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National Energy Emissions Audit Report

April 2020

Providing a comprehensive, up-to-date indication of trends in Australia's energy combustion emissions

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Key points

- **From 16 March 2020 when major lockdowns and closures began to 21 April 2020, electricity consumption was slightly lower in 2020 than in either 2019 or 2018.**
- **In 2020 total consumption was 2.4 per cent lower than in 2019 and 2.5 per cent lower than in 2018.**
- **The period from mid-March to mid-April was significantly warmer in both 2019 and 2018 than it has been in 2020.** While reduced economic activity may have contributed to the reduction in electricity consumption, it was certainly not the only causal factor, contributing a reduction of perhaps about 1 per cent relative to both 2018 and 2019.
- **It is unsurprising that there has been no substantial impact on electricity given the majority of major energy users like mining, mineral processing and manufacturing establishments are still operating.** While the number of people working in offices, shopping centres, hotels, educational establishments and other types of buildings is reduced, air conditioning and lighting for those office and shopping centres continues and many households normally empty during the working week are continuously occupied.
- **Gas use has remained stable** with the three sectors (electricity, manufacturing and LNG production) accounting for over 70 per cent of total gas consumption in eastern Australia facing relatively little impact from the pandemic response.
- **Over the past year, the steady growth in renewable generation has been displacing black coal generation.** Most of the displacement has occurred at Mount Piper power station, in New South Wales, which has been having severe coal supply problems
- In the year to March 2020, sent out **renewable generation, together with rooftop solar, supplied 48.3 TWh, which represented a 24.9%** share of total NEM generation.
- **Renewable generation reached just above 50% for nearly two hours on either side of midday on Easter Saturday, 11 April,** the first time that this mark has been achieved over a period of more than a few minutes.
- **In the last few years, rooftop solar has made an increasingly important contribution to total supply,** particularly during the summer months. Over the past three summer periods (defined as December to March inclusive), rooftop solar has supplied successively 10.1, 12.4 and 16.3 per cent of all electricity generated in South Australia and 5.3, 6.3 and 7.7 per cent in Queensland.
- **Emissions embodied from LNG exports in eastern Australia represent a far larger carbon footprint than domestic gas emissions in the NEM.**

INTRODUCTION

Welcome to the April 2020 issue of the *NEEA Report*, with data updated to the end of March 2020. Data presented includes greenhouse gas emissions arising from: the generation of electricity in the National Electricity Market (NEM), the consumption of natural gas in eastern Australia (the area covered by the NEM), and the consumption of petroleum fuels throughout Australia.

This issue focusses on examining whether changes in either electricity or gas consumption resulting from the pandemic response and economic slow-down are as yet apparent. It also includes a new graph, showing the emissions embodied in LNG exported from Queensland.

ENERGY EMISSION TRENDS

All fossil fuels

Figure 1 shows total annual energy emissions estimated and reported by NEEA since 2011. Recall that these account for roughly 80% of Australia's total energy combustion emissions. They exclude all coal and gas consumed in Western Australia and the Northern Territory, including the large volumes used to produce Liquified Natural Gas (LNG). The figures also exclude coal used by industries such as steel, cement and alumina in eastern Australia.

