Australian National University

Australian National University Institute for Climate, Energy & Disaster Solutions

Australian Energy Emissions Monitor

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Australian Energy Emissions Monitor

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Key Points

- This time last year, fossil fuel combustion emissions in eastern Australia were rebounding, following the easing of pandemic lockdowns. Since August 2021, however, emissions have again been decreasing on an annualised basis, as consumption of petroleum fuels have not yet returned to their pre-pandemic levels.
- Annual emission reductions are entirely attributable to the growing share of renewable electricity generation, with emissions from gas, as well as from petroleum fuels, remaining constant. Reducing these emissions, which at the end of March this year accounted for just over half of total fossil fuel emissions in eastern Australia, is a huge policy challenge for the new government.
- Looking explicitly at the National Electricity Market, in the year to May 2022, grid scale renewable generation, including hydro, supplied 27.7% of total grid generation, while wind and solar farms alone supplied 19.2%. If rooftop solar generation is included, the respective shares become 17.5% for wind and solar farms, 25.1% for all grid renewable generation, and 34.2% for all renewable generation including rooftop solar.
- Also in the National Electricity Market, over the 12 months from May 2021 to May 2022, monthly median spot wholesale prices increased by over five times in Victoria and South Australia, six times in Tasmania and New South Wales, and seven times in Queensland. Average prices rose steadily for the whole period up to March 2021 and have increased drastically since then.
- The volume weighted average monthly availability of coal fired generators in the National Electricity Market averaged between 70% and 80% for most of the two years from January 2020 to January 2022, but this year has fallen from 79% in January to 65% in May.
- The increase in petrol and diesel prices is more recent. After adjusting for the excise reduction at the end of March, the increase in daily wholesale prices since the start of January to the end of May was about 54% for both petrol and diesel.
- Public subsidies to support the continuing operation of Australia's two remaining oil refineries can have no effect on fuel prices in Australia and does nothing for fuel security, since Australia depends on imports for more than 90% of its consumption of crude oil and petroleum products. Subsidising these refineries is an explicit obstacle to a transition towards a cleaner, more efficient and lower emission road transport system.

Introduction to the June 2022 issue

Welcome to the June 2022 issue of the *Australian Energy Emissions Monitor*, which is a bi-monthly publication of the ANU Institute for Climate, Energy and Disaster Solutions, providing timely analysis of the most recent trends in energy related greenhouse gas emissions. The publication is intended as a service to Australia's energy community.

This issue opens with an update of the summary information on progress in reducing fossil fuel emissions in Australia, which is provided with every issue. A change in this issue, following the detailed examination of Western Australia in the April issue, is that from now on the regular update will be confined to the five states of eastern Australia. Progress in Western Australia will be reviewed annually. This issue also includes the regular update on growth in renewable generation in the National Electricity Market (NEM).

The particular feature of this issue is provision of clear and up to date graphical data on some of the main aspects of the energy cost crisis currently engulfing Australia. As always, the aim is to provide accurate background information to the current policy debates. The information provided includes spot wholesale prices and availability of coal fired generators in the National Electricity Market, and wholesale petrol and diesel prices.

As always, more detailed information on which emissions are reported in each issue of the *Monitor* and which are not, and on data sources and methodology, are in the Appendix. The underlying data is provided in a separate online document alongside the report.

Hugh Saddler (author and analyst) and Frank Jotzo (Head of Energy, ICEDS)

Is Australia decarbonising its energy supply?

This issue of *AEEM* is, needless to say, the first since the change in government following the election on 21 May. The new government has been quite clear it intends to achieve more rapid reductions in Australia's greenhouse gas emissions than seemed likely prior to 21 May. Figure 1 shows moving annual energy combustion emissions in eastern Australia, meaning the five states plus the ACT. Figure 2 shows changes in emissions since June 2011. The logic of starting from June 2011 is that it was the last complete year before the introduction of the short-lived carbon price, affecting electricity and gas, but not consumption of petroleum fuels.

