POLICY BRIEFING

Australia's greenhouse emissions are peaking

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Summary

1. Australia's greenhouse gas emissions are peaking at about 540 Megatonnes (MT) of $CO_{2\text{-equivalent}}$ per year (Figure 1). After a brief plateau, we expect that they will decline by 3-4% over 2020-2022, and perhaps much more in the following years.
2. The reason is that ***Australia's world-leading per-capita rate of deployment of solar and wind energy*** [1] is displacing fossil fuel combustion.
3. Deployment of solar and wind energy is the cheapest way to make deep cuts in emissions because of their low and continually falling cost. Solar and wind are reducing electricity prices.
4. Declining emissions throughout the 2020s ***depends upon Government***, particularly the Federal Government, to facilitate construction of adequate electricity transmission and storage to allow ***continued rapid deployment*** of solar and wind. Without this, ***emissions may rise again.***
5. Continued deployment of solar and wind at current rates allows Australia to meet its Paris emissions target at low or zero net cost without using past Kyoto accounting credits.
6. Higher deployment rates of solar and wind would yield deeper cuts in emissions at low cost, but requires supportive Government policy including adequate transmission and storage.

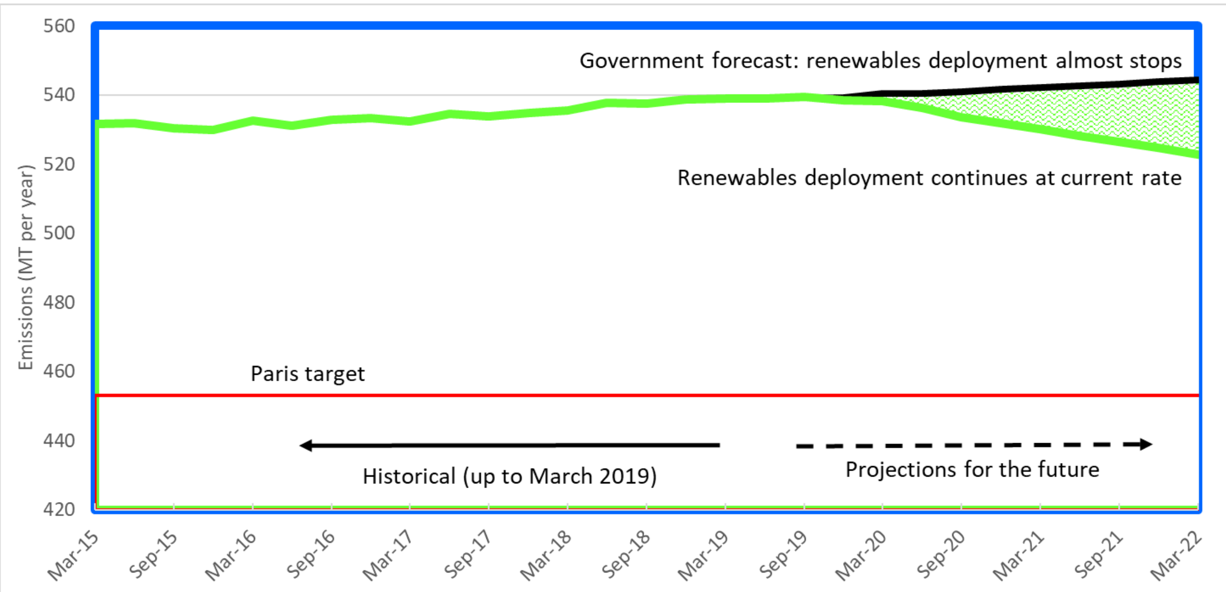

Figure 1: Historical and projected total Australian emissions in Megatonnes of CO_2 (equivalent) per year. Black line: Government emissions projections [2], which assume that deployment of solar and wind almost stops. Green line: solar and wind deployment continues at the current rate.

Emissions reductions

The current deployment rate of wind and solar photovoltaics (PV) is fast enough to cause emission reductions of about ***10 MT per year*** within the electricity sector. Figure 2 shows the rapid recent increase in the solar PV and wind energy fraction in the National Electricity Market (NEM).

