The Health of the National Electricity Market

2019

ENERGY SECURITY BOARD

Volume 1: The ESB Health of the NEM Report

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1. Executive Summary

Over the last year the transformation of the National Electricity Market (NEM) has progressed at a remarkable pace and scale. Utility scale wind and solar PV continued its rapid roll out with an additional 3,184 MW of wind and solar accredited over the past 12 months. See Figure 1 below.

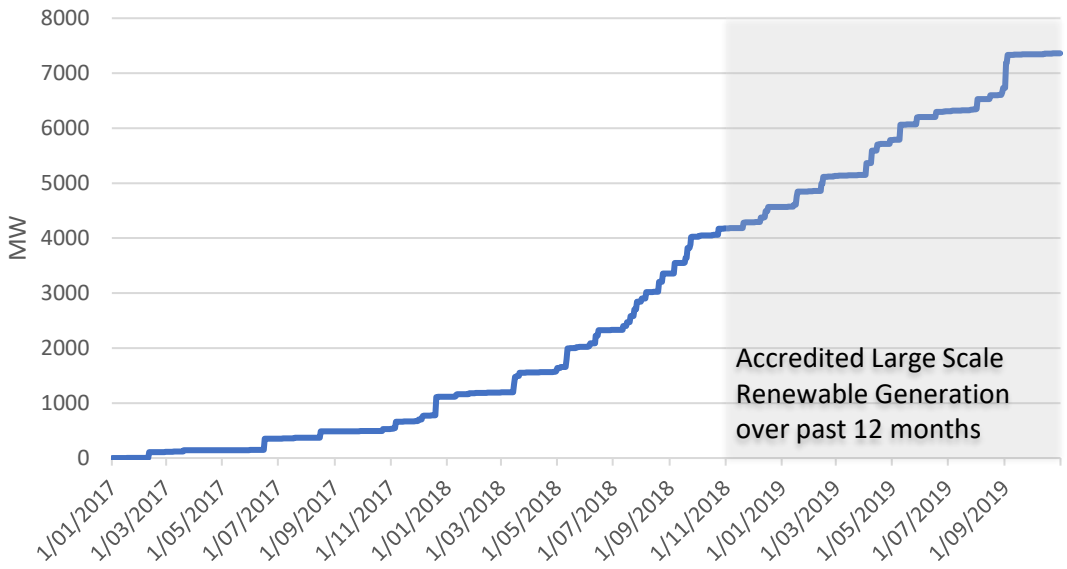

FIGURE 1: LARGE-SCALE RENEWABLE GENERATION ACCREDITED FOR THE NEM SINCE 1 JAN 2017

SOURCE: CLEAN ENERGY REGULATOR

Equally remarkable is the growth in Distributed Energy Resources or rooftop solar PV, batteries and smart meters. Over the last year the number of installations remained at 140,000 – 160,000 per month; however the average size of each installation increased. The 6.5-9.5 kW category is now the most common size of solar panel installation. This is shown in Figure 2.

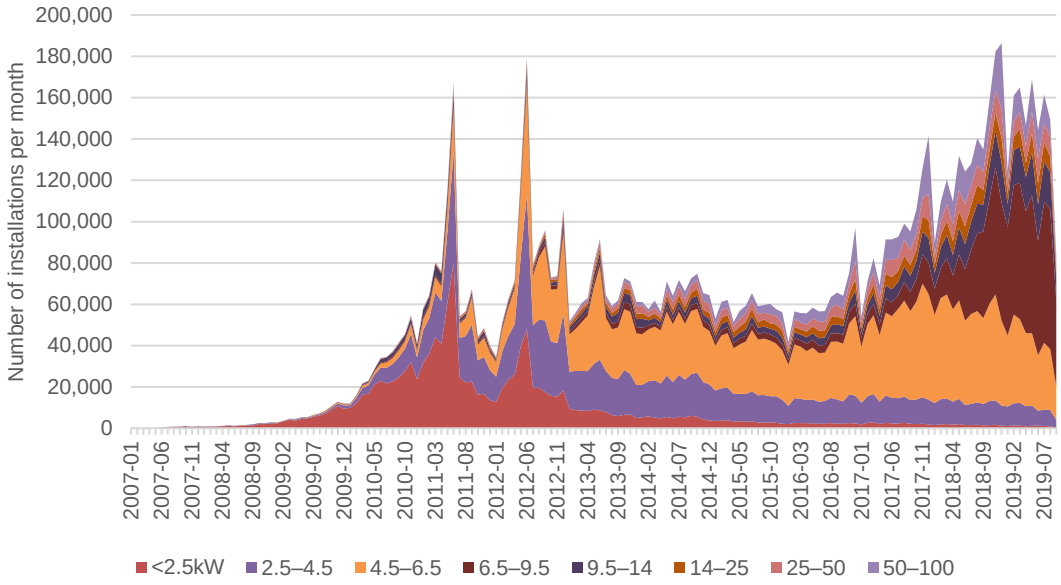

FIGURE 2: SMALL SCALE SOLAR INSTALLATIONS BY SIZE IN KW SINCE JAN 2007

SOURCE: AUSTRALIAN PV INSTITUTE

AEMO estimates that 16% of electricity consumed in the NEM in 2018-19 was generated by wind and solar PV and this is forecast to increase rapidly, driven by falling technology costs, government programs, and consumer preferences. By 2022 the proportion is forecast to be around 27% and by 2030 above 40%. This size and pace of transition places Australia in an international cohort that includes Ireland, California, Germany, Spain and Portugal.

Australian jurisdictions are in different phases of transition. Tasmania with its hydro and wind resources is able to operate at close to 100% renewables. South Australia operates with a variable renewables output of about 53% annually. Other States in the NEM are currently operating in a zone of 10-20% of variable renewables output and this proportion is growing quickly. What is uniquely Australian is the proportion of generation from rooftop solar PV. At present this is about 5% of total NEM generation output; by 2030 it is expected to be 10%.

The challenges that this rapid introduction of large and small scale Variable Renewable Energy poses were identified in the *Independent Review into the Future Security of the National Electricity Market* (the Finkel Review). As the proportion of low cost variable renewable generation increases, the focus is to provide:

- supply when solar and wind are not available,
- system security through new markets for services like frequency, voltage control, and inertia, and system strength
- transmission network reconfiguration to accommodate new (mainly renewable) generation in new locations,
- distribution network reconfiguration to accommodate distributed energy resources (rooftop solar, batteries and smart meters, etc),
- affordable energy and reward for customers, and
- strong and agile governance of system operations, regulation and market development.

The pressure to meet these challenges grows as the proportion of variable renewables increases. The Finkel Review set out a transition path for the industry. It made 50 recommendations for an orderly transition to ensure a reliable, secure and affordable system as carbon emissions reduced. The Energy Security Board has been implementing the 49 of those recommendations that were agreed by the COAG Energy Council.

A Strategic Energy Plan to implement the transition has been developed by the COAG Energy Council for the NEM. As a first step six objectives were agreed. This annual 'Health of the NEM' assesses progress and the future outlook against these objectives. This assessment is summarized in Table 1. The next sections of the Health of the NEM Report analyse these six objectives in more detail.

Progress is being made and the current status and outlook overall is improved on previous years.

This improvement is largely because what needs to be done is now clearer and implementation has begun: the task is now to finish that implementation over coming years.

TABLE 1: CURRENT STATUS AND FORWARD OUTLOOK FOR THE NEM

	Proposed Ratings		**Last Year's Ratings**	
	Current status	Outlook	Current status	Outlook
Affordable energy and satisfied consumers	Moderate-Critical	Moderate	Critical	Moderate
Secure electricity and gas system	Critical	Critical	Critical	Critical
Reliable and low emissions electricity and gas supply	Critical	Moderate	Moderate	Critical
Effective development of open and competitive markets	Moderate	Good-Moderate	Moderate	Good-Moderate
Efficient and timely investment in networks	Moderate-Critical	Moderate	Moderate-Critical	Moderate-Critical
Strong but agile governance	Moderate	Moderate	Critical	Moderate-Critical

As the table makes clear the issue of most concern in the NEM is *security*. This is a critical issue at present and for the future. While there has been understandable concern about reliability, and whether or not there is sufficient supply or demand response when wind and solar is not available, the more immediate worry is maintaining security. To be secure the electricity system must operate within defined limits of frequency, voltage, inertia and system strength and be able to maintain that through disturbances. Failure to do so can seriously damage a power system and lead to significant supply interruptions.

Reliability has been rated as critical a worse rating than last year. Even though no immediate gap in supply was identified in the ESOO, maintaining reliability has been a

challenge. More severe weather conditions in summer, along with ageing generators, is an immediate issue.

Over the longer term the NEM has additional future requirements. These include:

- Changing to a long-term, fit-for-purpose market design, based on a clear understanding of the need to support security and reliability as the market transitions.
- Integrating Distributed Energy Resources into distribution networks and the NEM in order to optimise the use of Distributed Energy Resources for the benefit of all electricity system users.
- Recognise the importance of demand side flexibility – particularly important with increased variation in weather.
- Developing a market design to recognize the need for a cost effective and resilient system in the face of the more frequent and severe weather events being experienced.
- Need to invest in digital tools for the operation and management of the system.
- Need to modernise the rules and law to be assured they adapt to the rapidly changing technical environment.
- Ensuring that regulatory frameworks can adequately respond to the rapid transformation of the system while continuing to provide safeguards for consumers.
- Understanding the changing role of financial contracts in the NEM as the operating profiles and generation mix transforms and the impact this has on the competitive dynamics at a wholesale and retail level.
- Monitoring new investment in generation and networks and checking that projects are underway and being delivered successfully and on time.
- Ensuring that future workforce requirements to manage the network construction and the continued rapid uptake of variable renewable energy and distributed energy resources are understood and met.
- Monitoring the unintended consequences from continued policy uncertainty on future investment.
- Continuing the co-operative working culture between the three market bodies so the policy and its implementation are world leading.

Beyond the management of the NEM there are related community and industry adjustment matters that require government attention. The potential development of hydrogen as a commercial industry and new energy source should continue. The introduction of infrastructure and programs to assist in the take-up of electric vehicles should continue. In addition, Australia is active in energy intensive industries, such as aluminium and steel. Given our global comparative advantage in renewable energy resources we should move to pursue opportunities where possible. Industrial processes that can adjust to use cost effective variable renewable generation to the greatest extent possible will have a competitive advantage. Finally, those communities based heavily on industries where change is occurring may require industry adjustment assistance.

2. Strategic Energy Plan Assessments

The Health of the NEM assesses the current and future outlook against the six outcomes identified in the Strategic Energy Plan.

1. Affordable energy and satisfied customers
2. Secure electricity and gas system
3. Reliable and low emissions electricity and gas supply
4. Effective development of open and competitive markets
5. Efficient and timely investment in networks
6. Strong but agile governance

These areas were also identified in the Finkel Review and are all required outcomes for a healthy electricity system

Each are addressed in some detail below.

2.1 Affordable Energy and Satisfied Consumers

2.1.1. Overall assessment - Affordable energy and satisfied consumers

To assess the health of the NEM in terms of affordability and consumer satisfaction four objectives are examined. These are whether:

1. Energy is increasingly affordable for all consumers, supported by consumer protections and access to dispute resolution.
2. Consumers are empowered to manage their demand and can access distributed energy and energy efficiency solutions.
3. Consumers are able to and can easily identify and secure the best deal for their circumstances.
4. Vulnerable consumers are on suitable pricing plans, receiving concessions when needed, and can benefit from distributed energy and energy efficiency schemes.

A summary of the assessment made against each of these criteria is set out in Table 2.

TABLE 2: AFFORDABLE ENERGY AND SATISFIED CONSUMERS

	Proposed Ratings		Last Year's Ratings	
	Current status	Outlook	Current status	Outlook
Energy is increasingly affordable for all consumers, supported by adequate consumer protections and access to dispute resolution	Critical	Moderate	Critical	Moderate
Consumers are empowered to manage their demand and can access distributed energy and energy efficiency solutions	Moderate-Critical	Moderate	Critical	Moderate
Consumers are able to easily identify and secure the best deal for their circumstances	Good-moderate	Good	Critical	Moderate
Vulnerable consumers are on suitable pricing plans, receiving concessions when needed, and can benefit from distributed energy and energy efficiency schemes	Critical	Moderate-Critical	Critical	Moderate
Overall	Moderate-Critical	Moderate	Critical	Moderate

2.1.2 Affordability and consumer protections

Affordability has improved slightly for retail consumers. Previous price rises have been well documented and were largely driven by overbuilt networks in Queensland and NSW, rising wholesale fuel costs, retail market inefficiencies and the cost of a range of renewables subsidies whose cost is passed on to consumers.[1] Figure 3 shows this past behaviour.

[1] ACCC REPI Review…

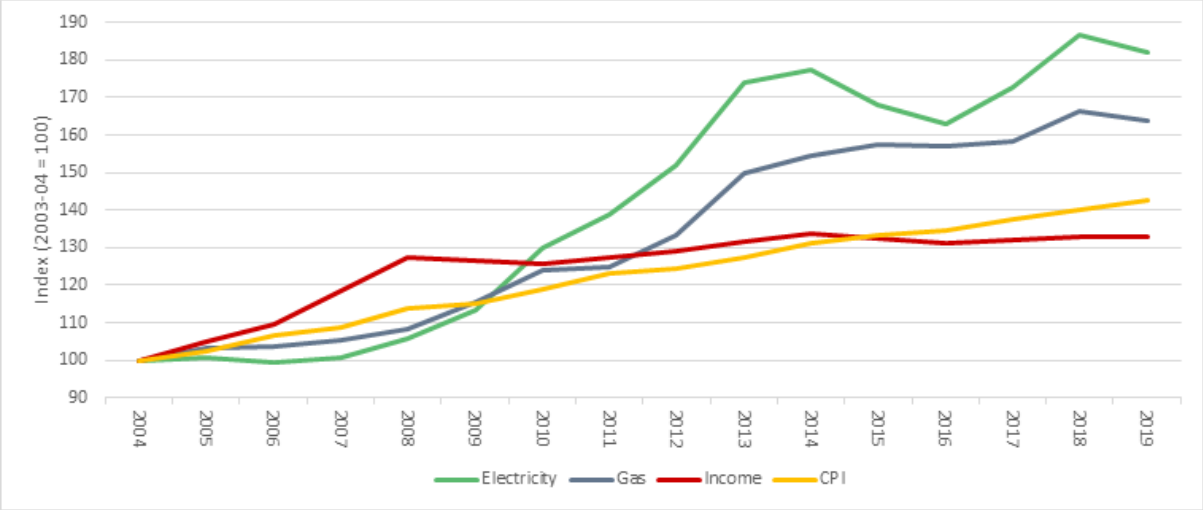

FIGURE 3: LONG TERM TRENDS IN RETAIL ENERGY PRICES AND INCOME

SOURCE: ANNUAL RETAIL MARKETS REPORT 2018-19 - AER ANALYSIS USING DATA FROM THE AUSTRALIAN BUREAU OF STATISTICS (ABS). ELECTRICITY AND GAS PRICE INDEX – CONSUMER PRICE INDEX, CAT. NO. 6401.0, VARIOUS YEARS; INCOME INDEX – ABS, HOUSEHOLD INCOME AND WEALTH, AUSTRALIA, 2017-18.

