

# WIND POWER OUTLOOK 2007

## Wind: Powering a Cleaner, Stronger America

Wind power is striding into national public view as the elegant icon of energy security and action to curb global warming, and for good reason. Clean, cost-effective, inexhaustible, and readily available, wind power is an essential element of the solution to both climate change and America's increasing demand for electricity.

As this annual report points out, the U.S. wind energy industry is putting up equipment in record numbers. Wind is now one of the largest sources of new power generation in the country, second only to natural gas for two years in a row. Further increasing the percentage of electricity wind produces in America will help stabilize electricity costs, generate revenue for farmers and rural communities, and create tens of thousands of jobs, while powering our economy with a domestic, emissions-free source of energy.

The American Wind Energy Association (AWEA) estimates that, after installing over 2,400 megawatts (MW) in 2006, the industry will install over 3,000 MW in 2007. About 31 billion kilowatt-hours (kWh) will be generated by wind power in the U.S. in 2007, enough electricity to power the equivalent of nearly 3 million average homes.



Courtesy PPM Energy

Demand for wind power is booming because wind is a source of energy that is both clean and cost-effective.

As wind power grows at a rate of 25%-30% per year, it creates employment. In 2006 alone, leading wind turbine manufacturers opened facilities in Iowa, Minnesota, Texas,

and Pennsylvania. New contracts for wind energy components such as towers and gearboxes create jobs across the country, even in states that do not have a large wind resource. Many rustbelt communities that have been losing manufacturing jobs now see economic opportunity returning thanks to the high demand for wind turbines.

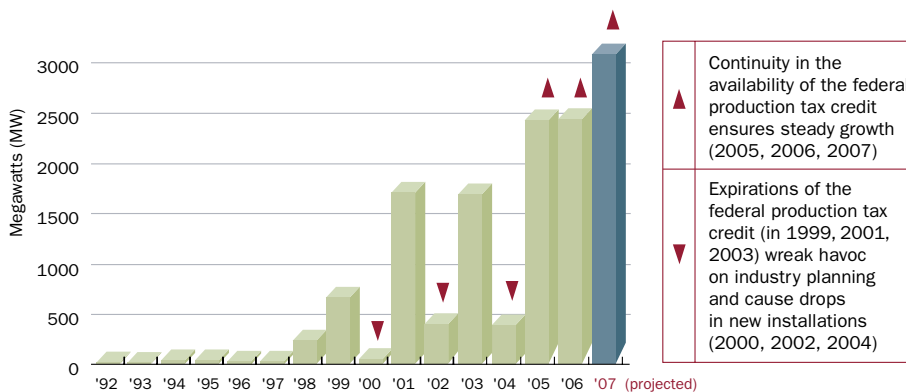
Winds of change are blowing in the heartland as well. Farmers reap a "second crop" year round from turbines in their fields, earning income that can help them to stay on the land and preserve a way of life. The wide open landscape where once-ubiquitous windmills helped homesteaders and ranchers pump water for their cattle now plays host to a new generation of wind turbines that generate clean, inexhaustible power.

The clean symbol of the wind turbine is also popping up as a call to action against global warming, from wind energy purchases by stores like Starbucks and Staples and ski resorts in New England and the Rockies to rural towns in the heartland. Businesses are reducing their carbon footprint by purchasing wind power. Politicians, heeding public opinion, are calling for clean energy in their policy platforms.

Winds of change... How strongly are they blowing? As this report suggests, that will largely depend on the policies and infrastructure we put in place today. Just as they have promoted successive waves of coal, nuclear and other technologies, policies can today support the next windy, sunny, renewable wave. The choice is ours.

Executive Director  
American Wind Energy Association

### Annual Installed U.S. Wind Energy Capacity On the Rise



# Market Trends: All About Growth

## LARGER PROJECTS:

Eight of the 45 new wind projects completed in 2006 were over 100 MW in size, including the world's largest single wind farm: FPL Energy's 735-MW Horse Hollow Wind Energy Center in Taylor and Nolan counties, Texas.

## LARGER TURBINES:

Today's wind turbines are twice as powerful on average as those installed just six years ago (the average generating capacity of a turbine installed in 2006 was 1.6 MW, up from 0.76 MW in 2000) and generate enough electricity to serve the equivalent of 400 homes or more. The largest wind turbines installed in 2006 – in Rio Vista, California – are again twice that size (3 MW).

