THE Main Street ECONOMIST
Agricultural and Rural Analysis

Issue 3, 2013 | Federal Reserve Bank of Kansas City

The Cycles of Wind Power Development

By Jason P. Brown, Economist

Wind power, with its recent dramatic pace of development, has the potential to alter the energy landscape in some areas of the United States. Before 2006, wind power development was sparse. However, installed capacity doubled by 2008 and accelerated rapidly through 2012. Although wind power still accounts for a small share of the nation's electricity supply, the recent surge in development has sparked discussion about wind's potential as a significant source of long-term renewable energy.

Utility-scale wind turbines are sprouting throughout the nation, particularly in the Midwest. More favorable economic conditions and government support have contributed significantly to the expansion of wind power. The expansion has been pronounced throughout the Midwest and Great Plains due to higher-quality wind resources. Expanded wind power development has been accompanied by growth in domestic manufacturing of wind turbines and components.

Despite improving economic conditions, federal renewable energy policies have provided crucial support to wind power development. In the past decade, favorable wind energy policies have faced expiration and renewal numerous times, leading to contractions and expansions in both development and domestic manufacturing. These boom-and-bust cycles raise questions about whether wind energy can realize its long-term potential without government support.

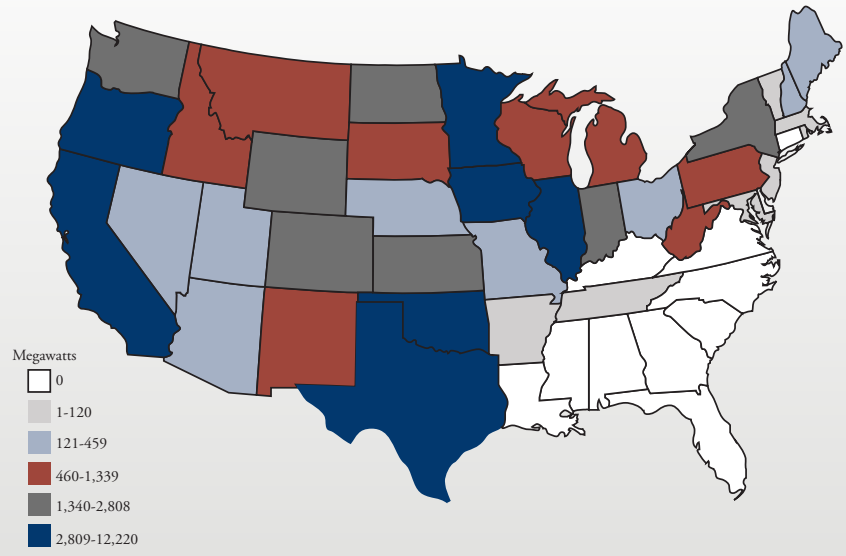
Fundamentals of Wind Power Development

More favorable economic conditions, along with federal and state policies, have driven developments in wind power, such as the installation of wind turbines. Over the past decade, energy and electricity prices relative to wind power have risen, causing utility companies to consider wind as an alternative to other fuel sources. Despite the economics, federal policy has been the key to reducing the relative cost of wind power. Meanwhile, state policies have also contributed to increased demand for wind power, fueling the expansion in some states.

Wind power development has expanded rapidly in the past six years. The nation's wind industry took 25 years to reach 10,000 megawatts (MW) of installed capacity in 2006. By 2008, total installations had surged to 25,000 MW. By the end of 2012, estimated total capacity was about 60,000 MW, enough to power between 14 million and 24 million homes annually.[1]

Wind power development has been particularly strong in the Midwest and Great Plains. In Iowa, for example, total installed wind power capacity in 2012 was 5,133

Map 1
Total Installed Wind Power Capacity as of 2012



Source: U.S. Department of Energy.

MW, a 300-percent increase from 2007 (Map 1). The rapid increase in development in Iowa and other states has also increased the share of electricity generated by wind. In nine states, wind power accounts for more than 10 percent of total electricity generated. In 2012, the top five states in wind power as a share of total electricity generated were Iowa (24.5 percent), South Dakota (23.9 percent), North Dakota (14.7 percent), Minnesota (14.3 percent) and Kansas (11.4 percent).[2]

The competitiveness of wind energy depends significantly on wholesale electricity prices. Electricity generated from traditional sources such as coal or natural gas is often less expensive. However, electricity prices tend to fluctuate with changes in the cost of fuel. The national average electricity price in 2010 was 9.83 cents per kilowatt-hour (kwh), a 16-percent increase since 2000.[3] Average wind power prices compared favorably to wholesale electricity prices from 2003 through 2008 (Wiser and Bolinger). However, wind power prices increased in 2009 due to increases in the cost of materials used to build turbines. This increase, combined with a sharp drop in wholesale electricity prices, pushed wind energy to the top of the range for wholesale power prices.

