

NSW Department of Planning, Industry and Environment

# NSW Electricity Infrastructure Roadmap

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Building an Energy Superpower  
Detailed Report

November 2020



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Cover image: Large scale solar generation.

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# 1. Introduction

NSW has some of the best renewable energy resources in the world. As the global economy moves to reduce its carbon emissions, NSW can attract huge investment in new, low carbon industries and can benefit from some of the lowest electricity prices in the Organisation for Economic Co-operation and Development (OECD). But to take advantage of these opportunities there needs to be substantial investment in modernising the electricity system, including by building transmission, generation, long duration storage and firming infrastructure.

The State also needs to deliver this infrastructure to replace four coal-fired power stations that are scheduled to close within the next 15 years, starting in 2023. These power stations currently provide around three quarters of the State's energy supply; if they are not replaced before they close there will likely be substantial price rises. That investment is unprecedented in both its scale and the relatively short time over which it must be made, given existing generation and transmission took 30 years to plan and build. The retiring power stations now need to be replaced in less than 15 years. The infrastructure needed to replace these power stations also has long lead times – for example pumped hydro to keep the system reliable can take up to 8 years to plan, design and build. This is why it is important to start developing the infrastructure now.

The purpose of the NSW Electricity Infrastructure Roadmap is to deliver this infrastructure and secure NSW's future as an energy superpower. In this respect, the Roadmap is expected to attract \$32 billion of timely and coordinated private sector investment by 2030 in large-scale generation, storage and transmission to maintain a reliable, secure and affordable supply. It will support an expected 6,300 construction jobs and 2,800 ongoing jobs<sup>1</sup> mostly in regional NSW in 2030 and an estimated \$1.5 billion in lease payments to landholders in regional NSW by 2042 and reduce NSW's carbon emissions by a total of 90 million tonnes of CO<sub>2</sub>e (MtCO<sub>2</sub>e) by 2030.

This document builds on the framework set out in the NSW Electricity Strategy which takes an integrated approach to all demand and supply options, including action by households and small businesses, demand management, and investment in large-scale, affordable and reliable generation.

The Roadmap explains the rationale for the policies and programs that are specifically designed to attract and secure that large-scale investment in new electricity infrastructure. The Roadmap will be supported by other actions in the Strategy such as a case management service to support projects in navigating planning and approvals processes. This document complements the Roadmap Overview by providing the technical, economic and policy reasons for the actions that the NSW Government has decided to take.

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.

1. Forecast jobs figures were calculated using the methodology in Rutovitz, J., Briggs, C., Dominish, E., Nagrath, K. (2020), *Renewable Energy Employment in Australia: Methodology*. The Institute for Sustainable Futures, University of Technology Sydney.

# 2.

# Building an Energy Superpower

NSW has world leading renewable energy and pumped hydro resources. These resources, combined with falls in technology prices, put NSW in a position to have globally competitive energy prices and drive jobs. The Roadmap could reduce average electricity prices for heavy industry to USD\$84 per megawatt hour (MWh) by 2030 (including network costs), which would place NSW indicatively in the top 10 per cent of the OECD.<sup>2</sup> Beyond direct construction and ongoing jobs, lower energy prices under the Roadmap will increase household disposable income and business investment which is forecast to support a net increase of 23,600 jobs over the NSW economy in the period 2032 to 2037.<sup>3</sup>

Building the infrastructure to take advantage of these resources – long duration storage, Renewable Energy Zone (REZ) transmission and generation, and firming – can also put NSW in a position to prosper as the world reduces its carbon emissions. Globally, financial markets, consumers, governments and major companies are demanding low carbon emissions goods and services.

Many parts of the economy, including chemicals and materials manufacturing, transport, and heavy industry, are going to rely on energy and fuels produced from renewable energy to decarbonise. For this reason, there are substantial economic opportunities created by making the most of the State's renewable energy and firming resources.

One example of such opportunities is a new hydrogen industry, which could generate approximately \$200 million per year in additional GDP by 2030 nationwide,<sup>4</sup> in which NSW can take part. There are also many potential industry applications for synthetic fuels, including liquid organic hydrogen carriers (LOHC) to transport and store hydrogen and other chemicals made using cheaper green energy.

The international markets for chemical and synthetic fuels, such as ethanol and methanol, are worth tens of billions of dollars and are expected to grow domestically and internationally over time as demand and use applications increase. Increasing NSW's capacity to capture a fraction of the domestic and international market using low-cost renewable energy sources could enable the realisation of significant economic and industry benefits in the State.

It is not just the State's renewable energy resources which create these opportunities. Certain industrial processes, such as the production of aluminium, require reliable electricity. NSW's storage potential, like our pumped hydro sites, create the opportunity to provide firm electricity supply and position the State well in such international markets.

2. 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.

3. Based on Aurora Energy Research modelling commissioned by the Department.

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



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

## NSW has world leading renewable energy and pumped hydro resources

A REZ involves the coordinated development of new grid infrastructure in energy rich areas, to connect multiple generators (such as solar and wind farms) in the same location. REZs capitalise on economies of scale, unlocking new generation at lower cost. They also provide opportunities for upfront planning and early community engagement.

Regional NSW has abundant energy resources that provide huge opportunities for new energy projects. The NSW Transmission Infrastructure Strategy, released in 2018, identified the Central-West, New England and South West regions as locations for REZs. 25 datasets were used in determining the location of the three REZs in NSW, including strategic agricultural land and land zoning. These locations were found to have exceptional energy resources including wind, solar, bioenergy and hydro and are relatively close to existing transmission and distribution infrastructure and load centres. They also have reduced environmental, heritage and land-use constraints, and benefit from existing investment interest from the private sector. As a result, the REZs align with the Government's regional growth priorities, developed in consultation with regional communities.

Unlocking the REZs will diversify the State's energy mix and expand our transmission capabilities, opening new parts of the National Electricity Market (NEM) for energy generation in locations with strong renewable resources.

Importantly, these REZs do not preclude the development of energy projects in other parts of the State, such as the Hunter Valley and South East and Tablelands, which may already have enough grid capacity to connect new projects.

The NSW Government worked with the Australian National University to provide mapping analysis which showed that NSW has widespread opportunities for pumped hydro development. The analysis identified 20,000 reservoirs that could be used for possible schemes. The Australian Energy Market Operator (AEMO) has projected that NSW will need nearly 2.3 gigawatts (GW) of energy storage to maintain system security and reliability in addition to Snowy 2.0. Only a small number of the total possible schemes identified would need to be developed to help meet this projection.

For example, New England has some of the best natural energy resources in the country, some of the State's best potential sites for pumped-hydro development and strong investor interest. Given the proximity of pumped hydro opportunities to the New England Renewable Energy Zone, these potential projects could complement the development of generation in the REZ, providing dispatchable storage capacity to back up variable renewable generation.

### Photography

Solar farm at Moree, NSW.

Image courtesy of Neil Fenelon, Department of Planning, Industry and Environment.



## Building the infrastructure to take advantage of these resources will grow the economy and reduce power prices

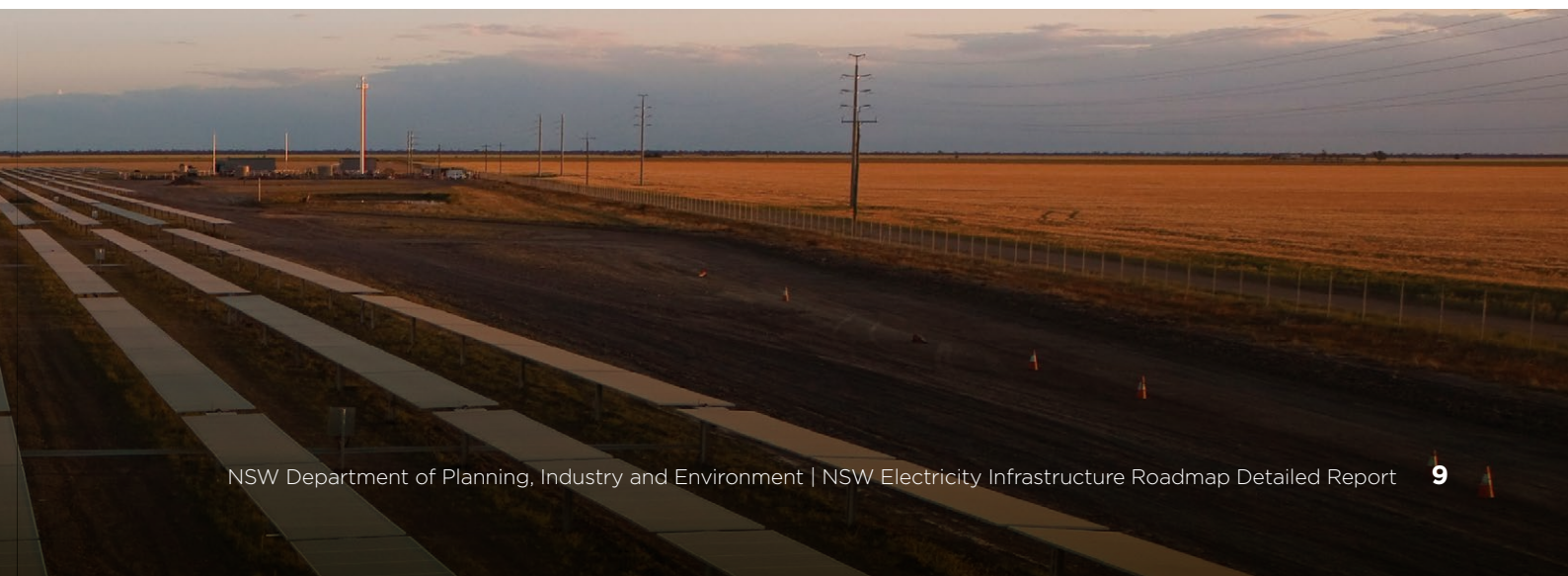
Coordinated build out of new transmission, generation and storage infrastructure will deliver lower power prices for households and businesses in NSW, and support an expected 6,300 construction jobs and 2,800 ongoing operational jobs in 2030 mostly in regional NSW, as a result of attracting an estimated \$32 billion of private sector investment. The Roadmap is expected to reduce household average annual energy bills by \$130 per year and small business average annual energy bills by \$430 per year between 2023 and 2040.

Landholders in regional NSW will also be able to lease their land to host new electricity infrastructure, such as solar and wind generation projects, providing an additional source of revenue. The level of investment facilitated by the Roadmap means landholders are expected to receive \$1.5 billion in lease payments to 2042 (Central-West \$430 million, New England \$660 million, South West \$280 million and other locations up to \$130 million).

The Roadmap will also ensure the continued supply of reliable electricity to NSW households and businesses as the system transitions. AEMO's 2020 Electricity Statement of Opportunities found that NSW would be in breach of the NEM's interim reliability standard from 2023-24 onwards and risk electricity supply risks during high demand periods, such as during a summer heatwave, in 2029-30.

Consumers carry the risk that generation closures result in long periods of high prices or unexpected outages. If the market is slow to plan, build and commission replacement generation, Aurora market modelling indicates an additional cost to consumers of on average, around \$20 per megawatt hour (MWh) over the period 2023 to 2042 (see Figure 1).

AEMO's Integrated System Plan (ISP) notes that the least-cost and least-regret transition of the NEM is from a centralised coal-fired generation system to a diverse portfolio of renewable energy supported by dispatchable firming and enhanced transmission grid and service capabilities. Modelling from the ISP has confirmed the necessary replacement generation in NSW is likely to be a mix of wind, solar, gas, and storage. Aurora estimates that \$5.1 billion of long duration storage and between \$22.4 to \$33.6 billion of wind and solar investment will be required to meet the energy requirements of NSW and maintain a reliable supply.



## Global demand for low carbon products is likely to accelerate

A total of 197 countries have signed the Paris Climate Agreement, under which nations agreed to limit global warming to between 1.5 and 2 degrees Celsius. As of June 2020, nations, states and cities with a cumulative annual GDP of almost \$46 trillion (about 53 per cent of the world) have adopted a net zero emissions target. Domestic and international investors are increasingly concerned about lending to governments with high-carbon economies and carbon-intensive businesses.

Global demand is increasing for low emission products and investments, creating substantial economic opportunities. Major 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. British businessman Sanjeev Gupta is already investing \$1.3 billion in the Whyalla steel works to transition that plant into a green steel mill. Company directors are also facing litigation risks for failing their duty of care and diligence to address foreseeable climate-related risks that would cause harm.

Capital markets are responding to this shift with global green bond and green loan issuance increasing by 51 per cent from US\$170.6 billion in 2018 to US\$257.7 billion in 2019. This trend is likely to accelerate as, globally, financial regulators (including APRA and ASIC), credit ratings agencies, leading commercial lawyers, central banks and leading investment firms highlight that the investment risks of climate change are material, foreseeable and actionable now. Bodies such as the Task Force on Climate-related Financial Disclosure are also expected to continue to advance the understanding of the impacts of climate change on financial markets.

Leveraging these global trends, the development and integration of reliable low-cost, low-emission electricity into the NEM and NSW generation mix provides industries with a wider variety of energy options to suit their energy needs and optimise production.

## Big economic opportunities for our energy

Access to cheap, reliable and clean energy will position NSW’s industry to take advantage of major sustainable energy opportunities through industry growth, and related construction and employment.

It brings the opportunity for NSW to retain industries that would otherwise be at risk due to global competition and investor pressure to decarbonise (e.g. aluminium, steel and ammonia production). Modelling indicates NSW could see:

- some \$50 million in additional revenue and \$14 million in associated annual direct wages for every percentage point increase of industry output relative to current levels in green aluminium;
- an estimated \$102 million for every percentage point of global ammonia market share captured by NSW; and
- up to \$20 million in additional annual revenue for every percentage point increase in industry output relative to current levels in green steel production.

Cheap, reliable and clean energy will also increase the competitiveness of existing industries and expanding their capacity to meet increased demand (e.g. data centres, advanced manufacturing, transport and logistics).

Finally, it will be possible to capture new industries that leverage NSW’s existing competitive advantages (e.g. hydrogen, sustainable synthetic fuel production, controlled environmental horticulture, transport and logistics, and commercialising enabling technologies). NSW will also be able to capture its share of the national hydrogen industry estimated at \$200 million per year in additional GDP by 2030.



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

# 3.

# Benefits of the Roadmap

Modelling found that the Roadmap would result in:

- Average annual household bill savings of \$130 a year between 2023 and 2040;
- Average annual small business savings of \$430 a year between 2023 and 2040;
- NSW being in the top 10 for lowest industrial electricity prices across the OECD;
- A net increase of 23,600 jobs over the NSW economy in the period 2032 to 2037; and
- Private investment in generation, transmission and storage infrastructure of \$32 billion by 2030.

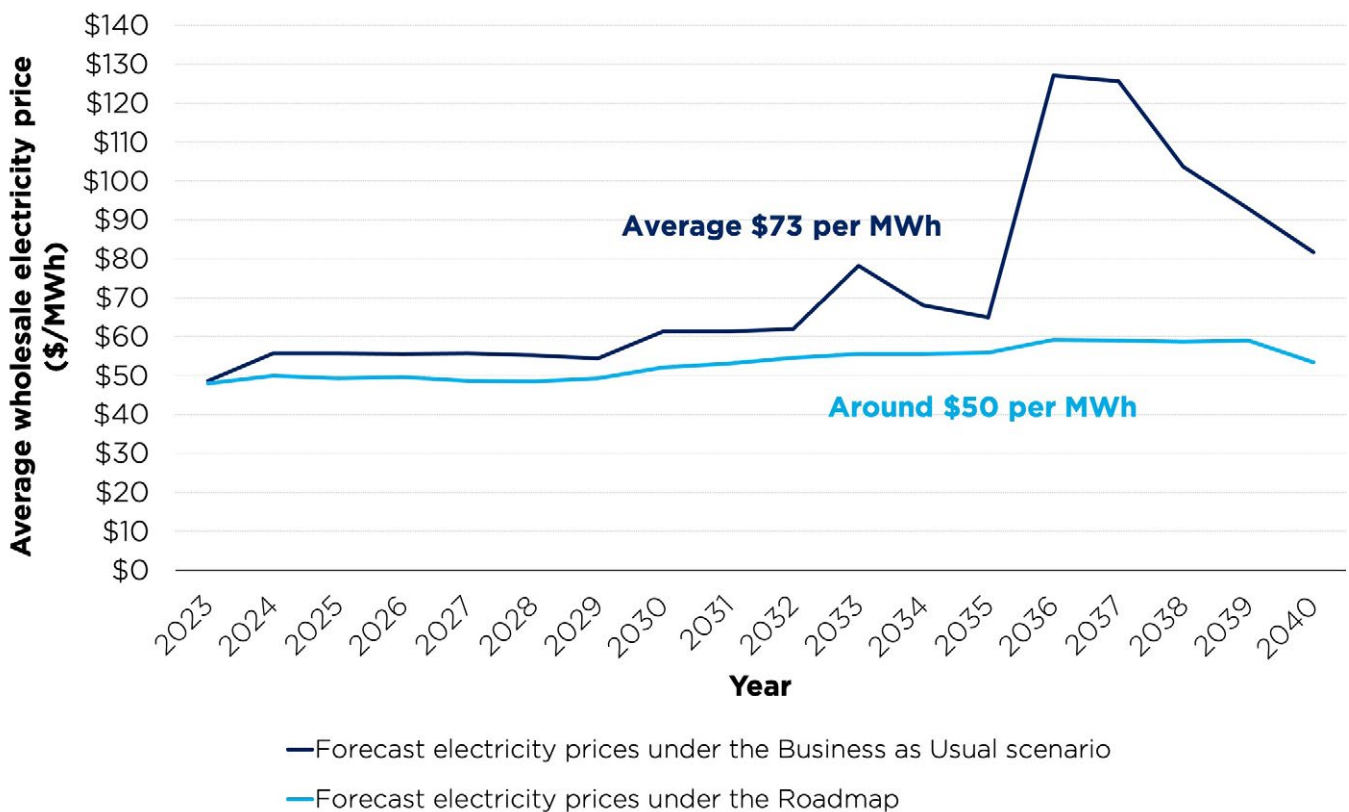
The benefits to consumers and the NSW economy of this investment will be substantial and diverse.

Modelling undertaken by Aurora demonstrated that this investment would benefit consumers by reducing retail electricity prices by 8 per cent compared to no action, with total system costs around \$12.4 billion lower in present value terms.

