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NATIONAL ENERGY EMISSIONS AUDIT

National Energy Emissions Audit Report

February/March 2021

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

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Key points

- Between February 2020 and January 2021 annual energy combustion emissions fell by about 7.3 %, about 22.3 Mt CO2-e, of which about 12.8 Mt CO2-e relate to petroleum use which was directly impacted by the pandemic response.

- Total energy consumption was the lowest it has been in six years in South Australia, five years for the NEM as a whole and four years in NSW, Victoria and Tasmania.

- Total electricity consumption in 2019-20 however was *slightly higher* than in 2018-19 in Queensland, South Australia and Tasmania. There was a slight increase in NSW.

- There is no evidence that in NEM states (excluding Victoria where similar data is not yet available) economic lock-down and associated economic recession caused a significant drop in total electricity consumption.

- Within electricity consumption a small shift may have occurred from general business consumption to residential consumption (which would be expected given the tendency to work from home during the pandemic).

- Commentators who continue to assert that Australia has experienced a fall in electricity consumption, are simply transferring the experience of Europe and the USA, giving no consideration to the actual evidence of what has happened in Australia.

- The highest peak demand in the NEM (for this financial year) occurred on Sunday 24 January 2021.
    - This was the hottest day of the summer in many parts of eastern Australia, but it is the first ever time that the summer peak has occurred on a Sunday.
    - This 2020-21 peak demand was lower relative to each of the previous five summers, undoubtedly caused of the growing supply from rooftop solar.
    - Rooftop solar made a larger contribution to the grid during the 2020-21 peak demand than either Liddell (output 750MW) or Yallourn (output 1,300MW).

- Petroleum emissions are expected to reach around 125 Mt CO2-e in 2030. By contrast, electricity generation emissions are expected to fall to 111 Mt.

- On the basis of current policy settings, by 2030 petroleum emissions will be a considerably larger source of emissions in Australia than electricity generation.
- Transport accounts for 75% of total petroleum consumption with most of the rest coming from mining (14%) and agriculture (5%).

+ The four remaining oil refineries in Australia are old and relatively small. Altona was commissioned in 1949, Geelong in 1954, Kwinana in 1955 and Lytton in 1963. Although each has been upgraded and modified over the years, for most of their lives they have been oriented to producing more petrol than any other product. Two (Kwinana and Altona) are scheduled to close.

+ Geelong and Lytton oil refineries have recently reported heavy operating losses for 2020. Geelong, has indicated that it will depend on continuing government subsidy to remain open, while Lytton said that it is currently reviewing the future of the refinery. The capacity of these two refineries will only be sufficient to produce less than a quarter of the volume of petroleum products (which Australia consumed in 2018-19).

+ It is hard to see the logic of spending public money to maintain the operations of Geelong and Lytton given they are old, inefficient refineries that mainly produce petrol, which will be the first fuel to decline with the rise of electric vehicles.

+ The best way to increase Australia's energy security in the medium term would be to reduce consumption of petrol by rapidly switching to electric passenger vehicles, and focus on diesel and jet fuel supplies as the main energy security challenge.

Introduction

Welcome to the February- April 2021 bumper issue of the NEEA Report, presenting electricity related data updated to the end of March 2021, data on gas consumption to the end of February, and petroleum product consumption to the end of January. Details on data sources and methods are included in the appendix.

Overall trends in energy 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. Each updates the identical Figures in the last NEEA Report. Recall that the energy combustion emissions reported by the NEEA are about 80 % of total national energy combustion emissions. Emissions sources excluded are electricity generation and all other gas use in Western Australia and the Northern Territory, and coal use throughout Australia in all industries other than electricity generation. Electricity generation data is to the end of March 2021, gas to the end of February 2021 and petroleum to the end of January 2021.

