Australia's renewable energy industry is delivering rapid and deep emissions cuts

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Summary

During 2018 and 2019 Australia is likely to install about 10,400 Megawatts (MW) of new renewable energy, comprising 7,200 MW of large-scale solar photovoltaic (PV) systems and windfarms together with 3,200 MW of small-scale rooftop PV systems. Combined, this represents 30% of Australia's peak electricity demand.

The Australian renewable energy industry is convincingly demonstrating its capacity to install large amounts of wind and PV systems. If industry is able to continue to deploy wind and PV ***at the current rate*** into 2020 and beyond then Australia will:

- comfortably exceed the 2020 large scale Renewable Energy Target (LRET) of 33,000 GWh
- be capable of supplying up to 29% renewable electricity in 2020, 50% in 2025 and 100% in the early 2030s
- achieve 26% emissions reductions in the electricity sector by 2020/21
- meet its entire 26% Paris emission reduction target for the whole economy in 2024/25

The current deployment rate could well continue. Prices of wind and PV are falling rapidly, potentially opening new markets and placing downwards pressure on electricity prices. Opportunities are broadening beyond the wholesale market as companies recognise the economic and environmental credential benefits of renewable energy.

Developments in PV and wind both globally and within Australia are happening far faster than public discourse suggests. It is therefore highly desirable that national energy planning has a real-world view of the facts on the ground in order to prepare for this rapid change.

Global developments

Prices of wind and PV continue to fall rapidly, and the scale of deployment continues to rise rapidly. PV and wind now comprise 60% of annual global net new capacity additions (Figure 1), and nearly 100% in Australia. As prices decline an ever-increasing portfolio of market opportunities present themselves, and annual deployment is expected to continue to increase.

The silicon solar cell (which constitutes 95% of the world solar market) is disrupting the global energy industry just as the silicon chip previously disrupted the electronics industry.