Network businesses will recover some Roadmap program costs from consumers, subject to the approval of an Independent Regulator. Program costs are forecasted to be well offset by lower energy prices so that the average NSW residential consumer is \$130 a year better off overall.

The Roadmap will also benefit other NEM states. Aurora's forecasts show that in the long term average wholesale prices will reduce in Queensland (\$10/MWh), South Australia (\$15/MWh), Tasmania (\$16/MWh) and Victoria (\$19/MWh) due to the policies implemented in NSW.

The replacement of ageing power stations with a mix of transmission, generation and storage produces a forecast reduction in emissions from NSW's power sector of 90 MtCO<sub>2</sub>e to 2030.



**Figure 1.**

Forecast wholesale electricity prices under the Business as Usual scenario and under the Roadmap. Price spikes under the Business as Usual scenario reflect expected plant closures.

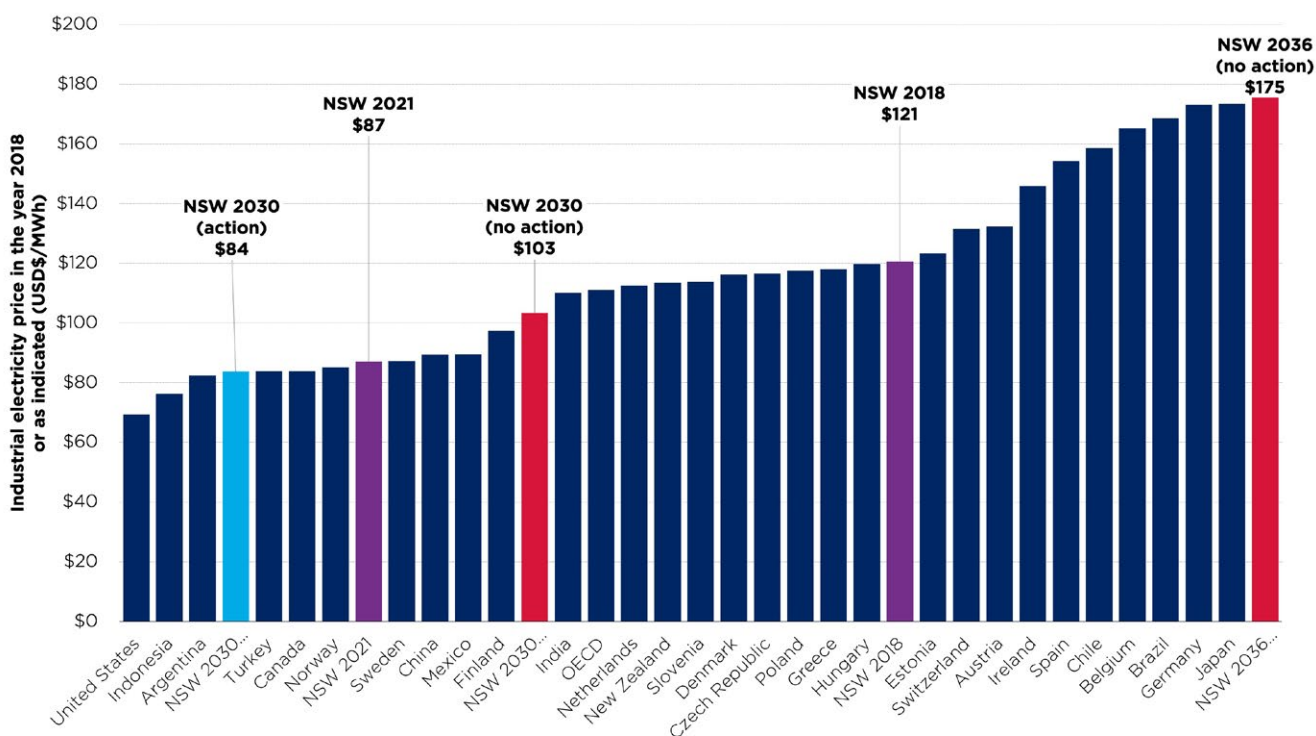
## Economic benefits

Electricity is a core input to industry productivity and household consumption, so its cost has a large influence on economic activity. Computable General Equilibrium modelling indicates that the Roadmap would result in an expected additional 23,600 full-time equivalent jobs across NSW, a 0.8 per cent increase in household disposable income and support a 0.5 per cent increase in Gross State Product in the mid-2030s.

Distributional impacts in the NEM are difficult to assess accurately over the medium to long term. Energy is an input to every sector, changes in energy policy have effects throughout the

economy which change over time, and the effects on producers and consumers often offset each other. Some industry sectors will benefit more than others.

The development of infrastructure which delivers cheap, reliable and clean electricity is also expected to enable new economic opportunities to transform and expand existing industries, and foster new sectors in NSW over time. As shown below, delivered electricity prices for trade exposed heavy industries are expected to reduce to USD\$84/MWh<sup>5</sup> by 2030 by implementing the Roadmap, indicatively placing NSW in the top 10 per cent of OECD jurisdictions and standing in contrast to USD\$103/MWh without the Roadmap.



**Figure 2.**

Comparison of delivered industrial electricity prices in the OECD in 2018 or as otherwise indicated.

5. 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.

## Regional benefits

The Roadmap will put regional energy intensive industries and high-value agriculture in a position to leverage opportunities to improve their competitiveness through proximity to low-cost energy.

It is expected that the Roadmap will deliver \$32 billion in private sector investment by 2030 and support 6,300 construction jobs and 2,800 ongoing jobs mostly in regional NSW in 2030. A number of these jobs will be delivered through the development of energy storage infrastructure, such as pumped hydro projects which offer

a significant boost to regional NSW and help improve water security.

To balance the benefit of electricity infrastructure investment in the regions with impacts on landholders and regional communities, the NSW Government will ensure there is a coordinated approach to the planning and delivery of projects across infrastructure types. The Energy Corporation of NSW will be established to coordinate infrastructure delivery, particularly in REZs, and engage with communities to understand local expectations and realise local benefits.

In addition to targeting investment in REZs, the Roadmap includes the development of a coordinated approach to land-use planning to provide an opportunity for communities to engage with REZ delivery in a holistic way and give communities more certainty about the location and timing of electricity infrastructure. The Energy Corporation of NSW will seek to achieve a balance between electricity, agriculture, heritage, visual amenity, mining and other land uses within the proposed REZs.

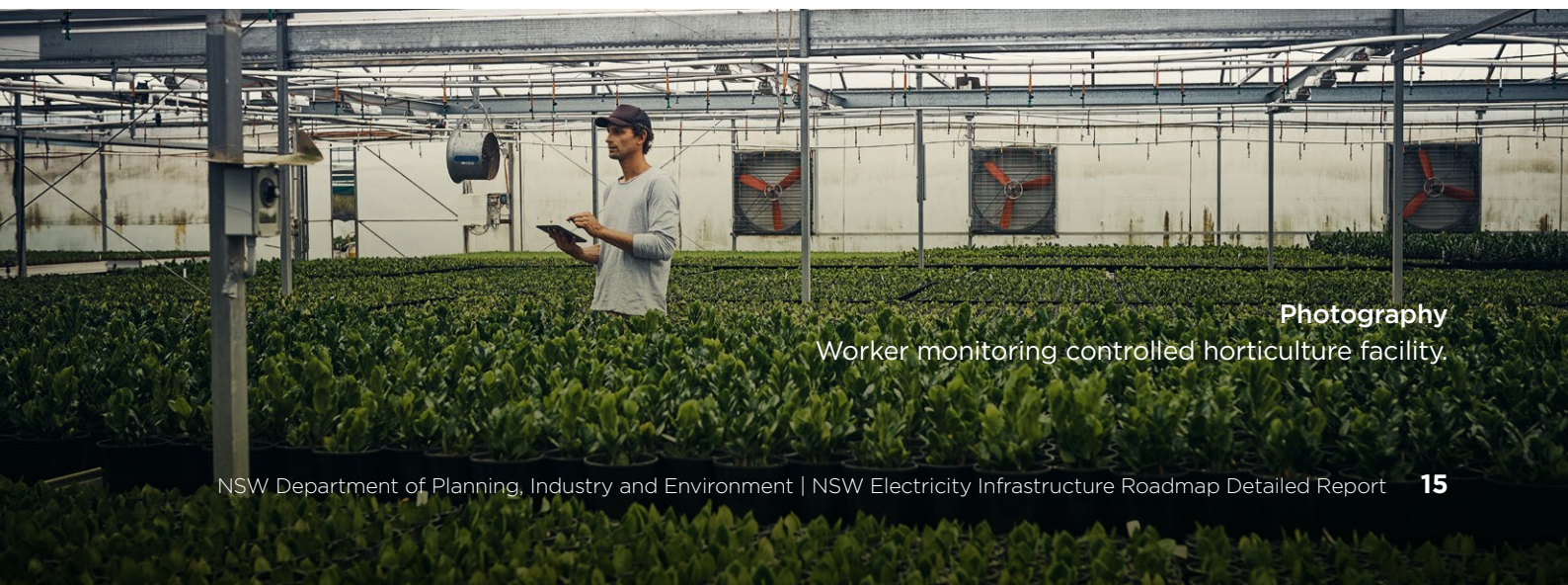
A Consumer Trustee will also play a key role in achieving this balance. This will include applying a merit criteria assessment as part of project selection which encourages projects that meet both the State's energy needs and benefit host communities.

The merit criteria will include, for example:

- commitments to improve local employment opportunities
- compatibility and complementarity with existing agricultural land uses
- local community engagement and support for projects.

The Roadmap will help drought-proof traditional farming communities, providing new income streams for landholders that host electricity infrastructure. Landholders could receive an estimated \$1.5 billion in lease payments to 2042 (Central-West \$430 million, New England \$660 million, South West \$280 million and other locations up to \$130 million). The Energy Corporation of NSW and Consumer Trustee will work with generation and storage proponents and local communities to ensure the economic benefits of REZs are equitably shared across the community through community benefit-sharing schemes. Developer contributions could amount to \$265 million based on historical experience. The Roadmap plans for community benefit sharing to be coordinated in areas with multiple generation and storage projects – making contributions go further – and improving social outcomes such as upgrading playgrounds and parks.

In addition to direct financial contributions, major electricity infrastructure projects will bring other benefits to local communities, including improvements to roads, telecommunication capacity and upgrades to local distribution networks. In developing the REZs, the Energy Corporation of NSW will also work with the community and local stakeholders to identify ways electricity infrastructure projects can support local employment.



**Photography**

Worker monitoring controlled horticulture facility.

# 4.

# Why we need a Roadmap



Reform is needed to make sure we have the required capacity to replace closing power stations at the right time, in the right places and in optimal portfolios. Currently, the electricity market is not designed for the scale, speed and complexity of the transition that NSW faces, which is compounded by investment risk from the energy transition and the regulatory settings that govern transmission investment and access.

These circumstances necessitate reform led by the NSW Government given its primary responsibility for economic development, land use planning, environmental impact regulation and most importantly utilities including electricity. The Commonwealth has a complementary role to play in developing assets that it owns (e.g. Snowy 2.0), seeking to ensure that electricity infrastructure development across state boundaries is efficient, and providing relevant approvals.



**Photography**  
Snowy Mountains Hydroelectric Scheme, NSW.

## The electricity market is not designed for transformational change

The market and regulatory rules that govern NSW's electricity industry were established when generation and transmission capacity was high; the focus of their design was to prevent over-investment and increase the efficiency with which existing plants were operated. These goals were addressed through independent economic regulation of natural monopoly networks, a spot market for the compulsory trading and central dispatch of electricity generation, and corporatisation and then leasing of assets to maximise commercial incentives and disciplines to achieve efficiencies in operations and investment.

The initial regulatory and market frameworks were implemented in NSW and Victoria, then were incorporated into the National Electricity Market (NEM) which is governed by Commonwealth, state and territory Ministers, and statutory agencies.

This initial phase of electricity industry reform began in the 1990s. At the outset of the 2020s, the context for investment has changed so much that a large shift in policy direction is required. The change in market conditions is this:

- Coal-fired power stations are approaching the end of their lives, creating a need for substantial investment in replacement infrastructure;
- Transmission networks lack adequate capacity to serve the best locations for renewable energy generators, so will quickly become congested as their output grows;
- The variability of wind and solar increases the need for complementary investment in storage and firming capacity;

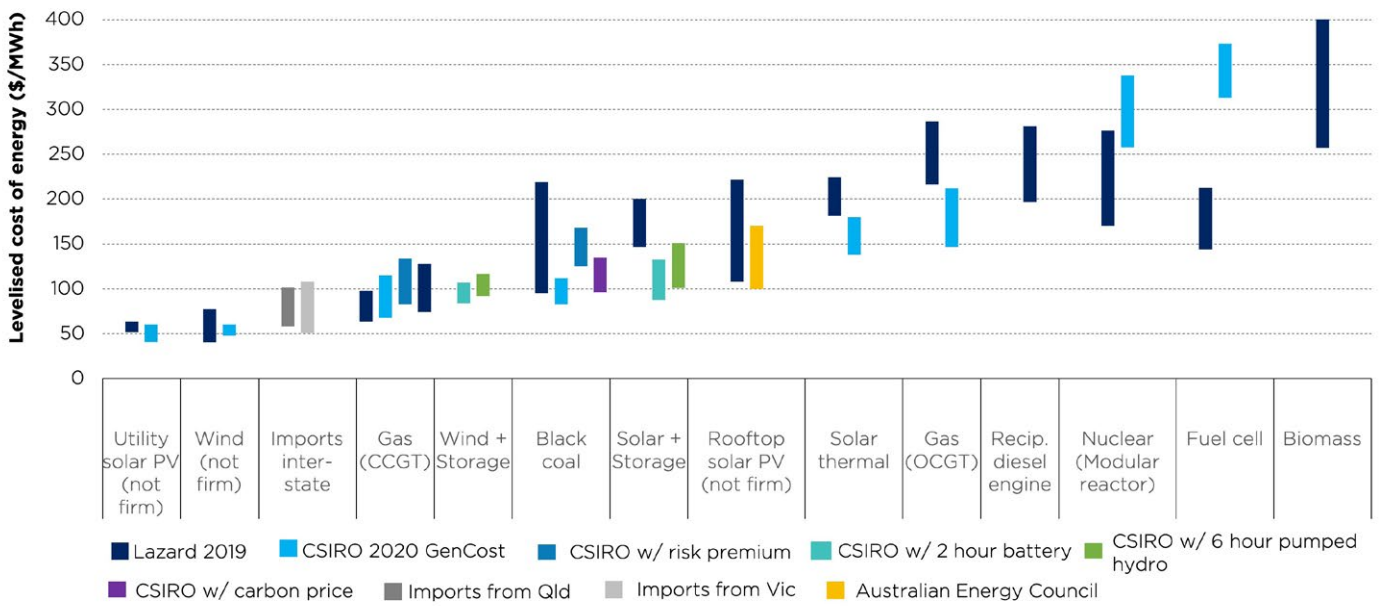
- Changing electricity infrastructure economics, with the least cost replacement infrastructure involving large levels of capital investment to produce electricity at very low marginal cost; and
- The growth in distributed technologies like rooftop solar which help customers manage their energy use and costs.

For these reasons, platforms and price signals are needed to ensure the best use of these technologies and to ensure that they are developed at the lowest cost for consumers.

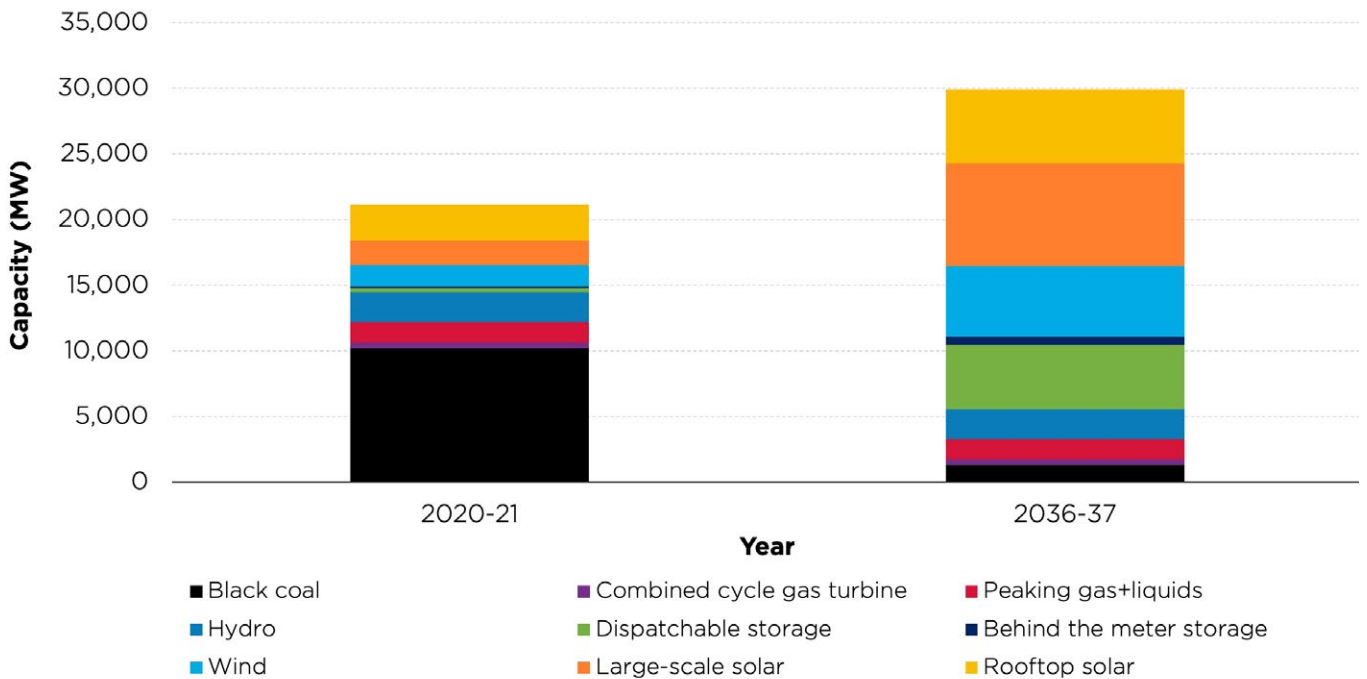
## NSW has the largest challenge and an attractive opportunity

NSW faces the largest challenge of all the NEM jurisdictions in managing the transition from its existing electricity sources. Four of NSW's five coal-fired power stations – supplying three-quarters of its electricity use and two-thirds of its peak demand – are scheduled to close between 2023 and 2035.

