GE
Energy

The Case for Wind

GE Energy's Perspective

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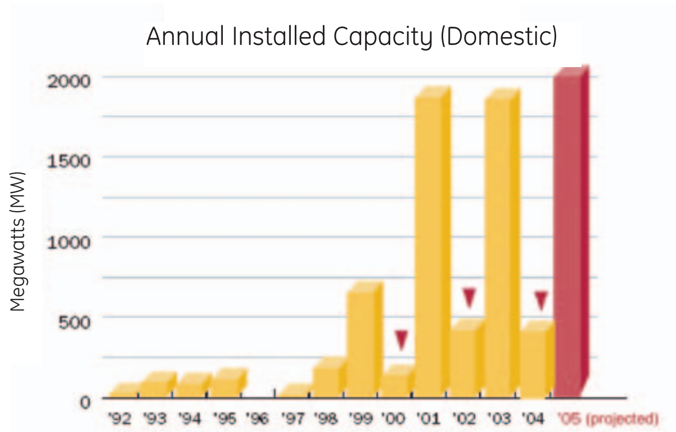
imagination at work

Introduction

Wind energy can become a significant player in the US energy portfolio. At GE Energy we see a future where 20% of the nation's energy can be cost-effectively derived from wind. Today's wind technology has the potential to achieve 5 to 10% penetration levels; however, envisioned technology advances and maturation may enable more.

Wind is an energy source, not a power source, and should be viewed as displacing fossil fuel consumption, thereby reducing overall US dependence on imports, primarily natural gas. As wind displaces fossil fuel plants, these plants end up moving more into a reserve capacity, but do not disappear.



Market

GE Energy's main wind turbine manufacturer competitors are Vestas, Enercon, Gamesa, Suzlon, and Siemens: these are all overseas competitors. Vestas continues to lead the world market share today with ~ 30% in 2005 compared with GE Energy's ~ 18%.

In 2005, GE Energy captured ~ 61% of the US market compared to ~ 28% for Vestas. While there are some state driven subsidies for renewables, it is certain that the Production Tax Credit (PTC) is driving the high demand for wind turbines in the US.

GE Energy had over $2 billion in revenue in 2005, and delivered over 1300 wind turbines: The US installation volume was limited by manufacturing capacity. In particular, gearboxes, castings and blades were supplier pinch points, preventing further growth. A constrained supplier base caused by a lack of long-term commitment to incentives also drove commodity prices higher, placing pressure on industry profit margins in a low margin business.

