Small Wind Potential for Personal Energy Independence

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1. Executive summary

Energy captured through wind turbines is not just for large wind farms; smaller turbines can be a great resource for homes and businesses looking to reduce their dependence on fossil fuels, decrease their carbon footprint, and stabilize energy costs. A wind turbine can provide all of a family's need for energy, given adequate land space, the wind resource, and either net metering through a local utility or battery backup. While a small wind system can cost from $3,000 to $6,000 per kilowatt (kW) of installed capacity,[1] once operational, the 'fuel' is free.

Wind energy is not appropriate for every site, and unlike solar energy, requires extensive understanding of the wind resource at the site and regular maintenance over the life of the system. But if the resource is appropriate and the site is large enough, wind energy can be a cost effective alternative to energy from a local utility company and can significantly reduce dependence on fossil fuels.

The most important factors to know before purchasing a wind turbine are the energy use at the site, the average wind speed at the site, and applicable permitting and zoning ordinances. If the site is deemed appropriate, the next step is to find an appropriate wind turbine. Rated capacity is not necessarily reliable due to inconsistencies from one manufacture to another. Instead, look to rotator swept area and power curves to estimate average power output at any given site.

The small wind industry has grown by leaps and bounds in the last couple years, and is expected to continue to improve in technology, cost, and reliability due to favorable governmental policies and new industry standards. That said, wind is a site-specific technology, and it is highly recommended that anyone looking to purchase a wind turbine do adequate research to fully understand all of the factors that go into developing this resource.

Audience for this Paper

The purpose of this paper is to give general, introductory information to home and business owners interested in installing a small wind system, on their own properties (typically in rural areas), for their own use. For this paper's purpose, small wind systems are defined as those greater than 1 kW and less than 100 kW rated capacity.

This paper is not aimed at persons interested in developing a wind farm, or leasing property for development of a large wind farm.

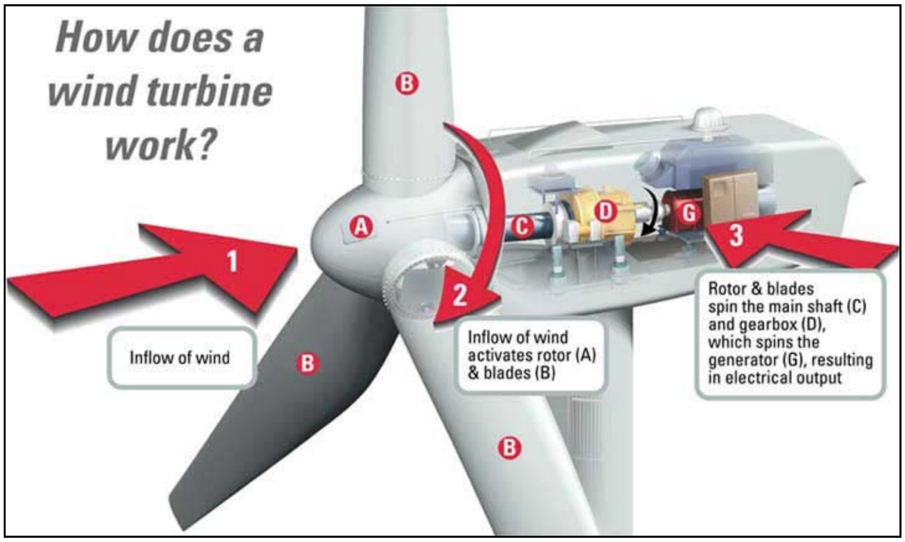
2. Need for renewable energy

Dependence on fossil fuels is hurting the economy, the environment, and threatening national security. By pouring money into limited and polluting fuel sources, the nation, and future generations are at risk.