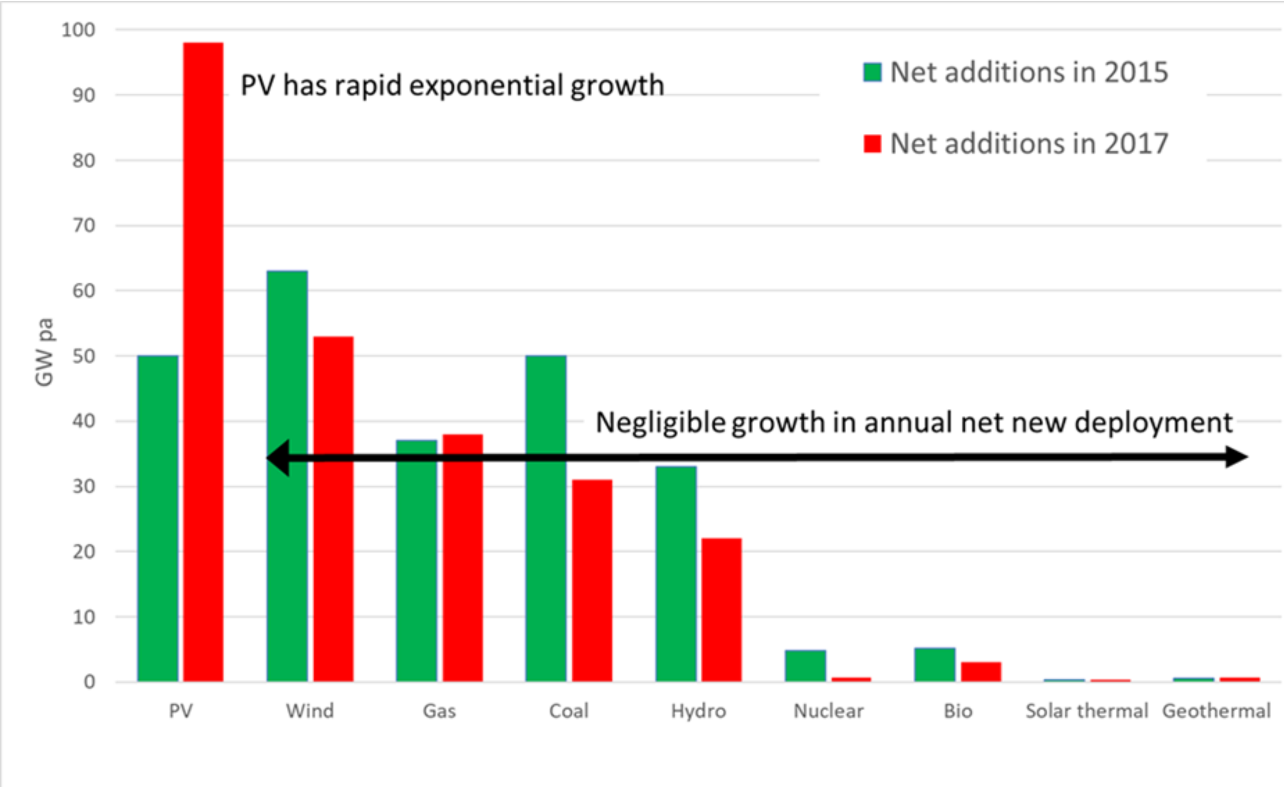

Figure 1: Net new global generation capacity additions in 2015 and 2017. PV is growing rapidly whilst the other generation technologies have negligible growth in annual net new deployment [1-6].

Large-scale PV and wind systems in Australia

The Clean Energy Regulator (CER) [7] closely monitors the construction of all renewable energy projects over 5 MW, and completion (accreditation) of smaller projects (> 100kW) that also fall into the LRET. It maintains a register of projects that are accredited (completed), committed and probable. As of August 2018, the CER had identified 7,200 megawatts (MW) of new large-scale renewable energy projects that will be accredited during 2018 and 2019, about half each for PV and wind and 2% for other technologies. Figure 2 shows the accredited and expected (committed and probable) installations for 2016 – 2019.

