

NSW Department of Planning, Industry and Environment

NSW Electricity Infrastructure Roadmap

Building an Energy Superpower
Overview

November 2020



energy.nsw.gov.au

The NSW Electricity Infrastructure Roadmap was informed by advice from a range of leading energy market advisers. Specifically, the NSW Department of Planning, Industry and Environment (the Department) commissioned consultancies to help advise on the development and assessment of specific policies identified and proposed by the Department.

- KPMG was engaged to analyse the core policies developed and proposed by the Department which have been summarised in this document. Additionally, KPMG was engaged to prepare a report on the industry opportunities to identify broader

economic opportunities associated with the reforms.

- NAB supported the Department with a review and evaluation of the weighted average cost of capital (WACC) used by Aurora when determining the cost of new investment in the energy sector.
- Aurora supported the Department with all aspects of the energy market modelling including long term wholesale energy price forecasts and consumer prices associated with the policies.
- The Office of the Chief Scientist and Engineer led the work on future industrial and economic opportunities associated with the policies.



Office of the
Chief Scientist
& Engineer

The work of all advisers has been provided to the Department of Planning, Industry and Environment according to an agreed scope of works and subject to the limitations outlined in each advisers report and terms of engagement.

Find out more

www.energy.nsw.gov.au

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Cover image: Solar farm at Dubbo, NSW. Image courtesy of Neoen.

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The Hon. Matt Kean MP
Minister for Energy and Environment

Minister's foreword

Our electricity system has served us well, but it is under increasing pressure. Most of our power stations are coming to the end of their lives and need to be replaced. We need new sources of power to help our State grow.

Making sure that we build our modern grid at the lowest cost and in places that work for our regional and rural communities is an absolute priority of the NSW Government. New energy infrastructure needs to support, rather than take away from, our communities. If we don't act now, we are going to become heavily dependent on electricity imported from other states, risk years of higher electricity prices in NSW or see development in the wrong places.

Instead, we can use our world class regional dams to build pumped hydro power stations that work hand in hand with cheap solar and wind power. We can locate these projects in places that help our rural and regional communities, and we can encourage the private sector to build the lowest cost generation needed to replace the closing power stations.

NSW has an enormous opportunity if we act now. The NSW Government has a vision to deliver some of the cheapest, most reliable and cleanest energy in the world.

The private sector sees the potential in NSW and has signalled it is ready to invest with over 120 large-scale energy generation projects already in the pipeline, totalling over \$25 billion in potential investment.¹

The NSW Electricity Infrastructure Roadmap will provide on-the-ground benefits for regional communities who have been doing it tough with drought, bushfires and the COVID-19 crisis. This plan will not only help us recover, but also set our State up to be an energy and economic superpower.

Our plan will deliver three Renewable Energy Zones, pumped hydro schemes and generation to power our economy, day and night, for decades to come.

This means lower electricity bills for households and businesses. This means cheap, low carbon electricity that our industries need to thrive into the future.

This plan will drive an estimated \$32 billion in private investment to 2030 and support an estimated 6,300 construction jobs and 2,800 ongoing jobs, mostly in regional NSW in 2030. It will also provide a competitive advantage in low cost, clean energy, re-industrialising the State and attracting even more investment, jobs and innovation.

NSW is faced with an important choice: to be left behind as the world transitions to a low cost, low carbon future, or set ourselves up to be a State where new industries thrive and jobs and wealth are created.

The NSW Government thinks the choice is clear.

The Hon. Matt Kean MP
Minister for Energy and Environment

1. As of October 2020. Based on project information on the NSW Planning Portal and Major Projects register.

Executive summary

NSW is at a crossroads. As our existing power sources come to the end of their lives and global markets seek cleaner, cheaper and more reliable energy sources, we have a once in a generation opportunity to redefine the State as a modern, global energy superpower.

Timely action to deliver the electricity infrastructure of our future—pumped hydro, Renewable Energy Zone (REZ) generation, firming and transmission—can unlock internationally competitive energy prices to grow the economy, support jobs, and attract major new industries. The scale of potential benefits is substantial: around \$32 billion in private investment and an estimated 6,300 construction jobs and 2,800 ongoing jobs in 2030.²

The NSW Electricity Infrastructure Roadmap is our plan to transition the electricity sector and seize those opportunities. It is a decisive step down the path towards thriving regions, a revitalised and re-industrialised economy, and better livelihoods for all NSW citizens.

Our modern electricity system will be built on five foundational pillars:

1. **Driving investment in regional NSW:** supporting our regions as the State's economic and energy powerhouse.
2. **Delivering energy storage infrastructure:** supporting stable, long-term energy storage in NSW.
3. **Delivering Renewable Energy Zones:** coordinating regional transmission and renewable generation in the right places for local communities.

4. **Keeping the grid secure and reliable:** backing the system with gas, batteries or other reliable sources as needed.
5. **Harnessing opportunities for industry:** empowering new and revitalised industries with cheap, reliable and low emissions electricity.

The Roadmap is a coordinated framework to deliver that modern electricity system. It is a whole of system approach to deliver new generation, transmission, long duration storage and firming.

This Roadmap will set us ahead of global trends, keeping our industries competitive—and attracting new ones—with forecast NSW heavy industry electricity prices indicatively expected to be in the lowest 10 per cent of the Organisation for Economic Co-operation and Development (OECD).³ It will make it cheaper to do business at all scales, saving the average small business an estimated \$430 (small business bills) a year on electricity bills. It is also expected to directly improve NSW livelihoods, with estimated savings of around \$130 a year for the average household electricity bill. The Roadmap will set NSW apart as a true global leader delivering the electricity infrastructure needed to support a modern, prosperous economy.

2. All ongoing jobs estimates include on-site and off-site employment generated through investment in electricity generation and storage infrastructure. Source: University of Technology Sydney, Institute for Sustainable Futures, *Renewable Energy Employment in Australia: Methodology*, June 2020.

3. NSW Department of Planning, Industry and Environment calculations based on data from: International Energy Agency, *World Energy Prices 2018*, May 2018.



Photography
A wind farm near the town of Dalgety, NSW.

The energy superpower vision

Our vision is for NSW consumers to enjoy some of the cheapest, cleanest, most reliable energy in the world. This will make NSW one of the most attractive places to start and grow a business, while our households will spend less on electricity bills and can invest more in themselves.

Under the Roadmap, we estimate average industrial electricity prices to fall to around USD\$84 per megawatt hour (including grid costs) —placing NSW prices in the cheapest 10 per cent of OECD jurisdictions.⁴ Unlocking our abundant clean energy resources ensures we can also meet growing international investor and market demand for new, low carbon industries. With the estimated 3 gigawatts (GW) of firm capacity by 2030 under the Roadmap, we can also ensure this supply is reliable.

Meanwhile, we estimate households will pay, on average, \$130 less a year on their electricity bills from 2023 to 2040. Small businesses are expected to save an average of \$430 (small business bill savings) a year on their electricity bills over the same period.

Our regions will be the State's powerhouse. They will see an estimated \$32 billion by 2030 in significant development opportunities arising from electricity infrastructure investment and new jobs. We will open the door for new low carbon, energy intensive industries to compete in global markets, and attract modern industries to our regions. This will be done in a way that supports our farmers and landowners, with lease payments from infrastructure helping to drought-proof the regions.

Becoming an energy superpower requires a clear plan and consistent signals to the energy sector. The Roadmap is the NSW Government's plan to do just that.

All estimates of private investment, transmission capacity, jobs, bill savings, pricing and related outcomes are based on indicative development pathway forecasts developed by Aurora Energy Research for the Department. The Consumer Trustee, once appointed, will publish a detailed plan on the development pathway and the long term interests of consumers.

4. Based on International Energy Agency (IEA) industrial energy price information for 2018 collated for the OECD, and KPMG and Department analysis of delivered energy costs for a small industrial customer in NSW. NSW costs based on wholesale and scheme cost forecasts from Aurora Energy Research prepared for the Department with adjustments for equivalence with IEA prices. NSW prices include network costs for a typical customer using 10 gigawatt hours a year in the Ausgrid network area with an 80 per cent load factor and a 3 per cent retailer margin and existing NSW and Commonwealth schemes (e.g. Large-scale Generation Certificates, Small-scale Technology Certificates, Energy Savings Certificates, Climate Change Fund). Foreign exchange rate based on five year average.

Attract investment in industries of the future



Top 10 for lowest industrial electricity prices across the OECD.



\$200 million opportunity per year in Gross Domestic Product (GDP) growth from national hydrogen industry by 2030.



\$20 million opportunity in annual revenue for every 1% increase in 'green' steel output.

Booming NSW regions



\$32 billion in regional energy infrastructure investment expected to 2030.



6,300 construction jobs and **2,800** ongoing jobs expected in 2030, mostly in regional NSW.



\$1.5 billion in lease payments estimated by 2042 to landholders hosting new infrastructure where communities want it and in a way that supports farming.

More for small businesses



Forecast \$430 a year saving on an average small business electricity bill from 2023 to 2040.

More for NSW households



Forecast \$130 a year saving on an average household electricity bill from 2023 to 2040.

Reliable energy



3 gigawatts of firm capacity estimated by 2030.

Clean energy



90 million tonnes of reduced carbon emissions to 2030.

Note: The estimates above represent expected benefits of the NSW Electricity Infrastructure Roadmap based on available information at the time of this report.

Why we need a Roadmap

With some of the best natural energy resources in the world, NSW is in a unique position to benefit from emerging low cost technologies like wind, solar, batteries and pumped hydro. Global investors are poised to invest in clean, reliable and affordable infrastructure if we get the market settings right.

By acting now, we can ensure NSW continues to enjoy reliable electricity supply into the future as our power stations approach the end of their operational lives over the next 15 years. A clear and coordinated Roadmap can drive investment in new electricity infrastructure where we need it, coordinating new generation without congesting the grid, delivering cheaper energy to households and businesses, and providing new jobs and industries for our regions.

