Powering ahead: Australia leading the world in renewable energy build rates

Matthew Stocks, Ken Baldwin and Andrew Blakers

matthew.stocks@anu.edu.au: kenneth.baldwin@anu.edu.au; andrew.blakers@anu.edu.au;

The Energy Change Institute, Australian National University, Canberra, ACT 2601, Australia

Further information:

http://energy.anu.edu.au/ http://re100.eng.anu.edu.au/

4th September 2019

Summary

- Australia is leading the world in the installation of renewable electricity capacity with per capita rates 2.5 times the next best (Germany). This is 4-5 times faster per capita than the European Union, Japan, the USA or China and ten times faster than the world average.
- Australia has just now (August 2019) installed sufficient additional renewable energy capacity to meet the 2020 Renewable Energy Target of 33,000 GWh p.a. (revised downward by the Abbot Coalition Government in 2015)
- The current pipeline of projects is sufficient to exceed the original target of 41,000 GWh p.a. around the end of 2020
- Australia is on track to install more than 16 Gigawatts (GW) of renewable power over the 3 years 2018-20, which can be compared with average and peak power demands of 24 and 36 GW respectively
- Unlocking investment in transmission is key to maintaining the renewable energy pipeline

Exceeding the Renewable Energy Target

Australia has recently installed sufficient new wind and solar farms to deliver the generation required to exceed the 2020 Renewable Energy Target. The Clean Energy Regulator (CER) estimated that 6,400 MW [1] of additional large scale renewable energy projects would lead to the generation of 33,000 GWh of energy per year from eligible renewable generators. According to the latest data released by the CER on 4th September, this was delivered with the accreditation of the approval of the 148.5 megawatt Cattle Hill Wind Farm on August 30th, 2019.

Importantly, meeting the Renewable Energy Target is not the end of the renewable energy build pipeline. Looking forward, analysis presented in Figure 1 suggests that there will be a further 6 GW of large-scale renewable power projects completed by the end of 2020. There is 2.5 GW of large scale solar and 3.5 GW of wind power under construction or announced that could be completed in this timeframe. This new build would be expected to produce a further 11,000 GWh of electricity assuming a capacity factor of 40% for wind and 21% for large-scale solar. This is significant, because the new annual renewable energy generation would by then be capable of generating more than the old Renewable Energy Target of 41,000 GWh per annum legislated in 2009 by the Rudd Labor Government, which was reduced to 33,000 GWh by the Abbot led Coalition Government in 2015 [2].