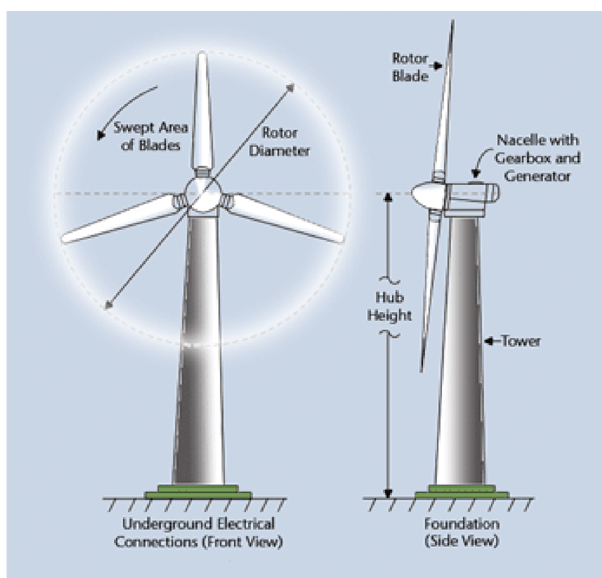
[1] American Wind Energy Association. *Small Wind FAQ.* Retrieved Nov. 3, 2009 http://www.awea.org/smallwind/faq_buying.html#Howmuchdoesawindsystemcost

Of particular concern is the climate change, which is largely attributed to rising levels of human-induced carbon dioxide and other greenhouse gases in the atmosphere. The affects of climate change are already being seen in changing weather patterns, more frequent storm events, sea level rise, and water shortages. It is essential to take responsibility as individuals to address this global problem. Wind energy can be a large part of the solution, and many areas have great potential to use wind energy as a replacement for fossil fuels.

3. What is small wind



Small wind systems generate clean energy that can be used to power a home, farm, school, or small business. Wind turbines produce electricity as moving air causes the blades to spin and power a generator. Traditional small wind turbines are mounted on a horizontal axis, with a three-blade turbines, similar to the large, utility scale wind turbines. The smaller turbines range from 9 to 69 feet in diameter and produce less than 100 kW of electricity (typically 1-10 kW). In contrast, utility-scale turbines can be 130 to 239 feet or more in diameter producing upwards of 2,500 kW. This paper is focused on the opportunity for small wind investments for home and business owners, primarily in rural areas.



Drawing of the rotor and blades of a wind turbine, courtesy of ESN

Historically small wind systems were stand-alone power generators used to draw water or generate electricity in remote locations that did not have ready access to the electricity grid. In recent years, new small wind systems are predominately connected to the utility grid, so that if electricity demand exceeds the supply being generated by the system, electricity can be provided by the local utility company. Conversely, on-grid systems can feed electricity to the utility grid if the power generated on-site from a small wind system exceeds demand, generating an electricity "credit" and eliminating the need for pricey onsite battery storage.

Turbine technology has advanced significantly in the last few years, creating systems that are quieter, more reliable, and better able to blend into the surrounding area. With only two or three moving parts, wind turbines are fairly simple. Most small turbines have three main parts: three blades which are each 2-15 feet in length, a generator located at the hub, and a tail. Some designs popular in urban settings, called vertical axis turbines, feature a cylinder-like component that revolves vertically, or perpendicular to the ground, (like a barbershop pole). Most small wind turbines are mounted on a steel tower 35-140 feet high, which can be a lattice tower (like a radio tower), a freestanding monopole (like a street light), or a guyed monopole (like a street light with support cables from mid-tower to the ground).

4. Wind systems costs

It does little good to decide upon a small wind system by the initial cost, or first cost, of the installed turbine. Instead, an interested buyer should examine the long term costs or the cost effectiveness over the life of the wind turbine. The first step when deciphering turbine cost effectiveness is to figure out how much energy is required by the site and how much is currently being paid for that electricity. Excess capacity can be expensive and provide few benefits (besides altruistic ones) to the wind turbine owner; yet small turbines are not easily scaled up if more energy is required. Sizing the system right the first time will give the best return on investment. Nationally, homes use approximately 10,000 kilowatt-hours (kWh) of electricity per year (about 830 kWh per month), though this amount can vary considerably. An air-conditioned home in Arizona, for example, will use significantly more electricity than a non-air-conditioned home on the central coast of California.

The second step is to measure average wind speed. Depending upon the average wind speed in the area, a wind turbine with a rotor diameter of three to ten meters[2] (given adequate wind) will be required to make a significant contribution to meet the demand for an average home. If utility rates are tiered, offsetting only the most expensive electricity may make the system more cost effective.