As the figure shows both electricity and gas prices fell slightly against income levels and the consumer price index in 2018-19. The modest decrease was largely related to a decline in retail margins and a fall in wholesale costs. Retail prices remained largely steady across the NEM, with only modest improvement in affordability. The improvement was related to falls in average energy usage with growing distributed energy (rooftop solar) and energy efficiency. The decline in energy usage is most remarkable in Queensland and South Australia where there is a high penetration of rooftop solar. (See Figure 4.)

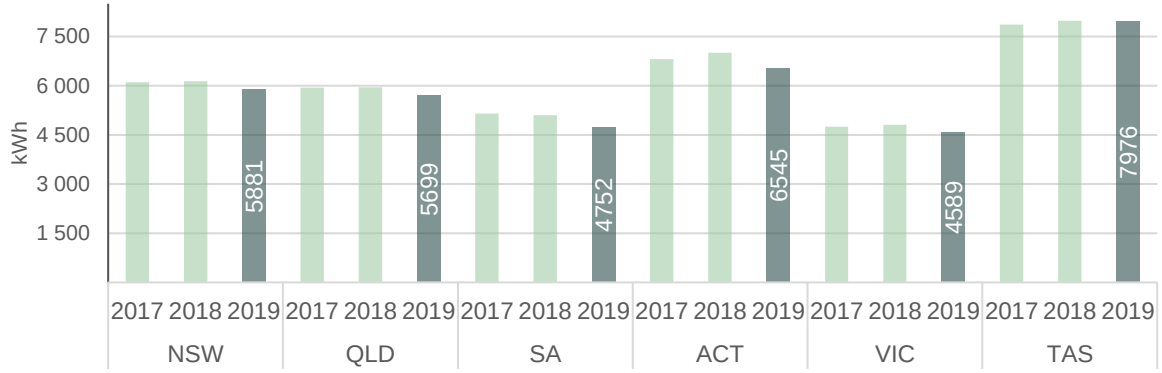

FIGURE 4: AVERAGE CONSUMPTION PER CUSTOMER

SOURCE – AER: AFFORDABILITY REPORT, 2019

These trends reflect the broad median and hide the impact on different types of consumers. Low income households spend far more of their income on energy than average households; a low income household regularly spends 8-10% of income compared to 2-4% for an average household. Different types of households also have different energy usage and low income homes are less likely to see the benefits of investing in solar power or energy efficiency. The improvement in power bills when investing in household solar power is evident in the following chart, Figure 5.

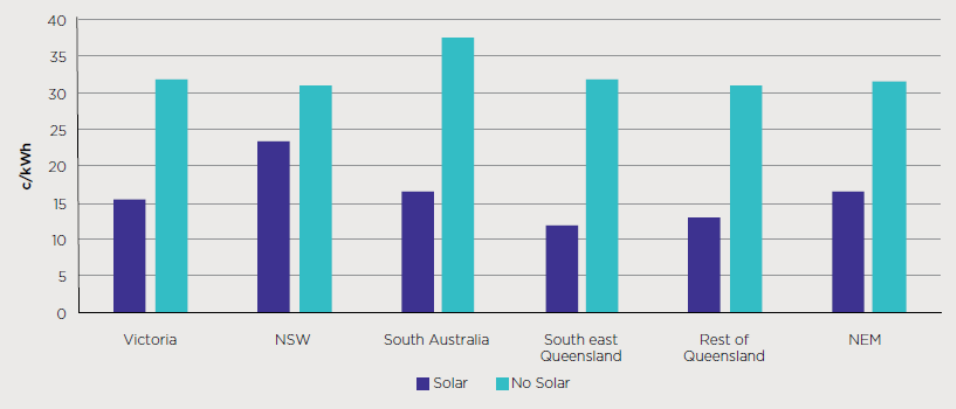

FIGURE 5: SOLAR AND NON-SOLAR AVERAGE EFFECTIVE PRICE COMPARISON

SOURCE: ACCC RETAIL ELECTRICITY PRICING INQUIRY, 2018

Recent reforms to retailer pricing and advertising came into effect in mid 2019. These reforms include implementation of a Default Market Offer (DMO) and Victorian Default Offer (VDO). The reason for these changes was to reduce prices for customers who do not, or cannot, access market offers; and to improve the ability for customers to shop around by providing a reference point for comparisons between retail offers. Early indications from the ACCC and AER report some positive signs of impact from the DMO and VDO.

Looking forward, the AEMC analysis of trends in forward prices[2] show potential downward trends in in retail pricing, reflecting current expectations around new investment in renewable generation and storage, as well as regulated network prices. On a national basis, residential electricity prices and bills are expected to decrease by 7.1 % (or $97) over the period from 2018-19 to 2021-22[3]. This trend is primarily driven by wholesale costs reducing in most of the states and territories as new low cost renewable capacity enters the system. There are other factors that will influence consumer prices but this trend is a welcome development. It is important to note the need for significant investment over the next decade in both transmission and distribution networks. Ensuring that this investment is managed in the most cost effective and timely manner is both a future challenge and a risk. This is discussed further in section 2.5 below.

It is a major concern that the ability to monitor commercial and industrial energy prices is poor. The ACCC has identified further work to survey and monitor energy prices in this sector[4] but this recommendation has yet to be implemented. The Energy Security Board strongly supports the ACCC view on this matter and will work with large commercial and industrial sector and the broader industry during 2020 to develop benchmarks and the surveys required to reliably report against this important metric.

Customer *disputes and complaints* to the ombudsman have declined. In 2018-19, 2.9% of customers raised complaints, down 6.6% from the year before. Billing issues remained the top cause of complaints.

Finally the number of *customers seeking protection* through hardship programs increased in all regions except Queensland. The AER monitoring of hardship programs shows that the average debt of electricity hardship customers is now significantly higher – increasing by

[2] AEMC, *Residential Electricity Price Trends*, 2019
[3] AEMC, *Residential Electricity Price Trends*, 2019
[4] ACCC *Retail Electricity Pricing Inquiry*, 2018

about $200 in 2018-19. About 45% of customers on hardship plans are not meeting their ongoing energy costs and only 29% of customers successfully complete the hardship program. These results suggest some structural problems with current programs. In response the AER undertook a review of hardship programs and released a new policy guideline in March 2019 (Hardship Guideline). Retailers submitted 49 new and improved customer hardship policies for approval in June 2019. Hopefully next year's data will provide improved indicators.

2.1.3 Empowered to manage demand

Consumers ability to manage their demand continues to improve but the ability to do so varies significantly between different types of households and businesses. Low income homes and renters have generally less opportunities to reduce their energy use through both efficiencies and distributed energy resources.

Being paid for demand management is one step forward. Integrating demand management and load profiling is important to achieve best consumer outcomes. When there are high degrees of roof top solar penetration the market changes.

Since the introduction of competitive metering, smart meters penetration is beginning to grow across the NEM. The penetration of smart meters is shown in Figure 6 below where mandatory smart metering in Victoria is the stand out.

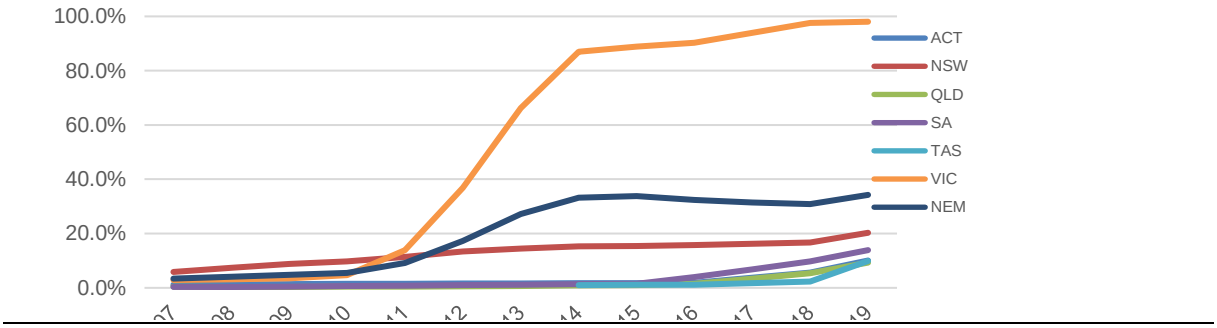

FIGURE 6: PENETRATION OF SMART METERS OVER TIME

SOURCE: ESTIMATES BASED ON PUBLISHED AEMO METER TYPES

But having a smart meter does not mean that customers necessarily use it to manage their costs. In fact only about 33 % of consumers with a smart meter report that it helps in managing their energy costs. Many consumers do not take up new tariffs or services with their new meter. The largest impact on cost management continues to be solar installation without the addition of batteries and smart meters. Nevertheless Australia is forecast to make up 30 % of the global demand for residential battery technology in 2019. These forecasts are driven strongly by government subsidy schemes supporting the industry.

The Australian economy has become more *energy efficient* with lower energy intensity and higher energy productivity. Economic growth over recent decades has generally outpaced growth in energy consumption (Figure 7). This reflects cumulative improvements in energy efficiency as well as a shift in the Australian economy away from energy-intensive industries such as manufacturing towards less energy-intensive industries such as services. Increased use of renewable energy for electricity generation has also had a positive impact on energy productivity. Energy productivity improved by 2.0 % in 2017–18 and by 20 % over the past ten years. Australia now creates $294 million in GDP for every petajoule of energy consumed, nearly $50 million more than a decade earlier. This is shown in Figure 7 below.

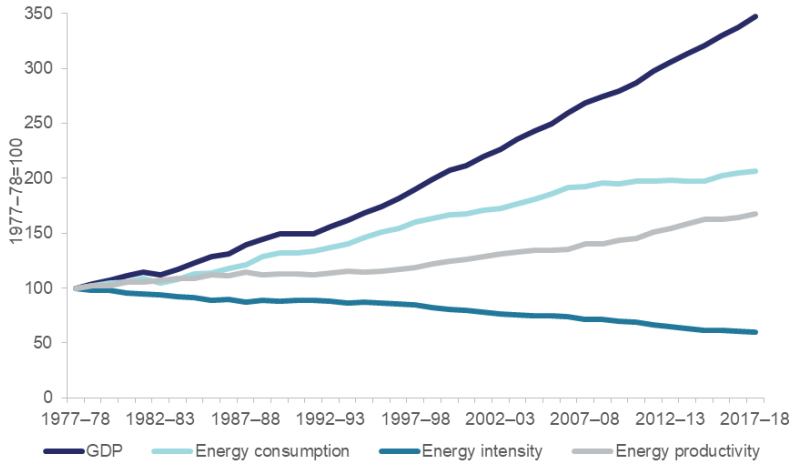

FIGURE 7: AUSTRALIA'S ENERGY PRODUCTIVITY GROWTH ($GDP/ENERGY CONSUMPTION)

SOURCE: AUSTRALIAN ENERGY STATISTICS 2019, DEPARTMENT OF ENERGY AND ENVIRONMENT

The improvement in energy productivity is pleasing but much more is possible. Australia's energy productivity improvement is well behind that of its international peers. As the Finkel Review and the ACCC[5] agreed Australia should expand policies to capture further cost effective energy efficiency improvements.

There has been some progress. For example the COAG Energy Council progressed a Trajectory for Zero Energy Buildings. Major gaps remain, particularly in industrial energy efficiency where Australia's rate of improvement lags many peers. This is shown in Figure 8 below.

[5] ACCC, Retail Energy Pricing Inquiry, 2018

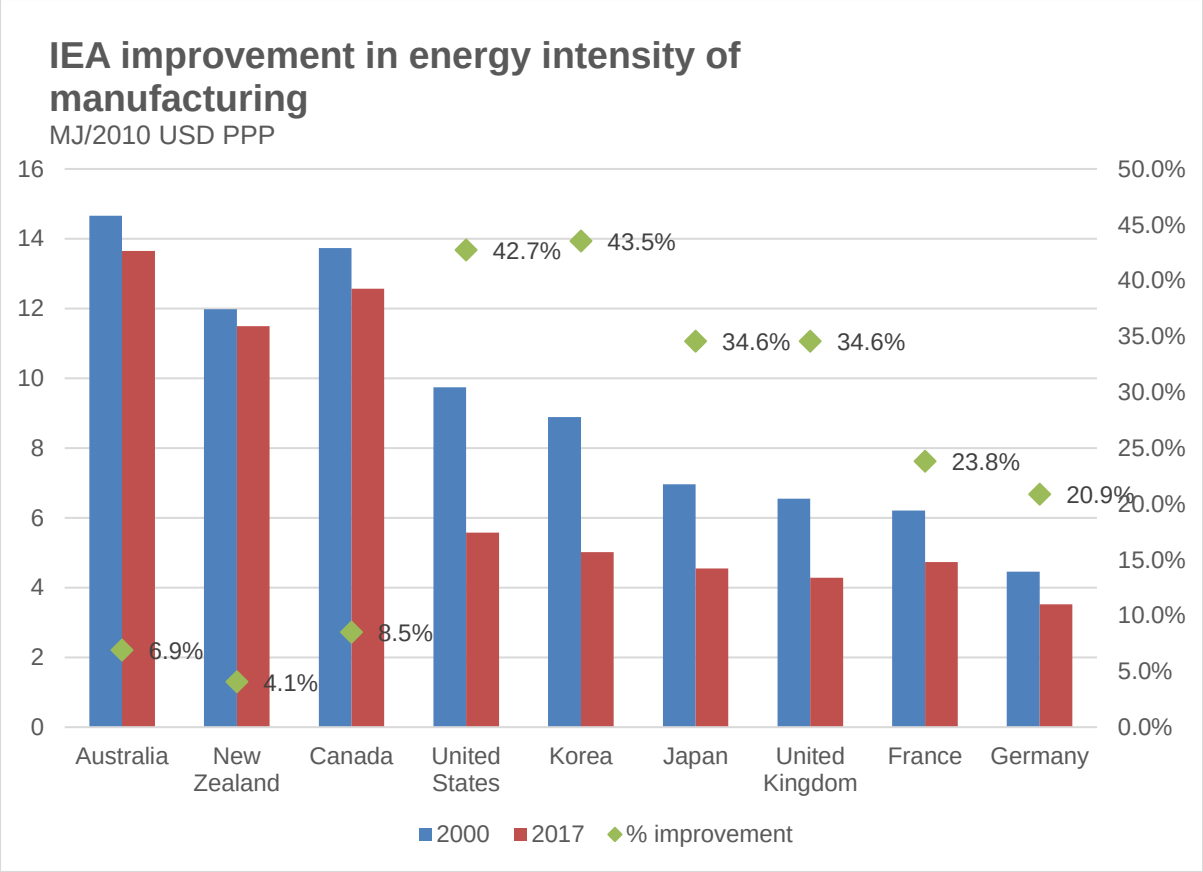

FIGURE 8: IMPROVEMENT IN ENERGY INTENSITY OF MANUFACTURING

SOURCE: INTERNATIONAL ENERGY AGENCY, 298 WORLD ECONOMIC OUTLOOK

2.1.4 Identifying the best deal

To identify the best deal available consumers can now more easily compare energy plans with the implementation of a Default Market Offer and the Victorian Default Offer on 1 July 2019. As well as reducing standing offer prices, these schemes provide a common benchmark price against which all prices are compared. This prevents confusion caused by a past approach where discounts were offered by retailers without being clear about a common reference price that the discount related to. The Electricity Code also prohibits retailers from presenting conditional discounts as their headline discount in South Australia, NSW and South East Queensland.

