

The Winds of Change: Evaluating the Potential and Risks of Wind Power Investment

Wind power has historically been a very small piece of the U.S. power generation landscape, primarily due to high relative production costs and significant logistical challenges. However, recent changes in fossil fuel prices, coupled with heightened awareness and concern regarding environmental issues associated with traditional sources of power generation, have led many investors to consider investments in wind power more seriously than ever before.

Despite the recent emergence of factors that could drive an increase in wind power investment, we feel that any increase will be minimal. Given the inherent risks and uncertainties associated with long-term wind power projects, several conditions must be in place to produce economic returns at a level that investors will require. While we believe that specific opportunities for value creation will indeed exist, wind power will continue to play a very small role in U.S. power generation.

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Wind-powered electricity generation has long been an extremely small and uneconomic part of the power generation landscape, requiring federal subsidies and utility green power programs to support its existence. Due to issues regarding cost, reliability, transmission constraints, and other factors, the prevailing belief of energy industry experts and other market participants has consistently been that wind power will always play a very small role in U.S. power generation.

Wind power currently represents less than 1% of total U.S. electric power generation capacity and an extremely small fraction of power generated.¹ However, over the last several years, wind power has seen a higher rate of generation capacity growth than any other type of power generation, including natural gas. In addition, several important industry participants, such as General Electric and Goldman Sachs, have made sizable investments in this energy source. These developments, plus the emergence of additional environmental and economic drivers, have caused industry analysts to take note and have led many to update their forecasts on wind power. Some estimates now project that the U.S. could

see a significant boom in wind power, increasing its share of domestic generation capacity by as much as 10 to 20 percent over the next 12 to 15 years.²

Is this forecast realistic, or has the potential of wind power been exaggerated? In an effort to better understand the long-term prospects for wind power generation, we have analyzed several factors affecting the growth in investment for this alternative energy source and offer our conclusions regarding implications for wind power generation in the U.S. energy infrastructure. This analysis includes:

- An assessment of the issues driving the growth of wind power
- A review of the challenges that wind power must overcome
- An appraisal of what is required for wind power to become a significant part of the nation's power generation and supply structure
- An analysis of a "typical" wind power project

¹ "Renewable Energy: Wind Power's Contribution to Electric Power Generation and Impact on Farms and Rural Communities," U.S. Government Accountability Office, September 2004.

² www.auea.org

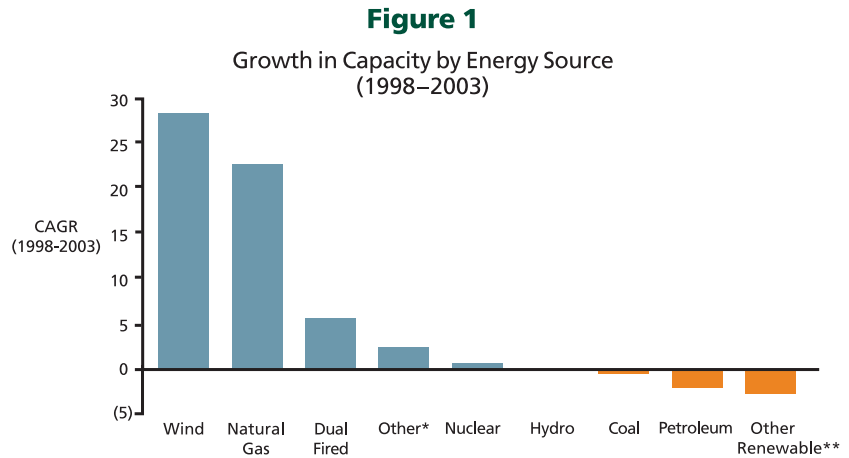
We believe that our analysis provides potential investors with an informed view of wind power as well as a framework for thinking about the issues that impact the success of a potential investment in this power source. As with all capital-intensive projects, factors impacting the specific investment must be assessed before drawing conclusions about expected project outcomes.