**Today's wind turbines are twice as powerful on average as those installed just six years ago.**

## LARGER COMPANIES:

Mergers and acquisitions are a natural cycle in the maturation of the market. Examples from 2006 include Babcock & Brown acquiring Superior Renewable Energy, BP acquiring Orion and Greenlight Energy, and international energy giant Iberdrola

buying up Community Energy, Midwest Renewable Energy, and moving to acquire ScottishPower and its U.S. subsidiary PPM Energy, one of the country's largest owners and developers of wind projects.

## MORE AVAILABLE CAPITAL:

Investment dollars are eager to find their way into this fast-growing sector. In contrast to the 1990s when the high cost of capital constrained the industry's growth and only a handful of European financial institutions were funding U.S. wind energy projects, today's financiers come from a broad base of U.S. and international institutions - a sign that wind is one of the most attractive energy markets in the U.S. today.

## HIGHER COSTS HITTING ALL TECHNOLOGIES:

Worldwide appetite for steel and other factors have driven up capital costs for all power technologies including wind. However, wind's comparative cost-effectiveness has not been eroded because wind is spared from increases in the price of fuels (such as natural gas and coal) needed to run conventional power plants (see cost graph below). What's more, new turbines' increased productivity partially offsets the increase in the cost of new equipment.

## SUPPLY CHAIN GROWING PAINS:

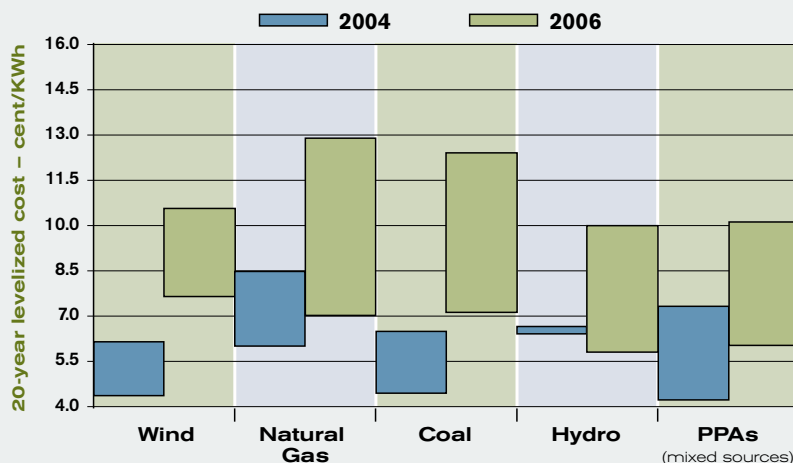
The U.S. and global wind energy markets are facing a wind turbine shortage as demand for wind power continues to increase. To foster development of a robust supply chain, the U.S. government needs to provide steady policy support including a national renewable portfolio standard (RPS) and a long-term extension of the renewable energy production tax credit (PTC). Previous short-term extensions have led to a boom-and-bust cycle that prevented businesses from growing to their full potential. Long term incentives would unleash literally billions of dollars of investment.

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Courtesy Gamesa Eolica

## Wind In Competitive Range: Costs Going Up For All Resources



Puget Sound Energy (PSE), like other utilities throughout the country, faces significant increases in resource costs. The company's major investments in wind have made PSE the largest utility producer of renewable energy in the Pacific Northwest.

Data and slide courtesy Puget Sound Energy.

## From Rustbelt to Windbelt

When Gamesa, a Spanish wind turbine manufacturer, decided to open new facilities in Pennsylvania, the company reused an abandoned U.S. Steel plant in Bucks County, PA. The three state-of-the-art wind turbine facilities that now stand on the former plant's 20 acres:

- Won an award for design and construction innovation, and renovation of an environmentally blighted site;
- Employ more than 300 skilled laborers, creating much-needed manufacturing jobs in the area;
- Produce high-tech blades, nacelles, and towers for the company's line of 2.0-MW turbines;
- Ensure the production of clean, inexhaustible energy in the U.S.