It is pleasing to see that the proportion of customers on market offers, rather than standard offers, has risen across the NEM (except in Tasmania). Around 24% of electricity consumers and 15% of gas consumers in the NECF jurisdictions[6] remain on standing offers. Victoria has the highest level of market offers at 94% in electricity and 97% in gas [7].

6 Covering Qld, SA, NSW, ACT and Tas but not Victoria, WA or NT.

7 AEMC: 2019 competition review Table 4.1

Switching between retailers to get a better deal remains active though switching has slowed in most jurisdictions since mid 2018. The 2019 peak reflected a response to state and Commonwealth promotional programs.

The ACCC Retail Electricity Pricing Inquiry made recommendations on switching and price comparators. These recommendations have led to a range of upgrades and improvements to government provided price comparators, including the AER's Energy Made Easy and Victoria's Energy Compare. This has significantly improved the performance of these web sites. In addition NSW launched a new "Energy Switch" service which goes further than a price comparator and allows consumers to easily switch retailers. It includes the use of electronic bills to give better personalised advice and links to wider Service NSW services for additional support.

The Commonwealth has also gone beyond residential consumers and introduced a new bill benchmarking tool for small businesses (checkyourenergyspend.com.au). This site enables small business to compare their energy bills against other like business operations.

These types of developments are welcome. More fundamental change is coming so that, in future consumer demand response would be an available and valuable option for consumers.

2.1.5. Vulnerable customers can access suitable plans, concessions, distributed energy resources and energy efficiency schemes

The number of customers receiving concessions is broadly a quarter of the population and the way these concessions interact with hardship plans is complex. There are a number of customers on hardship plans that are not eligible for concessions which suggests some improved design of hardship plans and a review of their interaction with concessions may be useful.

It is clear that barriers remain for vulnerable consumers in both new technology uptake and switching (where low income households are the least likely to switch). This is leading to vulnerable consumers falling further behind as the market transitions and is despite a range of existing government support programs. At this time there is no indication that technology upgrades are being considered by retailers as part of hardship programs.

2.2. Secure electricity system

2.2.1 Overall assessment - Secure electricity system

As the Executive Summary in Section 1 noted, security is a critical issue at present and in the future. The operation of the NEM requires the system be maintained within defined limits to deliver electricity to consumers that is safe and of a consistent quality. The parameters that are important include frequency, voltage, inertia, and system strength. Failure to maintain these security parameters within their defined limits can damage the power system and lead to supply interruptions. Increasing penetration of variable renewable energy resources and distributed energy resources is making it more difficult to maintain security.

Frequency refers to the number of cycles of current and voltage made per second in an AC system. The operational frequency of the NEM is 50 cycles per second (Hertz). The frequency of the power system varies whenever the supply from generation does not precisely match customer demand. Frequency control performance in the NEM has been declining over recent years.[8]

Voltage is the electrical force or electric potential between two points that gives rise to the flow of electricity. The voltage across the network is increased or decreased at various points using transformers to reduce losses during transmission and distribution and to lower voltage to a usable level.

Inertia refers to the rotating mass of a turbine and alternator of a generating unit. Synchronous generators such as coal, gas and hydro as so called because their rotation is synchronised with the frequency of the system (i.e. 50 cycles per second). If the frequency of the system deviates, the physical inertia embodied in the spinning mass of the generators resists the change. With less synchronous generation online there is lower inertia and a higher Rate of Change of Frequency when a disturbance occurs. Higher frequency swings are apparent with a higher risk of tripping of generation (or load) and a higher risk to the security of the system.

System strength is an umbrella term that refers to a suite of interrelated factors which together contribute to power system stability. It reflects the sensitivity of the power system to disturbance and indicates system robustness with respect to properties other than inertia. System strength can affect control systems and the ability of the power system to both remain stable under normal conditions and return to steady-state conditions following a disturbance. Reduced levels of synchronous generation are resulting in areas with below acceptable system strength, requiring AEMO to either constrain or dispatch generation out of merit order.

Variable renewable generation is non-synchronous and cannot easily accommodate variations in load power factors. There is less inertia in the system so that a sudden change in frequency caused by generation ceasing unexpectedly, due say to equipment failure or a sudden change in the weather, cannot be easily arrested. The anticipated exits of ageing synchronous coal fired generation suggests that these security issues will take some time to manage. The expected closure profile of NEM coal fired generation is in Figure 9.

[8] AEMC, *Frequency Control Frameworks Review*, 2018

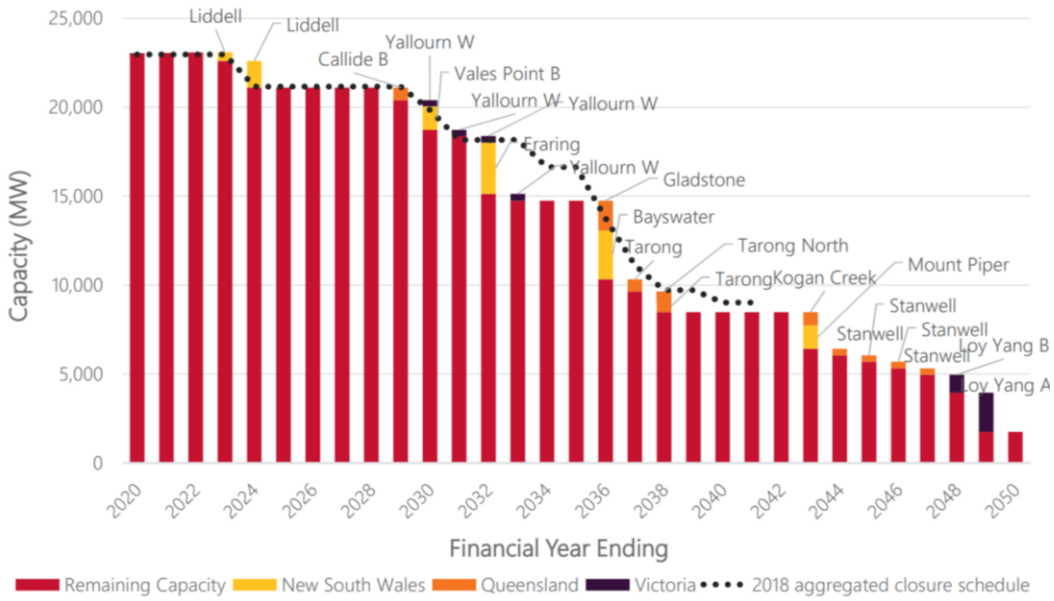

FIGURE 9: EXPECTED CLOSURE PROFILE FOR NEM COAL-FIRED GENERATION.

SOURCE: AEMO

To assess security in the NEM two objectives are examined. The first is the extent to which the markets operate safely, securely and efficiently, and are able to do so under a full range of operating conditions with minimal intervention. This is assessed for the present and in the future. The second objective examined is whether system planning and development is informed by clear and transparent rules. This too is assessed for the present and in the future. The assessment for each of these objectives is in Table 3. It is important to note that this assessment applies to the NEM as whole and that particular jurisdictions have different (less severe) ratings.

TABLE 3: SECURE ELECTRICITY AND GAS SYSTEM

	Proposed Ratings		**Last Year's Ratings**	
	Current status	Outlook	Current status	Outlook
Markets operate safely, securely and efficiently, under a full range of operating conditions, with minimal intervention	Critical	Critical	Critical	Critical
System planning and development is informed by clear and transparent rules	Moderate-Critical	Moderate-Critical	Critical	Critical
Overall	Critical	Critical	Critical	Critical

Given this overall rating for security, and its lack of improvement on last year, the ESB is focussed on the matter. There have been System Security Frameworks, rule changes, synchronous condensers installed and an improved frequency control service markets. There is nevertheless much to be done.

2.2.2 Secure operations and interventions

One indication that the NEM is in a critical state of security at present is that AEMO has had to intervene significantly in the operations of the NEM. These *interventions* have been done to maintain system security over the last two years. In 2018-19 the number of interventions increased to 75, up from 32 in the year before. Corresponding with these interventions, AEMO issued over 158 directions to maintain system security in 2018-19 and 100 directions in 2017-18. Most of these directions related to system security in South Australia and a small number (5) for Victoria. The number of directions each year is shown in Figure 10 where the recent rise is obvious.

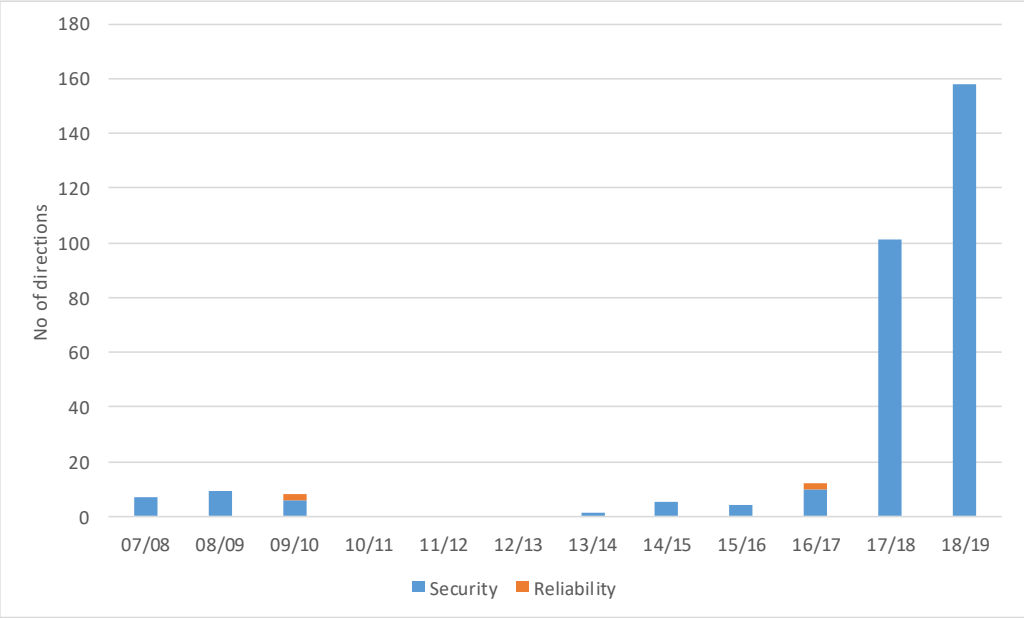

FIGURE 10: AEMO DIRECTIONS BY TYPE.

SOURCE: AEMO

The average duration of the interventions was about 7 hours in the period from 2007-08 to 2016-17. In the next two years the duration of the intervention rose substantially; in 2018-19 it was 26 hours and in the year before it was 61 hours.

These interventions, driven by security concerns, come at a cost to consumers. In 2017-18, the cost of AEMO directions (the compensation recovery amount) was almost $18.2 million. In 2018-19, the cost of AEMO directions was $15.7 million.

2.2.3 System planning and development

Whether or not system planning is informed by clear and transparent rules is especially important with so much change in the system. A number of specific steps are being taken and these are very much work in progress. What is likely to evolve is markets of some kind for the ancillary services of frequency, inertia, voltage and system strength. The ideal is to co-optimise markets and dispatch. There will be new products and services with the objective of assuring security at lowest costs, but in the operating arena all of this has to be co-optimised to achieve the best outcomes.

As a first step it is important that changes are visible to the operator and market participants. New reporting requirements are in place, including for the AER and AEMO in relation to frequency and market ancillary service performance. Trends and outcome reporting in this area are especially important for market participants given the degradation in frequency

control performance in the NEM that has been observed. As the system shifts to more variable renewables the potential for imbalances between supply and demand increases and these can cause frequency disturbances.

During 2019, the AEMC investigated intervention mechanisms and system strength in the NEM. The final report recommends a number of changes to the interventions framework to reduce market distortion and costs to consumers while maintaining efficient price signals and incentives for investors when intervention occurs. A number of measures have been introduced to improve power frequency control. Certain generators are now required to operate in a way that is responsive to changes in the local power system frequency and further improvements to frequency control arrangements can be anticipated. Existing arrangements could be improved.

It is also notable that transmission companies are now obliged to run their systems with defined levels of inertia. They can meet this obligation through either installing equipment (like synchronous condensers) or contracting with synchronous generators to supply the service. The transmission company in South Australia is in the process of installing synchronous condensers to meet their obligation.

As Distributed Energy Resources are integrated into the system a number of challenges arise. An ESB workplan of what needs to be done to integrate Distributed Energy Resources has been published and work is underway. One first step is simply visibility so that the operator and the distribution companies know where these resources are located and their characteristics. From 1 December 2019, installers have to provide technical details of newly installed distributed energy resources (including small scale battery storage systems and rooftop solar) to AEMO. The DER register will help improve visibility of these resources and assist network businesses and AEMO to manage the power system.

Voltage control can be a major issue for distribution networks in those cities where rooftop solar penetration exceeds 20% of homes. Most of Perth, Brisbane and Adelaide are in this category. The level of demand for grid power in some feeders or even whole suburbs of cities can drop close to zero in the middle of the day as demand is met by rooftop solar PV. This fall in grid power demand can occur (and change) suddenly with changes in weather. Networks must have more visibility of the security of their operations and flexible sources of supply and demand response when it may be quickly needed to maintain both frequency and voltage stability. Technical Standards for Distributed Energy Resource devices and smart software can also help address these issues. In addition AEMO needs to be able to support better load shaping and localised storage requirements.

As well as the laws of physics that must be met there are also external factors to be considered in the security area. In December 2018 AEMO prepared its inaugural report on the cyber security preparedness of the NEM. The conclusions were that the current regulatory provisions were inadequate to address cyber security risk. This is an important conclusion given the independent hackers and sovereign states that are known to have accessed some electricity systems internationally causing system interruptions. A national response is needed and the Commonwealth Government is developing a national strategy. They will lead the approach in the electricity sector, supported by AEMO.

Finally the recent horrific bushfires emphasize the importance of electricity system resilience as extreme weather events become more frequent and intense. This needs serious attention in the years ahead as further extreme events including fire, flood and high temperatures can be expected. Mean temperatures in Australia have been steadily increasing over the last century as Figure 11 shows. The particular specifications and cost of equipment able to withstand these conditions must be re-examined.

