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National Energy Emissions Audit Report

June 2020

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

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Key points

- The steady consumption of electricity and gas has generally been unaffected since the start of lockdown.

- **Emissions from electricity generation have fallen sharply due the increased renewable generation in the NEM.** The decreased emissions from energy generation is not due to any change in consumption.

- **The total annual emissions covered by NEEA (in electricity and transport) have dropped by about 1.6 per cent since February 2020.** This translates to a drop of around 4.9 Mt CO_2-e. **Just over half the reduction is due to reduced consumption of petroleum fuels,** almost entirely attributable to the economic slowdown.

- **The big drop in consumption of petroleum fuels during April reduced emission by** about 3 Mt CO_2-e or 3% of annual transport emissions (0.6 per cent of total national emissions for the year or 7 per cent for the month).

- **Sales of domestic aviation fuels fell by 75 per cent in April, compared with March.**

- **Sales of petrol, auto LPG and retail diesel, which are used almost entirely for road transport by passenger and light commercial vehicles, fell by a combined 36 per cent in April, compared with March.**

- Emissions from bulk sales of diesel used particularly in mining and heavy road transport, but also agriculture, rail transport, shipping and construction have been almost unaffected.

- **Total sent out coal fired generation fell to less than 70 per cent of grid level generation (generation excluding rooftop solar).** This is undoubtedly the first time that the share of coal fired electricity across the NEM has fallen to this level since the foundation of electricity supply in Australia, during the 1880s.

- **May recorded the highest ever monthly level of wind generation.** Victoria has now overtaken South Australia as the state which usually has the largest volume of wind generation; a trend which is likely to continue, as several very large windfarms in western Victoria are either completed or commissioned.

INTRODUCTION

Welcome to the June 2020 issue of the *NEEA Report*, with data relating to electricity and gas updated to the end of May2020, and data related to petroleum fuels to the end of April. 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 again looks at what effect the pandemic induced economic slowdown has affected consumption of all forms of energy. It finds that consumption of electricity and gas has been almost unaffected, as has consumption of petroleum fuels in many applications. However, consumption of road vehicle and aviation fuels have been dramatically reduced. Emissions from electricity generation have also fallen sharply, but this has been caused, not by lower consumption, but by a more or less coincidental acceleration of the shift towards renewable generation in the NEM.

HOW HAS THE ECONOMIC SLOWDOWN AFFECTED ENERGY CONSUMPTION AND EMISSIONS?

There have been a number of reports from other countries about how the economic shutdown has reduced energy consumption, with corresponding reductions in greenhouse gas emissions and in other air pollutants arising from fossil fuel combustion. Many people have been interested to know whether those changes are occurring in Australia. The previous *NEEA Report* discussed preliminary data, which ended in March for petroleum and April for gas and extended into May for electricity. This data showed a sharp fall in consumption of aviation fuels, but no other reduction in consumption of other petroleum products. For gas, it appeared to show an uptick in consumption in Victoria, but no change in other states, outside Western Australia. There was also no strong evidence of any change in electricity consumption.

Data is now available up to the end of April 2020 for petroleum products, and to the end of May for gas consumption and electricity. Figure 1 is the update, to the end of April 2020, of the regular *NEEA Report* graph of total moving annual emissions from energy combustion. It shows a distinct drop in emissions in April from both petroleum fuels and electricity generation, contributing to a drop since February in the total annual emissions covered by NEEA of about 1.6 per cent, which is about 4.9 Mt CO_2-e. Just over half of this reduction arises from lower consumption of petroleum fuels, which seems to be almost entirely attributable to the economic slowdown. Just under half is attributable to lower electricity generation emissions, and this seems to be attributable to an increase in the share of renewable generation, and almost entirely unrelated to the economic downturn.