The main costs associated with a small wind system investment are the turbine itself, installation, permitting fees, and utility interconnects. Wind turbines do require regular maintenance, but once installed the operational costs should be minimal, and the fuel is always free. Small wind turbines can cost anywhere from $3,000 to $6,000 per kilowatt (kW) of installed capacity.[3] This means that a 5 kW wind system can cost anywhere from $15,000 to $30,000.

Despite this significant initial outlay, wind energy systems can be cost effective over their lifetime due to the avoided costs of utility payments. This payback period, or the time it takes the system to pay for itself, depends on the cost of electricity, wind system cost, the wind resource on site, and any state or federal rebates and incentives. Installations tend to be most cost effective in regions where the cost of electricity exceeds $0.10 per kWh.

The main federal rebate available to anyone installing a system of 100 kW or less is the investment tax credit (ITC). The ITC is a 30 percent tax credit on total installed cost and can make the difference between a system being cost effective and not. Sadly, state incentives vary widely from non-existent to feed-in-tariffs where utilities will actually pay for excess electricity. The highest incentive levels and largest percent of installed capacity in the US can be found in California, Nevada, Arizona, Oregon, New

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[2] Gipe, Paul; Wind Energy Basics, Second Edition. Chelsea Green Publishing. 2009
[3] American Wind Energy Association. *Small Wind FAQ.* Retrieved Nov. 3, 2009
http://www.awea.org/smallwind/faq_buying.html#Howmuchdoesawindsystemcost

York, Massachusetts, and Ohio. New Jersey and Hawaii also have state incentives for small wind, but their permitting processes are so cumbersome they have effectively restricted the market. For the specific details of state and local governments programs check out the Database of State Incentives for Renewables & Efficiency (DSIRE) at www.dsireusa.org.

The most important factor in determining the payback period on your wind system is the amount of power the system will generate. The formula for power generation is:

$$P = 0.5 \times rho \times A \times V^3$$

Where:

P = power in watts
rho = air density
A = rotor swept area (m^2)
V = wind speed in meters/second

While the math can seem intimidating, the two main components of power generation are wind speed and turbine swept area. Before purchasing a wind turbine, find out the average prevailing wind speed at the location. Wind power is measured on a scale from Class 1 (weakest) to Class 7 (strongest). The American Wind Energy Association (AWEA) holds that a site needs an average of Class 2 wind (9.8-11.5 mph) for a wind power system to be feasible.[4] This requirement will vary based on other conditions at the site such as altitude and landscaping. It is also important to note that the higher the wind turbine is placed, the greater the wind speed and consistency. Even incremental increases in wind speed can have a large effect on power output because the energy in the wind is proportional to the cube of the wind's speed (imagine the wind hitting the turbine blades as a cylinder, and the faster the wind is blowing, the larger the volume of cylinder that passes through the blades). This means that by doubling the wind speed, the power output increases eight times (2x2x2=8).

Aside from wind speed, no other single parameter is more important than the turbine's swept area when determining a particular small wind turbine's ability to generate energy.

$$A = \prod \times r^2$$

Where:

A = rotor swept area (m^2)
∏ = pi (3.14)
r = radius (1/2 of the rotor diameter)

Again, small increases are can make a large impact because the swept area is an exponential function of the length of the rotor blades. Here a doubling of the length of the radius increases the swept area by four times (2x2=4).

[4] American Wind Energy Association. *Small Wind Tool Box.* Retrieved November 3, 2009. http://www.awea.org/smallwind/toolbox2/INSTALL/evaluate.html

The last factor in the equation is air density. Air density does not have the same exponential effect that wind speed and rotor length have, and is therefore less significant. However, a wind turbine at sea level, where the air density is higher, will perform better than in higher elevations with less air density.

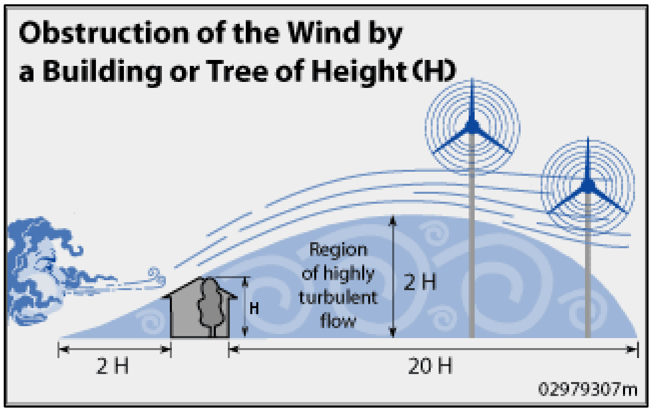
5. What is the opportunity for an individual land owner?

