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LIDDELL THE LINE IN THE SAND

WHY IT'S TIME TO HIT PAUSE ON THE CLOSURE OF COAL-FIRED BASELOAD POWER STATIONS IN THE NEM

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Executive Summary

With the recent closure of Liddell Power Station, the electricity system is on a knife's edge. It is time for energy policy makers to take stock – and focus on energy security – before it is too late.

Australia can continue down the path of closing what have been reliable low-cost baseload power stations without adequate replacements being available.

Or it can do what should be obvious to all elected officials – keep the lights on while building new power stations that are able to meet the real-world energy needs of Australian households and industry.

This IPA Research Paper demonstrates that energy security has been given insufficient attention by energy policy makers. It should in fact be the priority of all governments. We can no longer afford the luxury of pretending otherwise.

The recent announcement by Origin Energy's new owner, Canadian private equity fund Brookfield, that it is prepared to entertain discussions about keeping open Eraring power station (Australia's largest baseload plant) rather than closing it in 2025, should be welcomed by the New South Wales government.

At the very least, this is a victory for the real world over ideologically driven theoretical energy-market models that promise a high level of certainty while failing to explain why power prices and the risk of blackouts keep increasing.

While previous closures of baseload plants in New South Wales and South Australia were effectively offset by the shutdown of energy intensive aluminium smelters in New South Wales and Victoria, and by the shutdown of the car industry, Hazelwood's closure in May 2017 provided an insight into what awaits Australia.

Wholesale prices jumped more than 70 per cent compared with the previous year. Over the following three years, the average wholesale electricity price was 135 per cent higher than the average over the previous decade. All the while, threats to system reliability became more acute.

Yet, between 2011 and 2021, wind turbine capacity in Australia increased more than 320 per cent to 8,951 MW. Solar capacity increased 672 per cent to more than 19,000 MW.

To put this in context, Hazelwood power station produced 1,600 MW.

But what is occurring in Australia has already been tried, and has failed, elsewhere. Germany and California offer sobering lessons for Australia on the risks of moving towards a high level of dependence on renewable energy.

Germany's electricity costs 50 per cent more than France, yet produces 8 times the CO_2 emissions. Californian households now pay 66 per cent more compared with the rest of the US.

But unlike Germany and California, Australia cannot rely on electricity supplies from neighbours. As an electricity system that is literally an island, the proportion of variable renewable energy in the energy grid, at 21.7 per cent (in 2021), already makes Australia the world leader by that measure.

The Albanese government's push to increase renewable energy to 82 per cent by 2030 will only result in higher prices and lower reliability. No feasible or affordable combination of intermittent renewables, batteries, pumped hydro and grid extensions can substitute for the reliable and affordable power provided by the proven technology of existing baseload power stations.

The strains on the system will be made worse by the push to electrify everything, especially motor vehicles and industrial processes like steel smelting and minerals processing. Electricity demand is set to increase significantly. Critical international lessons have been ignored by Australian policy makers.

While Australia and other developed countries off-shored their energy intensive manufacturing to China, India and South East Asia, this was achieved by large-scale investment in new coal and gas fired power stations.

This explains why worldwide generation of electricity using fossil fuels is actually rising. In 2021, wind and solar only contributed 10 per cent of global electricity supplies. Fossil fuels still generate more than 80 per cent.

Promised and widely promoted, the global energy transition is not happening at anywhere near the pace politicians and renewable advocates are suggesting.

The inconvenient truth is that no major industrialised country has successfully decarbonised its electricity sector through large-scale investment in renewable energy.

Yet against all the international evidence, Australian governments – federal and state – insist they can deliver lower electricity prices, while electrifying everything and keeping the lights on.

The continuing refusal of the Federal Government to consider nuclear energy as an option means that it has in effect placed a desire to promote renewable energy above the stated policy objective of reducing emissions. Given the confusion of such a stance, it is legitimate now to prioritise energy security as the overriding objective – providing a stable national electricity grid and removing the source of upward pressure on wholesale prices.

The IPA concludes that in New South Wales and across Australia more generally, it is time for elected officials to do their job and focus on energy security and affordability – keeping the lights on and ensuring the remaining fleet of baseload power stations continues to operate for as long as is necessary.

No baseload power station should be allowed to close unless and until a like for like baseload replacement – be it coal-fired or nuclear – is ready to come online. For most operators, this will mean pushing out closure dates well beyond those promised in the rush to meet the Federal Government's unrealistic plans for net zero and increased renewable energy.

Introduction

Australia, like all modern economies, relies on electricity to power its economy and provide the living standards its citizens have all come to enjoy.

For decades, our electricity networks and markets worked cohesively to supply the energy needs of Australian households and businesses. Demand increased in line with population and economic activity, but the electricity market attracted new investment when it was needed (though much of it was publicly funded).

The priority for policy makers was to ensure security of supply, including regulating regional monopolies on network infrastructure, and subsequently electricity price increases tended to be in line with inflation.

But Australians now face a different paradigm with regard to energy. The push for a zero carbon future has led to a surge in intermittent energy sources which while capable of providing energy, do not necessarily do so when it is needed or in a form compatible with the electricity system. This paradigm shift has upended the electricity market.

Australia is following the path taken by many other nations which have adopted the policy-led approach to renewable energy investment; but it is doing so blindly, and without properly assessing the likely outcomes of such an approach.

This IPA Research Paper examines international energy trends and the lessons to be learned from fellow OECD nations which have implemented energy policies similar to Australia's.

Unfortunately, the lessons are not positive and to date they have not been learned.

Among OECD nations, electricity and broader energy demand is stagnating. The policy-mandated pursuit of variable renewable energy has led to higher electricity prices, increased supply risks, falling consumption and less-competitive domestic local industry in most jurisdictions.

However, with the push to electrify everything, especially motor vehicles and industrial processes like steel smelting and minerals processing, electricity demand could increase significantly.

The experience of other energy markets, especially those which have pursued aggressive decarbonisation strategies like Germany and California, demonstrates the real-world consequences of higher prices and lower reliability when traditional energy sources such as baseload power stations are closed without adequate replacements being in place.

But unlike Germany and California, Australia cannot rely on electricity supplies from neighbours.

As an electricity system that is literally an island, the proportion of variable renewable energy in the energy grid, at 21.7 per cent (in 2021), already makes Australia the world leader by that measure.

This research paper examines the effect of successive closures of baseload power stations in New South Wales, South Australia and Victoria. Put simply, whatever spare capacity there was in the system has gone.

The closure of large energy users like the Kurri Kurri and Point Henry aluminium smelters over the past decade, along with the shutdown of the Australian automobile industry, mitigated the impact of power station closures.

In contrast, the closure of Hazelwood Power Station in 2017 gave a taste of what can happen when additional large baseload plants close. Wholesale power prices jumped more than 80 per cent, and the threats to system reliability became more acute.

The recent closure of Liddell Power Station has placed the system on a knife-edge.

It is not too late for Australia to learn from experience. We must not forgo energy security and expose our economy to the cascading effect of higher energy prices by forcing the early retirement of our dispatchable electricity generators.

The announcement that the new owners of Eraring Power Station – Australia's largest – are prepared to delay its previously announced closure in 2025 should be welcomed. Likewise, other power stations slated to close over the next decade should not be allowed to close until adequate replacement capacity is available.

But instead of acknowledging the central role fossil fuel baseload power stations play in providing low cost and reliable power, the Albanese government continues to maintain against all evidence that pursuing a renewable energy future (82 per cent by 2030) is not only achievable but will reduce energy costs.

All this at a time when government policy is simultaneously aiming to increase the use of electric vehicles, support greater electrification in households, and re-invest in energy intensive manufacturing.

The outcome of this wishful thinking is unlikely to be efficacious. And, as always, it will be Australian households and businesses that pay the cost – not the policy makers.

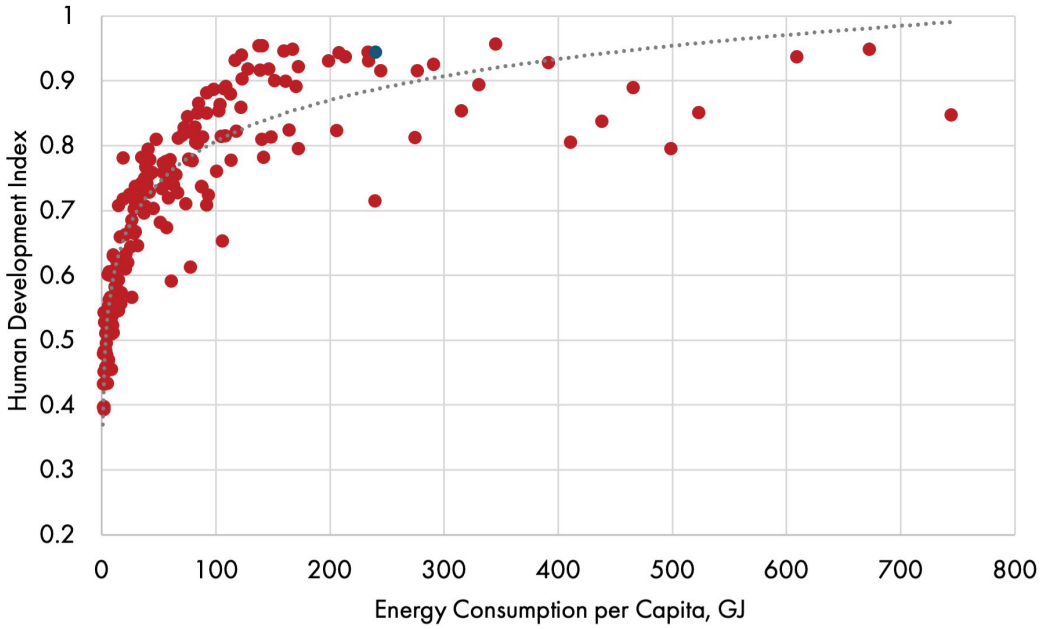
World electricity trends

The importance of energy

Energy is essential in a modern society and advanced economy such as Australia.

As shown below, countries with high levels of per capita energy consumption tend to rate higher on the United Nation's human development index. Rising energy consumption per capita produces significant gains in prosperity but, as with many economic variables, eventually diminishing returns set in. This point of diminishing returns may move further out in the future if increased autonomous manufacturing and advanced IT systems play an increasingly important role in a nation's economic development and prosperity.

Figure 1: The relationship between human development and energy consumption.



Source: United Nations Development Program, website; Our World In Data, website.

Electricity is just one form of energy, but an important one. Worldwide, it accounts for around a quarter of total energy consumed. Though usually unseen, and for the main part unappreciated until we don't have it, electricity is literally everywhere in our lives. It powers nearly all the things we use daily – the lights in our homes, our mobile devices, our televisions, refrigerators, air conditioning and cooking appliances.

