CLIMATE CHANGE POLICY PARTNERSHIP

Wind Power: Barriers and Policy Solutions

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TOWARD A LOW-CARBON ELECTRICITY SECTOR

CCPP Technology Policy Brief Series

Wind Power

POLICY BRIEF

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Series Overview:

Toward a Low-Carbon Electricity Sector

This paper is one in a series by the CCPP at Duke University to explore the barriers facing large-scale, low-carbon electricity generation and increased efficiency in the near-term – primarily the next ten to fifteen years. Policy drivers may be necessary to provide the right price signal to develop low-carbon emission technologies, but a price signal alone may not be enough to enable broad-scale deployment.[1] Significant technical, legal, infrastructural, and social barriers prevent the implementation of the necessary technologies and efficiency improvements.

The series provides an overview of the barriers and outlines general policy options for lawmakers who wish to speed the development and/or wide-scale deployment of low-carbon energy technologies. It will include papers focusing on specific energy generation technologies, including renewable energy and energy storage, and energy efficiency, a cost-effective near-term option for displacing carbon-intensive energy generation.

[1] Policy drivers are under consideration include a nationwide cap-and-trade system for greenhouse gas (GHG) emissions, regulation of GHGs emissions under the Clean Air Act, expanded action on the state and regional levels, or some combination thereof.

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I. Executive Summary

Wind power is becoming a mainstream power-generating technology. In the United States, the share of wind power in the nation's power system is increasing faster than any other source of energy in the past few years. However, many barriers are threatening its further expansion. The government's financial incentives lack long-term stability. The outlook for wind power's future competitiveness is unclear. The intermittent nature of wind power imposes a severe limit on its market penetration. The antiquated transmission infrastructure is not only limiting the availability of wind sites, but hindering means of mitigating the intermittency. Balkanized ownership and regulatory structures block efforts to revamp the transmission system and delay regulatory reforms. The barriers to further expansion of the wind power sector are severe and complex. This policy brief explains these barriers in layman's terms and proposes practical approaches to address these issues. A possible solution for the intermittency problem is energy storage, which involves various technological options and a wide range of regulatory and institutional barriers. These barriers are addressed in a separate policy brief.

In the past few years, growth in wind turbine demand outpaced the increase in production. Wind turbines are available, but prices have risen significantly. Wind turbine manufacturers are ramping up slowly due to concerns over quality control and lack of confidence in continued market growth. Historically, the 1980s wind farm rush in California led to the American wind turbine industry's poor quality control and eventual near-bankruptcy in the 1990s. It is important to learn from history and create policies to preempt potential pitfalls. Whether wind power in this country is on a track to a sustainable future or a fiasco in the next few decades depends on the policies made in the next few years. This policy brief also explores other issues, including workforce constraint and the potential changes in long-term public attitudes, and recommends options for addressing them.

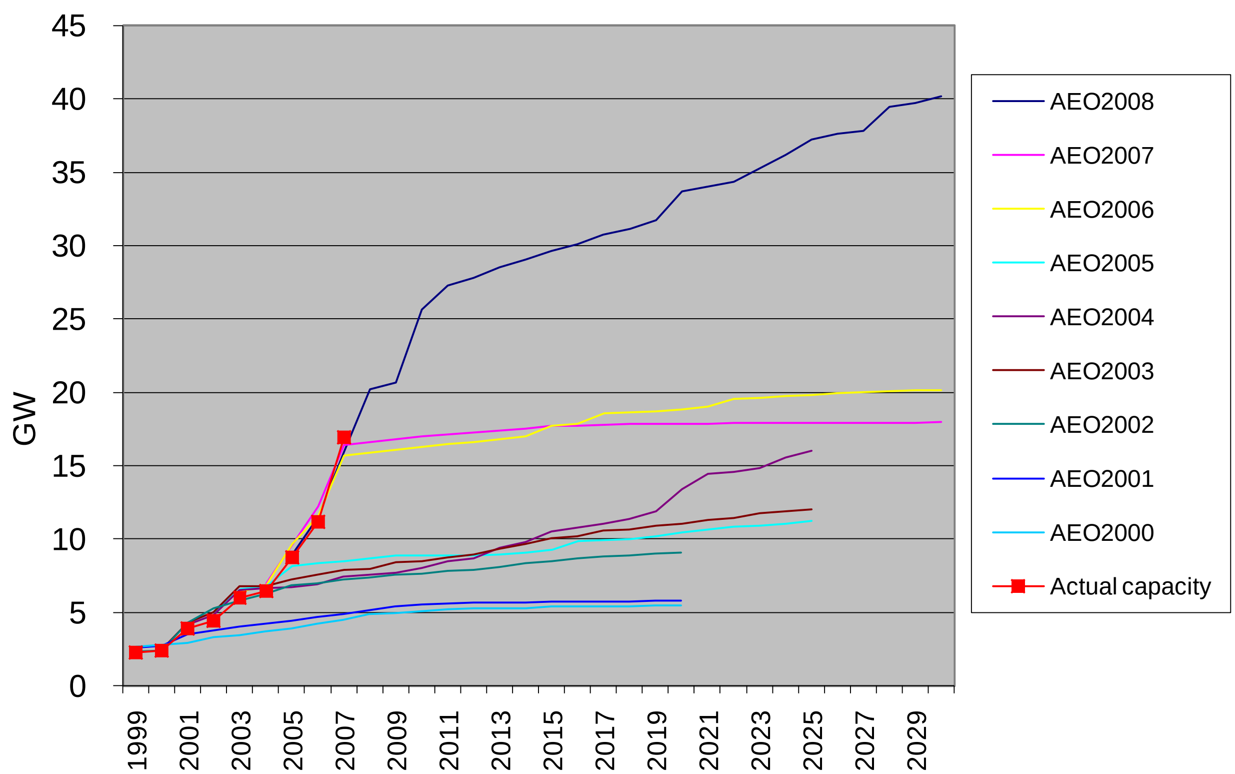
Wind energy is a clean and abundant source of energy. It requires many government agencies and industries to work together to exploit the maximum potential of this resource. The Department of Energy has recently publicized its goal to provide 20% of U.S. electricity demand from wind energy by 2030. While this goal is inspiring, we must recognize that it is not an easy task. This policy brief provides ideas for the first steps in a long-term plan to make our energy system more sustainable.

II. Introduction

Wind power is increasingly recognized by the utilities as a mainstream power-generating technology. While wind generators currently provide less than 1% of electricity in the United States, the share of wind in the nation's power system is increasing faster than any other source of energy. Interest in wind will likely continue to grow as policymakers seek low-carbon energy sources to reduce the nation's greenhouse gas emissions.

