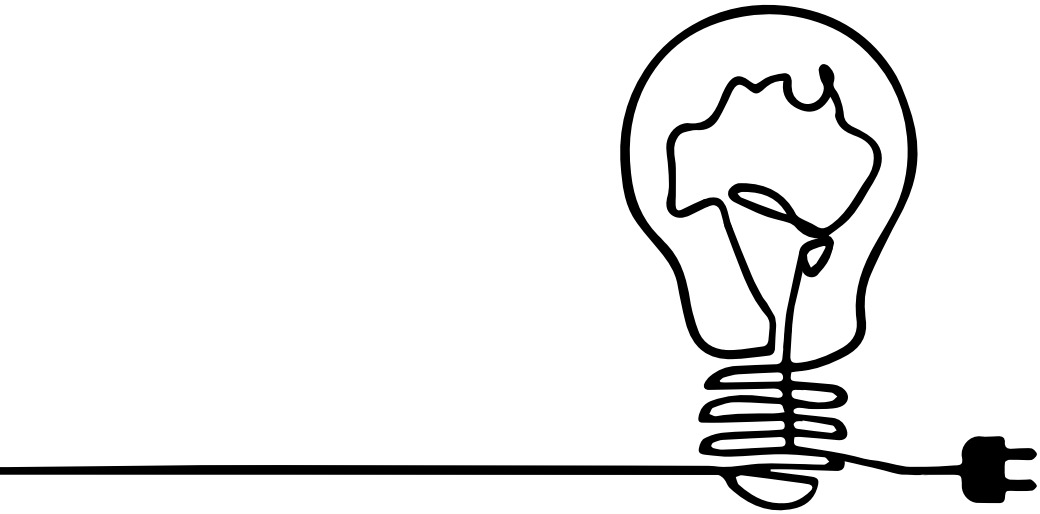
Australian

ENERGY COMPENDIUM

2024

UNDERSTANDING
THE ENERGY
TRANSITION



About the Australian Energy Compendium

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About 89 Degrees East

We are a data, strategy and delivery agency that has been trusted to deliver critical insights to corporates, government, industry bodies and advocacy organisations for over a decade.

We are dedicated to supporting the clean energy transition and have worked with Offshore Wind Energy Victoria, Marinus Link, Bass Offshore Wind Energy (BOWE), Elanora Offshore, Clean Energy Council, Clean Energy Finance Corporation, Nature Conservation Council and The Sunrise Project. We have also worked on projects with Energy Consumers Australia and the Department of Climate Change, Energy, the Environment and Water.

Our research unit is led by Dr Rebecca Huntley, Australia's leading climate change and environmental social researcher. Rebecca is a Fellow of The Research Society, the author of *How to Talk About Climate Change in a Way That Makes a Difference* (2020) and was integral to developing *The Climate Compass* project.

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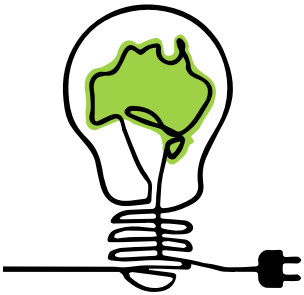

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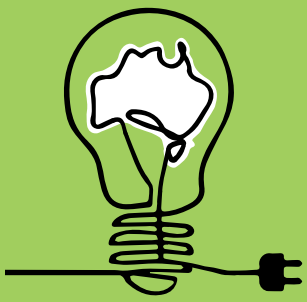


Introduction

Australia is embarking on a transformative journey towards a sustainable and innovative energy future. The path ahead is marked by significant change, reshaping our daily lives, and industries.

Change, while inevitable, is fraught with challenges and opportunities. Australia is well-positioned to lead the global energy transition, however, to be successful, we need everyone on the journey.

At 89 Degrees East, we know that clear communications is is required and widespread understanding starts with a shared vocabulary.

Through our research and work on renewable energy projects we know there is a critical gap between the wealth of information available and the public's understanding of it.

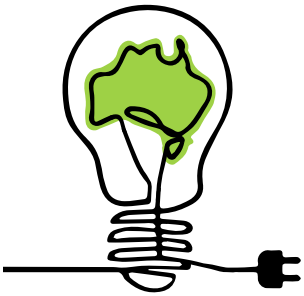
The Australian Energy Compendium is one of our contributions to this challenge.

Designed to demystify the language and concepts of the energy transition, we hope this compendium provides a shared vocabulary and supports informed dialogue across the nation.

This inaugural edition is merely the beginning. We invite you to contribute your suggestions via energycompendium@89degrees.com to enrich the next edition in 2025.

Welcome to the conversation.

The 89 Degrees East Team



Australians have shifted from ‘if and when’ to ‘when and how’

Australians strongly support the transition to renewable energy amid increasing community concern about climate change. Analysis of research into public attitudes towards climate change over the past two years consistently shows Australians support taking action to tackle global warming and back investments in renewable energy. Australians have shifted from ‘if and when’ to ‘when and how’.

Research also reveals Australians are growing more concerned about extreme weather events and link these to a changing climate. The *Climate Compass Report 2022* showed weather, floods, bushfires, heatwaves and drought were the top five reasons Australians gave for their increasing concern about climate change.

That report also found 70 per cent of Australians believed the country was already experiencing the effects of a changing climate, while 2023 research for Lifeline[1] found almost all (97 per cent) 18-24 year-olds were concerned that extreme weather events were becoming more frequent and more severe.

In 2023, research for the Sunrise Project[1] found the majority of Australians (65 per cent) believe collective action is needed now to tackle climate change. However, in the past two years, there has been a decline in Australians' confidence that we're on track to address this global challenge.

The 2022 Climate Compass found just over a third of Australians were confident the country was moving in the right direction on climate change and almost three-quarters believed businesses, corporations, federal and state governments should be doing more to address the problem.

When it comes to our energy future, the same report found renewables enjoyed strong support with three-quarters of Australians backing the use of more renewable energy in the future. Fossil fuels enjoyed far less support, with more than a third of Australians reporting a high level of concern about coal, oil and gas in the 2022 Climate Compass compared to 28 per cent in 2020.

Similarly, Australia Institute research in 2023 found two-thirds of Australians supported phasing out coal mining and transitioning to other industries.

The importance of a structured and supported transition was highlighted in the Sunrise Project 2023 research with 58 per cent of Australians agreeing the country should close its remaining coal-fired power stations and replace them with renewable energy as soon as possible, so long as there was a solid plan to support workers and communities.

[1] Research conducted by 89 Degrees East

The same report also revealed that 72 per cent of Australians believe increasing access to renewable energy, including rooftop solar, would be good for the average Australian.

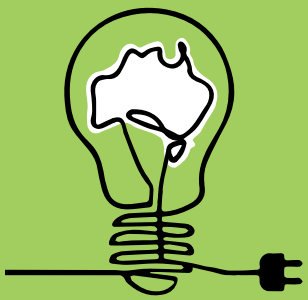
Overall, since the 2022 federal election, community attitudes to energy transition have shifted from a focus on 'if and when' to 'when and how'. How will the transition benefit and impact me, my family, my household, my workplace, my business, and my community?

As the global race to net zero gathers pace, climate change has also increasingly become a critical yardstick for considering social licence. While climate change was once viewed purely through an environment, social, and governance (ESG) lens, today it is considered a material risk for many companies.

But social licence cuts both ways. Consumers are looking at the approach of all companies to climate action, but they are also sensitive to issues around greenwashing. They want those companies at the forefront of the energy transition to drive the change in a way that is mindful of the impacts on communities.

It's not just the economic legitimacy of large-scale renewable energy projects that is under the microscope. The whole sector must build socio-political legitimacy and community trust, in order for the energy transition to progress as smoothly as possible, to the benefit of people and the planet.

Dr Rebecca Huntley
Research Director, 89 Degrees East



Energy transition terminology: A-Z

The Australian Energy Compendium has over 160 terms, compiled to help you understand the language of the energy transition. Each of the definitions is formatted as follows:

Electrolyser

> **Definition:** A device that can split water molecules into oxygen and hydrogen atoms which is key for producing hydrogen fuel.
>
> **Example:** Renewable hydrogen is produced when the electrolyser is powered by electricity from renewable sources. Australian company Hysata, has developed what it says is the world's most efficient electrolyser, which will be tested at a commercial scale in Rockhampton, Queensland (QLD).

Let us know your suggestions for future editions -
energycompendium@89degreeseast.com

A

Abatement

Definition: The reduction or mitigation of pollution or emissions to lessen their harmful impacts on the environment.

Example: Transitioning to renewable energy sources, such as wind or solar power, to decrease our reliance on fossil fuels and lower carbon emissions.

Adaptation

Definition: Taking action and making adjustments to social, economic and ecological systems to mitigate for the anticipated change in the climate.

Example: Adaptation initiatives in Australia range from major tree planting programs to improving disaster resilience strategies.

Aggregation

Definition: Whether done by individuals or organisations, aggregation involves combining various approaches to cut down on carbon. It can also refer to individuals or organisations collaborating to bulk buy energy at a lower price.

Example: When a community collectively combines efforts to, for example, install solar panels on individual homes, implement energy-efficient practices, and plant trees to absorb carbon dioxide.

Agrivoltaics

Definition: The practice of co-locating solar panels or photovoltaic systems with agricultural activities, such as grazing sheep, on the same area

of land. Agrivoltaics aims to optimise the benefits of solar energy generation while minimising potential conflicts with agricultural land use.

Example: The Parkes Solar Farm in New South Wales (NSW), where solar panels are mounted above grazing land, allows sheep to continue grazing beneath the solar arrays.

Ammonia

Definition: A pungent-smelling, colourless gas composed of nitrogen and hydrogen. Widely used as a nitrogen-rich fertiliser in various industrial processes, it plays a crucial role in agriculture and chemical production.

Example: Ammonia has been identified as a potential clean energy carrier and method of decarbonising the food value chain. "Green ammonia" can be produced using renewable energy sources and has the potential to serve as a carbon-free fuel.