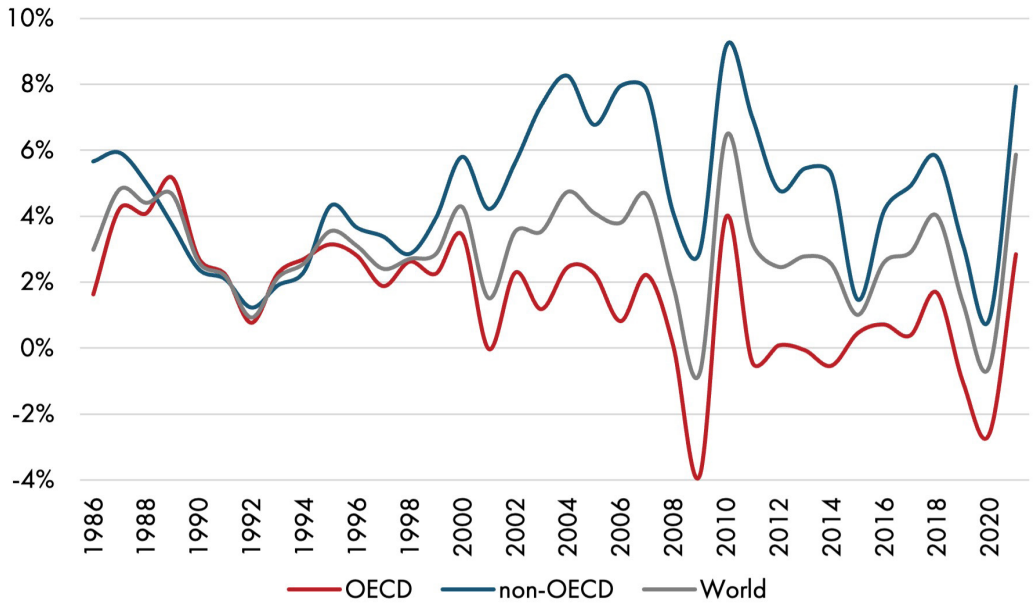
Without electricity, our economy as we know it would simply not function. Industries such as manufacturing, mining and healthcare all rely heavily on it. In particular, the IT industry depends heavily on electricity. The network of servers, data storage sites and computers that make up the internet, support the cloud and let us work from home are heavily energy-intensive and require an uninterrupted supply of electricity to function.

World electricity trends

While world electricity generation has been rising steadily in the 21st century, the distribution of this growth has been uneven. Total world electricity generation increased 83 per cent in the period 2000 to 2021, but the vast majority of this growth has been in non-OECD nations.

As can be seen in figure 2 below, at the macro-level OECD and non-OECD electricity generation growth tend to move together over time. However, since the start of the 21st century there has been a noticeable divergence between the two. Electricity generation growth in the non-OECD has been considerably higher than the OECD as a greater share of energy-intensive manufacturing has shifted to nations such as China, India and those in South-East Asia.

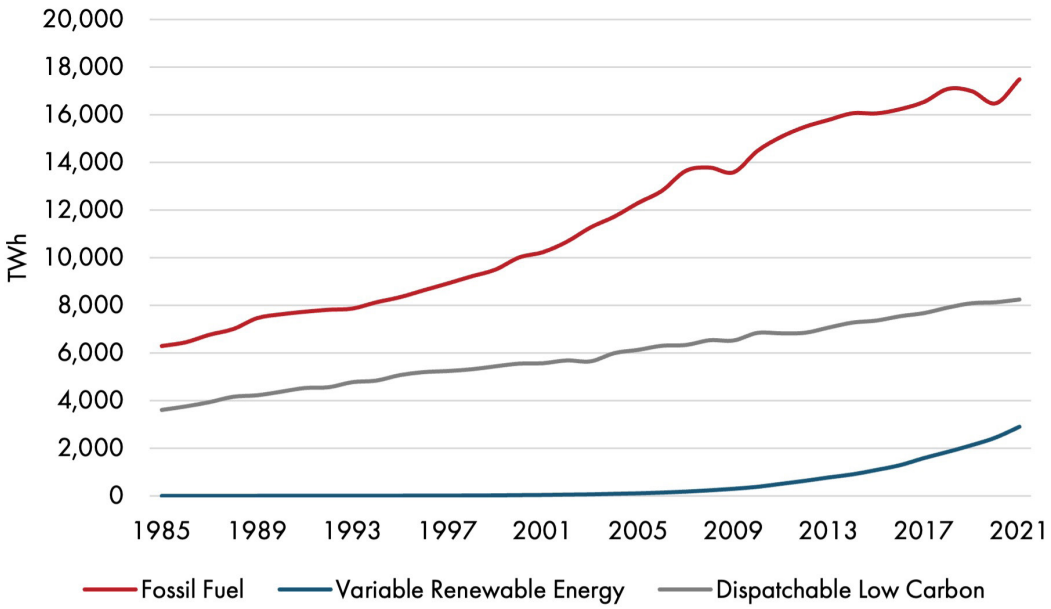
Figure 2: OECD and non-OECD electricity generation growth.



Source: BP, Statistical Review of World Energy.

There is another noticeable difference between OECD and non-OECD nations. Whereas OECD nations are making commitments to reducing their reliance on fossil fuels, non-OECD countries are consuming electricity sourced from coal, gas and oil at record and still rising levels. So much so that growth in coal and gas fired electricity in the non-OECD has more than offset any declines in the OECD in recent years.

Figure 3: Rising world use of fossil fuel-powered electricity.



Source: BP, Statistical Review of World Energy.

It may be an inconvenient truth, but world generation of electricity using fossil fuels is actually *rising* – even since the Paris Treaty was signed in 2015. With China, India and South-East Asian nations continuing to invest in new coal-fired power stations, this trend seems unlikely to change any time soon.[1]

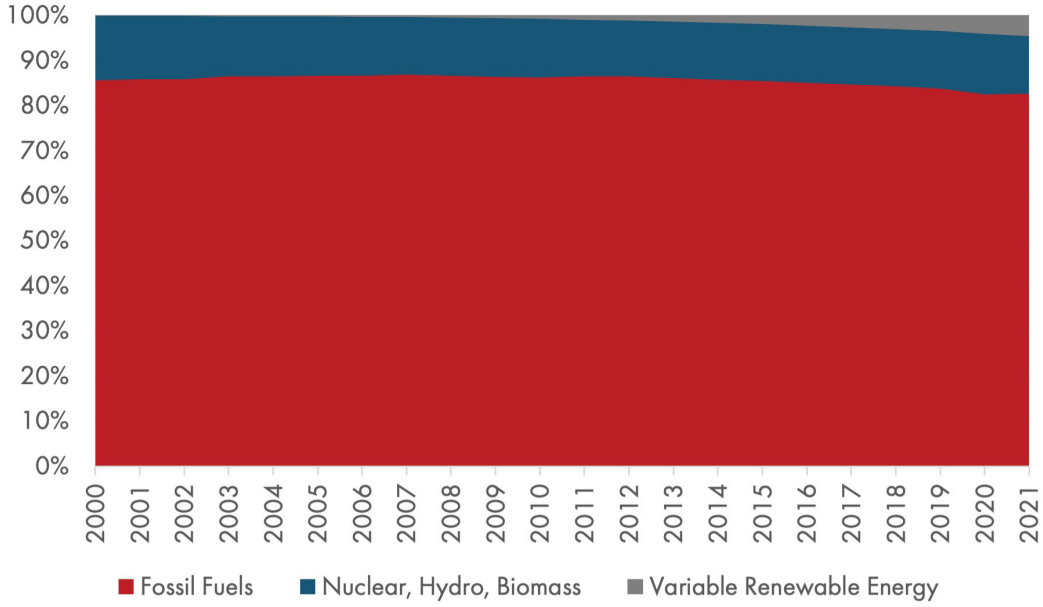
Despite billions of dollars of annual investment subsidies, Variable Renewable Energy (VRE), which includes solar, and wind generated electricity that is reliant on the weather and therefore not dispatchable, is not even growing at a rate that covers incremental annual increases in electricity demand – let alone offsets the effects of closing existing coal and gas fired power plants.

In 2021, electricity sourced from wind and solar accounted for 10 per cent of global electricity generation. When considered in the broader context of total energy use (that includes transportation fuels and industrial heat sources), VRE was just 4.6 per cent of total energy consumption in 2021 – up from 1 per cent in 2011.

The promised and widely promoted global energy transition is just not happening at anywhere near the pace politicians and renewable advocates are suggesting.

1 Bloomberg News, *China to Speed Up Construction of Coal Power Plants This Year*, Bloomberg, 20 January 2023.

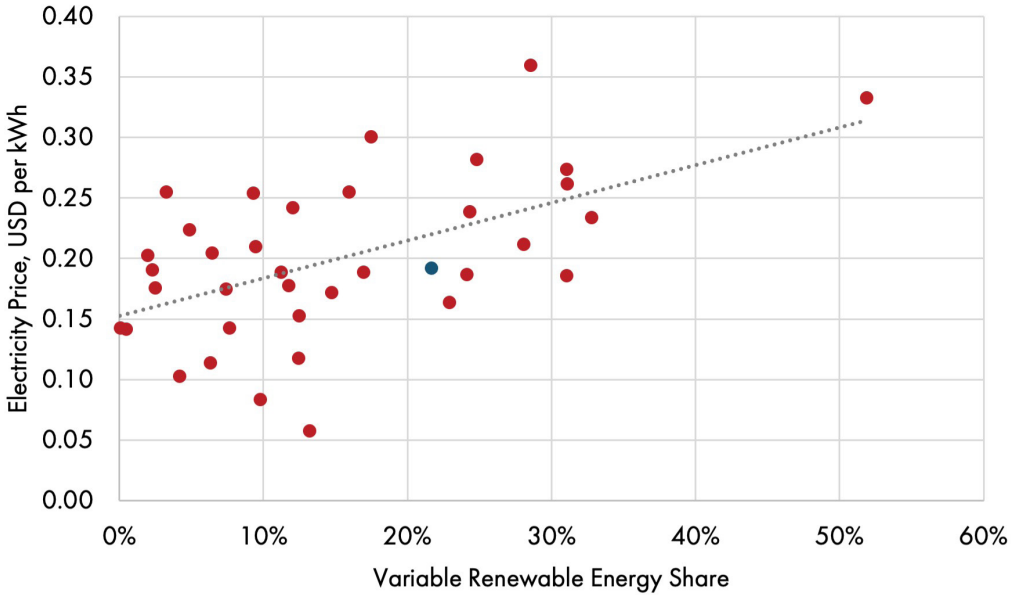
Figure 4: The global energy mix is far from shifting to 100 per cent variable renewable energy.



Source: BP, Statistical Review of World Energy 2022.

Policy makers in governments around the world, including Australia, need to become more realistic about what can and cannot be achieved with wind and solar energy. Moreover, there must be a greater focus on the economic impacts of the rapid deployment of VRE. The experience of OECD nations demonstrates definitively that replacing dispatchable electricity generators with VRE correlates closely with rising retail electricity prices, debunking the policy makers' promises that renewable energy is cheap.

Figure 5: Variable renewable energy correlates with higher electricity prices in OECD nations.



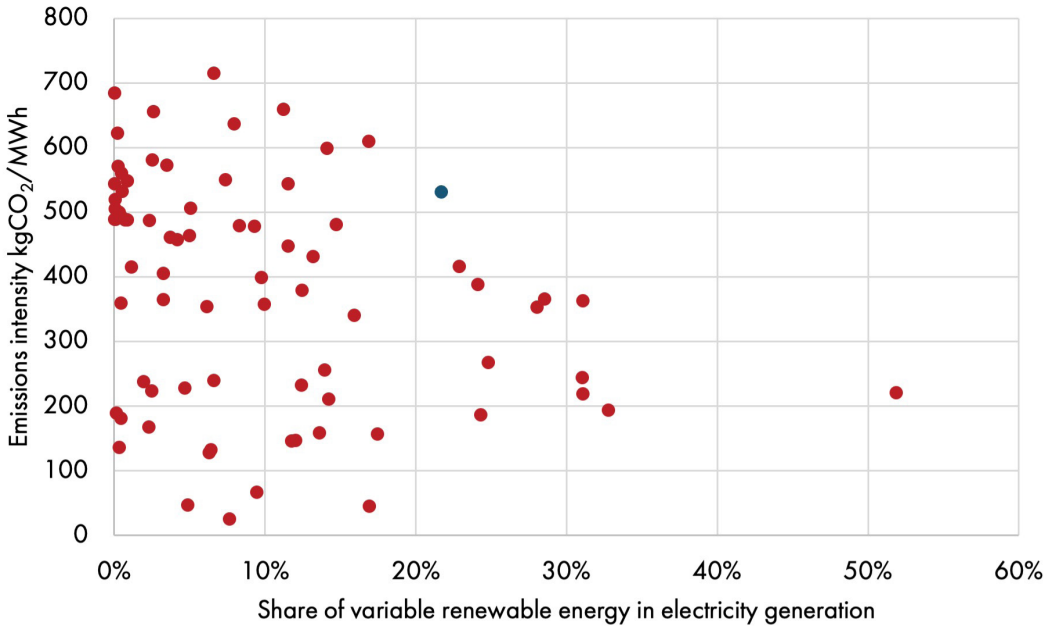
Sources: Australian Energy Council; BP.

