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NATIONAL ENERGY EMISSIONS AUDIT

National Energy Emissions Audit Report

September 2021

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

Hugh Saddler

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Key points

- For the 12 months to February 2021, annual energy combustion emissions reported by NEEA fell by 7.4%, yet over the preceding three months (until June 2021) 2.0% of this fall was reversed.

- Average emissions intensity (gm CO_2-e/km) of new vehicles sold has been gradually decreasing, but, unsurprisingly, were still 23% more emissions intensive than new vehicles sold in Europe.

- Australia's emissions intensity of new vehicles remains higher than the OECD average due the larger average-sized vehicle and the almost complete absence of policy measures designed to encourage the purchase of lower (especially zero) emission vehicles.

- In 2020, electric vehicles, including both battery and plug-in hybrid, accounted for 0.39% of total new light vehicle sales, of which Tesla accounted for just over half. For the whole light vehicle fleet at the end of 2020, electric vehicles accounted for only 0.12% of the fleet.

- For electricity, notwithstanding the rapid growth in wind and solar generation in Australia, the resultant reduction in emissions from 2011 to 2019 has been smaller than the USA, Japan, the UK and the EU.

- Emissions reductions in electricity have been partially lost by the commissioning, between 2016 and 2018, of no less than seven new Liquified Natural Gas plants in Australia estimated to have increased Australia's annual emissions by up to about 15 Mt CO_2-e.

- Total emissions from road transport fuels (LPG, petrol and retail diesel sales), were about 6 Mt CO_2-e lower in 2020 than in 2019. This is equivalent to about 6% of total Australian transport emissions in 2019-20, or 1.6% of Australia's total energy combustion emissions.

- In the 12 months to July 2021 the total share of renewable generation in the NEM was above 30% for the first time ever (on an annual basis). On a month-by-month basis, it was above 30% in every month from September 2020 to March 2020.

- It is becoming increasingly common for wind and solar plants to constrain their output —either on the instruction of the system operator (AEMO), to maintain secure supply conditions in relevant parts of the transmission grid, or of their own choice — to avoid negative prices

+ There is no simple or obvious relationship between the share of variable renewable generation and the spot wholesale electricity price. If anything, there may be an inverse one – high wind and solar correlates with low wholesale prices.

Introduction

Welcome to the August 2021 issue of the NEEA Report, and apologies for the long delay since the last issue. Because it is nearly five months since our last issue, this new issue starts with an update in the NEEA estimate of changes in Australia's total energy combustion emissions up to the end of June 2021. This is followed by a short section on recent trends in the emissions efficiency of new vehicles, using data contained in a recently published report by the National Transport commission. The report then uses Australia's most recent National Greenhouse Gas Inventory (NGGI), published at the start of May, to do a comparison and reconciliation between the NEEA annual estimates (which exclude some of Australia's energy emissions) with the NGGI. The report also adds a summary comparison of trends in official figures for Australia's energy emissions, as calculated by successive national inventories, with corresponding trends for the EU, the UK the USA and Japan. The next section presents monthly data over the last four years, to see what effect, if any, the pandemic lockdowns have had on energy consumption. The final section updates the progress made in displacing coal and gas fired generation in the NEM by wind and solar, up to the end of July 2021 and also includes graphs comparing shares of variable renewable generation in each state with average wholesale prices over the past few years. As usual, details on data sources and methods are included in the appendix.

Trends in energy consumption and emissions

Figure 1 shows total annual energy combustion emissions, by major source, as estimated by the NEEA, and Figure 2 shows each of the five sources separately. Electricity generation data is to the end of July 2021, gas and petroleum data to the end of June 2021.