Figure 1

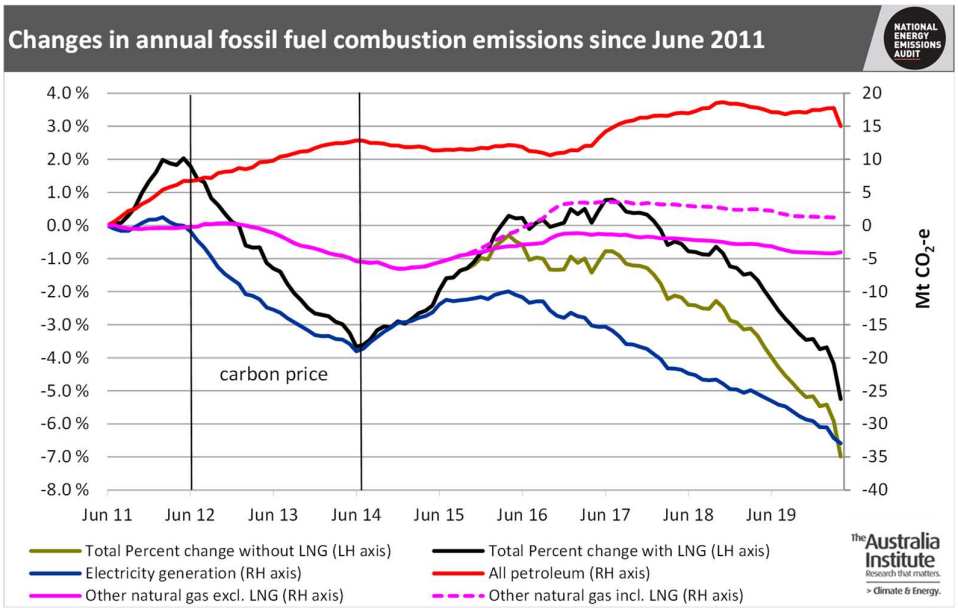


Figure 2 shows consumption, in energy units, expressed as monthly average daily consumption, for the period since January 2018. Gas consumption excludes all gas used to generate electricity and also gas used by the oil and gas industry, mainly to produce LNG for export. Recall that data for petroleum products cover the whole of Australia, but, for electricity and gas, exclude Western Australia and the Northern Territory. This means that about 30 per cent of national "other gas" consumption is excluded, and about 17 per cent of national electricity consumption.

The data show clearly the effects of seasonal weather on consumption of gas and electricity: winter heating for gas and both winter heating and summer cooling for electricity. Consumption of petroleum products, which is largely measured by reported sales at wholesale, rather than to final consumers, shows an increase during November and December, followed by a sharp reduction in January, as retailers and large bulk users stock up in advance of the holiday break.

What the data does not show is any marked change in the consumption trends for either electricity or gas. April gas data had suggested a possibly out of the normal increase in gas consumption in Victoria, but no such increase can be seen in the May data. At no stage since the start of lockdown has there been a clear indication of reduced electricity consumption caused by any other factor than mild daily weather conditions. Electricity consumption has been slightly lower than in 2019, but this can be explained by weather which for much of the time has been either less hot, during much of March and early April, and less cold, during May, than in 2019.

