U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

2012 WIND TECHNOLOGIES MARKET REPORT

AUGUST 2013

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6. Wind Power Price Trends

Earlier sections documented trends in wind turbine prices, installed project costs, O&M costs, and capacity factors—all of which are determinants of the wind power PPA prices presented in this chapter. In general, higher-cost and/or lower-capacity-factor projects will require higher PPA prices, while lower-cost and/or higher-capacity-factor projects can have lower PPA prices.

Berkeley Lab collects data on wind PPA prices from the sources listed in the Appendix, resulting in a dataset that currently consists of 302 PPAs totaling 24,626 MW from wind projects installed between 1998 and the end of 2012. Although this sample represents just 42% of *all* wind power capacity built in the United States over the 1998–2012 timeframe, it represents 70% of the wind power capacity that was built over this period *and* that sells power through a "bundled" PPA (i.e., a PPA that bundles together the sale of electricity and renewable energy certificates, or RECs).[61]

Throughout this chapter, PPA prices are expressed on a levelized basis over the full term of each contract and are reported in real 2012 dollars.[62] Whenever individual PPA prices are averaged together (e.g., within a region or over time), the average is generation weighted.[63] Whenever they are broken out by time, the date on (or year in) which the PPA was signed or executed is used, as that date provides the best indication (i.e., better than commercial operation date) of market conditions at the time. Finally, because the PPA prices in the Berkeley Lab sample are reduced by the receipt of state and federal incentives (e.g., the levelized PPA prices reported here would be at least $20/MWh higher without the PTC, ITC, or Treasury Grant), and are also influenced by various local policies and market characteristics, they do not directly represent wind energy generation *costs*.

This chapter summarizes wind PPA prices in a number of different ways: by PPA execution date, by region, and compared to wholesale power prices both nationwide and regionally. In addition, REC prices are presented in a text box on page 54.

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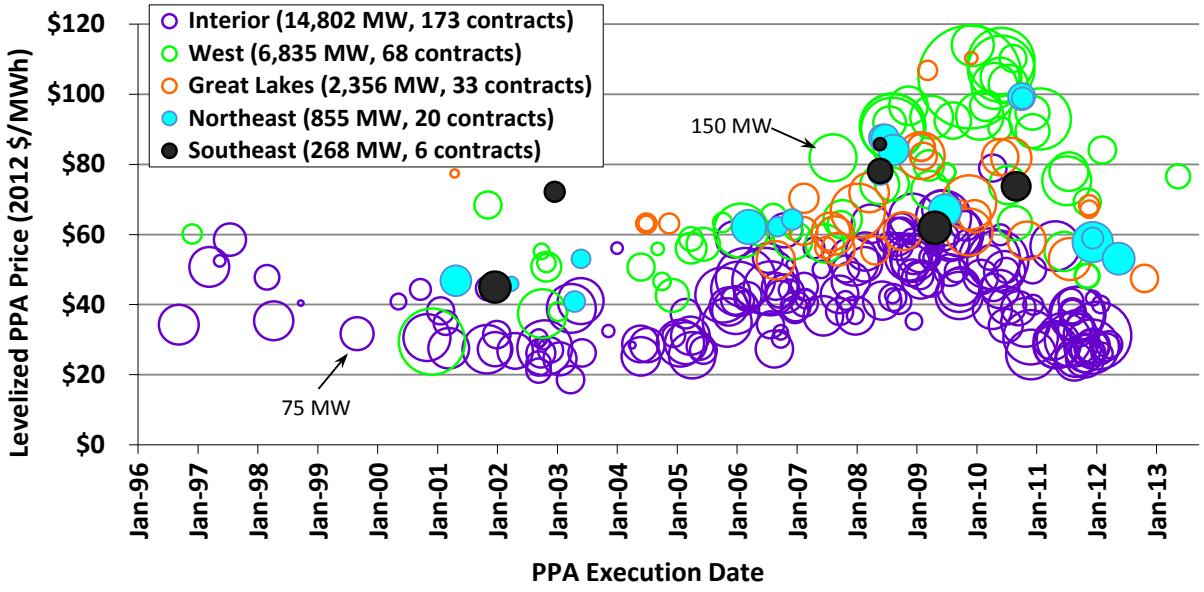
[61] The 58,878 MW of wind power capacity built in the United States from 1998–2012 can be broken down as follows: 13,750 MW sell power on a merchant basis (no PPA); 9,082 MW are owned by utilities (no PPA); 389 MW are located in Alaska, Hawaii, or Puerto Rico (excluded as potential outliers); 268 MW are interconnected on the customer side of the meter (no PPA); and the remaining 35,388 MW are potential candidates for inclusion in Berkeley Lab's bundled PPA database. The 24,626 MW currently in our sample therefore represents 70% of the total potential PPA sample. Much of the roughly 10.7 GW of wind power capacity missing from our sample is located in Texas, where projects within ERCOT fall outside of FERC's jurisdiction and are therefore not required to report price information to the same extent as are other projects.