The recent abundance of natural gas has put downward pressure on electricity prices, increasing competition with wind energy. Natural gas-fired power plants generally generate cheaper electricity than does wind power. Although low wholesale electricity prices were likely caused by the recession-induced drop in energy demand, the ongoing development of significant shale gas deposits has also reduced expectations for gas price increases in the near future. Affordable natural gas is a serious competitor to wind as new power plants come on line or existing plants convert from coal to natural gas.

Perhaps more significant than the effect of economic conditions, government policy has played an important role in wind power's growth. Production-based tax credits (PTCs) are the predominant federal policy used to support wind energy development. The credits in the Energy Policy Act of 1992 reduce taxable income for qualified wind power developers by 2.3 cents per kwh of electricity produced for the first 10 years of operation. Research has shown that the credit offsets the cost of developing wind power by about one-third (Wiser). More recently, PTCs have also been allowed to be converted into upfront cash grants. Having cash in advance specifically helped the wind industry weather the financial crisis from 2008 to 2009 (Bolinger, Wiser and Darghouth; Lu, Tchou, McElroy and Nielsen).

Although PTCs have existed for more than 20 years, eligibility guidelines recently were modified. The

Issue 3, 2013 Federal Reserve Bank of Kansas City

American Taxpayer Relief Act, passed in January 2013, revised the credit by: (1) removing "placed in service" deadlines and replacing them with deadlines that use the beginning of construction as a basis for determining facility eligibility; and (2) extending the deadline for wind energy facilities by one year, from Dec. 31, 2012, to Dec. 31, 2013.[4] These actions contributed to further expansion by creating near-term incentives to produce and install wind turbines and components.

Individual state policies have also supported wind power development. Recently, state-specific Renewable Portfolio Standards (RPS) have supported development by requiring electricity suppliers to use specified amounts of renewable energy in their supply mix (Wiser and Barbose). However, an RPS does not require wind energy to be the only renewable source. Other possible sources include hydropower, solar and biofuels. According to the U.S. Department of Energy, RPSs are in place in 29 states.

State policies supporting wind power development are common throughout the Federal Reserve's Tenth District. Of the District's seven states, five have an RPS or goal in place (Table 1). RPS requirements vary by state, with the share of energy required from renewable sources by 2020 ranging from 10 to 30 percent. Colorado, which implemented the District's first RPS, has the most aggressive and multifaceted standard and places the highest requirements on sources derived from investor-owned utilities. New Mexico has a similar feature in its RPS. The future of state policies, however, is in flux. In 2013, legislators in at least 14 of the 29 states with an RPS have introduced bills to reduce or repeal the renewable energy mandates (Tracy).

Table 1
Renewable Portfolio Standards in Tenth District States

State	Type	Year	Target for Renewable Sources Generating Electricity
CO	Standard	2004	Investor-owned utilities: 30 percent by 2020 Electric cooperatives: 10 percent by 2020 Municipal utilities serving 40,000+ customers: 10 percent by 2020
KS	Standard	2009	20 percent of peak demand capacity by 2020
MO	Standard	2008	15 percent by 2021
NE	None		
NM	Standard	2007	Investor-owned utilities: 20 percent by 2020 Rural electric cooperatives: 10 percent by 2020
OK	Goal*	2010	15 percent by 2015
WY	None		

** Not a statute.*
Source: Database of State Incentives for Renewables and Efficiency.

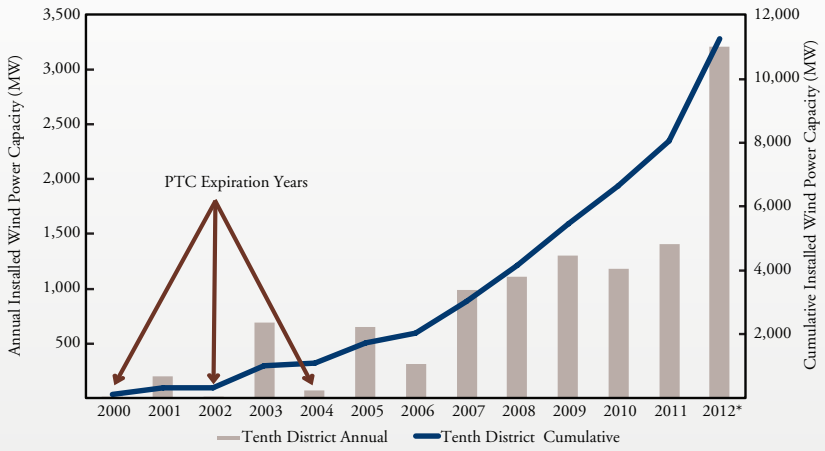
Wind energy supporters refer to several possible benefits to justify federal and state policies. Benefits include a net carbon reduction in global, regional and local environments when wind replaces fossil fuels such as coal or natural gas; presumed fuel diversity benefits; and the potential effect of wind power installations on local economies. One recent study found modest local effects from wind power development—an additional MW of installed capacity increased county personal income by $11,000 and employment by 0.5 job (Brown, Pender, Wiser, Lantz and Hoen).

