Wind Power: *It's the right thing to do*

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Abstract

This paper examines a number of considerations, problems, solutions and costs associated with wind power. The legal, social and environmental positives outweigh the negatives that result in the conclusion of "why would anyone not consider using wind power". Global environmental benefits as well as individual benefits could result by favorable government assistance.

Wind power is a clean, non-polluting, sustainable electrical power source for use by homeowners, business, and utility companies. The current all-inclusive price for wind power is higher than today's environmentally subsided price for U.S. fossil fuel electricity. There are many valid reasons for household and business wind power conversion, e.g., decreasing pollution, self-sufficiency, and avoidance of future utility rate hikes. However, additional economic parity between wind power and fossil fuel sources is needed to increase wind power generation in the U.S. Federal tax credits for wind power and other nonpolluting renewable alternative energy sources would help. Increases in wind power generation assist the U.S. and the world in fighting pollution and global warming. Unfortunately, until Americans are forced to adopt or given economic incentives to adopt better electrical generation methods, a majority of citizens will not convert to less polluting methods.

Introduction

A wind turbine captures the wind and converts it into electricity to be used in homes, business or sold to the electric company. The familiar mechanical windmills were created in the late 1800's to develop the US western frontier. These windmills were multiple blade mechanical versions that harnessed the wind to pump water or generate small amounts of electricity to power lights, radios and kitchen appliances for rural families. ("Connecting a Small Scale Renewable Energy System to an Electric Transmission Grid," 2003)

The energy crisis of the 1970's and 1980's raised the awareness of using wind as an alternate energy source. Installing and using wind power became feasible with favorable tax credits and federal regulations. From 1976 – 1985, farmers and homeowners in the US installed 4500 – 5500 small turbine systems. ("Connecting a Small Scale Renewable Energy System to an Electric Transmission Grid," 2003)

The unreliability of these wind systems created problems. Today's small wind turbines are more reliable and operate up to five years without maintenance, with estimated lives of 20-40 years.

Why Consider Wind Power?

Wind power produces no air pollution, does not deplete natural resources, does not threaten the earth's climate and uses a renewable resource. As of 2001, coal made up 52% of the fuel source to create the electricity in the U.S. ("U.S. Electricity Sources," 2003). Coal harms the environment and human health when mined, transported, and burned.

Wind generation hedges against sure future energy shortages, oil embargos or utility rate hikes. Wind generation has low operating costs, other than routine maintenance, there is little or no future cost. The question should be

"why would anyone not consider using wind power?"

The Grassroots campaign for wind power in Colorado lists the top ten reasons to buy wind power. ("Top Ten Great Reasons to Buy Wind Power," 1998)

The list is:

1. **Clean up the state's air**. Buying wind power reduces smog, acid rain, and air pollution.
2. **Renewable energy.** Wind is inexhaustible.
3. **For the kids' sake**. Our oil, natural gas, and coal won't last forever. We need to begin to develop our state's wind and solar resources now.
4. **Your dollars count.** Utility companies are spending millions of dollars to build wind farms but it's your money that's making it happen.
5. **Cheap energy is a myth**. Yes, wind is a bit more expensive initially, but think of the hidden costs of cheap fossil fuel energy: smog, acid rain and snow, oil spills, climate change, human health impacts, nuclear waste, and lost salmon species. Wind is the real bargain.
6. **It's your choice.** You can choose to use clean, renewable energy.
7. **Curb your own pollution.** Buying wind power is a cheap easy way to dramatically reduce the environmental impacts of your energy use.
8. **Climate Change.** Each cent you spend on wind power keeps a pound of carbon dioxide, the chief greenhouse gas, out of the air. Let's be penny wise, not pound foolish.
9. **Bang for the buck.** For the price of a six-pack of coke or a single video rental each month, you can save 1200 pounds of coal and avoid 2400 pounds of air pollution each year.
10. **It's the right thing to do.**

Drawbacks to a Wind System

The major drawback to a wind system is the initial up-front purchasing and installation cost. There is no on-going fuel cost as in fossil fuel generated electricity, which fails to include the environmental damage and the natural resources depletion in its costs. The unreliability of wind can be a problem, as the wind does not always blow strong enough to fulfill electricity needs. Wind is classified as an intermittent power source and consumers need a backup electricity source.