Figure 1: Moving annual energy combustion emissions, eastern Australia, 2011-21

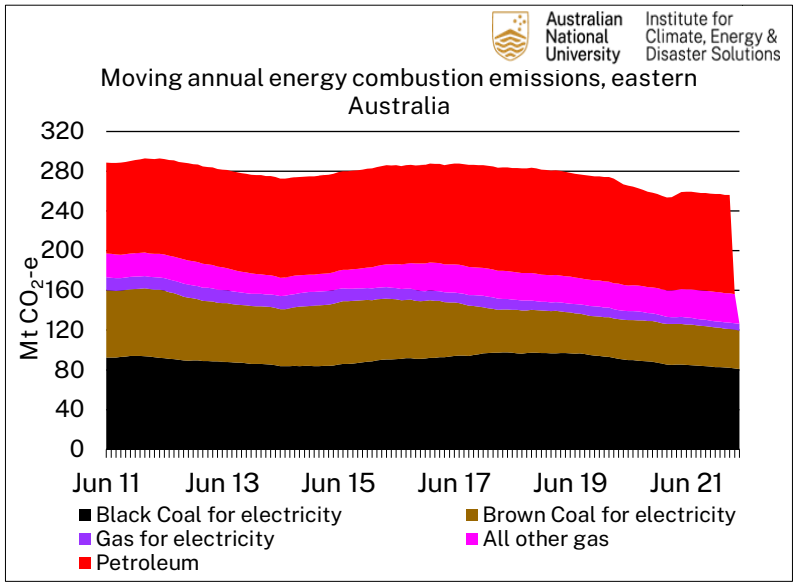
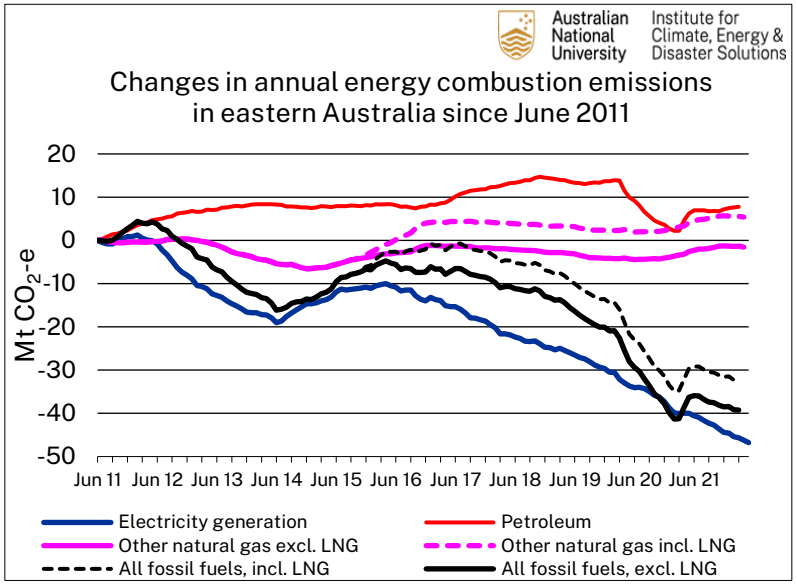


Figure 2: Changes in moving annual energy combustion emissions in eastern Australia since June 2011



As *AEEM* and its predecessors have been reporting for several years, until the onset of the pandemic, emissions from electricity generation were steadily decreasing, whereas emissions from use of petroleum products were actually increasing and emissions from gas consumption were fairly constant. The overall outcome has been that total fossil fuel combustion emissions in eastern Australia have fallen by only 4.9% over a period of more than eight and a half years.

