AWEA Small Wind Turbine Global Market Study 2007

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SUMMARY

State and Federal policy remain the pivotal factor for sustaining and growing the market for small wind electric systems in the U.S. and abroad. The U.S.-pioneered Small Wind industry has not benefited from any federal-level incentive since 1985, though has seen annual growth of 14-25% since 1990. Roughly 7,000 Americans purchased small wind systems in 2006, but these systems are still far too expensive for most consumers. A 30% federal investment tax credit would help consumers overcome this up-front cost hurdle and could grow the market 40% annually. Production methods would then mature, lowering costs and making the U.S. industry even more competitive in the world market. Approximately half of all sales made by U.S. manufacturers in 2006 were exports, signifying that Small Wind is still one of the few renewable energy technologies the U.S. dominates. However, with inequitable state and federal financial treatment with solar photovoltaics (PV), its market counterpart, Small Wind may struggle to maintain its position.

A 30% federal tax credit could grow the Small Wind industry 40% per year

TERMINOLOGY

The term "small wind" is defined as wind-powered electric generators with rated capacities of 100 kilowatts (kW) or less. A small wind system may include, as necessary, a turbine, tower, inverter, wiring, battery, and foundation. Costs associated with their installation may also include shipping and labor. The term "micro wind" is a subset of the "small wind" classification and is generally defined as turbines less than 1kW in capacity. These units are typically used in off-grid applications such as battery charging, on sailboats and recreational vehicles, and for pumping water on farms and ranches.

MARKET SURVEY FINDINGS:

1. How big is the market for small wind in the U.S.?

- Units sold in the U.S. in 2006 (by both U.S. and foreign companies): **6,807**
- Installed capacity added in U.S. in 2006: **17,543 kW**
- Total U.S. sales in 2006: **$56,082,850**
- **6,639** of these 6,807 units (98%) were sold by U.S. manufacturers, equating to 16,093 kW of capacity and $50,904,350 in sales.
- The export market for U.S. manufacturers continues to account for roughly half of their sales.

2. How big is the market for small wind outside the U.S.?[1]

- Units sold in non-U.S. in 2006 (by both U.S. and foreign companies): 9,502
- Installed capacity added in non-U.S. in 2006: 19,483 kW
- Total non-U.S. sales in 2006: $61,131,500

1 Non-U.S. totals in this study represent a less complete sampling of data than U.S. sales due to unavailable market information from several non-U.S. companies.

3. What are the sales breakdowns for off-grid vs. grid-connected small wind systems by U.S. manufacturers?[2]

2 On occasions where verification was unavailable, turbines < 1kW were assumed to be off-grid.

U.S. MFRS.	Units (in U.S. by U.S. mfrs.)	kW (in U.S. by U.S. mfrs.)	Sales ($USD in U.S. by U.S. mfrs.)	Units (sold abroad by U.S. mfrs.) *	kW (sold abroad by U.S. mfrs.) *	Sales ($USD abroad by U.S. mfrs.) *
ON-Grid	706	5,158	$18,197,600	511	1,792	$5,558,000
OFF-Grid	5,933	10,935	$32,706,750	8,660	16,328	$48,725,500
TOTAL	6,639	16,093	$50,904,350	9,171	18,120	$54,283,500

* Non-U.S. totals in this study represent a less complete sampling of data than U.S. sales due to unavailable market information from several non-U.S. companies.

4. What are the sales breakdowns for off-grid vs. grid-connected small wind systems by non-U.S. manufacturers?

NON-U.S. MFRS.	Units (in U.S. by non-U.S. mfrs.)	kW (in U.S. by non-U.S. mfrs.)	Sales ($USD in U.S. by non-U.S. mfrs.)	Units (sold abroad by non-U.S. mfrs.) *	kW (sold abroad by non-U.S. mfrs.) *	Sales ($USD abroad by non-U.S. mfrs.) *
ON-Grid	35	1,388	$4,772,000	228	1,301	$6,230,000
OFF-Grid	133	62	$406,500	103	62	$618,000
TOTAL	168	1,450	$5,178,500	331	1,363	$6,848,000

5. How many residential-scale turbines are in the U.S.?

- An estimated 2,500 grid-connected, residential-scale turbines (1-10kW) are currently being used in the U.S. The quantity of "micro" turbines (< 1kW) is estimated to be substantially larger, but unconfirmed. Approximately 6,800 Americans purchased small wind systems in 2006.