AEMO's 2020 Integrated System Plan concluded that firmed renewables are the lowest cost replacement of this generation (Figure 3). AEMO also forecasts that the proportion of renewables in NSW's energy mix in 2036-37 will be larger than in 2020-21 (Figure 4), which reflects the unprecedented investment in renewable generation, transmission and firming is needed to maintain a reliable, secure and affordable supply over this transition.



**Figure 3.** Levelised cost of energy replacement from generation technologies (Sources: CSIRO, Lazard, and Australian Energy Council).



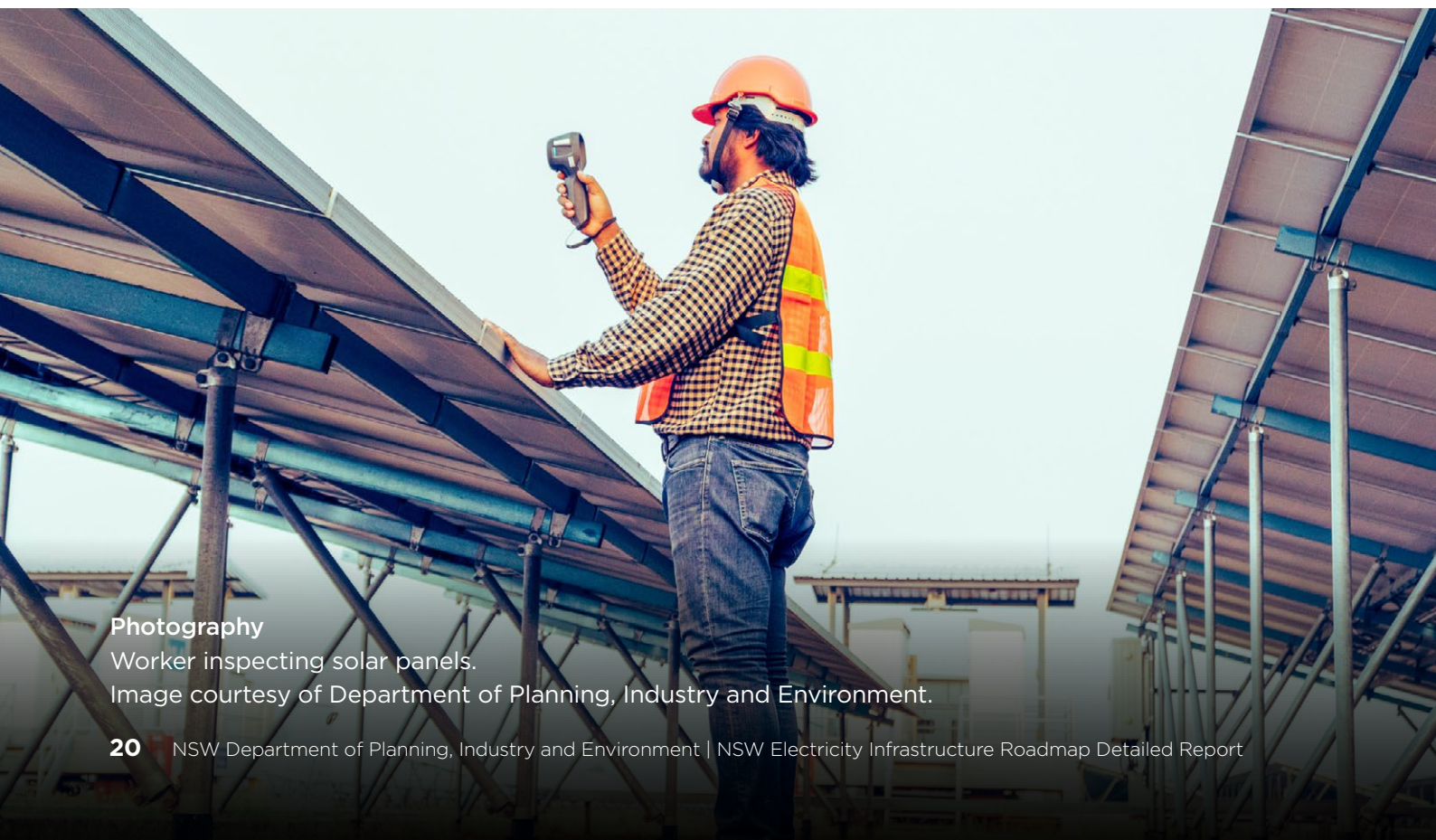
**Figure 4.** AEMO's forecast for NSW generation capacity.

Moving from coal to a firmed mix of wind and solar is a complex investment and coordination task. For example, to replace the Eraring power station's 2,880 MW of capacity will require in the order of 50 wind and solar developments, assuming an average capacity of 200 MW per project and an average capacity factor of 30 per cent. These developments will need to be supported by and coordinated with additional transmission and firming investments.

It would be both risky and a lost opportunity for NSW to rely on investment in interstate capacity to fill the supply gaps created by the scheduled closure of coal-fired generators. Increased reliance on imports would place the reliability of NSW's supply at risk of interconnector constraints and failures, and the state-based renewable energy targets of Victoria and Queensland are not being planned to meet NSW's demand as our coal-fired generators close.

The risks of interconnector constraints due to bushfires were highlighted during the 2019-20 bushfire season when significant bushfire activity caused the Victorian-NSW interconnector to trip. This caused NSW and Victoria to separate, which significantly impacted the amount of spare generation capacity available to NSW, having reduced that reserve amount by over 2,200 MW. This significant reduction of spare generation capacity meant NSW was at risk of system security issues.

Further, NSW has substantial wind, solar and pumped hydro resources, and their development will increase regional jobs and economic activity with an expected 6,300 construction jobs and 2,800 ongoing jobs on electricity infrastructure mostly in regional NSW in 2030. It will also provide a base for further development to produce low-carbon products and establish new manufacturing industries. This includes opportunities for green aluminium, which could deliver up to \$50 million in additional annual revenues and up to \$14 million in annual direct wages for every percentage point increase in industry output.



**Photography**

Worker inspecting solar panels.

Image courtesy of Department of Planning, Industry and Environment.

## Investment faces heightened risks

There is a number of regulations and government programs intended to support investment in new capacity. They include:

- **Current market mechanisms**, in particular the spot price of electricity (which is bounded by regulated cap and floor prices); marginal loss factors that discount generators' revenues by the losses incurred in supplying their output to customers; remuneration of frequency control ancillary services; reserve capacity mechanisms in the form of a Retailer Reliability Obligation and a Reliability and Emergency Reserve Trader scheme; the notice of closure requirement; the Regulatory investment test for transmission (RIT-T); and the 'Actionable Integrated System Plan (ISP)' measures;
- **Commonwealth funding** of the Underwriting New Generation Investments (UNGI) program, and specific investments (such as the Snowy 2.0 pumped hydro project and the potential gas power stations near Newcastle); and
- **Existing NSW programs** to strategically plan the development of the State's electricity system, provide bespoke access for new renewable generation in REZs, and the streamlining and case management of approvals of energy investments.

Despite the scale and scope of these investment drivers, they are insufficient to bring forward timely, coordinated and optimised investment required in NSW.

The primary reason for this is investment risk. Investment risk is driven by a number of risks:

- **Price risk:** currently, the primary price signal for investment in generation is the energy price. But it is difficult for generators to sell long term contracts for their energy, with the contract market dominated by contracts

for one to three years in the future. This is problematic for investors in new generation. Investors and lenders need to be confident of earning sufficient returns to justify their investment in a project. However, the assets they are investing in have 15 year (batteries) to 50 year life spans (pumped hydro).

The uncertainty of returns over the life of the assets means that investors are only willing to invest when short term prices are sufficiently high to justify the long term risk. This results in investment being delayed until there are periods of scarcity pricing; that is, periods when participants are able to bid up electricity prices due to tight supply and demand conditions.

- **Price volatility risk:** a form of price risk, which relates to the intraday price changes in the market. Intraday price volatility is important for storage: energy storage makes returns by storing electricity when it is cheap and releasing it when it is expensive. Price volatility is caused by higher penetrations of renewables – renewables are able to generate electricity at very low marginal cost and can therefore force prices down when renewable energy is abundant (e.g. when it is windy or sunny); and is dampened by higher penetration of storage – storage creates demand for electricity in low price periods, providing something of a price floor, and provides supply during high price periods, providing something of a price ceiling.

As noted above, energy contract periods are generally up to three years, meaning that investors in storage do not have long term certainty over intra-day price volatility. This means that they wait for the price spikes required to justify their investment before making the investment. As a consequence, since the lead time for certain types of storage (e.g. pumped hydro) is lengthy this means the system can remain unbalanced for lengthy periods.

- **Market access** presents a significant risk for renewable generation, because many of NSW's prospective renewable resources are located where grid capacity is low. Transmission upgrades to increase grid capacity require regulatory approval. Approval is based on forecasts of new generation that will connect to justify a transmission project. This creates a 'chicken and egg' problem for REZ: transmission projects will not be approved unless there is sufficient forecast generation in the REZ, and generation will not commit to build in the REZ unless there is approved transmission.
- **Policy risk** has risen due to the growing likelihood that policy settings and investment support will change periodically across the Commonwealth and states in response to shifts in public attitude and changes of government. Changes of policy in other NEM jurisdictions could also alter the projected supply-demand balance and impact on investment returns in NSW. Recent examples include decisions by Victoria and Queensland to set new renewable energy targets, and the Commonwealth's decision to fund Snowy 2.0 and potential to fund a new gas power station at Kurri Kurri.

- **Technology risk** is also high as new energy sources and storage technologies are developed across the world, resulting in ongoing cost declines and efficiency improvements.

These risks compound the impact of intrinsically high barriers to entry into a market dominated by a small number of vertically integrated 'gentailers' which have incentives to delay investment in new capacity to protect the value of their existing assets.

Consumers bear the price shocks which are a consequence of these risks but are not empowered to manage them.

Reform to coordinate timely investment in transmission, generation, firming and storage is needed to manage these risks on behalf of consumers. This will entail consumers sharing risks and rewards that would normally be borne by private investors. Without reform, wholesale electricity prices are forecast to more than double as power stations retire (see Figure 1).



**Photography**  
Tumut Hydroelectric Power Station, Snowy Mountains, NSW.

**5.**

**Why we  
need a  
Roadmap  
now**



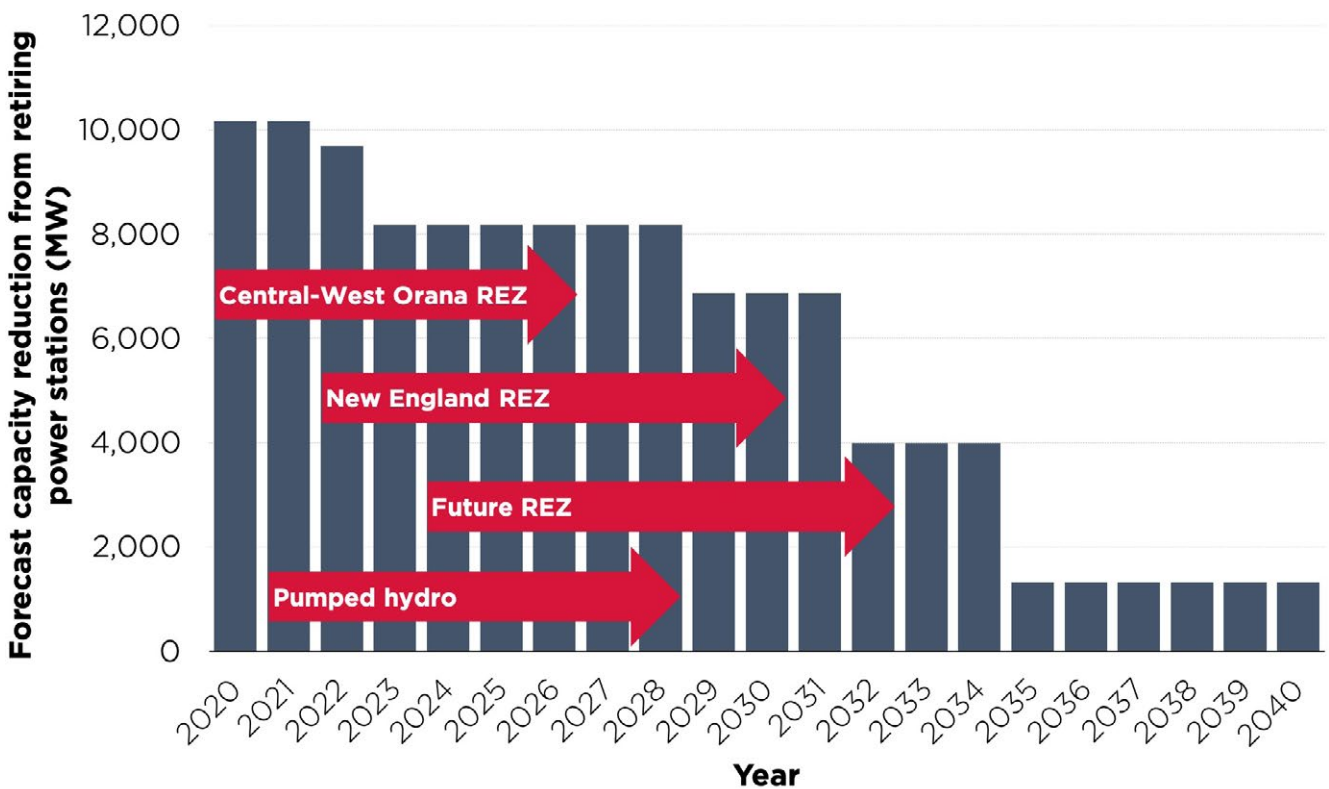
NSW's existing generation and transmission network took around 30 years to plan and build, but the majority of this infrastructure needs to be replaced in less than 15 years. The window to replace generation capacity could narrow further if power stations close early, especially given the growing risk of failure inherent as thermal plants age. This signifies the need for an unprecedented rate of investment in electricity infrastructure.

The coordinated build for each REZ can take up to ten years, and each pumped hydro project needs up to eight years to develop. The footprint of required new electricity infrastructure could be up to 11,000 km of transmission and over 2,000 km<sup>2</sup> of generation. Expecting replacement to come online 'just in time' would require developers to build 3,000 MW of generation and storage capacity each year from 2032 to 2036 and see NSW power imports increase from around 10 per cent to almost 30 per cent. For comparison, the private

sector's highest NSW installation rate is 830 MW in 2018 without new transmission. Replacement would still take eight years even with double this rate of investment.

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, leaving NSW consumers vulnerable to price spikes and electricity shortfalls.

Strategic planning and committed engagement through the Roadmap are also critical to ensuring new private sector-led investment. This will allow for new generation, transmission and storage to be built in a coordinated manner before power stations close over the next 15 years to avoid price spikes.



**Figure 5.** Example infrastructure lead times to replace aging power stations.

The Roadmap will drive integrated and coordinated investment in large-scale electricity infrastructure, specifically generation, transmission, and firming of variable renewable electricity to maintain an affordable, reliable and secure supply. Coordinated investment and strategic planning will also help establish social licence for projects, ensuring a whole-of-Roadmap approach to land use planning, community consultation and giving communities more certainty about location and timing. For the reasons given above, the current regulatory and policy settings will not achieve that goal. There are major gaps in investment drivers that the Roadmap will fill.

The cheapest prospective sources of generation are large-scale wind and solar farms located in NSW's Renewable Energy Zones. The State has committed to three REZs, in the Central-West Orana, New England, and South West regions of NSW to support an initial 12 GW of new transmission capacity by 2030, and even more over time. The development of wind and solar generation would be sized and timed to replace the progressive closure of coal-fired power stations. Timely investment in optimal mixes of renewable generation will be driven by the Electricity Infrastructure Investment Safeguard, under which Long Term Energy Services Agreements will be awarded through competitive processes.

The expansion of renewable generation must be accompanied with increased transmission capacity to bring these new, clean sources of power from REZs in inland NSW to demand centres that are predominantly located along the eastern, coastal regions of the State. The transmission grid that now serves the REZs is designed to supply modest levels of power in the opposite direction, from current generation centres to the regions in which the REZs are located. A REZ Transmission Development Scheme is proposed to ensure the timely provision of capacity to bring renewable power from REZs to market.

Power demand and supply must be balanced in real time to maintain a reliable and secure power system. Because renewable electricity generation and customer usage can both fluctuate rapidly, investment in complementary forms of capacity is needed.

For this reason, transmission upgrades will also be needed in different REZs and across state borders to allow wind and solar power to be shared across diversified weather systems, so that a surplus in one region can supply a deficit in another, with interstate interconnection upgrades identified in the AEMO's ISP.

Investment in large-scale storage and firming capacity will also be needed to balance the supply of variable renewable energy. This can include:

- **Long duration storage** of electricity is one type of firming, providing large amounts of reliable electricity on demand, by storing surplus of renewable electricity, and releasing it into the grid when demand exceeds supply. Currently, pumped hydro is the primary form of long duration storage; it is able to provide long injections of stored power (from hours to days). Hydrogen from the large-scale electrolysis of water has the long term potential to balance supply and demand over seasons, and to supply other uses such as fuel cell vehicles, industrial heat and export. In the future, long duration storage batteries may also become economic.
- **Short duration storage** such as batteries can provide rapid and short injections of power (up to a few hours) to stabilise the power system against rapid movements in the supply-demand balance.
- **Fast start gas-fired or bioenergy generation** can provide backup to renewable energy, transmission and storage because it is more independent of weather. Gas-fired generation also has the potential to be converted to zero-emissions hydrogen firing as this technology becomes economic.

These firming investments will be brought forward under Long Term Energy Services Agreements which will be awarded through Electricity Infrastructure Investment Safeguard competitive processes.

The development of a timely and optimal mix of generation, storage and firming to replace the existing fleet is the core purpose of the Roadmap and complements the development of REZ transmission capacity. This summary is elaborated in the following section.



**Photography**  
Gas-fired power station.

## Supporting long duration storage

The NSW Government will use the Electricity Infrastructure Investment Safeguard (outlined in the breakout box below) to develop long duration storage and firming capacity.