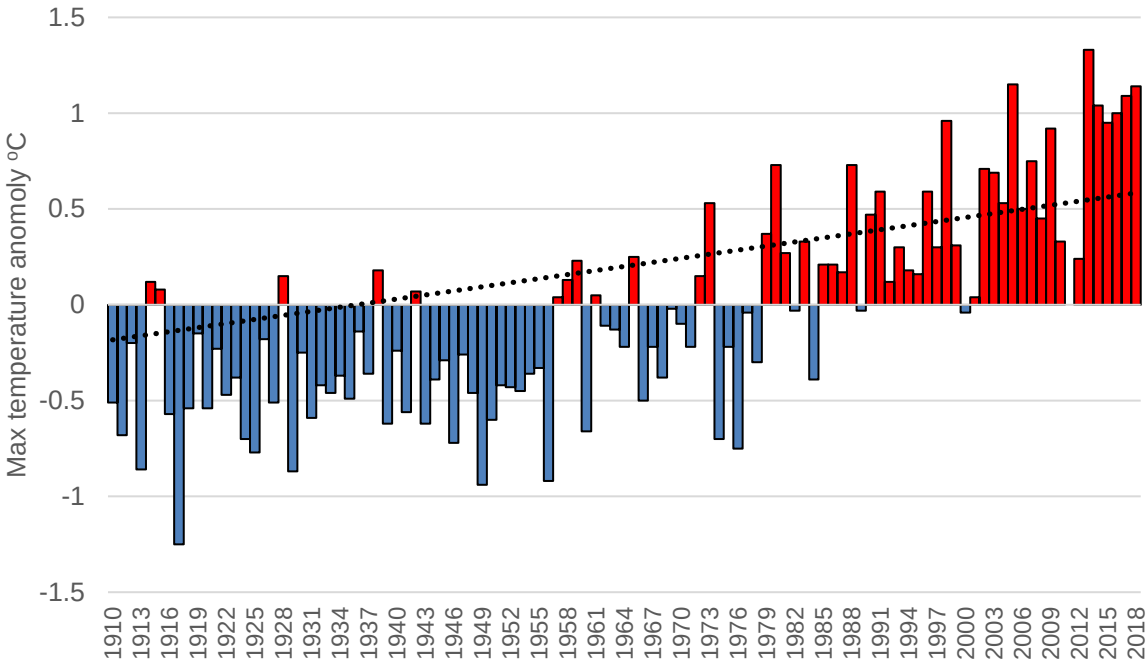

FIGURE 11: AUSTRALIAN MEAN TEMPERATURE ANOMALY.

SOURCE: AUSTRALIAN BUREAU OF METEOROLOGY

The COAG Energy Council has asked the ESB to recommend interim measures to improve system security and reliability by March 2020. The intention is that these measures will be implemented during 2020 as a precursor to post 2025 market design options that are due to be presented to Council later in 2020. These interim measures will build on existing work and focus on improvements in the markets for the ancillary services of frequency control, voltage control, inertia and system strength. For the moment the critical rating on the health of NEM security remains, but there is work being done to address the issues.

2.3. Reliable and low emissions electricity supply

2.3.1 Overall assessment - Reliable and low emissions

To assess whether or not the electricity system is reliable and delivering reduced emissions two objectives are examined. The first is whether the electricity sector is delivering its share of emissions reduction to meet national requirements, and doing so while maintaining reliable supply. The second objective is whether investors are efficiently managing risk to support investment, ongoing operations, generation retirements, and required innovation. The current status and outlook for each of these objectives is in Table 4 below. As a reference last year's rating is also shown. The assessment for emissions reduction in the sector has improved but for low emissions power to be both built and available, integration work is needed. The assessment of reliability of the system is now critical though the outlook has improved reflecting market design changes and other measures being progressed. Investor behaviour is rated critical reflecting the extent of government intervention. Some Government intervention is intended to improve reliable supply but it can also distort the market and lower investor confidence.

TABLE 4: RELIABLE AND LOW EMISSIONS ELECTRICITY AND GAS SUPPLY

		Proposed Ratings		**Last Year's Ratings**	
		Current status	Outlook	Current status	Outlook
Electricity and gas sectors efficiently deliver at least their share of emissions reduction target/s while ensuring reliable supply	Emissions	Moderate	Moderate	Moderate	Critical
	Reliability	Critical	Moderate-Critical		
Investors efficiently manage risk to support investment, operation, retirement and innovation decisions		Critical	Moderate	Moderate	Critical
Overall		Critical	Moderate	Moderate	Critical

2.3.2 Reliability and emissions reduction

Over recent years the *reliability* of the NEM has come into question. Reserves have tightened following the closure of the Flinders Power Station in South Australia and Hazelwood in Victoria. The number of Lack of Reserve notices has increased in recent years as shown in Figure 12.

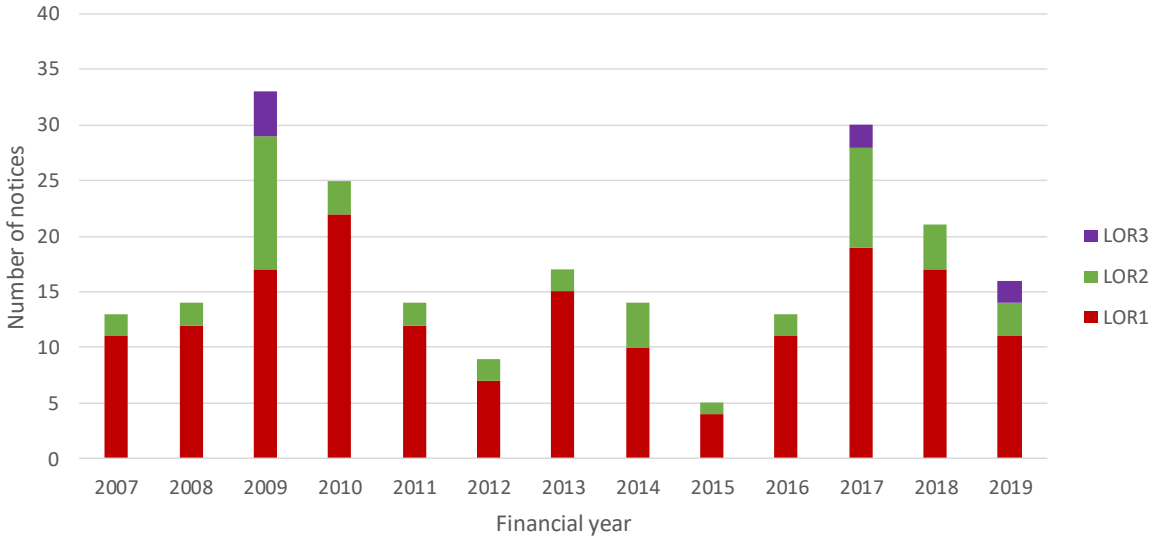

FIGURE 12: LACK OF RESERVE NOTICES 2006-07 – 2018-19

SOURCE: AEMO

The tightening of supply and demand, combined with consecutive extreme weather days, as well as planned and unplanned outages of thermal plant caused South Australia and Victoria to experience involuntary load shedding as shown in Figure 13. The earlier unserved energy in 2008 -09 was related to severe drought at that time.

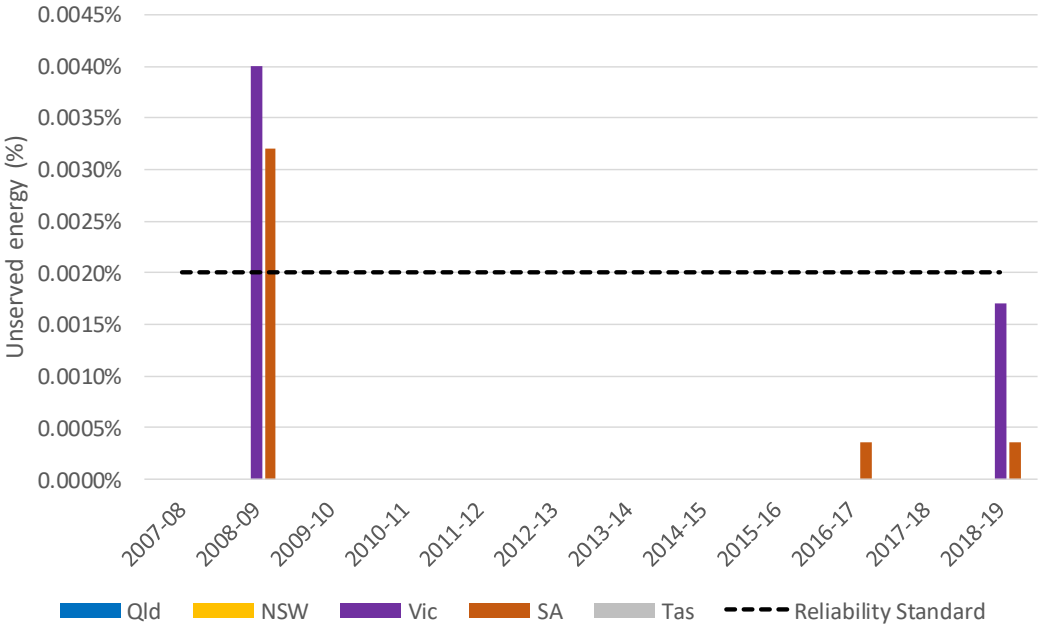

FIGURE 13: PERFORMANCE AGAINST THE RELIABILITY STANDARD

SOURCE: AEMO

The future outlook for the reliability of the NEM was assessed by AEMO in the 2019 Electricity Statement of Opportunities (ESOO) report. Their analysis found that the Reliability Standard was likely to be met in all jurisdictions, except Victoria this year, though going forward supply would be tight during the summer peaks in South Australia, Victoria and New South Wales.

The reason it is nevertheless rated as critical is that weather events are now more severe, especially over summer, and the thermal generator fleet is ageing and increasingly less dependable.

In the 2019 ESOO, AEMO raised concerns about the risks to reliability from 2023-24 onwards. The future outlook for unserved energy is shown in Figure 14. With ageing plant and an increased risk of extreme temperatures the likelihood of tail risk events is increasing, and this impact may not be addressed by the current standard. As a result AEMO has suggested potential variations to the Reliability Standard to accommodate this tight position. The matter is currently being considered by the ESB for the COAG Energy Council meeting in March 2020. The AEMC is also in the process of considering a rule change to seek a jurisdictional derogation for Victoria to allow AEMO to contract for emergency reserves under the reliability and emergency reserve trader (RERT) mechanism on a multi-year basis in that state.

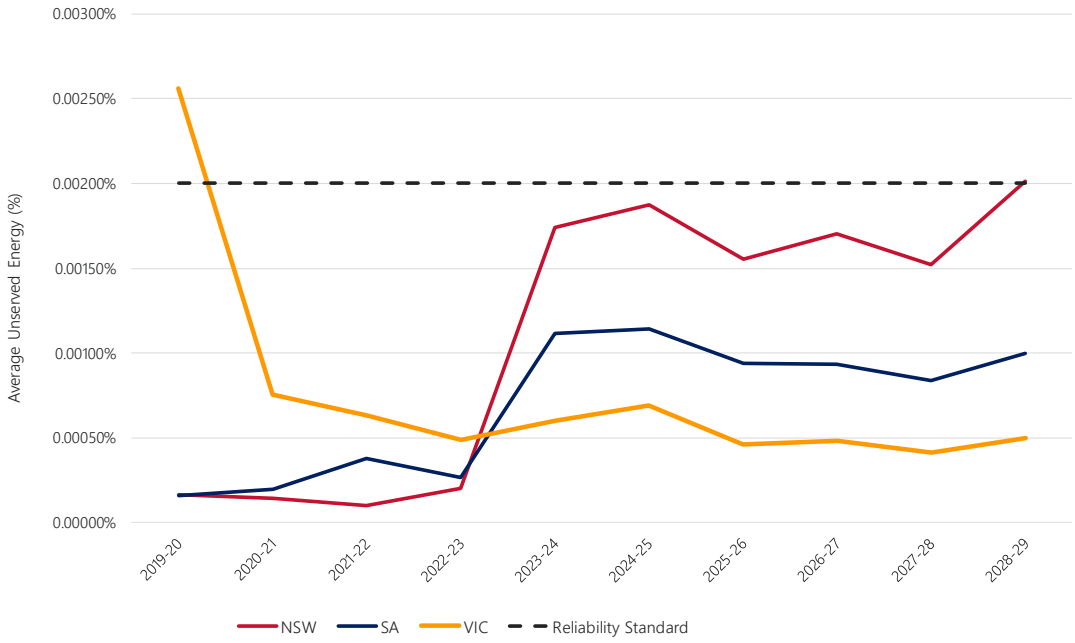

FIGURE 14: FORECAST UNSERVED ENERGY OUTCOMES

SOURCE: AEMO, ELECTRICITY STATEMENT OF OPPORTUNITIES, 2019

Over the longer term, there are a number of projects underway that will improve reliability. The Snowy 2.0 project has begun early works and its completion in the mid 2020s will increase flexible and dispatchable power substantially. The Commonwealth has provided funds to the Clean Energy Finance Corporation to support investment in generation and other projects to support the increased variable renewables in the system. Advanced negotiations were progressed with two projects in late 2019 for the Underwriting New Generation Investment program and more will be chosen in the years ahead. In addition to this initiative the expansion in the transmission network described in the networks comments below also assists with reliability.

Since 2005 total *emissions* across the NEM have fallen 15%. By 2030 emissions for the NEM are forecast to fall a further 26% to 41% below 2005 levels. This trend in emissions reflects the planned closure of ageing coal and gas fired generation, and its replacement by renewable generation and a variety of large and/or small scale storage projects. Major power stations that are forecast to close by 2030 include Torrens Island A, Liddell, Callide B, Swanbank E, Yallourn and Vales Point. Beyond 2030 falling emissions are expected to

continue with the projected closure of Eraring, Bayswater, Gladstone and Torrens Island B in the early to mid-2030's.

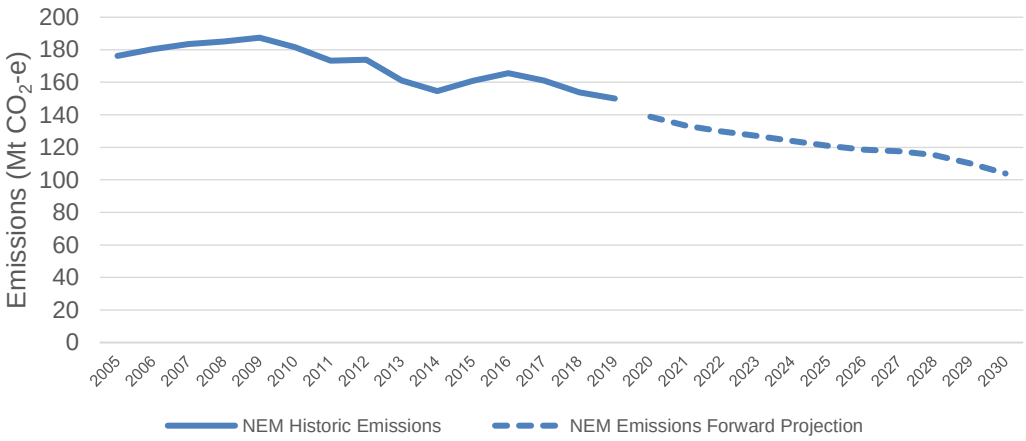

FIGURE 15: NEM EMISSIONS - HISTORIC AND FORWARD PROJECTION

SOURCE: AUSTRALIA'S EMISSIONS PROJECTIONS 2018, DEPARTMENT OF THE ENVIRONMENT AND ENERGY

2.3.3 Investment

The NEM, along with most global power systems, is transforming at a rapid pace. Globally this change was initially driven by a range of Government policies. Over time this rate of transformation has increased, as scale, innovation and changing consumer preferences drive down the relative costs and increase the preference for these newer technologies.