The Growth of Wind Power

While wind generation is currently a very small portion of U.S. power production, it is the fastest-growing type in the country. According to the Department of Energy (DOE), wind generation capacity grew over the past five years at approximately 23%, rising to 6,740 Megawatts (MW) by the end of 2004, as shown in Figures 1 and 2. The renewal of the Production Tax Credit (PTC), which provides federal subsidies for renewable energy projects, also fueled an additional increase of over 2,000 MW in 2005.³

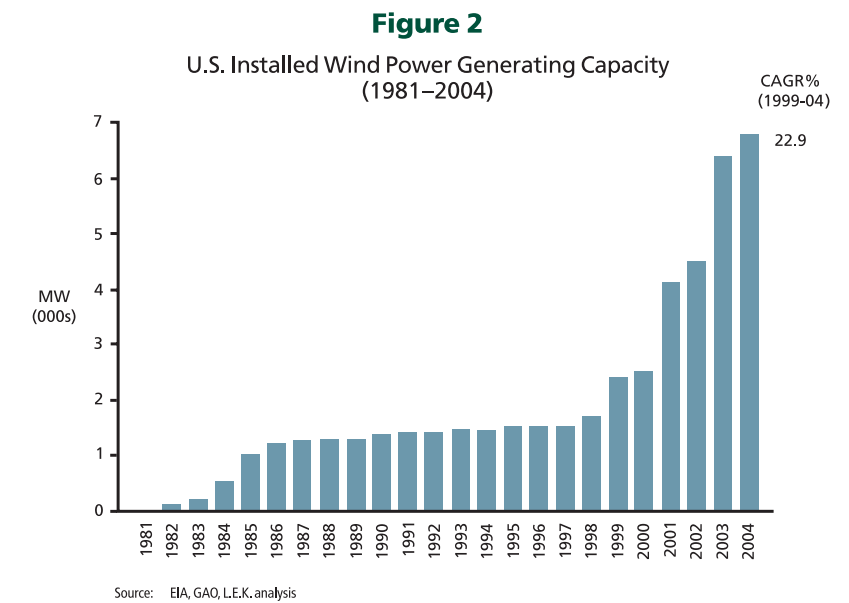
The investment in this area does not appear to be limited to a niche set of speculative investors. Rather, the growth appears to be driven by a diverse set of market participants:

- FPL Energy is the leading wind power investor among investor-owned electric utilities and now holds over a third of the nation's total capacity.
- In March 2005, Goldman Sachs announced its acquisition of Houston-based developer Zilkha Renewable Energy (now known as Horizon Wind Energy).



Share of 2003 Capacity (%)	0.7	22.0	18.1	0.3	10.5	10.5	33.0	3.8	1.2
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Note: Wind capacity data is end-of-year AWEA data; all other data is 2003 DOE EIA net summer generating capacity
 *Includes other gases, batteries chemicals, etc; **Includes wood, waste, landfill gas, solar, biomass, geothermal etc.
 Source: DOE EIA, AWEA, L.E.K. analysis.



- John Deere has recently announced that it is creating a business unit to fund and develop wind projects.
- MidAmerican Energy, 80% owned by Warren Buffet's Berkshire Hathaway, has recently completed a \$323M, 310.5 MW project in Iowa.

What is driving this increasing level of investment in wind power capacity and what is the likely "end game" for wind power in terms of its share of total generation?

³ www.eia.doe.gov

In order to develop a perspective on the future of wind power, we have analyzed several factors that are positively affecting wind power economics today in order to gauge both the potential impact of each variable, as well as the likelihood that the factor will persist for the medium- or long-term. Since wind projects are anticipated to provide investors returns over a 25-to-30 year-life, it is important to assess the likely impact of growth drivers beyond the next few years.

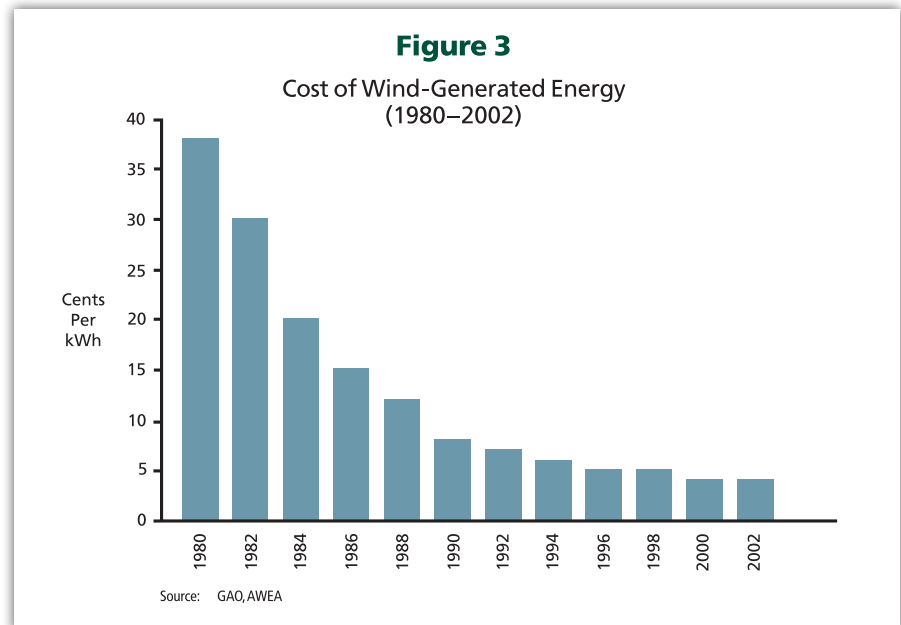
We believe that there are five key wind growth drivers:

