



**Australian Government**

**Department of the Environment and Energy**

# **Guide to the Australian Energy Statistics 2017**

August 2017



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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 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. It is available at [www.environment.gov.au/energy/energy-statistics](http://www.environment.gov.au/energy/energy-statistics)

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 [Australianenergystatistics@environment.gov.au](mailto:Australianenergystatistics@environment.gov.au).

Energy Statistics and Analysis section  
Department of the Environment and Energy  
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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, Transport and Regional 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
TPES	Total primary energy supply

# 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 and industry, and to meet Australia's annual international energy reporting obligations. This official energy dataset also underpins 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 industry, in energy content and physical units. The most detailed sub-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 databases, estimates using statistical techniques, and public company reporting. Datasets from private subscription services and industry associations are also used.

The AES has been published by the Department of the Environment and Energy (2017), 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 made available through a series of tables in Excel format at <http://www.environment.gov.au/energy/energy-statistics>. A list of the AES tables available on the website is provided in Table 2.1.

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 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.

The AES main unit is petajoules (PJ).  $1 \text{ PJ} = 1 \times 10^{15}$  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. A car using 6.7 litres of petrol per hundred kilometres could drive around 436 million kilometres on one petajoule.

Table 1.1: 2017 *Australian Energy Statistics* tables

<i>Table name</i>	
Table A	Australian energy supply and consumption, energy units
Table B	Australian energy intensity and energy consumption per person, by state, energy units
Table C	Australian energy consumption, by state, by fuel, energy units
Table D	Australian energy consumption, by state, by detailed fuel, energy units
Table E	Australian energy consumption, by state, by industry, energy units
Table F	Australian energy consumption, by state, by industry, by fuel, energy units
Table G	Australian energy consumption, by state, by fuel, physical units
Table H	Australian total final energy consumption, by fuel, by industry, energy units
Table I	Australian production of primary fuels, by state, physical units
Table J	Australian energy supply and trade, by fuel type, energy units
Table K	Australian consumption of petroleum products, by state, physical units (under review)
Table L	Australian consumption of electricity, by state, 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, by fuel type, physical units
Table P	Australian consumption and production of coal, by state, physical units
Table Q	Australian consumption and production of natural gas, by state, physical units
Table R	Australian production of gas, by type and state, 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
- other refined products not elsewhere classified
- lubricants, greases, solvents and bitumen
- 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. <http://www.cleanenergyregulator.gov.au/NGER/Legislation>

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Box 2.1: Glossary of energy types

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

**Biofuels:** Liquid fuels produced by chemical conversion processes that result 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, coke oven gas (from the coke making process), and black liquor (sulphite lyes).

**Coal seam gas:** Methane 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.

**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:** Natural gas which has been cooled to temperature (about -160°C) at which it becomes liquid at atmospheric pressure.

**Liquefied petroleum gas:** 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 other refined petroleum products.

**Natural gas:** Methane that has been processed to remove impurities to a required standard for consumer use. It may contain small amounts of ethane, propane, carbon dioxide and inert gases such as nitrogen. In Australia, natural gas comes from conventional gas and coal seam gas. It includes sales gas, gas consumed by processing plants and transported in pipelines, but does not include gas re-injected, flared or vented.

**Natural gas liquids:** Derived from the natural gas stream in separation and/or liquefaction facilities, excludes 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.

**Uranium:** a mildly radioactive element that once mined is 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, sulphite lyes (black liquor).

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## 2.2 Industries

Industry classifications in the AES generally follow the 2006 edition of the Australian and New Zealand Standard Industry Classification (ANZSIC) in 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 classification is detailed 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 ABS Energy Accounts (cat. no. 4604.0) would assign this use to the residential sector.

The IEA framework requires that conversion activities that occur within industry sectors be moved to the conversion sector. Conversion activities that have been transferred to the conversion sector 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 PV panels is also counted in the electricity supply industry.

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, some conversion activities such as petroleum refining, coke oven and blast furnace operations and own use in gas transmission and distribution are aggregated with their industry sectors (e.g. manufacturing and transport sectors). 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 total in Tables E and F, but the sum of all sectors in these tables remains the same.

Revisions were made in the 2011 and 2012 editions of the AES to classify all relevant electricity generation activities within the electricity supply sector. Previously an industry-based approach was used and many electricity generation activities were classified in sectors such as manufacturing and mining. These revisions were made back to 2002–03 and this has created some structural breaks in subsector time series in Table F. There is currently insufficient information to address these structural breaks.