This trend is not expected to change. The 2019 World Energy Outlook from the International Energy Agency identifies that "*a new phase of technology-driven transformation is emerging, propelled in large part by advances in digital technologies".* As power systems change so do their operations and the services needed. However it is also important to recognise that the design of electricity markets must adapt to ensure that the efficient and timely investment in the resources and services that is needed occurs.

The draft Integrated System Plan highlights a range of potential scenarios for how the NEM may evolve. Under the Central Scenario, by 2042, almost 18,000 MW of ageing mainly coal fired generation will close and be replaced by over 11,000 MW of Pumped Storage, almost 12,000 MW of Wind, 21,000 MW of Utility Scale Solar, as well as 13,300 MW of distributed solar and nearly 3,000 MW of battery storage.

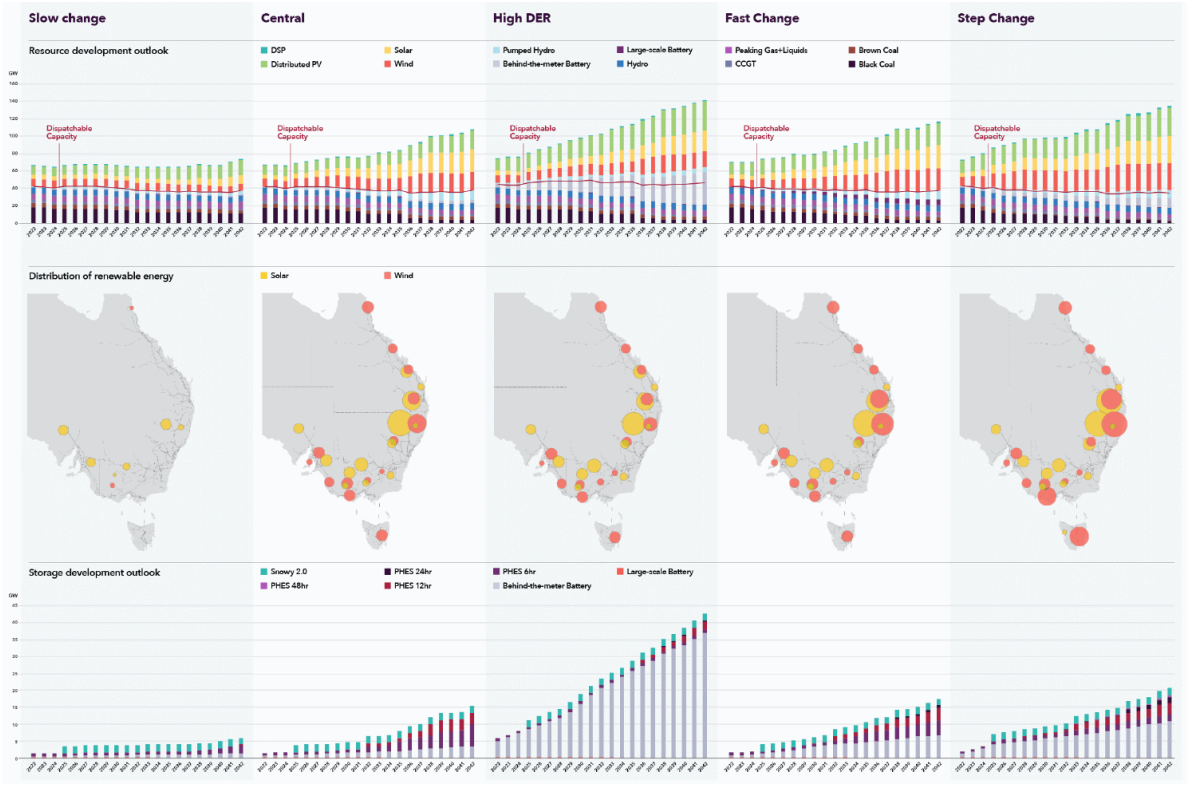

FIGURE 16: DRAFT 2020 INTEGRATED SYSTEM PLAN

SOURCE: AEMO

The COAG Energy Council has requested the ESB to advise on a long term, fit-for-purpose market design to support reliability. Interim measures will be reported in March 2020 and longer term design measures for 2025 and beyond will be reported later in 2020. NEM modifications are necessary to meet the needs of future sources of generation and flexible resources can be anticipated including demand side response, storage and distributed energy resource participation. A flexible demand side response industrial, commercial and residential will support a more reliable energy system in of the future. In circumstances where generation will become more weather dependent this is especially relevant.

Emerging issues include:

- The need to monitor the impacts of continued policy uncertainty on investment. Inappropriate investment, including lower investment may lead to a lessening of competition, lower reliability, higher long-term pricing through inefficient investment decisions and the requirement for increased Government support for future investment.
- Reviewing the emissions reduction goals for 2030 and beyond, consistent with the 1.5 – 2 degree Paris Agreement goals. The current targets imply relatively rapid decarbonisation beyond 2030.

- The need to ensure that future workforce requirements for the electricity sector are assessed to ensure a properly skilled workforce is available to support the continued rapid uptake of variable renewable energy and distributed energy resources.

2.4. Effective development of open and competitive markets

2.4.1 Overall assessment - Effective development of open and competitive markets

To assess whether or not the electricity market is developing into a more open and competitive market four criteria are examined.

1. Are wholesale and retail markets competitive and are they delivering efficient outcomes for consumers ?
2. Are the financial markets for electricity and gas related services deep, liquid and transparent ?
3. Is their access to efficiently priced fuel and transport ?
4. Are there incentives for innovation to enable value from new technologies ?

Overall the assessment was moderate for the health of open and competitive markets and the health outlook is improved to good-moderate. This rating is similar to the previous year though we do note some improvements in the retail markets and the fact that turnover in the contract markets has increased from last year's low. The assessments are summarised in Table 5.

TABLE 5: EFFECTIVE DEVELOPMENT OF OPEN AND COMPETITIVE MARKETS

	Proposed Ratings		**Last Year's Ratings**	
	Current status	Outlook	Current status	Outlook
Wholesale and retail markets are competitive and deliver efficient outcomes for consumers	Moderate-Critical	Moderate	Moderate-critical	Good
Deep, liquid and transparent financial markets for electricity and gas and related services	Moderate	Good	Moderate	Moderate
Access to efficiently priced fuel and transport	Moderate	Moderate	Moderate	Moderate
Innovation is incentivised and enables value from new technologies	Moderate	Good	Moderate	Good
Overall	Moderate	Good-moderate	Moderate	Good-moderate

2.4.2 Wholesale and Retail Market Competition

In 2018 the ACCC raised concerns about insufficient competition in the wholesale and retail electricity markets. It is pleasing to note that the AER has recently found some positive signs of improved competition in the retail market. The retail market share of Tier 2 retailers

increased from 16% to 18% over the period from Q1 2018-19 to Q1 2019-20[9]. Their share of small business customers also increased from 16% to 17% over the same period. This increase was at the expense of larger retailers. The retail market share in the NEM (excluding Victoria) is shown in Figure 17.

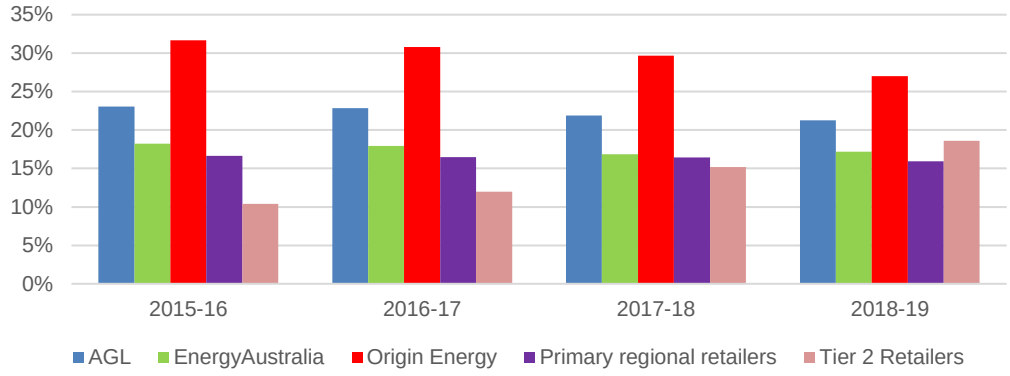

FIGURE 17: RETAIL ELECTRICITY MARKET SHARE TREND (NEM RESIDENTIAL CUSTOMERS EXCL VICTORIA)10.

SOURCE: AER

The introduction of the Default Market Offer and the Victorian Default Offer were discussed in section 2.1.2. These mechanisms led to significant pricing and advertising reforms that brought more transparency to customers, narrowed the gap between standing offer and market offer prices, and encouraged smaller retailers in the market. Previous retail pricing practices were certainly not consistent with vigorous competition.

In the wholesale markets prices declined as new lower cost capacity entered the market. This included 2,338 MW of solar, 2,566 MW of wind and 210 MW of OCGT. Current forward prices are trending down to around $60 per MWh across all regions. This is shown in the forward price outlook in Figure 18.

[9] Quarterly Retail Performance Report Q1 2019-20, AER

[10] Tier 1 retailers include Origin Energy, AGL and EnergyAustralia, as they collectively service the majority of the retail markets in NSW, South Australia and south-east Queensland. Primary regional retailers include Ergon Energy, ActewAGL and Aurora Energy. Tier 2 retailers include all other retailers.

FIGURE 18: HISTORICAL AND FORWARD PRICE OUTLOOK, JANUARY 2020 BY FINANCIAL YEAR

SOURCE: AEMO, ASX

The outlook for wholesale markets depends on future market designs. The introduction of separate markets for ancillary services and the way in which flexible and firm energy are valued as the market develops will be major influences. The retail market is expected to continue its improvement.

2.4.3 Transparent and liquid contract markets

Turnover in the wholesale contract market for both futures and OTC electricity contracts has increased. Figure 19 shows contract market turnover increasing to above three times the physical volume in 2018-19. In 2019-20 exchange traded volumes are currently averaging 39% above FY18/19. These are welcome developments.

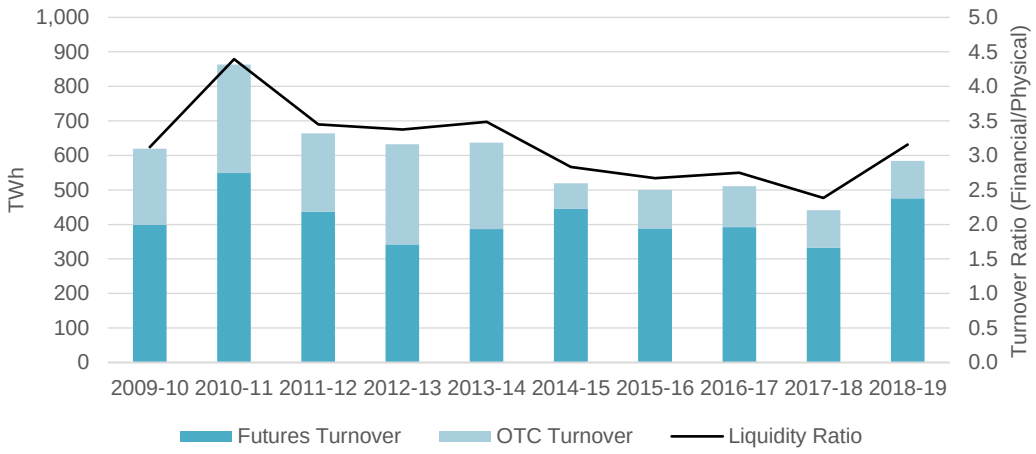

FIGURE 19: CONTRACT MARKET TURNOVER AND LIQUIDITY RATIO, NEM (EXCL TAS).

SOURCE: AFMA, ASX, AEMO

In July 2019 the ASX introduced a Voluntary Market Making scheme for some of the NEM wholesale contracts that are currently traded. The AEMC found (in relation to a proposed market making rule change) that early results from this scheme were positive, that bids and offers were available in all jurisdictions for most periods on trading days, including consistent end of day prices. This indicated an availability of contracts for trading and that prices posted by the market makers were within the specified bid-ask spreads.

In the gas market volumes at Gas Supply Hubs increased during 2019. This is evident in Figure 20. In addition, a Day Ahead Auction for pipeline capacity was introduced and this nascent market has seen growing activity. Increased interest and activity has also been observed in the Victorian Gas Futures Contract which had seen very little trading volumes prior to 2019.

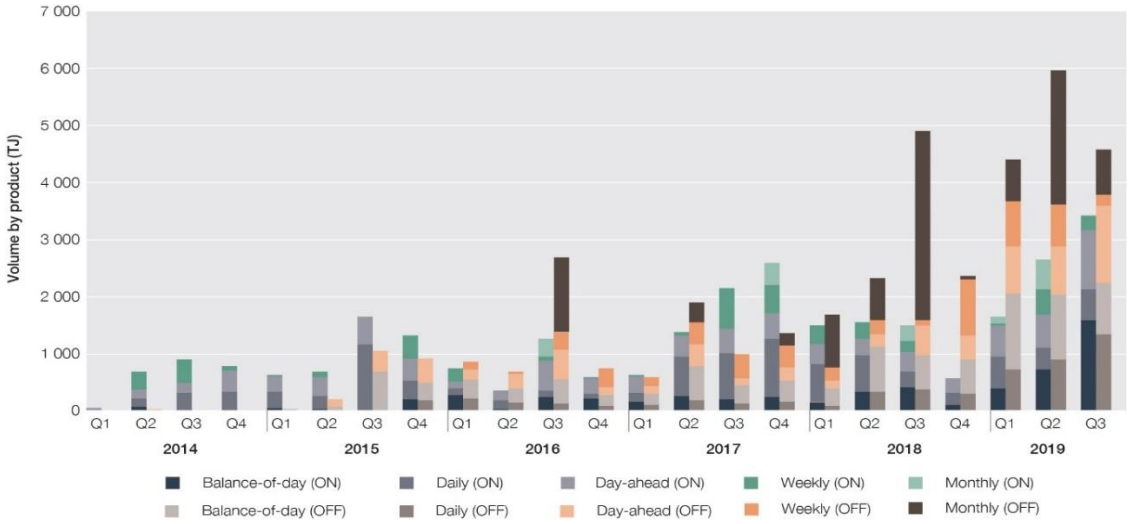

FIGURE 20: GAS SUPPLY HUB - TRADE VOLUMES BY PRODUCT

SOURCE: AER

Market behaviour in both electricity and gas has improved on last year with deeper financial contract markets in electricity and increased trading volumes in gas. These improvements are expected to continue with the changes made in the markets.

2.4.4 Access to efficiently priced fuel and transport

Good information about gas and coal reserves, and costs, are essential to allow market participants to make efficient investment and operational decisions. The international reference price for coal is shown in Figure 21. Across 2018-19 the input cost for black coal fell. This fall is not necessarily reflected in the contracts that generators have with coal suppliers.

The challenge in the longer term is supply. As coal mines deplete there is not always supply nearby to fill any gaps for existing generation and transport from alternative sources is not always available. Coal supply constraints have been evident in a number of places across the NEM during the past year. Furthermore as the development of new coal mines becomes difficult it is expected that supply in some locations will be tight.

