Keys to Achieving 20 Percent Wind by 2030

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ABSTRACT

To meet growing demand for electricity through the year 2030, the U.S. will need to ramp up its generating capacity quickly and significantly while accounting for national security concerns, environmental impacts, and fuel price pressures. Renewables will be critical for meeting this demand, and wind power is ready today to meet this challenge with affordable, reliable energy.

A collaborative government-industry technical report released recently by the U.S. Department of Energy explores a model scenario by which wind provides 20 percent of the nation's electricity by 2030 (www.20percentwind.org). The report finds that such a goal is feasible and evaluates the costs, benefits, and challenges related to its achievement, which would require 300 gigawatts of wind capacity to be installed by 2030.

U.S. wind resources provide far more energy than needed to achieve this milestone, and current wind technology is able to attain what DOE calls an "ambitious, but achievable, goal." However, several near-term challenges must be overcome for the nation to achieve the milestone of 20 percent wind by 2030. Utilizing wind to satisfy 20 percent of U.S. capacity needs would improve our energy security; offset demand for fossil fuels, helping to ease fuel price increases; generate well-paying jobs, a new income source for rural landowners and tax revenues for local communities; reduce electric sector CO_2 emissions and water use; and put a substantial amount of affordable, reliable, renewable power on the grid.

INTRODUCTION

As the leading source of carbon-free electricity generation that is rapidly deployable today, wind power can play a vital role in the critical early years of an effort to combat global warming and deliver stable electricity prices, promote our nation's energy security, dramatically reduce water use, and foster jobs and economic growth.

A groundbreaking technical report released by the U.S. Department of Energy (DOE) in May examined the feasibility of wind providing 20 percent of U.S. electricity supply by 2030. The report was a collaborative effort with many contributors, including DOE, the National Renewable Energy Laboratory (NREL), the American Wind Energy Association (AWEA), and the consulting firm of Black & Veatch. It assessed the challenges, evaluated the costs, and quantified the benefits, and found that 20 percent wind by 2030 is an "ambitious but achievable goal."

THE 20 PERCENT WIND SCENARIO

U.S. electricity demand is expected to grow to 5.8 billion megawatt-hours (MWh) annually in 2030, based on an assumption of load growth of 1.5 percent annually. To meet 20 percent of that projected demand, the wind industry must install more than 300 gigawatts (300,000 megawatts) of new wind electric generating capacity—over 280 gigawatts more than in August 2008. To meet that milestone, installations of new wind electric generating capacity must steadily increase to 16,000 MW of new capacity annually, or average 12,700 MW annually, through 2030.

In 2008, the wind industry expects to add more than 7,500 MW of new capacity, an amount that is actually ahead of schedule to meet the "20 percent by 2030" mark. The industry's demonstrated ability to rapidly ramp up wind equipment manufacturing, delivery, and project construction is a good sign. However, achieving the 20 percent vision will require stable policies that encourage investments in clean energy technologies and promote construction of the transmission infrastructure needed to deliver renewable energy to urban areas.

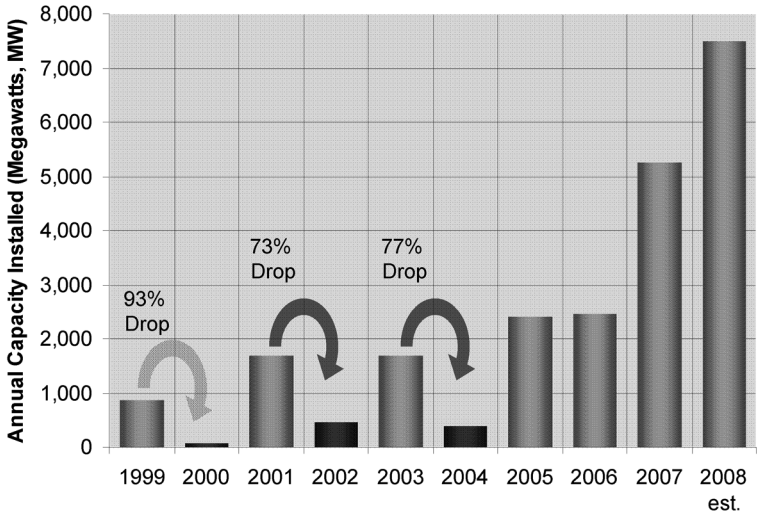

Figure 1. Cumulative Wind Installations by 2030

COSTS AND BENEFITS OF ACHIEVING 20 PERCENT WIND

The report found that the "20 percent by 2030" milestone would cost 2 percent more than a "no new wind" scenario due to higher upfront capital costs. This estimated additional investment would be equal to about 0.06¢/kilowatt-hour (kWh), or about 50¢ per month for the average household.

