

Atmosphere

OUR ATMOSPHERE AND CLIMATE

The atmosphere is the thin envelope of air surrounding the Earth and extending up to the margins of space. It is essential to life, protecting surface organisms from lethal doses of solar radiation, including UV, x-ray and gamma radiation.

The atmosphere provides a buffer to extreme surface temperatures, moderating and diluting the sun's heat during the day, and insulating the surface at night. It is the medium that provides the wind, and supports water vapour as clouds that eventually bring rain to the surface.

The atmosphere is the reservoir for oxygen and carbon dioxide essential for animal and plant metabolism, and nitrogen for conversion to nitrates; a vital soil nutrient essential for plant growth.

Yet the atmosphere is under threat; man-made conditions such as pollution, smog, the greenhouse effect and depletion of the ozone layer are changing its fundamental stability.

Composition of the atmosphere

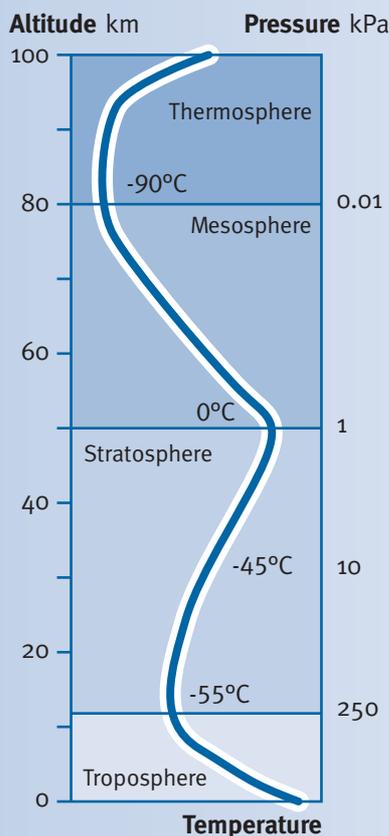
99% of the atmosphere by volume consists of oxygen (21%) and nitrogen (78%).

Human influences affecting the atmosphere

Ozone depletion

The ozone layer is a region in the stratosphere where the gas ozone accumulates. It is a natural but toxic form of oxygen, produced as a by-product of lightning strikes. Ozone has the important ability to shield or block the passage of ultra-violet (UV) radiation arriving from the sun.

When ozone quantities are reduced, excessive levels of harmful UV radiation can reach the surface. Over the Antarctic region, large ozone-depleted 'holes' have appeared each winter, which shift around reaching Australia in spring and early summer exposing us to abnormally high UV levels. Smaller holes have appeared over arctic regions.



Divisions of the atmosphere

Troposphere

The innermost layer of the atmosphere which extends to about 17 km above sea level at the equator but significantly less at the poles. It contains about 75% of the mass of the Earth's air. The air in this zone is turbulent and well mixed, and is affected by surface topography.

Stratosphere

The Stratosphere extends from about 17 km to 48 km above the surface. In this region, the air is calm with little vertical mixing. The stratosphere has a relatively high ozone (O₃) concentration, which is vital to filtering much of the sun's UV radiation.

Mesosphere

Extends from about 50 to 80 km above the surface, where temperatures again start to fall.

Thermosphere

Extends from 80 km to the boundary of space, and where temperatures increase to over 100°C due to high-energy bombardment of air particles by electromagnetic radiation. This also converts the gaseous air molecules to ions.



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Chlorofluorocarbons (CFC) are gases formerly used as refrigerants and industrial chemicals which are now largely phased-out. These gases, when released into the atmosphere catalyse the ozone molecule, transforming it to simple oxygen.

One CFC molecule can destroy many hundreds of ozone molecules and can persist for generations.

Air pollution

Air pollution occurs due to the emission of gases that are by-products or wastes from industry, transport, agriculture and domestic practices. The most significant air pollutants are nitrous oxides (NO₂, NO₃), sulphur dioxide (SO₂), hydrocarbons and wood smoke.