The problem is not that the generation of electricity via a solar PV cell or wind turbine is expensive – indeed the shift to mass manufacturing of these items in China has delivered substantial cost reductions over the last decade. But prices are set by markets and not just the cost of equipment.

Markets dominated by VRE are regularly exposed to prolonged periods in which solar and wind generators produce well-below their theoretical maximum potential. Gaps in supply and the resulting tight market set electricity prices (usually delivered by the highest cost, but flexible sources of generation) at higher levels in order to reduce demand.

No major industrialised nation has yet successfully decarbonised its electricity sector through large-scale investment in renewable energy. In fact, nations with the lowest emissions intensity for electricity generation are those with high shares of nuclear, hydroelectricity and geothermal energy – all of which are dispatchable sources of electricity.

Figure 6: There is no correlation between variable renewable energy and electricity emissions.



Source: Our World In Data; BP, Statistical Review of World Energy 2022.

The experience of electricity markets that are closing down reliable, low-cost baseload generators has not been positive. The intended policy outcome of low carbon emissions is only being achieved in part, and many markets are experiencing a series of unintended consequences – higher electricity prices and reduced grid reliability (often culminating in energy shortages).

Germany and California provide telling examples of these unintended consequences.

Case Study 1: Germany's Energiewende – billions spent to be worse off

Germany's Energiewende policy has been held up as the wunderkind of the bold transition to renewable energy. But instead of being the inspiration for a global renewable energy movement, Germany serves as the perfect example of problematic policy-led energy systems.

The cracks in Germany's energy transition had started to appear long before Russia invaded Ukraine, causing a spike in gas prices. Experts at McKinsey reported on the progress of Energiewende in 2019:

> *Germany has been a leader in the transition toward a low-carbon-energy system, but it will still miss most of its energy-transition targets for 2020.*
>
> *...Today's necessary message is clear: the country misses key targets... problems are emerging in all three dimensions of the "energy triangle." These recent struggles in Germany illustrate the potential pitfalls of a fast energy transition, but they can provide important lessons for other countries endeavoring on their energy transition.*
>
> *On the core issue of environmental sustainability, the energy transition is lagging far behind its 2020 targets. In 2018, 866 million tons of CO_2 equivalents (CO_2e) in emissions were released. While this amount represents a 4.5 percent drop from the previous year, it was still 116 million tons above the target of 750 million tons for 2020.*
>
> ***Security of supply under pressure***
>
> *... Germany has enjoyed a highly secure electricity supply for decades, but the tide is beginning to turn. The German power grid repeatedly faced critical situations in June of this year: significant shortfalls in available power were detected on three separate days. At its peak, the gap between supply and demand reached six gigawatts—equivalent to the output of six major power plants. Imports arranged on short notice from surrounding countries were required to stabilize the grid. Also, the price for balancing energy jumped to €37,856 per megawatt-hour in one instance. In 2017, the price for balancing energy averaged €63.90 per megawatt-hour.*
>
> *....The supply situation will become even more challenging in the future. The phaseout of nuclear power until the end of 2022, and the planned reduction of coal-fired generation, will gradually shut down further secured capacity. If new generation facilities are not added, the reserve margin will tumble, with consequences that vary considerably from one region to the next. Industrial areas in western and southern Germany will be hit especially hard, as large drains on capacity exist in these regions and high rates of renewable expansion are unlikely there. Furthermore, the shift from dispatchable capacity to fluctuating renewable sources could also lead to problems in situations when demand is high but supply from renewable energy is low...*

Electricity costs remain high

Economic development and growth have long constituted a problematic area for energy transition—especially when it comes to electricity-price development. For years, German consumers have paid more for their electricity than their European neighbors do. Today the electricity price for households is still about 45 percent above the European average.[2]

The risks forecast by McKinsey have not only been realised but accelerated by the Russian invasion of Ukraine. But, as distinguished American environmentalist and energy author Michael Shellenberger highlighted in 2022, this was still a situation created entirely by bad German energy policy:

> *Green campaigns have succeeded in destroying German energy independence—they call it Energiewende, or "energy turnaround"—by successfully selling policymakers on a peculiar version of environmentalism. It calls climate change a near-term apocalyptic threat to human survival while turning up its nose at the technologies that can help address climate change most and soonest: nuclear and natural gas.*
>
> *At the turn of the millennium, Germany's electricity was around 30 percent nuclear-powered. But Germany has been sacking its reliable, inexpensive nuclear plants.*
>
> *...Germany has also spent lavishly on weather-dependent renewables—to the tune of $36 billion a year—mainly solar panels and industrial wind turbines. But those have their problems. Solar panels have to go somewhere, and a solar plant in Europe needs 400 to 800 times more land than natural gas or nuclear plants to make the same amount of power. Farmland has to be cut apart to host solar. And solar energy is getting cheaper these days mainly because Europe's supply of solar panels is produced by slave labor in concentration camps as part of China's genocide against Uighur Muslims.*
>
> *The upshot here is that you can't spend enough on climate initiatives to fix things if you ignore nuclear and gas. Between 2015 and 2025, Germany's efforts to green its energy production will have cost $580 billion. Yet despite this enormous investment, German electricity still costs 50 percent more than nuclear-friendly France's, and generating it produces eight times more carbon emissions per unit. Plus, Germany is getting over a third of its energy from Russia.*
>
> *Germany has trapped itself. It could burn more coal and undermine its commitment to reducing carbon emissions. Or it could use more natural gas, which generates half the carbon emissions of coal, but at the cost of dependence on imported Russian gas. Berlin was faced with a choice between unleashing the wrath of Putin on neighboring countries or inviting the wrath of Greta Thunberg. They chose Putin.*[3]

2 Fridolin Pflugmann, Ingmar Ritzenhofen, Fabian Stockhausen, and Thomas Vahlenkamp, *Germany's energy transition at a crossroads*, McKinsey website, 21 November 2019.

3 Michael Shellenberger, *The West's Green Energy Delusions Empowered Putin*, 4 March 2022.

Germany's energy policy has been an expensive exercise in replacing what worked with what people hoped would work. The outcome has been higher prices, reduced economic growth and increased risk to the nation's energy security.

As noted in a 2019 article in Der Spiegel, one outcome Energiewende has delivered is an increase in government waste:

> *In the Economics Ministry alone, 287 officials are working on the issue, divided into four divisions and 34 departments. There are at least 45 additional bodies at the federal and state levels, full of people who also want to move the project forward. They collect vast quantities of data and come up with complicated incentives -- a huge effort that has produced only modest results.*[4]

Case Study 2: California dreaming

American author and journalist Robert Bryce has written extensively on the energy policy failings of the state of California. The state has followed Germany down a path of setting renewable energy mandates that force the closure of large baseload generators – nuclear power plants in their case.

The results have been similar to those in Germany – less reliable supply, higher prices and minimal environmental benefit:

> *Perhaps the most obvious casualty of California's climate policies is the state's tattered electric grid. Blackouts in the state have become so common, particularly in the Bay Area, that media outlets have largely quit reporting on them. Nearly every day, maps of Pacific Gas & Electric's service territory show outages across wide swaths of central California. The state's increased blackouts are coinciding with skyrocketing electricity prices. And those skyrocketing electricity prices are coinciding with the implementation of some of America's most-aggressive renewable-energy mandates.*
>
> *In 2008, Governor Arnold Schwarzenegger signed an executive order that required the state's utilities to obtain a third of the electricity they sell from renewables by 2020. In 2015, Governor Jerry Brown signed a law that boosted the mandate to 50 percent by 2030. In 2018, California lawmakers imposed yet another mandate that requires the state's electric utilities to procure at least 60 percent of their electricity from renewables by 2030 and to be producing 100 percent "zero-carbon" electricity by 2045.*
>
> *What has happened since The Terminator signed that executive order? Between 2008 and 2021, the all-sector price of electricity in California increased five times faster than rates in the rest of the continental United States. Last year alone, the all-sector price of electricity in California jumped by 9.8 percent to 19.8 cents per kilowatt-hour. Residential prices increased even more, jumping by*

4 Frank Dohmen, Alexander Jung, Stefan Schultz und Gerald Traufetter, *German Failure on the Road to a Renewable Future*, Spiegel International website, 13 May 2019.

11.7 percent to an average of 22.8 cents per kilowatt-hour. California residential users are now paying about 66 percent more for electricity than homeowners in the rest of the US.[5]

Renewable energy has promised much, with multiple studies claiming solar and wind have the lowest cost of electricity generation of all possible sources. Nevertheless, the experience of energy markets around the world has shown otherwise. The promised price reductions do not occur, and there is a strong positive correlation between the share of intermittent electricity generation in a market and electricity prices..

Empirical studies of the impact of renewable energy on electricity prices are beginning to tell a different story from the forward-looking thought pieces that have to date dominated the political and economic landscape.

A 2020 paper by Michael Greenstone and Ishan Nath at the University of Chicago demonstrated that renewable energy mandates in the United States have caused retail electricity prices to be 11-17 per cent higher than they would otherwise have been. While these policies delivered carbon abatement, it came at a cost ranging from $60 to $300 per tonne of CO_2.[6]

The authors attributed this higher cost, which contradicts many of the theoretical findings on renewable energy deployment, to "indirect grid integration costs such as transmission and intermittency".

These are the very costs that have been broadly overlooked in the race to replace dispatchable generation with intermittent renewables. Yet, there have been studies warning of this emerging issue for some time.

The Nuclear Energy Agency first released its studies on the total system cost impacts of variable renewable energy in 2012 and provided an update in 2019. This study not only showed that there are additional costs associated with managing high shares of variable renewable energy but also that dispatchable energy sources become more costly due to the additional requirement to flex around the often policy-prioritised renewable energy sources:

Profile costs (or utilisation costs) refer to the increase in the generation cost of the overall electricity system in response to the variability of VRE output. They are thus at the heart of the notion of system effects. They capture, in particular, the fact that in most of the cases it is more expensive to provide the residual load in a system with VRE than in an equivalent system where VRE are replaced by dispatchable plants... the presence of VRE generation generally increases the variability of the residual load, which exhibits steeper and more frequent ramps. This causes an additional burden, also called the flexibility effect, to other dispatchable plants in terms of more start-ups and shutdowns, more frequent cycling and steeper ramping requirements, leading to lower levels of efficiency, an increase in the wear and tear of equipment and higher generation costs.[7]

5 Robert Bryce, *California's Energy War on the Poor,* Quillette, 11 July 2022.

6 M. Greenstone and I. Nath, *Do Renewable Portfolio Standards Deliver Cost-Effective Carbon Abatement?,* 2020, University of Chicago.

