AWEA Small Wind Turbine Global Market Study

YEAR ENDING 2009

AWEA

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Summary

Small Wind Reaches 100 MW Milestone in U.S. with 15% Growth

Despite an economic downturn, the U.S. market for small wind turbines – those with rated capacities of 100 kilowatts (kW)[1] and less – grew 15% in 2009 with 20.3 Megawatts (MW) of new capacity and $82.4 million in sales. This growth equates to nearly 10,000 new units and pushes the total installed capacity in the U.S. to 100 MW.[2]

Half of this 100-MW milestone capacity came within the past three years of the industry's 80-year history. Manufacturers attribute this growth to a mixture of new and improved federal and state incentives, optimistic private equity investors, and sustained consumer demand.

The 2009 American Recovery and Reinvestment Act expanded the federal investment tax credit (ITC) for small wind turbines, allowing consumers to take fully 30% of the total cost of a small wind system as a tax credit. In 2009 an additional $80 million of private equity was invested into manufacturing companies during the peak of the economic recession, boosting to at least $252.7 million the total of outside equity invested across 20 manufacturers (most of them U.S.-based) over the past five years. This investment provided companies with capital to increase production, lower costs, meet sustained demand, and even acquire competitors.

Table 1

2009 U.S. Sales	2009 Global Sales
20.3 MW	42.5 MW
15% growth over 2008	10% growth over 2008
9,800 units	21,000 units
$83 million in sales	$189 million in sales

Other Key Statistics:

- 95% of all small wind systems sold in the U.S. last year were made by U.S. manufacturers
- 2/3 of all small wind systems sold in the world last year were made by U.S. manufacturers
- Approximately 250 companies worldwide manufacture or plan to manufacture small wind turbines, 95 of which—more than one-third—are based in the U.S.
- An estimated 100,000 units have been sold in the U.S. since 1980[3]

Survey Findings and Analysis

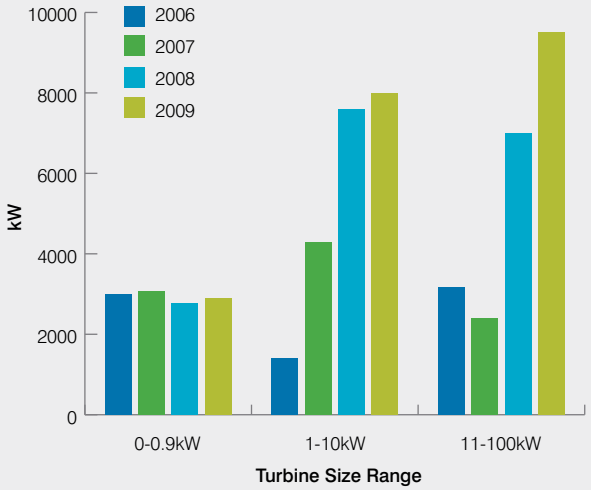
Based on a 2010 AWEA survey of manufacturers around the world, the U.S. market continued to grow in 2009 primarily because of the new U.S. federal investment tax credit (ITC), sustained consumer demand, external private equity investment in manufacturing, and the ability of manufacturers to identify and leverage specific market niches.

The ITC was perhaps the most important factor in last year's growth. The credit opened markets that have historically been just out of reach, sent a powerful signal to investors about the technology's promise, and helped consumers purchase small wind systems during a recession when other financing mechanisms were hardest to obtain.

The enactment of the ITC – the industry's top priority – has also allowed industry members and advocates to shift their political efforts toward other salient issues, including permitting, net metering and standardized interconnection regulations, and the appropriation and allocation of federal research and development funds. Manufacturers have also focused more resources on improving turbine performance, certifying equipment to meet a newly created performance and safety standard,[4] reducing costs, strengthening dealer networks, defining new market niches, and scaling up production.

U.S. installed capacity increased by 15% last year, but the number of units sold decreased by 6%. This trend demonstrates a continued market shift toward larger, grid-tied systems. Since 2007 the residential and commercial / light industrial market segments have emerged as dominant, with sales of off-grid turbines (generally those smaller than 1 kW and used to charge batteries) remaining flat.

Fig. 1: U.S. SMALL TURBINE MARKET GROWTH BY SEGMENT



(In general, systems 0-0.9 kW correspond to the off-grid market, systems 1-10 kW correspond to the residential market, and systems 11-100 kW correspond to the commercial / light industrial market.)

Fig. 2: 2009 GLOBAL SALES

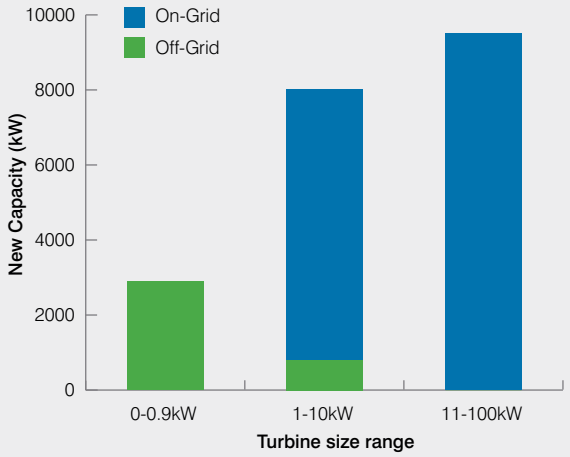
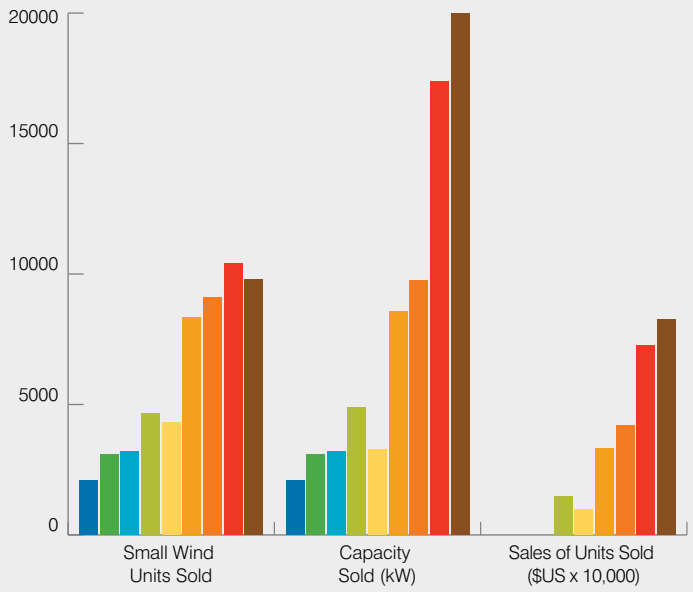


Fig. 3: GROWTH OF U.S. SMALL WIND MARKET



Year	Units	kW	Sales $US
2001	2,100	2,100	(not avail.)
2002	3,100	3,100	(not avail.)
2003	3,200	3,200	(not avail.)
2004	4,671	4,878	$1,489
2005	4,324	3,285	$990
2006	8,329	8,565	$3,320
2007	9,092	9,737	$4,197
2008	10,386	17,374	$7,266
2009	9,800	20,300	$8,240

Manufacturers report that while interest in small wind has increased through the economic recession, consumers are delaying purchasing decisions until financing becomes more available and affordable. Therefore, as the economy recovers, many manufacturers expect a surge in sales.

Table 2. 2009 Global Sales

	Units	kW
Off-Grid	15,500	7,600
On-Grid	5,200	34,400
Total	20,700	42,000

Demand Drivers

Consumer demand continues to be fueled by a combination of the following factors, though economics and environment remain primary concerns:

Economics

- Length of payback period, or IRR*
- Financial hedge against rising prices of conventional electricity
- Financial stability compared to volatile prices of conventional electricity

Practicality

- Reliability of electricity supply
- Natural synergism with solar PV technology
- Diversity of applications, including those remote and off-grid

Values

- Environment
- Independence
- Image enhancement
- Consumer choice
- Self-reliance
- Do-It-Yourself
- High visibility, particularly for commercial consumers

Drivers Specifically For Real Estate Developers

- Marketability of a "Zero-Energy Home"
- Practicality of integrating small wind and solar hybrid systems
- Possible availability of rebates for both developers and consumers
- Whether installation cost can be built into the price of a property
- Role in defining the progressive character of neighborhood
- Appeal of "renting vs. owning" electricity

** Many investors view the internal rate of return (IRR) of a renewable energy technology to be a superior method of assessing its value to its payback period. IRR, not payback period, is the primary tool used to assess the profitability of other types of financial investments (IRAs, stocks, etc.). Investors also point out that unlike mutual funds and stocks, renewable energy systems are generally far less susceptible to external risk.[5] Measuring profitability in terms of payback also reinforces the negative perception that renewable energy is unaffordable and that consumers should postpone purchases until technological improvements reduce costs. However, when compared with other investment options using IRR, renewable energy investments can become much more attractive.*

Growth Potential and Industry Projections

The world's leading 15 manufacturers continue to predict exponential sales growth in the U.S. market over the next five years, with projections of over one gigawatt (1,000 Megawatts) of cumulative installed small wind capacity in the U.S. by 2015, despite current economic conditions and the cooled sales of 2009.[6] The economic recession led these manufacturers to pare down their growth projections somewhat from last year's report,[7] but they remain optimistic about achieving their target. Primary drivers include the eight-year 30% federal investment tax credit enacted in October 2008, recent and potential private equity investment, and greater equipment supply and manufacturing capabilities.

