Australian Government

Department of Climate Change, Energy, the Environment and Water

Australian Energy Update 2023

September 2023

Acknowledgements

The authors would like to express their appreciation for the assistance and support provided by colleagues in the Department of Industry, Science and Resources, the Clean Energy Regulator, the Bureau of Infrastructure and Transport Research Economics, and the Australian Bureau of Statistics.

The Department acknowledges the traditional owners of country throughout Australia and their continuing connection to land, sea and community. We pay our respects to them and their cultures and to their elders both past and present.

Copyright and disclaimer

Content contained herein should be attributed as Australian Energy Update 2023, Australian Government Department of Climate Change, Energy, the Environment and Water, September, Canberra.

Cover image: Aerial view above Royalla Solar Farm near Canberra, ACT, Australia. Steve Tritton / Shutterstock.

Foreword

The way we supply and use energy in Australia continues to transform, and at an increasing rate. This includes transformational changes in the type of energy we use, how we use it and where it comes from. Change comes as new technologies are adopted and renewable energy supply grows, as our economy changes, and as awareness of our energy use and its economic cost and impact on the climate grows.

We need timely, accurate, comprehensive, comparable and readily accessible energy statistics to help understand these and other changes. We need this understanding to plan for Australia's energy future, and to make sound policy and investment decisions, including action to address global climate change.

The *Australian Energy Statistics* is the authoritative and official source of energy statistics for Australia to support decision making and international reporting, and to help understand how our energy supply and use is changing. It is updated each year and consists of detailed historical energy consumption, production and trade statistics and balances. It includes all types of energy and all parts of the economy.

This edition contains data to financial year 2021–22 for Australian energy consumption, production and trade, and calendar year 2022 for electricity generation. This report, the full dataset, and a guide are available online. Release of the 2024 edition, containing data for financial year 2022–23, is expected in September 2024. An intervening release of updated electricity generation data is expected in the first half of 2024.

Australia's energy consumption fell in 2021–22, for a third successive year. Energy use in electricity supply decreased as coal generation fell below half of total generation. With the easing of COVD-19 restrictions across the period and more hot and cold weather, residential, commercial and air transport energy use all increased, though passenger road transport activity fell again.

2021–22 was a record year for Australia's clean energy supply and renewable generation increased 19 per cent, accounting for 31 per cent of Australia's electricity generation. Solar electricity generation grew 25 per cent in the 2021–22 year and is 14 times higher than a decade ago.

For more information or to provide feedback regarding the *Australian Energy Statistics*, please contact energy.statistics@dcceew.gov.au.

Energy Statistics and Analysis Section
National Energy Transformation Division
Department of Climate Change, Energy, the Environment and Water
September 2023

Contents

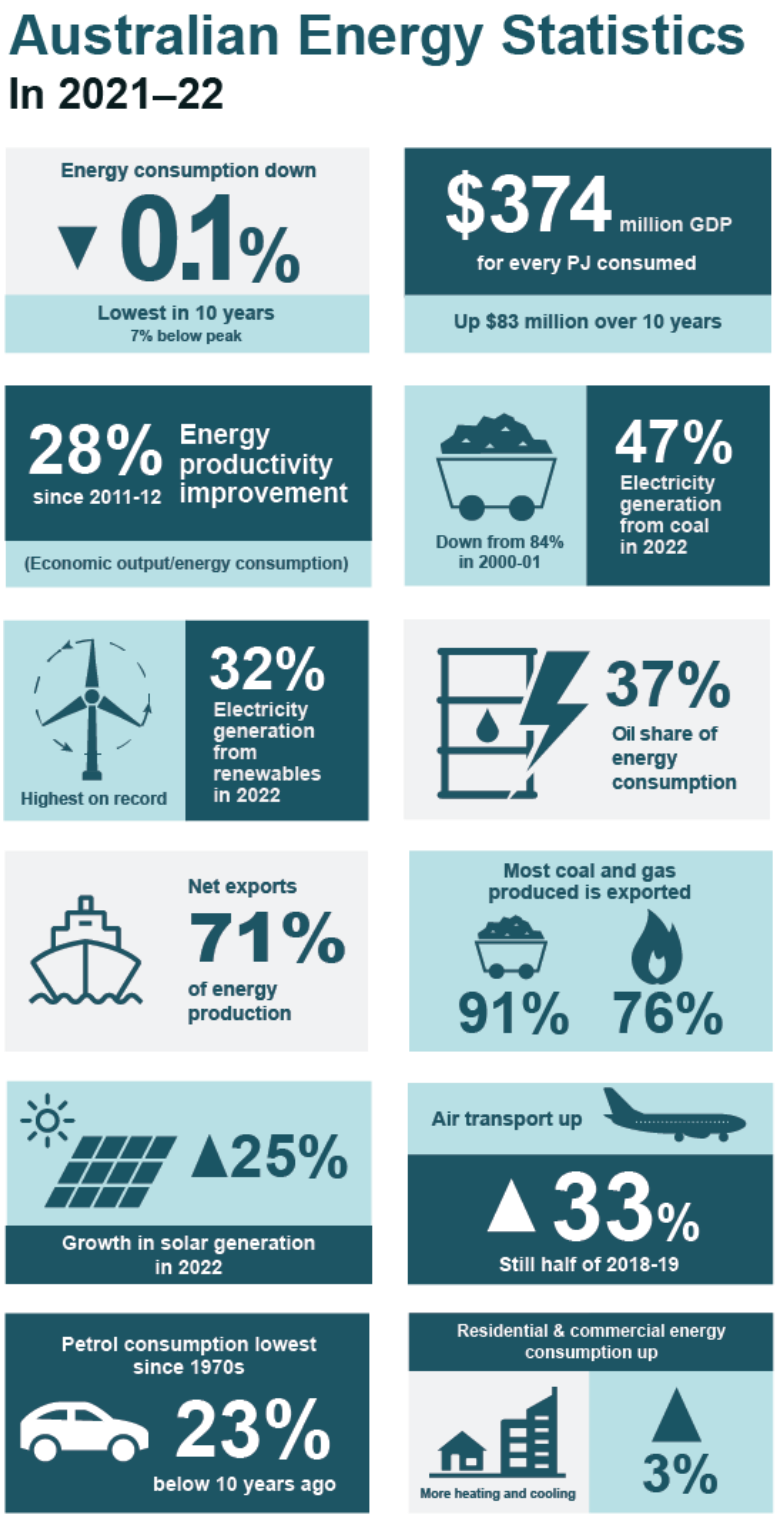
Figures

Tables

Abbreviations and acronyms

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
AEMO	Australian Energy Market Operator
AES	Australian Energy Statistics
APS	Australian Petroleum Statistics
BITRE	Bureau of Infrastructure and Transport Research Economics
BREE	Bureau of Resources and Energy Economics (former)
COVID-19	Coronavirus disease 2019
CSG	Coal seam gas
DISR	Department of Industry, Science and Resources
DCCEEW	Department of Climate Change, Energy, the Environment and Water
GJ	Gigajoule (10^9 joules)
GWh	Gigawatt hours
GDP	Gross domestic product
IEA	International Energy Agency
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
NGERS	National Greenhouse and Energy Reporting Scheme
NGL	Natural gas liquids
ORF	Other refinery feedstock
OCE	Office of the Chief Economist
PJ	Petajoule (10^{15} joules)
PV	Photovoltaic

Executive summary



- Australia's energy consumption fell slightly in 2021–22, a third successive decline
- Over two-thirds Australian energy production is exported, including most coal and gas
- Renewable electricity generation at record levels, almost one third of all electricity
- Transport energy use increased with air transport recovery, road use still down
- The imported share of refined petroleum product consumption rose to record levels

Energy consumption

- The Australian economy grew 3.6 per cent in 2021–22 to $2.2 trillion. Population grew 1.2 per cent to reach 26.0 million people.
- Australia's energy consumption fell slightly, 0.1 per cent in 2021–22 to 5,762 petajoules, the third successive year of decreased total energy consumption. After record declines the previous two years, energy consumption is 7 per cent below the all-time peak of 6,188 petajoules reached in 2018-19.
- The drop in energy consumption from three years ago has been 426 petajoules: the same amount of energy obtained from filling a 55-litre tank of petrol 227 million times.
- Energy productivity is on the rise. Energy productivity, as measured by gross domestic product (GDP) divided by energy consumption, improved 3.7 per cent in 2021–22 and 28 per cent over the past ten years. Australia now creates $374 million in GDP for every petajoule of energy consumed, 22 per cent more than a decade ago.
- The largest reduction in energy use in 2021–22 occurred in the electricity supply sector, which reduced 3 per cent, as increased renewables generation reduced the consumption of fossil fuels in the sector. Consumption in the electricity sector refers to fuel inputs, network losses and own-consumption of electricity.
- Total final energy consumption, or total demand by end users, increased 1 per cent. Higher final consumption of renewable electricity more than covered this increase in total final consumption in 2021–22.
- The largest increase in energy consumption was in the transport sector, which grew 2 per cent as air transport activity increased by one-third, offsetting lower road transport activity, including the lowest level of petrol consumption since the 1970s.
- Energy consumption in the electricity supply sector, and in transport, were each about 25 per cent of all energy use. Manufacturing was 18 per cent of use, and mining 15 per cent.
- Energy use grew 3 per cent in the commercial and services sector and the residential sector, mostly due to increased electricity demand for heating and cooling.
- Manufacturing sector energy use decreased 1 per cent, driven by reduced alumina and aluminium production and lower chemicals manufacturing activity.
- Coal consumption fell 4 per cent in 2021–22, in line with the continued long-term decline in coal-fired electricity generation, which constitutes about 88 per cent of all domestic coal use.
- Oil remained Australia's largest source of primary energy consumption, at 37 per cent of the total, and gas use remained steady at 27 per cent of the primary energy mix.

Energy production

- Energy production rose 1 per cent in 2021–22 to 19,111 petajoules, mainly driven by an increase in natural gas production.
- Natural gas production rose 6 per cent to 6,076 petajoules in 2021–22, as the year was less impacted by COVID-19 and by scheduled outages and maintenance.
- Black coal production was 11,216 petajoules (417 million tonnes), remaining by far Australia's largest contributor to energy production, despite being hampered in the last two years by heavy rainfall causing pit flooding and damaging transport infrastructure.
- Crude oil and condensate production grew 1 per cent in 2021–22, and naturally-occurring LPG production rose 15 per cent. LPG in Australia is often produced alongside natural gas and so increased production also led to increased LPG output.

- Renewables production increased 10 per cent, due to the rapid expansion of solar and wind electricity production, while biomass production fell with a smaller sugar harvest.

Electricity generation

- Total electricity generation in Australia rose 2 per cent in 2021–22 to around 272 terawatt hours (978 petajoules). This figure includes industrial, rooftop solar PV and off-grid generation.
- Renewable generation increased 19 per cent in 2021–22, contributing 31 per cent of total generation (84 terawatt hours), an increase of four percentage points. Generation within the National Electricity Market, Australia's main grid, was 33 per cent renewables in 2021–22.
- Renewable generation in Australia grew further in calendar year 2022, to 32 per cent of total generation (88 terawatt hours), the highest on record. In calendar year 2022, solar generation constituted 14 per cent of total generation and wind 11 per cent.
- The share of renewable generation now well surpasses the historical peak of 26 per cent (9 terawatt hours), which was recorded in 1964–65 as the Snowy Mountains hydro-electric scheme came progressively online. Australia's 88 terawatt hours of renewable generation in 2022 is about 10 times higher than this figure in absolute terms.
- About 19 per cent of Australia's electricity was generated outside the electricity sector by industry and households in 2021–22, including 10 per cent by the mining and manufacturing sectors and 8 per cent from small-scale solar PV.
- Fossil fuel generation fell 4 per cent in 2021–22, with a 5 per cent decline in coal-fired generation and 1 per cent drop in gas-fired generation.
- Natural gas-fired generation in 2021–22 fell nationally to the lowest level in a decade, and in the southern and eastern states which constitute the National Electricity Market, fell to the lowest level seen since the early 2000s. There was a partial rebound in the second half of 2022, but not a full return to previous levels.
- Coal-fired generation fell below half of all generation, to 49 per cent in 2021–22 and 47 per cent in calendar year 2022. This compares to a 68 per cent share a decade ago.

Energy trade

- The majority of Australia's energy production is exported and Australia exports much more energy than it imports. Net exports (exports minus imports) were equal to 71 per cent of production in 2021–22.
- Energy exports rose 1 per cent in 2021–22 to 15,623 petajoules. This was due to increased natural gas exports, which rose 7 per cent.
- The 7 per cent rise in LNG exports to 4,637 petajoules was due to fewer outages, higher post-lockdown demand in Asian markets, and the Russian invasion of Ukraine impacting Russian exports. LNG exports grew an average of 16 per cent per year over the last decade.
- Exports of crude oil/condensate and LPG, both partially sourced from the gas extraction sites which experienced production rebounds, rose 5 and 16 per cent respectively.
- Black coal exports fell 1 per cent, the result of China's restrictions on Australian coal imports and continued issues with floods and storm damage.
- Energy imports rose 1 per cent to 2,129 petajoules in 2021–22.
- Refinery closures saw crude oil imports fall 29 per cent while refined product imports rose 17 per cent to replace refinery output. The share of consumption of refined petroleum products met by imports, 74 per cent, was the highest on record.

About the Australian Energy Statistics

The *Australian Energy Statistics* (AES) is the authoritative and official source of annual energy statistics for Australia, covering all types of energy and all parts of the economy. It provides information designed to increase the understanding of energy supply and use in Australia, to support decision making in government, industry and more broadly, and to meet annual international energy reporting obligations. AES data also supports the calculation of greenhouse gas emissions from energy supply and use.

The AES provides detailed energy consumption, production and trade statistics and balances, by state and territory, by energy type and by industry, in energy content units and volume or mass units. Concepts, definitions and presentation align as closely as possible with the framework used by the International Energy Agency (IEA).

Key data sources include facility level reporting from the *National Greenhouse and Energy Reporting Scheme* (NGERS); the *Australian Petroleum Statistics* (APS); the *Resources and Energy Quarterly*; datasets and estimates from other Australian and state government agencies; internal estimates using statistical techniques; and public company reporting. Some datasets from private subscription services and industry associations are also used to compare with these estimates and sources.

The AES has been published by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) (2022 to 2023); the Department of Industry, Science, Energy and Resources (2020 to 2021); the Department of the Environment and Energy (2017 to 2019); the Department of Industry, Innovation and Science (2015 and 2016); the Bureau of Resources and Energy Economics (BREE) (2012 to 2014); the Australian Bureau of Agricultural and Resources Economics and Sciences (ABARES) (1989 to 2011); and various previous Australian government agencies; since the mid-1970s.

The AES dataset is available online in Excel format. A list of the AES Excel tables available on the energy.gov.au website is provided in Table 1. An energy flows schematic is also available on the website.

This report, the *Australian Energy Update*, highlights recent trends in Australian energy consumption, production, and trade.

The *Guide to the Australian Energy Statistics* assists users in better understanding the AES and supports the transparency of the dataset. It contains information on definitions and concepts, data sources and methodology, conversion factors, confidentiality, and historical revisions.

The main unit in the AES is the petajoule (PJ). One petajoule = 1 x 10^{15} joules. One petajoule, or 278 gigawatt hours, is the heat energy content of about 43,000 tonnes of black coal or 29 million litres of petrol. One petajoule is equivalent to filling up a car with a fuel tank capacity of 55 litres of petrol around 532,000 times. A car using 6 litres of petrol per hundred kilometres could drive approximately 483 million kilometres on one petajoule, more than three times the distance from the Sun to the Earth.

Table 1 2023 Australian Energy Statistics tables

Table name	Table contents
Table A	Australian energy supply and consumption, energy units
Table B	Australian population, GDP and energy consumption, by state and territory
Table C	Australian energy consumption, by state and territory, by fuel, energy units
Table D	Australian energy consumption, by state and territory, by detailed fuel, energy units
Table E	Australian energy consumption, by state and territory, by industry, energy units
Table F	Australian energy consumption, by state and territory, by industry and fuel type, energy units
Table G	Australian energy consumption, by state and territory, by fuel, physical units
Table H	Australian total final energy consumption, by industry, by fuel, energy units
Table I	Australian production of primary fuels, by state and territory, physical units
Table J	Australian energy supply and trade, by fuel type, energy units
Table K	Australian energy consumption in 2021–22, by state and territory, by industry, selected fuels, energy units
Table L	Australian consumption of electricity, by state and territory, physical units
Table M	Australian energy imports, by fuel type, physical units
Table N	Australian energy exports, by fuel type, physical units
Table O	Australian electricity generation, by state and territory, by fuel type, physical units
Table P	Australian consumption and production of coal, by state and territory, physical units
Table Q	Australian consumption and production of gas, by state and territory
Table R	Australian renewables consumption, energy units
Table S	Australian production and exports of uranium, physical and energy units

One petajoule (PJ) explained

The joule is the standard unit of energy in general scientific applications. One joule is the equivalent of one watt of power radiated or dissipated for one second.

One petajoule is 10^{15} joules (1 million billion) or 278 gigawatt hours.

37,183

The electricity used by 37,183 households in a year[1]

817,647

The electricity used by 817,647 refrigerators in a year[2]

868,750

The electricity used by 868,750 televisions in a year[3]

483 million

The number of kilometres a car can drive on 29 million litres of petrol[4]

[1]Based on the average home using approximately 27GJ of energy per year in 2021-22
[2]Based on a typical 3 star fridge using 340 kWh of electricity per year
[3]Based on a 55 inch 5 star label television using 320 kWh of electricity per year
[4]Based on a car consuming 6 litres of unleaded petrol per 100 kilometres

Energy consumption

Energy consumption measures the amount of energy used in the Australian economy. It includes energy consumed in energy conversion activities (such as electricity generation and petroleum refining), but nets off derived or secondary fuels produced domestically (such as electricity and refined oil products) to avoid double counting of energy. It is equivalent to total primary energy supply. It is equal to domestic production plus imports minus exports (and changes in stocks). Further detail is provided in Department of Climate Change, Energy, the Environment and Water (2023) *Guide to the Australian Energy Statistics*.