In past years, the U.S. Energy Information Administration has consistently underestimated the growth of wind power and has revised its projection upward every year. The Annual Energy Outlook (AEO) 2008 doubled its long-term projections from the previous year to 40 GW by 2030. Within months after publication of the AEO 2008, the U.S. Department of Energy (DOE) published a report titled "20% Wind Energy by 2030" and proclaimed a far more aggressive target of 305 GW by 2030 (U.S.DOE, 2008). This DOE report comes on the heels of well-publicized campaigns by Texas oilman T. Boone Pickens and former vice president Al Gore to drastically increase the nation's reliance on wind energy.

Figure 1. Projections of wind power capacity



The DOE 20% Wind report provides a vision with detailed discussion of various issues that need to be addressed. However, the report did not propose specific actions for addressing those issues. The issues fall into a wide range of jurisdictions. Many federal and state agencies are involved. For example, the Department of Interior's Minerals Management Services (MMS) is in charge of approving offshore wind projects. The MMS is conducting a wide range of studies on the environmental impacts of offshore wind farms. Siting land-based wind projects is mainly within the jurisdiction of state governments, while the U.S. Fish and Wildlife Service provide guidance regarding wildlife impacts. The Federal Energy Regulatory Commission (FERC) is in charge of interstate transmission policies and is revising transmission rules to accommodate the expansion of wind power. The DOE is supporting a great deal of research and development on wind technologies. The provision of a Production Tax Credit (PTC) has been authorized by Congress. The Emergency Economic Stabilization Act of 2008 has recently extended the PTC for wind power until the end of 2009. It will require efforts from legislators, federal and local government agencies, and industries, as well as the public, to fully exploit the potential of wind energy.

Wind power is already a commercially competitive power-generating technology for utilities. Currently, the size of a typical wind turbine is around 1–3 MW. A large wind farm, with an array of hundreds of turbines, may have a capacity in the range of a few hundred MW. Because wind does not blow all the time, the capacity factor (actual power output over theoretical full capacity output) is significantly lower than coal-fired and nuclear power plants. The average U.S. wind power capacity factor is 27% in 2007 (compared to 73.6% for coal-fired and 91.5% for nuclear in the same year) (DOE/EIA, 2008). Because wind is intermittent and operators have no control over when it blows, a power system may become unstable once wind energy reaches a certain proportion of total power output.[1] A simultaneous stoppage of many wind farms may cause a blackout, unless the system is coupled with a dispatchable backup source or an energy storage system.

Wind resources are not evenly distributed. In the United States, the richest wind energy resources exist in the Midwestern region from Texas to North Dakota and in offshore regions along the east and west coasts. Current estimates of U.S. land-based and offshore wind resources suggest that the resource base is many times more than enough to supply the electrical energy needs of the entire country. Challenges remain in developing the required physical and institutional infrastructure (wind farms, transmission, regulations, financial incentives, etc.) to utilize the resource.

Currently, wind power is the most competitive source of renewable electricity. In 2007, the total installed wind power capacity in the US was 16.9 GW and annual growth rates during the past decade hovered around 20%. To grow to 305 GW by 2030 (DOE 20% target), annual wind power installation must maintain an average growth rate of 14% for the next 22 years. While possible, it is undoubtedly challenging to maintain such high growth rate over decades. This policy brief outlines barriers that will

[1] The percentage depends on the system's capacity in managing intermittence, which depends on many factors such the capacity of standby dispatchable power, the transmission capacity, the accuracy of wind forecasts, the availability of storage facilities, etc. The upper limits to wind power penetration would vary from place to place.

likely interfere with the expansion of domestic wind energy and suggests policy options for addressing the barriers if policymakers wish to maintain or accelerate the industry's growth.

III. Benefits of Wind Power Generation

Wind power generation does not emit greenhouse gases, though, as with any technology, wind power does have a small carbon footprint due to the energy consumed and carbon emitted in manufacturing, transporting, and installing wind turbines. The lifecycle carbon emissions for wind power are among the lowest of all energy technologies. A study by the International Energy Agency (IEA) estimated lifecycle carbon dioxide emissions for wind power at 7–9 grams of carbon dioxide per kilowatt-hour (kWh). By comparison, coal- and natural gas-fired plants released 955 and 430 grams per kWh, respectively (Thorpe, 1998).

The cost of electricity generated from wind power is largely competitive with fossil-fueled power, thanks in part to the Production Tax Credit (PTC) scheduled to expire in December 2009. The costs of wind power vary with the quality of the wind sites, size of the turbines, and scale of wind farms. In 2007, the amortized costs range from approximately 3–6.5 cents/kWh with the PTC or 5–8.5 cents/kWh without PTC (Wiser & Bolinger, 2007). By comparison, the levelized electricity production cost at new coal-fired power plants is estimated at about 4.7–7.0 cents per kWh with varied assumptions on future coal prices (Falk, 2008; Woods, 2007).

Wind turbines are commercially available and can be quickly deployed on a moderate scale. The environmental impacts (excluding visual impact) of wind turbines are minimal or manageable. Wildlife collisions, in particular those involving birds and bats, with wind turbines are a real concern, but no significant impacts on bird or bat populations have been documented to date (U.S.DOE, 2008). A wind turbine causes almost no irreversible damage to a site. If a wind turbine is determined undesirable after it is installed, it is usually possible to remove it and restore the site to its original state.

The growth of the wind power industry can contribute to job creation. The logistical difficulty involved in transporting large blades from factory to wind farm will dictate that factories be located close to demand. Due to the rapid growth in the past few years, several major turbine makers are opening or expanding their blade production capacity in the United States (Vestas in Colorado, Suzlon in Minnesota, GE Wind in Iowa, and Gamesa in Pennsylvania) (Red, 2008). The manufacturing of wind turbine blades is a labor-intensive process which therefore creates new job opportunities.

The current economic environment (uncertain economic outlook, high fuel cost, and impending carbon regulation) is favorable to investment in wind power. When the outlook is uncertain, there is a value in postponing costly investments such as new nuclear or coal-fired power plants (IEA, 2007). The small-scale nature of wind power allows investments in small increments and thus reduces the magnitude of risks involved (Redlinger, 2002). Construction of wind energy projects generally completes in 5 to 12 months.[2] By comparison, it takes 3 to 5 years to build coal-fired power plants and 5 to 10 year for nuclear plants.[3] Only gas-fired power plants can be completed in a similar timeframe as wind projects and with similarly small upfront capital investment. In addition, wind turbines require no fuel and emit no carbon. It seems very likely that wind power will play an increasing role in the electric power system both in the United States and worldwide. Nevertheless, there are many barriers that, if not addressed, may slow down or even stop the expansion of wind power.

IV. Near-Term Bottlenecks

Although there are many political and business leaders advocating for faster expansion of wind power, many bottlenecks remain. Some of these bottlenecks are already being addressed. It requires a certain amount of resources, deliberation, and time to remove the bottlenecks. In some cases, faster near-term growth is not necessarily beneficial to the long-term health of the wind power industry. For example, the wind farm rush in California in the 1980s led to the wind industry's poor quality control and eventually the bankruptcy of nearly the entire U.S. wind turbine industry in the 1990s (Est, 1999). It requires carefully designed policies to mitigate these constraints. This section introduces some of the most significant bottlenecks, followed by a discussion of a long-term challenge—public attitude.