# Wind Power: An Essential Element of the Climate Change Solution



Warming of the planet's climate system is beyond doubt and on track to cause massive disruptions, according to the world's scientists. Dramatic illustrations of global warming's impacts are the rapid rise in Arctic temperatures, which are increasing at almost twice the global average rate, and the notice by the U.S. Fish & Wildlife Service to list the polar bear as threatened.

**The good news is that wind power makes it feasible and affordable to achieve a big chunk of the aggressive reductions in emissions of carbon dioxide (CO<sub>2</sub>) that scientists say are needed.**

## WIND CAN DELIVER ZERO-EMISSIONS ELECTRICITY IN LARGE AMOUNTS:

According to a study by the American Solar Energy Society (ASES), energy efficiency and renewable energy technologies can provide most, if not all, of the U.S. carbon emissions reductions needed to contain atmospheric carbon concentration at 450-500 parts per million (ppm), the level targeted in the more protective climate change bills before Congress (we're at 380 ppm today). In this ASES scenario, wind provides about 20% of electricity supply — the share envisioned by President Bush in a speech in 2006 — and is one of the largest reduction “wedges.”

## WIND DELIVERS ZERO-EMISSIONS ELECTRICITY AT AN AFFORDABLE COST:

No other new power plants being built in the U.S. today generate ZERO-emissions electricity at a cost per kilowatt-hour anywhere near as affordable as wind. In fact, for both economic and environmental reasons, it makes sense to include more wind into the nation's electricity mix.

A national requirement to generate 20% of electricity from renewable sources by 2020 would lower emissions by more than 400 million tons of CO<sub>2</sub> per year by 2020, while saving American consumers nearly \$50 billion in electric and natural gas bills, according to the Union of Concerned Scientists.

## THE AFFORDABLE COST OF WIND IS

**STABLE OVER TIME:** Wind farms do not use any fuel for their operations, so the price of wind power does not vary when fuel prices go up. When utilities acquire wind power, they lock in electricity at a stable price for twenty years or more.

## WIND POWER IS READILY AVAILABLE:

America's wind resource is vast, wind power technology is reliable, and wind farms can be developed in a short time frame. Study after study, as well as experience in Europe, suggests that it is technically feasible to integrate 20% wind power or more into large regional electrical systems. Adjustments in transmission policy and investment in transmission infrastructure can help make this a reality.

## WIND POWER DELIVERS COMPOUND

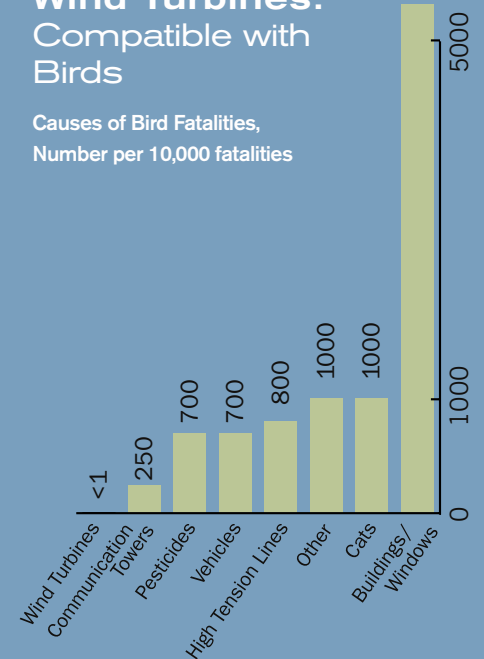
**ENVIRONMENTAL BENEFITS:** Wind power operates without emitting any greenhouse gases (GHG) and has one of the lowest GHG lifecycle emissions of any power technology. In addition, wind causes no emissions of harmful pollutants, no mining or drilling for fuel, no radioactive or hazardous wastes, and no use of water for steam or cooling. Wind farms can spread out over large areas but their footprint is light as farmers and ranchers continue to work the land up to the foot of the turbines. Most land uses remain as before when a wind farm is installed.



Courtesy GE Energy

## Wind Turbines: Compatible with Birds

Causes of Bird Fatalities, Number per 10,000 fatalities



Data Sources: Erickson et al., 2002. Summary of Anthropogenic Causes of Bird Mortality.