Figure 2

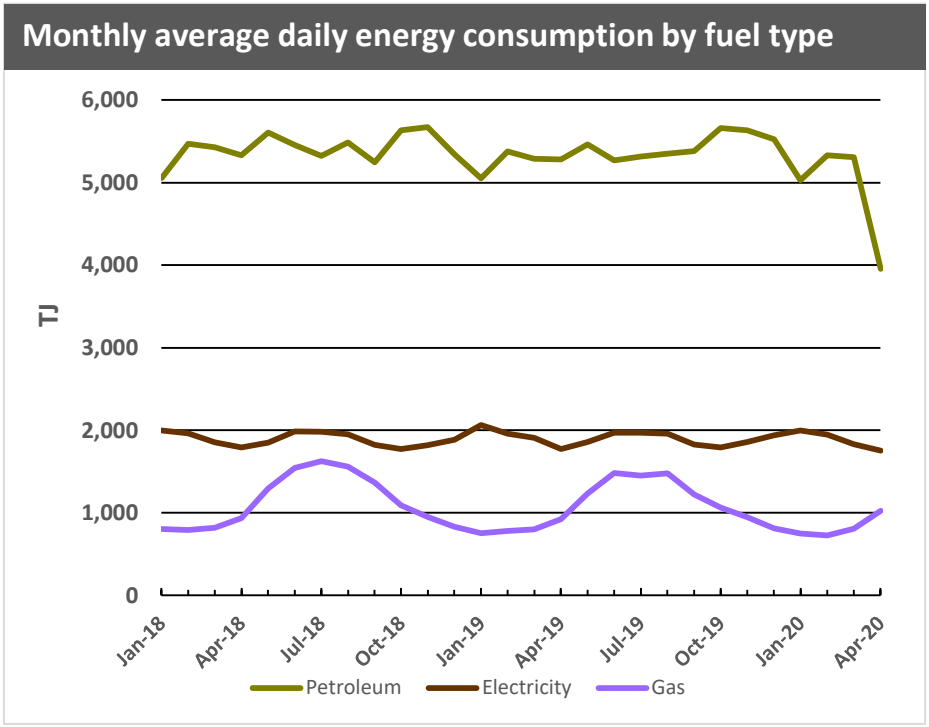
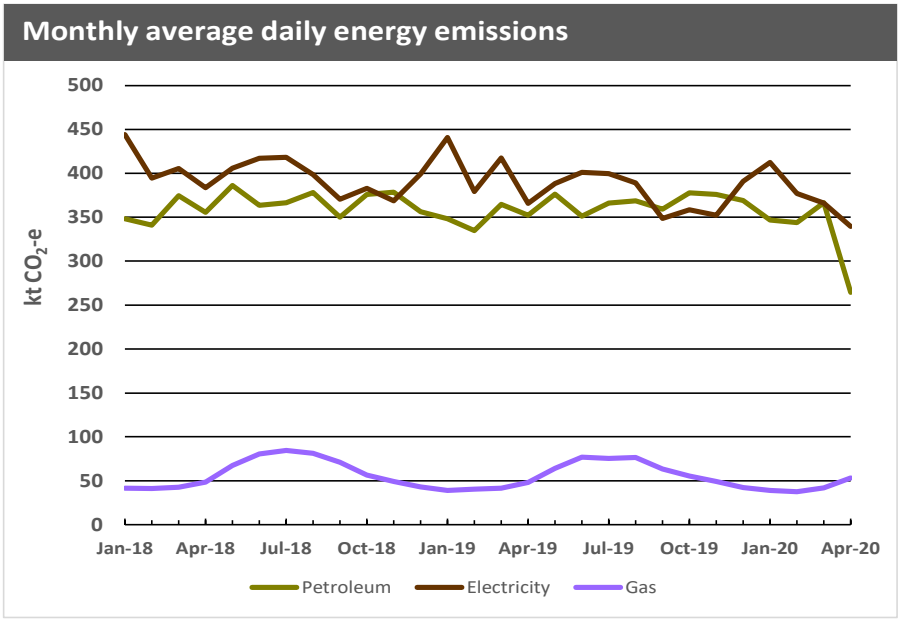