7 OECD Nuclear Energy Agency, The Costs of Decarbonisation: System Costs with High Shares of Nuclear and

While this report focused on striking a balance between nuclear energy and variable renewable energy, the lessons are relevant to any electricity grid undertaking a shift from large "baseload" generators to variable renewable energy-based systems. In their modelling of the system costs under scenarios based on increasing shares of variable renewable energy, the study found:

> *System costs vary between less than USD 10 per MWh of VRE for a share of 10% of wind and solar PV to more than USD 50 per MWh of VRE for a share of 75% of wind and solar PV. Almost as important is the increase of USD 28 per MWh of VRE to almost USD 50 per MWh of VRE, both at a share of 50% of wind and solar PV, as a function of the availability of flexibility in the system in the form of interconnections with neighbouring countries and flexible hydroelectric resources. While such estimates come with some degree of uncertainty, the order of magnitude provides clear indications for policy choices.*[8]

These system costs are only an additional cost to an existing system using dispatchable sources of electricity in a base case scenario. In the scenario with a high share of variable renewable energy the impact on total electricity provision costs is severe – yet consistent with the international experience:

> *Reaching a 75% VRE target finally implies almost doubling the costs for electricity provision to almost USD 70 billion per year, representing more than USD 33 billion above the base case.*[9]

Australia is on the path to this scenario – we are following Germany and California.

The federal Labor government's energy policy is directing an 82 per cent share for variable renewable energy in Australia by 2030. But the international experience and studies are now clear: closing down our existing dispatchable generators will lead to even higher electricity prices.

Renewables, 2019, p.16.

8 Ibid., p.20.

9 Ibid., p.21.

The Australian experience mirrors the rest of the OECD

More renewable energy = higher prices

Australia has long been considered the lucky country. When it comes to energy, we certainly are. We have abundant sources of energy and have been notably successful in using low cost electricity to grow the economy and improve the lives of our people over the last century.

Our electricity grids are marvels of modern engineering that often go unnoticed. The east coast National Electricity Market has over 40,000 kilometres of transmission lines connecting 65 gigawatts of generators to more than 10 million daily consumers.

It is remarkable that this complex network of individual customers and multiple suppliers can operate every second of every day within some remarkably narrow engineering parameters. At every moment, demand in the grid must be met almost exactly by generation. The tolerance of differences between the two is minimal.

Too much demand, and the drain on the grid would at best cause our lights to flicker and at worst go off altogether.

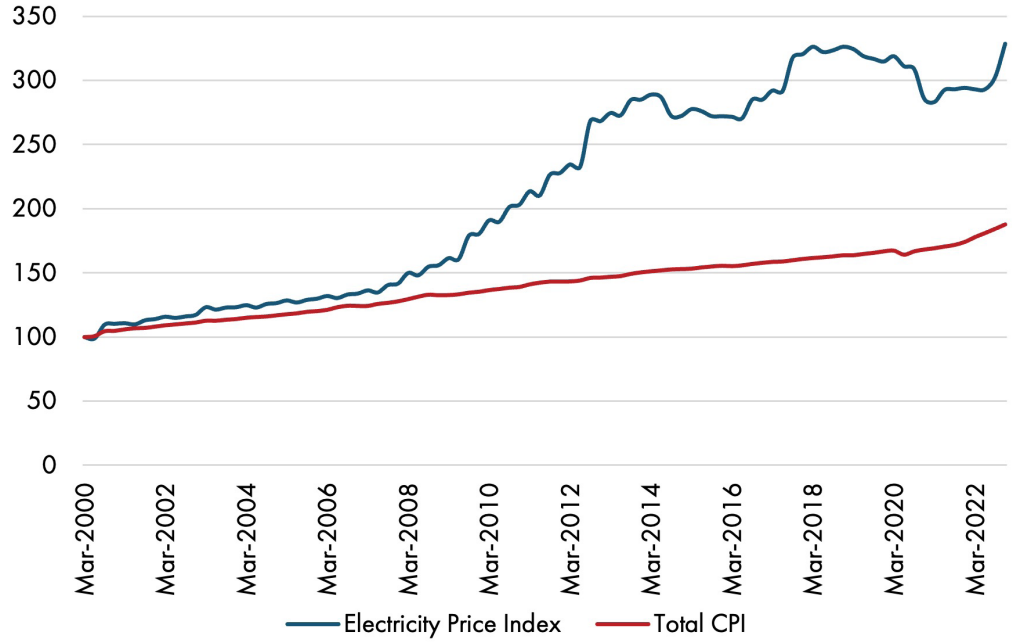
Too much supply can overload the grid, with the surge in electrical energy potentially damaging key infrastructure and maybe even the electrical appliances in our homes if appropriate safeguards are not in place.

This is the great strength of dispatchable and controllable energy in our electricity network. The system we built over a century was based on coal, gas and hydroelectricity generators that system operators and engineers had control over. Coupled with a well-designed market, the grid worked.

But in the last decade, something has gone awry in our electricity markets. The proven engineering and economic imperatives that once guided them have been supplanted by the wishful thinking of central policy makers.

As a result, our electricity prices have skyrocketed, with the electricity prices for households rising at more than double the rate of inflation.

Figure 7: Electricity has outstripped inflation in the calculation of CPI.



Source: Australian Bureau of Statistics.

Despite higher prices, there has been minimal investment in new reliable dispatchable sources of electricity. Instead, the lion's share of electricity investment has been directed towards variable renewable energy projects.

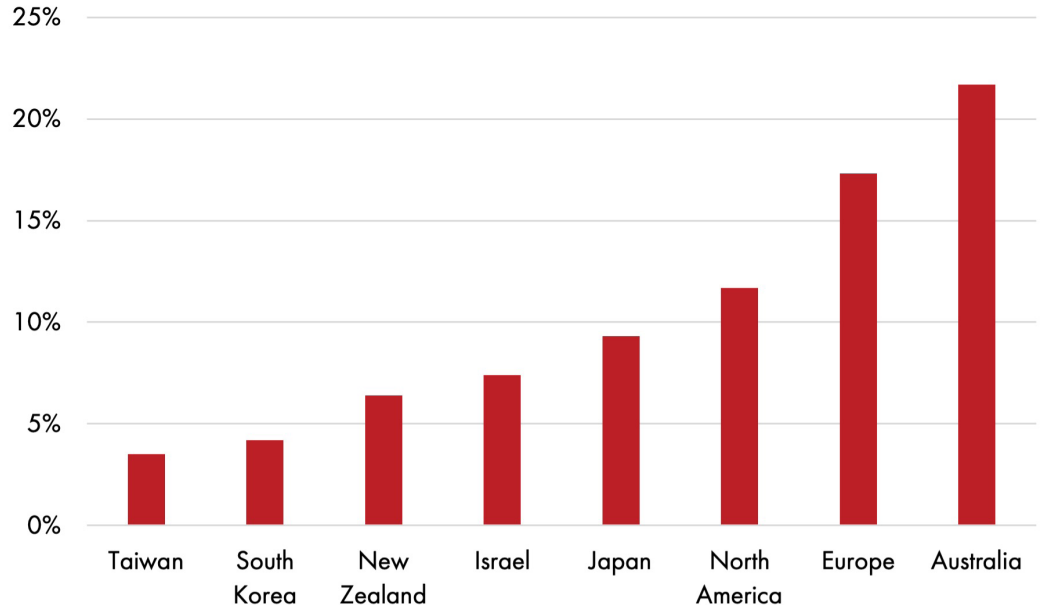
The extensive commentary about a decade of inaction in addressing climate change, and government holding back investment in renewables, could not be further from the truth. Renewable energy capacity and generation have surged in Australia.

From 2011 to 2021 wind turbine generating capacity increased 321 per cent to 8,951 megawatts. In the same period solar capacity, including both rooftop installation on houses and purpose-built solar farms, increased a staggering 672 per cent to 19,074 megawatts.

Australia is not a laggard in variable renewable energy – in fact for a nation with no imports or exports of electricity (often known as an 'islanded grid') we have the highest share of variable renewable energy generation in the world. When compared to the continental-scale electricity systems in Europe and North America, Australia's share of variable renewable energy is actually higher (see Figure 8).

Countries including Denmark, Germany and the UK all have higher individual shares, but their electricity grid connections to France, Norway and other European nations provide them with opportunities to import and export their intermittent energy sources and balance them with dispatchable nuclear and hydro energy when required.

Figure 8: Australia leads the world in variable renewable energy.



Source: BP, Statistical Review of World Energy 2022.

The issues for Australia relating to high variable renewable energy reliance are already starting to emerge. We simultaneously have low hydroelectric, nuclear and geothermal power while government policy is requiring our economy to lessen the carbon footprint of its electricity supplies.

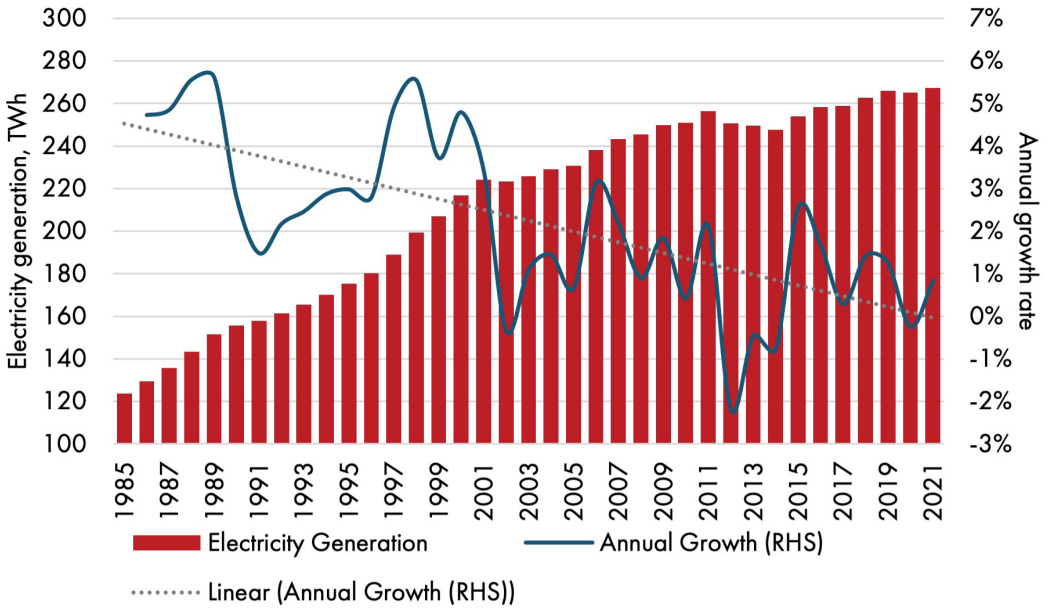
The result is consistent with the international experience – higher electricity prices. And unfortunately, we can expect more price rises to come if our existing dispatchable generators are rapidly closed to meet the government's mandated energy targets.

The impact of rising electricity prices

Higher electricity prices are weighing down the Australian economy and hurting households. Electricity consumption in Australia has barely changed since 2015-16 and has only grown at an annual average rate of 0.4 per cent in the last decade.[10]

Against a backdrop of rising population and a growing economy, this is not an indicator of a functioning energy market or prospering economy. The stagnant growth in electricity consumption is not the outcome of significant investment in energy efficiency, but rather a reflection of the decline in manufacturing activity in Australia which, since the GFC, has seen a 10 per cent decrease in Industry Gross Value Added.[11] In particular, Australia has experienced the closure of some of its most energy intensive businesses, such as aluminium smelting and car manufacturing.

Figure 9: Growth in Australia's electricity generation growth has plummeted.



Source: BP, Statistical Review of World Energy.

Worse still, on a per capita basis, both electricity consumption and total energy consumption in Australia peaked over 15 years ago and have been declining ever since.[12] If electricity consumption is an indicator of progress and economic development, this country is not on the path to prosperity.