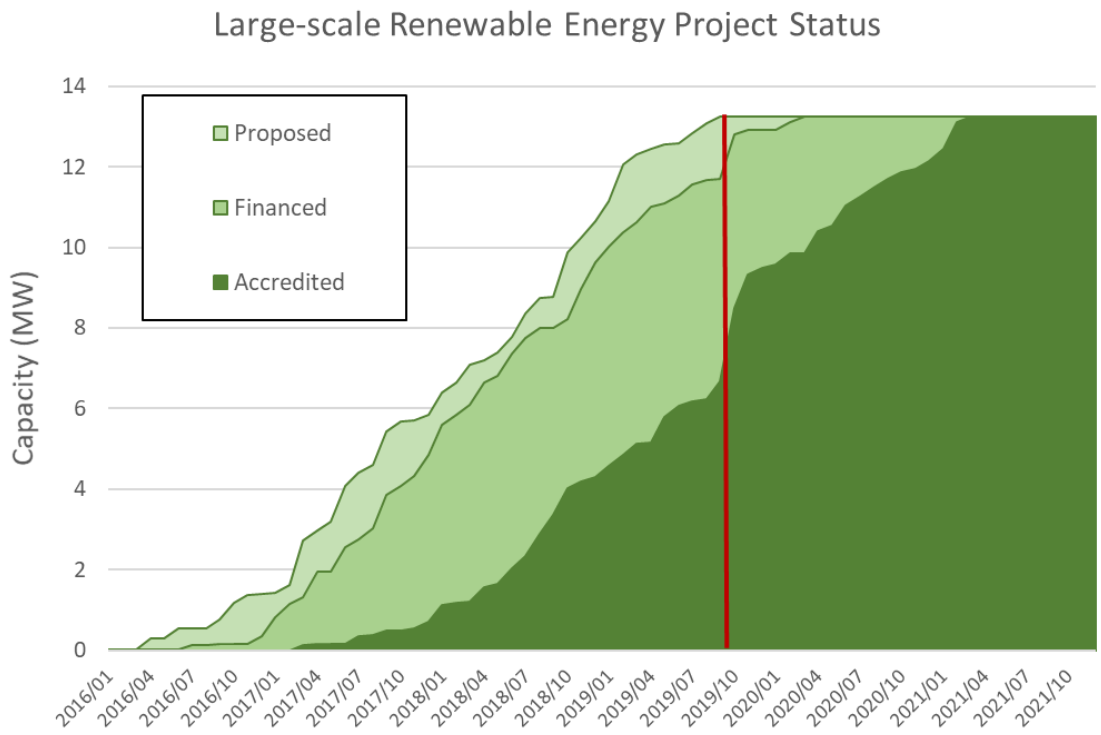

Figure 1. Status of large-scale renewable energy installations in Australia. Data to the right of the red line are forecasts based on publicly announced projects. For comparison, Australia's average and peak demand for electricity is 24 and 36 GW respectively.

Rooftop solar

About 9 GW of roof mounted solar PV has now been deployed, which is by far the largest per capita rooftop-PV deployment in the world [3]. Australian cities have good sunshine by world standards, and the cost of electricity from rooftop PV systems is far below the retail tariff for most homeowners and businesses. Australian rooftop solar penetration now exceeds 24% – the highest in the world [4].

Installation rates of rooftop solar have continued to increase, setting new records in 2018. 1.6 GW of small scale (<100 kilowatt) systems were installed, breaking the record of 1.1 GW installed in 2017. Rolling 6-month installation rates (Figure 2) indicate that there is expected to be more than 1.9 GW installed in 2019.

Installations are increasing in size as the market continues to grow, as shown in Figure 2. Systems less than 2.5 kilowatts in size dominated installations around 2011 and 2012, with significant spikes in monthly installations at that time driven by the end of various generous state feed-in-tariff schemes and STC multipliers [5-7]. Typical installations have increased in size with the market now dominated by the 5-10 kilowatt systems [8] with the price of systems dropping from an average of $2.40/Watt to $1.00/Watt [9].

The recent steady increase seen in Figure 2 can be attributed to the improving economics. 2018 analysis [10] by consumer group Choice last year showed simple payback periods of 2 to 5 years if

half of the electricity was exported, and 5 to 7 years if 75% was exported. This is equivalent to a tax-free return of greater than 13.5%, much higher than the returns achievable with alternate low risk investments or with mortgage borrowing rates.

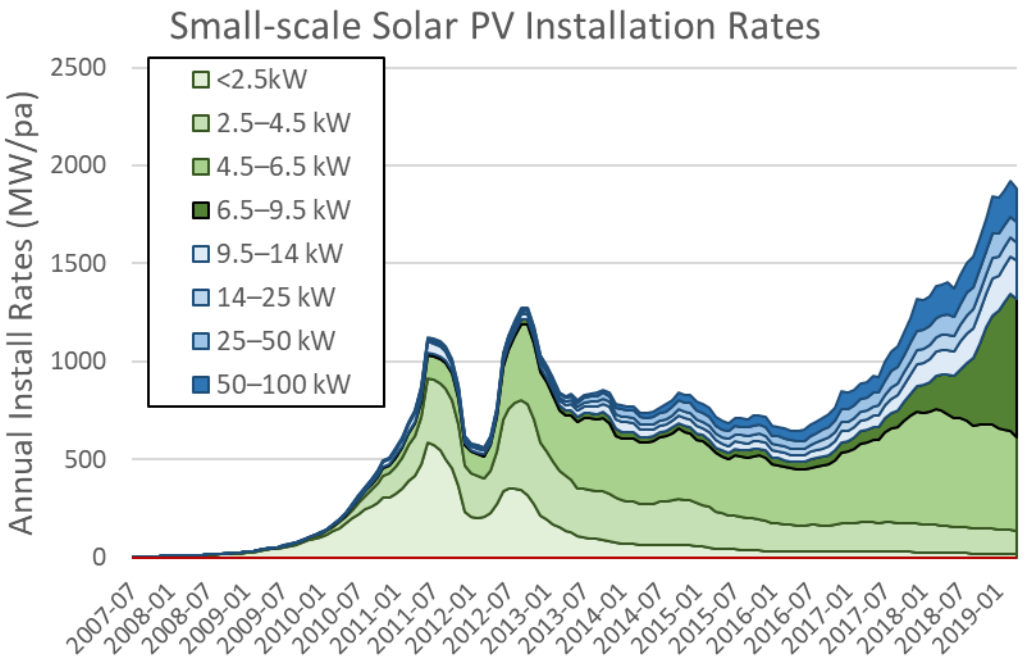

Figure 2 Rooftop (<100 kilowatt) solar PV installation rates. Plotted value is installations in the prior six month period. Clean Energy Regulator data from APVI.org.