Table 3. Grid-Tied Residential Market Potential

Potential Installations, Millions	2010*	2020**
Homes with ½ to 1 acre of land	12.0	13.9
Homes with >1 acre of land	25.2	29.3
Gross potential number of homes for small wind turbines	37.2	43.2
Net potential number of homes for small wind turbines†	13.0	15.1

If each of these 15.1 million homes installed a 7.5 kW wind turbine, the total generation capacity would be 113,000 MW.

* Millions of U.S. homes connected to the utility grid
**Growth according to U.S. Census Bureau, American Housing Survey, 1998.
†Approximately 35% of these homes will have a sufficient wind resource, defined as a U.S. Department of Energy wind class of 2 or better. To meet the electrical needs of a typical U.S. home, a small wind turbine in a moderate wind regime must have a rotor diameter of 16 to 25 feet and be installed on a tower 60 to 150 feet tall. These dimensions are unsuitable for homes on small lot sizes.
†† All data in this table are taken from the AWEA Small Wind Turbine Industry Roadmap (2002).

States

Manufacturers report that the fastest growing markets were in the Midwest last year, but the largest markets overall remain in the Northeast, upper Midwest, and California.

In general, states that offer small-wind consumer incentives at a level of $2 per Watt of capacity or more attract the strongest share of the market. In recent years the states with the highest sales percentages have been CA, NV, AZ, OR, NY, MA, and OH. A handful of states, particularly New Jersey, have long had strong market potential due to incentives and robust utility policies, but local permitting challenges have throttled the markets' potential. In early 2010, however, New Jersey and Delaware joined seven other states (CA, NV, WI, VT, MI, OR, and NH) in enacting legislation to streamline the permitting process at the state level, opening the potential of these markets.[8] (*See also "Market Factors and Developments," page 9*)

Quantifying the size of state-level markets remains difficult because of the dispersion and complexity of dealer networks. Most manufacturers are unable to report sales figures by state or region. Consequently, a definitive measurement of state markets is beyond the scope of this study.

However, manufacturers consistently report that state markets can be assessed, generally, in proportion to one another based on the extent of their respective incentive programs and other public policies. California, for example, remains far and away the largest state market due to its relatively long history of generous incentives and streamlined permitting laws. Different policies and financial incentive structures also affect different market niches. For example, robust net metering policies generally open markets for turbines 10 kW and larger, and financial incentives for residential consumers generally create markets for turbines 20 kW and smaller.[9]

Market Factors and Developments

Federal incentives. On October 3, 2008 Congress passed the Emergency Economic Stabilization Act of 2008, H.R. 1424, that included an eight-year, 30% federal-level investment tax credit (ITC) to help consumers purchase qualified small wind systems with rated capacities of 100 kW and less. The amount of this credit was stringently capped, however, until the passage of The American Recovery and Reinvestment Act (ARRA) of 2009, H.R. 1, on February 17, 2009, which removed the cost caps. A 30% ITC has since been available for small wind turbine consumers. The legislation, in its current form, will last through December 31, 2016.[10]

This legislation marked the first federal incentive for small wind technology since 1985 and provides the industry with stable, long-term policy that has historically been out of reach for other renewables. Industry members value its passage as an important step toward achieving political parity with the solar PV industry, small wind's market counterpart, which has enjoyed a federal ITC since 2005. Still, manufacturers report, lopsided state-level incentives continue to favor solar PV and make true marketplace parity difficult to achieve.

The ARRA also created a U.S. Treasury grant program (Section 1603) allowing commercial consumers, for a limited time, to receive payments in lieu of the ITC. This new incentive structure allowed incentives to flow to projects and taxpayers more immediately than a tax credit, which must be redeemed at the end of the fiscal year. The grant program has been instrumental in growing all segments of the wind and solar industries, and AWEA is lobbying for its extension through 2012.

Additionally, the ARRA created a 30% ITC to help manufacturers of renewable energy equipment, like small wind turbines, invest in the creation, expansion, or re-equipment of manufacturing facilities *(see also "Manufacturing," page 18)*.

Installer and equipment certification. In December 2009, AWEA finalized a technical standard that can now be used voluntarily to test small wind systems to performance and safety criteria. Third-party organizations like the Small Wind Certification Council (SWCC)[11] can now certify systems tested to this standard. An average of 6-12 months of field testing is required to meet the standard's requirements, so no turbine will likely become certified until the end of 2010.

Certification has long been a major goal of the small-wind industry, which for decades has largely been self-regulated. Industry members look to certification as a way to provide consumers, regulators, and policymakers with transparent and credible information about the safety, performance, and reliability of the technology. Many in the industry see certification as a strong sign of the industry's maturity and as a building block for lasting growth.

The popular *Energy Star*[12] government program, administered by the Department of Energy (DOE) and the Environmental Protection Agency (EPA) to certify many energy-efficient consumer goods, will likely incorporate small wind systems and other renewable generators in the near future. Industry sees great potential for this initiative to take small wind turbines further into mainstream markets. The DOE and EPA indicate they will rely heavily on SWCC certification when granting selective Energy Star labels to qualified equipment.

The North American Board of Certified Energy Practitioners (NABCEP)[13] also plans to begin the process of certifying small wind turbine installation professionals in the fall of 2010. This voluntary program aims to offer experienced installers an opportunity to identify and market themselves as experts in their field. Installation is an important factor in a turbine's performance, cost, and public acceptance.

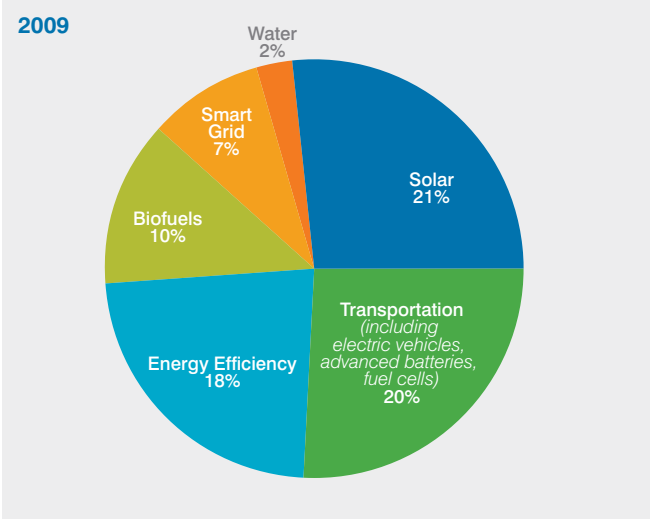
While equipment and installer certification programs will be voluntary, market forces are likely to institutionalize them throughout the industry. A number of states and localities have indicated that they plan to make certification a requirement to connect to the electricity grid and/or obtain a zoning permit. Incentive program managers in numerous states indicate they will require certification, or evidence of intent to achieve certification, in order to be eligible for funding. These states include AZ, CA, IA, MD, ME, MT, NC, NV, OH, VT, and WA.

External investment. Last year an additional $80 million of external private equity was invested in manufacturing companies during the peak of the economic recession, boosting to at least $252.7 million the total of outside equity invested across 20 manufacturers (most of them U.S.-based) over the past five years. This investment provided companies with capital to increase production, lower costs, meet a sustained demand, and even acquire competitors.

During economic recessions and other periods of stagnation and high risk, private equity and venture capital investors generally choose to reinvest in companies they already support rather than look for new investments. Consistent with this trend, several small-wind manufacturers that received funding in the past five years received additional funds in 2009.

Thirty-two percent of all venture capital in the U.S. in 2009 was invested in the clean technology sector but continued to favor the solar industry, which received nearly a quarter ($1.2 billion) of all clean-technology venture funding in 2009.[14]

Fig. 4: TOP VENTURE CAPITAL CLEAN-TECH SECTORS



Source: Cleantech Group (cleantech.com)

Zoning/permitting. Poor or nonexistent local permitting practices continue to thwart an estimated 1/3 of all planned small wind turbine installations. Overly restrictive and cumbersome regulations can limit a turbine's productivity, discourage customers and investment, and repel local industry-related businesses from communities.

However, a small but growing trend toward statewide permitting may reduce this barrier. To date, nine states have enacted statewide laws that, to various degrees, streamline the permitting of small wind systems. With an estimated 25,000 different local zoning jurisdictions in the U.S.,[15] AWEA and industry members are attempting to address permitting challenges at the broader state level of government.

For more information on permitting challenges and solutions, see the 2008 AWEA permitting guidebook, "In the Public Interest: How and Why to Permit for Small Wind Systems," at www.awea.org/smallwind/pdf/InThePublicInterest.pdf.

