Renewable Energy Investment in Australia

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Abstract

Renewable energy investment has increased significantly in Australia over recent years, contributing to a continuing shift in the energy generation mix away from traditional fossil fuel sources. Current estimates suggest that investment in renewable energy has moderated from its recent peak and is likely to decline further over the next year or two. In the longer term, the transition towards renewable energy is expected to continue. Significant coal-fired generation capacity will be retired over coming decades and is likely to be replaced mainly by distributed energy resources and large-scale renewable energy generators, supported by energy storage.

Introduction

Investment in renewable energy generation has increased markedly in Australia over recent years, driven by a combination of factors including government policy incentives, elevated electricity prices and declining costs of renewable generation technology. This investment is contributing to a changing energy mix in Australia. Over the past decade, the share of electricity generation from renewable sources has increased steadily to be nearly 20 per cent in 2018 (Graph 1).[1] This share was higher in 2019 and is expected to continue increasing as projects that are currently under construction or have been recently completed begin generating output.

Investment in renewable energy generation is expected to moderate in the near term as some of the recent drivers unwind and because of challenges with integrating renewable energy sources into the electricity grid. However, over the longer term, the transition towards renewable energy generation is expected to continue as ageing coal-powered stations are retired and the process of decarbonisation continues.

This article discusses recent developments in large-scale and small-scale renewable energy investment in Australia and the drivers of this investment. It then considers the implications of increased renewable generation for the electricity grid and energy storage investment. Finally, the article considers the outlook for investment in renewable energy generation, transmission infrastructure and storage.

Large-scale Renewable Energy Generation Investment

Investment in large-scale renewable energy projects increased significantly between 2016 and 2019. It is estimated to have accounted for nearly 5 per cent of non-mining business investment at its recent peak in 2018. This investment was completed almost entirely by the private sector, with large-scale renewable projects driving much of the strong growth in private sector electricity-related investment during this period (Graph 2). Investment in new renewable energy projects over recent years has been broadly evenly split between wind and solar farms. Queensland, Victoria and New South Wales have accounted for the vast majority of projects.

Renewable energy investment has supported activity and employment, particularly in regional areas where large-scale renewable generators tend to be located. Information from the Reserve Bank's liaison with energy industry stakeholders suggests that most components associated with renewable energy generation are imported (e.g. solar panels and wind turbines). Nonetheless, there are spillovers to domestic firms, with some contacts suggesting that local content accounts for 25–40 per cent of total costs. This local content is mainly engineering, construction and installation services.[2] Some manufacturing firms have also reported stronger demand for locally produced electricity generation-related equipment.

Drivers of Investment

A number of factors have driven investment in large-scale renewable projects since 2016, including elevated wholesale electricity prices, government policy incentives, declining technology costs and improved access to finance.

Wholesale electricity prices

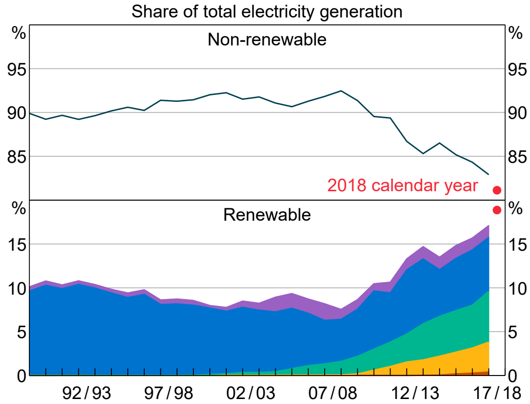
Investment in renewable energy generation has been supported by a significant increase in wholesale prices in the National Electricity Market (NEM) since 2015. The NEM is the electricity grid that covers the east coast and southern states of Australia. Western Australia and the Northern Territory have separate grids.