Location restrictions may be a problem and include sufficient lot size, potential zoning issues, and community complaints about a tall tower. It, also, may include expensive and time-consuming processes to connect to a utility grid. Some communities have height restrictions that would make a wind tower unfeasible without a zoning exception. New cellular phone towers may make wind turbine towers more acceptable.

Wind Power Problems

A number of people have heard about these potential problems with wind power:

a) Wind turbines attract and kill birds
b) Wind turbines are noisy
c) Wind turbines throw ice and blades that could kill someone
d) Wind turbines & towers destroy the looks of the countryside.

The first three issues are overstatements of the general state of wind power turbines today. The last one is more a perception than anything else.

The National Wind Coordinating Committee did a study to count bird deaths by turbines and used that research to project total bird deaths for the entire US based on estimates of operating turbines at the end of 2001. The study indicated a total mortality rate was 6400 bird fatalities per year from wind turbines, while utility transmission lines kill 130 – 174

million bird deaths per year, collisions with cars kill 60-80 million birds per year, collisions with building and house windows kill in excess of 100 million birds per year, and agricultural pesticides kill 67 million birds per year. (Sagrillo, 2003)

Noise was a problem with some early wind turbine designs. Engineering and appropriate setbacks from residences have reduced the noise problems. A wind turbine 250 meters from a residence is no noisier than a kitchen refrigerator. ("Is Noise a Problem for Wind Turbines?," 2002) The current home-sized wind turbines have a noise level of 52 to 55 decibels.

Ice build up on wind turbine blades simply slow down the blade rotation (Sagrillo, 2000) Flying ice is not a problem, as the blades won't turn when they are iced. Current improved turbine and blade designs make it very rare for a blade to fall from a turbine.

Everyone has his or her own definition of what constitutes a nice looking countryside. Some people think fences, houses and barns are unsightly. To some wind turbine towers are no more unsightly than an older windmill, just new and different.

Wind Power Now

Last year, the total US generated wind power grew by 10% to 4700 megawatts, or enough to power about 1.4 million homes, but trailed the global increase of 28%. (Anderson, 2003) However, the Mid-American Energy power company is planning to build the world's largest wind farm in northern Iowa - a 310-megawatt project.

Suncor Energy Inc. is building a 30-megawatt wind power plant in southern Alberta, Canada at a cost of $48 million. ("Suncor to build $48 million wind power plant," May 30, 2003)Germany led Europe with 8754 megawatt of wind power installed at the end of 2001 ("Another Record Year for European Wind Power," 2003) and Germany has announced that they plan to convert 25% of their countries energy needs to wind power by 2025. Germany has decided to phase out nuclear power and convert to wind power instead. ("Germany Boosts Wind Power," June 2003)

Spain is the second highest wind power user in Europe with 3337 megawatts of wind power installed at the end of 2001. The rest of the top six at the end of 2001 are Denmark at 2417 megawatts, Italy at 697 megawatts, Netherlands at 493 megawatts and UK at 474 megawatts.) ("Another Record Year for European Wind Power," 2003) The US is second to the European countries in the total amount of wind power generated. However, Europeans use substantially less electricity than Americans. The Average American use a little more than twice the electricity than the average the European. ("Wind Power in 2002," 2003)

Equipment Specifics

Wind power equipment is similar around the world. Evaluating and understanding wind power equipment is necessary before trying to use wind for electricity generation.

Equipment needed for a modern wind system large enough to power a standard household include a rotor with two or three blades, a generator, a battery bank if desired, a tower to mount the turbine, and at least an acre of land.

The blades can be made of almost any material. The blades of the modern wind turbine are made of wood, fiberglass or composite. (Gipe, 1999) Fiberglass is the most popular material for turbine blades today. Fiberglass is strong, inexpensive, not subject to metal fatigue, and can be formed in many different designs.

The wind turbine drives a generator. To connect to a utility company, you will need an induction generator which will use power to start. When the wind is sufficient, the

generator quits pulling electricity and starts to generate electricity. The power will also be converted from DC power to AC power, which is used in a house with normal wiring or to a utility company.