Table 2.1: Industries covered in the AES

<i>Industry</i>	<i>Division</i>	<i>Subdivision</i>	<i>Group</i>	<i>Class</i>
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 <b>a</b>	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.

### 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*.

<http://www.iea.org/statistics/resources/manuals/>

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.

Total energy consumption in the AES is a net concept. To avoid double counting, secondary fuels that are produced domestically are subtracted from primary fuels. At an aggregate level, it is equivalent to the IEA concept of total primary energy supply.

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

Figure 3.1: Total primary energy supply



**Total net energy consumption:** A measure of the total energy used within the economy. At an aggregate level, total net energy consumption is equivalent to total primary energy supply. It is equal to consumption of all fuels minus the secondary or derived fuels produced within the economy, which is equivalent to the total consumption of primary fuels in both the conversion and end-use sectors plus net imports of transformed fuels. This term is most useful when

describing total energy use at an industry or regional level, as TPES is not applicable in these circumstances.

Total net energy consumption 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 transformed 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 (Figure 3.2).

**Total final energy consumption (TFEC):** The total energy consumed in the final or end-use sectors. It is equal to TPES less 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 as well as transformed by energy producing industries. Examples are gas and liquefied petroleum gas used in town gas manufacturing, all 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: Total net 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, less exports, less 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
<b>Controlling corporations <sup>a</sup></b>		
2008–09	125 000 tonnes carbon dioxide equivalent	500 terajoules consumption/production
2009–10	87 500 tonnes carbon dioxide equivalent	350 terajoules consumption/production
From 2010–11	50 000 tonnes carbon dioxide equivalent	200 terajoules consumption/production
<b>Facilities <sup>b</sup></b>		
All years	25 000 tonnes carbon dioxide equivalent	100 terajoules consumption/production

<sup>a</sup> 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.

<sup>b</sup> 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: CER, <http://www.cleanenergyregulator.gov.au/NGER/Reporting-cycle>

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 the Environment and Energy 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 predominate 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) published by the Department of the Environment and Energy, the *Resources and Energy Quarterly* published by the Department of Industry, Innovation and Science, 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 the Australian Bureau of Agricultural and Resource Economics and Sciences (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 so as 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, as estimation techniques are further developed, and as the market itself changes. As such, historical data series may be compiled using different sources and methods.

## 4.2 Energy production

### Coal

State level saleable black coal production data in physical units are sourced from state governments and Department of Industry, Innovation and Science estimates, as published in the *Resources and Energy Quarterly* and the *Resources and Energy Statistics Annual*. 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 is 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 sourced primarily from NGERS reporting in energy units.

## 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, supplemented by data reported to 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 gas used by processing plants and gas transported in pipelines, but does not include gas re-injected, flared or vented. Gas production by basin data in physical units are sourced from the *Australian Petroleum Statistics*. The APS data are based on survey data collected directly from companies, data reported to National Offshore Petroleum Titles Administrator, data reported to state governments, the AEMO Gas Bulletin Board, and public company reports. Gas production includes conventional and coal seam gas, as well as ethane. Physical volumes are converted to energy units using the conversion factors in section 5. Production data are cross-checked against NGRS reporting and secondary sources such as EnergyQuest.

## Uranium

Uranium production data in physical units are sourced from company reports and Department of Industry, Innovation and Science estimates, as published in the *Resources and Energy Quarterly*. These are converted to energy units using the conversions in section 5.

## 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 NGRS reporting. Biodiesel production is assumed to be equal to consumption, which is the sum of consumption in each sector reported in NGRS (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

Electricity generation by fuel data are primarily sourced from facility level reporting in NGERs. Some facility level reporting, not currently captured in NGERs, has been included from state government sources. 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 market operators of Australia's electricity networks.

In 2015, the 'multifuel' 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 scope for reallocating multifuel generation in previous years may be considered in future editions of the AES.

#### 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

#### Agriculture

Energy consumption by fuel and state is estimated, based predominantly on farm survey data on energy expenditure sourced from ABARES, mainly for automotive gasoline, diesel and electricity use, and partially on NGERs data for large users, mainly for natural gas.