Long Term Energy Services Agreements for **Long Duration Storage** projects will likely be

structured to include a minimum availability payment (**Availability Payment**) for the contract term. Conditions will be prescribed in the procurement documentation that must be met for the Availability Payment to be made, including operating according to agreed procedures which maximise project revenue and therefore value to consumers.



**Photography**  
Lyell Dam, NSW.

## **Electricity Infrastructure Investment Safeguard**

The NSW Government will establish an Electricity Infrastructure Investment Safeguard (**Infrastructure Safeguard**) to drive investment in REZ generation, long duration storage and firming capacity. The Infrastructure Safeguard puts in place the regulatory settings to create a long term investment signal for electricity infrastructure.

Under the Infrastructure Safeguard, a Consumer Trustee will be appointed to run competitive process rounds to offer Long Term Energy Services Agreements for generation, long duration storage and firming.

Projects will access the NEM through transmission infrastructure developed under the Transmission Development Scheme described below.

Development pathways for generation, long duration storage, and firming will guide these competitive processes and ensure investment planning is integrated, to produce the lowest cost and high reliability for electricity consumers.

Technologies can participate in the competitive process that is appropriate for each energy service, with different types of contracts expected to be awarded to wind, solar, gas and storage projects. The firming pillar will be technology neutral.

Long Term Energy Services Agreements will be option contracts which give the project optional access to a competitively set minimum price for their energy service.

A dedicated Scheme Financial Vehicle will be the counterparty to the Long Term Energy Services Agreements. The Scheme Financial Vehicle will recover payments to projects

under these Long Term Energy Services Agreements by on-selling energy services or with funding contributions from distribution network businesses who will pass these costs on to consumers through network charges.

The Consumer Trustee will set out a development pathway for generation equivalent to the size of the Central-West Orana REZ, the New England REZ and about 1 GW of outstanding projects to be delivered within this decade, and as otherwise needed, to ensure system reliability and to minimise ten year average electricity prices. It will also set a development pathway for long duration storage for 2 GW within this decade (in addition to Snowy 2.0) and as otherwise needed to firm the system.

An additional firming development pathway may also be deployed if more firming is reasonably necessary to meet the NSW Energy Security Target and is in the public interest.

These principles will be given effect by the Consumer Trustee, which will set out a schedule of competitive process rounds until 2040 for Long Term Energy Services Agreements to deliver this infrastructure at lowest cost for consumers and aligned to the development of REZ transmission.

The Consumer Trustee will have discretion over the schedule for competitive process rounds if it considers doing so would be in the best interests of consumers and it is within the framework provided by the statute. For example, the Consumer Trustee could adjust scheduling to account for REZ transmission commissioning timeframes; decline to award contracts if prices are too high; or award more contracts in a competitive process round to capture the economies of scale presented by a project with a low bid price.

The Consumer Trustee will give market participants and new entrants advance notice of each competitive round which allows projects to undertake planning and feasibility work ahead of bidding, to drive competition.

Pumped hydro and compressed air storage projects require a specific set of geological and/or hydrological circumstances to be viable, so there are limited locations available, only some of which are located in a REZ.

Long Duration Storage projects located in a REZ will have advantages in minimising transmission connection costs and accessing the shared transmission network. However, to develop the best projects in the state, the Long Duration Storage program will be, subject to transmission constraints, location-neutral.

### Pumped hydro recoverable grants program

Pumped hydro projects can make a substantial contribution to NSW’s future electricity storage needs, but they require bespoke design, face long lead times and are capital intensive, which creates a high barrier to their development.

To improve competition for Long Term Energy Services Agreements for long duration storage projects, the NSW Government will hold an open tender of recoverable grants to establish a 3 GW pipeline of ‘shovel ready’ pumped hydro projects that can make competitive bids for Long Term

Energy Services Agreements. The grants will help meet the significant upfront costs of establishing the feasibility of potential projects.

The program would be implemented by extending the existing Emerging Energy Program. This will fund a second pre-investment study round with \$50 million of recoverable funding for pumped hydro projects.

AEMO’s Integrated System Plan finds that by the mid-2030s, NSW could need about 2.3 GW of storage with 4 to 12 hours of duration to maintain system reliability and security under most scenarios. This is in addition to the Commonwealth developing Snowy 2.0 (2 GW).

Pumped hydro projects face long lead times with costly development activities taking up to four years and procurement and construction taking another four years. Currently, if the Consumer Trustee calls a competitive process for long duration storage, pumped hydro projects may not be able to respond competitively in time.

Unlike the first round of the Emerging Energy Program, the Government would recover grants for pumped hydro when the project reaches financial close or development rights are sold. The program is well placed to accept and assess grant applications using existing processes and governance arrangements and will also draw on the industry and commercial expertise of an established assessment panel.

The key parameters of the recoverable grant program are:

Grant budget	Up to \$50 million
Target capacity	3 GW
Minimum capacity per project	30 MW
Minimum storage duration	8 hours (with preference for >12 hours)
Support type	Recoverable grant for feasibility study
Recipient contribution	Greater or equal to grant funding
Allocation process	Competitive funding round(s)

## Supporting firming capacity

Long Term Energy Services Agreements for **firming** projects are one way that a forecast shortfall of the Energy Security Target could be addressed. The Energy Security Target is a capacity target for firm rated plant and is set at the level of firm rated capacity needed to service NSW's electricity needs during a one in ten year peak demand period, with the largest two units of NSW's generators experiencing an outage.

Long Term Energy Services Agreements for firming projects may be entered into with eligible projects in line with a firming development pathway if:

- a material breach of the Energy Security Target is forecast within a period that, if a competitive process for firming Long Term Services Agreements is not held imminently, firming generation is unlikely to be able to be built in time to address that shortfall
- the Consumer Trustee considers that the breach of the Energy Security Target is unlikely to be addressed by other publicly announced private sector or Government projects or programs
- the Minister for Energy (Minister) is satisfied that the holding of a firming competitive process forms part of the best policy response to address the forecast shortfall
- the Minister is satisfied that holding the firming procurement competitive process is in the public interest.

Long Term Energy Services Agreements for firming are technology neutral. Projects would be eligible to bid for firming contracts if AEMO would register them as Scheduled Generators and they satisfy eligibility criteria similar to that required for Long Duration Storage Long Term Energy Services Agreements. Gas peaking plants would need to be hydrogen ready, which would mean that the plant is capable of running on hydrogen for a minimum proportion of its operating time each year.

Where they meet the eligibility criteria, bioenergy projects will be eligible for Long Term Energy Service Agreements.

## Supporting Renewable Energy Zone generation

The NSW Government has announced its priority REZs in the Central-West Orana, South West and New England regions of NSW. The Roadmap is designed to deliver these REZs. There will also be a process to work with and recognise privately coordinated proposals for new NSW REZs.

The Infrastructure Safeguard, together with the transmission reforms outlined below, will encourage new renewable generation – which is mainly expected to comprise of large-scale wind and solar power projects – to locate within a REZ. However, the Infrastructure Safeguard will retain the flexibility to support high quality renewable generation projects in other locations which dispatch into the NSW NEM region.

The following section explains how this will be done in more detail.

# Infrastructure Safeguard scheme – design details

## Competitive process

The Infrastructure Safeguard will have clear administrative arrangements for the competitive processes, including their frequency (e.g. up to twice-yearly), eligibility criteria (summarised below), merit criteria, and considerations for the Consumer Trustee in setting a ceiling price for acceptable bids.

### **Electricity Infrastructure Investment Safeguard: indicative eligibility criteria**

**New:** projects that are committed after the release of the NSW Electricity Strategy including (1) greenfield developments; and (2) site-extensions of existing projects that add capacity above the original nameplate capacity.

**Region:** projects that would be registered as scheduled or semi-scheduled in the NSW region of the NEM once developed.

**Duration:** for long duration storage, projects must be capable of dispatching their nameplate capacity for at least 8 hours.

**Financial and technical capability:** projects must be proposed by people with appropriate commercial and technical capabilities, including maintaining appropriate credit worthiness.

**Registration:** projects must be capable of participating in AEMO's central dispatch process and for REZ generation, projects must be capable of being registered under the *Renewable Energy (Electricity) Act 2000 (Cth)*.

**Other financial support:** projects must not be in receipt of financial support from prescribed programs (including the Commonwealth's Underwriting New Generation Investments program).

**Planning:** projects must have either received NSW planning approval or demonstrate a credible plan to obtain that approval.

**Other approvals:** projects must have received, or demonstrate a credible plan to receive, other appropriate regulatory approvals, including such relevant approvals that may be required under the *Competition and Consumer Act 2010 (Cth)* and the *Foreign Acquisitions and Takeovers Act 1975 (Cth)*.



From each competitive process, the Consumer Trustee would identify a portfolio of projects to be awarded Long Term Energy Services Agreements based on its individual and collective assessments of those projects. Those assessments would take into account the results of previous rounds, and updated modelling of future demand and supply needs.

Long Term Energy Services Agreements will include incentives for proponents to progress their projects swiftly. Contracts may be terminated if milestone dates are missed, with a replacement contract awarded to the next ranked bidder. The Consumer Trustee can require bid bonds, which would be forfeited if construction is not commenced as agreed, or liquidated damages clauses included to recover the cost of negotiating with a new counterparty for a replacement contract.

### **Electricity Infrastructure Investment Safeguard: indicative merit criteria**

**Eligibility criteria:** projects must meet the minimum standards set out in the eligibility criteria.

**Value:** competitiveness of the bid taking into account the strike price, contract term, prospective offtake agreements with third parties, and market competitiveness of the project and the expected time to financial close and commercial operations.

**System requirements:** impact/contribution of the project to the reliability, security and operation of the NSW electricity system.

**Connection:** projects must have a credible pathway developed to obtain a connection agreement from the relevant network service provider and meet the relevant Generator Performance Standards.

**Location:** for REZ generation, projects would be given a higher merit assessment if they are located in a REZ.

**Social impacts:** the level of community support for the project, including evidence of community engagement and strategies to minimise adverse social impacts and maximise community co-benefits.

**Local economic benefits:** the level of local economic activity supported by the project, for example the number of in situ jobs supported by the project and the proportion of project costs offered to local contractors and any other local, State or onshore Australian economic benefits.

**Compatibility with farming:** assessed having regard to the land on which the projects are proposed and the design of the infrastructure, such as whether it is compatible with grazing.

**Financing arrangements:** projects must have a credible pathway to secure debt and equity funding.

**Expertise:** capacity of key people to deliver the project, engage constructively with the Government, coordinating bodies and the relevant communities and operate the project in accordance with industry best practice.

## Contract provisions

The terms and conditions in Long Term Energy Services Agreements will be decided by the Consumer Trustee in accordance with the scheme's regulatory framework. Different contract structures will be defined for the different infrastructure types to achieve the goals of:

- preserving existing NEM price signals to encourage investment in projects which are located in the right places and generate at the right times;
- conforming with industry standards where possible so Long Term Energy Services Agreements can be on-sold, to help hedge cash flows (to fix costs to consumers in advance) and improve liquidity in the futures market (so small energy retailers can hedge market price risk);
- having sufficient flexibility to deal with change in market design so that consumers only pay once; and
- allocating risks to those best able to manage these risks.

For example, generation projects could be supported by swaption contracts—swap contracts with put options (i.e. an option for the generator to exercise where it would pay the scheme any revenue it receives from the wholesale electricity market when spot prices are above an agreed level in return for being paid for the times when spot prices are below the agreed level) to remove price risk, with bidders nominating a volume to receive the fixed price.

## Management of financial risk

Once Long Term Energy Services Agreements have been awarded, the Consumer Trustee will actively hedge the resultant financial risks of the Scheme Financial Vehicle. For example, contracts could be entered into with energy retailers or other parties on terms that are comparable to those in the Long Term Energy Services Agreements. However, such back-to-back contracts may be sold at lower prices and/or shorter terms.

The management of this risk will be complex and requires the detailed further development of management strategies, which may also include:

- signing contracts with existing generators to enable selling firmed contracts into the contract market;
- signing power purchase agreements with companies based in NSW, which would also increase liquidity in the contract market and help companies to reduce their carbon footprint;
- signing “over the counter” (OTC) swaps with wholesale market counterparties including electricity retailers, which could give new entrant and second tier retailers access to wholesale renewable energy; and
- selling exchange-based products (e.g. ASX futures), which would improve the liquidity of the futures market.

The scope for competition to reduce the risk transferred to consumers through the Long Term Energy Services Agreements will also be explored. For example, the competitive process merit criteria will favour projects which can demonstrate offtake agreements with energy retailers and third parties as this would reduce the chance they put their option under the Long Term Energy Services Agreement.

## Development will be staged, adaptive and competitive

Infrastructure will be developed in a staged and adaptive process, including under the oversight of an independent and expert Consumer Trustee. The timing of the competitive tenders will be re-assessed periodically against relevant factors such as the investment, price, and reliability levels achieved and projected, and changes in the NEM rules that impact on investment incentives.

Evidence from markets in which support for new generation is competitively allocated is that major reductions in generation costs can result, as supply chains are established and learning curves are traversed. The large reduction in offshore wind costs in the United Kingdom (UK) is a frequently cited example, where falling costs have led the UK Government to lower forecasts of offshore wind costs in 2025 by 47 per cent compared to forecasts made in 2016.

## Cost recovery

The Consumer Trustee acts on behalf on consumers to create a long term contract investment market. The scheme will recover the net cost of the Infrastructure Safeguard with contributions from distribution network businesses, which would then pass the cost onto retailers and consumers, similarly to how energy prices and network costs are currently passed onto consumers.

The Financial Trustee would, subject to oversight from the Independent Regulator, identify the net cost of the scheme. That cost would be apportioned amongst distribution businesses. Some customer loads could be exempt from payment, including trade-exposed entities.

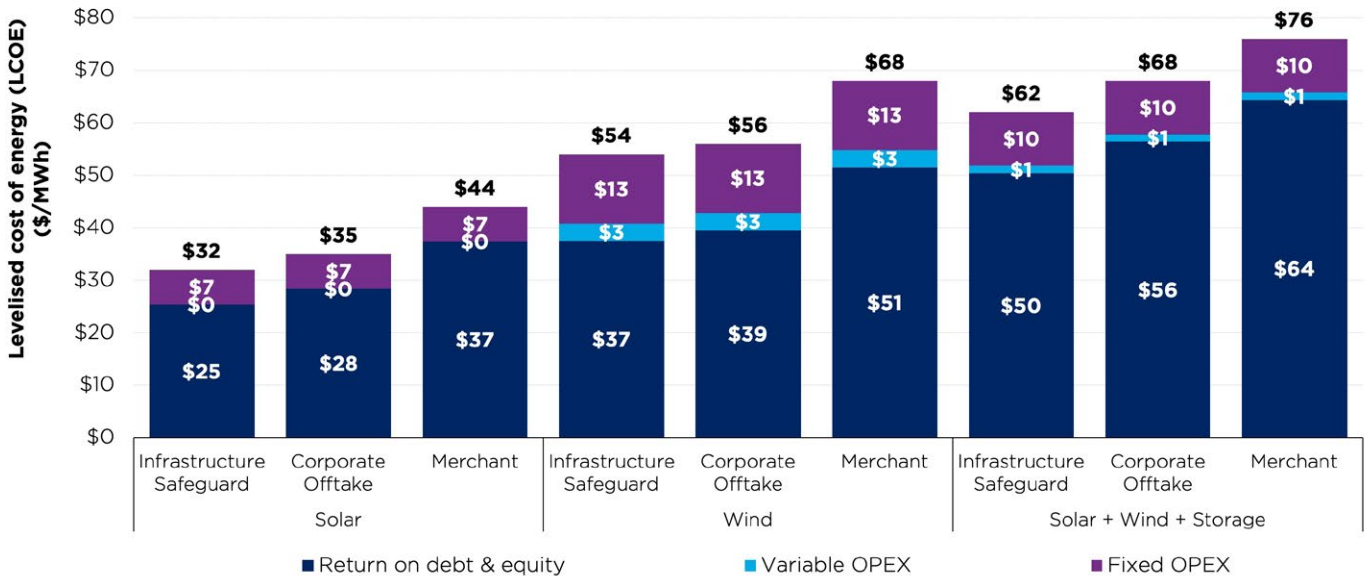
Benefit-sharing provisions will be included in the Long Term Energy Services Agreements. These will provide for profits above a threshold to be returned to the Scheme Financial Vehicle, to repay payments that have previously been made. Benefit-sharing payments will reduce the amount to be recovered from consumers through distribution businesses.

## The Infrastructure Safeguard reduces the cost of development

As designed, the Infrastructure Safeguard will provide long term certainty for investors and lower the cost of capital. An optimised portfolio of capital-intensive infrastructure with zero fuel costs and low operating costs (e.g. solar, wind and pumped hydro) will further reduce the cost of capital. The electricity price investors need to invest in 2023 is expected to be around 20 per cent lower if they have a Long Term Energy Services Agreement. The Infrastructure Safeguard will allow important factors such as location and community support to be factored into the decision criteria, thus contributing to the NSW Government's wider policy goals.

Modelling shows that projects with Long Term Energy Services Agreements will have reduced costs compared to those taking merchant risk.

Advice from NAB concludes that the scheme is expected to lower weighted average cost of capital by 0.64 to 1.30 per cent for new generation projects hence a lower wholesale cost of electricity and substantial economic growth for NSW.



**Figure 6.**

Estimated impact on the Levelised Cost of Energy (LCOEs) of solar, wind, and storage (based on forecast capital costs in 2029).<sup>6</sup>

6. These estimates 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 how it protects the long term interests of consumers.

