WIND FREQUENTLY ASKED QUESTIONS (V10.09)

WIND BASICS

What are wind turbines made of?

The towers are mostly tubular and made of steel. The blades are made of fiberglass-reinforced polyester or wood-epoxy.

How Much Wind Is Needed to Power a Wind Turbine?

Wind speed is a crucial element in projecting turbine performance, and a site's wind speed is measured through wind resource assessment prior to a wind system's construction. Generally, an annual average wind speed greater than four meters per second (m/s) (9 mph) is required for small wind electric turbines (less wind is required for water-pumping operations). Utility-scale wind power plants require minimum average wind speeds of 6 m/s (13 mph).

The power available in the wind is proportional to the cube of its speed, which means that doubling the wind speed increases the available power by a factor of eight. Thus, a turbine operating at a site with an average wind speed of 12 mph could in theory generate about 33% more electricity than one at an 11-mph site, because the cube of 12 (1,768) is 33% larger than the cube of 11 (1,331). (In the real world, the turbine will not produce quite that much more electricity, but it will still generate much more than the 9% difference in wind speed.) The important thing to understand is that what seems like a small difference in wind speed can mean a large difference in available energy and in electricity produced, and therefore, a large difference in the cost of the electricity generated. Also, there is little energy to be harvested at very low wind speeds (6-mph winds contain less than one-eighth the energy of 12-mph winds).

What is "capacity factor"?

Capacity factor is one element in measuring the productivity of a wind turbine or any other power production facility. It compares the plant's actual production over a given period of time with the amount of power the plant would have produced if it had run at full capacity for the same amount of time.

$$\text{Capacity Factor} = \frac{\text{Actual amount of power produced over time}}{\text{Power that would have been produced if turbine operated at maximum output 100\% of the time}}$$

A conventional utility power plant uses fuel, so it will normally run much of the time unless it is idled by equipment problems or for maintenance. A capacity factor of 40% to 80% is typical for conventional plants.

A wind plant is "fueled" by the wind, which blows steadily at times and not at all at other times. Although modern utility-scale wind turbines typically operate 65% to 90% of the time, they often run at less than full capacity. Therefore, a capacity factor of 25% to 40% is common, although they may achieve higher capacity factors during windy weeks or months.

It is important to note that while capacity factor is almost entirely a matter of reliability for a fueled power plant, it is not for a wind plant—for a wind plant, it is a matter of economical turbine design. With a very large rotor and a very small generator, a wind turbine would run at full capacity whenever the wind blew and would have a 60-80% capacity factor—but it would produce very little electricity. The most electricity per dollar of investment is gained by using a larger generator and accepting the fact that the capacity factor will be lower as a result. Wind turbines are fundamentally different from fueled power plants in this respect.

If a wind turbine's capacity factor is 33%, doesn't that mean it is only running one-third of the time?

No. A wind turbine at a typical location in the Midwestern U.S. should run about 65-90% of the time. However, much of the time it will be generating at less than full capacity (see previous answer), making its capacity factor lower.

What is "availability" or "availability factor"?

Availability factor (or just "availability") is a measurement of the reliability of a wind turbine or other power plant. It refers to the percentage of time that a plant is ready to generate (that is, not out of service for maintenance or repairs). Modern wind turbines have an availability of more than 98%--higher than most other types of power plant. After more than two decades of constant engineering refinement, today's wind machines are highly reliable.

How big is a wind turbine?

Utility-scale wind turbines for land-based wind farms come in various sizes, with rotor diameters ranging from about 50 meters to about

90 meters, and with towers of roughly the same size. A 90-meter machine, definitely at the large end of the scale at this writing (2005), with a 90-meter tower would have a total height from the tower base to the tip of the rotor of approximately 135 meters (442 feet). Offshore turbine designs now under development will have larger rotors—at the moment, the largest has a 110-meter rotor diameter—because it is easier to transport large rotor blades by ship than by land.
Small wind turbines intended for residential or small business use are much smaller. Most have rotor diameters of 8 meters or less and would be mounted on towers of 40 meters in height or less.

<u>ELECTRICITY</u>

<u>*What is electricity and how is it measured?*</u>
Electricity is the movement of electrons in a current.