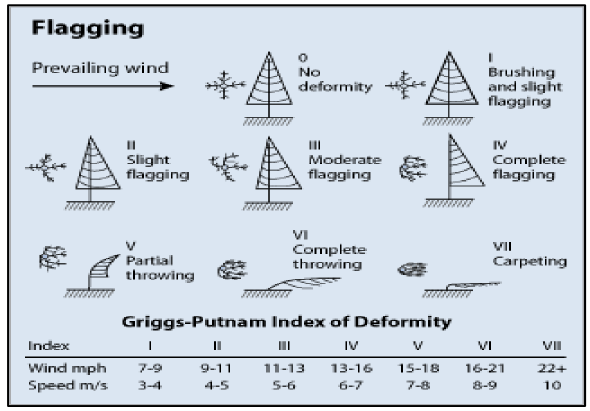
When considering a small wind system, the three most basic steps are to understand electricity demand load, measure the wind speed at hub height, and to understand the local zoning/permitting restrictions and issues. With those three factors, a land owner is prepared to analyze the appropriateness and effectiveness of a small wind system.

It is important to reduce energy use through energy efficiency and conservation first, because energy consumption will dictate the size of the wind turbine necessary. The capacity of wind systems cannot be easily or inexpensively expanded incrementally (like adding larger blades or a bigger turbine) and adding a second tower and turbine is costly. It costs less to save energy than to create energy, and it is better to have one turbine that meets maximum demand (or the percentage of demand deemed appropriate). To obtain average energy use, identify kWh per day, month and year from a year's worth of utility bills. Do not guess. Another option is to perform a detailed analysis of the home or business' energy load if utility bills are not available.

Additionally, putting up the largest turbine possible, in hopes of selling excess electricity to a local utility is not economically advisable at this time due to the unavailable or typically low rates paid by utilities for excess wind energy. Choosing a turbine that most closely matches electricity production to demand provides the highest value by offsetting retail-rate grid purchases while minimizing excess energy sell-back. If electricity prices are tiered, consider simply offsetting the most expensive energy to get the fastest return on investment.

The amount of wind at the site will be the biggest determinant of energy production. Average wind speed is critical because the Annual Energy Output (AEO) of a small wind system is a function of the cube of the average wind speed (discussed on pg. 3). Be sure to determine the wind resources at "hub height," the top of the tower where the generator will live: typically 80 – 140 ft high. A turbine not properly sited can result in excess wear and tear and less uniform wind speeds that will affect energy output and may lead to early failure. Measuring wind can be done through a professional site assessor, with wind maps, or an anemometer.





In general, a viable home site will have average winds speeds between 8-14 mph. For an "ideal site" the industry standard says the lowest point of the turbine rotor should be at least 30 feet above anything within 500 feet[5] to reduce turbulence and maximize wind speed (see Image **). As a start, property owners may want to refer to wind resource maps by state at National Renewable Energy Lab[6] or by obtaining airport wind speed data in the area. It is important to note that average wind speeds increase with height and may be 15–25 percent greater at a typical wind turbine hub-height of 80 feet (24 meters) than those measured at airport anemometer heights. One can also observe vegetation for flagging, or the effect of strong winds on an area's vegetation[7] (see Image**). Depending on the size of the turbine, an anemometer can be the most accurate way to measure wind speed, but they can also be pricey and range from $600-$1,200.

6. To connect or not to connect to the grid

In remote areas, remaining untied to the utility grid can provide many logistical and economic benefits, but where a property owner has the ability to connect to the grid and the utility offers net metering, it is often in the best interest of the property owner to connect to the grid. The main factor that make an off- grid system sensible is location. A new power line can cost anywhere from $15,000 to $50,000 per mile, depending on the terrain.[8] An off-grid system should pair a wind generator with a small to medium sized solar array, and battery backup. The pairing of solar and wind is an important option to consider because wind and solar have complementary power curves: wind is traditionally more productive in the winter, and in the mornings and evenings, when less sunlight is available. Both of these power sources are variable and it is important to backup the system with batteries or a typical generator for off times. This will allow for continuous power, to any number of appliances, and in many different weather situations.