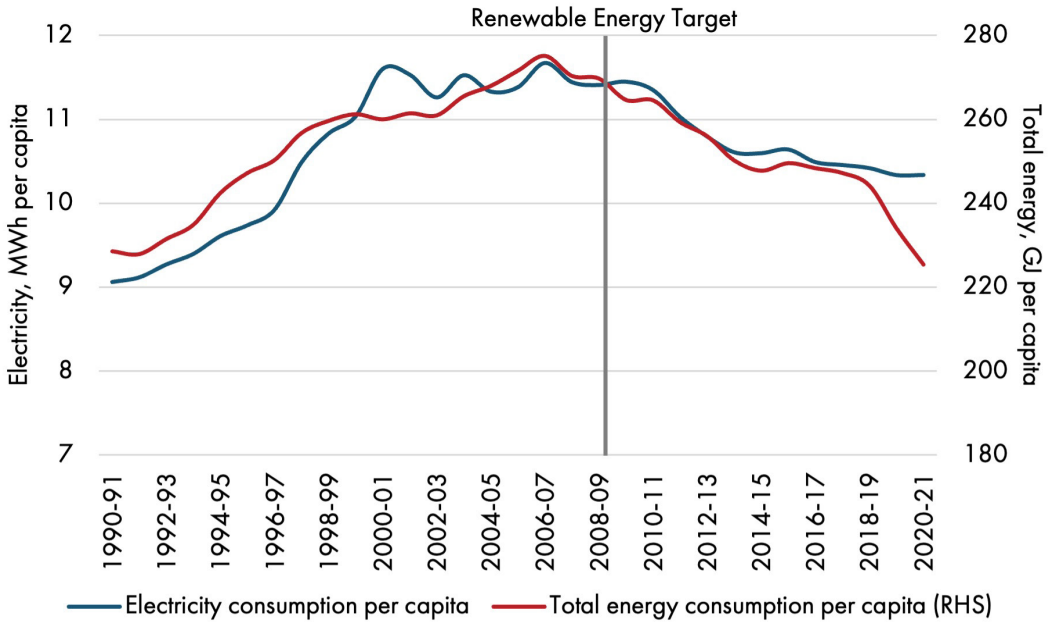
As can be seen in figure 10, it is also noticeable that the peak in Australia's per capita electricity and energy consumption coincided with the boosted Renewable Energy Target policy put in place by the Rudd government in 2007.

10 Department of Climate Change, Energy, the Environment and water, *Australian Energy Statistics*; BP, Statistical Review of World Energy 2022.

11 Australian Bureau of Statistics, *Australian System of National Accounts*, 2021-22 financial year, table 5.

12 Department of Climate Change, Energy, the Environment and Water, *Australian Energy Statistics*, Table B1.

Figure 10: The rise and decline in per capita electricity and energy consumption in Australia.



Source: Department of Climate Change, Energy, the Environment and Water, Australian Energy Statistics 2022.

What happened?

To paraphrase the distinguished American economist Thomas Sowell, when it comes to our electricity supplies, in Australia we have spent the last 20 years replacing what worked with what sounded good.

Whereas Australia previously had an electricity system based on dispatchable power sources including coal, gas and hydroelectricity, we have rapidly pivoted towards intermittent wind and solar energy sources.

In an attempt to decarbonise Australia's electricity system, policy makers across the country and at all levels of government took the nation down the same path several OECD nations have taken and mandated large increases in renewable energy sources (particularly wind and solar) at the expense of dispatchable sources – including the zero carbon nuclear energy.

Unfortunately, as previously highlighted, there have been few, if any, success stories in this space.

In Australia, the multitude of studies predicting lower costs of electricity arising from the mass deployment of variable renewable energy have often been compromised by assumptions that overlooked the strict operating parameters of the electricity grid. They ignored the total system cost approach in favour of a narrow focus on the cost of creating energy at a single site.

The much vaunted and publicised levelised cost of electricity (LCOE) that assesses the financial cost of an independent generating asset became the preferred metric of policy makers and politicians alike.

William Pentland of Genbright best described the misunderstanding and misuse of LCOE in a 2014 Forbes article:

> *The LCOE is like a bad line of code in a software program used to develop other software programs. It has dangerously skewed investors' understanding of the economics of generating electricity from renewable energy resources. It has also had perverse and difficult to undo impacts on local, state and federal energy policies.*[13]

This affect is more technically outlined in the 2021 book *Decarbonised Electricity – The Lowest Cost Path to Net Zero Emissions* by Australian energy experts Geoff Bongers, Andy Boston, Stephanie Bryom and Nathan Bongers, who summarised it superbly:

> *A major, albeit not publicly well-appreciated, risk of this transformation is that far-reaching and expensive decisions may be made – and may already have been made – on incorrect or misleading information flowing from conventional modelling approaches. Metrics widely in use at present, it is argued here, are simplistic and no longer appropriate for supporting key decision-making.*
>
> *...Changes in the market's mix of generation, plus the public and political focus on the need to maintain a fit-for purpose system, mean that cost comparison metrics used in the past have become less useful today.*[14]

Bongers et al consider an approach similar to the OECD Nuclear Energy Agency report on evaluating total system costs of the electricity grid to be a superior approach to simply identifying the stand-alone measurement of costs of an individual asset (such as a wind or solar farm):

> *A fundamental flaw in much of the existing modelling is the mindset that assesses the cost (to consumers) of deploying a particular generation technology independently of the grid in which it must be integrated, and that assesses the only useful output from the technology as electricity. This is of importance as the currently dominant approach to grid transition involves adding technologies that cannot be measured via levelised cost of energy (LCOE), such as synchronous condensers and battery storage.*
>
> *... LCOE, as a guide for policy, planning and development in the NEM, has significant shortcomings and in a diversifying system, its applicability has become increasingly limited. Critically, the use of LCOE in a market pursuing large-scale decarbonization can deliver very inaccurate and misleading signals for investors.*[15]

13 William Pentland, Levelized Cost Of Electricity: Renewable Energy's Ticking Time Bomb?, Forbes, 29 November 2014.

14 Geoff Bongers, Andy Boston, Stephanie Byrom & Nathan Bongers. Decarbonised Electricity. The Lowest Cost Path to Net Zero Emissions. Gamma Energy Technology P/L, Brisbane, Australia, February 2021.

15 Ibid., p.9.

It was only in 2022 that the CSIRO began to consider the total system cost in its flagship Gencost study. Even then the results seem to significantly underestimate the total system costs for integrating high levels of variable renewable energy in Australian electricity markets. Unfortunately, as William Pentland highlighted, there is often a contagion effect of using LCOE estimates. In Australia's case it is that the Australian Energy Market Operators grand visions for our future grid, the Integrated System Plan, draws heavily on the LCOE figures produced in the Gencost study.

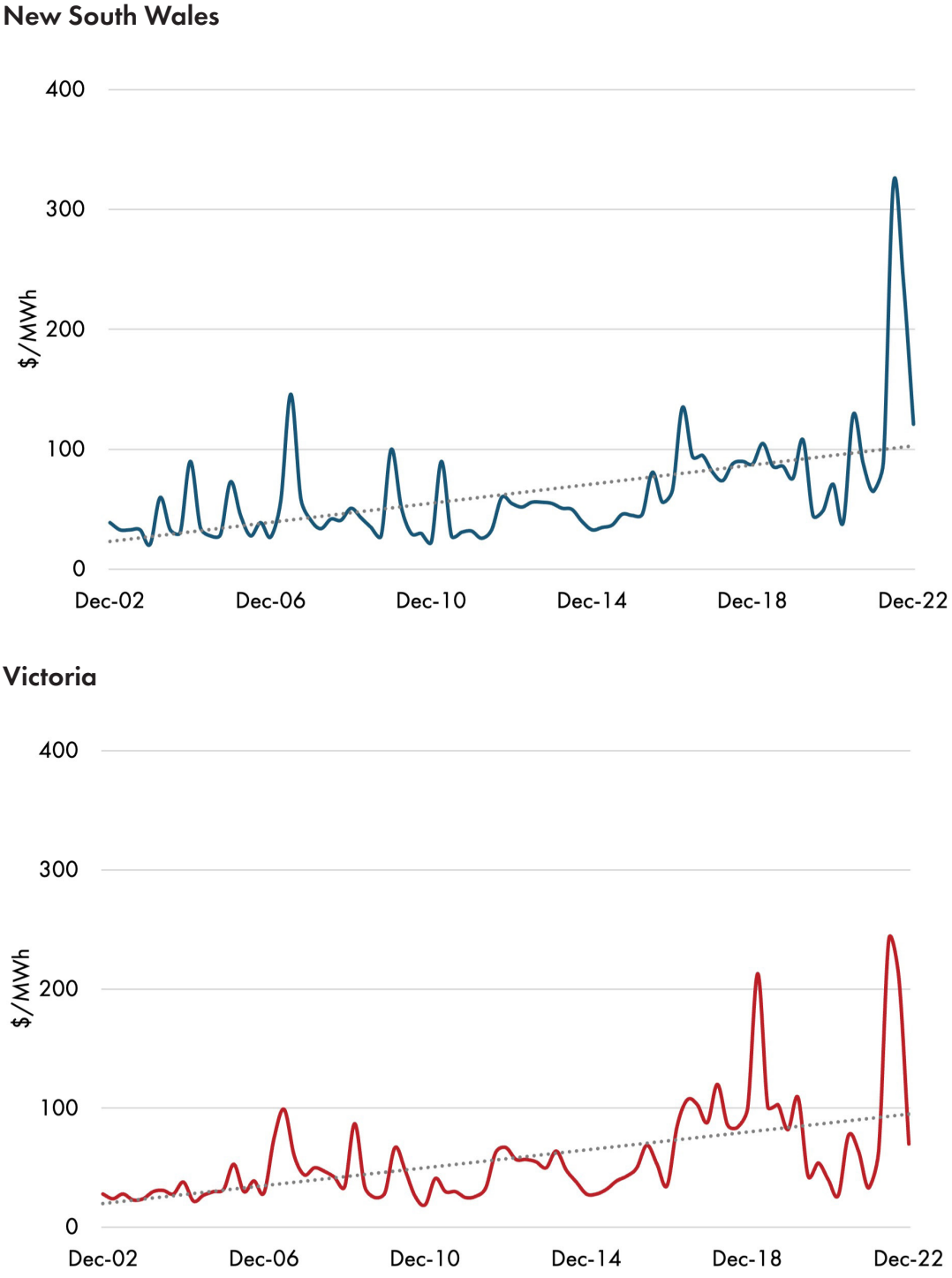
Pro-renewable energy policy is delivering an electricity market that is coming under increasing stress – higher prices and supply that is unable to respond to market signals.

Despite the claims that renewable energy would reduce energy prices in Australia, we have seen the opposite. COVID-19 managed to moderate price hikes for a while due to the reduced demand for electricity in 2020 and 2021, but since the economy re-opened, demand has grown again and electricity prices are now rapidly rising. The trend of rising wholesale electricity prices across the NEM is captured in Figure 11.