Improved resource assessment technology. Accessing high average prevailing wind speeds is one of the most important factors in a turbine's performance. A number of private-sector companies develop advanced technologies to identify geographic regions with greatest average wind speeds, and recently more companies are assessing conditions in very specific locations to identify small-wind sites. Traditional wind resource maps typically evaluate wind conditions at a height of 50 meters above ground, which corresponds to the hub heights of large-scale turbines. Small-turbine site assessors must extrapolate from this data to apply it to small wind systems, which typically reach no higher than 30 meters. Additionally, no affordable tool is presently available to assess wind resources in urban or built-up environments. Because site assessment is such an important factor in the technology's viability, private companies are focusing more on improving analytical resource modeling tools.

The North American Board of Certified Energy Practitioners (NABCEP) is also in the process of initiating a new credential to certify Wind Site Assessors who evaluate wind resource conditions and turbine production potential at site-specific locations.

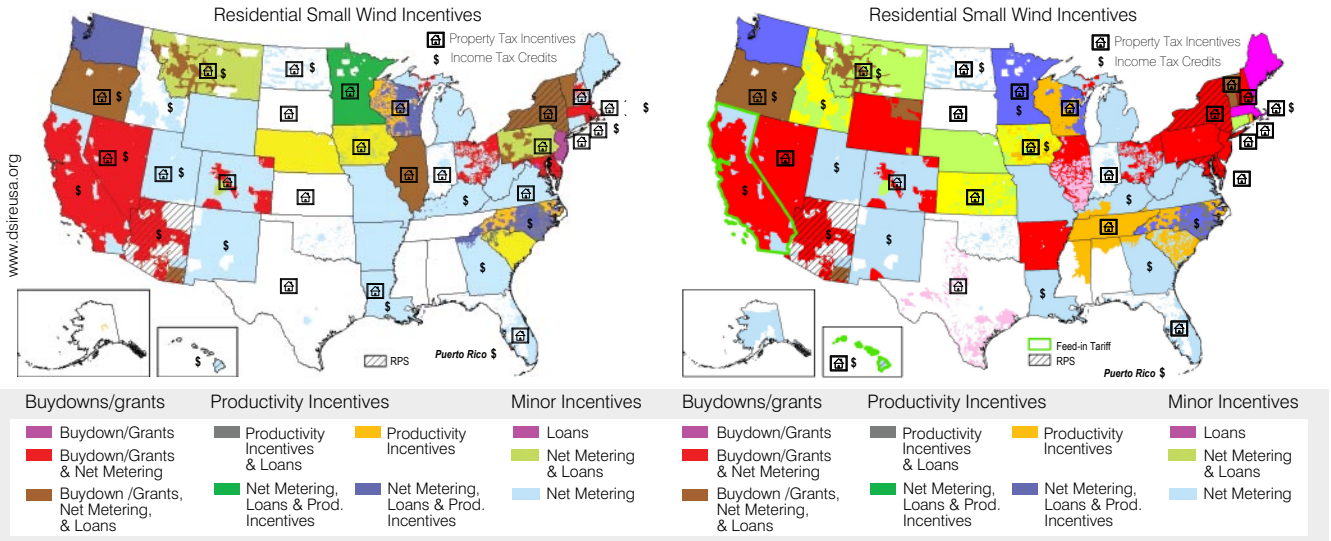
The public sector is taking note as well. In May 2009 the U.S. Department of Energy awarded a $475,000 grant to a private company to develop a consumer-friendly "site analysis tool" to help consumers predict a turbine's performance, environmental impact, and other installation aspects.[16] State governments that offer financial incentives for small wind equipment are indirectly vested in the technology's performance, and advanced resource assessment tools may increase fund administrators' confidence in the technology and lead to improvements in consumer incentives.

Consolidations. New government incentives make the market more attractive than ever before to start-up companies hoping to compete for these funds, growing consumer interest, and external investment. More than 250 identified manufacturers in the world are competing for a large but finite number of market niches to serve, and some may look to consolidation over the next few years as the best means to grow.

Several prominent manufacturers were acquired by other companies or filed for bankruptcy last year. Reasons are as varied as the companies, but some acquisitions were abetted by acquiring companies' ability to secure external investment in recent years. As private external investment in the industry continues to climb (*see "External investment," page 10*), more companies may look to mergers and acquisitions as efficient ways to expand quickly into the growing market.

Fig. 5: STATE POLICIES AND INCENTIVES

October 2008 **April 2010**



Maps prepared by Trudy Forsyth of the National Renewable Energy Laboratory. Data source: DSIREUSA

State policies and incentives. At the state, utility, and local levels, policies continue to be fragmented and changing – but generally improving – across regions and even communities, as illustrated in the maps above.

Top state, utility, and local policy goals for the industry continue to be to:

- Streamline zoning ordinances at the local and especially state levels,
- Increase the availability and size of financial incentives,
- Standardize grid interconnection rules and procedures, and
- Implement or improve state/utility net metering policies.

Growth in the number of manufacturers, dealers, installers, supply chain members, installed units, and advocates has led to a larger industry presence at local levels, forcing these issues to the fore in local and state legislatures.

The economy. Manufacturers report that the economic recession beginning in the fall of 2008 caused many consumers, particularly homeowners, to delay their decisions to purchase small wind turbines. The recession caused the value of many homes to decline and limited the availability of credit, particularly home equity credit, which many consumers rely on to finance small wind projects. Consumer interest remains strong, however, and as the economy recovers manufacturers predict a resurgence in sales in the residential and light industrial market segments.

Improved dealer/installer networks. Many leading manufacturers are renewing their efforts to improve their dealer and installer networks (often one and the same). These manufacturers are investing heavily in the selection and training of these professionals who work most closely with the end-user/customer for the 15-25 year lifespan of the turbine. Installers/dealers are also typically the same parties who assess sites for resource quality and lobby for favorable local incentives and zoning regulations. They are therefore key to building and preserving local markets for small-wind technology.

"PACE" bonds. A Property-Assessed Clean Energy (PACE) bond is a financial tool to help consumers invest in often high-initial-cost renewable energy equipment or energy efficiency measures. PACE bonds are issued by municipalities and usually purchased by institutional investors such as banks, pension funds, or mutual funds. Municipalities in turn lend the proceeds to residential or commercial applicants to help them purchase renewable energy equipment or finance energy efficiency retrofitting measures. The consumers then repay their loans over 20 years via an annual assessment on their property tax bill.

A PACE bond program therefore alleviates two barriers to the small-wind market: high up-front costs, and payback periods that exceed the term of property ownership.

Loans sourced from PACE bond sales are attractive to consumers because they can be combined with other state, utility, and federal incentives. They also offer an alternative to home equity loans, the principal financing mechanism for residential small-wind consumers, which have been difficult to obtain in the current economic recession.

As reported in previous AWEA market studies, investments in small wind systems can become unattractive if the investment's payback period exceeds the time for which the turbine will be owned (*see page 6 for a discussion of using payback period versus IRR in marketing approaches*). Therefore, for example, if a residential turbine's payback period is seven years, but the homeowner plans to sell the property in five, the owner will not be able to enjoy the financial benefits of the system.[17] Because a loan financed through a PACE bond is repaid over 20 years through property taxes, a homeowner who sells a property (and a turbine) before the turbine's cost is fully recouped is not burdened with paying the full cost of the turbine. Instead, the next owner of the property (and turbine) assumes payment.

On the opposite side of the deal, institutional investors find PACE bonds attractive because the bonds are backed by property taxes, which have very low default rates and can survive property foreclosures.

PACE bonds also have political appeal. Their implementation helps to employ equipment installers locally, encourages clean energy, and raises taxes only on the property owner(s) who elect to participate.

To date, PACE bonds are available in 18 states, and some federal legislators are looking to help enable their creation at the state level. For more information see http://pacenow.org.

Government attention. Small wind's growth and potential has attracted the attention of regulators and legislators at all levels of government, who are increasingly designing public policy with this industry in mind. Unequal policy treatment between small wind and solar PV persists, particularly at the state level, but small wind is building a strong presence at bargaining tables.

The federal small wind turbine ITC provided not only financial support for consumers and manufacturers, but also a strong positive signal to investors, state governments, and media about the viability of the industry.

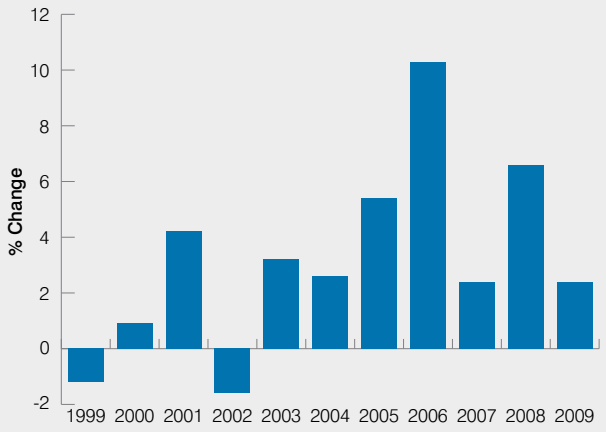
Also at the federal level, the U.S. Department of Energy's highly competitive Advanced Research Projects Agency-Energy (ARPA-E) program recently awarded two of four renewable energy projects to small wind turbine developments.[18] The role of ARPA-E is to invest in high-risk, high-reward technologies and concepts. Industry members do not generally view technological breakthroughs as necessary to achieve their growth goals, but the ARPA-E awards help the industry build upon its credibility and mainstream status.