Australian Carbon Credit Units (ACCUs)

Definition: A financial instrument awarded by the Clean Energy Regulator to eligible energy efficiency, renewable energy generation and carbon sequestration projects that result in a reduction of greenhouse gas emissions. One ACCU represents one tonne of carbon dioxide equivalent greenhouse gas that is not released into the atmosphere.

Example: A farmer, landholder, business, state government or local council can participate in the ACCU Scheme and earn ACCUs for emissions avoidance or storage of carbon dioxide in vegetation and soil.

Australian Energy Market Commission (AEMC)

Definition: The independent body responsible for making and amending the rules that govern the National Energy Market (NEM), and for advising governments on how energy markets should be developed.

Example: The AEMC published rules for community engagement for energy transmission projects in late 2023, mandating that local communities be consulted sooner about major transmission projects in their area.

Australian Energy Market Operator (AEMO)

Definition: The government and industry body responsible for operating Australia's largest gas, electricity and power systems. AEMO's role is to deliver energy security for all Australians. The former Council of Australian Governments (COAG) established AEMO on 1 July 2009. Ownership of AEMO remains a shared arrangement between government and industry stakeholders.

Example: Following extensive consultation, AEMO publishes a roadmap for Australia's energy transition, through the Integrated System Plan (ISP). The ISP includes an optimal development path of generation, storage and transmission to meet the energy needs of homes and businesses.

Australian Energy Regulator (AER)

Definition: The independent statutory authority responsible for overseeing and regulating the energy market to ensure fair and efficient outcomes for customers.

Example: The AER plays a crucial role in setting the prices that electricity distributors can charge, and aims to balance the need for network investment and maintenance with the goal of preventing unnecessary costs for energy customers.

Australian National Registry of Emissions Units (ANREU)

Definition: The official registry where all transactions of carbon credits and emissions units are recorded. The ANREU is administered by the Clean Energy Regulator.

Example: In Q3 2023 the ANREU issued a quarterly record of seven million Australian Carbon Credit Units (Clean Energy Regulator Quarterly Carbon Market Report, September Quarter 2023).

Australian Renewable Energy Agency (ARENA)

Definition: The Australian Government body responsible for supporting the transition to renewable energy through accelerating the pace of pre-commercial innovation. ARENA was established in 2012 and aims to help commercialise new technologies

and businesses to support the clean energy transition.

Example: Since 2012, ARENA has supported 663 projects with $2.25 billion in grant funding, unlocking a total investment of almost $9.75 billion in Australia's renewable energy industry (ARENA 2023).

B

Baseline

Definition: The baseline is the electricity threshold that triggers the commencement of large-scale generation certificate creation for a renewable energy power station.

Example: Baselines are established according to the guidelines outlined in the Renewable Energy (Electricity) Regulations of 2001.

Baseload power

Definition: The power resources that generally run continuously throughout the year and operate at stable output levels. Baseload power is optimised for operational stability and involves low variable costs per unit of electricity produced. The value of baseload plants is mostly economic, and not related to their ability to follow the constantly varying system demand.

Example: Baseload plants are typically coal-fired and gas-fired combined-cycle power plants.

Behind-the-meter battery

Definition: A battery storage system installed on the customer's side of the electric meter, allowing them to store and use electricity on-site, usually in conjunction with renewable energy sources like solar panels.

Example: The installation of a battery storage system means a homeowner no longer has to export excess solar energy generated from their rooftop system to the grid. Instead, they can store the energy in their behind-the-meter battery and draw on it as needed to power their home.

Big batteries

Definition: An informal term to describe large-scale energy storage systems that store and release energy. These systems play a crucial role in stabilising electrical grids, managing intermittent renewable energy sources, and enhancing energy reliability. There are four types of solar batteries depending on their application and scale - lead acid, lithium-ion, nickel cadmium and flow.

Example: Tesla's Hornsdale Power Reserve is one of the largest lithium-ion battery installations globally, with a capacity of 150 megawatts (MW).

Biodiversity

Definition: The variety of life on Earth at all levels of biological organisation, including the diversity of species, genes, ecosystems and ecological processes.

Example: Biodiversity is considered in relation to the impact of energy production and consumption on ecosystems and the organisms within them. It involves assessing and managing how energy projects may influence the diversity and health of plant and animal species, including through pre-construction surveys, site planning, and monitoring during operation.

Bioenergy

Definition: Bioenergy is the energy derived from organic materials, commonly referred to as biomass. Bioenergy can be harnessed through processes such as combustion, fermentation, and conversion of biomass into biofuels..

Example: In biomass power plants, organic materials such as wood, agricultural residues, or dedicated energy crops are burned to produce heat, which in turn is used to generate the steam that drives turbines to produce renewable energy.

Biofuels

Definition: Renewable fuels that can be derived from organic materials, such as plants, crops, and organic waste. These fuels are alternatives to traditional fossil fuels and can be utilised in transportation, heating, and electricity generation.

Example: Two primary types of biofuels are bioethanol, produced from crops like corn or sugarcane, and biodiesel, derived from sources such as vegetables or animal fats.

Biogas

Definition: A gaseous renewable energy source produced when microorganisms break down organic matter such as agricultural residues, animal manure, municipal waste, and sewage.

Example: The anaerobic digestion process occurs in the absence of oxygen and breaks down these organic materials, producing a mixture of gases that can be captured and used as a clean-burning fuel for electricity generation, or as a vehicle fuel.

Biomass

Definition: Organic materials, primarily derived from plants and other living organisms, that can be used as a source of renewable energy. In the context of energy, biomass can include wood, agricultural residues, crop waste, and organic materials. Biomass can be utilised for heat and electricity generation, or converted into biofuels.

Example: A biomass power plant may use wood pellets as a fuel source. These pellets are burned to produce heat, which is then used to generate steam and drive turbines to produce renewable energy.

Black coal

Definition: Black coal, also known as anthracite or bituminous coal, is a type of coal that contains a higher carbon content than brown coal, but less carbon than anthracite coal. It is widely used as a fuel for electricity generation and in industrial processes.

Example: In Australia, the Hunter Valley in NSW is known for significant deposits of black coal. Black coal mining in this region provides a major source of energy for electricity generation and major exports for Australia.

Black/brown hydrogen

Definition: Hydrogen is produced using black or brown coal to power the gasification process.

Example: Hydrogen is currently used as a feedstock for chemical production, in steel production and to generate heat and power.

Blue hydrogen

Definition: Hydrogen is produced using natural gas and where the carbon emissions from the production process are sequestered using carbon capture and storage technology.

Example: Woodside Energy is investigating a number of blue hydrogen projects around the world, including one in WA.

Brown coal

Definition: Brown coal, also known as lignite, is a type of coal characterised by its brownish-black colour and relatively low carbon content. It has a high moisture content and is softer than black coal. While abundant, brown coal has lower energy content and efficiency compared to other coal types.

Example: The Latrobe Valley in Victoria (VIC) is home to extensive deposits of brown coal. The Loy Yang Power Station uses brown coal for electricity generation.

C

Capacity factor

Definition: A measure of how efficiently a power plant or energy generation system operates over time. It represents the ratio of the actual output of a power plant to its maximum potential output if it were to operate at full capacity, continuously.

Example: If a wind farm has a capacity factor of 40 per cent, that indicates it is operating at 40 per cent of its maximum potential output on average.

Capacity Investment Scheme (CIS)

Definition: The Capacity Investment Scheme provides a national framework aimed at driving new renewable dispatchable capacity and ensuring reliability in Australia's rapidly changing energy market over the next decade and beyond.

Example: The CIS is targeting 32GW capacity of clean energy made up of 9GW of dispatchable capacity and 23 GW of variable capacity as part of the goal to reach 82 per cent renewables in the energy system by 2030.

Carbon capture and storage (CCS)

Definition: The capture of carbon dioxide (CO2) from the burning of fossil fuels and manufacturing before they enter the earth's atmosphere. Underground storage is the most common where CO2 is captured and injected deep underground into sedimentary rocks (such as sandstone) or saline aquifers. CO2 can be transported from the emission sources, such

as power stations or natural gas production, to the storage location. Detractors of CCS say it is extremely expensive, and will never be a zero emissions solution, particularly when attached to highly polluting projects.

Example: There are a number of proposed CCS projects under development in Australia and Chevron's CCS project at the Gorgon LNG plant in WA is designed as the largest CCS system in the world.

Carbon credits

Definition: A permit that companies or individuals purchase allowing them to emit a certain number of greenhouse gas emissions..

Example: In Australia, companies covered under the Safeguard Mechanism can purchase carbon credits to offset their greenhouse gas emissions. The spot price for Australian Carbon Credit Units was between $30 and $32 in late 2023 and there were approximately 23 million Australian Carbon Credits in the Australian National Register of Emissions Units (ANREU) (Clean Energy Regulator Quarterly Carbon Market Report, September Quarter 2023).

Carbon dioxide equivalence (CO2-e)

Definition: A metric that allows for a standardised measurement of the overall warming effect of multiple greenhouse gases. It is estimated by multiplying the amount of gas by the global warming potential of the gas.

Example: The CO2-e value provides a more comprehensive measure of overall greenhouse gas impact by considering the varying potency of different gases in contributing to global warming.

Carbon Farming Initiative (CFI)

Definition: The CFI was a program that aimed to encourage landowners and farmers to adopt practices that reduce greenhouse gas emissions or sequester carbon in the landscape. It provided a framework for crediting Australian carbon offset projects, allowing participants to generate Australian Carbon Credit Units (ACCUs) that could be sold. It has since been succeeded by the Emissions Reduction Fund.

Example: Landowners who planted trees on previously cleared land

could generate and sell ACCUs based on the amount of carbon sequestered.

Carbon footprint

Definition: The total amount of greenhouse gases, primarily carbon dioxide, emitted directly or indirectly by an individual, organisation, or product.

Example: By reducing energy consumption and switching to renewable sources, we can significantly reduce our carbon footprint.

Carbon markets

Definition: A financial trading system dedicated to the buying and selling of carbon credits.

Example: In Australia, there are federal and state-based carbon markets that sell carbon credits under different schemes as well as international carbon markets.