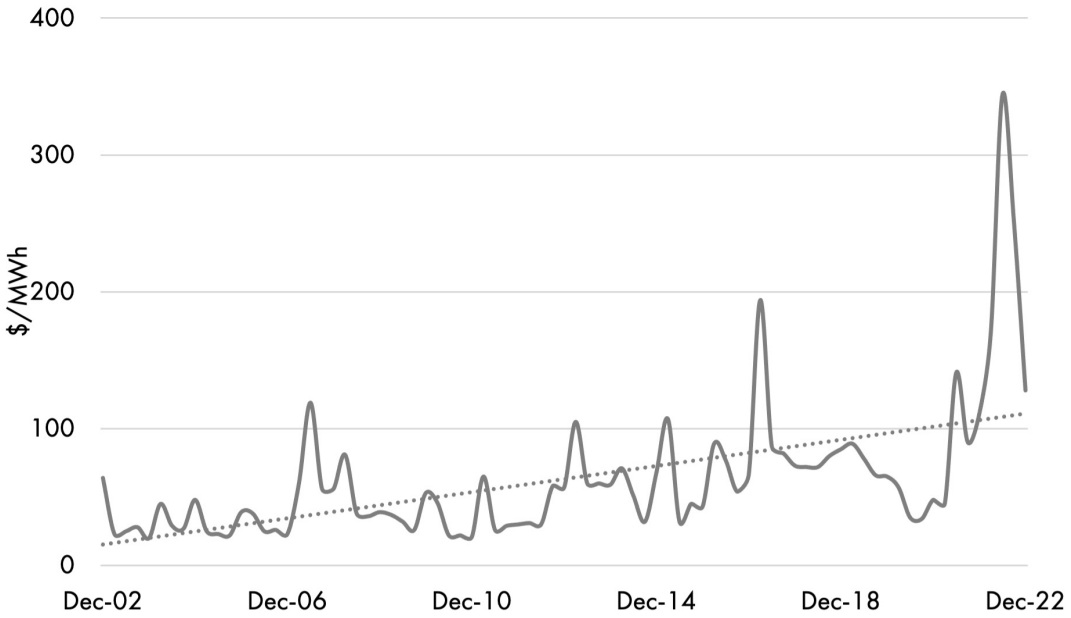
In 2022 we glimpsed the future as disruptions at several power stations across eastern Australia removed nearly 8 gigawatts of dispatchable generators from the market during winter. As figure 11 also shows, the resulting price spike was extraordinary. Even though there is an abundance of renewable energy capacity, it was incapable of supplying the market at this time – winter is typically a low period for solar generation and wind droughts are common.

The resulting undersupply and lack of competition pushed wholesale electricity prices to historical highs in every state connected to the NEM, and eventually led the AER to take the extraordinary measure of suspending the market – albeit at a market price of $300 per MWh.

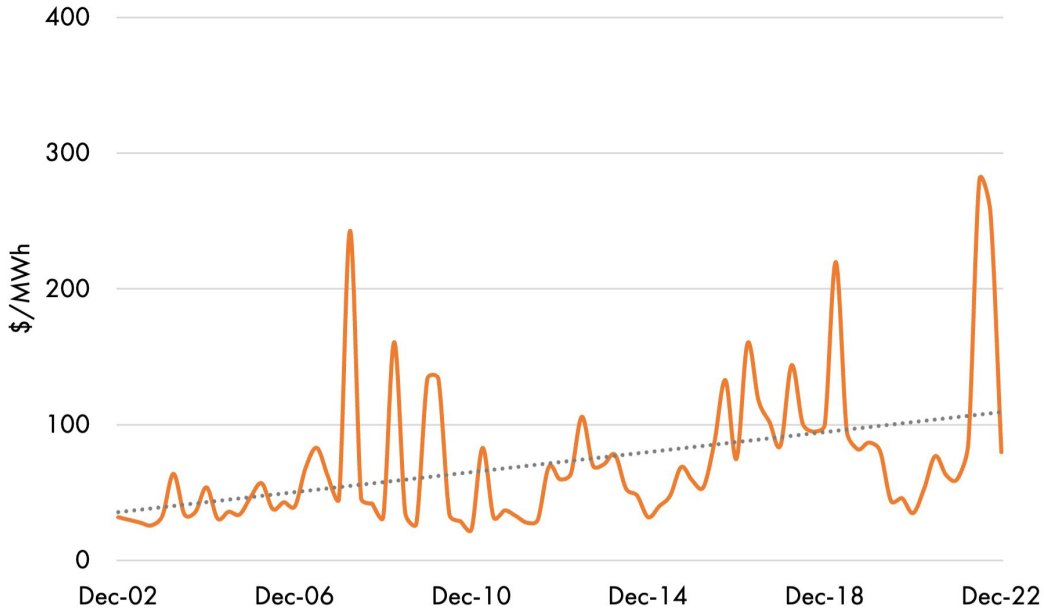
Figure 11: Rising wholesale electricity prices across the NEM.



Queensland



South Australia



Source: Australian Energy Regulator.

The outlook for Australia's electricity market

There is ample evidence of policy failure in overseas energy markets from which Australia can and should learn. But we can also see the impact of events playing out in our own energy markets. In the last decade around 4 gigawatts of dispatchable generator capacity have closed in Australia.

A review of these closures provides ample insight into the challenges the nation faces as it rushes to close more than 20 gigawatts of capacity by 2035.

Australia has been sleepwalking into the energy crisis for over a decade.

Part 1: Wallerawang and Munmorah power station closures

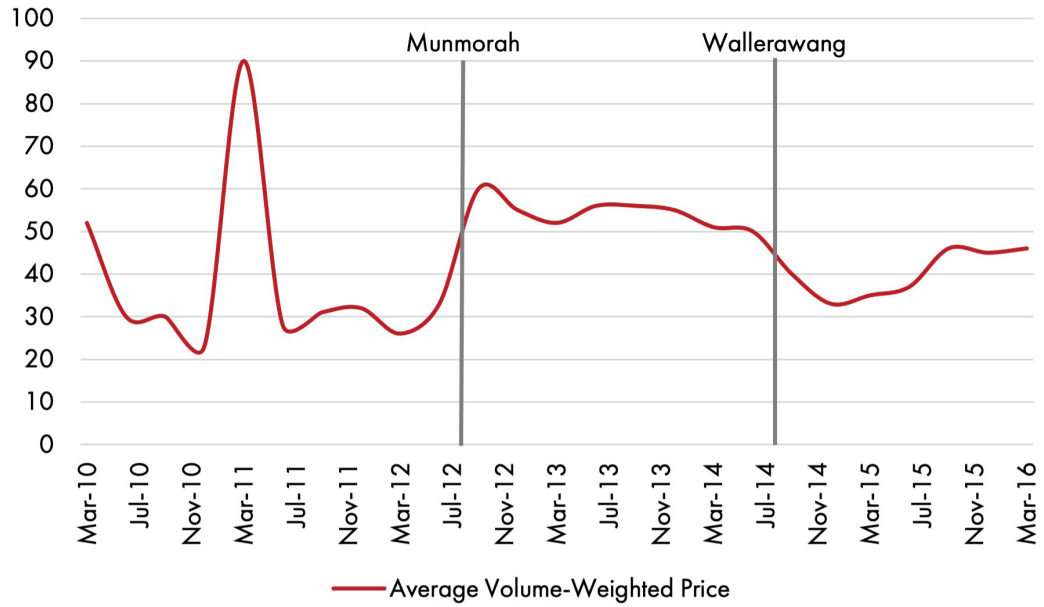
In a short space of time, the New South Wales electricity market experienced the closure of two power plants. Delta Electricity's Munmorah power station near Lake Macquarie shut down in 2012, just prior to the privatisation of Delta Electricity. This removed 1,400 megawatts of capacity from the market – although half of this capacity had already been mothballed since 2010.

Shortly after, Delta Electricity sold the Wallerawang power station to Energy Australia along with the nearby Mt Piper plant. In November 2014, the new owners permanently closed the Wallerawang asset down, removing another 1,000 megawatts of capacity from New South Wales' electricity market.

Faced with dwindling demand and increased competition from lower-cost electricity imports from Queensland, it was simply market forces at work that closed Munmorah and Wallerawang. New South Wales at the time had an oversupplied electricity market and no growth in demand.

The impact of the two power stations closures can be seen in Figure 12. Whereas Munmorah's closure tightened the electricity market and caused an immediate doubling of wholesale prices in New South Wales, Wallerawang's closure was accompanied by the closure of the Kurri Kurri aluminium smelter – one of the largest electricity consumers in the state. The subsequent drop in demand led electricity prices lower even with Wallerawang's closure.

Figure 12: New South Wales wholesale electricity prices after the closure of the Munmorah and Wallerawang power stations.



Source: Australian Energy Regulator

There have been no additional power station closures in New South Wales since Wallerawang shut down. Nevertheless, electricity supplied from its dispatchable coal and gas generators has decreased nearly 14 per cent, or 9,000 gigawatt hours, since then. This has been more than offset by variable renewable energy generation increasing by more than 11,000 gigawatt hours by 2021-22.

Despite the appearance of abundant electricity supply, this period again shows that the market conditions created by rising wind and solar energy generation do not deliver the promised lower prices. New South Wales' average wholesale electricity price increased by 170 per cent.

Part 2: Closing the last coal-fired power station in South Australia

Of all the states in Australia, South Australia is leading the charge to replicate Germany's energy policy. And it is experiencing similar challenges.

The Australian Capital Territory may claim to be powered by 100 per cent renewable energy, but this is mainly supported by a series of contractual arrangements it has with several wind farms in Victoria that offset its total electricity consumption.

The national capital is instead a small part of the New South Wales electricity market, which gets around 80 per cent of its electricity from fossil fuels.

South Australia is therefore the undisputed king of renewable energy in Australia. Wind and solar energy account already account for over 60 per cent of the state's electricity generation (higher than Germany and Denmark), up from 20 per cent 10 years ago – a fact the state government is volubly proud of.

It may not be as proud of the fact it also has the highest retail electricity prices in Australia, as well as the highest proportion of electricity customers on hardship programs.[16] It would seem the rising number of negative wholesale price periods often attributed to renewable energy has had little beneficial impact on the electricity consumer's experience in South Australia.

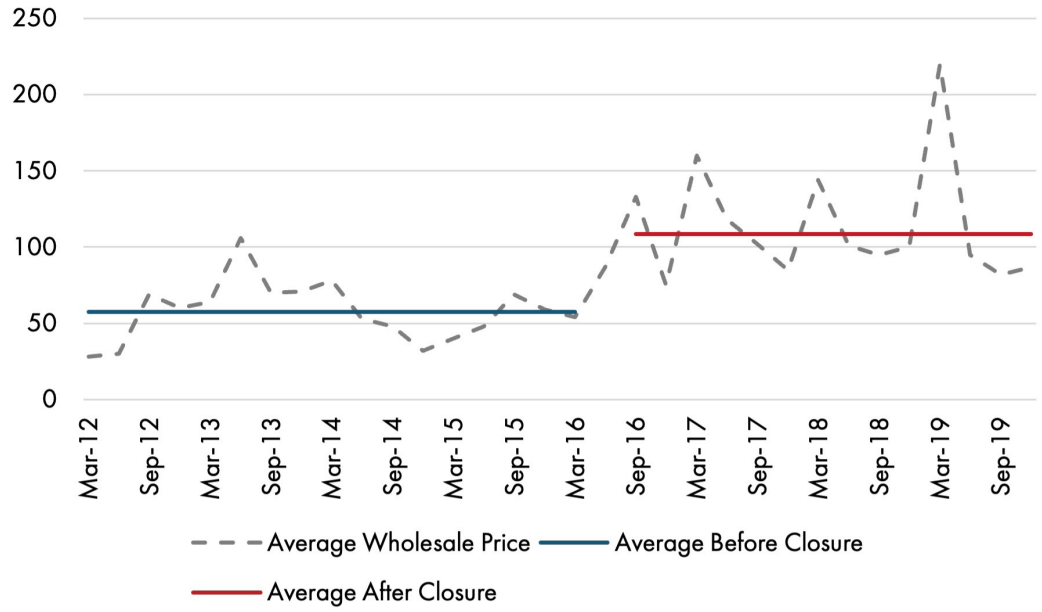
Figure 13: Residential electricity median market and standing offer prices.