Photochemical smog, the dirty orange haze that blankets cities and industrial areas, results from the reaction between sunlight, nitrous oxides and sulphur dioxide. It is sourced primarily from car exhausts and industry emissions.

Acid rain results from the reaction between sulphur dioxide and raindrops, producing sulphuric acid. The acid lowers the pH of rainwater, attacking stone buildings and killing forests. Sulphur dioxide is mainly a product of industrial processes, primarily the burning of fossil-fuel coals with high sulphur content.

Air pollution and smoke are particularly concentrated in cities, where in some cases people have to stay indoors or wear air filters to reduce the incidence of bronchial conditions.

Greenhouse effect

The greenhouse effect occurs when certain gases in the air permit short-wave solar radiation to reach the Earth, but trap outgoing long-wave (heat) radiation.

Some gases contribute more strongly than others, increasing their concentration in the atmosphere may warm the atmosphere and subsequently the surface of the Earth outside normal temperature ranges.

The major greenhouse gas is carbon dioxide, contributing about 80% of greenhouse emissions. Other important greenhouse gases are methane (about 16%), nitrous oxide (about 3%), PFC's and CFC's. Methane is 21 times more potent and nitrous oxide is 310 times more potent than carbon dioxide.

Carbon dioxide results from the burning of carbon-containing fuels, such as coal, oil and gas. Unusual natural events such as volcanic eruptions can also release huge quantities of carbon dioxide.

Methane is a by-product of oil and gas production, as well as a breakdown product of fermentation and decay. Most atmospheric methane emissions derive from natural production in the gut of livestock, and decay of dead plant matter.

Greenhouse sinks are areas that 'take up' carbon dioxide naturally, such as forests and vegetation, by way of natural photosynthesis. Sinks are promoted as a way to reduce the effect of greenhouse gas emissions. If sufficient sinks are established a balance might be restored between emissions and uptake.

Gippsland's atmosphere

Gippsland has excellent air quality across much of the region, primarily due to the limited adverse emissions associated with rural activities and forested regions. The Latrobe Valley's air is compromised, primarily due to the high concentration of heavy industry in the area.

CASE STUDY

Dairy impacts on the greenhouse effect

Nitrous oxide is a greenhouse gas with 310 times the effect of carbon dioxide. It is believed that during the 1990's nitrous oxide emissions increased by up to 41%, largely due to nitrogenous fertilisers used in the dairy and grain industry. Studies are being undertaken to look at better nitrogen fertiliser management on dairy farms.

So far the findings have shown:

- Nitrous oxide is released from waterlogged soils with heavy stocking rates. As wet soil is anaerobic, nitrogen-using bacteria are not present. Avoid heavy stocking on wet and waterlogged soils.
- Nitrogen fertilisers should only be applied to actively growing pastures at rates below 50 kg/ha between 21 and 28 days apart.

www.greenhouse.unimelb.edu.au/Dairy.pdf

Resources

Bureau of Meteorology

www.bom.gov.au

Greenhouse Victoria

www.greenhouse.vic.gov.au



Climate

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Climate is the set of long-term averaged meteorological conditions for a particular location or region. Weather is not the same as climate; weather describes only the local meteorological conditions at a particular location and time.

Meteorology embraces the study of climate and weather, from which we derive weather forecasting and climate modelling. It includes monitoring and predicting physical weather properties such as temperature, humidity, precipitation, sunshine, cloud cover, wind direction and speed.

Effects of climate

Climate affects the way we farm our land and the patterns we base our lives around. It impacts upon the amount of water we can use from rivers and streams. It is responsible for seasonal variations in temperature, humidity, precipitation and wind patterns.

An understanding of climate is vital to ensuring good land management practices are maintained and that sufficient water is available for the environment, human use and agricultural requirements.

Our land management practices have derived from traditional European farming practices, where Europe's regular, predictable weather patterns ensured reliable harvests and adequate water supplies. Australia is affected by periodic yet unpredictable long droughts, requiring alternate farming practices to those of Europe. Poor soils and lack of understanding of Australia's climate has led to widespread land degradation, erosion and salinisation.