The Roadmap can unlock economic opportunities—optimising our water infrastructure through pumped hydro, growing our regional communities through coordinated development where locals welcome it, and implementing a world class grid. We will be putting the State on the path to becoming one of the lowest cost, lowest carbon regions in the world.

This Roadmap takes action to seize these opportunities.

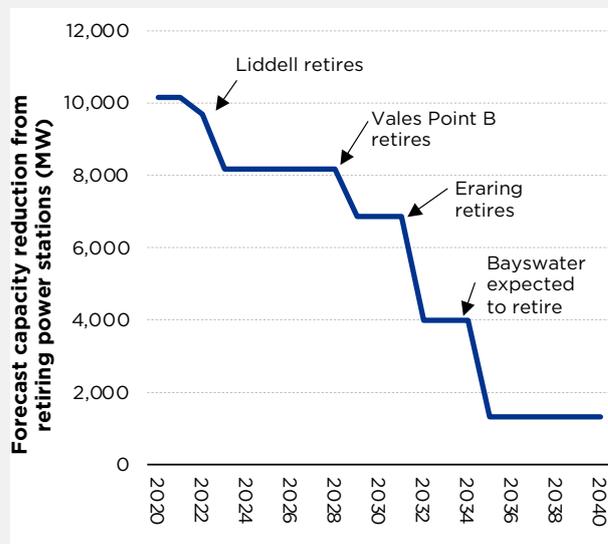
The NSW Government is committed to getting the settings right to deliver the electricity infrastructure we need. This will put into action the commitments made in the NSW Electricity Strategy and complement the NSW Government's household and small business energy initiatives.

We will make the reforms needed to properly coordinate generation, transmission, storage and firming investment at the time and scale needed. For consumers, coordinated development means lower construction costs, a more reliable system, greater bill savings and fewer price shocks. For businesses, it makes NSW the best and easiest place in which to invest and grow.

According to AEMO, the cheapest replacement is a mix of wind, solar, storage, gas and transmission.⁵

By providing the right investment environment, we create a substantial economic opportunity for NSW. We can create a competitive advantage for local businesses in the production of low cost, low emissions energy with heavy industry hubs, infrastructure and skills, to support low emissions fuel and material production.

Expected power station retirements in NSW



Source: AEMO, 2020 *Integrated System Plan*, July 2020.

Four of the five NSW coal power stations, accounting for three quarters of NSW's electricity supply, are expected to close in the next 15 years.

5. CSIRO, *GenCost 2019-20*, May 2020.

Why we need to act now

Keeping costs down and ensuring ongoing reliability means taking action now to deliver new electricity infrastructure.

The backbone of our current electricity system took 30 years to build and commission. Almost all of it was built by Government.

Four of the State's five existing coal fired power stations are expected to close within 15 years, starting with the Liddell power station in 2022-23. These power stations currently provide around three quarters of NSW's electricity supply and two thirds of the firm capacity we need during summer heat waves. As those power stations get older, they also start to fail more often, creating reliability problems.

If we take action to coordinate and unlock investment before they close, households and businesses will benefit from stable electricity prices and supply, avoiding issues that occurred

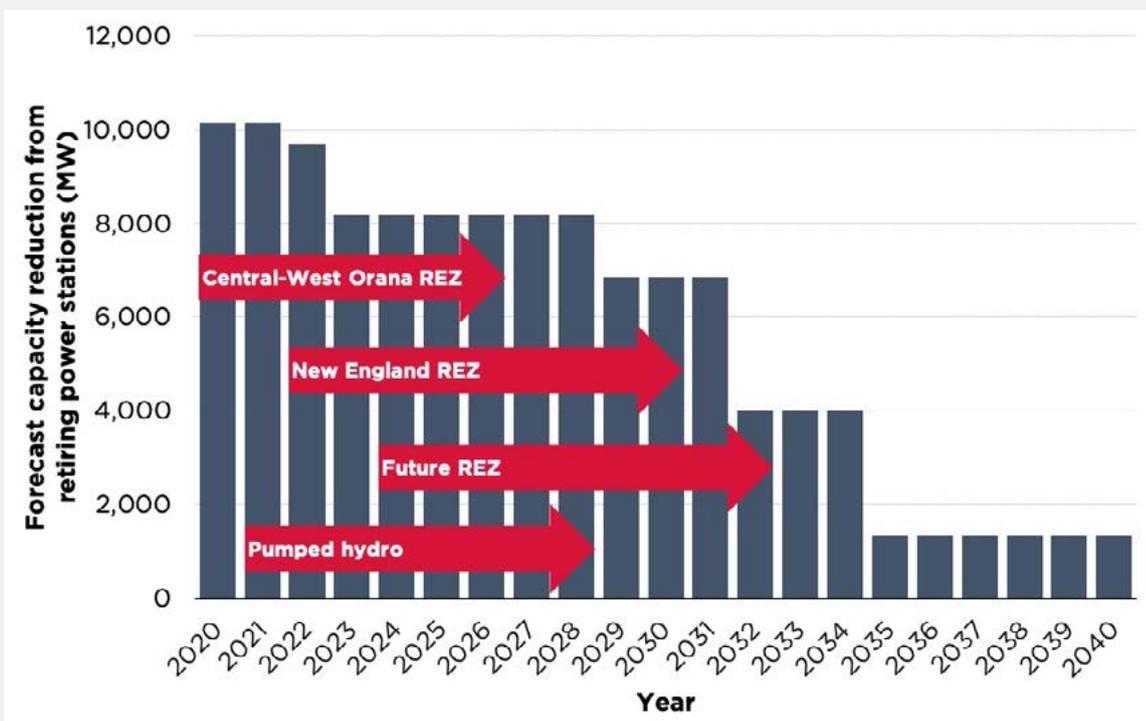
when average NSW electricity prices increased by 60 per cent after power station closures in South Australia (Northern) and Victoria (Hazelwood).⁶

The cheapest replacement infrastructure we need has long construction times. It can take up to 10 years to build a Renewable Energy Zone and eight years to build a large pumped hydro project.

The status quo encourages investors to wait for high price signals before committing to new projects. This leaves a long delay between rising prices and new generation or storage coming online, in the meantime leaving our State vulnerable to price spikes and electricity shortfalls.

Strategic planning and committed engagement are also critical to ensuring new private sector led investment. This will allow for new generation, transmission and storage to be built before power stations close over the next 15 years in order to avoid a rapid increase in prices.

The infrastructure needed to replace power stations has long lead times



Source: AEMO, 2020 Integrated System Plan, July 2020.

6. AEMO, National Electricity Market Data Dashboard, www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/data-nem/data-dashboard-nem#nem-dispatch-overview

What is the Roadmap?

The NSW Electricity Infrastructure Roadmap is the NSW Government's plan to deliver the major infrastructure needed to modernise our electricity system and power our economy.

Under the Roadmap, consumers will benefit from low cost, clean electricity generation backed up by 24 hour power sources. To do this, we are getting the investment settings in NSW right for the private sector to compete to deliver the new infrastructure we need at the lowest cost.

The Roadmap complements other NSW Government initiatives that are already helping NSW households and businesses to reduce their energy use and save money on energy bills, including the Energy Security Safeguard, Solar for Low Income Households and Empowering Homes programs.

The five pillars of our Roadmap:

- 1 Regional NSW - the State's powerhouse (pages 14-17)
- 2 Delivering energy storage infrastructure (pages 18-25)
- 3 Delivering Renewable Energy Zones (pages 26-31)
- 4 Firming (pages 32-33)
- 5 Opportunities for industry (pages 34-43)

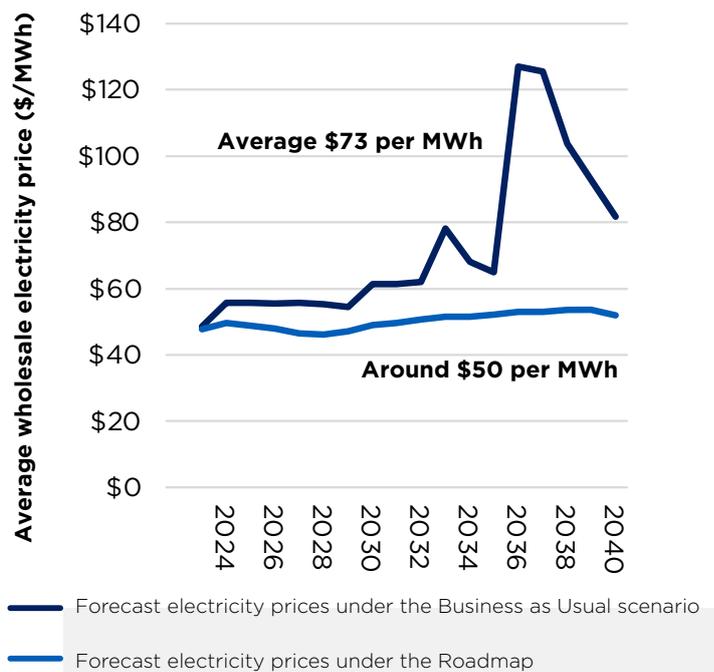
The future of electricity in NSW

The NSW Government has a vision for our future that will deliver cheap, reliable and clean energy that powers the economy.

That means giving households and businesses access to cheap electricity, revitalising regional areas with an influx of investment and jobs and attracting new industries and businesses to NSW.

This future also means a more reliable electricity system while we transition to new, cleaner energy sources that will deliver on our ambition of net zero emissions by 2050.

Cheaper electricity under the Roadmap



Source: Aurora Energy Research forecasts prepared for the Department.



Photography
Snowy Mountains Hydroelectric Scheme, NSW.

Regional NSW - the State's powerhouse

Through the coordinated build out of electricity infrastructure under the Roadmap, we can deliver growth and long term jobs where our communities need it most. Our Renewable Energy Zones and pumped hydro sites have the potential to deliver a huge boost to local communities.

Host communities could also benefit from improvements to their distribution networks, connecting them with the low cost, clean electricity generated locally.

Major energy infrastructure projects will bring jobs to the regions with flow on benefits, including improvements to roads and telecommunications.