Figure 1

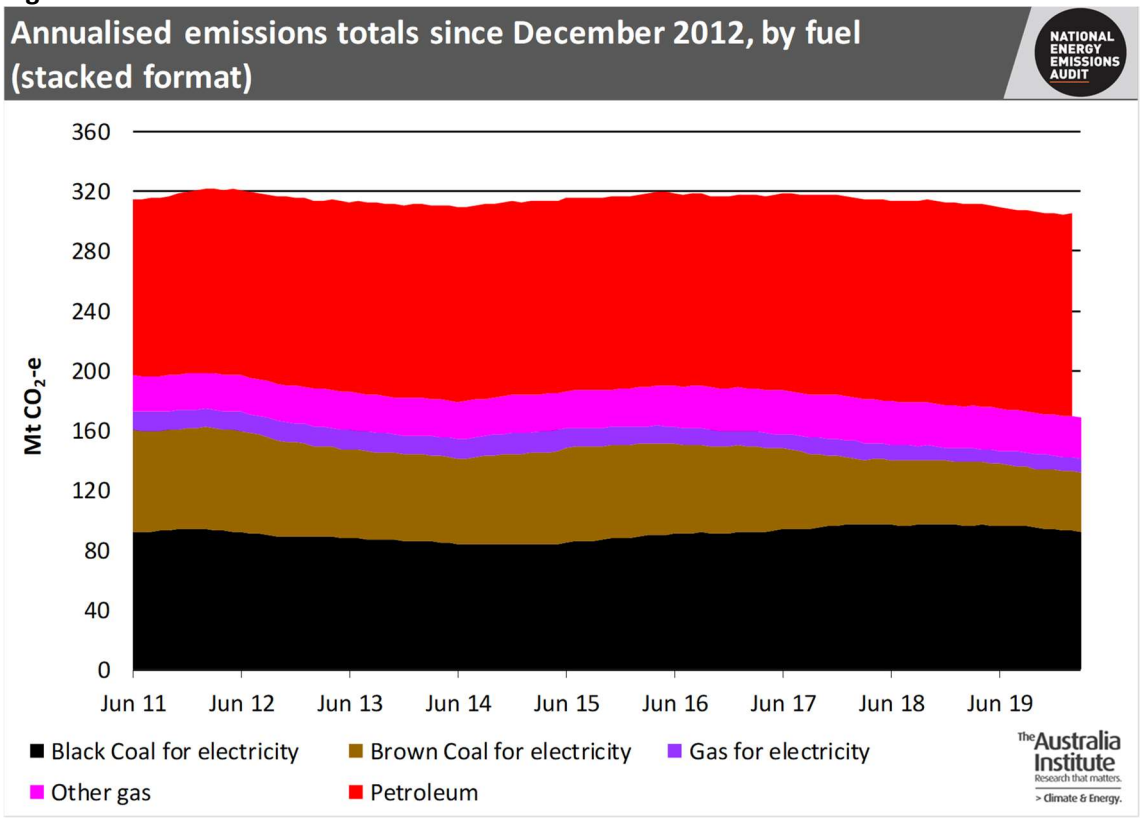


Figure 2 shows the change in annual emissions, relative to June 2011, on a month by month basis. It also shows, on the right hand axis, the absolute changes in total emissions, relative to the year ending June 2011, in emissions from each of the main fuel types. It is easy to see that the decrease since the peak, which was reached in the year ending May 2012, just one month before the carbon price, imposed mainly on emissions arising from consumption of coal and gas, came into force, has been entirely driven by reduced emissions from electricity generation. It is equally easy to see that the largest countervailing source of increased emissions has been consumption of

petroleum products, most of which is attributable to increases in consumption for transport.

Regular readers will note that the figures for petroleum emissions in these two graphs differ slightly from those previously presented. The changes result from a revision of the official *Australian Petroleum Statistics* data, included in the issue for January 2020, released in mid-March, as a result of careful work by the energy statistics team, now located in the Department of Industry, Science, Energy and Resources, to correct for under-reporting prior to 2018.

Figure 2

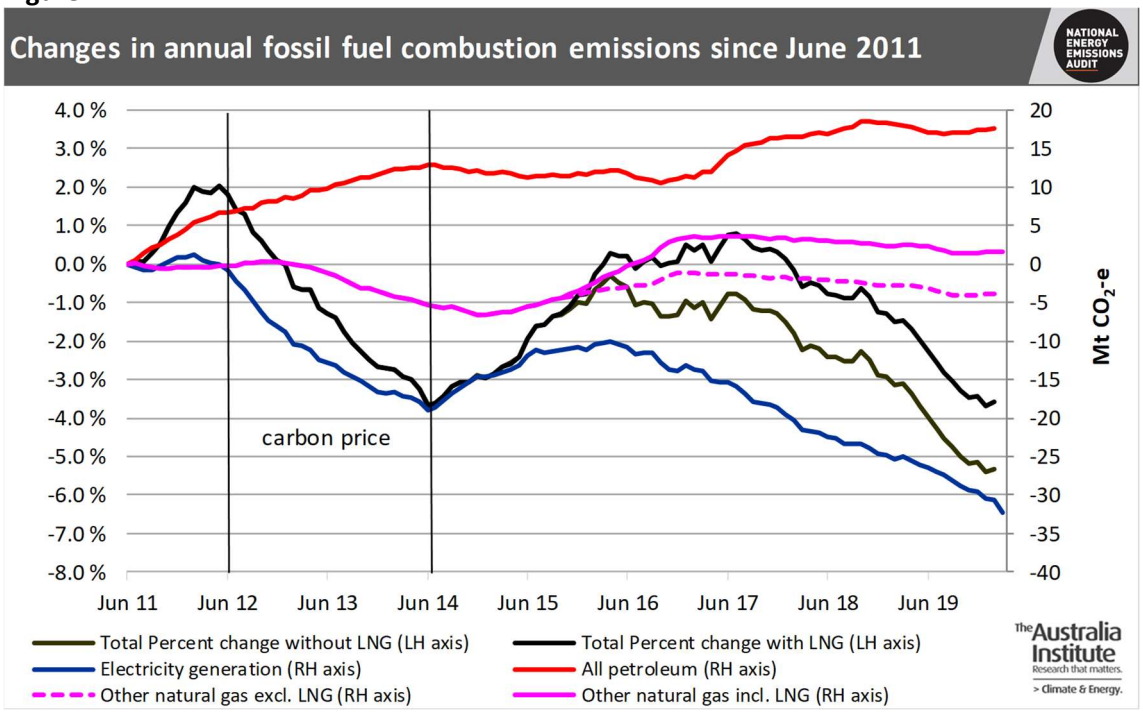


Figure 2 also shows that gas consumed to extract, transport, and convert coal seam gas to LNG has caused a significant increase in emissions. On the other hand, in the past year or so consumption of gas for other purposes (excluding electricity generation) has fallen. This is probably a somewhat delayed response to higher wholesale gas prices, which first appeared at the start of 2017, as the Queensland LNG plants ramped up to full production volume.