Figure 3



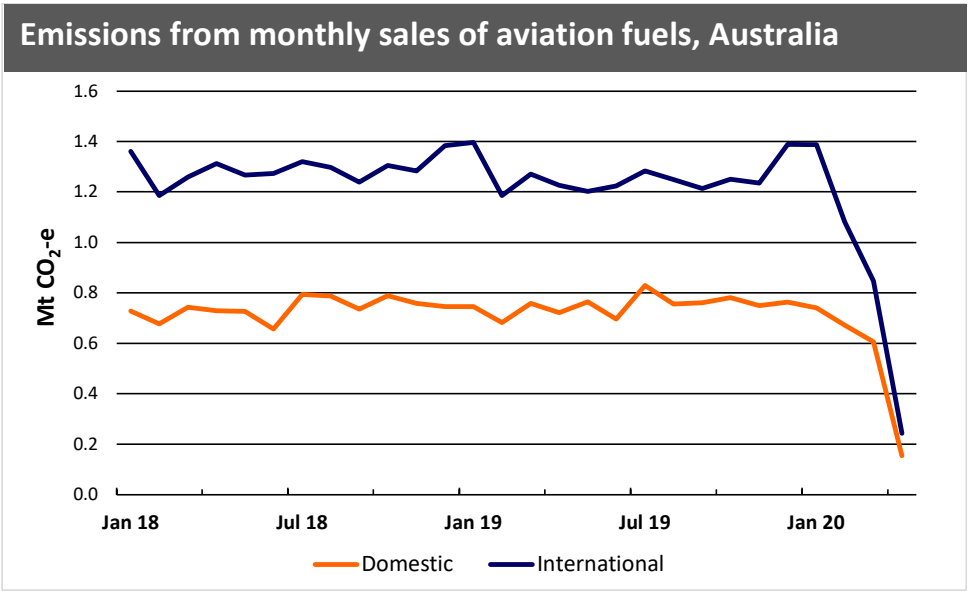
Some readers may be surprised by how much larger consumption of petroleum products by final consumers is than consumption of electricity, when both are expressed in the same energy units. The reason for the difference is the enormous difference in the efficiency with which the two energy sources convert energy supplied

to the consumer into useful energy services. Most petroleum products are used in internal combustion engines of various types. In a typical application, such as a motor vehicle, energy delivered to the wheels in an ordinary petrol or diesel engine car is between a third and a quarter of the energy content of fuel in the tank. By contrast, in an electric vehicle the ratio of useful energy delivered to energy supplied is usually greater than three quarters. For stationary applications, where the electric alternative does not require a battery, the ratio is even larger.

Where electricity loses out is in the initial conversion of primary energy, such as coal or gas, to electricity, at the power station. That effect is clearly seen in Figure 3, which shows that in most months over the past two and a half years total emissions from electricity generation have been larger than total emissions from consumption of petroleum fuels. The gap is narrowing, however, as the share of zero emission renewable generation increases. The graph also shows that the big drop in consumption of petroleum fuels during April reduced emission by more than 100 kt CO_2-e per day, equal to about 3 Mt CO_2-e, or 0.6 per cent of Australia's total national emissions, for the whole month.

Which particular petroleum products contributed to the large fall in emissions seen in Figure 3? Figures 4, 5 and 6 show emissions arising from sales of each of the separate petroleum products. Sales of aviation fuels, shown in Figure 4, fell by 10 per cent in March, and a further 75 per cent in April, for domestic activity. Sales for international aviation fell by 22 per cent in March, from an unusually high level in February, and a further 71 per cent in April. Sales of petrol, auto LPG and retail diesel, which are used almost entirely for road transport, by passenger and light commercial vehicles, and some heavy freight vehicles, are shown in Figure 5. They fell by a combined 36 per cent in April.

Figure 4



Emissions from bulk sales of diesel, together with the relatively small volumes of non-auto LPG and fuel oil, are shown in Figure 6, which shows that they have been almost unaffected. These are the fuels used particularly in mining and heavy road transport, but also agriculture, rail transport, shipping, construction and, in smaller volumes, almost all other sectors of the economy. Figure 6 suggests that some users may have stocked up during March and then reverted to more or less normal levels of activity in April. In other words, it appears that consumption of petroleum fuels by all of these sectors was almost unaffected, to the end of April, by the economic downturn.