The Renewable Energy Zones will also help drought-proof farming communities, providing new income streams for landholders that host energy infrastructure. We will also encourage investors to build renewables in places and ways that support farming.

To ensure lasting benefits beyond construction, the NSW Government will work to attract energy intensive industries, such as minerals processing, IT and data centres, agriculture, manufacturing or food processing to be co-located with the new energy infrastructure.



An estimated
\$32 billion
private investment
in energy infrastructure
by 2030.



\$1.5 billion in
lease payments
by 2042 estimated for
landholders choosing
to host electricity
infrastructure.

Around
6,300 regional
construction jobs
expected in 2030.



New
agricultural jobs
through intensified
cultivation and food
manufacturing supply
chain opportunities
unlocked by
cheaper energy.





Photography
Workers inspecting wind farm near Bungendore, NSW.

Case study

Renewables and agriculture

Tom Warren is a sheep farmer from Dubbo. Since 2017, he has hosted a 55 hectare solar farm on his property which is owned and operated by Neoen. Tom's farm is an example of the benefits that can be realised through co-locating agriculture and renewables.

Tom grazes his Merino wether sheep on the land under the tracking solar panel system. The condensation that runs off the solar panels in the mornings helps to keep the grass growing, and provides a food source for his sheep, while the panels themselves provide shade for the sheep in the warmer months. Tom is a firm believer in the benefit of multi-purposing farming land, for the benefit of both farmers and renewable energy producers.

“

Grazing of sheep, of the appropriate breed, and solar farming can co-exist without a problem whatsoever, and with a net benefit overall to the community and also to the owner of the land and the owner of the sheep. It's a win-win. An absolute win-win.”

Tom Warren



Photography

Solar farm at Dubbo, NSW. Image courtesy of Neoen.

By supporting the coordinated build out of energy infrastructure, the Roadmap can provide new investment, growth and long term jobs in the regions.

Under the Roadmap, new energy projects will not only compete to generate low electricity prices, but also on how they will deliver the best outcomes for local communities. This includes commitments for how they will:

- improve local employment and business opportunities
- ensure compatibility and complementarity with existing agricultural land uses
- maintain strong local community engagement and support for their project.

Regions hosting Renewable Energy Zones can also benefit from improved telecommunications capacity, leveraging the ability for telecommunications infrastructure to be co-located with transmission lines.

Improvements to local electricity distribution networks could allow regional communities to directly benefit from the cheap, clean electricity produced locally in Renewable Energy Zones.

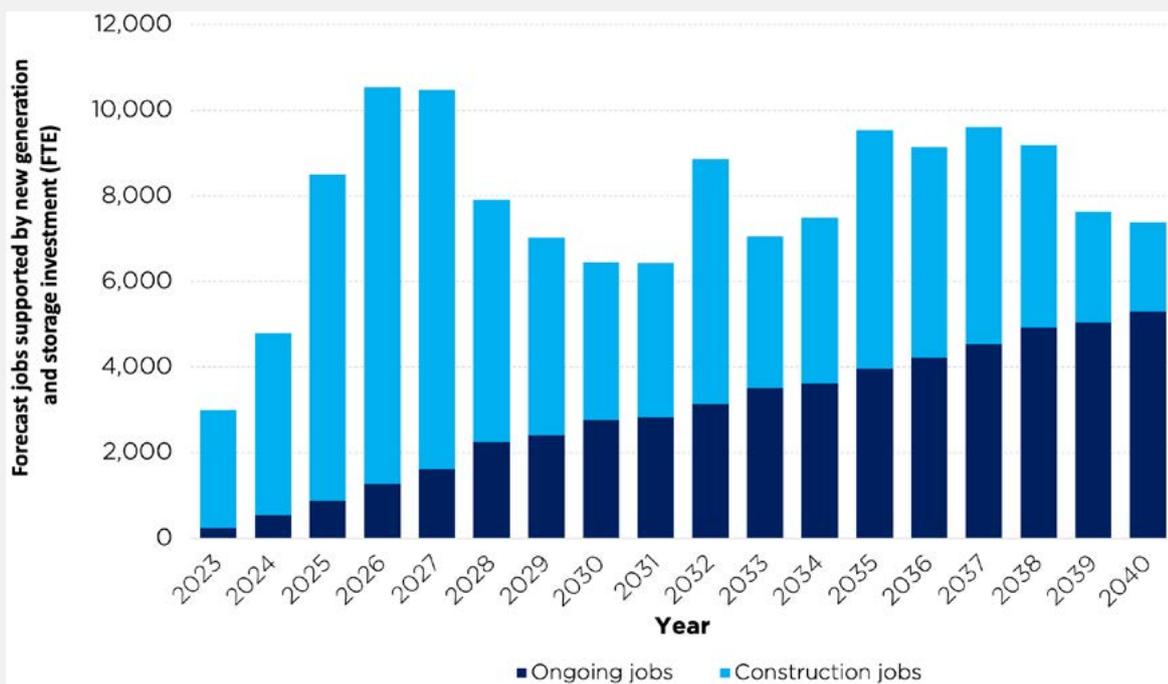
Energy Corporation of NSW

The interests of local regional communities will also be a core consideration of the Energy Corporation of NSW, the entity responsible for coordinating the delivery of the Renewable Energy Zones in the Central-West Orana, New England and South West NSW.

The Energy Corporation will take a holistic view of Renewable Energy Zone infrastructure delivery. This includes engaging with communities to understand local expectations and realising on-the-ground benefits.

The Energy Corporation will seek to achieve a balance between electricity, agriculture, heritage, visual amenity, mining and other land uses within the proposed Renewable Energy Zones. It will also be able to restrict network connection of projects over 30 megawatts (MW) in Renewable Energy Zones where reasonably necessary to maintain social licence, such as where projects would be in close proximity to towns and face strong local community opposition.

Forecast construction and ongoing jobs



Source: Forecast jobs figures were calculated using the methodology in University of Technology Sydney, Institute for Sustainable Futures, *Renewable Energy Employment in Australia: Methodology*, 2020.

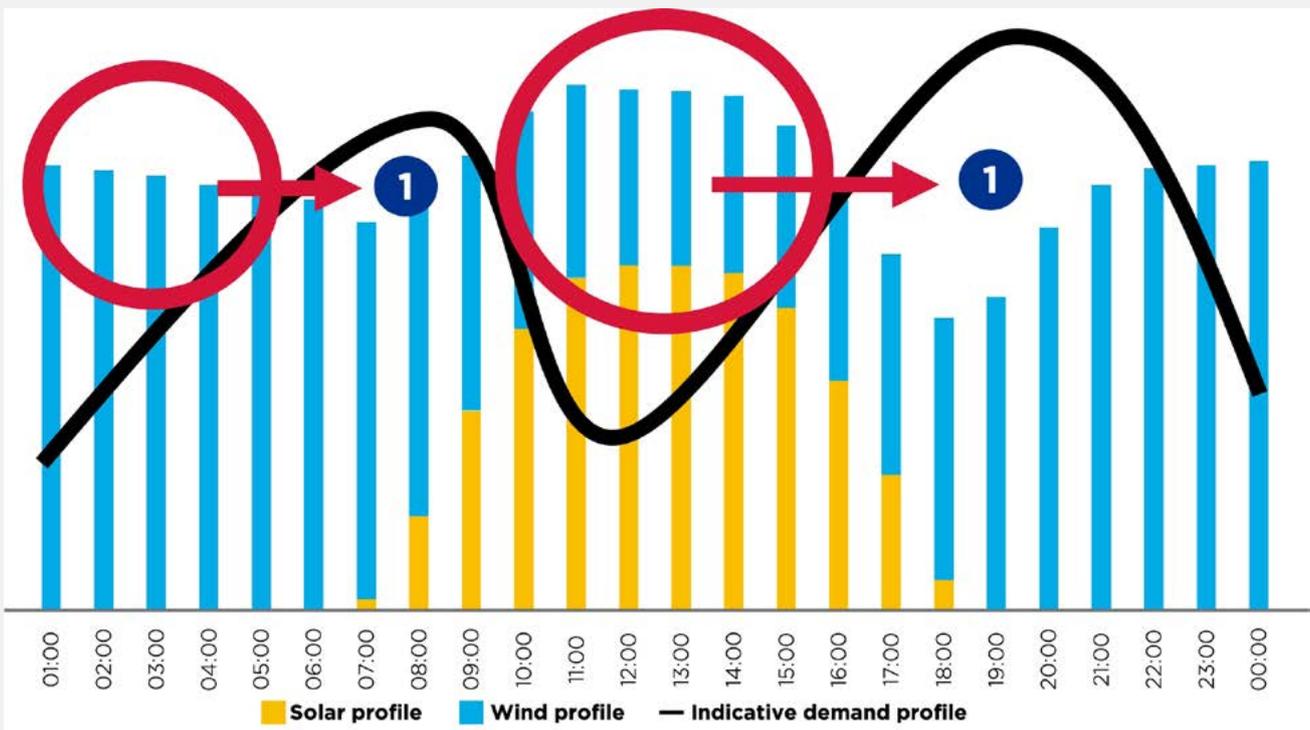
Delivering energy storage infrastructure

Ensuring 24 hour power

While renewables are the cheapest and cleanest form of new generation, they rely on environmental factors—like sun and wind—to produce electricity. Sometimes, like when the sun is shining and the wind is blowing, these natural resources are abundant. Other times, less so. This means renewables need to be backed up by long duration storage, to ensure power is available at all times when it is needed.

Energy storage infrastructure—such as batteries and pumped hydro—allows renewable energy to be stored and then released on demand when it is needed, creating stability and reliability in the electricity system.

How storage ‘firms’ renewables ⁷



1 Wind and solar can produce abundant energy, but not always when we need it. The figure above is a hypothetical example of how batteries and pumped hydro can ‘firm’ renewables by storing excess energy when demand is low, like in the middle of the day, and releasing it when demand is high, like in the evening as people return home from work or school.