These Figures have been included in almost every issue of the *AEEM*, and its predecessor publications, but until the last issue (April 2022), the petroleum emissions shown were those from the whole of Australia, including WA and the NT. The April 2022 issue looked in greater detail at energy combustion emissions in WA and showed that the factors driving fossil fuel combustion there differ in fundamental respects from those operating in eastern Australia. In the case of petroleum fuels, growth in consumption, and resultant emissions, was mainly driven by growing road transport consumption, whereas in WA

the main driver of consumption growth was consumption of diesel by the mining industry. In the case of electricity generation and gas emissions, the structure of both industries, and the policy frameworks within which they operate, differ markedly from corresponding structures and policy frameworks in eastern Australia. It therefore seems more sensible to look at eastern Australia as one overall energy system and WA as a completely different system. The last issue of *AEEM* looked at energy emissions in WA in some detail. Future issues will repeat this examination of WA at least once a year. Other issues will mainly focus on eastern Australia, which is the source of around 85% of Australia's electricity generation emissions and just under 80% of emissions from petroleum fuels. The share of gas consumption is somewhat lower, because of the enormous consumption of gas in WA, for both the production of LNG and also other energy intensive mineral processing activities.

The remainder of this issue will be concerned only with fossil fuel combustion emissions in eastern Australia.

Figure 2 shows that annual emissions from petroleum consumption remain lower than they were prior to the arrival of the pandemic in March 2020. This can also be seen in Figure 3, which shows total annual emissions.

Figure 3: Moving annual fossil fuel emissions

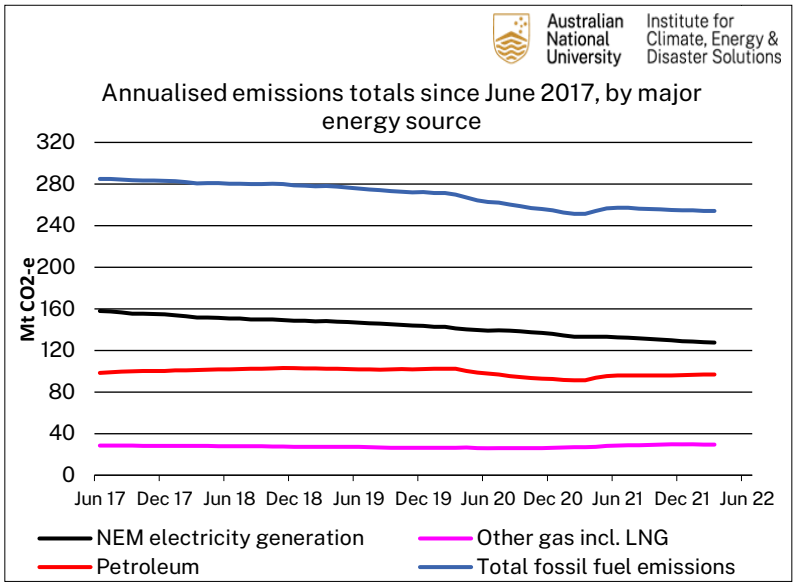
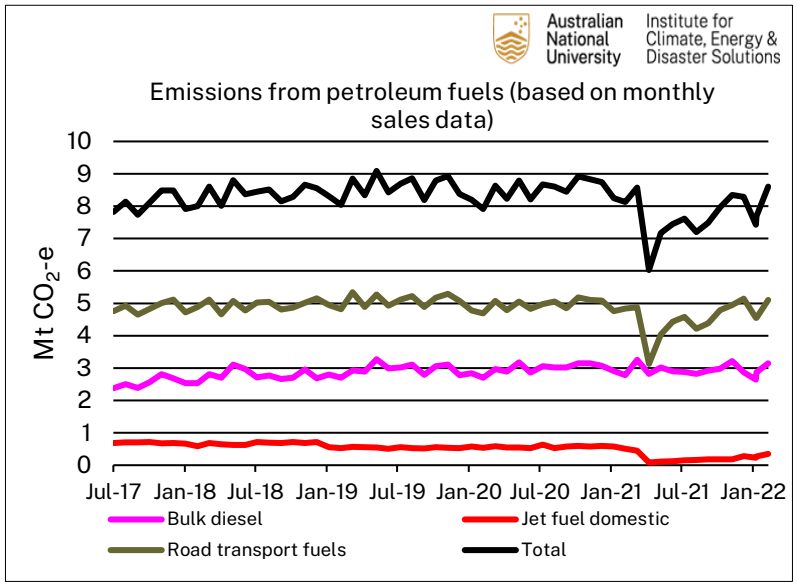


Figure 4 looks at the main components of petroleum product consumption month by month since 2016. This makes it much easier to see the impact of the pandemic on consumption of road transport fuels and on jet fuel used by domestic aviation. While the effect on road transport was larger in absolute terms, the effect on aviation fuel consumption was relatively larger, and consumption has yet to return to pre-pandemic levels. Consumption of bulk diesel, much of which is used by mining activities, and also by farming and construction, has been almost unaffected by the pandemic.

