

COMMUNITY GUIDE TO RENEWABLE ENERGY

Hydrogen & Renewable EnergyRegulatory Guidelines | 003







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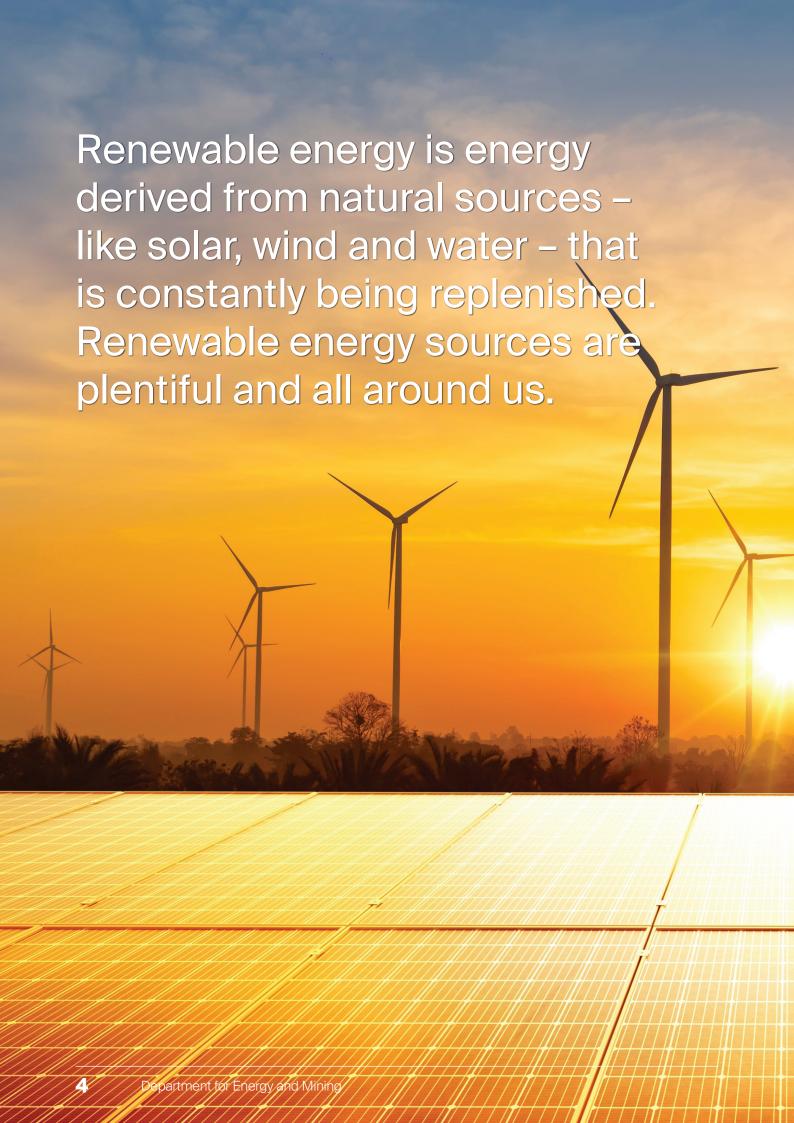
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Introduction

The world is changing how it uses energy.

South Australia is dealing with climate change and how we can use our sun, wind and other natural resources to emit less carbon and support new economic opportunities.



What is the difference between energy and electricity?

ENERGY

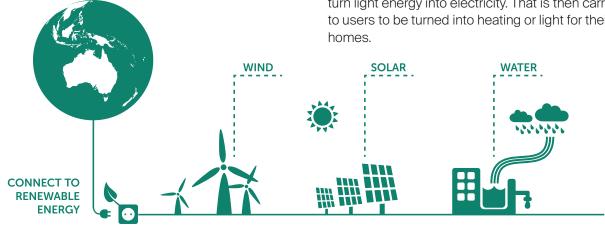
Energy is the ability for something to do work or to be powered. Energy comes in different forms such as thermal, mechanical, chemical, light and electrical. It is stored as potential energy and activated as kinetic energy.

For example, a lithium-ion battery stores chemical potential energy. When connected to a load, such as an electric vehicle, the chemical reactions inside the battery release this stored energy, converting it into kinetic energy to drive the electric motor.

In a hydroelectric dam, water stored in a reservoir behind a dam has gravitational potential energy. When released, the water flows through turbines, converting this potential energy into kinetic energy, which is then used to generate electricity through a generator.