Wholesale prices in the NEM are determined by supply and demand. Supply-side factors appear to have been the main driver of higher wholesale electricity prices because demand for electricity has been broadly stable over recent years. In the early 2010s there was an oversupply of generation

Graph 1

Australian Electricity Generation by Fuel Type

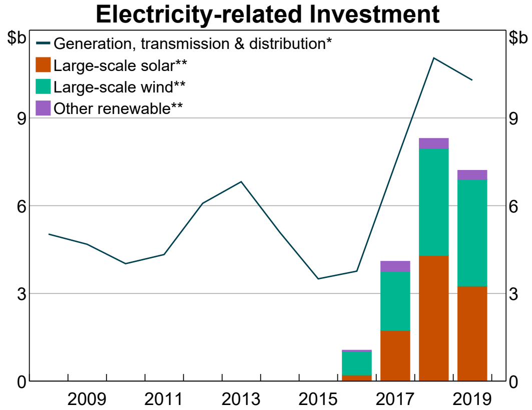
Share of total electricity generation



Source: Department of the Environment and Energy

Graph 2

Electricity-related Investment



* Renewable and non-renewable; work done by the private sector for the private sector; 2019 observation annualised

** Capital expenditure is assumed to be distributed equally over the project's life; 'other renewable' includes large-scale battery, biomass, pumped hydro and hybrid

Sources: ABS; Clean Energy Council; Clean Energy Regulator; company websites; Deloitte Access Economics; public reports; RBA capacity, which helped keep prices low (Wood, Blowers and Percival 2018; Rai and Nelson 2019; Simshauser 2019). The supply-demand balance has tightened considerably since then as a number of (primarily coal-fired) generation plants have been retired. Two brown coal-fired plant closures, Northern in South Australia (2016) and Hazelwood in Victoria (2017), had a particularly notable impact on supply. These plant closures removed over 2 gigawatts (GW) of relatively cheap generation capacity, which was equivalent to 5 per cent of total NEM capacity in 2015/16 (AER 2018).[3] The withdrawal of this coal-fired generation meant that higher-priced gas and black coal-fired generation became more important in the NEM, particularly during periods when renewable power was not being generated. At around the same time, the price of gas and, to a lesser extent, black coal rose strongly, increasing the cost of electricity generation using these inputs. This contributed to increases in the average price of wholesale electricity (Wood *et al* 2018; Rai and Nelson 2019; Graph 3).

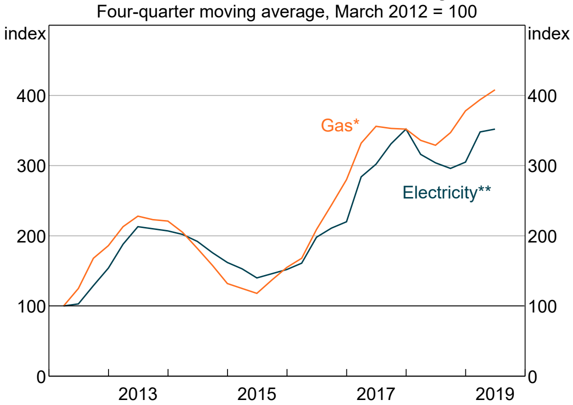
Government policies

Government climate change-related policies have also encouraged investment in large-scale renewable electricity generation. One key Australian Government policy is the Renewable Energy Target (RET), which targets 33,000 gigawatt hours (GWh) of additional large-scale renewable electricity generation by 2020.[4] The RET incentivises the development of new renewable energy power stations. It does this by requiring liable entities, predominantly electricity retailers, to source an annually increasing proportion of their electricity requirements from renewable generators. Under the RET, renewable power plants can create large-scale generation certificates (LGCs) for each megawatt hour (MWh) of renewable electricity generated. These certificates can then be sold or transferred to liable entities or other companies looking to surrender certificates voluntarily.[5]

Graph 3

Wholesale NEM Gas and Electricity Prices

Four-quarter moving average, March 2012 = 100



* Volume-weighted
** Population-weighted
Sources: AEMO; RBA

Over 2015 and 2016, the LGC spot price more than doubled to around $85/MWh in response to an expected shortfall in certificates (AER 2017). This supported renewable energy investment by providing an important revenue stream alongside earnings from the sale of electricity. The price of a certificate has more than halved since mid 2018 because it has become clear that the generation capacity from renewable energy power plants completed and under construction would be sufficient to meet the RET (CER 2019b).