Figure 1

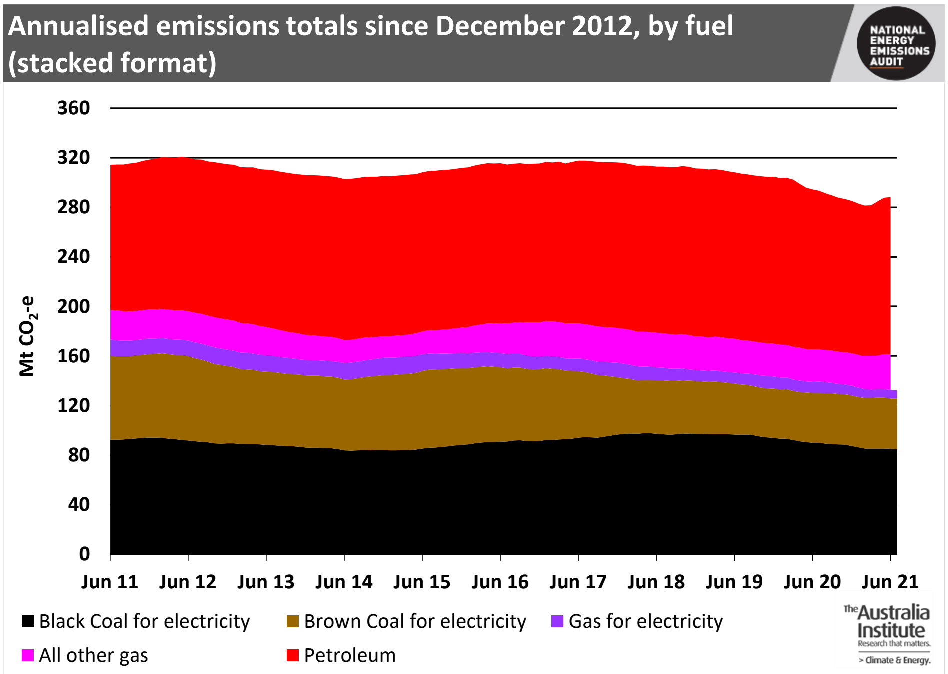


Figure 2

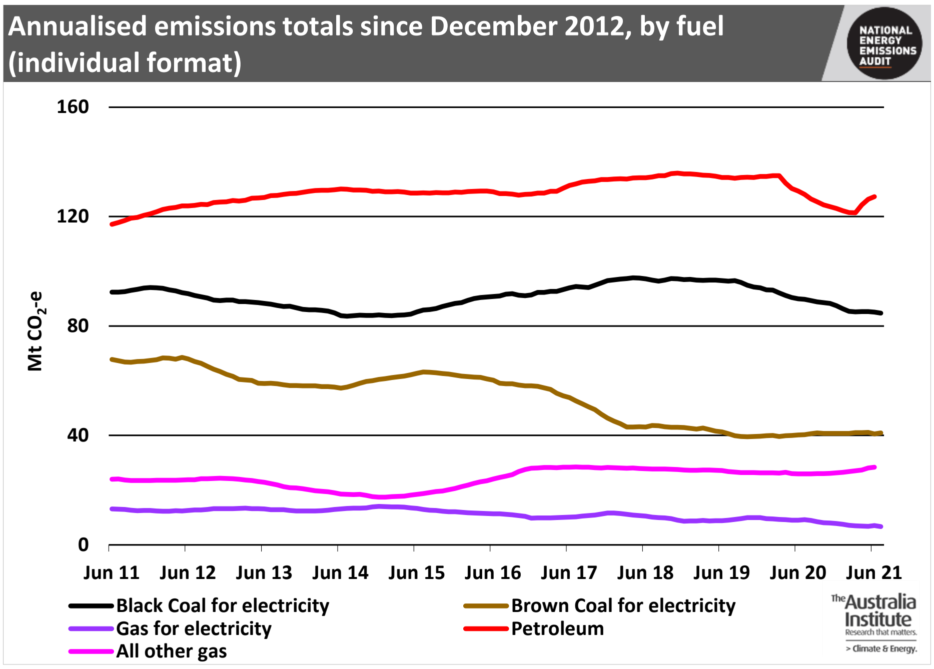


Figure 3 shows just the changes in emissions, making them much easier to see. Between the end of February 2020, just before lockdowns were introduced, and the end of February 2021, annual energy combustion emissions reported by NEEA fell by 7.4%. Over the next three months, however, 2.0% of this fall was reversed, so that annual emissions at the end of May were 5.4% lower than in February 2020, corresponding to 16.3 Mt CO_2-e, of which about half relate to reduced emissions from the use of petroleum fuels. In the absence of major changes in transport policy, the pre-pandemic trends suggest that this reduction will be completely reversed when lockdowns end. Figure 4 shows only changes in total emissions, but both with and without emissions from the production and processing of coal seam gas to export LNG in Queensland.

Figure 3

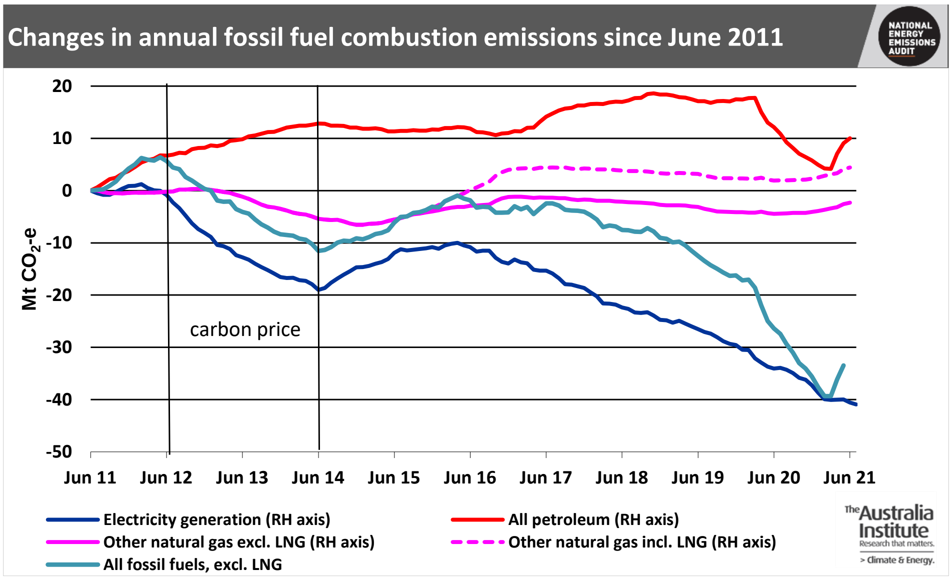
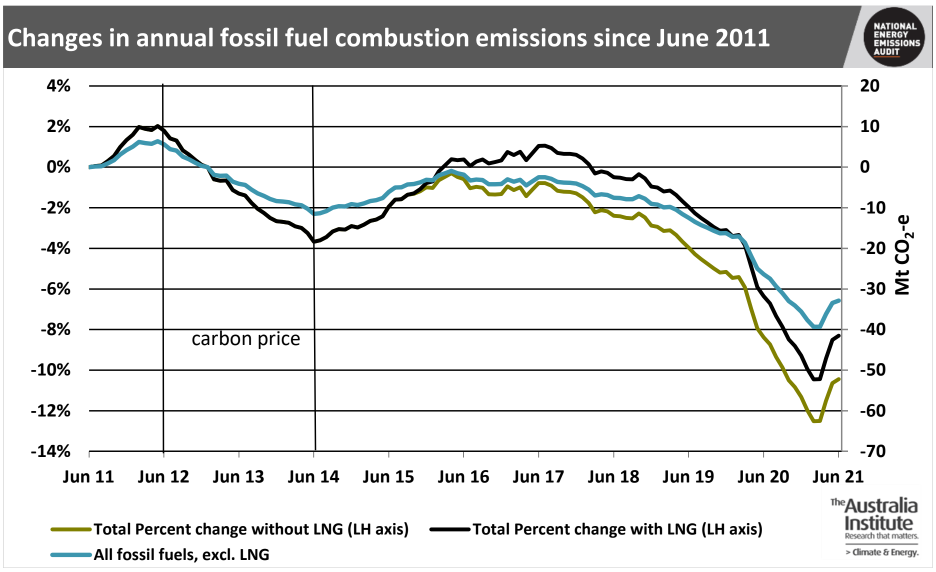


Figure 4



A short note on electric vehicle sales

At the start of August, the National Transport Commission published *Carbon dioxide emissions intensity for new Australian light vehicles 2020*. This is the most recent of a regular series of publications on this topic. Light vehicles include cars, SUVs and light commercial vehicles. The report finds that the average emissions intensity (measured in gm CO_2-e per km) of new vehicles sold in Australia has been gradually decreasing, but, unsurprisingly, a comparison of Australian sales in 2020 with sales across Europe in 2019 finds that on average new vehicles sold in Australia are 23% more emissions intensive than new vehicles sold in Europe. The main reasons for this large difference are the larger averaged size of new vehicles in Australia and the almost complete absence of policy measures designed to encourage the purchase of lower emission vehicles. Many commentators have observed that, in the absence of such policy measures, many vehicle manufacturers choose not to make their most fuel-efficient models available in the Australian market.