Emissions outside the electricity system are projected by the Government to increase by ***about 3 MT per year*** on average over the 2020s [2]. This is considerably lower than in previous years because construction of additional emissions-intensive natural gas export terminals has slowed sharply [3,4].

The large difference between a 10 MT annual reduction within the electricity sector and 3 MT annual increase elsewhere would cause an overall decline in emissions of 7 MT per year (1.3% per year).

According to the Government's document "Australia's emissions projections 2018" [2], annual emissions are projected to increase from 540 (today) to 563 MT in 2030. ***These projections assume that deployment of solar PV and wind almost stops*** in the 2020s, and that emissions from electricity generation are 163 MT in 2030 (compared with 179 MT in the year to March 2019).

However, if current renewable energy deployment rates stay constant then electricity emissions in 2030 will be about 60 MT and Australia will be able to meet its Paris emissions target [5] without using past Kyoto accounting credits. The net cost would be low or zero because of low and continually falling prices for solar PV and wind.

Subject to provisos explained in the end notes, we are confident that emissions will fall in 2020, 2021 and probably 2022 because 16-17 Gigawatts of wind and solar deployment is "locked in" for deployment in 2018-20 [1,6]. A discussion of uncertainties is included in the end notes.

The emissions trajectory for 2022 and beyond depends mainly on how much solar and wind is deployed. Changes in land clearing rates or coal mining or economic activity would also affect emissions. Continued rapid deployment of renewable energy post 2020 allows continued emissions reductions. However, if the renewable energy pipeline is stopped or slowed down (e.g. because of inadequate transmission and storage) then emissions may rise again from 2022.

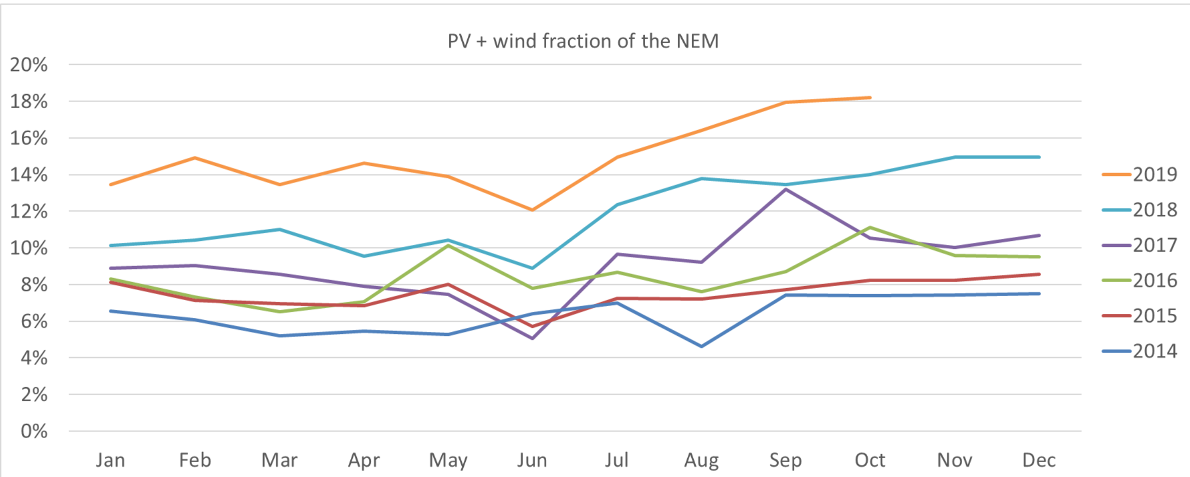

Figure 2: Monthly solar PV and wind fraction of electricity generation in the National Electricity Market [7] over 2014-19 showing a sharp increase from 2018. Hydro provides a further 7% of renewable electricity, on average.

Emissions in the electricity sector are rapidly falling (Fig. 3) because of rapid deployment of new solar PV and wind, which is displacing burning of fossil fuels [8]. The falls in the electricity sector are about to be substantially faster than increases in emissions from all other sectors combined.