- Improvements in technology
- Environmental benefits from “clean” energy sources
- Continued government subsidization and promotion
- Rapidly increasing fossil fuel costs
- Emphasis on diversification of U.S. power sources

Improvements in Technology

Historically, the most significant challenge to wind power has been its extremely low level of efficiency relative to other power generation sources. In the early 1980s, when the initial utility-scale wind turbines were installed, wind-generated electricity cost as much as 30 cents/kWh, many times that of nuclear, gas or coal. However, as Figure 3 shows, by 1990, improvements in wind turbine technology decreased the cost of production by more than 75%.⁴

In the last decade, wind power designs have incorporated much taller turbine towers as well as larger rotor diameters, resulting in further efficiency improvements. While the rate of efficiency improvement has flattened considerably in recent years,



proponents of wind power maintain that there are still opportunities to improve efficiency and lower wind power costs. Wind turbine manufacturers have recently piloted new turbine technologies, but there is still a great deal of uncertainty regarding the efficiency improvements associated with these introductions.

Environmental Benefits from “Clean” Energy Sources

As with many other renewable energy sources, wind power generation is considered a “green” technology because it does not generate air or water emissions and does not produce hazardous waste materials. Also, wind power does not deplete natural resources such as coal, oil, or gas, or cause environmental damage through extraction or transportation of source fuels.

Over the last two decades, reports on the deteriorating condition of the earth’s atmosphere, as well as concerns regarding natural resource depletion, began to

accelerate the level of research and development in renewable energy technologies. Recently, setbacks in fuel cell technology development and difficulties with landfill gas technology have shifted more of the renewable generation emphasis to wind power. In addition, recent success in pilot utility green power programs have sparked greater interest in further rollouts of these programs, highlighting the potential demand for renewable energy sources by the general public.⁵

Continued Government Subsidization and Promotion

Partiality driven by the environmental benefits noted above, the federal government has intermittently promoted renewable energy investment and continued to strengthen this position through the 2005 Energy Act, where the current level of PTC (\$19/MWh) was affirmed and extended through 2007.⁶

⁴ & ⁵ www.awea.org

⁶ Please see L.E.K.’s Client Advisory: *Energy Act of 2005 – Implications for Private Equity*, for a more in-depth review of the 2005 Energy Act.

It is important to note that there are few examples of this type of subsidization persisting in situations where a technology is expected to continue to be uneconomic (without federal support) for the long term. Consequently, there is considerable uncertainty surrounding the future application of both production tax credits and renewable energy credits beyond the short term.

Furthermore, while the PTC was extended, the legislation did not include a proposed U.S. Senate provision that 10% of the nation's electricity be generated from renewable sources by 2020. Many states have established a Renewables Portfolio Standard (RPS) in recent years, though individual states' ability to enforce the standard is unclear, and most energy industry participants view the RPS as a guideline.

Rapidly Increasing Fossil Fuel Costs

Wholesale power prices have risen dramatically in the last several years – over 100% in the past year alone – driven in large measure by the price of natural gas⁷ (see Figure 4). Since natural gas-fired power plants are the price-setters in most U.S. regions, the economics underlying power generated by other fuel sources have improved substantially during this period. This is true for wind power and has led to a marked improvement in investors' perspectives on future wind power investment.

It is our strong belief that the fundamental economics must work if wind power generation growth is going to be sustained. We have summarized our current perspective on this issue in the last section of this article.

Emphasis on Diversification of U.S. Power Sources

Driven by the recent volatility in gas prices as well as by increasing concerns regarding political stability in major oil-and-gas-producing nations, certain industry analysts feel that the U.S. would benefit from reducing its dependence on oil and natural gas for power production. While this view has gained consensus in recent years, it is considered to be a minor factor in any shift to renewable energy investment. Though gas-fired power plants represented the majority of capacity additions in the last eight years, this fuel source accounts for less than 20% of annual power generation⁸ (Figure 5).