Figure 5

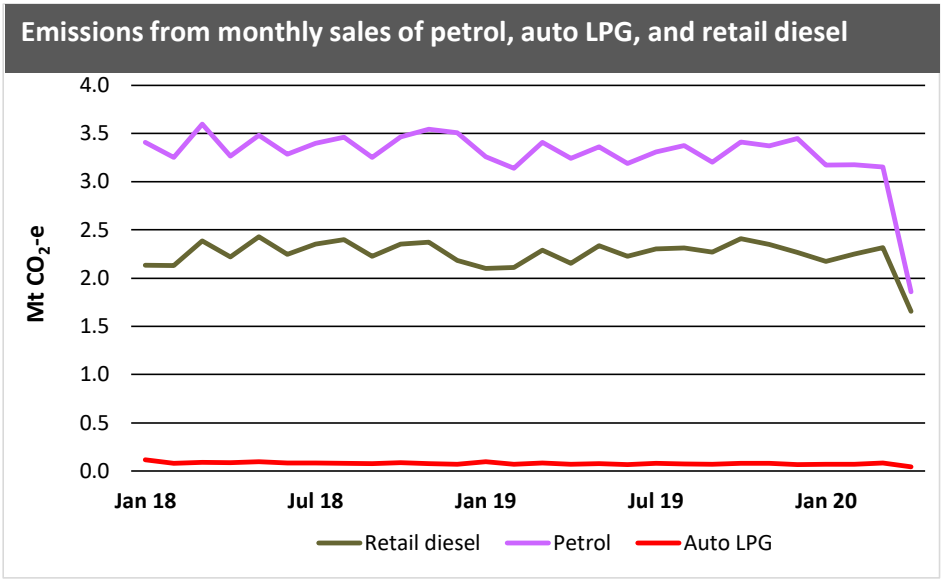
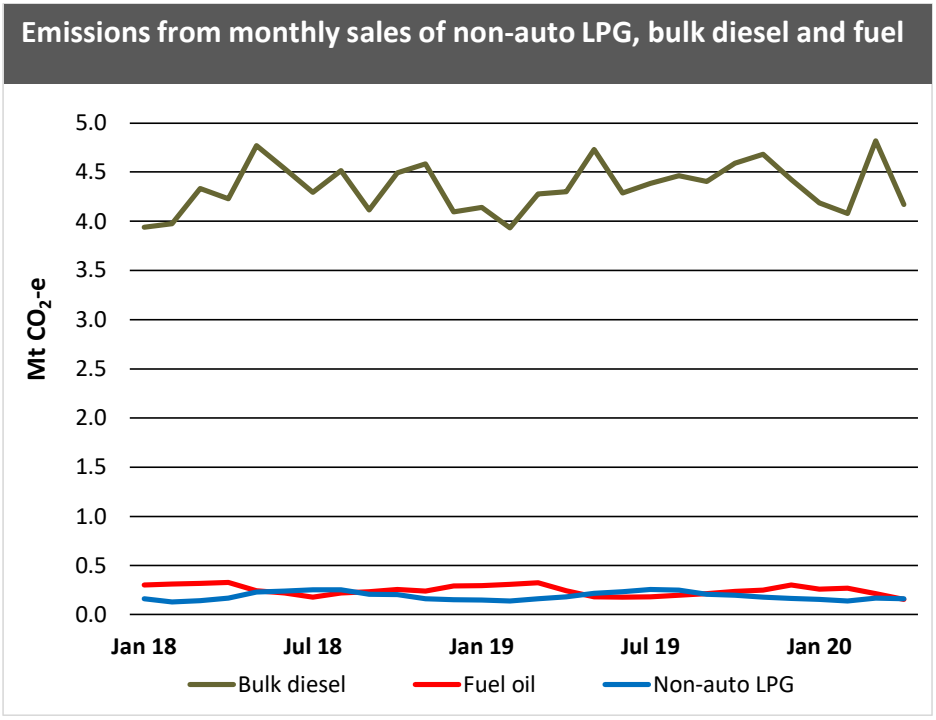


Figure 6



In terms of total emissions reduction, the drop in domestic aviation during March and April contributed about 0.7 Mt CO_2-e, and the drop in road transport fuels about 2.2 Mt CO_2-e.

WHAT HAVE BEEN THE CHANGES IN ELECTRICITY GENERATION IN THE NEM?