If you are using the wind turbine to charge a battery bank instead of connecting to a utility, an alternator is used to generate AC power (as opposed to DC power) for powering a cabin or small house. However, this type of power fluctuates as the wind fluctuates. Power from this wind machine must be treated or conditioned before use, even if it is used to charge a battery bank. (Gipe, 1999) A synchronous inverter is used to treat the power.

Excess wind is always a concern. The rotor is designed for winds blowing at speeds within the turbine's operating range. Somehow, the wind system must be able to withstand excess wind without ripping the blades off or knocking the tower over. The simplest method is to decrease the area of the rotor intercepting the wind. The less area exposed to the wind, the less damage to the blades and less force against the tower. One method in household systems is called horizontal furling, the rotor swings sideways toward the tail. The tail vane is used for pointing into the wind while the rotor is running. This exposes less area to the wind and lessens the wind pressure against the blades and tower. Some manufacturers use a vertical furling option. In this case, the rotor tilts up and back over the tail.

The tower is a key part of a wind system. Tower considerations include height, strength and type. The general consensus is the taller the tower the more wind power. A minimum height for a household wind system is an 80-foot tower. If there are trees or buildings around, a 100-120 foot tower is recommended. ("The Most Frequently Asked Questions About Wind Energy," 2002) The rule of thumb is the tower should be 30 feet taller than anything within 300 meters. Also wind velocity increases with greater altitude so the higher the tower, the more wind you will be able to capture.

The wind tower must be able to withstand strong forces in high winds. Towers are rated based on the thrust load they can endure without buckling. In the US, manufacturers must design their wind systems to withstand winds up to 120 miles per hour. The turbine and the tower must be matched to assure the turbine and tower doesn't sway too much at the same time and allow the blades to hit the tower.

There are three types of household towers – free standing, pole and guyed. Free standing towers are self-supporting. These towers depend on their foundation to prevent the tower from falling over. The tower must be very strong internally and are usually lattice or truss towers, which can be shipped in 20-foot sections. Freestanding towers are more expensive but take up less space. A crane maybe needed in installation.

Freestanding pole towers are used for lightweight turbines while tubular pole towers (which use fatter poles than pole towers) are used for heavier turbines. These towers can be made from steel tube, steel pipe, wood, concrete or even fiberglass. The pole towers are only available in limited sizes and strengths and require heavy equipment for installation. Pole towers are seldom used in the US.

Guyed towers use anchors and connecting cables to stabilize the tower. These are the most frequent choice for household sized wind machines. (Gipe, 1999) Guyed towers can be made of steel lattice or pipe. The welded lattice type of towers is mass-produced for the telecommunications industry. Therefore, these towers are widely available in a range of sizes and are modestly priced. Steel pipe towers can be fabricated locally from steel pipes and are bolted or slipped together. For either type, extra high strength stranded steel cables or aircraft cable (which is even stronger) is used to anchor the tower to the ground. Three to five guys (wires) are used at each level

depending on height. Tilt-up towers must use four guys at each level. Tilt-up towers permit the tower to be raised and lowered for installation or maintenance. Tilt-up towers are more expensive. Anchors are usually long steel shafts screwed into the ground. The guy radius should be no less than one-half the height of the tower (Gipe, 1999) and up to 75-80% of the height of the tower.

Wind Needed

Sufficient wind speed is critical to a productive wind system. Average wind speed needs to be above 8 miles per hour to be effective. (Bergey, 2000) Commercial wind farm require a higher average wind speed. The Department of Energy (DOE) has wind resource maps for all states. If your site is rather flat, then the DOE maps will be an accurate reflection of your average wind speed. However, if your site has hills, trees or other obstructions, then the wind needs to be measured with an anemometer over a period of time.

The U.S. Department of Energy's National Resources Energy Laboratory (NREL) rates North Dakota as the highest in potential for wind power generation. Rounding out the rest of the top ten in the US are Texas, Kansas, South Dakota, Montana, Nebraska, Wyoming, Oklahoma, Minnesota & Iowa. California is rated number 17 in potential but they already have the highest generation of wind power in the US and are estimated to retain this leadership at the end of 2003. ("U.S. Wind Resource – US Wind Maps," 2003)

The useful wind is affected by the size of the rotor and the wind speed distribution. The larger the blade size, the more wind you can capture, e.g. increasing the rotor size by 20% increases the capture area by 44%. (Gipe, 1999)

Legal Issues in Wind System

Legal issues need to be addressed before deciding to buy and install a wind power system. A building permit may be needed with the proper zoning before installing a wind power system. This may or may not be a problem depending on location and neighborhood. In a rural area where telephone communication towers already exist, this may be less of a problem. A suburban area may require attending zoning board meetings, educating neighbors and zoning board members.