Figure 1

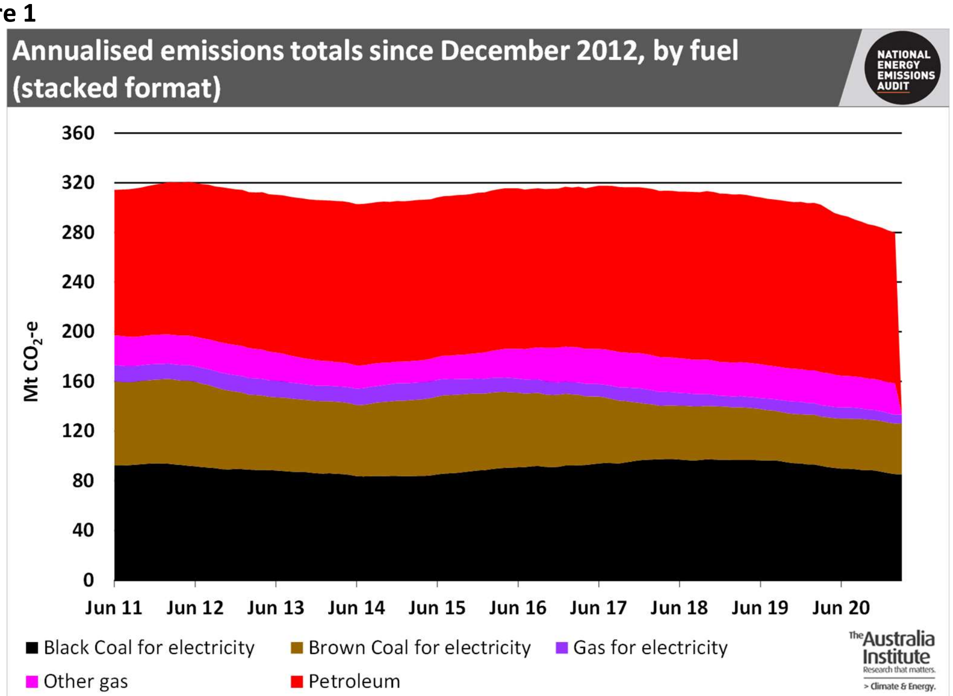


Figure 1 shows how the various sources contribute to total emissions, while Figure 2 shows each source separately. Figure 3 shows just the changes in emissions, making them much easier to see. Between the end of February 2020, just before lock-downs were introduced, and the end of January 2021, annual energy combustion emissions reported by NEEA fell by about 7.3 %. This fall is equivalent to about 22.3 Mt CO_2-e, of which about 12.8 Mt CO_2-e relate to emissions from the use of petroleum fuels. Most of the remaining 9.5 Mt CO_2-e to the ongoing fall in electricity generation emissions, as the NEM transitions away from coal and gas generation and towards wind and solar. The economic lock-down had a large impact on consumption of petroleum fuels for road and air transport, as described in previous NEEA Reports, but only a small effect on electricity consumption. The fall in moving annual electricity consumption, including rooftop solar, in the NEM states over the ten months February to December 2020 was only 0.9 %. The next section of this report looks in more detail at recent electricity consumption trends in four of the five NEM regions (excluding Victoria, for reasons explained below). It also includes the annual update of peak summer demand in each region, and the NEM as a whole. The report concludes with a more detailed look at consumption of petroleum fuels.

Figure 2

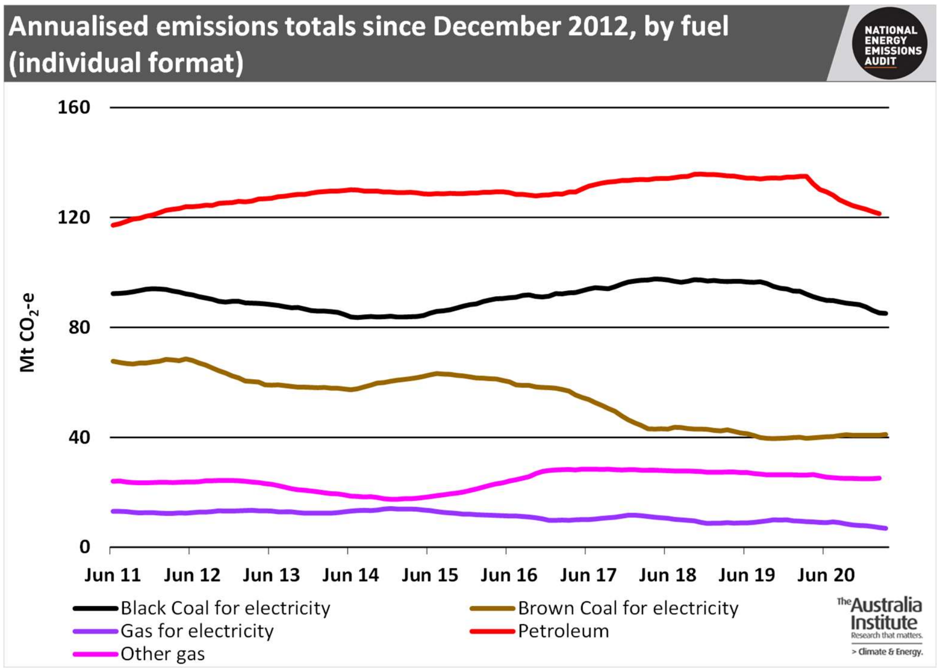
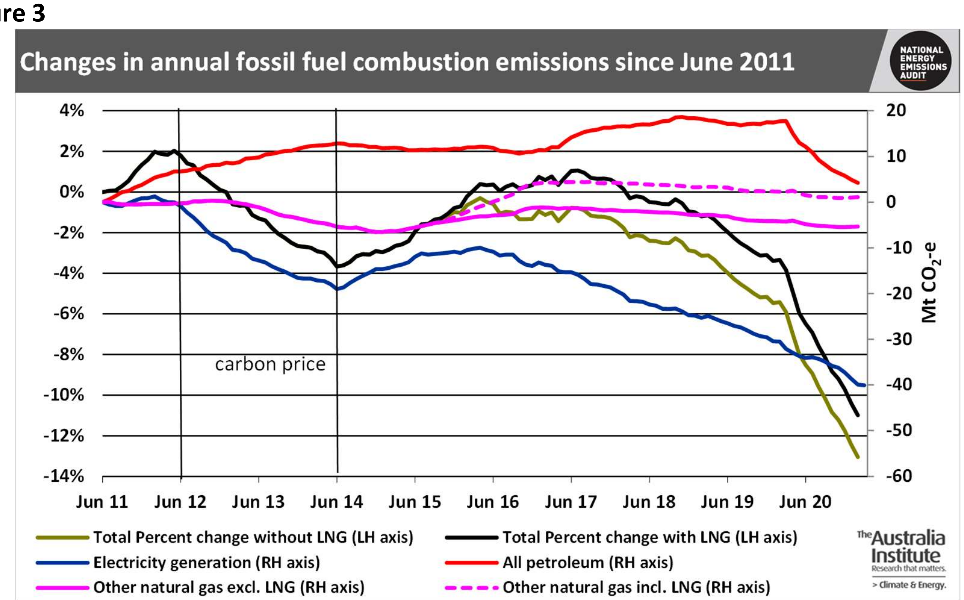