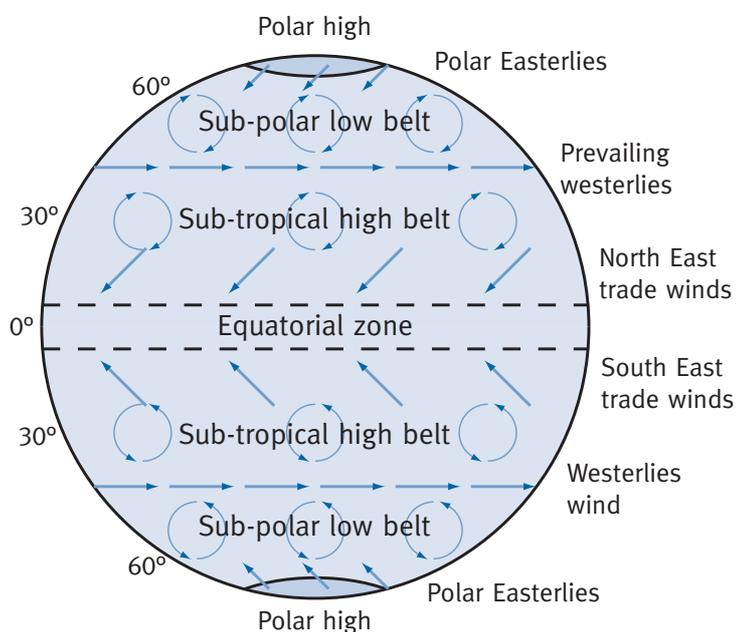
The influence of drought in SE Australia is strongly influenced by Pacific winds and currents, particularly the EL Nino effect and the Southern Oscillation Index (SOI). Meteorologists are becoming more skilled at predicting these events.

Wind

Wind is basically the motion of air, and is a major influence in climate. This is due to its moderating effect on temperature extremes and its importance to global air circulation patterns.

Wind patterns vary at global, regional and local scales, and vary during the course of the day in often-predictable patterns. These are dependant on factors like temperature, season and local topography.

Global climate and wind circulation



The global wind circulation refers to the Earth's general wind patterns, and result from a number of important influences. These include latitude, rotation of the earth, season, and proximity to land or water. The Earth has three major wind and climate zones that form 5 broad bands around the Earth. These are driven by the fact that the equator receives the most solar radiation from the sun. This net heat gain warms and humidifies the lower atmosphere, causing the air to convect upwards and form extensive low-pressure systems. This mechanism allows for the distribution of heat from lower to higher latitudes.

Seasonal variation in climate

Due to the tilt of the Earth's axis, the climate will vary across the Earth according to the amount of solar radiation that particular latitudes receive at different times of the year.



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In Australia, maximum radiation is received in summer. This moves the climate bands further south, e.g. winter high-pressure systems that move centrally across the continent result in elevated temperatures in the southern region with clear days and less rain. Northern parts of the continent become subject to equatorial monsoons, with strong equatorial lows and cyclones prevailing. This is the 'wet' season.

As the next winter approaches the pattern shifts north. The southern part of the continent is then subject to drier weather.

CASE STUDY Climate in the Gippsland region

The Gippsland region enjoys a generally mild climate, though there is considerable variation from the high ranges in the north to the coastal plains in the south. Elevations range from in excess of 1,500 m in the alpine areas down to low river valleys and coastal areas.

Rainfall

Much of Gippsland's rainfall is sourced from lows that develop off the NSW coast which then move south and west into Gippsland, with the remainder arriving as intense lows from south-westerly airflows.

Elevated areas are wetter and cooler than lowlands, where maximum rainfall is produced due to conditions associated with incoming cold fronts moving up and over the ranges. Lowland areas often miss out on this precipitation, causing areas such as the Gippsland Lakes hinterland, Heyfield, Sale and Maffra districts to be deficient in rain and consequently drier. Areas such as the Macalister district are reliant on irrigation for sufficient agricultural water.