Current is the flow rate of charges through a wire. Current is measured in amperes, and is sometimes called amperage, though engineers frown on this term.

Voltage is a measure of power. Voltage in itself is not entirely dangerous. It is amperage that kills people.

A **watt** is a measure of power (voltage or volts x current (current or amperes).

<u>*What are Kilowatts, Megawatts and Gigawatts?*</u>
They are measures of power.
Watts, Kilowatts, Megawatts and Gigawatts (terms go up in measures of 1,000) 1 kilowatt (kW)= 1,000 watts 1 megawatt (MW)= 1,000 kW 1 gig watt (GW)= 1,000MW

<u>*What is a kilowatt hour?*</u>
A kilowatt-hour (kWh) is a unit for measuring energy. It is, as its name suggests, one kilowatt of power used over a period of one hour.

A light bulb is typically 60 watts; leave it on for an hour you have used 60 watt hours, or .06 kWh

A typical personal computer uses approximately 70 watts. In addition, a 17" monitor uses another 80 watts. That comes to 150 watts in an hour, or .15 kWh. If you have the same computer on for only 4 minutes (say, to check your e-mail), that would come to .01 kWh.

With an LCD monitor that uses only 35 watts, an hour of usage will come to .105 kWh.

<u>*What is the difference between AC and DC*</u>
Alternating current (AC) is the kind of electrical current commonly used to power all your household items, available from plug outlets in your wall. Alternating current is the most efficient transmission of energy. Its most common form is a sine wave, meaning a very "smooth" wave. Other forms of alternating current are triangular and square waves. The magnitude of alternating current varies in a cyclical form.

Direct current (DC), on the other hand is a current whose polarity remains constant (with no variation). Direct current is most commonly available in batteries.

<u>*Why is AC more commonly used?*</u>
It is much better suited to transmission over long distances. With direct current, there is a potential loss of power relational to the distance it travels.

<u>ELECTRICITY GENERATION</u>

<u>*How much electricity can one wind turbine generate?*</u>
The ability to generate electricity is measured in watts. Watts are very small units, so the terms kilowatt (kW, 1,000 watts), megawatt (MW, 1 million watts), and gigawatt (pronounced "jig-a-watt," GW, 1 billion watts) are most commonly used to describe the capacity of generating units like wind turbines or other power plants.

Electricity production and consumption are most commonly measured in kilowatt-hours (kWh). A kilowatt-hour means one kilowatt (1,000 watts) of electricity produced or consumed for one hour. One 50-watt light bulb left on for 20 hours consumes one kilowatt-hour of electricity (50 watts x 20 hours = 1,000 watt-hours = 1 kilowatt-hour).

The output of a wind turbine depends on the turbine's size and the wind's speed through the rotor. Wind turbines being manufactured now have power ratings ranging from 250 watts to 5 megawatts (MW).
Example: A 10-kW wind turbine can generate about 10,000 kWh annually at a site with wind speeds averaging 12 miles per hour, or about enough to power a typical household. A 5-MW turbine can produce more than 15 million kWh in a year--enough to power more than 1, 400 households. The average U.S. household consumes about 10,000 kWh of electricity each year.

How many turbines does it take to make one megawatt (MW)?
Most manufacturers of utility-scale turbines offer machines in the 700-kW to 2.5-MW range. Ten 700-kW units would make a 7-MW wind plant, while 10 2.5-MW machines would make a 25-MW facility. In the future, machines of larger size will be available, although they will probably be installed offshore, where larger transportation and construction equipment can be used. Units up to 5 MW in capacity are now under development.

The wind doesn't blow all the time. How much can it really contribute to a utility's generating capacity?
Utilities must maintain enough power plant capacity to meet expected customer electricity demand at all times, plus an additional reserve margin. All other things being equal, utilities generally prefer plants that can generate as needed (that is, conventional plants) to plants that cannot (such as wind plants).
However, despite the fact that the wind is variable and sometimes does not blow at all, wind plants do increase the overall statistical probability that a utility system will be able to meet demand requirements.