If there is an option to connect to the grid, and the local utility will allow for net metering (allowing a 'bank' for any excess energy for a period of time), then a grid connected system might be a less costly alternative to adding solar and battery backup. Other factors to examine include interconnect and potential sale of excess electricity. Public Utility Regulatory Policies Act (PURPA) requires local utilities to

[5] Sagrillo, Mick & Ian Woofenden. *How to Buy a Wind Generator.* Homepower, Issue 131 June/July 2009
[6]NREL maps can be found at: http://www.windpoweringamerica.gov/wind_maps.asp
[7] US Department of Energy. *Estimating Your Wind Resource.* Retrieved November 23, 2009. http://www.energysavers.gov/your_home/electricity/index.cfm/mytopic=10920
[8] Sagrillo, Mick & Ian Woofenden. *How to Buy a Wind Generator.* Homepower, Issue 131 June/July 2009 http://www.energysavers.gov/your_home/electricity/index.cfm/mytopic=10920

connect with small wind energy systems. However, utilities may have power quality and safety concerns and should be contacted before connecting to their distribution lines.[9] The utility should also provide a list of requirements for connecting to the grid. Sale of excess electricity is limited in the U.S., so be sure to check with the local utility before making assumptions.[10]

7. Choosing a turbine

The current practice in the wind industry is to describe power output based on their capacity factor (often represented in a kW rating). This capacity factor rating works well as a common comparison point when there are standards and verification, like the solar industry. Unfortunately, the small wind industry does not have any standards and the kW rating on a turbine can be calculated at the manufacturer's discretion. This means that two manufactures with 5kW wind turbines could have calculated that capacity at wind speeds of 10 mph or 24 mph (respectively), and anywhere in between. This lack of consistency makes it difficult to predict the power output potential of the turbine at your site simply based on the capacity factor.

Instead, a prospective buyer should examine a turbine's swept area and power curve. As discussed above, the swept area is one of the main factors in power output (in addition to wind speed), and a power curve will give the expected energy output at varying wind speeds (in kWh or a similar measure). A thorough buyer will ensure the manufacturer is using power curves that have been verified by an independent third party. Manufactures of large wind turbines may also give production as annual energy output (AEO) or annual energy production (AEP), which is also more accurate than capacity estimates.

The good news is that there are several new small wind system certifications on the way. The Small Wind Certification Council (SWCC) is an independent body that is working to create a program that would certify power output and noise levels, as well as durability and safety requirements.[11] This information will be placed on an easy-to-understand label and compiled into a web directory with power curves, annual energy performance curves, and sound pressure levels for each model certified.[12]

Additionally, the North American Board of Certified Energy Practitioners (NABCEP) is in the process of launching its new Small Wind Certification for installers. Based on information on their website, the exam will be held in early 2010.[13] Even with exams and certifications, any prospective buyer should be sure to do due diligence by calling the manufacturers, checking references, and comparing products.

One other consideration when choosing a turbine is the breaking mechanism. Turbines without rotor breaking mechanisms can self destruct if they go into "overspeed" mode.[14] Breaking mechanisms may be mechanical, or electrical and aerodynamic. A mechanical breaking system may yaw, or turn the turbine, away from the wind in an extreme wind event. Examples of electrical and aerodynamic braking

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[9] Ibid.
[10] Note that selling energy back to the utility for a monetary payment and net metering can be very different. Net metering does not include compensation for excess electricity, it simply measures the amount of energy used over a period of time, with any electricity generation counting as negative usage.
[11] Small Wind Certification Council, http://smallwindcertification.org/about.html Retrieved 11/10/09.
[12] Ibid.
[13] North American Board of Certified Energy Practitioners, http://www.nabcep.org/news/small-wind-certification-comes-to-nabcep. Retrieved 11/10/09.
[14] Gipe, Paul; Wind Energy Basics, Second Edition. Chelsea Green Publishing. 2009

include rotor furling, which allows the rotor to turn toward the tail vane, and systems which pitch, or turn the blades into the wind to reduce the surface area and angle exposed to the wind. All turbines should have a breaking mechanism to ensure the turbine can be controlled in high winds.