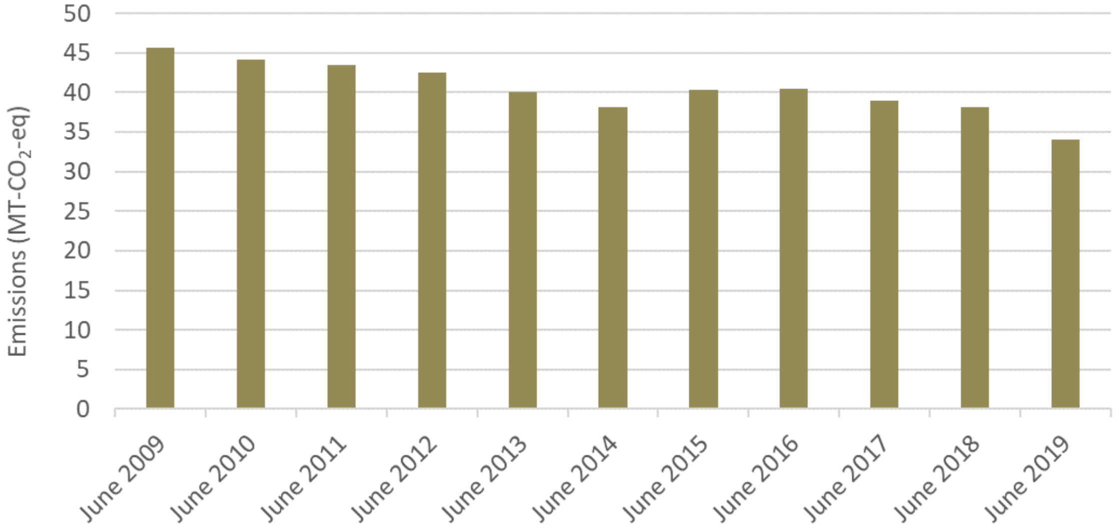

Figure 3: Emissions reductions in the National Electricity Market over the last decade for the June quarter. Carbon pricing caused a decline in 2013 and 2014. The sharp decline in 2019 is due to accelerating deployment of solar PV and wind. The NEM covers about 85% of national emissions from the electricity sector.

Emissions in the electricity sector will continue to decline PROVIDED that Australia's deployment of new solar PV and wind continues at current or accelerated rates.

Government policy that is more stable and supportive of renewable energy than at present would encourage continued or accelerated deployment of solar and wind.

Transmission and storage of wind and solar electricity

Balancing 50-100% renewable electricity is straightforward at modest cost using off-the-shelf methods including stronger interstate transmission (to smooth out local weather), storage (pumped hydro and batteries), demand management and occasional spillage of renewable electricity [9,10,11].

If the Federal Government helps companies to quickly build more transmission to allow electricity from wind and solar farms to reach cities, then electricity emissions will continue to rapidly decline. Otherwise, investment in wind and solar may slow down, causing emissions to stop falling or even to increase again. Helping companies build pumped hydro and battery storage facilities is also important.

Changes to outdated transmission rules in the NEM (designed for a fossil fuel electricity system) would greatly speed up investment in transmission and storage. The Federal Government is best placed to initiate this change. Fortunately, additional transmission and storage is not expensive. These costs add about $5 per Megawatt-hour (MWh) to the cost of electricity in the NEM when there is 50% renewable energy, rising to $25 per MWh at 100% renewables [9]. These balancing costs must be added to the generation cost of wind and solar PV electricity which is currently about $50 per MWh. Total costs ($55-75/MWh) are lower than the volume-weighted average spot prices in the five NEM states in 2018-19, which were $83-128 per MWh [12].

Thus, facilitating further deployment of wind and solar will reduce net emissions in Australia at low or zero net cost.

More investment in interstate transmission smooths out supply, demand and price differences between states, leading to more efficient generation of electricity in the NEM and lower average prices. The lower prices offset the cost of the extra transmission.