6. How many companies manufacture small wind turbines?

- U.S.: This survey identified 12 established and eight forthcoming U.S. manufacturers of small wind systems. Sales figures were reported by 9 of these established companies.
- Non-U.S.: This survey identified 47 non-U.S. small wind turbine manufacturers, though it is unclear how many of these have begun production. Of these 47, a minimum of 13 have recorded sales, 8 of

which provided data for this survey.

- Many non-U.S. manufacturers produce "micro" turbines (< 1kW) and sell only regionally, particularly those in China. Of the few companies that have entered the U.S. market, most are based in the United Kingdom, Canada, or Germany.

High up-front costs of small wind systems, compounded by a lack of means for overcoming this hurdle, were identified by respondents as the largest market barrier.

7. What are the growth trends for Small Wind?

- In its current and historic state without a federal-level incentive to assist consumers purchase small wind systems, the U.S. market continues to grow an estimated 14-25% annually. Grid-connected, residential-scale systems 1-10kW in capacity constitute the bulk of this growth.
- A 2005 AWEA survey documented 30 megawatts (MW) (aggregate) of small-wind installed capacity in the U.S. as of 2004, with a then-forecasted 14MW of additional capacity installed in 2005. This projection for 2005 included an estimated 13,000 new units, representing $25 million in sales and 14-25% annual growth. The U.S. market is expected to continue on this trajectory barring any major policy-related or technological shifts. The advent of a 30% federal Investment Tax Credit could lead to an estimated 40% annual growth for each year the credit is in place.[3] AWEA is currently advocating for legislation that would create such a credit.

8. What factors affect market growth?

The purchase price of a small wind system remains the single largest factor affecting market growth, domestically and abroad. For Small Wind, this is a function mainly of production volumes, but also of rising costs of raw materials such as copper and steel. Market growth is also largely a function of local, state, and federal policies (or lack thereof), particularly rebate programs and property tax exemptions[4] but also other financial incentives, standardized interconnection policies, annualized net metering, local zoning statues, and permitting processes.

The demand for small wind systems originates with consumers' concerns about climate change, rising and unpredictable natural gas prices, and energy security. Many consumers, but now representing a smaller percentage of the market, are driven by the desire or need to supply electricity independently from the electric grid. The growth of the solar photovoltaics (PV) industry can even contribute to demand for small wind turbines, as the two technologies are often market complements. However, the solar PV industry's growth is largely a result of a federal investment tax credit to help consumers purchase solar systems. An imbalance of federal incentives that

3 This estimate is based in part on the growth experienced by the solar PV industry after the 2005 enactment of its federal Investment Tax Credit of 30% of the cost, with a cost cap of $2,000 for equipment for residential use.
See also: Jennifer L. Edwards, Ryan Wiser, Mark Bolinger, and Trudy Forsyth, "Evaluating state markets for residential wind systems: Results from an economic and policy analysis tool" (December 1, 2004). Lawrence Berkeley National Laboratory. Paper LBNL-56344. http://repositories.cdlib.org/lbnl/LBNL-56344 p.55.

4 Jennifer L. Edwards, Ryan Wiser, Mark Bolinger, and Trudy Forsyth, "Evaluating state markets for residential wind systems: Results from an economic and policy analysis tool" (December 1, 2004). Lawrence Berkeley National Laboratory. Paper LBNL-56344. http://repositories.cdlib.org/lbnl/LBNL-56344 p.39.

benefits solar PV effectively subsidizes Small Wind's competition and most often proves to be a market barrier.

Costs of traditional energy (i.e., natural gas, coal) also affect the demand for alternative energy sources like Small Wind. Areas with energy costs of over $0.10/kWh tend to have greater market potential.