Source: Australian Energy Regulator, Annual retail markets report 2021–22, figure 2.3.

South Australia's misadventures in energy policy can be traced back to the closure of the Northern power station in Port Augusta. In response to the government mandated rise in variable renewable energy generation, Alinta permanently shut down the Northern power station in May 2016. The average wholesale electricity price more than doubled within 3 months and higher prices were locked in for the state until the COVID-19 pandemic created softer demand conditions in the market.

16 Australian Energy Regulator, Annual retail markets report 2021–22.

Figure 14: Rising wholesale electricity prices in South Australia after the closure of the Northern power station.



Source: Australian Energy Regulator

In addition to higher prices, South Australia is facing rising challenges in managing its grid. As noted in the 2020 AEMO Electricity Statement of Opportunities report, this isn't being solved exclusively by adding new battery storage and building more interconnection to New South Wales.

The 2020 ESOO modelling includes 86 MW of committed VRE generation as well as 50 MW of additional battery storage capacity, 15 MW of gas generator upgrades, and 123 MW of additional liquid-fuelled generation in South Australia.[17]

Significantly, "liquid-fuelled generation" refers to a set of leased diesel generators that were required to meet demand at peak times.[18] South Australia also increased its use of these generators during the winter of 2022 when gas supply was tight and prices high.

These diesel generators are set to continue operating because, as noted by the Australian Energy Regulator in the 2022 edition of its *State of the Energy Market* report:

> *both South Australia and Victoria could breach the Interim Reliability Standard in 2023–24.*[19]

The report also succinctly highlights the rising risks associated with the increased deployment of variable renewable energy across the NEM – particularly in South Australia:

> *The wind and solar generators entering the market are less able to support system security. For this reason, the rising proportion of renewable plant in the*

17 Australian Energy Market Operator, *Electricity Statement of Opportunities*, 2020, p124.

18 https://www.abc.net.au/news/2019-08-28/back-up-power-generators-leased-to-private-companies/11457824

19 Australian Energy Regulator, State of the Energy Market, 2022, p.53.

NEM's generation portfolio will mean more periods of low inertia, weak system strength, more volatile frequency and voltage instability. It also raises challenges to the generation fleet's ability to ramp (adjust) quickly to sudden changes in renewable output.

AEMO is more frequently relying on directions to keep the system secure. Directions for system security are intended a last resort intervention, when the market has not delivered the necessary requirements. In South Australia, directions to market participants to take action to maintain or restore power system security have been in place for a substantial amount of time in the past 2 years at a substantial cost. In 2021 total costs for directing South Australian generators for system strength reached $94 million – almost double those costs in 2020.[20]

To South Australia's credit, the AEMO report acknowledges that actions are underway to address its grid reliability issues:

In South Australia, 4 synchronous condensers, installed by ElectraNet, started operating in October 2021 to provide system strength and inertia. Each has a flywheel with a large amount of momentum. In the event of a disturbance on the network, these provide the electrical inertia to power through the fault. They have reduced the number and cost of market interventions, relaxed constraints on wind and solar output and reduced the amount of gas generation required down to 2 units. Directions in South Australia fell from being in place over 80% of the time in the last quarter of 2021 to below 20% of the time in the first quarter of 2022.[21]

Further investment is likely to be required to boost South Australia's grid reliability. In late 2022 the system was again exposed when storm damage to a transmission tower cut an interconnector to Victoria.[22] Despite the investment in reliability management, the state faced a dual challenge of too much electricity from strong solar PV output at times (which would normally be exported to Victoria) and insufficient generation in other periods to operate the grid within the strict engineering parameters.

This was not the first time South Australia had faced transmission issues – in November 2016 the entire state endured a blackout. According to the Australian Energy Regulator:

The state-wide blackout on 28 September 2016 resulted from unprecedented circumstances. It was triggered by severe weather that damaged transmission and distribution assets, which was followed by reduced wind farm output and a loss of synchronism that caused the loss of the Heywood Interconnector. The subsequent imbalance in supply and demand resulted in the remaining electricity generation in SA shutting down. Most supplies were restored in 8 hours, however the wholesale market in SA was suspended for 13 days.[23]

20 Ibid., p.53.

21 Ibid., p.53.

22 AEMO, South Australia disconnected from the National Electricity Market, Media release issued 13 November 2022.

23 Australian Energy Regulator, The Black System Event Compliance Report, 2018, p.5.

There is no disputing the trigger of the event was weather-related; however, South Australia's reliance on variable renewable energy contributed to the problem. Media reports and political statements have often overlooked the inquiry report's detail on wind generation and its role in the tripping of the interconnector. But the inquiry report clearly shows that in the space of just 9 minutes, from 15.42 to 15.51, generation from wind farms fell 21 per cent. The resulting increased reliance on the Heywood interconnector from Victoria exceeded its operating thresholds causing it to disconnect South Australia.[24]

South Australia's electricity policies and experiences provide valuable insights into the challenges associated with high shares of variable renewable energy in a grid at the expense of dispatchable generation. Households and businesses in the state are experiencing rising electricity bills in direct contradiction of the claim that renewable energy is cheap and even forces wholesale prices down.

Renewable energy from wind and solar may be low cost, but the market conditions they produce create significant risks that must be mitigated by expensive investments in additional grid connections, energy storage and back up. Often this increases reliance on fast-response dispatchable generators, such as diesel and gas peakers, which are among the most expensive sources of electricity available.

Yet, even at higher prices and with more investment to come, reliability continues to be a problem. The latest Electricity Statement of Opportunities from AEMO still forecasts significant risks for South Australia, and it seems each successive report revises this risk up and brings it forward.

Rather than learning from the South Australian experience, other states in Australia are going down the same path. They too are closing their dispatchable generators and replacing them with variable renewable energy sources.

Part 3: The closure of Hazelwood

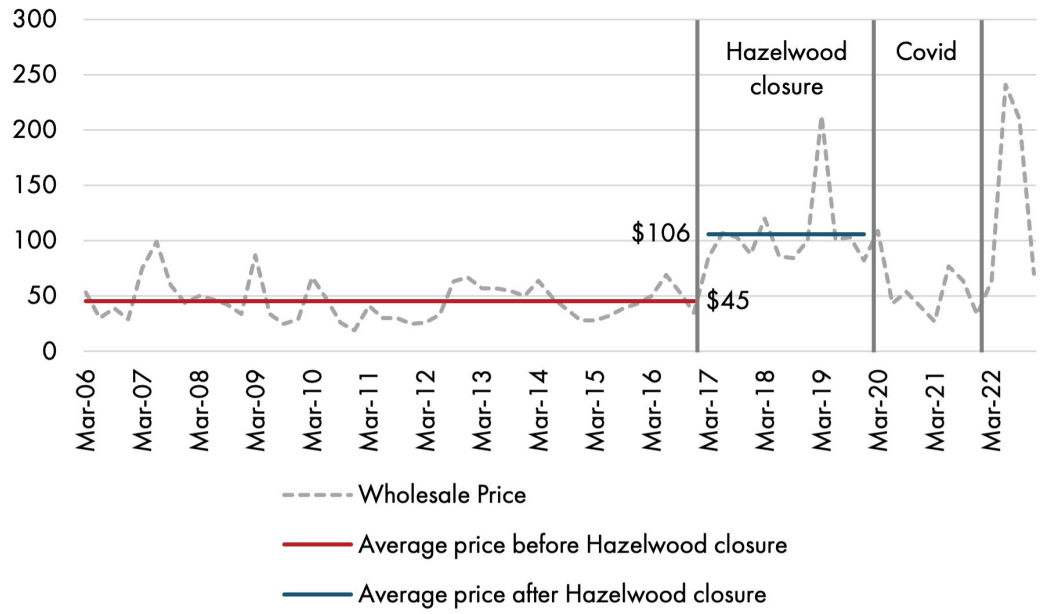
With a capacity of 1,600 megawatts, the Hazelwood power station was a critical piece of Victoria's energy infrastructure. For more than 50 years the plant delivered reliable, dispatchable electricity into the NEM using brown coal sourced from the adjacent mine.

Victoria's energy market was up-ended on 3 November 2016 by the announcement the Hazelwood power station would close. Hazelwood was an aging asset, but still produced 10,000 gigawatt hours of electricity in 2015-16 – around 20 per cent of Victoria's electricity supply.

As can be seen in figure 15 below, the impact on wholesale electricity prices in Victoria was severe. The average price in the March quarter of 2017 was $85 per MWh – up 70 per cent from the same period twelve months earlier, and the power station did not go fully offline until 29 March 2017.

24 Australian Energy Regulator, The Black System Event Compliance Report, 2018, p.41.

Figure 15: Impact of Hazelwood closure on Victorian wholesale electricity prices.



Source: Australian Energy Regulator

The following quarter delivered extreme price increases for Victorians, due to a shortage in dispatchable supply. The wholesale electricity price increased further and averaged $107 per MWh in the June quarter 2017.

Higher electricity prices became a feature of the Victorian economy for the next three years – averaging $106 per MWh. In the ten years prior to Hazelwood's closure, electricity price averaged just $45 per MWh. This was despite renewable energy generation in Victoria rising 27 per cent, or 2,200 gigawatt hours, from 2015-16 to 2018-19.

The broader problem was that the NEM is an interconnected electricity grid. The shortfalls and higher prices in Victoria were exported to other states, which also experienced higher electricity prices. This increase became locked in until weaker demand during COVID-19 pandemic eased prices.

Table 1: Average annual wholesale prices before and after the Hazelwood closure.

State	2014-15	2015-16	2016-17	2017-18	2018-19
NSW	$36	$54	$88	$85	$92
QLD	$61	$64	$103	$75	$83
SA	$42	$67	$123	$109	$128
TAS[25]	$37	$97	$76	$88	$88

Source: Australian Energy Regulator

25 Tasmania's 2015-16 price spike pre-dated the Hazelwood closure and was the result of low water flow into its hydroelectric power stations. Technical problems also prevented electricity imports via the Basslink interconnector from Victoria. Diesel generators were used more often but caused higher prices throughout 2015-16.

The closure of Hazelwood not only caught the Australian Energy Market Operator off guard, but also immediately created a significant shift in their future risk assessments for the stability of the NEM.

Here is their assessment of risks in the NEM just three months prior to the announced closure of Hazelwood:

> *Under a neutral economic and consumer outlook – and in the absence of new generation, network or non-network development – coal-fired generation withdrawals at the levels assumed may lead to reliability standard breaches.*[26]

The next report, released in September 2017, provided a significant shift in the assessed risks:

> *AEMO's 2017 Electricity Statement of Opportunities (ESOO) modelling shows reserves have reduced to the extent that there is a heightened risk of significant unserved energy (USE) over the next 10 years, compared with recent levels.*
>
> *AEMO's analysis shows a heightened risk that the current NEM reliability standard will not be met, and confirms that for peak summer periods, targeted actions to provide additional firming capability are necessary to reduce risks of supply interruptions.*
>
> *... The highest forecast USE risk in the 10-year outlook is in 2017–18 in South Australia and Victoria. This risk is being addressed by the South Australian Government's Energy Plan developing additional diesel generation and battery storage, and AEMO pursuing supply and demand response through the Reliability and Emergency Reserve Trader (RERT) provisions.*[27]

As previously highlighted, this assessment came at a time when electricity demand growth was stagnant and renewable energy investment was surging. Yet, the closure of just one major coal-fired power station with a capacity of 1,600 megawatts created significant reliability risks and higher prices in the NEM.

The question now is, how will the government's plan to close the next 20,000 megawatts in the next seven years affect the NEM, electricity consumers and the Australian economy?

