

Impact of wind energy on environment, agriculture, birds, bats, climate and humans



energy

Department:
Energy
REPUBLIC OF SOUTH AFRICA



EMBASSY OF DENMARK



The environmental impact of wind power can be perceived as minor, particularly compared to the environmental impact of traditional energy sources. Wind power, unlike fossil fuel power sources, consumes no fuel or water, and

emits no air pollution. The average wind farm in the UK will pay back the energy used in its manufacture within six to eight months. This compares favorably with coal or nuclear power stations, which take about six months¹.

Land use

While a wind farm may cover a large area of land, many land uses such as agriculture are compatible, with only small areas of turbine foundations and infrastructure made unavailable for use. This 'footprint', which is

typically around 1000 square meters per turbine, does not include the 5-10 turbine diameters of spacing required between wind turbines. Because of this spacing, the area included within the perimeter of the wind farm will be

larger. However, it is important to note that the land between the turbines - minus the 'footprint' area - is still usable for its original purpose².

Birds

Danger to birds is often the main complaint against the installation of wind turbines. However, based on the figures below, it follows that bird fatalities due to wind turbines are dwarfed by collisions with building, windows, high tension lines, vehicles and communication towers, as well as killings by cats and pesticides⁴.



Figure 1³

It is estimated that more than 10,000 migratory birds are killed in Toronto each year between the hours of 11:00 p.m. and 5:00 a.m. in collisions with brightly lit office towers.

A real concern for birds is noted in the 2004 study in *Nature*, in which it was estimated that up to a quarter of all bird species could become extinct by 2054 due to global climate change, for which wind energy is one of the solutions.

The Peñascal Wind Power Project in Texas is located in the middle of a major bird migration route, and the wind

farm uses avian radar originally developed for NASA and the United States Air Force to detect birds as far as four miles away. If the system determines that the birds are in danger of flying into the rotating blades, it shuts down the turbines. The system automatically restarts the turbines when the birds have passed⁵.

Some paths of bird migration, particularly for birds that fly by night, are unknown. A study suggests that migrating birds may avoid the large turbines⁶, at least in the low-wind non-twilight conditions studied. A Danish survey in 2005 (*Biology Letters*

2005:336) showed that less than 1% of migrating birds that passed an off-shore wind farm in Rønne, Denmark, got close to collision, though the site was studied only during low-wind non-twilight conditions⁷.

In March/April 2011 Birdlife South Africa and Wind Energy Specialist Group (BAWESG) developed the '[BAWESG] Best Practice Bird Monitoring Guidelines for Southern Africa'⁸. These guidelines were written for environmental practitioners with the intention of standardizing monitoring across the numerous wind projects now proposed in South Africa.

Bats

"Because bats can detect objects with echolocation, they seldom collide with man-made structures," said Erin Baerwald of the University of Calgary in Canada, "an atmospheric-pressure drop at wind-turbine blades is an undetectable — and potentially unforeseeable — hazard for bats, thus

partially explaining the large number of bat fatalities at these specific structures⁹."

In April 2009 the Bats and Wind Energy Cooperative released initial study results showing a 73% drop in bat fatalities when wind farm operations were

stopped during low wind conditions, when bats are most active¹⁰. Bats avoid radar transmitters, and placing microwave transmitters on wind turbine towers may also reduce the number of bat collisions^{11,12}.

1 www.bwea.com/ref/faq.html

2 Power Technologies Energy Data Book, NREL

3 A Summary and Comparison of Bird Mortality from Anthropogenic Causes with an Emphasis on Collisions, Erickson, et. al

4 <http://www.flap.org>

5 Matthew McDermott. "Texas Wind Farm Uses NASA Radar to Prevent Bird Deaths" Treehugger

6 "Wind turbines a breeze for migrating birds". *New Scientist* (2504): 21. 18 June 2005

7 <http://climatechange.110mb.com/nations-wind-power-energy.htm>

8 http://www.birdlife.org.za/page/6102/birds_and_wind_energy

9 <http://spolife.blogspot.com/2011/04/why-do-bats-die-horribly-at-wind.html>

10 "Effectiveness of Changing Wind Turbine Cut-in Speed to Reduce Bat Fatalities at Wind Facilities", American Wind Energy Association, 2009-04-28

11 Aron, Jacob (2009-07-17). "Radar beams could protect bats from wind turbines". *London: The Guardian*.

12 Nicholls, Barry; Racey, Paul A. (2007). "Bats Avoid Radar Installations: Could Electromagnetic Fields Deter Bats from Colliding with Wind Turbines?". *The Guardian* (2009-07-17).