Carbon neutrality

Definition: Achieving a balance between the amount of emitted carbon dioxide and the amount removed from the atmosphere, resulting in no net increase in greenhouse gas levels.

Example: Many countries and companies have committed to becoming carbon neutral by offsetting their emissions through renewable energy projects or carbon capture technologies.

Carbon removal

Definition: The process of removing carbon directly from the atmosphere and securing it in long-term storage such as geological formations, or naturally in trees through reforestation.

Example: The Intergovernmental Panel on Climate Change has said carbon removal activities will be critical to reach net zero.

Carbon sequestration

Definition: The process of storing captured carbon dioxide deep within the earth..

Example: A CSIRO report found Australia has vast geological storage capacity for carbon sequestration along with nature-based technologies like forestry and soil carbon (CSIRO, Australia's carbon sequestration potential, November 2022).

Carbon sink

Definition: A natural or artificial reservoir that absorbs more carbon dioxide from the atmosphere than it releases.

Example: Natural carbon sinks include oceans, soils and forests while the process of carbon capture and storage can store carbon in geological formations which act as a carbon sink.

Circular economy

Definition: A model of resource production and consumption that focuses on sustainability through reducing waste, recycling and extending the product life cycle..

Example: Australia aims to transition to a circular economy by 2030 to help address challenges like climate change, biodiversity and pollution.

Clean Energy Council (CEC)

Definition: The peak body representing Australia's national clean energy sector, which also manages the accreditation of installers of small generation units.

Example: The CEC has made 45 recommendations to the Federal Government in 2023 to help get Australia back on track towards meeting its renewable energy targets (CEC Power Playbook - Accelerating Australia's Clean Energy Transformation, October 2023).

Clean Energy Finance Corporation (CEFC)

Definition: The Australian Government's "green bank" which invests in the clean energy sector to help Australia achieve its net zero targets.

Example: The CEFC commenced operating in 2012. In its first ten years, it invested an average of $1 billion a year into projects designed to help cut Australia's carbon emissions, including solar farms and big batteries (CEFC, 2023).

Climate

Definition: The long term average weather or atmospheric conditions in a particular region, with trends typically measured over a period of 30 years.

Example: Characteristics of the climate include rainfall, wind and temperature patterns.

Climate change

Definition: Long-term shifts or changes in temperatures and weather patterns.

Example: The United Nations says the climate is warming with the average temperature of the Earth's surface now about 1.1°C warmer than it was before the Industrial Revolution in the late 1800s. The UN stresses that the world is not on track to meet the Paris Agreement target to keep global temperature from exceeding 1.5°C above pre-industrial levels.

Climate crisis

Definition: The threat of damaging and irreversible changes to the Earth's climate from global warming.

Example: The climate crisis or climate emergency generally references the expected consequences of catastrophic global warming including sea level rises, environmental destruction and increased natural disasters.

Climate finance

Definition: Financial resources, including loans or grants, to support activities to mitigate or adapt to climate change.

Example: Australia has climate finance programs that support projects to tackle climate change in the Pacific and Southeast Asia.

Coal

Definition: Coal is classified as sedimentary rock. It is composed of accumulated plant matter and formed over millions of years. It is predominantly made of carbon and releases energy through combustion. The moisture content and plant matter or how hard the coal is, determine the energy content and efficiency. Australia has the third largest coal reserves in the world and the second largest exporter of coal (Geoscience Australia, Coal, 2020). (*See also Black coal, Brown coal and Thermal coal*).

Example: A key pillar of Australia's energy transition is decarbonising our energy supply, in particular this means phasing out coal-fired power generation.

Conference of the Parties (COP)

Definition: The annual United Nations meeting on climate change that includes those countries who are parties to the United Nations

Framework Convention on Climate Change (UNFCCC).

Example: At annual COP meetings, the member countries assess and review progress on tackling climate change and set future priorities, upholding the UNFCCC treaty. At COP28 in the United Arab Emirates, countries agreed to 'transition away' from fossil fuels. This language was not as strong as many advocated for but it was the first COP to officially acknowledge that fossil fuels are the root cause of climate change. Australia has bid to host COP31 in 2026, in partnership with Pacific nations, with the decision to be made in 2024.

Consumer Energy Resources

Definition: Resources that can generate or store electricity and provide additional supply or reduce demand at the local level. Also known as Distributed Energy Resources.

Example: Consumer Energy Resources include rooftop solar units, wind power generating units, combined heat and power units, battery storage, and lectric vehicle batteries used to export back to the grid.

Community batteries

Definition: Large batteries that provide shared renewable energy storage for local neighbourhoods..

Example: The Federal Government is funding the installation of 400 community batteries across Australia which it says will provide shared storage for up to 100,000 households to store excess solar energy for peak-time use (The Department of Climate Change, Energy, the Environment and Water (DCCEEW), Community Batteries for Household Solar program, 2023).

Critical minerals

Definition: Minerals indispensable to modern technologies, economies and national security, and those whose supply chains are vulnerable to disruption.

Example: Rare earth elements are among those listed on Australia's official Critical Minerals List. These elements, such as neodymium, dysprosium, and terbium, are essential components in the manufacturing of high-tech devices such as electric vehicle batteries and wind turbines.

D

Decentralised energy

Definition: Energy generation that occurs closer to the point of consumption, reducing transmission losses and increasing resilience.

Example: Local solar panels on rooftops contribute to decentralised energy production, reducing reliance on centralised power plants.

Default market offer (DMO)

Definition: The government sets a safety net for customers called the Default Market Offer, which outlines a reference price for customers to compare different market offers. The reference price restricts how much energy retailers can charge customers on default plans. These are also referred to as standing offer contracts.

Example: Retailers in NSW, South Australia and south-east Queensland are not allowed to charge customers and small businesses who are on a standing offer contract more than the DMO. The Australian Energy Regulator decides the price cap set for the DMO.

Demand

Definition: The amount of electricity end-users are consuming from the power grid.

Example: Demand for energy varies across the day and in between states. Energy is charged at a lower rate during off-peak periods and at a higher rate during peak demand periods. There are other types of demand referred to in energy including *operational demand*, *peak demand* and *underlying demand*.

Dispatchable generation

Definition: Dispatchable energy generation can be controlled and deployed into the energy grid on demand.

Example: Dispatchable generation typically includes coal-fired power plants, gas-fired power station, pumped hydro and battery storage. It is vital for Australia's energy grid to provide backup to variable renewable capacity and ensure the electricity grid remains stable and secure.

Distributors

Definition: Energy companies responsible for building and maintaining electricity or gas distribution infrastructure like poles, wires and pipelines.

Example: Distribution companies operate in discrete geographical locations and consumers cannot choose their distribution provider.

E

Electrification

Definition: The transition from using fossil fuels to electricity as the primary energy source in various sectors, such as transportation and heating.

Example: The Australian Capital Territory has announced an electrification plan that will include transitioning all households off gas appliances by 2045. Legislation was introduced in late 2023 to prevent gas connections for new buildings.

Electrolyser

Definition: A device that can split water molecules into oxygen and hydrogen atoms which is key for producing hydrogen fuel.

Example: Renewable hydrogen is produced when the electrolyser is powered by electricity from renewable sources. Australian company Hysata, has developed what it says is the world's most efficient electrolyser, which will be tested at a commercial scale in Rockhampton, Queensland (QLD).

Emissions reduction target

Definition: Dated commitments to reduce carbon emissions that can be set by international bodies, governments or individual companies.

Example: Australia has committed to achieving net zero emissions by 2050 and has set an interim emissions reduction target of reducing greenhouse gas emissions by 43 per cent below 2005 levels by 2030.

Energy and Climate Change Ministerial Council (ECMC)

Definition: A forum for the Commonwealth, states and territories and New Zealand to partner on nationally significant energy and climate change priorities and reforms. This council replaces the former Energy National Cabinet Reform Committee, which was preceded by the COAG Energy Council.

Example: ECMC has oversight over the Energy Security Board, Australian Energy Market Commission, Australian Energy Market Operator and the Australian Energy Regulator.

Energy Consumers Australia

Definition: Energy Consumers Australia (ECA) is an independent organisation created by the Council of Australian Governments. They work to ensure consumers have their values, expectations and needs met through a modern, flexible and resilient energy system. ECA conduct research, identify issues, produce resources and consumer advice. They work closely with other consumer organisations, ombudsmen, energy companies, regulators and governments to improve outcomes for consumers.

Example: ECA consulted extensively with the energy industry and community stakeholders to transform an innovative framework and research into practical products to be used by policymakers, industry and community groups. The exemplar resources to support households reduce their energy bills were designed for low income households, low income renters, older people and Indigenous Australians.

Energy efficiency

Definition: The ratio of useful energy output to the total energy input, aiming to minimise energy waste and maximise productivity. Energy efficiency is often described as the cheapest form of energy.

Example: Installing energy-efficient appliances and improving insulation can help increase energy efficiency in buildings.

Energy mix

Definition: The combination of various primary sources of energy generation for a given geographic area.

Example: The energy mix in Australia varies from state to state, but typically includes a mix of fossil fuels like coal, natural gas, oil and renewables like solar and wind power.

Energy Ombudsman

Definition: A free and independent dispute resolution service for energy customers who can't resolve a complaint they have with their gas or electricity provider.

Example: Each state and territory has its own independent and impartial energy ombudsman service.

Energy storage

Definition: The capture and retention of energy for later use, enabling a more reliable and flexible energy supply.

Example: Batteries, pumped hydro storage, and compressed air energy storage are common methods of energy storage.

Energy transition

Definition: The global shift from fossil fuel-based energy systems to cleaner, more sustainable alternatives, is driven by the need to combat climate change and ensure energy security.

Example: The energy transition requires significant investments in renewable energy infrastructure and policy support from governments worldwide.

Ethanol blended petrol

Definition: A biofuel that is a blend of petrol and ethanol. Ethanol is a colourless, alcoholic liquid that is considered a renewable fuel when produced from agricultural sources such as sugarcane and grains.

Example: Australian fuel quality standards allow up to 10 per cent (by volume) of ethanol in unleaded petrol.

