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Energy and Resources**

Guide to the Australian Energy Statistics

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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.

Foreword

The *Australian Energy Statistics* (AES) 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 *Guide to the Australian Energy Statistics* aims to increase the understanding, transparency and accessibility of the AES dataset. It contains information on the publication tables, definitions and concepts, data sources and methodology, conversion factors, confidentiality and revisions.

Please direct any feedback regarding the *Australian Energy Statistics* to energy.statistics@industry.gov.au.

Energy Statistics and Analysis section
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Abbreviations and acronyms

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
ADO	Automotive diesel oil
AEMO	Australian Energy Market Operator
AES	Australian Energy Statistics
ANZSIC	Australian and New Zealand Standard Industrial Classification
APS	Australian Petroleum Statistics
BITRE	Bureau of Infrastructure and Transport Research Economics
BREE	Bureau of Resources and Energy Economics (former)
CER	Clean Energy Regulator
CSG	Coal seam gas
FES	Fuel and electricity survey
GWh	Gigawatt hours
IDF	Industrial diesel fuel
IEA	International Energy Agency
FOE	Fuel oil equivalent
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
NEM	National electricity market
NGERS	National Greenhouse and Energy Reporting Scheme
NGL	Natural gas liquids
ORF	Other refinery feedstock
OCE	Office of the Chief Economist
PJ	Petajoules
PV	Photovoltaic
TFEC	Total final energy consumption - a measure of the total energy consumed within the economy
TPES	Total primary energy supply - a measure of the total energy supplied within the economy

1. About the Australian Energy Statistics

The *Australian Energy Statistics* (AES) is the authoritative and official source of annual energy statistics for Australia. It provides information designed to increase the understanding of energy supply and use in Australia, to support decision making in government, industry and other stakeholders, and to meet Australia's annual international energy reporting obligations. This official energy dataset also supports the calculation of Australia's 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 sector. The most detailed sectoral coverage is provided in the energy-intensive manufacturing sectors. Where possible, the data is compiled and presented using concepts and definitions intended to align the AES 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. Datasets from private subscription services and industry associations are also used for comparison.

The AES has been published by the Department of Industry, Science, Energy and Resources (2020 and 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 tables available on the website is provided in Table 1.1.

The AES is accompanied by the *Australian Energy Update* report, which highlights recent trends in Australian energy consumption, production and trade.

This *Guide to the Australian Energy Statistics* is designed to assist users in better understanding the AES and how it is compiled, and to increase the transparency of the dataset. It contains information on the publication tables, definitions and concepts, data sources and methodology, conversion factors, confidentiality and historical revisions.

Table 1.1: 2021 *Australian Energy Statistics* data table index

Table name	
Table A	Australian energy supply and consumption 2018-19 and 2019-20, 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 2019–20, 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, physical units
Table R	Australian production of gas, by type, state and territory, energy units
Table S	Australian production and exports of uranium, physical and energy units

2. Coverage of the Australian Energy Statistics

2.1 Energy types

The AES includes the following energy products:

- black coal
- brown coal
- metallurgical coke
- coal by-products (including blast furnace gas, coke oven gas, coal tar and benzene/toluene/xylene feedstock)
- brown coal briquettes
- natural gas (including methane, ethane, coal seam gas and liquefied natural gas)
- hydrogen
- crude oil, condensate and other refinery feedstock
- liquefied petroleum gas (LPG)
- town gas
- petrol (including unleaded and leaded automotive gasoline)
- diesel (including automotive diesel oil and industrial diesel fuel)
- aviation gasoline
- aviation turbine fuel
- kerosene (including for lighting and power)
- heating oil
- fuel oil
- lubricants, greases, solvents and bitumen
- other refined products not elsewhere classified
- biofuels (including ethanol and biodiesel)
- biogas (including landfill biogas and sludge biogas)
- wood and wood waste (including firewood, woodchips, black liquor/sulphite lyes)
- bagasse
- other biomass and industrial waste
- electricity
 - solar electricity (including solar PV and solar thermal)
 - wind electricity
 - hydro electricity

- geothermal electricity
- thermal electricity (including coal, oil, gas and bioenergy-fired generation)
- solar hot water
- uranium oxide.

A simplified glossary of energy types is contained in Box 2.1. These are broadly consistent with the formal definitions of energy types found in the National Greenhouse and Energy Reporting Regulations 2008.

Box 2.1: Glossary of energy types

Bagasse: Fibrous residue of sugar cane milling processes used as a fuel (to raise steam) in sugar mills and in power plants for electricity generation.

Biofuels: Liquid fuels produced by chemical conversion of organic matter that results in the production of ethanol and biodiesel. It does not include the total volume of petrol or diesel into which biofuels are blended.

Biogas: A gaseous fuel derived or recovered from biomass, including landfill (garbage tips) gas and sewage gas.

Black coal: Hard coal with high energy content. In Australia, anthracite, bituminous and sub-bituminous coals are referred to as black coal.

Brown coal: Has a low energy and high ash content. It is unsuitable for export and is predominately used to generate electricity in power stations located at or near the mine. Also referred to as lignite.

Briquettes: Briquettes are manufactured from brown coal, briquetted under high pressure. Also referred to as BKB.