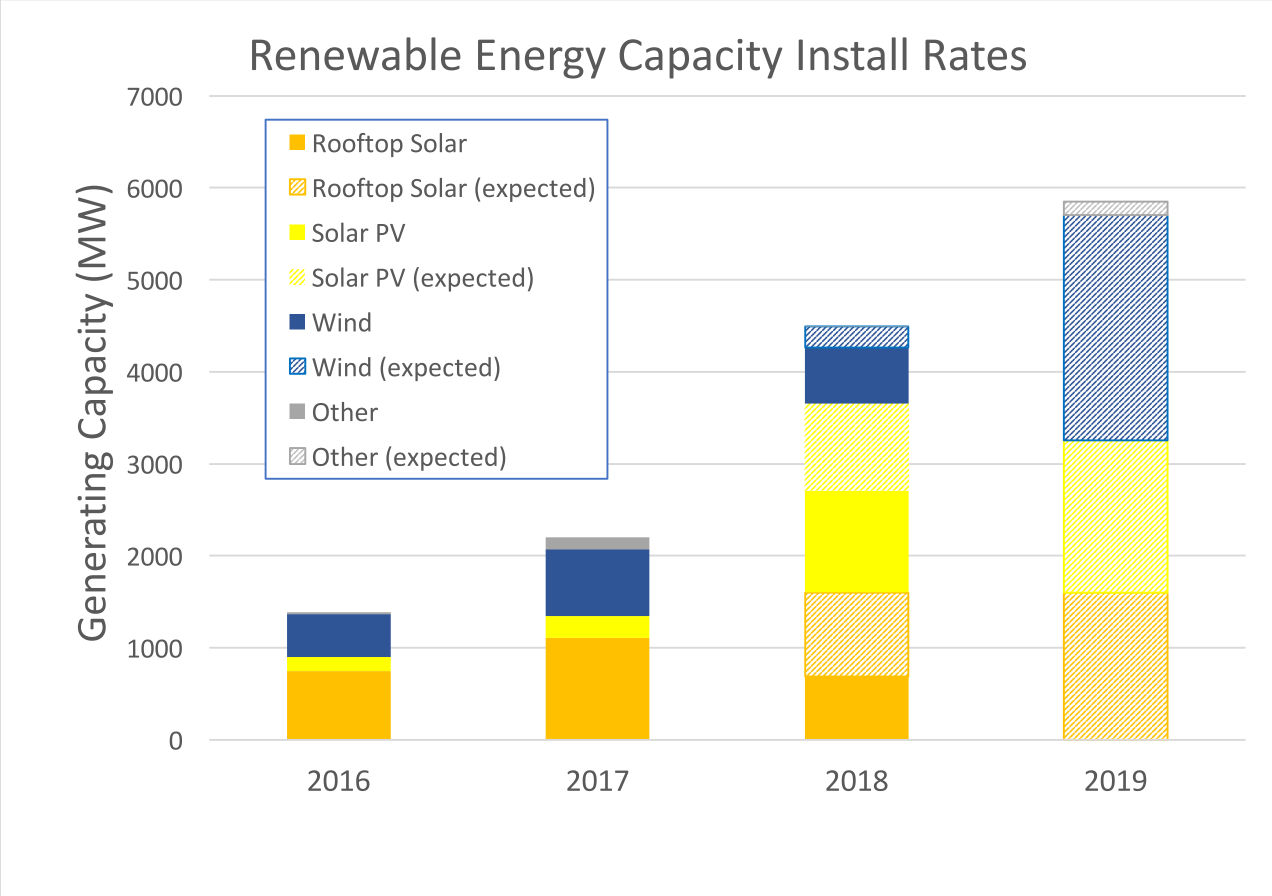

Figure 2: Rooftop solar, large scale solar, wind and other generating capacity completed or expected to be installed for 2016 – 2019.

Typically, solar and wind projects are taking 12 and 18 months respectively from final investment decision to **completion** of construction. The accredited, committed (reached financial close) and proposed (with high probability) renewable projects from 2016 to 2020 are shown in Figure 3.

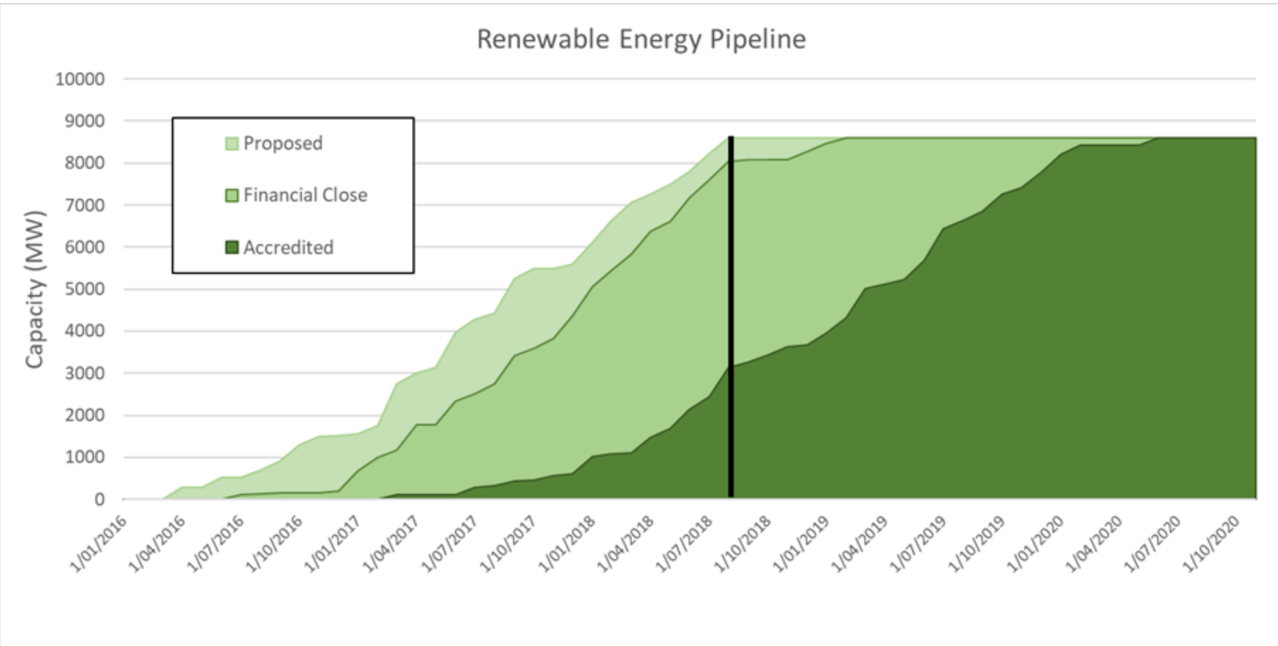

Figure 3: Actual and probable deployment of large (> 0.1 MW) systems in Australia based on CER data [7]. It can be seen from the graph that about 4,000 MW per year is currently being installed. This figure is available in an accompanying spreadsheet.