ELECTRICITY

Electricity is a type of energy and a secondary energy source. It is created by converting primary sources of energy – like fossil fuels, wind and solar energy – into electricity. For example, solar panels turn light energy into electricity. That is then carried to users to be turned into heating or light for their homes.





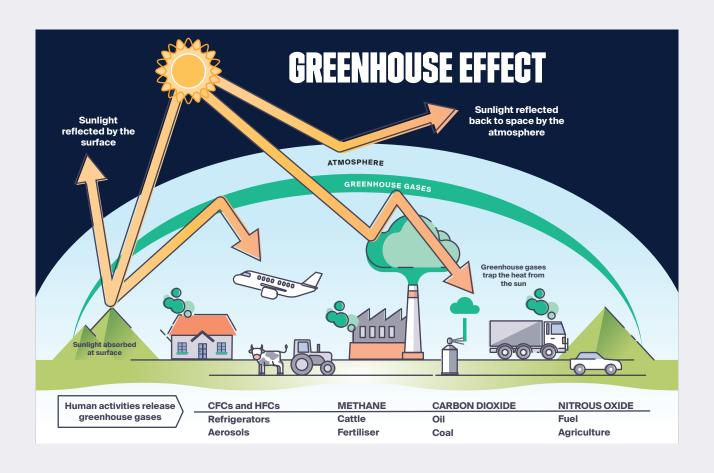
What is climate change?

Climate change refers to significant and lasting changes in the Earth's climate, particularly an increase in average global temperatures. It is mostly driven by human activities, especially burning fossil fuels like coal, natural gas and oil. These fuels have been used for years to power our cars, businesses and homes.

Burning fossil fuels releases greenhouse gases, also known as carbon emissions, into the atmosphere. These gases, including carbon dioxide (CO2) and methane (CH4), act like a blanket around the Earth, trapping the sun's heat. This process, called the greenhouse effect, is natural and necessary to support life. However, an excess of greenhouse gases intensifies it, leading to global warming.

The increase in global temperatures affects the weather, environment, and ecosystems, causing more frequent and severe weather events like heatwaves, storms, and floods, as well as long-term changes in climate patterns. These changes pose significant risks to human health, agriculture, water resources and the environment.

To mitigate climate change, it is essential to reduce greenhouse gas emissions. One effective way is to transition from fossil fuels to renewable energy sources like solar, wind, and hydroelectric power. These sources produce minimal greenhouse gas emissions. By adopting renewable energy and improving energy efficiency, we can reduce our carbon footprint and work towards a more sustainable and resilient future.





What is renewable energy?

Renewable energy is energy derived from natural sources – like solar, wind and water – that is constantly being replenished. Renewable energy sources are plentiful and all around us.

Changing from fossil fuels to renewable energy is known as the 'energy transition'.

About 90% of the world's carbon emissions come from the burning of fossil fuels. Most of Australia's emissions come from energy production, which involves burning fossil fuels to produce electricity and heat. This is followed by emissions from transport, agriculture, and industrial processes like iron and steel production.

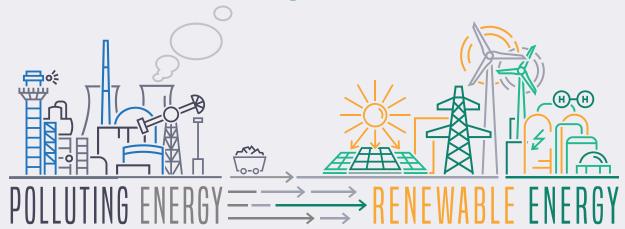
Some ways industries can reduce carbon emissions include:

- burning hydrogen or biomethane instead of coal or gas
- using solar and wind power for electricity
- fuelling transport with alternative renewable fuels like e-methanol or plant-based biofuels.

SOUTH AUSTRALIA IS A LEADER IN RENEWABLE ENERGY

The last coal fired electricity generator in South Australia was retired in 2016 and, in 2024, we already had nearly 75% net renewable energy generation in our electricity network.

The Energy Transition





What is net zero?

Net zero emissions means decreasing carbon emissions until the amount of greenhouse gases produced by human activities is balanced by the amount removed from the atmosphere. This is achieved by reducing emissions and using methods to remove or offset the remaining emissions.

Some of the ways this is done is by:

- generating low emissions electricity, such as with wind, solar and hydroelectricity
- electrifying vehicles and equipment so they don't burn fossil fuels
- making homes and buildings more energy efficient to reduce consumption, such as with smart meters and appliances
- removing carbon dioxide from the atmosphere, known as carbon sequestration.