Consumers generally desire a payback period – the time needed to recoup costs of an investment – of five years or less, and a U.S. homeowner will own a home for an average of six years.[5] Payback periods for small wind systems currently range anywhere from six to 30 years depending on numerous factors such as wind resource quality, siting, permitting costs, prevailing energy costs, and turbine performance. Lowering residential-scale turbine costs, and thus the payback period, to fit this home ownership time frame of < 6 years would likely benefit the market. Investment would otherwise be discouraged by any payback period longer than the time for which the home is owned. A 2006 study by the Lawrence Berkeley National Laboratory estimates that a 30% federal investment tax credit with no cost cap could reduce the simple payback period of a system by an average of 4.5 years, and a state property tax exemption can similarly reduce this period by four years.[6]

Certification of a turbine model's performance, reliability, sound pressure levels, and safety to a nationally- or internationally-accepted standard would also benefit the industry. There is currently no such certification process available in the U.S., though the Small Wind Certification Corporation (SWCC) is slated to emerge in 2008 or 2009 as an entity authorized to certify small wind turbines[7] tested to a forthcoming AWEA-created standard. Such a certification process is intended to verify product claims to benefit the consumer and, ultimately, the industry.

Federal-level legislation to establish a uniform net metering policy would also make owning a (grid-connected) small wind system more economically attractive while potentially removing many procedural barriers. Net metering laws ensure that compensation from a utility to a turbine owner for any excess electricity produced is at retail – not wholesale – rates, and often preordain that a utility allow the turbine to connect to the grid.

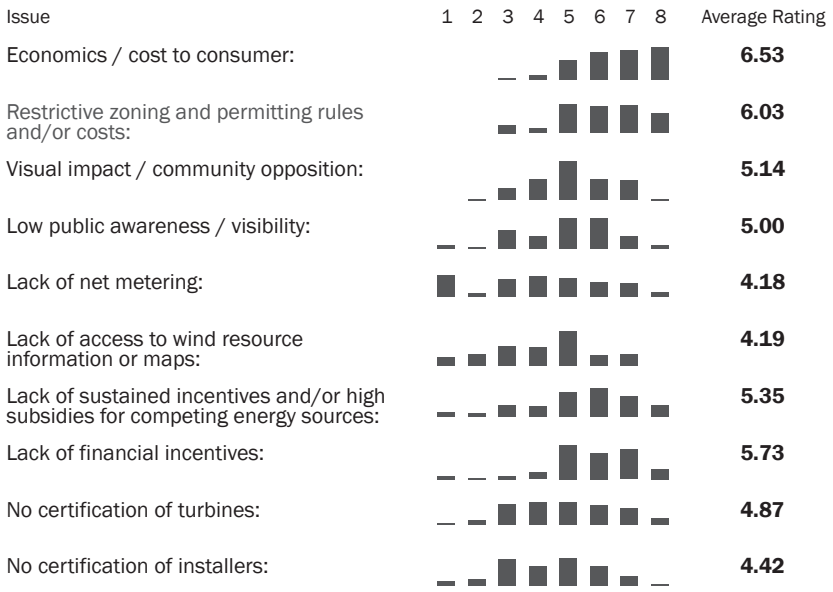
5 National Association of Realtors. "The 2006 National Association of Realtors Profile of Home Buyers and Sellers." 2006.

6 Jennifer L. Edwards, et al. http://repositories.cdlib.org/lbnl/LBNL-56344 p.39.
This study did not specifically address the effect on the simple payback period of combining these two factors.

7 Turbines with a swept area of <200m^2

Survey: "What are the key market barriers for small wind turbines?"

Ratings of the following issues from **1 - Not an Issue** to **8 - Largest Barrier**.
Total of 72 respondents.



9. Where are small wind systems being sold?

- The market remains predominantly homes, farms, ranches, small businesses, industry/factories, public and private facilities, and schools.
- U.S. manufacturers sell in all 50 states, but the leading markets are in California, New York, Vermont, Massachusetts, Pennsylvania, Ohio, Texas, Maine, and Arizona. The market exists mostly in states where policies, regulations, and incentives are conducive to making small-wind installations practical, cost-effective, and simply feasible. Costs of traditional electricity and wind resource quality are also important factors, but none more so than the presence of incentive or rebate programs.
- Small wind systems are not suitable for every home. As a rule of thumb, at least one acre of open land and an adequate wind resource[8] are necessary to achieve an attractive financial return on an installation.
- Top export markets, which persistently account for roughly half of all sales by U.S. manufacturers, are Canada, the UK, China, Europe (non-UK), and India.
- Grid-connected, residential-scale models (1-10kW) are the fastest-growing market segment. Residential applications, on- or off-grid, dominate the sales distribution, as shown in the following table.