Record levels of renewable energy installations

Combined installations by year across large-scale and small-scale schemes including forecasts for 2019 and 2020 are shown in Figure 3. In 2018, 5.1 GW of solar photovoltaics and wind was accredited by the Clean Energy Regulator. This broke the record of 2.2 GW installed in 2017.

The increase was primarily driven by the dramatic rise of large-scale solar farms, which comprised half of the new build capacity accredited in 2018. There was a ten-fold increase in solar farm construction from the 2017 value of 0.24 GW to 2.4 GW in 2018. In 2019, 2.3 GW of solar installations is forecast.

A large increase in wind installations is also occurring. New wind deployment is expected to rise from 1 GW in 2018 to 2.4 GW in 2019, contributing to a total renewable build exceeding 6.5 GW (1.9 GW small scale solar; 2.3 GW of large scale solar; and 2.4 GW wind). This is around 500MW more than forecast in the 2018 analysis [30].

The change in the installation mix can be seen in Figure 4 which shows the cumulative installs of new renewable energy projects accredited by the Clean Energy Regulator under the Renewable Energy Target legislation. Early projects were mostly biomass, such as methane capture and combustion from rubbish tips. The bulk of projects accredited between 2002 and 2017 were wind. It is only in recent years that large scale solar has made a significant contribution to the large-scale mix.

Looking forward, we predict that 2020 will at least match the record 5 GW of total installations that was achieved in 2018. This is based on the projects which have been publicly announced, financed and/or are under construction. Rooftop solar installation is assumed to continue at the same rate as

2019 (1.9 GW), although trends suggest that this may exceed 2 GW as commercial rooftop projects become more common. Large-scale solar announcements have reduced relative to the highs of 2018 and 2019. However, there may still be more solar projects to be announced that could be delivered in 2020 given the short construction period for solar.

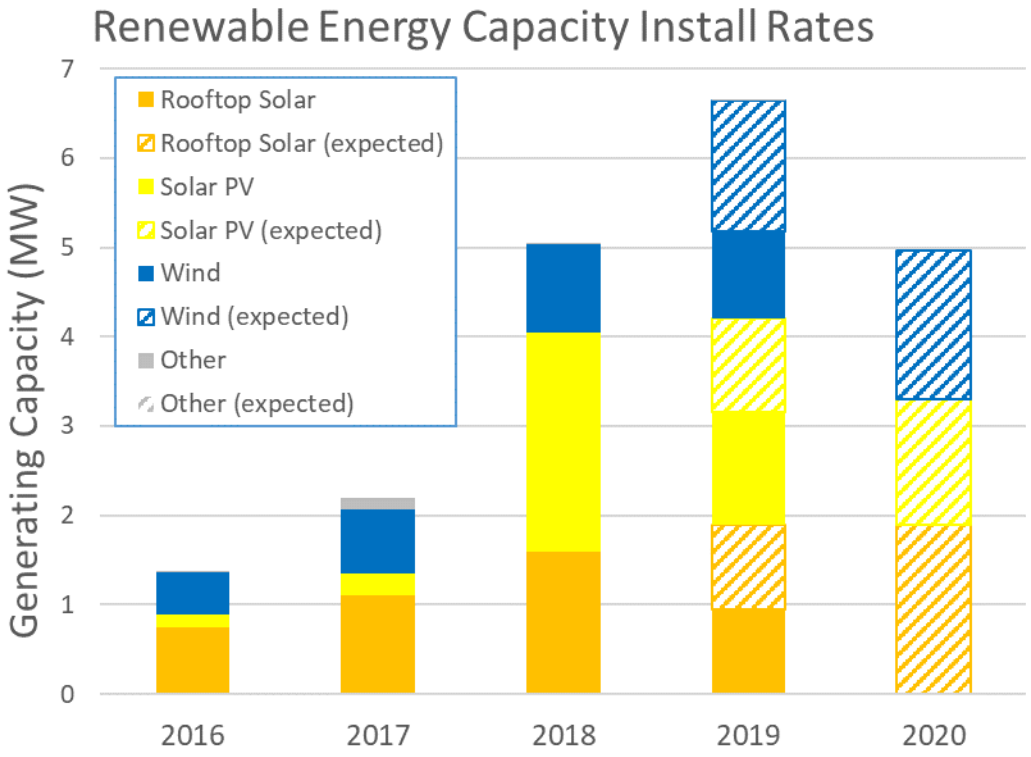

Figure 3. Current (solid) and forecast (hashed) installations of renewable electricity capacity in Australia.