In South Australia, carbon sequestration includes:

- replanting cleared land
- encouraging planting of woody crops in plantation forestry and farming landscapes
- using cropping and grazing practices that keep more carbon in the soil
- regenerating native vegetation in conservation areas, farms, pastoral regions and coastlines

South Australia's Net Zero Strategy includes actions to reduce emissions across all economic sectors.





What are we doing to achieve net zero?

Both the Australian and South Australian governments have carbon reduction targets: goals for how much less carbon is emitted in the country or state. These targets fulfill our country's international climate change commitments.

At the 28th Conference of the Parties to the United Nations Framework Convention on Climate Change in Dubai in 2023 (COP23), more than 140 countries committed to transitioning away from fossil fuels, to achieve net zero greenhouse gas emissions by 2050.

National & state decarbonisation snapshot

43% less national emissions by 2030 (from 2005 levels)

82% renewable electricity

in the national energy market by 2030



national emissions bv 2050

Global renewables superpower

South Australian targets

100% net renewable electricity by 2027

60% less state emissions by 2030 (from 2005 levels)

Global decarbonisation snapshot

2050

Around the world, countries are responding to climate change and taking action to decarbonise. They are transforming how they produce, transport and consume energy to create green economies.

More than 140 countries, including China, India, the US and the EU, have a net zero target, covering about 88% of global emissions



What's the role of government in the energy transition?

The government provides policies, targets, legislation and funding to guide energy markets and support industry, business and consumers to invest in clean energy and reduce emissions. Targeted

projects, subsidies and incentives are aimed at addressing inequalities to ensure a just and lowcost energy transition for all communities.



What's the energy industry's role?

Industry will drive the energy transition by innovating, researching and investing in renewable energy projects, decarbonised products and consumer goods. Private companies and energy

markets will not achieve net zero on their own. They will need to be guided by national and state government policies, regulation, incentives and support where necessary.



Supplying the world's energy transition

The South Australian government has big ambitions for our state's economy over the next 25 years. We aim to take advantage of our abundant wind, solar and mineral resources to capitalise on the global green transition, while helping our state and the rest of the world to decrease their emissions. We can:

- export extra renewable energy when we have it
- produce and export green products such as steel and iron made in factories powered by renewable energy and burning green fuels such as hydrogen
- export minerals that are mined in South Australia, like copper, graphite or rare earths, so they can be used to build renewable energy technology, like wind turbines and solar panels, around the world.



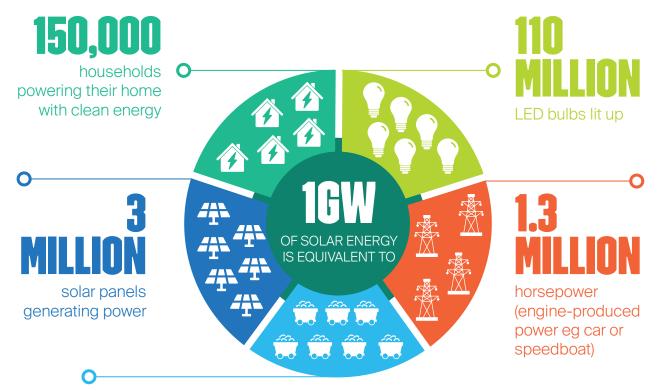
How much more energy will we need?

Forecast growth in population, electrification and the economy overall will significantly increase South Australia's electricity demand by nearly 50%. It's expected to increase from around 16,000 gigawatthours in 2023-24 to nearly 23,000 in 2030-31.

A gigawatt (abbreviated as GW) is a unit of power equal to one billion (1,000,000,000) watts. By comparison, an average light bulb uses between 25 and 100 watts.

A gigawatt-hour (abbreviated as GWh) represents 1 GW of electricity generated over one hour. It's often used to measure the output of large of utility-scale renewable projects.

We are on track to provide the bulk of the extra electricity supply with renewable energy, including large-scale wind, solar farms and storage facilities, as well as consumer-led electricity generation through rooftop solar panels. The South Australian Hydrogen and Renewable Energy Act 2023 provides the legislative framework to support this growth.



545,000
TONNES
of coal prevented from being burned to power

the grid each year

How much energy is 1GW?

WHAT DO WE MEAN BY LARGE OR UTILITY SCALE?

Large or utility scale renewable energy farms or plants generate anything from thousands of kilowatts to hundreds of megawatts (MW) or even gigawatts of solar power.

In contrast, household and community solar energy and battery storage supplies enough energy for small groups of people or businesses.

