FACTS ABOUT WIND ENERGY AND NOISE

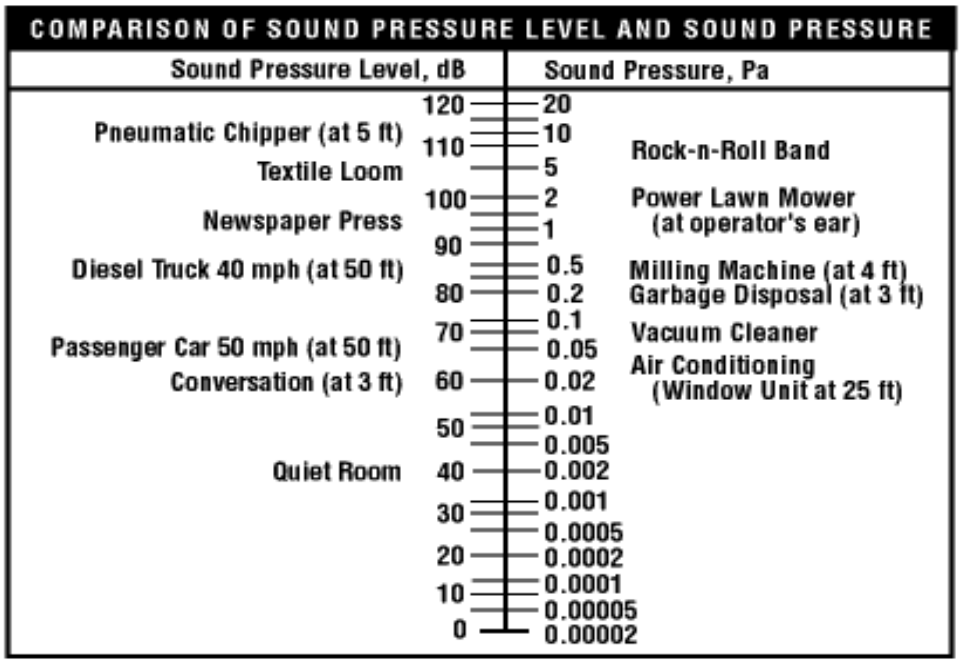
What is noise?

"Noise," when one is talking about wind energy projects, basically means "any unwanted sound."

Whether a noise is objectionable will vary depending on its type (tonal, broadband, low-frequency, impulsive, etc.) and the circumstances and sensitivity of the individual who hears it (often referred to as the "receptor").

As with beauty, often said to be "in the eye of the beholder," the degree to which a noise is bothersome or annoying is largely in the ear of the hearer. What may be a soothing and relaxing rhythmic swishing sound to one person may be quite troublesome to another.

Because of this, there is no completely satisfactory and impartial way to measure how upsetting a noise may be to any given person. Still, it **is** possible to objectively measure how loud a noise is. Here is a table showing the loudness ("sound pressure level") of some common noises:



Source: Canadian Centre for Occupational Health and Safety
(see www.ccohs.ca/oshanswers/phys_agents/noise_basic.html).

What kinds of noise do wind turbines produce?

Wind turbines most commonly produce some **broadband** noise as their revolving rotor blades encounter turbulence in the passing air. Broadband noise is usually described as a "swishing" or "whooshing" sound.

Some wind turbines (usually older ones) can also produce **tonal** sounds (a "hum" or "whine" at a steady pitch). This can be caused by mechanical components or, less commonly, by unusual wind currents interacting with turbine parts. This problem has been nearly eliminated in modern turbine design.

How noisy are wind farms?

Good question, and a difficult one.

Wind plants are very, very quiet compared to other types of industrial facilities, such as manufacturing plants, but most industrial plants are not located in rural or low-density residential areas. In those types of areas, background noise tends to be lower than in urban areas.

On the other hand, wind plants are always located where the wind speed is higher than average, and the "background" noise of the wind tends to "mask" any sounds that might be produced by operating wind turbines—especially because the turbines only run when the wind is blowing. The only occasional exception to this general rule occurs when a wind plant is sited in hilly terrain where nearby residences are in dips or hollows downwind that are sheltered from the wind—in such a case, turbine noise may carry further than on flat terrain.

Virtually everything with moving parts will make some sound, and wind turbines are no exception. However, well-designed wind turbines are generally quiet in operation, and compared to the noise of road traffic, trains, aircraft, and construction activities, to name but a few, the noise from wind turbines is very low.

Noise used to be a very serious problem for the wind energy industry. Some early, primitive types of turbines built in the early 1980s were extremely noisy, to the point that it was annoying to hear them from as much as a mile away. The industry quickly realized that this problem needed to be dealt with, however (particularly in Europe, where turbines are often located in or near residential areas), and manufacturers went to work on making their machines quieter.

Today, an operating wind farm at a distance of 750 to 1,000 feet is no noisier than a kitchen refrigerator or a moderately quiet room.