F

Feasibility licence

Definition: A permit that allows an organisation to conduct certain studies or activities to assess the feasibility of a proposed project.

Example: Proposed offshore wind projects in Australia must obtain a feasibility licence to undertake environmental studies and other activities in the declared offshore wind zones to support their applications for a commercial licence.

Feasibility studies

Definition: An analysis of a proposed project or initiative to determine if it is viable and assess its strengths and weaknesses.

Example: Feasibility studies are usually the first major step in evaluating a proposed project and precede a final investment decision.

Firming

Definition: Ensuring energy output is maintained to keep the electricity grid stable when renewable generation is intermittent or interrupted.

Example: Firming capacity can be activated to supply reliable power to support wind and solar generation. Australia is looking to invest in battery storage and pumped hydro to supply firming capacity to the National Electricity Market.

Fossil fuels

Definition: Non-renewable energy sources such as coal, oil and natural gas that are formed

from the remains of ancient, decomposing plants and animals.

Example: Many power plants still rely on burning fossil fuels to generate electricity.

Fugitive emissions

Definition: Leaks or losses of gases such as carbon dioxide and methane from coal and gas mining activities.

Example: Fugitive emissions are estimated to contribute between eight and 10 per cent to Australia's total carbon emissions each year. DCCEEW includes emissions generated during the production, processing, transport, storage, transmission and distribution of fossil fuels in its fugitive emissions calculations, as well as those from decommissioned coal mines and oil and gas wells.

G

Geothermal energy

Definition: A source of renewable energy generated from the Earth's heat.

Example: Geothermal energy can be sourced from steam or water and, according to Geoscience Australia, there is great potential for geothermal energy generation in Australia. However, the technical and economic barriers to exploiting this resource remain high.

Gigawatt (GW)

Definition: A measure of electricity equal to one billion watts.

Example: The Clean Energy Council says there was 2.7GW of rooftop solar capacity added in Australia throughout 2022 (Clean Energy Council, Clean Energy Australia Report, April 2023).

Gigawatt hour (GWh)

Definition: A large unit of energy measurement used to calculate how much energy has been used with a gigawatt hour equal to one billion watt-hours or one million kilowatt-hours.

Example: Renewables generated approximately 88,000 GWh of electricity in calendar year 2022 in Australia (DCCEEW Australian Energy Statistics, Table 0 - Electricity generation by fuel type 2021-22 and 2022, June 2023).

Global warming

Definition: The long-term rise in the average temperature of the Earth and its oceans.

Example: Global warming occurs when greenhouse gases are trapped in the Earth's atmosphere,

blanketing the earth and trapping heat from the sun.

Green hydrogen

Definition: Hydrogen that is produced from splitting water into hydrogen and oxygen molecules using renewable-powered electrolysis. The only by-product of electrolysis is water.

Example: Australia has a number of proposed green hydrogen projects that plan to use solar or wind energy to power electrolysers to produce renewable hydrogen.

Green steel

Definition: Steel manufactured sustainably using non-fossil fuels like green hydrogen to power the manufacturing process..

Example: Steel manufacturing is one of the most emissions-intensive heavy industries and uses a coal-fired blast furnace. Green steel production could emerge as a new manufacturing industry for Australia with its abundant natural resources and emerging green hydrogen production. A number of proposed green steel projects have been announced in Western Australia.

Greenhouse gases

Definition: Gases including carbon dioxide, water vapour, methane and nitrous oxide that exist in the Earth's atmosphere. They support the natural atmospheric process that ensures the Earth remains at a habitable temperature.

Example: Scientists say greenhouse gases, particularly carbon dioxide, help to keep the Earth's temperature stable. Rising levels of carbon dioxide in the atmosphere, however, can trap additional heat, leading to global warming.

Greenwashing

Definition: Where misleading or false information is presented about the sustainability credentials of an organisation or product.

Example: An organisation can be accused of greenwashing if its marketing activities overrepresent or make false claims about its activities or products as environmentally friendly, ethical or sustainable.

Grey hydrogen

Definition: Hydrogen produced using steam to separate natural gas or methane..

Example: Grey hydrogen production uses the same technique as blue hydrogen production, except the emissions released are not captured and stored.

Grid integration

Definition: The process of incorporating renewable energy sources into existing power grids, ensuring smooth and reliable electricity supply.

Example: Grid integration requires advanced technologies and smart systems to manage the intermittent nature of renewable energy sources.

H

Heat pump

Definition: A heating device that extracts heat from a source (such as the surrounding air, geothermal ground energy or waste factory heat), warms the air further and then discharges it into a home or building.

Example: Heat pumps are a more efficient source of warmth than conventional electric or gas heaters because they transfer heat rather than generate heat. In Australia, heat pump technology is in use in reverse-cycle air conditioners. The International Energy Agency (IEA) estimates the deployment of heat pumps globally could reduce CO2 emissions by at least 500 million tonnes in 2030.

Hydrogen

Definition: The most abundant chemical element in the world. Hydrogen is the first element in the periodic table and is a colourless, odourless and highly flammable gas.

Example: Hydrogen molecules are capable of holding an abundance of energy and that energy is released when the hydrogen is burnt and the molecules split apart. Renewable hydrogen - or hydrogen produced using renewable sources like solar and wind power - is expected to play a key role in helping to decarbonise the manufacturing sector in particular. (*See also Green hydrogen, Blue hydrogen, Grey hydrogen and Black/brown hydrogen*).

Hydropower or hydroelectric power

Definition: The generation of electricity using the energy of moving water..

Example: Hydropower has been in use for thousands of years as a source of energy generation. Typically, water from a dam or body of water creates kinetic energy as it passes through a turbine which is converted into electrical energy. There are more than 120 operating hydroelectric power stations in Australia (Clean Energy Council, Hydro, 2020), with the Snowy Mountains Hydro-electric Scheme the largest.

Industrial heat

Definition: Industrial heat refers to the intense heat needed to transform raw materials into the essential and foundational materials of modern life. It is used in various industrial processes, such as manufacturing, chemical production, and power generation.

Example: Industrial heat is often produced through processes like combustion, electrical heating, or other methods and plays a crucial role in many industrial applications, including heating, melting, and chemical reactions.

Inertia

Definition: The ability of the electricity grid to maintain a steady frequency of supply.

Example: System inertia is important to help support the reliability and security of the energy grid as it helps to keep the power supply stable. Coal-fired power plants have typically supplied system inertia in Australia and it will be important to find new sources of system inertia - such as grid-scale batteries - to help maintain the frequency stability as part of the transition to renewables.

Inflation Reduction Act (IRA)

Definition: Legislation signed into law in August 2022 in the United States of America that was designed to help build a new clean energy economy and combat climate change.

Example: The Inflation Reduction Act includes a number of tax provisions

to help accelerate clean energy innovations in transport, buildings and manufacturing and billions of dollars in loans and grants for clean energy and climate investments.

Information and communication technologies (ICT)

Definition: A diverse set of technological resources and tools (hardware and software) that can be used to support the transmission, storage, creation, sharing and exchange of information.

Example: ITC technologies are used in a number of smart energy devices such as *Vehicle-to-the-Grid* technology and *smart meters*.

Interconnectors

Definition: High voltage electricity cables that connect power grids in different jurisdictions and allow energy to flow in both directions.

Example: Interconnectors will become an important part of the National Energy Market as they allow electricity to be shared between states, enabling access to new forms of renewable energy generation and increasing the reliability of supply.

Integrated System Plan (ISP)

Definition: The AEMO's roadmap for the efficient development of the National Electricity Market over the next two decades and beyond.

Example: The ISP's mission is to ensure the design of the lowest cost, secure and reliable energy system to support Australia's transition to net zero.

International Energy Agency (IEA)

Definition: The leading global energy authority that has a mandate to support energy security and the clean energy transition.

Example: Originally founded to help ensure oil security in the 1970s, the IEA is now working to help support climate change policy and transition global energy systems to a net-zero future. Australia became a member of the IEA in 1979.

Intermittent generators

Definition: Energy generators that do not produce a consistent and continuous output of electricity due to external factors like the weather.

Example: Wind farms and solar energy are two types of intermittent generators as they rely on the wind or sun to produce electricity.

Inverters

Definition: A device that converts direct current (DC) from a generation source or battery into alternating current (AC) that can be used or fed into the electricity grid.

Example: Solar panels generate DC electricity, but the energy grid operates on AC electricity. An inverter will convert the DC electricity generated into AC electricity so it can be used in the home or fed into the grid.

J

J-curve

Definition: The visual representation of a trend where there is a sharp drop followed by a rapid increase above the starting point.

Example: J-curves can occur at the introduction of a new technology where a rapid increase in development and adoption leads to a significant decrease in the cost of production or implementation.

K

Kilowatt (kW)

Definition: A unit of power measurement. One kilowatt is a measure of one thousand watts of electrical power.

Example: A 5kW solar panel system has a maximum power output of 5kW of power.

Kilowatt Hour (kWh)

Definition: A unit of energy measurement used to calculate how much energy a home or device has used.

Example: A 1kW appliance that is run for one hour will use one kWh of energy. The average annual electricity consumption for QLD households is approximately 5,500 kWh, according to the Australian Energy Regulator (Frontier Economics/AER, Residential Energy Consumption Benchmarks, 2020).

L

Liquified Natural Gas (LNG)

Definition: Natural gas that has been cooled into a liquid form to enable it to be efficiently and safely transported via ship.

Example: Australia is one of the world's largest LNG exporters, with most exports delivered to markets in Asia.

Load shedding

Definition: An emergency measure where energy distributors cut off power supply to some areas to prevent a wider disruption during times when electricity supply cannot meet demand.

Example: Load shedding can occur in circumstances where severe weather has damaged transmission infrastructure, a generator fails or when power demand spikes during a heatwave.

Low carbon

Definition: Describes something that has a lower or reduced amount of carbon dioxide emissions compared to fossil fuels.

Example: A low-carbon economy is one that is based on energy resources that have a lower level of emissions.

M

Market price cap

Definition: The maximum price the energy spot market can reach during dispatch and trading intervals.

