NSW GOVERNMENT Environment, Climate Change & Water

The wind energy fact sheet

Wind farms produce clean energy, generate jobs and income in regional areas and have minimal environmental impacts, when appropriately located.

To increase community understanding and involvement in renewable energy, the NSW Government has established six Renewable Energy Precincts in areas of the best known wind resources: New England North West Tablelands, Upper Hunter, Central Tablelands, NSW/ACT Border Region, South Coast and Snowy-Monaro.

As part of this initiative, the NSW Department of Environment, Climate Change and Water has created this information brochure to provide the community with unbiased information about wind energy. The technical information has been reviewed by the Centre for Environmental and Energy Markets (University of NSW).

For more information on renewable energy, please visit the Renewable Energy Precincts Resources webpage at www.environment.nsw.gov.au/climatechange/reprecinctresources.htm

How wind power works

A wind turbine comprises a **tower**, topped by an enclosure called a **nacelle**, and the rotor, which is the propeller-like structure connected to the nacelle.

The nacelle houses an electrical **generator**, power control equipment and other mechanical equipment, connected to the rotor **blades**. The wind strikes these blades and causes the rotor to spin. When the wind is strong enough, the rotational energy in the rotor is converted to electrical energy within the generator.

The voltage of the electricity produced by the wind turbine is then increased by a transformer and substation to enable it to be fed into the electricity grid.

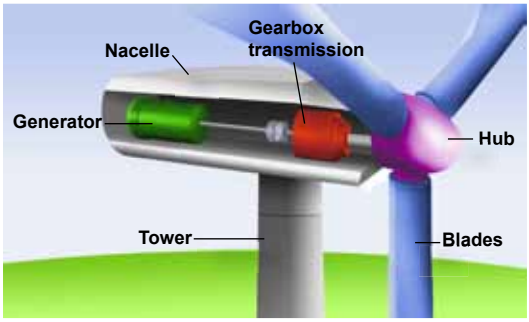
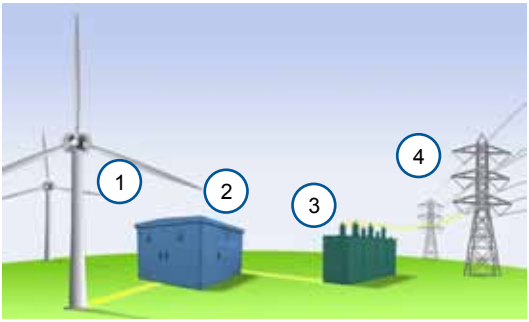


Figure 1 **A wind turbine**



1. **Rotating generator converts wind energy to electricity**
2. **Transformer increases voltage for transmission to substation**
3. **Substation increases voltage for transmission over long distances**
4. **Transmission to the grid**

Figure 2 **How wind turbines transfer power to the electricity grid**

Interest in wind energy is growing rapidly

On average, the annual global capacity of wind energy has grown around 30% every year since 2000[1].

In 2008–09, wind energy accounted for around 1.5% of electricity generation in Australia[4]. The Australian Bureau of Agriculture and Resource Economics predicts that wind energy generated in Australia will increase by 11 fold from now to 2030[5].

Individual wind towers are generally much smaller capacity than coal or gas power stations; however, collectively they can supply electricity at a large scale.

At present, wind energy is generally not only the cheapest renewable energy technology, but also the only one ready now for large-scale deployment. Technologies such as large-scale solar power, geothermal, wave and tidal energy are very promising but are not ready for mass deployment.

Wind energy investment is growing rapidly because governments have set clean energy targets and it is set to become an important supplier of electricity in NSW, Australia and worldwide.

Sixteen nations (including Australia) now each have more than 1000 megawatts of installed wind capacity[2]. Globally, this represents less than 2% of electricity generation but in some nations wind is now a significant part of the energy mix, supplying upwards of 10% of electricity needs in some US states (eg Texas), Spain and Portugal, and 20% in Denmark.

Australia

Australian wind energy generation is also growing at a significant rate, with approximately 1700 megawatts of operating wind farms[3]. The Commonwealth has legislated a 20% renewable energy target to be achieved by 2020.

New South Wales

Wind energy currently supplies less than 1% of NSW's electricity needs. However, NSW has good quality wind sites with higher wind speeds than many European wind farms. Wind farms currently proposed for development in NSW would increase renewable energy consumption in NSW from 6 to 19% (based on total electricity consumption in 2008).

The largest wind farm currently operating in NSW is the Capital Wind Farm near Goulburn (pictured next page). With a generating capacity of 141 megawatts, it supplies power equivalent to the needs of around 60,000 households. Around 80% of its output is used to supply clean energy to power Sydney's desalination plant.