PANDEMIC RESPONSE

The dramatic changes in working patterns since mid-March 2020 have prompted much speculation about what the impact might be on energy consumption and greenhouse gas emissions.

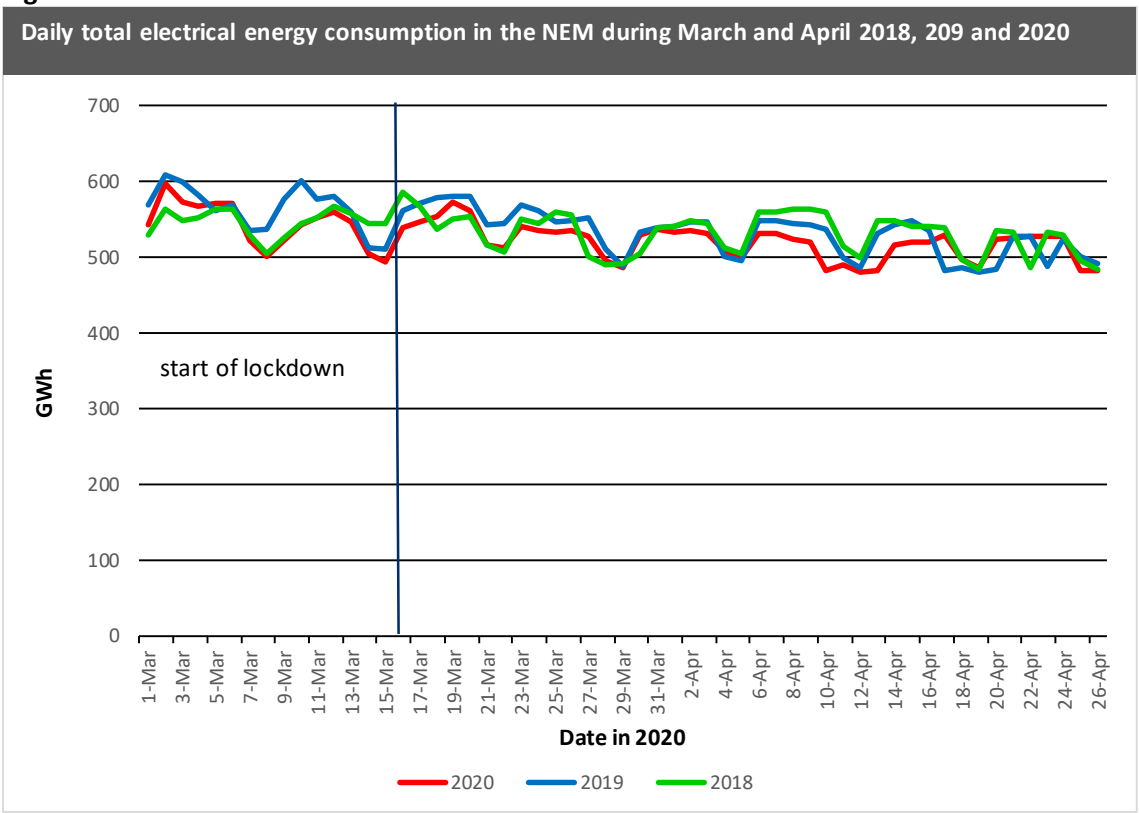
There can be no doubt that by far the largest effect will be on consumption of petroleum products used to fuel transport – most obviously aviation fuel, but also, probably to a relatively lesser effect, petrol and diesel. The source data used for the NEEA is monthly sales of petroleum products, published in *Australian Petroleum Statistics*, with a lag of 6 to 7 weeks after the end of the month to which the most recent data relate. This means that data for March 2020, the first month likely to show any change, is unlikely to be available before mid-May.

For natural gas, the major uses, apart from electricity generation, are manufacturing and LNG production. These three sectors (electricity, manufacturing and LNG production) account of over 70 per cent of total gas consumption in eastern Australia (i.e. excluding Western Australia and the Northern Territory), which is the consumption reported by NEEA.

It appears that all three of these sectors have been affected relatively little by the pandemic response, suggesting that the impact on gas consumption may be small. That said, in Victoria, total daily gas consumption is between two and three times higher in winter than in summer, because of heavy use for space heating in the residential and commercial sectors. If the economic shut down continues until then, more people at home during the day may cause gas consumption to increase, at least in Victoria, the ACT and colder parts of New South Wales and South Australia.