[62] Having full-term price data (i.e., pricing data for the full duration of each PPA, rather than just historical PPA prices) enables us to present these PPA prices on a levelized basis (levelized over the full contract term), which provides a complete picture of wind power pricing (e.g., by capturing any escalation over the duration of the contract). Contract terms range from 10 to 35 years, with 20 years being by far the most common. Prices are levelized using a 7% real discount rate.

[63] Generation weighting is based on the empirical project-level performance data analyzed in the previous chapter of this report and assumes that historical project performance (in terms of annual capacity factor as well as daily and/or seasonal production patterns where necessary) will hold into the future as well. In cases where there is not enough operational history to establish a "steady-state" pattern of performance, we used discretion in estimating appropriate weights (to be updated in the future as additional empirical data become available).

Wind Power Purchase Agreement Prices Generally Have Been Falling Since 2009 and Now Rival Previous Lows Set a Decade Ago (Despite the Trend Towards Lower-Quality Wind Resource Sites)

Figure 32 plots project-level levelized wind PPA prices by contract execution date, showing a clear downward trend in PPA prices since 2009—both overall and by region (see Figure 24 for regional definitions). This trend is particularly evident within the Interior region, which—as a result of its low average project costs and high average capacity factors shown earlier in this report—also tends to be the lowest-priced region over time. Prices generally have been higher in the rest of the United States and have been particularly high in the West in recent years.[64]



Note: Size of "bubble" is proportional to project nameplate capacity.

Figure 32. Levelized Wind PPA Prices by PPA Execution Date and Region

Figure 33 provides a smoother look at the time trend nationwide (the blue bars) by averaging the individual levelized PPA prices shown in Figure 32 by year. After topping out at nearly $70/MWh for PPAs executed in 2009, the average levelized price of wind PPAs signed in 2011/2012—many of which were for projects built in 2012—fell to around $40/MWh nationwide, which rivals previous lows set back in the 2000–2005 period.

[64] Regional differences can affect not only project capacity factors (depending on the strength of the wind resource in a given region), but also development and installation costs (depending on a region's physical geography, population density, labor rates, or even regulatory processes). It is also possible that regions with higher wholesale electricity prices or with greater demand for renewable energy will, in general, yield higher wind energy contract prices due to market factors. For example, recent high prices in the West may be due, in part, to aggressive renewable energy policies (along with certain elements of policy design) in California, which give developers a strong negotiating position. Relatively stringent permitting and regulatory requirements may also make California a particularly expensive state in which to build wind power projects.

While this temporal trend of rising and then falling PPA prices is directionally consistent with the turbine price and installed project cost trends shown in earlier sections, the fact that PPA prices have approached previous lows is nevertheless notable, given that installed project costs have not returned to 2000–2005 levels (Figure 20) and that wind projects increasingly have been sited in lower-quality wind resource areas (Figure 29). Clearly, the turbine scaling described in Chapter 5, along with other improvements to turbine efficiency, have more than overcome these headwinds to drive PPA prices lower.