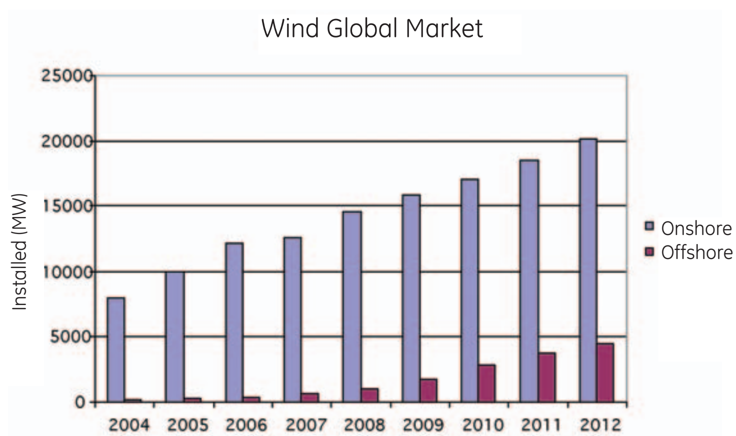
World Market

	Installed MW 2003	Share 2003 %	Installed MW 2004	Share 2004 %	Installed MW 2005	Share 2005 %
VESTAS (DK)	1,812	25.1%	2,783	33.4%	3,186	27.9%
GE WIND (US)	1,503	20.8%	918	11.0%	2,025	17.7%
ENERCON (GE)	1,218	16.9%	1,288	15.4%	1,505	13.2%
GAMESA (ES)	956	13.2%	1,474	17.7%	1,474	12.9%
SUZLON (Ind)	178	2.5%	322	3.9%	700	6.1%
SIEMENS (DK)	552	7.6%	507	6.1%	629	5.5%
REPOWER (GE)	291	4.0%	276	3.3%	353	3.1%
NORDEX (GE)	242	3.3%	186	2.2%	298	2.6%
ECOTÉCNIA (ES)	48	0.7%	214	2.6%	239	2.1%
MITSUBISHI (JP)	218	3.0%	214	2.6%	233	2.0%
NEG MICON (DK)	855	11.8%	na	na	na	na
Others	215	3.0%	334	4.0%	567	5.0%
Total	8,088	112%	8,513	102%	11,207	98%

Source: BTM Consult ApS - March 2006

Table reference to GE is Germany.

In the years that the PTC expired (1999, 2001, 2003), the installed capacity dramatically decreased the following year (2000, 2002, 2004). Demand recovered when the PTC was renewed. Internationally, there are other drivers fueling growth: Kyoto Protocol (carbon trading), Feed in Tariffs, Renewable Portfolio Standards.



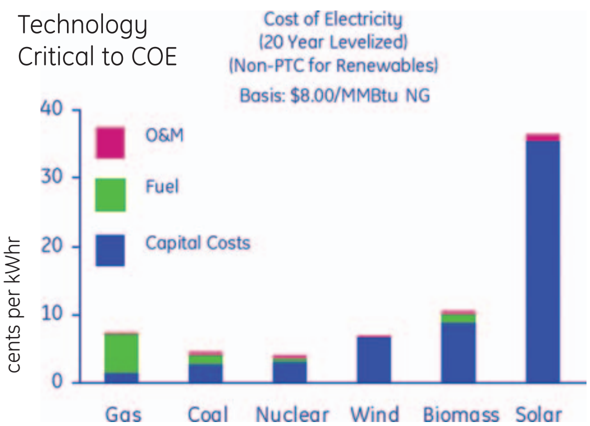
If global incentives stay in place, it is expected that the new installed capacity will double 2005 levels by 2012.

In spite of the present boom in the wind industry, profit margins are lower when compared to other power generation technologies. Commodity prices, which represent a large part of the costs of wind turbines, have risen by 28% (steel) to 120% (copper) in the last two years.

PTC

The pre-credited cost of energy (COE) for wind has come down 5x in the last 20 years, and is now competitive with traditional gas generated sources at current high gas prices. As with any new technology there is resistance to stray from the known, and the PTC ensures that power producers have an economic incentive to generate power from wind. In addition, it should be noted that wind energy is not yet competitive with energy from coal, and that over 50% of today's energy in the US comes from coal. It is estimated that the PTC cost for wind energy was approximately $330 million in 2005: this incentive—spread over all of the US wind power producers—ensured there was adequate profit to incentivize continued investment. The estimation of the Congressional Joint Committee on Taxation estimates the PTC will cost $2.8 billion for the 10-year period from 2005 to 2015. This does not take into account the revenues and taxes collected as a result of new wind farms, sales tax, job creation, payroll tax and business taxes down the supply chain.

Technology
Critical to COE



While the PTC predominately benefits wind energy, other technologies (Biomass, etc.) benefit as well. Solar and Biomass have a long development cycle ahead to be cost-competitive sources of energy, and therefore represent only a niche market, even with the PTC subsidy. There have been various tax benefits and subsidies for fossil and nuclear technologies going back to the 1950s and continuing today. GE Energy supports these programs and believes that the current wind and solar programs should be extended to keep pace with the other technologies.