#### Mining

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

## 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 iron and steel and non-ferrous metals, consumption is as reported in NGERS. For other sub-sectors, where the NGERS coverage is lower, the growth reported by those facilities covered in NGERS is used to estimate energy consumption for the sub-sector as a whole. 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 subsector, fuel type and state are based on three key sources: the *Australian Petroleum Statistics* (APS), estimates provided to the Department by 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 and LPG consumption are based on APS data, while diesel and natural gas consumption are based on BITRE data (which accounts for vehicle kilometres travelled and fuel intensity for each state, each fuel type and each vehicle type). 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. Similarly, water transport energy use estimates are mainly from BITRE and NGERS. Bunkers are based on the APS. Air transport energy use data are mainly from the APS, with additional splits from BITRE estimates. Other transport consumption and transmission pipeline estimates are sourced from NGERS.

## Residential

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

Residential gas consumption by state is estimated based on population, income, prices and number of households.

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 ABS *Environmental Issues: Energy Use and Conservation, Mar 2014* survey (cat. no. 4602.0.55.001).

LPG consumption in the residential sector is as reported in the *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 growth value added, as reported in ABS cat. no. 5220.0 *Australian National Accounts: State Accounts*. 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 ABS cat. no. 5368.0 *International Trade in Goods and Services, Australia*, 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.

### Oil

Crude oil, LPG and petroleum products import and export data in physical units are sourced from ABS cat. no. 5368.0 *International Trade in Goods and*

*Services, Australia*, as published in the monthly *Australian Petroleum Statistics*, and *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 ABS cat. no. 5368.0 *International Trade in Goods and Services, Australia*, as published in the *Resources and Energy Quarterly*. These estimates are converted to energy units using the conversions in section 5. Natural gas imports from the Joint Petroleum Development Area are based on estimates and public company reporting.

## Uranium

Uranium export data in physical units are Department of Industry, Innovation and Science estimates, as published in the *Resources and Energy Quarterly*. Uranium export volumes are not available from the ABS due to confidentiality restrictions. These are converted to energy units using the conversions in section 5.

### 4.6 Stock changes

In 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 positive sign. A stock build has a negative sign. 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 Statistics Report No.4*, prepared by Coal Services Pty Limited and *Queensland Coal Production Statistics 2016*. 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 *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 conversion factors (or calorific values), 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 <sup>3</sup> (thousand)	bcm	billion cubic metres
L	litre	M	mega	10 <sup>6</sup> (million)	m <sup>3</sup>	cubic metre
t	tonne	G	giga	10 <sup>9</sup> (billion)	ft <sup>3</sup>	cubic feet
g	gram	T	tera	10 <sup>12</sup> (trillion)	bbl	barrel
W	watt	P	peta	10 <sup>15</sup>	Gcal	gigacalorie
Wh	watt hour	E	exa	10 <sup>18</sup>	Mtoe	million tonnes of oil equivalent
		b	billion	10 <sup>9</sup>	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:	<i>bbl</i>	<i>ft<sup>3</sup></i>	<i>L</i>	<i>m<sup>3</sup></i>
From:	Multiply by:			
bbl	1	5.615	159	0.159
ft <sup>3</sup>	0.1781	1	28.3	0.0283
L	0.0063	0.353	1	0.001
m <sup>3</sup>	6.289	35.3147	1000	1

Source: IEA (2005) Energy Statistics Manual

1 L LPG = 0.254 m<sup>3</sup> gas

1 L LNG = 0.625 m<sup>3</sup> 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 figure below represents the energy of one petajoule in terms of some common consumer items:

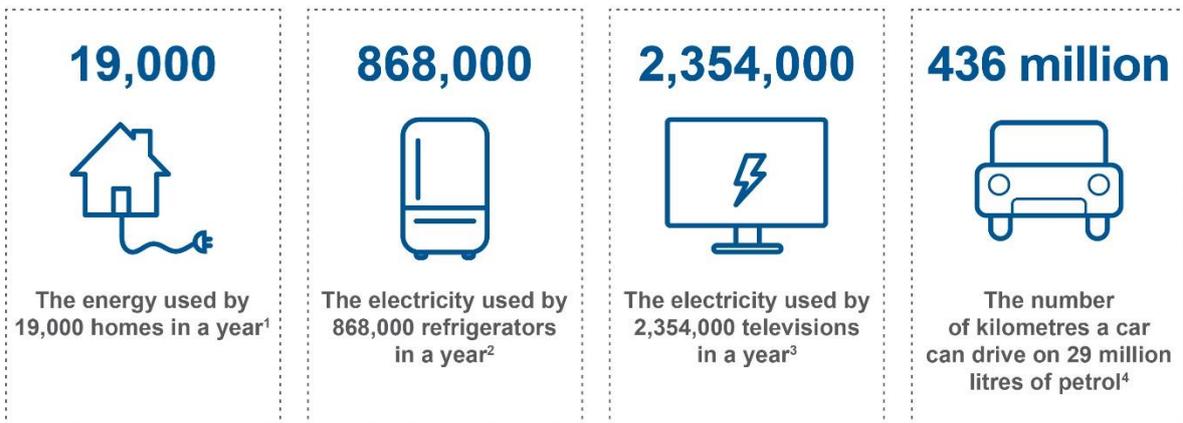
The basic unit of power, or energy per unit time, is the watt (W), which is equal to one joule per second. Within the AES, electricity usage (power consumption) is typically reported in gigawatt hours (GWh).