Figure 7 shows changes, expressed in percentage terms, of total annual generation in the NEM, of total annual emissions, and of average emissions intensity up to the end of May 2020. The particularly sharp fall in all indicators, over the past three months, reflects the combined effect of rapid growth in renewable generation and electricity consumption during March, April and May which has been slightly lower than in 2019. As discussed previously, lower electricity consumption can be explained by generally milder weather than in 2019.

Figure 7

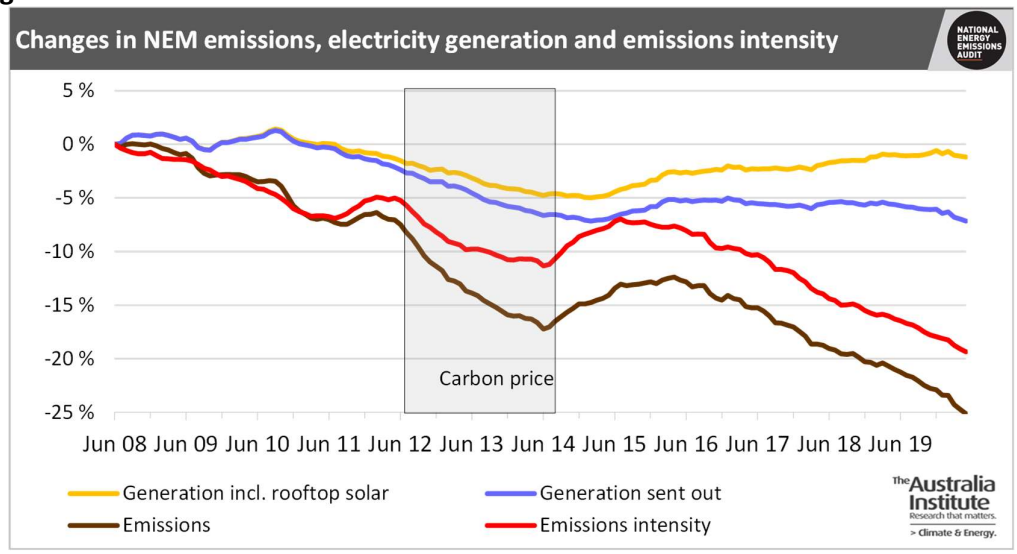


Figure 8 shows the changing generation mix, with strong growth in wind and solar generation causing a continuing fall in black coal generation and a more modest fall n gas generation. The last *NEEA Report* recorded that total renewable generation in the NEM passed the milestone level of 25 per cent of total generation, including rooftop solar. Figure 8 shows that this share is continuing to grow rapidly, and also shows that total grid renewables, i.e. exclusive of rooftop solar, are very close to 20 per cent.

On the other side of the ledger, in the year to May 2020 total sent out coal fired generation fell to below 66 per cent of total generation. Of symbolic significance, it also fell to less than 70 per cent of grid level generation, i.e. generation excluding rooftop solar. This is undoubtedly the first time that the share of coal fired electricity across the five states now making up the NEM has fallen to this level since the foundation of electricity supply in Australia, during the 1880s.

Finally, Figures 10 and 11 show, in two different ways, another record – the highest ever monthly level of wind generation. Figure 10 shows average monthly generation , in MW, by each of the main forms of renewable generation in the NEM separately. Note that there are no consistent data for generation from rooftop solar prior to May 2015. Figure 11 shows average monthly wind generation in each state separately. It can be seen that Victoria has now overtaken South Australia ss the state which usually has the largest volume of wind generation. This relationship seems certain to continue, as several very large windfarms in western Victoria are either very close to completion, or are have just been commissioned and are now gradually scaling up production. Note also that over recent months AEMO has curtailed output from windfarms in south Australia on a number of occasions.