# More Wind, More Jobs

Wind power is a source of new jobs, especially in manufacturing. Across the U.S., many rural towns and cities that have lost economic ground from the decline of once-reliable and flourishing industries such as steel are now seizing an opportunity to make a comeback. From Pennsylvania to Iowa, from North Dakota to Louisiana, manufacturing facilities – each of which employ hundreds of workers, are popping up – all because of the demand for wind.

In 2006, four **wind turbine manufacturers** (Clipper Windpower, Gamesa, Siemens and Suzlon) opened new U.S. manufacturing and assembly plants. TECO/Westinghouse announced an agreement with DeWind to manufacture wind turbines in a new facility in Texas.

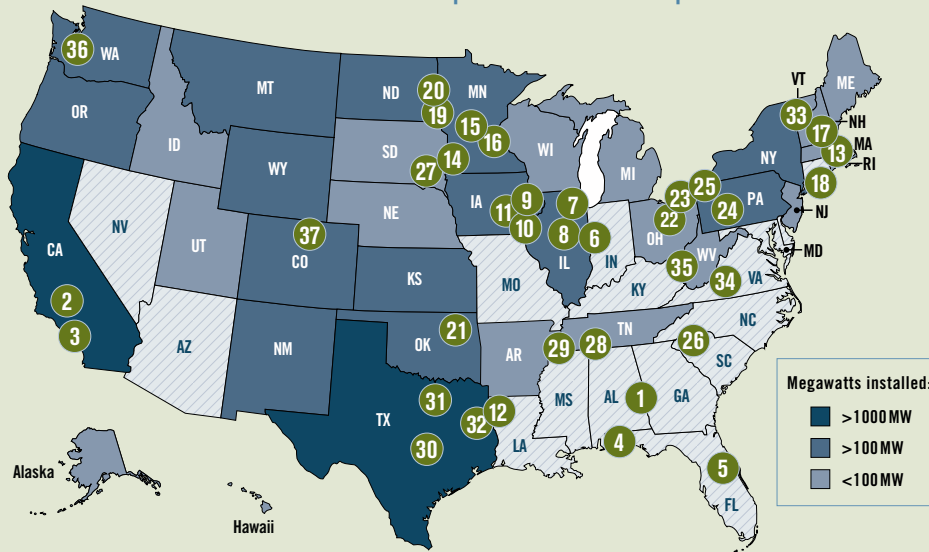
Vestas, the world's largest wind turbine manufacturer, plans to open a facility in Colorado, the company's first-ever in the U.S. In early 2007, Acciona Energia of Spain announced that it would build a new wind turbine manufacturing facility in West Branch, Iowa.

Investment and new business is also flowing into the **supply chain**, which is seeing significant increases in orders. In Clinton, Illinois, a long-vacant freight car plant is now ringing again with the sound of repairmen reconfiguring it to produce towers for wind turbines, as Texas-based manufacturer Trinity expands its wind tower production line to meet demand across the country. In Oakley, Ohio, Cast-Fab, an almost century-old metal foundry, now manufactures iron

hubs and castings for wind turbines. Wind power is also creating jobs in **services** like engineering, transportation, wind assessment and forecasting, legal and financial services, marketing, and more.

The long dry spell in U.S. wind turbine manufacturing investment appears to have been broken. A long-term extension of the production tax credit (PTC) and a national renewable portfolio standard (RPS) requiring that a growing amount of electricity be generated from renewable sources would sustain and accelerate the economic and job growth we are already seeing today. Just as wind's energy potential has barely been tapped, we have only just begun to see wind's potential to create economic benefits.

## Utility-scale Wind Turbine Manufacturing and Supply Chain: Examples of Companies Across the U.S.



Wind power creates manufacturing jobs even in regions like the Southeast that do not have a large wind resource.