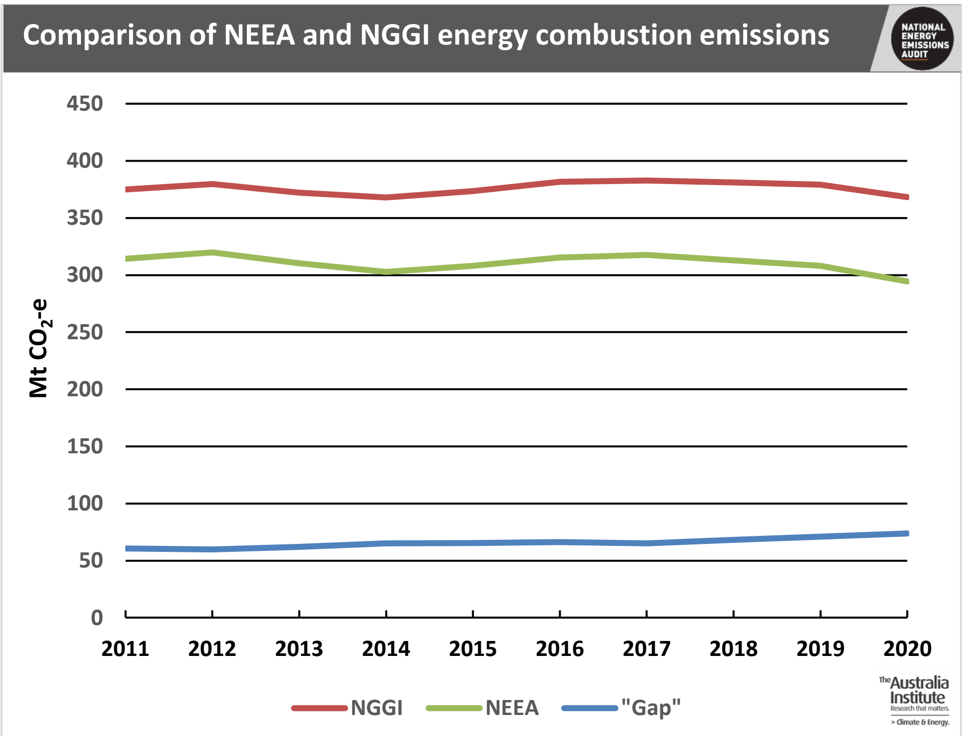
The report also includes what is almost certainly the best and most up-to-date data on electric vehicle numbers in Australia. It uses sales data from the Federated Chamber of Automotive Industries (FCAI) with its own estimation, using state-by-state new vehicle registration data, for Tesla, which is excluded from the FCAI data. In 2020, electric vehicles, including both battery and plug in hybrid vehicles, accounted for 0.39% of total new light vehicle sales, of which Tesla accounted for just over half. For the whole light vehicle fleet at the end of 2020, electric vehicles accounted for only 0.12%. Since new sales include a larger share of electric vehicles than the whole fleet, the fleet share of electric vehicles is gradually increasing, but obviously very slowly.

Reconciliation between NEEA and the NGGI

Figure 5 compares NEEA estimates of total annual energy combustion emissions with the National Greenhouse Gas Inventory (NGGI) figures. The NGGI numbers are larger than NEEA, because data for some of the energy emission sources included in the NGGI are not publicly available. These mostly relate to WA and the NT and include both electricity generation and all other uses of natural gas in these two jurisdictions. Missing data also includes all use of coal, throughout Australia, to supply heat for manufacturing activities, such as cement production and processing of metal ores.

It can be seen that from 2011 to 2019 (the last "pre-pandemic" year) NGGI emissions increased slightly (by 1.1%), whereas NEEA emissions decreased slightly (by 2.0%). As the NEEA has been reporting for several years, the main driver of emission increases is road transport, and the main driver of decreases is decarbonisation of electricity generation. These decreases have been offset by the commissioning, between 2016 and 2018, of no less than seven new LNG plants in Australia – three in Queensland, three in Western Australia (one floating offshore), and one in the Northern Territory. Together, we estimate these have increased Australia's annual emissions by up to about 15 Mt CO_2-e, of which over half has occurred in Western Australia and the Northern Territory. This, together with slower decarbonisation of electricity generation, are the main reasons that NEEA emissions have fallen slightly faster than NGGI emissions.

Figure 5



Comparing Australia with other high income countries

Figures 6 and 7 show relative changes in, respectively, emissions from electricity generation and emissions from all other energy combustion activities, including transport, space and hot water heating in buildings of all kinds, and industrial process heat. The data shown cover the period from 2011 to 2019, and compare Australia with the USA, Japan, the UK and the EU as a whole.

For electricity, it can be seen that, notwithstanding the rapid growth in wind and solar generation in Australia, the resulting reduction in emissions has been smaller than in any of the other countries or groups of countries. Note that the initial increase in this source of emissions in Japan was caused by the decision to close down most of the country's nuclear power station, in the aftermath of the Fukushima disaster.

For all other energy combustion, Japan, the EU and the UK have all achieved emission reductions, though these are smaller than the reduction in emissions from electricity generation. Both the USA and Australia have significantly increased their emissions, mainly because of increases in petroleum use for road transport and, in Australia's case, augmented by emissions from the gas used at LNG plants.