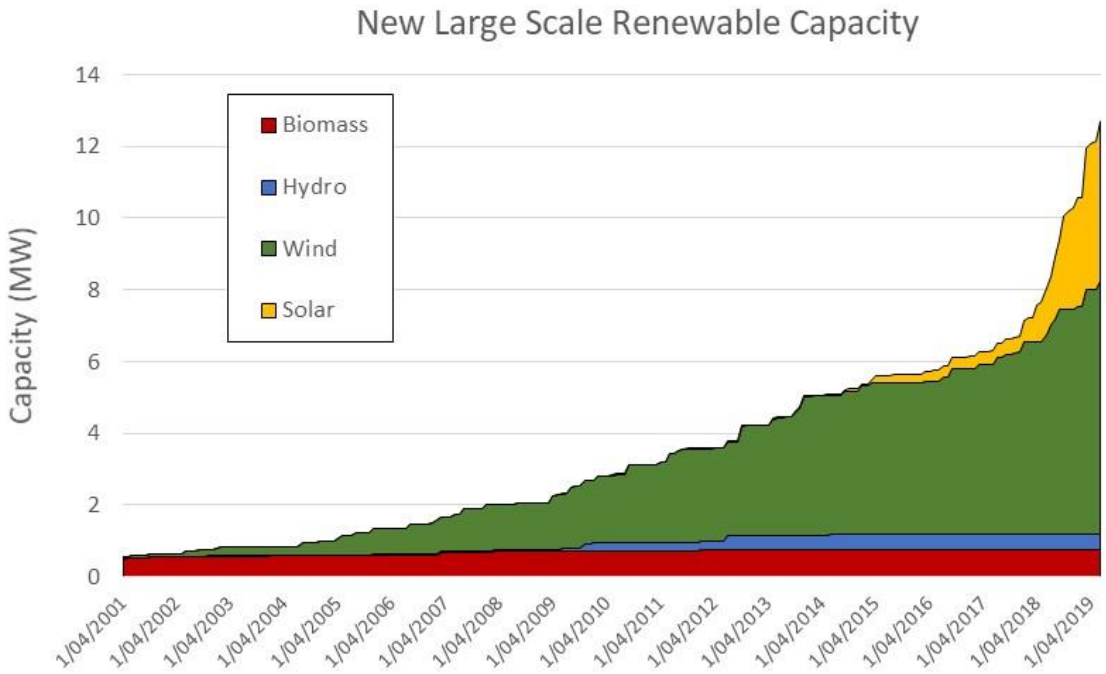

Figure 4. Breakdown of accredited renewable energy projects since the commencement of the Renewable Energy Target in April 2001. Data: Clean Energy Regulator [1, 11]

Australia is the runaway leader in worldwide renewable electricity deployment rates

Australia is leading the world in the rate of our transition towards renewable electricity. Australia installed renewable energy at a rate of more than 200 Watts per person in 2018 and is on track for more than 250 Watts per person in 2019 as shown in Figure 5. This is more than two and a half times faster than the next fastest country, Germany, and is about ten times faster than the world average.