However, the higher capital costs would be more than offset by carbon benefits, natural gas savings, and other benefits, including:

- **Improved U.S. energy security.** By tapping into a vast, inexhaustible, domestic resource, the U.S. can reduce its dependence on increasingly scarce conventional fuels like natural gas. Overall, natural gas consumption throughout the economy would be reduced 11 percent, and the use of natural gas for electric generation by 50 percent. Significantly reduced natural gas consumption will help lower gas prices, leading to fuel cost savings of nearly $130 billion, according to supplemental analysis.

- **Reduced demand for fossil fuels.** Wind could help trim electricity

sector use of coal by 18 percent in 2030, avoiding more than 80 GW of new coal capacity, and significantly reduce pollution.

- **Thousands of well-paying domestic jobs.** In 2030, the wind industry would support 500,000 jobs—at least 150,000 direct wind industry employees, plus more than 100,000 jobs in associated industries (e.g., accountants, lawyers, steel workers, and electrical manufacturing), and more than 200,000 jobs through economic expansion based on local spending.

- **A new income source for rural landowners.** Royalty payments of more than $600 million by 2030 ($2,000-$4,000/megawatt installed) would be paid to farmers and ranchers who allow wind turbines to be built on their land.

- **Increased local property tax revenues** of more than $1.5 billion by 2030.

- **Reduced CO_2 emissions.** In the year 2030 alone, 825 million metric tons of CO_2 emissions would be avoided, about 25 percent of the CO_2 that would have been emitted by the electric sector under the no new wind scenario. This reduction is the equivalent of removing 140 million vehicles from the road, and could nearly level projected growth in electricity sector CO_2 emissions. The 20 percent wind scenario would reduce CO_2 emissions by a cumulative 7.6 billion tons by 2030. Supplemental analysis shows that at an average carbon price of $22 per ton of CO_2, this would avoid nearly $100 billion in carbon cost.

- **Reduced water use in the electric sector.** By 2030, four trillion gallons of water, equivalent to a 40-year supply for the city of Phoenix, would be saved by offsetting the use of water in fossil fuel power plant steam systems.

WIND'S MAINSTREAM STATUS

The decision to undertake the 20 percent wind study grew out of the wind industry's impressive performance over the last decade,

culminating in last year's record-setting market success. In 2007, wind made up 35 percent of all new electric generating capacity installed in the U.S., second only to natural gas. The first two quarters of 2008 have continued at a breakneck pace. With a cumulative total of 20,000 MW installed by August 2008, the industry is on track for a 45 percent expansion for the second year in a row.

A combination of factors has contributed to this remarkable market growth:

- **Wind technology has matured**, steadily improving the performance and productivity of individual turbines.
- **Fuel prices have risen sharply** and become more volatile since the California electricity crisis of 2001. Since wind power uses no fuel, it offers stable and predictable energy prices.
- **Demand for wind—and other renewables—is on the rise**, due in large part to concerns about climate change. Consumers want clean, reliable, and affordable electricity, and utilities are working to diversify their resource portfolios to stabilize prices.
- **The domestic supply chain is expanding**, with the industry opening, expanding, or announcing at least 41 new manufacturing facilities in the U.S. in the last 18 months. In 2005, the average wind turbine installed in the U.S. utilized less than 30 percent American-made components. Turbines installed in 2008 use nearly 50 percent domestic components.
- **The federal production tax credit (PTC) has been stable** for several years in a row, enabling the wind industry to lay the groundwork for significant expansion in the coming years. The PTC levels the playing field for wind power with other electricity sources, which receive a wide variety of subsidies (many of them permanent in the federal tax code). It is set to expire at the end of 2008, threatening more than 75,000 jobs and $11 billion in investment planned for 2009.

STATE-OF-THE-ART TECHNOLOGY

Modern turbines stand 400 feet tall and capture premium wind resources higher above the ground, increasing electricity output and

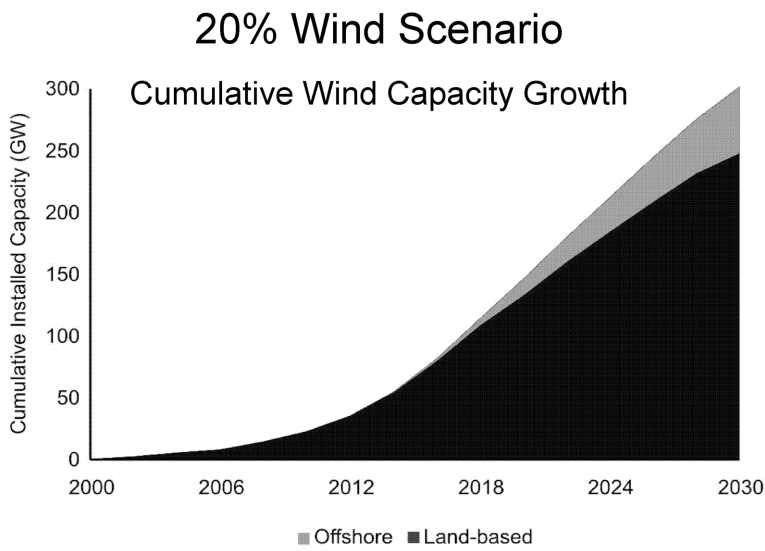

Figure 2.
Historic Impact of PTC Expiration on
Annual Installation of Wind Capacity