## The Infrastructure Safeguard puts consumers first

As observed above, the Infrastructure Safeguard reduces the cost of developing future electricity infrastructure by reducing the risk of projects and the returns investors require of them. It does this in a number of ways:

- 1. Reducing scarcity pricing:** the Infrastructure Safeguard ensures that new plant is built before old generation retires. This means that, when old generation closes, there is more supply, limiting the number and size of high price periods caused by tight supply and demand conditions.
- 2. Ensuring a reliable electricity system:** ensuring that new plant is built before old plant closes ensures that the system has sufficient capacity to keep the lights on during periods of high electricity demand.
- 3. Driving down bid prices:** the scheme is designed to ensure that bid prices are as low as possible. This includes by fostering competition to allow outstanding projects to compete with REZ projects, and for the opening of private led REZs. It also includes using a hidden bid cap, to encourage lower energy bids. Further, because Long Term Energy Services Agreements are option contracts, the bid prices reflect minimum returns for properly maintained and operated plant. This means that investors are willing to bid lower prices.
- 4. Using an option contract structure:** also means that consumers are only at risk of making payments under the Infrastructure Safeguard if projects put their option contracts. Projects are incentivised to only put their options if prices are low.
- 5. Contributions from distribution businesses will only be made if prices are low:** if projects do put their options, the contribution is only charged if energy prices fall below the prices projects bid. If prices are higher than a project's bid price, the project pays consumers. And because the Infrastructure Safeguard reduces the risk for investors, bid prices are going to be lower than the energy price investors would have needed

to see to invest without this reform. In other words, consumers only make payments under the Infrastructure Safeguard if they are already ahead.

- 6. Benefit-sharing:** the Long Term Energy Services Agreements include benefit sharing provisions so that if generation, storage and firming projects receive payments, but then in future years make excess profits, they are required to pay back previous payments.
- 7. Independence:** an independent Consumer Trustee will plan how to meet the development pathways in the best interests of consumers, including coordinating investments across transmission, generation, firming and storage.

## The Infrastructure Safeguard supports regional communities

The Infrastructure Safeguard will support regional communities in which the projects are developed. Not only will it drive substantial investment into regional NSW, the Long Term Energy Services Agreements and merit criteria will also encourage:

1. locals to be employed to support long term employment in our regions;
2. projects to be designed in a way that is compatible with existing agricultural production on the land where the generation is installed. For example, this could include ensuring that solar farms do not stop sheep grazing on the land;
3. local economic activity projects to stimulate local economic activity by prioritising local content and jobs; and
4. projects to locate in areas which are supported by local communities.

Additionally, the infrastructure supported by the Infrastructure Safeguard will drive investment into regional NSW. Landholders who host this infrastructure will receive lease payments for doing so. The lease payments for new generation under the Roadmap are forecast to equate to \$1.5 billion in nominal terms up to 2042. They will also continue after that date. This additional income for landholders will help farmers supplement their income and drought proof their businesses.

## 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 Renewable Energy Zones in 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 realise 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 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 significant community opposition.

### Why a contracting approach?

Early Federal and state renewable energy targets were certificate schemes, but certificate schemes are less conducive to optimisation against multiple criteria, rather than the cost of energy alone.

The International Renewable Energy Agency (IRENA)'s *Renewable Energy Auctions: Status and Trends Beyond Price (2019)* identified a number of benefits of auctions including:

- strong opportunity for **price discovery** and a track record of achieving low prices for solar and wind power;
- **flexibility in design** which allows tailoring to country-specific conditions;
- scope for inclusion of auction **objectives beyond price** to also consider economic, social and environmental factors; and
- a high proportion of contracted projects **progress to commercial operation**, although delays are commonly experienced.

Despite the growing prevalence of auctions, there are challenges in designing and implementing them which can be addressed by:

- **Removal of contracting capacity** – contract schemes remove tradable contract volumes from the market, which reduces liquidity and makes purchasing wholesale electricity more challenging for market participants, unless schemes trade contract capacity back into the market, which is planned in the NSW Infrastructure Safeguard. In addition, by using option contracts, projects continue to have an incentive to enter into contracts which offer better returns in the market.
- **Response to spot price signals** – long term contracts can make projects agnostic to wholesale price signals by transferring too much price risk to the buyer. Generators which are not incentivised to reduce output when spot prices are negative will continue to produce electricity, which can destabilise markets and reduce system security. This has been seen in South Australia (involving wind projects supported by contracts with the ACT Government) and Queensland (involving solar projects supported by contracts with that State's government). Option contracts will incentivise projects to build and operate plant which is able to earn strong returns commercially, without having to put their option. The Consumer Trustee will be tasked to develop Long Term Energy Services Agreement structures which mitigate or remove these effects according to principles set. One way this can be done is by requiring generators to identify when they produce electricity and making them accountable for generating at those times, which is what is proposed under the Infrastructure Safeguard.
- **Quality of project selection** – governments may make flawed decisions on which projects to contract with, resulting in higher consumer costs. The Infrastructure Safeguard addresses this risk by allocating that task to an independent Consumer Trustee acting under clear rules and transparency requirements.

In summary, the Infrastructure Safeguard will be a mechanism which has benefits in coordination, community acceptability and cost of capital. It is flexible in allowing the Consumer Trustee to adapt the competitive process over time within the legislative framework.

## Delivering Renewable Energy Zone transmission

A key to NSW's transition from its existing electricity supply is to strengthen the electricity export capacity of the State's REZs to its load centres, by augmenting the shared transmission network.

The State will do this by making targeted reforms to the regulatory approval and cost recovery frameworks for REZ transmission, including the Regulatory Investment Test for Transmission (RIT-T), enabling the timely delivery of the REZ shared network. Transmission system operators must receive regulatory approval before they proceed with scale-efficient transmission upgrades. Approval is based on forecasts of new generation that will connect to justify a transmission project. This creates a 'chicken and egg' problem for REZ: transmission projects will not be approved unless there is sufficient forecast generation in the REZ, and generation will not commit to build in the REZ unless there is approved transmission.

Although Scale Efficient Network Extension reforms were made to remove this problem, they have not been sufficient because all risk of under-utilisation of approved augmentations is left with the transmission company.

The Roadmap reforms will establish a bespoke NSW regime, similar to the RIT-T and National Electricity Rules cost recovery provisions for REZ transmission projects, to allow scale-efficient transmission investments to proceed. To do this, a Transmission Efficiency Test ('the test') will be introduced.

The overarching purpose of the test is to determine the prudent and reasonable cost of building and operating that REZ transmission line or upgrade, and protect consumers from paying more than necessary for its development, while creating incentives for the line to be built in a timely way and at an efficient scale.

The test would involve multiple stages and robust analysis to ensure that the investment is justified, and recovery of its costs is warranted. The NSW Government would make a **declaration** that a proposed transmission line is a 'declared REZ'. The test would involve making a declaration that a proposed transmission line is a 'declared REZ transmission line.' The Independent Regulator would then be required to conduct a comprehensive **assessment** to inform a **determination** of the prudent and reasonable costs that can be recovered. The transmission company would then be required to develop the project and would be entitled to the level of **cost recovery** determined by the Independent Regulator.

As generators and storage projects connect to the shared network through a declared REZ, they would pay an ongoing access fee. The new regulatory arrangements for REZ transmission would also facilitate the transmission company accessing low cost financing for new transmission development, if needed.

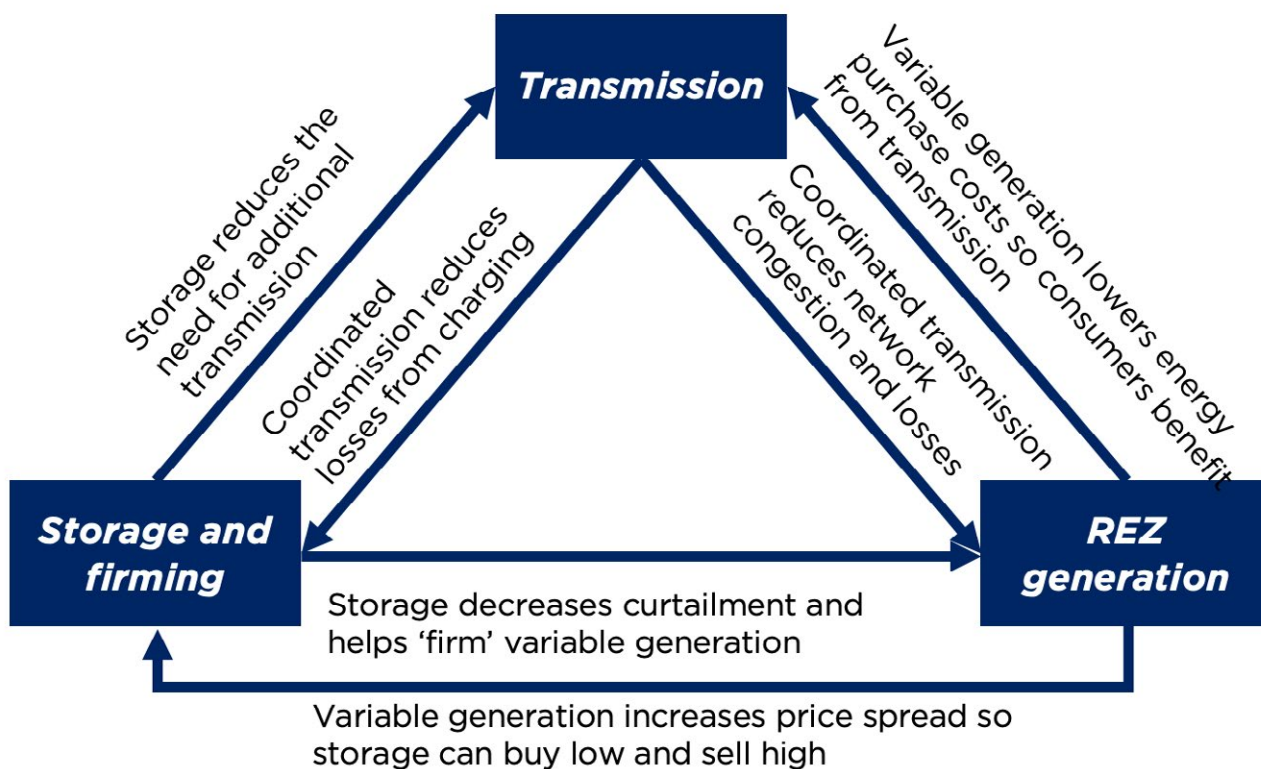
Transmission route design will be led by the Energy Corporation of NSW, which will be tasked with developing route options which open up the best renewable energy and storage resources, and are most supported by the local community.



**Photography**  
Hume Dam, NSW. Image courtesy of WaterNSW.

## Integrated ‘whole of system’ approach

The individual programs described above and shown in the diagram below are crucial to the achievement of the Roadmap’s objectives. However, their benefits will be maximised if their delivery is done through an integrated, ‘whole-of-system’ approach. This will ensure that the capacity, location and timing of transmission, generation and firming projects are harmonised to maximise the affordability, reliability and security of NSW’s electricity supply, and economic and social benefits to regional communities.

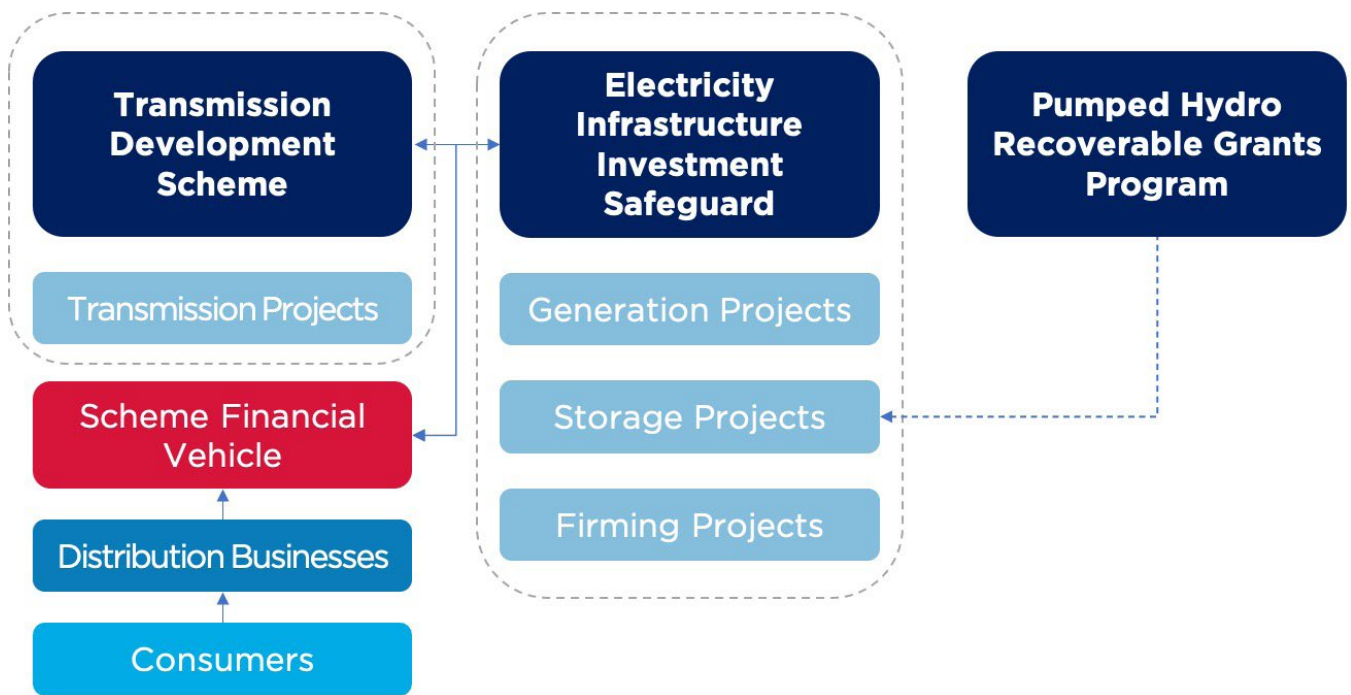


**Figure 7.** The need for an integrated ‘whole-of-system’ approach.

The Roadmap coordinates investment in REZ generation, transmission and firming storage.

- Without timely generation investment, developing storage and transmission will increase reliability and avoid peak prices, but will not lower prices for consumers. Wholesale prices would be around \$15 per MWh higher on average to 2040.
- Without timely storage investment, there would be 2.3 GW less firming capacity to support system reliability and excess generation will be lost and not stored for later use. Modelling for the government indicates that around 5 per cent of output from the REZ would be curtailed without storage investment. In addition, it would mean that NSW would be unlikely to satisfy its Energy Security Target over the long term.
- Without timely transmission investment, storage will be less financially viable and new generation investment will be constrained. For example, current loss for generators in the New England region mean generators get paid 16 per cent less for their output than the NSW regional reference price, which significantly discourages generation investment in the region.





**Figure 8.** Overview of Roadmap actions and key relationships.

Integration would be achieved by offering contracts for firming REZ generation, long duration storage and firming in each Infrastructure Safeguard competitive round, in pursuit of development pathways that are aligned to achieve optimal pricing and reliability outcomes. The declaration of each REZ would also be timed to match and support the firming REZ

generation development pathway, to maximise connections to each REZ. While the primary focus of the Roadmap is on developing the three NSW Government REZs, ‘outstanding’ projects outside the REZs and other private-led REZs with substantial public benefit may be supported to improve competition for agreements.

# Appendix

# Market Modelling of the Electricity Infrastructure Investment Safeguard

## Introduction

This appendix provides a summary of the National Electricity Market (NEM) modelling (approach and results) for the Electricity Infrastructure Roadmap by the firm Aurora Energy Research on behalf of the Department of Planning, Industry and Environment.

## Modelling approach

Aurora Energy Research (AER) used its proprietary AER-NEM model for this analysis. This model solves for wholesale and Frequency Control Ancillary Service (FCAS) market outcomes at 30-minute intervals. For calculation of wholesale market prices, the features of the NEM were assumed to be consistent with current market design configurations (i.e. a gross pool energy only market across five regions with separate markets for ancillary services).

The model optimisation ensures that each marginal entrant in each region of the NEM generates a specified return on capital subject to their asset-specific costs, generation volume and shape, captured wholesale prices, FCAS prices, region-specific Marginal Loss Factors (MLFs), and various grid constraints.

The Aurora modelling projected the new and replacement generation and storage capacity required to meet the NSW Energy Security Target. This approach not only considered the costs of introducing replacement capacity but also the revenues that the projects would receive should they proceed.

The AER-NEM model also uses forecast wholesale prices, based on the underlying capacity mix, to calculate strike prices for Long Term Energy Service agreements by entry year for generation assets (wind and solar) by each NSW REZ and for long duration storage assets. The calculated strike prices are subject to the swap structures and level of supply required under the Electricity Infrastructure Investment Safeguard Development

Pathways, as well as asset costs, merchant revenue tails, marginal loss factors and economic curtailment (generators choosing not to dispatch because wholesale prices are too low).

Most of the modelling inputs were based on the AEMO 2020 Integrated System Plan (ISP) Draft Central Scenario assumptions. These inputs are summarised as follows:

- operational demand (with an adjustment for the recent extension of the NSW Energy Savings Scheme to 2050)
- rooftop solar penetration
- behind-the-meter battery penetration
- electric vehicle penetration
- technology cost assumptions (using the updated May 2020 CSIRO/AEMO GenCost updates)
- technology operating parameters
- Renewable Energy Zone (REZ) level load factors for solar and wind.

In addition, interconnector upgrades to QNI (Queensland-NSW Interconnector) and VNI (Victoria-NSW Interconnector), Project Energy Connect (South Australia to NSW), and VNI West projects all proceed in line with AEMO 2020 ISP Draft Central Scenario timings. Humelink is assumed to be delivered in line with the Snowy Hydro 2.0 project.

In some cases the modelling selectively deviated from AEMO 2020 ISP Draft Central Scenario inputs. These exceptions are described below.

## REZ network infrastructure

Where higher levels of renewable penetration were required to meet the Infrastructure Safeguard Development Pathway, the REZ build limits were increased and additional transmission costs were included in the retail bill impact analysis. Assumptions were also made on future MLFs (Marginal Loss Factors) so that as more generation builds in a REZ, the MLFs in that region decline in line with AEMO guidance. In New England and Central West Orana REZs, it has been assumed that the additional transmission infrastructure will lead to more robust MLFs in those REZs.

## Commodity prices

AEMO's commodity assumptions were updated to reflect short-term reductions in commodity prices, particularly gas, that have been driven, at least in part, by COVID-19, as well as global gas over-supply. After the initial reductions to reflect lower commodity prices, the modelling assumes that commodity prices recover and are consistent with the long-term view of AEMO (for gas, \$10-13 per gigajoule by the mid-to-late 2020s in real 2020 terms).

## Weighted Average Cost of Capital (WACC)

The modelling used different WACCs for new generation and storage projects that reflect the risk profile of the investor. These are shown in the figure below. Projects that are part of the Infrastructure Safeguard achieve lower WACCs than projects that are either not eligible for the program or participant in the market on an uncontacted "merchant" basis. The table below summarises the WACC assumptions used by Aurora Energy Research.