26 Australian Energy Market Operator, Electricity Statement of Opportunities, 2016.

27 Australian Energy Market Operator, Electricity Statement of Opportunities, 2017.

Where to from here - the closures still to come

Australia's energy market and policy making is now at a crucial point. Government policy is mandating a fundamental shift in the nation's electricity supply while simultaneously aiming to stimulate greater demand through industrial policy, increased immigration and electrification.

The cracks are already appearing.

On 31 August 2022 AEMO released its 2022 edition of the Electricity Statement of Opportunities. A key finding of the report was that reliability gaps are forecast in all mainland NEM regions in the next decade, based on existing and committed developments only. Furthermore, the report noted; *"Since the 2021 ESOO, potential retirements and commissioning delays to committed projects have also influenced the reliability forecast".*[28]

This includes reliability gaps forecast in South Australia (from 2023-24), Victoria (2024-25) and New South Wales (2025-26).

While the report noted the large and still growing capacity of variable renewable energy, it also signalled this warning:

> *there is enough resource potential to approach and on occasion reach 100% instantaneous supply from renewable resources.... A high proportion of this renewable generation is from inverter-based resources (IBR, meaning wind and solar generation, including distributed PV). With AEMO's current operating toolkit, it would not be possible to maintain the power system securely under these conditions.*[29]

AEMO subsequently released a report titled Engineering Roadmap to 100% Renewables in December 2022. While it is admirable that AEMO is finally adopting the total system approach advocated by numerous energy experts around the world, it also confirms that Australia is on the path to incurring the additional costs associated with high variable renewable energy shares in a grid's electricity mix. Costs inevitably borne by households and businesses.

Notably, the roadmap is a document rich in engineering and policy action items – but it provides no cost information or economic assessment of its planned 100 per cent renewable future.

On 21 February 2022 AEMO released an update to its 2022 Electricity Statement of Opportunities report "due to material changes affecting available generation capacity in the National Electricity Market from that set out in the 2022 Electricity Statement of Opportunities".[30]

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28 Ibid., p11.

29 Ibid., p14.

30 Australian Energy Market Operator, Update to 2022 Electricity Statement of Opportunities, 2023.

The key findings of this update were that recent government actions to invest in energy storage had delayed, but not solved the looming reliability problems facing the NEM. But delays to Snowy 2.0 and the Kurri Kurri gas project (both government-led initiatives) were still putting New South Wales' energy security at risk.

More bad news for New South Wales

New South Wales now finds itself at the forefront of energy market risks. The permanent closure of the Liddell power station at the end of April 2023 is likely to create similar market issues to those caused by the closure of Hazelwood.

Recent experience in Australia and around the world highlights why the occasion of Liddell's closure should mark a line in the sand for the close of baseload power plants.

Liddell was a coal-fired power plant with a capacity of 2,000 megawatts. It had been operating well below its potential due mainly to its age – its generators were first commissioned in 1971. Nevertheless, it had still been producing around 10 per cent of New South Wales' electricity supply.

The surge in variable renewable energy output in New South Wales in recent years (tripling in the last five) is not enough to offset this closure. Clearly, if it were, New South Wales would have been spared the electricity market crunch that came in the winter of 2022.

It wasn't.

New South Wales can instead expect to experience greater price variability in the future. During periods of high renewable energy output, warm sunny days with lots of wind, wholesale prices will be low reflecting strong supply availability and the near zero marginal cost of renewable energy projects.

(It is worth noting that this abundance of renewables is also contributing to their own commercial challenges. The low prices when renewables are abundant reduce the financial returns on wind and solar projects, making them almost un-investable. It is no surprise, though concerning, that the Clean Energy Finance Corporation has returned to offering financing deals for wind and solar farms in Australia.[31])

But when less than ideal conditions prevail, such as wind droughts at night, tight supply conditions will leave a market more reliant on flexible generators such as gas turbines to set wholesale electricity prices.

In the past this may have been manageable, but with Liddell's closure New South Wales can expect to experience even tighter market conditions, with higher price volatility, increased risks of load shedding (the favoured euphemism for brownouts) and demand response (also known as paying large energy consumers to not use energy).

31 Australian Financial Review, Energy prices are soaring, so why are taxpayers helping out new solar?, 15 November 2022.

New South Wales' electricity supply is clearly at risk. Despite its age, Liddell still produced 8,000 gigawatt hours of dispatchable electricity in 2021-22. In comparison, the state's entire network of large-scale wind and solar projects provided about the same amount of electricity that year.

The Kurri Kurri gas power station offered some hope for managing New South Wales' electricity market risks, but it is now delayed at least a year as the result of an ill-conceived policy to have it run partly on hydrogen from day one.

New South Wales' only option is to rely on its network connections to Queensland and Victoria to import even more electricity. But as Hazelwood's closure showed, the integrated NEM also allows the export of reliability risks and higher prices to other states.

Liddell's closure will not only create sustained higher prices for New South Wales households and businesses, but the contagion effect will increase demand and prices in Queensland in particular. Unfortunately, this winter Queensland also finds itself with the prospect of a tighter electricity market, with the Callide coal-fired power station still partly offline for maintenance and repairs.

New South Wales cannot continue down the path of closing reliable, low-cost baseload generators without adequate replacements being available.

Unfortunately, it is.

It gets worse

In February 2022 Origin Energy announced it was bringing forward the closure of the Eraring power station from 2032 to 2025.

Eraring is the largest power station in Australia, with a capacity of 2,800 megawatts. Like Liddell, it has been operating well below its potential, but its output of around 12,000 gigawatt hours represents around 15 per cent of New South Wales' electricity.

The Perrottet government response to the announcement was typical of the head-in-the-sand political approach to energy policy:

> *NSW energy supply will remain secure after the closure of the Eraring Power Station following the NSW Government's announcement that it will move to accelerate transmission upgrades and the construction of new electricity generation.*
>
> *To ensure energy reliability, the NSW Government will work with industry partners to install the Waratah Super Battery, a 700MW/1400MWh grid battery, by 2025 to release grid capacity so Sydney, Newcastle and Wollongong consumers can access more energy from existing electricity generation.*

> *"New South Wales has the strongest reliability standard in the country – the Energy Security Target – which aims to have sufficient firm capacity to keep the lights on even if the State's 2 largest generating units are offline during a one-in-10 year peak demand event," Mr Kean said.*[32]

The Waratah Super Battery, though large, provides no new energy into the New South Wales electricity grid. At best, at any given time it can deliver 25 per cent of Eraring's maximum output – for just two hours before recharging. The government's own project website describes the battery more as a "shock absorber" than a source of new energy.[33]

For the new state government, there is still the potential to avoid the worst of the electricity market problems it has inherited.

On 27 March 2023 private equity fund Brookfield Asset Management signed a deal to finalise the purchase of Origin Energy. A government-led deal with the new owners to delay the closure of Eraring is possible, with Brookfield previously indicating it was open to extending Eraring's operating life to maintain market stability.[34] This would not only be a major political achievement, it would save the state millions in unnecessary electricity bill increases.

Over 20 gigawatts of dispatchable capacity are still scheduled to close by 2035

The federal government's energy policy is clear, albeit problematic. Renewable energy is to account for 82 per cent of Australia's electricity by 2030. This comes despite the mounting empirical evidence that such mandates elevate electricity prices.

But the energy sector is following this lead, with several companies announcing earlier retirement for their assets over the last year.

This disruption will not go unnoticed in electricity markets. Australians should be bracing for higher prices in the future, as more than 20 gigawatts of dispatchable, reliable coal and gas fired power stations are set to close by 2035. The power stations scheduled to close produced around 40 per cent of Australia's electricity in 2021-22.

32 New South Wales Government, NSW response to the closure of the Eraring Power Station.

33 EnergyCo website, Waratah Super Battery, viewed 5 April 2023.

34 Angela MacDonald-Smith and Samantha Hutchison, Brookfield open to talks with NSW on Eraring sale, Australian Financial Review, 28 March 2023.

Table 2: Australia power station closures to 2035.

Power Station	State	Fuel	Expected Closure	Capacity MW	Generation GWh
Liddell	NSW	Coal	2023	2,000	8,106
Eraring	NSW	Coal	2025	2,880	12,012
Torrens Island B	SA	Gas	2026	800	1,074
Collie	WA	Coal	2027	340	1,248
Callide B	QLD	Coal	2028	700	4,293
Yallourn	VIC	Coal	2028	1,450	8,363
Bluewaters	WA	Coal	2029*	400	1,636
Muja	WA	Coal	2029	1,094	4,113
Vales Point B	NSW	Coal	2029	1,300	6,278
Bayswater	NSW	Coal	2033	2,600	14,861
Callide C	QLD	Coal	2035	825	2,570
Gladstone	QLD	Coal	2035	1,680	5,911
Kogan Creek	QLD	Coal	2035	750	5,541
Loy Yang A	VIC	Coal	2035	2,200	15,143
Stanwell	QLD	Coal	2035	1,400	8,616
Tarong & North	QLD	Coal	2035	1,840	11,095
Total				22,259	110,860

Notes: Expected closure date for Bluewaters based on AEMO forecast.

Queensland government owned generators expected to close by 2035 to achieve the state's 80 per cent renewable energy target.

Source: AEMO, Clean Energy Regulator, company reports.

To accommodate the federal government's renewable energy target, several of the power stations shown in table 2, plus those not listed (Mt Piper, Millmerran and Loy Yang B) may need to close sooner or at least significantly curtail their output.

The federal government has already opted against the advice of the Energy Security Board in its announced version of a capacity mechanism scheme. Instead of delivering a program of incentives to keep some of these dispatchable generators online and capable of delivering energy or grid management services in times of generation shortfalls, the government has created another channel for funding variable renewable energy projects with its Capacity Investment Scheme.[35]

The Capacity Investment Scheme is the antithesis of the dispatchable generation the NEM needs to replace the lost output from the power stations listed above.

35 Australian Financial Review, *Coal and gas cut out of capacity mechanism*, 8 December 2022.

Replacing this output with variable renewable energy projects and the associated network, storage and frequency management projects in the timeframe required is not only challenging, recent experience in Australia with delays and cost blow outs on projects including Snowy 2.0 and the Western Renewables Link/VNI West project, suggest it is completely unrealistic.

Not only will projects not be built in time, they will be increasingly expensive which will simply add to energy consumer pain.

And, with their high usage of variable renewable energy, these are the very projects that advocates of the total systems cost approach to modelling energy markets suggest are driving energy prices higher.

Conclusion

The Australian energy market is an experiment being keenly watched by international observers. For some, Australia's continuing push to increase the proportion of variable renewables in its energy markets provides a counter-narrative to the obvious energy market failures in Europe and North America.

In reality, pursuing the renewables dream has little to do with economics; it is more about ideological purity. But it's Australian households and industry that will pay the price for this ideological experiment, not those in Europe and North America looking for vindication despite their own failures.

Australia faces an inflection point.

It can continue down the path of closing what have been reliable low-cost baseload power stations without adequate replacement being available.

Or it can do what should be obvious to all elected officials – keep the lights on while planning to build new plant that is actually capable of meeting the real world energy needs of Australian households and industry.

Liddell's closure means the system is now on a knife's edge. Until new replacement capacity is built that can meet what dispatchable power stations actually provide, Australia is at serious risks of energy shortages.

Variable renewable energy has proven to be an unsuitable substitute when dispatchable generators close down, and a growing body of evidence shows it is also an expensive one.

At the very least, policy makers should halt the premature closure of baseload power stations.

LIDDELL THE LINE IN THE SAND: WHY IT'S TIME TO HIT PAUSE ON THE CLOSURE OF COAL-FIRED BASE LOAD POWER STATIONS IN THE NEM

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