7. Chart is illustrative only, based on typical generation profiles.

Pumped hydro

One of the most effective and reliable forms of long duration storage is pumped hydro—when the sun’s not shining and the wind’s not blowing, the water runs down a hill through massive turbines.

It works by running water from an upper reservoir to a lower one through a turbine to generate electricity. When cheap, clean energy is available, water is pumped back to the upper reservoir. Here it is stored, ready to be released and generate electricity when needed. It can also provide inertia and important services to support electricity grid stability.

Pumped hydro projects will stimulate regional NSW economies through construction and operation, supporting jobs and attracting new industries.

Pumped hydro is a proven form of large scale energy storage technology used across the world to produce reliable electricity.

How a pumped-storage hydroelectric power station works

1.

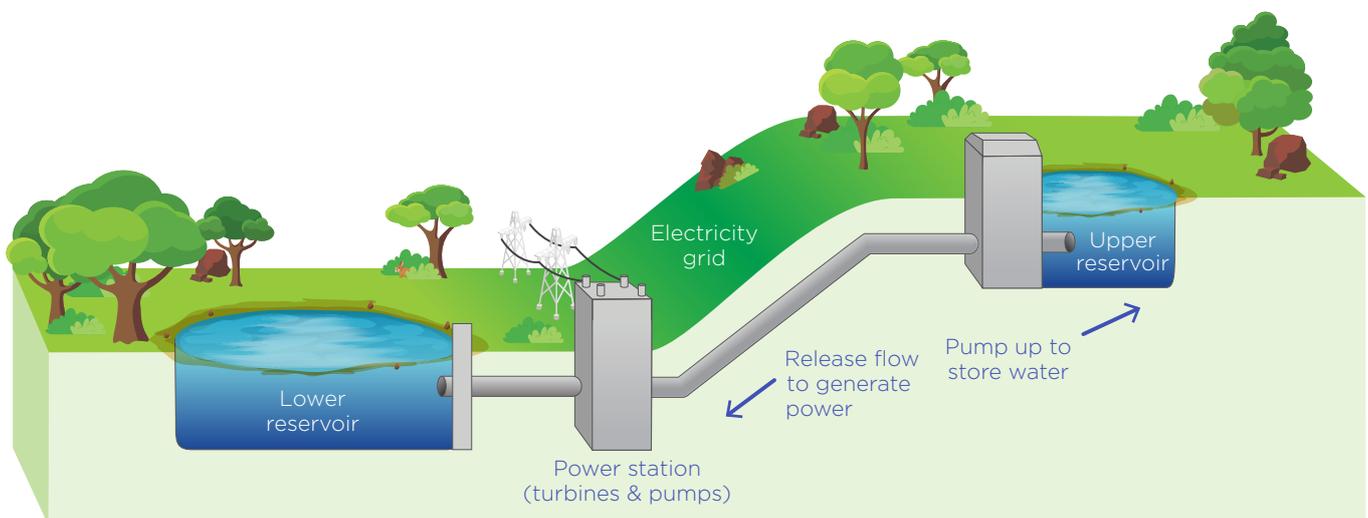
Water is pumped into the upper reservoir using cheaper energy when demand is low or there is an excess of renewable energy because the sun is shining and the wind is blowing.

2.

When there is a spike in demand, or a drop off in wind or solar generation—even for a short time—energy is called for and the water is released.

3.

The water flows quickly down the pipes which turns the turbines to generate power.



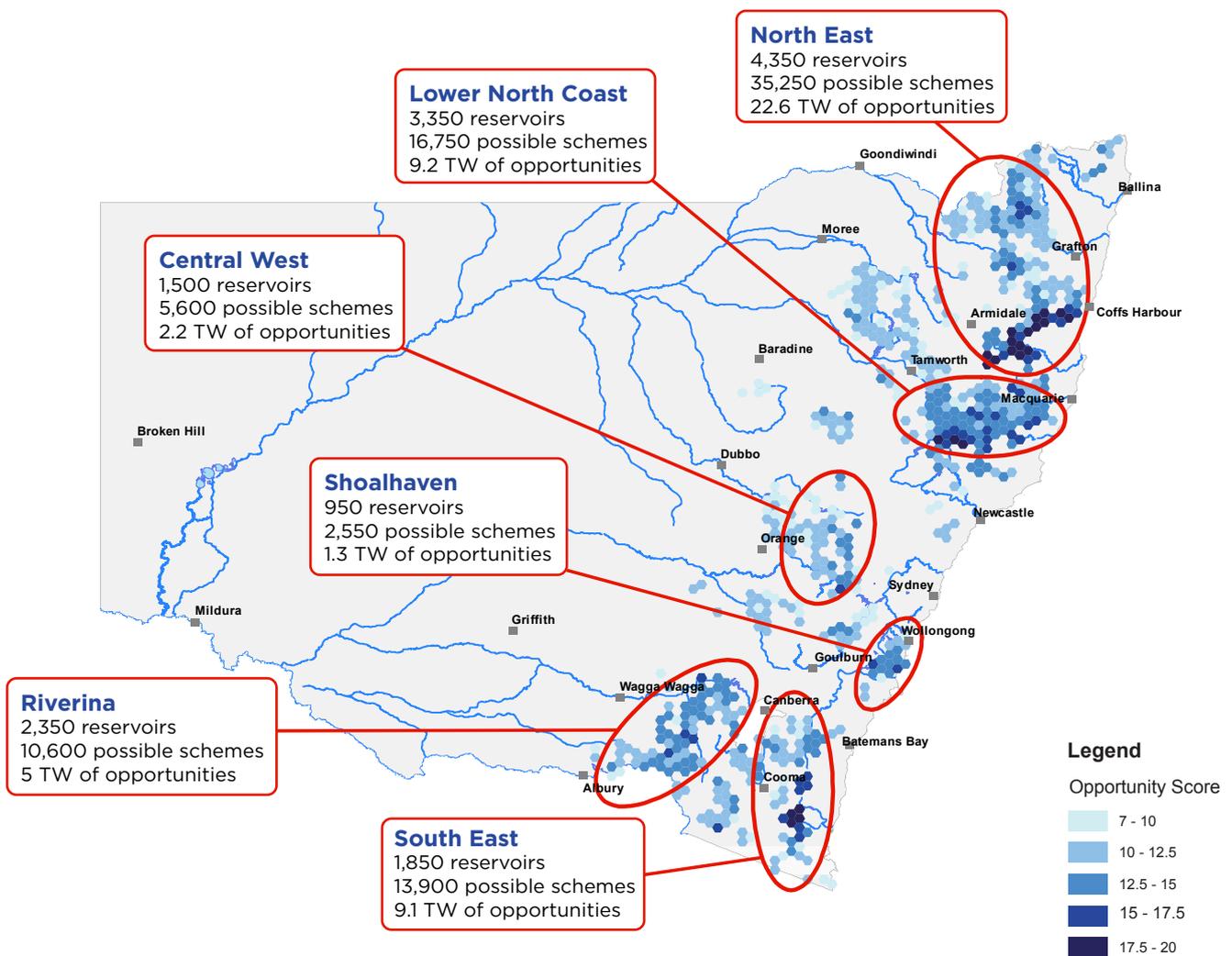
The Australian Energy Market Operator's (AEMO) Integrated System Plan finds that by the mid-2030s, NSW will need about 2.3 GW of energy storage with four to 12 hours of duration to maintain system reliability and security.⁸ This is in addition to the new 2 GW of capacity at Snowy 2.0 being developed by the Commonwealth. NSW needs to invest in more pumped hydro infrastructure.

As highlighted in the NSW Pumped Hydro Roadmap, NSW has considerable potential for pumped hydro projects and the private sector is ready to invest.

However, the costs of feasibility studies can be prohibitive for developers. Furthermore, projects can take, on average, eight years to plan and build.

Given the long lead times and upfront costs, the NSW Government is taking action now to provide the support that is needed to ensure pumped hydro projects are built before the closure of existing power stations to deliver reliability in the energy system.

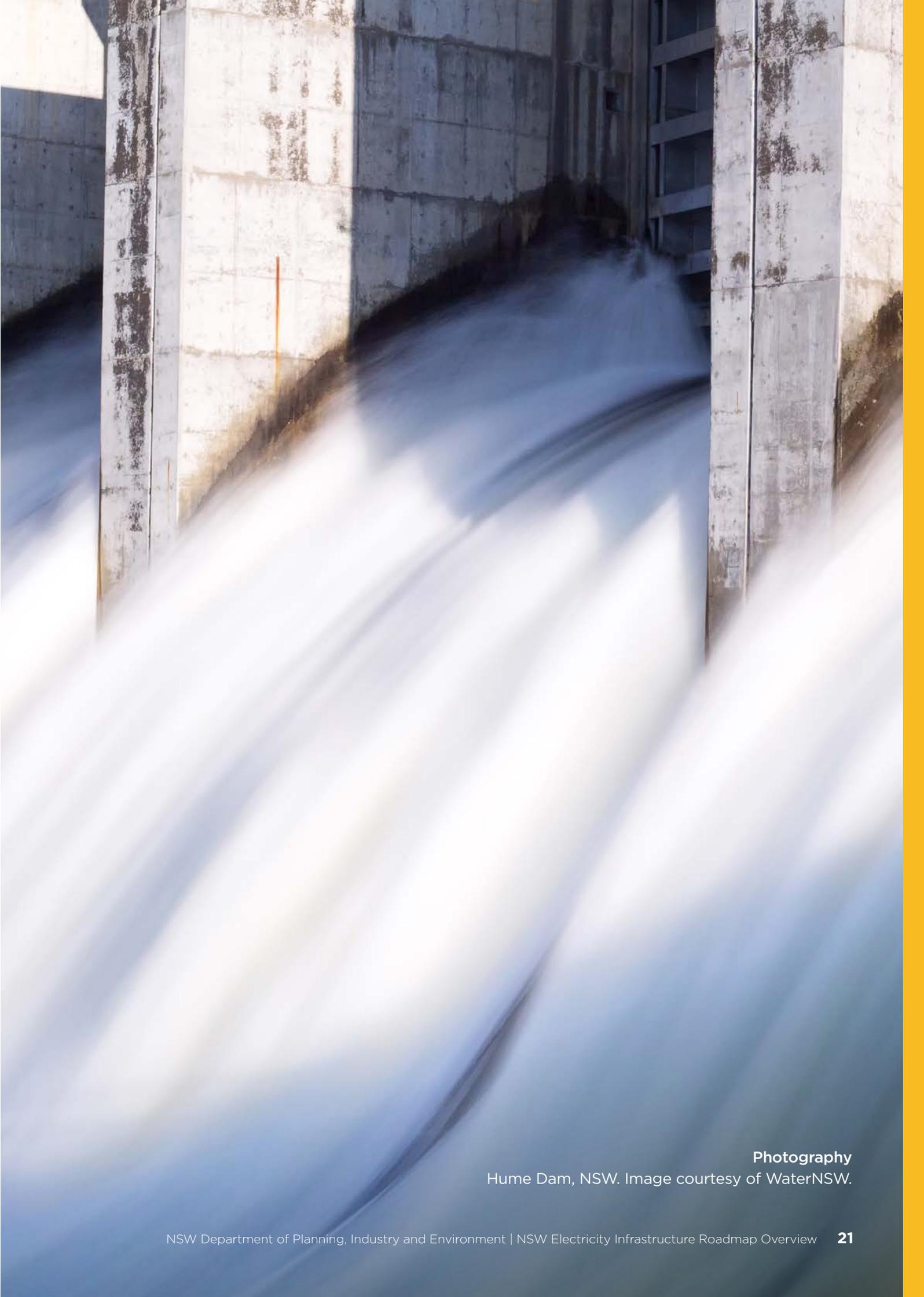
Working with the Australian National University, the NSW Government mapped 20,000 reservoirs in the natural landscape that could be used as storage for pumped hydro energy as part of the NSW Pumped Hydro Roadmap.⁹