The Hydrogen and Renewable Energy Act 2023 – discussed below – regulates all renewable energy projects that generate, store or transmit 5 MW or more.

WHY DO WE NEED PROJECTS SO BIG AND WHERE WILL THAT ENERGY GO?

Huge amounts of renewable electricity will be needed in the coming years to meet the expected growth in energy demand and help our homes, businesses and industries move away from fossil fuels

The South Australian government is encouraging more industry to base themselves here, particularly green industries. For example, making green steel from our magnetite or processing our copper and gold, rather than shipping it to other countries for processing. Higher processed products are worth more and these additional industries offer more jobs into our economy. But of course, more big industry also needs more energy!





Renewable energy in South Australia

HYDROGEN AND RENEWABLE ENERGY ACT

The South Australian government wants more large-scale renewable energy projects in the state, including hydrogen, solar, wind and battery storage, to help us meet our net zero targets and strengthen our economy. It's important that these projects respect the people, land and environment they

affect. The Hydrogen and Renewable Energy Act 2023 sets the rules for how these projects must operate. Further information about the Act can be found on the Department for Energy and Mining's website.

RELEASE AREAS

A release area is an area of pastoral land, certain Crown (state-owned) land, and state waters that the government declares to be suitable and available for renewable energy development. Release areas involve government working with Native Title groups, pastoralists and other landowners, representative organisations, communities, and interest groups to identify areas of land that can sustainably host large-scale renewable energy development. In this process, an area will be

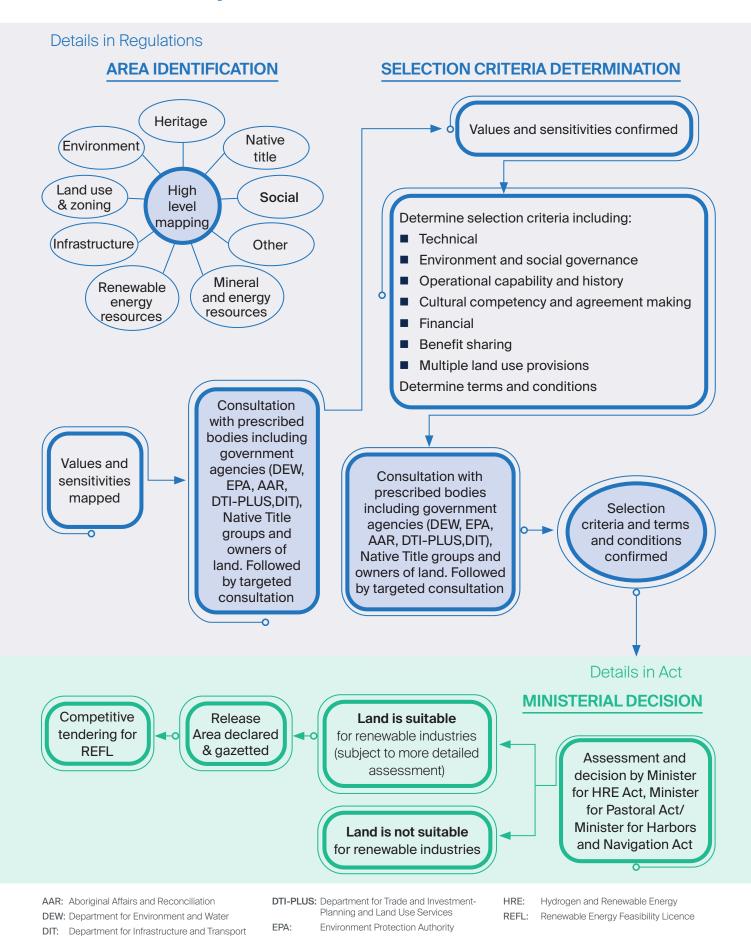
proposed for development, government will hold a public consultation on the proposal and, if it's decided that the area meets expectations, declare it open for tenders. Companies will then tender to put their renewable energy projects on that land. Projects will be expertly assessed against specific tender criteria, and the Minister may then choose one or more that can apply for a Renewable Energy Feasibility Licence.