Coal by-products: Includes blast furnace gas (from iron and steel processing), coal tar and benzene/toluene/xylene (BTX) feedstock, and coke oven gas (from the coke making process).

Coal seam gas (CSG): Natural gas held within coal deposits, bonded to coal under the pressure of water. It may also contain small amounts of carbon dioxide and nitrogen. Also referred to as coal seam methane and coal bed methane. Included in natural gas in the AES tables.

Coke: Produced from black coal, is a porous solid composed mainly of carbon and ash, which is used in blast furnaces that produce iron.

Condensate: Hydrocarbons recovered from the natural gas stream that are liquid under normal temperature and pressure.

Conventional gas: Natural gas trapped and extracted from the pores of a petroleum reservoir rock which doesn't necessarily require fracking to produce. Includes gas from deep-water reservoirs.

Crude oil: Naturally occurring mixture of liquid hydrocarbons under normal temperature and pressure.

Geothermal energy: Heat derived from the Earth.

Hydro: Energy content of electricity produced in hydro power plants.

Liquefied natural gas (LNG): Natural gas that has been cooled to the temperature it becomes liquid at atmospheric pressure (about -160°C).

Liquefied petroleum gas (LPG): A mixture of lighter hydrocarbons, such as propane and butane. It is normally a gas at the surface. It can be naturally occurring and also produced as a by-product of crude oil refining.

Liquid fuels: All liquid hydrocarbons, including crude oil, condensate, LPG and refined petroleum products.

Natural gas: A mixture of gaseous hydrocarbons and other compounds extracted from geological reserves. Predominantly composed of methane often along with small quantities of ethane, propane, carbon dioxide and other gasses. Can be further distinguished as coming from conventional or unconventional reserves.

Natural gas liquids: Derived from the natural gas stream in separation and/or liquefaction facilities. Natural gas liquids do not include methane.

Non-renewable resources: Resources, such as fossil fuels (crude oil, gas, coal) and uranium that are depleted by extraction.

Petroleum: Generic term for all hydrocarbon oils and gases, including refined petroleum products.

Petroleum products: These include liquefied petroleum gas, refined products used as fuels (aviation gasoline, aviation turbine fuel, automotive gasoline, power kerosene, lighting kerosene, heating oil, automotive diesel oil, industrial diesel fuel, fuel oil, refinery fuel and naphtha) and refined products used in nonfuel applications (solvents, lubricants, bitumen, waxes, petroleum coke for anode production, and specialised feedstocks). Included in oil aggregates in the AES tables.

Renewable resources: Resources that can be replenished at a rate equal or greater than the rate of depletion, such as biomass, hydro, solar, wind, ocean and geothermal.

Solar energy: Generated when energy from the sun is converted into electricity or used to heat air, water and other fluids. Solar thermal is the conversion of solar radiation into thermal energy or heat, commonly used for hot water systems. Solar photovoltaic (PV) converts sunlight directly into electricity using photovoltaic cells.

Town gas: Manufactured gaseous fuels. Largely replaced by increased availability of natural gas.

Wind energy: Generated when energy from the wind is converted into electricity through a turbine. Currently in Australia, all wind turbines are on-shore.

Unconventional gas: Natural gas extracted from reserves requiring techniques that differ from those typically used to extract conventional gas (e.g. dewatering, fracking). Coal seam gas reserves are the primary source of unconventional gas in Australia.

Uranium: A mildly radioactive element that is mined and processed into uranium oxide (U_3O_8).

Wood and wood waste: Any plant material used directly for heat or converted into other forms prior to combustion. Includes firewood, woodchips, and sulphite lyes (black liquor).

2.2 Industries

Industry classifications in the AES generally follow the 2006 edition of the *Australian and New Zealand Standard Industry Classification (ANZSIC)* (ABS cat. no. 1292.0). However, to better represent energy flows throughout the economy and for consistency with international energy statistics conventions, the AES uses a modified ANZSIC classification structure. This modified classification structure contains additional classes in some industries, particularly energy intensive industries, and it aggregates energy use in other classes where appropriate. The AES industry classifications are in Table 2.1.

Physical use of fuels is assigned on the basis of activity type, rather than to industry of ownership. For example, consumption of fuel in a residential vehicle is treated as a transport activity in the AES, while an industry-based approach such as the *Energy Accounts* (ABS cat. no. 4604.0) would assign this use to the residential sector.

The IEA framework requires conversion activities occurring within industry sectors be reported separately from final consumption activities within a conversion sector. Conversion activities that have been transferred to conversion activities sections in the energy balance in Table A include electricity generation, petroleum refining, coke oven and blast furnace operations, and own use in gas transmission and distribution.

For example, electricity generation for own use at a mine site is included in the electricity supply industry in the AES. Similarly, electricity generation by households with solar panels is also counted in the electricity supply industry. The consumption of this electricity generated for own use is included in the mining and residential sectors.

While LNG processing can also be considered a conversion activity, gas used to operate liquefaction plants is currently included in the mining sector in the AES tables.

In Tables E and F, most conversion activities are aggregated with their industry sectors (e.g. manufacturing and transport sectors) with electricity supply treated as a separate industry sector. These conversion activities are aggregated by sector to maintain long-term time series comparisons. As a result, some of the sector totals in Table A differ from the sector totals in Tables E and F, but the sum of all sectors in these tables remains the same.