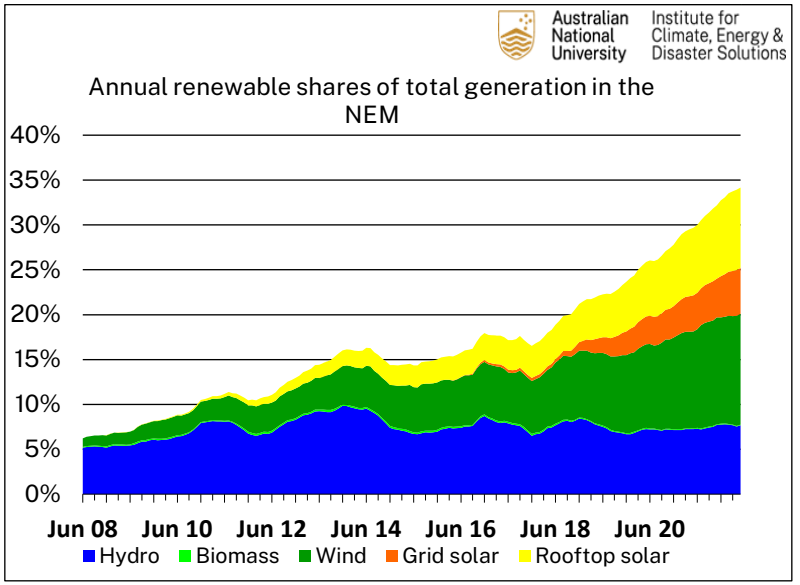
Figure 4: Emissions from petroleum fuels (based on monthly sales data)



Electricity system transition progress

This section provides a quick update, to the end of May 2022, of regular key graphs showing the transition of electricity in the NEM from fossil fuel to renewable generation. Figure 5 shows the moving annual shares of renewable generation in the NEM. In the year to May 2022, variable grid renewable generation, i.e. wind and grid solar, reached 19.2% of total sent out grid generation in the NEM, and all renewable grid generation, i.e. including hydro, reached 27.6%. When rooftop solar is included, the corresponding shares of all generation are 17.5% for grid wind and solar, 25.1% for all grid generation, including hydro, and 34.2% for all renewable generation. Figure 6 shows the same data, but expressed as individual month by month shares. The very large increase in hydro generation, right at the end of the graph in May 2022, is presumably an effect of the extremely high NEM spot prices now being experienced. While detailed analysis of trading interval (5 minute) data would be needed to understand precisely what has been happening, it is reasonable to assume that the owners of Australia's major hydro resources, i.e. Tasmanian Hydro and Snowy Hydro, are both taking advantage of the high prices and also, to some extent, helping to ameliorate possible extreme hydro prices at certain times.

Figure 5: Moving annual shares of renewable generation in the NEM, 2008-21



Finally, Figure 7 shows for each individual mainland NEM region (state) moving annual variable grid generation, i.e. wind plus grid solar, as a share of total grid generation in each state. These shares are an indicator of each state's progress towards a renewable grid. As the shares increase, the need for storage to cover supply during periods of low wind and/or solar generation, i.e. to ensure supply reliability, steadily increases, as does the need for investments to ensure grid security. These investments are likely to include new transmission capacity and deployment of grid forming inverters, a potentially very important new technology, at wind and solar farms.