The CER construction pipeline data does not include future capacity linked to high-profile announcements of new renewable energy targets and industry trends including:

- The Victorian renewables target of 25% by 2020 and 40% by 2025 [8], including a 650 MW reverse auction soon to be announced [9]
- The Queensland renewables target of 50% by 2030 [10]
- The Northern Territory renewables target of 50% by 2030 [11]
- The announcement of a more than 1 GW renewables program by Sanjeev Gupta [12]
- The appetite for many companies to enter into power purchasing agreements with PV and windfarm operators [13, 14] for access to reduced cost electricity, and for corporate image and sustainability goals.
- The demand for PV on commercial and industrial roofs is rapidly growing.

Small-scale rooftop PV systems behind the meter

Deployment of small-scale (< 0.1 MW) PV on the roofs of buildings is growing rapidly (Figure 4). Based upon activity in the first half of 2018, a total of 1,600 MW is likely to be deployed in 2018. The average system size has increased from 3 kilowatts (kW) in 2012 to nearly 7 kW in 2018 [7, 15] in line with costs per watt for the average size systems dropping by almost 60%.

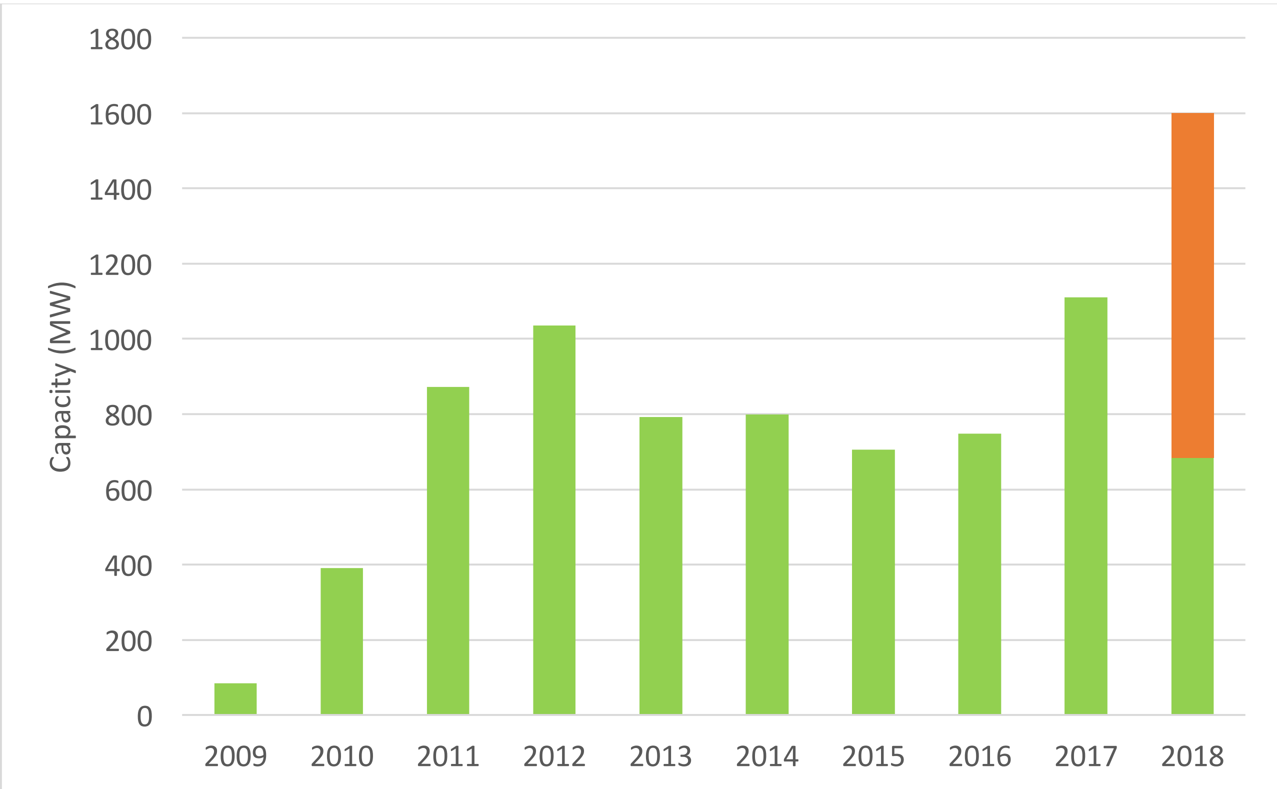

Figure 4: Annual small-scale (< 0.1 MW) rooftop PV capacity additions including an estimate of 1,600 MW for the whole of 2018 based on installations for the year to June [7].