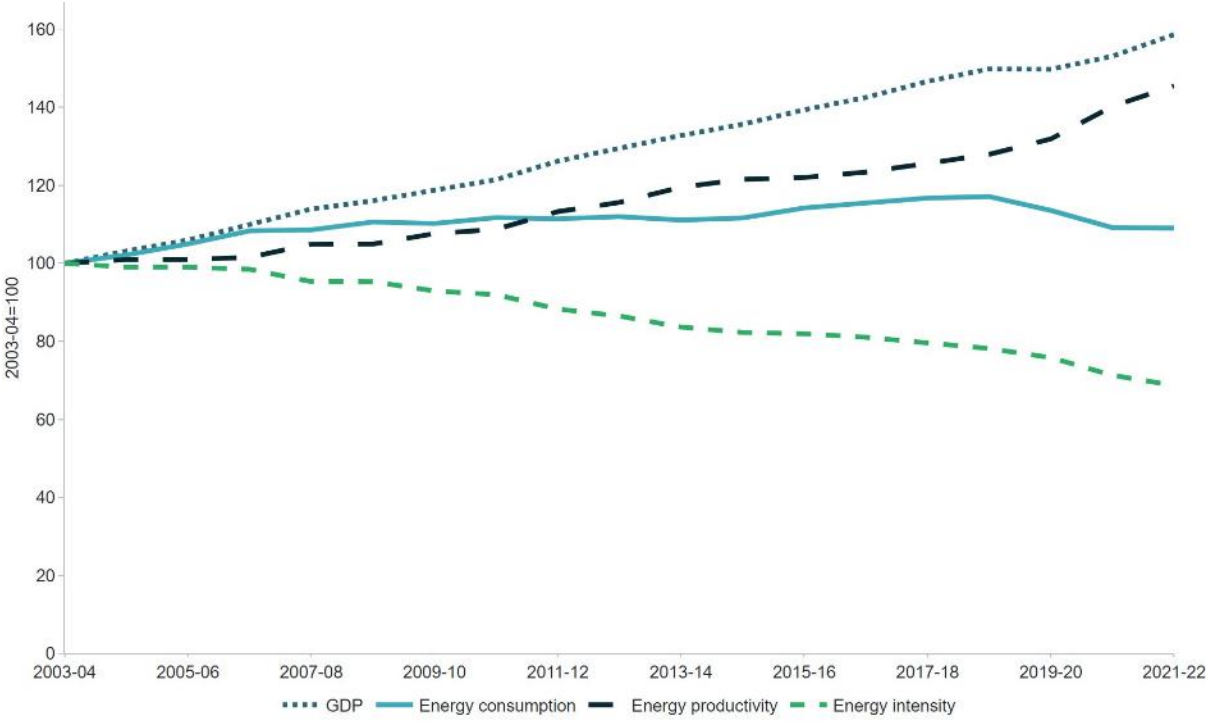
Energy consumption fell 0.1 per cent in 2021–22 to 5,762 petajoules, the third successive year of decline and down 7 per cent from the all-time peak of 6,188 petajoules reached in 2018-19. The drop in energy consumption from three years ago, 426 petajoules, is the same amount of energy obtained from filling a 55-litre tank of petrol 227 million times.

In 2021–22, the Australian economy grew 3.6 per cent to $2.2 trillion. Population grew 1.2 per cent to reach 26.0 million people.

Energy productivity

The relationship between energy use and economic output can be described in terms of the energy intensity, or inversely, the energy productivity, of the Australian economy. Energy intensity measures the amount of energy used to produce a unit of economic output (energy consumption/GDP), while energy productivity measures the amount of economic output produced per unit of energy input (GDP/energy consumption).

Figure 1 Australian energy intensity and energy productivity



Source: DCCEEW (2023) Australian Energy Statistics, Table B

Table 2 Australian population, GDP, and energy consumption

	2011–12	2021–22	2021–22 growth (per cent)	10 year average annual growth (per cent)
Population (millions)	22.7	26.0	1.2	1.4
GDP ($ billion)	1,714.9	2,155.7	3.6	2.3
Energy consumption (PJ)	5,888.4	5,762.1	-0.1	-0.2
Energy consumption per capita (GJ)	259.0	221.6	-1.3	-1.5
Energy intensity (GJ/$ million)	3,433.8	2,673.0	-3.6	-2.5
Energy productivity ($ million/PJ)	291.2	374.1	3.7	2.5

Source: DCCEEW (2023) Australian Energy Statistics, Table B, and Australian Bureau of Statistics (2023)

The Australian economy has shown lower energy intensity and higher energy productivity over time, as economic growth in Australia over recent decades has generally outpaced growth in energy consumption (Figure 1). This reflects cumulative improvements in energy efficiency as well as a shift in the Australian economy away from highly energy-intensive industries such as manufacturing towards less energy-intensive industries such as services. Increased use of renewable energy instead of fossil fuels for electricity generation has also had a positive impact on energy productivity.

Energy productivity improved 3.7 per cent in 2021–22 and 28 per cent over the past ten years (Table 2). Australia now creates $374 million in GDP for every petajoule of energy consumed, which is $83 million more than a decade ago. Put another way, Australia uses 22 per cent less energy per dollar of economic output than a decade ago. Australia also uses 14 per cent less energy per person than a decade ago.

Energy consumption, by fuel type

Fossil fuels (coal, oil and natural gas) accounted for 91 per cent of Australia's primary energy mix in 2021–22. Oil, including crude oil, liquefied petroleum gas (LPG) and refined products, accounted for the largest share of energy consumption, at 37 per cent in 2021–22 (Table 3) with coal at 28 per cent and natural gas at 27 per cent.

Table 3 Australian energy consumption, by fuel type

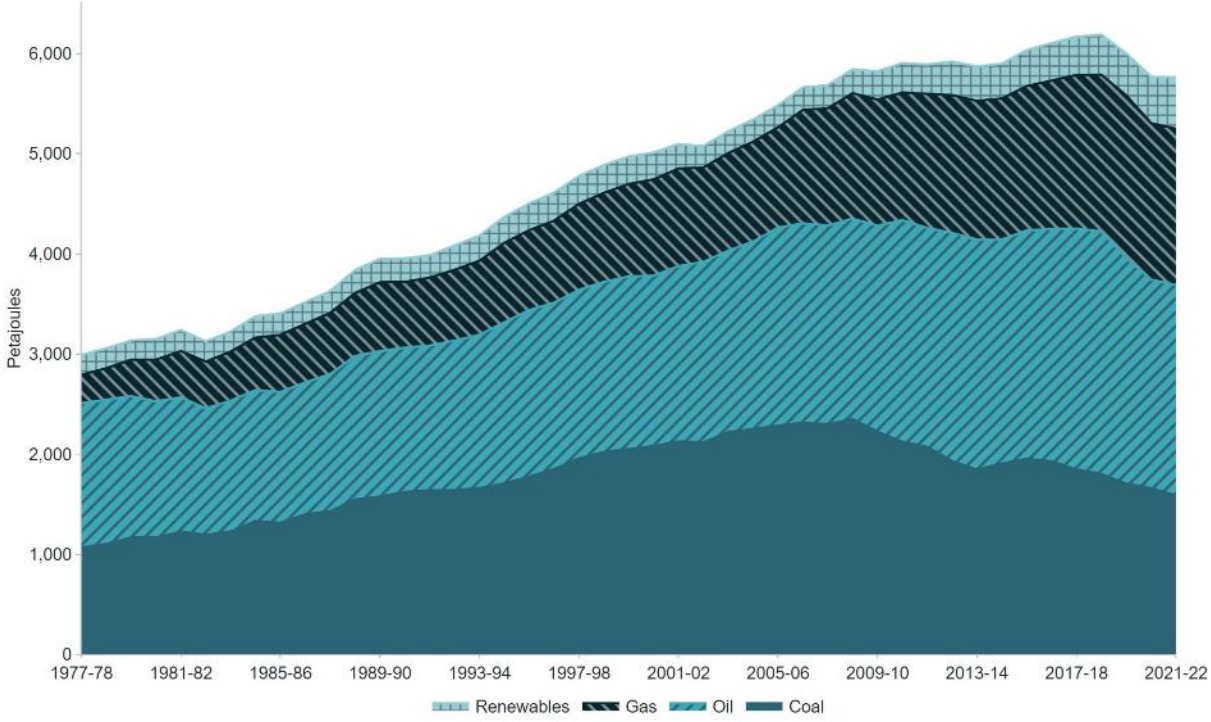
	2021–22 PJ	2021–22 share (per cent)	2021–22 growth (per cent)	10 year average annual growth (per cent)
Oil	2,103.4	36.5	1.0	-0.4
Coal	1,586.8	27.5	-4.5	-2.6
Gas	1,559.3	27.1	-0.1	1.5
Renewables	512.5	8.9	10.3	5.7
Total	**5,762.1**	**100.0**	**-0.1**	**-0.2**

Source: DCCEEW (2023) Australian Energy Statistics, Table C

Oil consumption includes domestic and imported crude used by Australian refineries, and imported refined products used by industry and households, but nets off refined products produced domestically to avoid double counting of energy.

Oil consumption increased 1 per cent in 2021–22 (Table 3), after two successive large declines, remaining substantially below pre-pandemic levels of consumption.

Figure 2 Australian energy consumption, by fuel type



Source: DCCEEW (2023) Australian Energy Statistics, Table C

Coal remained the second largest fuel consumed in 2021–22 (Figure 2). Domestic coal consumption fell 4 per cent in 2021–22, more than the average ten-year rate of decline of 3 per cent.

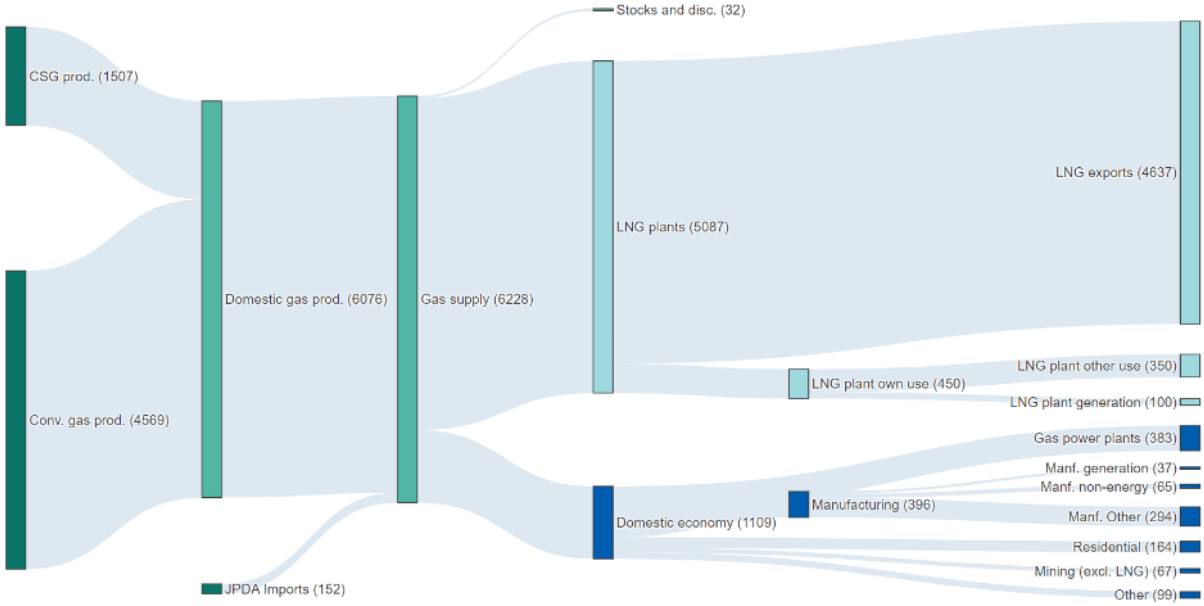
Lower coal-fired electricity generation has driven this continued decline, with this activity accounting for most of Australia's domestic coal consumption. The other notable usage of coal is in Iron and steel production, and this has remained mostly steady across the same period. Declining domestic consumption of coal stands in contrast to trends in production and exports, discussed in subsequent sections of this publication.

Natural gas accounted for 27 per cent of energy consumption in 2021–22. Gas consumption remained steady with lower gas-fired electricity generation and alumina refining activity offset by increased gas consumption at LNG plants.

Around 33 per cent (520 petajoules) of Australia's gas consumption in 2021–22 was used for electricity generation, the majority of which was by gas-fired power plants and the remainder undertaken by businesses in other industries. Gas-fired generation by industry includes generation at smelters, metals refineries and mines, as well as unprocessed natural gas used to generate electricity during the gas production and gas liquefication processes. All such self-generation by industry is, by international statistical convention, included in the electricity supply activity sector in the Australian Energy

Statistics, rather than to the original industry such as mining and manufacturing. Figure 3, by contrast, illustrates these different components assigned to their original industries of ownership.

Figure 3 Australian natural gas flows, petajoules, 2021–22



Note: Components may not sum due to rounding. Gas power plants include some generation by other economic sectors.

Source: DCCEEW (2023) Australian Energy Statistics, Tables A and F and internal sources

When on-site electricity generation use is included, mining (including LNG plants) accounted for about 33 per cent of Australian domestic gas use in 2021–22 with 29 per cent (450 petajoules) of Australian natural gas consumption occurring at LNG plants. This consumption only includes the gas actually consumed at LNG plants, and does not include the proportion exported as LNG.

Manufacturing accounted for 25 per cent (396 petajoules) of Australian domestic gas use in 2021–22, when on-site electricity generation is included. Of this, around 65 petajoules was used for non-energy purposes, such as feedstock for chemicals production (Figure 3).

Gas remains by far the largest source of energy for end consumers of energy within the manufacturing sector, accounting for 42 per cent of manufacturing final energy use in 2021–22. The gas share of energy use in the sector has been steady at around 40 per cent for two decades despite industry structure and reduced energy consumption activity. Final Energy Consumption, ie, consumption by end users, is discussed more comprehensively further below.

Renewable energy sources accounted for the remaining 9 per cent of Australian energy consumption in 2021–22. Renewable energy consumption comprises mainly biomass, hydro, wind and solar energy. In 2021–22, renewable energy consumption rose 10 per cent, due to strong growth in solar and wind (Table 4).

Renewable energy use includes energy used for electricity generation as well as various direct uses of renewable fuels such as firewood for residential heating, bagasse (sugar cane waste) combustion for heat in manufacturing, and solar hot water.

Table 4 Australian renewable energy consumption, by fuel type

	2021–22 PJ	2021–22 share (per cent)	2021–22 growth (per cent)	10 year average annual growth (per cent)
Biomass	171.0	33.4	-1.5	0.2
- wood and other[a]	86.6	16.9	1.1	0.4
- bagasse	84.4	16.5	-4.0	0.0
Municipal and industrial waste	4.7	0.9	1.0	na
Biogas	18.5	3.6	4.9	2.0
- landfill gas	13.9	2.7	5.3	na
- other biogas	4.6	0.9	3.8	na
Biofuels	6.1	1.2	-1.8	-7.0
- ethanol	4.8	0.9	-2.2	na
- biodiesel	0.2	0.0	33.1	na
- other liquid biofuels	1.2	0.2	-3.6	na
Wind	104.8	20.4	18.6	15.4
Hydro	61.2	11.9	11.9	1.9
Solar PV	124.9	24.4	25.1	29.8
Solar hot water	21.3	4.2	8.4	5.6
Total	**512.5**	**100.0**	**10.3**	**5.7**

Notes: a includes wood waste, charcoal, sulphite lyes and other biomass

na – not available

Source: DCCEEW (2023) Australian Energy Statistics, Table R

Renewable energy used for electricity generation increased 17 per cent while direct use of renewables was steady in 2021–22. This continues the long-term trend, where all substantial growth in renewable energy activity is for electricity generation rather than direct use. In 2021–22 electricity supply accounted for 65 per cent of total Australian renewable energy use, up from 38 per cent a decade ago.

Consumption of bagasse, the remnant sugar cane pulp left after crushing, fell 4 per cent in 2021–22 due to a smaller sugar crop in the 2021 season (ASMC 2023). Bagasse has long been a significant source of renewable energy in Australia for direct heat and for electricity production, comprising 16 per cent of total renewable energy use in 2021–22.

Wind and solar energy use have grown rapidly in the past decade, and combined were 49 per cent of all renewable energy consumption in 2021–22, up from 16 per cent a decade ago. Solar PV has grown from negligible levels in the mid-2000s to 125 petajoules in 2021–22, growing 25 per cent in the most recent year.

In addition to ongoing rooftop solar PV expansion, the last five years have seen large-scale solar PV power generation grow almost 20-fold.

Wind energy use grew 19 per cent in 2021–22, higher than 15 per cent growth per year over the last decade. Hydro energy has been broadly stable over time, but grew 12 per cent in 2021–22 due to wetter weather and more favourable selling conditions for hydro generators (AEMO 2022).

Solid municipal and industrial waste can be used to generate electricity or direct heat, and provided around 5 petajoules of energy in 2021–22. Biogas from landfill, sewerage and other sources provided a further 18 petajoules of energy in 2021–22, most used for electricity generation.

Energy consumption, by sector

The electricity supply, transport, and manufacturing sectors collectively accounted for over two-thirds of energy consumption in 2021–22 (Table 5).