From 2002-03 Tables E and F concord with the above described activity-based approach to energy accounting with respect to electricity generation. In earlier years these tables report electricity generation activities according to an industry-based approach. This means that there are some structural breaks due to electricity generation activity being reported outside of the electricity supply sector before 2002-03 and within the electricity supply sector thereafter. There is insufficient historical information to address these structural breaks.

Table 2.1: Industry classification covered in the AES

Industry	Division	Subdivision	Group	Class
Agriculture, forestry and fishing	A			
Mining	B			
Coal mining		06		
Oil and gas extraction		07		
Other mining		08–10		
Manufacturing	C			
Food, beverages and tobacco		11–12		
Textile, clothing, footwear and leather		13		
Wood and wood products		14		
Pulp, paper and printing		15–16		
Petroleum refining				1701
Other petroleum and coal product manufacturing				1709
Basic chemical and chemical, polymer and rubber product manufacturing		18–19		
Non-metallic mineral products		20		
Glass and glass products			201	
Ceramics			202	
Cement, lime, plaster and concrete			203	
Other non-metallic mineral products			209	
Iron and steel			211–212	
Basic non-ferrous metals			213–214	
Fabricated metal products		22		
Machinery and equipment		23–24		
Furniture and other manufacturing		25		
Electricity, gas, water and waste services	D			
Electricity supply		26		
Gas supply		27		
Water supply, sewerage and drainage services		28–29		
Construction	E			
Commercial and services ^a	F–H, J–S			
Transport, postal and warehousing	I			
Road transport		46		
Rail transport		47		
Water transport		48		
International bunkers				
Coastal bunkers				
Air transport		49		
Domestic air transport				
International air transport				
Other transport, services and storage		50–53		
Residential				
Solvents, lubricants, greases and bitumen				

Notes: ^a Includes divisions F, G, H, J, K, L, M, N, O, P, Q, R, S. Source: Modified from ABS (2013), Australian and New Zealand Standard Industrial Classification (2006 edition), (cat. no. 1292.0).

3. Concepts and definitions

3.1 Framework

The data is compiled and presented using concepts and definitions intended to align the AES with the framework used by the IEA, where possible. This is summarised briefly below. Further information on the IEA framework can be found in the [IEA \(2005\) Energy Statistics Manual](#).

Energy commodities are either extracted or captured directly from natural resources (primary fuels), or by transforming primary fuels into other energy sources (secondary or derived fuels). Secondary fuels can also be derived from other secondary fuels.

Primary fuels: The forms of energy obtained directly from nature, involving only the extraction or collection of the energy source. They include non-renewable fuels such as coal, natural gas, crude oil and condensate, and naturally occurring LPG; and renewable fuels such as wood, bagasse, landfill gas, hydroelectricity, wind energy and solar energy.

Secondary fuels: The forms of energy that result from transforming fuels. They include electricity, petroleum products, and LPG produced in refineries. These can also be referred to as derived fuels. To avoid double counting, secondary fuels that are produced domestically are subtracted from primary fuels when calculating energy consumption.

Total primary energy supply (TPES): A measure of the total energy supplied within the economy. It is equal to indigenous production of primary fuels plus net trade of all fuels and stock changes and statistical discrepancies (Figure 3.1). TPES includes both primary and secondary fuels.

Figure 3.1: Example of Total Primary Energy Supply



Numbers may not add due to rounding.

Total energy consumption: A measure of the total energy consumed within the economy in net terms. It equal to the consumption of all fuels minus domestic production of secondary or derived fuels. At a national, economy-wide level, total net energy consumption is equivalent to total primary energy supply.

It includes fuel inputs in conversion activities—notably the consumption of fuels used to produce petroleum products and electricity—and own use and losses in the conversion sector. It also includes the consumption of secondary fuels, such as refined petroleum products, that are not produced domestically. It does

not include secondary fuels that are produced domestically, such as coke, coal by-products and petroleum products, as the energy embodied in these fuels is already accounted for in the primary fuels that they are produced from.

It is also equal to the sum of all energy consumed in end use sectors, or total final energy consumption, plus the fuel inputs in conversion activities, and own use and losses in the conversion sector (Figure 3.2).

Total final energy consumption (TFEC): The total energy consumed in the final or end-use sectors. It is equal to TPES or total energy consumption minus energy consumed or lost in conversion, transmission and distribution.

Conversion: The process of transforming one form of energy into another (derived) form before final end use. Energy used in conversion is the energy content of fuels consumed or lost in transformation and in energy transmission and distribution systems. Examples are crude oil and other hydrocarbons used as feedstock in oil refineries, and all fuels (including electricity) used in power stations. Therefore, energy used in conversion also includes energy lost in the production, conversion and transport of fuels (such as energy lost in coke production) plus net energy consumed by pumped storage after allowance for the energy produced.

Figure 3.2: Example of Total Energy Consumption



3.2 Energy balance

A commonly used format for the presentation of energy statistics is the balance in which both the sources of supply for each commodity and its uses are shown in a single column. The balance format is conceptually identical to a simple cash account where the sources of income should, when summed, balance the total expenditure after changes in cash deposits are taken into account. The energy balance seeks to show the supply of fuels used within the country and so exports are subtracted to calculate the total domestic supply.