Figure 3



Electricity consumption during the economic lock-down

Every year the Australian Energy Regulator (AER) requires each of the thirteen electricity distributors (formally, Distribution Networks Service Providers – DNSPs) to make very detailed quantitative submissions on their activities using a highly prescriptive standard template. Because the templates are so detailed and so prescriptive, the data provided, almost all of which is made publicly available by the AER, constitutes a performance data set which is highly consistent over time. The AER usually publishes the submitted data four or five months after the end of the year to which the data relate. The five Victorian DNSPs submit on a calendar year basis, meaning that data for 2020 is unlikely to be available until May 2021. The nine DNSPs in the other four NEM states and the ACT submit on a financial year basis and all of their submissions for the year to June 2020 were published before the end of last December. Thus these submissions include within their annual totals the impact on electricity consumption of the first and most economically stressful three and a half months of the pandemic period. Finally, note that consumption is reported separately for residential and non-residential consumers (excluding the small number of very large industrial consumers, such as aluminium smelters, zinc smelters, and paper mills, which are supplied directly from the transmission grid).

If the economic lockdown had a significant impact on electricity consumption, this should show up as a fall in total consumption for the year 2019-20.

Figure 4

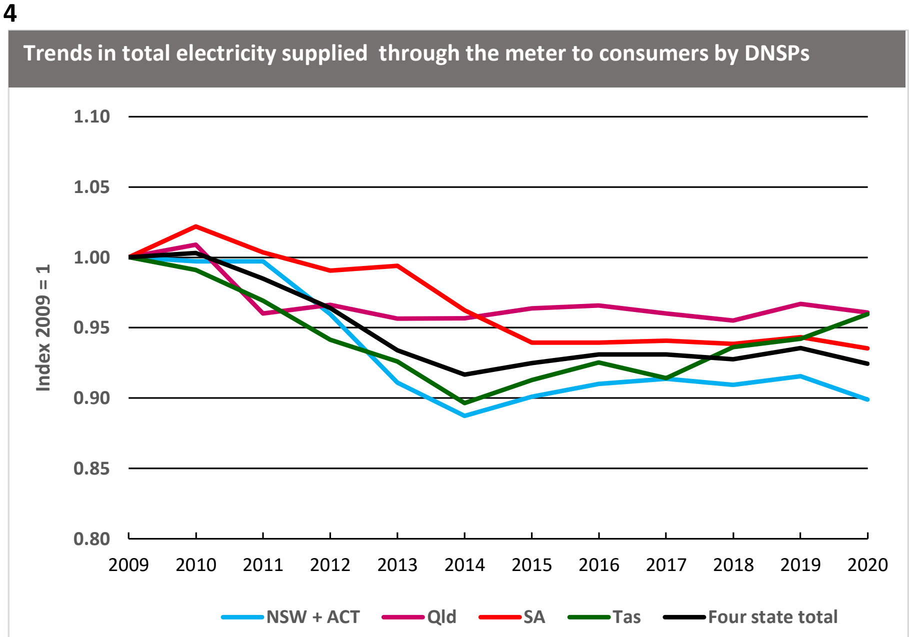
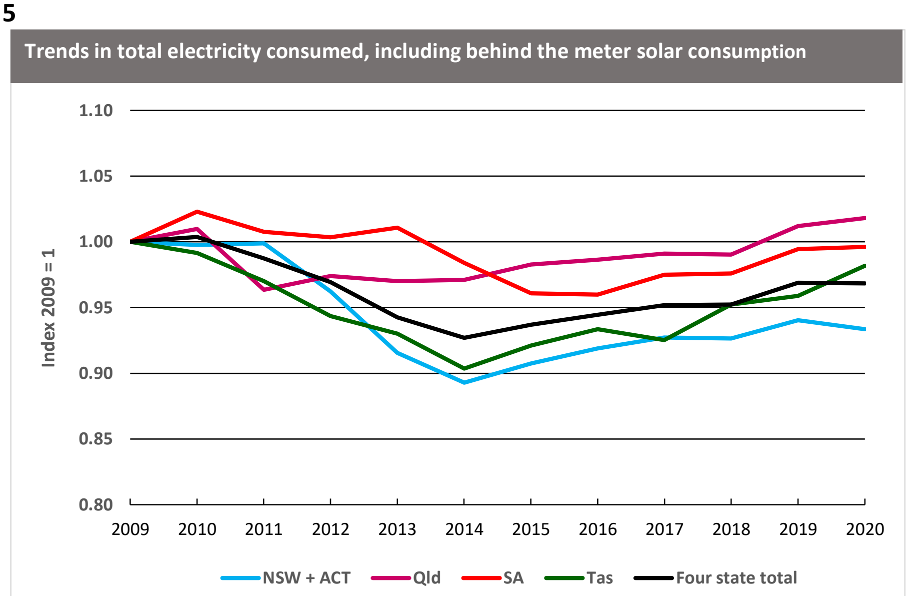