Table 5 Australian energy consumption, by sector

	2021–22 PJ	2021–22 share (per cent)	2021–22 growth (per cent)	10 year average annual growth (per cent)
Transport	1,445.3	25.1	1.8	-0.7
Electricity supply	1,417.4	24.6	-3.3	-2.0
Manufacturing	1,016.4	17.6	-1.5	-1.8
Mining	865.9	15.0	1.8	6.8
Residential	497.7	8.6	2.8	0.9
Commercial	296.1	5.1	2.8	0.3
Agriculture	114.6	2.0	-3.5	1.6
Construction	37.2	0.6	-3.5	1.7
Water and waste	17.8	0.3	-5.7	1.4
Other	53.6	0.9	-0.9	-2.1
Total	**5,762.1**	**100.0**	**-0.1**	**-0.2**

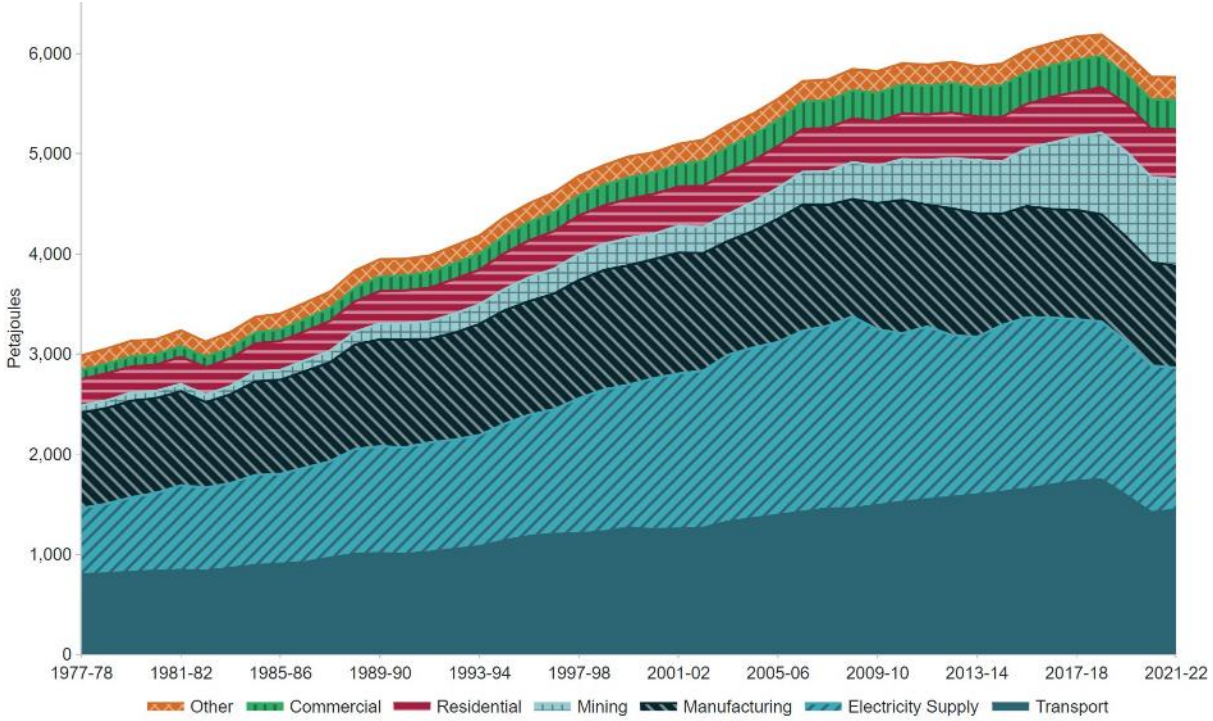
Source: DCCEEW (2023) Australian Energy Statistics, Table E

The electricity supply sector accounted for 25 per cent of energy consumption in 2021–22. Energy consumption in this sector (including fuel inputs to electricity generation, own use of electricity, and losses) declined 3 per cent despite increased electricity generation. Lower consumption in the electricity supply sector reflects a shift from fossil fuel generation with thermal losses to non-thermal renewable generation sources with no fuel losses.

When measuring primary energy consumption, a change in thermal electricity generation has a greater effect than a change in some renewable generation such as wind, solar and hydro, because the energy of these renewables is measured when turned into electricity.

For example, if wind generation rises by 1,000 gigawatt hours, then energy consumption would rise by 3.6 petajoules, because the electricity generated is measured. If coal-fired generation rises by 1,000 gigawatt hours, then energy consumption would increase by the amount of coal consumed to generate the electricity, which would be around 10 petajoules (assuming an efficiency of 35 per cent).

Figure 4 Australian energy consumption, by sector



Source: DCCEEW (2023) Australian Energy Statistics, Table E

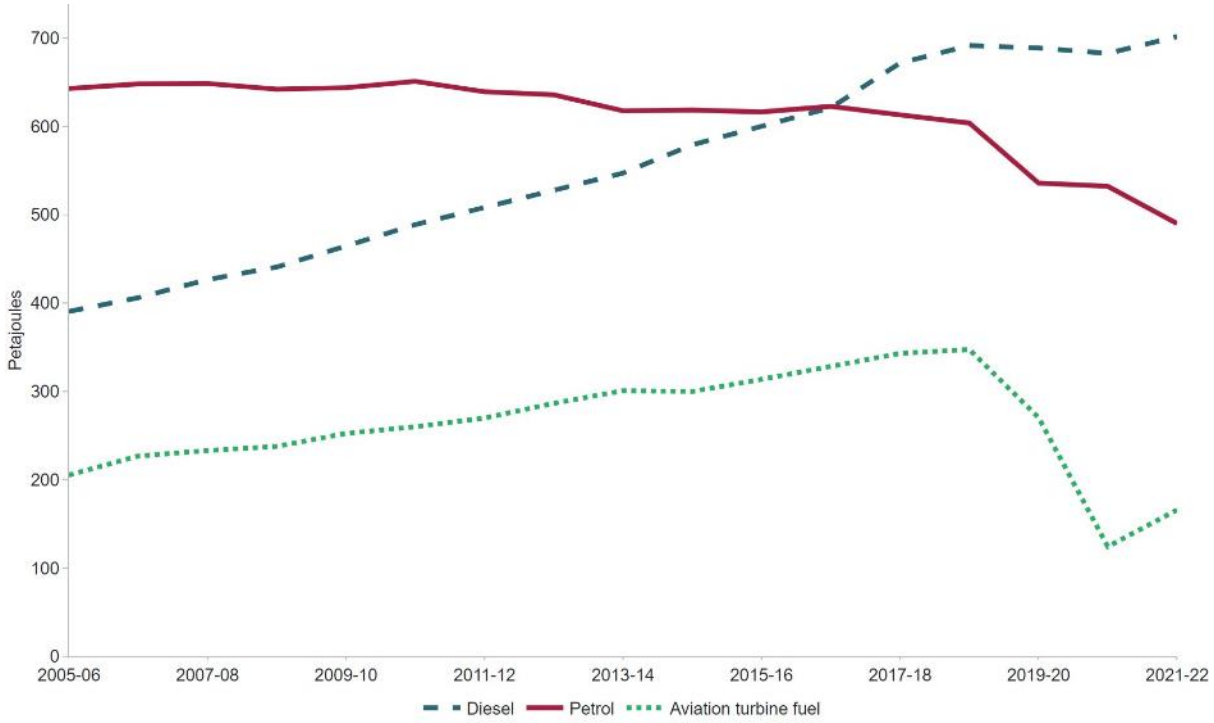
Transport energy consumption rose 1.8 per cent in 2021–22 (Table 6) with air transport and to a lesser extent water transport offsetting a continued decline in road transport consumption. The energy use of the transport sector has been especially volatile in the last three years, influenced by domestic and international travel restrictions and the change in work and consumption patterns induced by the COVID-19 pandemic.

Table 6 Australian transport energy consumption, by subsector

	2021–22 PJ	2021–22 share (per cent)	2021–22 growth (per cent)	10 year average annual growth (per cent)
Road	1,114.7	77.1	-2.5	-0.3
Air	168.0	11.6	32.8	-4.7
Rail	63.5	4.4	-1.2	3.0
Water	58.0	4.0	22.3	-0.3
Other	41.0	2.8	8.6	5.9
Total	**1,445.3**	**100.0**	**1.8**	**-0.7**

Source: DCCEEW (2023) Australian Energy Statistics, Table F

Figure 5 Australian transport energy consumption, by major fuel type



Source: DCCEEW (2023) Australian Energy Statistics, Table F

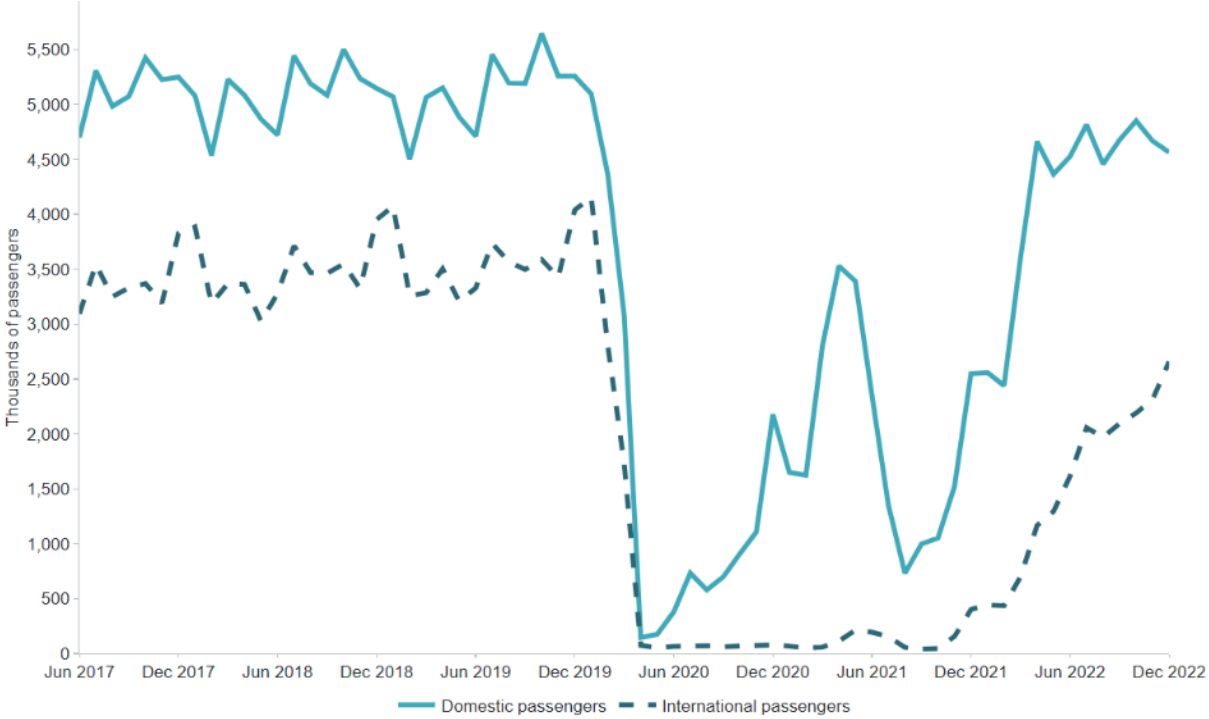
Air transport energy use, nearly all aviation turbine fuel, rose 33 per cent on the previous year but remained at about half the pre-pandemic levels seen in 2018–19 (Figure 5). Air transport energy use includes fuel supplied at Australian airports to international flights.

Air transport activity has been severely impacted by the COVID-19 pandemic, with recovery across 2022 still not returning the sector to pre-pandemic activity levels. Monthly international short-term visitor and short-term resident arrivals each shrank to a few thousand per month in mid-2020, after each peaking above one million per month in December of the years leading up to 2020 (ABS 2023b).

International passenger movements were far slower to rebound than domestic flights even as restrictions on inbound travel eased, and across 2022 they remained low compared to pre-pandemic levels, though returned to about half 2019 levels by the end of 2022 (Figure 6).

Domestic aviation activity levels fell dramatically during periods of widespread lockdown and border closures in Australia, fluctuating as restrictions and circumstances changed across 2020 and 2021. Passenger movements in the first 12 months of the pandemic were very reduced but by mid-2022, after state borders had re-opened, had returned to above 4 million domestic passengers a month, at the level of activity observed in quieter pre-pandemic months.

Figure 6 Monthly aviation passenger numbers, domestic and international inbound and outbound



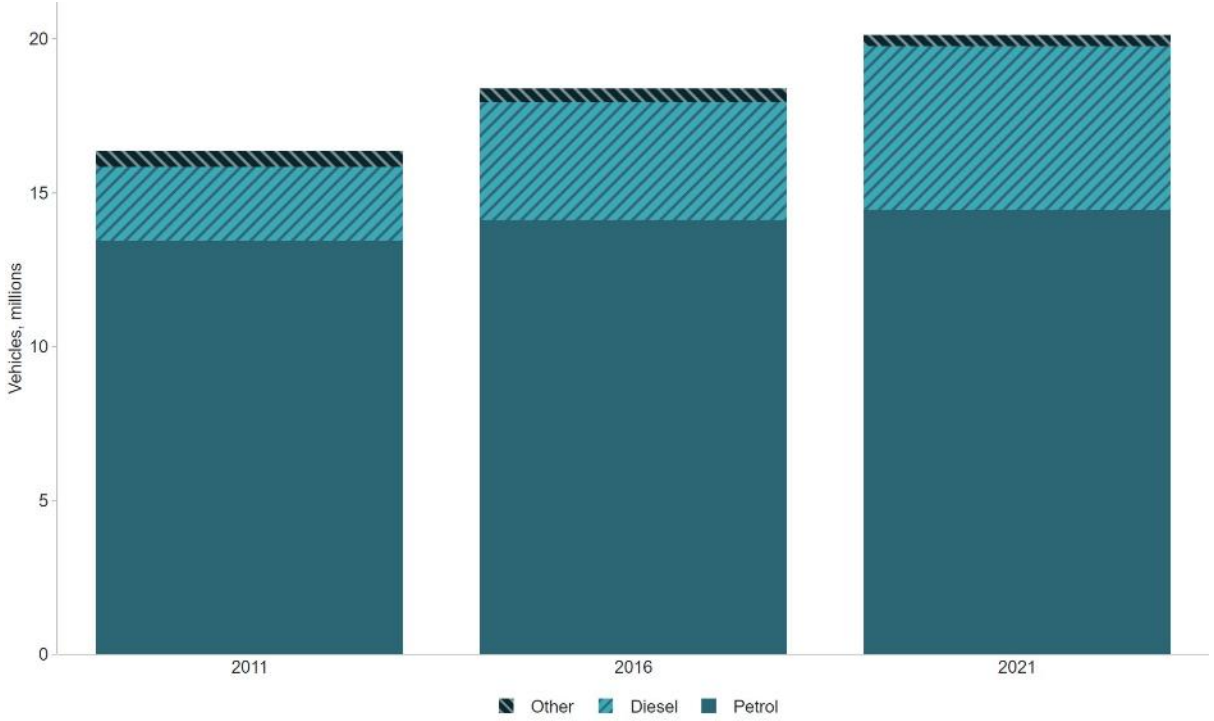
Source: Bureau of Infrastructure and Transport Research Economics (2023) Aviation Statistics

Road transport comprised just over three-quarters of total transport energy consumption in 2021–22 but fell on the previous year, due to 8 per cent lower petrol use. Petrol use was 19 per cent lower than the pre-pandemic 2018–19 level, and total petrol use in Australia was at its lowest level since the 1970s. A key factor in the decline of petrol use is the net effect of various COVID-19 border and lockdown policies, as well as ongoing mode of work changes with greater working from home levels resulting in fewer car journeys to workplaces.

There has also been a longer-term pattern of switching to diesel vehicles by households. Australia's diesel vehicle stocks (including non, light commercial and freight) have more than doubled in size since 2011, to 5.3 million vehicles in 2021 (ABS 2021) (Figure 7). Fuel efficiency has also, over time, limited the growth of road transport fuel consumption, with petrol use per kilometre decreasing about 14 per cent from pre-2004 to post-2015 manufactured vehicles (ABS 2020).

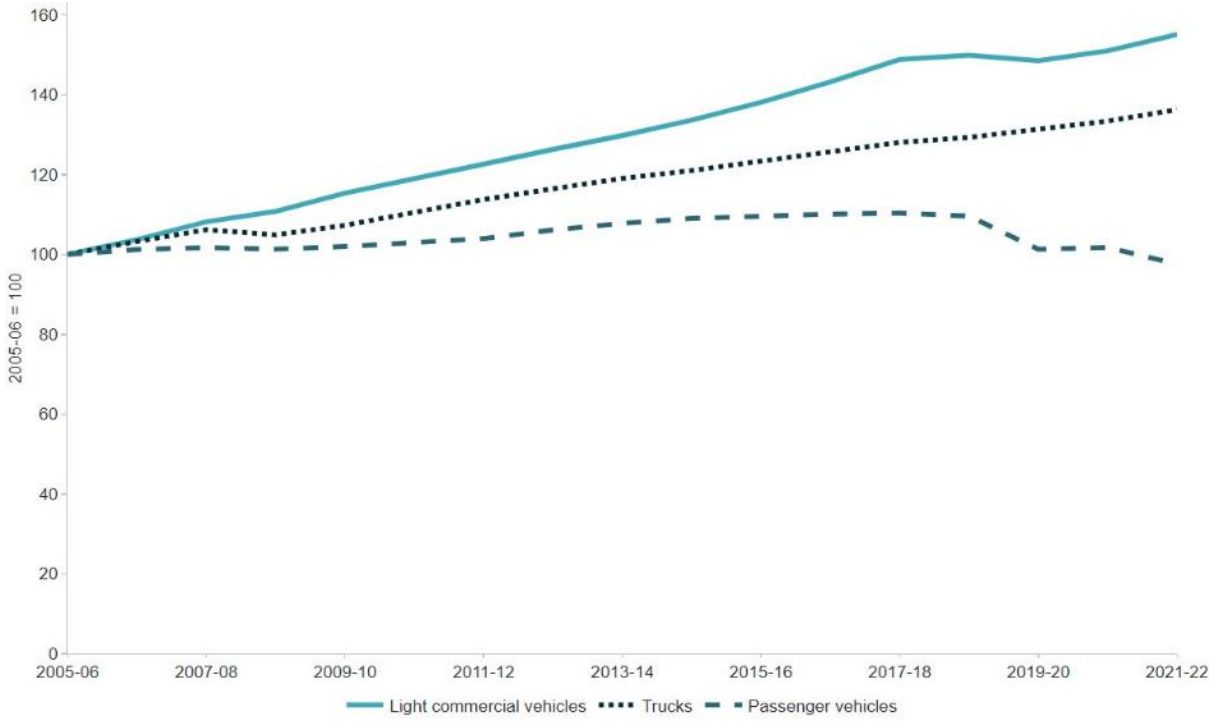
Freight activity remained essentially unaffected through the pandemic. Truck vehicle kilometres grew about 2 per cent each year while passenger vehicle kilometres fell away 4 per cent in 2021–22, to now be 11 per cent below pre-pandemic levels (Figure 8).

Figure 7 Australian motor vehicle registrations, by fuel type



Source: Australian Bureau of Statistics (2021) Motor Vehicle Census, Australia, 31 Jan 2020

Figure 8 Index of annual kilometres travelled, selected vehicle types



Source: Bureau of Infrastructure and Transport Research Economics (2022) Australian Infrastructure Statistics—Yearbook 2022

Table 7 Australian manufacturing energy consumption, by subsector

	2021–22 PJ	2021–22 share (per cent)	2021–22 growth (per cent)	10 year average annual growth (per cent)
Non-ferrous metals	333.0	32.8	-2.8	-1.9
Chemicals	187.6	18.5	-4.2	-1.7
Food, beverages, tobacco	143.2	14.1	-0.5	-0.5
Ferrous metals	115.8	11.4	-0.1	-1.2
Petroleum refining[a]	61.8	6.1	-0.2	-2.9
Wood, paper and printing	52.5	5.2	0.5	-1.1
Cement	49.7	4.9	-0.3	-2.8
Other	72.9	7.2	5.2	-3.1
Total[b]	**1,016.4**	**100.0**	**-1.5**	**-1.8**

Notes: a Energy consumption in petroleum refining equals total energy consumption (feedstock and own use) minus derived fuel production. The derived fuel production is netted off to avoid double counting of this energy in other sectors.

b Consumption excludes consumption for generation of electricity, which is recorded in the electricity supply sector.