At GE Energy, we believe that the goal should be to eliminate the need for PTCs, and that PTCs could be gradually phased out after the end of the decade if:

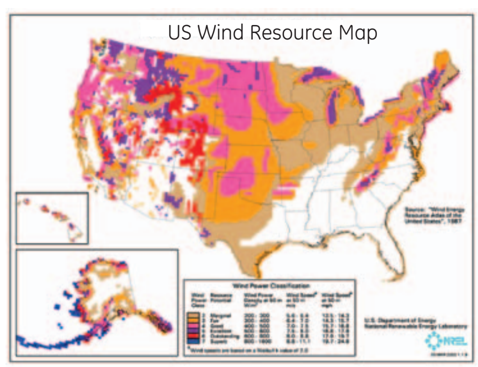
- PTC was extended continuously through the end of the decade, as opposed to the start/stop method
- R&D increased through that period
- A broad based market for trading green credits was established (could be carbon trading)

This longer-term approach could result in further investments in technology, and capital improvements that could lower component costs, and increase the ability to obtain financing for projects.

Wind Business Model

The costs of alternative sources of energy over a 20-year period are examined when an investment decision is being made regarding the purchase of generating equipment. With the high cost of hydrocarbons today, wind energy has become an attractive alternative, but not long ago the price was half of today's price; and there is no guarantee that it will stay high. Power Purchase Agreements (PPA) are based on this long-term price outlook for hydrocarbons.

Wind is an energy resource. As the oil and gas industries map out the locations of their resources, so does the wind industry. The Low Wind Speed Technological innovations—supported by US Government R&D—have allowed the penetration of wind turbines into lower class wind locations that would otherwise not have been economically feasible.



Wind turbines are typically operational more than 97% of the time. The amount of power generated by a wind turbine at any given time is dependent on the wind. For US wind energy sites developed in the last several years, the wind is typically high enough to generate power 80% of the time and full rated power 20% of the time.

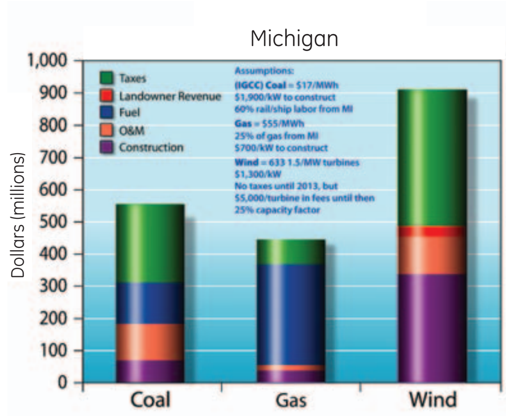
Wind variability is factored into the overall assessment of the plant economics and the delivered cost of electricity. It should be noted that some traditional sources of energy such as gas turbines do not operate continuously either, and serve to augment the supply during peak periods when the value of the energy is high. The reason for a turbine sitting idle is economic use of assets for gas turbines (i.e., high fuel cost) vs. wind availability for wind turbines. However, the commonality to both is that costly assets sitting idle are taken into account in the financial analysis before a project is developed. It has been shown in studies across the world (NY, CO, CA, NM, PA, Denmark, Germany, Spain) that the current transmission delivery systems and grid stability are typically minimally impacted by intermittent supply on the order of up to 10%. Experience and studies show that there are areas that support a much greater percentage of intermittency, depending on the extent and location of other traditional forms of generating capacity and typical demand timing.

Wind Energy Expansion Beneficiaries

GE Energy believes that the entire value chain benefits from increased penetration of wind turbines in the US: manufacturers, suppliers, utilities, government, society, and consumers.

The Danish Wind Manufacturers Association estimates that for every added MW of installed wind capacity there are 22 direct and indirect job-years created. Benefits are realized through supply chain manufacturing, turbine assembly, construction, operations, maintenance, property tax revenues, land owner revenues, and community economic multiplier effects. The economic impact of wind energy has been studied in several US states and shows wind energy has a greater positive economic impact than either coal or gas sources of energy.

As most wind turbines are placed in rural areas, property tax from the wind turbine farms provide much needed revenue for building schools, roads, bridges, and other needed infrastructure. A typical 100 MW farm can create $500 thousand to $1 million per year in local tax revenue. Rural land owners also benefit through land lease payments that can generate $2500 to $4000/MW/year. The American Corn Growers Foundation and Association support wind power farming as an alternative income stream for farmers and landowners and as an economic development opportunity for rural areas.