State government policies have also encouraged renewable generation investment. These policies are more varied and include reverse auctions (where renewable energy projects bid for power supply contracts with the state government), state-based renewable energy targets and other commitments. While not all state-based commitments are legislated, they tend to target a larger proportion of renewable generation than the national RET (Table 1).

Cost of electricity generation

The costs of wind- and solar-generated electricity have decreased markedly over the past decade. While it is difficult to compare the cost of electricity generation from different sources, one common approach is to use the Levelised Cost of Electricity (LCOE) measure. This represents the present value of the cost of building and operating a power plant over its assumed life. While renewable power plants have quite high fixed costs, their operating costs are very low owing to the zero cost of fuel (e.g. wind and sunlight). The LCOE for new renewable power plants has fallen significantly over the past decade and is estimated to be between 40 and 60 per cent

Table 1: Renewable Energy Generation by State

	Actual in 2018 %	Renewable energy generation commitment[(a)]
NSW	17	No commitment
Vic	17	25 per cent by 2020, 40 per cent by 2025, 50 per cent by 2030
Qld	9	50 per cent by 2030
WA	8	No commitment
SA	51	No commitment
Tas	95	100 per cent by 2022
ACT	54	100 per cent by 2020
NT	4	50 per cent by 2030
Aus	19	23.5 per cent by 2020

(a) State RET or equivalent

Sources: Climate Council; Department of the Environment and Energy; State government websites

of the cost of a new fossil fuel plant (Graham *et al* 2019) (Graph 4). This decline in the cost of new renewable generation has been driven by technological innovation as well as falling manufacturing and installation costs. On this measure, a new generation-only renewable plant is much cheaper to build than a new fossil fuel plant. However, if the cost of storage is incorporated, the case is less clear.[6] For example, LCOE estimates for a new renewable plant with six hours of pumped hydroelectricity storage is around that of a new coal-fired plant (Graham *et al* 2019). This estimate does not incorporate the risk that a new coal-fired power plant could encounter greenhouse gas emissions constraints over the course of its economic life. Once possible emission constraints are priced, the LCOE of a new coal-fired plant is higher than a new renewable generation plant with storage.

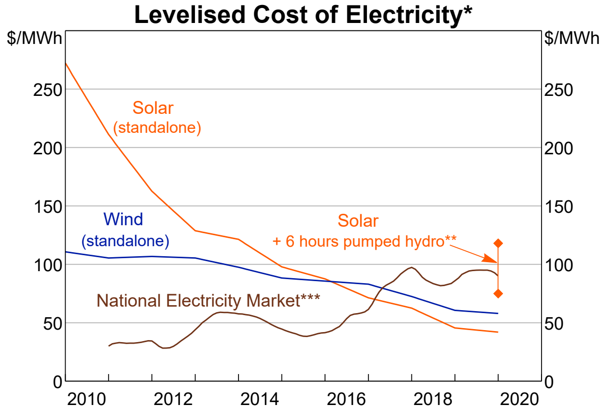
Financing for new projects

Finally, improved access to finance for developers of renewable generation power plants has been important in supporting increased investment. This is particularly important because investment in large-scale renewable energy generation tends to be highly geared. Liaison contacts suggest gearing ratios are often between 60 and 85 per cent. Domestic banks appear to have provided a significant proportion of this finance. There is evidence that project financing arrangements have evolved over the past couple of years, with increased overseas financing and the use of sophisticated financial contracts.