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| <ul style="list-style-type: none"> <li>1 <b>Vectorply</b>, Phenix City, AL (composites for blades)</li> <li>2 <b>GE Energy</b>, Tehachapi, CA (wind turbine manufacturing facility)</li> <li>3 <b>Bragg Crane &amp; Rigging Service</b>, Long Beach, CA (cranes, rigging, transportation)</li> <li>4 <b>GE Energy</b>, Pensacola, FL (blade technology development)</li> <li>5 <b>Mitsubishi Power Systems</b>, Lake Mary, FL (gear boxes)</li> <li>6 <b>White Construction Inc.</b>, Clinton, IN (construction services)</li> <li>7 <b>Winergy Drive Systems Corporation</b>, Elgin, IL (gear units, generators, power converters)</li> <li>8 <b>Trinity Industries</b>, Clinton, IL (towers)</li> <li>9 <b>Clipper Windpower</b>, Cedar Rapids, IA (turbine manufacturing, assembly)</li> <li>10 <b>Siemens</b>, Fort Madison, IA (blades)</li> </ul> | <ul style="list-style-type: none"> <li>11 <b>Acciona Energia</b>, West Branch, IA (planned) (turbine manufacturing)</li> <li>12 <b>Beaird Industries</b>, Shreveport, LA (towers, tower flanges and bolts)</li> <li>13 <b>Second Wind Inc.</b>, Somerville, MA (anemometers, electronic controllers, sensors/data loggers)</li> <li>14 <b>Suzlon Wind Energy</b>, Pipestone, MN (blade manufacture, turbine assembly)</li> <li>15 <b>D.H. Blattner &amp; Sons</b>, Avon, MN (construction)</li> <li>16 <b>M.A. Mortenson Co.</b>, Minneapolis, MN (construction)</li> <li>17 <b>Hendrix Wire &amp; Cable Inc.</b>, Milford, NH (cables to substations)</li> <li>18 <b>Hailo LLC</b>, Holbrook, NY (ladder and lift systems)</li> <li>19 <b>DMI Industries</b>, West Fargo, ND (towers)</li> <li>20 <b>LM Glasfiber</b>, Grand Forks, ND (blades)</li> <li>21 <b>Trinity Structural Towers</b>, Tulsa, OK (towers)</li> </ul> | <ul style="list-style-type: none"> <li>22 <b>Owens Corning Composites</b>, Granville, OH (composites for blades)</li> <li>23 <b>Hamby Young</b>, Aurora, OH (substations and high voltage applications)</li> <li>24 <b>Gamesa</b>, Ebensburg, PA (blade, nacelle, tower manufacturing)</li> <li>25 <b>GE Energy</b>, Erie, PA (wind turbine components)</li> <li>26 <b>GE Energy</b>, Greenville, SC (turbine assembly plant)</li> <li>27 <b>Knight &amp; Carver</b>, Howard, SD (blade manufacturing)</li> <li>28 <b>Aerisyn Inc</b>, Chattanooga, TN (towers)</li> <li>29 <b>Thomas &amp; Betts Corp.</b>, Memphis, TN (towers, tower flange and bolts)</li> <li>30 <b>DeWind, Inc./TECO Westinghouse</b>, Round Rock, TX (wind turbine manufacturing)</li> <li>31 <b>Trinity Structural Towers</b>, Fort Worth, TX (towers)</li> <li>32 <b>CAB Incorporated</b>, Nacogdoches, TX (blade extender, hub, nacelle frame, tower flange and bolts)</li> <li>33 <b>NRG Systems</b>, Hinesburg, VT (anemometers, sensors/data loggers)</li> <li>34 <b>GE Energy</b>, Salem, VA (wind turbine components)</li> <li>35 <b>Tower Logistics</b>, Huntington, WV (lifts for turbines)</li> <li>36 <b>PowerClimber</b>, Seattle, WA (traction hoists, rigging equipment)</li> <li>37 <b>Vestas</b>, Windsor, Colorado (planned) (blade and turbine manufacturing)</li> </ul> |
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# Wind: Next Big Option for New Power Generation

Wind energy is growing fast. But just how quickly will it expand as a share of total electricity supply? To what extent will conventional technologies continue to provide the lion's share of electricity?

Our current electricity supply was built up in successive waves, as one technology rose to meet the needs of a particular time and market, and then was succeeded by another (see chart below). After the heroic era of dam building for **hydroelectric power** during the Great Depression, **coal** became the largest source of new power generation for decades, providing massive amounts of electricity for the economy's growth. With years of intensive subsidies, **nuclear power** capacity was built up in the 1970s and 1980s, further centralizing our electricity supply. **Natural gas** surged to about 20% of U.S. electricity supply in less than two decades, fueled by the opening of the monopoly energy business to competition and the search for cleaner energy sources. With the rise of natural gas prices, that spectacular boom is coming to an end. **Wind** has now been the second-largest source of new electricity generation for two years in a row. Could wind be the next big wave?