The energy balance shown in Table A summarises the overall energy situation for Australia. The first section of an energy balance presents the energy available for domestic use. This is equal to indigenous production of primary fuels, plus imports of primary and derived fuels, minus exports, net changes in stocks and statistical discrepancies. This supply of energy is equal to total energy consumption, also referred to as total primary energy supply.

The second section of the balance describes the energy flows involved in converting primary fuels to derived fuels. Inputs to the conversion process are shown as positive and outputs (the derived fuel produced) as negative. For example, the row relating to petroleum refining shows input of crude oil feedstock, fuels such as natural gas and electricity used to provide energy for refinery processes, and an output of petroleum products. The total for this row shows the amount of non-oil fuels (natural gas and electricity) consumed in the conversion process. The quantity of petroleum products consumed as refinery fuel is shown separately in the 'Fuel use in conversion' row.

The net amount of each fuel available for final use is shown in the 'Total final energy consumption' row. The final section shows the way this final energy is used by broad end-use sectors.

4. Methodology and data sources

4.1 Overview

Data collected under the National Greenhouse and Energy Reporting Scheme (NGERS) have been adopted as the main energy consumption data source for the AES since 2011.

Under the *National Greenhouse and Energy Reporting Act 2007*, businesses that consume and/or produce above a minimum level of energy are subject to mandatory reporting requirements. These thresholds are designed to include all large energy consuming and producing entities in the Australian economy. These reporting thresholds are listed in Table 4.1. However, NGERS data represent only a subset of total Australian energy use, as households and most small to medium businesses are not required to report under NGERS.

Table 4.1: NGERS reporting thresholds

Year	Emissions				Energy
Controlling corporations ^a					
2008–09	125,000 tonnes equivalent	carbon	dioxide		0.5 petajoules consumption/production
2009–10	87,500 tonnes equivalent	carbon	dioxide		0.35 petajoules consumption/production
From 2010–11	50,000 tonnes equivalent	carbon	dioxide		0.2 petajoules consumption/production
Facilities ^b					
All years	25,000 tonnes equivalent	carbon	dioxide		0.1 petajoules consumption/production

^a If a business breaks the controlling corporation threshold it must report its energy consumption, production and/or emissions data for each facility under its control.

^b If a business does not break the controlling corporation threshold but one of the facilities under its control breaks the facility threshold, that business is only required to report for that facility.

Source: National Greenhouse and Energy Reporting Act 2007, Reporting Cycle, Clean Energy Regulator

NGERS is managed by the Australian Government Clean Energy Regulator (CER). Facility-level energy consumption and production data are sourced from the CER by authorised Department of Industry, Science, Energy and Resources officers, for the purposes of compiling the AES. The Department receives access to the latest NGERS data by the end of February each year.

In some sectors—for example, mining and non-ferrous metals—where NGERS coverage is almost universal, it is possible to use the NGERS as the predominant source of information for the AES. For most industries, there is some reporting under NGERS, but some estimation continues to be required to determine state and national industry energy consumption aggregates. In other sectors with low or no NGERS coverage, including agriculture and residential, it is necessary to rely on other information sources and/or statistical estimation techniques.

Information from other Australian government agencies, state agencies, industry associations and publicly available company reports are also used to supplement and/or validate NGERS data. These sources include trade data and various survey collections from the Australian Bureau of Statistics (ABS), the monthly *Australian Petroleum Statistics* (APS) and the *Resources and Energy Quarterly* published by the Department of Industry, Science, Energy and Resources, and datasets from the Bureau of Infrastructure, Transport and Regional Economics (BITRE), and the Australian Energy Market Operator (AEMO).

Prior to the introduction of NGERS, the Fuel and Electricity Survey (FES) compiled by ABARES, and its predecessors, was the primary data source for the AES. The FES was a nationwide annual survey of around 1,400 energy users and producers, and asked questions on the quantity of fuels and electricity they produced and consumed. The survey respondents represented around 60 per cent of total Australian energy consumption. With the introduction of NGERS, survey year 2008–09 became the final year that the FES was conducted. The FES was discontinued following the establishment of NGERS to reduce the reporting required by businesses.

The data sources and methods outlined in the following sections are the current data sources and methods used in the AES. Over time, these may change as new and improved data and information sources become available, other sources are discontinued when estimation techniques are further developed, and as the market itself changes. Accordingly, historical data series may be compiled using different sources and methods.

4.2 Energy production sources

Coal

State-level saleable black coal production data in physical units are sourced from state governments and the Department of Industry, Science, Energy and Resources estimates, as published in the *Resources and Energy Quarterly*. These are converted to energy units using the conversions in section 5.

Brown coal production data in physical units for Victoria is sourced primarily from NGERS reporting. State government reporting was formerly used for South Australian production. In the AES tables, South Australian coal production is recorded as brown coal, to meet IEA reporting requirements. These are converted to energy units using the conversions in section 5.

Production data for coke, brown coal briquettes and coal by-products are derived from a mixture of NGERS and published business reporting.

Oil

Crude oil, LPG and refined products production by state data in physical units are sourced from the monthly *Australian Petroleum Statistics* (APS). The APS data are based on survey data collected directly from companies under the *Petroleum and Other Fuels Reporting Act 2017*, supplemented by data reported to the National Offshore Petroleum Titles Administrator and public company

reports. These are converted to energy units using the conversions in section 5. Production data are cross-checked against secondary sources such as EnergyQuest.