A. Uncertain financial outlook

1. Policy-induced incentive uncertainty

The U.S. Government's provision of a production tax credit (PTC) for renewable energy has been on-again off-again. The most recent PTC provision is scheduled to expire at the end of 2009. Historically, the on-and-off provision of a PTC has created a boom-and-bust cycle of wind turbine installations. Even for projects that could be profitable without a PTC, there is still a strong incentive to postpone the projects until the PTC becomes available again. The policy-induced boom-and-bust cycle creates artificial market volatility and uncertainty and has widespread impacts on the industry. For example, the uncertain market outlook discourages wind turbine manufacturers and component suppliers from expanding aggressively. Volatile demand imposes serious risk to suppliers. From a manufacturer's

[2] Not including licensing.
[3] Summarized from publications and news reports.

perspective, it is generally safer to have a large backlog of unfilled orders than to build excessive capacity (often funded with loans). If the PTC is not provided on a long-term basis, the expansion of wind power is likely to slow down significantly. A long-term (through 2030, for example), stable provision of the PTC or a sufficiently high carbon price pursuant to a national cap-and-trade system is likely necessary to ensure a transparent incentive outlook, which is in turn essential for stable and rapid growth.

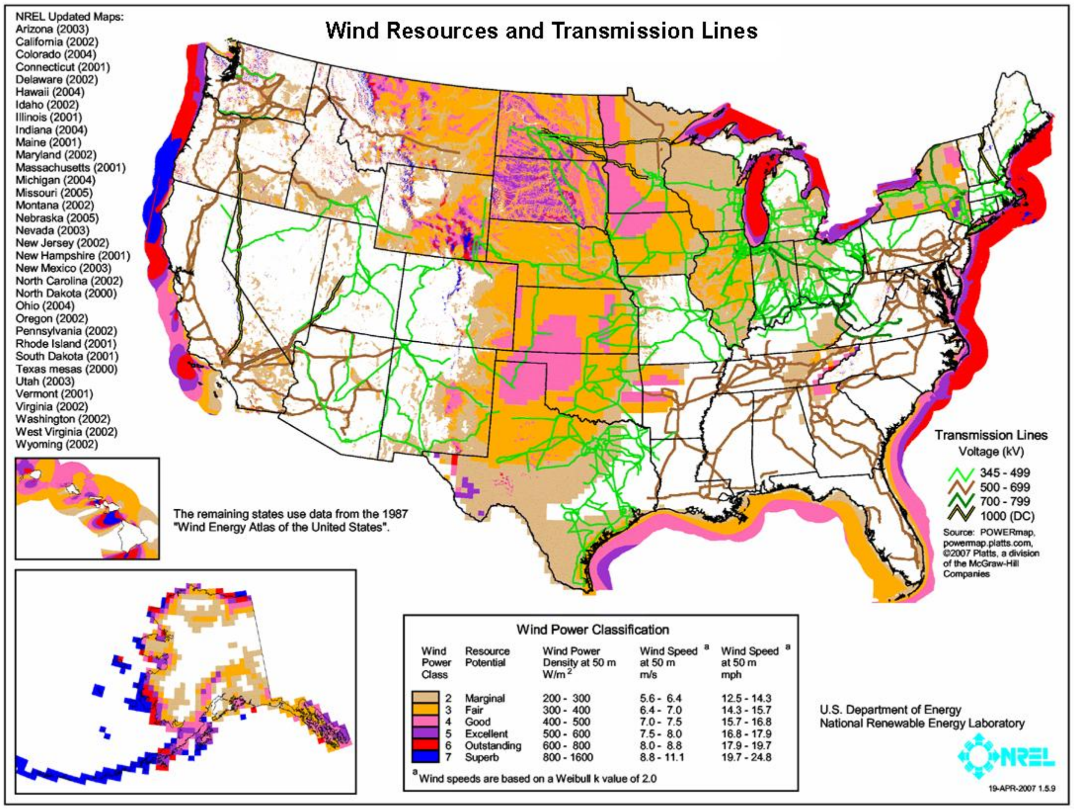
2. Market-driven price uncertainty

Its small-scale nature provides wind power with a competitive edge over coal-fired power and nuclear, but not over gas-fired power, which is equally small-scale. In fact, gas-fired power enjoys a very important advantage because it is dispatchable. High natural gas prices in the past few years have contributed to the rapid growth of wind power. If natural gas prices drop in the coming years, wind power's competitiveness might decline significantly, putting its potential carbon saving at risk. Without policies to maintain the competitiveness of wind power, it would be optimistic to assume that the high growth rate of wind power will sustain over decades.

B. Transmission bottlenecks

A large number of excellent wind sites are located in remote areas currently without either access to the power grid or, if they do have access, are without sufficient capacity to transmit the power output to population centers. A wind farm is impractical if it cannot sell electricity through the power grid. The transmission problems are widely recognized by the utilities and regulators. They are discussing, formulating and implementing measures for relieving the constraints in some places. For example, Texas has started the Competitive Renewable Energy Zones (CREZs) process. CREZ designation is designed to solve the "chicken-or-the-egg" transmission dilemma: wind project developers are reluctant to build in areas without transmission, while transmission developers would not build lines to such areas without any generation facilities. In July, 2005, the Texas State Legislature authorized the Public Utility Commission of Texas to designate CREZs and develop a plan to construct transmission lines to deliver electricity from the CREZs to customers. The CREZ transmission lines are paid for by all utilities consumers. The Texas CREZ is a pioneering model for resolving the transmission bottlenecks for wind power. California is also assessing CREZs both within the state and possibly in neighboring states.

Figure 2. Distribution of wind resources and transmission lines



However, on the national level, the transmission issues are far more complicated. The U.S. power grid is an extremely complex system. Seven Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs) operate the sections with deregulated power markets, where transmission and generation are managed by separate entities. Vertically integrated utilities operate the parts of power grid known as non-RTO areas. The power grid is divided into about 500 owners (Wald, 2008). As a result, a vast number of stakeholders (owners, operators, generators, consumers, regulators, etc.) with different interests are involved in the system. Different rules are followed at different parts of the interconnected grid. It is extremely difficult to obtain a permit to build an interstate transmission line. The fragmented governance has hindered the development of transmission system. For the past 15 years, investment in transmission lagged behind the growth of power demand and generation. There are already many bottlenecks and congestion problems in the system. The responsible institutions can barely keep up with the daily transmission demand, much less expand it to meet the future requirements of wind power. The balkanized institutional structure cannot be changed without a great deal of legal, regulatory, and institutional overhauls.