Marinus Link (an additional undersea cable between Tasmania and Victoria) would improve access by mainland states to the wind and hydro generation & storage resources of Tasmania ("Battery of the Nation") whilst also reducing the effect on Tasmania of occasional outages of the single existing undersea transmission cable.

State Governments can take the initiative of establishing Renewable Energy Zones e.g. [13] to overcome outdated transmission rules in collaboration with or separately from the Federal Government. These zones would be in places with good wind, sun and pumped hydro energy storage resources. The role of Government is to help companies provide new high capacity (Gigawatt-scale) transmission from these zones to cities, either via new powerlines or upgrades of existing transmission.

Rooftop PV reduces demand during hot summer afternoons when air conditioning loads are high, and the electricity system is under stress. On the other hand, high levels of rooftop PV can sometimes cause problems when sunny days coincide with low demand. Problems can be addressed in a straightforward way by incentives to reduce or shift demand at critical times, local battery storage and rule changes in the electricity system. In the future, the very large storage in the batteries of electric vehicles can be leveraged to smooth out supply and demand at both a local and national level by managing the charging times of the vehicles (in a similar manner to off-peak electric water heating).

Renewable energy

Wind and solar PV constitute about 65% of global net new capacity additions with gas, hydro and coal comprising most of the balance [10]. The dominance of solar PV and wind is likely to further increase in the 2020s due to ***continued decline in the cost of solar PV and wind***. Solar PV and wind comprise virtually all new generation capacity in Australia because they are cheaper than alternatives such as coal, gas, nuclear and other renewables.

Australia is installing 16-17 Gigawatts of new solar PV and wind over the 3 years 2018-2020 [1]. This is nearly 3 times faster per capita than the next best country (Germany), 4-5 times faster per capita than China, the EU, Japan or the USA and 10 times faster than the world average [1]. Australia is a global renewable energy superstar. For comparison, average and peak electricity generation in the NEM is about 23 and 35 GW respectively.

Australia's National Electricity Market (NEM) is currently sourcing about 25% of its electricity from renewable energy comprising 18% from solar PV and wind and 7% from hydro (Figure 2). The renewable energy fraction of NEM generation will likely reach 26% at the end of 2019. If the current deployment rate continues, then Australia will reach 50% renewable electricity in 2024. Solar PV generation is increasing particularly rapidly and will be about 11% of NEM generation at the end of 2019 (Figure 4).

Deployment of solar PV and wind is sufficiently rapid to reach Australia's original 41 Terawatt-hour (TWh) Renewable Energy Target early in 2021 [1], which in turn causes a reduction of emissions in the electricity sector of about 35 MT (6% of national emissions from all sources). Australia can go far beyond this modest reduction.

There is a large potential pipeline of solar PV and wind energy projects. For example, Queensland transmission company Powerlink reports that it has “*150 enquiries or applications to connect totalling nearly 30,000MW and almost all of them are from renewable sources*” [14].

PROVIDED that the current renewable energy deployment rate continues, then Australia will deploy 71 GW of new wind farms, PV farms and rooftop PV over 2018-2030. This is enough to produce 136 TWh of new renewable electricity per year in 2030 (see the end notes) and to reduce emissions by about 125 MT compared with current Australian emissions of 540 MT per year.

DOUBLING current solar PV & wind deployment rates for the period 2021-2030 would yield an additional 55 GW of solar PV and wind, producing about 105 TWh per year. This is enough to eliminate the remaining coal and gas to create an all-renewable electricity system and also to make substantial emissions reductions in land transport by providing clean electricity to charge electric vehicles. Emissions reductions of about 220 MT per year in 2030 would be possible in the electricity and transport systems compared with current emissions from all sources of 540 MT; i.e. a reduction equal to about 40% of the current national total.

Doubling current deployment rates of solar PV and wind is technically straightforward at low or zero net cost. For context, deployment rates of solar PV and wind tripled between 2017 and 2019. The required additional transmission and storage could comfortably be constructed to keep pace with the accelerated deployment of solar PV and wind. Solar PV, wind, high voltage transmission and pumped hydro storage are off-the-shelf technologies each with more than 150 GW of global deployment.