The Effects of Wind Power Policies on Development

Expansion and contraction in the wind energy industry is often related to shifts in renewable energy policies. Tenth District states with a RPS or goal produce the majority of wind power. Manufacturing of wind turbines and components has followed the path of wind power production, with strong growth in the Plains states. Similar to wind power development, manufacturing production and employment also rises and falls with changes in policy.

Recent changes in renewable energy policy have contributed to fluctuations in wind power development. The PTC was set to expire a number of times, including in 2000, 2002 and 2004. In turn, the wind energy industry experienced less development in those years (Chart 1). This pattern suggests that the renewal and expiration of the credits creates

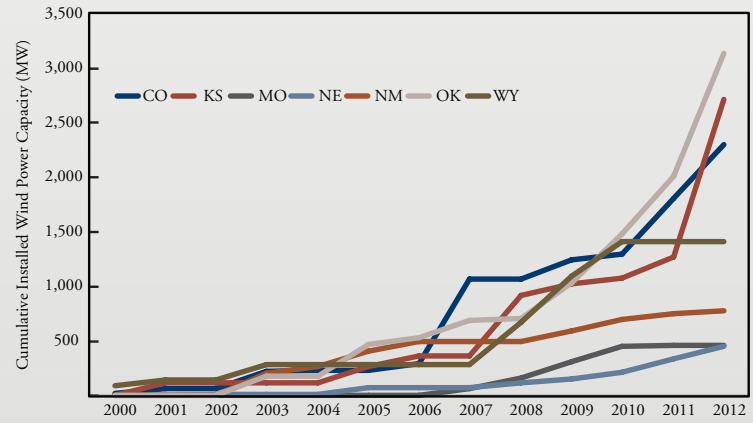
Chart 1
Annual and Cumulative Installed Wind Power Capacity in the Tenth District



Source: U.S. Department of Energy.

** The 2012 numbers on installed capacity are from the American Wind Energy Association*

Chart 2
Installed Wind Power Capacity Among Tenth District States



Source: U.S. Department of Energy.

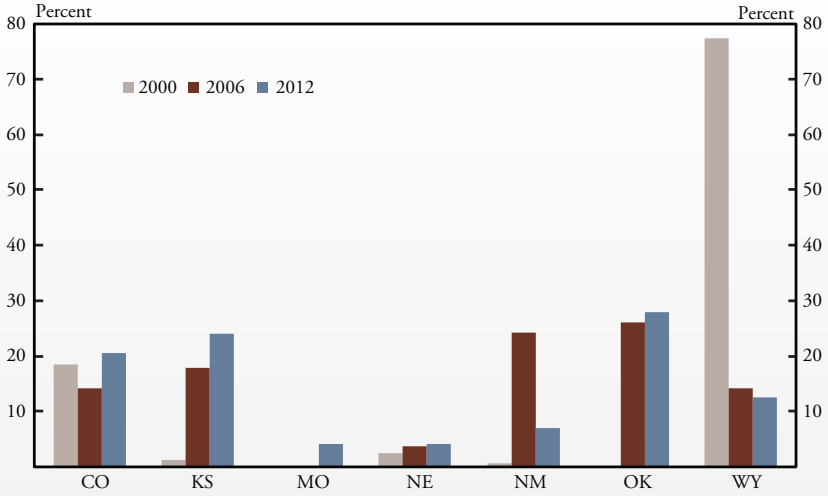
boom-and-bust cycles of wind power development.