Figure 4 shows the trend in total electricity supplied by DNSPs to consumers in each of the four states each year, expressed as changes relative to a 2009 base year. It appears that in 2020 consumption was less than in 2019 in every state except Tasmania, and in the four states combined.

However, for many consumers, both residential and commercial, supply through the meter is not the only source of electricity consumed on the consumer's premises. A large and rapidly growing fraction of consumers have installed rooftop solar systems and also consume some of the electricity generated by these systems on-site, without energy leaving the premises. This is termed behind the meter consumption. It can be calculated as the difference between AEMO's estimates of total electricity generated each year by these rooftop systems and the quantity exported to the local DNSP, as reported by each DNSP to the AER

Figure 5 shows that if behind the meter consumption is added to supply through the meter, total electricity consumption in 2019-20 was slightly higher than in 2018-19, except in New South Wales. For the four states in total consumption was almost unchanged.

Figure 5



It follows that there is no evidence that in these states the economic lock-down and associated economic recession caused a significant drop in total electricity consumption. It would seem that many economic and business commentators, who continue to assert that Australia has experienced a fall in electricity consumption, are simply transferring the experience of Europe and the USA, giving no consideration to the actual evidence of what has happened in Australia.

There is, however, some evidence that a small shift in consumption may have occurred, from general business consumption to residential consumption. Previous issues of NEEA Report have speculated that this may have been occurring, because of the move to working at home. The trends seen in Figures 6 and 7 appear to be confirmation of such a shift. Some qualification is needed, because available data do not allow behind the meter consumption to be allocated between residential and non-residential consumers, and it is therefore not included in these Figures. That said, it seems likely that, as a total group, residential consumers currently consume more behind the meter than non-residential consumers. If correct, that would increase the observed shift from non-residential to residential consumption.

Figure 6

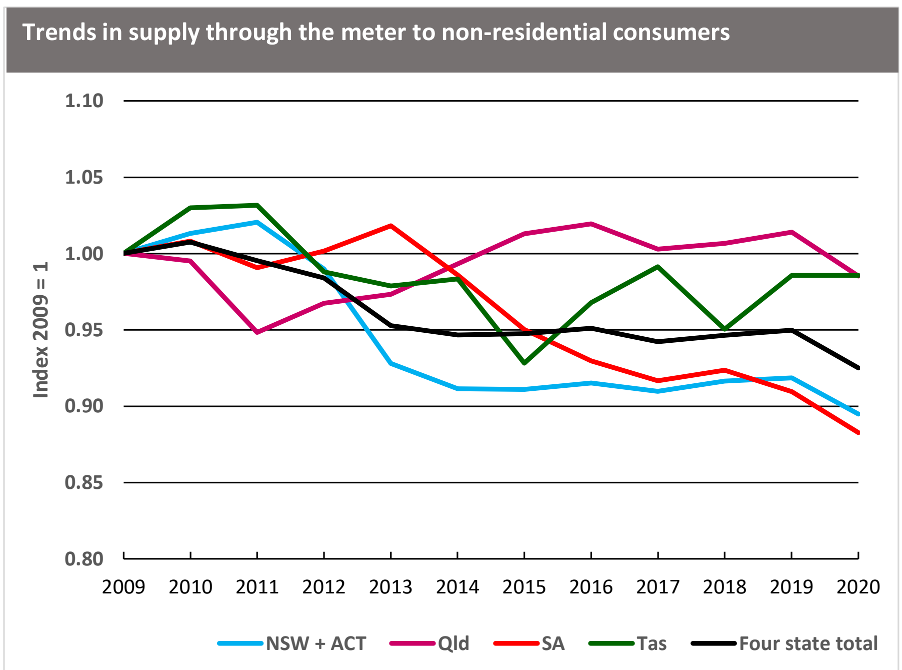
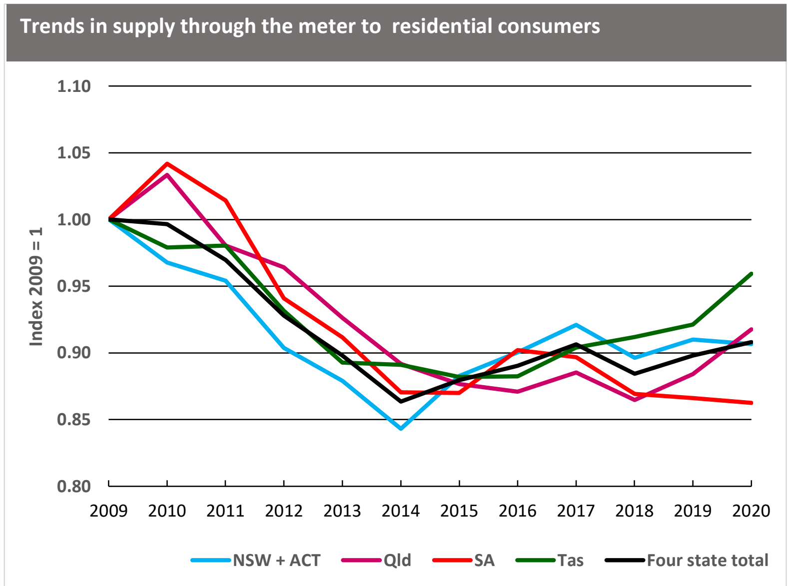