Long-term power purchase agreements (PPA) assist developers to obtain finance by providing revenue surety. Historically, developers typically entered into PPAs with electricity retailers, who had obligations to purchase electricity from renewable sources under the RET. Over the past few years, however, projects have been increasingly supported by PPAs with other corporate entities. Corporate PPAs can take many forms but often involve the corporate entity entering into an electricity supply contract directly with the generator. Corporates are entering

Graph 4

Levelised Cost of Electricity*



* This can be regarded as the minimum constant price at which electricity must be sold in order to break even over the lifetime of an asset

** Range of CSIRO estimates

*** Wholesale electricity price (not levelised cost of electricity); 12-month moving, population-weighted average

Sources: AEMO; CSIRO; IRENA; RBA

into PPAs to reduce their electricity costs and exposure to price volatility as well as to meet environmental commitments. The electricity prices specified in corporate PPAs appear to have declined over the past five years or so, with prices in some recently signed contracts well below the current NEM wholesale electricity price.

The Clean Energy Finance Corporation (CEFC) and the Australian Renewable Energy Agency (ARENA) have also played an important role in helping developers obtain finance by directly financing projects and encouraging private investment. These agencies have directly invested around $8.5 billion in clean energy-related projects since their inceptions. They estimate that this investment has encouraged a further $25 to $30 billion of additional private sector investment (ARENA 2019 and CEFC 2019).

Small-scale Renewable Energy Investment

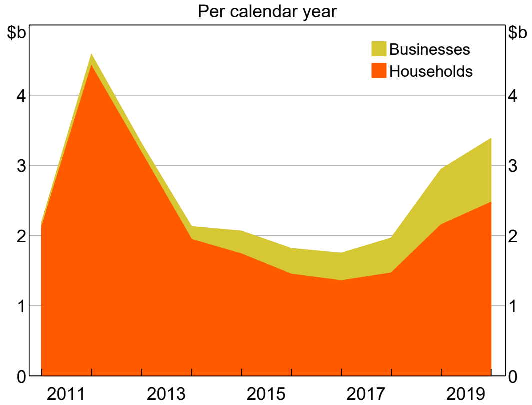
Australia's small-scale renewable generation capacity has grown rapidly in recent years and is now equivalent to around 20 per cent of the NEM's total capacity. Spending on small-scale generation (mainly rooftop solar electricity and heating) has increased in recent years to around $3.5 billion in 2019 (Graph 5).

Households have been the main driver of small-scale renewable investment and around one-quarter of dwellings are now fitted with rooftop solar panels. This has been incentivised by government policies, including the Australian Government's small-scale technology certificate scheme and state-based feed-in tariffs. These incentives, and the high price of retail electricity, has meant that the 'payback period' (i.e. the amount of time it takes for energy savings/income to offset purchase and installation costs) for a typical residential solar installation has declined and currently ranges between four and six years for most states. The decline in payback periods over recent years has been driven mainly by high retail electricity prices and falling costs of solar panel systems (GEM 2016, 2019).

Graph 5

Small-scale Solar Investment*

Per calendar year



* Small-scale solar installations are defined as having capacities below 100kW; investments below 15kW are assumed to be households; investments above 15kW are assumed to be businesses; 2010–2018 use Bloomberg small scale solar investment data; 2019 is an estimate based on Australian small scale solar capacity increases and cost reductions

Sources: APVI; Australian Energy Council; Bloomberg New Energy Finance; Clean Energy Regulator; IRENA; RBA

There has also been an increase in businesses installing rooftop solar over recent years. Firms are estimated to have accounted for more than 20 per cent of the spending on small-scale renewable generation in 2019. Businesses tend to have larger electricity consumption needs than households and they also often have the ability to install larger systems (i.e. more roof space). Liaison suggests businesses are increasingly considering investment in rooftop solar panels.