Seasonality. Small wind turbine sales tend to decline late in the year as energy consumption typically falls, and increase in late spring and summer months as energy consumption and costs rise. Some manufacturers assess this fluctuation at approximately 20%.

Wind-diesel hybrids. Hybrid systems using both wind and diesel generators, usually for remote applications, continue to be an important part of the commercial / light industrial market. In 2009 approximately 20% of turbines 50-100 kW were sold for wind-diesel hybrid systems, nearly all of which were in Alaska. Canada is looking to adopt policies to attract some of this market share. Manufacturers report growth in this application in Caribbean, Pacific, Asian, Russian markets.

Electricity prices. Electricity prices across all sectors have risen by 6% since 2006 to an average of 9.44 cents/kWh.[19] High prices of traditional electricity make alternative energy sources more competitive on an incremental-cost basis, particularly when factoring in renewable energy's other financial and intangible benefits.[20]

Fig. 6: U.S. RESIDENTIAL ELECTRICITY PRICE TRENDS



Source: U.S. Department of Energy, Short-Term Energy Outlook, March 2010

Utility policies. The quantity and quality of state/utility grid-interconnection and net metering laws and practices are generally improving, though slowly. These utility-related policies will have an increasing effect in the industry as the market continues to shift toward grid-tied systems. While balkanized and cumbersome utility regulations rarely thwart installations completely, they often magnify installations' time, expense, and complexity.

Congress is currently considering legislation that would create standardized, nationwide grid interconnection and net metering policies. Streamlined interconnection would create more predictability in the marketplace and net metering would, among other benefits, remove disincentives to consumers wishing to purchase larger turbines.[21]

The National Fire Protection Association will likely create a section in its National Electric Code (NEC) specifically for small wind turbines in its next revision in 2011. The new section will explicitly list requirements for turbine safety, and in turn help streamline grid interconnection processes. Electrical safety has not historically presented a challenge to small wind installations under existing NEC regulations, but proponents of including small wind in the code see it as an investment in the industry's future and a catalyst for growth.

Increased public awareness. A large share of media inquiries at AWEA focus on small wind issues. Feature stories generally involve high-profile installations, consumer success cases, and permitting challenges. This public exposure, which is predominantly consumer-oriented, highlights local policy needs and solutions, generates consumer inquiries, and presents the technology as mainstream.

However, a single failed installation can garner as much public attention as a dozen successful installations. Many industry members report that this effect highlights the importance of careful siting, installation, product development, and testing. Governments and major financial players have invested unprecedented levels of funding and social capital into the small-wind industry, and industry members wish to guard these relationships carefully.

Increasing publicity, public incentives, and competition from falling prices of solar PV technologies place greater pressure, survey respondents say, on small wind turbines to perform well in the field. The new federal investment tax credit is encouraging start-up manufacturers to enter the market at an accelerated rate, and industry members are looking to equipment certification standards to provide a foundation for this market growth.

Workforce development. Community and technical colleges are devoting more resources and curricula to training professionals to site, install, maintain, and market small wind systems. Small-turbine manufacturers traditionally train installers and dealers in-house, but as the industry grows at current and projected rates, manufacturers may require more field-ready professionals to help expand their reach. (*See also "Improved dealer/installer networks," page 13.*)

FERC ruling. In early 2010 the Federal Energy Regulatory Commission (FERC) ruled that wind turbines 1 Megawatt (MW) and smaller, including all small wind turbines, no longer are required to file an application with the FERC in order to obtain classification as a Qualifying Facility (QF). This is expected to ease the process for small wind systems to benefit from applicable state/utility net metering programs (*see "Utility policies," page 14).*

The Public Utility Regulatory Policies Act of 1978 (PURPA) established a class for certain energy generators called "Qualifying Facilities," or QFs, that would receive special rate and regulatory treatments, including the right to sell energy or capacity to a utility, the right to purchase certain services from utilities, and relief from certain regulatory burdens. Before this FERC ruling, to be classified as a QF, a generator-owner was required to apply for this status through a sometimes onerous process and pay a fee. The FERC ruling (in Docket No. RM09-23-000) eliminates this requirement for generators 1 MW and smaller, and QF applications must now only meet technical requirements.

The FERC noted that the filing exemption for facilities 1 MW or less will not weaken its role in overseeing QF program participation. Although facilities 1 MW or less account for approximately 48% of all QF filings, these facilities only represent about 0.5% of the QF capacity certified. A purchasing utility may nevertheless appeal an exemption, but this FERC decision should eliminate many cost and time burdens associated with filing for QF status.

For more information see www.ferc.gov/industries/electric/gen-info/qual-fac.asp.

Federal renewable electricity standard. Legislation may be considered again in 2010 that would create a nation-wide requirement for major utilities to derive a certain percentage of their generation from renewable sources by a certain date. Called a renewable electricity standard, or RES, this type of policy currently exists in more than 28 states and has created a sustained market for renewables in those jurisdictions. Depending on how the policy is structured, an RES may provide an incentive for utilities to encourage small-scale, customer-sited renewables like small wind turbines to be added to the generation mix. For more information on the RES and other legislation, see www.awea.org/legislative.

All major RES bills proposed in the recent past would allow electricity generated by distributed renewable generators, like small wind systems, to be counted as three times as valuable as electricity generated from centralized renewables. This may provide incentives for utilities to own and operate small wind systems, to encourage consumers to generate a surplus of electricity from their own systems, or to buy the environmental attributes of a customer's excess generation in the form of renewable electricity credits, or RECs.

The U.S. House of Representatives passed The American Clean Energy and Security Act (H.R. 2454), a comprehensive energy and climate bill, on June 26, 2009. The bill contains an RES that would require major electric utilities to derive 20% of their generation from renewable sources by 2020, but allow for 8% of the requirement to be met through energy efficiency improvements. The Senate Energy and Natural Resources Committee reported an energy bill, The American Clean Energy Leadership Act, out of committee on June 17, 2009. The bill contains a 15% RES by 2020, and allows for 4% of the standard to be met through energy efficiency improvements. The full Senate may consider consider legislation this year that includes an RES.

Federal climate change legislation. Congress may consider legislation in the foreseeable future that would establish a ceiling, or cap, on carbon dioxide (CO_2) emissions allowed on an economy-wide basis. Renewable energy systems like small wind turbines, which emit no CO_2, could become more cost-competitive under this law.

In order for an entity to emit greenhouse gases within the cap, it would have to acquire pollution allowances, either for free or through auction from the federal government (depending on the structure of the legislation). Entities that receive allowances, but do not need them to offset their emissions because they produce little or no CO_2, would then be allowed to sell their allowances to others that do need them. This system is known as "cap-and-trade."

Depending on whether the legislation is passed, and in what form, distributed renewable energy generation technologies like small wind systems could benefit directly and indirectly. In theory, federal auction proceeds could be used to fund consumer incentive programs, and states and utilities could receive incentives if they adopt policies that support distributed renewables.

AWEA is actively advocating for climate change legislation and working to see that it includes provisions to help small wind. For more information see www.awea.org/legislative.

Costs

Price ranges for small wind turbines – and even for a single model – vary widely due to the numerous factors affecting installation, but costs for a well-sited[22] turbine tend to gravitate between $3 – 6 per Watt, and $0.15 – $0.20 per kilowatt-hour. Costs and cost-recoupment periods can vary due to the following factors, ranked in approximate order of importance:

- Availability and quality of state incentives and state/utility net metering policies
- Average annual wind speed
- Prevailing costs of traditional electricity. Installations tend to be most cost-effective in regions where the cost of utility-provided electricity exceeds $0.10 per kWh.
- Cost of equipment, installation, and maintenance. Estimated operations and maintenance (O&M) costs average $0.01 – $0.05 per kWh. Other calculation methods place O&M costs at roughly 1% of the retail cost of an installation, accrued annually.[23]
- Sales and property tax rates (and incentives)
- Raw manufacturing materials
- Insurance
- Method of financing
- Permitting costs, which can range from $0 to $1,000+ depending on the zoning jurisdiction
- Application type. Installations for businesses may benefit from special tax incentives.