Source: DCCEEW (2023) Australian Energy Statistics, Table F

Energy consumption in the manufacturing sector fell 1.5 per cent, in 2021–22 (Table 7), with the decline concentrated in the two largest energy using sectors of non-ferrous metals and chemicals production. Use of all broad energy groups, including natural gas, electricity, and coal, decreased for the year.

The non-ferrous metals manufacturing sector consists of the production of several metals including zinc, lead and silver, but is dominated in energy consumption terms by the energy-intensive stages of aluminium production, including alumina refining from bauxite, and aluminium smelting from alumina. Those activities both decreased in 2021–22 (DISR 2023) in line with the 3 per cent decrease in energy consumption in the sector.

Energy use in the chemicals sector also fell 4 per cent. This decline was particularly concentrated in Victoria, where some large energy using businesses reduced activity, citing lower feedstock availability with the closure of the refinery at Altona.

Around half of food product manufacturing energy consumption is the burning of cane waste (bagasse) for heat energy at sugar mills. The 4 per cent decrease in total Australian bagasse consumption in 2021–22, associated with a smaller 2021 sugar harvest, (ASMC 2023), left food product manufacturing energy use down 1 per cent in 2021–22.

Energy use in the petroleum refining sector is calculated as total energy consumption (feedstock and own use) minus derived fuel production. Energy use in this sector has reduced with refinery closures in March 2021 at Kwinana in Western Australia and at Altona in Victoria in August 2021 but was flat in year-to-year movement due to increased demand for transport fuels from the remaining refineries.

Table 8 Australian mining energy consumption, by subsector

	2021–22 PJ	2021–22 share (per cent)	2021–22 growth (per cent)	10 year average annual growth (per cent)
Oil and gas	530.6	61.3	2.2	9.1
- LNG plants	379.1	43.8	3.4	13.3
Coal	152.2	17.6	-0.9	2.9
Other mining	235.3	27.2	2.8	4.4
Total[a]	**865.9**	**100.0**	**1.8**	**6.8**

a Consumption excludes consumption for generation of electricity, which is recorded in the electricity supply sector.

Source: DCCEEW (2023) Australian Energy Statistics, Table F and internal sources

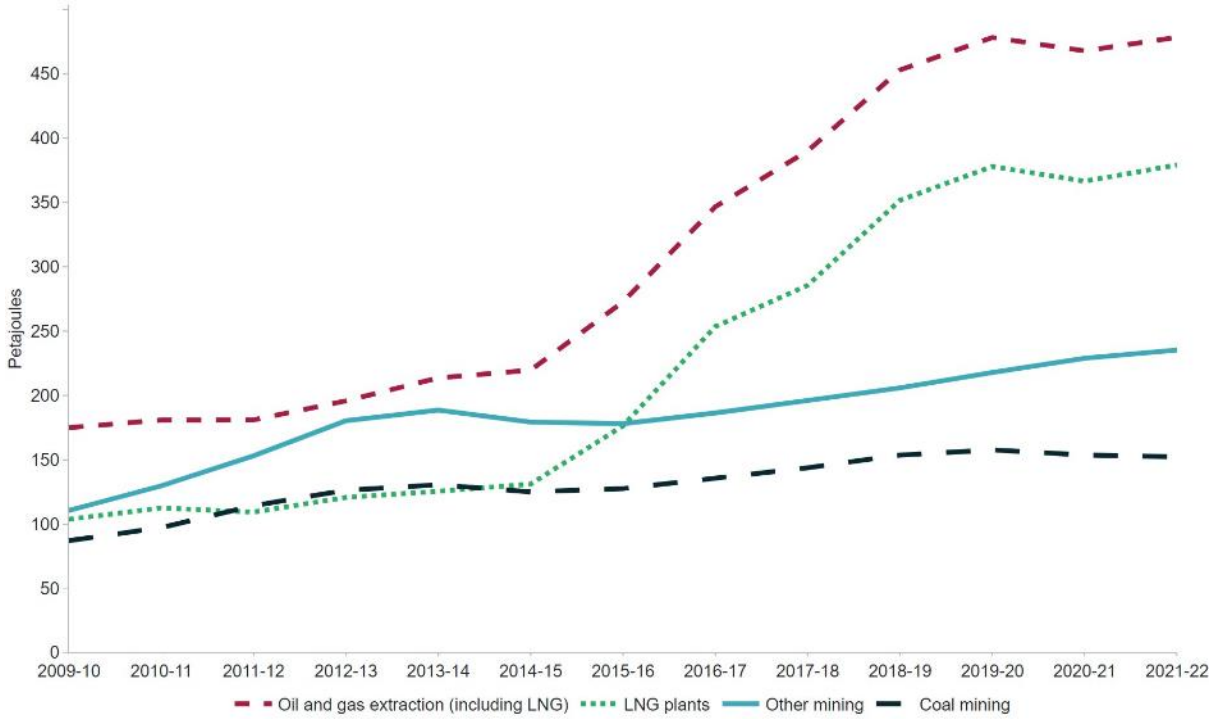
Energy consumption in the mining sector was up 2 per cent in 2021–22 (Table 8), a slower rate of growth than the 7 per cent ten-year average during which several liquefied natural gas (LNG) plants opened, greatly expanded the energy use of the sector. LNG plants now constitute nearly half of all mining sector energy use (Figure 9).

LNG plant energy activity increased 3 per cent in 2021–22, rebounding after a year which saw lower exports due to operational shutdowns. LNG plant consumption figures exclude gas used for electricity generation at gas processing and liquefaction plants (around 100 petajoules in 2021–22), which is included in the electricity supply sector in consumption data in the AES. The figures do, however, include consumption of the self-generated electricity.

In total, including the gas used to generate electricity, LNG plants accounted for just under 30 per cent of Australian gas consumption in 2021–22. Excluding this usage, LNG plants accounted for 24 per cent.

Energy use in other mining, a broad category encompassing metals and minerals extraction, grew 3 per cent, as iron ore extraction grew 2 per cent (DISR 2023). Coal mining energy use fell 1 per cent, which is in line with a decrease in production.

Figure 9 Australian energy consumption in mining



Source: DCCEEW (2023) Australian Energy Statistics, Table F and internal sources

In the agriculture sector, energy consumption fell 3 per cent and in the small water supply and waste sector, energy consumption fell 6 per cent. In both sectors, wetter climate conditions reduced demand for energy use to pump water.

In 2021–22 total crop production volume grew 16 per cent while crop area only grew 2 per cent, indicative of more productive growing conditions with less need for irrigation (ABARES 2022).

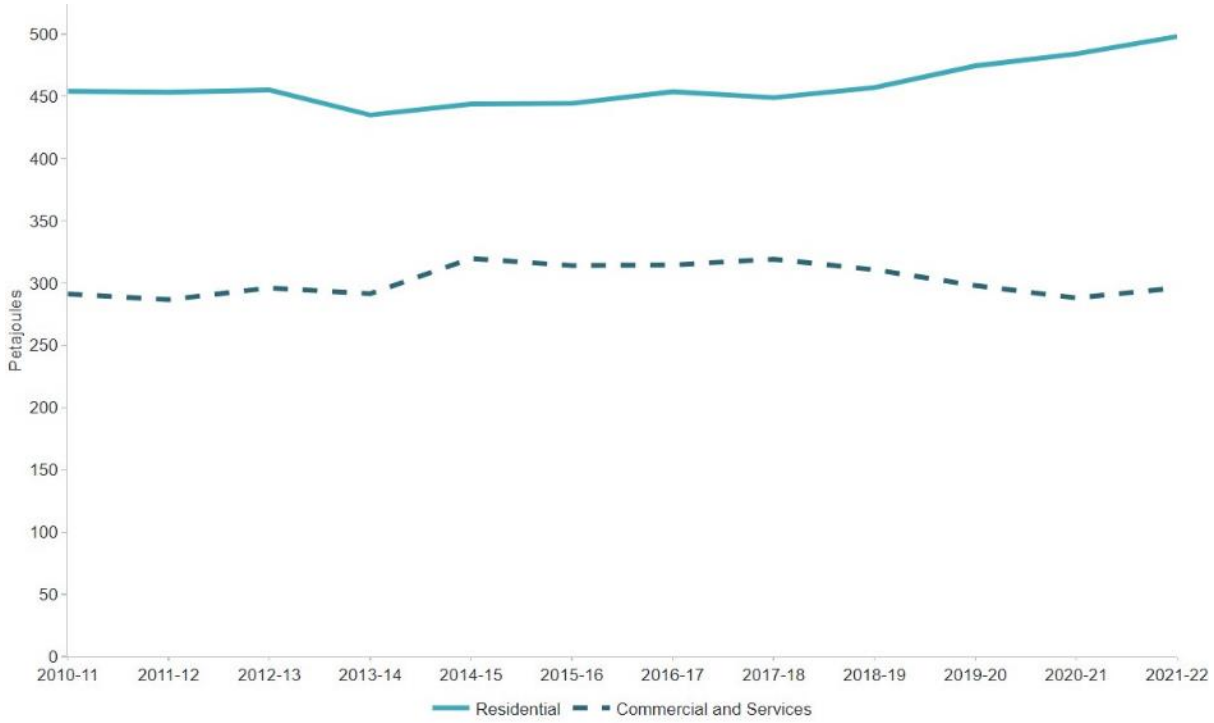
Energy consumption in the residential sector and in the commercial and services sector each grew 3 per cent in 2021–22 (Figure 10). Residential sector consumption includes the use of electricity generated from rooftop solar photovoltaic (PV) systems and from the grid.

In the residential sector, increased electricity demand drove higher energy consumption, while natural gas consumption declined. In the commercial sector, electricity and natural gas demand both rose (AEMO 2022). Warmer summer weather and cooler winter weather compared to the previous year contributed to increased demand in most of the country.

While this weather was a strong influence over higher consumption than the previous year, the broader context of the ongoing influence of the pandemic and post-pandemic structural change also remains.

Residential consumption during the COVID-19 era has been higher than seen at any point prior to 2020. Over the decade before the COVID-19 pandemic, residential consumption had risen below population growth rates, as improving energy efficiency and changing consumer behaviour reduced individual consumption levels. Per capita residential energy use therefore fell 10 per cent between 2009–10 and 2018–19. This trend has reversed during the pandemic, with residential energy use per capita growing 2 per cent per year across the last three years.

Figure 10 Energy use in commercial and services sector and residential sector



Source: DCCEEW (2023) Australian Energy Statistics, Table E

Lockdown restrictions continued into 2021–22, and there has been an ongoing shift of working patterns, seeing more daytime residential energy demand. In August 2021, 41 per cent of employed people reported regularly working from home, up from 32 per cent in 2019 (ABS 2022).

Conversely, COVID-19 activity reductions also affected the commercial and services sector in parts of the country until late 2021 or even early 2022. This is an economic sector which collectively employs around three quarters of Australian workers (ABS 2023c) and covers industries including retail and wholesale trade, accommodation, food services, professional and technical services, health and education, government, finance, and information and communications technology.

As lockdowns closed some commercial enterprises and more workers in some industries worked more frequently from home, commercial sector energy consumption fell in 2019–20 and again in 2020–21. Any further effects in 2021–22 appear to have been more limited, despite extended lockdowns in Sydney and Melbourne well into the reference period. Instead, commercial sector consumption rose alongside residential demand, driven by increased heating and cooling needs.

Final energy consumption

Final energy consumption is the energy used by the final or end-use sectors, a subset of total energy consumption. Final energy is suited to the measurement of energy demand by the final consumer. It includes all energy consumed, except energy that is used to convert or transform primary energy into different forms of energy. For example, fuels consumed in the generation of electricity are excluded, but the end use of electricity is included. Also excluded is refinery feedstock that is used to produce petroleum products and fuels used in coke ovens and blast furnaces in iron and steel manufacturing.

Table 9 Australian total final energy consumption, by fuel

	2021–22 PJ	2021–22 share (per cent)	2021–22 growth (per cent)	10 year average annual growth (per cent)
Coal	104.3	2.5	0.9	-0.2
Gas	994.0	23.9	0.2	2.7
Refined products	2,004.5	48.3	1.0	-0.4
Electricity	872.6	21.0	2.1	1.0
- Generated from coal	*429.3*	*10.3*	*-4.9*	*-2.4*
- Generated from gas	*158.4*	*3.8*	*-1.2*	*0.3*
- Generated from oil	*15.0*	*0.4*	*-0.1*	*5.7*
- Generated from renewables	*269.9*	*6.5*	*18.5*	*12.3*
Renewables	178.1	4.3	-0.1	-0.2
Total	**4,153.5**	**100.0**	**1.0**	**0.5**

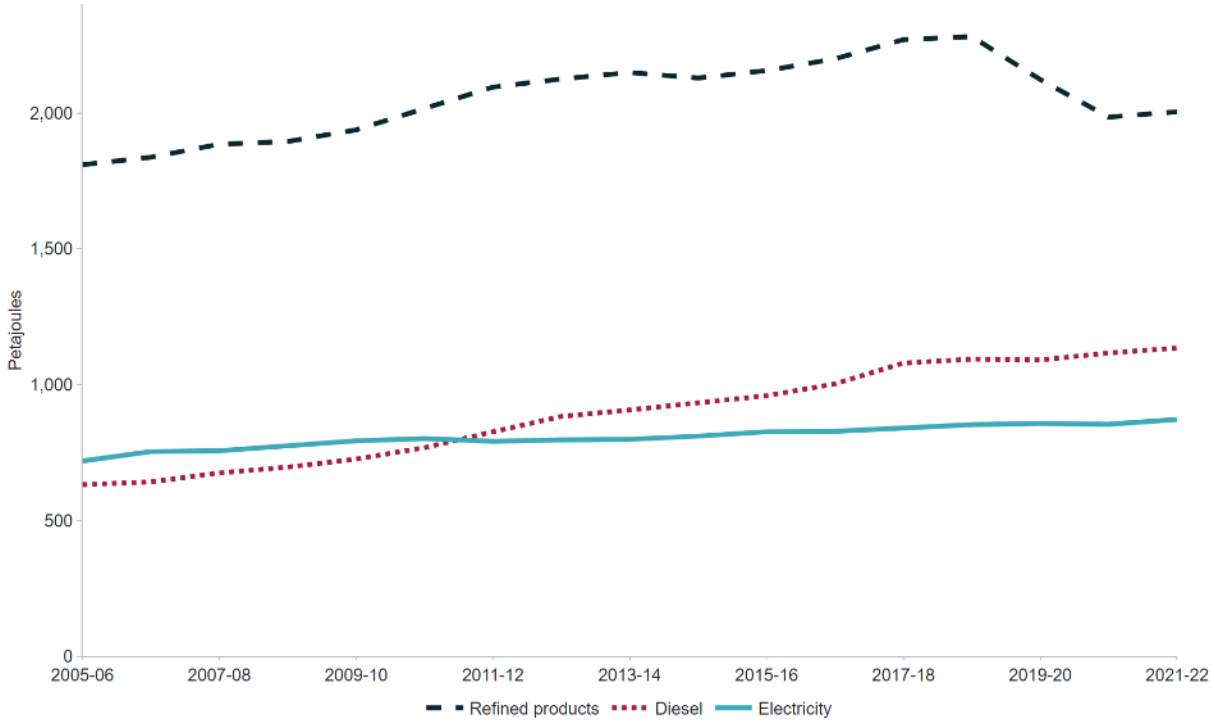
Notes: Total Final Energy Consumption excludes the coal, gas, renewables, and other energy used for electricity generation and other conversion. Electricity consumption breakdown by generation source is derived from total generation share.

Source: DCCEEW (2023) Australian Energy Statistics, Tables H, O

Final energy consumption grew 1 per cent in 2021–22 (Table 9 and Table 10). Electricity consumption, up 2 per cent, was the main driver of growth. There was a 42 petajoule growth in apparent final consumption of renewable electricity (apportioning electricity consumption according to the total generation mix). This means that in the current year, renewable electricity growth more than accounted for the entire (40 petajoule) increase in end user consumption.

Refined products currently constitute nearly half of all final energy consumption, with diesel alone having surpassed electricity as a final consumption fuel in the last decade (Figure 11).

Figure 11 Australian final energy consumption, refined products and electricity



Source: DCCEEW (2023) Australian Energy Statistics, Tables F, H

In most industries, consumption is similar or identical between consumption (Table 5) earlier in this chapter, and final consumption (Table 10). However, in contrast to the slight decline in overall consumption, Australian final consumption grew 1 per cent.

The difference is the activity of sectors such as electricity generation and petroleum refining, whose consumption is not part of final consumption. In particular, as thermal electricity generation declines, the electricity sector exhibits lower consumption of energy (ie thermal losses) to provide the same final consumption of electricity.

This higher level of growth in final energy demand illustrates how a focus on end-use sectors can paint a more accurate picture of energy demand from the perspective of consumer need.

Table 10 Australian total final energy consumption, by industry

	2021–22 PJ	2021–22 share (per cent)	2021–22 growth (per cent)	10 year average annual growth (per cent)
Transport	1,426.6	34.3	1.8	-0.7
Mining	865.9	20.8	1.8	6.8
Manufacturing	852.1	20.5	-1.7	-1.7
Residential	497.7	12.0	2.8	0.9
Commercial	296.1	7.1	2.8	0.3
Agriculture	114.6	2.8	-3.5	1.6
Construction	37.2	0.9	-3.5	1.7
Water and Waste	17.8	0.4	-5.7	1.4
Other	45.6	1.1	-1.0	-1.9
Total	**4,153.5**	**100.0**	**1.0**	**0.5**

Note: Energy consumption in some sectors differs from Table 5 due to exclusion of energy used for conversion activities and for own use in conversion sectors, such as electricity generation, petroleum refining and coke ovens.

Source: DCCEEW (2023) Australian Energy Statistics, Table H

Energy consumption, by state and territory

In 2021–22, energy use decreased in South Australia, New South Wales and Queensland and rose elsewhere (Table 11).