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.

## 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.**



<sup>1</sup>The average home uses approximately 50 gigajoules of energy in 2014–15

<sup>2</sup>A typical 2.5 star fridge uses 320 kWh of electricity per year

<sup>3</sup>A 50 inch 5 star label television uses 320 kWh of electricity per year

<sup>4</sup>A car consuming 6.7 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	$4.1868 \times 10^{-6}$	1	$10^{-7}$	3.968	$1.163 \times 10^{-3}$
Mtoe	41.868	$10^7$	1	$3.968 \times 10^7$	11630
MBtu	$1.0551 \times 10^{-6}$	0.252	$2.52 \times 10^{-8}$	1	$2.931 \times 10^{-4}$
GWh	0.0036	860	$8.6 \times 10^{-5}$	3412	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 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 to 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*. <http://www.cleanenergyregulator.gov.au/NGER/Legislation>

Table 5.4: Gross energy content of solid fuels

		<i>GJ/t</i>			<i>GJ/t</i>
<b>Black coal</b>			<b>Brown coal</b>		
<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	<b>Uranium</b>		
Steelworks		32	Metal (U)		560 000
Other		23	Uranium oxide (U <sub>3</sub> O <sub>8</sub> )		470 000
<i>Queensland</i>					
Exports			<b>Other</b>		
metallurgical coal		29	Coke		27
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

	<i>MJ/m<sup>3</sup></i>
<b>Natural gas (production)</b>	
Victoria	38
Queensland	37.45
Western Australia	40
South Australia, New South Wales	37.45
Northern Territory	40
Average sales quality	39.3
<b>Ethane (average)</b>	64.7
<b>Town gas</b>	39
<b>Coke oven gas</b>	18.1
<b>Blast furnace gas</b>	4

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

Table 5.6: Gross energy content of liquid fuels

	<i>Volume</i>	<i>Specific volume</i>	<i>Weight</i>
	MJ/L	L/t	GJ/t
<b>Primary Products</b>			
Crude oil and other refinery feedstocks			
indigenous (average)	37	1250	46.3
imports (average)	38.7	1160	44.9
LPG			
naturally occurring (average)	27	1866	49.4
<b>Refined Products</b>			
Automotive diesel oil	38.6	1182	45.6
Automotive gasoline	34.2	1360	46.4
Aviation gasoline	33.1	1412	46.8
Aviation turbine fuel	36.8	1261	46.4
Ethanol	23.4	1266	29.6
Fuel oil low sulphur	39.7	1110	44.1
Heating oil	37.3	1238	46.2
Industrial diesel fuel	39.6	1135	44.9
Lubricants and greases	38.8	1120	43.4
bitumen	44	981	42.7
solvents	34.4	1229	44
waxes	38.8	1180	45.8
LPG			
propane	25.5	1960	49.6
butane	28.1	1760	49.1
mixture	25.7	1890	49.6
Methanol	15.6	1263	19.7
Naphtha	31.4	1534	48.1
Power kerosene	37.5	1230	46.1
Refinery fuel (fuel oil equivalent)	40.8	1050	42.9
<b>Other Products</b>			
Liquefied Natural Gas	25	2174	54.4

Source: Australian Petroleum Statistics, NGERS.

## 6. Confidentiality

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 may be 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*.

<http://www.cleanenergyregulator.gov.au/NGER/Legislation>

## 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 2017 some minor revisions were made, mainly in the manufacturing, mining and electricity generation sectors. These were to update the AES in line with revisions in source data and to improve consistency in the current data series.

Some revisions were also made to the layout of key tables, including Table F and Table O, to improve consistency across fuel types shown in the tables, which should make it easier for users to sum data series.

For further information about revisions to the AES, please contact [Australianenergystatistics@environment.gov.au](mailto:Australianenergystatistics@environment.gov.au).