Displaced Carbon Dioxide

A single residential-scale turbine displaces the carbon dioxide (CO_2) produced by 1.5 average cars. The 100 MW of cumulative small-wind installed capacity in the US translates to:[24]

- 17,000 cars removed from the road
- 12,000 equivalent number of homes powered
- 101,000 tons of CO_2 displaced per year

Building-Mounted Turbines

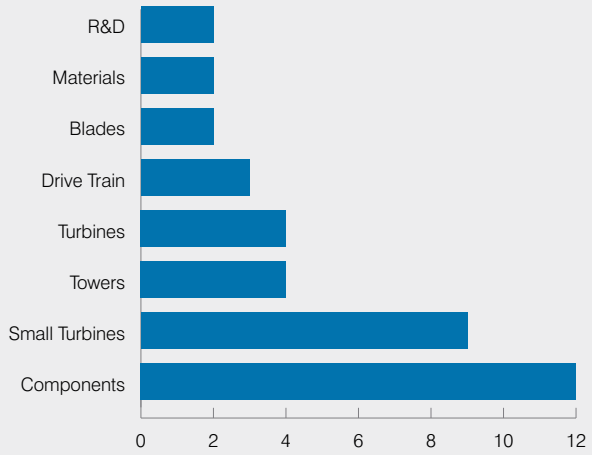
In 2009, 187 units were reported sold for use in urban/rooftop settings in the U.S., representing 400 kW of installed capacity and less than 2% of the U.S. market.

At least 17 companies worldwide manufacture or plan to manufacture building-mounted models, a high proportion of which are of vertical-axis configuration.

Generally, building-mounted installations face challenging performance obstacles due mainly to the turbulent and unpredictable nature of winds around buildings and other structures. Any turbine installed in a location or manner that limits its access to the wind resource will render its performance (i.e., output, measured in kilowatt-hours) below that of a turbine installed in an area where there is a robust, consistent wind resource. A small number of companies are working to address the difficulty of siting building-mounted turbines by using software and other computer models to predict wind resources more accurately in these environments. To date, however, siting and performance challenges have severely limited the size and potential of the market for building-mounted turbines.[25]

Manufacturing

Fig. 7: 2009 NEW OR EXPANDED FACILITIES BY COMPONENT



Nine new small-wind production facilities were opened or expanded in the U.S. in 2009, representing one-quarter of all such facilities in the wind energy industry.

Several small start-up manufacturers narrowed their product lines in recent years while making their products more adaptable to different markets (such as by enabling them to service both on- and off-grid applications). Few leading manufacturers now offer more than three or four different models and instead focus on catering to narrower market niches.

This trend may be a result of the economic recession and a market now occupied by at least 250 different manufacturers vying for market share.

Manufacturer Profile

Approximately 250 companies in the world manufacture, or plan to manufacture, small wind turbines. Of these:

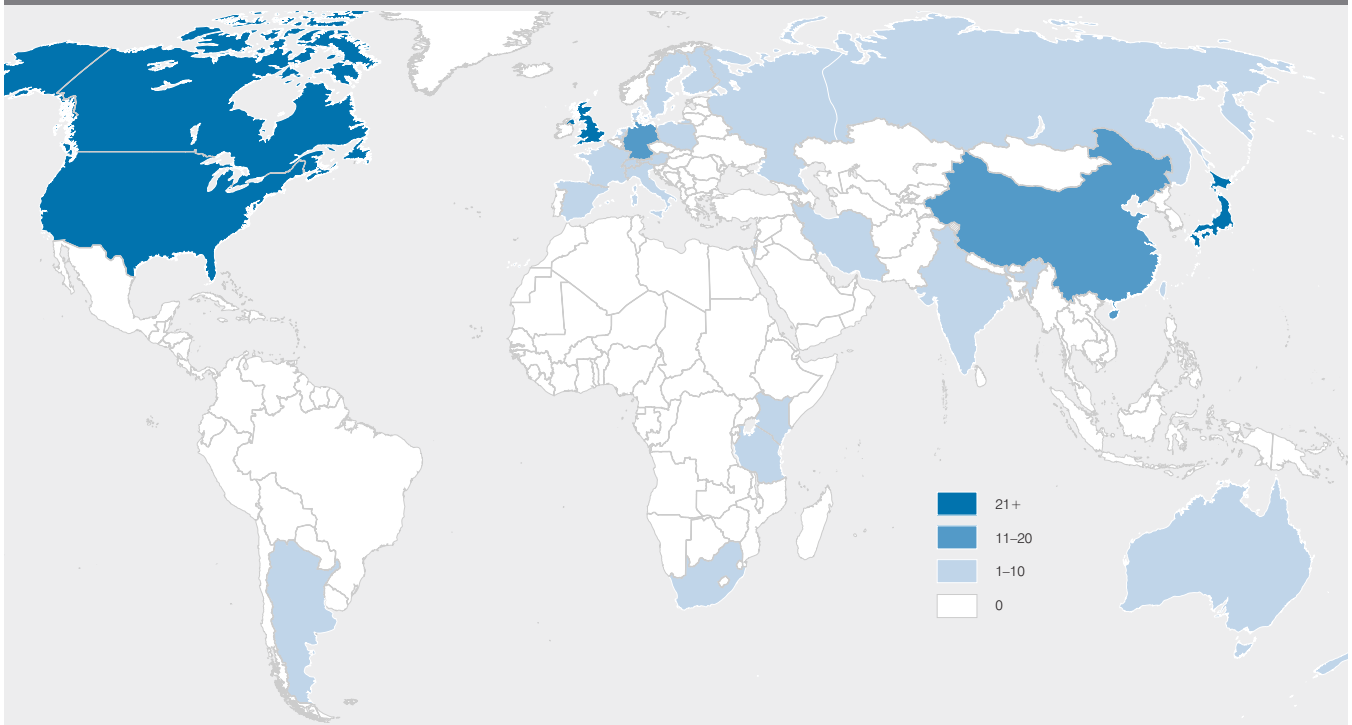
- 95 (36%) are based in the United States
- At least 47 (12 U.S.) have begun to sell commercially
- 99% have fewer than 100 employees

The number of identified manufacturers in the U.S. increased from 66 to 95 last year, and 26 countries are now home to more than 250 manufacturers. The vast majority are in start-up phases and roughly half the world market share is held by fewer than 10 U.S. manufacturers.

Table 4. Five Largest Manufacturers in 2009, in kW Sold

Company	Country	kW Sold Worldwide
Southwest Windpower	U.S. (AZ)	11,700
Northern Power Systems	U.S. (VT)	9,200
Proven Energy	U.K. (Scotland)	3,700
Wind Energy Solutions	Netherlands	3,700
Bergey WindPower Co.	U.S. (OK)	2,100

Fig. 8: GLOBAL DISTRIBUTION OF IDENTIFIED MANUFACTURERS



Global Distribution of Manufacturers

U.S.	(95)	Spain	(5)	Israel	(2)	Iran	(1)
Japan	(29)	Sweden	(5)	Italy	(2)	Kenya	(1)
Canada	(24)	South Africa	(4)	Russia	(2)	Poland	(1)
U.K.	(22)	France	(3)	Argentina	(1)	New Zealand	(1)
China	(19)	India	(3)	Australia	(1)	Switzerland	(1)
Germany	(16)	Taiwan	(3)	Austria	(1)	Tanzania	(1)
Netherlands	(6)	Finland	(2)	Denmark	(1)		

Industry-Wide R&D Priorities

Advanced materials, manufacturing techniques, and design hold some of the keys to achieving higher production volumes and lower costs. Individual manufacturers' research and development (R&D) priorities differ, but as a whole, stakeholders identified the following industry-wide R&D needs:

Efficiency

- **Blades:** Improve efficiencies from approximately 32% to 45%
- **Alternators:** Improve efficiencies from 65-80% to 90-92%
- **Inverters:** Inverters offer less room for improvement, as most are already over 90% efficient. Most are adopted from those used in the solar photovoltaic industry, which has focused heavily on improving inverter efficiencies over past decades.

Design

- Continue to increase swept area[26] to capture more energy while minimizing design loads. This also may include the use of new composite materials and molding processes.
- Reduce the number of components in a system.
- Research reliability issues pertaining to lightning, corrosion, bearing lubrication, alternator winding insulation, and electronics.
- Focus on "design for manufacturing" techniques.
- Reduce the overall use of materials, as measured in pounds per Watt.
- Minimize the use of moving parts.
- Phase out mechanical furling systems.
- Improve turbine performance in low-wind conditions.
- Consider incorporating technology from utility-scale turbines such as gearboxes, mechanical brakes, upwind rotor designs, active yaw control, stall rotor-control, and variable-pitch blades, into commercial / light industrial -scale (21-100 kW) designs.

Other

- Maintain performance standards, certification, and third-party equipment testing sites.
- Adopt advanced tower materials and designs to reduce installation time and cost.
- Develop processes and tools that can more accurately predict a turbine's energy production at a given site.
- Establish robust and well-trained installer / dealer networks.
- Develop advanced tower foundations to decrease installation time and expense.
- Work with the U.S. Department of Energy to develop programs to take new technologies to market and increase public awareness of small wind.
- Develop wireless and Web-based turbine performance monitoring capabilities to minimize the frequency of site inspections.