Future scenarios

The Australian renewable energy industry is convincingly demonstrating the capacity to rapidly deploy PV and wind systems, at a rate of 10,400 MW over 2018 and 2019 (comprising the 7,200 MW in large-scale renewables and 3,200 MW in rooftop solar). This represents 30% of Australia's peak electricity demand (37,000 MW [16]).

It is interesting to project this rate if the Australian renewable energy industry is able to continue its currently demonstrated capacity for deployment into the future. Figure 5 illustrates the consequent rapid decline in demand for fossil fuel electricity generation if this renewables deployment rate continues.

Under this scenario renewable electricity generation will be capable of supplying up to:

- 29% of national electricity demand in 2020
- 50% in 2025
- 100% in the early 2030s

The assumptions of this scenario are:

- Demand (including behind-the-meter demand) remains constant. Demand has changed little in the last decade [17].
- Large-scale PV, small-scale PV and wind continue to be deployed at a rate of 2,000 MW, 1,600 MW and 2,000 MW per year respectively.
- Capacity factors of 21%, 15% and 40% are assumed for new large-scale PV, small-scale PV and wind respectively.
- Existing hydro and bio generation remains constant at 20 terawatt-hours (TWh) per year.
- Fossil fuel meets the balance of demand.

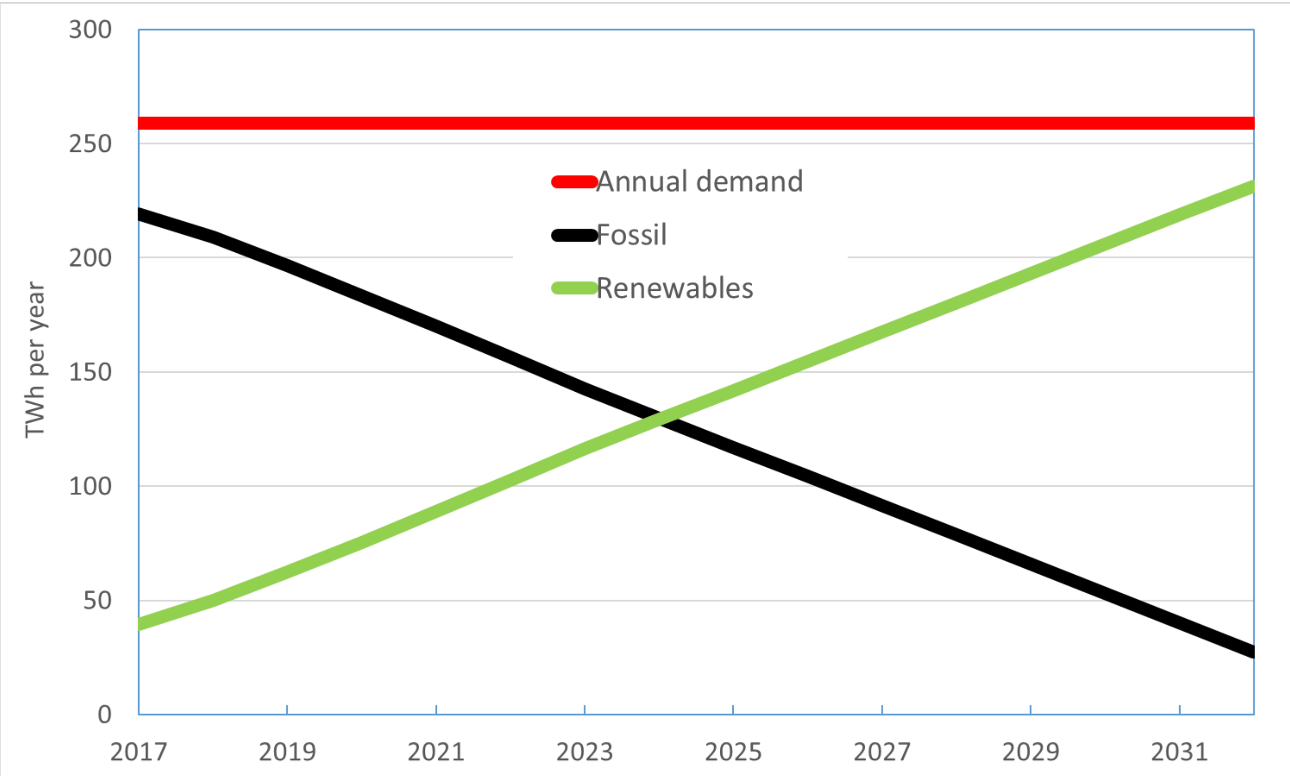

Figure 5: Modelled increase in annual PV and wind generation in terawatt-hours (TWh) and the consequent reduction in fossil generation based on extrapolation of current industry deployment rates for renewables.