Courtesy Alliant Energy

"I recognize the importance of wind power... It's possible we could generate up to 20% of our electricity needs through wind."

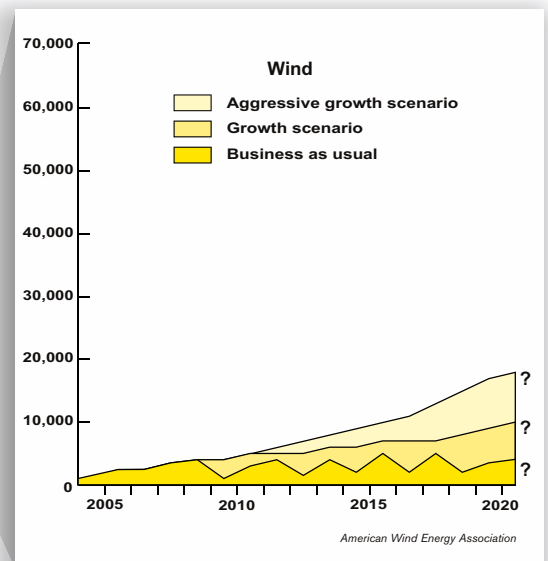
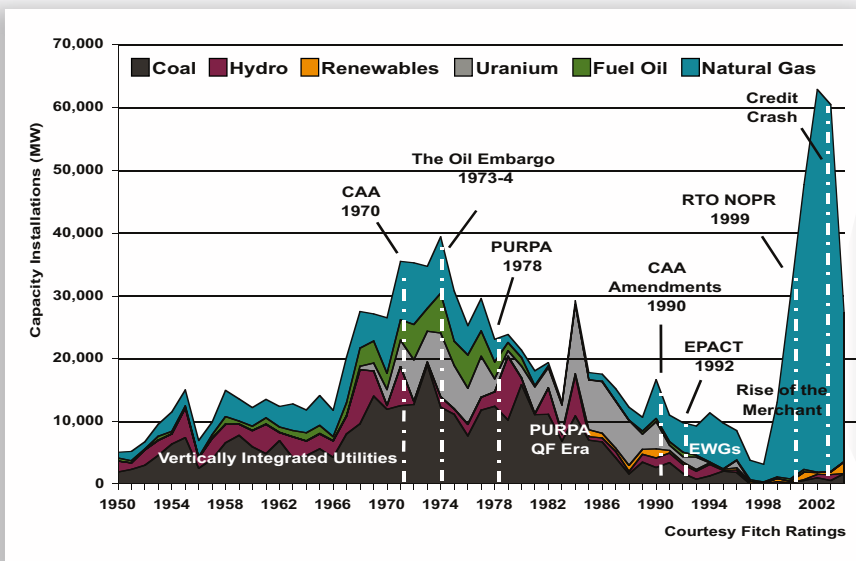
President George Bush

Scenarios regarding our energy future differ widely-- but they do agree on one thing: if policies and regulations remain on a business-as-usual or incremental course (with only modest constraints on carbon emissions for example), the share provided by wind will grow, but will not approach its real potential, which many estimate at 20% or more of electricity supply. Indeed, the news is full of announcements of proposed coal plants (about 150 as of early 2007 according to the U.S. Department of Energy, of which only about a third were considering technologies to reduce carbon dioxide emissions) and of the possibility of new nuclear plants.

The energy market is at a critical juncture. For wind, other renewables, and efficiency to make up the next new, clean wave, we need a transformation of our energy practices, policies, and infrastructure, starting with minimum requirements and standards (renewable portfolio standard), tax incentives (long-term production tax credit), and aggressive limits on emissions. One area where transformation is also vital is our electricity transmission rules and infrastructure.