This 'rain shadow' results from the Strzelecki ranges to the west and Wilsons's Promontory to the south drawing off incoming rain. Rainfall distribution over the year is relatively even for most areas, being slightly drier in summer.

The southern slopes of the Great Dividing Range, the Strzelecki Ranges and coastal western areas, receive high rainfalls of 1000 to 1600 mm/yr, falling as snow above 600 m in winter. Annual rainfall decreases from 1000 mm to less than 600 mm in the central lowlands due to the Strzelecki rain shadow.

Temperature

Gippsland temperatures are mild along the coast with winter averages around 10°C and summer averages around 20°C and moderated by sea breezes. Further inland, summer temperatures occasionally exceed 40°C with associated hot northerly winds. In winter frosts are frequent. Temperatures are markedly cooler in alpine areas, often falling well below freezing.

The warmest district is around Sale and Maffra, which is at low elevation and not affected by tempering coastal climates. Sale has the highest recorded temperature in the district, 45.6°C.

Coastal areas are generally milder, with cooling sea breezes in summer and blanketing cloud cover retaining warmth in winter.

Winter weather in the east is often the warmest in the state, with northerly winds bringing first rain, then descending down the flanks of the mountains. The descent warms the air, bringing milder conditions to the district lowlands.

Wind

There is a relative absence of strong northerly winds in Gippsland, due to the barrier of the Great Dividing Range. Summer winds tend to be easterly and south-easterly, often associated with the sea-breeze effect. Winter winds are predominantly westerly or south-westerly for most districts.

The south-west coast and isolated capes and promontories experience very strong wind regimes. This has led to the development of wind farms exploiting these winds for electricity production, such as the Toora wind farm. Average monthly wind speeds are 8.0 m/s at Toora and 7.2 m/s at Cape Liptrap, with high wind flux values recorded at both sites.

The region has generally excellent air quality, though in the Latrobe Valley air quality is compromised by the district's industry base and electricity generation.

Resources

Bureau of Meteorology
www.bom.gov.au



Weather

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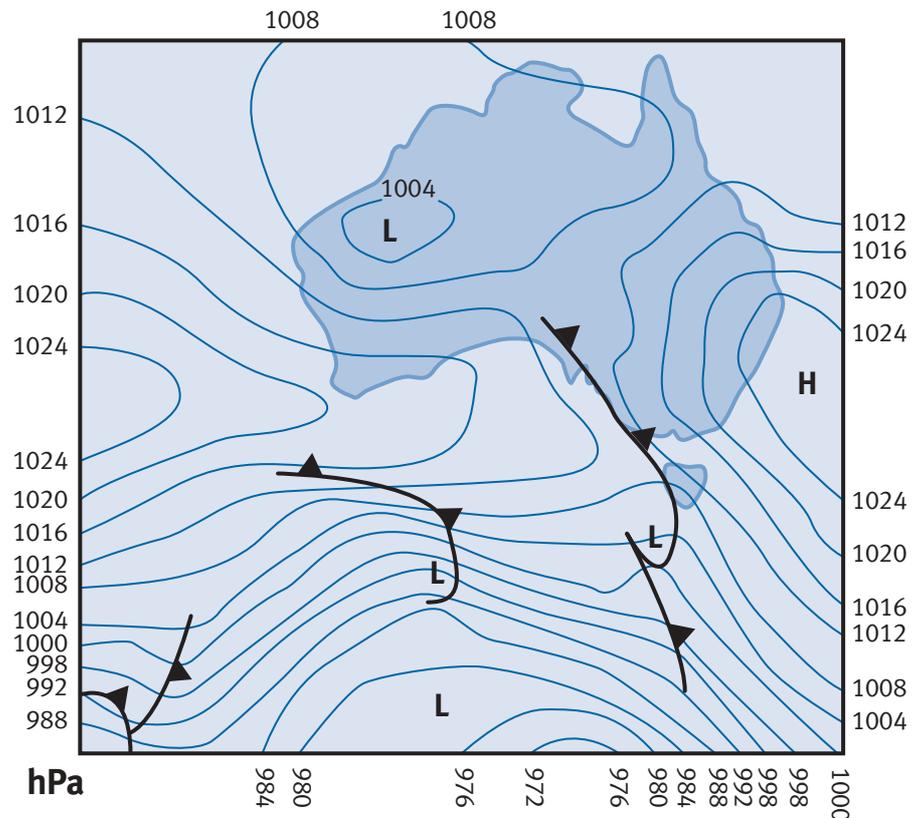
Note: For further information on weather topics, see also the Climate Information Sheet.