Figure 6

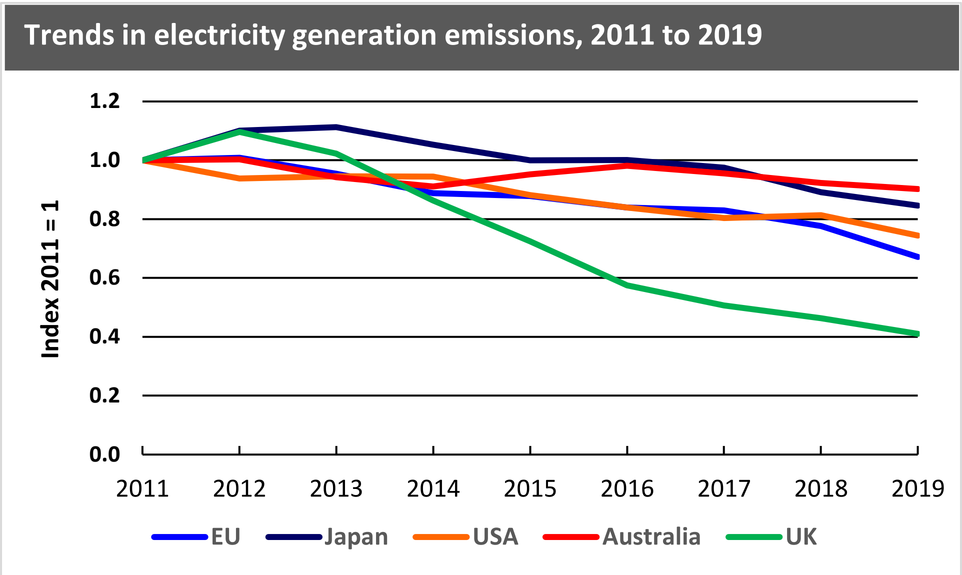
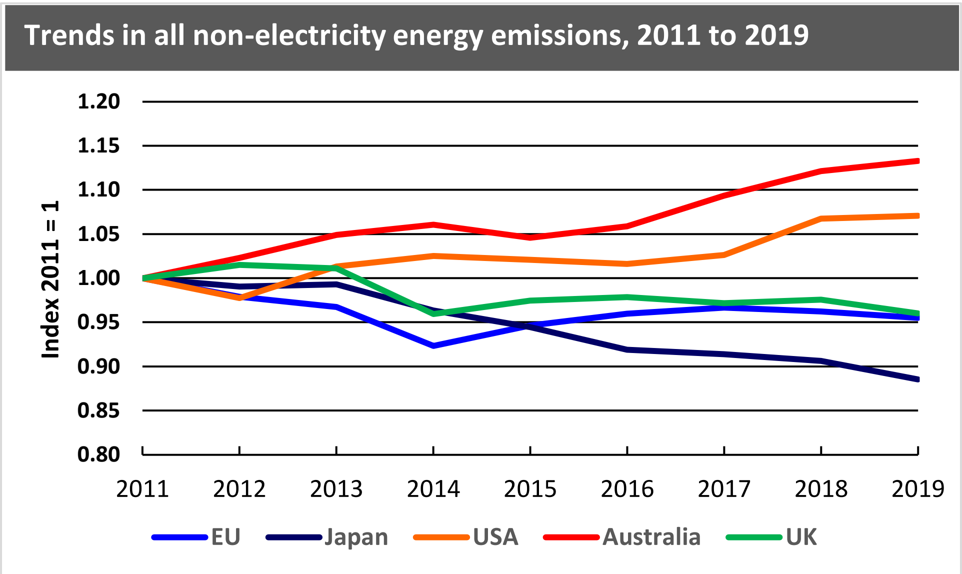


Figure 7



In the two years since 2019 Australia's energy combustion emissions have decreased, but so too have corresponding emissions in the other OECD countries represented in Figures 6 and 7. At least some of this reduction is attributable to reduced economic activity caused by the pandemic. How much reduction this has caused and how much emissions might increase after economic activity returns to pre-pandemic levels are key questions. The next section of this report examines the relevant data for Australia.

The effect of pandemic lockdowns on energy emissions

Previous NEEA reports have examined the effect on energy consumption, and consequent energy emissions of the reduced economic activity caused by the public health responses to the COVID-19 pandemic. This report updates that analysis to the end of June 2021, which is prior to the current lockdowns in New South Wales, Australian Capital Territory and Victoria. Figures 8 to 14 show monthly average daily consumption of petroleum products, electricity and gas nationally, and in each of the six states. Data for petroleum products is comprehensive, but data for electricity and electricity excludes both Western Australia and the Northern Territory. The gas data represent consumption by consumers other than electricity generators, and also exclude all consumption in either Western Australia or the Northern Territory. It also excludes gas used by the gas industry itself; both for extracting gas and for processing it to either pipeline quality gas or to LNG for export.