Figure 6: Monthly shares of renewable generation in the NEM

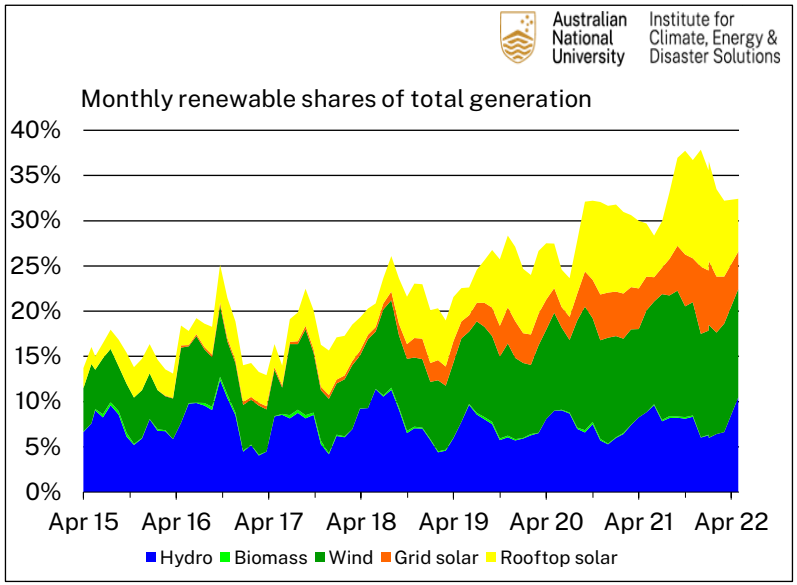
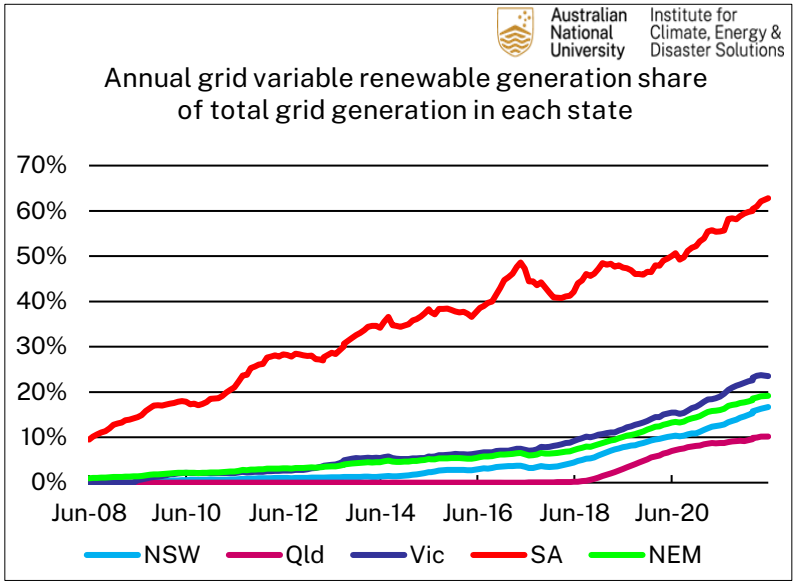


Figure 7: Moving annual shares of total grid generation being supplied by variable grid generation in each state.