Many people are advocating for a national power transmission system to accommodate greater expansion of wind power. For example, the American Wind Energy Association (AWEA) has recommended several transmission corridors for wind power (AWEA, 2006). American Electric Power (AEP) proposed an interstate transmission backbone system for wind resources integration (American Electric Power, 2007). A consulting firm Anbaric Holding LLC also advocates a national electric superhighway (Krapels, 2008). However, it remains unclear how to overcome the institutional and regulatory barriers to carry out any of these proposals.

Because many existing transmission policies were developed with conventional power generators in mind, they place wind power at a disadvantage. For example, transmission users are often required to schedule their use of the transmission system in advance. Transmission operators historically would charge severe penalties on deviations to the schedule. The rationale for imposing such penalties was to motivate generators to follow their schedule. This turned out to be unfair to wind power generators, however, because they have no control over the schedule of wind. The FERC issued a Notice of Proposed Rulemaking on imbalance penalties for intermittent resources in April 2005 and adopted a final rulemaking that exempts intermittent generators (such as wind power) from higher imbalance penalties in February 2007. This particular case exemplifies a trend: as wind power becomes increasingly recognized as a mainstream power technology, transmission policies are gradually modified to accommodate the special features of wind power.

Cost responsibility for transmission upgrades represents another aspect of the transmission bottleneck. Currently, the standard approach is the first-mover-pays rule. A proposed generation project is responsible for the reliability effects and costs of all transmission upgrades associated with its particular interconnection. However, due to the relatively small size of wind projects compared to typical power plants, the cost of transmission upgrades often amount to a substantial burden. A wind developer often abandons a project at the last moment only to reenter the queue later to take advantage of a later developer's upgrades (Radford, 2007). In order to break the logjams, some transmission operators are in the process of changing the rules to spread transmission upgrade costs among multiple developers, utilities, or end-users. For example, the California Independent System Operator (ISO) has established a new category of transmission asset called Multi-User Resource Trunkline. The California ISO would invest in grid expansion in anticipation of new wind power projects and recover the cost through ISO-wide transmission access charges. As wind power gains importance in the power system, we may expect regulators to gradually adopt this type of rule change more broadly.

C. Intermittency

A major disadvantage of wind power is its intermittency[4]. The capability of managing fluctuant output is a default feature of every power system, however, simply because the demand for electricity is fluctuant. The consumption of electricity varies with the time of day and season of the year. Any electric power system would require a certain amount of dispatchable capacity with or without an intermittent source like wind. It is commonly quoted that as long as wind power constitutes a certain proportion of the electricity mix (about 20%), the intermittency of its contribution would have a very limited and manageable impact on the stability of the system. However, since no country in the world has ever operated a power system predominantly supplied with intermittent sources, rapid escalation of wind power to a dominant power source in the near-term would be risky.

Globally, Denmark has the highest percentage (nearly 20%) of wind power in its total power mix. The Danish grid manages the intermittency by interconnecting with the hydropower-dominated Norwegian grid. Hydropower is highly dispatchable and can therefore compensate for the intermittency of wind power. Rapid expansion of wind power in Texas has already had an impact on the power grid. On February 26, 2008, a sudden drop in wind power output triggered an electric emergency and forced the Texas grid operator to cut service to some large customers (O'Grady, 2008).

Intermittency may be mitigated by connecting an array of geographically-dispersed wind farms. The peak and trough of power outputs from different locations can cancel each other out and provide a relatively stable output. However, the transmission system in this country must be significantly improved to take advantage of the geographically-dispersed and interconnected wind systems.

Transmission capacity has a direct impact on wind power's profitability. When wind farms generate excess electricity that cannot reach demand due to constraints on the transmission grid, they are forced to pay the transmission operator to accept their electricity. Wind power generators are increasingly forced to accept negative prices[5] in the western part of Texas as wind projects have expanded in this area (Goggin, 2008).

A 2007 IEEE study surveyed studies on the impacts of wind power integration in the power system. It found that the cost of wind Integration is low (up to 10% of the wholesale value of wind energy) for penetration up to 20% (Smith, Milligan, DeMeo, & Parsons, 2007). However, there are concerns that

[4] Some argue that the term "variability" represent the problem better than "intermittency", because even when wind is blowing, the strength of wind is not stable and the power output is variable.

[5] Although the prices fall below zero, a wind plant may continue operating if the negative electricity price does not entirely negate the value of the 2 cents/kWh federal renewable electricity production tax credit plus the value of other state incentives.

these studies may not fully account for all the costs of intermittency. For example, as wind power expands, some of the combined cycled gas turbines (CCGT) originally designed for baseload operation may be forced to operate in dispatchable mode. Although it is technically feasible to operate CCGT as dispatchable capacity, the efficiency of CCGT will decline significantly with intermittent operation and the air pollution will increase too (Gotschall, 2008).

The grid system must deal with wind power intermittency as a part of its load management. There are many options to enhance grid operators' capacity in managing load fluctuation. For example, instead of paying a power producer to supply more output, a grid operator may pay the customer to shut down some of his/her electric appliances, which is known as demand side response (Chandler, 2008) or dispatchable load (IESO, 2008). Switching off some wind turbines for operational reserve or running them at reduced output (known as curtailment) can also be an option to ensure system stability (Gül, 2005). Although curtailment may be an effective method to ensure grid stability, it should used only as the last resort because this approach renders wind resources wasted. Better wind forecasting would enhance wind power's integration into the grid. Although wind power is now exempted from imbalance penalties, the aberrations to schedule still incur grid-wise costs. If wind forecasting becomes more accurate, the magnitude of aberration will reduce and wind power will become more competitive. Smart grids[6] may also improve load management and prevent system failures. In the long term, the problem with intermittency might be resolved if utility-scale electricity storage technologies become commercially competitive and widely deployed.

D. Wind turbine supply constraints: Quality and reliability

Since 2005, the demand for wind turbines has been outgrowing supply. Merrill Lynch identified the main bottleneck components as large bearings and gearboxes (Efiong & Crispin, 2007). Although manufacturers are already expanding their capacity to produce more gearboxes and bearings, the supply is unlikely to catch up with the fast growing demand in the next few years. This supply constraint allows manufacturers to raise their prices as well as profit margins. Although wind turbines remain generally available, the prices have increased significantly. According to BTM Consult APS, a Danish wind power consultant, the price of land-based wind turbines has risen 74% in the past three years (Greenwire, 2008).

There are two rationales behind suppliers' reluctance to expand faster. First, rapidly ramping up production has historically led to difficulties in quality control. Rapid expansion would inevitably bring in

[6] Smart grids are advanced power transmission systems equipped with intelligent, distributed, and highly-adaptive control systems to improve the efficiency, reliability, and safety of power transmission.

inexperienced managers and workers. The risks of mismanagement, lower productivity, and quality deterioration increase with the speed of expansion. In situations where certain components are highly sensitive to malfunctions—bearings and gearboxes are the wind turbine components most likely to malfunction—the suppliers' reputations are highly valuable assets. Quality control problems could ruin a company's reputation and jeopardize its long-term survival. Second, profit margins have historically been low, and the market growth rates have been volatile. The intermittent U.S. PTC policy certainly adds to this reluctance. Ditlev Engel, president and chief executive officer of Vestas, commented: 'Over the last 10 years, the U.S. production tax credit for wind generation has been extended repeatedly for brief periods. If you would have instead said in 1999, "Let's make a ten-year PTC," I can tell you we would already by now have seen many more industries being built and developed in the United States, including ourselves (Rosenberg, 2008).'