Figure 8

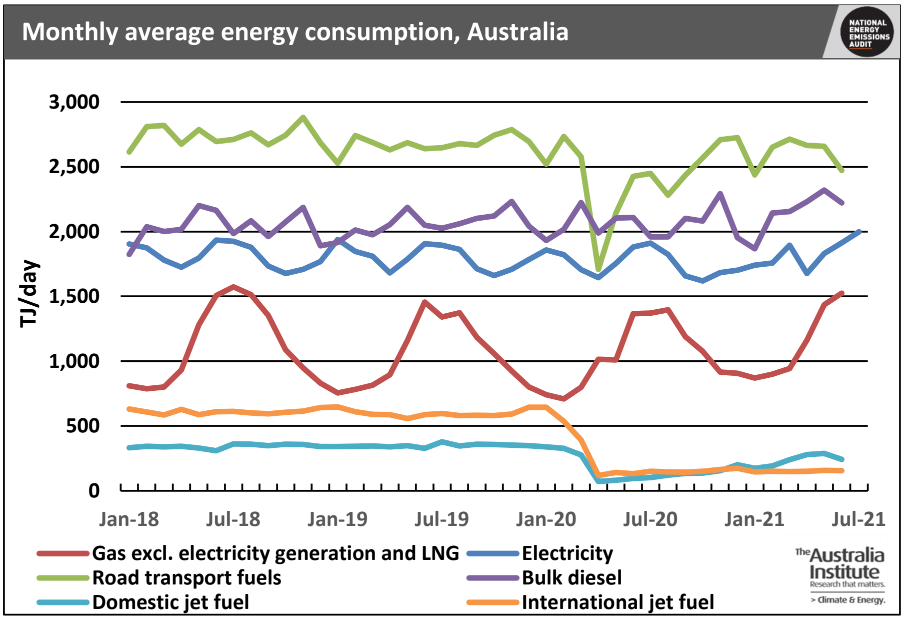


Figure 9

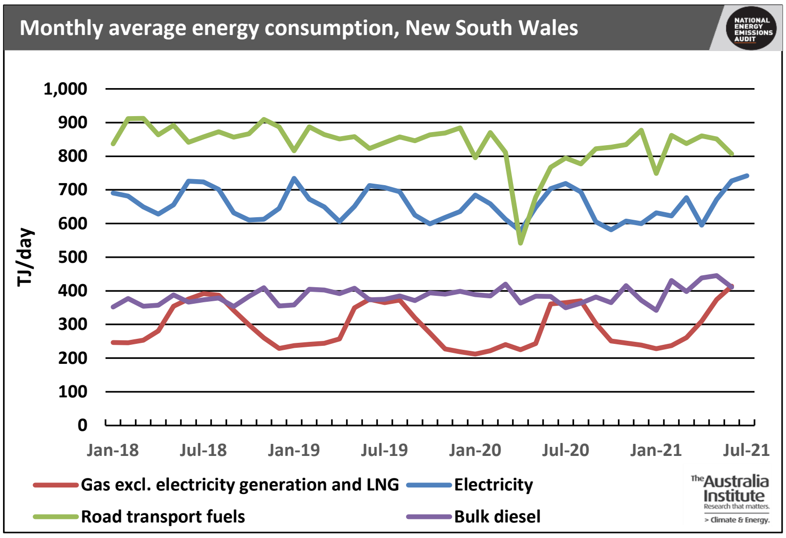


Figure 10

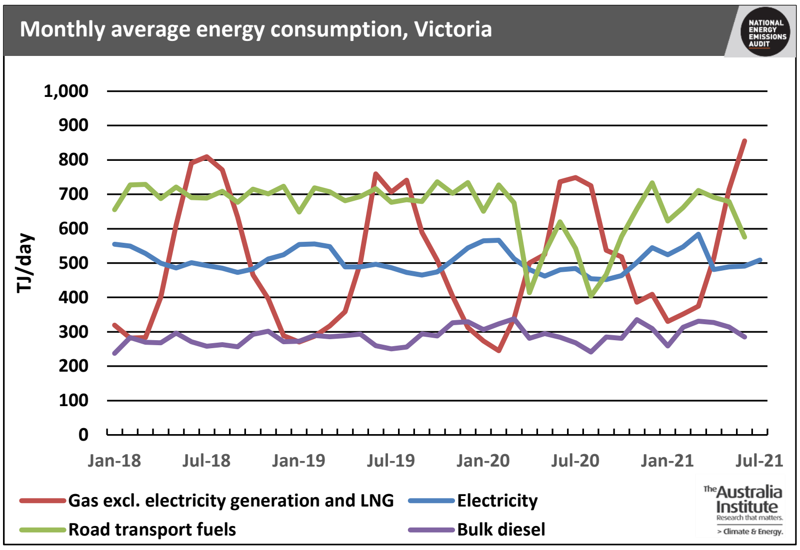


Figure 11

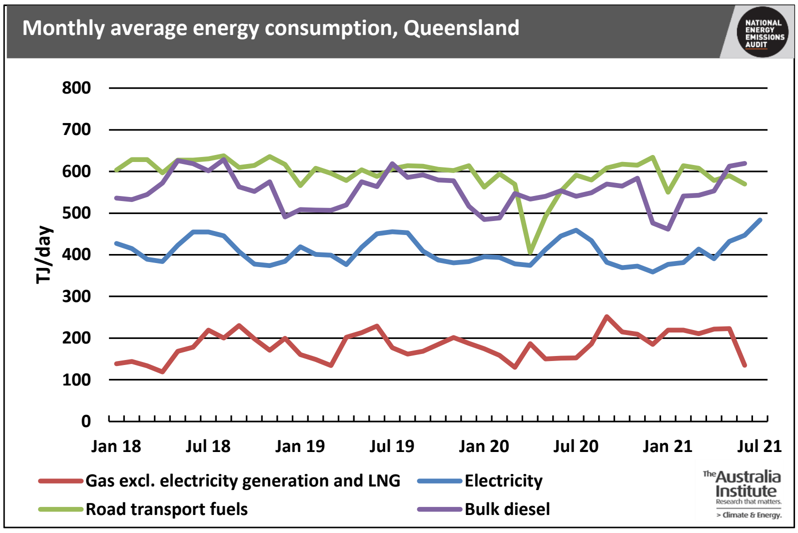


Figure 12

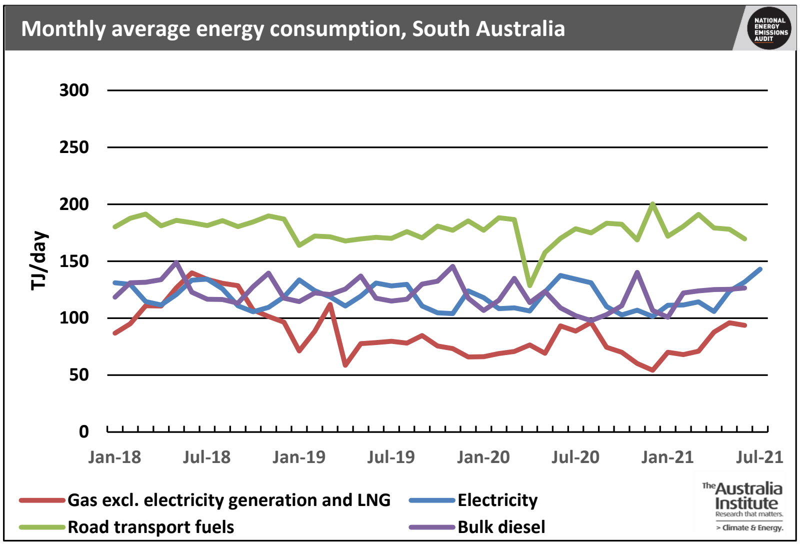


Figure 13

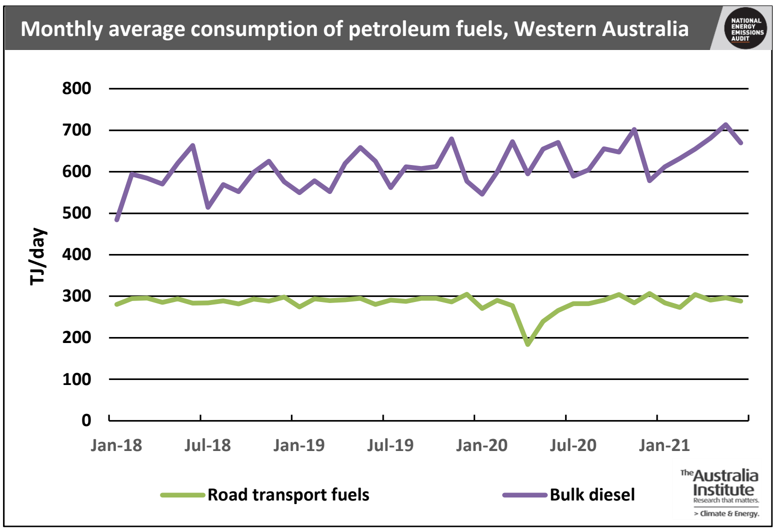
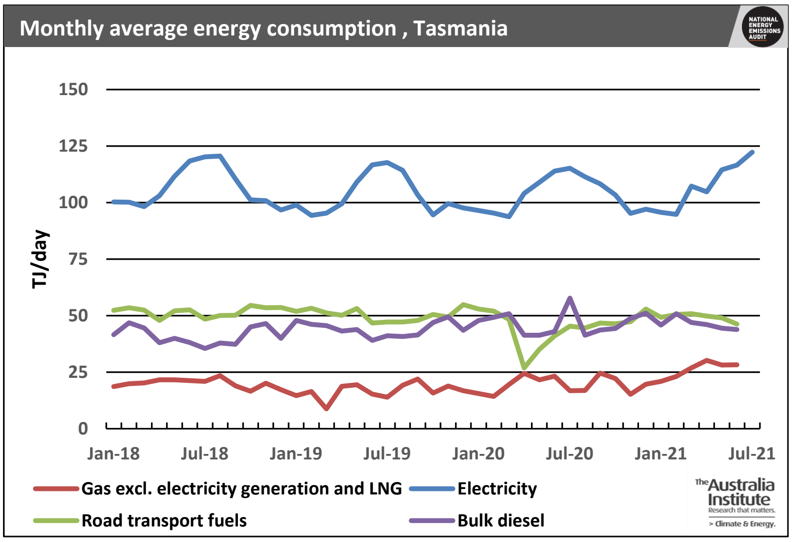


Figure 14



The NEEA has previously reported the impact of the initial lockdown in March–April 2020 on consumption of road transport and aviation fuels. The most recent data, presented here, show, as expected, that the impact on consumption of aviation fuel for international flights has continued., while fuel consumed by domestic aviation has gradually increased and now appears to be close to pre-pandemic levels. Road transport fuel consumption also fell sharply in March-April 2020, but since then appears to have returned to pre-pandemic levels in all states except Victoria, where the prolonged lockdown later in 2020 caused a second sharp fall in consumption.