The development of batteries and other forms of electricity storage is not an industry priority at present. Market momentum is tilted heavily toward grid-tied turbines which essentially use the electricity grid as a means of "storage" and do not incorporate or require batteries.[27]

The Global Market

Fig. 9: U.S. GLOBAL MARKET SHARE (kW)

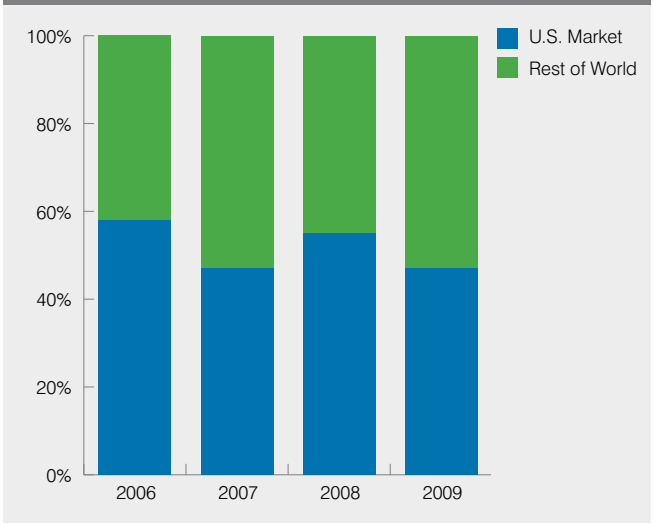
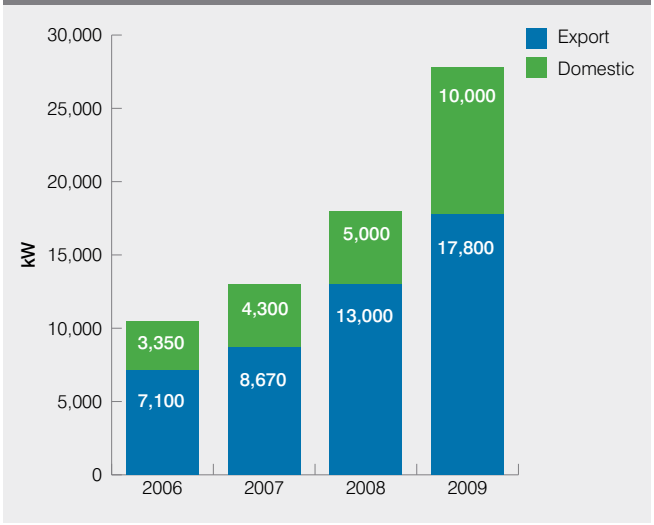


Fig. 10: U.S. MANUFACTURERS' EXPORTS (kW)



The U.S. continues to comprise approximately half the global market, which, according to a 2010 AWEA survey, grew by at least 42.5 MW (10%) and more than 21,000 units in 2009. U.S. manufacturers produced 2/3 of this capacity, maintaining their historically dominant position in the global market.[28]

Exports accounted for approximately 36% of U.S. manufacturers' sales, an increase from 28% in 2008. An overwhelming majority (95%) of units sold in the U.S. in 2009 were produced by U.S. manufacturers, continuing an historical trend.

U.S. state and government policies, particularly incentives, have begun to catch up with those of other major turbine-producing countries. Particularly with an uncapped ITC, the U.S. appears prepared to improve its market share in the global industry. With improved state and federal policies related to permitting, net metering, and grid interconnection, the U.S. could attract not only a larger share of the market, but more domestic jobs from expanding manufacturing facilities. At least two foreign manufacturers intend to create manufacturing facilities in the U.S. due to the market's growth, potential growth, and the federal ITC.

Feed-In Tariffs. A growing global trend to implement feed-in tariffs (FITs), a type of production-based financial incentive for small, on-site renewable generators, has largely been absent from the U.S. policy arena to date.[29] A number of U.S. states[30] have introduced legislation that would create a version of the FIT, but mostly for solar PV technology. In 2009 the state of Vermont became the first U.S. governmental jurisdiction to enact a FIT specifically for small wind systems.

Asia. Very few Asian manufacturers responded to the 2010 and previous AWEA small wind market surveys, and as a result this study can report little about this area of the market. Its potential is believed to be large, particularly in China, Japan, and India, but no quantitative analysis is yet available.

The United Kingdom and Canada. After the U.S., the U.K. and Canada are the largest identified markets for small wind. The Canadian Wind Energy Association and RenewableUK (formerly the British Wind Energy Association) publish annual market reports that include statistical and analytical analyses of their respective and global markets.
See www.smallwindenergy.ca/en/SmallWind.html and www.bwea.com/small/index.html.

In 2009 the Canadian Wind Energy Association hired a full-time Small-Wind Advocate to work to secure federal and provincial incentives for small wind in Canada. Small wind now has dedicated federal representatives in the world's three largest markets (U.S., U.K, and Canada).

Table 5. Feed-In Tariffs

COUNTRIES WITH FEED-IN TARIFFS	
Algeria	Kenya
Australia	Malaysia
Austria	Mongolia
Canada	New Zealand
China	The Netherlands
Czech Republic	Philippines
Great Britain	Portugal
Finland	Serbia
France	Slovenia
Germany	South Africa
Greece	Spain
India	Switzerland
Iran	Taiwan
Israel	Turkey
Ireland	Ukraine
Italy	USA
Japan	

Source: Paul Gipe, www.wind-works.org/articles/feed_laws.html

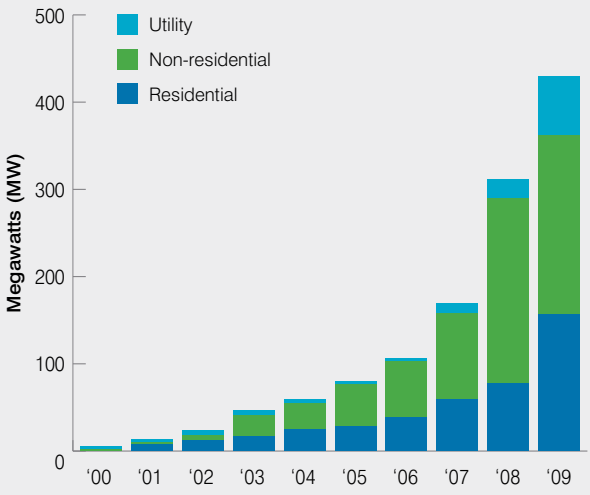
Solar Photovoltaics

The small wind and solar photovoltaics (PV) industries share nearly identical markets. They also benefit from – and are susceptible to – similar public policies at the local, state, and federal levels.

The solar PV industry is significantly larger and more mature than small wind, and consequently can be analyzed more easily in macroeconomic contexts. The small wind industry today, comparatively, is small enough that its growth trends are more a factor of the management, capitalization, and operations of individual companies rather than of macro-economic fluctuations in commodities prices, labor supply, etc.

This difference offers small wind industry members to "look ahead" in their own markets to some degree by analyzing the solar industry today. To help achieve this goal, below is an overview of the solar PV market status and its trends.

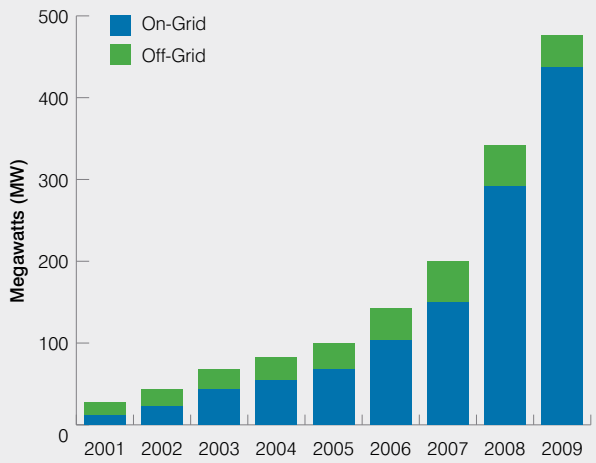
Fig.11: GRID-TIED PV CAPACITY ADDITIONS (U.S.)



Source: SEIA, IREC

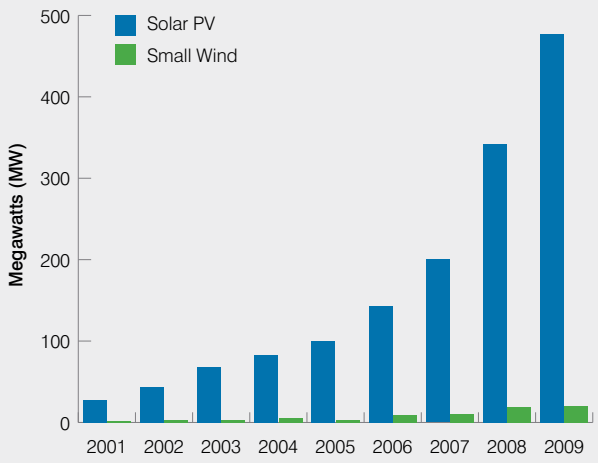
Growth. The solar PV industry grew 38% and installed 429 MW of grid-tied capacity in the U.S. in 2009, of which 156 MW was installed for residential uses and 207 MW for commercial applications. Included in this total growth is the share installed by utilities, which is a market segment newly enabled by changes to the federal ITC.[31]

Fig. 12: U.S. SOLAR PV GROWTH



Source: SEIA, IREC

Fig. 13: NEW SMALL WIND VS. NEW SOLAR PV (U.S.)