On the global level, the wind turbine market is oligopolistic. Less than ten turbine manufacturers, including Vestas (Denmark), Suzlon (India), GE Wind (United States), Gamesa (Spain), and Siemens (Germany), dominate the wind turbine markets in most countries except China, where the market is split by over 40 small domestic turbine suppliers plus the international manufacturers. Among major turbine producers, Suzlon has been relatively aggressive in expansion. Unfortunately, there have been news reports that Suzlon is having quality problems, which forced the recall of almost all the wind turbine blades it sold in the United States (Wright, 2008).

Many wind turbine components require labor-intensive manufacturing processes. Manufacturers may want to shift some of their production activities to countries with low wages. Although the difficulties in the transportation of large turbine blades push for local production, many other components may be outsourced. It is also possible to import blades of small turbines. Unlike major international turbine manufacturers that are conservative in expansion, Chinese wind turbine producers are expanding aggressively. With more than 40 wind turbine newcomers eager to capture a piece of this booming market, China is expected to become the world's largest producer of wind turbines by 2009 (Schwartz & Hodum, 2008).

Few Chinese turbine manufacturers operate internationally. They are mostly small startups without sufficient testing facilities and quality assurance systems. These companies are usually unable to provide warranty and maintenance service overseas. Shi Pengfei, vice president of the China Wind Energy Association, acknowledged that "quality control is a big problem" in China. Due to lower efficiency and more frequent technical failures, Chinese wind turbines operate at an average capacity factor of about 20%, which is significantly below global rates (~25–30%) (Nakanishi, 2008). Another disadvantage of Chinese wind turbine manufacturers is that they generally lack state-of-the-art technology and mainly focus on producing small turbines. (Although small turbines are easier to transport, they are less efficient.)

Up to now, wind power project developers in the United States have been cautious about their choice of wind turbine providers. Few developers are willing to purchase turbines from manufacturers without a good track record on reliability. However, their costs are significantly lower and supply is ample. Some developers may eventually be tempted to try turbines from unfamiliar suppliers. Some Chinese manufacturers are also trying to supply components such as gearboxes to major international wind turbine companies. For example, GE Energy has an agreement with Nanjing High Speed & Accurate Gear Company to jointly develop gearboxes for GE's 1.5-MW wind turbines.[7]

If the wind power industry is going to expand much faster than it is at present, a rapid increase of turbine and component production in China might be inevitable. Established wind turbine manufacturers and component suppliers might also have to expand at speeds faster than they can manage, resulting in the deterioration of wind turbine reliability. Institutional mechanisms to protect wind project developers may be necessary to prevent potential damage from substandard technologies.

E. Workforce constraint

Due to rapid growth in recent years, the wind power industry is currently facing a workforce shortage. The wind power industry needs specialized technicians with knowledge of mechanics, hydraulics, computers, and meteorology. The maintenance technicians must be willing to climb over 200–300 feet in all kinds of weather (LA Times, 2008). In the long term, as long as wind power remains profitable, more personnel will be trained and drawn into this industry. In the near term, however, if expansion accelerates beyond the rate of workforce buildup, the quality of construction, maintenance, and worker safety may suffer. In order to accelerate the workforce buildup, various government agencies will need to work together in developing vocational curricula and making such education programs more widely available.

V. Long-Term Challenge: Social Desirability

Supporters of wind power often take its social desirability for granted despite the existence of anti-wind groups. However, social attitudes toward a technology may lead to surprising turns in the long-term. For example, nuclear power was almost unanimously embraced as an environmentally friendly technology in the 1950s and the early 1960s, but strongly opposed by antinuclear groups after the 1970s. Hydropower

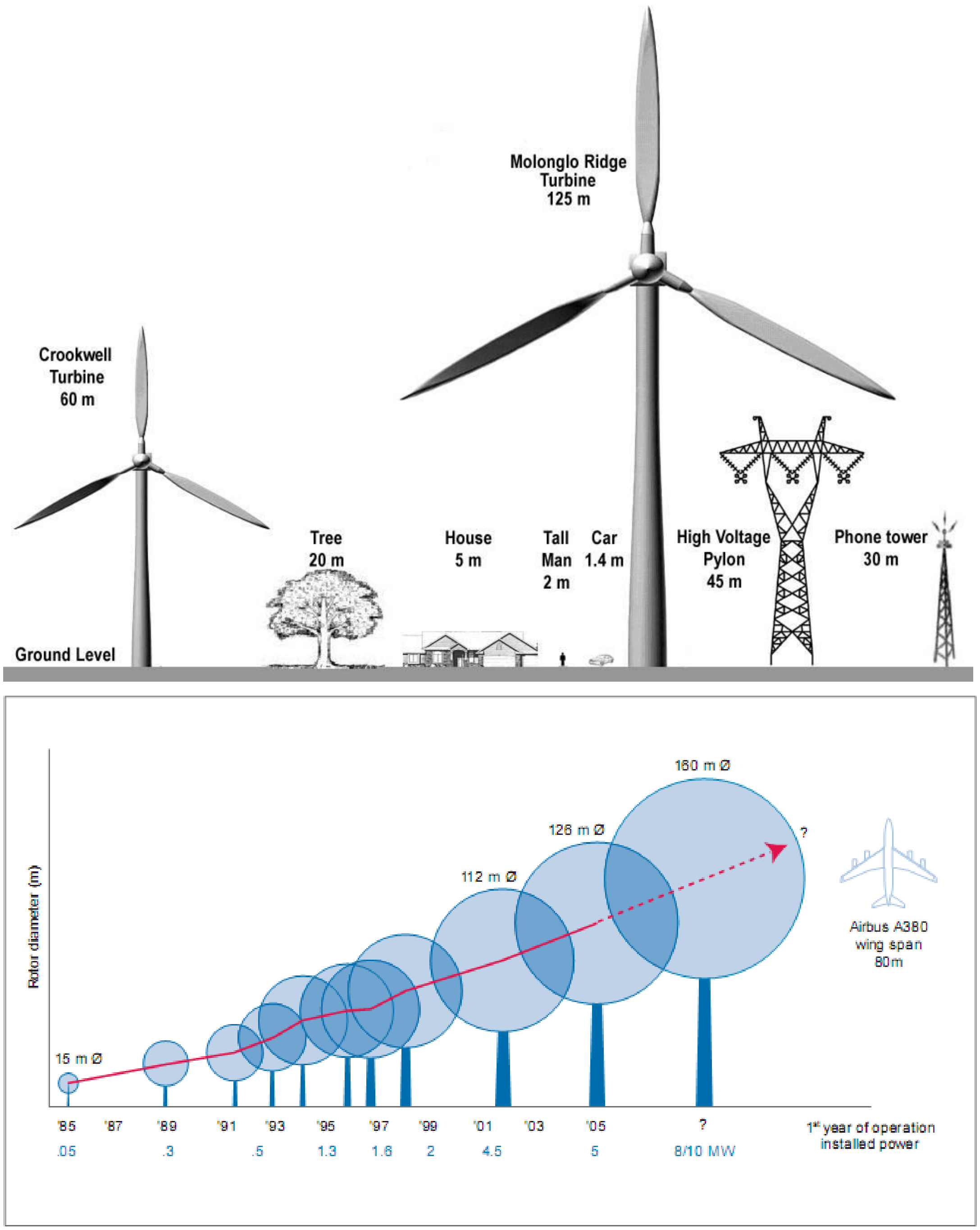
[7] http://www.ge-energy.com/about/press/en/2006_press/083006.htm.