The construction pipeline and the renewable energy target

2017 was a record year for renewable energy with 2,200 MW being added. During 2018 and 2019, Australia will install a further 10,400 Megawatts (MW) of new renewable energy. This represents a per-capita rate of 224 Watts per person per year, which is amongst the highest rates in the world. Reasons for this high rate include excellent solar and wind availability, high wholesale and retail electricity prices and a highly capable and experienced industry. Government support programs, notably the RET, allowed the industry to reach critical mass and hence low prices, which in turn allowed the industry to grow and further reduce prices.

The growth of large-scale PV and wind systems was driven initially by the Government's large-scale Renewable Energy Target (LRET) [18] to procure an additional 33,000 GWh of large scale renewable electricity. The CER estimates that meeting the LRET target requires that 6,400 MW of new large-scale projects is committed by the end of 2018 [7]. The current projection of 8,700 MW of committed projects over this period (Figure 3) indicates that the LRET will be comfortably exceeded.

Renewable energy developers are well aware of these projections, which indicates they believe that only small or zero financial support is required for projects to be competitive in 2020 and beyond. Indeed, the typical price of carbon abatement from the Emission Reduction Fund ($12/tonne equivalent to $11/MWh for a coal-fired power station) would be sufficient to draw many more projects to financial close.

Despite the early achievement of the LRET target (which we predict will occur in 2019), the rapid renewable deployment rate might be expected to continue for a number of reasons:

- Large-scale Generation Certificates (LGCs) will continue to be issued to accredited new generating capacity by the CER after 2020 out till 2030.
- Renewable investment opportunities are broadening beyond the wholesale market, with companies increasingly realising the economic and environmental credential benefits of renewable energy supply contracts. For example, Sanjeev Gupta has announced that he will add 1GW behind the meter at the Whyalla steelworks [12], and Sun Metals in Townsville have already installed 125 MW of solar generating capacity [19].
- The price of wind and PV will continue to fall rapidly, opening up further market opportunities, as well as placing downwards pressure on electricity prices.
- Increased deployment of electric vehicles in place of internal combustion vehicles and increased deployment of electric heat pumps in place of gas for water and space heating is expected to increase electricity demand. Since nearly all new generation capacity in Australia is PV and wind, a sharp increase in demand is expected to be met by a large increase in the deployment rate of PV and wind.
- Retiring existing coal power stations will be replaced by PV and wind.

Commercial and industrial deployment behind the meter

An important recent development is rapid growth in deployment of large-scale (> 0.1 MW) PV on the roofs of commercial and industrial enterprises (Figure 6). The need for electricity in such businesses is often well-matched with solar availability, which allows high levels of self-consumption. Such systems are "behind the meter", which means that the PV is competing with the commercial & industrial tariff rather than the (lower) wholesale tariff.

Figure 6 suggests that large growth in this market is likely over the coming years.