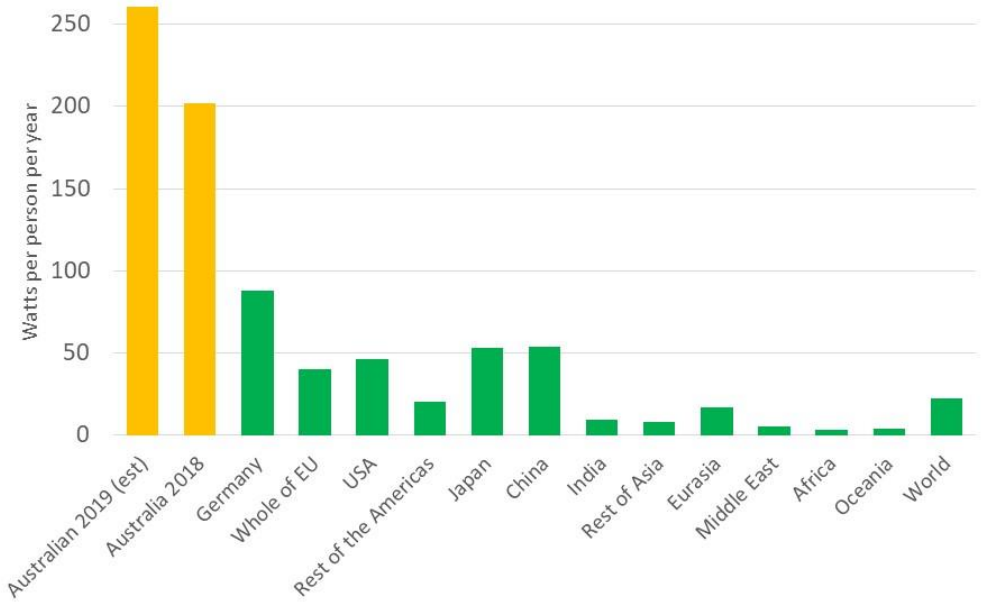

Figure 5. Renewable energy capacity installations per capita in 2018. International capacity data from the International Renewable Energy Agency [12].

Renewable energy leading to electricity emissions reductions

The Clean Energy Regulator collects emissions data from the Australian Energy Market Operator as part of its responsibility for Australia's National Greenhouse Accounts. This data shows that the National Electricity Market recorded its lowest ever level of emissions of 34.1 Megatonnes (MT) of CO_2-eq as shown in Figure 6.

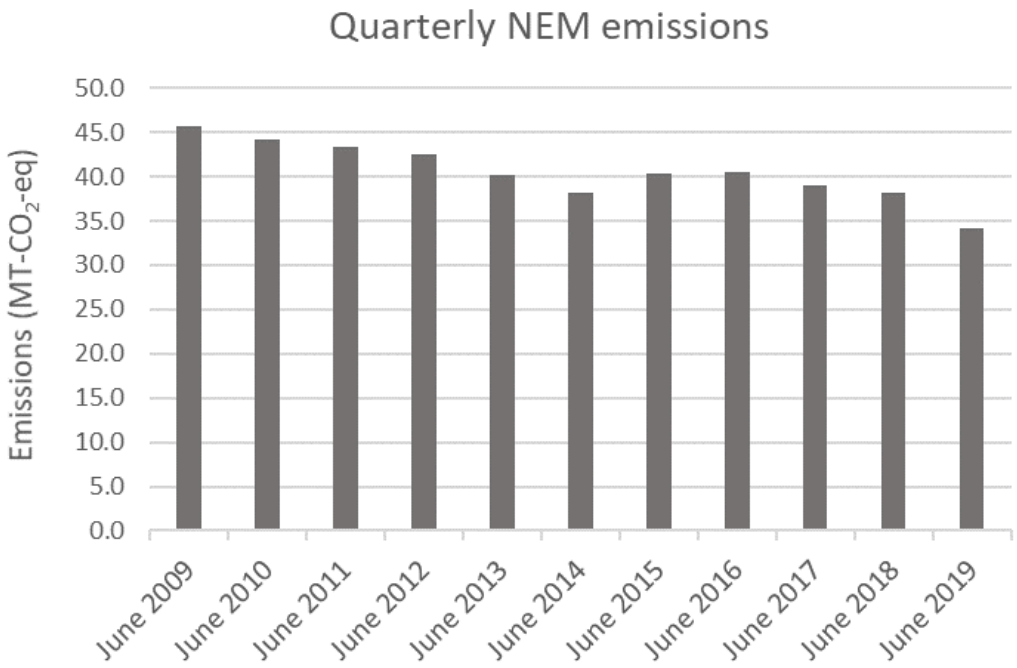

Figure 6. June quarter emissions for the National Electricity Market. Increased renewable generation has seen quarterly emissions drop to their lowest ever levels. Data: Clean Energy Regulator [11] and AEMO [13]

This decline in emissions is primarily driven by generation from newly-deployed wind and solar. Figure 7 shows the breakdown of generation for the National Electricity Market in the June quarter from 2009 to 2019. In 2019, new wind and solar were responsible for an additional 1,900 GWh of generation: a change of almost 4% of the total quarterly generation in just 1 year. Brown coal (the most carbon intensive generation) was reduced by 1,200 GWh.