Figure 7



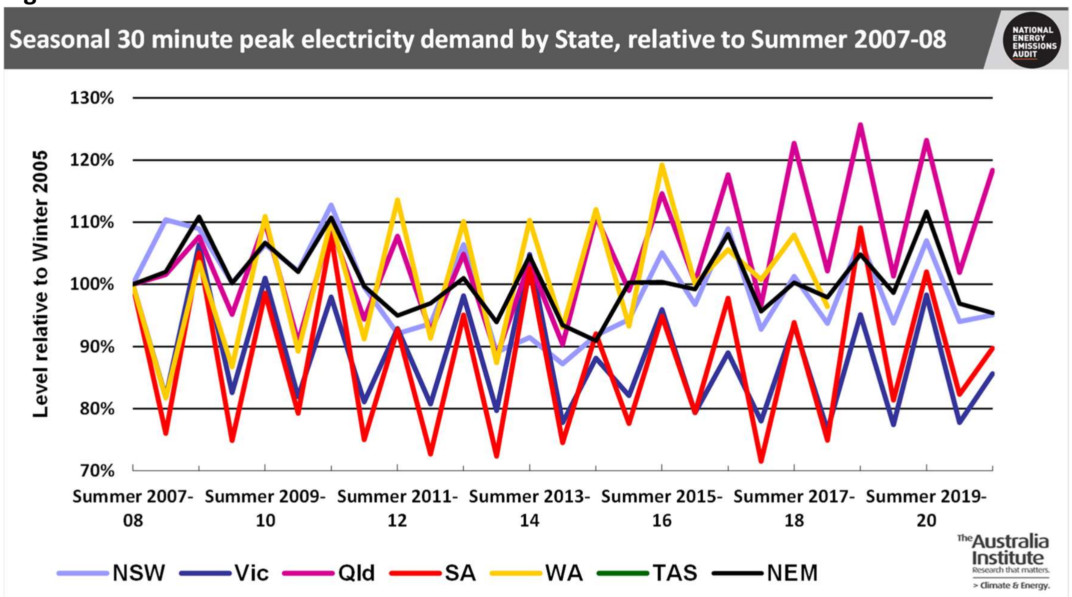
Peak demand and total electricity consumption, summer 2020-21

Every six months the NEEA Report updates the trends in seasonal peak demand and total seasonal consumption in the NEM. Summer is defined as the four months December to March, which are the months which always have higher peak demand and higher consumption then the immediately preceding (November) and following (April) months. (For the same reason, the winter months are defined as running from May to August inclusive.)

Figure 8 shows the trend in peak trading interval (average 30 minute) demand on the whole NEM grid, i.e. excluding the contribution of rooftop solar, and in each state (NEM region). (The dispatch interval (5 minute) demand was undoubtedly somewhat higher, but is not used by the NEEA Report.)

Interestingly, the NEM peak occurred on Sunday 24 January 2021. This was the hottest day of the summer in many parts of eastern Australia, but it is the first ever time that the summer peak has occurred on a Sunday. This was probably the consequence of two coincident factors: the “extra long weekend” effect of the following Monday being followed in turn by the Australia Day public holiday, and the additional effect of COVID on many businesses which would operate “normally” on the Monday. Monday was also extremely hot and was the peak demand day in both New South Wales and Victoria. (Peak demand in Queensland and South Australia was three and a half weeks later, in mid-February.