Source/Activity	Indicative noise level dB (A)
Threshold of hearing	0
Rural night-time background	20-40
Quiet bedroom	35
Wind farm at 350m	35-45
Car at 40mph at 100m	55
Busy general office	60
Truck at 30mph at 100m	65
Pneumatic drill at 7m	95
Jet aircraft at 250m	105
Threshold of pain	140

Source: The Scottish Office, Environment Department, Planning Advice Note, PAN 45, Annex A: Wind Power, A.27. Renewable Energy Technologies, August 1994. Cited in "Noise from Wind Turbines," British Wind Energy Association, http://www.britishwindenergy.co.uk/ref/noise.html .

The best test is to simply experience the noise from a turbine for yourself. You will find that you can stand directly beneath a turbine and have a normal conversation without raising your voice.

What have manufacturers done to reduce wind turbine noise?

Most rotors are upwind: A wind turbine can be either "upwind" (that is, where the rotor faces into the wind) or "downwind" (where the rotor faces away from the wind). A downwind design offers some engineering advantages, but when a rotor blade passes the "wind shadow" of the tower as the rotor revolves, it tends to produce an "impulsive" or thumping sound that can be annoying. Today, almost all of the commercial wind machines on the market are upwind designs, and the few that are downwind have incorporated design features aimed at reducing impulsive noise (for example, positioning the rotor so that it is further away from the tower).

Towers and nacelles are streamlined: Streamlining (rounding or giving an aerodynamic shape to any protruding features and to the nacelle itself) reduces any noise that is created by the wind passing the turbine. Turbines also incorporate design features to reduce vibration and any associated noise.

Soundproofing in nacelles has been increased: The generator, gears, and other moving parts located in the turbine nacelle produce mechanical noise. Soundproofing and mounting equipment on sound-dampening buffer pads helps to deal with this issue.

Wind turbine blades have become more efficient: As the wind energy industry and wind engineers gain more experience with wind turbine operations, turbine blades are constantly being redesigned to make them more efficient. The more efficient they are, the more the wind's energy is converted into rotational energy and the less aerodynamic noise is created.

Gearboxes are specially-designed for quiet operation: Wind turbines use special gearboxes, in which the gear wheels are designed to flex slightly and reduce mechanical noise. In addition, special sound-dampening buffer pads separate the gearboxes from the nacelle frame to minimize the possibility that any vibrations could become sound.

What about small wind turbines for household or battery-charging use?

Small wind turbines, paradoxically, tend to be noisier for their size than large machines, for two reasons:

(1) The rotational speed of the blade tips is higher; and

(2) Much more research money, both from government and private industry, has been invested in reducing noise from large turbines.

The manufacturer of a small wind turbine should be able to provide you with information about its noise levels, based on standard measurement techniques. In addition, you can ask owners of small turbines about their experiences on the American Wind Energy Association's Home Energy Systems discussion list. To subscribe to this discussion, send an e-mail message to awea-wind-home-subscribe@yahoogroups.com .

As with other types of equipment owned by homeowners, small wind turbines can be regulated by local communities through noise ordinances. Typically, such an ordinance will specify an allowable decibel level for noise at the property line nearest to the source.

What other noises are associated with large wind projects?

Wind turbines are large pieces of industrial equipment, and installing them is, in essence, a major construction project. The construction phase of a project lasts only a few months, but during that period, noises will be produced that are typical of heavy construction, including:

Truck traffic: A modern wind turbine is larger than a Boeing 747, with rotor blades that weigh thousands of pounds each and must be trucked to the site along with tower sections and other large components. The sound level is that caused by a highway truck moving at slow speed.

Heavy equipment: A large construction crane is usually needed to install the nacelle and rotor atop the turbine tower. Cement mixing is necessary for turbine foundations. The sound levels of this equipment is comparable to a highway truck moving at slow speed.

Foundation blasting: May occasionally be required if the wind plant is being installed in hilly or mountainous terrain where bedrock is close to the surface and cannot be broken up by other means. More frequently, foundation holes are excavated using backhoes, sometimes with a pneumatic hammer to break up subsoil rock.

Obviously, it is desirable for construction activities that are likely to produce noise to be scheduled during normal working hours.

What can be done to reduce the likelihood of a noise problem from a wind project?

A noise analysis can be done based on the operating characteristics of the specific wind turbine that will be used, the type of terrain in which the project will be located, and the distance to nearby residences. Particular attention will need to be paid if residences are sheltered from the wind.

Also, pre-construction noise surveys can be conducted to find out what the normally-occurring background noise levels are at the site, and to determine later on what, if anything, the wind project has added to those levels.

The most common method for dealing with a potential noise issue, as indicated above, is to simply require a "setback," or minimum distance between any of the wind turbines in the project and the nearest residence, that is sufficient to reduce the sound level to a regulatory threshold.

Some permitting agencies have set up noise complaint resolution processes. In such a process, typically, a telephone number through which the agency can be notified of any noise concern is made public, and agency staff work with the project owner and concerned citizens to resolve the issue. The process should include a technical assessment of the noise complaint to ensure its legitimacy.

In general, wind plants are not noisy, and wind is a good neighbor. Complaints about noise from wind projects are rare, and can usually be satisfactorily resolved.