Map
NSW Pumped Hydro Roadmap.

8. Australian Energy Market Operator, 2020 Integrated System Plan, July 2020.

9. NSW Government, NSW Pumped Hydro Roadmap, December 2018.



Photography
Hume Dam, NSW. Image courtesy of WaterNSW.

What action are we taking?

The NSW Government will support the development of lowest cost energy storage by getting the settings right to encourage private sector investment.

1

Electricity Infrastructure Investment Safeguard – long duration storage

The NSW Government will reform the electricity infrastructure investment market by creating the Electricity Infrastructure Investment Safeguard. A Consumer Trustee will be appointed to protect the long-term interests of consumers.

The Consumer Trustee will run competitive processes on behalf of consumers to award Long Term Energy Services Agreements. These Agreements will provide investors with the long-term certainty they need to lower the cost of electricity.

The first limb of the Electricity Infrastructure Investment Safeguard involves a clear Development Pathway for long duration storage projects—like pumped hydro—to balance out the higher penetration of variable renewable energy. This will maintain the reliability and security of our electricity supply.

The Consumer Trustee will follow an investment objective for long duration storage of 2 GW by 2030 (in addition to Snowy 2.0) and as otherwise needed to support the State in maintaining reliability over the medium term while keeping downward pressure on energy prices.

2

Pumped Hydro Recoverable Grants Program

Developing pumped hydro infrastructure has a high degree of financial risk because of the lack of detailed subterranean information, meaning complex feasibility studies are required.

The Pumped Hydro Recoverable Grants Program will provide grants to developers to assist with the cost of early stage, detailed project feasibility studies for new pumped hydro projects.

The program will allow the initial project risks to be shared between the NSW Government and developers and provide a runway to support projects that otherwise may not be advanced enough to compete in the Infrastructure Safeguard market. If a project moves to the construction phase, the grant will be repaid to the NSW Government.

A budget of \$50 million will be available to support up to 3 GW of pumped hydro projects, with an estimated 1 GW of undeveloped greenfield land and around 2 GW of previously developed brownfield land projects.

Three pumped hydro projects have already been awarded grants in the first round of the NSW Emerging Energy Program to assist with early stage development activities. This next round will provide larger funding amounts to fast track more development work needed to build these types of projects.

Case study

Snowy 2.0

Snowy 2.0 is a project to expand the original Snowy Mountains Hydroelectric Scheme with an additional 2 GW of electricity generation capacity and 350,000 megawatt hours of energy storage. Producing enough power for 500,000 homes, it will link the Tantangara and Talbingo Reservoirs with a 27 km tunnel and a new power station that will be around 1 km underground.¹⁰

Snowy 2.0 will be critical to the future security and reliability of our energy system and will put downward pressure on electricity prices through providing much needed generation capacity and energy storage, reducing our reliance on more expensive forms of generation.



10. Australian Government Department of Industry, Science, Energy and Resources, *Pumped hydro*, www.energy.gov.au/government-priorities/energy-supply/pumped-hydro-and-snowy-20

What is the Electricity Infrastructure Investment Safeguard?

The Electricity Infrastructure Investment Safeguard (Infrastructure Safeguard) is an investment signal to deliver the new electricity infrastructure NSW needs.

The Infrastructure Safeguard provides a framework for technologies to compete to deliver the energy services they are best placed to deliver, including:

- Renewable Energy Zone generation
- long duration storage
- firming.

A Consumer Trustee will be appointed to run a competitive process to offer Long Term Energy Services Agreements to projects on behalf of consumers. The Agreements will drive investment in projects that align with identified needs and provide investors with certainty.

In this way, the Infrastructure Safeguard will provide a pathway for the delivery of low-cost, reliable energy infrastructure.

The Infrastructure Safeguard will also support the NSW Energy Security Target while striking the right balance of technologies to replace our retiring power stations and support local communities.

Operation of Long Term Energy Services Agreements

The nature of each Long Term Energy Services Agreement will depend on the type of project and identified need. For Renewable Energy Zone projects, the Agreements give generators the option to sell their electricity at an agreed price. Options contracts give generators assurance of a minimum price for their electricity, while a competitive process maximises value for consumers.

For long duration storage projects, Agreements will give projects the option to receive an availability payment. This provides revenue assurance for the term of the Agreement and ensures long duration storage projects are built to keep the grid reliable. If a shortfall in the NSW Energy Security Target is forecast, Agreements can be used to support the delivery of firm generation to meet the State's reliability needs.

The Consumer Trustee

The Consumer Trustee is responsible for protecting the interests of consumers. It does this by finding the best Long Term Energy Services Agreements for consumers. In order to make sure electricity retailers are able to secure long-term contracts, the Consumer Trustee will be allowed to on-sell any energy services purchased through the Infrastructure Safeguard to retailers or NSW companies. It can also require contributions from distribution network businesses to cover any of its remaining costs. While those contributions are added to network charges, consumers are the ultimate beneficiaries of lower electricity prices under the Infrastructure Safeguard.

The Consumer Trustee will be responsible for following infrastructure investment objectives and determining the design and schedule of competitive processes to award Long Term Energy Services Agreements.

Putting consumers first

The Infrastructure Safeguard has been designed to ensure new energy infrastructure optimises benefits for consumers at lowest cost and risk. It will do this by:

- encouraging new, low cost projects
- keeping project costs down, leading to lower energy bills
- reducing risks of delayed investment and associated price spikes

- ensuring sufficient capacity in the system to keep the lights on when demand is high.

Long Term Energy Services Agreements give investors confidence by providing assurance of a competitively set minimum return. However, under the Infrastructure Safeguard, payments are only likely to be triggered if consumers are already benefiting from low energy prices.

If prices increase again and the project is making strong returns in the market, the project repays consumers – a win-win scenario.



Photography
Large scale solar generation.