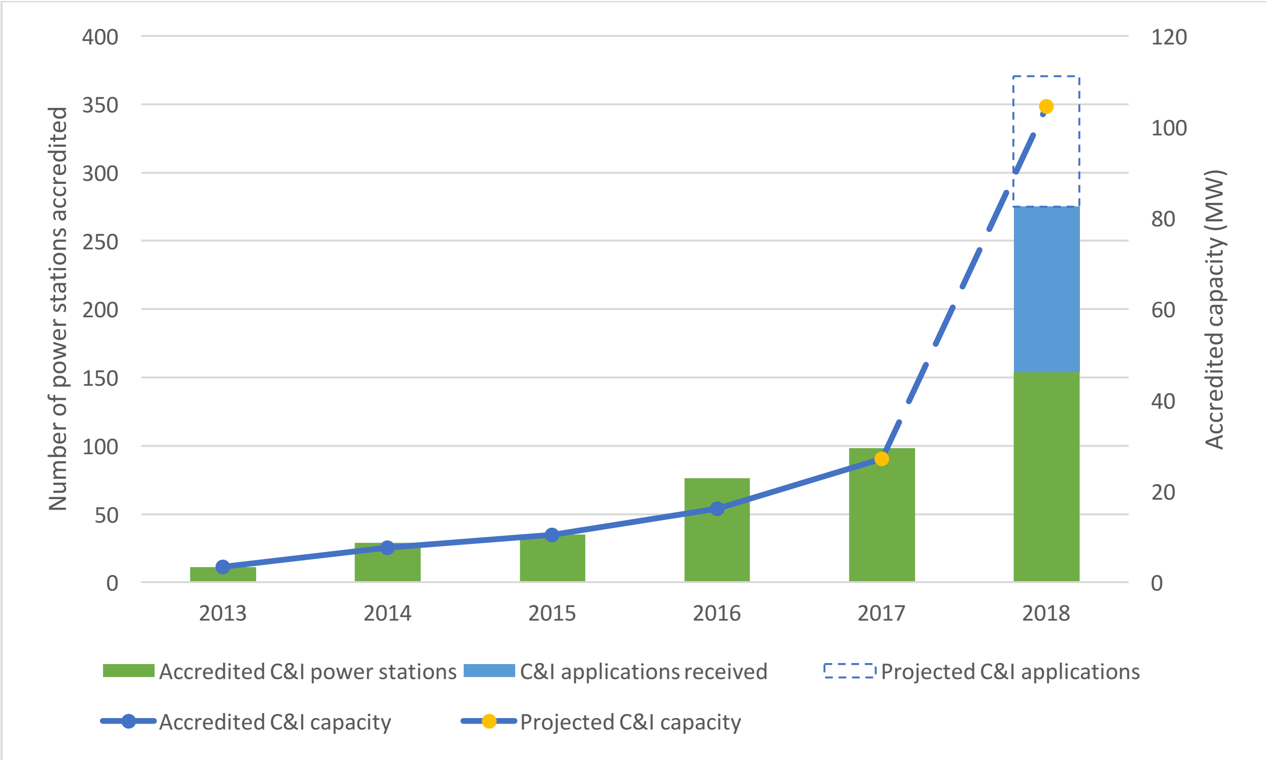

Figure 6: Commercial and industrial (> 100 kW) PV system deployment [7]

Meeting the Paris greenhouse emissions target

The cheapest way to meet the Paris emissions reduction target is by large scale substitution of zero emission wind and solar PV into the electricity system with coal and gas retiring as their need reduces. Emission reductions in other sectors is generally considered to be more expensive than in the electricity sector.

Using the renewable energy deployment scenario described above, the electricity sector emissions will reduce by more than 26% in 2020/21, and Australia's entire Paris target of 26% reduction across all sectors of the economy (not just "electricity's fair share") would be met in 2024/25.

Assumptions: Australian Greenhouse gas emissions in 2017 were 534 Megatonnes (MT) [20]. Under the Paris agreement, Australia will reduce greenhouse gas emissions from 612 MT/year in 2005 by 26% to 453 MT/year by 2030 [21], which is a reduction of 81 MT/year from current emissions. We assume that all emission reductions are obtained within the electricity system through progressive closure of black coal fired power stations which have an average emission intensity of 0.9 tonnes per MWh.

Falling PV and wind prices

Wind and PV prices have been falling for decades. Price decrements have accelerated in the past 5 years as the global industry reaches critical mass. Increasing industrial solar cell efficiency and reducing area-related costs combine to ensure that PV prices will continue to fall for many more years.

PV and wind electricity prices in Australia are currently $50-65/MWh [22] and falling. The best available global prices for PV for large systems in similarly sunny countries are in the A$30-50/MWh range [23,24], which is likely to be matched within Australia during the next few years. Continuously falling costs of PV and wind will continue to place downwards pressure on electricity prices.

For comparison, the average wholesale price of electricity in NSW in 2018 is $82/MWh [25,26]. Thus, increased amounts of renewable electricity will put downwards pressure on prices.

The expected cost of electricity from a new coal fired power station is about $70/MWh [27] which is higher than the cost of PV and wind. Soon, PV and wind will be competitive in Australia with the marginal cost of operating an existing black coal fired power station (fuel and maintenance). There is an increasing corporate appetite to buy renewable energy directly [13,14], a trend that could lead to premature closure of existing coal power stations. PV and wind may soon match the wholesale price of gas in Australia ($9/GJ) [28] which means that PV electricity could directly compete for provision of industrial heat.