Example: The wholesale price of electricity changes with supply and demand but the market price cap sets the maximum level. The Australian Energy Market Commission (AEMC) adjusts the market price cap for the National Electricity Market in line with the inflation rate by 28 February each year. For 2023/24 the market price cap is $16,600/ MWh (AEMC, Schedule of reliability settings for 2023-24, February 2023).

Methane

Definition: An odourless gas made up of both carbon and hydrogen. It is a greenhouse gas and it is the main component of natural gas.

Example: Methane is released through the mining of fossil fuels like coal and gas, but also naturally from agriculture, wetlands, waste and landfill emissions. In Australia, the agriculture sector is the greatest source of methane emissions. Australia has pledged to cut methane emissions by 30 per cent by 2030.

Megawatt (MW)

Definition: A measure of electricity equal to one million watts and typically used to describe power output for large generators like power stations.

Example: Australia's largest solar farm, the Western Downs Green Power Hub in QLD, has an output capacity of 460MW.

Microgrid

Definition: A small electricity grid that provides energy generation and storage to a local area. The microgrid can be a subset of the wider electricity grid or operate independently of the main grid.

Example: The Victorian Government is developing Community Microgrids using solar, batteries and distributed energy resources for buildings in Mallacoota, Omeo and Corryong. It follows the decision to assess the potential of new resilient energy infrastructure following the 2019-20 extreme fire season.

Mitigation

Definition: The action of removing or reducing greenhouse gas emissions from the atmosphere to help reduce climate change.

Example: Using renewable energy sources helps to mitigate climate change because it does not release greenhouse gases into the atmosphere.

N

National Adaptation Plans (NAPs)

Definition: Strategies that identify the key actions individual countries will take to make preparations for a changing climate.

Example: National Adaptation Plans, including Australia's, use risk assessments to determine the activities needed to improve climate resilience.

National Australian Built Environment Rating System (NABERS)

Definition: A sustainability rating system that provides comparable measures for the environmental performance of Australian buildings including hotels, shopping centres, offices, high density residential buildings and aged care facilities.

Example: An initiative of the Australian Government, NABERS rates the efficiency of buildings for energy, water, waste and indoor environment and assigns a one to six-star rating.

National Energy Market (NEM)

Definition: The interconnected energy network and wholesale market that connects Australia's east coast and southern states, supplying approximately nine million customers.

Example: The NEM delivers about 80 per cent of Australia's electricity consumption and is one of the largest interconnected electricity systems in the world. It does not

include WA and the Northern Territory.

National Energy Transformation Partnership

Definition: A framework for the Commonwealth Government of Australia and state and territory governments to work together to transform Australia's energy system to support the push for net zero emissions by 2050.

Example: The partnership was signed in 2022 and committed to maximising economic opportunities of the transition and ensuring reliable and affordable electricity to benefit Australian households, businesses and communities.

Nationwide House Energy Rating Scheme (NatHERS)

Definition: The Nationwide House Energy Rating Scheme (NatHERS) provides energy ratings for new dwellings. This is helping create energy efficient, resilient and comfortable homes that cost less to run. The Scheme is administered by the Department of Climate Change, Energy, the Environment and Water on behalf of the states and territories.

Example: Assessments provide a star rating out of 10 which estimates the amount of energy needed to heat and cool the property, as well as greenhouse gas emissions, based on hundreds of factors. NatHERS is used during the design phase of the house and house features and materials, along with the position on the block. Started in 1993, currently around 90 per cent of new home designs in Australia are using the Scheme.

Net zero

Definition: A state where the amount of greenhouse gas emissions produced is equal to the volume of greenhouse gases taken out of the atmosphere.

Example: More than 140 countries have agreed to reach net zero emissions by 2050 to avoid catastrophic global warming.

Nuclear energy

Definition: Nuclear energy is a form of energy released from the nucleus, or core, of atoms. Electricity from nuclear power is produced by nuclear fission of uranium or

plutonium in nuclear power plants. This releases energy in the form of heat and radiation, which is harnessed to spin turbines that drive magnetic generators, which produce electricity. Uranium is the fuel most widely used to produce nuclear energy.

Example: Nuclear energy is a low-emissions power supply and is used in more than 30 countries around the world. However, it is currently banned in Australia through two pieces of legislation - the Australian Radiation Protection and Nuclear Safety Act (1998); and the Environment Protection and Biodiversity Act (1999).

O

Offgrid

Definition: Buildings, homes or communities that are not connected to mainstream utility services including the national energy grid. They are usually located in regional or remote areas and means the user is wearing all the risk of outages.

Example: King Island, in the Bass Strait in between Tasmania and Victoria, now has a renewable energy network consisting of solar, wind, diesel, storage and demand management. Previously, King Island relied exclusively on diesel to generate power.

Offset (carbon)

Definition: The process of investing in environmental projects to reduce greenhouse gas emissions to compensate for generating carbon emissions elsewhere.

Example: Companies and individuals can participate in carbon offset schemes where carbon credits are purchased to compensate for greenhouse gas emissions. Some airlines offer carbon offsets to be purchased for individual flights. Carbon offset projects can include reforestation or renewable energy.

Offshore wind energy

Definition: Energy generated from wind farms located in the ocean or large lakes that is converted into electricity.

Example: Offshore wind farms feature turbines that are either floating or fixed to the ocean floor and capture energy from winds that are usually higher and more consistent over water compared to land. Australia's first offshore wind zone was declared in the Bass Strait off Gippsland in VIC.

Offshore wind zone

Definition: An area the Federal Government has declared as being suitable and approved for the development of offshore wind energy.

Example: The Federal Government has declared two offshore wind zones in Australia - in the Pacific Ocean off the Hunter coast in NSW and in the Bass Strait off Gippsland, VIC. Further areas are under consideration. Offshore wind farms can only be built in declared offshore wind zones.

Operational demand

Definition: Demand for energy that is supplied from the national electricity grid as compared to demand that is met from rooftop solar or batteries.

Example: Operational demand typically falls during the middle of the day when the solar output is the highest.

P

Paris Agreement

Definition: The legally binding international treaty on climate change negotiated by 196 parties at the 2015 United Nations Climate Change Conference (COP21) in Paris.

Example: Specifically, the Paris Agreement had two central goals: to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels" and "to limit the temperature increase to 1.5°C above pre-industrial levels". Australia signed the Paris Agreement in 2016.

Passivated Emitter and Rear Cell (PERC)

Definition: Modified solar cell technology that improved the efficiency and performance of standard silicon solar cells.

Example: Australian Professor Martin Green was the recipient of the Millennium Technology Prize in 2022 for his PERC innovation which is now the world's most commercially viable and efficient silicon solar cell technology. The PERC reduced the costs of using solar panels and resulted in greater and more efficient energy generation.

Peak demand

Definition: A time of day, or year when demand for electricity from the grid is at its highest.

Example: In all states except for Tasmania (TAS), peak electricity demand occurs during summer, while in TAS peak demand happens during winter.

Peaking plants

Definition: Energy generators that are only operated when demand for electricity is high, operating one to five per cent of the time.

Example: Peaking plants are usually gas-fired as these can be started and operational faster than a coal-fired power plant. The proposed Brigalow Peaking Power Plant in QLD will use green hydrogen and natural gas to produce enough power to support 150,000 homes during peak periods.

Photovoltaic (PV)

Definition: The method for converting energy from sunlight into electricity.

Example: PV cells power solar panels to capture the energy of the sun and transform it into electricity energy.

Power Purchase Agreement

Definition: An arrangement between an energy generator and a customer or "off-taker" for the purchase of power at an agreed price over a fixed period of time, usually 10 years. Power Purchase Agreements are most commonly used for renewable energy generation.

Example: The City of Sydney has a Power Purchase Agreement with renewable energy retailer Flow Power. This ensures all City of Sydney operations – including pools, sports fields, depots and buildings are powered by 100% renewable energy, from wind and solar farms in regional New South Wales (NSW).

Pumped Hydro

Definition: Energy storage system where water is cycled between two dams of different heights. Water in the lower dam is pumped to the higher dam during off-peak periods until it is needed for energy generation and released through rotating turbines.

Example: The Snowy 2.0 pumped hydro project is planned to produce enough energy to power the equivalent of 500,000 homes and will be the largest renewable energy project in Australia.

Q

Quantum technology

Definition: Technology that harnesses the way light and matter behave at an atomic or subatomic level.

Example: The Australian Government released the National Quantum Strategy in May 2023 to provide a pathway for the development of quantum technologies that can help to support emissions reduction, cyber safety and drug development.

R

Rare earth magnets

Definition: Magnets made from the rare earth elements neodymium, praseodymium, dysprosium and terbium making them more efficient and powerful than other magnets.

Example: Rare earth magnets are used in wind turbines and electric vehicles. Australia has some of the world's most abundant sources of rare earths and the Federal Government's Critical Minerals Strategy nominated the production of magnets as a technology priority.

Rare earth minerals

Definition: A series of 17 metallic elements found within mineral sands. Rare earth minerals can have magnetic and luminescent properties.

Example: Rare earth minerals are used in a variety of applications in digital, low carbon and defence technologies including smartphone screens, and magnets to power wind turbines and fighter jets.

Reference price

Definition: The benchmark price for electricity set by a government, which outlines the maximum bill a customer on a standing offer should pay if they use an average amount of energy for their area.

Example: Reference prices vary across Australia and are designed for customers to use to compare their electricity contracts. Retailers are required to state how their offer compares to the reference price.

Reforestation

Definition: The natural or intentional replanting or restocking of trees and plants in existing forest areas.

Example: The Australian Government announced a plan in 2014 to plant 20 million trees by 2020 to help reestablish urban forests and green corridors. DCCEEW said an audit found that more than 29 million trees over two metres in height had been established as at 30 June 2021.

Regenerative agriculture

Definition: An approach to food and farming production that focuses on the conservation and rehabilitation of the ecosystem and soil regeneration.

Example: Also known in Australia as holistic farming practices, there are a number of sustainable or regenerative agriculture practices in use on Australian farms.

Reliability

Definition: The extent to which customers have a continuous supply of electricity. This requires the power system to generate enough capacity and the network to distribute electricity, to meet demand.