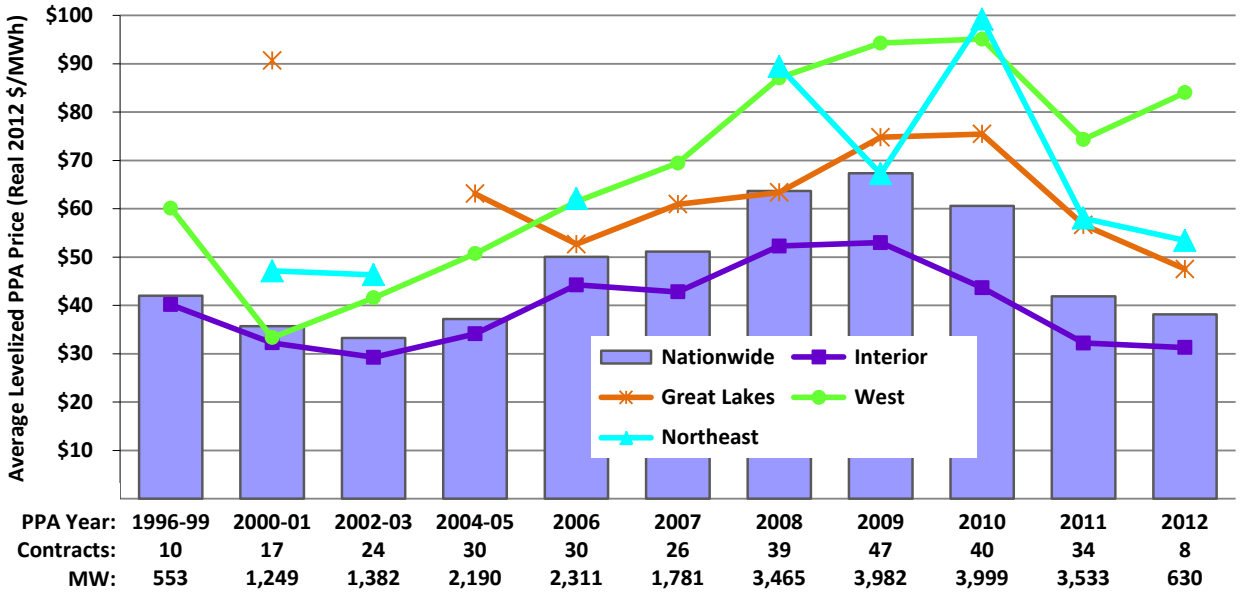


Figure 33. Generation-Weighted Average Levelized Wind PPA Prices by PPA Execution Date and Region

Figure 33 also shows trends in the generation-weighted average levelized PPA price over time among four of the five regions broken out in Figure 32 (the Southeast region is omitted from Figure 33 owing to its small sample size). Figures 32 and 33 both demonstrate that, based on our data sample, PPA prices are generally low in the U.S. Interior, high in the West, and in the middle in the Great Lakes and Northeast regions. The large Interior region, where much of U.S. wind project development occurs, saw average levelized PPA prices of just over $30/MWh in 2011 and 2012.

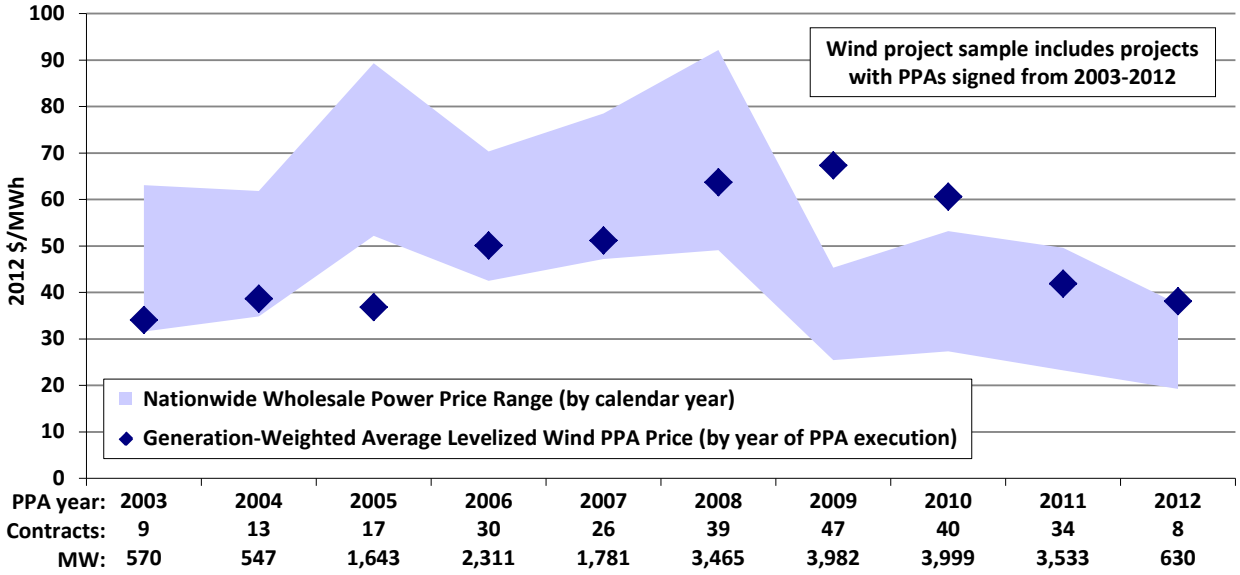
Low Wholesale Electricity Prices Continued to Challenge the Relative Economics of Wind Power