Renewable Energy Grid Integration

Significant new renewable generation capacity has been added to the NEM over the past couple of years (Graph 6). The changing mix of electricity generation towards a higher share of renewables and the retirement of coal-fired generation presents challenges for maintaining power system stability. This is because renewable energy generation sources have different physical characteristics to conventional sources, have weather-dependent output and are being located in remote parts of the electricity grid. The existing NEM transmission system was designed to transport power from large centralised generators (generally coal-fired plants) to end users. In contrast, renewable energy power plants tend to be geographically dispersed based on the availability of wind and solar resources. In some cases they are being built in areas of the grid with insufficient transmission capacity. The increasing prevalence of distributed energy resources (e.g. rooftop solar panels on residential properties) also presents challenges for network stability.

These challenges are generating uncertainty and leading to financial losses for renewable energy developers and contractors involved in construction, presenting a downside risk to new investment. Partly as a result of the rapidly increasing supply of renewable energy generation capacity, the Australian Energy Market Operator (AEMO) has been intervening in the market more frequently to maintain system security. For example, some renewable energy generators have had their output constrained because of insufficient grid capacity. In addition, some generators located in weak areas of the grid have faced significant reductions in marginal loss factors, reducing the revenue earned for electricity produced.[7] Tighter technical standards on connecting to the grid (such as requiring generators to install extra technology) have also led to connection delays and higher costs for new projects.

Energy Storage

Solar and wind generation rely on meteorological variables, which may not be in sufficient supply at times when electricity is needed. As a result, storage is required to match supply and demand for energy. Batteries and hydroelectricity are the most common forms of storage in Australia, although emerging hydrogen storage technologies are also being proposed and trialled.

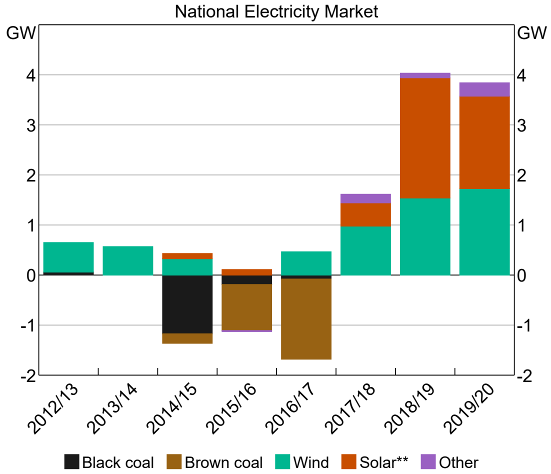
Investment in batteries has been limited to date because of the relatively high cost per unit of electricity stored. While investment in small-scale battery storage has increased in recent years, battery installations still significantly lag total rooftop solar installations (Graph 7). A more supportive policy environment and declining costs of battery storage are likely to have contributed to the recent increase in investment. Investment in large-scale batteries has also been fairly limited. Battery systems are fast to dispatch, meaning they can respond quickly to demand requirements, although the amount of energy they can hold is relatively small.[8]

Hydroelectricity can produce larger amounts of electricity over a longer duration when compared with battery storage. It operates by running water through hydroelectric turbines. Pumped hydropower facilities store electricity during periods of high supply or low demand by pumping water to an elevated reservoir where it can be used later to generate hydroelectricity. Pumping facilities can be built into existing hydroelectric plants and expand the amount of power they can dispatch considerably. There are over 100 hydroelectricity plants and three major pumped hydroelectricity plants currently operating in Australia which, combined, provide between 5 and 7 per cent of Australia's electricity supply (ARENA 2020).