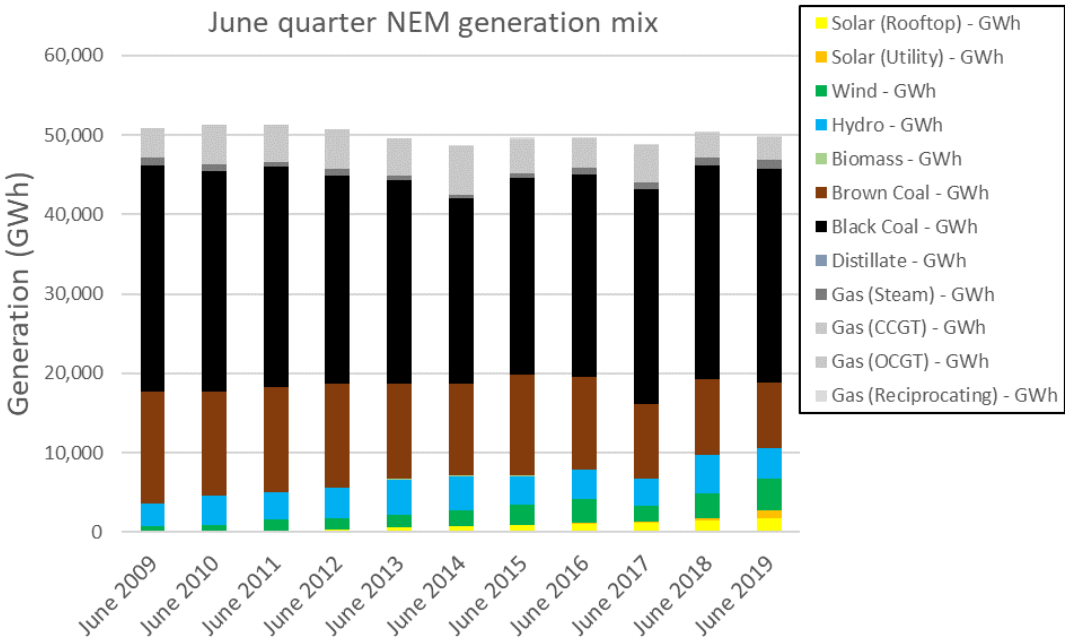

Figure 7. June quarter generation for the National Electricity Market. Analysis of AEMO data sourced from OpenNEM.org.

Continuing the reductions in electricity emissions is critical for Australia to meet the Paris target of 26-28% reduction on 2005 emissions. Figure 8 shows the change in quarterly emissions for different sectors of the Australian economy from 2013 to the end of 2018. Electricity is the only sector that has seen significant decreases in emissions, with several sectors showing steady increases (including stationary energy, transport and fugitive emissions), resulting in rising overall non-land sector emissions. Continued strong reductions in electricity sector emissions is therefore critical for Australia to meet its Paris commitments.

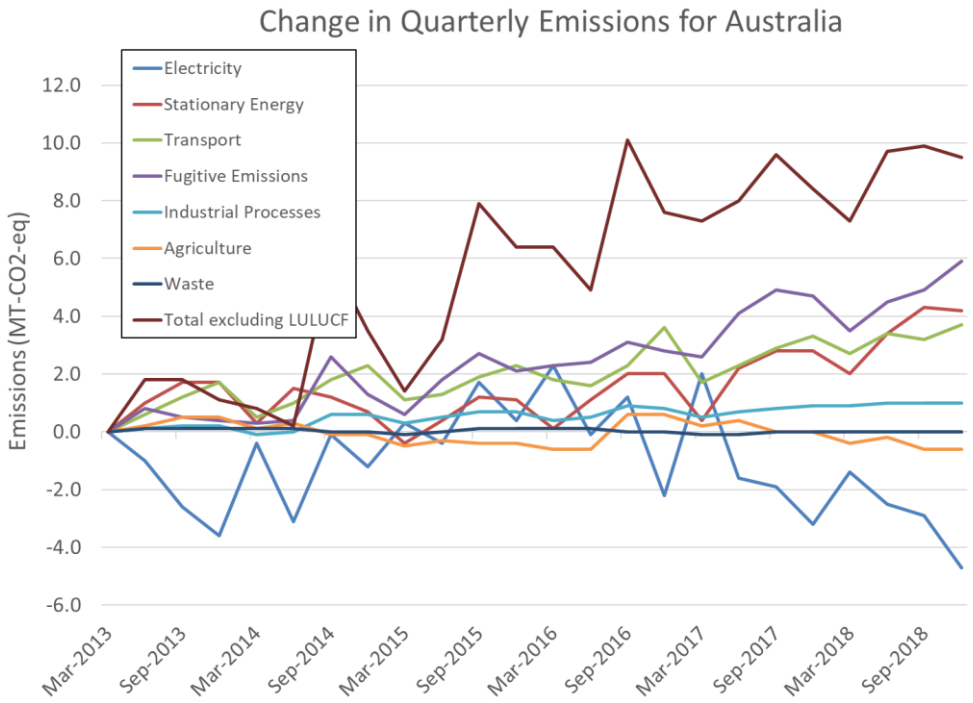

Figure 8. Change in Australia's Quarterly Emissions since 2013 broken down by sector. Electricity is the only sector with significant reductions with most sectors increasing. Analysis of Clean Energy Regulator quarterly emissions data.