To find a local distributor, check the American Wind Energy Association (AWEA) for a list of manufacturers and suppliers of wind turbines. The list includes wind turbines for use in residential, farm, and commercial/industrial applications: (www.awea.org/smallwind/smsyslst.html). Not all small wind manufacturers are members of the AWEA, so be sure to check online or in the yellow pages for wind energy system dealers in any specific area. Windustry, also has a list of wind energy companies and a 'look-up' catalog of manufacturers, developers, consultants, and small wind industry installers: (www.windustry.com/companies?filter0[]=113&filter1[]=187).

In general, the market for wind turbines is developing quickly. To read a fuller discussion of development including future drivers and barriers to greater market presence for the US small wind market, please see Appendix A.

8. Conclusion

Before buying a wind turbine, be sure to do adequate research; a wind energy system can be an expensive and time consuming purchase. It will not be like a solar array; it will be more like a car that requires regular maintenance over time. The American Wind Energy Association has a list of question in the Home Power 2009 buyer's guide (see Appendix B: Suggested Resources) or on their website (www.awea.org/smallwind/smsyslst.html) that are helpful when buying a turbine. It behooves a cautious buyer to learn more about the wind resources on the site, the applicable laws and regulations, and any other associated costs before making a purchase decision. With adequate resources and maintenance, a wind turbine can be a great investment and can last for 20 years or more.

Appendix A: US Market Growth of Small Wind

While small wind has been around for a long time, 2008 and 2009 saw tremendous market expansion. The AWEA Small Wind Turbine Global Market Study for 2008 cited that in 2008 the US market grew 78 percent, with sales of 10,500 units totaling 17.3 MW and $77 million. [15] Unlike large turbines, 94 percent of small turbines were produced in the US.[16] The growth was dominated by on-grid residential (1-10kW systems) and upper commercial systems (21-100kW).[17] These small, distributed generation systems are important because it means people are depending less on electricity from utility companies, and reducing the need to build transmission lines and large power plants with fossil fuel-based power generation. The cumulative effect of 80 MW of installed small wind capacity in US translates to 76,000 tons of carbon reductions each year, which is equal to 13,300 cars off the road, or enough power for 9,200 homes.

The market for small wind turbines is being driven by the rising and volatile price of electricity, decreased costs for turbines, new types of financing, and federal tax credits and state incentives (discussed above) associated with wind energy, and concern over the environment and climate change. Residential electricity prices are projected to increase at an annual rate of about 1.1 percent in 2009 and 1.8 percent 2010.[18] While these may seem small, even incremental increases can have big impacts on the ability of people to heat and cool their homes.

In addition, as electricity prices go up, the cost of wind energy is going down. On average, the cost per kilowatt-hour (kWh) of electricity produced by small wind systems is $0.10-$0.11 per kWh over the life of the wind energy system.[19] This is less than the cost of electricity in many areas such as California and Florida, and is reaching cost parity with the average cost of electricity in the US (2007 average cost of electricity was $0.0913 per kWh[20]). Part of the cost decreases are due to the influx of private equity investment capital into the industry. The boost has helped increase manufacturing capacity, which enables supply to catch up with demand and takes advantage of economies of scale to bring down the costs.

The commercial-sector has also seen the availability of Power Purchase Agreements (PPA) increase. PPA's allow property owners to contract with a third party to install and operate a wind power system, and then simply purchase the power from that system instead of from the utility. This has proved an attractive financing method for these more expensive projects, or for those who want to see an immediate decrease in their operating costs.

In addition, consumers are moving toward renewable energy due to their concern for the environment and climate change, and their increased knowledge about wind turbines. Despite economic slowdown in late 2008 and early 2009 – residential sales of small wind systems were 15-20 percent higher in early

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[15] American Wind Energy Association. *Small Wind Global Market Study 2008.* www.awea.org/smallwind/pdf/09_AWEA_Small_Wind_Global_Market_Study.pdf

[16] Ibid.