8 An "adequate wind resource" for small wind turbines is generally considered to be a "class 2" resource or better, which is itself defined as an average wind speed of at least 5.6 - 6.4 m/s at an elevation of 50m. Wind resources are expressed in terms of wind power classes, ranging from class 1, the lowest, to class 7, the highest, and depends on air density and speed at given elevations. See: http://rredc.nrel.gov/wind/pubs/atlas/maps.html for more.

Application	Distribution (2006)
Rural or Suburban Homes	51%
Farms	19%
Small Businesses	10%
Schools or Public Facilities	10%
Urban Settings	5%
Other	6%

10. What are the technological barriers and goals for Small Wind?

- No single technical issue clearly emerged from survey responses as a dominant barrier. The majority of open-ended responses to this question pertained to Standards & Ratings and reflects, as other studies have, the strong industry-wide desire for a small-wind certification process.[9]
- Respondents were also asked to rate the importance of the various issue-areas on behalf of which AWEA is advocating. Those of greatest importance were Legislation (at both federal and state levels), Certification and Standards, and working with the U.S. Department of Energy's National Renewable Energy Laboratory to create high-resolution wind resource maps.
- Manufacturers are designing small wind systems to fit the market model of any other household "appliance," meaning they are made to be increasingly easy to install, operate, and maintain. Some turbine models transmit live data remotely so that a customer can monitor the system's performance from a home computer and know immediately if maintenance is needed.
- Specifically, technological advancements include: advanced blade design and manufacturing methods, operation in lower wind speeds (lowering the "cut-in" threshold), alternatives to furling, slower rotor speeds (to reduce sound levels), wireless display units, integrated inverters, using rare earth permanent magnets rather than ferrite magnets, using induction generators rather than power electronics, designing electronics to meet stronger safety and durability standards, and others.

9 Rhoads-Weaver, Heather. "SWCC Organizational Survey Summary." September 2006. Available at http://www.irecusa.org/uploads/media/SWCC_Survey_Summary-Public.pdf

11. How many U.S. jobs are created by the industry?

- Extrapolated from a relatively modest sample, the 12 identified established U.S. manufacturers employ a cumulative 250-350 individuals for the direct production of small wind systems. This figure does not include the hundreds of dealers and installers located throughout the U.S., in every state. Nor does this estimate include

retailers, component vendors, consultants, testing facilitators, or individuals further down the supply chain.

12. How much have costs come down? How much are they expected to go down?

- The retail cost per kilowatt-hour (kWh) of electricity produced by small wind systems has declined from $0.15-$0.18 per kWh to $0.10-$0.11 per kWh, with a goal of $0.07 per kWh within five years. As a comparison, utility-scale wind turbines currently produce electricity at a rate of 4-7 cents per kWh, and solar PV at a rate of 18 cents per kWh.[10] Hardware costs have remained relatively steady over the 20 years, though the cost of raw materials like copper and steel have increased, particularly in the past 3 years.
- The 2005 AWEA market survey found that the industry aims to reduce hardware costs 20% by 2010 to $1,700 per installed kW of capacity. Costs are still expected to drop, though a sharp increase in production volumes spurred by a federal investment tax credit would contribute to a significant reduction in marginal production costs.

10 2004 estimate, which includes present federal policies for a commercial system, accelerated depreciation, and a federal investment tax credit. Solar Energy Industries Association Road Map http://www.seia.org/roadmap.pdf. Cost of electricity rate for utility-scale wind includes a federal Production Tax Credit of 2.0 cents per kWh.

13. How does Small Wind's growth compare to that of solar photovoltaic (PV) technology?

Over 80% of all grid-connected small wind systems 10kW of capacity and less include some solar PV component, indicating the two technologies share very similar markets.

According to recent studies by the Solar Energy Industries Association (SEIA),[11] the U.S. market for solar photovoltaics (PV) grew 20% per year until 2006 when growth jumped to 36%, largely from the introduction of a federal investment tax credit in 2005. Like Small Wind, the solar PV industry is seeing a shift toward a greater proportion of on-grid applications, with the average size of a residential grid-connected system increasing to 4.5kW installed.[12] One critical factor differentiating the two technologies' growth trends is that solar PV has had a 30% federal investment tax credit (capped at $2,000 for residential applications) in place since 2005, whereas small wind has had no federal-level incentives since 1985 and is the only mainstream renewable energy technology without one.