The consumer benefits from a lower wholesale price of power, as well as the displacement of imported fossil fuels. A study of the impact of a 100 MW wind farm in New York suggests that this would result in a 64% reduction in NG, 15% reduction in coal, 9% reduction in oil, and 12% reduction in other sources. Such fuel displacement would vary by the fuel mix of the state. This would result in a total carbon displacement equivalent to 25,000 acres of forest, as well as reductions in sulfur and nitrogen oxides that contribute to acid rain.

Wind technology is also advancing other areas of technology. While wind turbines will never power vehicles directly, wind power can be used indirectly to power those vehicles in a hydrogen economy. Such hydrogen fuel could be produced without the need for fossil fuels. In the same manner, wind powered desalination is also a perfect partnership to clean technologies.

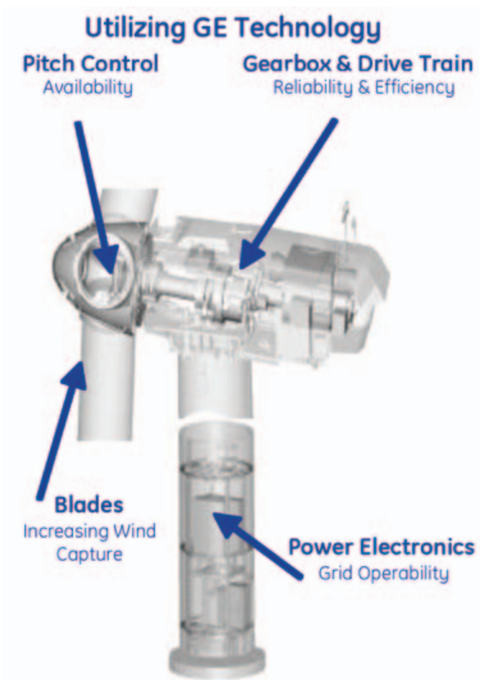
Technology

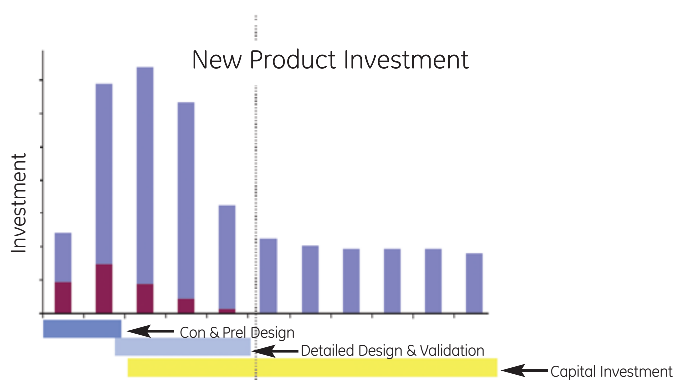
GE Energy is investing more than $70 million annually in advancing wind turbine technology to further lower the cost of electricity. These efforts are focused on improving efficiency through advanced aerodynamics, control systems, generators and power-electronic grid interface technology. GE has considerable experience with these technology applications in other GE products and businesses. Along with the use of advanced composite materials in our wind turbine blades, these technology improvements will allow larger rotors for a given turbine power rating and will also provide a stabilizing effect on the utility grid. These improvements will substantially increase the value of our turbines to the customer, and competition can help decrease the electricity cost to utilities.

In addition, as production volumes stabilize and supply chain consolidations and expansions occur, further decreases in cost are anticipated. However, without stable market growth, these additional volume-based production cost improvements may not be achieved.

The wind turbine manufacturing industry, while achieving dramatically reduced COE in the past, faces the current challenge of huge increases in commodity prices in a low margin business. Technology advancement is needed to offset the rise in commodity prices.