Total emissions from road transport fuels in Australia, as defined by NEEA, i.e. auto LPG, petrol and retail diesel sales, were about 6 Mt CO_2-e lower in 2020 than in 2019. This is equivalent to about 6% of total Australian transport emissions in 2019-20, or 1.6% of Australia's total energy combustion emissions. This is obviously a very small reduction which, on present trends, seems highly likely to be temporary only.

By contrast, there is no clear evidence of a significant change in consumption of either electricity or gas in any month since the start of the pandemic. Consumption of both is sensitive to weather; above average temperatures in summer mean that more electricity is used for space cooling, while below average winter temperatures mean that more electricity and/or gas is used for space heating. Gas consumption is particularly sensitive to winter temperatures in Victoria, because the majority of dwellings use gas for both space heating and water heating. In no other state is that the case. It is conceivable that, if more households are spending all day at home energy consumption for space heating could increase. Several of the graphs suggest that consumption of gas, and possibly also electricity, may have been particularly high in June. It is more likely, however, that higher consumption was the consequence of particularly cold and wet weather during much of the month.

Generation mix, emissions and prices in the NEM

Figures 15 and 16 update the regular NEEA graphs showing trends in total generation and emissions in the NEM. In the year ending July 2021, annual emissions had fallen almost 30% from the peak level reached in the year to December 2008. Annual NEM generation fell by about 10% over the same period but, when the contribution of rooftop solar is included, the total fall in electricity consumed has been less than 3%.

Figure 15

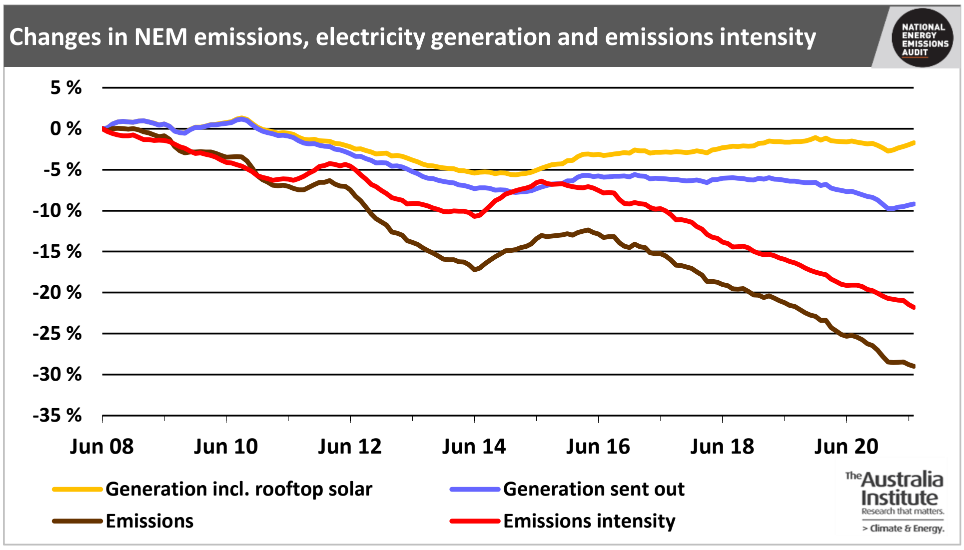
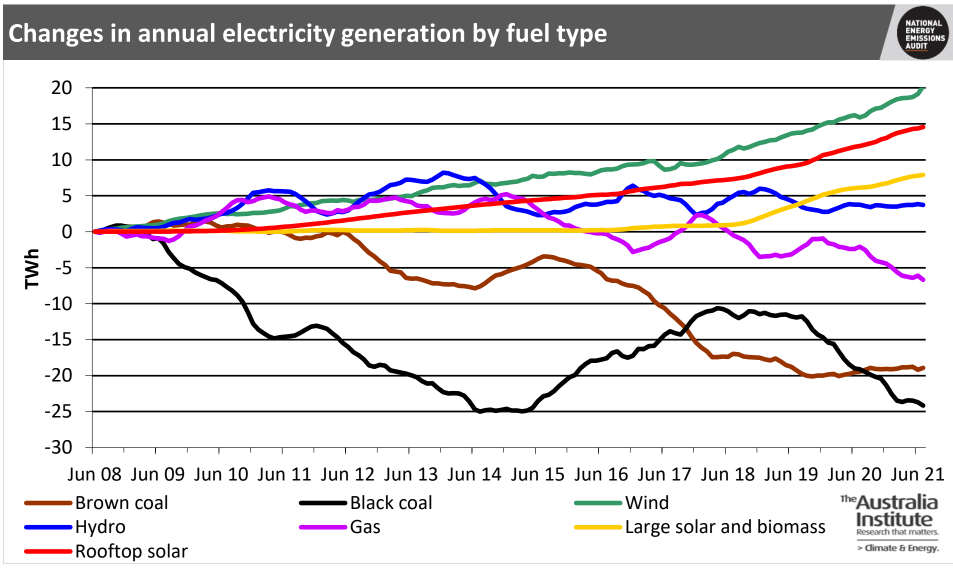


Figure 16 also shows a continuation of general trends which have been evident for about the last two years. Supply from black coal and gas fuelled generators has been steadily falling, brown coal and hydro have been steady, while wind and solar continued to grow strongly.

Figure 16



Figures 17 and 18 provide data to the end of July on the total share of renewable generation in the NEM; Figure 17 is month by month data, while Figure 18 is moving annual data. It can be seen that in the year ending July 2021 the share was above 30% for the first time ever on an annual basis. On a month-by-month basis, it was above 30% in every month from September 2020 to March 2020.