[17] Ibid.

[18] Energy Information Administration. *Annual Energy Outlook 2009.* http://www.eia.doe.gov/oiaf/aeo/index.html

[19] American Wind Energy Association. *Small Wind Global Market Study 2008.* www.awea.org/smallwind/pdf/09_AWEA_Small_Wind_Global_Market_Study.pdf

[20] Energy Information Administration. *Electricity.* Retrieved November 3, 2009. http://www.eia.doe.gov/fuelelectric.html

2009 than one year prior. Given this trajectory, the wind industry is projecting increased growth over the next five years in the US.

Market Drivers

The 2009 AWEA Market Study predicts a 30-Fold increase, moving from a cumulative capacity of 80 MW in 2008 to over 1,700 MW by the end of 2013. [21] The long term market drivers include: predictable incentives, climate legislation, increased industry standards, and better interconnection requirements to the larger grid.

As with any investment, the greater the certainty, the lower the risk; and the lower the risk, the easier it is to finance a project. That is why the wind industry was elated at the passage of the Emergency Economic Stabilization Act of 2009 that ensured the 30 percent investment tax credit (ITC) for eight years. The market was further buffered with the American Recovery and Reinvestment Act of 2009, which removed a stringent cap on the ITC. These predictable incentives will buoy the wind industry for years to come.

Further momentum is building as businesses and homeowners look for ways to comply with early climate legislation in states like California, and in anticipation of Federal climate change legislation. Two key components of Federal legislation would be a cap on green house gas emissions, and federal Renewable Electricity Standard (or Renewable Portfolio Standard) which would mandate that utilities derive a certain percentage of their electricity from renewable sources. Many states already have Renewable Portfolio Standards, which are driving both small and large-scale renewable energy development. The utilities and businesses that get on board first will take advantage of low demand and will gain expert knowledge to use as demand increases.

The wind industry itself is also benefiting from its own advancement and increased professionalism. In 2008 there were over 66 manufacturers in the US.[22] As the industry increases its presence in communities through manufacturing plants, corporate headquarters, and local installers, those communities are becoming more welcoming to the products they produce. Through public awareness and education, companies are helping to diminish fears and shift public perception, which can lead to relaxed zoning ordinances and permitting policies.

A final factor that is increasing wind energy presence is the ability to connect to the utility grid. Having reliable and assured grid tie-in can decrease the cost of a small wind system and make it easier for individuals to utilize this intermittent renewable energy resource. While utility companies technically are required to allow small wind systems to tie into the grid through the Federal Public Utility Regulatory Policies Act of 1978 (PURPA), the rules are still cumbersome and the complexity often increases costs. New National fire codes (2011) should help to streamline process with nationally standardized electrical safety requirements for small wind.[23]

[21] American Wind Energy Association. *Small Wind Global Market Study 2008*
www.awea.org/smallwind/pdf/09_AWEA_Small_Wind_Global_Market_Study.pdf
[22] American Wind Energy Association. *Small Wind Global Market Study 2008*
www.awea.org/smallwind/pdf/09_AWEA_Small_Wind_Global_Market_Study.pdf
[23] Ibid.

Along with interconnection, utilities are beginning to allow for net metering. Net metering means that a property owner can provide excess electricity (when renewable energy system generate more electricity than the property uses) to the utility grid, and also benefit from using electricity from the grid when the generation does not meet demand. This allows property owners to avoid installing expensive battery systems or contingent energy systems. While not uniform or standardized between utilities, net metering is becoming increasingly available.

Barriers

The two main barriers to a greater presence of small wind are cost, and permitting and zoning regulations. As mentioned before, the first step in deciding if a small wind system is appropriate is to understand average wind speed at the project location. The cost of the wind turbine and other equipment will factor into the end cost of the system, and can fluctuate with demand and with raw material availability. Over the last few years, rising global prices of aluminum, copper, and steel have impacted manufacturing costs. But the turbine cost and energy gains are just two in a list of many factors that contribute to cost. Wind turbines are not like appliances that can be left for a long period of time without maintenance; they need regular evaluations and tune ups, like a car. And while the "fuel" (wind) is free and infinite, routine maintenance over the average lifespan of 20 years can costs average $0.01-$0.05 per kWh.[24] Insurance and financing costs should also be factored into the final cost of any system.