## Our Electricity Supply Was Built up in Successive Waves: Will Wind Be Next?

### Annual U.S. Generating Capacity Installations by Source





Courtesy GE Energy

# Electricity Transmission Rules and Infrastructure: Key to the Nation’s Strategic Wind Resource

What’s needed	Progress to date	What’s left to do
<p><b>Geographically larger electricity markets:</b> Needed because the larger the market, the easier it is to balance variable supply and demand. In addition, the more spread out the wind farms, the smoother their aggregate output.</p>	<p>Large regional transmission organizations (RTOs) exist in the East, Midwest, California and Texas and wind is being successfully integrated into these regions. But progress in setting up RTOs is slow in the rest of the country.</p>	<p>Continue to create RTOs. Provide utilities in smaller, non-RTO systems with the ability and incentive to function as part of broader balancing and transmission areas.</p>
<p><b>Fair standards for connecting to transmission lines:</b> Needed because interconnection standards were originally designed for conventional power technologies, and did not “fit” new technologies like wind.</p>	<p>Standardized national interconnection rules and “grid code” standards specifically designed for large, utility-scale wind turbines are in place since 2005. Wind turbines can now contribute to overall electric system stability.</p>	<p>Reliability rules will undergo continual development as wind penetration increases. These rules must not discriminate against wind.</p>
<p><b>Non-discriminatory policing of existing transmission lines:</b> Needed because transmission rules were originally designed for dispatchable, conventional power and impose penalties on deviations from schedule (“imbalance penalties”). Since wind farm output fluctuates naturally, penalties can run so high as to price wind out of the market.</p>	<p>The Federal Energy Regulatory Commission (FERC) has recognized that wind and other weather-dependent, renewable technologies have different output characteristics and has sought to remove discriminatory barriers to their market access. FERC Order 890 (February 2007) on transmission reform specifies that for wind power, penalties and charges due to wind’s variable nature should be based on actual costs.</p>	<p>The section of FERC Order 890 on imbalance penalties now needs to be applied in all energy markets.</p>
<p><b>More efficient use of existing transmission lines:</b> Needed because long-term, “firm” contracts can lock up transmission lines even if they are not fully used. Short, “non-firm” contracts don’t provide the assurance necessary to finance new wind farms.</p>	<p>FERC Order 890 establishes an intermediate, flexible solution referred to as “conditional firm.” “Conditional firm” contracts help new generators like wind farms get the transmission access they need, opening up the way for more wind on the wires while also ensuring more efficient use of existing lines.</p>	<p>The principle of “conditional firm” is clearly set by FERC. Now FERC, Congress, states and utilities should work together to ensure that such contracts can be signed for a long period of time (at least five years).</p>
<p><b>New transmission lines and “corridors” from windy heartland to areas with high electricity demand:</b> Vast, strategic wind resources can be tapped with new transmission lines. The Dakotas alone have a wind resource large enough to supply half of the country’s electricity.</p>	<p>The Energy Policy Act of 2005 directs the U.S. Department of Energy (DOE) to designate “national interest electric transmission corridors” based on the need for reasonably priced electricity, more supply, diversity of energy sources, and energy security. The U.S. wind industry has filed comments with DOE noting that wind power can make a large contribution on all counts.</p> <p>Regional efforts, including an initiative led by the Western Governors’ Association, are encouraging development of clean energy transmission lines.</p>	<p>Regional efforts should continue. In addition, the federal government should expand the models and initiatives already under way in Texas, California, Minnesota and Colorado, and at the regional level. DOE should designate and Congress should require swift implementation of national interest electric transmission corridors to tap the heartland’s vast wind resources.</p>
<p><b>Solution to the “Chicken and the Egg” dilemma:</b> There is a transmission “chicken or the egg” dilemma because no wind farms will be proposed or built in a windy but transmission-poor area unless there is a definite plan for new transmission. However, no transmission will be planned or built unless there are wind farms built in the area to request the transmission.</p>	<p>California, Texas, Minnesota, Colorado and New Mexico all faced this “chicken or egg” problem for meeting their renewable energy portfolio standards (RPS) requiring that a growing amount of electricity be produced from renewable sources. Their solutions vary but essentially they made a state policy decision to establish a process that builds transmission first. FERC ruled in April 2007 in support of such a process.</p>	<p>Enact a national renewable energy portfolio standard (RPS). Enact legislation creating National Renewable Energy Zones to facilitate transmission planning for wind and other renewable energy sources to meet the RPS. The RPS requirement is in a time frame that generally matches up well with that for transmission lines.</p>