Weather is the meteorological conditions of a particular location at a particular time. The location can be local, e.g. a town or city, regional, e.g. a district or even a country. Weather records can be collected over a period of time and then averaged to give information about the climate for the locale. The study of climate and weather is known as Meteorology.

Forecasting the weather

Weather forecasting requires accurate measurements be taken for numerous weather indicators, including temperature, humidity, precipitation, sunshine, cloud cover, wind direction and wind speed. These are usually collected at weather stations at regular intervals. Weather stations are located in most towns and cities, as well as airports, farms, research stations and remote outposts.

Collected weather information (synoptic data) is forwarded to major weather facilities, such as the Bureau of Meteorology headquarters, where weather maps are constructed, forecasts issued and data added to climate profiles.



Weather maps

Weather maps are featured in daily newspapers across the country, and are a useful guide to the weather. They indicate the broad weather conditions and forecasts up to a week ahead. A weather map displays an outline of the region covered, typically a map of Australia, with information on air pressure, pressure fronts, troughs, wind speed and precipitation. The map will be for a particular time and date.

Air pressure

The unit of air pressure is the bar or millibar, and is indicated on a weather map with smooth curving lines known as isobars, measured in hectopascals (hPa). Air pressure along any isobar will be equal at any point along the line.

Air pressure differs due to the density of the air at any location and time, due to unequal heating and cooling of the Earth's surface. Land masses will generally heat the air more than the oceans.

Warm rising air is less dense than colder air, and is shown on a weather map as an area of low pressure (L), usually indicating cloudy or rainy weather. Areas of high pressure (H) will form where there is descending, cool air, usually indicating fine or clear weather.

Wind

Winds are caused by convection, where rising air is replaced by cooler surface air rushing in. Weather maps will often display short arrowtail lines from major cities. These indicate wind speed at that



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location. When arrowtails are present there is usually an accompanying legend detailing wind speed for each type of arrowtail.

Wind can be described according to its strength, frequency and periodicity. It is measured using anemometers that record wind speed and direction at timed intervals, usually every 15 minutes or hourly. Each wind monitoring station in the country records wind data in detailed charts, listing averages for every hour and every day of the year. High-altitude winds are recorded with weather balloons, usually released twice per day.

Surface winds are created when air is drawn in from a low-pressure cell adjacent to a high-pressure cell that is pushing air out. Surface winds will always move from high-pressure zones toward low-pressure zones. Isobars on a weather map can be used to indicate the general wind flow strength and direction.

The effect of the Earth's rotation causes the descending air in high pressure cells to spiral in an anti-clockwise direction, pushing air down and out. In low-pressure cells, the air will spiral inward and upward, drawing air at the surface in a clockwise direction. These directions of rotation are reversed in the Northern Hemisphere.

When isobars are closely spaced the air pressure gradient is steeper, causing winds as air moves from high to low pressures. Often storm 'fronts' form ahead of intense lows, where steep pressure gradients create unstable moisture-laden air. Fronts are indicated by solid heavy lines with triangular saw-teeth points, representing cold fronts, or semi-circular points representing warm fronts.

Precipitation

Precipitation refers to all forms of moisture arriving as weather. This includes rain, hail, snow, sleet and dew. Precipitation is measured using a rain gauge, in millimetres or points. (100 points of rain equals one inch, or approximately 25 mm).

Precipitation is indicated on the weather map with hatched areas, showing where rain has fallen or may be expected.