For electricity, Figure 3 shows total daily consumption of electrical energy in the NEM, including all energy supplied by rooftop solar, over the period from 1 March to 21 April 2020. The series for 2019 and 2018 have been moved backward, by 2 and 3 days respectively, so that weekends coincide for all three series. It is apparent that, over the whole period from 16 March, when major lockdowns and closures began, consumption was slightly lower in 2020 than in either 2019 or 2018. In 2020 total consumption was 2.4 per cent lower than in 2019 and 2.5 per cent lower than in 2018. However, it is easy to see during the first two weeks of March consumption was also lower than in 2019, though not so much lower than in 2018.

Figure 3



Further analysis of relevant data reveals that the weather on average was somewhat warmer in both 2019 and 2018 than in 2020. Looking at data for the Richmond RAAF Base weather station, which is representative for metropolitan Sydney and many areas beyond, it emerges that the average daily maximum temperature over the relevant period was 24.8 degrees C in 2020, 26.1 degrees C in 2019 and 29.6 degrees C in 2018. There were 2 days with maxima above 30 degrees in this period in 2020, 4 days in 2019 and 16 days in 2018. For Melbourne and surrounds Tullamarine Airport weather station is taken as representative. The average daily maximum temperature was 20.6 degrees in this period in 2020, 25.0 degrees in 2019 and 24.3 degrees in 2018. There was one day only with a maximum temperature above 30 degrees C in this period in 2020, 6 days in 2019, and 4 days in 2018.

It is therefore obvious that the period from mid-March to mid-April was significantly warmer in both 2019 and 2018 than it has been in 2020. It is therefore not at all surprising that electricity consumption over the period since the pandemic response has been lower than in the corresponding periods during 2019 and 2018. While reduced economic activity may have contributed to the reduction in electricity consumption, it was certainly not the only causal factor, contributing a reduction of perhaps about 1 per cent relative to both 2018 and 2019.

A rough estimate of the resultant reduction in emissions can be calculated by assuming that the extra consumption would have been supplied by black coal in New South Wales and Queensland, brown coal in Victoria, gas in South Australia, and hydro in Tasmania. A 1 per cent reduction in each state over the entire period from 16 March (when lockdown started) to 24 April would have resulted in a reduction of about 197 kt CO2-e, equal to about 0.04 per cent of Australia's total annual emissions.

It is not difficult to explain the apparently small to negligible impact of the shut down on electricity consumption. The great majority of mining, mineral processing and manufacturing establishments are still operating. While the number of people working in offices, shopping centres, hotels, educational establishments and other types of buildings is reduced, most still have some people working in them and therefore require air conditioning and lighting to continue. On the other hand, many households normally empty during the working week are continuously occupied, with consequently increased use of lighting and appliances. As the weather becomes cooler, the growing requirement for space heating in southern Australia may see consumption of electricity, as well as gas, actually increase.

SEASONAL ELECTRICITY

In the year to the end of March 2020, total consumption of electricity supplied from the NEM grid continued to decline very gradually, as it has bene doing for over a year, while total annual consumption of electricity, including supply from rooftop solar, gradually increased. These trends are shown in Figure 4, which also shows the steady fall in emissions. Figure 5 shows that over the past year, the steady growth in renewable generation has been displacing black coal generation. The displacement has been occurring at Mount Piper power station, in New South Wales, which has been having severe coal supply problems, and in the year to March 2020 supplied only 4.3 TWh to the NEM.

Combined wind and solar generation supplied to the NEM has increased by more than 4.3 TWh since May 2019, and if rooftop solar is also included, the same increase has taken only six months.

Notwithstanding the various problems now being encountered by the renewable generation industry, to suppose that growth in energy supplied over the next three years will be insufficient to the withdrawal of the roughly 10 TWh currently being supplied each year by the Liddell coal-fired power station, the oldest plant on the NEM, is a stretch. Unless, that is, the current electricity policy mess, which is the root cause of most of the problems, becomes so much worse.

It is interesting to note that some politicians are now calling for the federal government's Underwriting New Generation Investment (UNGI) program to be investigated by the Auditor General.[1] For a full breakdown of the concerns regarding the UNGI program, see the relevant briefing note by the Climate & Energy team at The Australia Institute.