PROJECTS ON PRIVATE LAND

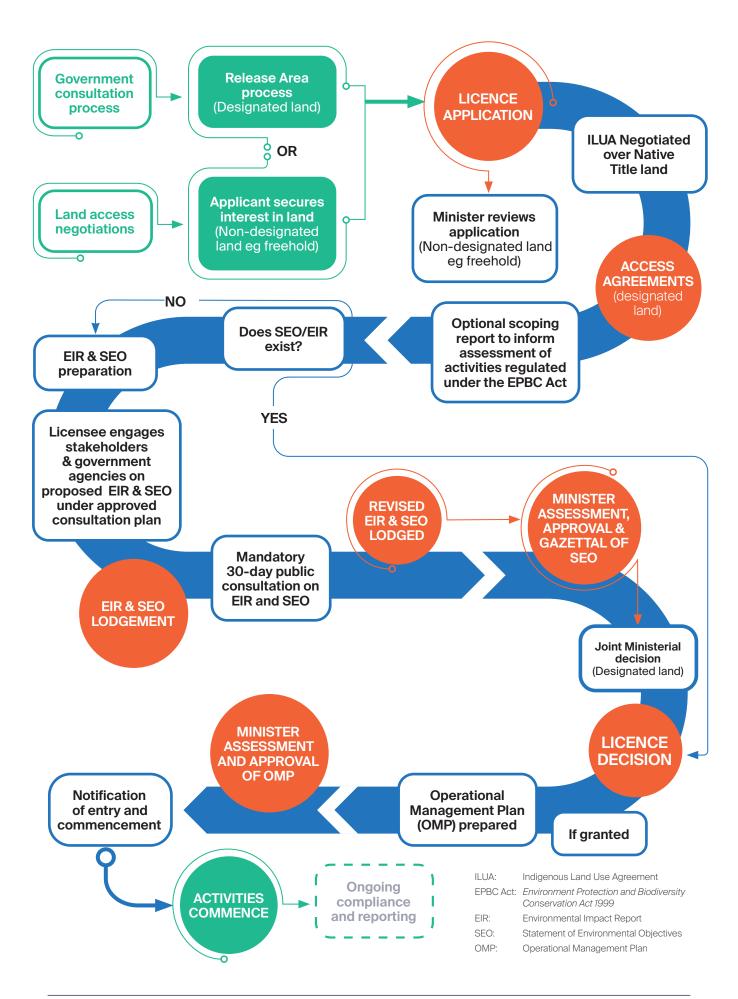
For projects on privately owned land, such as freehold land, renewable energy companies can approach landowners directly to negotiate conditions for having their projects on that land. The Hydrogen and Renewable Energy Act has strict laws that aim to ensure fair outcomes for Aboriginal peoples, landowners, communities and other

pre-existing land rights holders. Companies must engage with impacted people throughout the life of the project. These individuals and groups also have opportunities to provide formal submissions on proposed projects at specific points during licence application, operations and closure.

Release area process



Hydrogen and Renewable Energy Act licensing process





Types of renewable projects

The main types of renewable energy projects in South Australia are wind, solar and battery storage. The production of renewable hydrogen is also an emerging industry in South Australia.

WIND

Wind turbines use the energy of the wind to spin an electric generator, which produces electricity. Wind turbines are often on hilltops, on wide open flat lands or in or near the ocean, where the wind blows consistently. Wind energy is one of the lowest-cost sources of new electricity supply in Australia.



HOW BIG ARE WIND TURBINES?

Onshore (land-based) wind turbines are usually around 150m tall. Their blades are between 40m and 90m long.

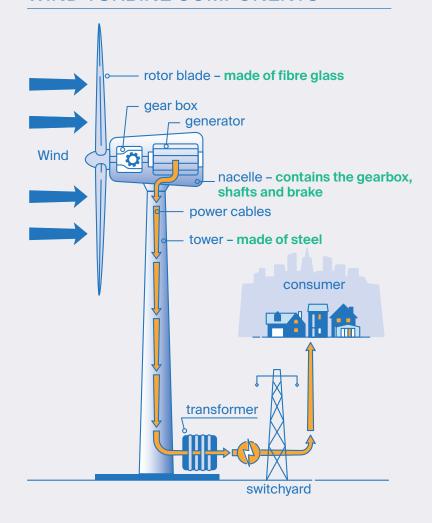


WIND TURBINE COMPONENTS

HOW FAR APART SHOULD THE WIND TURBINES BE?

Wind farms vary based on factors like wind speed, turbine type and land costs. The recommended space between each turbine is about seven times the rotor diameter. For example, if the rotor diameter is 83 metres, the recommended distance between turbines is 550-600 metres (83 x 7).

This ensures that none of the turbines affects airflow to the others.



Starfish Hill was the first wind farm built in South Australia. It generates enough clean, renewable energy to power around 10,000 homes annually.