Solar PV costs are expected to keep falling, perhaps as much as 50% within the next 4 to 7 years.[13] Small Wind is pressed to keep astride of this rate, though market barriers for the small-wind industry appear to be influenced more by policy than by technological advancements.

The U.S. market share of solar PV remains under 20%, whereas small wind continues to be a U.S.-dominated technology, with exports accounting for 40-50% of sales by U.S. manufacturers.

11 Prometheus Institute and Solar Energy Industries Association. "2006 Solar Industry Year in Review: U.S. Solar Industry Charging Ahead." 2006. http://www.seia.org/Year_in_Solar_2006.pdf

12 Source: Larry Sherwood of the Interstate Renewable Energy Council

13 Marbek Resource Consultants Limited. Survey of Small (300 W to 300 KW) Wind Turbine Market in Canada. Contract No.: NRCan-03-0652. Prepared for the Wind Energy R&D Program of the CANMET Energy Technology Centre-Ottawa (CETC), Energy Technology and Programs Sector, Department of Natural Resources, Government of Canada, Ottawa, Ontario, 2005. (92pages).

STATE PRIORITIES

Top Issues: Rebates and Zoning (tied for first), and Developing High-Resolution Wind Resource Maps.

Respondents were asked to choose from a comprehensive list what they believed to be the top two areas in need of improvement for each state. States were then ranked according to their impact – potential or demonstrated – on the Small Wind market, as calculated by the number of responses received for each state. (For example, more responses were given for California than for Kansas. Respondents could comment on any and all states.) An asterisk (*) in the following table indicates that no single issue was ranked significantly higher than others for that state, or that the response rate was insufficient.

STATE (Alpha)	1st PRIORITY	2nd PRIORITY	State (Ranked by Priority, Hi-Lo)	
			State	Rank
AL	*		CA	1
AK	Wind Maps		NY	2
AZ	Net Metering		CO	3
AR	*		MA	3
CA	Zoning		KS	5
CO			MN	5
CT	Zoning	Rebates	MI	7
DE	Rebates	Zoning	ND	7
FL	*		PA	7
GA	*		CT	10
HI	Rebates	Zoning	HI	10
ID	*	Wind Maps	OR	10
IL	Rebates	*	MT	13
IN	Wind Maps	Rebates	NV	13
IA	Rebates	Interconnection	NJ	13
KS	Net Metering	Rebates	WI	13
KY	Wind Maps		IA	17
LA	*		NH	17
ME	Rebates	Zoning	NM	17
MD	Zoning	*	OH	17
MA	Zoning		WA	17
MI	Rebates		ID	22
MN	Rebates	Zoning	TX	22
MS	*		WY	22
MO	Interconnection		AK	25
MT	*		IL	25
NE	Wind Maps		IN	25
NV	Rebates		VT	25
NH	Zoning	Wind Maps	AZ	29
NJ	Zoning	Zoning	FL	29
NM	Zoning	Wind Maps	AL	31
NY	Zoning	Zoning	KY	31
NC	Rebates	Wind Maps	ME	31
ND	Rebates		MD	31
OH	Zoning	Wind Maps	MO	31
OK	Zoning		NE	31
OR	Zoning	Wind Maps	NC	31
PA	Rebates	Zoning	OK	31
RI	Zoning		SD	31
SC	*		UT	31
SD	USDA/Farm		DE	41
TN	*		GA	41
TX	Rebates	Wind Maps	AR	43
UT	Interconnection		LA	43
VT	Zoning	Zoning	MS	43
VA	*		RI	43
WA	Wind Maps		WV	43
WV	*		VA	48
WI	Rebates	Wind Maps	SC	49
WY	Rebates	Wind Maps	TN	49

CONCLUSION

Consumer prices and state and federal policies are the most essential components of sustaining and growing Small Wind. However, without conscientious zoning, permitting, and grid-interconnection regulations in place, rebate and incentive programs have no platform upon which to grow the market and streamline production. Small Wind is poised to play an important role globally to supply clean, affordable, and local power to end-users, and Small Wind's long history shows that the industry is capable of overcoming obstacles it faces. Geopolitical, climatic, and economic forces have and will continue to drive demand, but the industry's maturation and accelerated growth are largely dependent on U.S. policy at the national, state, and local levels. As the U.S. lags behind world competitors in other renewable energy technologies, Small Wind remains the only major U.S.-dominated clean energy technology. With the right policies in place, Small Wind could lead the U.S. into a stronger position in the global energy paradigm.