In South Australia, a 2 per cent reduction was driven by the substantial replacement of gas-fired electricity generation with wind and solar, reducing the consumption (thermal losses) in that sector. Consumption in most end use sectors still increased in South Australia.

Table 11 Australian energy consumption, by state and territory

	2021–22 PJ	2021–22 share (per cent)	2021–22 growth (per cent)	10 year average annual growth (per cent)
New South Wales[a]	1,374.4	23.9	-1.9	-1.6
Victoria	1,146.1	19.9	1.6	-2.4
Queensland	1,427.8	24.8	-1.0	0.8
Western Australia	1,257.8	21.8	1.5	2.5
South Australia	301.1	5.2	-2.5	-0.2
Tasmania	105.0	1.8	1.9	-0.2
Northern Territory	149.8	2.6	3.0	4.3
Australia	**5,762.1**	**100.0**	**-0.1**	**-0.2**

Note: a Includes Australian Capital Territory

Source: DCCEEW (2023) Australian Energy Statistics, Table C

Victoria's energy consumption rose 2 per cent, with increased road and air transport activity after the previous year's steep COVID-induced declines. Air transport, especially, grew strongly, increasing 52 per cent on the previous year as more domestic and international flights returned to Melbourne.

In New South Wales (including the Australian Capital Territory), energy consumption fell 2 per cent due mostly to a 8 per cent decline in road transport activity, which was the result of extended lockdowns and movement restrictions between Sydney, regional NSW, and borders in the second half of 2021. New South Wales remained by far the largest state for international air transport with international flight activity becoming more concentrated in Sydney during the pandemic. New South Wales' share of Australian international air transport energy use was 55 per cent in 2021-22, compared to a 46 per cent share three years earlier, pre-pandemic.

Energy consumption in the electricity supply sector fell in most states due to the replacement of thermal generation sources such as coal and gas with non-thermal renewables. Thermal generation was displaced most prominently by solar power in New South Wales, South Australia and Queensland, and wind in Victoria.

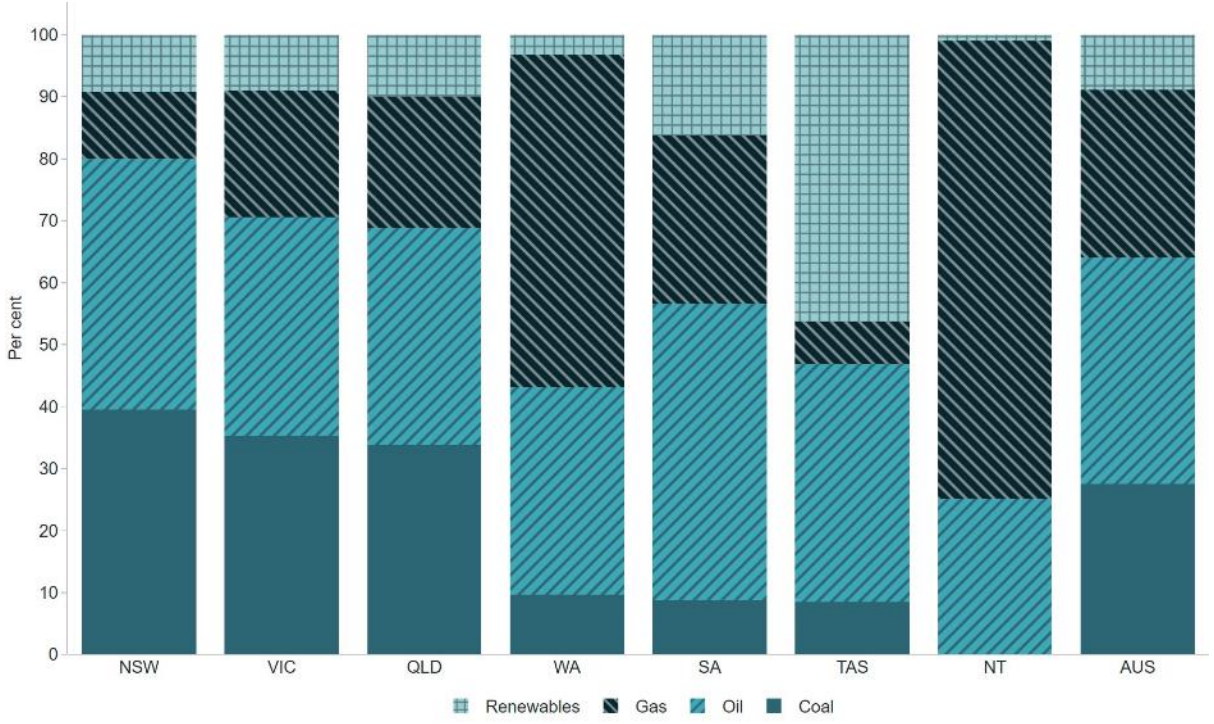
The decline of coal consumption for electricity supply in Queensland drove that state's overall energy use decline, as energy consumption in most Queensland end use sectors still increased.

Tasmania recorded an increase in energy use by the electricity supply sector due to higher total generation, all from hydro power, resulting in more network losses (recorded as consumption of electricity).

Western Australia saw Australia's only increase in coal-fired power generation activity for the year. Energy use in Western Australia, more broadly, increased 2 per cent. The state remained largely unaffected by internal COVID restrictions, meaning road transport activity was still 99 per cent of pre-pandemic levels and increased from the previous year. Commercial and residential energy use both rose due to weather factors.

Northern Territory's 3 per cent increase in energy use can be attributed to higher energy use at large LNG plants after prior operational shutdowns, and to higher residential electricity use. Another factor was a tripling in international aviation energy activity, reaching record levels, largely a result of the scheduling of non-stop flights between Darwin and London which temporarily replaced Perth routes. The fuelling of international flights at Australian airports forms part of air transport energy use, and previous Darwin flights were generally much shorter journeys within Southeast Asia (BITRE 2023b), requiring less fuel.

Figure 12 Australian energy mix, by state and territory, 2021–22



NSW includes Australian Capital Territory

Source: DCCEEW (2023) Australian Energy Statistics, Table C

The mix of fuels used in each Australian state and territory varies widely, driven by activities such as electricity generation and liquefied natural gas exports (Figure 12).

All six states' energy use includes oil as over a one-third share, which reflects the importance of oil products to transport activities in Australia. In New South Wales (40 per cent) and Queensland (35 per cent), oil has now surpassed coal as the largest energy source.

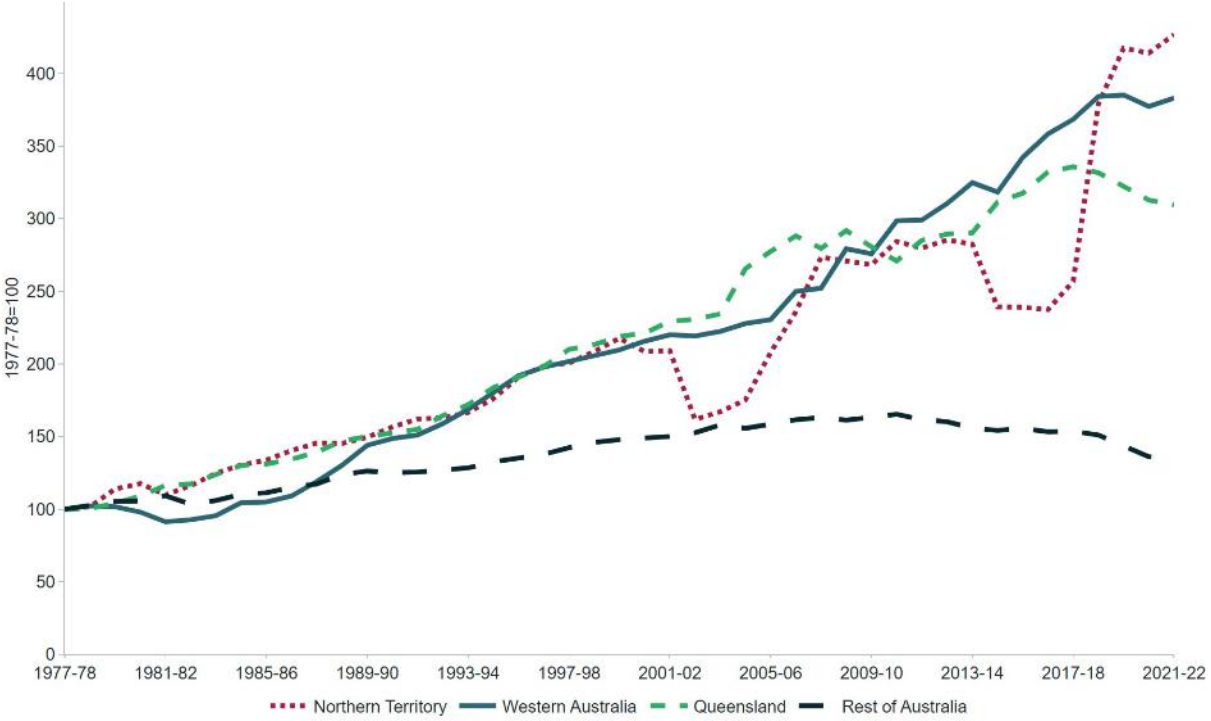
Natural gas accounted for nearly three-quarters of all energy use in Northern Territory and just over half in Western Australia in 2021–22. LNG plants in these two jurisdictions consume natural gas as they liquefy it for export, and gas is also the majority source for electricity generation.

Tasmania (46 per cent) and South Australia (16 per cent) are proportionally the heaviest users of renewable energy, due respectively to hydro power in Tasmania and wind and solar power in South Australia. Western Australia at 3 per cent and Northern Territory at 1 per cent have the lowest shares of renewable energy.

New South Wales' energy mix contains the largest share of coal, 39 per cent, due to the high percentage of electricity generation from coal. Northern Territory uses no coal and the coal shares in Western Australia, South Australia and Tasmania are also below 10 per cent.

Over the last few decades, energy consumption has grown much faster in the resources-focused economies of Queensland, Western Australia, and Northern Territory, compared with the remainder of Australia (Figure 13). Some energy consumption growth can be attributed to increased resources sector activity including the opening of LNG plants. Population growth has also contributed. These three jurisdictions have seen populations more than double since 1980, above Australia's overall growth.

Figure 13 Australian energy consumption growth, selected states and territories



Source: DCCEEW (2023) Australian Energy Statistics, Table C

Energy production

Primary production

Energy production is defined as the total amount of primary energy produced in the Australian economy, measured before consumption or transformation into secondary energy products. Forms of renewable energy that produce electricity directly without a thermal component, such as wind, hydro and solar PV, are also considered primary energy sources. Coal-fired electricity generation is considered secondary energy production and is not included, as the coal is already accounted for when mined.

Production of primary energy rose 1 per cent in 2021–22, amounting to 19,111 petajoules (Table 12). Increased natural gas production underpinned the increase, offsetting lower black coal production.

Table 12 Australian energy production, by fuel type

	2021–22 PJ	2021–22 share (per cent)	2021–22 growth (per cent)	10 year average annual growth (per cent)
Black coal	11,215.7	58.7	-1.3	1.3
Brown coal	415.7	2.2	-3.3	-5.7
Natural gas	6,076.0	31.8	6.0	10.9
Oil and NGL	723.0	3.8	0.6	-2.0
LPG	168.3	0.9	14.8	6.7
Renewables	512.5	2.7	10.3	5.7
Total	**19,111.2**	**100.0**	**1.4**	**3.1**

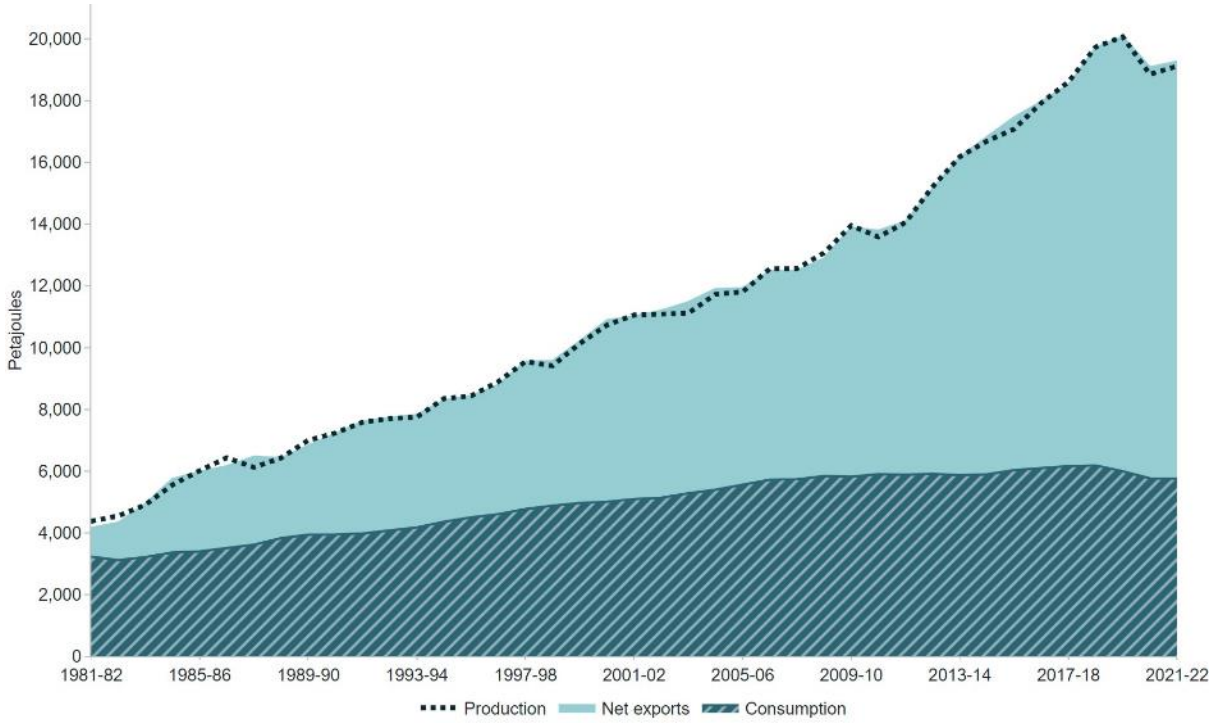
Source: DCCEEW (2023) Australian Energy Statistics, Table J

Australia is a substantial net exporter of energy, including coal and natural gas, with net exports (exports less imports) equating to over two-thirds of production (Figure 14).

At 11,216 petajoules (417 million tonnes), black coal remained by far Australia's largest contributor to energy production, with New South Wales and Queensland producing almost all black coal in Australia. Black coal production continued to be hampered by flooding and storm damage at pits, ports and rail infrastructure (DISR 2023), and was also impacted by China's restriction on coal imports from Australia until early 2023.

Brown coal production fell 3 per cent in 2021–22 to 416 petajoules (40 million tonnes). Almost all brown coal produced in Australia is used for electricity generation. Brown coal production has declined across the decade and was 55 per cent of its peak production quantity in 2009–10.

Figure 14 Australian energy balance



Note: Production equals Consumption plus Net exports, difference between these is statistical discrepancy.

Source: DCCEEW (2023) Australian Energy Statistics, Tables C, J

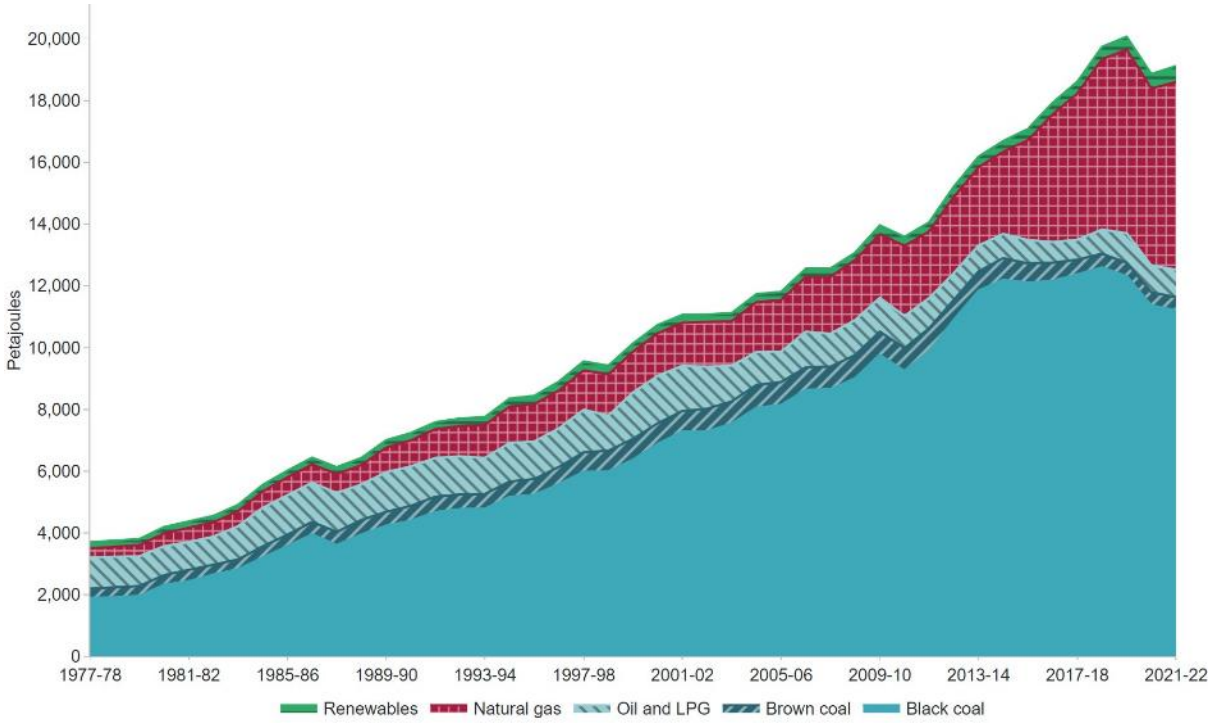
Natural gas production increased 6 per cent in 2021–22 to 6,076 petajoules (162 billion cubic metres). Production increases represent a return to previous levels after operational shutdowns the previous year. Western Australia remained Australia's largest producer of natural gas with 3,732 petajoules (99 billion cubic metres), well over half of total gas production. Western Australia produces over three times the quantity of gas it did a decade ago.

Queensland gas production of 1,541 petajoules (41 billion cubic metres) in 2021–22 was more than five times the level of a decade ago. Coal seam gas accounted for around one-quarter of Australian gas production on an energy content basis, and over two-thirds of east coast gas production.