Weather

A study entitled 'The influence of large-scale wind power on global climate' found that wind power has a negligible effect on global-mean surface temperature, and it would deliver "enormous global benefits by reducing emissions of CO₂ and air pollutants"¹³.

There may be micro-climate change due to turbulence in the wakes of the spinning turbine rotors, but more efficient rotors may significantly reduce this¹⁴.

Climate change

Climate change is now generally accepted to be the greatest environmental threat facing the world, and keeping our planet's temperature at sustainable levels has become one of the major concerns of policy makers. The United Nations Intergovernmental Panel on Climate Change projects that average temperatures around the world will increase by up to 5.8°C over the coming century¹⁵. This is predicted to result in a wide range of climate shifts, including melting ice caps, flooding of low-lying land, storms, droughts, and violent changes in weather patterns.

The power sector is the largest single source of emissions, accounting for about 40% of CO₂ emissions and about 25% of overall emissions¹⁴. Wind power does not emit any climate change inducing carbon dioxide or any other air pollutants. Within three to six months of operation, a wind turbine has offset all emissions caused by its construction, to run virtually carbon free for the remainder of its 20-year life¹⁴. Furthermore, in an increasingly carbon-constrained world, wind power is risk-free insurance against the long term downside of carbon intensive investments.

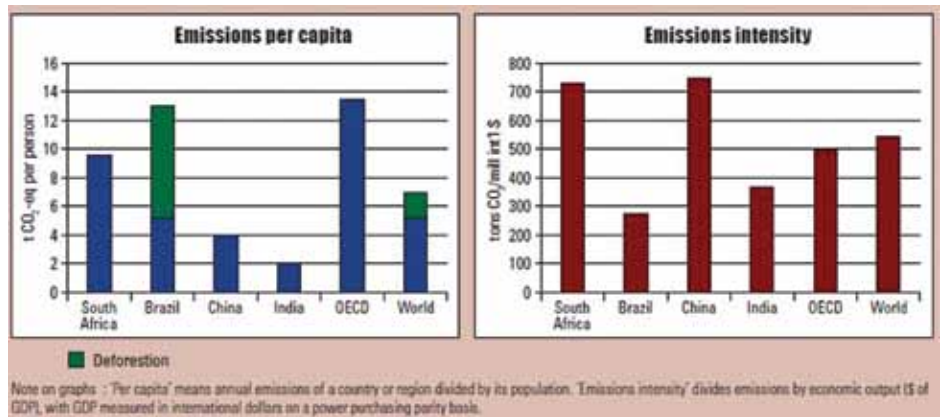
South Africa's GHC emissions per capita and intensity (\$ GDP) are higher than the world average¹⁶.

Not only is the application of wind energy a cost effective fossil fuel saver, thereby combating climate change, it also saves water. Water availability is seen as one of the most decisive factors that will affect the future economic development of South Africa¹⁷.

According to the Integrated Resource Plan (IRP 2010), the share of new wind

capacity planned until 2030 (excluding committed) is 8400 MW, generating 22075 GWh/year at 30% load factor.

In comparison with a coal fired power station having CO₂ emissions of 936 kg/MWh and a water usage of 229 l/MWh (Pulverised Coal with Flue Gas Desulphurisation (FGD))¹⁸, 8400 MW, 22075 GWh/year wind energy generation would save 20.662 Mt CO₂ emissions and 5055 million liter of water usage per year.



Safety

Operation of any utility-scale energy conversion system presents safety hazards. Wind turbines do not consume fuel or produce pollution during normal operation, but still have hazards associated with their construction and operation.

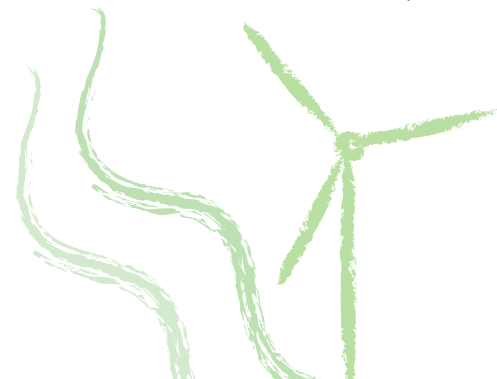
There have been at least 40 fatalities (1970s to 2011) due to construction, operation, and maintenance of wind turbines, including both workers and members of the public, and other injuries and deaths attributed to the wind power life cycle^{20,21,22}. Most worker deaths involve falls or becoming caught in machinery while performing maintenance inside turbine housings. Blade failures and falling ice have also accounted for a number of deaths and injuries. Deaths to members of the public include a parachutist colliding with a turbine and small aircraft crashing into support structures²³.