PV data source: Larry Sherwood; SEIA

In 2009 new small wind capacity was comparable to that of the solar PV industry in 2000.

The Solar Energy Industries Association predicts a 100% growth in the PV market in 2010.[32] However, with a record amount of oversupply, limited credit markets, and the exhaustion of the generous Spanish feed-in tariff incentive in 2009, some analysts expect a global decrease in sales volume of 30% or more.[33]

Policies. A 30% federal ITC is available to consumers of residential and commercial PV systems through December 31, 2016, as is now available for small wind. The solar version of the credit, however, for the first time allows utilities to take advantage of the credit. This provision therefore opens the PV market to utilities, which contributed 66 MW (15%) of the industry's growth in 2009. Solar systems accounted for 13% of all new utility announcements and filings last year, up from 6% in 2008.[34]

The solar, small-wind, and large-scale wind industries are looking for enactment or expansion of similar federal policies, including, among other items, a strong federal renewable electricity standard, a price on carbon dioxide, an extension of the Section 1603 Treasury grant program that provides grants to commercial consumers in lieu of an ITC, and an extension of an ITC available specifically to help equipment manufacturers expand operations.

General trends. Amidst its growth, the global solar industry experienced a significant shakeout last year. Global demand reached record levels in 2008 and caused equipment providers to place large supply backorders and expand facilities rapidly to accommodate consumer interest. Then, in 2009, global demand for solar slowed, largely due to the economic recession and an exhaustion of Spain's generous feed-in tariff incentive. This dive in demand left a major supply surplus in the market and an overcapacity in production facilities. Prices fell accordingly, but many manufacturers were unable to lower their costs at the same pace and remain

profitable. Companies' stock prices fell, which helped enable a surge in mergers and acquisitions. Particularly susceptible to acquisition were new manufacturers and those insufficiently specialized or invested in solar production. As a result, as in the small-wind industry, PV growth in 2009 came primarily from well-established manufacturers.[35]

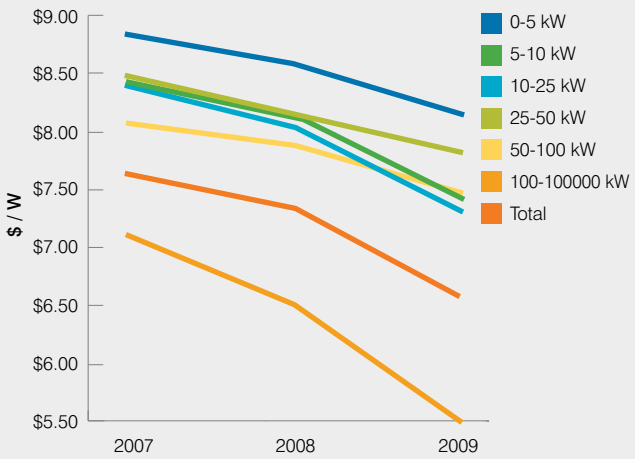
While recent supply surges have hurt the solar industry, higher production volumes – enabled by the ITC and external investment in manufacturing – have helped small wind suppliers lower prices and meet demand.

Other trends emerging in the solar PV sector include a rise in Power Purchase Agreements (PPAs)[36] as a project finance mechanism, and more vertically integrated approaches to production and distribution.[37]

Costs and design. Small wind systems generally have a greater potential for cost reductions than PV equipment, but rooftop PV installations have become more streamlined over past years – what was once a 20-30 hour task now requires an average of only 5-6 hours.[38] Falling PV costs are also pressuring small wind turbines to perform more competitively on the bases of installed cost and price per kilowatt-hour generated.

In 2008, PV manufacturers generally focused on reducing costs, as the technology had become largely commoditized. Today, many manufacturers are looking for new ways to differentiate their technologies or company brands. Small wind systems have not yet reached a stage of commoditization, though 99% of all small wind turbines sold in 2009 – and throughout the industry's history – have been of a single general configuration (horizontal axis, mounted on a tower). Sales and market share data strongly indicate the prevalence of a dominant design, perhaps ready to

Fig. 14: AVERAGE PV INSTALLED COST



Source: SEIA, IREC

worldwide produce (or plan to produce) an estimated 600 different models, some incorporating vastly different technological approaches.

Demand. Demand drivers for solar PV equipment are similar to those for small wind turbines (*see "Demand drivers," page 6*), as are market obstacles (*see "Market Factors and Developments," page 9*). Both industries face challenges in educating potential consumers and combating false information. The 2009 guide, "Smart Solar Marketing Strategies," published by Clean Energy Group and SmartPower, is one resource that identifies solar marketing tactics that may also be applied to small wind technologies.[39]

Conclusion and Outlook

Overall, the industry appears to be heading for sustained growth; the question is at what rate. If trends in investment and policy support continue, the U.S. may very well reach the industry's projection of installing more than 1 GW of cumulative capacity by 2015.

The small wind industry is expanding quickly but remains sufficiently small so that the success of any given company is more dependent on its products, managers, and capitalization than on global or national trends. For example, during the economic recession, manufacturers serving identical markets reported widely varying outcomes: growth, plateaus, or even bankruptcies. The recession has caused some companies to reconsider which markets to pursue and, at least until the economy recovers, to target specific niches rather than attempt broader marketing approaches.

U.S. market share is still concentrated in the hands of fewer than 10 of 95 identified U.S. manufacturers, but that may change as competition grows more mature, widespread, and intense. A general maturation of the industry, characterized by increases in private external investment, state and federal incentives, mergers and acquisitions, certification, and a host of other factors, will likely continue to change the dynamic of the market and the industry over the next 5 to 10 years.

Methodology and Reporting Manufacturers

All sales data reported in this study were obtained directly from manufacturers through telephone interviews, e-mail contact, or both. Responses were compared to previous years' sales as reported in 2007, 2008, and 2009 surveys. For purposes of estimating installed capacity, this study assumes that each turbine sold was also installed, and that the installation occurred within the same calendar year as the sale. However, depending on the manufacturer's sales cycle, a turbine's installation may occur after the calendar year in which it is sold.

Sales in dollar amounts are based on average turnkey installed system cost, which includes equipment, wiring, and installation. The purpose of this calculation method is to reflect the economic impact of the industry more completely than by considering only the cost of the turbine and tower, uninstalled. The cost for a given installation can vary considerably given any number of factors (*see "Costs," page 17*).

This study makes no extrapolations or assumptions on sales by manufacturers who did not report. Sales figures in this report therefore reflect a *minimum* amount.

All 253 identified world small wind turbine manufacturers were solicited for the 2009 AWEA small wind manufacturing survey. Of these, 40 responded and 30 had commenced production and sold at least one unit commercially by the end of 2009. Many, if not most, of these manufacturers are in start-up phases.

Fig. 15: IDENTIFIED MANUFACTURERS

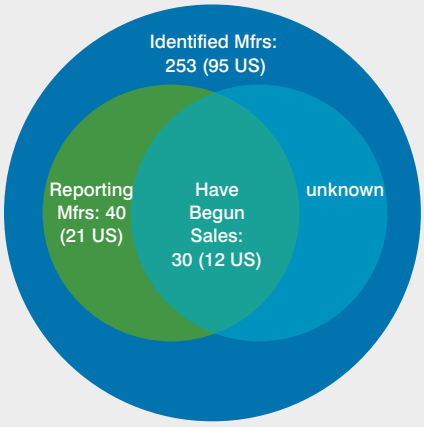


Table 6. Respondents to the 2009 AWEA Small-Wind Manufacturer Survey

Manufacturer	Primary Location
Abundant Renewable Energy	U.S. – OR
AeroVironment	U.S. – CA
AllEarth Renewables	U.S. – VT
Bergey WindPower	U.S. – OK
California Wind Systems	U.S. – CA
Dynastrosi Laboratories	U.S. – KY
DyoCore	U.S. – CA
Endurance Wind Power, Inc.	U.S. – UT
Everfair Enterprises	U.S. – FL
Helix Wind	U.S. – CA
Highest Wind, LLC	U.S. – NH
Northern Power Systems	U.S. – VT
Southwest Windpower	U.S. – AZ
TechnoSpin	U.S. – NY / Israel
Urban Green Energy	U.S. – NY
Ventera	U.S. – MN
Viryd Technologies, Inc.	U.S. – CA
Wind Eagle Corp	U.S. – TX
Wind Electric Company	U.S. – CA
Wind Turbine Industries Corp.	U.S. – MN

Manufacturer	Primary Location
Wind-Sail	U.S. – CA
Windation Energy Systems	U.S. – CA
Eoltec	France
Evance	U.K.
Gaia-Wind	U.K. – Scotland
Gazelle Wind Turbines	U.K.
Proven Energy	U.K.
Ampair	U.K.
FuturEnergy	U.K.
Windeco	Spain
MaManna	Canada
CleanField Energy	Canada
Entegrity Wind Systems	Canada
REDriven, Inc.	Canada
Raum Energy	Canada
Wind Simplicity	Canada
Fortis	Netherlands
Wind Energy Solutions	Canada/Netherlands
Unitron	India
WinPower	China

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Endnotes

1 (Installed/Rated/Nameplate) Capacity: Typically measured in Watts or kilowatts (1,000 Watts), "capacity" is a term commonly used to compare sizes of electricity generators of various types, including wind turbines. Capacity is generally calculated, or estimated, by measuring the rate of a turbine's electricity production, in Watts, at a given wind speed. Capacity does not indicate the amount of electricity a turbine produces over time (measured in kilowatt-hours, or kWh), but is sometimes used loosely to approximate a turbine's potential production. For more information on small wind turbine technology, see http://www.awea.org/smallwind/.

