

**Hawaii Renewable Energy Development Venture  
Technology Assessment  
Small Wind Turbines<sup>1</sup>**

**1. Overview**

Small wind turbines are defined as those with a capacity of 100 kW and under. Overall, the US market grew 78% in 2008. The largest segment of the market is residential (1-10kW) and is driven by investment and economies of scale but also by rising residential electricity prices and a heightened public awareness of the technology and its attributes. The commercial segment of the market is in the 21-100kW power range. The industry projects a 30X growth within as little as five years, despite the global recession, for a cumulative US installed capacity of 1,700MW by the end of 2013. Much of this growth will be spurred by the new eight-year 30% federal ITC passed in 2008 and augmented in Feb 2009. The market has become dominated by grid-connected units and will continue this trend as these larger systems become more affordable. The US commands 50% of the global market share with 33% of the 219 identified worldwide manufacturers.

2008 U.S. Sales	2008 Global Sales
17.3 MW	38.7 MW
78% growth over 2007	53% growth over 2007
10,500 units	19,000 units
\$77 million in sales	\$156 million in sales
80 MW cumulative installed capacity	
1,700 cumulative installed capacity by 2013	

**2. Status of Commercial Readiness**

Both small wind and solar now enjoy long-term, uncapped 30% tax credit for BOTH commercial and residential applications. Residential was formerly capped at \$2,000. With these new tax incentives in the US, this technology is essentially commercial – particularly in Hawaii with its higher energy costs. Small wind is in a race with solar PV toward “grid parity” – price per kWh on par with conventional forms of electricity – and now both industries enjoy nearly identical federal incentives for a more level playing field.

Better manufacturer capitalization has led to an increase in production volumes, sales forces, and technical support. The leading external market factors include rising and volatile prices of conventional electricity, state incentives, consumer education, and increased public concern for environmental issues. However, commercial-sector companies have

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<sup>1</sup> This report was extracted from a report on small wind prepared by the American Wind Energy Association entitled “AWEA Small Wind Turbine Global Market Study Year Ending 2009”. The full report is available at [www.awea.org](http://www.awea.org).

found difficulty securing financing for the typically more expensive turbines in this market and have found Power Purchase Agreements (PPAs) to be a more attractive financing method. PPAs will likely become more popular in 2009 as the expanded incentive takes effect and credit remains restricted throughout the economy. The industry predicts that the federal ITC will continue to help increase production and decrease consumer costs. Even in the recession, economies of scale are beginning to take shape in the industry and growth projections are the strongest in the industry's 80-year history.

### **Costs**

Small wind systems are ~90% steel and incorporate a significant amount of copper in their generators and wiring and are thus susceptible to fluctuating commodity prices. Prices for small wind continue to be widely scattered due to the numerous factors affecting installation costs but tend to gravitate between \$3-6/Watt. Small wind turbine installations are far more construction-intensive than solar PV, which after its manufacture is largely an electrical project. Expanding the federal ITC to small wind will likely allow economies of scale and put downward pressure on installed small turbine costs.

### **3. Appropriateness for Hawaii**

Hawaii would have a stronger share if it were not for its unusually cumbersome permitting processes that have severely limited small wind market share.

- Zoning/Permitting
  - Poor or absent permitting practices thwart an estimated 33% of all potential wind turbine installations
  - Restrictive regulations, particularly height limitations, can limit a turbine's productivity, discourage customers and investment, and repel local industry-related businesses from communities.
- The Economic Recession
  - Historically small-wind has been considerably more cost-competitive than solar PV on a cost per kWh basis but a surge in solar investment, a head-start on federal incentives, and falling production costs will likely result in PV costs at levels more competitive with small wind. Sharp drops in commodity prices in late 2008 and early 2009 have helped lower the costs of PV cells.
  - Potential consumers will have greater difficulty securing affordable home improvement loans.
- Rising Electricity Costs
  - Higher prevailing rates for residential, industrial, and commercial electricity makes small wind power more competitive with conventional electricity.

- Intangible benefits such as providing a consistent and predictable supply and cost of electricity for 20 – 30 years could add to its overall value to consumers.
- Utility Policies
  - Recent legislation in Hawaii has seen an upward trend in the quantity and quality of the state's utility net metering laws and practices.
  - Grid connection rules and procedures have an effect as the market shifts towards grid-connected systems.
  - The NFPA will create a section in its NEC specifically for small wind turbines in its next revision in 2011. It will explicitly list electrical safety requirements for small wind turbines 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 for the advancement cite a need to establish small wind in the code.
- Installer and Equipment Certification
  - Programs are nearing completion to certify small wind equipment and those who install them by the Small Wind Certification Council (SWCC) and the North American Board of Certified Practitioners (NABCEP).
  - Both programs are voluntary but market forces are likely to institutionalize them throughout the industry.
  - Some states have indicated that they plan to make certification a requirement to interconnect to the electricity grid, obtain a zoning permit, and/or receive public funds.
- Increased public Awareness
  - Public exposure which has been predominantly positive helps to highlight local policy needs and solutions, generate consumer inquiries and present the technology as mainstream

#### **4. Considerations related to specific technologies and/or resources**

The US DOE held 2 workshops for stakeholders in 2008 including the small wind turbine sector. Stakeholders identified the following manufacturing needs from an R&D perspective with an overarching focus of lowering a turbine's cost of energy:

- Efficiency
  - Blades: Improve efficiencies from ~32% to 42-45%;
  - Alternators: Improve efficiencies from 65-80% to 90-92%;
  - Inverters: Inverters offer less room for improvement as most are over 90%. Most inverters used in small wind turbines are adopted from those used in the solar PV industry that has

focused heavily on improving inverter efficiencies over past decades.

- Design
  - Continue to increase the swept areas to capture more energy while minimizing design loads. This 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 in terms of pounds per watt;
  - Minimize the use of moving parts and mechanical furling systems;
  - Improve turbine performance in low-wind conditions;
  - Consider incorporating more 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-scale (21-100kW) designs.
- Other
  - Adopt advanced tower material 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;
  - Develop wireless and web-based turbine performance monitoring capabilities to minimize the frequency of site inspections;
  - Continue to develop and support performance standards, certification, and third-party equipment testing sites.

The development of batteries and other forms of electricity storage were determined not to be an industry priority or focus. Market momentum is tilted heavily toward grid-tied turbines that essentially use the electricity grid as a means of “storage” and do not incorporate batteries.