was widely welcomed as engineering marvel in the 1930s and 1940s but has encountered widespread protests since the 1960s. Even the coal-fired steam engine used to be celebrated as the bringer of industrial civilization and a symbol of American progress in the late 19th century (Basalla, 1982). For a plan that requires several decades to implement (such as the DOE “20% Wind” vision), the potential changes in public attitude should not be slighted. If anti-wind sentiments are not taken seriously, they might jeopardize the long-term development of wind power.

The most frequently cited reasons for opposing wind turbine deployment include visual impacts on landscapes, noise, threats to wildlife (birds and bats in particular), and the potential negative impacts on property values. Research has shown that modern wind turbines generally have very limited impacts on noise and wildlife (U.S.DOE, 2008). However, it is incontrovertible that they are large and highly visible. Wind turbines often constitute dramatic modifications to landscapes, and a significant component of a property’s value is attributable to the surrounding landscape. According to the DOE 20% Wind report, only two U.S. studies have addressed the property value issues to date, and both studies found little evidence to support the claim that home values are negatively affected by the presence of wind power generation facilities.

The recent development of wind turbine technology also suggests that future wind turbines will likely continue to increase in size. With the expected rapid expansion of wind power, thousands of large-scale wind turbines are going to appear in many places. The transformation of landscapes in many places may be significant. Currently there are significant regional differences in attitude toward wind, and, fortunately, the best land-based resources are in areas where people are more inclined to accept turbines. However, whether the anti-wind sentiments will spread or intensify remains a considerable threat in the long-term future.

Figure 3. The sizes of wind turbines



Source: EWEA, Merrill Lynch

Wind farms are generally installed without monetary compensation to neighboring property owners. It is not uncommon for such dramatic landscape modification projects to be decided without informing all stakeholders. As wind power expands, its impacts on landscapes will inevitably become increasingly significant. It is important to formulate policies to mitigate these impacts and any potential social backlash.

VI. Policy Options to Address Barriers to Wind Energy

The ongoing wave of enthusiasm for faster expansion of wind power is facilitating the removal of many near-term bottlenecks. However, technological exuberance is likely a two-sided blade. Hasty expansion could eventually be counterproductive if policymakers and industry executives do not address the barriers described above. The following policy recommendations are aimed both at relieving near-term bottlenecks as well as addressing long-term social desirability.

A. Long-term investment certainty

1. Provide long-term price certainty with PTC and/or carbon price

The extension of PTC is unlikely to provide any further boost to wind power since the industry has already built it into their assumptions for the next 4–5 years. However, it will be serious blow if the PTC expires at the end of 2009. Unless the provision of PTC becomes permanent or at least long-term, the political uncertainty will likely continue to constrain suppliers' willingness to expand aggressively.

An alternative/addition to PTC is to impose a price on carbon emissions. Depending on the level and scope of the carbon price, it could provide wind power with a competitive advantage over fossil-fueled power. The incentive would be even stronger if the carbon price were coupled with the provision of a PTC.

2. Federal Renewable Portfolio Standard (RPS)

A renewable portfolio standard mandates utilities and other power providers to supply a specified minimum percentage of their power output with renewable energy sources. Wind power is usually the primary beneficiary of a RPS. Currently, twenty four states and the District of Columbia have a RPS.[8] RPS mechanisms tend to be most successful when the federal PTC is in place. During the hiatuses of the federal PTC, the RPS mechanisms alone were not able to sustain the growth of wind power. A federal RPS would provide a stable demand for wind power. It could also provide a long-term visibility of wind turbine market growth and encourage manufacturers to expand accordingly.

Renewable energy potential varies significantly among the states, however. If a federal RPS set a uniform standard without a mechanism to harmonize the unequal cost burdens due to divergent resources, it may not be fair to all the states. Several RPS proposals have been introduced in the Congress, but none

[8] http://apps1.eere.energy.gov/states/maps/renewable_portfolio_states.cfm.

has passed. The Edison Electric Institute, for example, has opposed a nationwide RPS. An important rationale for the opposition is that a federal RPS would "create inequities among states." It is possible to address the inequalities with proper design. For example, if the federal RPS scheme allows tradable credits, utilities in states without renewable resources may purchase renewable credits from resource-abundant areas and transfer the credits back to their home state to fulfill the RPS obligations. Market mechanisms would equalize the cost burdens among states.

B. Transmission

1. Federal funding for power transmission grid expansion

Although many stakeholders recognize the need to expand and upgrade the transmission infrastructure to accommodate wind power, they spend a great deal of time on allocating costs. Transmission operators tend to be reluctant to invest in grid expansion in anticipation of wind power projects because such investments tend to be risky. If the wind project is not completed as planned, their investment will be wasted. Wind project developers are also generally unwilling to pay for transmission expansions because it would amount to substantial financial burdens. Federal funding for new and upgraded transmission would accelerate the expansion of wind generation by removing concerns over who will pay.

2. Accelerate FERC rulemaking on transmission policies

The Federal Energy Regulatory Commission (FERC) routinely reviews transmission policies and makes or changes federal standards. As exemplified in the case of imbalance penalties for intermittent resources, the rulemaking process usually takes a year or two. A concerted effort to review transmissions rules and streamline the rule-development process may be necessary to facilitate the continued rapid expansion of the domestic wind industry. It is important to note, however, that changing transmission rules often involves complicated deliberations and numerous stakeholders. Whether the rulemaking process could be reasonably expedited without abridging stakeholders' rights needs to be assessed.

3. Federal Competitive Renewable Energy Zones (CREZ) process

The boom in wind energy in Texas is no coincidence. Texas is in a unique position to pioneer innovative policy like CREZ because Texas Interconnect is an independent power grid located entirely within the state of Texas. Unlike other parts of the United States, the Texas state government enjoys plenary authority over its power grid.