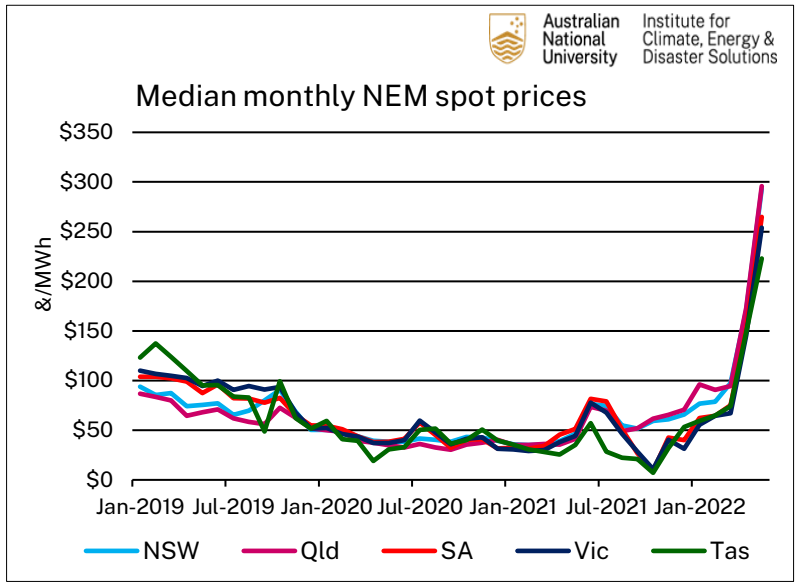


High energy prices: electricity and gas

As at the beginning of June, wholesale prices for electricity, gas and petroleum products are all at record or near record levels. The ultimate reason for these high prices is the reduced global supply of crude oil, natural gas and, to a lesser extent, coal, resulting from the embargoes on exports of these fossil fuels from Russia. However, in Australia, as in other affected countries, the effect on energy consumers depends on a number of additional factors, particular to each country.

Figure 8 shows spot wholesale electricity prices in the NEM over the past three and a half years. Averaging, by using the monthly median price, makes it easier to see the trend by minimising the impact of the data presented of occasional short-lived but extremely high prices.

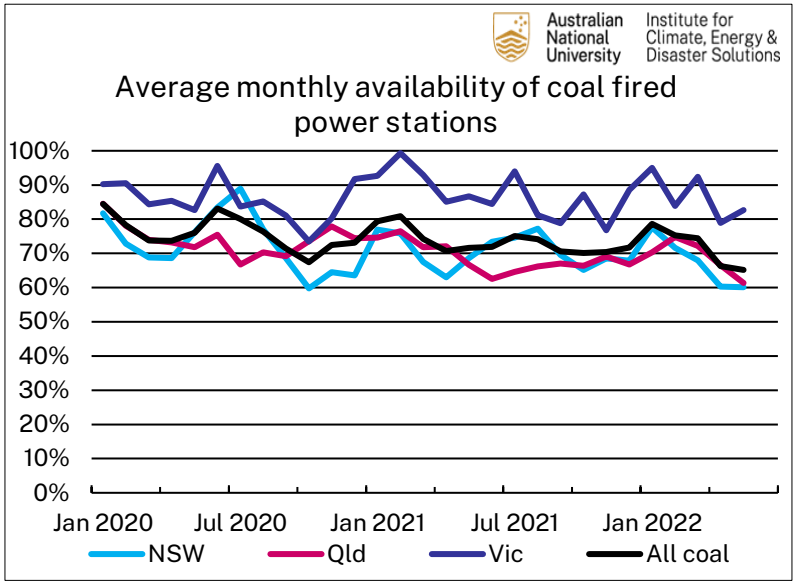
Figure 8: Median monthly spot prices in each NEM region (state)



The huge increase in spot prices during May is obvious. There are a number of factors which have caused this increase. One is the reduced availability of coal fired power stations, which continue to supply well over half the electricity consumed in the three largest state markets. This is shown in Figure 9, from which it can be seen that on average black coal power stations in New South Wales and Queensland have performed particularly badly. One factor contributing to low availability is that coal fired generator operators have always chosen to undertake scheduled maintenance during spring and autumn months when electricity demand is at its lowest annual levels. Another problem has been inability to obtain sufficient coal for fuel capacity operations; this has reportedly particularly affected Eraring and Mount Piper power stations in New South Wales.

The overall effect has been a general tightening of the balance between supply and demand at a time when the average contribution of solar generations is rapidly decreasing. Low availability of coal means that gas fired generators, although only a small contributor to total supply, are more frequently in the situation of being the marginal source of supply, thereby setting the spot price for the relevant trading period.

Figure 9: Average monthly availability of coal fired generators in the NEM



Obviously, there is no simple or short term solution to high price periods attributable to the unreliability of coal fired power stations. High gas prices are a different problem, and raise important but complex policy issues which are far beyond the scope of this *Monitor*. For example, was it a mistake not to accompany the approval of the Queensland LNG export projects with some form of domestic reservation policy, such as the policy in Western Australia described in the April *AEEM*? Should policy be more strongly directed towards encouraging residential and small business consumers to switch from gas to electric appliances, to reduce demand for gas?

