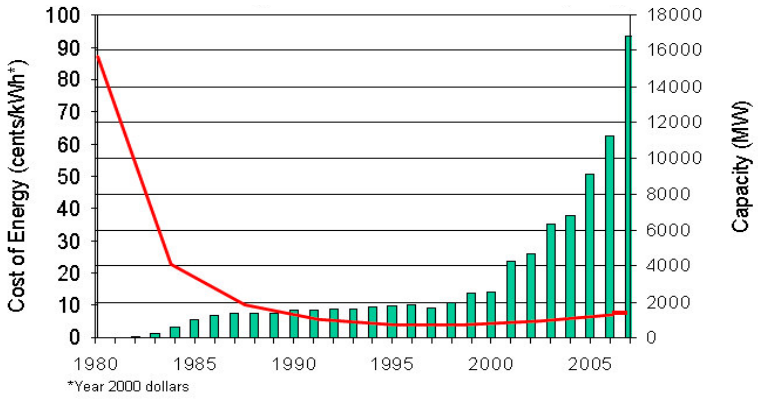
DOE Wind Energy R&D is Linked to Innovations Within and Outside Wind Power Industry, Study Finds

- Unprecedented growth in the wind power industry signals the emergence of wind as an important contributor to the U.S. power mix.
- Research and Technology Development (R&D) funded by DOE's Wind Energy Program is extensively linked to commercial applications of wind energy for power generation.
- More patents assigned to leading wind energy companies are linked to earlier DOE-funded patents than to any other organization.
- DOE initiative has produced more than 100 partnerships with industry, and led to multiple successfully commercialized, produced, and installed wind energy innovations.
- Leading domestic manufacturers of wind turbines—including GE Wind Energy, Clipper Windpower, and Southwest Windpower—attribute key innovations to partnerships with DOE.
- Leading global producers, including Vestas Wind and Mitsubishi, have a large number of patents linked to DOE-funded patents.
- The impact of DOE's wind R&D extends to industries outside wind energy, among them automotive and aerospace.

Advances in today's commercial wind energy generation are extensively linked to the Department of Energy's (DOE) three decades of investments in wind energy research, according to an independent evaluation study.

Prior to DOE's Wind Energy Program, wind technology performed poorly, cost exceeded 80 cents/kWh, markets were practically non-existent, and scientific and technical knowledge for improvements was largely missing. Now the technology is substantially advanced, the cost of energy produced by wind is below 10 cents/kWh, the knowledge base is extensive, and installed capacity has risen steeply (Figure 1).

Figure 1. Cost of energy and cumulative domestic capacity



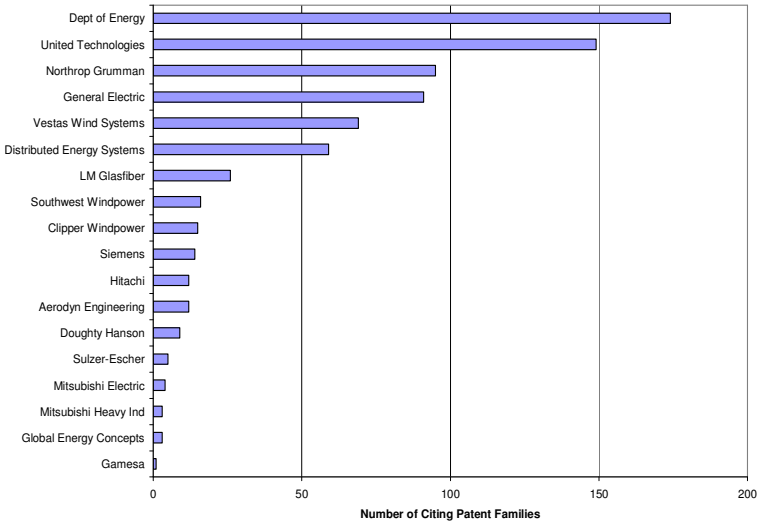
Source: DOE/NREL, January 2009.

The new study found that DOE has played an instrumental role in establishing highly influential intellectual property in the wind energy technology sector. This includes funding R&D for variable speed wind turbines, airfoils for blades, retractable rotor blades, doubly fed generator variable speed generation control systems, rotor control systems, and active pitch controls.

DOE-funded patents lead the way in patents assigned to leading wind energy companies

DOE leads among organizations whose patents are cited most frequently by leading organizations in the wind energy industry (Figure 2). The study identified 112 wind energy patents funded by DOE. Of 695 patents assigned to leading wind energy organizations, 25 percent cite one or more of the 112 DOE-funded patents or papers -- a higher percentage than for any other organization.