The Public Utilities Regulatory Policies Act (PURPA) of 1978 requires regulated utilities to connect small independent producers to the utilities grid and purchase their excess electricity. ("Connecting a Small Scale Renewable Energy System to an Electric Transmission Grid," 2003) Many states went on to pass a net-metering law, allowing the independent producer to receive cash for the net amount of electric sold (amount sold minus amount used), i.e., full retail value for the energy produced. However, some states, require the utility to purchase any excess power produced, but may only pay their avoided wholesale cost instead of a retail rate, e.g. a farmer a central Kansas, was charged by the local utility to install an extra meter and is paid only once a year for the electricity at a wholesale rate. (Sagrillo, 2002)

Sizing a Wind System

A wind power system's goal is usually to replace as much power as possible. However, some systems are for remote weekend cabin where there no electricity is available. In either case determination of how many kilowatts of electricity you will need is imperative. The simplest method is to review your electric bills for the last year and compute an average. If electric bills are unavailable, you can compute the size needed by reviewing

each electrical item. To size a system, the watts needed equals amps multiplied by volts. Most electrical items have the amps it uses listed on the item (like a refrigerator) or in the owners manual. The volts will most likely be 110 (for normal electric plug-ins) or 220 (for an electric stove or clothes dryer).

System Costs

Costs are determined after size requirements are determined. A typical home consumes 800-2,000 kWh of electricity per month, thus requiring a 10 kHz turbine. These systems, including installation, have a price range of $28,000 - $35,000. ("General Overview of Wind Systems," 2000). Other cost considerations are additional insurance needed to cover the wind system, and costs to hook up to the utility company.

Offsetting costs include utility company payments for excess energy produced, state property exemptions and any tax credits for wind power systems. Some states exempt all renewable energy systems from property taxes

Wind Farms

Wind farms are simply multiple wind turbines hooked together to supply electrical power to a utility grid. Since high volume electrical production is the goal, these turbines will most likely be on higher towers with larger rotors than a home wind system. These larger systems are more expensive and usually owned by a utility company.

These electrical generation systems are supplemental to a utility company's power generation since the wind is an intermittent power source. Utilities are expected to supply power at all times, even if the wind is not blowing, they can not depend on wind power for 100% of their power. Adding wind power capabilities does decrease the utility company's overall pollution level and decreases their dependence on fossil fuel sources for the future.

There is still a problem with the "not in my backyard" sentiment for wind farms. Although Americans want electricity on demand, they are not always willing to have a wind farm in the same area as their homes. One answer to this is offshore wind farms with power transmitted back to shore for use. Issues with loss of power during this transmission are still being addressed at this time.

Wind farms are usually beneficial to the local economy. Land lease payments benefit landowners while taking away little land use from the owner. Cattle or other animals can still be grazed in the field with the wind turbines. Farming of crops is also possible around the wind turbines. There are usually 1-2 jobs per megawatt created during construction as well as 2-5 permanent operating and management jobs created for each 50-100 megawatt of the system installed. Local construction and service industries benefit during construction with concrete foundations, tower materials, tower setting and some electrical work.

Government Incentives

Currently there is no federal energy tax credit for wind power. However, there is a 10% tax credit for residential solar power and a wind production tax credit for utilities using wind power. There is a bill in congress to allow a non-refundable tax credit for 40% of the cost for a small home wind power system. A form of this same bill has been in committee for the last three years and has yet to be passed.

Some states offer economic incentives to encourage wind power. Illinois offers a grant program that pays up to 50% of a wind system purchase. California offers a cash rebate and a tax credit that combined will pay for almost 50% of a wind system. California has also passed regulations that make getting a building permit and hooking up to a utility

more standard, easier and less time consuming. This also encourages home wind system installations.

Conclusion

The question should be "why would anyone not consider using wind power?"

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