Figure 8

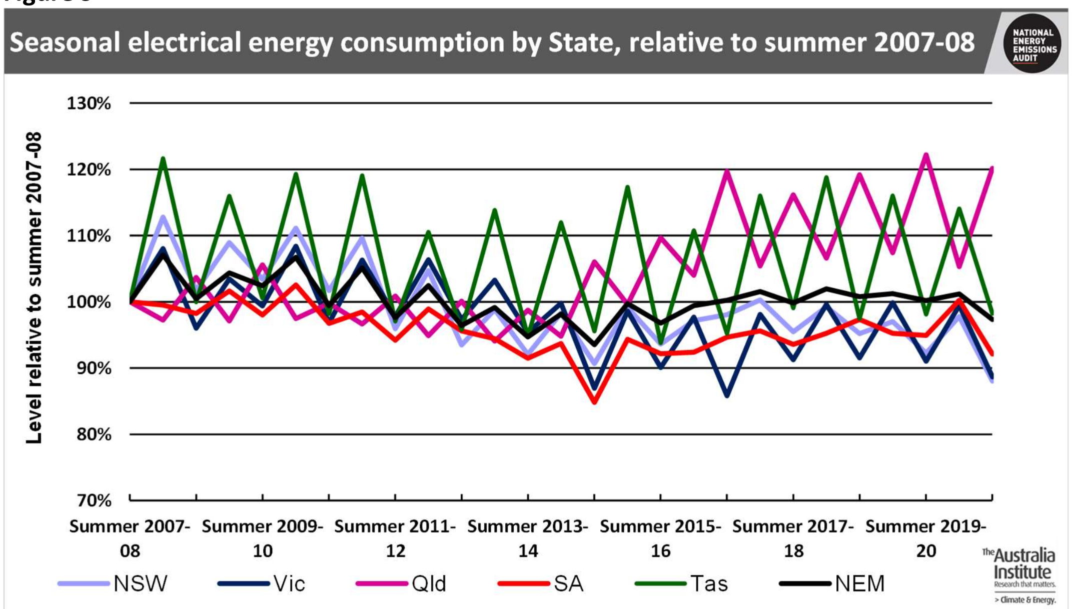


The lower level of the 2020-21 peak, relative to each of the previous five summers, is undoubtedly mainly caused by growing supply from rooftop solar. The summer 2020-21 NEM demand peak shown in Figure 8 occurred in the 18.30 NEM trading interval, meaning the trading interval ending at 18.30 Eastern Standard Time, i.e. 7.30 pm in New South Wales and Victoria, 6.30 in Queensland and 7.00 in South Australia. Peak demand including the contribution of rooftop solar occurred three hours earlier, in the 15.30 trading interval, and was 1,756 MW, equivalent to nearly 6 per cent, higher. At that time, output from Liddell was only about 750 MW, and output from Yallourn W only about 1,300 MW. Rooftop solar was thus making a larger contribution than either of these coal fuelled power stations to meeting peak demand on that day in the NEM.

Figure 9 shows the trend in total electrical energy consumed in the NEM over the whole summer, including the energy supplied by rooftop solar. It is interesting to note that Queensland is the only state in which both peak demand and maximum energy consumption always occur in summer. That also sometimes occurs in South Australia, but in New South Wales and Victoria, while peak demand occurs in summer, total energy consumption is consistently higher over the winter months. In Tasmania, both peak demand and total energy consumption are higher in winter. The overall outcome of this variation between states for the NEM as a whole is a much lower difference between winter and summer consumption than in any of the five NEM regions individually.

It can be seen that total energy consumption was the lowest for six years in South Australia, for five years in the NEM as a whole, for four years in New South Wales, Victoria and Tasmania, but in Queensland summer consumption was the second highest on record, after summer 2019-20. Detailed analysis, which AEMO and the various electricity supply industry participants are undoubtedly undertaking, would be required to determine the relative contributions to these outcomes of milder summer weather, changing electricity consumption behaviour, or other factors.

Figure 9



Trends in consumption of petroleum fuels

As the NEEA Report has previously shown, petroleum fuels have been the source of by far the largest impact of the pandemic lock-down on energy consumption and emissions. Figure 8 shows that by the end of December 2020 this impact had almost completely disappeared, though there will be a permanent legacy in the form of lower total emissions, as seen in Figures 1 to 3 above. Moving annual petroleum fuel emissions will continue to fall until at least March 2021, since April 2020 was the first month in which sales of petroleum fuels recorded a dramatic fall.