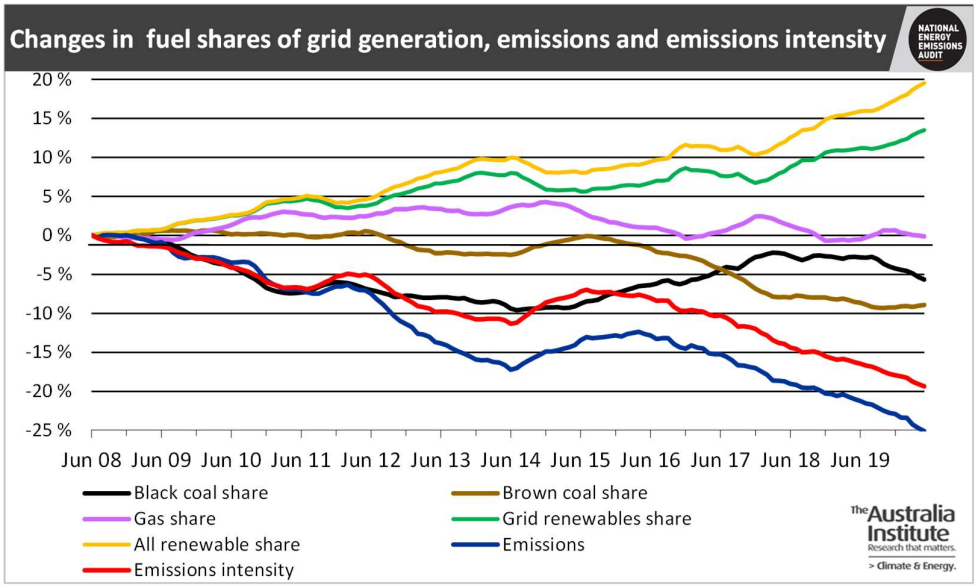


Figure 9

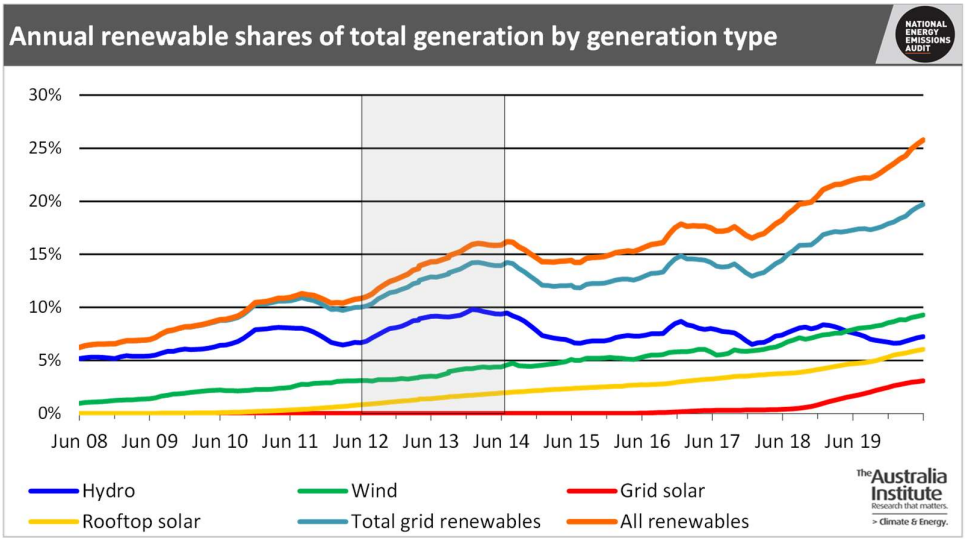


Figure 10

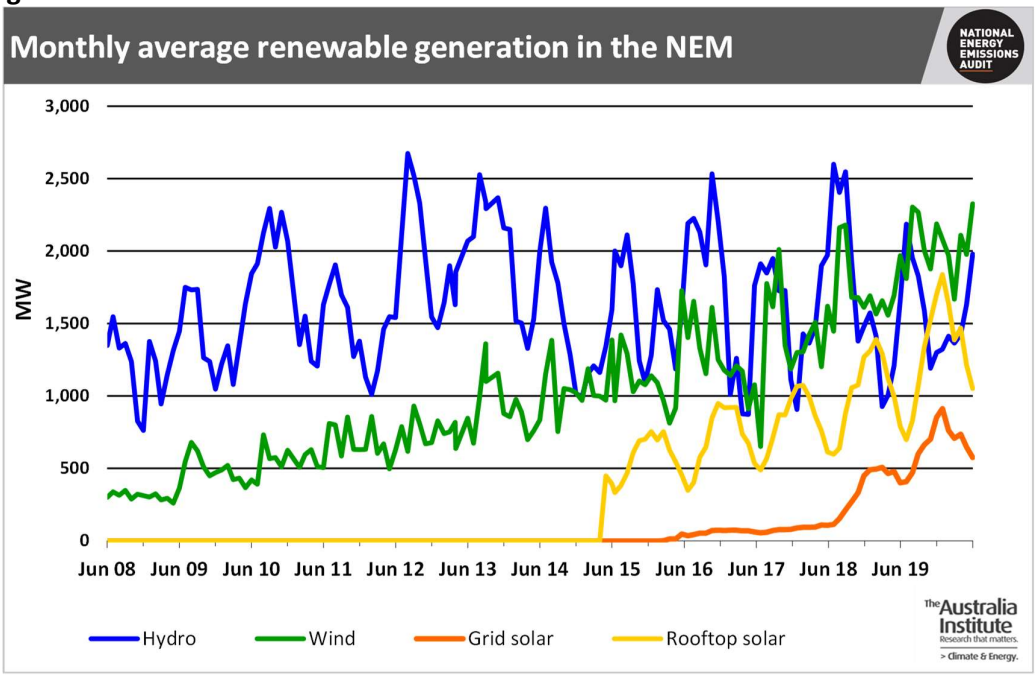