The Energy Policy Act of 2005 authorized the DOE to designate "National Interest Electric Transmission Corridors." For the first time in U.S. history, the FERC was granted limited authority[9] over transmission permit. The FERC has developed a permit process for the designated corridors. These corridors are designed to relieve existing transmission congestion rather than to support new deployment of renewable energy. If the purposes of the national interest corridors would be expanded to support renewable energy, they could be developed into the federal version of CREZ.

In order to replicate the Texas CREZ model nationally, the expansion and strengthening of federal authority over transmission would be necessary. At least two such bills have been introduced in Congress. In September 2007, Senator Harry Reid introduced the Clean Energy and Economic Development Act (S. 2076), which would require the President to designate national renewable energy zones and the FERC to promulgate regulations for cost recovery for transmission providers that build and operate facilities for the national renewable energy zones.

Representative Jay Inslee introduced the Rural Clean Energy Superhighways Act (H.R. 4059) in November 2007. The Act would require the President to designate national renewable energy zones and direct the FERC to pass regulations to ensure that investors of transmission capacity for renewable energy zones can recover their costs and a reasonable return through transmission service rates. It also directs the FERC to permit a renewable energy trunkline. In addition, the act would establish a Federal Transmitting Utility and a Transmission Fund that finances, owns, and operates electric transmission facilities of renewable energy trunklines (Logan & Kaplan, 2008).

4. Streamlining transmission permit process

The transmission permit process is highly complicated and uncertain. Permit difficulties have hindered investment in transmission capacity. Since the 1990s, utilities have added transmission capacity at a much lower rate than loads have grown (Hirst & Kirby, 2002). The regulatory authority over proposed transmission facilities is fragmented. Interstate transmission siting approvals are particularly complex and lengthy. Every state has its own transmission siting process, and the siting process is often contentious. Many communities along the transmission line may require local approvals. If the line crosses any federal lands or waterways, it will require additional approvals from respective federal agencies (Fox-Penner, 2001). The permitting process may take up to 10 years. In the case of Cross Sound Cable (connecting Long Island and Connecticut), legal disputes delayed the commercial operation even

[9] The FERC permit authority is strictly limited to the DOE-designated "National Interest Electric Transmission Corridors" and it is triggered only when the states have failed to act.

after the construction was completed.[10] States historically have had exclusive, plenary jurisdiction over transmission siting. The authorization of a limited federal role in transmission siting in the Energy Policy Act of 2005 could be the first step toward a gradual regulatory overhaul. It would be helpful if Congress further expanded and strengthened the FERC's authority over the permit process and instructed the FERC to streamline the process.

5. Creation of a national power grid

An underlying cause of the difficulties in revamping the national power grid is rooted in its balkanized institutional structure. The U.S. electric grid was not originally designed as a nationally integrated system. It is a collection of numerous small grids that were initially built by individual utilities to meet customer needs with locally generated electricity. The regulatory oversight was set up mainly at the state level. The FERC has only limited authority restricted to interstate issues. State public utility commissions (PUCs) generally allow cost recovery for only the projects with direct benefits to the state's rate-payers. It is difficult to gain approval for the financing of interstate transmission. Siting approvals are similarly confined by state boundaries. Siting a proposed transmission line is a localized process. Those seeking to construct new interstate transmission lines have to comply with the varying and potentially inconsistent requirements of several jurisdictions. Local oppositions often block projects that are in the broader public interest. The United States lacks a national system of long-range transmission backbones and has no institutional arrangement that can construct and maintain such a system. There are proposals on the physical design of interstate electric superhighway (American Electric Power, 2007) (Krapels, 2008), but the institutional and legal arrangements for implementing these plans are lacking.

If an institution is established and authorized to build, own, and operate a national power grid, the decision-making, rulemaking, and financing might be greatly simplified and accelerated. Certainly, it would be a daunting political challenge to nationalize the grid. However, the creation of a national power grid may proceed gradually and incrementally. The federal authority on National Interest Electric Transmission Corridors was a small step toward centralizing authority over the power grid. The next step could be further strengthening federal siting authority (Lewis, 2001).

It has been recognized that the U.S. power grid is outdated and that revamping the power grid is an urgent task. The need to revamp the antiquated and fragmented institutional structure should be as important as revamping the physical infrastructure.

[10] The cable was completed in 2002. There were continued legal disputes over possible environmental impact of buried undersea cable. The legal challenges delayed the operation until after the August 14, 2003 blackout, when the DOE ordered emergency permission for operation. The cable has since been operating.

6. Deploying smart grid technologies

Smart grids use automated systems (such as remote sensing equipment and automated switches) to improve the management of fluctuant loads. The system will be designed to anticipate and automatically respond to system disturbances (a feature known as “self-healing”). Smart grids are supposed to help prevent power outages, limit their spread, and restore power more quickly; they would therefore improve the power grid’s capacity to accommodate intermittent power sources such as wind. Title XIII of the Energy Independence and Security Act of 2007 established the Federal Smart Grid Task Force to coordinate smart grid activities across the Federal government and the DOE has developed plans to develop and deploy the smart grid. Supporting the deployment of the smart grid would facilitate the integration of wind energy into the power grid over the long-term.

The DOE wants state regulators to require utilities to at least consider smart grid technologies before they propose power plants or transmission lines. However, although the remote sensing and automatic response devices could enhance the reliability, efficiency, and security of the power grid, they may not qualify as a transmission capacity upgrade, transmission expansion, or power generation. Under current pricing rules (which differ from place to place), investors of smart grid devices may not be able to recover their costs. Smart grid technology may benefit a wide range of free-riders, but the incentives to stimulate smart grid investments are lacking (NETL, 2007). In order to facilitate the deployment of smart grids, it is important that the regulations are modified such that investment becomes profitable.

C. Wind turbine supply quality and reliability

1. Testing facilities and quality certification system

Rapid expansion of the wind power industry may cause deterioration of quality control. The continued shortage of wind turbines may also force project developers to accept inexperienced suppliers. Although major established wind turbine manufacturers have in-house testing facilities, new and small entrants often lack of such capacity. Ensuring quality may become challenging with accelerated wind power deployment. The federal government could help mitigate this risk by providing testing facilities and quality certification services to domestic wind project developers. Historically, the lack of authoritative product information and the absence of institutional mechanisms to provide such information contributed to the massive failure of American wind turbine industry in the 1970s and 1980s (Est, 1999). In order to ensure safety and reliability, the federal government may need to establish a trustworthy certification system and provide transparent information on wind turbine quality and reliability.

2. Domestic production activities deduction

The American Job Creation Act of 2004 created a tax deduction for incomes attributable to domestic production activities. The percentage of the deduction is 3% for 2005–2006, 6% for 2007–2009, and 9% for 2010. If such a tax deduction is increased to encourage the local production of clean energy technologies, it may encourage wind turbine manufacturers to locate their production lines in this country.