Maintaining the pipeline: overcoming transmission bottlenecks

There are strong prospects for continued high installation rates of renewables. The recent large growth in installations is driven in part by the very low cost of new solar and wind generation. In a recent interview for Reneweconomy, Alinta's CEO Jeff Dimery reported that the levelised cost of electricity for their Yandin Wind Farm was less than $50/MWh. Snowy chief Paul Broad also reported to Senate estimates that it expected to contract renewable projects at less than $50/MWh [14]. Queensland's energy minister indicated wind and solar in Queensland could be bought for $44/MWh and around $50/MWh respectively. Quarterly baseload generation futures throughout the NEM out to 2023, which is mostly generated by existing gas and coal power stations, are greater than $58/MWh [15] suggesting a pure economic case for continued installations. Wind and solar prices are likely to decline further throughout the 2020s.

State governments programs are also supporting further renewable electricity growth. The ACT has completed contracts for 100% renewable electricity [16]. Victoria and Queensland both have renewable energy targets of 50% renewable electricity by 2030 [17, 18]. South Australia is expecting to reach 100% by 2030.

The case for continued growth in rooftop solar remains strong. As described earlier, payback periods are of the order of 2 to 7 years depending on location and self-consumption [9]. Further cost reductions are expected to support continued roll-out.

Storage becomes important as levels of penetration approach and exceed 50%. By far the leading storage technologies are pumped hydro [19] and batteries [20], with a combined global market share of 98% [21]. Studies at ANU have demonstrated that there is vastly more off-river pumped hydro available than is required to balance a 100% renewable energy grid [22] - including in Australia. There have been more than ten recent public announcements of pumped hydro proposals, with the Snowy 2.0 scheme [23] being the most prominent. There are also numerous battery projects being developed in conjunction with wind or solar farms.

The primary headwind is transmission. Transmission constraints have resulted in reduced marginal loss factors [24], which reflects bottlenecks in transmitting electricity from some wind and solar farms to cities [25]. Tasmania's strong wind resource requires a further connection to the mainland to unlock more projects [26]. The limitations of the current planning frameworks for the transition were recognised in the Finkel review of the NEM [27], with recommendations in chapter 5 aiming to overcome these limitations, and in particular to strengthen AEMO's role. It is important for State or Federal Governments to undertake actions to unlock or directly support transmission expansion. For example, the Queensland government has committed to supporting new transmission to unlock solar and wind projects in far north Queensland [28] while the NSW government has provided the NSW/SA interconnector with critical infrastructure status [29].

References

[1] Clean Energy Regulator. *Large-scale Renewable Energy Target market data*. Available: http://www.cleanenergyregulator.gov.au/RET/About-the-Renewable-Energy-Target/Large-scale-Renewable-Energy-Target-market-data

[2] J. Tomaras. *Renewable energy policy: retreat, renewal and revitalisation?* Available: https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/BriefingBook45p/RenewableEnergy

[3] A. Bruce and I. MacGill. (2016). *FactCheck Q&A: is Australia the world leader in household solar power?* Available: https://theconversation.com/factcheck-qanda-is-australia-the-world-leader-in-household-solar-power-56670

[4] Australian Photovoltaic Institute. (2019). *Mapping Australian Photovoltaic installations*. Available: https://pv-map.apvi.org.au/historical#4/-26.67/134.12

[5] Department of Environment, Land Water and Planning, Victoria. *Closed feed-in tariff schemes*. Available: https://www.energy.vic.gov.au/renewable-energy/victorian-feed-in-tariff/closed-feed-in-tariff-schemes

[6] Department of Natural Resources, Mines and Energy "Queensland Solar Bonus Scheme ", ed, 2018.

[7] Department of Energy and Mining. *Solar feed-in payments*. Available: https://www.sa.gov.au/topics/energy-and-environment/energy-bills/solar-feed-in-payments

[8] Australian Photovoltaic Institute. *Market Analyses*. Available: https://pv-map.apvi.org.au/analyses

[9] Solar Choice. *Solar panel costs based on live database - August 2019*. Available: https://www.solarchoice.net.au/blog/solar-power-system-prices

[10] A. Potter. (2018). *Solar panel payback time*. https://www.choice.com.au/home-improvement/energy-saving/solar/articles/solar-panel-payback-times

[11] Clean Energy Regulator, "Quarterly Update of Australia's National Greenhouse Gas Inventory for December 2018," https://www.environment.gov.au/climate-change/climate-science-

data/greenhouse-gas-measurement/publications/quarterly-update-australias-nggi-dec-2018#targetText=Emissions%20per%20capita%20in%20the,cent%20on%20the%20previous%20year.