Natural gas

Gas production includes all gas produced in Australia that is destined for export and end-users. It also includes the gas used by wells, processing plants and gas distribution and transmission systems; it does not include gas re-injected, flared or vented upstream. Gas production includes conventional and coal seam gas, as well as ethane.

Annual gas production is derived from and cross-checked against a range of sources including the *Australian Petroleum Statistics*, the AEMO Gas Bulletin Boards, ABS trade statistics, NGERS reporting, the National Offshore Petroleum Titles Administrator, publicly available state government reporting, public company reports, and secondary sources such as EnergyQuest. Physical volumes are converted to energy units using the conversion factors in section 5.

Uranium

Uranium production data in physical units are sourced from Department of Industry, Science, Energy and Resources estimates, as published in the *Resources and Energy Quarterly*.

Biomass

Biomass (including wood, wood waste, bagasse and other types of biomass) production is assumed to be equal to biomass consumption, which is the sum of consumption in each sector (detailed in the energy consumption section).

Biofuels

Ethanol production is based on NGERS reporting. Biodiesel production is assumed to be equal to consumption, which is the sum of consumption in each sector reported in NGERS (detailed in the energy consumption section).

Solar hot water

Solar hot water energy production is assumed to be equal to consumption. Use of solar energy for hot water is based on Renewable Energy Certificates, as reported by the CER. The certificates are converted into yearly energy consumption, taking into account the deeming period of ten years for small-scale Renewable Energy Certificates.

4.3 Electricity generation sources

Fuels

Financial year electricity generation by fuel data are primarily sourced from facility-level reporting in NGERS. Generation from solar PV and geothermal is

estimated using the methods below. Generation by fuel data has been supplemented and/or benchmarked using Global-roam data for the NEM, as well as data from the AEMO.

In 2015, the 'multi-fuel' fuel category for electricity generation in the AES was discontinued. Previously this included thermal generation from multiple types of fuel inputs that could not be separately identified because of insufficient company reporting. Similar data for 2013–14 were estimated separately based on average conversion efficiencies, so their fuel use and generation could be reported under specific fuel types.

The calendar year estimates for electricity generation are drawn from multiple data sources including the NGERS data, Global-roam data, data from AEMO and data from the CER including data regarding the Renewable Energy Target. Calendar year estimates include some estimates based on financial year data where detailed calendar year data is not available. For example for industrial generation and some multi-fuel generation.

Solar electricity

Small-scale solar rooftop PV generation is based on the capacity and number of solar rooftop PV installations, reported by the CER. These are converted into generation using postcode dependant rating conversion factors found in *SGU STC Calculations for Small-scale Solar Panel Systems*, produced by the CER. Large-scale solar generation is sourced from NGERS reporting and data reported by the CER.

Geothermal

The geothermal generation series is based on estimates published by the Clean Energy Council in their annual *Clean Energy Australia Report* and public information on company websites.

4.4 Energy consumption sectors

Agriculture, including forestry and fishing

Energy consumption by fuel and state is estimated using farm survey data on farm production and energy expenditure sourced from ABARES, mainly automotive gasoline, diesel and electricity use. Natural gas consumption is based on NGERS data for large users.

Mining

Energy consumption by fuel and state is based on NGERS reporting. In the 2015 AES, mining was split for the first time into three subsectors: coal mining, oil and gas extraction (including LNG) and other mining. This split has currently been estimated back to 2002–03. Confidentiality requirements around the number of reporters and the publication of NGERS data means this split cannot be published across all states and territories.

Petroleum refining

Refinery feedstock, own energy use and production of derived fuels by fuel and state is based on the monthly *Australian Petroleum Statistics*. These are converted to energy units using the conversions in section 5.

Manufacturing

Energy consumption by fuel and state is mainly based on NGERS reporting. For some sub-sectors, such as non-ferrous metals, consumption is as reported in NGERS.

For other sub-sectors, where the NGERS coverage is lower, other methods are employed to complement NGERS reporting. Most typically, growth in indicators such as industry gross value added and employment levels are used to estimate activity, though some other sources such as published business reporting or output indicators are also used.

For manufacturing, some state level data for sub-sectors has been included in totals due to confidentiality requirements.

Electricity, gas, water and waste services

Energy consumption by fuel and state, including fuel inputs to electricity generation and own use by the sectors, is sourced from facility reporting in NGERS. For a small number of facilities, inputs to thermal electricity generation have been estimated using average conversion efficiencies.

Construction

Energy consumption by fuel and state is estimated using a combination of NGERS reporting and growth in industry gross value added for the sector.

Transport

Energy consumption estimates by transport sub-sector, fuel type and state are based on three key sources: the monthly *Australian Petroleum Statistics* (APS), estimates provided to the Department by the Bureau of Infrastructure and Transport Research Economics (BITRE), and NGERS reporting. BITRE also uses the APS in preparing its estimates, adjusted based on results of vehicle fleet models, activity indicators such as trends in traffic, and freight volumes and industry surveys.

In road transport, petrol, diesel and LPG consumption are based on APS data, while natural gas and electricity consumption are estimated based on BITRE data. Biofuels consumption estimates are sourced from NGERS and the APS.

