to enable adjustment to changing electricity needs, e.g., faster levels of electrification such as hydrogen electrolysers • provide reasonably priced insurance against delay of other network infrastructure projects or early retirement of existing generators	The design of Options to include low-cost future expansions, wherever possible. The preference for cost-effective over-sizing of the network rather than under-sizing, compared to the anticipated generation requirements, to reduce the risk of costly generation shortfalls and repeated community and landholder impacts.
Community acceptance	• ensure perspectives of local communities, landholders and other regional stakeholders are considered • minimise impacts on and maximise benefits for local communities, including the likelihood of repeated disruption of host communities over the short to medium term	Considering community and landholder impacts in Option design, wherever possible in this early concept stage Avoiding multiple impacts on the same community from future expansions through consultation and project delivery, where feasible and not cost prohibitive

Guiding principle	The development process seeks Network Infrastructure Options that…	Secured through the Strategy process by…
Innovation	• reduce or avoid the need for conventional 'poles and wires' • allow more efficient or less impactful delivery • make NSW future-ready for a dynamic and innovative energy market	Using categories of Options to adapt development to the needs of future innovations: for example, offshore wind may lead to less onshore network capacity, while a rapidly growing hydrogen economy may need more
Timeliness	• allow for timely delivery of projects • minimise risk of delays due to land use, environmental or planning constraints	Designing Options to reduce the risk from land-use, environmental and planning constraints, and building in optionality so that the overall network capacity is delivered as needed, even if an individual project is delayed

Frosty morning in a field in regional NSW.

Next steps

EnergyCo looks forward to engaging and working with communities, consumers, the Consumer Trustee and industry on the continued modernisation of NSW's energy system.

Work will continue on all categories of proposed network options, in support of REZ and PTIP development.

For the Strategy

The Consumer Trustee will independently consider the Network Infrastructure Options in preparing its Infrastructure Investment Objectives Report (IIO Report), which sets a 20-year development pathway for NSW's generation, firming and long-duration storage infrastructure.

For the Network Infrastructure Options

Potential projects will continue to be assessed and refined to ensure they benefit NSW consumers and host, regional and First Nations communities.

As Infrastructure Planner, EnergyCo will develop the design of each option, with detailed stakeholder engagement, before recommending a network solution to the Consumer Trustee for authorisation.

As a major NSW project, the option would then be subject to the NSW planning assessment process, which includes two further stages:

- environmental impact statements, which evaluate the social, environmental and economic impacts of network infrastructure, and
- development consents and management plans, which set the conditions to be met during project construction and operation.

Each of these steps involves comprehensive industry and community consultation processes, on top of EnergyCo's continuous engagement work.

For the REZs

- For **Central-West Orana**, EnergyCo as Infrastructure Planner is currently carrying out a competitive tender for a Network Operator for the CWO REZ network infrastructure, with a target delivery date of 2027/28. The Consumer Trustee is expected to hold competitive tenders for access rights to that network, under the CWO REZ Access Scheme.
- For **New England**, EnergyCo aims to submit a recommended network solution for the New England REZ for authorisation by the Consumer Trustee in 2024, with the NSW planning assessment process and construction to follow.
- For **Hunter-Central Coast**, EnergyCo, Transgrid and Ausgrid have begun the joint planning of network infrastructure, which may result in alternative options to those presented in this Strategy.
- For **South West**, EnergyCo published a draft Access Scheme for the South West REZ and a Access Scheme Positions Paper in March 2023 for public consultation.
- For **Illawarra**, which was formally declared on 27 February 2023, EnergyCo is now considering the optimal Network Infrastructure Options, taking into account the Southern Sydney Ring (an ISP Project) which will likely influence power flows in the REZ.

For the PTIPs

- The Hunter Transmission Project is expected to be delivered by 2027 to avoid shortfalls of NSW's Energy Security Target and to ensure both the CWO and New England REZ can export their full renewable generation capacity to the shared network.
- Construction of the Waratah Super Battery is expected to commence mid-2023 and to be completed before the earliest possible closure date of the Eraring coal-fired power station (August 2025).

References and Tables

Solar farm, solar panels.