Example: In Australia, the reliability standard mandates that the power system should meet at least 99.998 per cent of forecast consumer demand each year.

Renewable diesel

Definition: Diesel fuel is made from biomass sources like vegetable oils and animal fats, giving it a lower greenhouse gas footprint than traditional fossil diesel. It can also be known as Hydrotreated Vegetable Oil (HVO) diesel.

Example: Renewable diesel is chemically identical to fossil diesel so can be used in existing diesel engines. There are a number of biorefineries proposed or under development in Australia and biodiesel is already being trialled in trucks and mining equipment.

Renewable energy

Definition: Energy derived from natural resources that are replenished at a faster rate than they are consumed, such as solar, wind, hydro, and geothermal energy.

Example: Solar panels convert sunlight into electricity, making it a popular form of renewable energy.

Renewable Energy Zone (REZ)

Definition: Geographic areas declared to have strong potential for renewable energy like solar or wind resources. In these areas, renewable energy generation infrastructure is planned alongside transmission lines and storage facilities.

Example: The Australian Energy Market Operator has identified a number of potential onshore REZs on the east coast and candidates for offshore wind zones. State governments in NSW, VIC and QLD are progressing plans to develop a number of REZs.

S

Safeguard mechanism

Definition: The Australian Government's emissions policy for the country's largest industrial operations.

Example: The policy covers approximately 200 industrial facilities with carbon dioxide equivalent emissions of more than 100,000 tonnes annually including mining, oil and gas production, transport and manufacturing. The policy sets baseline limits on greenhouse gas emissions for each facility, which progressively decline towards 2050.

Smart meter

Definition: Digital electricity meters that record energy consumption, usually in 30 minute increments, and send back the data to the relevant electricity retailer.

Example: The Australian Energy Market Commission wants all customers to have smart meters by 2030 and says they will assist customers to access cheaper energy.

Social licence

Definition: The ongoing acceptance of an industry or organisation's actions and activities by its stakeholders and the broader community. It is essentially the permission granted by society for an organisation to conduct its operations.

Example: Social licence is becoming increasingly important as Australia builds renewable energy generations and transmission infrastructure in communities.

Solar cell efficiency

Definition: The performance rating of a solar cell or the amount of radiant light that touches a panel that is converted into electricity.

Example: ARENA has a target for solar cell efficiency to reach 30 per cent by 2030.

Solar energy

Definition: Energy sourced from the heat and radiant light emitted by the sun.

Example: Solar energy supplied 14 per cent of Australia's total electricity generation in 2022 (DCCEEW Australian Energy Statistics, Table 0 - Electricity generation by fuel type 2021-22 and 2022, June 2023).

Solar farm

Definition: Installations of multiple photovoltaic panels set up to generate electricity.

Example: Large scale solar farms generate approximately 7GW of grid-connected electricity in Australia each year, according to ARENA. The nation's largest solar farm, at Chinchilla in QLD, includes more than one million solar panels.

Substation

Definition: Electrical infrastructure that raises or lowers the voltage of electricity so it can be safely and efficiently transported via transmission networks or delivered into homes and businesses via distribution power lines.

Example: Substations transform electricity into high voltage power for transport through Australia's transmission network and then convert power to lower voltage electricity compatible with home and business use.

Sustainable Aviation Fuel (SAF)

Definition: Aviation fuel made from sustainable feedstocks, like used cooking oil, that produces fewer carbon emissions than traditional jet fuel.

Example: SAF can be blended with traditional jet fuel in most modern aircraft. The first transatlantic flight using 100 per cent SAF took off from London on 28 November 2023 and flew to New York. There are a number of biorefinery projects planned in Australia that would produce SAF.

T

Tariffs

Definition: The price or rate at which electricity is sold to a customer.

Example: Tariffs can vary based on when energy is used (off-peak or peak), which appliances are used (for example pool heaters or electric hot water) and demand.

Thermal coal

Definition: Black coal that is used in electricity production.

Example: Australia is known for its high-quality thermal coal and is one of the world's largest exporters of the commodity.

Tipping point

Definition: A tipping point in climate science is when a critical threshold is crossed, which leads to abrupt and likely irreversible change in natural systems. If triggered, these tipping points could potentially lead to further global compound events. The latest assessment by the Intergovernmental Panel on Climate Change (IPCC) says tipping points are possible or even likely within the Paris Agreement range of 1.5 to <2 degrees of warming.

Example: The Great Barrier Reef is nearing its tipping point, with near annual coral bleaching caused by frequent marine heatwaves. If this occurs the reef will become unrecognisable as a functioning ecosystem. Changes to the ice-sheets in Antarctica and Greenland, and the Amazon rainforest are other natural systems often referred to as being close to their tipping points.

Transmission

Definition: High voltage power lines, usually overhead, that transport energy over long distances.

Example: AEMO forecasts that close to 10,000 kilometres of new high-voltage transmission lines will be needed across by 2050, to support the transition to renewables in Australia.

U

Unbundling

Definition: When the operation of electricity transmission networks is separated from energy supply and generation to encourage competition.

Example: There are five state-based transmission network service providers across the NEM, but there are hundreds of electricity generators.

Underlying demand

Definition: All of the electricity used by consumers. This includes both that which can be sourced from the grid and from sources including rooftop solar and battery storage.

Example: South Australia hit a renewables milestone on 16 September 2023 when rooftop solar met 98.5 per cent of the state's underlying electricity demand between 1pm and 1:30pm, according to AEMO.

Uninterruptible Power Supply (UPS)

Definition: A device that provides a backup supply of electricity when power is lost or interrupted.

Example: UPS devices can help protect critical computer equipment from power surges and outages.

United Nations Framework Convention on Climate Change (UNFCCC)

Definition: The governing body that established an international treaty designed to combat climate change.

Example: The UNFCCC supports the international response to climate change including organising international governmental climate change negotiations, particularly through the Conference of the Parties (COP).

United Nations Intergovernmental Panel on Climate Change (IPCC)

Definition: The international body that leads the scientific monitoring, study and assessment of climate change.

Example: The IPCC was created in 1988 and has 195 members. More than 40 Australian experts were invited to participate in the IPCC's Sixth Assessment Report which was released in 2023.

Usage charge

Definition: The dollar amount a customer pays for each unit of electricity that their home or business consumes.

Example: Usage charges are calculated using cents per kilowatt hour. How much a customer pays in usage charges typically depends on their energy contract and the corresponding tariffs.

Utility-scale

Definition: Large energy projects - typically solar photovoltaic or battery storage - that feed power into the national electricity grid.

Example: At the end of 2022, there were 48 large-scale solar developments and 19 large-scale batteries under construction in Australia (Clean Energy Council, Clean Energy Australia Report, April 2023).

V

Vehicle-to-grid (V2G)

Definition: When energy stored in an electric vehicle (EV) battery can be exported to the electricity grid.

Example: V2G technology requires a bidirectional charger that allows the EV to communicate with the electricity network, allowing electricity to flow both ways between the car and the grid. South Australia was the first jurisdiction to approve the use of bidirectional V2G chargers.

Vehicle-to-home (V2H)

Definition: When energy stored in an EV battery is exported to help power a home and its appliances.

Example: EVs typically have three to four times the amount of storage capacity of a home battery.

Vehicle-to-load (V2L)

Definition: When energy stored in an EV battery is used to power or charge an external device.

Example: V2L charging is available in some models of EVs on sale in Australia and can be used to charge or power appliances or equipment while camping, for example.

Virtual power plant

Definition: A connected network of solar panels or home batteries that can be operated together to quickly inject renewable energy into the power grid.

Example: Tesla and the South Australian Government partnered on a virtual power plant that includes solar and battery infrastructure for over 4,000 homes.

W

Weather

Definition: Short-term atmospheric conditions or changes in a geographic area.

Example: Weather can impact energy production and the grid. Extreme weather like heatwaves or storms can place stress on the electricity system, with weather forecasts increasingly important for planning and grid management.

Wholesale price

Definition: The price energy retailers pay for the electricity that they sell and supply to customers.

Example: In late 2023, the growing impact of renewable energy generation helped push down the wholesale price of electricity to $63 per megawatt-hour (MWh), following a high of $216/MWh in the third quarter of 2022, according to AEMO (AEMO, Quarterly Energy Dynamics Report, October 2023).

Wind energy

Definition: Energy generated when wind currents are converted into electrical energy using wind turbines. Turbines convert the kinetic energy from rotational movement into electrical energy.

Example: Australia is home to some of the world's best wind resources, particularly in coastal regions like the one offshore in the Bass Strait. Wind energy currently supplies about 11 per cent of Australia's energy (DCCEEW Australian Energy Statistics, Table 0 - Electricity generation by fuel type 2021-22 and 2022, June 2023).

Wind farms

Definition: Groups of wind turbines situated in the same location on or offshore that are used to generate electricity.

Example: There are 110 wind farms operating across Australia (Clean Energy Council, Wind Industry Recycling Report, May 2023) and a number of proposed wind farms planned in Australia's two declared offshore wind zones. (See also offshore wind zone).

X

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Y

Yield

Definition: The amount of energy that can be produced from a source of energy generation, for example, a solar panel or wind turbine.

Example: The Clean Energy Council estimates a 4kW rooftop solar system in Australia has a yield of approximately 14-20kWh of power per day, depending on the location (Clean Energy Council, Average daily production of solar PV cells in Australia).

Z

Zero emissions

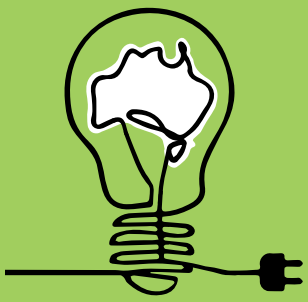
Definition: A state in which no greenhouse gases are emitted or the amount of greenhouse gases produced is equal to the volume of greenhouse gases taken out of the atmosphere.

Example: A zero emissions vehicle, like a battery electric vehicle or hydrogen fuel cell electric vehicle, does not use petroleum fuel and does not emit greenhouse gases from the tailpipe.