Air in low-pressure systems is usually warm and moist. The ascent of low-pressure air causes it to cool, condensing out moisture as clouds and

precipitation. If a moving low-pressure cell encounters elevated terrain such as a mountain range, it will be forced up at a more rapid rate, producing very high levels of rainfall. In Australia, this occurs along the great dividing range along the east and south-east coasts, and is known as orographic precipitation. When a low is 'squeezed' or stalled by certain combinations of regional air pressure and topography, huge rainfalls can occur over extended periods, leading to flooding.

Temperature

Temperate is not normally indicated on weather maps, though areas of high pressure typically indicate warmer temperatures rather than areas of low pressure, due to clearer, drier air in high pressure cells.

Temperature is measured in a shaded, insulated weather station using a dry-bulb thermometer.

Humidity

Humidity describes the moisture content in the air, which is measured using a hydrometer. Humidity is responsible for 'sticky' air in hot conditions. In cooler areas, fog is an indication of high humidity.

The amount of moisture the air can hold depends on the air temperature; warmer air can hold more water vapour than cool air. If the temperature of moist air falls, a point will be reached where water vapour starts to condense out as droplets. This is known as the dew point, and represents the maximum amount of moisture the air can hold at that temperature.

When warm, moist air is forced to cool, such as occurs in rising low-pressure systems, eventually the air's dew point is reached and moisture will precipitate as rain and clouds.

Resources

Bureau of Meteorology
www.bom.gov.au



Renewable Energy

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Renewable energy refers to the way the energy is harnessed and comes from sources which can be replenished or replaced such as solar radiation, wind and water.

Renewable energy is often referred to as “alternative energy”, a term used to describe energy sources that are an alternative to traditional fossil-fuels such as coal. However it should be noted that some forms of alternative energy may either use fossil fuels in their production, e.g. current hydrogen fuel, or in the case of firewood, the source may be utilised faster than it can be replenished.

Approximately 4% of Victoria’s energy consumption is from renewable sources. In 2005 the bulk of this was from hydro followed by biomass, wind and lastly solar energy.

Source: Sustainable Energy Authority Victoria

Renewable energy and climate

Unlike fossil-fuel energy, renewable energy is not harmful to the Earth’s atmosphere and climate. There is no net emission of greenhouse gases such as carbon dioxide, when producing renewable energy. This is important in the context of the greenhouse effect, the main contributor to which is believed to be carbon dioxide, sourced primarily from fossil-fuel energy production.

However, the manufacture of renewable energy infrastructure requires the input of energy from sources that are usually non-renewable. This energy is known as embedded energy, and it has a ‘payback’ time, i.e. recovering the energy spent in manufacture will take a certain amount of time, usually years. After that period, all energy generated will be ‘free’.

Renewable energy resources

Hydro-electricity is by far the largest source of renewable energy in Australia. Most is generated in Tasmania. There is also significant input from biomass resources such as bagasse, which is derived from crop wastes, predominately sugar cane. More recently, large-scale wind energy turbines are beginning to supply renewable energy.

The main sources of renewable energy are:

- Photovoltaics
- Wind energy systems
- Solar thermal systems
- Heat pump systems
- Hydro electricity systems
- Biomass resources such as methane, methanol, ethanol, biodiesel, hydrogen, bagasse, waste timber and firewood, and crop wastes
- Tidal and wave power systems
- Fuel cell systems

Applications

Large-scale renewable energy such as hydro-electricity and wind energy are designed to provide an important supplement to mains or grid-supply electricity. The snowy river hydro scheme supplies critical peak-load demand electricity for Sydney and Melbourne. Most of Tasmania’s electricity is sourced from hydro-electricity.

A recently recognised asset is wind. As an alternate energy source, it is controversial, though it has ‘clean’ advantages. With strong steady winds across the South Gippsland area, our region is considered to be one of the prime locations for wind turbines to generate electricity. However, the impact of wind farm development proposals on other values such as landscape amenity and biodiversity must be carefully assessed during the planning process.