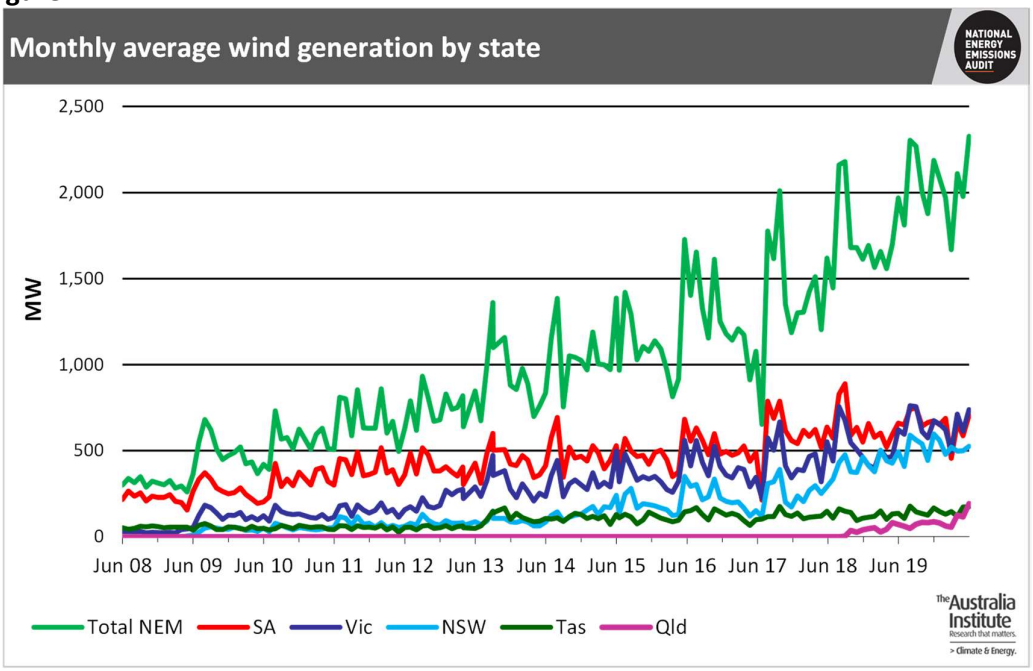


Figure 11



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.