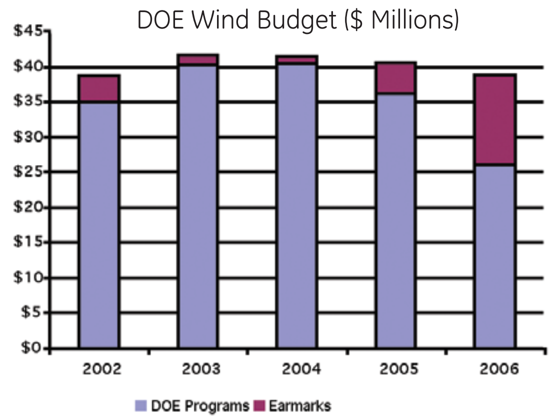
The cost of technology development is high, and the industry needs an increase in government participation to ensure a timely transition away from PTC. The typical government cost share for wind technology development programs is a small fraction of the total costs needed to bring a product to market.





The DOE budget has plateaued over the past five years, and the effective DOE portion to existing programs has actually decreased due to the effects of earmarks.

At the same time, the President's Advance Energy Initiative increases the request for solar and biomass budget by 79% and 65%, respectively. While GE Energy supports the President's request, we believe that the budget for wind energy should be increased by at least $30 million since the potential of wind to become a significant national energy source is more commercially viable than any other renewable energy source.



Transmission and Generation

To take full advantage of this country's vast wind resources, costly new transmission lines will be necessary, and even with no upgrades to the transmission lines, a much greater penetration of Wind is possible.

It was announced in early March that Arizona Public Service Company (APS), National Grid USA, and the Wyoming Infrastructure Authority signed a Memorandum of Understanding (MOU) to collaborate in development of new transmission lines between Wyoming and Arizona. While this is only being studied at this point, APS—and other utilities—are attracted to Wyoming's wind and coal resources. In addition, it was recently announced that seven utilities, including PG&E, would work with state government officials in the four states to determine the feasibility of the Frontier Line—which is proposed to feed the growing energy needs of the West. The line is proposed from Wyoming through Utah, and Nevada to California.

Recent experiences in the US (e.g., the Northeast Blackout of August 14, 2003) have shown that the growth of the US electric power grid presents an ongoing challenge. The grid is organic, with a continuous process of new transmission and generation being added, and older uneconomic and environmentally detrimental infrastructure being retired.

Accommodation of new wind generation fits within this process. New techniques and business arrangements are being developed to make the most of existing transmission. For example, Bonneville Power Administration is developing new transmission access arrangements that will increase the use of federally administered transmission for wind power, without requiring new construction. Ultimately, new transmission is required to accommodate large amounts of new wind generation. In many instances, where wind resources are best, the existing transmission is relatively weak. Improvements in the transmission for these regions adds system reliability for the customers served there. It is important to note that the development of any type of large new generation needed to meet America's energy needs will require new transmission. For the most part, in the future, large new generation will be forced to site even farther from large population and load centers. This issue is by no means unique to wind energy.

Increased penetration of wind generation will also affect the requirements of other generation. As new generation power by other fuels (such as natural gas, coal and nuclear), are inevitably developed, they will need to complement the variable characteristic of the wind generation. The technology necessary to provide this functionality is available. With a coherent and long-range wind energy policy, the market and grid planning systems will be able to adapt to these needs. Lastly, other emerging technologies, such as energy storage (i.e., water towers, batteries), will provide additional operational flexibility to economically meet the reliability needs of the grid.

Environmental

Aesthetics

Yesterday's wind turbine towers had a scaffold configuration and were not aesthetically appealing. Today's large commercial wind turbine towers are constructed with a single tubular structure having no visible protuberances. Yesterday's wind turbines were composed of smaller diameter rotors turning very fast and are visually distracting. Today's large commercial wind turbines have rotor diameters in excess of 250 ft. and appear to be turning very gently. There is also a better understanding and sensitivity to wind turbine farm design to better blend in with the surroundings. Some of the considerations resulting from studies are the thoughtful geometrical pattern of the cluster as opposed to scattered wind turbines, as well as uniformity with respect to design, rotational direction and speed, color, height, and rotor diameter. Executed with thoughtfulness, a wind farm will blend in seamlessly with its surroundings and can be viewed as a sculptural element of the landscape. There will always be, and should always be, places where wind turbine development is off-limits when aesthetic and other environmental issues cannot be overcome. However, with the limited choices for cleaner energy sources, these decisions should be made with the public good in mind.