The Challenges for Wind Power

While there are many benefits of wind power that support the likelihood of positive future prospects for this energy source, there are several obstacles that must be overcome if it is to become a significant portion of the overall U.S. power generation base.

We believe that there are five key challenges to wind power development and adoption:

- Transmission barriers and costs
- Reliability issues
- Uncertainty of Production Tax Credit (PTC)
- Aesthetics
- Project economics and capital investment

⁷ Bloomberg; Smith, A. et al, "The Power 'Peaker'—Weekly Data for U.S. Electric Utilities and IPPs," JP Morgan.
⁸ www.auea.org; www.gao.gov

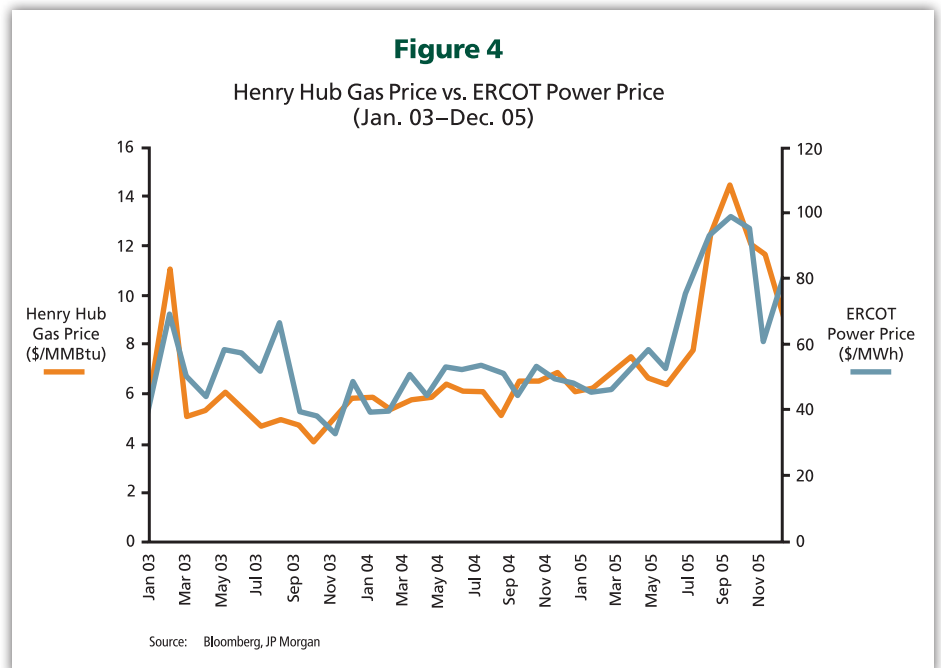
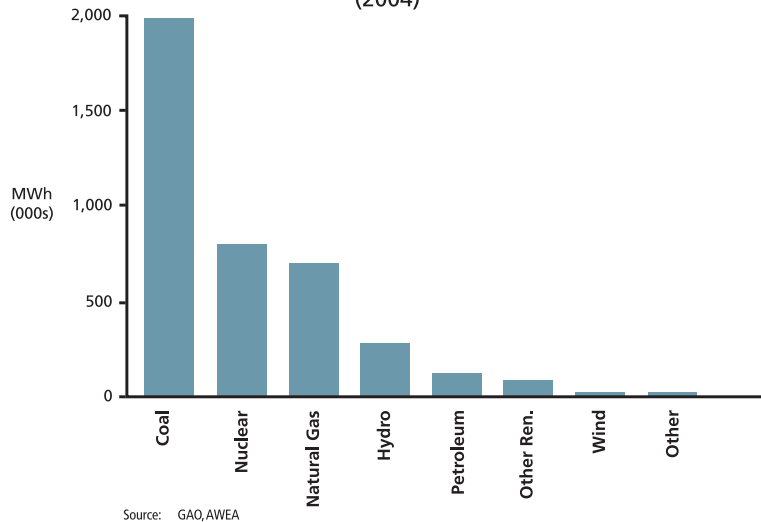


Figure 5

U.S. Power Generation by Source
(2004)



Transmission Barriers and Costs

Geographic limitation is a challenge for the generation of wind power because many parts of the U.S. do not have a sufficient amount of wind to sustain profitable levels of wind-generated power. Where wind is plentiful (often in remote locations) it may not be sufficiently close to high-demand areas or to nearby transmission lines. When a wind tower is in a remote location, there are often significant costs associated with connecting it to a regional grid and transmitting the energy produced. The costs associated with grid connectivity can quickly make a wind power project economically unfeasible. While there are indications that the U.S. transmission grid infrastructure is in line for a much-needed upgrade, transmission challenges could limit the role of wind power for a considerable time to come.