Smaller renewable applications are particularly important in rural or remote settings, where often connection to grid-based electricity or gas supply is expensive or not possible. Remote communities, outback stations and farms benefit here, though in many cases renewable electricity generation is supplemented by diesel generators.

Common applications include:

- Telecommunications
- Solar powered water pumping – gradually replacing the traditional windmill
- Solar electric fencing
- Solar lighting – for remote road locations where grid power is difficult to access
- Navigation – signal and marker buoys for shipping channels and remote lighthouses
- Stand-alone power systems (SAPS) – homes and businesses relying solely on renewable energy systems
- Grid-connect power systems – homes and businesses still connected to the mains grid, and equipped with renewable energy generators such as photovoltaic panels supplying power to the grid



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- Recreation vehicles – supplying power for appliances in mobile homes and caravans.
- Boating – recreational craft and yachts requiring power when engines are not running
- Security systems – no loss of security in the event of power failure
- Traffic management – electrified warning signs, emergency phones, lighting
- Small-scale garden – lighting, ponds, fountains

Economics of renewable energy

Currently in Australia, fossil fuels are an important export revenue earner. Infrastructure in Australia devoted to energy generation and distribution has a valuable role in employment. Other industries also benefiting from, or dependent on, fossil-fuels include; mining and exploration, manufacturing, road transport and the car manufacturing industry.

For renewable energy to replace fossil-fuels, there would need to be a major restructure in existing energy patterns and use, employment opportunities, manufacturing, and the need for training.

If renewable energy were to replace conventional energy generation too quickly, serious economic instability would result that could lead to economic depression or worse.

Though it is recognised that the greenhouse effect requires urgent attention in respect to energy generation, these difficulties suggest that it will be sometime before renewable energy can substantially or completely replace fossil-fuels.

Resources

The following websites will provide useful information on the topic of Renewable Energy.

Sustainable Energy Authority Victoria

www.seav.vic.gov.au

Australian and New Zealand Solar Energy Society

www.anzsos.org

Alternative Technology Association (Australian)

www.ata.org.au

Australian Greenhouse Office

www.greenhouse.gov.au

Video Education Australasia

www.vea.com.au

Video, renewable energy

Australian Broadcasting Corporation

www.abc.net.au

Landline program – windpower

CASE STUDY

Toora wind farm

The Toora wind farm was originally planned as an experimental project by the state government in 1991. Two possible sites in Gippsland were identified; Kilcunda and Toora. After privatisation of the State Electricity Commission of Victoria under the Kennett Government, the project was dropped.

The Stanwell Corporation Ltd., a Queensland State Government company, signed contracts with landholders in the area and applied for a planning permit. Changes to the local planning scheme had identified the general area as being suitable for wind farms and a permit was granted. There were 31 objections to the project, which meant that the Victorian Civil and Administrative Tribunal (VCAT) was utilised in the appeal process. Most of the appeals were on the grounds of visual impacts, noise and potential environmental hazards.

Construction commenced in early 2002, with the wind farm operational later that year. There are 12 turbines which each have a capacity of 1.75 MW. The Vestas Company manufactured these turbines in Denmark. The 117 tonne towers are 67 m high and were manufactured in Bendigo, Australia by A.D.I. Each tower is anchored by reinforced cement being approx 14 m² and 1.75 m deep. The concrete was manufactured on site as each tower footing is the equivalent of 32 cement trucks. Each was poured in one day!

Each tower houses a rotor with three 33 m long blades. The rotor and blades themselves weigh 23 tonne. The blades are constructed or reinforced plastic and carbon fibre. They commence turning at wind speeds of 14.4 km/h and shut off when the wind speed is greater than 90 km/h. The blades rotate 21.3 times/min.

Associated infrastructure includes the substation and feeder power lines to connect the farm to the grid.

The Toora Wind Visitor Information Centre is located at 50 Stanley Street, Toora, Vic. 3962. Telephone: (03) 5686 2311

References

www.toorawind.com.au/windfarm.htm