Future energy

Solar PV and wind are cheaper than new-build fossil or nuclear power stations. Soon they will compete directly with existing (sunk cost) black coal power stations. Australia’s elderly coal fleet can be largely retired over the 2020s at low or zero net cost.

Solar PV and wind can do much more than push coal and gas out of electricity production. Electric vehicles (EV) can push oil out of ground transport. EVs are still more expensive than ordinary vehicles, but the price difference is rapidly decreasing. EVs are much cheaper to run, for both energy and maintenance.

Natural gas for air and water heating is more expensive than using renewable electricity to operate heat pumps. Reverse-cycle air conditioners can efficiently heat and cool a house. Electric heat pumps can efficiently heat a hot water tank. The ACT Government has recently decided through its updated Greenhouse Plan [15] to transition to electricity and away from natural gas.

Complete conversion of the electricity system to renewables would reduce emissions by 33%. Additionally, complete conversion to renewable electricity of land transport (EVs) and air & water heating (electric heat pumps) would reduce Australia’s emissions by 20%. Electricity demand would need to increase by 50% [16]. This increased demand would be met by solar PV and wind because they are the cheapest option.

Thus, emission reductions of 50% are possible using entirely off the shelf equipment at a net cost of approximately zero, because expensive fossil fuels are being replaced by cheaper renewables.

Coal, oil and gas cause about 85% of Australia’s emissions. In the longer term, they can be eliminated through the use of solar PV and wind energy [10].

The new wind and solar PV farms, and associated pumped hydro energy storage and grid extensions, are mostly in regional areas, bringing long term sustainable investment and jobs. Solar PV and wind are now an $8 billion per year industry with 13,000 direct jobs [17].

The big picture is that PV and wind are the most practical route (both globally and in Australia) to rapid and deep emissions reductions. There are straightforward solutions to the teething problems of rapid technical change in the energy industry. Deep PV/wind electrification can remove 50% of total emissions in the near-medium term (and up to 85% in the 2030s).

This is a message of hope for rapid reduction of emissions at low cost.

Notes

The projections contained in this paper are not predictions. They depend on Government actions to a substantial degree.

Emission reductions depend upon adequate storage and transmission to facilitate continued rapid deployment of solar PV and wind. Federal and State Governments can be helpful or a hinderance.

With a mix of about one third each for solar PV farms, rooftop PV and wind farms, emissions in the electricity sector decline by about 1.8 MT per GW of new renewables. This assumes capacity factors of 38%, 21% and 12% for wind, PV farms and rooftop PV respectively, energy losses from transmission and curtailment of 7%, and current average NEM fossil fuel emissions intensity of 0.93 MT per TWh of generation.

There is considerable uncertainty about emissions in every sector: the rate of future LNG and coal exports; increases or decreases in land clearing rates; the effect of rainfall on hydro output; whether Gorgon sequestration will take place; the effect of drought on carbon fixation; probable increased use of electric vehicles and electric heat pumps; the level of economic activity; and many others.

Despite the uncertainty, substantial emission increases over and above Government projections are unlikely over the next 5 years at least, for reasons explained in the next paragraphs. A proviso for this statement is that the following events would render the projections invalid: a major increase in land clearing; or a sharp upward revision of emissions from the land sector or fugitive emissions from coal and gas mining due to a methodology change in calculations.

Data for Figure 1 is derived from [2] for historical emissions. Projections for future emissions use Government projections for all sectors except electricity [2]. Future projections of solar PV and wind deployment are 16.5 GW per 3 years (i.e. continuation of the trend from 2018-20) [1,6].