turbine efficiency. The average turbine installed in 2007 had 1.6 MW of capacity, twice as powerful as turbines installed in 2005 (rated at 750 kW). The largest land-based turbines operating today provide 3 MW of capacity each. Offshore projects use even larger machines, with 5-MW turbines planned for installation in the next two years. Several gigawatt-sized (at least 1,000 MW) projects are already in the development pipeline in California, Texas, South Dakota, and Wyoming. (One gigawatt—or 1,000 megawatts—of wind can generate enough electricity to power the equivalent of more than a quarter of a million homes).

Improved turbine design has led to a 70 percent reduction in capital cost since the early 1980s, according to Lawrence Berkeley National Laboratory (LBL). LBL has also recorded a 35 percent drop in operations & maintenance (O&M) cost and a 15 percent capacity factor improvement during the last 10 years. Turbines operating commercially before 1998 achieved an annual capacity factor of about 22 percent. On average, state-of-the-art turbines operating in 2004 and 2005 achieved 36 percent capacity factors.

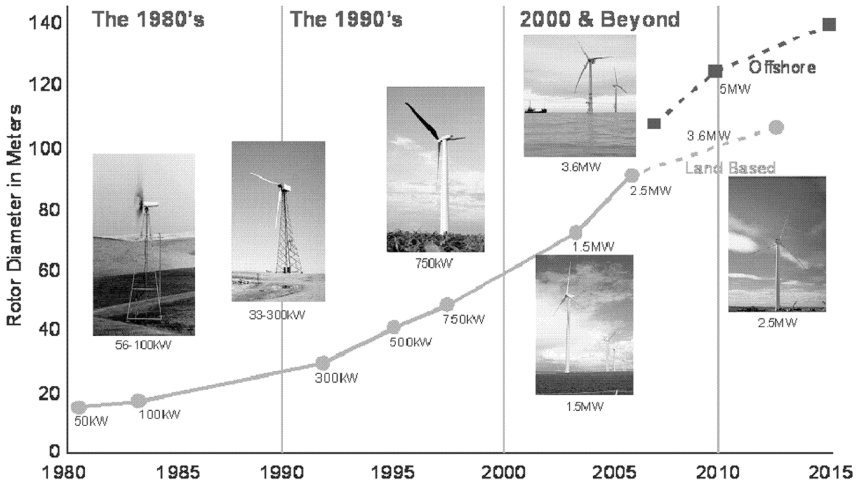

Figure 3. Evolution of Commercial Wind Technology

CHALLENGES & OPPORTUNITIES

The 20 percent wind by 2030 scenario is certainly achievable, but it will require enhanced transmission infrastructure, improved siting and permitting regimes, continued improvements in wind technology, as well as an expanded and improved U.S.-based supply chain. In each of these areas, technological progress paired with a policy framework that fosters renewables will enable the industry to overcome challenges and move toward achieving wind's full potential.

Transmission & Integration Challenges

Significant investment is needed in the nation's transmission system to access the best wind resource regions of the country, an investment that is needed anyway to relieve current congestion on the grid and improve reliability. In particular, a high-voltage transmission superhighway is needed to carry electricity generated in rural, windy areas of the Great Plains to load centers around the country. The current state-based regulatory structure is ill-suited to develop this interstate transmission highway system. A national commitment and greater federal government involvement will be critical to success. Regional transmission planning and regional cost allocation policies are

the most important components of a workable structure to promote transmission.

The current practice of "reactive" transmission planning must be replaced with "pro-active" planning. Four states are leading the way on proactive planning: Texas, California, Colorado, and Minnesota. The Texas model of competitive renewable energy zones (CREZ), in which transmission lines are planned to reach areas with the most economic wind resources, is extremely cost-effective and will provide low-cost wind power in perpetuity for Texas consumers. For example, the Texas CREZ plan will lead to $4.9 billion in transmission investments to major wind resource areas. The benefit to electric consumers: $2.4 billion per year in reduced fuel costs. This Texas model should be replicated in many other areas and on the national level to achieve 20 percent wind.