Figures

Image credits:
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Tables

Boxes

Glossary and abbreviations

Abbreviation	Long form
AEMO	Australian Energy Market Operator
CO_2e	Carbon dioxide equivalent
CWO	Central-West Orana
DAPR	Distribution Annual Planning Report
EII Act	*Electricity Infrastructure Investment Act 2020 (NSW)*
EII Regulations	*Electricity Infrastructure Investment Regulation 2021 (NSW)*
EnergyCo	Energy Corporation of New South Wales
ESOO	AEMO's Electricity Statement of Opportunities
EST	Energy Security Target
EUA Act	*Energy and Utilities Administration Act 1987 (NSW)*
GW	Gigawatt(s)
HCC	Hunter-Central Coast
HVAC	High voltage alternate current
HVDC	High voltage direct current
IASR	AEMO's Inputs, Assumptions and Scenarios Report
IIO Report	Infrastructure Investment Objective Report
ISP	AEMO's Integrated System Plan
LDS	Long-duration storage
LTESA(s)	Long-term energy services agreement(s)
Minimum objectives	The minimum infrastructure investment objectives established by EII Act section 44(3)
Minister	NSW Minister for Energy
NEM	National Electricity Market
NER	National Electricity Rules
Net Zero Plan	NSW Net Zero Plan Stage 1: 2020-2030
NIS	Network Infrastructure Strategy
NSP	Network Service Provider
OECC	NSW Office of Energy and Climate Change
OSW	Offshore Wind
Overall objectives	The overall infrastructure investment objectives established by EII Act section 44(2)
PTIP	Priority Transmission Infrastructure Project
PV	Photovoltaic
QED	AEMO's Quarterly Energy Dynamics
QNI	Queensland to NSW Interconnector
REZ(s)	Renewable Energy Zone(s)
Roadmap	NSW Electricity Infrastructure Roadmap
Strategy	Network Infrastructure Strategy
TAPR	Transmission Annual Planning Report
VNI	Victoria to NSW Interconnector

Endnotes

1 Australian Energy Market Operator (AEMO), 2022 Integrated System Plan, 2022.

2 The five projects being developed under AEMO's 2022 Integrated System Plan are the Queensland to NSW Interconnector Upgrade (QNI Upgrade), Victoria to NSW Interconnector Upgrade (VNI Upgrade), Project Energy Connect, HumeLink and VNI West.

3 Transgrid, Concept Design and Cost Estimate for the HumeLink Project – Underground, 2022

4 The minimum and overall infrastructure investment objectives are set out in Electricity Infrastructure Investment Act 2020 (NSW) s44.

5 The Illawarra REZ was declared after modelling for the Strategy was completed. EnergyCo will engage with generation and storage developers of projects that can connect to the existing network and consider network options to deliver its intended network capacity of 1 GW for the next Strategy.

6 The rationale for 4.5 GW network capacity, as compared to the modelled network capacity of 4 GW, is that this updated option will use a larger transformer of 1,500 MVA to benefit from economies of scales.

7 The *No Roadmap Modelling* uses a similar network development pathway as the Central scenario in the Consumer Trustee's Draft 2023 Infrastructure Investment Objectives Report. A comparison of development pathways can be found in Appendix A – Modelling Results

8 *Renewable Energy Zone (Central-West Orana) Order 2021* was declared by the Minister for Energy under *Electricity Infrastructure Act 2020 (NSW)* s19(1) on 28 October 2021 and commenced on publication in the NSW Government Gazette No 569 on 5 November 2021.

9 *Renewable Energy Zone (Central-West Orana) Access Scheme Order 2022* was declared by the Minister for Energy under *Electricity Infrastructure Act 2020 (NSW)* s24(1) on 19 December 2022 and commenced on publication in the NSW Government Gazette No 591 on 23 December 2022.

10 *Renewable Energy Zone (New England)* Order 2021 was declared by the Minister for Energy under *Electricity Infrastructure Act 2020 (NSW)* s19(1) on 10 December 2021 and commenced on publication in the NSW Government Gazette No 643 on 17 December 2021.