Australia produced 723 petajoules (20 billion litres) of crude oil and natural gas liquids in 2021–22, similar to last year. Naturally-occurring LPG production, typically linked to gas or oil production, grew 15 per cent to 168 petajoules (6 billion litres) in 2021–22.

Renewable energy production continued its long-term growth record, increasing 10 per cent to reach 513 petajoules in 2021–22. Wind and solar were the major sources of growth but hydro power also increased. Renewable energy accounted for 3 per cent of total energy production in 2021–22 (Figure 15).

Figure 15 Australian energy production, by fuel type



Source: DCCEEW (2023) Australian Energy Statistics, Table J

Australia also produces uranium oxide, which is exported for use in nuclear power plants overseas. After the Ranger mine closed in 2021, uranium oxide production fell 28 per cent in 2021–22 to 4,485 tonnes, the lowest level since 1995. The International Energy Agency (IEA) measures the energy of nuclear fuels by the heat content of steam produced in nuclear reactors. Uranium oxide is therefore not counted towards primary energy production in Australia as Australia has no nuclear power generation.

Electricity generation

In 2021–22 total electricity generation in Australia increased 2 per cent, to around 272 terawatt hours (978 petajoules), as demand increased across much of the country due to warmer and cooler weather at different points of the year (Table 13).

These figures capture all electricity generation in Australia. In addition to power plant output, it includes rooftop solar PV generation, generation by industrial facilities such as in mining and manufacturing, off-grid generation, and own-use of electricity at power plants. The inclusion of these components contributes to the difference in generation to that reported by the Australian Energy Market Operator.

Table 13 Australian electricity generation, by fuel type

	2021–22 GWh	2021–22 share (per cent)	2021–22 growth (per cent)	10 year average annual growth (per cent)
Fossil fuels	**187,536**	**69.1**	**-3.7**	**-1.8**
Black coal	101,076	37.2	-4.9	-1.4
Brown coal	32,516	12.0	-4.5	-5.1
Gas	49,280	18.1	-1.0	0.1
Oil	4,664	1.7	0.0	5.6
Renewables	**83,996**	**30.9**	**18.6**	**12.2**
Solar PV	34,687	12.8	25.1	29.8
- large scale	12,569	4.6	30.4	na
- small scale	22,117	8.1	22.3	24.1
Wind	29,108	10.7	18.6	15.4
Hydro	17,011	6.3	11.9	1.9
Bioenergy	3,190	1.2	-4.7	0.5
- bagasse	1,111	0.4	-8.0	na
- wood and other[a]	649	0.2	-11.0	na
- landfill biogas	1,099	0.4	-1.2	na
- sludge biogas and biofuels	274	0.1	13.1	na
- municipal and industrial waste	57	0.0	2.7	na
Total	**271,532**	**100.0**	**2.3**	**0.8**

Notes: a includes wood waste, charcoal, sulphite lyes and other biomass

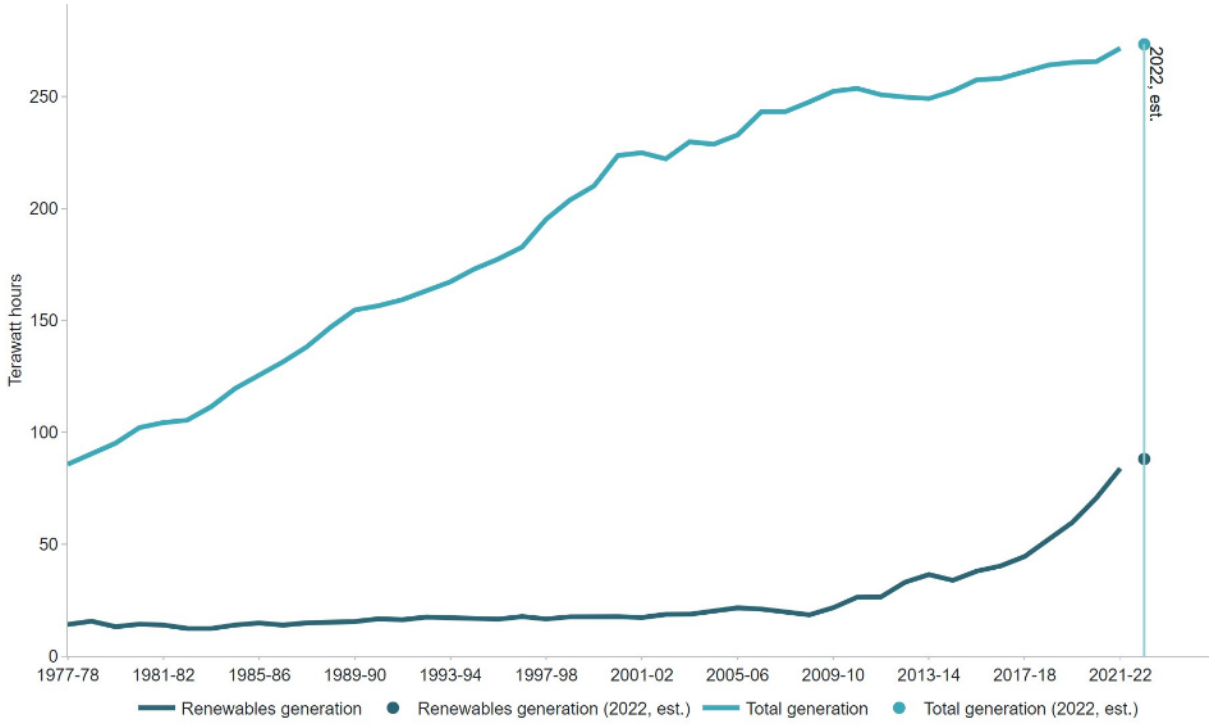
na – not available

Source: DCCEEW (2023) Australian Energy Statistics, Table O

Coal-fired generation fell 5 per cent in 2021–22, with black and brown coal-fired generation both individually falling 5 per cent. Coal remained the predominant source for electricity generation, although its share in the fuel mix fell below half, to 49 per cent, for the first time in 2021–22.

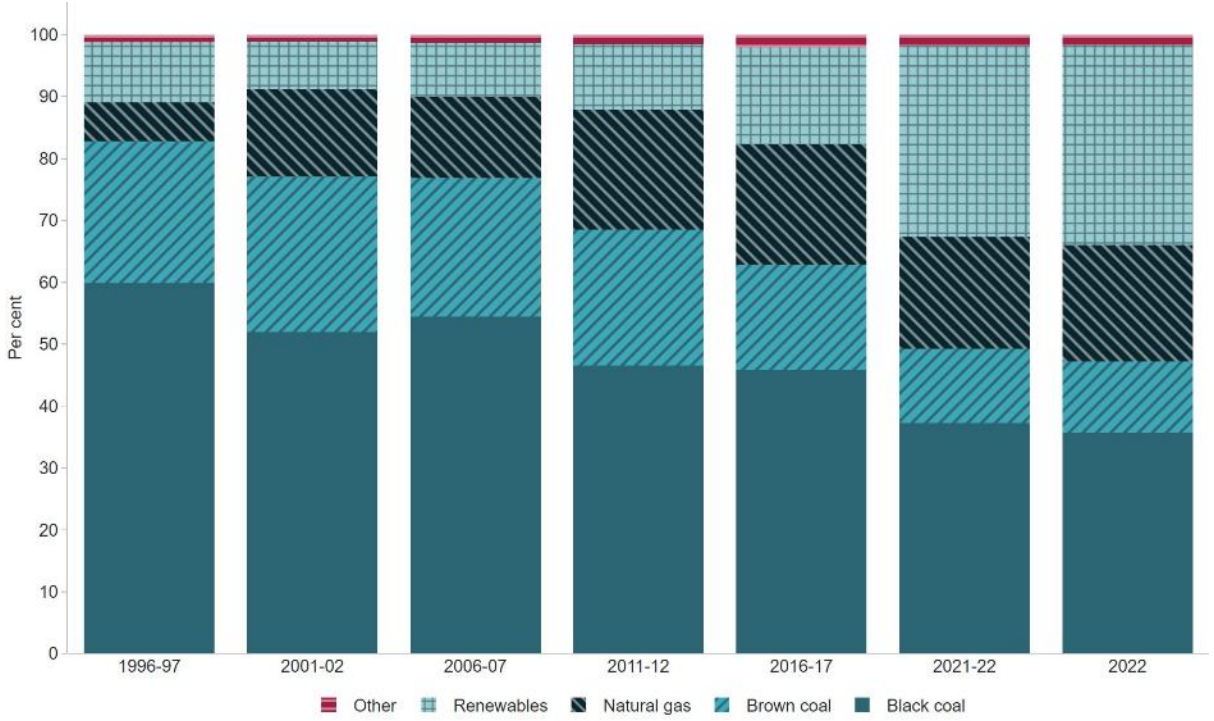
Coal's generation share has declined markedly from 68 per cent a decade ago, and a historical peak around 84 per cent in the late 1990s (Figure 17). In absolute terms there was 28 per cent less coal-fired generation in Australia than the peak level of 187 terawatt hours in 2006–07.

Figure 16 Australian electricity generation



Sources: DCCEEW (2023) Australian Energy Statistics, Table O; International Energy Agency (2023), World Energy Balances

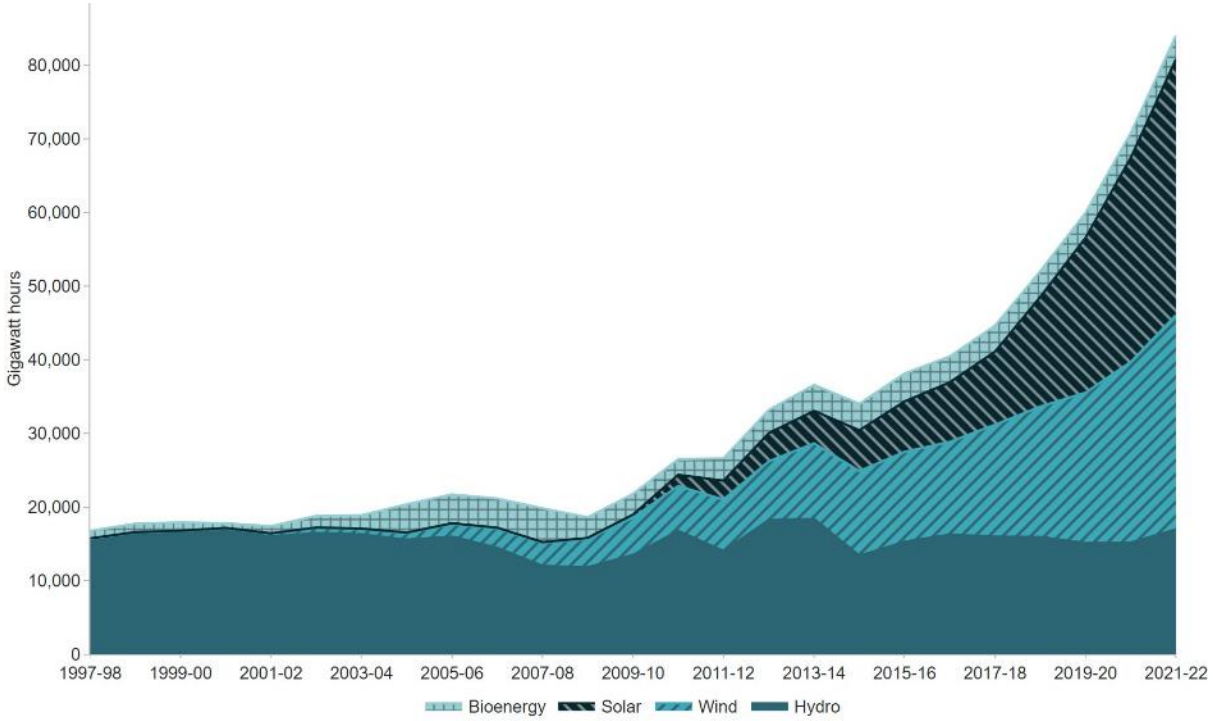
Figure 17 Australian electricity generation fuel mix



Source: DCCEEW (2023) Australian Energy Statistics, Table O

Renewable generation increased 19 per cent in 2021–22, accounting for 31 per cent of Australia's electricity generation, up four percentage points from 27 per cent last year. Renewable generation grew further in the 2022 calendar year (Figure 16).

Figure 18 Australian electricity generation from renewable sources, by fuel



Source: DCCEEW (2023) Australian Energy Statistics, Table O

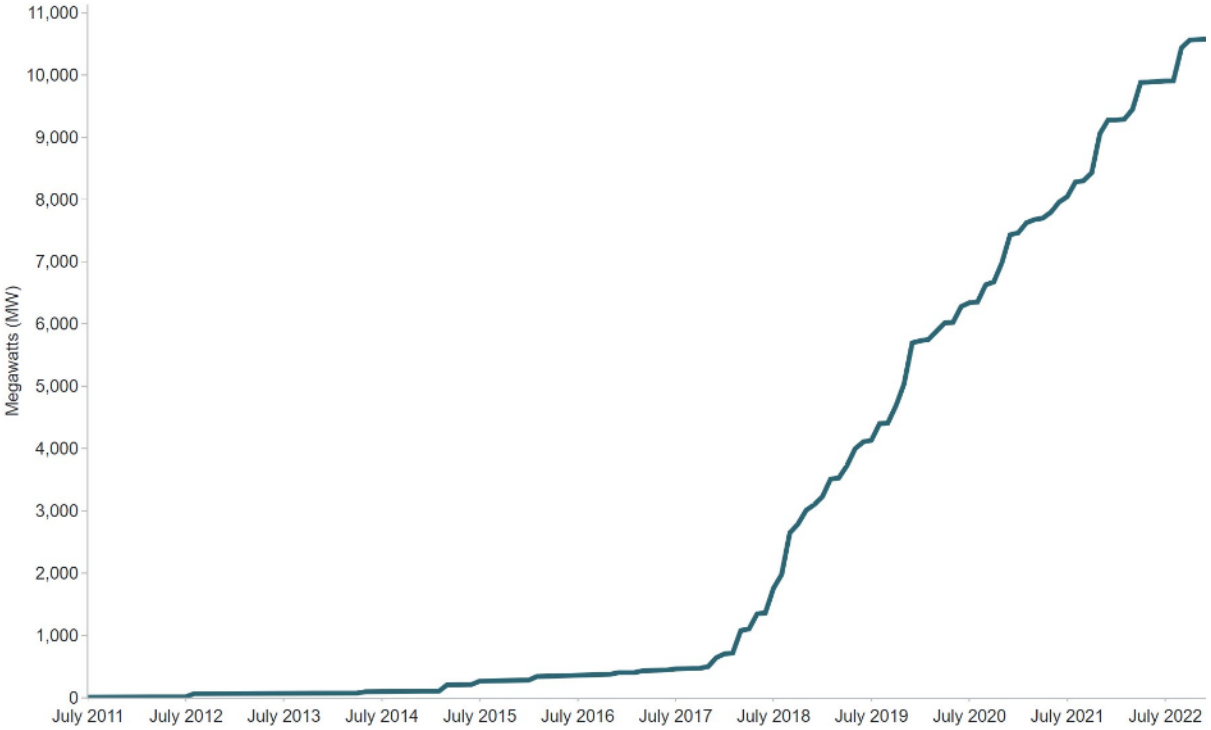
Now the largest contributor to renewable generation, solar power grew fastest again in 2021–22, widening the gap between solar power and wind generation. Solar PV accounted for 41 per cent of all renewable generation (Figure 18) and for 13 per cent of total electricity generation in Australia.

Solar electricity growth has been very rapid, growing an average of 30 per cent per year over the last decade. Large-scale, or utility-scale, generation has grown especially quickly in recent years, rising from nearly nothing about 7 years ago (Figure 19).

Wind generation rose 19 per cent in 2021–22 to contribute 11 per cent of total generation. Hydro power accounted for 6 per cent of total generation, growing 12 per cent due to increased generation in both Tasmania and New South Wales. As the composition of renewable energy has diversified significantly in Australia, the share of hydro in total renewable generation has fallen from 95 per cent in 2000–01 to 20 per cent in 2021–22.

Though now much less significant than non-thermal renewables, the use of bioenergy for electricity generation has long been a part of Australia's electricity mix, with bagasse generation in the sugar industry, and generation from landfill biogas being the predominant sources of electricity from bioenergy. Bioenergy generation fell 5 per cent in 2021–22, with most sources declining.

Figure 19 Cumulative capacity of accredited large-scale solar power stations



Source: Clean Energy Regulator (2023), Historical Large-scale Renewable Energy Target supply data

Natural gas-fired generation fell 1 per cent in 2021–22 and its share in Australia's electricity generation also fell to 18 per cent, the lowest level in a decade. Gas-fired generation fell in the largest gas-generating states of Western Australia (down 1 per cent), Queensland (down 8 per cent) and South Australia (down 23 per cent), but did grow in the smaller gas generation states of New South Wales and Victoria after a large dip the previous year.

Contributing factors to lower gas generation included higher gas prices and negative electricity wholesale prices during parts of the year. One notable factor contributing to the lowest South Australian gas-fired generation level in decades was the completion of four synchronous condensers in October 2021, which are spinning motors that reduce the need for gas generation to maintain grid stability in the heavily renewables dominated South Australian network (ElectraNet, 2023).

Oil-fired generation was steady in 2021–22 and contributed just under 2 per cent of Australia's electricity generation. As a source of electricity generation, oil is most prevalent in Northern Territory (9 per cent) and Western Australia (5 per cent) where diesel and fuel oil generation is traditionally common in remote areas far from gas, hydro and coal supply.