Challenges of Power System Operations with Variable Wind Energy

Studies and experiences of wind integration in Europe and the U.S. have demonstrated that wind energy can reliably supply 20 percent or more of a country's electricity. Changes in the structure and operation of the electric grid can allow it to operate more efficiently and greatly facilitate the integration of wind energy. One low-cost change that can significantly improve grid reliability and reduce operating costs with or without wind energy is the consolidation of the 140 independent grid operating areas in the U.S. into a handful of large balancing areas. The implementation of open, transparent electricity spot markets with sub-hourly redispatch intervals is also important to efficient grid operations with or without wind energy. Other changes helpful for wind integration include the use of state-of-the-art wind forecasting, flexible transmission services, and the deployment of additional capabilities on the system such as hydroelectric plants, demand response programs, energy storage technologies, and gas-fired combustion turbines.

Wind Turbine Technology Development Opportunities

For wind energy to achieve the 20-percent milestone with minimal cost impacts, capital costs must decrease by 10 percent and capacity factors must increase by 15 percent over the next few decades—a target that past performance indicates is readily achievable. The wind industry does not require any technological breakthroughs to reach the

20 percent vision, but a sustained research and development effort will make it possible to reach these cost and performance goals.

In the near term, wind technology R&D will focus on the following:

- Improving the reliability of gearboxes, towers, blades, and power electronics.
- Developing lighter drive trains, taller towers, and enhanced rotor technologies.
- Developing new materials and more aerodynamic designs to further improve blade performance.

Manufacturing/Supply Chain Challenges

General Electric has testified before the U.S. Senate that wind technology will be among the leading sources of new manufacturing jobs in the 21st century. With the emergence of the U.S. as the world's leading market for wind, there is huge interest among global wind manufacturers in participating in the American market.

Over the last 18 months, at least 41 manufacturing facilities have been opened, expanded, or announced in the U.S. to meet growing demand for wind components. As the wind industry's domestic supply chain expands, technology advances and improved systems in the manufacturing process will lead to additional cost reductions. Experienced workers will be needed as the industry ramps up production. Specialized services, such as large-load transport and logistics planning, will need to expand as well.

Programs to conduct full-scale component and turbine testing prior to installation will improve endurance and reliability, mitigate risk, and facilitate greater investment in wind.

Siting Challenges and Opportunities

As wind power's contribution to electricity supply increases, concerns about local siting, wildlife, and environmental issues will grow and need to be addressed. Improved siting regimes and coordination are necessary to plan for and minimize potential impacts while harvesting the nation's most promising wind resources. These efforts should be undertaken through a partnership of federal, state, and local government, the wind industry and non-governmental organizations, using the best available science. Guidelines and policies must not hinder expanded wind project development unfairly in relation to other types

of development. Also, government permitting and review capabilities should be scaled up to eliminate the potential for backlogs and avoid unnecessary delays.

OPPORTUNITIES TO MEET DEMAND GROWTH BEYOND 2030

The "20 percent by 2030" milestone is a landmark on the road toward achieving the full potential of our national wind resource. Beyond 2030, demand for electricity in the U.S. will continue to grow, and wind power will be a major contributor to a balanced mix of resources that satisfies our insatiable need for new generating capacity.

The prospect of plug-in hybrid electric vehicles holds great promise because the expense of their batteries would be covered by their fuel cost savings, and they could provide many megawatts of storage for the overall electrical power system. This would also allow wind power and other renewable energy resources to displace consumption of foreign oil.

As new technologies (such as plug-in electric hybrid vehicles) increase demand even further, wind can be deployed as distributed generation, providing electricity customized to specific demand centers. DOE and other industry groups are exploring smart grid technology, which will provide new opportunities to customize generation and deliver power through made-to-order facilities. Smart grid technology will open new doors for modular resources like wind, which can be installed incrementally depending on the type and amount of demand. Specialized technology will be needed to manage these kinds of changes and opportunities as they become available.

CONCLUSION

Wind power is a near-term solution to many of our nation's energy security, economic security, and environmental security concerns. Wind technology is proven, its costs are competitive, and the benefits of deploying large amounts of wind are wide ranging. Wind turbines have at least 20-year lifetimes, so equipment installed in 2030 will continue generating and delivering pollution-free electricity using an inexhaustible domestic resource through 2050. As we move toward the attainment

of our "20 percent wind by 2030" milestone—a mile marker on the road to achieving wind's full potential—there is room to grow and improve as we stay focused on our goal of clean, reliable electricity to power America's future.

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Randall Swisher has served as executive director of the American Wind Energy Association since 1989. Prior to that, he worked as legislative representative for the American Public Power Association and as energy program director for the National Association of Counties. He has also worked as professional staff for the House Interior Committee's Energy and Water Subcommittee. He was executive director for the D.C. Public Interest Research Group, where he first became involved with renewable energy advocacy in 1975. Between 1976 and 1981, Swisher served as an adjunct professor at Georgetown University and Georgetown University Law Center, where he taught courses on energy policy. Swisher has a Ph.D. in American civilization from George Washington University and a B.A. in political science from the University of Iowa.