Wind turbines are efficient

Efficiency measures how much of the primary energy source (eg wind, coal, gas) is converted into electricity. NSW coal-fired power stations convert 29% to 37% of the coal into electricity, and NSW gas plants convert 32% to 50% of gas processed into electricity. Wind turbines convert around 45% of the wind passing through the blades into electricity (and almost 50% at peak efficiency)[6,7].

Large wind turbines operate less of the time than NSW coal plants but they are more efficient at generating electricity.

Over time, coal power stations operate at around 85% of full capacity (known as the *capacity factor*). Gas power station capacity factors vary from as high as 85% to less than 10% (if designed only to supply electricity at peak periods)[8]. The average capacity factor for a large-solar plant that produces electricity during daylight hours is around 20–25%[9].

The average capacity factor for a wind farm in Australia is around 35%, and can range from 25% to 45%[10]. Wind farm capacity factors are lower than coal and baseload gas plants, but they use their energy source more efficiently and can be large-scale suppliers of electricity.

Photo: Infigen Energy

Wind farms reduce greenhouse gases

The scientific consensus is that Australia, and other nations, must start to reduce their greenhouse gas emissions in the next decade if we are to avert the risk of what the Intergovernmental Panel on Climate Change refers to as 'dangerous' climate change.

Every unit of wind energy fed into the NSW grid cuts greenhouse gas emissions.

Electricity generation is responsible for over a third of Australian and NSW greenhouse gas emissions, largely because of a heavy reliance on fossil fuels in power generation. At present, Australia has the second highest greenhouse gas emissions per unit of electricity produced.

A study by energy market specialists McLennan, Maganasik & Associates has found that every additional unit of wind power injected into the NSW grid replaces a unit of power from another generator – 'almost exclusively' a gas or coal-fired power station.

In NSW, on average, a 150 megawatt wind farm (the standard size of wind farms currently under development for NSW) produces enough electricity to power around 60,000–65,000 homes, saving on average 360,000 tonnes of greenhouse gas emissions annually.

A 500 megawatt wind farm (a large wind farm) on average produces enough electricity to power almost 200,000 homes – saving on average 1.3 million tonnes of greenhouse gas emissions annually[11].

Visit www.environment.nsw.gov.au/climatechange/greenhousegassavingstool.htm to use the NSW Wind Farm Greenhouse Gas Savings Tool and calculate the greenhouse gas savings for new wind farms in NSW.

NSW wind farms do not need additional fossil fuel generators as 'back-up' when there is no wind.

Coal-fired power stations can be turned down when they are not required to operate at full capacity, eg when the wind is blowing strongly.

A wind farm produces more energy in less than a year of operation, than used in its construction, and the operational lifetime of a turbine is at least 20 years[13, 14].

The NSW electricity market is designed to balance swift, unexpected shifts in demand and supply, be it on the demand side (eg weather changes) or on the supply side (eg a power generator going offline due to faults).

Generators bid to supply electricity at five-minute intervals. When the wind blows, the output of wind farms displaces output from coal or gas plants. When the wind is not blowing, electricity can be sourced from hydro, coal, gas plants or other renewable energy generators.

In addition, there are contingency services already operating to maintain electricity supply amidst exceptional events. Contingency services are generally set to allow for failure of the largest power unit, which in NSW is a 660 megawatt coal fired power station. As or June 2010, there were only 185 megawatts of wind power in an electricity system of 15,540 megawatts in NSW & ACT[12].

In future, as wind energy becomes more significant, greater participation by fast-response gas plants (that can turn up or down more quickly than coal plants) and/or renewable energy with storage, will be needed to maintain the right balance of generating plant to accommodate the intermittency of wind energy.

Wind energy can be integrated into the grid

In South Australia, grid and market operators have managed the integration of wind energy as it has increased from zero to supply 17% of electricity needs in just seven years.

Experience overseas and in Australia demonstrates wind farms can be successfully integrated into our electricity grid as they become more common.

Wind energy has been successfully integrated into the electricity grids of other leading wind jurisdictions such as Denmark and Portugal, where wind energy already meets 15% to 20% of annual electricity needs. In Portugal, wind energy has met as much as 50% of daily electricity needs.

The national electricity market (NEM) and electricity grid is designed to handle variability under most circumstances, including intermittent output from wind generators. New rules have been implemented to enable the operators of the NEM to control the output of intermittent generators larger than 30 megawatts (including wind farms) to manage any impacts.

The national electricity market grid covers Queensland, NSW, ACT, Victoria, Tasmania and South Australia. As more wind farms are connected to the grid, their increased geographic dispersion helps smooth out variability in wind between different areas.

The Australian Wind Energy Forecasting System, funded by the Australian Government, is improving the ability of grid and market operators to predict wind output.

Photo: Country Energy

Wind farms are safe

The fire risk at wind farms is very low.