## Snowy 2.0

Snowy Hydro 2.0 will begin delivering power from the beginning of 2026-27 to 2028-29 as the full 2 GW of capacity is ramped up over time.

## Energy Efficiency

Demand reductions from the NSW Energy Savings Scheme (ESS) have been factored into demand across all the modelled scenarios. The NSW Electricity Strategy announced that the NSW Government will extend the NSW ESS to 2050, with targets increasing gradually to 13 per cent by 2030. The Infrastructure Safeguard modelling also includes the impact of NSW's Peak Demand Reduction Scheme. The projected reductions to peak demand in NSW have been calculated by the professional services firm Common Capital.

Assumptions	Wholesale revenues	Safeguard revenues (wind)	Safeguard revenues (solar)	Safeguard revenues (storage)
Nominal risk free rate	2.5%	2.5%	2.5%	2.5%
Inflation	2.4%	2.4%	2.4%	2.4%
Debt margin	0.5%	0.3%	0.2%	0.4%
Market risk premium	9.5%	6.0%	5.5%	7.5%
Debt funding	55.0%	65.0%	68.0%	65.0%
Equity funding	45.0%	35.0%	33.0%	35.0%
Gamma	0	0	0	0
Corporate tax rate	30.0%	30.0%	30.0%	30.0%
Equity beta	1	1	1	1
Cost of equity (nominal post-tax)	12.0%	8.5%	8.0%	10.0%
Cost of equity (real post-tax)	9.4%	6.0%	5.5%	7.4%
Cost of debt (nominal pre-tax)	3.0%	2.8%	2.7%	2.9%
Cost of debt (real pre-tax)	0.6%	0.3%	0.3%	0.4%
Post-tax real WACC	4.5%	2.3%	2.0%	2.9%
Pre-tax nominal WACC	9.4%	6.0%	5.5%	6.9%
Pre-tax real WACC	6.8%	3.6%	3.1%	4.4%

**Table 1.**

Weighted-average cost of capital assumptions by technology and program.

## Business as usual scenarios

Aurora Energy Research modelled two potential business-as-usual counterfactuals to act as a baseline from which to assess the outcomes of the Infrastructure Safeguard. In effect, these are two potential futures for the NSW electricity market without the Infrastructure Safeguard.

The BAU **Perfect Foresight Scenario** assumes that participants (including generation and transmission businesses) in the NEM can accurately forecast future NEM outcomes and respond in advance to deliver an orderly transition from coal to other forms of generation and storage. For example, major coal plants exit at the times they have communicated to AEMO and a mixture of generation and storage technologies replace that coal capacity in a timely way such that each new entrant recovers their costs and their cost of capital. This approach assumes that a wholesale-only market structure can consistently deliver firm supply and close to least aggregate cost outcomes.

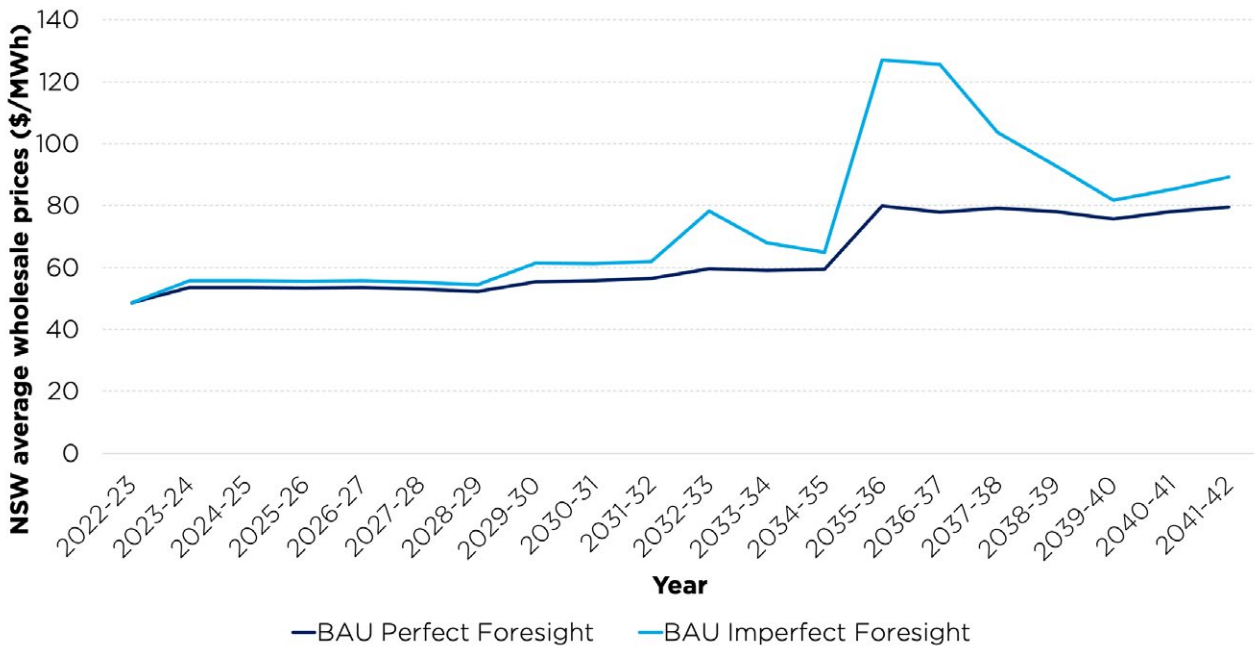
The BAU **Imperfect Foresight Scenario** assumes that market participants (including generation and transmission businesses) are slow to respond to events in the NEM and respond reactively to price signals, rather than accurately forecasting them. For example, as power stations retire, delivery of replacement generation will be delayed until an extended period of high prices has been observed.

To create this scenario, the modelling projected a generation mix where new capacity is only allowed to build in response to higher prices 1-3 years after power stations exit. This creates more volatile wholesale prices and lumpier investment cycles, ultimately driving up consumer costs. It assumes that wholesale-only markets may not deliver lowest cost outcomes for consumers as the NEM navigates a complex decarbonisation transition over the next 20 years.

The Department has adopted the BAU Imperfect Foresight Scenario as the baseline for the purposes of assessing the benefits of the Electricity Infrastructure Roadmap. The Department's view is this scenario more accurately reflects current market settings and historical observations of investment.

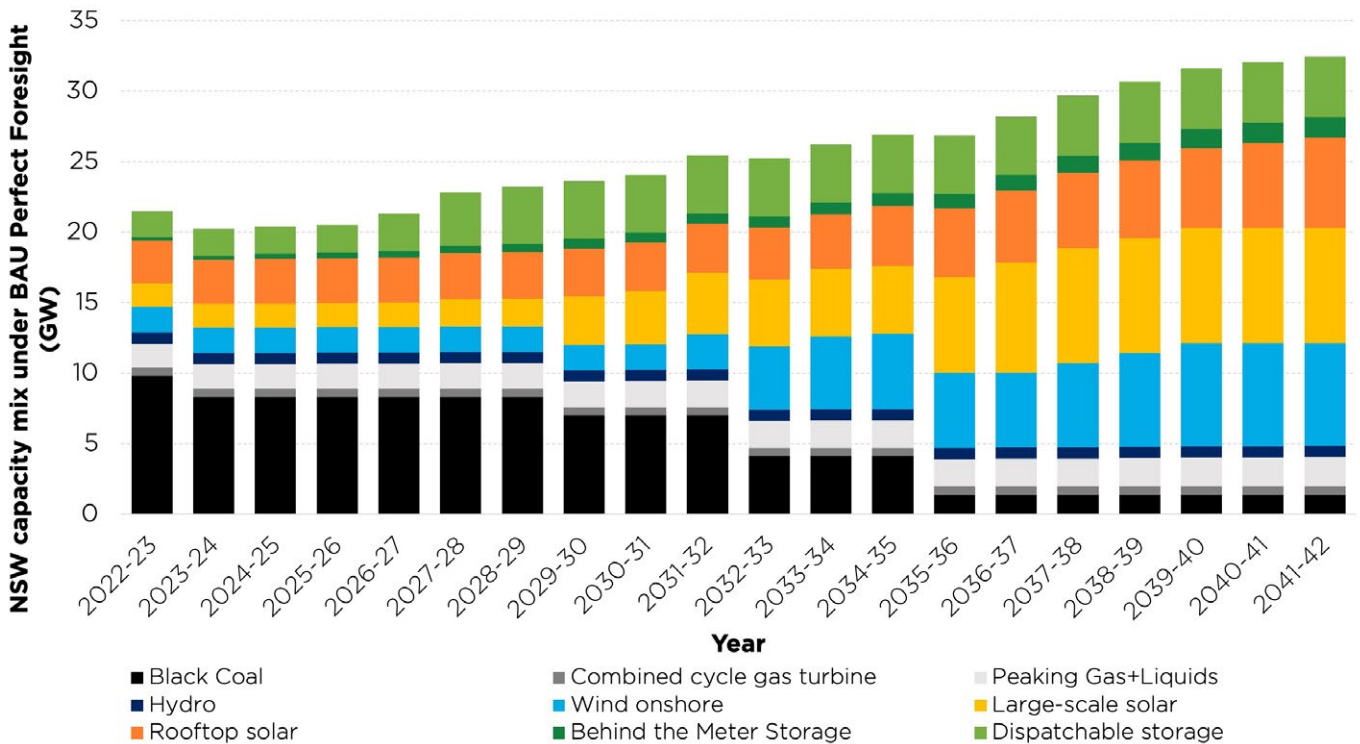
The BAU Perfect and Imperfect Foresight Scenarios both include the expanded NSW ESS. The NSW Electricity Strategy announced that NSW Government will extend the ESS to 2050, with targets increasing gradually to 13 per cent by 2030. The NSW Government will set scheme targets initially to 2030, with targets for the years beyond 2030 to be set later but assumed to be held at 13% for modelling purposes. The Peak Demand Reduction Scheme was not included within the BAU scenarios.

The BAU Imperfect Foresight Scenario leads to significant increases in wholesale market prices and inter-year wholesale price volatility in NSW over the entire forecast period to 2040 when compared to the BAU Perfect Foresight Scenario. The BAU Imperfect Foresight Scenario assumes that the NSW market responds to shifts in supply mix and tighter capacity margins in line with the last 5-6 years of observed market behaviour. This is similar to the responses observed after the closures of Northern in South Australia and Hazelwood in Victoria.



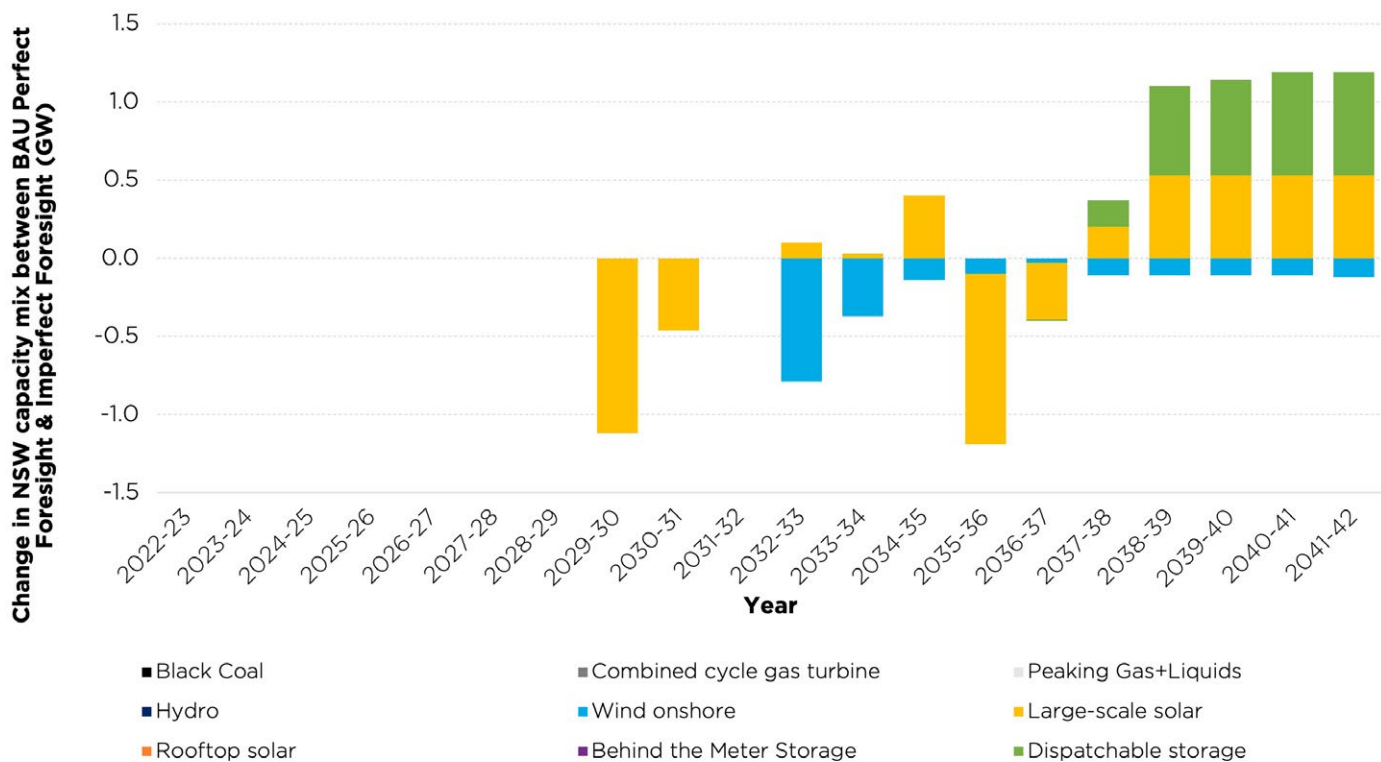
**Figure 9.** Business as Usual NSW time-weighted average wholesale electricity prices.

The total forecast capacity mix under the BAU Perfect Foresight Scenario is captured in the below figure and represents a close-to-optimal transition under the modelling given existing technology grid, policy, and regulatory configurations.



**Figure 10.** NSW capacity mix under the BAU Perfect Foresight Scenario.

Whilst the capacity mix under these two scenarios are similar at the end of the forecast horizon, investment cycles tend to be less smooth and more cyclical under the BAU Imperfect Foresight Scenario.



**Figure 11.** Change in the NSW capacity mix between the BAU Perfect Foresight & Imperfect Foresight Scenarios.

Aurora Energy Research found neither of these BAU scenarios would deliver the firm supply required to meet the NSW Energy Security Target. This is not unexpected given the NEM reliability settings are designed around a less stringent reliability measure. Wholesale-only markets may not reach the NSW Energy Security Target after the pre-existing capacity overhang has retired.

The Infrastructure Safeguard has been designed to meet the NSW Energy Security Target. The Infrastructure Safeguard is therefore modelled to deliver a materially higher level of reliability for consumers than the BAU scenarios.

## Electricity Infrastructure Investment Safeguard scenario

The Infrastructure Safeguard scenario uses similar modelling assumptions to the BAU Perfect Foresight outlook, except that it introduces new generation and storage capacity in NSW in line with the objectives of the Infrastructure Safeguard. The only other difference between the scenarios is that the Infrastructure Safeguard scenario also includes the NSW Government's

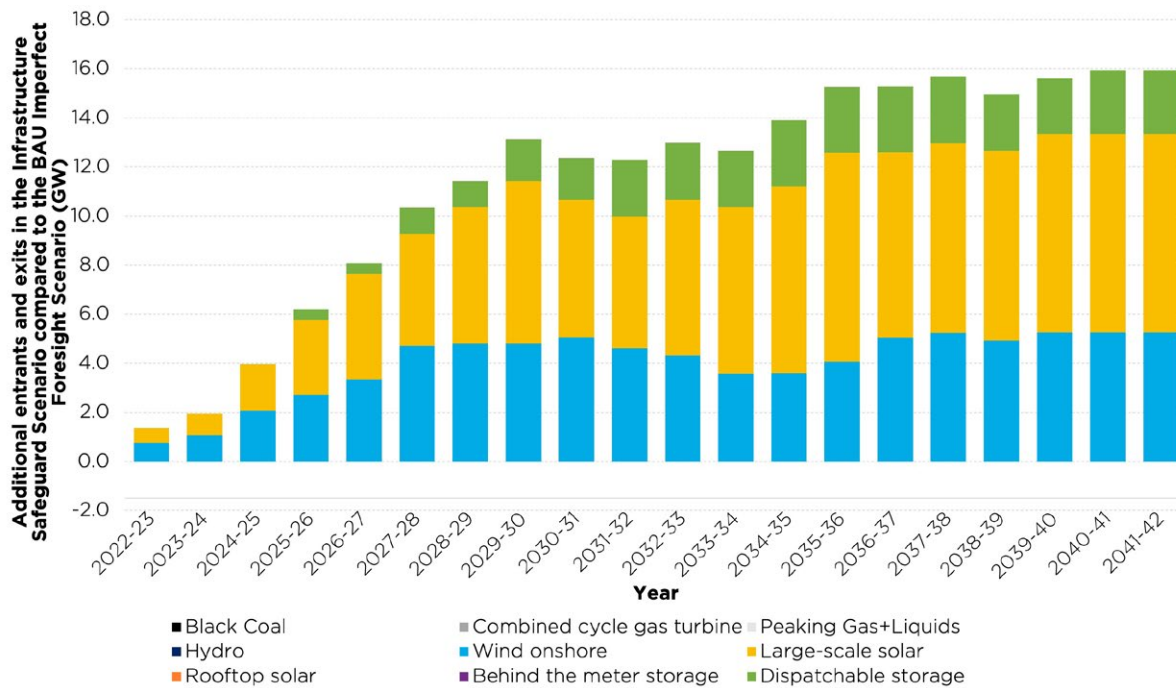
commitment to introduce a NSW Peak Demand Reduction Scheme.

The modelling assumes that eligible generation projects under the Infrastructure Safeguard are connected to the New South Wales region of the NEM and meet minimum size requirements of 30 MW. Long duration storage projects are assumed to be capable of storing electrical energy for at least 8 hours.

The Infrastructure Safeguard costs were calculated assuming a swap contract approach, where payments are made to eligible projects based on the difference between the wholesale price and a pre-determined strike price. Both the REZ generation and Long Term Energy Services Agreements were assumed to be provided for 20 years. The consumer bill impact modelling assumed that the Infrastructure Safeguard program costs are recovered from distribution businesses who would then pass the cost onto consumers.