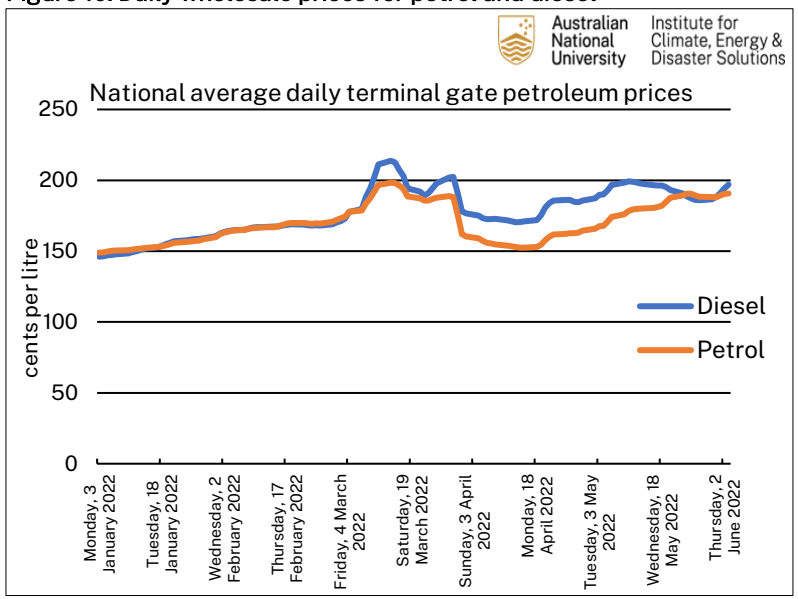
High energy prices: petroleum products

Turning to petroleum prices, Figure 10 shows daily wholesale prices for petrol and diesel in Australia since the beginning of January 2022. These prices include excise, and the graph clearly shows the impact on prices when excise was halved at the end of March. The national average is the volume weighted average of prices in Sydney, Melbourne, Brisbane, Adelaide, Perth, Hobart and Darwin, which are all almost identical.

Unlike electricity and gas, Australia is dependent on imports of either crude oil or petroleum products for the great majority (over 90%) of all petroleum consumption, meaning that prices in Australia are unavoidably closely tied to international prices. Clearly, the increase seen in Figure 10 is relatively smaller than the increase in electricity and gas prices. The reason is that the crude oil price, which is being directly affected by the war in Ukraine, is the largest, but not the only component of the retail price of petroleum products. Retail prices also include refining costs, shipping, retail margin and excise.

The terminal gate price is a price posted daily by each of the companies supplying wholesale petroleum fuels in Australia; these companies include the two remaining refiners plus a number of businesses which import petroleum products in bulk. The prices typically apply to a full road tanker load, for collection at the gate of a refinery or seaboard bulk terminal. These prices function as a maximum cap on wholesale prices. They are based on the daily ex-refinery price in Singapore plus shipping and Australian excise. Singapore is a major oil refining centre supplying east and South East Asia and the Pacific. Singapore prices are used very widely as a reference for petroleum product prices throughout this part of the world. At times when supplies are abundant, suppliers can of course offer lower prices to either retailers (the majority of which are, however, linked to one of the four wholesale suppliers), or to large bulk consumers. Now is of course not a time of abundant supply, meaning that the terminal gate price is the price underlying most if not all retail prices

Figure 10: Daily wholesale prices for petrol and diesel



Higher product prices largely reflect higher underlying crude oil prices. Product prices in Australia have for many years, indeed decades, been referenced to Singapore prices, including when wholesale petroleum product prices were set by the predecessor of the ACCC. Australian oil refineries, of which there are now only two still operating, are older, smaller and less efficient than more modern refineries in Singapore and in many other Asian countries, including Korea and Taiwan. That was also the case for the six refineries which have closed over the past two decades because they were unable to compete with the price of imported products.

Continuing operation of the two remaining refineries depends on subsidies from the Commonwealth, introduced last year by the previous Government, through the Fuel Security Act 2021. As its title indicates, the supposed reason for this legislation was to enhance the

security of Australia's supply of petroleum products. It cannot and will not reduce the price consumers pay for petrol and diesel because. As explained above, these prices are set by reference to international prices.