How many homes can one megawatt of wind energy supply?
An average U.S. household uses about 10 ,655 kilowatt-hours (kWh) of electricity each year. One megawatt of wind energy can generate from 2.4 to more than 3 million kWh annually. Therefore, a megawatt of wind generates about as much electricity as 225 to 300 households use. It is important to note that since the wind does not blow all of the time, it cannot be the only power source for that many households without some form of storage system. The "number of homes served" is just a convenient way to translate a quantity of electricity into a familiar term that people can understand.

How is the electricity produced at a wind farm stored?
Typically, storage is not needed, because wind generators are only part of the power plants on a utility system, and other fuel sources are used when the wind is not blowing.

How much energy can wind realistically supply to the U.S.?
Wind energy could supply about 20% of the nation's electricity, according to Battelle Pacific Northwest Laboratory, a federal research lab. Wind energy resources useful for generating electricity can be found in nearly every state.

The exact amount of capacity value that a given wind project provides depends on a number of factors, including average wind speeds at the site and the match between wind patterns and utility load (demand) requirements. It also depends on how dispersed geographically wind plants on a utility system are, and how well connected the utility is with neighboring systems that may also have wind generators. The broader the wind plants are scattered geographically, the greater the chance that some of them will be producing power at any given time.

How much electricity does wind generate in the U.S. today?
About 6,740 megawatts of wind power capacity were installed in the U.S. (as of January 2005), generating over 17 billion kilowatt-hours annually. That is as much electricity as about 1.6 million average American households (with 4.3 million people) use each year.

What is needed for wind to reach its full potential in the U.S?
A number of factors are needed, including:

> **Consistent policy support.** Over the past seven years (1999-2005), the federal production tax credit has been extended four times, but three times Congress allowed the credit to expire before acting, and then only approved short durations. These expiration-and-extension cycles inflict a high cost on the industry, cause large lay-offs, and hold up investments. Long-term, consistent policy support would help unleash the industry's pent-up potential.
>
> **Nondiscriminatory access to transmission lines.** Transmission line operators typically charge generators large penalty fees if they fail to deliver electricity when it is scheduled to be transmitted. The purpose of these penalty fees is to punish generators and deter them from using transmission scheduling as a "gaming" technique to gain advantage against competitors, and the fees are

therefore not related to whether the system operator actually loses money as a result of the generator's action. But because the wind is variable, wind plant owners cannot guarantee delivery of electricity for transmission at a scheduled time. Wind energy needs a new penalty system that recognizes the different nature of wind plants and allows them to compete on a fair basis.

New transmission lines. The entire transmission system of the wind-rich High Plains, which cover the central one-third of the U.S., needs to be extensively redesigned and redeveloped. At present, this system consists mostly of small distribution lines—instead, a series of new high-voltage transmission lines is needed to transmit electricity from wind plants to population centers. Such a redevelopment will be expensive, but it will also benefit consumers and national security, by making the electrical transmission system more reliable and by reducing shortages and price volatility of natural gas.

Transmission will be a key issue for the wind industry's future development over the next two decades.

WIND ECONOMICS

How much does wind energy cost?
Over the last 20 years, the cost of electricity from utility-scale wind systems has dropped by more than 80%. In the early 1980s, when the first utility-scale turbines were installed, wind-generated electricity cost as much as 30 cents per kilowatt-hour. Now, state-of-the-art wind power plants can generate electricity for less than 5 cents/kWh with the Production Tax Credit in many parts of the U.S., a price that is competitive with new coal- or gas-fired power plants.

What is the "production tax credit" for wind energy?
1.5 cent per kilowatt-hour production tax credit (PTC) for wind energy was included in the Energy Policy Act of 1992. Passage of the PTC reflected recognition of the important role that wind energy can and should play in our nation's energy mix. It also was intended to partially correct the existing tilt of the federal energy tax code, which has historically favored conventional energy technologies such as oil and coal.
Generally, the credit is a business credit that applies to electricity generated from wind plants for sale at "wholesale" (i.e., to a utility or other electricity supplier which then sells the electricity to customers at "retail"). It applies to electricity produced during the first 10 years of a wind plant's operation. The company that owns the wind plant subtracts the value of the credit from the business taxes that it would otherwise pay.