Figure 34 shows the range (minimum and maximum) of average annual wholesale electricity prices for a flat block of power[65] going back to 2003 at 23 different pricing nodes located throughout the country (refer to the Appendix for the names and approximate locations of the 23

[65] A flat block of power is defined as a constant amount of electricity generated and sold over a specified period. Although wind power projects do not provide a flat block of power, as a common point of comparison a flat block is not an unreasonable starting point. In other words, the time variability of wind energy is often such that its wholesale market value is somewhat lower than, but not too dissimilar from, that of a flat block of (non-firm) power.

pricing nodes represented by the blue-shaded area). The dark diamonds represent the generation-weighted average levelized wind PPA prices in the years in which contracts were executed (consistent with the averages presented in Figure 33).

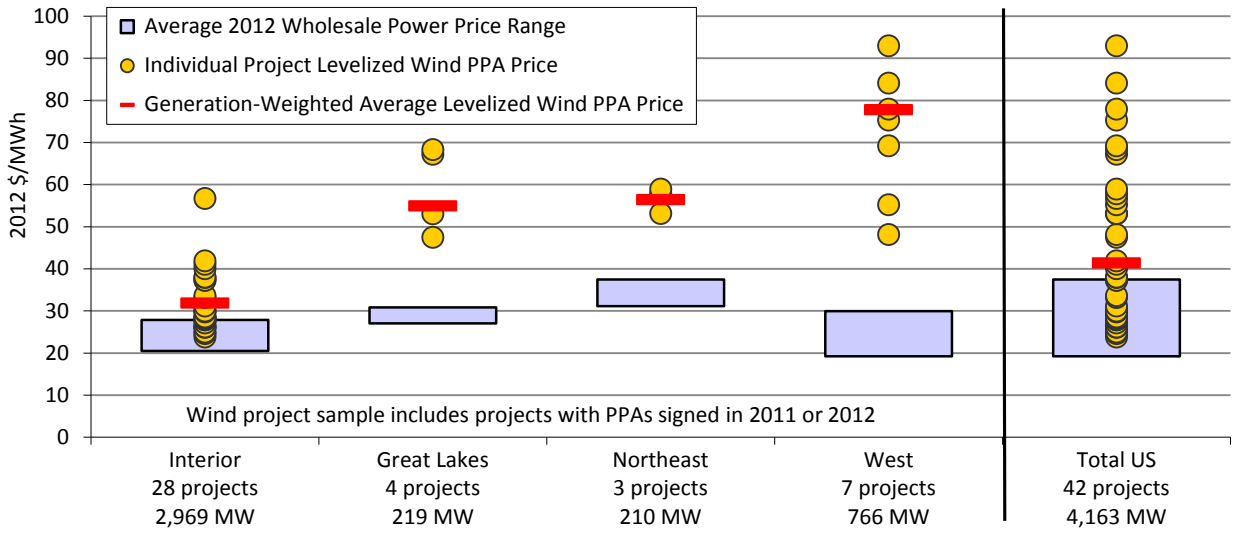
At least within the sample of projects reported here, average long-term wind PPA prices compared favorably to yearly wholesale electricity prices from 2003 through 2008. Starting in 2009, however, the sharp drop in wholesale electricity prices (driven by lower natural gas prices) squeezed average wind PPA prices out of the wholesale power price range on a nationwide basis. Wind PPA prices have since fallen, however, and in 2011 and 2012 reconnected with the upper end of the wholesale power price range.



Source: Berkeley Lab, FERC, Ventyx, IntercontinentalExchange

Figure 34. Average Levelized Long-Term Wind PPA Prices and Yearly Wholesale Electricity Prices over Time

Although Figure 34 portrays a national comparison, there are clearly regional differences in wholesale electricity prices and in the average price of wind power. Figure 35 focuses just on the sample of wind PPAs signed in 2011 and/or 2012 and compares those levelized long-term PPA prices to wholesale electricity prices in 2012 by region. The limited wind PPA sample size in some regions must be noted. Nonetheless, based on our sample, wind PPA prices are most competitive with wholesale power prices in the Interior region (where PPAs signed in 2011/2012 generally ranged from $20–$40/MWh) and are least competitive in the West (with a PPA price range in 2011/2012 of under $50/MWh to over $90/MWh), with the Great Lakes and Northeast regions falling in between (with a PPA price range of roughly $50–$70/MWh in 2011/2012).