Figure 8

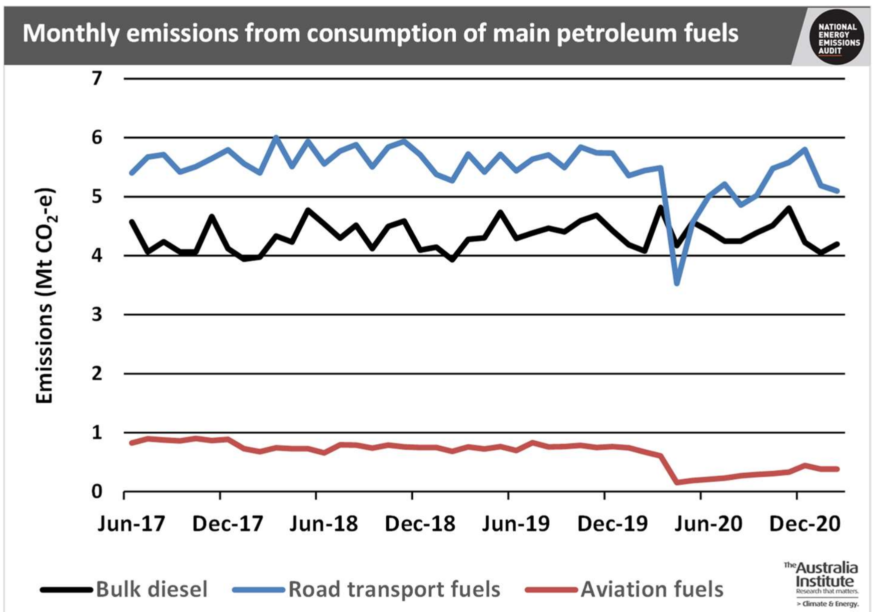
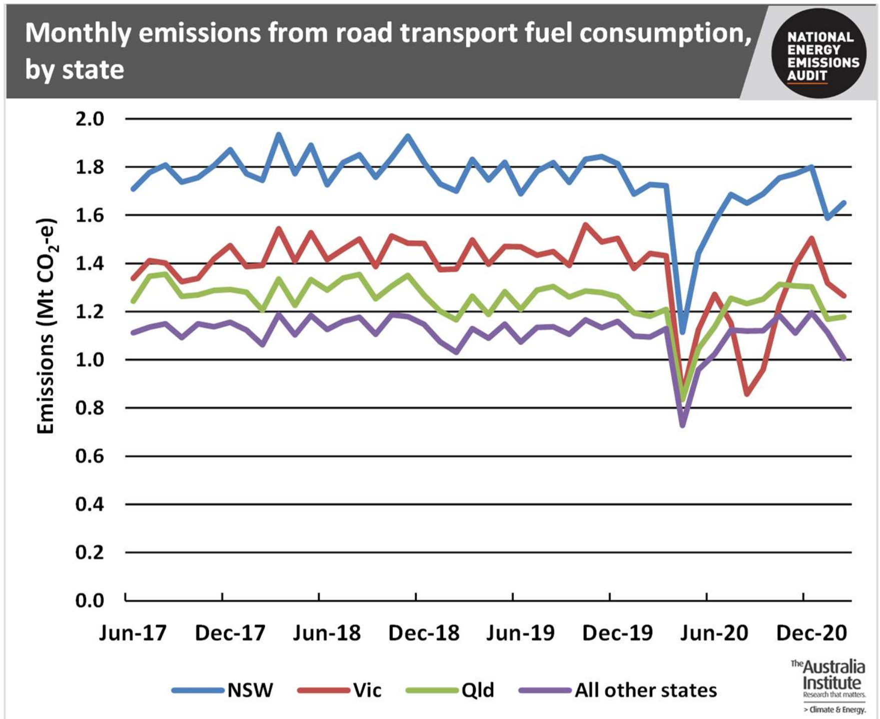


Figure 8 also shows that the impact on petroleum consumption was almost entirely confined to road transport and aviation fuels. For the purpose of this graph, road transport fuels are defined as the total consumption of petrol, auto LPG, and diesel sold through retail outlets. A significant share of diesel sold in bulk is also used for road transport, mostly for heavy freight vehicles and buses, but bulk diesel also includes fuel used in agriculture, mining, manufacturing and electricity generation. The data suggest that these sources of energy consumption were almost completely unaffected by the economic lock-down.

Figure 9 shows road transport fuels, as defined above, by state. It shows that consumption appears to have largely recovered from the heaviest impact of the lockdowns, but may not fully return to pre-lockdown levels, at least for some time. It also shows very clearly the effect of the second lockdown, in August and September, in Victoria.

Figure 8



Looking beyond the events of the past twelve months, it seems certain that the official view of the government, as expressed in *Australia's emissions projections 2020*, which was released last December, is that consumption of petroleum fuels, and associated emissions will soon return to their pre-2020 levels, as seen in Figures 2 and 3 above. Specifically, transport emissions are expected to increase gradually up to 2026, reaching a maximum level of just over 101 Mt CO_2-e, which is just slightly higher than the level in 2019. From 2026 to 2030, transport emissions are expected to fall by just 1.3%.

The key relationship between transport and petroleum emissions is that, as reported in *Australian Energy Statistics* for 2018-19 (the most recent available), transport (excluding international aviation and shipping) accounted for 75% of total petroleum consumption, measured in energy units. Most of the remaining petroleum consumption was in mining (14%), agriculture (5%), and (mainly remote area) electricity generation (3%).

The results published in *Australia's emissions projections 2020* show that fuel consumption and emissions from both mining and agriculture are expected, like transport, to continue gradually increasing, or at best not decreasing, out to 2030. Combining data from these two official publications, we have estimated that petroleum emissions are expected to reach around 125 Mt CO_2-e in 2030. By contrast, electricity generation emissions, including not only emissions in the NEM but also all of Australia's smaller grids and isolated remote area generation are expected to fall to 111 Mt. In other words, on the basis of current policy settings, by 2030 petroleum emissions will be a considerably larger source of emissions in Australia than electricity generation.

If Australia were serious about reducing greenhouse gas emissions, high priority would be given to developing and implementing policies for replacing transport powered by petroleum fuelled internal combustion engines with low emission alternatives. Of course no such policy exists or is being considered. Last September the government released with considerable fanfare its first *Low Emissions Technology Statement*. Only once, on p. 27, does the document mention "technologies in the transport sector …. Including battery, hybrid and plug-in hybrid electric vehicles and more efficient internal combustion engine vehicles". For these technologies "the Government will continue to monitor international developments and ensure Australian households and businesses are able to exercise consumer choice and adopt the latest technologies where it makes sense for them to do so".