## NSW Generation Capacity Mix

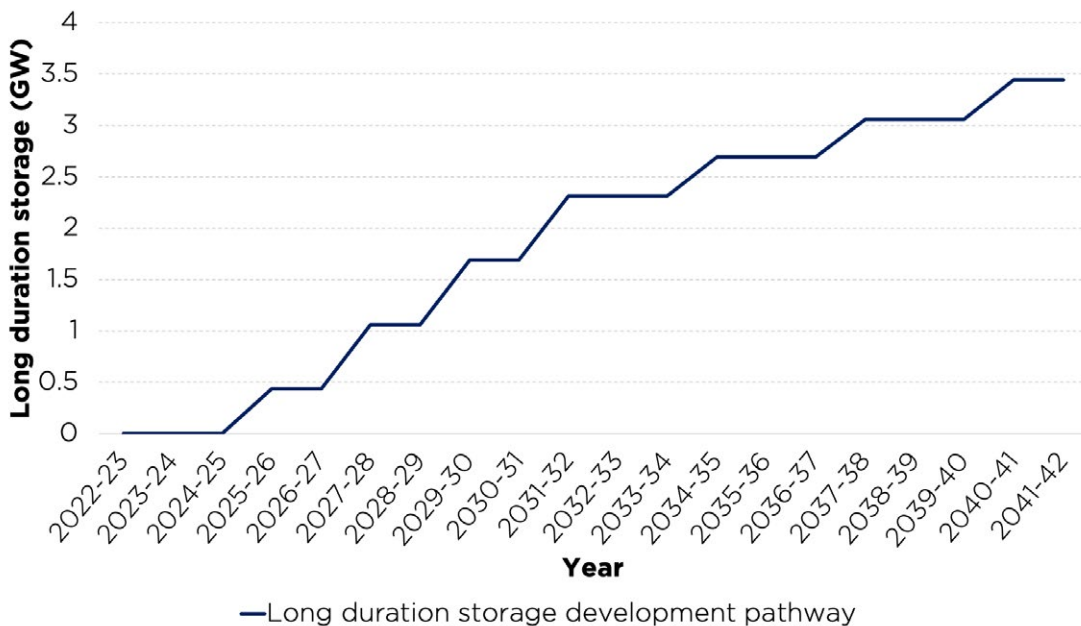
The modelling assumes that the Infrastructure Safeguard will deliver approximately 12 GW of additional generation capacity by 2030 in NSW compared to the BAU Imperfect Foresight Scenario.



**Figure 12.**

Additional entrants and exits in the Infrastructure Safeguard Scenario compared to the BAU Imperfect Foresight Scenario.

In addition, the modelling has assumed that the Long Duration Storage limb of the Infrastructure Safeguard shall support 2 GW of 8-hour storage capacity by 2030 in order to deliver additional firming capacity and meet the Energy Security Target.



**Figure 13.**

Assumed long duration storage development pathway under the Infrastructure Safeguard Scenario.



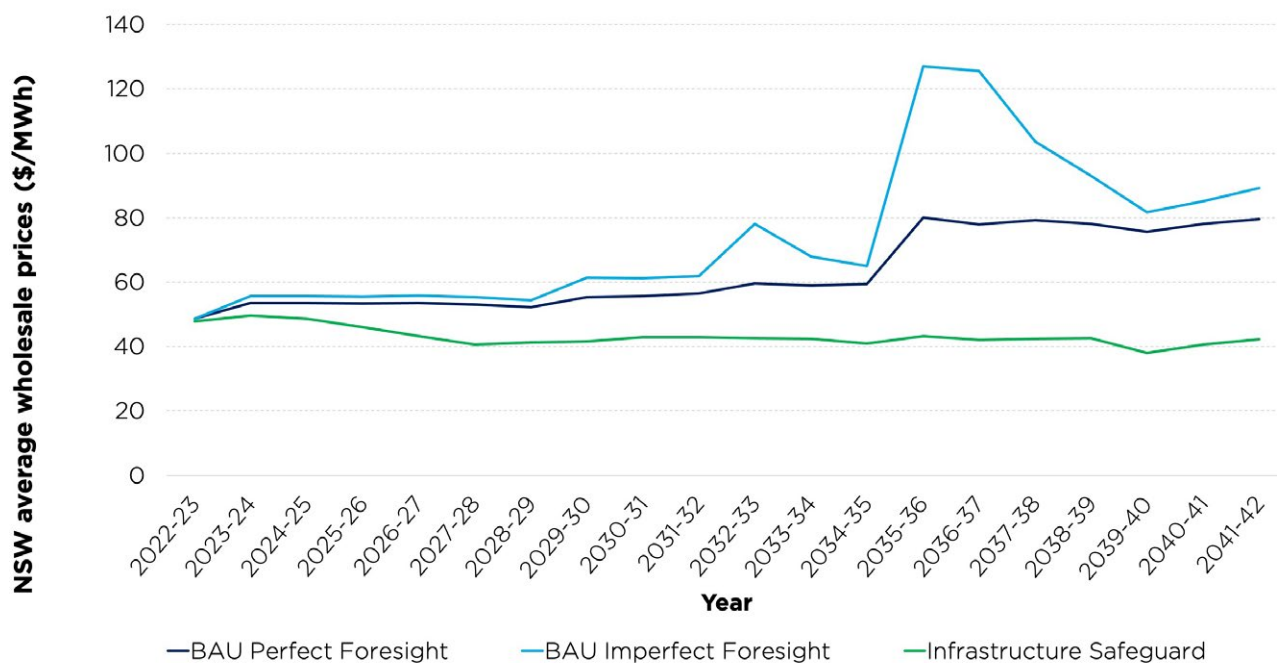
The Infrastructure Safeguard is therefore forecast to shift the NSW capacity mix more heavily towards wind, solar and storage when compared to both BAU scenarios. The development of new generation and long duration storage capacity is also brought forward in the Infrastructure Safeguard.

The Infrastructure Safeguard also allows for closer coordination between generation and storage development and REZ transmission infrastructure. The modelling forecasts that assets can bid at lower prices for Long Term Energy Services agreements as they have relative clarity around their future marginal loss factors and reduced cost of capital.

### Wholesale price results

The Infrastructure Safeguard delivers NSW wholesale price reductions of 40 per cent when compared to the BAU Imperfect Foresight Scenario over the forecast horizon to 2040.

The Infrastructure Safeguard inserts new, low marginal cost generation into the NSW generation supply stack, reduces new entrant cost of capital, and increases competition in the NSW wholesale electricity market. Again, inter-year price volatility is also dampened as scarcity pricing is forecast to reduce over time.

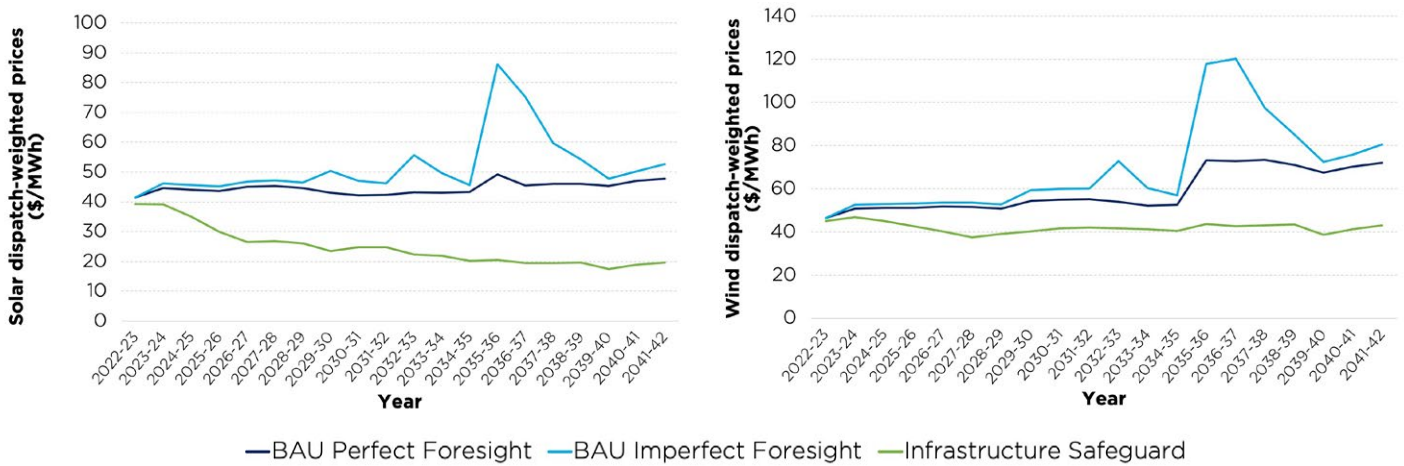


**Figure 14.** Time-weighted NSW wholesale electricity prices.

Dispatch weighted prices represent the average price that each type of generation technology receives. The impact on dispatch-weighted average prices is considerable for the Infrastructure Safeguard with significant reductions compared to both BAU scenarios.

Aurora Energy Research modelled these scenarios to align power station exits with the expected dates power stations owners have provided to AEMO. Power stations may have incentives to

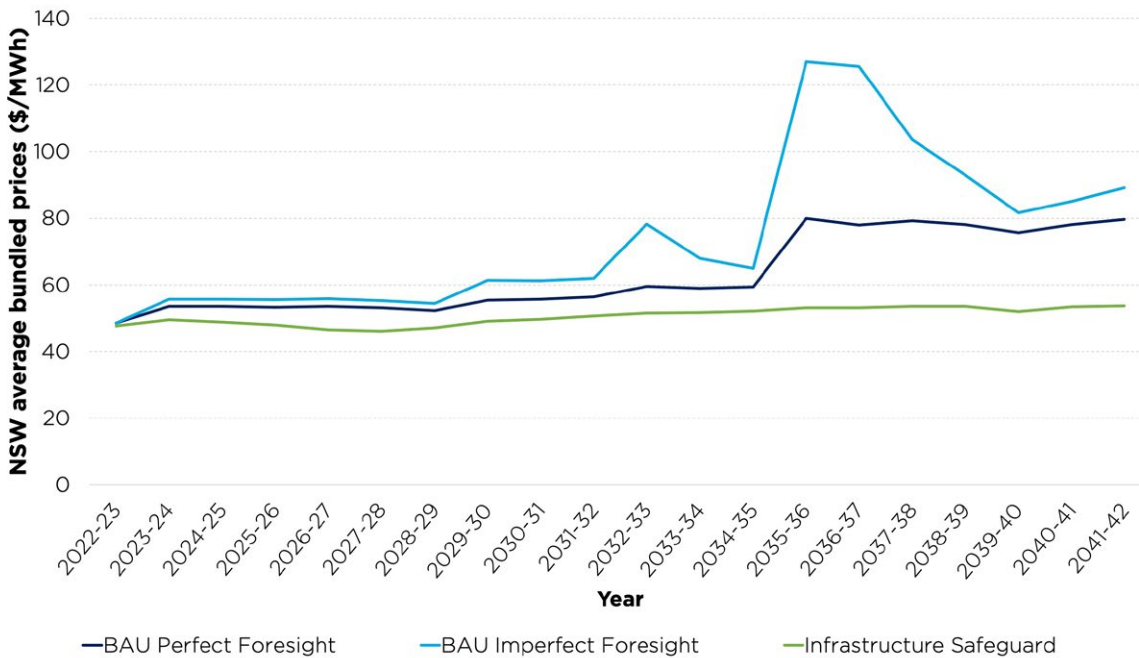
remain open even if wholesale prices are low because of long term hedging contracts and the benefit of deferring site remediation costs. Aurora Energy Research tested the outcomes if power stations chose to be placed in care and maintenance based on individual asset economics (i.e. assuming there are no long term hedge agreements or site remediation costs) and found that even though this would reduce consumer benefits, the Roadmap would still deliver a net benefit to consumers.



**Figure 15.** NSW time-weighted average of solar and wind dispatch-weighted prices.

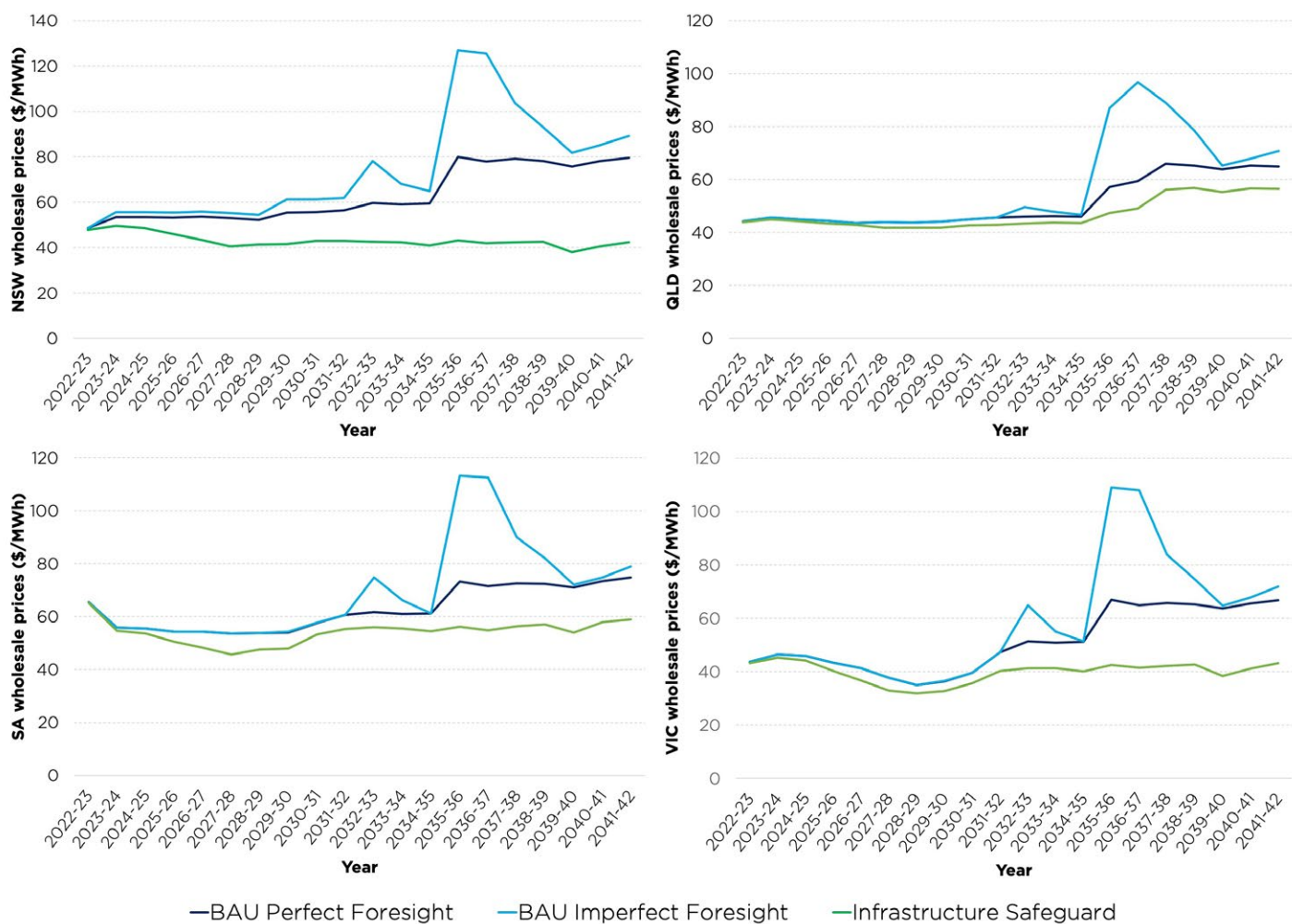
Bundled wholesale prices include both wholesale prices and the Infrastructure Safeguard scheme costs, averaged on a per MWh basis. Bundled BAU prices are the same as BAU wholesale prices as they don't include scheme costs. The Infrastructure Safeguard achieves a lower bundled wholesale price than both BAU scenarios.

This is primarily driven by the lower cost of capital achieved through the Infrastructure Safeguard across the 20-year contract life for new entrants, and reductions in infra-marginal rents as Infrastructure Safeguard strike prices have been modelled as occurring on a project basis depending on the technology and location.



**Figure 16.** NSW bundled time-weighted average wholesale electricity prices.

Aurora Energy Research also modelled the impact of the Infrastructure Safeguard on other states. The projections show reductions in future wholesale power prices in surrounding states.



**Figure 17.** Time-weighted average prices in NSW and other regions.

## Infrastructure Safeguard generation competitive process outcomes

Aurora Energy Research projected strike prices for the Infrastructure Safeguard using the 30-minute interval data generated by the consultant's underlying NEM dispatch model, and assuming that participants will compete at a level whereby their costs and cost of capital (in line with the WACC levels outlined in a stakeholder survey) are recovered.

Most international tender-style schemes to date pursue variable volume/shape swap structures in their contracts to encourage the lowest possible strike prices by reducing participant uncertainty and therefore cost of capital. Fixed volume/fixed shape swap structures are more likely to encourage firming generation, as well as increase the ability of the Scheme Financial Vehicle to on-sell the contracts to retailers and third parties. This fixed volume/fixed shape structure was assumed for the central analysis of the Infrastructure Safeguard.

There is some risk that participants will compete more conservatively into an Infrastructure Safeguard where there is additional risk of not meeting cumulative volumes as well as a specified shape – particularly initially as participants observe the initial impacts of the Infrastructure Safeguard on the NSW electricity market and factor those dynamics in.

In addition, while the model produces forecasts of optimised bidding outcomes, asset developers behaviour in the Infrastructure Safeguard competitive process may differ significantly based on a range of important factors: varying levels of sophistication and risk tolerance as bidders calculate a complex set of inter-related variables – e.g. merchant revenue tails post-contracted period, economic curtailment (i.e. forecasting negative price periods), FCAS causer pay costs,

and understanding of risk and risk management under fixed shape/fixed volume Long Term Energy Services agreements.