The pace of wind power development in the Tenth District has varied over time. Wind power development, in its infancy in the early 2000s, accelerated after 2007 (Chart 2). In 2000, five District states had installed wind power capacity, but 77 percent of it was in Wyoming (Chart 3). By 2006, all Tenth District states but Missouri had installed wind power. The distribution among states also became more uniform, with Oklahoma having the largest share (26 percent) followed closely by New Mexico (24 percent). States with RPS or goals had most of the installed capacity by the end of 2012, with Oklahoma, Kansas and Colorado each having more than 20 percent of the District's total installed capacity.

As wind power development has increased in the United States, so has domestic manufacturing of turbines and turbine components. The Upper Midwest has the highest concentration of these manufacturing facilities (Map 2). However, as development has consistently increased in the wind-abundant Plains states, manufacturers have opened or expanded facilities in those areas to minimize the transportation costs of the turbines and components. Colorado has at least four manufacturing facilities that produce towers and blades for turbines.

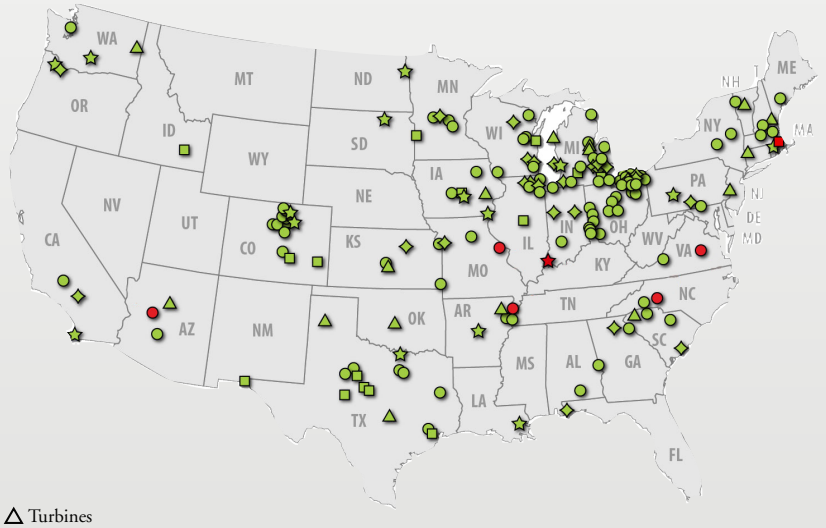
Manufacturing facilities have also

Chart 3
Distribution of Installed Wind Power Capacity in the Tenth District Over Time



Source: U.S. Department of Energy.

Map 2
Wind Turbine and Component Manufacturing Facilities



△ Turbines
◇ Nacelle Components
☆ Blades
○ Other
□ Towers

New facilities opened in 2012
Existing facilities online prior to 2012

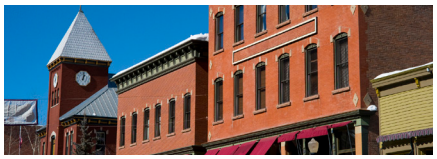
Source: U.S. Department of Energy, National Renewable Energy Laboratory.
Notes: The map includes wind turbine, component manufacturing facilities and supply chain facilities, but excludes corporate headquarters and service-oriented facilities. The facilities shown are not exhaustive. Facilities designated as "Turbines" may include turbine and/or nacelle assembly and, in some cases, the manufacturing of towers, nacelle components, blades or other components.

experienced the cycles of boom and bust associated with the expiration and renewal of the federal PTC. Since 2007, the timelines of reported operations convey a distinct pattern for several Tenth District manufacturing facilities. Employment at these facilities generally increased until 2012. However, companies then began reporting reduced orders due to the expected expiration of the PTC at the end of 2012. Companies responded by reducing employees and the hours worked by their remaining workforce. Following the extension of the PTC for a year, an increase in orders has enabled some companies to recall workers. Most companies, however, have been cautious in recalling workers.

Development Outlook

The outlook for wind power development depends on commodity prices and renewable energy policy. For example, there likely would be significantly less wind power development without implementation of the PTC. New wind power development and domestic manufacturing of wind turbines and component suppliers will continue to be influenced by state and federal policies. Because of uncertainty about renewable energy policies, the industry's manufacturing segment may face a series of future barriers.

Price fluctuations among energy sources that offer an alternative to wind are likely to contribute to the evolution of wind power development. The price of natural gas has fallen since 2008 from $12.76 per million British thermal units



(mmBtu) to near $4 per mmBtu, and futures markets and analysts anticipate low prices to persist for years. In fact, as of early July, futures prices on the New York Mercantile Exchange for a June 2015 contract were trading just above $4 per mmBtu. Persistent low natural gas prices will likely have a dampening effect on wind power development.