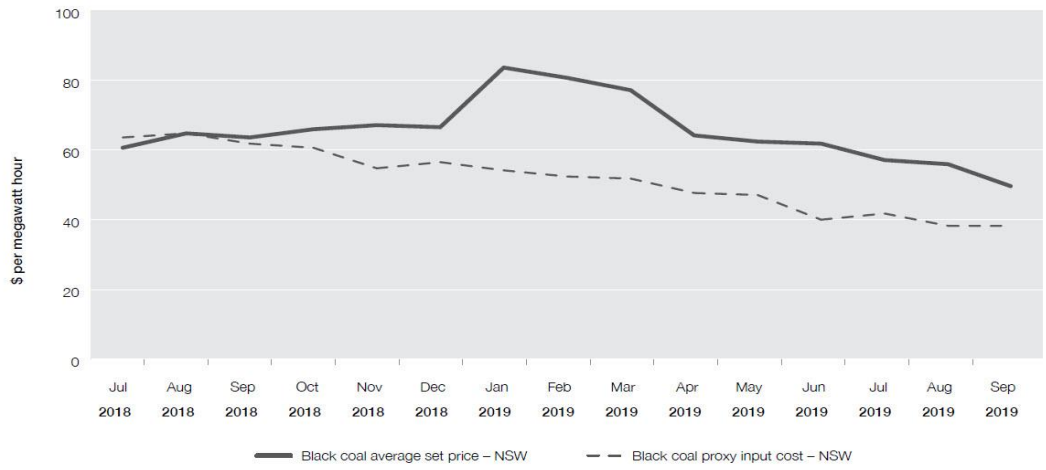

FIGURE 21: INTERNATIONAL REFERENCE PRICE FOR NEWCASTLE SPOT THERMAL COAL AND BLACK COAL PROXY INPUT COST IN NSW

SOURCE: AER

Gas prices also declined as shown in the Asian LNG netback price in Figure 22. The real challenge is gas supply and ensuring long term availability for both existing and any new gas generation plant. Commonwealth government policy to ensure sufficient domestic supply has been important and continuous monitoring of the effectiveness of the policy is required. Current expectations are that domestic supply out to the early 2030s is adequate but beyond that date prospective and planned gas developments need to proceed. Projected east coast gas production is shown in Figure 23. It is worth noting that several LNG import facilities are being considered in Victoria, NSW and South Australia. The wholesale gas market could change dramatically with these developments.

FIGURE 22: DOMESTIC AND LNG NETBACK GAS PRICES.

SOURCE: AER

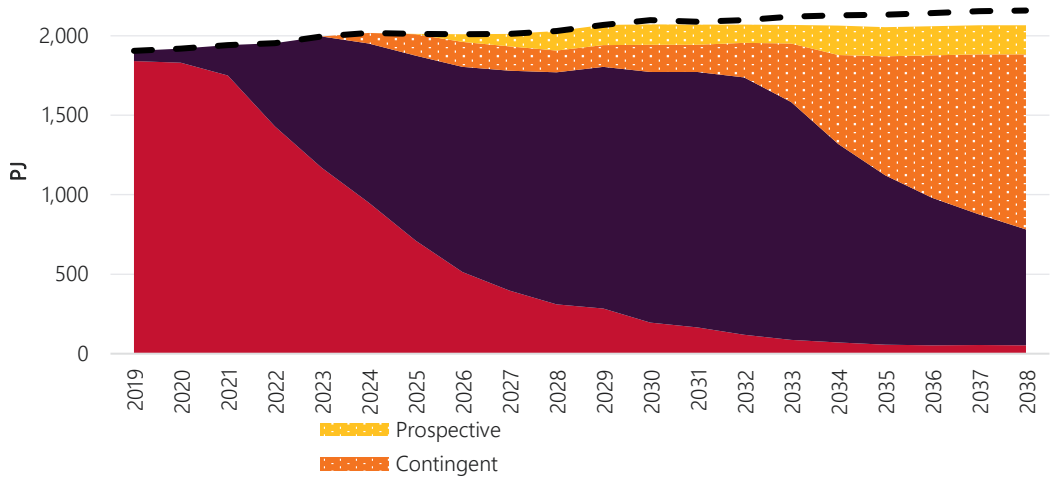

FIGURE 23: PROJECTED EASTERN AND SOUTH-EASTERN AUSTRALIA GAS PRODUCTION (EXPORT LNG AND DOMESTIC), 2019-38; SUPPLY FROM ALL AVAILABLE RESOURCES (INCLUDING UNCERTAIN UNDEVELOPED PROJECTS) (PJ)

SOURCE: AEMO

2.4.5 Innovation is incentivised and enables value from new technologies

A range of government incentives have enabled value to be realised from new technology. As the uptake of renewables has increased their costs have decreased. International prices for solar PV generation have fallen 85% in the last decade, wind 49% and battery storage by 85%[11].

Innovation and the adoption and adaptation of new technologies has been supported by Australian Renewable Energy Agency (ARENA) and its relationship with the AEMC and AEMO and industry participants. Over the past year, ARENA has supported development of solar PV generation, battery storage projects (including hybrid plants with a mix of renewable energy and storage), battery storage and the supply of new system services from batteries.

A further important area of innovation has been the development of innovative short term weather forecasting systems for wind and solar generators. Improvements in forecasting assist in the efficient integration of renewable energy.

Embedded battery storage (along with rooftop solar) is growing strongly, albeit off a low base. Energy storage and flexibility of supply and demand are important to manage the variability in renewable energy. The potential to use behind the meter generation, battery storage and demand flexibility through innovative systems, products and services has been recognised. In this area work has advanced on realising the full value of distributed energy resources with a number of trials underway including Virtual Power Plant[12] trials. These have been supported by ARENA and some state governments. AEMO has an integration

[11] BloombergNEF, technology cost declines since 2010 in “New energy outlook 2019”

[12] A Virtual Power Plant (VPP) broadly refers to a group of resources that are coordinated using software and communications technology to deliver services traditionally performed by a conventional power plant.

trial underway, focused on showing how Virtual Power Plants can deliver both energy and Frequency Control Ancillary Services.

ARENA has been active in other ways:

- It partnered with government agencies, market authorities, industry and consumer associations supporting information exchange and collaboration on Distributed Energy Resources. A significant number of studies, pilots and trials have been funded.
- ARENA and AEMO have partnered to trial demand response in high demand situations in Victoria, South Australia and NSW for the last two summers.
- Distributed Energy Integration Program held a number of events to share knowledge about virtual power plant development. DEIP examined Distributed Energy Resources and the regulatory challenges for networks developed reforms related to distribution network access and pricing arrangements for Distributed Energy Resources.

In 2020, the Distributed Energy Integration Program is overseeing four work streams:

1. DER Access, Pricing and Engagement: Building consensus and investigating new network access and pricing arrangements for distributed energy resources to meet changing community expectations and higher penetration of those resources
2. DER Interoperability: Coordinated industry wide development and implementation of data, communications and cyber security for distributed energy resources
3. DER Market Development: Testing the theory in practice for how distribution-level markets may deliver the more efficient outcome for consumers (including trials)
4. Electric Vehicles: Facilitating the efficient integration of EVs into existing networks and markets.

Distribution networks following their own initiative are undertaking innovation projects through the Demand Management Innovation Allowance and Demand Management Innovation Scheme.

Looking forward the growing presence of Distributed Energy Resources in households and business pose both a business threat and opportunity for retailers. As the integration of Distributed Energy Resources progresses the agility of smaller retailers appears to be a competitive advantage. It may also be that the historic gentailer model loses its competitive edge as retailers in that model are tied to a generation mix that may not be optimal on the transition path.

Changes in business models and different product and service offerings will be required to deliver value to customers in the future, as well as delivering innovation. Commensurate change in the types and use of financial contracts in the NEM will be required as the operating profiles and generation mix transforms. The impact this has on the competitive dynamics at a wholesale and retail level are not clear and will need to be monitored. Parties in the NEM are already developing new financial products to support trading with the changing supply mix in the NEM.
Emerging issues include:

- Monitoring the changes in the markets to ensure that the improvements noted continue, particularly in the retail market and that there are not barriers in place that prevent innovation and new entry, so that customers can take advantage of new and improved technologies (eg smart appliances).

- Monitoring both gas and coal availability so that supply difficulties do not cause unexpected generation outages.
- Understanding the changing role of financial contracts in the NEM as the operating profiles and generation mix transforms and the impact this has on the competitive dynamics at a wholesale and retail level.

2.5. Efficient and timely investment in networks

2.5.1 Overall assessment - Efficient and timely investment in networks

To assess whether investment in networks has been timely and efficient three objectives are examined.

- Are investment solutions optimal across all resources ?
- Is regulation of monopoly infrastructure efficient ?
- Do the networks have incentives to be efficient platforms for energy services ?

Table 6 presents summarises the assessments made. This is an area where there is a lot of change so assessments are difficult where the change has not yet been implemented. The Integrated System Plan continues to set out the way forward for the transmission networks and prioritizes certain Renewable Energy Zone developments. The inaugural Plan has been followed by a recent draft. Progress with the implementation of this Plan is well advanced.

The investment solutions are rated as a critical, worse than 2018, because of issues being faced by some new renewable generators in connecting to the existing grid. Constraints have been experienced but will be fixed as the grid changes its configuration to suit the new location of generators.

Some distribution networks have been challenged by the fast uptake of Distributed Energy Resources. The networks were not originally designed to manage dynamic and two way flows and need to adapt. Managing voltages across the distribution network also requires greater visibility of distributed resources and access to new communications, hardware and software solutions. This requires the development of new roles, systems and processes to realise the full potential of Distributed Energy Resources both for customers with Distributed Energy Resources and those without. Collaboration in this area must lead the way for network control and platform development.

TABLE 6: EFFICIENT AND TIMELY INVESTMENT IN NETWORKS

	Proposed Ratings		**Last Year's Ratings**	
	Current status	Outlook	Current status	Outlook
Investment solutions are optimal across all resources	Critical	Moderate	Moderate-critical	Moderate
Efficient regulation of monopoly infrastructure	Moderate	Moderate	Moderate-critical	Moderate
Networks are incentivised to be efficient platforms for energy services	Moderate-critical	Moderate	Moderate-critical	Moderate-critical
Overall	Moderate-Critical	Moderate	Moderate-critical	Moderate-critical

2.5.2 Investment solutions are optimal across all resources

For transmission the Integrated System Plan optimises new investments across the whole system. In the inaugural plan there were four projects identified as priorities. These were:

- Upgrade of the Queensland-NSW interconnect,
- Upgrade of the Victoria-NSW interconnect,
- Investment in synchronous condensers in South Australia, and
- A north west Victoria interconnect.

Each of these projects is on track to be completed by the required time. Projects at the next level of priority are at different stages of preparedness. Investment in the transmission sector is shown in Figure 24. As this shows investment has been relatively low in recent years when compared to the 2008-2014 period.

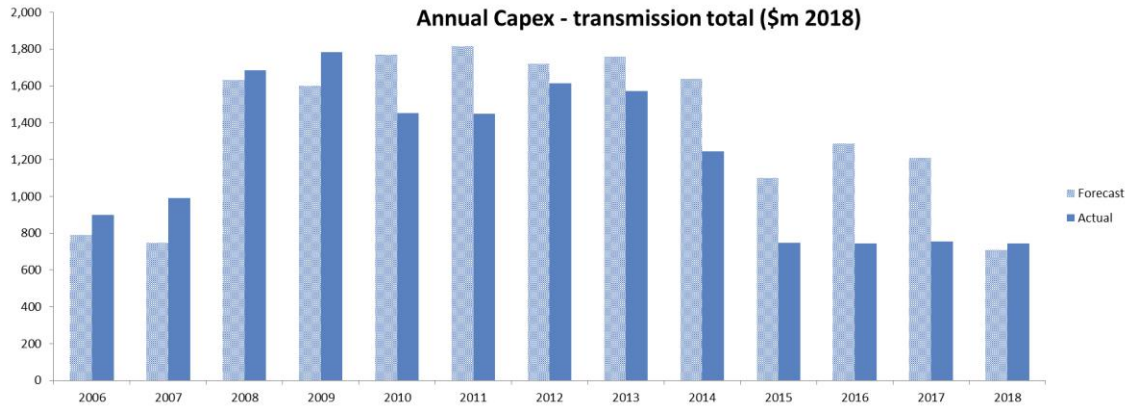

FIGURE 24: INVESTMENT IN TRANSMISSION

SOURCE: AER

At the distribution level, some networks are spending considerable effort to understand the changes required to integrate Distributed Energy Resources. This is important to enable the networks to understand where these resources are and what they can do - a first step in being able to use them optimally for the benefit of all electricity system users.

This area is very active and more progress is expected in the coming year. Investment in network assets could be made more efficient by realising the potential benefits from Distributed Energy Resources and obtaining services and support from these assets. This is being explored through the post-2025 market design process.

The pattern of investment in distribution since 2006 is shown in Figure 25.

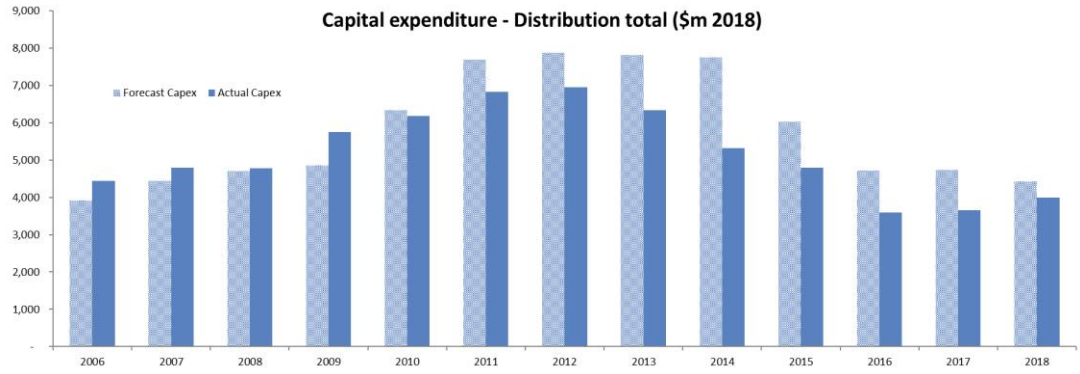

FIGURE 25: INVESTMENT IN DISTRIBUTION NETWORKS

SOURCE: AER

Finally, the productivity of transmission and distribution networks has been measured by the AER. This work shown in Figure 26 suggests that the reduction in demand on the distribution network (due to the growth of rooftop solar and energy efficiency) has reduced productivity. It is important that the spending required to adapt the networks to meet future challenges is well targeted to limit further productivity declines. The measurement of productivity in networks also warrants reconsideration where the services required of the network are changing. both network sectors could lift their productivity further.