[12] International Rnewable Energy Agency, Renewable Capacity Statistics 2019, Abu Dhabi, 2019. [Online]. Available: https://www.irena.org/publications/2019/Mar/Renewable-Capacity-Statistics-2019.

[13] Australian Energy Market Operator, "Quarterly Energy Dynamics Q2 2019," Available: https://www.aemo.com.au/-/media/Files/Media_Centre/2019/QED-Q2-2019.pdf.

[14] G. Parkinson. *Snowy says cost of "firm" wind and solar significantly below current base-load prices*. Available: https://reneweconomy.com.au/snowy-says-cost-of-firm-wind-and-solar-significantly-below-current-base-load-prices-76846/

[15] Australian Stock Exchange. *Australian Electricity*. Available: https://www.asx.com.au/products/energy-derivatives/australian-electricity.htm

[16] Environment, Planning and Sustainable Development Directorate - Environment. *Renewable energy target legislation and reporting*. Available: https://www.environment.act.gov.au/energy/cleaner-energy/renewable-energy-target-legislation-reporting

[17] Queensland Treasury. *CleanCo Queensland*. Available: https://www.treasury.qld.gov.au/programs-and-policies/cleanco-queensland/

[18] Environment Victoria. *Vic 50% renewables target builds supply before likely coal closures*. Available: https://environmentvictoria.org.au/2019/08/13/vic-50-renewables-target-builds-supply-before-likely-coal-closures/

[19] Australian Renewable Energy Agency, "Hydropower and Pumped Hydro Energy Storage." https://arena.gov.au/renewable-energy/pumped-hydro-energy-storage/#targetText=Hydropower%20converts%20the%20energy%20of,hydro%20energy%20storage%20(PHES).

[20] A. Liebman and K. Khalilpour. *Explainer: what can Tesla's giant South Australian battery achieve?* Available: https://theconversation.com/explainer-what-can-teslas-giant-south-australian-battery-achieve-80738

[21] Department of Energy *Global Storage Database*. (November 2018). Available: http://www.energystorageexchange.org/projects/data_visualization

[22] RE100 Group, "Global pumped hydro atlas." http://re100.eng.anu.edu.au/global/

[23] Snowy Hydro. *Snowy 2.0*. Available: https://www.snowyhydro.com.au/our-scheme/snowy20/

[24] Australian Energy Market Operator, "Updated Regions and Marginal Loss Factors: FY 2019-20," 2019, Available: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Loss_Factors_and_Regional_Boundaries/2019/Marginal-Loss-Factors-for-the-2019-20-Financial-year.pdf.

[25] G. Parkinson. *Confusion, uncertainty grips market as marginal loss factors changed again*. Available: https://reneweconomy.com.au/confusion-uncertainty-grips-market-as-marginal-loss-factors-changed-again-65439/

[26] N. Whiting. *The future of Tasmanian wind power hangs on improving mainland interconnection*. Available: https://www.abc.net.au/news/2018-06-18/the-future-of-tasmanian-wind-power-hangs-on-interconnection/9878508

[27] Karen Moses, Alan Finkel, Chloe Munro, Terry Effeney and Mary O'Kane, "Independent Review into the Future Security of the National Electricity Market."

[28] Department of Natural Resources, Minerals and Energy "Powering Queensland Plan: an integrated energy strategy for the state." https://www.dnrme.qld.gov.au/energy/initiatives/powering-queensland#targetText=The%20Powering%20Queensland%20Plan%20sets,and%20secure%20supply%20of%20electricity.

[29] Trans Grid. (2019). *Project EnergyConnect deemed critical infrastructure in NSW*. Available: https://www.transgrid.com.au/news-views/news/2019/Pages/Project-EnergyConnect-deemed-critical-infrastructure-in-NSW.aspx

.30] K. Baldwin, A. Blakers and M. Stocks *Australia's renewable energy industry is delivering rapid and deep emissions cuts* Available: https://energy.anu.edu.au/files/Australia%27s%20renewable%20energy%20industry%20is%20delivering%20rapid%20and%20deep%20emissions%20cuts.pdf