Nonetheless, the pace of wind power development largely depends on state and federal renewable energy policy. Wind power development in 2013 is expected to be less than in 2012 as credits in the current legislation expire at year's end. In spite of the uncertain future of the federal PTC, wind farm developments have been announced in Colorado, Kansas and Nebraska; though others have been delayed in Wyoming.

The manufacturing base associated with wind power development appears to have stabilized. Even with the expected slowdown in orders, several facilities have acquired large orders from Canada and Mexico. The production costs of U.S. plants that make turbine components appear to be competitive with those in other countries. Moreover, the difficulty and expense of transporting bulky products from distant countries limits competition from international manufacturers (Platzer).

One barrier to growth in wind energy, however, is the availability of adequate transmission for power generated by wind farms. Most wind farms are removed from larger cities where most electricity is consumed. Without increased transmission capacity, wind power development will likely be constrained. Currently, large-scale transmission line projects, like ones in Wyoming, are being explored that would allow wind power companies to send electricity to Nevada and California. Kansas plans to build transmission lines that would allow it to sell wind energy produced in western Kansas elsewhere in the Midwest. Some states, however, hesitate to use out-of-state renewable electricity if locally produced renewable electricity is available. States like Kansas that have an abundance of wind power still may find opportunities to sell into other markets with additional transmission planning and investment.

A key obstacle to the expansion of wind energy is federal support. Historically, changing policies have induced boom-and-bust cycles in wind power development. These cycles in turn have led to similar cycles in turbine manufacturing. Policy-induced boom-and-bust cycles may create substantial uncertainty within the industry. With continued brief spurts of government support, wind turbine manufacturers and component suppliers may conclude that long-term U.S. demand for their products is too uncertain.

Conclusion

Wind power development in the United States has increased substantially since the mid-2000s. By 2012, total installed capacity was near 60,000 MW, up from 10,000 MW just six years earlier. While the competiveness of wind power improved over part of this period, more recently wind power has been a more-expensive option on the wholesale electricity market. An abundance of natural gas as an electricity-generation source may affect the pace of wind power development.

Perhaps of greater significance is the uncertain future of the federal PTC, which is set to expire at year's end. Previously, new development, as well as the manufacturing base tied to wind turbines, has risen and fallen with the renewal and expiration of the federal PTC over time. This pattern is seen in annual installed capacity of wind power and employment levels at wind turbine and component manufactures. Uncertain demand and limited government support may limit the near-term growth potential for wind power generation.

ENDNOTES

[1]Data on wind industry capacity was obtained from the American Wind Energy Association, *http://www.awea.org/learnabout/industry_stats/index.cfm.*

[2]Data on the share of electricity generated by wind power was obtained from the American Wind Energy Association, *http://www.awea.org/newsroom/pressreleases/wind-generation-2012.cfm*

[3]Data on electricity prices was obtained from the Energy Information Administration, *http://www.eia.gov/totalenergy/data/monthly/index.cfm*

[4]Incentives and policies for renewable energy obtained from the U.S. Department of Energy, *http://dsireusa.org/rpsdata/index.cfm*

REFERENCES

Bolinger, Mark, Ryan Wiser, Naim Darghouth. 2010. "Preliminary Evaluation of the Impact of the Section 1603 Treasury Grant Program on Renewable Energy Deployment in 2009." Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory. April.

Brown, Jason P., John Pender, Ryan Wiser, Eric Lantz, Ben Hoen. 2012. "Ex Post Analysis of Economic Impacts from Wind Power Development in U.S. Counties." *Energy Economics*, November, pp. 1743-1754.

Lu, Xi, Jeremy Tchou, Michael B. McElroy, Chris P. Nielsen. 2011. "The Impact of Production Tax Credits on the Profitable Production of Electricity from Wind in the U.S." *Energy Policy*, July, pp. 4207-4214.

Platzer, Michaela D. 2012. "U.S. Wind Turbine Manufacturing: Federal Support for an Emerging Industry." Congressional Research Service, 7-5700.

Tracy, Ryan. 2013. "States Cooling to Renewable Energy." *The Wall Street Journal*, March 29.

Wiser, Ryan. 2007 "Wind Power and the Production Tax Credit: An Overview of Research Results." Senate Finance Committee. Hearing on Clean Energy: From the Margins to the Mainstream, 110th Congress, 1st session.

Wiser, Ryan, and Galen Barbose. 2008. "Renewables portfolio standards in the United States—A status report with data through 2007." Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory. April.

Wiser, Ryan, and Mark Bolinger. 2012. "2011 Wind Technologies Market Report." U.S. Department of Energy, Energy Efficiency and Renewable Energy, August.