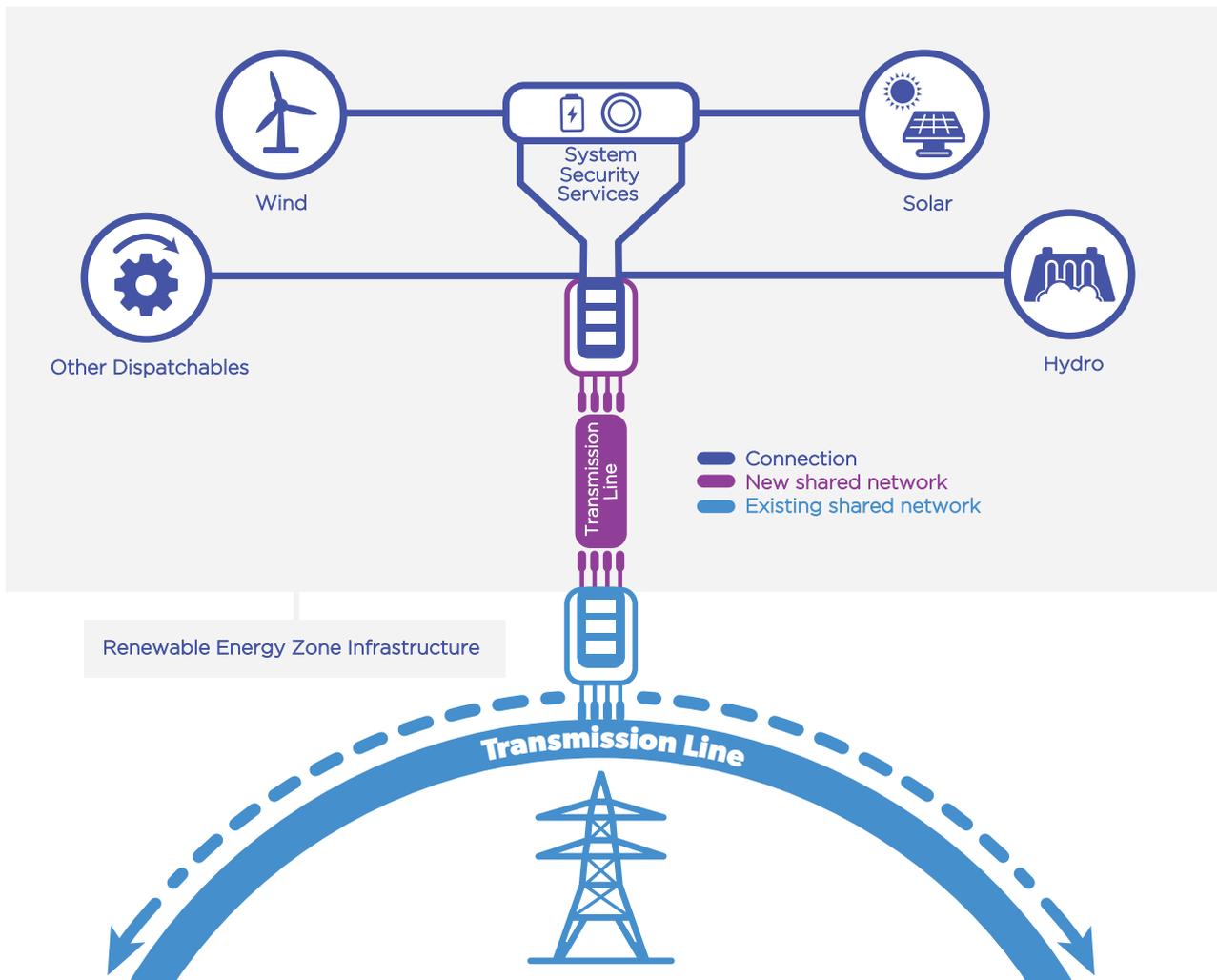
Delivering Renewable Energy Zones

Renewable Energy Zones are the modern-day equivalent of traditional power stations. They combine generation, transmission, storage and system strength services to ensure a secure, affordable and reliable energy system.

The Government is prioritising the delivery of three Renewable Energy Zones, including a 3 GW zone in the Central-West Orana region and an 8 GW zone in the New England region.

They will play a crucial role in delivering affordable energy to help replace the State’s existing power stations as they retire over the next 15 years.

What is a Renewable Energy Zone?



Coordinating generation and transmission infrastructure

Investment in generation and transmission on this scale has not occurred in NSW for decades. Our regulatory and market frameworks are not set up for the private sector to deliver the electricity infrastructure we need in the time and at the scale needed.

The transmission system is congested and its capacity to connect new generators is limited. Transmission projects have long lead times and can take many years to develop. These projects cannot currently be approved unless there is matching forecast generation. At the same time, generators will not commit to build unless the transmission has been approved to be built. Even with transmission, generators still need revenue certainty. This creates a 'chicken and egg' problem that is stifling investment in our energy sector.

If left to existing market signals, investment could come too late to prevent price spikes and reliability issues. It is also likely to occur ad-hoc, negatively impacting local communities. Coordination will ensure that investment is orderly, timely, optimised and efficient. It also allows for careful and deliberate consideration of community priorities and concerns.

Our Renewable Energy Zone goals

The Renewable Energy Zones will unlock a substantial pipeline of large-scale renewable energy and storage projects and deliver lasting benefits for NSW, including:

- **more reliable energy** from significant amounts of new energy supply
- **energy bill savings** from reduced wholesale electricity costs
- **emissions reduction** from a cleaner electricity sector
- **community partnership** from strategic planning and best practice engagement and benefit sharing.

The Roadmap builds on our existing work

In June 2020, the NSW Government announced that it would set up the Energy Corporation of NSW to work closely with communities and industry stakeholders, coordinating generation and transmission at every level. The NSW Government also committed \$120 million to get the State's first two Renewable Energy Zones up and running, and the Commonwealth Government committed to financially support the transmission for the Central-West Orana pilot Renewable Energy Zone.

The NSW Government is also establishing a special access rights regime for generators and storage providers to connect to the Renewable Energy Zones. Dedicated rights can de-risk new projects, enabling them to better forecast energy exports and revenue streams and lower their costs of finance. This also ensures strategic and optimal use of new transmission infrastructure, maximising the benefits of these investments to consumers.

This Roadmap introduces new elements to remove more barriers to investment and maximise Renewable Energy Zone benefits for communities.



Photography
Solar farm at Moree, NSW.

1

Renewable Energy Zone – Transmission Development Scheme

The Government will establish the Transmission Development Scheme to de-risk Renewable Energy Zone grid investment.

The Scheme will bridge the gap between when the grid is built and when generators connect, solving the ‘chicken and egg’ problem that currently prevents large-scale grid expansion.

The Scheme will be supported by a regulated cost recovery process that will facilitate low cost financing for new transmission development.

The Scheme is designed to minimise costs to consumers. It will involve a rigorous, independent assessment to determine the reasonable and prudent costs of building the Renewable Energy Zone transmission. This will protect consumers from cost overruns.

This builds on the financial support committed by the Commonwealth Government for the pilot Central-West Orana Renewable Energy Zone, and will enable additional zones to be built.

The Renewable Energy Zones will also support improvements to the distribution network, benefiting local communities.

Overall, the Scheme will allow Renewable Energy Zones to be planned in a way that meets the long-term energy needs of NSW.

2

Electricity Infrastructure Investment Safeguard – Renewable Energy Zone generation

The Electricity Infrastructure Investment Safeguard will unlock new generation in Renewable Energy Zones and increase competition in the energy market to drive down energy prices. It will give Renewable Energy Zone investors the long-term revenue certainty they need to secure lower cost project finance and build new infrastructure in NSW.

Long Term Energy Services Agreements will be awarded through a competitive process to Renewable Energy Zone generation projects. Projects will be assessed against a range of eligibility and merit criteria to ensure they meet the NSW Government’s objectives of delivering low cost electricity and strong community outcomes.

Awarding of Agreements will encourage generators to support local jobs and the local economy, engage with local communities and proceed in locations and ways that support agriculture.

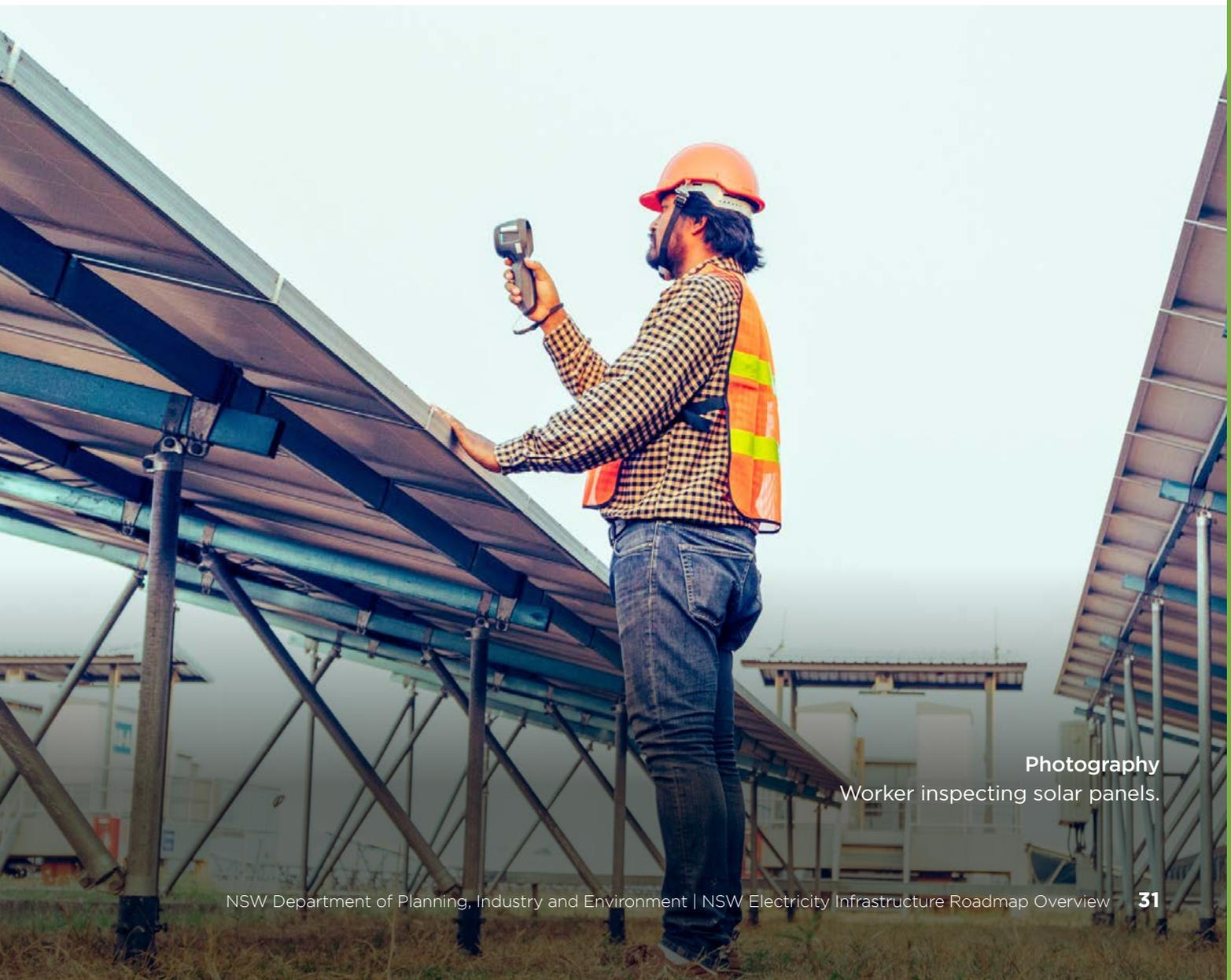
The Consumer Trustee will follow an investment objective for Renewable Energy Zones. This will see generation equivalent to the size of the 3 GW Central-West Orana Renewable Energy Zone, 8 GW New England Renewable Energy Zone built and a 1 GW allowance for outstanding projects by 2030 and otherwise to maintain reliability and minimise consumer prices.