Rail transport energy use estimates are based on NGERS reporting with some adjustments for consistency based on BITRE estimates. Water transport fuel oil estimates are based on APS data, while petrol and diesel estimates are based on BITRE data. Air transport energy use data are mainly from the APS. Other transport consumption and transmission pipeline estimates are sourced from NGERS.

Residential

Residential electricity consumption is estimated using econometric techniques, based on the number of households, income, electricity price, and the number of heating and cooling degree days.

Residential gas consumption by state is estimated based on income, prices, the number of households, and the number of heating degree days.

Residential solar hot water consumption is estimated based on postcode data for small-scale installations of solar water heaters, as reported by the Clean Energy Regulator. The growth in the installation number was used to provide trend estimates. Residential wood consumption is estimated based on the *Residential Energy Baseline Study: Australia 2015*.

LPG consumption in the residential sector is estimated based on the monthly *Australian Petroleum Statistics*, converted to energy units using the conversions in section 5. Other minor fuels are estimated using average annual growth rates, which are used to provide trend estimates.

Commercial and services

This sector is the sum of ANZSIC divisions F, G, H, J, K, L, M, N, O, P, Q, R and S. Energy consumption by division by fuel and state is estimated using a combination of growth in energy consumption reported in NGERS and growth in industry gross value added and expenditure, as reported in *Australian National Accounts: State Accounts* (ABS cat. no. 5220.0). Commercial solar hot water energy consumption is based on Large-scale Renewable Energy Certificates, as reported by the CER.

Lubes, greases, bitumen and solvents

Estimates for lubricants and greases, solvents, and bitumen are based on the monthly *Australian Petroleum Statistics*, converted to energy units using the conversions in section 5. Consumption of petroleum coke and waxes are estimated using NGERS data.

4.5 Energy trade

Coal

Coal and coal product import and export data in physical units are sourced from *International Trade in Goods and Services, Australia* (ABS cat. no. 5368.0) as published in the *Resources and Energy Quarterly*. These are converted to energy units using the conversions in section 5.

Coke export volumes are not available from the ABS due to confidentiality restrictions and are estimated using a balancing approach and information from published business reporting.

Oil

Crude oil, LPG and petroleum products import and export data in physical units are sourced from *International Trade in Goods and Services, Australia* (ABS cat. no. 5368.0), as published in the monthly *Australian Petroleum Statistics*, and the *Resources and Energy Quarterly*. These are converted to energy units using the conversions in section 5.

Gas

LNG export data in physical units are sourced from *International Trade in Goods and Services, Australia* (ABS cat. no. 5368.0), as published in the *Resources and Energy Quarterly*. Natural gas imports from the Joint Petroleum Development Area are based on estimates, public company reporting, and ABS trade statistics.

Uranium

Uranium export data in physical units are estimates from the Department of Industry, Science, Energy and Resources, as published in the *Resources and Energy Quarterly*. Uranium export volumes are not available from the ABS due to confidentiality restrictions.

4.6 Stock changes

From 2016 stock changes were published separately from statistical discrepancies in order to increase the transparency of the procedures for calculating the energy balance in Table A. Previously a combined figure was published that showed stock changes in combination with statistical discrepancies.

A stock draw is an addition to supply and has a negative sign (TPES = production + imports – exports – stock changes – discrepancies). A stock build has a positive sign. Note that this is opposite to the way stocks are presented by the IEA. Where no data are available about changes in stocks these have been assumed to be zero for the purposes of the AES.

For black coal, stock changes are estimated using data for New South Wales and Queensland. Data are taken from *NSW Coal Industry: Production & Stock Report (January 2019)*, prepared by Coal Services Pty Limited, NSW, and *Queensland Government Annual Coal Production Statistics 2019*. These are converted to energy units using the conversions in section 5.

For crude oil, LPG and refined products, stock changes are taken from the monthly *Australian Petroleum Statistics*. These are converted to energy units using the conversions in section 5.

Work is underway to estimate stock changes for natural gas for future editions, which are currently included with statistical discrepancies.

5. Units and conversions

This section outlines the main units of measurement used in the AES, and conversions to other commonly used units. It also includes energy content (calorific values) conversion factors, for converting between volume/mass units and energy units.

5.1 General

Table 5.1: Units of measurement and abbreviations

Units	Metric prefixes	Other Abbreviations
J joule	k kilo 10^3 (thousand)	bcm billion cubic metres
L litre	M mega 10^6 (million)	m ³ Cubic metre
t tonne	G giga 10^9 (billion)	ft ³ cubic feet
g gram	T tera 10^{12} (trillion)	bbl barrel
W watt	P peta 10^{15}	Gcal gigacalorie
Wh watt hour	E exa 10^{18}	Mtoe million tonnes of oil equivalent
	b billion 10^9	MBtu million British thermal units

5.2 Units of volume

Liquid volumes in the AES are reported in litres. Gaseous volumes are reported in cubic metres. Conversions between other common volume units are provided in the following table.