Graph 6

New Generation Investment and Withdrawals*

National Electricity Market



* Estimate for 2019/20 based on planned commissioning of committed projects in the NEM

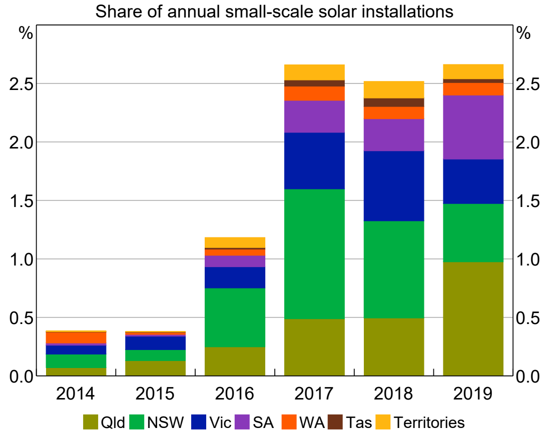
** Excludes rooftop solar photovoltaic installations

Sources: AEMO; AER; RBA

Graph 7

Solar with Concurrent Battery Installations

Share of annual small-scale solar installations



Sources: Clean Energy Regulator; RBA

Investment Outlook

Investment activity in large-scale renewable generation projects has moderated from its 2018 peak and current estimates suggest it will decline further over the next year or two. However, the outlook for investment over the longer term remains positive. The pace of future investment will depend on factors including wholesale electricity prices, the government policy environment and electricity grid considerations. Investment in the transmission network and energy storage will help support a continued increase in renewable energy generation.

Large-scale renewable energy generation

A number of factors suggest that investment activity in renewable energy will decline over the next couple of years. Some of the drivers of the increase in large-scale renewable investment over the past few years have become less supportive. In addition, electricity grid connection challenges have created uncertainty for renewable energy developers.

The generation capacity of new large-scale renewable projects that reached financial close in 2019 fell by around half compared with 2018 (Graph 8). However, the decline in investment activity in 2020 is not expected to be as sharp as implied by the fall in committed capacity, partly because delays have pushed out the construction timelines of a number of projects. While it can take several years for new projects to obtain development approvals and arrange finance, construction times are relatively short for many projects.[9] The relatively quick construction timelines of renewable energy projects creates some uncertainty for the investment outlook. If the investment environment becomes more favourable and grid integration issues are alleviated, projects could be added to the investment pipeline quite rapidly.

Near-term drivers

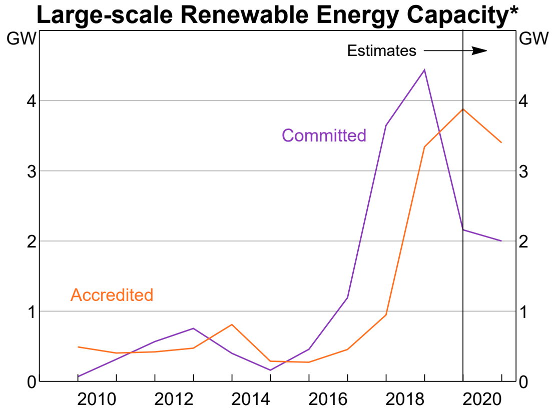
Developments in wholesale electricity prices are affecting returns for renewable generation plants and are likely to be weighing on decisions about future investment in large-scale renewable generation. There has been a notable change in how wholesale electricity prices evolve over the course of a day (intraday pricing). Daytime prices have declined significantly relative to the morning and evening peaks, mainly because of increased solar generation. This is most evident around the middle of the day when solar output is at its highest (Graph 9). The decline in intraday pricing appears to have occurred faster than expected. Occasionally, during days of abundant sunlight and wind, the large electricity load generated by renewables can drive prices negative, reducing returns for generators. In addition, wholesale electricity price futures suggest a decline in the average price over coming years, in large part due to the increase in renewable generation capacity. Average wholesale prices remain higher than the LCOE of new renewable generation but this gap is expected to narrow. As a result, wholesale electricity prices are expected to provide less support for future investment.