The U.S. Congress recently (July 2005) extended the wind PTC to expire for the fourth time since it was created, through December 31, 2007. While the U.S. wind industry welcomed the extension, it noted that a longer term for the PTC is needed to provide a stable financial environment industry. Such a stable financial environment would allow the industry to reduce wind energy's cost—for example, by allowing wind farm development companies to order wind turbines in larger quantities.

An incentive similar to the PTC is made available to public utilities (which do not pay taxes and therefore cannot benefit from a tax credit). The incentive is called the Renewable Energy Production Incentive (REPI) and it consists of a direct payment to a public utility installing a wind plant that is equal to the PTC (1.5 cents per kilowatt-hour, adjusted for inflation). However, since the REPI involves the actual spending of federal funds, money must be "appropriated" (voted) for it annually by Congress. It is sometimes difficult to obtain full funding for REPI because of competing federal spending priorities.

1 *The PTC is adjusted annually for inflation, and stood at 1.8 cents/kWh as of December 2003*

Why does the cost of wind energy vary from place to place?
The most important factors in determining the cost of wind-generated electricity from a wind farm are: (1) the size of the wind farm; (2) the wind speed at the site; and (3) the cost of installing the turbines. Each of these factors can have a major impact. Generally speaking:

- The larger the wind farm, all other factors being equal, the lower the cost of energy;
- The higher the wind speed, the lower the cost of energy;
- The less expensive construction costs are, the lower the cost of energy.

On New England ridgelines, for example, wind farms are likely to be smaller, to experience lower wind speeds, and to cost more to install than in the flat terrain of northern Plains states. While wind power may cost less than 5 cents/kWh in the northern Plains, it may cost 6-7 cents/kWh in New England.
In the case of offshore wind farms, the distance that power must be transmitted to shore is a fourth potentially significant cost element.

If wind energy is competitive, why does it need a tax credit subsidy from the government? Isn't this government interference

in the free market?
The energy market has never been free — large energy producers such as coal and oil have always been able to win government subsidies of various kinds. To take just one example, the federal government has paid out $35 billion over the past 30 years to cover the medical expenses of coal miners who suffer from "black lung disease." These subsidies mean that the true cost of coal is not reflected in its market price.
As the previous answer indicates, the wind PTC was passed by Congress to give wind a "level playing field" compared with other subsidized energy sources.

More generally, coal receives a huge hidden subsidy resulting from the fact that its full environmental and health costs are not accounted for. The hidden environmental and health costs of coal and other fossil fuels are also confirmed by a major 10-year study by the European Union.

Nuclear power and oil also benefit from hidden subsidies. The potential cost of damages that might result from an accident at a nuclear power plant are too large for the insurance industry to cover, so the federal government has pledged to act as "insurer of last resort" above a certain level of cost. The cost of oil does not reflect government military expenditures that are required to make sure that the shipping lanes to the Persian Gulf remain open.

If wind energy is competitive, why do "green power" or "green pricing" programs charge extra for it?
There are several reasons for the cost premium (typically 2 to 3 cents per kilowatt-hour) that most green marketers charge for wind-generated electricity. Among them:

- If the power is being sold by a marketing company, it has to recover the cost of its marketing campaigns;
- Whether the power is being sold by a marketing company or a utility, the sale is being done on a piecemeal basis. Often one turbine's output is sold, then another's, and another's. Also, the term of the sales to retail customers is short, typically a year or two. This is more expensive, and risky, than buying all of the power from a 50-megawatt or 100-megawatt wind farm for 10 years.

If my utility uses more wind energy, will that make my electric rates go up?
Yes, probably, but not much. Let's say that wind energy costs 2 cents more per kilowatt-hour (2 cents/kWh) than the rest of the electricity your utility is generating or buying—a conservative estimate. If your utility were to decide to use wind energy to generate 10% of its electricity (more than nearly all utilities in the U.S.), then the added cost to you would be 0.2 cents/kWh. An average U.S. home uses about 800 kWh per month, so you would pay an extra $1.60 per month, or about a nickel a day.