Table 5.2: Conversion between units of volume

To:	bbl	ft ³	L	m ³
From:	Multiply by:			
bbl	1	5.615	159	0.159
ft ³	0.1781	1	28.3	0.0283
L	0.0063	0.353	1	0.001
m ³	6.289	35.3147	1,000	1

Source: IEA (2005) Energy Statistics Manual

1 L LPG = 0.254 m³ gas

1 L LNG = 0.625 m³ natural gas

5.3 Units of energy

The basic international unit of energy across all energy types is the joule (J). It is defined as the amount of work done by a force of one newton exerted over a distance of one metre. The AES reports in petajoules (PJ) or 10^{15} J. One petajoule, or 278 gigawatt hours, is equivalent to about 29 million litres of

petrol. The box below represents the energy of one petajoule in terms of some common consumer items.

The basic unit of power, or energy per unit time, is the watt (W), which is equal to one joule per second. Within the AES, electricity usage (power consumption) is typically reported in gigawatt hours (GWh).

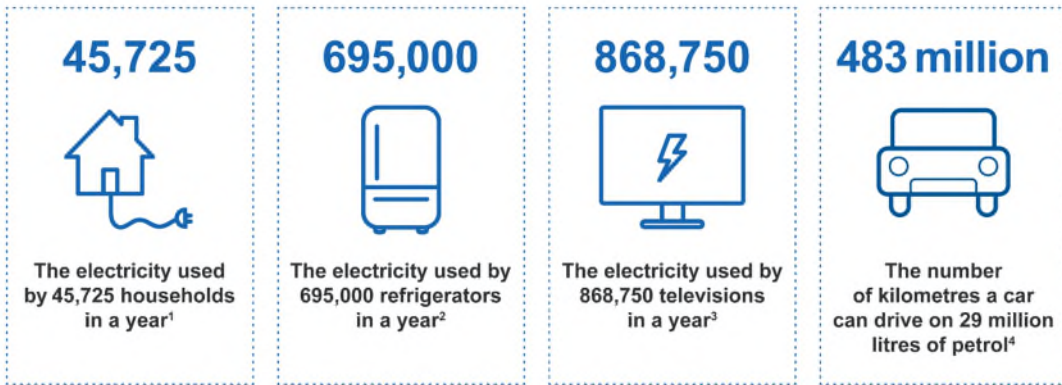
Many other units of energy are in use in Australia and internationally, including British thermal units (Btu), calories (cal) and tonnes of oil equivalent (toe). Conversions between other common units of energy are provided in Table 5.3.

Box 5.1: One petajoule explained

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.



¹Based on the average home using approximately 22 gigajoules of electricity in 2018-19
²Based on a typical 3 star fridge using 400 kWh of electricity per year
³Based on a 55 inch 5 star label television using 320 kWh of electricity per year
⁴Based on a car consuming 6 litres of unleaded petrol per 100 kilometres

Table 5.3: Conversion between units of energy

To:	PJ	Gcal	Mtoe	MBtu	GWh
From:	Multiply by:				
PJ	1	238,800	0.02388	947,800	277.8
Gcal	4.1868×10^{-6}	1	10^{-7}	3.968	1.163×10^{-3}
Mtoe	41.868	10^7	1	3.968×10^7	11,630
MBtu	1.0551×10^{-6}	0.252	2.52×10^{-8}	1	2.931×10^{-4}
GWh	0.0036	860	8.6×10^{-5}	3,412	1

Source: Based on IEA (2005) *Energy Statistics Manual*.

5.4 Energy content conversions

Sometimes the data collected are in quantity terms rather than energy content, particularly for production and trade. To enable comparability, and to construct an energy balance, it is necessary to present supply and consumption data consistently in energy terms. This requires the conversion of units such as litres and tonnes to energy units, an exercise that can involve a significant degree of uncertainty. For example, the energy content of a tonne of coal can vary according to its region or locality of origin, and according to the maturity of the mine from which it was extracted. Similarly, conversion factors for other primary energy sources such as crude oil, natural gas and wood, can also vary by region and other factors.

The heating or energy or calorific value of a fuel type is the quantity of heat released during the combustion of a specified amount of that fuel. The gross energy content includes all of the heat released from the fuel, including any carried away in the water formed during combustion. The net value excludes the latent heat of the water formed during combustion. The differences between gross and net are typically about 5–6 per cent of the gross value for solid and liquid fuels, and about 10 per cent for natural gas (IEA 2005 Energy Statistics Manual).

The factors used in the following tables are used when converting individual types of fuel from volume or weight to energy content, or vice versa. The values are indicative only because the quality of any fuel varies with factors such as location and air pressure. Values given here apply at a temperature of 15°C and a pressure of 1 atmosphere (101.3 kilopascals).

The values are the gross energy content of the fuel; that is, the total amount of heat that will be released by combustion.

These conversions are broadly consistent with those in the *National Greenhouse and Energy Reporting (Measurement) Determination 2008*.

Table 5.4: Gross energy content of solid fuels

GJ/t		GJ/t	
Black coal		Brown coal	
<i>New South Wales</i>		<i>Victoria</i>	10.3
Exports		Briquettes	22.1
metallurgical coal	29	<i>South Australia</i>	12.4
thermal coal	27		
Electricity generation	23	Uranium	
Steelworks	32	Metal (U)	560,000
Other	23	Uranium oxide (U ₃ O ₈)	470,000
<i>Queensland</i>			
Exports		Other	
metallurgical coal	29	Coke	27.0
thermal coal	27	Wood (dry)	16.2
Electricity generation	21	Wood (green)	10.4
Other	23	Bagasse	9.6
<i>Western Australia</i>			
Thermal coal	19.7		
<i>Tasmania</i>			
Thermal coal	22		

Source: NGERs, state government reporting.