There is a range of factors that drive behaviour in the competitive process:

Factors driving strike prices lower

- low cost of capital for contracted revenue streams
- REZ access rights and coordination of generation and transmission reducing MLF and grid risks
- declining technology costs over the forecast horizon

Factors driving strike prices higher

- reduced value in merchant revenue tails post-contracted period as dispatched weighted average prices for generation is driven down in NSW with additional capacity
- increased economic curtailment (i.e. negative prices) which reduce both contracted volumes (as Long Term Energy Services agreements would not pay-out in negative price periods) and revenue from subsequent merchant tails
- increased gap between the fixed shape weighted quarterly price for each REZ and the dispatch weighted average price of the specific asset
- any challenges in wind and solar assets meeting fixed volume and fixed shape under Long Term Energy Services agreements.

The two major benefits of an Infrastructure Safeguard at a system level are: firstly, sizeable reductions in cost of capital for new generation assets; while, secondly, maintaining competition. The cost of capital reductions identified in a stakeholder survey (based on industry and lender feedback) are material. In addition, evidence from Australia and internationally indicate that well-designed competitive processes, like auctions, with consistent rules and regular timing can drive significant cost reductions and competition between participants. Auction participants can gear planning and supply chains around competitive process schedules and achieve significant cost reductions – ultimately benefiting consumers.

This impact is likely to be increased if transmission is coordinated increasing both cost of capital reductions and ability of participants to plan and connect in a timely and efficient way. Consequently, the modelling forecasts relatively low auction strike prices, even when including a premium to reflect additional risk for developers under fixed volume/fixed shape swap structures.

## **Long Duration Storage outcomes**

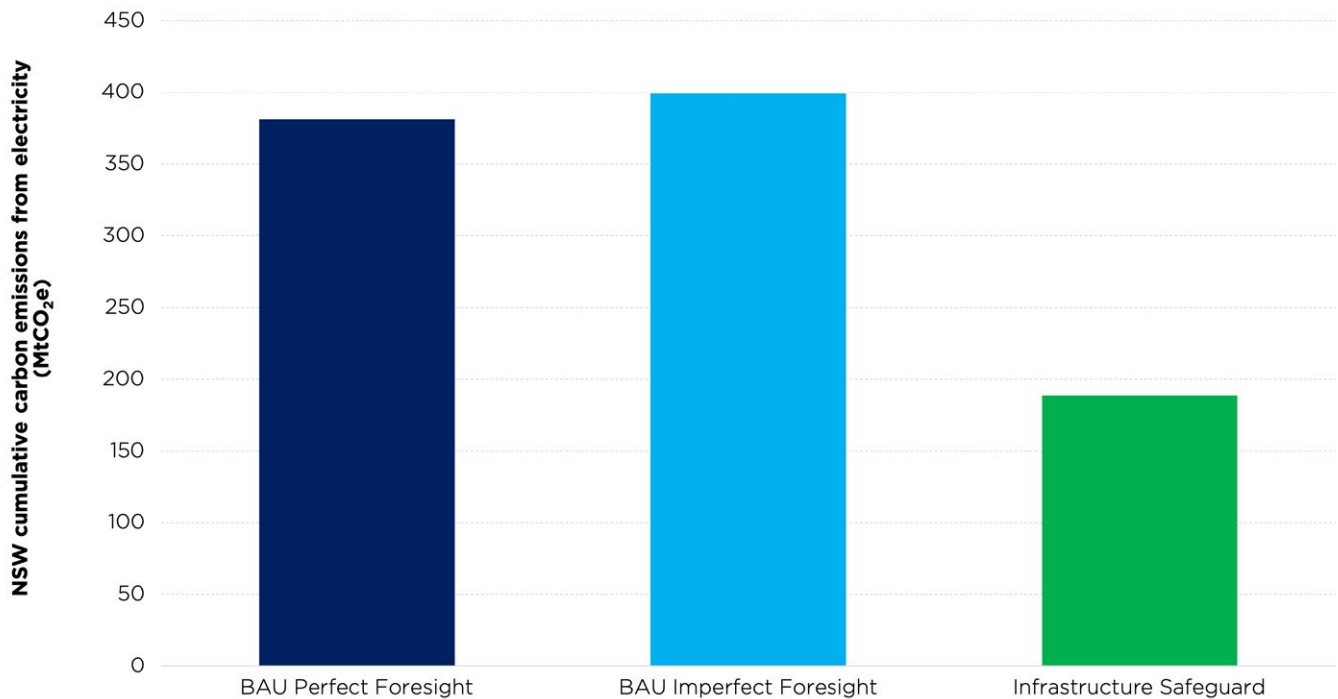
As outlined above, the modelling has assumed that the Long Duration Storage limb of the Infrastructure Safeguard shall support 2 GW of 8-hour storage capacity by 2030 (in addition to Snowy 2.0). In the modelling, Aurora Energy Research found up to around half of this storage capacity could be delivered to firm generation assets with Long Term Energy Services agreements rather than directly contracted long duration storage assets with their own agreements.

The modelling forecasts that the payments under Long Term Energy Services agreements with Long Duration Storage assets would need to provide approximately 20-40 per cent of the revenue per annum on average through the period of the program to deliver this volume of storage. This assumes that the storage asset is operating in the wholesale and FCAS markets and making 60-80 per cent of its revenue from merchant energy arbitrage and frequency stability provision. The modelling assumes that the asset receives a top-up payment equivalent to the ‘missing money’ for the asset to be profitable over its life.

As intra-day price volatility increases over time with increased variable renewable energy penetration and technology costs reduce, the unit cost of the Long Duration Storage is also forecast to decline over time.

## Emissions

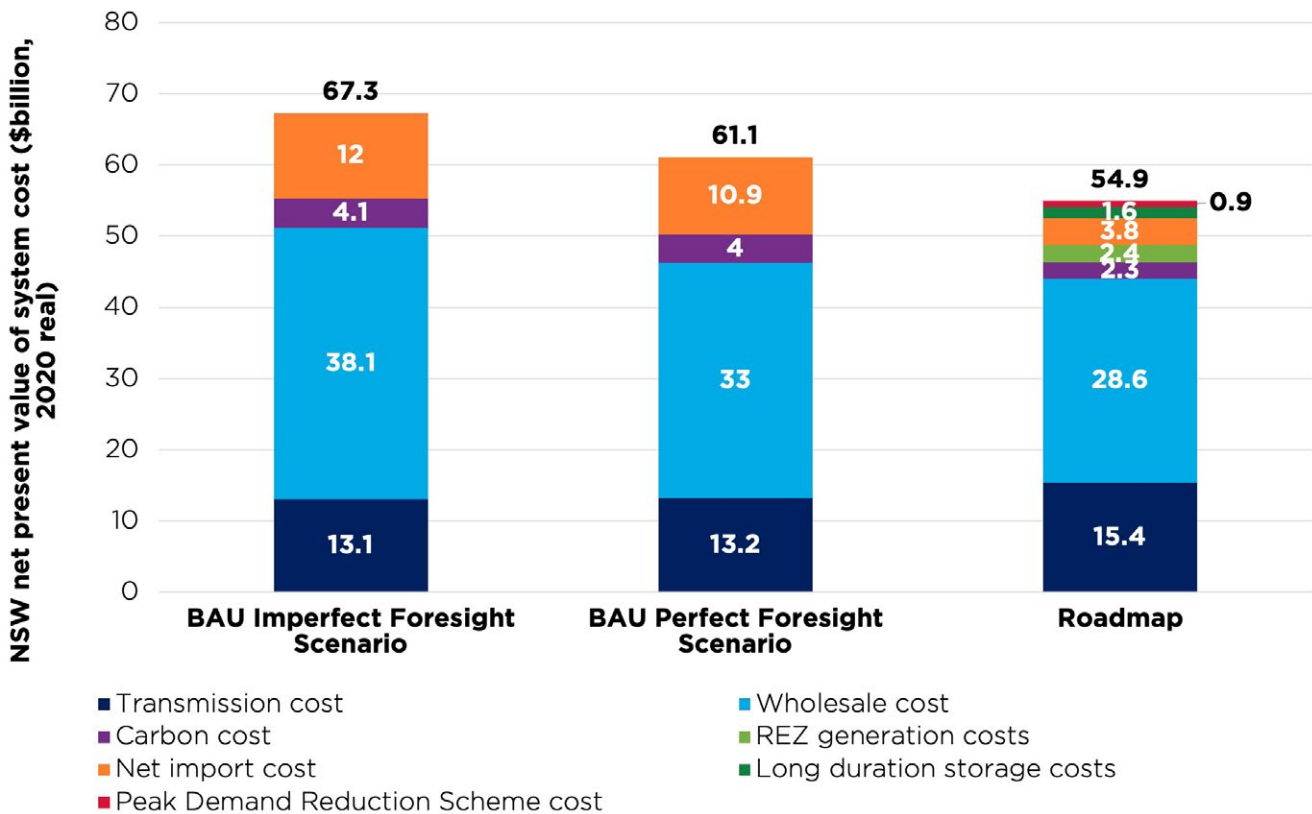
The Infrastructure Safeguard is forecast to deliver significant volumes of generation and long duration storage. The modelling indicates that the Infrastructure Safeguard would result in significant reductions in emissions from the NSW power sector that would deliver forecast cumulative emissions reductions of about 210 MtCO<sub>2</sub>e to 2040 when compared to BAU Imperfect Foresight Scenario where market participants are slow to respond to changes in the NEM and there is a delay in replacement generation.



**Figure 18.** Total NSW emissions from electricity generation to 2040.

## System costs and consumer prices

Aurora Energy Research estimated the aggregate NSW system-wide costs associated with delivering the two BAU scenarios and Infrastructure Safeguard scenario. There are seven categories of cost that have been compared across scenarios – these have all been discounted at a rate of 7 per cent to provide like-for-like aggregate cost comparisons.



**Figure 19.** Net present value of NSW system costs.

Aurora Energy Research found the Infrastructure Safeguard would have lower aggregate system costs than both BAUs. The major driver is the reduced imports and reduced wholesale and import costs over the forecast horizon, as well as reduced carbon costs. Aurora Energy Research found the most expensive option is forecast to be BAU Imperfect Foresight Scenario where a disorderly exit from major power stations increases consumer costs materially.

Aurora Energy Research also found BAU scenarios would ultimately have lower transmission costs than the Infrastructure Safeguard scenario given the lower levels of generation built in REZs under those scenarios. The retail price benefits of the Roadmap accounts for this higher transmission cost.

Aurora Energy Research’s results indicate some assets may participate in the competitive process at or below their dispatch-weighted average prices given the assumed 20-year contract length and lower cost of capital through surety of revenue provided by the Infrastructure Safeguard. As such, the modelling indicates that the Scheme Financial Vehicle may receive net payments for some periods from asset owners over the life of the program to 2040. Consequently, Infrastructure Safeguard scheme costs are relatively low.

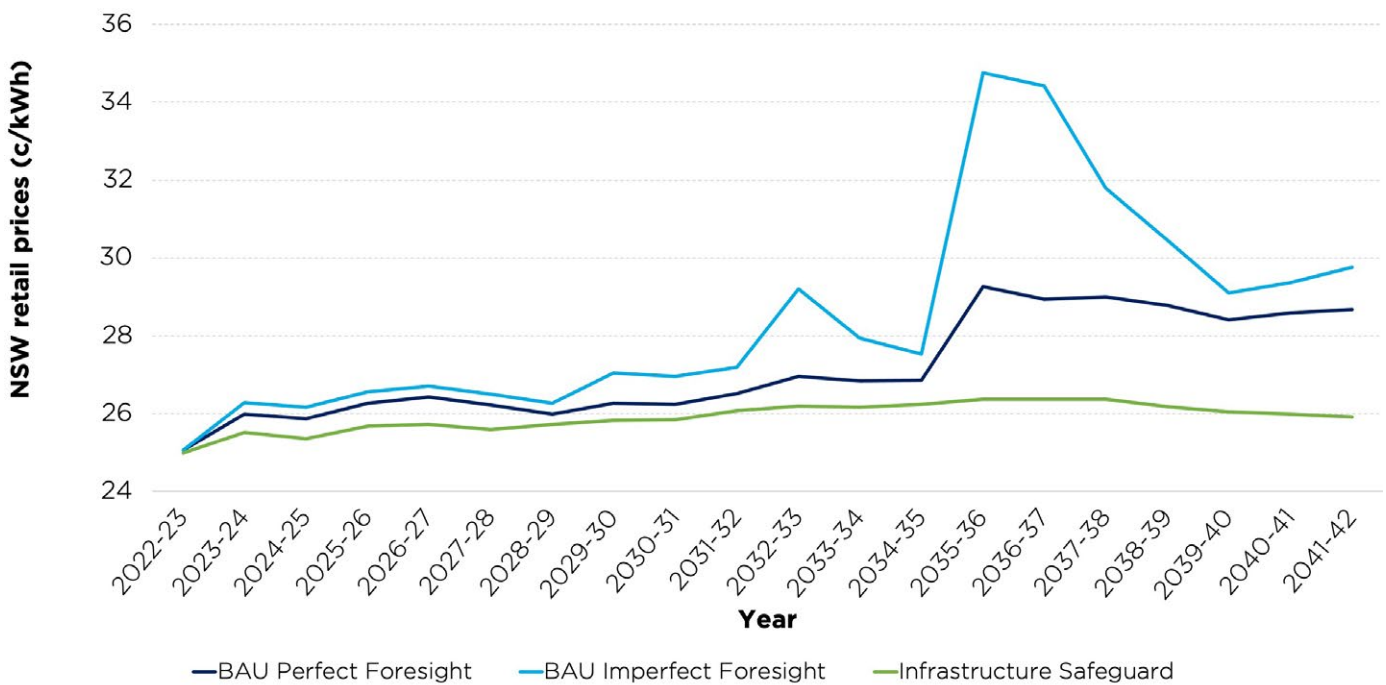
These aggregate system cost calculations do not factor in the transfer of merchant price risk from private developers to the Scheme Financial Vehicle, although the Scheme Financial Vehicle can mitigate its exposure by seeking to sell-on the Long Term Energy Services agreements to off-takers, but will bear some of the risk of material deviations from forecast price outcomes over time.

Aurora Energy Research also found the Infrastructure Safeguard would deliver lower cost bills to consumers. This includes the assumption that a portion of NSW industrial load (~11.5 TWh) is 90 per cent exempt from the Infrastructure Safeguard costs and so residential customers bear a greater proportion of the Infrastructure Safeguard costs.

Aurora Energy Research found that the Infrastructure Safeguard has been designed to both bring down the cost of capital for new entrants (given in capital intensive projects

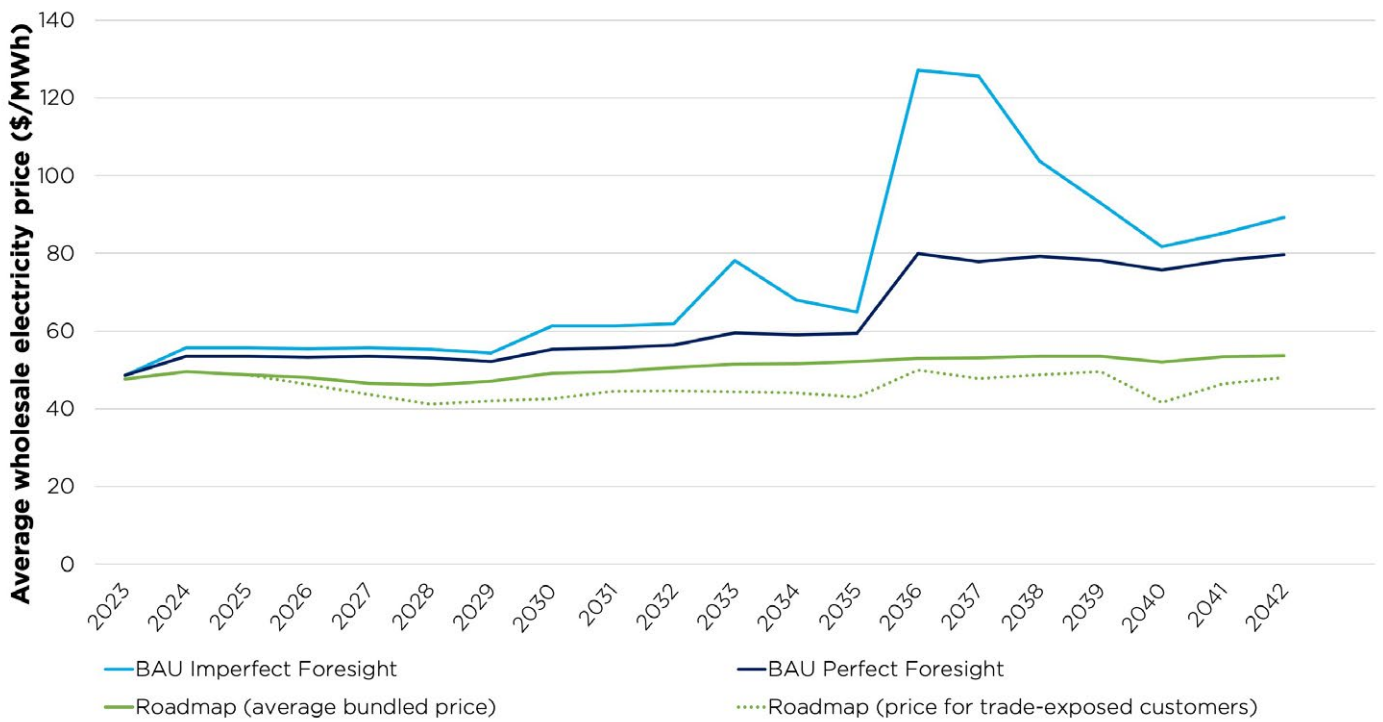
with lower operating costs the cost of capital is the major driver of aggregate consumer costs) while also maintaining competitive pressure to drive down costs through well-designed tender processes. In a modelled forecast future, the Infrastructure Safeguard would deliver both those outcomes and so create lowest future aggregate costs for consumers.

The Department used these retail price forecasts and assumed the average NSW household consumes 5.9 MWh a year to estimate bill savings as a result of the Infrastructure Safeguard.



**Figure 20.** Forecast NSW residential retail prices.





**Figure 21.**

Forecast bundled wholesale prices for a typical customer and a trade-exposed customer.

Figures 20 and 21 are based on an assumption that emissions intensive trade exposed industries in NSW receive an exemption from 90% of the costs of the Electricity Infrastructure Investment Safeguard. The eligibility criteria, scope and level of exemptions is indicative only and subject to detailed scheme design in consultation with stakeholders.



Photography  
Lyell Dam, NSW.



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