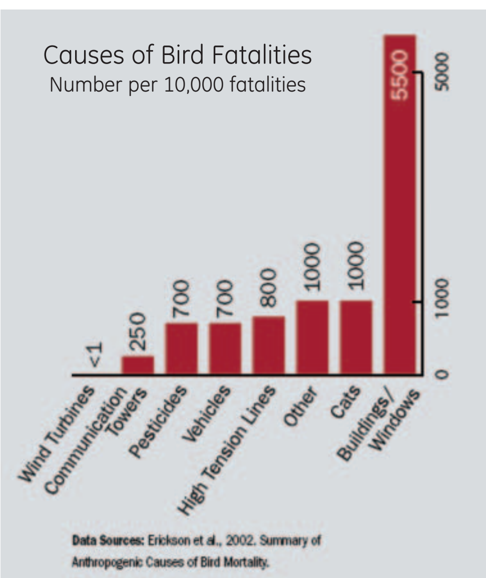
Virtually all large commercial wind turbines are located in rural areas—most on family farms—where the added income and jobs in the local community are welcome. Additionally, wind turbines are better neighbors than traditional energy sources and provide power generation with zero to low carbon emissions. In addition, while farmers earn extra rental income, farmers continue to farm as they have always done.

Birds

Virtually any tall man-made structure will pose a collision risk to birds, but the risk from wind turbines is very small when compared to buildings, communication towers and transmission towers. Today's tubular tower design gives no reason for birds to be attracted for nesting as the older scaffold design had been. The benefits of a clean energy source should be weighed against any small, added threats, and the corresponding losses due to conventional energy sources.

Wind turbines pose less risk than other man-made structures, and proper siting is the most important aspect to reduce risk to birds. Sites should be studied to determine the migratory and local avian patterns.

The most notable area of bird fatalities has been the Wind Resource Center in the Altamont Pass, California. It should be noted, however, that these wind turbines are older vintage and are constructed of lattice-type towers, are much shorter and have rotors that spin much faster than today's large commercial tubular tower wind turbines.



Noise

Anything with moving parts can generate noise. The degree to which noise is objectionable is subjective. As wind turbines are generally located in rural areas that are also in windy regions, the background noise of the wind tends to mask the sound of the wind turbine: when the wind is not blowing, the rotor is not turning. At a distance of 750 to 1000 ft., today's large commercial wind turbine farm is no noisier than a kitchen refrigerator. The reduction of noise over older wind turbines has been a result of streamlining towers and nacelles, increasing sound proofing of nacelles, designing more efficient blades, designing gearboxes for quite operation, and positioning of the rotor. Given all of this, the proper site of an individual wind farm location should take into consideration the distance from neighboring residences, existing local background noise, the specific turbine to be installed and the type of terrain where the project will be located.

Conclusion

As the US moves toward a cleaner energy future, it is important to realize that a portfolio approach towards energy generation is required. The US cannot afford an over-reliance on any single energy resource. Renewables will inevitably form a significant portion of the US energy portfolio augmenting the existing fossil fuel infrastructure. Wind is first to be economically viable—solar, geothermal/waste heat recovery, and biomass/waste gasification will all develop significantly in the next decade, each with a viable cost of energy.

Conventional energy sources will continue to be important. Coal gasification and carbon sequestration are important technologies that GE is pursuing—IGCC coal plants will enable cleaner coal plants and economic capture of CO2. High efficiency gas turbines optimized for synthesis gas and high hydrogen content gas will be required to combust a more diverse fuel mix. Finally, 4th generation nuclear plants hold the promise of a modular failsafe design along with the ability to reprocess spent fuel.

A stable and proactive government policy is required to achieve this vision. It is needed to overcome inherent inertia, level the playing field for new alternatives, and establish market-based pricing for important externalities. The goal is very worthwhile in terms of environmental emissions, energy security, import deficit reduction, and investment in US-based jobs.