Planning

The NSW Government will establish a Renewable Energy Zone planning framework to streamline assessments, attract investment, optimise complementary land uses and deliver enduring benefits for regional communities.

For communities, it will provide an opportunity to engage with Renewable Energy Zone delivery as a whole, rather than in a piecemeal, project-by-project way. It will also seek opportunities for broader scale community benefit sharing and better environmental outcomes.

The NSW Government will support planning processes to reduce assessment timeframes and planning fees for Renewable Energy Zone projects, saving investors time and money.



Photography
Worker inspecting solar panels.

Firming

Dispatchable electricity infrastructure is critical

Firming refers to generation that can deliver electricity to the market on demand.

Firming can be provided by a range of technologies, including batteries, gas generators and demand response. In the future, fast firming may also be able to be provided by hydrogen generators.

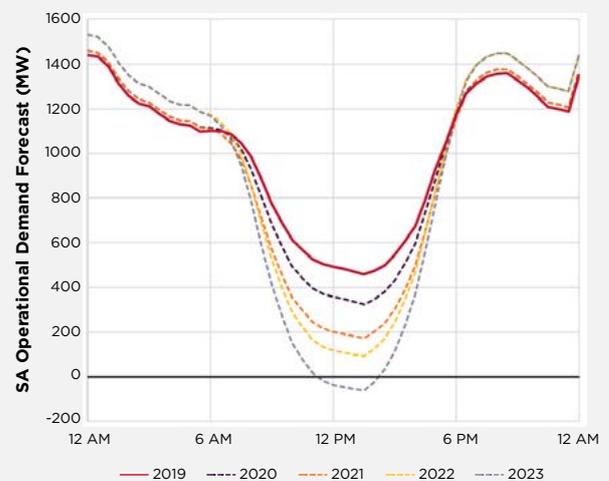
As the electricity market moves towards more generation that relies on variable conditions, like weather, firming is increasingly valuable to ensure we can quickly stabilise the electricity system and meet peak demand.

The Electricity Infrastructure Investment Safeguard will ensure enough firming capacity is in the market to back up renewables and keep the system stable.

For example, gas peaking plants can help provide stability because they can sit at a low-level or even be offline during low-demand periods, and rapidly ramp-up to meet evening demand. Big batteries can also store and dispatch energy when needed. Bioenergy can also provide on-demand energy, complementing other firm technologies.

Where a breach of the State's Energy Security Target is identified, these projects will be eligible to compete for Long Term Energy Service Agreements. The firming pillar is technology neutral, with technologies eligible if they meet the technical requirements.

South Australian 'Emu' Curve forecasting a steeper evening ramp over time¹¹



As renewable generation, particularly rooftop solar, enters the system, the ramp up in evening electricity demand on the grid is predicted to become steeper without action, as shown here in South Australia's 'emu curve'. Firming technologies can rapidly increase their output to meet this demand trend.

11. Australian Energy Market Operator, *Minimum operational demand thresholds in South Australia*, May 2020.



Photography
Gas-fired power station.

Opportunities for industry

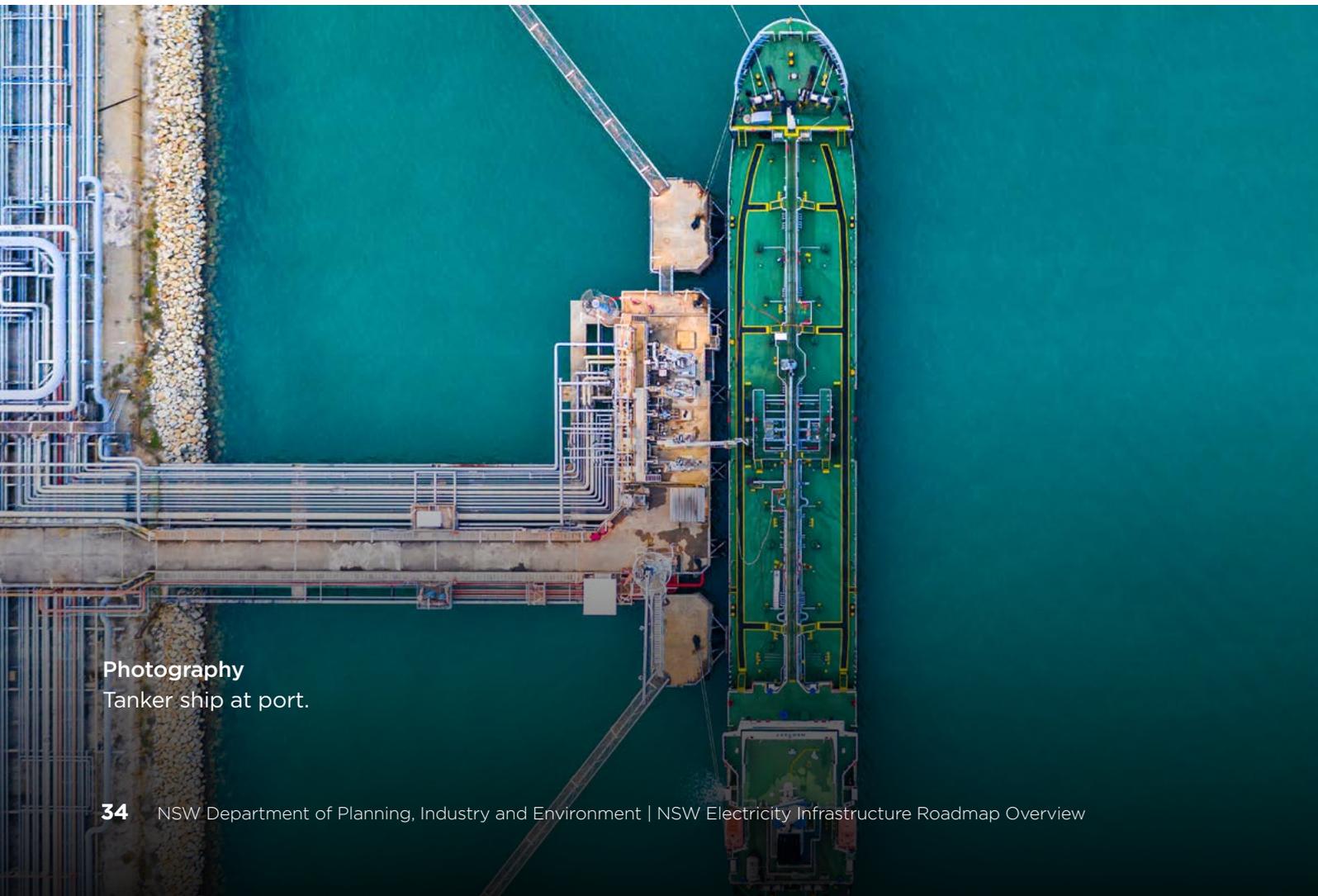
A destination for industry

As we head towards a low carbon future, access to cheap, clean and reliable energy will create a competitive advantage for NSW. This will attract businesses and enable new industries to emerge and grow, underwriting our prosperity and setting us up for generations. This potential will be realised through:

- existing industries becoming more cost competitive as they electrify to support continuation of their operations
- enabling additional capacity for industry to expand output and market share
- creating the enabling conditions for new industry sectors to emerge and grow.

With cheap, reliable and clean energy, and a proven record of committing to innovation, NSW has the potential to re-industrialise and attract even more investment, jobs and innovation.

Major vehicle manufacturers, such as Volkswagen and Toyota, are targeting carbon neutral supply chains. South Korea and Japan have announced an intention to move to a “hydrogen economy”, in part to decarbonise. NSW’s focus on delivering Renewable Energy Zones, and low cost reliable electricity will attract manufacturing opportunities to our State.



Photography
Tanker ship at port.

Case study

Leading the world in fresh food production

Agriculture is a strategic industry for NSW and offers significant growth potential, with strong and growing regional and international demand and the ability to leverage NSW and Australia's competitive advantage as a safe and high quality food producer.

The NSW Government is already trialling the development of a world-leading production

hub as part of the Agribusiness Precinct at the Western Sydney Aerotropolis. A pre-feasibility study identified the hub's potential to deliver up to **2,500 direct** and **12,000 indirect jobs at full production** and **\$2.8 billion revenue over 10 years**, all while positioning NSW to meet the growing domestic and international demand for fresh food.¹²