Figure 4

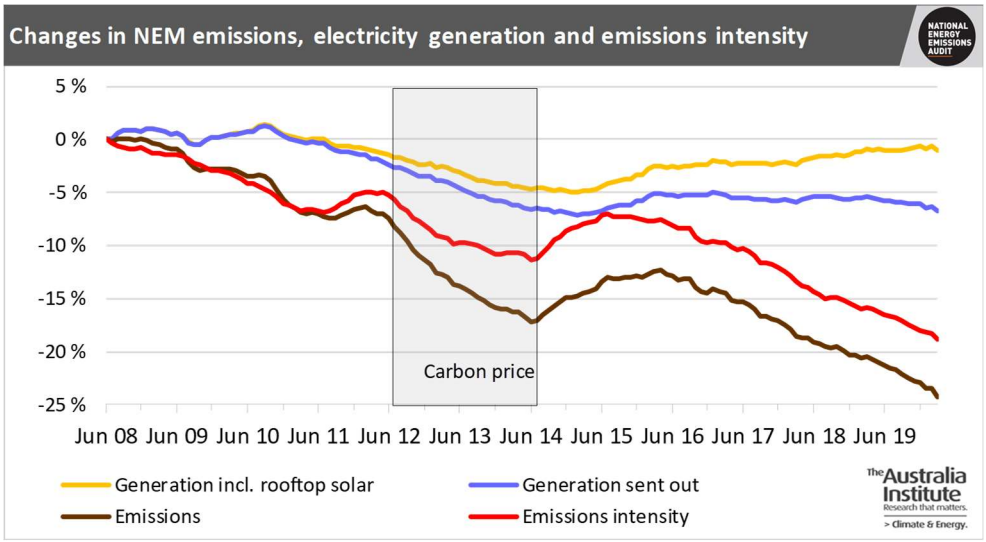
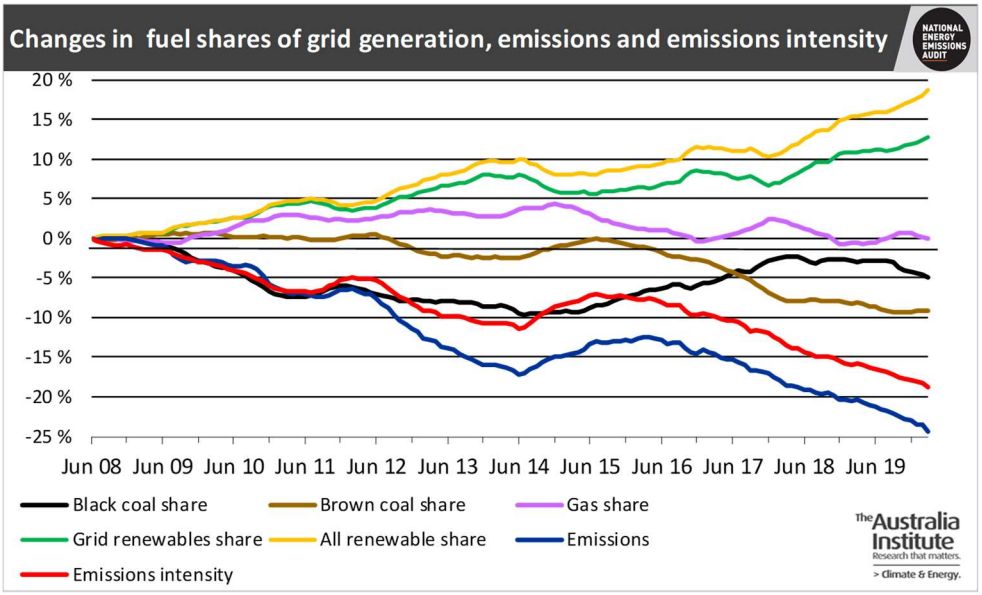


Figure 5



[1] Morton (2020) *Zali Steggall calls for investigation of Coalition plan to underwrite gas, hydro and coal power* https://www.theguardian.com/australia-news/2020/apr/27/zali-steggall-calls-for-probe-of-coalition-plan-to-underwrite-gas-hydro-and-coal-power

The growth in total renewable generation in the NEM since 2008 is shown in Figure 6, in absolute terms, while Figure 7 shows growth as a share of total sent out NEM generation. In the year to March 2020, sent out renewable generation, together with rooftop solar, supplied 48.3 TWh, which represented a 24.9% share of total NEM generation.