Wind farms can be struck by lightning, just like tall buildings, but they are equipped with comprehensive lightning protection systems that transfer high voltages and currents safely to the ground.

The fire risk is very low. The flammable parts are located high above the ground, away from vegetation and high voltage connections are underground.

Wind turbines have safety mechanisms to cope with extreme wind conditions.

Wind turbines are manufactured to operate in high winds – the risk of blades or other parts coming off is minimal.

In addition to being designed and manufactured to Australian and international standards, wind turbines can be turned off or turned into the wind so that they don't spin in extreme winds (>100 km/hour). Wind turbines have a brake system that holds the rotor blades still[15].

Photo: Suzlon Energy Australia

Around the clock monitoring allows each turbine to be controlled according to the conditions

Noise

Modern wind turbine designs have significantly reduced the noise from turbines. Turbine designers are working to minimise noise, as noise reflects lost energy and output.

NSW controls on wind farm noise are amongst the strictest in the world.

Noise levels at nearby residences are managed through the siting of turbines, the approvals process for wind farms and operational management of the wind farm.

The noise limit for wind farms is 35 A-weighted decibels, which is usually around 5 A-weighted decibels above a quiet countryside. Alternatively, the limit is 5 A-weighted decibels above the level of background noise (ie without wind farm noise), if that is greater than 35 A-weighted decibels.

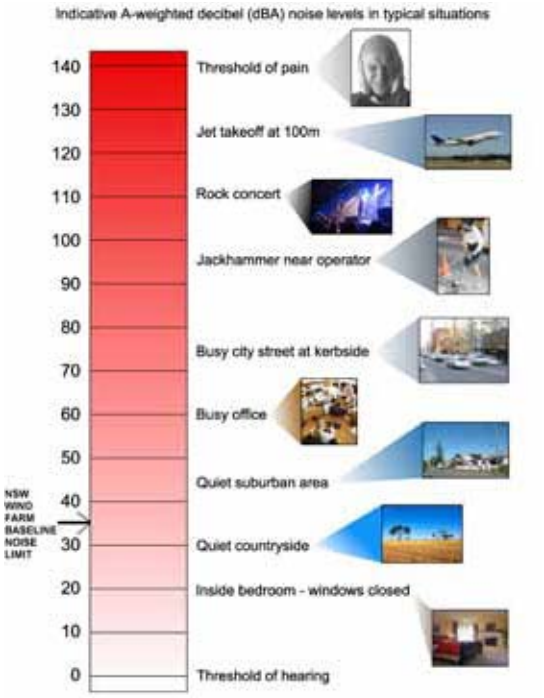


Figure 3 The level of common sounds

NSW currently uses the South Australian Wind Farms Environmental Noise Guidelines (2003) in the assessment process for approving wind farms.

Before it can operate, a wind farm has to demonstrate that noise levels at neighbouring residences will meet strict noise limits. These limits are designed to ensure that the noise from a wind farm is not intrusive for the average person. For example, the Minister for Planning required the Kyoto Energy Park (near Scone) to remove 13 turbines from its proposed wind farm to ensure that noise levels will remain within set limits.

Conditions of planning approvals require that noise monitoring is routinely carried out on wind farms, with the results provided to planning authorities. Independent monitoring may also occur to ensure compliance with noise standards.

Noise from wind turbines is similar to other types of noise in our day-to-day environment

Low frequency sound and infrasound (ie usually beneath the threshold of human hearing) are everywhere in the environment. They are emitted from natural sources such as wind and rivers and artificial sources such as traffic and air conditioning[16].

Modern turbine designs which locate the blades upwind instead of downwind have significantly reduced the level of infrasound. Scientific and health authorities have found the low level of infrasound emitted by wind turbines pose no health risks[17].

The World Health Organisation and Australian health authorities, including the National Health Medical Research Centre, have concluded that 'there is no published scientific evidence to positively link wind turbines with adverse health effects' (July 2010)[18].

Economic benefits

Wind farms provide local jobs in construction and operations.

It is estimated that new renewable energy projects under the Australian Government's Renewable Energy Target scheme could lead to the creation of more than 6000 jobs in NSW[19]. A large proportion of these jobs will be in the construction and operation of wind farms in regional areas.

According to the United Nations Energy Program, renewable energy creates more jobs per dollar invested than conventional power generation (ie coal or gas)[20].

Wind farms provide an alternative source of income for land owners.

Wind farms provide a valuable stream of guaranteed annual revenue for land owners that host turbines, which helps to 'drought-proof' their farms. Wind turbines can comfortably coexist with other land uses such as grazing and cropping.

Increased employment in areas where wind farms are located will provide flow-on benefits to local businesses.

Wind farm developers often voluntarily invest in local communities, such as upgrading local infrastructure and contributing funds to community projects. For example, AGL is providing $15,000 per annum (increasing in line with inflation) to a community fund for each of four wind farms it has built in South Australia over their lifetime.