Figure 17

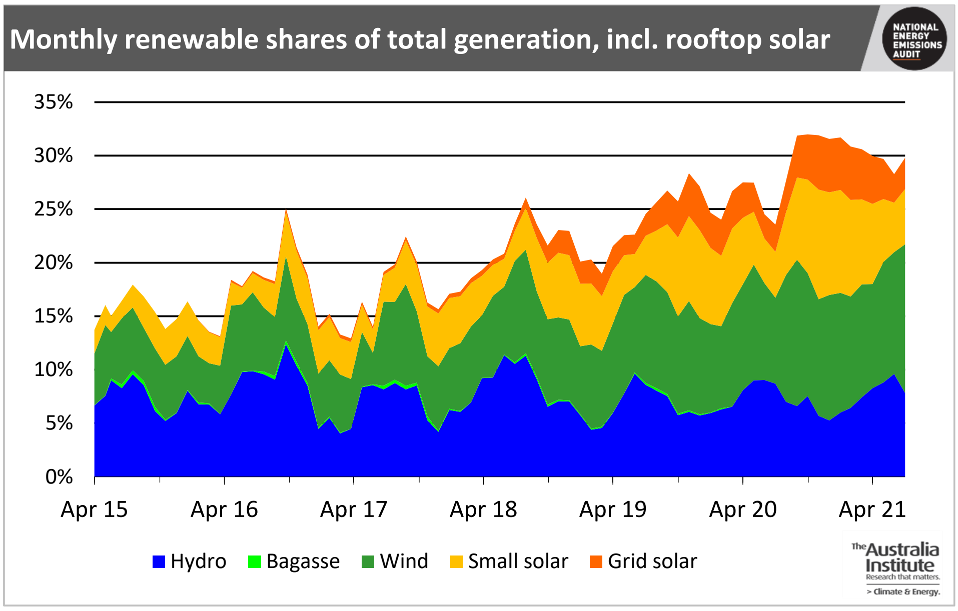
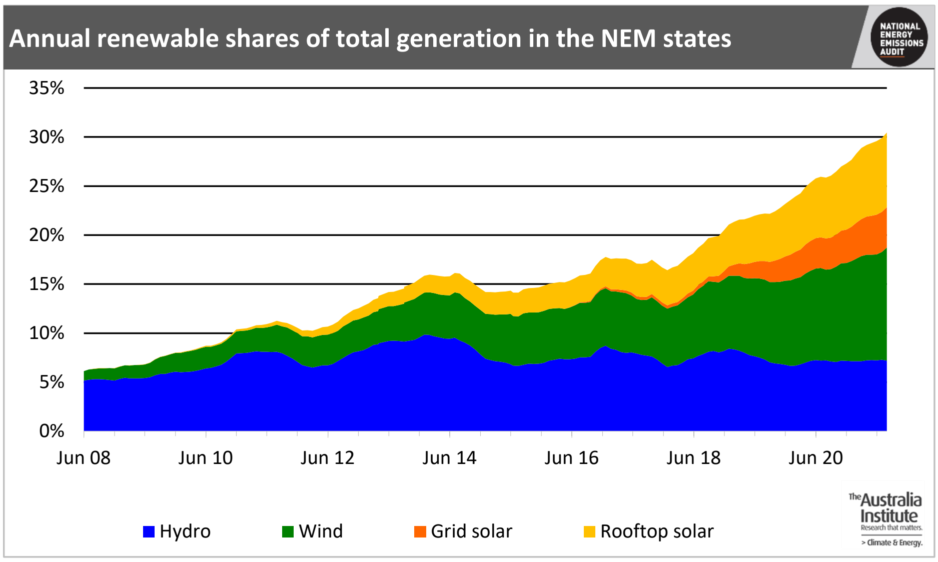


Figure 18



The final four graphs show the relationship between the monthly share of variable generation, meaning wind plus solar, including rooftop solar, and monthly spot wholesale prices, in each of the four mainland regions (states) in the NEM. Price is shown as both mean and median for each month; the median is a better indicator of trends because it reduces the apparent impact of occasional extreme price events, such as that which occurred in June, following the explosive destruction of one of the two super-critical units at Callide power station in Queensland. Figures 19, 20 ,21 and 22 show, respectively, New South Wales, Queensland, Victoria and South Australia.