Figure 6

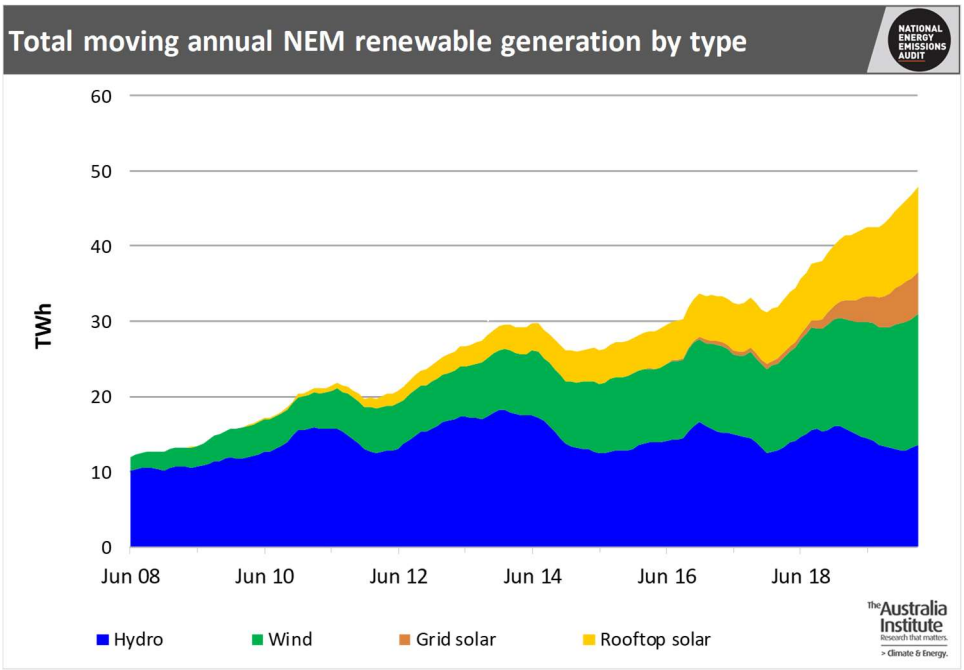
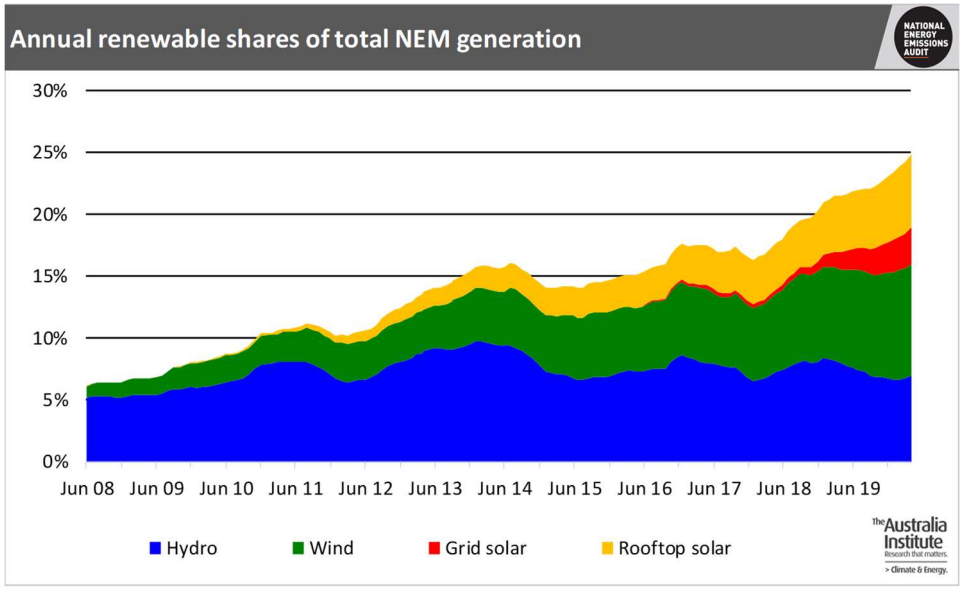


Figure 7



Given the rates of growth over recent months, it seems almost certain that the 25% mark will be reached in the year to April 2020. We already know that on 11 April, which was Easter Saturday, renewable generation reached just above 50% for nearly

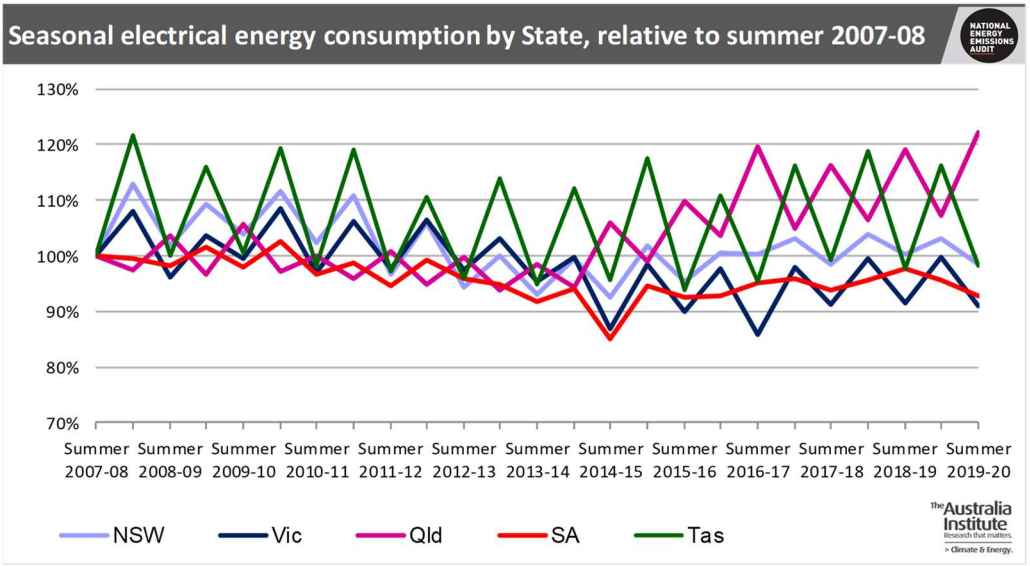
two hours on either side of midday, the first time that this mark has been achieved over a period of more than a few minutes.