11 *Renewable Energy Zone (Hunter-Central Coast) Order 2022* was declared by the Minister for Energy under *Electricity Infrastructure Act 2020 (NSW)* s19(1) on 6 December 2022 and commenced on publication in the NSW Government Gazette No 569 on 9 December 2021.)

12 *Renewable Energy Zone (South West) Order 2022* was declared by the Minister for Energy under *Electricity Infrastructure Act 2020 (NSW)* s19(1) on 31 October 2022 and commenced on publication in the NSW Government Gazette No 515 on 4 November 2021.

13 *Renewable Energy Zone (Illawarra) Order 2023* was declared by the Minister for Energy under *Electricity Infrastructure Act 2020 (NSW)* s19(1) on 22 February 2023 and commenced on publication in the NSW Government Gazette No 98 on 27 February 2023.

14 Infrastructure Planner appointment made under *Electricity Infrastructure Investment Act 2020 (NSW)* s63(2)

15 Network Operator recommendation made under *Electricity Infrastructure Investment Regulations 2021 (NSW)* s43.

16 Direction and authorisation made, respectively, under *Electricity Infrastructure Investment Act 2020 (NSW)* s32(1)(b) and 36(2).

17 Service provider appointment made under *Electricity Infrastructure Investment Regulations 2021 (NSW)* s43(1)(d)(ii) and 45(1)(b).

18 *Priority Transmission Infrastructure Project Direction (Waratah Super Battery Project) 2022* was declared by the Minister for Energy under *Electricity Infrastructure Act 2020 (NSW)* s32(1)(b) on 13 October 2022 and commenced on publication in the NSW Government Gazette No 473 on 14 October 2022

19 Revenue Determination (Contestable) Transgrid – Waratah Super Battery – System Integrity Protection Scheme Service component was made by the Australian Energy Regulation under Electricity Infrastructure Investment Act 2020 (NSW) s38 on 14 December 2022.

20 Aurecon, 2021 Costs and Technical Parameter Review, a report prepared for the Australian Energy Market Operator, 2021

21 *Electricity Infrastructure Investment Act 2020 (NSW)* s26 requires access fees determined under s24 to include a community and an employment component. *Electricity Infrastructure Investment Regulations 2021 (NSW)* s56 and s57 set out further details about these components and the purpose for which funds from access fees can be spent.

22 International Energy Agency (IEA), World Energy Outlook 2022, 2022

23 MBB, Supply Chain Analysis Report – NSW Electricity Infrastructure, a report to the NSW Department of Planning, Industry and Environment, 2022

24 MBB, Supply Chain Analysis Report – NSW Electricity Infrastructure, a report to the NSW Department of Planning, Industry and Environment, 2022.

25 UTS and SGS Economics and Planning, Employment, Skills and Supply Chains: Renewable Energy in NSW – Final Report, a report to the NSW Department of Planning, Industry and Environment, 2022. This is consistent with the projections in J Rutovitz et al, 'The Australian Electricity Workforce for the 2022 Integrated System Plan: Projections to 2050'. *The Institute for Sustainable Futures for RACE for 2030*, which sees national employment expected to grow by 37,000 in 2023 to peak at 81,000 jobs in 2049.

26 NSW Office of Energy and Climate Change (OECC), Electricity Infrastructure Jobs Advocate's first report to the Minister for Energy, NSW Government, November 2022.

27 Department of Climate Change, Energy, the Environment and Water (DCCEEW), Energy Ministers' Meeting Communique, Australian Government, 8 December 2022.

28 Australian Energy Market Operator (AEMO), Energy Security Target Monitor Report - May 2022 Further Report, 2022

29 Firming Direction was issued under *Electricity Infrastructure Investment Act 2020 (NSW)* s47(2).

30 Department of Climate Change, Energy, the Environment and Water (DCCEEW), Energy Ministers' Meeting Communique, Australian Government, 8 December 2022

31 The build limits for generation projects across NSW, outside of REZs, were applied in line with the assumptions used in the Australian Energy Market Operator (AEMO), 2022 Integrated System Plan, 2022.

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Cover image courtesy of GettyImages. Mother and daughter walking near wind turbines.

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