Zero waste

Definition: A sustainability concept where waste production is minimised and any waste produced is composted, recycled or reused.

Example: Efforts to promote a circular economy or zero waste in Australia include the removal of many single-use plastics, upgraded recycling initiatives and reducing food waste.



Our journey from coal to renewables

From the early days of coal to the present era of renewables, the trajectory of Australian energy reflects both technological advancements and environmental awareness.

In the pre-Federation era, coal emerged as the new 'gold rush', becoming Australia's second-largest export and a crucial economic driver. As the 1800s progressed, technological innovations allowed coal to transform from a mere resource into a powerhouse, providing electricity to major cities.

Post-World War II, Australia experienced rapid economic growth, leading to the construction of coal-fired power stations and a widespread adoption of electricity.

The Snowy-Hydro Scheme was completed in 1974, 25 years after construction commenced. In the mid-1960s the Snowy was generating 26 per cent of Australia's energy generation, a historical peak for renewables. The 1960s to the 1980s witnessed a shift towards environmental consciousness and the exploration of further renewable energy sources.

The 1990s marked a gradual move away from hydroelectricity. While the development of hydroelectric schemes faced challenges such as environmental concerns and high costs, alternative renewable resources began to gain prominence, signalling a changing landscape in Australia's energy mix.

The 2000s brought significant growth in solar and commercial wind farms. By 2009, plans for large-scale wind farming projects were underway to address the nation's energy needs. Notably, Sydney's desalination plant became powered by 100 per cent renewable energy, showcasing the potential of wind power in meeting critical infrastructure demands.

In 2012, Australia's first large-scale solar farm opened near Geraldton in WA. Australian scientists and researchers have been leading the way in solar research and innovation, including the development of the Passivated Emitter and Rear Cell (PERC) – the world's most commercially viable and efficient silicon solar cell technology.

Australian households and businesses have embraced the use of solar power, especially as the cost of installation and panels has decreased. As of 31 December 2023, there were more than 3.69 million solar panel installations in Australia, with a combined capacity of over 34.2 gigawatts since April 2001 (Australian PV Institute, Australian PV market, 2023). Across 2021, '22 and '23 there was an average of more than 3GW of new rooftop solar capacity added each year, on top of the large-scale projects. In 2022, there were also 47,100 solar battery installations, up 55 per cent from 2021 (SunWiz, 2023 Annual Sunwiz Australian Battery Report, 2023).

Today, Australia stands at a crossroads in its energy history. While fossil fuels, particularly coal and gas, have played a pivotal role in meeting energy needs and fostering economic stability, there is a growing recognition of the finite nature of these resources and their impact on the environment and contributing to climate change.

Coal and gas continue to be the second and third largest exports for Australia, behind iron ore. Across 2021-22, 91 per cent of coal and 76 per cent of gas was exported (DCCEEW, Australian energy trade 2021-22, 2022). Australia continues to export far more energy than consumed.

The following timeline illustrates modern Australia's journey from the early use of coal for electrification to the exploration of renewable energy sources, the transition to secure Australia's energy needs and meet emission reduction targets. It reflects the nation's response to environmental concerns, technological advancements, and the ongoing quest for sustainable, affordable, and abundant energy solutions.

Transition timeline

- **1791:** Mining of coal begins near Newcastle NSW beginning Australia's association with fossil fuels. By 1799, Newcastle was exporting coal.
- **1863:** A single arc lamp is illuminated on Sydney's Observatory Hill to mark the marriage of the Prince of Wales, kickstarting a rivalry between Sydney and Melbourne in the pioneering race to electrify.
- **1888:** Tamworth becomes the first Australian city where transmission lines come into effect, powered by a 240 DC volt power plant using a mixture of coke and wood.
- **1889:** First electric trams commence operation in Melbourne.
- **1904:** Sydney's first electric streetlight is switched on, symbolising the commencement of electrification in major cities.
- **1916:** The Tasmanian Power Authority begins operation, seizing on its plentiful water resources to commission the first large-scale hydro generation - the 6.8-megawatt Waddamana Hydroelectric Power Station.
- **1924:** VIC begins to develop its Latrobe Valley brown coal deposits.
- **Post-World War II:** Rapid economic growth leads to the construction of coal-fired power stations, transforming energy production and distribution.
- **1949-1974:** The Snowy Hydro Scheme is built including eight power stations, 16 major dams, aqueducts and interconnected tunnels.
- **1960s-1980s:** Rising environmental awareness prompts experimentation with renewable energy resources, especially with solar panel research.
- **1981:** Australia's first solar power station at White Cliffs in NSW was constructed by a team from the Australian National University. The station consisted of 14, five-metre parabolic dishes.
- **1987:** The first commercial wind farm was built in WA, marking the beginning of Australia's experimentation with wind power.

1988–1999: Two pieces of Commonwealth legislation were introduced - Australian Radiation Protection and Nuclear Safety Act (1998); and the Environment Protection and Biodiversity Act (1999) - banning nuclear power production in Australia.

1992: The construction of the last major hydroelectricity dam in TAS signals a decline in hydroelectric power development in Australia.

1998: The National Electricity Market begins operation under the National Electricity Market Management Company, later called AEMO.

2001: The first Mandatory Renewable Energy Target in Australia is enacted, with two per cent of the nation's electricity generation to come from renewable sources.

2009: Plans for large-scale wind farming projects are put in place to offset Australia's energy needs. Sydney's desalination plant is powered by a wind farm in Bungendore, showcasing the potential of wind energy.

2010: Australia's last new coal-fired power station, Bluewaters 2 power station, opens in WA.

2012 - 2017: Around one-third of Australia's coal-fired power stations close.

2012: Australia's first large-scale solar farm opened near Geraldton in WA.

2015: Australia is one of 196 parties to adopt the legally-binding, international treaty on climate change, known as the Paris Agreement.

2020: Construction begins on Snowy 2.0 to link two existing dams with 27km of tunnels and an underground power station. The original forecast was to start providing power in 2021 for a cost of $2B, it is now forecast to be 2028 and $12B

2020: Agnes Gold Mine in WA has a ground-breaking renewables-based micro-grid operational with 14MW of wind combined with 4MW of solar and a 14MW.4MWh battery.

2022: A record year for clean energy in Australia. Renewable energy accounted for 35.9 per cent of electricity generation, up from

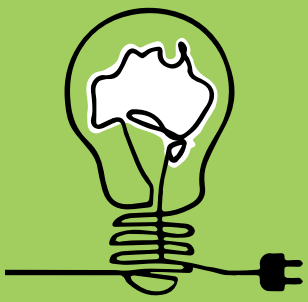
32.5 per cent in 2021 and double that of 2017 (Clean Energy Council, Clean Energy Australia Report, April 2023).

- **2022:** Professor Martin Green was awarded the prestigious Millennium Technology Prize for his leadership in the development of the Passivated Emitter and Rear Cell (PERC) – the world's most commercially viable and efficient silicon solar cell technology.
- **2022:** Australia's first offshore wind zone was declared in the Bass Strait off Gippsland in VIC in December 2022.
- **2023:** Australia's largest solar farm in QLD's Western Downs was completed, with 400 megawatt capacity and more than a million solar panels.
- **2023:** Investment in large-scale energy storage projects in Australia reaches a record high, as six energy storage and hybrid projects worth A$2b reach the investment stage.
- **2023:** National Electric Vehicle Strategy encourages update of EVs, as Australia lags behind other countries.
- **2023:** Queensland Government announces emissions reduction target of 75 per cent below 2005 levels by 2035.

Future (Projected):

The transition to renewables is expected to accelerate, with further research and the implementation of more efficient and new technologies.

- **2026:** Australia is bidding to co-host with Pacific nations the United Nations climate summit in 2026 (COP31).
- **2030:** Australia has committed to reducing greenhouse gas emissions by 43 per cent below 2005 levels by 2030. This includes 82 per cent of electricity generated from renewables.
- **2038:** AEMO forecasts Australia's last coal power plant will close.
- **2050:** Australia has committed to achieve net zero emissions by 2050.



Australia's changing energy mix for electricity

Electricity generation is Australia's biggest contributor to greenhouse gas emissions. The mix of energy sources used to generate electricity is changing dramatically, as it is for many nations around the world.

Since the 1950s, burning coal (black and brown) at large power stations has dominated the energy mix in Australia. Natural gas has also played an important role at power stations for decades.

Pumped hydro was the first major renewable energy source and storage mechanism. The Snowy Hydro-Electric Scheme is the most well known and to this day is considered a major engineering feat. In the mid-1960s the Snowy Scheme was generating 26 per cent of Australia's energy generation.

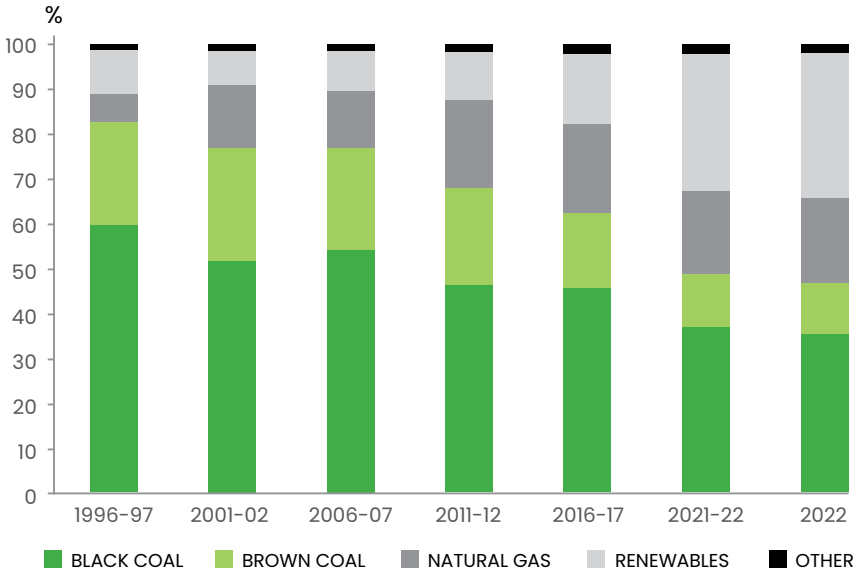
Over the past 30 years, renewable energy in the form of solar and wind have been playing a greater role in the energy mix. As well as being cleaner and better for the environment, they are also now cheaper than coal and gas.