Permitting is a barrier due to basic costs or difficulty in obtaining the permit. Permitting costs can range from $0 to $1,000 or more depending on the zoning jurisdiction. Interconnection and net metering – while progress is being made – adds to the complexity and costs of most projects. More significant though, may be the actual zoning and permitting restrictions. Cost effectiveness does not matter if a turbine cannot be installed in the first place. Some of the most significant municipal planning and permitting obstacles include:

- Complex or unclear local permitting requirements
- Inspectors and permitting authorities who are inexperienced with small wind
- Permitting requirements and fees that vary considerably across the more than 25,000 jurisdictions nationwide
- Covenants within homeowner association bylaws and CC&Rs that prohibit both wind and solar based on aesthetics opinions

Overall, poor or non-existing permitting practices are estimated to have turned away an estimated third of all potential projects[25] because they often lead to small wind projects being evaluated based on the same detailed permitting process required for large wind farms. Even if projects are not evaluated based on large wind farms, requirements like height limitations are often unnecessarily restrictive and impact small wind productivity and economic viability, and discourage industry related businesses within the area.

In order to better understand the local zoning/permitting restrictions and issues contact the local building inspector, planning commission, or planning department. They will have information on

[24] American Wind Energy Association. *Small Wind Global Market Study 2008*
www.awea.org/smallwind/pdf/09_AWEA_Small_Wind_Global_Market_Study.pdf
[25] Ibid.

building permits and lists of requirements including height and noise restrictions, setbacks, and capacity limitations. Property owners will also want to check with their homeowners association or coastal commission (if applicable) for regulations that may prohibit or restrict turbines.

As early as possible, a property owner will also want to talk to their neighbors to minimize viewscape impact issues. Neighbors may have objections because of concerns the wind turbine will block their views, create excessive noise or impact their property values. These concerns can be addressed by supplying objective data. For example, the ambient noise level of most modern residential wind turbines is around 52 to 55 decibels. This means that while the sound of the wind turbine can be picked out of surrounding noise if a conscious effort is made to hear it, a residential-sized wind turbine is no noisier than your average refrigerator.[26] Talking with neighbors and local environmental groups like the Audubon Society will also ensure that turbines are located outside of major bird and bat migratory flyways.

[26] Department of Energy. *Small Wind Electric Systems: A U.S. Consumer's Guide*. 2007

Appendix B: Suggested Resources

American Wind Energy Association, Small Wind website. http://www.awea.org/smallwind/

Database of State Incentives for Renewables and Efficiency, Department of Energy, Energy Efficiency and Renewable Energy. http://www.dsireusa.org/

Department of Energy, Energy Efficiency and Renewable Energy, Wind and Hydropower Technologies Program, Wind Powering America, Wind Resource Maps. http://www.windpoweringamerica.gov/wind_maps.asp

Factsheet: The Economics of Small Wind by AWEA http://www.awea.org/smallwind/toolbox2/factsheet_econ_of_smallwind.html

Gipe, Paul; Wind Energy Basics, Second Edition. Chelsea Green Publishing. 2009.

Sagrillo, M. & Woofenden, I., How to Buy a Wind Generator. Home power magazine. June/July 2009 Available on the AWEA website: www.awea.org/smallwind/pdf/How_to_Buy_A_Wind_Generator.pdf

Small Wind Electric Systems, A U.S. Consumer's Guide, Produced for the U.S. Department of Energy by the National Renewable Energy Laboratory, a DOE national laboratory, March 2005, DOE/GO-102005-2095, http://www.windpoweringamerica.gov/pdfs/small_wind/small_wind_guide.pdf

The *Farmers' Guide to Wind Energy: Legal Issues in Farming the Wind, June 2007,* provides legal information for individuals developing wind projects, regardless of size. This includes farmer-owned large utility-scale wind farms as well as smaller on-farm or residential wind turbine projects. http://www.flaginc.org/topics/pubs/index.php#FGWE

Windustry. Learn about Wind Energy: Welcome to our Wind Basics Series. www.windustry.com/wind-basics/learn-about-wind-energy/learn-about-wind-energy

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