Reliability

The intermittent nature of wind generation limits its ability to contribute power

reliably during peak demand periods.

Consequently, wind assets often have to be backed up by other forms of generation in order to meet regional requirements for available generation capacity. Wind's lack of contribution to peak generation capacity inhibits investment when reserve capacity is a regional issue.

Uncertainty of the Production Tax Credit (PTC)

Recent federal PTCs have been a major contributor to the current level of commercial investment in wind power and are often a critical factor in bottom-line viability of a project. However, the continued availability of these tax credits is uncertain. While there have been examples where federal funding has continued on a long-term basis despite a lack of profitable returns, they are rare. As a result, there is a great deal of uncertainty about the role PTCs will play in future wind power investments.

Aesthetics

Recently, wind power has been challenged by significant resistance to the placement of wind assets where they are visibly evident. Often the most effective locations for wind towers are on ridge or mountain tops and other open areas where they might be considered "eyesores." Cape Wind Associates recently sought to construct wind towers off the shore of Cape Cod, until local opposition stalled the project. Senators Lamar Alexander and John Warner, from Tennessee and Virginia, respectively, recently proposed the "Environmentally Responsible Windpower" bill, which would stop tax credits for offshore and certain land-based wind farms. Though the bill was rejected by the Senate, more legislation is reportedly on the way.

Project Economics and Capital Investment

Of the five main challenges to wind power development, economics is the most critical, because wind generation involves a large initial capital outlay with a significant level of risk and uncertainty over a long project life. As a result, investors expect correspondingly significant returns. This is one of the primary reasons why wind power has historically been a small part of the overall energy production landscape. For this reason, any review of the potential for wind power investment should include an economic analysis of a possible wind project based on current investment conditions and expectations for drivers of project revenues and costs. To better understand the economics of a wind power project, L.E.K. has developed a feasibility analysis (below) with a "typical" wind project scenario.

Analyzing a “Typical” Wind Power Project

As noted above, the primary determinant of investment in wind power generation in the U.S. is and will continue to be the fundamental expectations for economic returns based on forecasts for natural gas and electricity prices in the future. In order to appropriately assess expected power prices that will impact the economics of a wind farm project, this analysis should be developed on a region-specific basis. Based on several factors, especially the regional mix of generation fuel types as well as the regional demand profile, average annual power prices can differ by several \$/MWh across different regions, greatly impacting project returns. That being said, we have used expectations for the Electric Reliability Council of Texas (ERCOT) power prices (a region characterized by relatively high wholesale power prices) in our analysis of the economics for a “typical” wind project.

The basic project economics are driven by several factors, each involving some level of uncertainty in advance of project initiation. The primary factors are:

Quality of the Wind Source

Based on the location of the wind project and the nearby geographical conditions, more or less wind power can be produced. This is obviously one of the most critical factors, as the majority of wind project costs are incurred upon initial investment in the project, with economic returns then being generated as power is produced during the useful life of the project.

Cost of the Installed Base

The initial capital investment in establishing a wind power resource is the most significant project cost, as subsequent variable costs associated with power production are relatively low. Most of this initial cost is associated with the wind turbines (which have risen in price by 20%–25% over the last 24 months), as well as some additional setup costs associated with the build out of the physical plant.

Grid Connectivity

As noted in the previous section, transmission constraints or limited grid availability can be a significant hurdle for a wind project. Depending on location, additional transmission costs associated with a wind project can range from \$2 to \$25/MWh.

Production Tax Credit (PTC)

As noted above, the federal government offers significant financial incentives in the form of PTCs and Renewable Energy Credits (RECs) to wind power generators. The legislation governing the level of incentives is reviewed on a three-year basis, and the PTC is currently at a level equivalent to \$19/MWh of power production. While this is a significant positive benefit for wind generation, the three-year review period causes much uncertainty regarding the level of incentives over the life of the potential project.

Financing Costs

The majority of power projects, wind energy included, are characterized by a fairly high degree of debt financing. The terms of this funding vary by project and by developer, and must be considered when evaluating any generation project.

Operating and Maintenance Costs (O&M)

A certain level of fixed and variable maintenance expenditures will be required to run the wind plant as well as keep it in condition to ensure power production over its useful life.