Coal is declining with gas and renewables increasing

Coal's share of electricity generation has declined from 83 per cent in 1996—97 to 47 per cent in 2022. With natural gas increasing from 6 to 19 per cent over the same period. Renewables (solar, wind and hydro) contributed 32 per cent of total electricity generation in 2022 up from 10 per cent in 1996—97 (DCCEEW Australian Energy Statistics, Table 0 - Electricity generation by fuel type 2021-22 and 2022, June 2023).

The Australian Government has set a target of 82 per cent of electricity generation from renewables in 2030. AEMO now forecasts that in 2038 the last coal-fired power plant in Australia will be closed. The following graphs and tables demonstrate the change in electricity generation since 1996—97.

Electricity generation by fuel in Australia



	1996-97	2001-02	2006-07	2011-12	2016-17	2021-22	2022
BLACK COAL	59.9	51.9	54.4	46.5	45.8	37.2	35.7
BROWN COAL	22.9	25.1	22.4	22.0	16.9	12.0	11.5
NATURAL GAS	6.3	14.1	13.1	19.4	19.6	18.1	18.8
RENEWABLES	9.8	7.7	8.7	10.6	15.7	30.9	32.3
OTHER	1.2	1.1	1.4	1.5	2.0	1.7	1.7

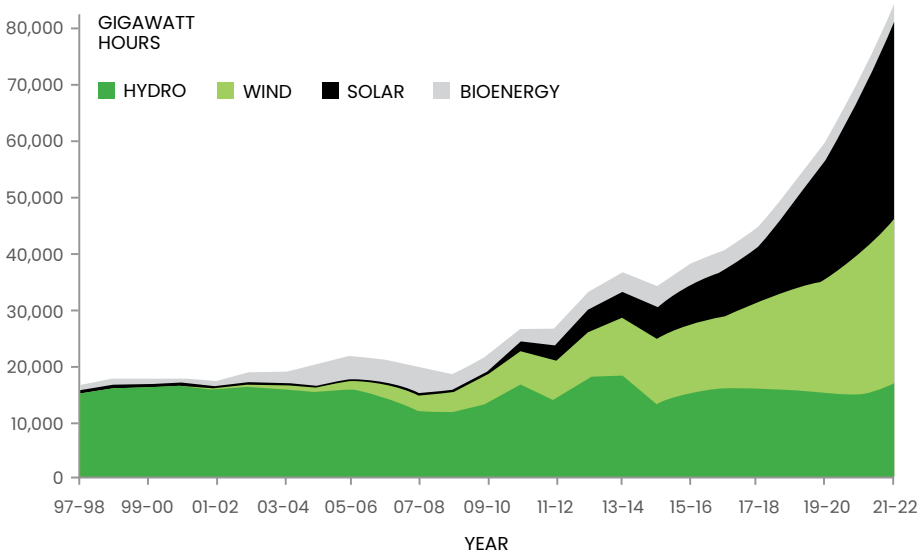
Source: DCCEEW Australian Energy Statistics, Table 0 - Electricity generation by fuel type 2021-22 and 2022, June 2023.

Renewables seeing a rapid rise in wind and solar

Electricity generation from renewables is gathering pace and has increased by more than 200 per cent in the past decade. Pumped hydro has led the way for renewable energy generation in Australia for decades. It is only in recent years that it has been surpassed by wind (2018—19) and solar (2019—20). Bioenergy, primarily from the combustion of wood and sugarcane pulp, has also played a constant role in electricity generation. It wasn't until 2008—09 that wind surpassed bioenergy and 2012-13 for solar.

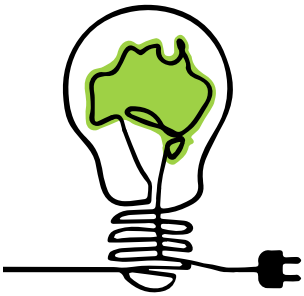
The following graph and data table shows the increase in electricity generation of wind from 2015—16 and solar from 2017—18.

Australian electricity generation from renewable sources



	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
HYDRO	15,318.2	16,284.9	16,020.8	15,967.3	15,149.6	15,199.7	17,010.9
WIND	12,199.5	12,597.0	15,174.4	17,712.0	20,395.9	24,535.4	29,107.8
SOLAR	6,838.3	8,071.7	9,929.9	14,848.5	21,033.2	27,717.0	34,686.6
BIOENERGY	3,789.9	3,500.5	3,517.7	3,495.9	3,351.6	3,346.2	3,190.3

Source: DCCEEW Australian Energy Statistics, Table R, 2022.

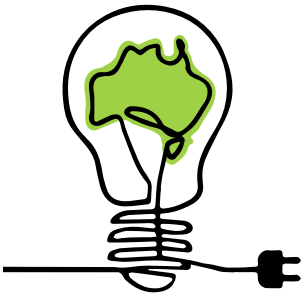


Abbreviations

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AFMA	Australian Financial Markets Association
ARENA	Australian Renewable Energy Agency
BESS	battery energy storage system
CEFC	Clean Energy Finance Corporation
CSG	coal seam gas
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEIP	Distributed Energy Integration Program
DER	distributed energy resources
DMIA	demand management innovation allowance
DMIS	demand management incentive scheme
DMO	default market offer
EBSS	efficiency benefit sharing scheme

ECA	Energy Consumers Australia
ENA	Energy Networks Australia
ESB	Energy Security Board
ESC	Essential Services Commission
EV	electric vehicle
FCAS	frequency control ancillary services
GAP	Gas Acceleration Program
GJ	gigajoule
GW	gigawatt
GWh	gigawatt hour
Hz	Hertz
HHI	Herfindahl–Hirschman index
ICT	information and communication technology
IRENA	International Renewable Energy Agency
ISP	integrated system plan
kW	kilowatt
kWh	kilowatt hour
LCOE	levelised cost of electricity
LNG	liquefied natural gas
MJ	megajoule
MOS	market operator services
MLO	market liquidity obligation
MtCO2-e	million metric tonnes of carbon dioxide equivalent
mtpa	million tonnes per annum
MW	megawatt
MWh	megawatt hour

NEM	National Electricity Market
OCGT	open cycle gas turbine
PJ	petajoule
PST	pivotal supplier test
PV	photovoltaic
RAB	regulatory asset base
RERT	reliability and emergency reserve trader
RET	renewable energy target
REZ	renewable energy zone
RIN	regulatory information notice
RIT	regulatory investment test
RIT–D	regulatory investment test – distribution
RIT–T	regulatory investment test – transmission
RRO	Retailer Reliability Obligation
SAPS	stand-alone power systems
TJ	terajoule
TJ/d	terajoules per day
TW	terawatt
TWh	terawatt hour
UNGI	Underwriting New Generation Investment program
VPP	virtual power plants
WACC	weighted average cost of capital



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Australian Energy Statistics, Table 0 - Electricity generation by fuel type 2021-22 and 2022: energy.gov.au/publications/australian-energy-statistics-table-o-electricity-generation-fuel-type-2021-22-and-2022

Australian Energy Statistics, Table R: energy.gov.au/energy-data/australian-energy-statistics/renewables

Australian PV Institute, Australian PV market: pv-map.apvi.org.au/analyses#

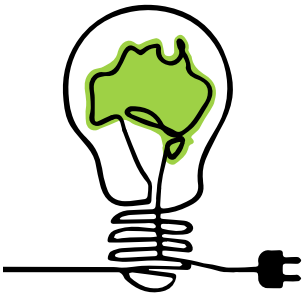
Clean Energy Council, Clean Energy Australia Report: cleanenergycouncil.org.au/resources/resources-hub/clean-energy-australia-report

Clean Energy Council Power Playbook - Accelerating Australia's Clean Energy Transformation, October 2023: cleanenergycouncil.org.au/news/clean-energy-council-releases-power-playbook

Clean Energy Regulator Quarterly Carbon Market Report, September Quarter 2023: cleanenergyregulator.gov.au/Infohub/Markets/quarterly-carbon-market-reports/quarterly-carbon-market-report-%E2%80%93-september-quarter-2023

The Sunrise Project, 2022 Climate Compass: sunriseproject.org/compass/

2023 Annual Sunwiz Australian Battery Report: www.sunwiz.com.au/battery-market-report-australia-2023/



Useful sources

The amount of information on the energy sector, renewable energy and the energy transition is vast. The following is a selection of key Australian agencies and organisations, and their websites, who are involved in driving our energy transition.

Australian Energy Infrastructure Commissioner - aeic.gov.au

Australian Energy Market Commission - aemc.gov.au

Australian Energy Market Operator - aemo.com.au

Australian Energy Regulator - aer.gov.au

Australian Renewable Energy Agency - arena.gov.au

Australian Trade and Investment Commission - globalaustralia.gov.au/industries/net-zero

Clean Energy Council - cleanenergycouncil.org.au

Clean Energy Finance Corporation - cefc.com.au

Clean Energy Regulator - cleanenergyregulator.gov.au

Commonwealth Scientific and Industrial Research Organisations (CSIRO) - csiro.au

Department of Climate Change, Energy, Envioronment and Water - dcceew.gov.au & energy.gov.au/

Department of Industry, Science and Resources - industry.gov.au

Energy Consumers Australia - energyconsumersaustralia.com.au

Energy Made Easy - energymadeeasy.gov.au

Energy Networks Australia - energynetworks.com.au

Geoscience Australia - ga.gov.au/

Nationwide House Energy Rating Scheme - nathers.gov.au/

Additional international information sources

International Energy Agency - iea.org

Intergovernmental Panel on Climate Change - ipcc.ch

United Nations Climate Action - un.org/en/climatechange

United Nations Climate Change Conferences - un.org/en/climatechange/un-climate-conferences

United Nations Development Programme, climate dictionary - climatepromise.undp.org/news-and-stories/climate-dictionary-everyday-guide-climate-change