Stabilisation of the grid

Stabilising an electricity grid with high levels of variable PV and wind is straightforward [29] and comprises storage and strong interconnection with high voltage cables between regions to smooth out the effect of local weather and demand. By far the leading storage technologies are pumped hydro [30] and batteries [31], with a combined global market share of 98% [32].

The cost of hourly balancing of the NEM is about $5/MWh for a renewable energy fraction of 50%, rising to $25/MWh for a renewable energy fraction of 100% (Figure 7 [29, 33]). The proposed Snowy 2.0 storage is sufficient for hourly balancing of the grid for a renewable energy fraction of 50% [33]. Additional storage would be required to balance a 100% renewable grid [29].

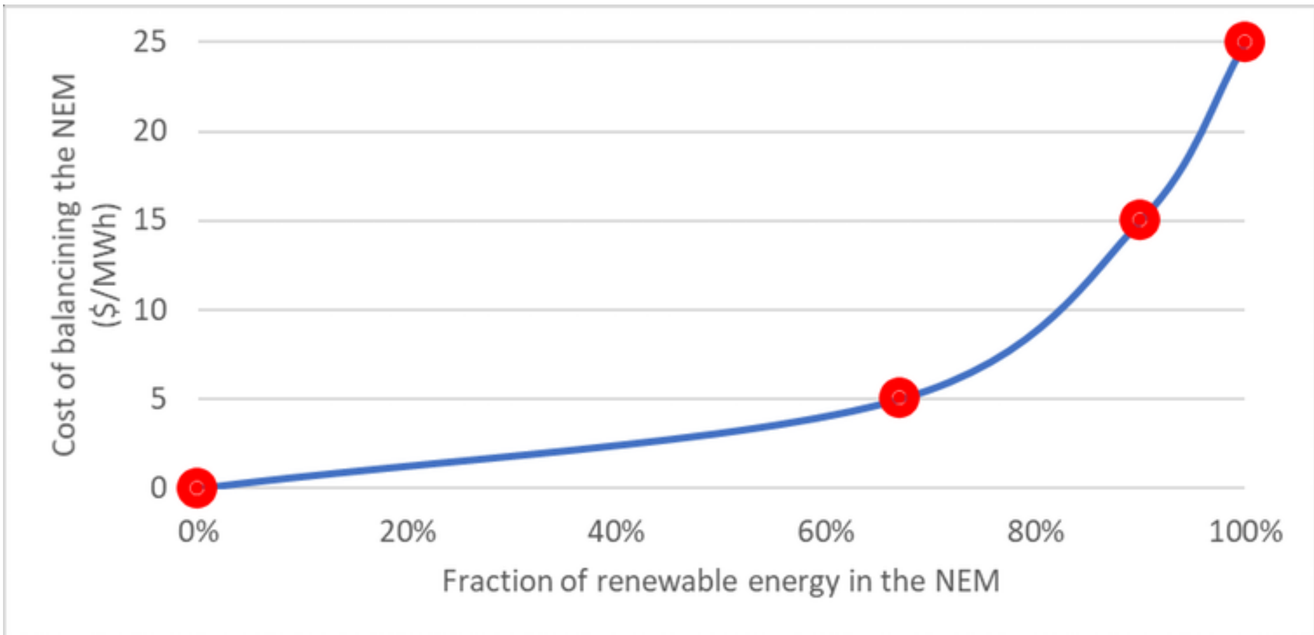

Figure 7: Cost of hourly balancing of the NEM (A$ per MWh) as a function of renewable energy fraction [28]

Government support for renewables

This paper demonstrates that Australia's renewable energy industry has the capacity to deliver deep and rapid emissions reductions. Direct Government support for PV and wind would help enhance industry capability but is no longer critical. What is crucial is Government policy certainty that will enable the renewable industry to realise its potential to deliver deep emissions cuts.

The most useful support that the Government could provide is provision of high voltage interconnectors between states and to renewable energy zones (containing large numbers of PV and wind farms). This is akin to Government provision of toll roads to resolve road traffic bottlenecks and the NBN to resolve internet traffic bottlenecks. Support for storage would also be very useful, for example through Snowy 2.0 or similar schemes.

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