Twice each year NEEA publishes updates of graphs showing summer and winter seasonal electricity consumption in each state (NEM region). For many years consumption has almost always been higher in each of the eight months from December to March and May to August, than in any of the other four months. For simplicity, the former are defined as summer and the latter as winter. Figure 8 shows total electricity consumption, including consumption supplied by rooftop solar installations, for successive summer and winter periods in each NEM region. The data are expressed on an index number basis, referenced to summer 2007-08, thus allowing results for each of the five states to be displayed on a common basis in the same graph.

Differences between the states are striking. Queensland consistently uses more electrical energy over the four summer months than over the four winter months, which is an obvious consequence of its tropical/subtropical climate. Each of the other four states use more electricity in winter than summer, even though peak demand is almost invariably higher in summer than winter, except in Tasmania.

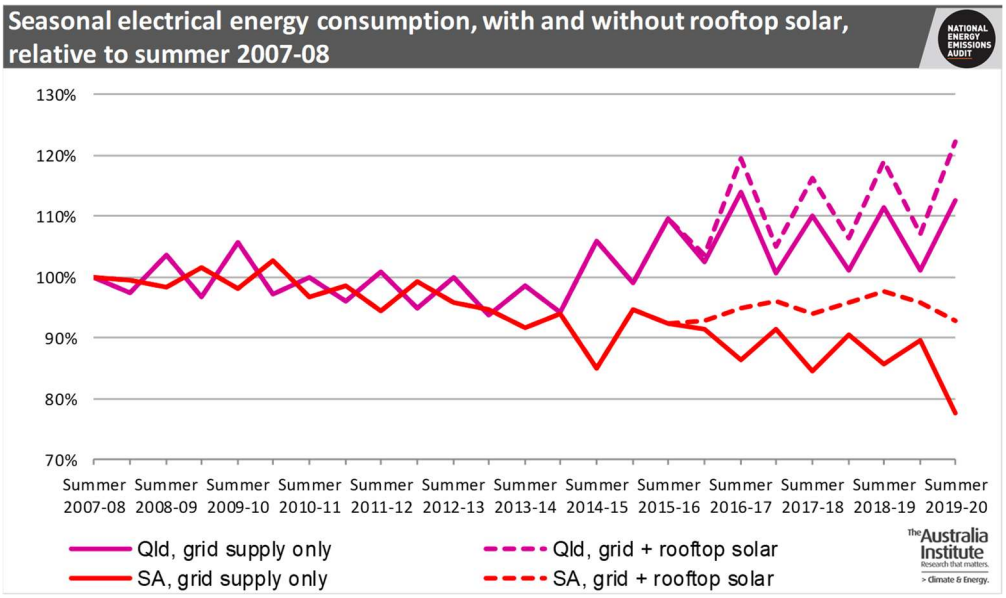
Interestingly, this pattern appears to be changing in South Australia, which, like New South Wales and Tasmania, has always used more electricity in winter than in summer. In 2016-17, summer consumption was higher than in the previous winter, though not higher than the subsequent winter. In 2018-19, summer consumption was higher than in both the previous and the subsequent winters. Queensland has always used more energy in summer.

Figure 8



In the last few years, rooftop solar has made an increasingly important contribution to total supply, particularly during the summer months. This is shown in Figure 9, which shows seasonal electricity consumption, with and without rooftop solar, in Queensland and South Australia, the two NEM states with the largest shares of rooftop solar, relative to total consumption. Without rooftop solar, gas generation in South Australia would have had to supply 20 per cent more electricity in summer 2017-18 and 44 per cent more in summer 2019-20. The corresponding increases of coal fired generation required in Queensland would have been 6 per cent in 2017-18 and 10 per cent in summer 2019-20.

Figure 9



The strong seasonal effect of latitude on solar generation is very obvious in the more southerly location of South Australia. The further south the location, the bigger the difference in daylight hours between summer and winter, meaning a bigger difference in solar generation.