Major studies have found no statistical evidence that wind farms reduce property values.

The most comprehensive Australian study to date on land values and wind farms was undertaken by the NSW Valuer General. The study found no impacts from wind farms on the sale prices of rural and township properties. It found sale prices for 4 out of 13 lifestyle properties were lower than expected, but as they were located next to properties with no impacts it was not clear the wind farm was the cause. Overall, the study found no statistical evidence to substantiate the claim that wind farms harm land values. This is consistent with the findings of major international studies[21].

NSW communities support wind farms

In 2010 the NSW Government commissioned a survey of more than 2000 residents and 300 businesses in regional areas in NSW on attitudes to wind farms and renewable energy. The survey found there was strong community support for wind farms[22].

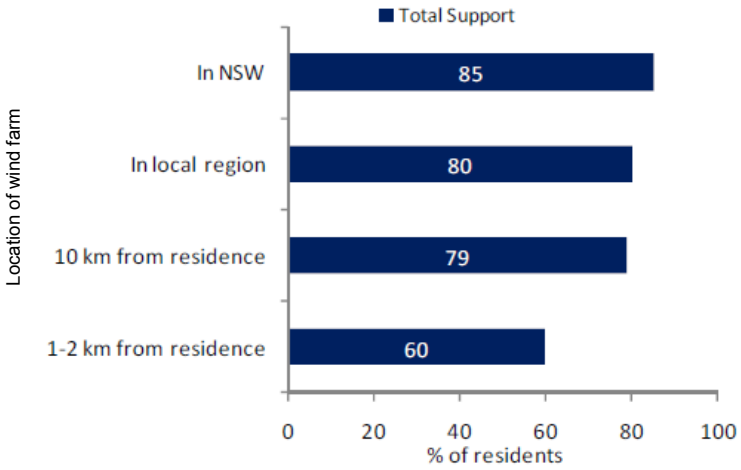


Figure 4 Overall support for wind farms

Shadow flicker

Shadow flicker on nearby residences can be avoided through the approvals process by ensuring good siting of wind farms and setting operational guidelines.

Wind turbines may create shadow flicker on nearby residences when the sun passes behind the turbine.

However, this can easily be avoided by locating the wind farm to avoid unacceptable shadow flicker, or turning the turbine off for the few minutes of the day when the sun is at the angle that causes flicker. Shadow flicker is considered in the NSW development assessment process to ensure potential impacts are addressed.

Decommissioning of turbines

Timely decommissioning of turbines that are no longer in use is a standard condition of consent for wind farms in NSW. Decommissioning wind farms is a straightforward task.

In Europe many older wind farms are being re-powered with new turbines; this could also be expected to occur in New South Wales. Existing wind sites have considerable value – the wind resource is well understood and structural foundations, electricity transmission and local community acceptance are already in place.

Local environment

Wind farms use far less water than coal-fired power plants.

Coal-fired power stations use large amounts of water in their operations, primarily in cooling towers and boilers. Any reduction in coal fuel electricity will lead to reduced use of NSW's finite sources of water.

Wind farms are often built on land that has already been impacted by land clearing. Not only do they coexist easily with other land uses (eg grazing, crops) but they have a smaller footprint than other energy generation such as coal and gas plants.

Wind farms have minimal local environmental impacts.

The ground disturbance and vegetation clearing required for wind farms is minimal compared with coal mines and coal-fired power stations. If wind farms are decommissioned, the landscape can be returned to its prior condition.

Impacts of wind farms on the local environment are assessed in the planning stages.

Potential impacts on the local environment (eg plants, animals, soils) are part of the environmental assessment for each wind farm proposal. Turbine locations and operations are often modified as part of the approval process to avoid or minimise impacts on threatened species or communities and their habitats. Any unavoidable impacts can be offset with conservation improvements of similar ecosystems which are unaffected by the proposal.

Livestock appear unaffected by the presence of wind farms. Experience in Australia and overseas shows that livestock will graze right up to the base of wind turbines and often use them as rubbing posts or for shade[23].

If wind turbines are appropriately located, bird and bat collisions with the turbines are likely to be rare.

Studies indicate that the main human-induced threats to birds and other species are habitat destruction from land clearing, pet cats, buildings, cars, powerlines and climate change. In specific areas (eg bat caves) wind turbines may have significant impacts. The specific risks to birds and bats are considered as part of the development assessment and approval process. For example, some of the turbines at a proposed wind farm in the Southern Tablelands are currently being assessed for impacts on an endangered bat colony. If impacts are found to be likely to be significant, the project would need to be reconfigured to reduce the impact.

Want to know more?

Visit Renewable Energy Precincts Resources webpage at
http://www.environment.nsw.gov.au/climatechange/reprecinctresources.htm

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