While there are other variables in addition to those highlighted above, fluctuations in these other factors typically do not significantly impact the expected economic returns associated with a wind power project. In order to gain a greater sense for the feasibility of wind power investment under various scenarios, we estimated the levelized costs⁹ associated with wind generation, given best estimates of the key variables impacting project economics. The assumptions used are:

- 100 MW wind farm with a 30-year project life
- 30% capacity factor
- \$1,300/kW installed base (reflects recent turbine price increases)
- \$25/MW O&M costs (Note: \$/MW costs are at rated capacity; corresponds to 0.82¢/kWh at 30% capacity factor)
- 50% leverage with debt at 7.5% for 15 yrs
- 1.9¢/kWh production tax credit
- No additional renewable energy credits or ancillary services expenses

⁹ Levelized cost is a summary measure of the average cost of electricity per kilowatt-hour, expressed in current dollars. It is defined as the net present value of all direct costs (for capital, fuel, and O&M) over the expected lifetime of the system, divided by the system's total lifetime output of electricity.

Building on this analysis, we estimated the level of economic value (positive or negative) associated with wind investment.

Key Findings

Based on these assumptions, the levelized cost of power would be ~\$64 /MWh without the production tax credit. Including the production tax credit, the levelized cost drops to ~\$51/MWh. Note that this is an analysis “to the busbar”: the operating and cost assumptions do not include transmission costs that wind energy may incur in the absence of grid connectivity. As noted above, costs associated with grid connectivity for wind power under beneficial conditions can be around \$2/MWh, but can be more than \$20/MWh under unfavorable conditions.

Given the assumptions used in this analysis, natural gas prices of \$8–\$9/MMBtu are necessary for new wind generation projects (with no additional transmission costs) to provide reasonable economic returns without the PTC. With the tax credit in place at 2006–2007 levels, necessary natural gas pricing drops to \$6–\$7/MMBtu. At current wholesale power prices, grid-connected wind power is likely economic with and without the production tax credit.

However, it is critical that investors analyze wind economics over the full life of the project. Given expectations for natural gas prices (as reflected in Henry Hub

futures trading¹⁰) this favorable environment for wind generation will likely persist through 2006–07 and into 2008, as shown in Table 1. However, expectations indicate natural gas prices in 2009–11 to be ~\$8/MMBtu, and many industry analysts expect prices to settle at a long-term equilibrium of \$5–\$7/MMBtu in the next 8 to 10 years.

Table 1

Year	Average Annual Natural Gas Futures
2006	\$9.25/MMBtu
2007	\$9.64/MMBtu
2008	\$9.23/MMBtu
2009	\$8.77/MMBtu
2010	\$8.39/MMBtu
2011	\$8.01/MMBtu
2012 +	\$5.00–7.00/MMBtu

Using the analysis from above and incorporating electricity pricing forecasts for the ERCOT region, as calculated using the L.E.K. regional electricity supply/demand model, we have estimated net present values for this “typical” wind project in ERCOT. Under favorable grid connectivity conditions, incorporating current expectations for natural gas prices and assuming sustained current production tax credit levels for the life of the project, wind investment is likely a positive net present value project that generates economic profit over the life of the investment. However, additional

transmission costs above the \$4–\$6/MWh range or any decline in gas price expectations would change this view. Additionally, future removal or lowering of the PTC at any time in the next 20 years would certainly make this “typical” wind investment uneconomic.

Conclusion

Environmental and economic factors have improved the fundamentals underlying wind project investment. However, there are still significant risks and barriers that will likely persist. We believe that any wind investment will likely not generate a reasonable economic return without the benefit of a long-term, sustained production tax credit.

Additionally, transmission costs related to grid connectivity or line loss are likely to make many wind projects uneconomic, even with a long-term production tax credit in place. For this reason, wind power investment must be evaluated on a project-by-project basis, as project-specific factors (especially grid connectivity issues and geographical conditions driving capacity factors) will determine the outcome of the assessment. While there will continue to be some incremental growth in wind power, we do not believe that it will become a significant factor in U.S. power generation in the foreseeable future. Though further clarity regarding the level of ongoing government subsidization may improve this view, much uncertainty (and project risk) remains.

¹⁰ Henry Hub is the pricing point for natural gas futures contracts traded in the New York Mercantile Exchange. It is a point on the natural gas pipeline system in southern Louisiana and is owned by Sabine Pipe Line LLC.

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