Figure 2. Organizations whose patents are cited by the largest number of wind energy patent families owned by leading organizations in wind energy.



Leading wind energy companies (e.g., GE Wind Energy, Clipper Windpower, Distributed Wind Energy, Southwest Windpower and Vestas Wind) own patents with strong linkages back to DOE-funded patents and papers. Additionally, leading wind turbines and system components in today's market, such as GE Wind Energy's 1.5 MW wind turbine, Clipper Windpower's Liberty turbine, Southwest Windpower's Skystream turbine, Knight and Carver's STAR (Sweep Twist Adaptive Rotor) wind turbine blades, and TPI Composites blade fabrication techniques are all traceable to DOE-funded research.

The impact of DOE's wind energy R&D extends well beyond the wind energy industry

The study found evidence of DOE-supported wind energy patents that are linked to application areas outside wind power generation, including hybrid vehicles, power converter systems, hydrogen production from hydropower, electric motors and generators, pulp and paper process machinery, and fuel cells. Some companies outside the wind energy industry whose patents are tied to DOE-funded wind energy patents and papers include:

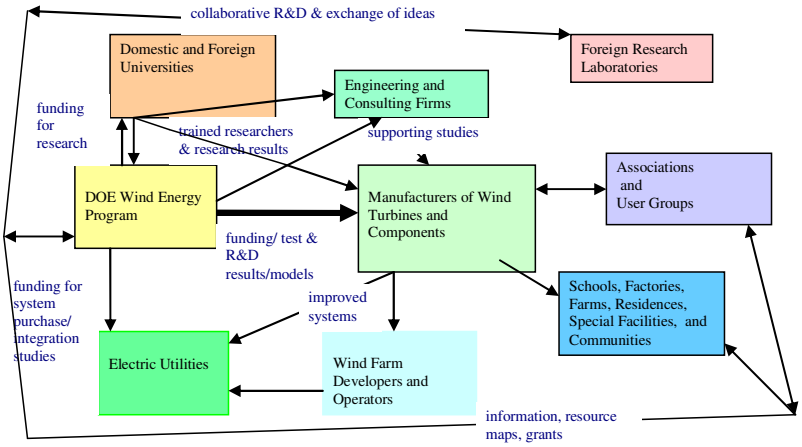
- Asea Brown Boveri, ABB (engineering and power management);
- Hamilton Sundstrand and Honeywell (aerospace);
- Ford, Denso and Honda (automotive);
- Microsoft (software);
- Sprint Nextel (telecommunications);
- Caterpillar (construction and mining equipment).

DOE's strategic partnerships with industry and others are key elements in its success

A significant element in DOE's influence and contribution made to the wind energy industry has come from the rich network of relationships it has established with other organizations over the period from the 1970's to 2008 (Figure 3). These organizations include:

- Manufacturers of wind turbines and components;
- Developers and operators of wind farms;
- Electric utilities;
- Engineering and consulting companies;
- Universities, domestic and foreign research laboratories;
- Associations and user groups;
- Marketers and users of wind energy systems.

Figure 3. Network of relationships between DOE Wind Energy Program and key partners in domestic/foreign industry, academia, and other interests



DOE's Wind Energy Program has entered into over 100 partnerships with more than 65 companies since its inception to advance wind energy technology. The partnerships have included leading companies in the commercialization of wind turbines, such as GE Wind Energy and Clipper Windpower (utility scale), and Southwest Windpower and Bergey Windpower (distributed-use providers).

The historical tracing and patent/paper citation analysis used in this study documents the knowledge creation and dissemination for more than three decades of the DOE's Wind Energy Program's R&D investments. The study found substantial and compelling evidence connecting outputs of the Program to commercial applications of wind power generation, as well as to applications outside the wind energy industry.

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Source: Ruegg Rosalie and Patrick Thomas (2009). *Linkages from DOE's Wind Energy Program to Commercial Renewable Power Generation.* U.S. Department of Energy, Washington, DC.
http://www.eere.energy.gov/ba/pba/pdfs/wind_energy_r_and_d_linkages.pdf

For more information, contact:
Jeff Dowd, PBA Program Evaluation Lead, Office of Planning, Budget, and Analysis (PBA)
Megan McCluer, Program Manager, Wind & Hydropower Technologies Program