Table 5.5: Gross energy content of gaseous fuels

	MJ/m ³
Natural gas (production)	
Victoria	38.0
Queensland	37.5
Western Australia	38.0
South Australia, New South Wales	37.5
Northern Territory	37.5
Australia (average)	37.9
Ethane (average)	64.7
Town gas	39.0
Coke oven gas	18.1
Blast furnace gas	4.0

Source: Australian Petroleum Statistics, NGERs, state government reporting.

Table 5.6: Gross energy content of liquid fuels

	Volume	Specific volume	Weight
	MJ/L	L/t	GJ/t
Primary Products			
Crude oil and other refinery feedstocks			
indigenous (average)	37.0	1,250	46.3
imports (average)	38.7	1,160	44.9
LPG			
naturally occurring (average)	27.0	1,866	49.4
Refined Products			
Automotive diesel oil	38.6	1,182	45.6
Automotive gasoline	34.2	1,360	46.4
Aviation gasoline	33.1	1,412	46.8
Aviation turbine fuel	36.8	1,261	46.4
Ethanol	23.4	1,266	29.6
Fuel oil low sulphur	39.7	1,110	44.1
Heating oil	37.3	1,238	46.2
Industrial diesel fuel	39.6	1,135	44.9
Lubricants and greases	38.8	1,120	43.4
bitumen	44.0	981	42.7
solvents	34.4	1,229	44.0
waxes	38.8	1,180	45.8
LPG			
propane	25.5	1,960	49.6
butane	28.1	1,760	49.1
mixture	25.7	1,890	49.6
Methanol	15.6	1,263	19.7
Naphtha	31.4	1,534	48.1
Power kerosene	37.5	1,230	46.1
Refinery fuel (fuel oil equivalent)	39.7	1,050	42.9
Other Products			
Liquefied Natural Gas	25.0	2,174	54.4

Source: Australian Petroleum Statistics, NGERS.

6. Confidentiality

The *National Greenhouse and Energy Reporting Act 2007* details confidentiality requirements for reporting information. When releasing statistics it must be done in a way that is not likely to enable the identification of an individual person or organisation, either directly or indirectly. This requires the application of statistical methods, which preclude identification, while allowing sufficient detailed information to be released to make the statistics useful. Most commonly, this involves removing or altering information, or collapsing detail.

For instance, if a cell in a published table of the AES were to contain data from only a small number of companies (or from many companies but only one or two predominated) then it could be possible for a third party to deduce information about the companies involved. Identification or disclosure risks could also be present where separate tables of the AES contained common elements that could be compared to reveal specific information.

In order to mitigate against these identification and disclosure risks, data concerning some fuel types and industries in the AES tables are aggregated or withheld from the published tables. Where confidentiality measures extend beyond the fuel types and industries narrowly affected by confidentiality issues (e.g. where information could be deduced by subtracting other published data from an aggregate) this is noted in the tables.

Departmental officers are bound by restrictions on the access, use and publication of NGERs data under the *National Greenhouse and Energy Reporting Act 2007*.

7. Revisions

Revisions are made to the AES to update the data in previous years of the series. These revisions are made to ensure that the AES presents an accurate picture of Australian energy production and use, including in historical periods. Often a revision will reflect changes in source data, such as the NGERS or APS. The AES can also be revised to correct errors or to account for changes in estimation techniques.

Estimation methods are regularly reviewed due to changes in data availability or because of broader structural changes within industries. When new estimation methods are implemented these can sometimes create structural breaks in existing data series. To reduce the impact of structural breaks, new estimation methods are usually applied or 'back-casted' to previous time periods of the series.

In the 2021 edition of the AES, consumption of diesel and electricity was revised for the construction sector back to 2008–09 based on improved estimates in line with ABS data sources. To maintain the supply and use balance, own use of electricity in the electricity generation sector was also adjusted.

The APS data was recently updated with the introduction of mandatory reporting obligations for petroleum producers and sellers. The transport sector oil consumption estimates were revised for the past number of years to make the estimates consistent with the petroleum sales numbers published in the APS. Consumption of gasoline and LPG for road transport sector was revised back to 2016-17 and 2017-18 respectively. Diesel consumption in rail and international water transport sectors was revised for 2018-19. Fuel oil consumption in water transport sector, and aviation gasoline and turbine fuel consumption in air transport sector was revised back to 2014-15.

The method used to estimate activity levels for fuels and sub-sectors within the manufacturing sector with lower NGERS coverage was updated to include employment alongside Industry Value Added as an additional measure of activity level, and also to include a conservative efficiency assumption.

Electricity consumption estimates were revised back to 2008–09 for a number of lower-electricity-using manufacturing sectors, in line with ABS data sources. This revision impacted on historical state level electricity consumption within several NEM states.

Additionally, some small estimates of consumption for coal and some coal by-products were revised and in some cases discontinued in line with the most recent NGERS data.

For further information, please contact energy.statistics@industry.gov.au.