RESPONDENT PROFILE and METHODOLOGY

This survey was divided into two parts: the first to be answered only by manufacturers, the second for all interested individuals, organizations, and companies (including manufacturers). Responses came from a wide spectrum of the industry, such as researchers, component vendors, manufacturers, engineers, consultants, utilities, local government offices, engineers, dealers/distributors/installers, and others. Sales statistics were provided by small wind turbine manufacturers.

Geographically, responses to qualitative, non-sales questions came from the U.S. (66 respondents / 25 states), Canada (10 respondents), Germany (1 respondent), and China (1 respondent). 323 individuals, companies, and/or organizations were solicited for responses via e-mail and reflect an industry-wide response rate of 30%.

Quantitative (sales) responses represent 17 total established manufacturers, of which 9 are U.S. companies (reflecting an 75% response rate among established U.S. manufacturers), and 8 are non-U.S. companies (an estimated 20% response rate). It is estimated an additional eight U.S. manufacturing companies have been created by the time of this survey, but had not yet begun production and had no sales in 2006.

Each of the 17 responding manufacturers provided figures for 2006 U.S. sales, not all provided figures for non-U.S. sales. Correspondence was made with each responding company to verify data, which was then further compared to estimates from other manufacturers, both foreign and domestic, and existing outside market research.

This study's growth projections hinge on forecasted future legislation, particularly a federal investment tax credit, and are therefore dependent on the relatively high uncertainty of Congressional action. Accordingly, the emphasis of this study was placed on 2006 actual sales, as this data would provide for the most accurate, albeit instantaneous, evaluation of the industry. Growth and other industry trends were somewhat difficult to determine because the responses to this 2007 survey captured a larger percentage of the market than did the previous, 2005 AWEA small-wind study.

U.S. sales by U.S. manufacturers are based on closed-book figures directly from a thorough sampling of manufacturers, and confidence in these figures is high. Non-U.S. sales figures however represent probably at best 50% of non-U.S. manufacturers. Foreign manufacturers were widely unavailable to provide data and U.S. manufacturers either did not have foreign figures available or provided no response.

U.S. companies were asked most pressingly for U.S. sales data because this was anticipated to be the most complete data set of those requested. Creating a thorough picture of the global market from non-U.S. companies' sales was expected to be difficult, evidenced by the very low initial response to a more expansive online survey to both U.S. and foreign manufacturers. The first priority of this survey was to identify, with confidence, U.S. sales by U.S. manufacturers. The second priority was non-U.S. sales by U.S. manufacturers, third was non-U.S. manufacturers' sales to the U.S., and lastly was non-U.S. sales by non-U.S. manufacturers.

Sales in dollar amounts are based on the retail installed total cost of the system (not just the turbine and tower) to reflect the economic impact of the industry more comprehensively.

GLOSSARY

- **(Installed/Rated/Nameplate) Capacity:** A measure of a *rate* of electricity generation at a specific instant in time at a given wind speed. A 10 kilowatt (kW) turbine, for example, means that at a given wind speed of, say, 25 mph, the turbine produces electricity at a rate of 10kW. Capacity is the most common measure of a turbine's size.
- **Furling:** The automatic process by which a turbine's rotor (the hub and blades, i.e., the part that rotates) turns itself to face slightly or completely away from the oncoming wind. Very high wind speeds can cause a turbine's blades to spin so fast that damage to the turbine may result. Furling causes the wind to hit the blades less directly, thus slowing the rotor to a safer speed.
- **Interconnection:** The process of linking a generator, like some types of small wind systems, to the electric grid. Interconnection requires

permission from the local utility, and rules for doing so often differ on a case-by-case basis.