With the price of natural gas, oil, and other fuels soaring today (August 2005), wind energy is becoming more of a bargain than ever. A recent landmark study of wind integration into the New York State electric power system, looking at a 10% addition of wind generation (3,300 MW of wind in a 34,000-MW system), projected a **reduction** in payments by electricity customers of $305 million in one study.

What grants or incentives are available to defray the cost of a small wind electric system?
As of March 2009, the federal government offers an investment tax credit for the purchase and installation of qualifying small wind electric systems, worth 30% of the value of the system. There may also be state tax incentives available.

What is the "energy payback time" for a wind turbine?
The "energy payback time" is a term used to measure the net energy value of a wind turbine or other power plant--i.e., how long does the plant have to operate to generate the amount of electricity that was required for its manufacture and construction? Several studies have looked at this question over the years and have concluded that wind energy has one of the shortest energy payback times of any energy technology. A wind turbine typically takes only a few months (3-8, depending on the average wind speed at its site) to "pay back" the energy needed for its fabrication, installation, operation, and retirement.

WIND FARMS

What is a wind farm or wind power plant?
Wind farms, also called wind energy plants and wind power plants, provide most of the power generated by wind in the USA. Wind farms produce energy on a large scale. The three largest wind farms in the world are all found in California. These are found at Altamont Pass, east of San Francisco, in the Tehachapi Mountains and at San Gorgonio Pass, north of Palm Springs. Each of these farms has thousands of wind turbines.

The wind farm at Altamont receives winds at average speeds of 18-27 miles per hour. It is the single largest wind farm in the world with over 7,000 turbines.

The Tehachapi Wind Farm is the second largest, with about 5,000 turbines. The farm is 40 square miles, with prevailing northwesterly winds blowing through passes in the mountains. The site has very limited value otherwise. Between March and September, winds average 15-20 miles per hour.

The wind farm at San Gorgonio Pass has about 4 ,000 wind turbines in 70 square miles. Hot air rises over the Coachella Valley, forcing cooler air through a pass between the San Bernardino and San Jacinto Mountains . Wind speeds there average 15-20 miles per hour.

Wind plants can range in size from a few megawatts to hundreds of megawatts in capacity. Wind power plants are "modular," which means they consist of small individual modules (the turbines) and can easily be made larger or smaller as needed. Turbines can be added as electricity demand grows. Today, a 50-MW wind farm can be completed in 18 months to two years. Most of that time is needed for measuring the wind and obtaining construction permits—the wind farm itself can be built in less than six months.

<u>How are wind farms developed?</u>
Commercial wind farms are built by wind energy developers using private sources of funding. Feasibility studies are made to assess the potential wind resource available site. Wind monitoring equipment mounted on towers measure wind strength, direction and frequency over an extended period. An environmental impact assessment is undertaken to determine the effects of any development on the site: this includes studies on flora, fauna, archaeology, cultural heritage, landforms, land use, noise and electromagnetic interference.

<u>OFFSHORE WIND</u>

<u>Why don't we put all the wind turbines out to sea?</u>
Wind turbines can be sited offshore, where the wind blows harder and larger turbines can be installed. Many offshore wind farms are being proposed and developed today in densely populated Europe, where there is limited space on land and relatively large offshore areas with shallow water.

However, the urgent need to respond to climate change means that we will need to use as many renewable resources as we can, as quickly as possible, and that means both onshore and offshore wind. Also, the U.S. has very large onshore areas that are suitable for wind development, and not so much suitable offshore area.

Furthermore, since many people like the look of wind turbines, it should not be assumed that it would be more desirable to put all wind turbines far offshore. Onshore wind farms can provide significant economic development in the form of tax revenue to hard-pressed rural communities and rent payments to farmers. Onshore wind farms can therefore make a significant contribution to reducing and reversing the decline of rural communities that we have seen in the Plains States over the last several decades.