The Australian Government's RET has been met by the recent increase in renewable electricity generation capacity (CER 2019a). LGC futures have declined to around $15/MWh in 2022 and may decline further as more renewable capacity comes on line (Mercari 2020). As a result, the RET is unlikely to provide much support for investment in renewable generation in the future.

Weak system strength in some remote parts of the electricity network has made it challenging to connect and integrate renewable generation sources, leading to significant delays in grid

Graph 8

Large-scale Renewable Energy Capacity*



* Large-scale renewable projects are defined as 'committed' upon reaching financial close and 'accredited' when approved by the Clean Energy Regulator to participate in the Renewable Energy Target

Source: Clean Energy Regulator

connections (AEMO 2020; CER 2020). Some associated regulatory actions in response to these issues have included output constraints, marginal loss factor reductions and the imposition of additional technical requirements on new generators. These challenges are likely impacting new renewable energy investment and general confidence in the sector (CEC 2019).

Medium- and longer-term drivers

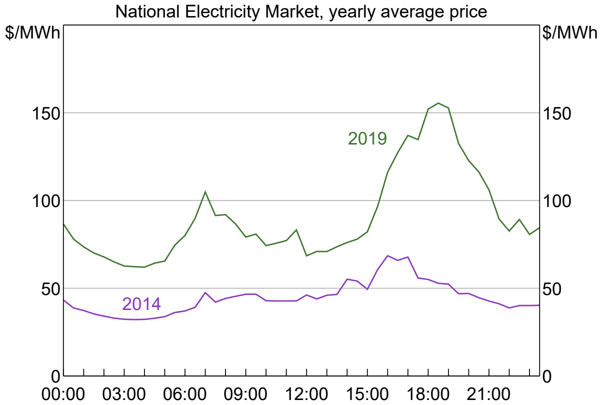
While near-term drivers of investment in new renewable generation have weakened, medium- and longer-term factors remain positive. There continues to be strong interest from firms, households and investors in renewable energy investment. A substantial number of projects have secured development approvals but are not yet committed. While electricity demand in the NEM is expected to remain broadly flat over coming years, the potential uptake of electric vehicles represents an upside risk (AEMO 2018). Electric vehicles could both increase electricity demand and provide storage for the network by allowing households to draw down upon their batteries during periods of high demand, strengthening the economic case for further renewable energy investment.

Many of Australia's coal-fired power-plants will be retired over the longer term. Around 63 per cent or 15GW of capacity is expected to be removed from the NEM by 2040 (AEMO 2019b). The next major withdrawal of capacity is likely to be the Liddell coal-fired power station (1.8 GW), which is expected to close in 2023 (AEMO 2019a). As capacity is removed from the system, new generation will be required to replace it, much of which is likely to come from renewable sources. There is also the potential for some coal-fired plants to retire early, leading to higher wholesale electricity prices. This would encourage further investment in renewable generation.

Graph 9

Intraday Wholesale Electricity Prices*

National Electricity Market, yearly average price



* Population weighted

Sources: ABS; AEMO; RBA

Current state government policies are supportive of renewable investment over the longer term, with most state and territory governments targeting at least 40 per cent renewable generation by 2030. However, existing Australian Government policy will provide less support than in the past given the RET has been met. Liaison with energy industry stakeholders suggests that uncertainty around future national policy direction is constraining investment.

There is increasing awareness both domestically and globally of the macroeconomic and financial stability risks posed by climate change.[10] For example, energy-intensive firms face risks if pricing or regulation changes require them to transition to lower-carbon means of production faster than expected. The climate change-related concerns of individuals, firms, financial institutions and investors are likely to continue to support investment in renewable energy.

Small-scale renewable energy generation

Household investment in rooftop solar generation is expected to continue, though some liaison contacts expect the growth in installations to ease in the next few years. This is due to the relatively high level of saturation and declining retail electricity prices and incentives. Investment in rooftop solar by businesses is likely to remain robust with many business liaison contacts indicating that they are considering installing generation capacity. A continued decline in the cost of these technologies and awareness of climate change issues should continue to support rooftop solar investment.