The subsidy to refiners is paid quarterly on the basis of petrol, diesel and jet fuel produced during the preceding quarter. The first payment, for Q1 2021-22, was $12,445,666, shared by the two refineries. It is hard to see how these payments, which under the legislation as it stands will be paid until the end of 2026-27, provide public value for money. In the year 2020-21, imports of major petroleum products accounted for 67% of total sales of these products. In addition, imports of crude oil and other refinery feedstock accounted for 64% of the inputs to refineries. Overall this means that Australia depends on imports for about 90% of its consumption of petroleum products. It is hard to see the security justification for providing public subsidies to support businesses which can supply only about one tenth of Australia's current consumption of petroleum products.

In the meanwhile, the owners of these two refineries have long argued that they cannot afford the capital investment needed for the upgrades needed to reduce the sulphur content of the fuels they produce. The previous government supported these companies by consistently opposing demands that Australia impose a requirement for petroleum fuels sold in Australia to meet the same minimum quality standards that apply in all European countries and most other OECD member countries, including the USA, Canada and Japan.

This refusal has and is continuing to have a negative impact on both air quality in Australian cities and on Australia's greenhouse gas emissions, because internal combustion engines which can use low sulphur fuels are more efficient, and therefore emit fewer emissions per tonne kilometre travelled. What is perhaps even worse is that global vehicle manufacturers have little interest in supplying electric vehicles to Australia because the economic incentives for consumers to switch to low emission vehicles are much weaker than in other high income counties. What this means over that the policies of the previous government are, by actively propping up old, inefficient oil refineries, explicitly inhibiting the transition to a cleaner and more self-reliant transport energy system.

In other words, the transport energy policy mess is at least as bad as, and probably worse, than the electricity industry policy mess.

Appendix: Notes on methodology and data sources

Data on electricity generation and electricity consumption is for the five states constituting the National Electricity Market (NEM) only, i.e. data exclude Western Australia and the Northern Territory. All data are monthly totals, sourced from AEMO, accessed through NEM-Review. Data on gas consumption are also for the five eastern states only; sourced from the Australian Energy Regulator's weekly *Gas Market Report*. The main source of petroleum consumption data is monthly sales of petroleum products, compiled by the Department of Industry, Science, Energy and Resources and published as *Australian Petroleum Statistics*. Unlike the sources used for electricity and gas data, petroleum data covers the whole of Australia at the state level. The emission factors used for petroleum products and gas are based on *National Greenhouse Accounts Factors* and, in the case of petroleum products, are CO_2-emission factors only, because the (much smaller) emission factors for methane and nitrous oxide depend on the type of equipment in which the petroleum products are used.

Many of the graphs in *Australian Energy Emissions Monitor* are presented as moving annual totals. This approach removes the impact of seasonal changes on the reported data. Annualised data reported in *Australian Energy Emissions Monitor* 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. Both demand and generation, as shown in the *Monitor* 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. Large users include the three pumped hydro schemes in the NEM, but since these both consume and generate electricity, net consumption, averaged over time, is only the difference between consumption and generation, termed round-trip losses.

Generation is defined to include only electricity supplied by large generators connected to the transmission grid. The numbers reported by AEMO are "as generated" generation, meaning the generation required to supply total demand, including auxiliary loads. However, most of the analysis and results presented in the *Monitor* show sent out generation, meaning as generated generation, minus auxiliary loads. To estimate auxiliary loads, the *Monitor* uses auxiliary load factors for each power station, published by AEMO and used in all its modelling work, including the modelling supporting the Integrated System Plan. Similarly, the Monitor uses AEMO figures for the emissions intensity (emissions per unit generated) of each power station.

Demand 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. This has been growing very rapidly and in the year to December 2021 totalled over 16 TWh. Also excluded is generation from landfill and sewage gas plants, and

various other small generators, totalling about 2 TWh. All these types of small generators supply into their local distribution network, not the NEM grid. 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.