Emissions within the electricity sector comprise 33% of total emissions and are changing much more rapidly than in other sectors in terms of MT per year. This is the most interesting emissions sector. Historical emissions are known up until March 2019 [2]. Reliable emissions data for electricity can be calculated in almost real time for the period April-October 2019 because the sources of electrical production and their emissions intensity are known [7]. Probable emissions reductions in the electricity sector can be estimated for 2020-2021 from the known solar PV and wind deployment pipeline for 2018-20 as published by the Clean Energy Regulator [6]. Emission reductions for 2022 and beyond are speculative since the deployment rate of solar PV and wind post 2020 is unknown.

Note that emissions reported on an annual basis [2] have a lag of up to 1 year, and that the data is issued quarterly with a 5-month lag. Thus, data for the year April 2018 to March 2019 was issued in at the end of August 2019. Additionally, there is a lag of up to a year between initial accreditation of a solar PV or wind power station and full power output.

Emissions outside the electricity system are projected by the Government to increase by about 3 MT per year over the period to 2030. Continued deployment of rooftop solar PV at the current rate of 2 GW per year reduces emissions by about 2 MT per year. Deployment of solar PV farms and wind farms can greatly additionally reduce emissions.

Emissions outside the electricity sector comprise the following: (1) transport (19%); has been growing at about 1.5 MT per year, and is unlikely to rapidly increase because driving habits are unlikely to rapidly change; it may decrease over the 2020s if there is rapid uptake of electric vehicles; (2); stationary energy and fugitive emissions (30%); strongly associated with large and highly visible fossil fuel intensive projects (such as LNG exports), which take many years to plan and reach maturity; known near-term projects are already factored into Government projections; (3) Industrial processes & product use, Agriculture, Waste, (21%); disparate activities, all relative small emitters, sudden major increases unlikely; (4) LULUCF (-4%); sensitive to a rapid increase in land clearing.

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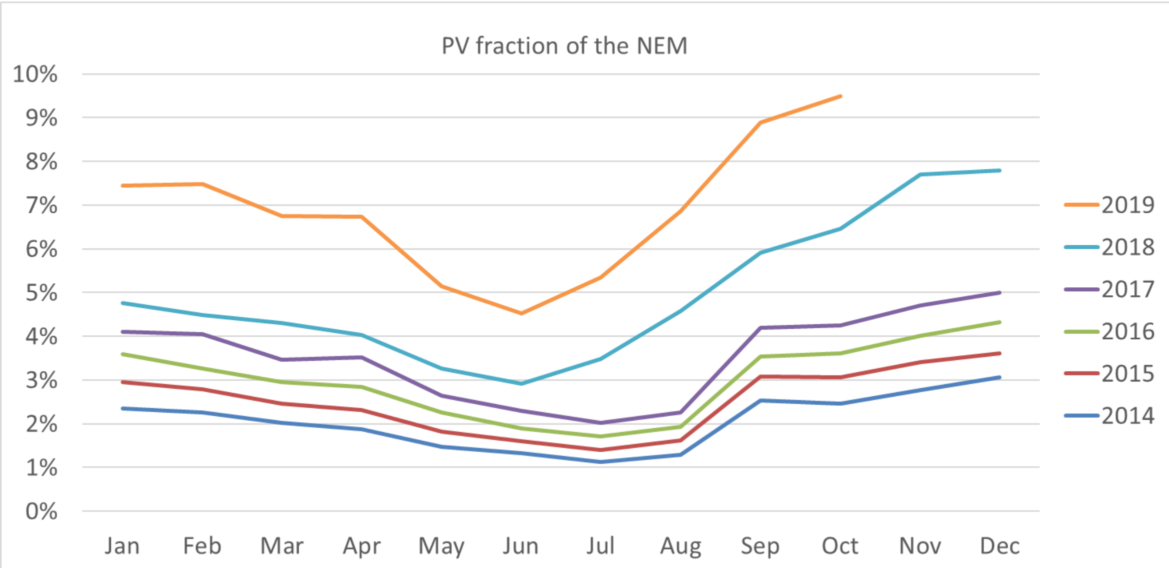

Figure 4: Monthly solar PV (ground + roof-mounted) fraction of electricity generation in the National Electricity Market [7] over 2014-19, showing strong growth since 2018.

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