- **Inverter:** An electronic device that converts electricity into a form that can be used by everyday household appliances. Wind turbines and many other types of generators initially produce electricity in the form of Direct Current (DC), but standard electrical appliances use electricity in a form called Alternating Current (AC). An inverter converts the DC electricity into AC, which is the form that comes out of a standard electrical socket.
- **Investment Tax Credit (ITC):** A form of financial incentive that a state or federal government can implement to help consumers reduce the up-front ("investment") cost of an expensive one-time purchase, such as a small wind system.
- **Kilowatt (kW):** A measure of a rate of electricity production. A wind turbine's size (its production "capacity") is measured in kilowatts and represents the rate at which the turbine can produce electricity at a given wind speed.
- **Kilowatt – hour (kWh):** A measure of an amount of electricity produced over time. A home's electric bill, for example, is expressed in kWh to reflect an amount of electricity consumed during the previous month.
- **Net Metering:** A policy implemented by some state or local governments to ensure that any extra electricity produced by a generator, such as a small wind system, can be sent back into the grid for credit. For example, if a home's (grid-connected) small wind turbine produces more electricity than the home can use, the excess electricity is sent back into the distribution grid to be used by someone else. This excess generation would cause the small-turbine owner's home electric meter to spin backwards to indicate essentially "negative" electricity usage. At the end of the billing period, usually a month or sometimes a year, the meter would indicate a "net" consumption or production of electricity. By using a single meter to measure in- and out-flow, any excess electricity produced is automatically compensated by the utility at a one-to-one ratio with normal retail energy rates.

  Without net metering, a small-wind system owner would be required to have two electric meters on his or her home, provided the utility allowed the turbine to be connected to the grid at all. One meter would measure electricity consumed from the grid (for when the wind isn't blowing), and the other would measure any extra electricity sent back to the grid when the turbine produces more than the home needs. This scenario is called "duel metering." Unlike net metering, however, excess electricity produced by the turbine would be credited to the homeowner by the utility not at the full retail price, but rather at a rate known as "avoided cost," or wholesale rates.

- **Net Metering, Annualized:** Annualized net metering is a form of the net metering policy (see: Net Metering) that averages a home's net electricity consumption or production over the span of one full year, rather than a shorter time period. This policy is favored by consumers because it accounts for the seasonal variations of a home's electricity usage, thereby allowing for more accurate compensation from the utility.
- **Permitting:** The process of obtaining permission from a local governing body to perform a construction or similar project, such as installing a small wind system, on one's property.
- **Sound Pressure Levels:** Sound output ("noise").
- **Wind Resource Map:** An image of a geographic area showing average wind speeds at a particular elevation above ground level.

RESOURCES

Small-Wind Markets

- Jennifer L. Edwards, Ryan Wiser, Mark Bolinger, and Trudy Forsyth, "Evaluating state markets for residential wind systems: Results from an economic and policy analysis tool" (December 1, 2004). Lawrence Berkeley National Laboratory. Paper LBNL-56344. http://repositories.cdlib.org/lbnl/LBNL-56344
- Forsyth, Trudy and Rhoads-Weaver, Heather. *Overcoming Technical and Market Barriers for Distributed Wind Applications: Reaching the Mainstream*. National Renewable Energy Laboratory and eFormative Options, LLC. Conference Paper NREL/CP-500-39858. July 2006. http://www.nrel.gov/docs/fy06osti/39858.pdf
- AWEA 2005 global small-wind market study: *Home and Farm Wind Energy Systems: Reaching the Next Level* http://www.awea.org/smallwind/documents/AWEA_SWT_Market_Study_6-05.pdf
- AWEA U.S. Small Wind Turbine Industry Roadmap http://www.awea.org/smallwind/documents/31958.pdf

Net Metering and Grid Interconnection

- Cooper, Chris et. al. *Freeing the Grid: How Effective State Net Metering Laws Can Revolutionize U.S. Energy Policy.* Network for New Energy Choices, Report 01-06, November 2006. http://www.newenergychoices.org/uploads/netMetering.pdf
- http://www.awea.org/faq/netbdef.html
- http://www.awea.org/smallwind/toolbox2/utilities.html
- http://www.awea.org/smallwind/toolbox2/grid_connecting.html

Zoning and Permitting

- Green, Jim and Sagrillo, Mick. *Zoning for Distributed Wind Power: Breaking Down Barriers.* National Renewable Energy Laboratory, Conference Paper NREL/CP-500-38167. August 2005.
- http://www.awea.org/smallwind/toolbox2/zoning.html
- http://www.awea.org/smallwind/toolbox2/TOOLS/permitting.html

Wind Resource Maps

- http://www.eere.energy.gov/windandhydro/windpoweringamerica/wind_maps.asp
- http://rredc.nrel.gov/wind/pubs/atlas/maps.html

Solar PV

- http://www.seia.org/Year_in_Solar_2006.pdf
- http://www.seia.org/roadmap.pdf

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