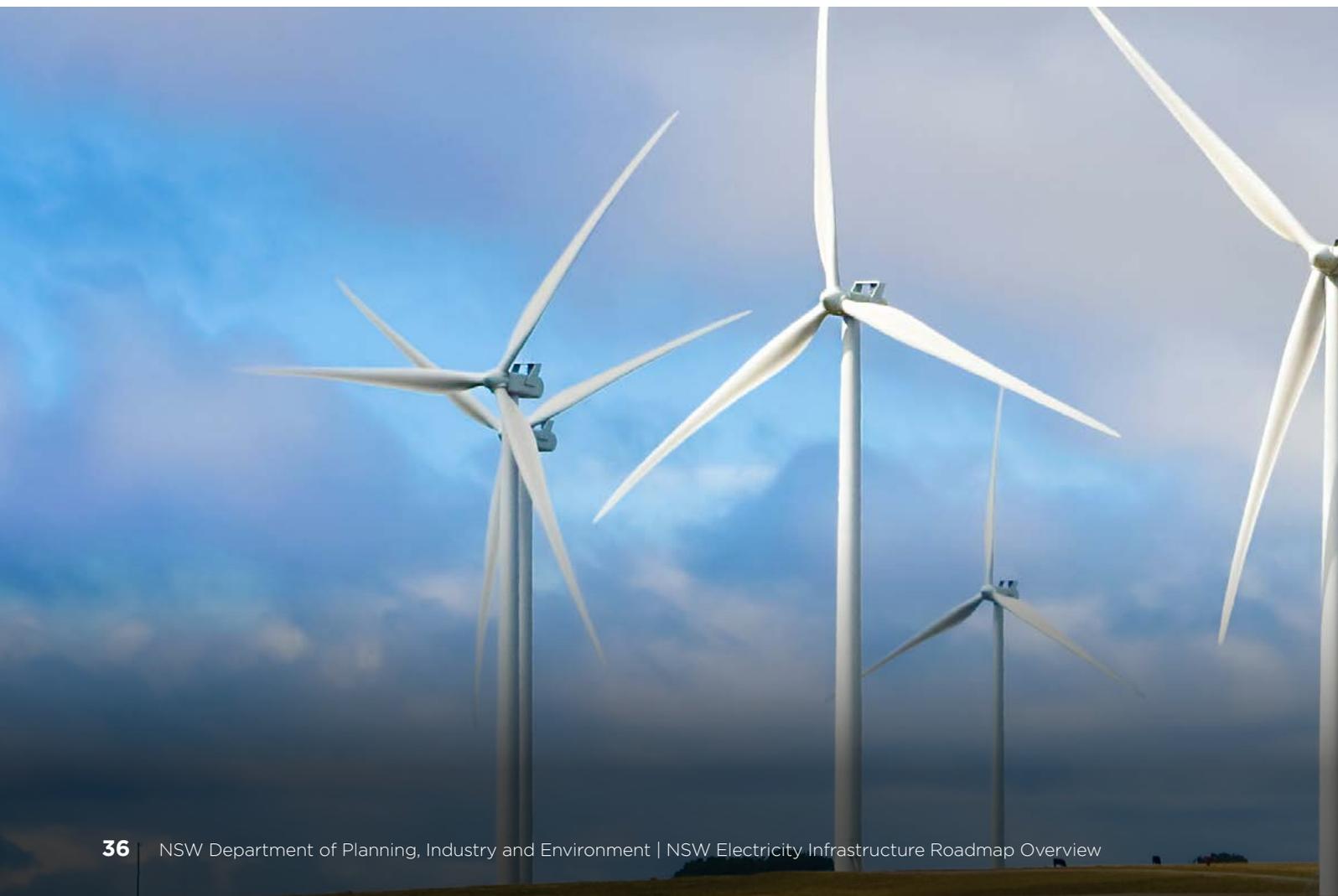
Photography
Worker monitoring controlled horticulture facility.

12. KPMG, *World-class intensive integrated production hub in the Western Sydney Aerotropolis: NSW Government's Agribusiness Precinct - A pre-feasibility study for the NSW Department of Primary Industries*, February 2019.

Our State's competitive advantage

NSW is well placed to harness the potential of abundant low-cost, low-emissions and reliable electricity to grow existing industries and foster new ones. NSW owes its competitive advantage to a number of factors, including its:

- **Abundant resources:** including strong renewable energy opportunities in wind and solar and significant potential for pumped hydro development.
- **Large and diverse economy:** with strong finance and private investment sectors, including green finance and major clean energy investment experience.
- **Proximity to markets:** particularly Asian markets where NSW enjoys well-established trading relationships.
- **Established industries:** that could benefit from low-cost energy or electrification, such as steel, aluminum, agriculture, and minerals processing.
- **Technological capability:** enabling transition pathways, such as digital technologies, artificial intelligence, advanced manufacturing and design.
- **Enabling infrastructure:** strong existing infrastructure backbones to support growing and emerging industries, including energy, IT and digital communications, and domestic and international freight capability.
- **Regional capacity:** diverse and motivated regional communities with access to key enablers like transport corridors, skills and education and industry.



Seizing the opportunity

Through the NSW Electricity Strategy, the Net Zero Plan and now the Electricity Infrastructure Roadmap, we are facilitating the delivery of clean, low cost, reliable energy and supporting the State's economy and industries to realise the opportunities it presents.

The Electricity Strategy and this Roadmap will deliver Australia's first coordinated Renewable Energy Zones. They will improve energy efficiency and resilience, increase new generation and storage capacity, and decrease the cost of electricity for businesses and industry.

The Net Zero Plan will support investment in new technologies to harness this cheap, reliable and low emission electricity across multiple sectors of the economy. Through the Plan, the NSW Government has committed \$450 million to an Emissions Intensity Reduction Program, taking direct action to support large NSW-based sources of emissions to transition their plant, equipment and other assets to low emissions alternatives.

This will be complemented by the Commonwealth's \$450 million commitment to NSW from the Climate Solutions Fund. The Climate Solutions Fund supports Australian businesses, farms and land managers to take practical, low-cost actions to reduce emissions.



Photography
Wind farm at Taralga, NSW.



A NSW hydrogen industry

The hydrogen industry in Australia is expected to generate approximately **\$200 million per year** in additional Gross Domestic Product (GDP) by 2030.¹³

The industry in NSW could grow substantially with new uses for hydrogen, including: in replacing or supplementing methane gas as a renewable energy storage and transport medium; in electricity firming and remote power supply; and in feedstock in industrial processes including steel, ammonia, chemicals and synthetic fuels.¹⁴



Controlled environmental horticulture

Horticulture already **contributes around nine per cent of total gross value of production** of NSW primary industries in 2016-17—**around \$1.4 billion**.¹⁵

Controlled environment horticulture can improve water efficiency, overall farm productivity and the viability of agriculture in harsh climates. However, it can consume up to 10 to 20 times the amount of energy per kilogram as broad-acre farming.¹⁶

Low-cost electricity infrastructure can reduce costs and make more efficient, high-yield controlled environment horticulture sites viable in strategic locations.

13. Council of Australian Governments Energy Council, *Australia's National Hydrogen Strategy*, 2019.

14. KPMG and NSW Office of Chief Scientist and Engineer, *Report on NSW: A Clean Energy Super Power*, November 2020.

15. NSW Department of Primary Industries, *NSW Primary Industries Performance Data & Insights 2017*, December 2017.

16. Rural Industries Research and Development Corporation, *Benchmarking Energy Use on Farm, Rural Industries*, June 2015.



Photography
Tomatoes growing in controlled horticulture greenhouse.



Green aluminium production

Every percentage point increase in green aluminium industry output relative to current levels is expected to deliver an additional **\$50 million in annual revenues** and around \$14 million in annual direct wages in today's dollars.¹⁷

Demand for aluminium is expected to remain strong in a decarbonised economy, as it is an infinitely recyclable, lightweight material critical to many technologies.¹⁸



Green steel production

Every percentage point increase in green steel industry output relative to current levels is expected to deliver up to an additional **\$20 million in annual revenues** and up to \$7 million in annual direct and indirect wages in today's dollars.¹⁹

NSW has a number of existing steel manufacturers utilising various processes in the Illawarra, the Hunter and Sydney. A green steel industry in just one NSW region has the potential to support an expected 10,000 jobs.²⁰

17. KPMG and NSW Office of Chief Scientist and Engineer.

18. World Economic Forum, *Aluminium can help to build the circular economy. Here's how*, 30 June 2020, www.weforum.org/agenda/2020/06/heres-how-aluminium-can-help-to-build-a-greenrecovery, accessed 27 July 2020

19. KPMG and NSW Office of Chief Scientist and Engineer, *Report on NSW: A Clean Energy Super Power*, November 2020.

20. Grattan Institute, *Start with steel: A practical plan to support carbon workers and cut emissions*, May 2020.



Photography
Molten iron ore used in steelmaking process.



Green ammonia production

Every percentage point of global market share able to be captured by NSW is worth approximately **\$102 million** in today's dollars.²¹

Global ammonia production is forecast to grow by more than 20 per cent to 2030.²² If NSW captured 6.5 per cent market share of a future ammonia shipping fuel market this is expected to create an additional 15,000 jobs.²³



Sustainable synthetic fuel production

The international market for synthetic fuels and chemicals, such as ethanol and methanol, is worth **tens of billions of dollars**. The International Energy Agency forecasts the consumption of **37 billion litres** per annum of synthetic aviation fuels by 2030, for example.²⁴

Increasing NSW's capacity to capture a fraction of the domestic and international market using low-cost, clean energy could deliver significant economic and industry benefits.



Transport and logistics

Every additional one per cent share of registered passenger vehicles that are battery electric vehicles in NSW has the potential to result in direct **cost savings of up to \$89 million per annum**.

Hydrogen will be a vital input into the emerging Fuel-Cell Electric Vehicle (FCEV) industry. In 2030, **operating costs in NSW may be up to \$234 million lower for FCEV buses**, compared to internal combustion engine buses (in today's dollars).

Total future operating costs of FCEV articulated and semi-rigid trucks are expected to be up to **\$103 million per annum and \$42 million per annum lower than current levels** compared to internal combustion engine trucks, respectively.²⁵

21. KPMG and NSW Office of Chief Scientist and Engineer.

22. McKinsey & Company, *Decarbonization of industrial sectors: the next frontier*, June 2018.

23. Grattan Institute

24. International Energy Agency, *Are aviation biofuels ready for take off?*, 18 March 2019, www.iea.org/commentaries/are-aviationbiofuels-ready-for-take-off, accessed 19 October 2020

25. KPMG and NSW Office of Chief Scientist and Engineer.



Photography
NSW electric bus trial. Image courtesy of Transit Systems.

Additional information

The NSW Government will work with industry, communities, manufacturers, market bodies and other stakeholders to deliver our plan for a secure, affordable and clean energy future.

Links to further NSW Government information and supplementary documents, listed below, can be found on the [Electricity Infrastructure Roadmap webpage](#)

- Electricity Infrastructure Roadmap – Building an Energy Superpower
 - [Detailed report including an appendix on the modelling approach and outcomes](#)
 - [Benefits for Regional NSW](#)
 - [NAB Weighted Average Cost of Capital Report](#)
 - [KPMG and NSW Office of Chief Scientist and Engineer report on NSW: A Clean Energy Superpower](#)
- [NSW Transmission Infrastructure Strategy](#)
- [Pumped Hydro Roadmap](#)
- [NSW-Commonwealth Memorandum of Understanding on Energy and Emissions](#)
- [Net Zero Plan: Stage 1, 2020 to 2030](#)
- [Electricity Strategy](#)
- [Renewable Energy Zones website](#)



Photography
Bowral, NSW.



energy.nsw.gov.au