2 See "Methodology," page 26

3 An estimated 75% of these units are 10 kW or smaller. The total number of units currently installed in the U.S. is likely fewer than 100,000 due to an undetermined number of decommissioned turbines. From 2006-2009 the percentage of units 10 kW and smaller has increased to 99% of all units sold, indicating that most growth is occurring in the residential market.

4 See, "Installer and equipment certification," page 9

5 See also: Michael Vickerman, "Solar: Payback Analysis and Internal Rate of Return." Energy Bulletin. March 20, 2007. http://www.energybulletin.net/node/27490 or http://news-views.renewwisconsin.org/node/19326?q=node%2F19326.

6 This estimated growth is arrived at by surveying the world's leading 15 manufacturers and aggregating each of these companies' self-predicted annual sales for each of the next five years. No analysis or further speculation has been contributed to this figure.

7 See page 6 of the 2009 AWEA Small Wind Turbine Global Market Study at www.awea.org/smallwind/pdf/09_AWEA_Small_Wind_Global_Market_Study.pdf

8 For more information on permitting, see "In the Public Interest: How and Why to Permit for Small Wind Systems." AWEA, 2008. www.awea.org/smallwind/pdf/inthepublicinterest.pdf.

9 For a complete and current listing of incentives and policies affecting small wind and other renewables, see the Database for State Incentives for Renewables and Efficiency, administered by the North Carolina Solar Center, at http://dsireusa.org.

10 The ARRA offered a number of other incentives for both consumers and producers of small wind systems. For details see www.awea.org/legislative/pdf/AWEA_Summary_ARRA_Provisions_of_Interest_to_Small_Wind.pdf. See also the Database for State Incentives for Renewables and Efficiency Web site at http://dsireusa.org.

11 See www.smallwindcertification.org

12 See www.energystar.gov

13 See www.nabcep.org/certification/future-certifications/small-wind

14 CleanTech Group http://cleantech.com/about/pressreleases/20090106.cfm and PricewaterhouseCoopers/National Venture Capital Association MoneyTree™ Report. Data from Thomson Reuters, "Total U.S. Investments by Year Q1 1995 - Q4 2009" www.nvca.org/index.php?option=com_docman&task=doc_download&gid=543.

15 Jim Green and Mick Sagrillo, "Zoning for Distributed Wind Power: Breaking Down Barriers." National Renewable Energy Laboratory conference paper NREL/CP-50038167, www.nrel.gov/docs/fy05osti/38167.pdf.

16 See http://apps1.eere.energy.gov/news/daily.cfm/hp_news_id=166 and Topic Area 2C of https://e-center.doe.gov/iips/faopor.nsf/UNID/C53C9A2E58F1258485257530000661 91/$file/FINAL_FOA_PMC113_1-FOA-Grants_Gov_with_M005.pdf.

17 Many factors contribute to demand other than cost recovery. See "Demand drivers" on page 6.

18 The ARPA-E is modeled after the Defense Advanced Research Projects Agency (DARPA), the agency responsible for technological innovations such as the Internet and stealth aircraft technology. The goal of ARPA-E is to fund projects that will develop transformational technologies that reduce America's dependence on foreign energy imports, reduce U.S. energy related emissions (including greenhouse gasses), improve energy efficiency across the economy, and ensure that the U.S. maintains its leadership in developing and deploying advanced energy technologies. See a list of funded projects at http://arpa-e.energy.gov/FundedProjects.aspx.

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20 Other benefits include: a fixed cost of electricity for the 20+ year life of the turbine, reduced peak electricity demand, security against fuel price increases and volatility, reduced pressure on the electricity grid, increased in-state generation, greater market competition from increased consumer choice, and improved local small-business economies.

21 For more information in net metering and interconnection, see the "Freeing the Grid" publications by the Network for New Energy Choices at www.newenergychoices.org.

22 Generally, turbines installed at a site with access to average wind speeds of at least 12 mph at hub height.

23 See: Sagrillo, Mick, "Wind System Operation and Maintenance Costs." Factsheet from AWEA Windletter, December 2002 http://renewwisconsin.org/wind/Toolbox-homeowners/Operation%20and%20maintenance%20costs.pdf.

24 A well-sited 10 kW turbine generates about 1,090 kWh/month in 12 mph average winds. In the turbine's expected lifetime of 20 years it can displace approximately 340,000 lbs. of CO_2. Each kilowatt-hour (kWh) of electricity produced in the U.S. results in 1.55 lbs. of CO_2 emitted into the atmosphere, on average, reflecting the current US electricity production mix. Source: U.S. Department of Energy. The U.S. Environmental Protection Agency estimated in 2000 that the average passenger car emits 11,450 lbs. of CO_2 per year. Average annual home energy use in the U.S. is 10,565 kWh.

25 See the Bibliography for more information on urban/rooftop installations. RenewableUK (formerly the British Wind Energy Association) also tracks the number of building-mounted small wind systems installed in the United Kingdom in its annual small wind systems market report. See www.bwea.com/small/index.html.

26 "Swept area" is the surface area of a turbine rotor, $A = \pi \cdot r^2$, where r is the radius of the rotor (i.e., the length of one blade).

27 For more information about grid interconnection, see www.awea.org/smallwind/toolbox2/grid_connecting.html.

28 This estimation of the U.S. global market share may be somewhat inflated because only 19 of 158 identified foreign manufacturers responded to the AWEA market survey. However, these 19 manufacturers are believed to represent the bulk of the foreign market. Confidence in market share trends over the past three years is relatively high because generally the same manufacturers respond to the AWEA survey. See also, "Methodology," page 26.

29 A FIT for small, distributed generation is an incentive policy that works similarly to the reverse of a Renewable Electricity Standard in that it establishes a set price at which a utility purchases electricity from a renewable generator, such as a small wind system, and allows market forces to adjust the amount of energy produced (supply) and demand accordingly. Unlike up-front rebates and tax credits, this policy is based on output (cents/kWh) rather than turbine size (kW), and therefore rewards performance. Unlike net metering, all electricity generated – not just the excess – is sent into the grid and awarded payment from the utility at a price above regular retail electricity rates.

30 See www.wind-works.org/FeedLaws/USA/USAList.html#USA

31 "U.S Solar Industry Year in Review 2009," Solar Energy Industries Association. April 15, 2010. http://seia.org/galleries/default-file/2009%20Solar%20Industry%20Year%20in%20Review.pdf.

32 Rhone Resch, SEIA President, in an interview with E&E TV. www.eenews.net/tv/video_guide/1150. Posted on April 15, 2010.

33 Paula Mints, "The PV Industry 2009: In Search of Stability and Sustainability" http://www.renewableenergyworld.com/rea/news/article/2009/08/the-pv-industry-2009-in-search-of-stability-and-sustainability1?cmpid=WNL-Wednesday-September2-2009. Navigant Consulting, August 31, 2009.

34 Elisa Wood, "US Solar Spins a 360." Edison Electric Institute and RenewableEnergyWorld.com, www.renewableenergyworld.com/rea/news/article/2009/12/us-solar-spins-a-360. December 8, 2009.

35 Nathanial Gronewold, "Brighter Days Seen for Solar, Next-Gen Biofuels." E&E, June 9, 2009. Nathanial Gronewold, "World Solar Industry Appears Headed for a Shakeout." E&E, August 12, 2009. Jennifer Kho, "How PV Manufacturers Are Driving Down Costs." E&E, July 31, 2009.

36 A PPA is contract between a consumer and a company that owns and operates an energy generator. The PPA establishes a price and time period for which the generator owner/operator will sell electricity to the consumer. This arrangement provides the consumer a predictable, assured electricity price over an extended period of time; freedom from risks and responsibilities associated with equipment ownership; and the ability to use renewable energy without a large up-front capital investment. The PPA provides the generator owner/operator predictable cash flow on their investment and certain tax advantages.

37 Jim Montgomery, "Five Predictions for PV Solar." Photovoltaics World, January 12, 2010.

38 Elisa Wood, "US Solar Spins a 360." http://www.renewableenergyworld.com/rea/news/article/2009/12/us-solar-spins-a-360, December 8, 2009.

39 "Smart Solar Marketing Strategies," Clean Energy Group and SmartPower. www.cleanegroup.org/Reports/CEG_Solar_Marketing_Report_August2009.pdf

Ron Stimmel | Manager, Legislative Affairs and Small Systems

1501 M St. NW, Suite 1000 | Washington, DC 20005 | Ph: 202.383.2546 | rstimmel@awea.org | www.awea.org/smallwind