Figure 19

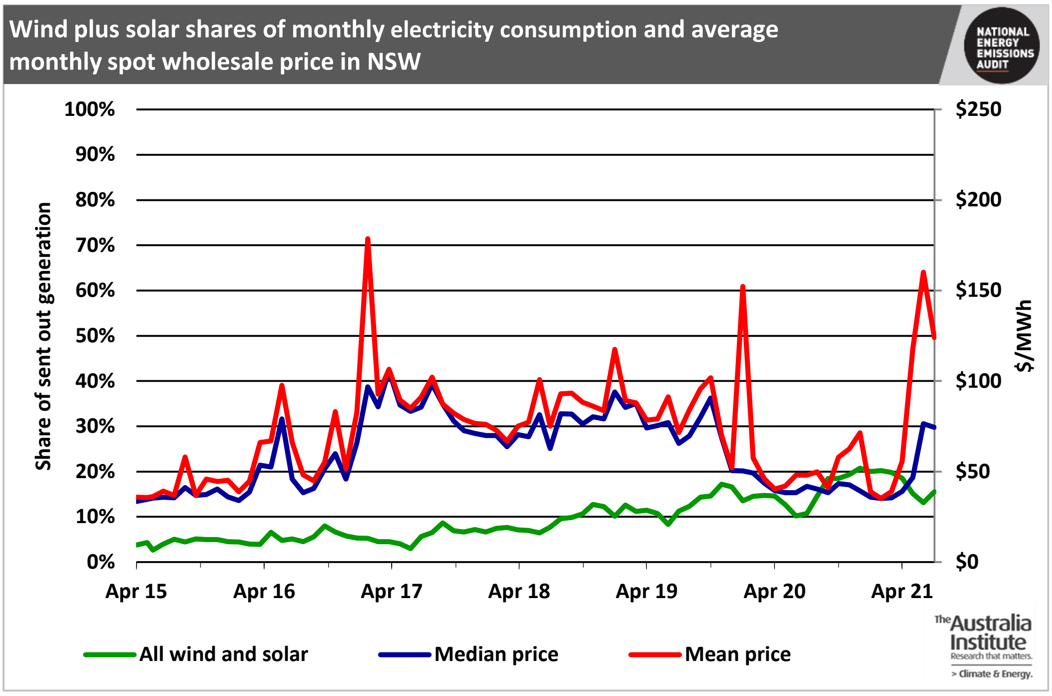


Figure 20

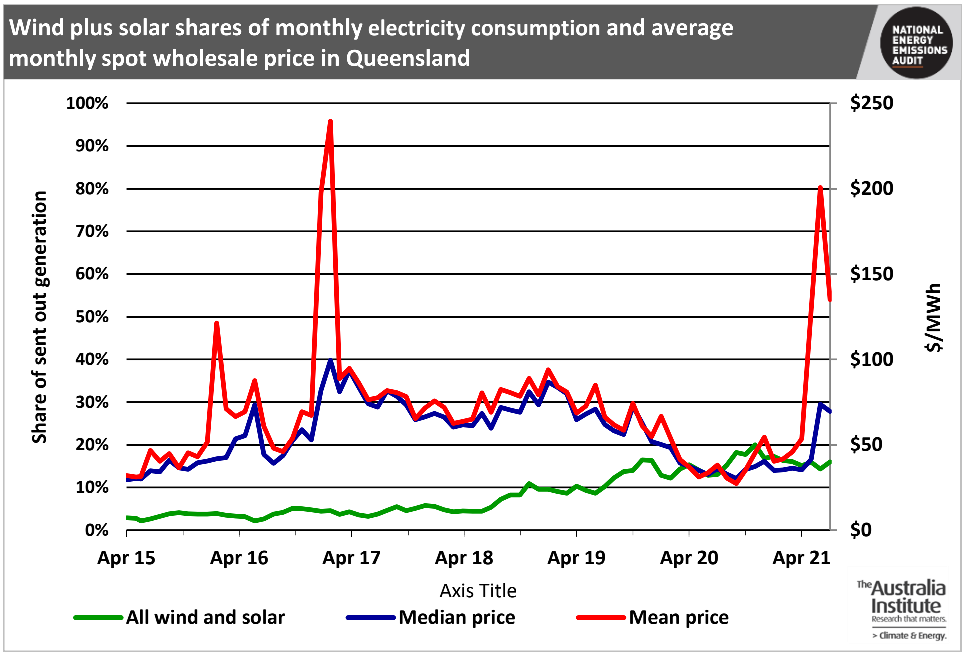


Figure 21

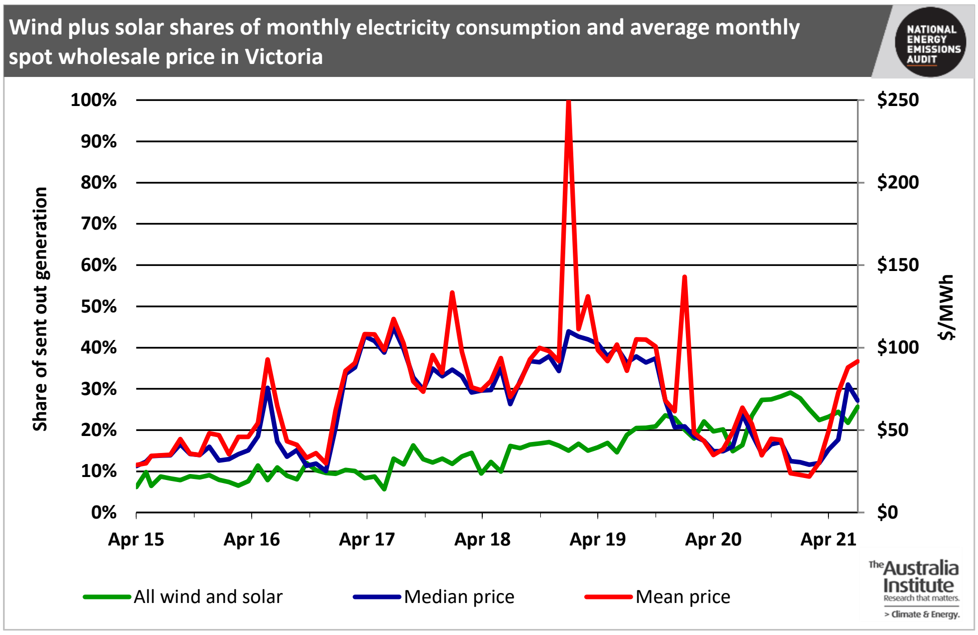
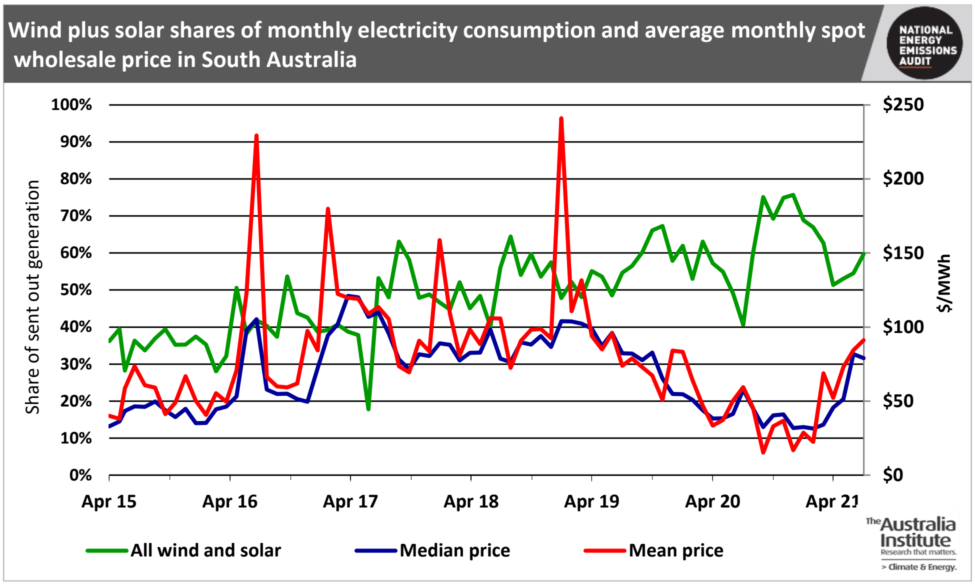


Figure 22



The four graphs show that, over the medium to long term, there is no simple or obvious relationship between the share of variable renewable generation and spot wholesale price. Any relationship there may be is a an inverse one – high wind and solar with low wholesale prices. It is most certainly not a direct relationship – i.e. high wind and solar with high prices – as critics of renewable generation have often tried to claim. In the short term there definitely is an inverse relationship; wholesale prices often fall below zero in the middle of very sunny days or on very windy days. It is becoming increasingly common for the operators of wind and solar plants to constrain their output at such times. Sometimes this is done on the instruction of the system operator (AEMO), in order to maintain secure supply conditions in relevant parts of the transmission grid. At other times, the individual wind and solar farm operators choose themselves to constrain output, in order to avoid negative prices, i.e. in order to avoid having to pay to generate. A number of commentators have pointed out that this sometimes means that observed peak output levels of wind and solar generation are lower than they would be if there were no curtailment .

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 and the Northern Territory. 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 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.