This document was followed up, in February 2021, with its *Future fuels strategy discussion paper*. This much criticised document proposes almost no expenditure of public funds, other than a $74.5 million Future Fuels Package, which, it says, "will help businesses and regional communities to take advantage of opportunities offered by hydrogen, electric, and bio-fuelled vehicles". There will also be some modest investments through the CEFC in refuelling infrastructure and some modest electric vehicle trials.

By contrast, with these lacklustre efforts to reduce petroleum emissions, the government is spending larger sums to support Australia's continuing dependence on petroleum fuels. In April 2020, it announced that it would spend $94 million to buy and store crude oil in the USA for 10 years. However, as a May 2020 Parliamentary Library briefing paper, entitled *Liquid fuel security: a quick guide–May 2020 updated May 2021*, points out, "The extent to which it assists Australia's physical or strategic oil reserve is less clear, considering the time delay and shipping requirements to bring such stock to Australia as well as the challenges in refining it once here."

Such a realisation was perhaps behind the government's December 2020 announcement that it would subsidise the continuing operation of oil refineries in Australia with so-called production payments at a rate of 1 cent per litre of petrol, jet fuel or diesel produced. The announcement states that the cost of the first six months alone will be $83.5 million.

Notwithstanding this largesse, two of Australia's four remaining oil refineries will soon be closing. In October 2020 BP announced that it would close its Kwinana refinery, in Western Australia, currently Australia's largest, and in February 2021 Exxon Mobil announced that it would close its considerably smaller Altona refinery, in Melbourne. When these closures are completed Australia will have just two refineries, one at Geelong and one at Lytton, in Brisbane. All four of these refineries are both very old and very small by current international standards. Altona was commissioned in 1949, Geelong in 1954, Kwinana in 1955 and Lytton in 1963. Although each has been upgraded and modified over the years, for most of their lives they have been oriented to producing more petrol than any other product.

As NEEA Reports have been documenting for some years, Australian petroleum consumption is moving away from petrol and towards much higher shares of the heavier middle distillate products diesel and jet fuel, and this has made it even more difficult for Australian refineries to be competitive with large modern refineries in Singapore, Korea and Japan.

Unsurprisingly, both the Geelong and Lytton refineries have recently reported heavy operating losses for 2020. Viva Energy, the company which owns Geelong, has indicated that it will depend on continuing government subsidy to remain open, while Ampol (formerly Caltex Australia) has said that it is currently reviewing the future of the refinery. The capacity of these two refineries will be sufficient to produce less than a quarter of the volume of petroleum products which Australia consumed in 2018-19. In that year, Australia imported almost 60% of the petroleum fuels it consumed as refined products, and imported most of the rest as crude oil to be refined in Australian refineries.

Domestic production of crude oil and condensate accounted for only a few per cent of input to Australian refineries. The chemical composition of most Australian produced crude oil is not well matched to the configuration of Australian refineries, meaning that the bulk of production, equivalent to about 30% of Australian consumption, is exported. In 2018-19 the four domestic refineries supplied only 30% of diesel consumption and 38% of jet fuel consumption but 60% of petrol consumption.

Very obvious security challenges are presented by the combination of extreme import dependence with the essential role of petroleum fuels in fuelling transport and other services. The crude oil stockpile purchase and refinery subsidy payments, together with $211 million in competitive grants to pay for the construction of additional onshore storage for diesel fuel, are major components of the government's response to the April 2019 *Liquid Fuel Security Review* interim report.   (No final report has been released.)

Even without the foreshadowed closures, the continuing consumption shift away from petrol and towards diesel will steadily increase Australia's import dependence. For practical purposes, all petrol is used by either passenger or light commercial motor vehicles. These are the categories of petroleum consumption which can most readily be displaced by electric vehicles. It is hard to see the logic of spending public money to subsidise old, inefficient refineries to continue producing mainly petrol. A much better option would be to spend any public funds available to support accelerated adoption of electric vehicles, as many other countries are now doing. Such public expenditure would both increase energy security, by reducing import dependence, and also reduce greenhouse emissions from consumption of petroleum fuels.

It is an indictment of both the *Technology Investment Roadmap* report and the subsequent *Future Fuels Strategy Discussion Paper* that neither document makes a distinction between technologies to replace petrol and technologies to replace diesel and jet fuel. Electric vehicles are a rapidly maturing and widely available technology, which are a direct (and in many ways superior) replacement for petrol fuelled (and also diesel fuelled) passenger vehicles. They are a technology to encourage and support, not a technology on which to merely keep a "watching brief", let alone a technology to denigrate and ridicule, as the Prime Minister did so publicly during the election campaign less than two years ago.

By contrast, technical alternatives for large diesel engines used in road freight vehicles, railway locomotives, and mobile equipment used in mining and agriculture, are much less mature. They are also, arguably, a much more important input to overall economic activity than private motor vehicles. The best way to increase Australia's energy security in the medium term would be to reduce consumption of petrol by rapidly switching to electric passenger vehicles, and focus on diesel and jet fuel supplies as the main energy security challenge. In the longer term, the most promising zero emissions options for heavy road vehicles seem likely to be either heavy duty electric propulsion or hydrogen made from renewable electricity.

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.