WHERE SHOULD WIND FARMS BE LOCATED?

A wind farm needs to be in a place where there is:

- strong and consistent wind conditions
- access to electricity transmission so the electricity it creates can be sent to users
- road access
- enough space between each turbine
- flat or hilly land or elevated ridge lines.

On the Eyre Peninsula, for example, there are many areas with wind speeds of over eight metres a second, making it a good place to put windfarms.

Choosing the right location for a wind farm involves a combination of scientific analysis, environmental considerations, and logistical planning. Here are some key factors:

Wind resource assessment

Wind speed and consistency: The primary factor is the availability of strong and consistent winds. Developers use wind maps and data from meteorological towers to identify potential sites.

Long-term data collection: Data is collected over several years to understand the wind patterns and predict energy production accurately.

The environment and land use

Land size and use: Large, open areas with minimal obstructions are ideal. Farmland or pastoral land is often chosen due to its size and fewer stakeholders.

Wildlife and ecosystem impact: The potential impact on local wildlife, especially birds, is assessed. Developers are required by law to avoid or minimise any negative effects.

Proximity to infrastructure

Transmission lines: Being close to existing power transmission infrastructure reduces costs and improves efficiency.

Road access: Good road access is necessary for transporting large turbine components to the site.

Regulatory and community factors

Permits and licences: Developers must comply with local, state, and federal regulations.

Community input: It is crucial that companies engage with local communities to address their concerns and gain support.

HOW MUCH SPACE DOES A WIND FARM NEED?

Wind farms can be any size depending on their purpose. The turbines themselves take up less than 1% of the wind farm land area. Cables run under the ground to connect each turbine to a computer control station and the transformer that sends electricity through the transmission lines.

Roads must be built for transportation, construction and maintenance. Trenches are dug to house electrical cables and excavation done for the base of the turbines.

CAN THE LAND BE USED FOR OTHER PURPOSES AT THE SAME TIME?

Existing activities like farming and tourism can take place around the wind turbines and livestock are not disturbed, apart from during construction.

CAN WIND TURBINES BE RECYCLED?

The Clean Energy Council's landmark report, Winding Up: Decommissioning, Recycling and Waste Management of Australian Wind Turbines (Clean Energy Council, April 2023) shows that 85% to 94% of a wind turbine (by mass) can avoid going to landfill. The raw materials like steel, aluminium, copper and cast iron can be repurposed or recycled, while some parts can be reused and recommissioned.

To be given a hydrogen and renewable energy licence, companies must have a plan for how they will decommission (retire and dismantle) any infrastructure – the physical structures and facilities like buildings, roads and power supplies. They must also rehabilitate the land.

The Bungala Solar project covers around 800 hectares of rural land - about 800 soccer fields

SOLAR

Solar energy is created by the heat and light of the sun. Australia has the highest average solar radiation per square metre – ie the best solar resources – of any continent in the world.

HOW BIG ARE SOLAR FARMS?

The Bungala solar project near Port Augusta is one of Australia's biggest solar farms. Bungala 1 & 2 create 270MW (or 135ea). The project covers around 800 hectares of rural land. That's about 800 soccer fields.

WHAT IS THE BEST LOCATION?

A solar farm needs:

- really good sun, known as solar radiation
- large areas of flat or gently sloping land that have no obstacles to cast shadows, such as trees, buildings or mountains

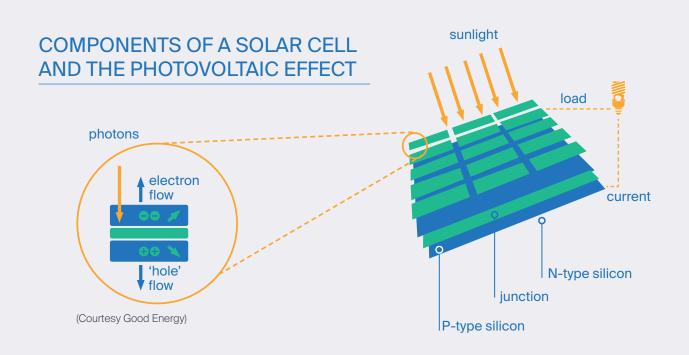


- areas that do not interfere with wildlife habitats, agricultural activities, cultural heritage, or local communities
- access to the electricity grid to deliver the power they generate and to receive backup power when the sun is not shining. The closer the solar farm is to the grid, the cheaper it is to transmit the electricity
- weather conditions that are ideally sunny, dry and cool with not too much wind and dust that can cover or damage the panels
- enough space to dig cables into the ground, build roads for access and build other infrastructure such as transformers.