<u>Where will offshore wind farms be built? How far out to sea will they be, and how deep?</u>
One of the largest offshore areas in the U.S. with shallow water is off Cape Cod, where a major wind farm has been proposed. Much of the rest of the U.S. coastline has at least some potential for wind development, but typically, turbine foundation costs increase rapidly with increasing water depth and wave height. The cost of connecting with utility power lines also increases rapidly as the distance from shore increases.
Still, there are advantages to siting wind farms further offshore. Wind speeds tend to be higher and the wind is steadier. This means that turbines built further offshore should capture more wind energy. Many hope that the technical challenges will be overcome and that in the future offshore wind farms will be built much further offshore, perhaps even on floating platforms at sea.

<u>Will they interfere with shipping?</u>
Developers intentionally site wind turbines outside of established shipping lanes, thereby avoiding conflicts with routine traffic. Should a ship inadvertently go off course, its radar will readily detect the wind turbines, which are excellent radar reflectors. Wind turbines are also equipped with warning devices to alert ships in foul weather. The U.S. Coast Guard authorizes wind turbine locations for navigational concerns and determines the markings, lights, and fog signals needed.

<u>Will they interfere with fishing?</u>
Given the relatively small area of seabed that is required there is no evidence to suggest that total fish catch will decline as a result of wind farm developments; if anything the opposite is true. Fish stocks have been in decline for many years due to overfishing. Many environmental groups believe that wind farms will provide welcome sanctuary for fish spawning as well as refuge from intensive fisheries activity.

The wind industry is working actively with the fishing industry to ensure, as the oil and gas industry has done before it, that the fishing industry is not disadvantaged by the growth of offshore wind farms.

How big will they look from shore?
Obviously, this depends on the size of the turbines, how close they are to the shore, and weather conditions. Most offshore wind farms are barely visible from shore.

What if there's a storm at sea?
As with onshore turbines, offshore turbines are warranted and tested to withstand extreme wind conditions. In the event of severe weather, the blades turn out of the wind and will slow down for safety reasons when wind speeds reach 50 miles per hour and above.

Will they disturb the seabed and cause coastal erosion?
Any proposed wind farm project will involve a full investigation of wave and coastal processes prior to construction. However, the turbine structures and distance offshore are such that it is very unlikely they would significantly affect the seabed or wave patterns. There is no evidence from the Danish experience with offshore wind farms of any detrimental effects on coastal processes.

The coastal erosion effects of higher sea levels and more extreme weather patterns due to global warming are already scientifically recognized, and far outweigh the potential effects of offshore wind farms.

Will they affect marine life?
There are three significant stages of a wind farm from the point of view of marine life: construction, operation and decommissioning. Construction and decommissioning have the potential to generate the most amount of disturbance, and the wind industry, as well as several marine conservation groups, is currently investigating these impacts on marine life.

However, it is important that such impacts be considered in the context of other marine activities such as fishing, shipping, oil and gas extraction, etc. Also, it should be noted that the duration of the construction and decommissioning would be about 6 months only. For the 20-year operational period there are no known impacts on marine life.

It has been suggested that the noise from wind turbines will travel underwater and could disturb sea life. But studies carried out on the impact of noise from existing offshore turbines note that the noise is very low frequency, and many species are actually unable to hear it.
As with any other local impact issues, these concerns will be addressed while a wind farm project is going through the permitting process.

ENVIRONMENTAL/HEALTH & SAFETY ISSUES

Wind turbines kill birds and thus have serious environmental impacts.
According to US Dept. of Energy, over the last decade, the wind community has learned that wind farms and wildlife can coexist successfully. Wind energy development's overall impact on birds is extremely low (<1 of 30,000) compared to other human-related causes, such as buildings, communications towers, traffic, and house cats. However, conventional fuels contribute to air and water pollution that can have far greater impact on wildlife and their habitat, as well as environment and human health.

Wind turbines are noisy.
Modern turbines produce very little noise. The turbine blades produce a whooshing sound as they encounter turbulence in the air, but this noise tends to be masked by the background noise of the blowing wind. An operating modern wind farm at a distance of 750 to 1000 feet is no noisier than a kitchen refrigerator. (US Dept of Energy).

Will using more wind energy reduce health care costs?
Yes! In 2000, the Harvard School of Public Health looked at the human health effects from two fossil-fuel-fired power plants in Massachusetts. It estimates that, each year, the air pollution from the plants causes:

- 159 premature deaths (each year
- 1,710 emergency room visits
- 43,300 asthma attacks

Replacing as much of this electricity as possible with wind energy would clearly lower associated health care costs.