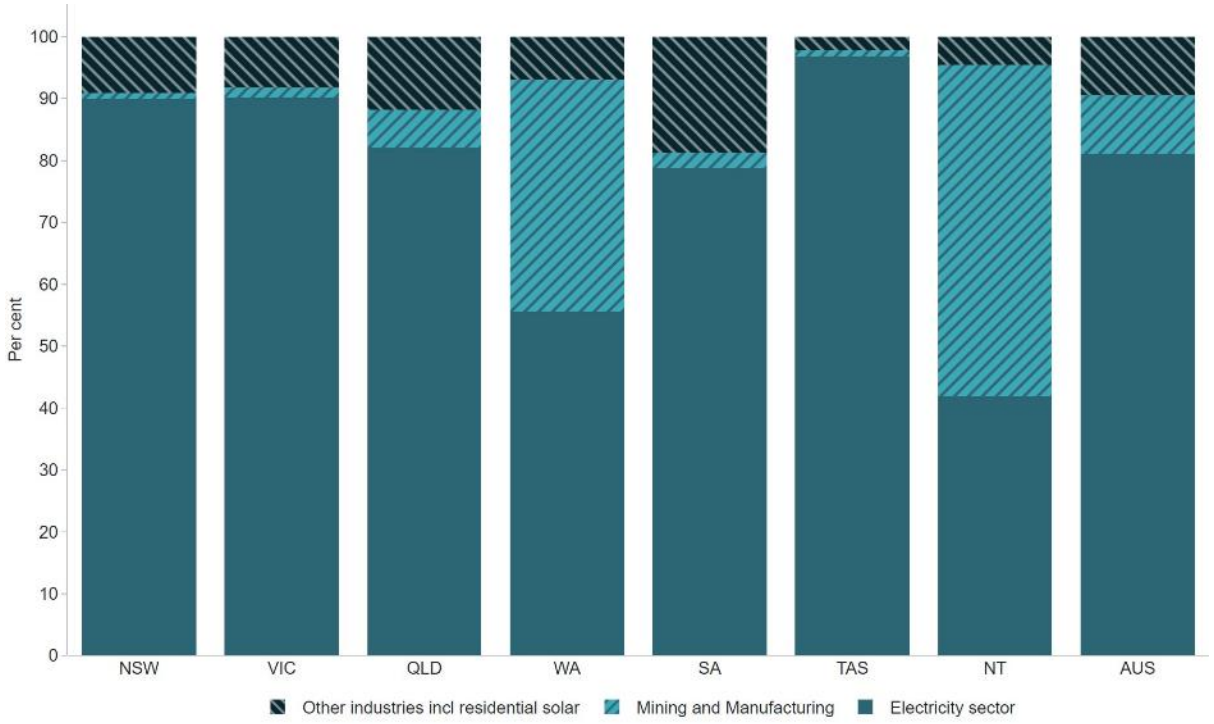
Electricity generation rose most strongly in Tasmania in 2021–22, up 13 per cent, with 17 per cent growth in hydro generation the primary driver. Full dams and generally favourable market conditions for hydro power meant that generation for export to the mainland increased in Tasmania (AEMO 2022). A 3 per cent increase in New South Wales generation was also driven partly by a 12 per cent increase in hydro output, which occurred for similar reasons to Tasmania.

About 19 per cent of Australia's electricity was generated by households and businesses outside the electricity sector (Figure 20). 38 per cent of electricity in Western Australia and 53 per cent in Northern Territory was generated by the mining and manufacturing sectors. Generation by sector is estimated using the industry classification reported by the facility, which does not differentiate between on-grid

and off-grid generation. Mining and manufacturing generation in the north and west can include on-site systems as well as contributors to electricity grid supply to population areas.

The share of total generation by the other industries and residential solar generation sector varies considerably but it is the second largest sector for electricity generation in all five states which are part of the National Electricity Market, varying from 19 per cent in South Australia to 2 per cent in Tasmania. This sector is largely dominated by solar PV generation by households, but some PV and other generation are also undertaken by a variety of business sectors.

Figure 20 Australian electricity generation, by industry, 2021–22



Note: NSW includes Australian Capital Territory

Source: DCCEEW (2023) Australian Energy Statistics, Table O

The National Electricity Market

Electricity generation discussed in the previous section covers all generation of electricity in Australia, including remote and off-grid locations, generation for own-use by mining or manufacturing businesses, and distributed solar PV generation regardless of location.

In 2021–22 about 76 per cent of Australian electricity generation was metered generation occurring on the largest national grid, the National Electricity Market (NEM). The NEM covers much of the populated area of the south and east of Australia, stretching from Port Douglas in Queensland to Port Lincoln in South Australia, and also extending to Tasmania. These areas are all physically linked by a network of transmission lines and high voltage direct current links between states.

Metered electricity generation in the NEM has remained fairly steady in recent years, sitting between 202 and 207 terawatt hours since 2016–17.

Table 14 National Electricity Market metered electricity generation, by fuel type

	2021–22 GWh	2021–22 share (per cent)	2021–22 growth (per cent)	5 year average annual growth (per cent)
Fossil fuels	**137,617**	**66.6**	**-4.9**	**-4.1**
Black coal	91,609	44.3	-5.7	-3.1
Brown coal	32,548	15.8	-4.6	-5.7
Gas	13,339	6.5	0.0	-6.4
Oil	121	0.1	141.9	2.9
Renewables	**68,793**	**33.3**	**18.1**	**15.6**
Solar PV	27,625	13.4	24.5	32.1
- large scale	10,076	4.9	29.1	78.0
- small scale	17,548	8.5	22.0	22.7
Wind	24,713	12.0	16.6	18.5
Hydro	16,273	7.9	11.2	1.0
Bioenergy	161	0.1	-11.0	-13.2
Total	**206,618**	**100.0**	**1.8**	**0.4**

Source: Global-Roam (2023) NEM Review 6 software

Note: Data includes metered generation and rooftop PV. Excludes batteries.

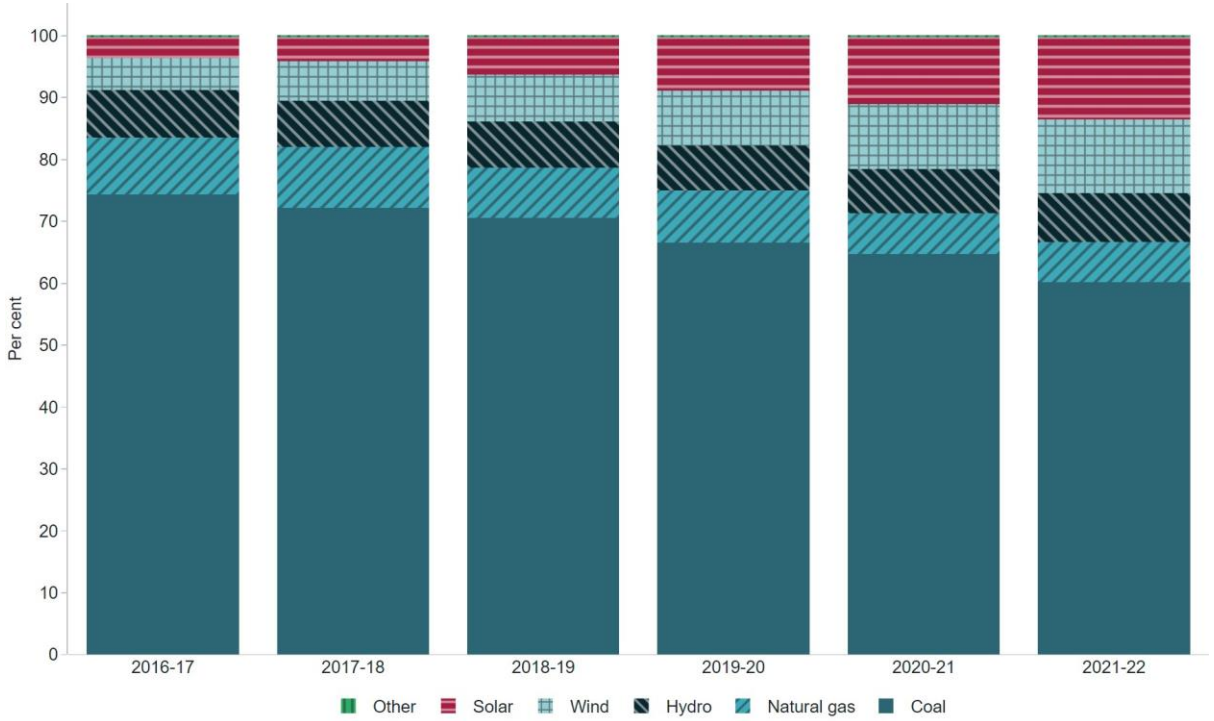
The renewables share of metered electricity generation in the NEM in 2021–22 was 33 per cent (Table 14), slightly above total electricity generation in Australia as a whole at 31 per cent (Table 13).

Renewables generation increased 18 per cent in the NEM in 2021–22 while fossil fuel generation fell 5 per cent. Over the last five years, renewable generation in the NEM grew an average of 16 per cent per year while fossil fuel generation fell 4 per cent per year.

In the last five years, gas-fired generation in the NEM has declined an average of 6 per cent per year, faster than other fossil fuels (Figure 21). Over two thirds of Australian gas-fired generation occurs

outside the NEM, principally in Western Australia and the Northern Territory, with substantial volumes generated by LNG production plants and at other off-grid facilities which generate electricity for their own use.

Figure 21 National Electricity Market metered electricity generation fuel mix



Source: Global-Roam (2023) NEM Review 6 software

Note: Data includes metered generation and rooftop PV. Excludes batteries. 'Other' includes oil products and bagasse.

Estimated electricity generation in calendar year 2022

The trends in generation in 2021–22 discussed in the previous sections are important contributors to trends in Australia's overall energy supply and use in that year. More recent estimates of electricity generation were published in June 2023 for the calendar year 2022, to improve the availability of up-to-date official data on total generation in Australia. The calendar year numbers are estimates drawn from several different sources as there is no reliable single source of calendar year data available. The methodology differs from the financial year estimates, which are largely based on data from the NGER Scheme. Please see the *Guide to the Australian Energy Statistics* for more information.

Total electricity generation in Australia was estimated to be 273 terawatt hours in calendar year 2022, up 2 per cent compared to 2021 (Table 15).

Table 15 Australian electricity generation, by fuel type, calendar year 2022

	2022 GWh	2022 share (per cent)
Fossil fuels	**185,057**	**67.7**
Black coal	97,540	35.7
Brown coal	31,411	11.5
Gas	51,505	18.8
Oil	4,601	1.7
Renewables	**88,208**	**32.3**
Solar PV	37,917	13.9
- large scale	14,039	5.1
- small scale	23,879	8.7
Wind	29,810	10.9
Hydro	17,379	6.4
Bioenergy	3,102	1.1
Total	**273,265**	**100.0**

Source: DCCEEW (2023) Australian Energy Statistics, Table O

Fossil fuel sources contributed 185 terawatt hours (68 per cent) of total electricity generation in 2022, down 3 percentage points on 2021. Coal-fired generation was 47 per cent per cent of total generation in 2022, continuing its long-term decline.

In addition to the long-term and ongoing trend of coal-fired generation decline, electricity generation fuel source trends during 2022 may also have been influenced by the dynamics of a global energy price crisis. Black coal output was negatively impacted by disruptions to fuel supply, increased reliability issues for coal generators, and a spike in global coal prices stemming from Russia's invasion of Ukraine. These events led to greater use of fuels such as gas and hydro for electricity generation, in place of coal.

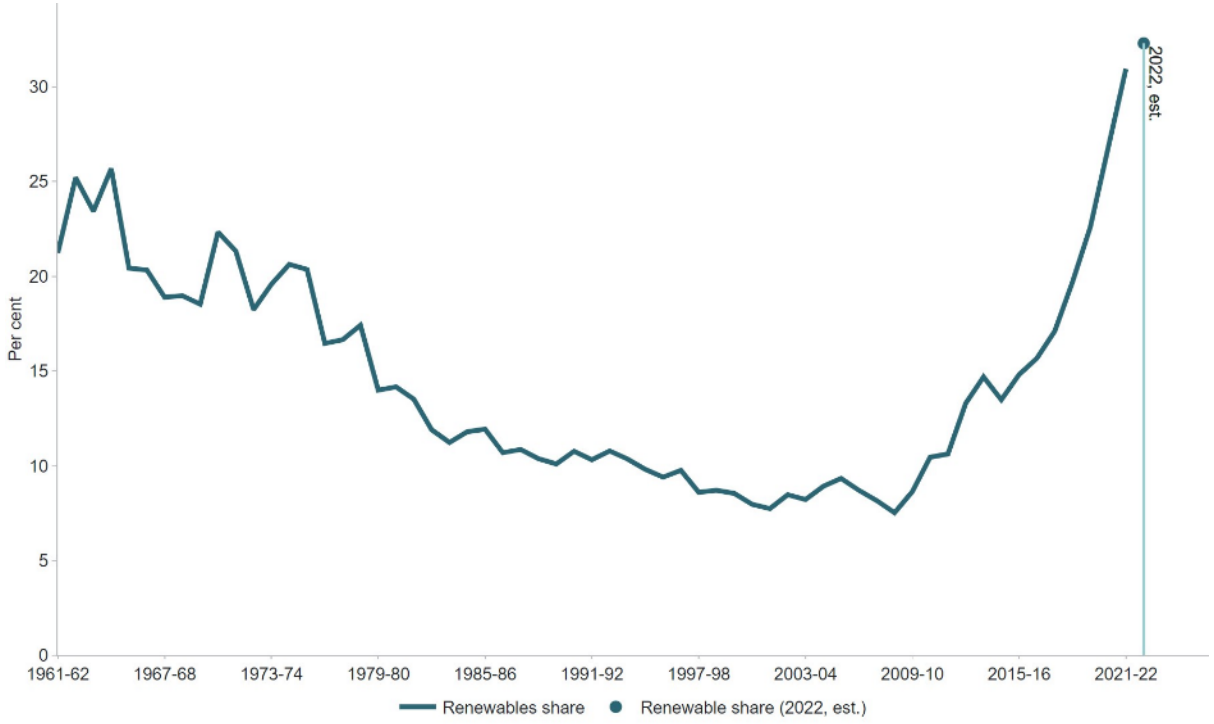
Gas-fired generation in 2022 was 19 per cent of total generation, up 1 percentage point on 2021 and also higher than in the earlier 2021–22 financial year. The Australian Energy Market Operator reported that in the last quarter of 2021, gas fired generation within the National Electricity Market reached its lowest level since 2003 (AEMO 2022). It then recovered into 2022.

Renewable sources contributed 88 terawatt hours, or about 32 per cent of total electricity generation in 2022. This share was up 3 percentage points on 2021. This represents the highest share of total generation on record, a share 1 per cent higher than the earlier 2021–22 financial year.

The historical peak of renewables share of total generation recorded was 26 per cent in 1964–65 as capacity in the Snowy Mountains hydroelectric scheme progressively came online (Figure 22) during a broader post-war expansion of electricity generation. At that time, about 9 terawatt hours of renewable electricity was generated, much lower than today's volumes.

The largest source of renewable generation in 2022 was solar (14 per cent of total generation), followed by wind (11 per cent) and hydro (6 per cent).

Figure 22 Australian electricity generation share from renewable sources



Source: DCCEEW (2023) Australian Energy Statistics, Table O; International Energy Agency (2023), World Energy Balances

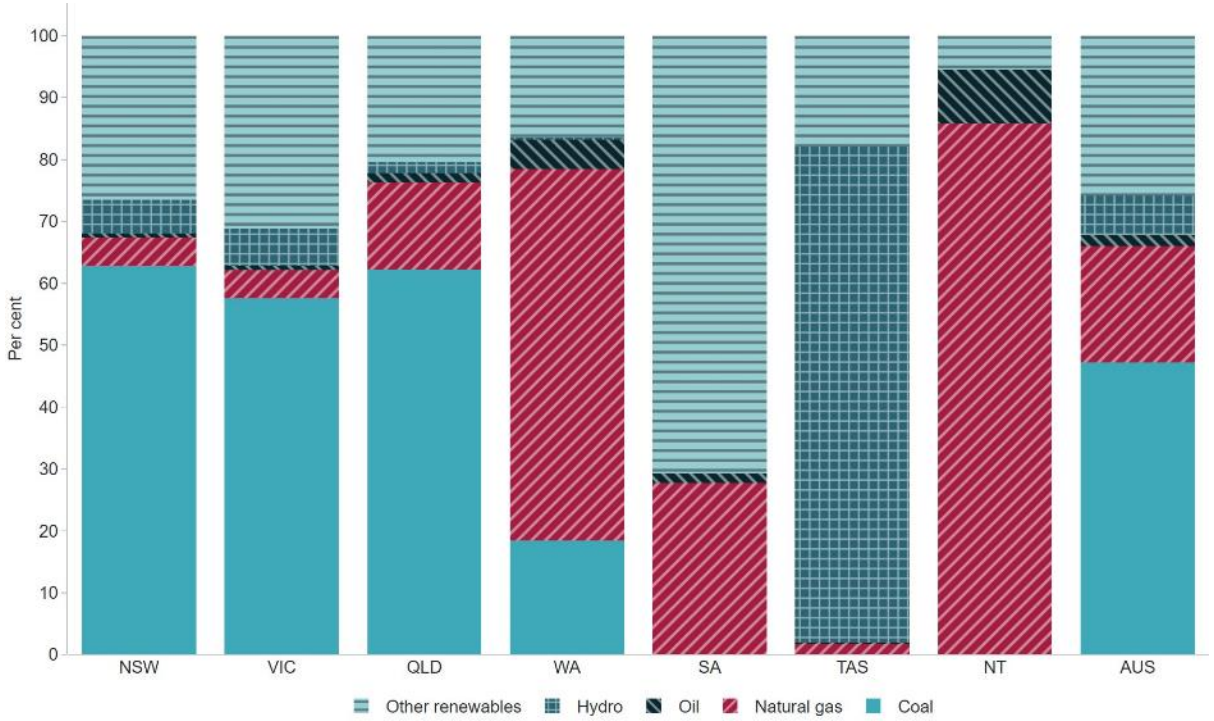
Generation sources vary across Australia. In 2022, despite continuing to recede, coal-fired generation continued to be the major source of electricity generation in New South Wales (63 per cent), Queensland (62 per cent) and Victoria (58 per cent) (Figure 23). In Victoria the generation is brown coal-fired and in Queensland and New South Wales, black coal.

Gas accounted for the majority of generation in Western Australia and the Northern Territory, and around one-quarter of South Australian generation. Western Australia accounted for just over half of Australia's gas-fired generation in 2022. In Northern Territory, Queensland, and Western Australia, gas-fired generation includes on-site generation at LNG plants, most of which are isolated systems not supplying the main state grid.

The renewable energy share of generation in 2022 was 98 per cent in Tasmania and 71 per cent in South Australia. In Tasmania, 80 per cent of all generation was hydro, while in South Australia, wind accounted for 44 per cent of generation and solar another 26 per cent.

New South Wales and Queensland were the main producers of large-scale solar electricity with 40 and 32 per cent of Australia's utility scale solar power respectively. They were also (both 28 per cent) the leading producers of small-scale solar electricity.

Figure 23 Australian electricity generation fuel mix, calendar year 2022



Note: NSW includes Australian Capital Territory

Source: DCCEEW (2023) Australian Energy Statistics, Table O

Energy trade

Exports

Australia exports most of its energy production, with exports equal to 82 per cent of production in 2021–22. Australia also exports much more than it imports, with net exports (exports minus imports) equal to 71 per cent of production.