WHAT ARE SOLAR PANELS MADE OF?

The active material in a solar cell is silicon. It's cut into thin paper-width sheets, which are coated to improve sunlight absorption and minimise reflection. The visible small gridlines on the panel are metal conductors. A plexi-glass sheet protects the cells and a back sheet protects the silicon from moisture and dirt. Solar panels are usually held together with an aluminium frame and have an junction box to string together solar panels in groups, known as arrays.

A typical solar panel consists of two silicon semiconductor layers, one negative (N-type) and one positive (P-type). The N-type silicon has free electrons and the P-type has free 'holes' (ie the absence of electrons). When these layers are exposed to sunlight, the silicon absorbs this light and generates electrons and holes that can be collected in an external circuit in the form of electricity. Without an external circuit these electrons and holes recombine and no electricity is generated.



CAN SOLAR PANELS BE RECYCLED?

The metals in solar panels, usually silver and copper, can be recycled and are needed in the energy transition to make other renewable energy infrastructure. Silicon can also be recycled. However, the panels are not easy to take apart and the process is expensive. Also, some metals used in solar panels, such as lead and cadmium, are toxic so can carry environmental risks.

Because of the rapid growth of the solar panel industry, lots of research is being done to improve solar panel recycling so the processes are improving quickly. The government is committed to supporting solar recycling solutions so we have less waste.

CAN THE LAND BE USED FOR OTHER PURPOSES AT THE SAME TIME?

'Agrisolar' or 'agrivoltaics' combines solar technology and farming so the land can be used efficiently, particularly for large-scale solar farms. 'Solar grazing' allows sheep to graze around the solar panels and use them for shade or protection. The sheep are useful to control grass growing under and around the panels. Solar panels can also be mounted on stilts so that crops and trees can be grown underneath. Agrisolar research is ongoing, looking for more options to make this work for everyone.

ENERGY STORAGE

(Also known as battery energy storage systems or BESS)

WHAT ARE BATTERIES USED FOR?

Batteries store energy so that it can be used when it's needed.

Batteries are used:

- in the national electricity grid
- 'behind the meter' in homes, businesses or industrial operations
- on the fringes of the grid in areas of poor connection or off grid eg in microgrids.

Using batteries together with renewable energy, which may produce less or more energy depending on how sunny or windy the weather conditions are, allows the energy to be stored when there is low demand and released (or dispatched) when people are using lots of electricity (peak demand).

WHAT'S A BIG BATTERY?

Many batteries installed together are known as grid-scale or large-scale battery energy storage systems (BESS). They supply electricity to the electricity transmission system that goes to homes and businesses.

Watch a useful video on what a big battery does, developed by Neoen.

WHERE SHOULD BATTERIES BE LOCATED?

Ideally batteries should be close to the source of generation, whether they're situated near solar panels on a house roof, or next to a solar or wind farm. Bigger batteries generally need flat land for sites.

HOW MUCH LAND DOES A BIG BATTERY TAKE UP?

Batteries come in different sizes. For example, one of the biggest big batteries in the world, the Victorian 300MW Big Battery, is a similar size to a football oval. South Australia's 250MW Torrens Island battery covers a similar area of land.

WHAT ARE BATTERIES MADE OF?

Lithium-ion is the most common battery chemistry. Other batteries can be lead-acid, lithium-iron-phosphate (LFP) and nickel-cadmium. Companies are trialling other methods for storing energy, for example thermal (energy created by heating or cooling) storage in a silicon battery.

PUMPED HYDRO ENERGY STORAGE

Pumped hydro energy storage (PHES) uses water reservoirs as a way of storing energy. Excess energy from the grid or a renewable energy source, such as a wind or solar farm, is used during low demand periods to pump water from a lower dam to a higher one, essentially converting the upper reservoir into a giant battery.

When it's needed, to support the grid to avoid blackouts or meet spikes in electricity demand, the stored energy is released by sending the water through a hydroelectric turbine back into the lower reservoir.

PHES can produce large amounts of electricity over a long duration so can provide reliable generation.

RENEWABLE HYDROGEN

Hydrogen is the lightest and most abundant chemical element in the universe. It can be made using water and electricity through a process called electrolysis. Hydrogen made with renewable energy is a clean-burning fuel called renewable hydrogen. It can play a major role in our zero emissions future by helping to replace fossil fuels in some energy-intensive sectors.