I've heard that wind turbines cause shadow flicker.
Shadow flicker is occasionally raised as an issue by close neighbors of wind farm projects. A wind turbine's moving blades can cast a moving shadow on a nearby residence, depending on the time of the year (which determines how low the sun is in the sky) and time of day. It is possible to calculate very precisely whether a flickering shadow will in fact fall on a given location near a wind farm, and how many hours in a year it will do so. Therefore, it should be easy to determine whether this is a potential problem. Normally, it should not be a problem in the U.S., because at U.S. latitudes (except in Alaska) the sun's angle is not very low in the sky, and the appropriate setback for noise (see above) will be sufficient to prevent shadow flicker problems.

What about turbines throwing blades, or ice? Is wind energy dangerous to the public?
It has been estimated by a number of reliable sources that 50,000 Americans a year die from air pollution, of which about one-third is produced by power plants. By contrast, in 20 years of operation, the wind industry (which emits no pollutants) has recorded only one death of a member of the public--a German skydiver who parachuted off-course into an operating wind plant. Blade throws were common in the industry's early years, but are unheard of-today because of better turbine design and engineering. Ice throw, while it can occur, is of little danger because setbacks typically required to minimize noise (see above) are sufficient to protect against danger to the public, and because ice buildup slows a turbine's rotation and will be sensed by a turbine's control system, causing the turbine to shut down. One European group that has investigated the ice throw question recommends a setback of 1.5 times the sum of a turbine's hub height and its rotor diameter.

Why not develop wind farms on mountains that are already being used for ski resorts?
Because of the potential danger from ice throw. As the above answer indicates, ice throw does not present a danger except for the area close to turbines (that is, within a few hundred meters). At ski areas, however, turbines would typically have to be sited very close to operating lifts and trailheads, making ice throw a safety concern.

I've heard that stray voltage from wind power plants can be transmitted through the ground, disturbing or harming livestock. Is this true?
No. There is nothing different or unusual about managing the electricity flow from an operating wind plant. Standard electric wiring practices are adequate to prevent stray voltage from occurring.

Will a wind project interfere with electromagnetic transmissions such as radio, television, or cell-phone signals?
First, this is not a problem for modern small (residential) wind turbines. The materials used to make such machines are non-metallic (composites, plastic, wood) and small turbines are too small to create electromagnetic interference (EMI) by "chopping up" a signal.

Large wind turbines, such as those typically installed at wind farms, can interfere with radio or TV signals if a turbine is in the "line of sight" between a receiver and the signal source, but this problem can usually be easily dealt with improving the receiver's antenna or installing relays to transmit the signal around the wind farm. Use of satellite or cable television is also an option.

Will a wind project interfere with radar?
Yes. Radar is basically designed to filter out stationary objects and display moving ones, and moving wind turbine blades create radar echoes. It is possible to modify a radar installation to eliminate this problem, according to a consulting firm that has studied it for the British government. According to the study: "This study concludes that radars can be modified to ensure that air safety is maintained in the presence of wind turbine farms. Individual circumstances will dictate the degree and cost of modification required, some installations may require no change at all whilst others may require significant modification."

If a wind project is proposed near an airport or military airfield, this issue will likely require further technical investigation. The interference is generally limited to objects (airplanes) that are physically shadowed by the turbines (that is, very low-flying aircraft), so the further the turbines are from an airfield and the lower their altitude, the less interference should occur.

Why is there sometimes opposition to wind energy projects?
Local opposition to proposed wind farms usually arises because some people perceive that the development will spoil the view that they are used to. It is true that a large wind farm can be a significant change, but while some people express concern about the effect wind turbines have on the beauty of our landscape, others see them as elegant and beautiful, or symbols of a better, less polluted future.
The visual effect of wind farms is a subjective issue, but most of the other criticisms made about wind energy today are exaggerated or untrue, and simply reflect attempts by particular groups to discredit the technology, worry local communities, and turn them against proposed projects. In the electronic age, myths and misinformation about wind power spread at lightning speed.