SEASONAL GAS

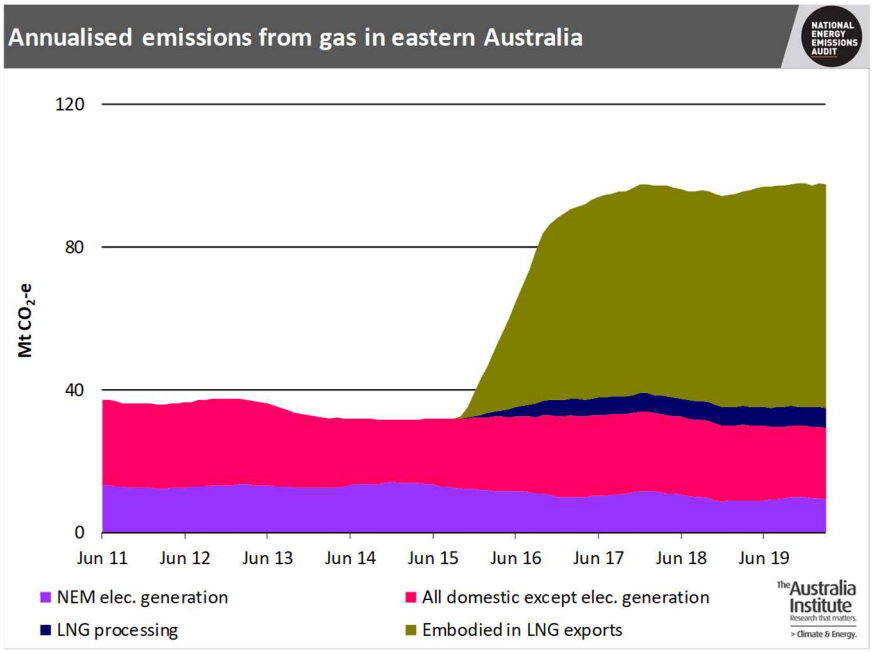
Since the three LNG plants came on stream, they have been processing well over half the gas produced in eastern Australia. Figure 10 shows the principal "uses" of gas in the interconnected eastern Australia gas system, expressed in terms of the greenhouse gas emissions produced when the gas is used.

Of course, the emissions shown against exported LNG do not occur in Australia, but in the Asian countries to which the exports are sent. It is worth recalling the research of the Australia Institute that revealed Australia as the third largest exporter of embodied

emissions from fossil fuels thanks to its leading role in exporting coal and LNG.[2] The emissions footprint from exported fossil fuels is more than twice the size of domestic emissions.

The graph is in terms of monthly adjusted moving annual totals, and extends to the end of March 2020. As already noted, and unsurprisingly, up to that date there is no evidence of any marked change in either domestic consumption or LNG exports.

Figure 10



As regularly pointed out, comparable detailed data are not available for either domestic gas use in Western Australia or LNG exports from Western Australia and the Northern Territory. If included, they would almost double emissions within Australia shown in Figure 10, and more than double the emissions embodied in LNG exports.

[2] Swann (2019) High Carbon from a Land Down Under https://www.tai.org.au/content/high-carbon-land-down-under-quantifying-co2-australia-s-fossil-fuel-mining-and-exports

APPENDIX: NOTES ON METHODOLOGY

Data on annual consumption of electricity, and seasonal peak demand, are for each of the six states. All other data are for the states constituting the National Electricity Market (NEM) only, i.e. they exclude Western Australia. All data are reported as annual moving averages. This approach removes the impact of seasonal changes on the reported data. Annualised data reported in *NEEA Electricity Update* will show a month on month increase if the most recent monthly quantity is greater than the quantity in the corresponding month one year previously. Most data are presented in the form of time series graphs, starting in June 2011, i.e. with the year ending June 2011. Some graphs start in June 2008. These starting dates have been chosen to highlight important trends, while enhancing presentational clarity.

Defining the particular meaning of the various terms used to describe the operation of the electricity supply system will help in understanding the data discussed.

Demand, as defined for the purpose of system operation, includes all the electricity required to be supplied through the grid level dispatch process, operated by AEMO. This includes all the electricity delivered through the transmission grid to distribution network businesses, for subsequent delivery to consumers. It also includes energy losses in the transmission system and auxiliary loads, which are the quantities of electricity consumed by the power stations themselves, mostly in electric motors which power such equipment as pumps, fans, compressors and fuel conveyors. Auxiliary loads are very large: in 2011 they amounted to 6.3% of total electricity generated and currently about 5.6%. Most of this load is at coal fired power stations, where it can be as high as 10% of electricity generated at an old brown coal power station and 7% at a black coal fired power station. Auxiliary loads are much lower at gas fired power stations, and close to zero at hydro, wind and solar power stations. Both demand and generation, as shown in the *Electricity Update* graphs, are adjusted by subtracting estimates of auxiliary loads. Thus demand, as shown, is equal to electricity supplied to distribution networks (and a handful of very large users that are connected directly to the transmission grid) plus transmission losses.

Generation is similarly defined to include only electricity supplied by large generators connected to the transmission grid. It does not include electricity generated by rooftop PV installed by electricity consumers, irrespective of whether that electricity is used on-site ("behind the meter") by the consumer or exported into the local distribution network. From the perspective of the supply system as a whole, the effect of this generation, usually termed either "embedded" or "distributed" generation, is to reduce the demand for grid supplied electricity below the level it would reach without such distributed generation. That effect can be clearly seen in the regular total generation graph; the gap between the red line – electricity sent out to the grid from large grid connected power stations – and the yellow line – that

electricity plus estimated electricity generated by distributed solar systems – is the electricity supplied by those systems.