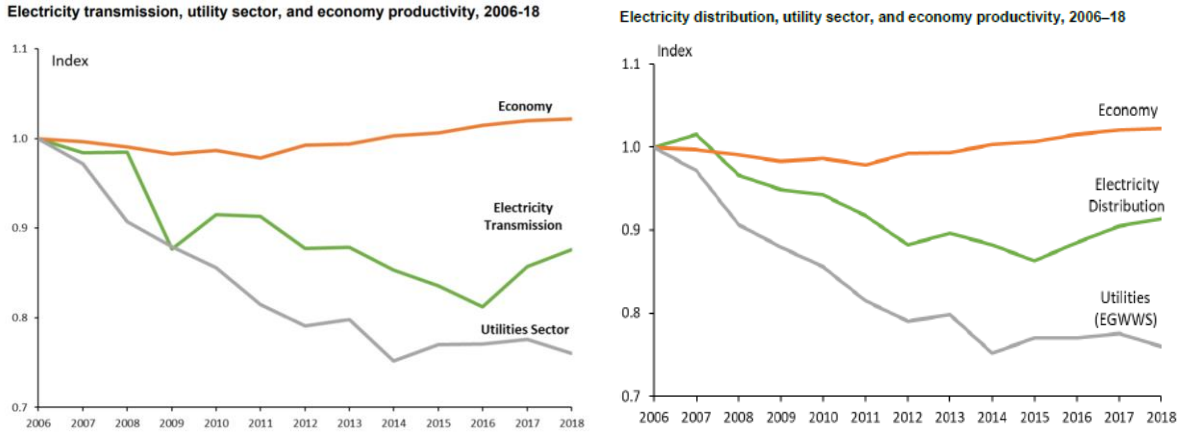

FIGURE 26: ELECTRICITY TRANSMISSION & DISTRIBUTION PRODUCTIVITY IN THE NEM.

SOURCE: AER

2.5.3 Efficient regulation of monopoly infrastructure

In the past year, a number of changes have been, or are being, made to the regulatory regime to accommodate the Integrated System Plan. The Integrated System Plan optimises across the whole system and the benefit-cost test by the AER and other procedures have been modified to make the Integrated System Plan actionable. To address Rule changes have been made to streamline the regulatory investment test for transmission and these are working well to date. Additional rule changes recommended by the ESB are currently out for consultation.

On the distribution network there is work underway considering the constraints that ring fencing places on the network companies and the extent to which this leads to optimal outcomes in a transitioning system. At present the ownership of batteries within the network is constrained and this may not be optimal nor fit with the role of the network if it is to be a platform to provide services. These are major changes being considered particularly in the context of so much rooftop PV entering the system so quickly.

2.5.4. Networks incentivised to be efficient platforms for energy services

This remains a work in progress. The decision to widen the role of networks is not trivial but appears to be necessary. There will be further developments during the coming year. A first step is to charge customers cost reflective tariffs and the extent to which this occurs is shown in Table 7.

TABLE 7: EXPECTED CUSTOMERS ON COST REFLECTIVE NETWORK TARIFFS IN THE NEM 2019/20

	Residential
Australian Capital Territory	28%
New South Wales	15%
Victoria[13]	9%
South Australia	0%
Queensland	2%
Tasmania	9%

SOURCE: AER

Emerging issues for networks include:

- That the future of the ISP will need to start considering integrated planning of gas development, hydrogen development and more immediately infrastructure to support the rollout of electric vehicles.
- Integrating Distributed Energy Resources into the system in a way that benefits all energy system users. In particular, developing new markets or regulated charges for DER services and incorporating this into future market design.
- Making suitable changes to regulation that both fully protect consumers and encourage the necessary network investment.

[13] Victorian figures are forecast for calendar year 2019.

2.6. Strong but agile governance

2.6.1 Overall assessment

A strong and agile system of governance is central to both delivering the National Energy Objectives and managing emerging issues. As the NEM changes rapidly the policy, regulation and rules need to keep up. And it is only through coordinated responses that are both timely and consultative that this is possible.

Three important areas of governance were identified in the Finkel Review and in the 2018 Health of the NEM report.

- Coordination between market bodies, and between market bodies and the COAG Energy Council;
- A greater sense of shared accountability for energy outcomes; and
- Timing of the rule change process.

During 2019 there has been considerable effort by the market bodies, the ESB and senior government officials to improve coordination. While there is always room for further improvement it is important to acknowledge that a number of major policy changes have been appropriately coordinated and managed. Work on the Integrated System Plan and its implementation is an example; as is the work and adoption during 2019 of the Retail Reliability Obligation. The COAG Energy Council met once in 2019 and further meetings planned for 2020 should improve its coordination with the other governance bodies.

As noted in 2018 the outlook for governance of the COAG Energy Council would improve with a commitment to review and renew the Australian Energy Market Agreement as recommended by the Finkel Review. A step in this direction did occur with the approval by the Energy Council of a Strategic Energy Plan. The objectives of the Plan now need to be formally reflected in the Statement of Expectations or equivalent strategy document of the market bodies.

Timing of the rule change process improved and work is continuing to add further improvements. By way of example these changes assisted with the implementation of the Integrated System Plan, and the timely introduction of the rule ensuring that generators gave three year notice of closure.

While the current status and the future outlook for governance has improved the pace of change in the NEM continues to present a significant risk. Mitigation of the risk of poor governance requires a continuing commitment by all parties to a coherent and coordinated approach to policy and its implementation. Ad-hoc policy driven by government anxiety about affordability, reliability, security or emissions reduction must have regard to the broader impact. A smooth orderly transition becomes difficult without measured consideration and coordination across the NEM.

This report rates the current status of Governance within the NEM as Moderate (see Table 6). The chances of delivering a coherent and coordinated approach to energy policy in the NEM have improved during 2019 making the outlook moderate. There is still much to be done.

TABLE 8: STRONG BUT AGILE GOVERNANCE

	Proposed Ratings		Last Year's Ratings	
	Current status	Outlook	Current status	Outlook
Overall	Moderate	Moderate	Critical	Moderate-critical

2.6.2 Governance in the NEM

The primary governance body in the NEM is the COAG Energy Council that is chaired by the Commonwealth and comprises all states and territories. Energy Ministers represent their jurisdictions. The NEM is managed by three 'market bodies': the Australian Energy Market Commission (AEMC); the Australian Energy Market Operator (AEMO) and the Australian Energy Regulator (AER). Each of the market bodies has a specific role. The Energy Security Board (ESB) was set up by the Energy Council for a three year period to oversee the implementation of the Finkel review recommendations, to improve the coordination of the market bodies, and to provide whole of system oversight.

The ESB is now moving into its final year. A review of the ESB is to be conducted for the Energy Council in 2020. Progress with implementing the Finkel recommendations has generally been good. See Appendix B. Coordination across the market bodies has improved and this is in part due to ESB efforts. When the ESB has a clear direction from Council to do something (like post 2025 market design) good progress is made with cooperation; but without such a direction coordination can be haphazard. Similar comments apply to the whole of system oversight.

Within the market bodies the AER faces a challenge to keep regulation 'fit for purpose'. The regulatory changes needed in the networks to manage a high penetration of large scale and small scale variable renewables is a daunting task and must be done in conjunction with the changes occurring. A similar observation relates to changes in the wholesale market.

As the operator of the system AEMO's role is to deliver power when it is demanded and via a NEM that is secure and affordable. The size of the challenge to do this, as the industry transitions, is difficult to overstate. AEMO's current role also encompasses system planning (through the ISP) and policy advice to Council. AEMO also provides information to the industry including forecasts. The forecasts that AEMO provide (in the ESOO and PASAs) is important for the industry as guides to likely futures. Similarly the Integrated System Plan is a very important document for grid planning in the NEM and in specific transmission companies. It is essential that this planning role be kept independent from AEMO's role as the operator. Transparency around the development of the ISP is a recognised prerequisite.

The challenge facing the AEMC is simply to keep up with the pace of change occurring in the NEM; and to be clear on its roe and responsibility in giving market development advice as this occurs. In general terms the AEMC has responsibility for the setting of rules in the NEM and for undertaking reviews and providing market development advice to COAG Energy Council and individual jurisdictions if requested. Any law changes must come from the Energy Council and any rule changes can come from Council and/or interested stakeholders. In practice most rule changes come from the market bodies.

2.6.3 Work underway

The Strategic Energy Plan continues to evolve along with the metrics used to assess how strategy is going. For better coordination this Plan must become more embedded in the

individual strategies and work of the market bodies as well as that of the COAG Energy Council. This marriage has really only just begun.

The industry rules are being reviewed by the ESB as part of the Finkel recommendation implementation. This review is not a thorough going over of the rules but rather some simplification. At this stage of the transition it was thought that a thorough review of the rules should wait and that the main focus should be on making the rule change process more agile and timely. Rule changes are tending to occur in 'bundles', such as those related to the Retail Reliability Obligation and the Integrated System Plan, and to make matters manageable for all parties it may be worth prioritising these types of changes at the expense of most one off requests that could be delayed.

Having said that it is clear that the rules are barely manageable. They have grown to a point of incomprehension for most people and are far too prescriptive. A review in due course should change many rules to guidelines that can then be varied as technology changes. Far too specific data requirements that were set before the digital age are a good example. It is also notable that the rule change process has been speeded up in response to NEM transition requirements. This has improved matters but can still be expedited further.

As part of the ESB work on immediate reliability and security measures a review of the NEM electricity reliability standard will be done to ensure that it is 'fit for purpose' and also to assess the benefits and costs to consumers of any change. Any change approved will be made in time to inform AEMO's Electricity Statement of Opportunities. Noting AEMC's work on coordination of generation and transmission investment, Ministers also asked ESB to expedite work on short term actions to progress and manage the entry of renewable energy zones into the system.

The ESB has also established working groups comprising members of all the energy market institutions to progress key items of work. Two significant examples of this are the working group pulling together draft rule changes to facilitate the actionable ISP and the ESB work to develop the Distributed Energy Resources Workplan published in November.

2.6.4 Governance Outlook

With the progress made on the Strategic Energy Plan a credible long term vision should now be the focus. Such a long term strategic vision is necessary to act as a guide in a rapidly changing market. The lack of a strategic direction has led to stakeholders deferring investment in the maintenance and construction of new generation, especially in flexible dispatchable generation. This has increased reliability risks, undermined affordability and slowed progress on emissions reduction. It has also raised barriers to entry and constrained competition in the market. With political uncertainty investment planning becomes very difficult and this has impacts well beyond the electricity industry.

Appendices

Appendix A - Overview of the National Electricity Market

The NEM is the electricity market that supplies most customers across Queensland, New South Wales, the Australian Capital Territory, South Australia, Victoria and Tasmania. These States and Territory make up the five regions in the NEM with the Australian Capital Territory included in the New South Wales region. This market delivers electricity to approximately 22 million people or 89% of the Australian population.[14]

183 TWh of electricity was consumed in the NEM in 2017-18. Residential customers accounted for approximately 26% of energy sales by volume, while commercial and industrial customers accounted for the remaining 74%. Aluminium smelters account for 13% of total consumption and 3% of the total is associated with the upstream projects supplying the Liquefied Natural Gas (LNG) facilities in Gladstone, Queensland.

The wholesale market

To provide a reliable supply of electricity to customers, the volume of electricity generated (supply) must balance with the volume of electricity consumed (demand) in real time at every location on the system. Reserve sources of energy to protect against the risk of outages and unexpected demand increases must also be provided. To achieve supply-demand balance, the wholesale market coordinates the dispatch of generators, through an 'energy only' market, where generators get paid a variable price for the electricity they produce, depending on supply-demand conditions at the time.

Generators bid the price at which they are willing to supply a certain volume of electricity and they are then dispatched in order of lowest price. Generator bids reflect a mix of technical characteristics (eg. fuel and shutdown costs, minimum load, contract volumes and capital costs). As demand from customers increases, more expensive generation is required to be dispatched to meet demand. The most expensive generator dispatched to meet demand (the marginal generator) sets the price paid to all generators dispatched in that time period (see Figure 27). This process of setting a dispatch price occurs every five minutes, and generation dispatched is paid the average price across a 30-minute settlement period (i.e. six dispatch periods).[15]

[14] Western Australia and the Northern Territory each have their own electricity markets physically not connected to the rest of the country.

[15] However, on 1 July 2021 the settlement period will change to five minutes to align with the dispatch period.

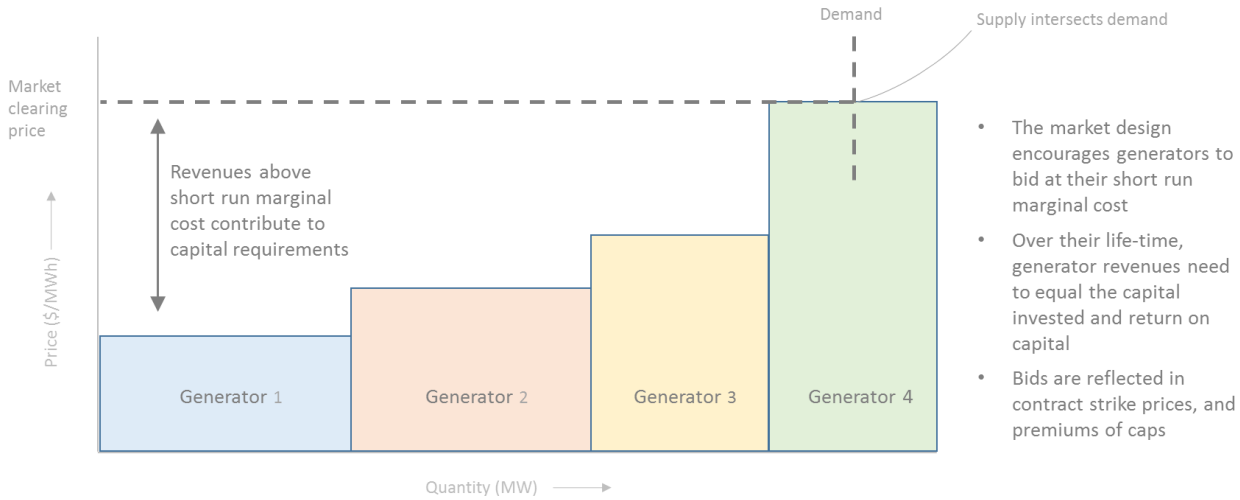

FIGURE 27: SIMPLIFIED EXAMPLE OF GENERATOR BID STRUCTURES.

SOURCE AEMC

The growth in variable renewable energy that is occurring brings additional low fuel cost supply (at close to zero) into the market. At times, the supply curve shifts to lower price generation; at other times throughout the day and across the year when variable renewable energy is operating at lower levels, the supply stack will not shift as much and may even worsen as technical limitations restrict the flexibility of ageing dispatchable generation. Ultimately this may lead to high cost coal and gas units needing to close or be mothballed for periods of time. The challenge for the market is ensuring that enough flexible generation remains to "firm" the output of the variable renewable energy when it is not operating.

Electricity generators who sell into the wholesale market use a mix of technologies, including coal fired plant, gas powered generators, wind turbines, utility scale solar PV, hydroelectric plant (including pumped hydro storage), and battery storage (see Figure 28). Electricity generated by small rooftop solar systems is not traded through the NEM and is treated by the market operator as a reduction in demand. New businesses are now emerging that look at the utilisation of residential PV and battery storage to allow the aggregation and trading of this output in the wholesale market.