WHY IS SOUTH AUSTRALIA INVESTING IN RENEWABLE HYDROGEN?

South Australia's abundant land, wind, sun and mineral resources create an opportunity to become a global leader in producing renewable hydrogen.

Growing the local hydrogen industry is key to cutting carbon emissions and powering cleaner industry and heavy transport.

By supporting a developing hydrogen industry, the South Australian government is future-proofing energy intensive industries and aims to attract international partners and investors to South Australia.

WHAT'S RENEWABLE HYDROGEN USED FOR?

Renewable hydrogen can capture and store excess renewable energy that can then be used during peak demand periods as a clean fuel source for power generation.

It can also be used:

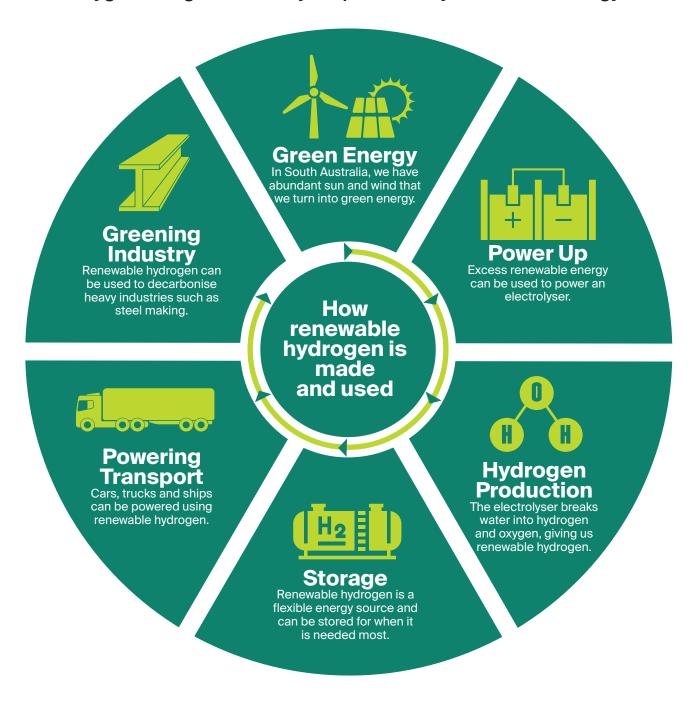
- as another energy supply to complement our wind and solar energy
- as a renewable energy source when the sun isn't shining and the wind isn't blowing
- to power transport including passenger vehicles, heavy road transport and shipping with no harmful emissions
- to decarbonise heavy industry to make products like green steel and green cement by replacing fossil fuel energy sources
- to make green ammonia, which can be used to create green fertilisers for the agriculture industry to grow food.

WHAT DOES A RENEWABLE HYDROGEN PROJECT LOOK LIKE?

There are a number of steps involved in making renewable hydrogen before it can be used. Hydrogen projects and developments across the state include production, storage and/or usage

projects, or hydrogen hubs where producers, users and exporters of hydrogen work side by side. Space and location requirements depend on the production stage.

Renewable hydrogen is made by splitting water into hydrogen and oxygen using an electrolyser powered by renewable energy.



BIOENERGY

Bioenergy is a type of renewable energy that uses organic materials, known as biomass, to produce transportation fuels, heat and electricity.

While biomass is mostly burned for heating, it is also expected to be major alternative fuel for transport sectors that are hard to electrify, such as airlines and ships.

WHAT ORGANIC MATERIALS ARE USED TO PRODUCE BIOENERGY?

Biomass includes plant- and algae-based materials such as:

- crop wastes eg straw
- forest residues eg bark chips and sawdust
- grasses grown for energy production
- animal manure
- algae
- food waste.

WHAT ARE THE TYPES OF BIOENERGY?

Types of bioenergy include:

TYPE	SOURCE	USE
Biofuels	Crops eg corn, sugarcane, algae	Transportation eg ethanol, biodiesel
Biopower	Wood chips, agricultural residues, animal manure	Electricity and heat production
Bioproducts	Various biomass eg plant materials, algae	Chemicals, materials eg bioplastics



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ACKNOWLEDGEMENT OF COUNTRY

As guests on Aboriginal land, the Department for Energy and Mining acknowledges everything this department does impacts on Aboriginal country, the sea, the sky, its people, and the spiritual and cultural connections which have existed since the first sunrise. Our responsibility is to share our collective knowledge, recognise a difficult history, respect the relationships made over time, and create a stronger future. We are ready to walk, learn and work together.

FURTHER INFORMATION

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