Transmission and storage

Improvements to transmission infrastructure and investment in energy storage are required to help maintain electricity grid stability and support a continued increase in renewable energy generation. AEMO's draft 2020 Integrated System Plan identifies over 15 potential projects to strengthen the transmission grid, with eight of these classified as priority projects (AEMO 2019b).[11] The total investment cost associated with these priority grid projects is likely to be at least $5 billion.[12] The Integrated System Plan also recommends that design and approval works for a second interconnector between Victoria and Tasmania should be progressed to permit delivery by 2027/28 .

Investment in electricity storage is likely to increase over coming years to help balance supply and demand within the NEM. An increasing number of renewable generation projects are likely to incorporate some form of battery storage and a number of pumped hydroelectricity projects are either being considered or are under construction in Australia. Pumped hydroelectricity projects tend to be relatively large and capital-intensive. For example, the Snowy 2.0 pumped hydroelectricity project will add around 2GW capacity at a cost of between $3.8 and $4.5 billion (Snowy Hydro 2017). Emerging hydrogen storage technologies may also have a significant role to play. Hydrogen can be stored and distributed in similar ways to natural gas by being liquefied or piped as gas. This makes hydrogen a potential future export for Australia as well as a means of domestic energy storage. The Council of Australian Governments' National Hydrogen Strategy suggests hydrogen production could contribute significantly to the economy by 2050 (COAG 2019). However, investment in supporting infrastructure and further cost reductions in this technology would be required before this becomes commercially viable at a large scale (CSIRO 2018).

Footnotes

[*] The authors are from Economic Analysis Department.

[1] The *Australian Energy Statistics* dataset is updated annually. The latest data on electricity generation are for 2018. See Department of the Environment and Energy (2019) for details.

[2] Large-scale renewable energy projects require significantly less labour during the operations and maintenance phase than the construction phase.

[3] Watts (W) are used to quantify rates of energy transfer. In this article they are generally used to refer to capacity, or the maximum rate at which energy can be produced by generating assets. Watt-hours (Wh) are units of energy, used in this article to refer to energy output.

[4] The accreditation of power stations and creation of large-scale generation certificates continues under the RET until 2030. See *Renewable Energy (Electricity) Amendment Bill 2015*.

[5] Some companies that are not liable entities under the RET choose to surrender large-scale generation certificates as part of their commitment to reducing their environmental impact.

[6] Storage allows electricity generated by a renewable power plant to be dispatched when needed.

[7] AEMO sets marginal loss factors annually (for the upcoming financial year) for every generator in the NEM. Marginal loss factors are forward-looking projections that take into account the portion of electricity that is expected to be 'lost' during transmission. A lower marginal loss factor means that a higher share of electricity is expected to be lost, which reduces a generator's revenue for the electricity they produce. For details of the marginal loss factors applicable for 2019/20, see AEMO (2019d).

[8] The largest lithium-ion battery in the world (the Tesla battery at the Hornsdale Power Reserve in South Australia) has a 100MW capacity and can store 129MWh of electricity. By comparison, over 4,000 MW of new renewable capacity was accredited in 2019 (CER 2020). The largest individual project accredited was the Coopers Gap Wind Farm, with a generation capacity of 453MW.

[9] The average build time for solar projects is around a year, while wind projects have longer average construction periods of around 18 months.

[10] For discussions of the economic and financial stability-related implications of climate change for Australia, see Debelle (2019) and RBA (2019).

[11] As at February 2020, two of the priority projects are committed and one has been granted regulatory approval.

[12] This is based on indicative cost estimates provided in the *Draft 2020 ISP Transmission Outlook Summary* (AEMO 2019c), as well as published capital costs of the priority projects already committed. It does not include any costs associated with design and approvals works for a second interconnector between Victoria and Tasmania.

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