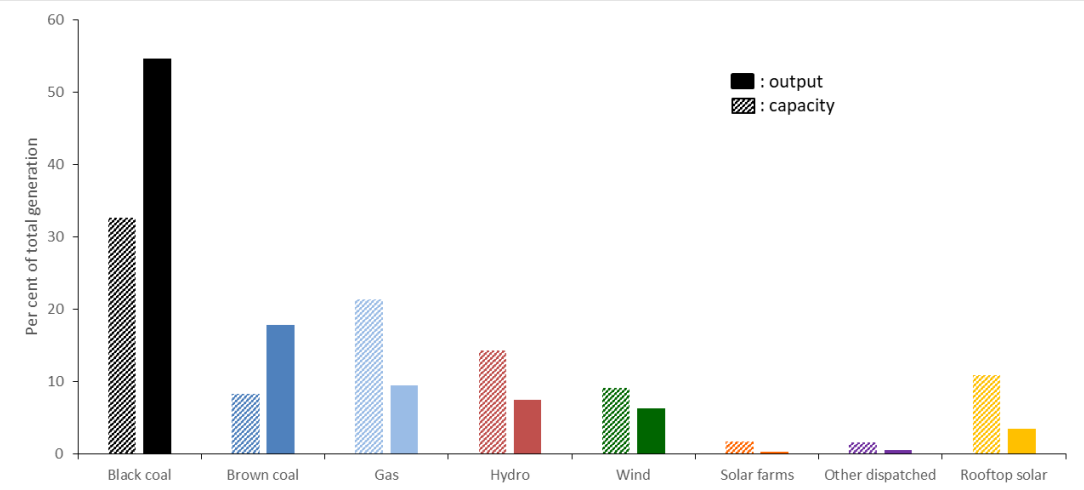

FIGURE 28: GENERATION IN THE NEM BY FUEL SOURCE, 2017-18.

SOURCE: AER

Energy retailers buy electricity directly from the wholesale market and pay for its transport through transmission and distribution networks to customers. They bundle a series of charges and manage the risk of price variability in the wholesale market to provide electricity to customers at a pre-determined rate.

In 2018-19, the wholesale spot price could vary between -$1,000/MWh and $14,500/MWh. Wholesale spot prices moving between a set floor and cap is part of the market design. This variability, between floor and cap, presents a significant risk to retailers (and to some extent generators) because retailers generally charge customers an effective rate of around $70-$150/MWh for wholesale costs (i.e. 7-15c/kWh).[16] To manage this risk, retailers and generators enter into financial hedge arrangements. These contracts allow market participants to fix the price for specified times and under certain conditions, thereby managing the risk of higher prices.

The financial market supports numerous financial products (such as caps, swaps, asian options, and swaptions) each with unique characteristics that together allow a participant to manage this financial risk under a variety of scenarios.

The contract market is an important feature of the NEM. When generation is contracted it has a strong incentive to be available and operating and to ensure plant is maintained to be able to defend contracts written with retailers. Contract markets can also provide longer-term investment signals for new generation. Consequently, it is important in future years as variable renewable energy continues to enter the market, typically supported through long term power purchase agreements, that the contract market continues to inform and signal the need for investment in firming assets that support the market when variable renewable energy is not at full production.

In addition to using financial hedge contracts, a retailer may also own and operate its own generation capacity. This allows companies to manage the risk of price volatility through an internal hedge. A company which is vertically integrated between generation and retail in this way is often called a ‘gentailer’.

Networks

Transmission and distribution networks in the NEM transport electricity from generators to consumers. Transmission networks transport power at high voltages from generators to major load centres in cities or large industrial users. Conventionally distribution networks transport electricity from various connection points along the transmission network and deliver electricity to customers through lower voltage networks. See Figure 29 below.

[16] Wholesale component of average residential customer effective prices 2017-18, ACCC, *Retail Electricity Pricing Inquiry – Final Report*, 2018, p.8 The wholesale prices (cents/kWh) exclude GST.

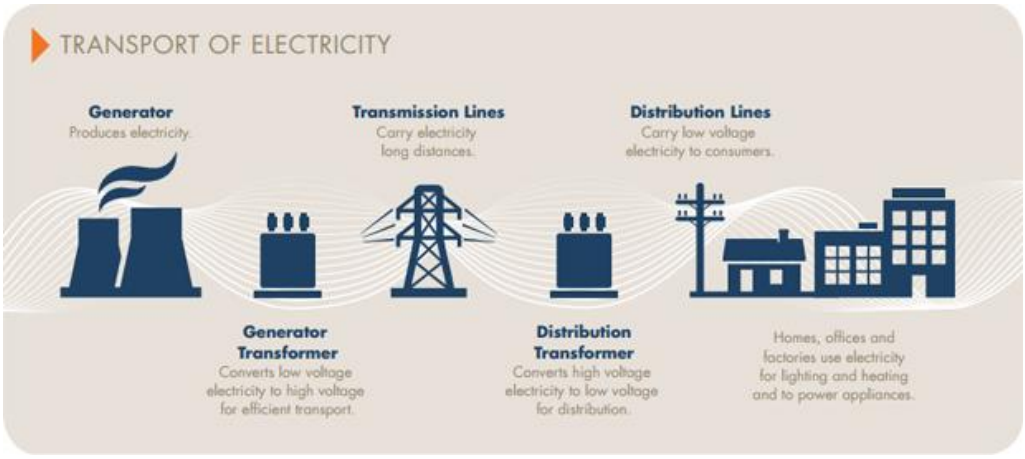

FIGURE 29: TRANSPORT OF ELECTRICITY SCHEMATIC. SOURCE: AEMO

Electricity networks are capital-intensive and incur declining average costs as output increases. Networks have been natural monopolies with efficient investment in both transmission and distribution networks achieved through regulation.
When transmission and distribution networks are considering augmentation or replacement of assets, the regulatory framework requires a range of options be considered, including consideration of non-network solutions, such as demand-side response or local generation. Expenditure is then recovered from consumers (via retailers) through network charges.

Changes underway in the NEM

Fundamental transformation is underway in the NEM. A system characterised by more variable and distributed generation technologies is emerging rapidly – more wind, solar PV and distributed batteries. AEMO estimates that 16% of electricity consumed in the NEM in 2018-19 will be generated by wind and solar PV,[17] but this level is forecast to increase rapidly,[18] driven by reductions in technology costs, government-based renewable energy targets and changing consumer preferences.

While a shift towards renewable energy is imperative to meet Australia's committed emissions reduction targets, more variable and distributed generation in the system is creating operational challenges. The current and emerging include:

- The impact on system security, including frequency control and system strength
- The increased risk of significant load shedding without sufficient flexible resources to manage the variable output and meet peak demand
- The increased economic pressure on thermal generation due to lower operating cost of wind and solar plant.

The existing variable renewable energy generation in the NEM varies across regions. AEMO estimates approximately 57% of electricity generated in South Australia will be from wind and solar PV in 2018-19.[19] When compared to major electricity systems internationally, only Denmark has a higher proportion of variable generation than South Australia (see figure 30). South Australia has entered what the International Energy Agency has termed 'Phase 4' of variable renewable integration, where advanced technologies are required to ensure

[17] AEMO, Integrated System Plan Generation Outlook, 2018
[18] Estimated to be 40% by 2030-31, AEMO, Integrated System Plan Generation Outlook, 2018
[19] AEMO, Integrated System Plan Generation Outlook, 2018

reliability. South Australia is at the forefront of the global energy transition towards renewable energy and the associated technical challenges. While the variable renewable energy share across the balance of the NEM and the rest of Australia in 2018 brought the IEA's annual share figures below 10%, the Clean Energy Regulator estimates that over 6,000 MW of large-scale renewable generation is expected to be operating by 2020, with the majority of this new generation being built in Victoria, Queensland and New South Wales.

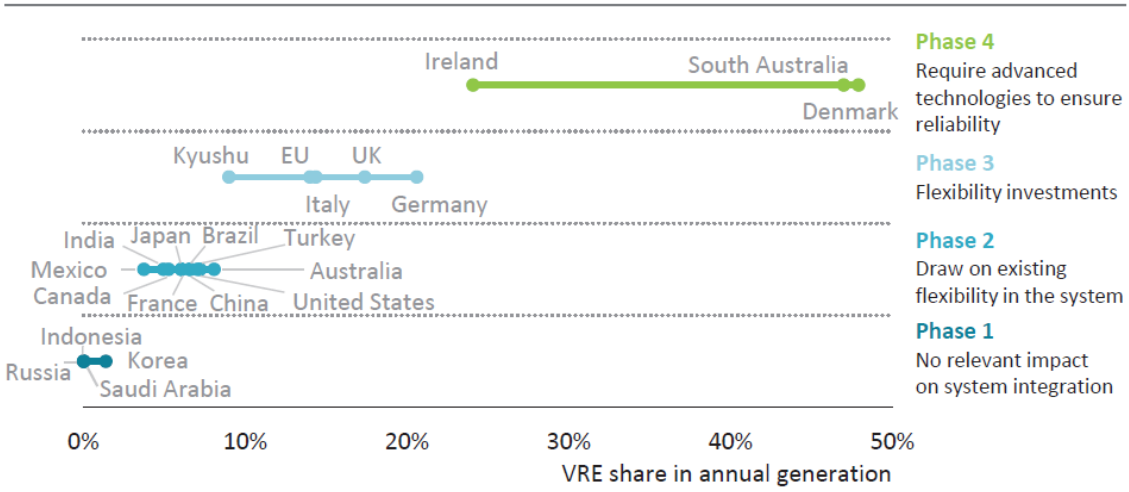

FIGURE 30: ANNUAL SHARE OF VARIABLE RENEWABLES GENERATION AND RELATED INTEGRATION PHASES IN SELECTED REGIONS/COUNTRIES, 2017.

SOURCE: IEA WORD ENERGY OUTLOOK 2018

Role of the market bodies

There are three market bodies tasked with the regulation, operation and market development of the NEM: the Australian Energy Regulator (AER), the Australian Energy Market Operator (AEMO) and the Australian Energy Market Commission (AEMC).

The AER is responsible for the economic regulation of the non-competitive sectors of the NEM, essentially distribution and transmission networks. The AER is also responsible for ensuring there is effective competition in the wholesale market and for the enforcement of compliance with the National Electricity Law and Rules and the National Energy Retail Law and Rules. The AER also provides information to consumers and plays a role in the performance of the gas market.

AEMO operates the power system and gas and electricity wholesale spot markets. AEMO is the body that keeps the electricity system operating. AEMO is responsible for implementing changes to the rules that impact on its system and market operations and importantly also provides information to market participants, for long term planning of the interconnected power system, including forecasting demand and supply and network development.

The AEMC is the market institution responsible for assessing changes to the National Electricity Rules and National Energy Retail Rules. These rules are the general statutory framework under the National Electricity Law and National Energy Retail Law which regulate the operation of the NEM. The AEMC is also responsible for market development and provides advice to the COAG Energy Council.

The Energy Security Board (ESB) was formed in 2017 to support the transition of Australian energy markets in the context of technological change and to advance the long-term

interests of consumers in this process. It has responsibility for the implementation of recommendations from the Finkel Review, to enhance coordination between market bodies and the COAG Energy Council and to provide strategic advice to the COAG Energy Council on energy security, reliability and affordability in the NEM.

Appendix B - Finkel Review Progress

Below is a timeline of the Finkel Recommendations by each of the respective bodies.

The status is reflected as;

- ‖ Under consideration / Hold
- ◆ Underway
- ● On track
- ✓ Complete

1. Preparing for summer	
1.1 Third party review of AEMO's demand forecasts and preparedness.	✓
2. Increased Security	
2.1 Adopt package of Energy Security Obligations.	✓
2.2 Consider the need for a market based mechanism for fast frequency response.	✓
2.3 Investigate rule changes to synchronous generators settings and frequency of the power system.	✓
2.4 Revise black system restart plans for each NEM region.	✓
2.5 Review regulatory framework for system security relevant to distributed energy resource participation.	✓
2.6 Consider a data collection framework for distributed energy resources	✓
2.7 Develop regular assessments of the resilience of the NEM.	◆
2.8 Update regulatory framework and funding to test new technologies.	●
2.9 Continual proof-of-concept testing for grid-scale solutions.	◆
2.10 Develop an annual cyber security report.	✓
2.11 Develop a strategy for extreme weather.	●
2.12 Facilitate a national assessment of future workforce requirements for the electricity sector.	●
3. A reliable and low emissions future - the need for an orderly transition	
3.1 Develop a whole-of-economy 2050 emissions reduction strategy.	●
3.2 Agree to implement an orderly transition: NEM emissions reduction trajectory	‖
3.2 Clean Energy Target	‖
3.2 Require all large generators to provide 3 years' notice of closure.	✓
3.3 Implement a Generator Reliability Obligation.	✓
3.4 Assess whether SA licencing arrangements should be applied elsewhere.	✓

3.4 Assess the need for a Strategic Reserve as an enhancement or replacement to RERT.	✓
3.4 Consider the benefits of a day-ahead market.	◆
4. More efficient gas markets	
4.1 Require generators to provide information on fuel resource adequacy	✓
4.2 AEMO given last resort power to enter into agreements with gas-fired generators.	‖
4.3 Governments adopt evidence based regulatory regimes.	●
4.4 Compile information on gas projects in an easily accessible format.	●
5. Improved system planning	
5.1 Develop an integrated grid plan.	✓
5.2 Identify potential projects that governments could support if market is unable to deliver investment in renewable energy zones.	●
5.3 Review ways in which AEMO's role in transmission planning can be enhanced.	●
5.4 Implement reforms to the Limited Merits Review regime	✓
5.5 Review of the Regulatory Investment Test for transmission.	●
6. Rewarding consumers	
6.1 ACCC to make recommendations on improving transparency and clarity of electricity retail prices.	✓
6.2 Health of the NEM report to include impact of changes made in the market on long-term retail contracts.	✓
6.3 Facilitate improved customer access to, and rights to share, energy use data.	●
6.4 Health of the NEM report to include affordability issues and emerging issues. Annual report ongoing	✓
6.5 Accelerate work on consumer protections.	●
6.6 Improve low income household access to distributed energy resources and energy efficiency programs.	●
6.7 Recommend a mechanism on demand response in the wholesale market	✓
6.8 Financial modelling of the incentives for investments by distribution network businesses	●
6.9 Review of regulation of individual power systems and microgrids.	✓
6.10 Accelerate the roll-out of broader energy efficiency measures.	◆
7. Stronger governance	
7.1 Agree to a Strategic Energy Plan that is informed by the blueprint.	✓
7.2 Form an Energy Security Board.	✓
7.3 Agree to a new AEMA.	‖

7.4 Commence annual public reporting on COAG EC priorities to COAG	●
7.5 Issue new Statements of Expectations to the AER and AEMC	●
7.6 Commence an annual 'Health of the NEM' report.	✓
7.7 Comprehensive review of the rules in light of changing NEM conditions.	◆
7.8 Recommendations of the Vertigan Review to expedite the rule-making process be implemented.	✓
7.9 Optimise rule change process.	●
7.10 Issue a Statement of Policy Principles to the AEMC.	‖
7.11 Ensure the AER and ESB are adequately funded.	✓
7.12 AEMO's Constitution updated to reflect a new skills matrix for directors.	✓
7.13 Reduce length of cooling off period for Independent Directors.	✓
7.14 Develop a data strategy for the NEM. Stage 1	✓
7.14 Develop a data strategy for the NEM. Stage 2	●