91 per cent of black coal energy production was exported, as was 76 per cent of domestic natural gas production and 86 per cent of crude oil production. Australia's energy exports grew 1 per cent in 2021–22 to 15,623 petajoules, with liquefied natural gas driving the growth (Table 16; Figure 25).

Table 16 Australian energy exports, by fuel type

	2021–22 PJ	2021–22 share (per cent)	2021–22 growth (per cent)	10 year average annual growth (per cent)
Black coal	10,173.5	65.1	-1.5	1.8
Coal by-products	22.1	0.1	-2.5	3.1
LNG	4,636.8	29.7	7.5	16.1
Crude oil	622.9	4.0	5.0	-0.3
LPG	149.2	1.0	15.7	10.1
Refined products	18.8	0.1	-50.5	-8.8
Total	**15,623.2**	**100.0**	**1.3**	**4.2**

na – not available

Source: DCCEEW (2023) Australian Energy Statistics, Table J

Black coal remains Australia's largest energy export in energy content terms (Figure 25) and about two-thirds of all exported energy. Exports of black coal fell 1 per cent in 2021–22 in energy content terms, to 10,173 petajoules (around 359 million tonnes). China's restrictions on Australian coal imports in addition to storm-related disruptions and floods, contributed to lower coal exports (DISR 2022). Coal exports grew an average of 2 per cent per year over the last decade.

LNG exports grew 7 per cent in 2021–22, to 4,637 petajoules (around 83 million tonnes). The increase was partly due to a rebound from outage and maintenance impacts the previous year, and also driven by higher post-lockdown gas demand in Asian markets and disruptions to Russian exports following the invasion of Ukraine (DISR 2022). Exports of LNG have increased an average of 16 per cent a year over the past decade, with several new facilities commencing production in that period.

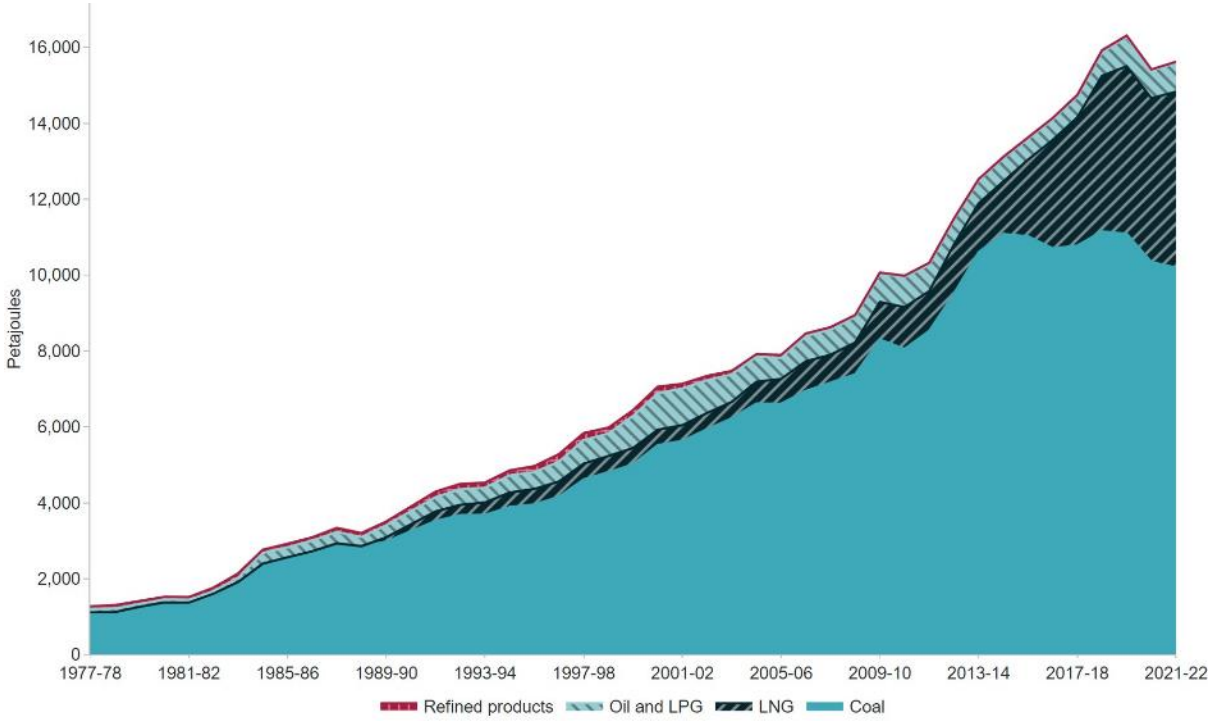
Crude oil exports rose 5 per cent in 2021–22 to 623 petajoules (17 billion litres) reflecting increased production at some of the same facilities that produce LNG.

Australia exports a small volume of refined products, though very little of Australian production is exported. Refined products exports halved with diesel, fuel oil and other product exports all decreasing substantially.

Figure 24 Australian energy trade, 2021–22

Source: DCCEEW (2023) Australian Energy Statistics, Table J

Figure 25 Australian energy exports, by fuel type

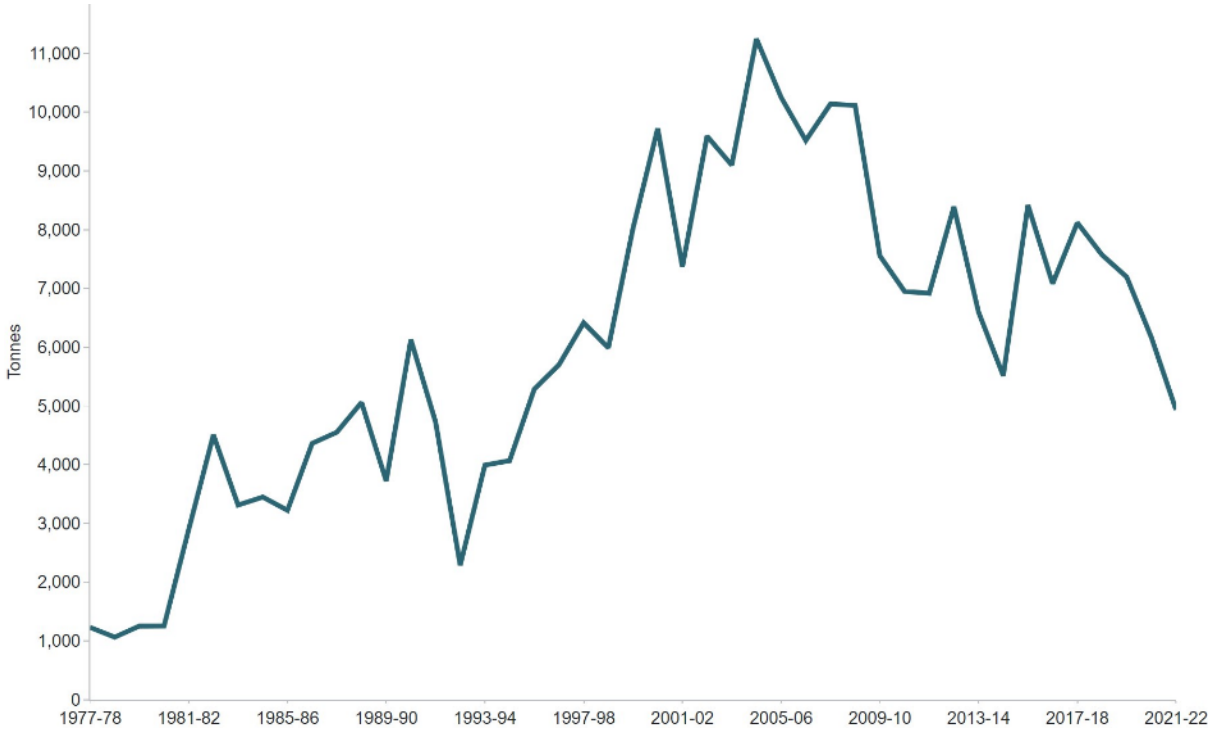


Source: DCCEEW (2023) Australian Energy Statistics, Table J

Australia also exports large volumes of uranium oxide, which is enriched overseas for use in nuclear power plants. Australia is ranked first for uranium resources and was the world's fourth largest producer in 2022 (World Nuclear Association, 2023). Uranium is not included in energy production or energy exports in the Australian Energy Statistics because it is not included in a country's energy balance. Instead, the heat content of the steam leaving the nuclear reactor for the turbine is counted, which is not applicable for Australia.

Lower production due to mine closure resulted in uranium exports decreasing 20 per cent in 2021–22, to 4,933 tonnes (Figure 26). While Australia exports all of its uranium production, the production and export figures can differ due to stockpiling and shipment timing.

Figure 26 Australian uranium exports



Source: DCCEEW (2023) Australian Energy Statistics, Table S

Imports

Australia's energy imports grew 1 per cent in 2021–22 to 2,129 petajoules (Table 17). Though imports were steady overall, the composition of imports changed substantially due to the closure of two refineries and Australia meeting more of the increased demand for refined products with imports.

Table 17 Australian energy imports, by fuel type

	2021–22 PJ	2021–22 share (per cent)	2021–22 growth (per cent)	10 year average annual growth (per cent)
Crude oil	386.6	18.2	-29.3	-10.3
LPG	20.5	1.0	21.7	-2.4
Refined products	1,554.6	73.0	16.9	7.3
Natural gas	152.1	7.1	-26.7	-2.4
Coal and coal byproducts	15.3	0.7	22.6	17.3
Total	**2,129.0**	**100.0**	**0.7**	**0.0**

Source: DCCEEW (2023) Australian Energy Statistics, Table J

Refined products and crude oil are by far Australia's largest energy imports (Figure 24), with the majority of consumption of these commodities met by imports.

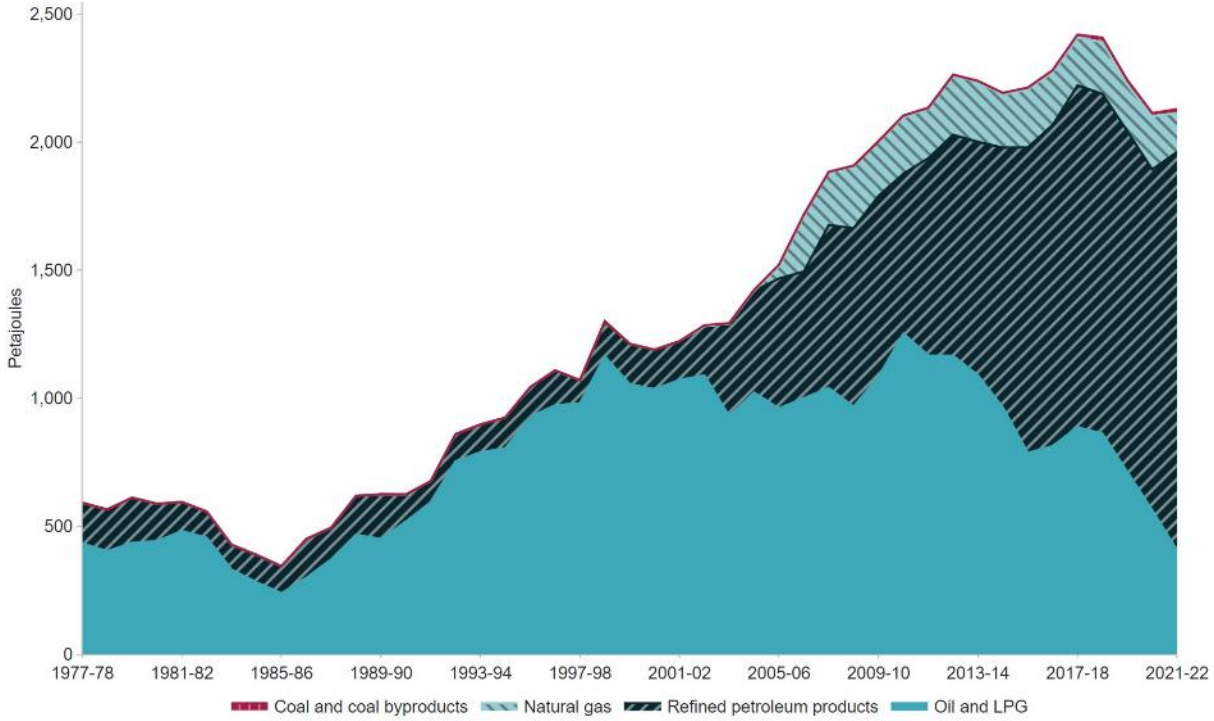
Imports of crude oil decreased 29 per cent in 2021–22, to 387 petajoules (around 10 billion litres). This reflects the fall in refinery production following the closure of the Kwinana and Altona refineries in 2021.

Imported crude oil accounted for nearly two-thirds of total refinery input in 2021–22 (Figure 27). Most of Australia's oil production occurs off the north-west coast, far from most domestic refining capacity in major cities.

Refined product imports grew 17 per cent to 1,555 petajoules (around 41 billion litres) in 2021–22. This growth was a product both of rising demand for refined products such as aviation turbine fuel and diesel, but also the shift from domestic refinery production to imports to meet this demand. Imported products accounted for around 74 per cent of total refined product consumption, the highest level on record (Figure 28).

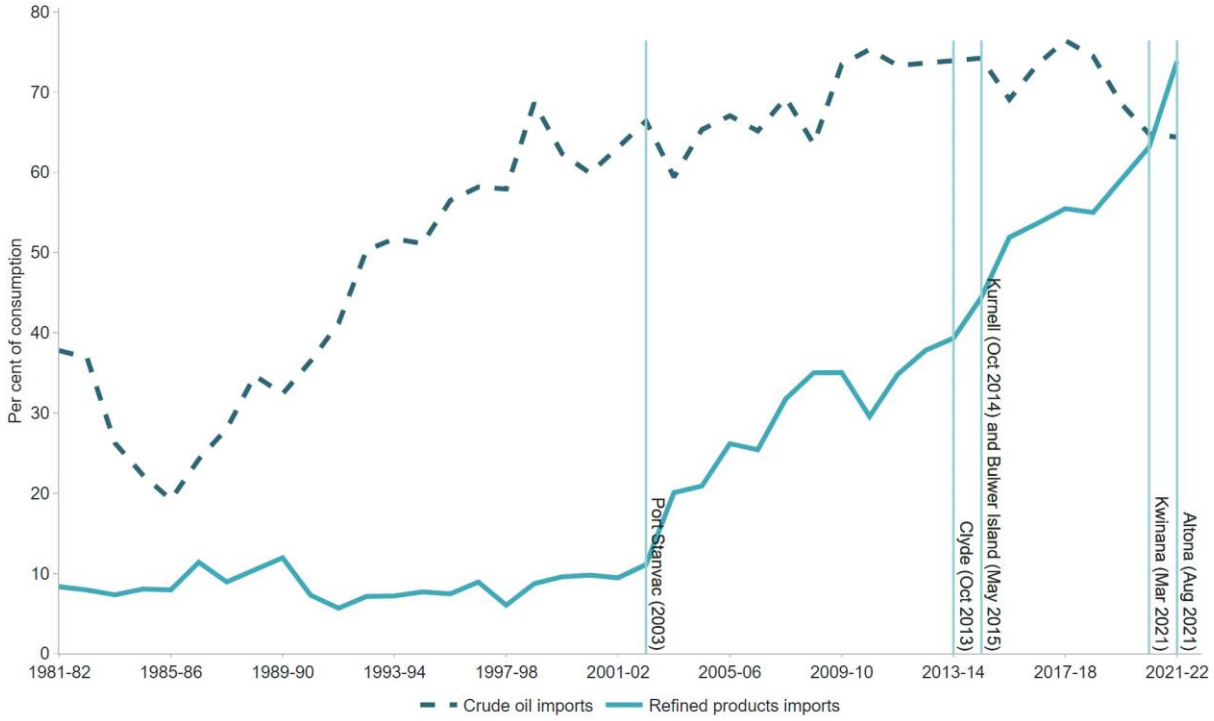
Natural gas imports are solely the gas produced in the Joint Petroleum Development Area which is sent by pipeline to be liquefied in Darwin for export. The import volume fell 27 per cent in 2021–22 due to natural field output decline (Santos, 2023).

Figure 27 Australian energy imports, by fuel type



Source: DCCEEW (2023) Australian Energy Statistics, Table J

Figure 28 Share of imports in total consumption of crude and refined products



Note: Refinery closures marked by year.

Source: DCCEEW (2023) Australian Energy Statistics, Tables D, J

References

Australian Bureau of Agricultural and Resource Economics and Sciences (2022), Agricultural commodities, Canberra.

Australian Bureau of Statistics (2020), Survey of Motor Vehicle Use, Australia, Canberra.

Australian Bureau of Statistics (2021), Motor Vehicle Census, Australia, Canberra.

Australian Bureau of Statistics (2022), Working Arrangements, Canberra.

Australian Bureau of Statistics (2023a), Australian System of National Accounts, Canberra.

Australian Bureau of Statistics (2023b), Overseas Arrivals and Departures, Australia, Canberra.

Australian Bureau of Statistics (2023c), Labour Account Australia, Canberra.

Australian Energy Market Operator (2020 to 2022), Quarterly Energy Dynamics, various editions, Melbourne.

Australian Sugar Milling Council (2023), Sugar Industry Summary Statistics, Brisbane.

Bureau of Infrastructure and Transport Research Economics (2023a), Australian Infrastructure Statistics—Yearbook 2022, Canberra.

Bureau of Infrastructure and Transport Research Economics (2023b), Aviation Statistics, Canberra.

Clean Energy Regulator (2023), Historical Large-scale Renewable Energy Target supply data, Canberra.

Department of Climate Change, Energy, the Environment and Water (2023a), Australian Energy Statistics, Canberra, September.

Department of Climate Change, Energy, the Environment and Water (2023b), Australian Petroleum Statistics, Canberra, May.

Department of Climate Change, Energy, the Environment and Water (2023c), Guide to the Australian Energy Statistics, Canberra, September.

Department of Industry, Science and Resources (2021 to 2022), Resources and Energy Quarterly, various editions, Canberra, July.

ElectraNet (2023), Power System Strength project, Adelaide

Global-Roam (2023), NEM Review 6 software, Brisbane.

International Energy Agency (2022), World Energy Balances, Paris.

Santos (2023) Annual Report 2022, Adelaide

World Nuclear Association (2022), World Uranium Mining Production, London.