D. Education/workforce training

1. Developing occupational curricula for wind power workers

While policymakers who focus on the wind industry may recognize the industry's increasing need for qualified employees, it is not yet recognized as a priority among policymakers who focus primarily on labor and education issues. The Department of Energy maintains the Energy Efficiency and Renewable Energy Clearinghouse, which collects curricula for occupations including wind power mechanical and electrical technicians. Federal agencies overseeing education and labor, on the other hand, have not yet developed occupational curricula for wind power workers. The National Skill Standards Board Institute is in charge of developing and disseminating industry-based skill standards. The Office of Vocational and Adult Education in the Department of Education provided initial support for state vocational education agencies to jointly develop curriculum focused around career clusters. Better inter-agency coordination would more effectively address the emerging need for wind power talent.

2. Funding for college programs and retraining of unemployed workers

Entry-level wind power technicians generally require six months to two years of training, which would be appropriate for technical and community colleges. The government may provide funding to technical and community colleges and universities for wind power programs to facilitate the workforce buildup. Retraining workers who have lost their jobs with the skills needed to work in wind power could reduce unemployment and relieve workforce constraint in wind industry.

E. Research and development

1. Wind turbine technologies

Continued research and development (R&D) are essential for the long-term competitiveness of wind power technology. Improvements in the efficacy of wind blades and turbines, as well as the strength, weight, and fatigue-resistance of materials, will increase the efficiencies and life spans of wind turbines.

New technologies may also reduce the cost of wind machines. Although industries do conduct their own research and development, government support is also important. The Department of Energy has been supporting such research and conducting much of it at its national laboratories. It is important to continue or expand the R&D.

2. Wind/weather forecasting

Better wind forecasting would make the intermittency more manageable. Wind power generation is directly linked to weather conditions. Accurate wind power forecasting must rely on accurate weather forecasts, the improvement of which requires a great deal of basic meteorological research. It is not generally profitable for wind power companies to invest in meteorological sciences and weather forecasting. The National Oceanic and Atmospheric Administration (NOAA) is in charge of weather forecasts in the United States, and wind power forecasters rely on NOAA for meteorological variables. It is important that NOAA continue to improve weather forecasting and the meteorological sciences.

3. Utility-scale energy storage

Utility-scale/grid energy storage is used to store excess electricity from the grid and release it when needed. In the long-term, as wind power expands, utility-scale energy storage facilities may be necessary to manage the intermittency. This scenario may arrive sooner than expected if wind power expands at accelerated speeds. The storage for wind power requires massive capacity. Potential utility-scale power storage technology indeed exists, such as pumped storage hydroelectric power, compressed air energy storage, and grid-tied batteries. Few of these technologies, however, are widely employed and commercially available. Further research, development, and demonstration are required to facilitate the deployment of utility energy storage.

F. Siting/landscape issues

1. Streamlining siting processes

Wind power siting processes are developing rapidly with legislative or regulatory changes occurring regularly across the country. The process differs from state to state, and not every state has siting guidelines. Potential offshore wind sites are largely within the jurisdiction of the federal government, which has not yet developed a streamlined licensing process for offshore wind projects. The first offshore wind power project in the United States[11] filed an application in November 2001 and has not yet been approved. This process is even lengthier than the siting schedule of a nuclear power plant. For

[11] Cape Wind proposed to build this offshore wind farm on Horseshoe Shoal in Nantucket Sound at Cape Cod, Massachusetts.

example, Exelon applied for an early site permit for a nuclear power plant at Clinton, Illinois in September 2003 and received approval in March 2007. In order to facilitate the siting process, the federal government may need to develop a consistent methodology to review and approve projects.

After the Fish and Wildlife Service published its "Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines" in 2003, the American Wind Energy Association (AWEA) complained that the guidelines were published before consulting the wind power industry and commented that they cause many unnecessary delays and unreasonable difficulties in siting wind power projects (AWEA 2003). AWEA also finds that the U.S. Forest Service's licensing directives[12] pose unnecessary hurdles and delays for wind power projects. The Minerals Management Service, which is in charge of regulating alternative energy projects on the Outer Continental Shelf, is expected to finalize its licensing regulations by the end of 2008. According to AWEA's comments, the Bureau of Land Management (BLM)'s siting policy[13] is relatively favorable for wind power development. AWEA recommends using BLM's licensing policy as the model for other licensing rules.

2. Guidelines on landscape preservation

There is a general consensus that the most valued landscapes (such as national parks, national historical monuments) should be preserved and not be made available for installing wind turbines. However, there will always be gray areas where people disagree on the tradeoff between the values of landscape aesthetic and clean energy. The Nantucket Sound offshore wind power project is a salient example. Currently, there is a lack of guidance on landscape preservation. Local communities are often unpleasantly surprised by the imposition of wind power projects, triggering outrage and causing the stakeholders to perceive wind turbines in negative ways. Any proposal that involves significant landscape transformation should require early engagement of stakeholders. However, if the engagement process is designed in a way that allows local communities to veto or delay projects, it might increase the hurdle for wind developers. It requires a carefully designed policy with clear guidelines on landscape preservation to clarify the gray areas, reduce conflicts, and facilitate the siting of wind projects. While it may be more appropriate for plan development and implementation to occur at the state and local levels, federal policymakers may consider providing guidance and resources to assist with the efforts.

3. Indemnification of visual impact liability

Some landowners who lease lands to wind project developers are requesting compensation for losses in property value that might occur as a result of the wind turbines. Due to the subjective and intangible

[12] The directives apply to lands managed by Forest Service.
[13] This policy applies to lands that are managed by the Bureau of Land Management.

nature of visual impacts, the loss of property value is difficult to measure. Landowners are not the only ones who could claim to be victims. If wind power companies bear the burden of all possible losses of property values in the viewshed of its turbines, the liability might become an unbearable risk. Although studies in the past indicate that wind turbines had no significant impacts on property values, the experience from the past is not a sufficient warranty for the future.

A possible way to reduce the risk of wind power projects is for the government to indemnify the liability of visual impacts. While wind turbines have other impacts (noise, wildlife, gear oil pollution, etc.), visual impacts are the most intangible and therefore the associated financial risks are the least predictable. If Congress preempts with an indemnification, the possible liability may be contained. However, it is also possible that an indemnification law may be interpreted as an official recognition of wind power's detrimental effect on property value and trigger more opposition. It is important to assess the pros and cons before pursuing such a policy.

VII. Conclusion

Wind energy is a valuable and abundant energy resource. It can provide clean and inexhaustible electricity at competitive prices. Although wind power is already on a track of rapid expansion, many barriers limit its ongoing growth. In order to sustain a long-term rapid expansion of the industry, policymakers need to address these barriers. This policy brief should provide useful ideas in developing effective policies for the sustainable expansion of wind energy. While this brief provides a broad overview of the issues, further briefs will address specific barriers in more detail.

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