If a turbine's brake fails, the turbine can spin freely until it disintegrates or catches fire. Often turbine fires cannot be extinguished because of the height, and are left to burn

themselves out. In the process, they generate toxic fumes and can scatter flaming debris over a wide area, starting secondary fires below.

Electronic controllers and safety sub-systems monitor many different aspects of the turbine, generator, tower, and environment to determine if the turbine is operating in a safe manner within prescribed limits. These systems can temporarily shut down the turbine due to high wind, electrical load imbalance, vibration and other problems. Recurring or significant problems cause a system lockout and notify an engineer for inspection and repair. In addition, most systems include multiple passive safety systems that stop operation even if the electronic controller fails²⁴.

The Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) provides legislation regarding the health and safety of persons at work and for the health and safety of persons in connection with the use of facilities and machinery.



20 Craig, David (2007-11-30). "Summary of Wind Turbine Accident data". Caithness Windfarm Information Forum
21 Cipe, Paul (2006). "Contemporary Mortality (Death) Rates in Wind Energy". Wind-Works.org.
22 "Edenhope and Ngarkat fires". Naracoorte Herald. 2005.
23 http://www.theenvironmentalist.com/old/index.php?option=com_content&task=view&id=55&Itemid=43
24 <http://www.aprendelo.com/rec/wind-energy-and-the-environment.html>

Standards

The development of international, uniform standards for wind turbines is done under the IEC, the International Electrotechnical Commission. Representatives from all member countries of the IEC can participate in the working groups developing the standards. South Africa, through the SABS, is a permanent member of the IEC Technical Committee 88, which is responsible for standards relating to wind turbines.

Table Standards series issued by the IEC TC 88

IEC 61400-1 Design requirements for wind turbines
IEC 61400-2 Design requirements small wind turbines
IEC 61400-3 Design requirements for offshore wind turbines
IEC 61400-4 Gears for wind turbines
IEC 61400-11 Acoustic noise measurement techniques
IEC 61400-12-1 Power performance measurements
IEC 61400-13 Measurement of mechanical loads
IEC 61400-14 Declaration of sound power level and tonality
IEC 61400-21 Measurement of power quality characteristics
IEC 61400-22 Conformity Testing and Certification of wind turbines
IEC 61400-23 TR Full scale structural blade testing
IEC 61400-24 TR Lightning protection
IEC 61400-25-(1-6) Communication
IEC 61400-26 TS Availability
IEC 61400-27 Electrical simulation models for wind power generation
IEC 60076-16: Transformers for wind turbines applications

Under development:

IEC 61400-5 Wind turbine rotor blades

These standards have been recommended and are being adopted by the South African Bureau of Standards (SABS) as South African National Standards (SANS).

Testing and Certification

Recognized certifying bodies exist internationally for providing wind turbine certifications such as Germanischer Lloyd (GL), Det Norske Veritas (DNV), and TÜV. These perform the design verification of wind turbines and components in simulation, as well as further verification of the design through testing (measurements), following IEC international standards for wind turbines.

Developing and strengthening SANS to support the creation and resuscitation of specific industries such as the wind industry have been identified in the IPAP 2 2011/12 – 2013/14. It states that a key milestone for the wind industry is the standardization "[of] wind turbines on design requirements, acoustic noise measurement techniques, measurement and assessment of power quality, conformity testing and certification, lightning protection, and power performance measurements of electricity producing wind turbines."



Environmental Impact Assessment

The construction of facilities or infrastructure for the generation of electricity where the electricity output is 20 megawatts or more is a listed activity for which an Environmental Impact Assessment is required in terms of the National Environmental Management Act, Act No 62 of 2008.

The scoping report is to be approved by the relevant authority and must address all environmental and related activities and impacts and provide alternatives as identified during the public participation process.

The Department of Environmental Affairs launched a study in 2010 entitled 'Development of a Strategic Environmental Framework for the Optimal Location of Wind Farms in the Northern Cape, Western Cape, Eastern Cape and Kwazulu-Natal' in collaboration with the Departments of Agriculture and Energy and key stakeholders such as Eskom, South African Wind Energy Association (SAWEA), Birdlife South Africa, and provincial departments, among others. The objective of the study is to streamline and coordinate the

environmental impact assessment process, taking into account environmental and agricultural impacts on birds and bats, for example, thereby developing guidelines and toolsthat will assist wind developers and Environmental Impact Assessment (EIA) authorities in the expeditious processing of wind farm EIA applications.

Conclusion

Wind power, like any power generation technology, can and does impact the environment and humans. Its impact, however, can be minimized or mitigated to a large extent with proper planning, such as making use of environmental impact assessment, as well as insisting on internationally recognized standards, testing and certification procedures, and the observance of applicable laws and regulations.