Source: Berkeley Lab, Ventyx, IntercontinentalExchange

Figure 35. Levelized Long-Term Wind PPA Prices in 2011/2012 and Yearly Wholesale Electricity Prices by Region

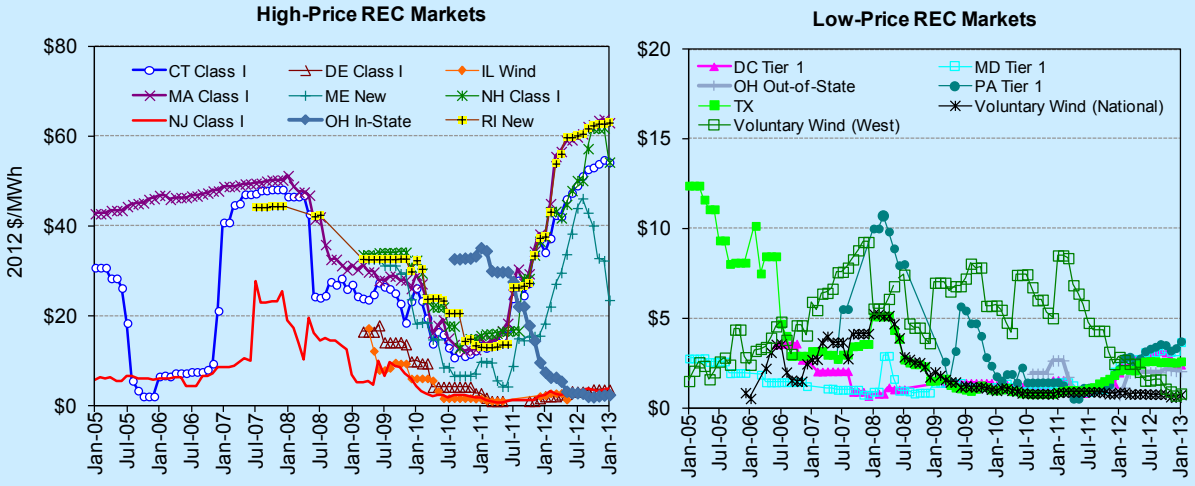
Important Note: Notwithstanding the comparisons made in Figures 34 and 35, neither the wind nor wholesale electricity prices presented in this section reflect the full social costs of power generation and delivery. Specifically, the wind PPA prices are reduced by virtue of federal and, in some cases, state tax and financial incentives. Furthermore, these prices do not fully reflect integration, resource adequacy, or transmission costs. At the same time, wholesale electricity prices do not fully reflect transmission costs, may not fully reflect capital and fixed operating costs, and are reduced by virtue of any financial incentives provided to fossil-fueled generation and by not fully accounting for the environmental and social costs of that generation. In addition, wind PPA prices—once established—are fixed and known, whereas wholesale electricity prices are short term and therefore subject to change over time (EIA and others project natural gas prices to rise, and therefore wholesale electricity prices to also increase, over time). Finally, the location of the wholesale electricity nodes and the assumption of a flat block of power are not perfectly consistent with the location and output profile of the sample of wind power projects.

In short, comparing levelized long-term wind PPA prices and yearly wholesale electricity prices in this manner is not appropriate if one's goal is to account fully for the costs and benefits of wind energy relative to its competition. Another way to think of Figures 34 and 35, however, is as loosely representing the decision facing wholesale electricity purchasers that are otherwise under no obligation to purchase additional amounts of wind energy—i.e., whether to contract long term for wind power or to buy a flat block of (non-firm) spot power on the wholesale electricity market. In this sense, the costs represented in Figures 34 and 35 are reasonably comparable in that they represent (to some degree, at least) what the power purchaser would actually pay in the year in question.

REC Prices Rose in the Northeast, Remained Depressed Elsewhere

The wind power sales prices presented in this report reflect only the bundled sale of both electricity and RECs; excluded are projects that sell RECs separately from electricity, thereby generating two sources of revenue. REC markets are fragmented in the United States but consist of two distinct segments: compliance markets, in which RECs are purchased to meet state RPS obligations, and green power markets, in which RECs are purchased on a voluntary basis.

The figures below present indicative monthly data of spot-market REC prices in both compliance and voluntary markets, grouped into High-Price and Low-Price markets; data for compliance markets focus on the "Class I" or "Main Tier" of the RPS policies. Clearly, spot REC prices have varied substantially, both across states and over time within individual states, although prices across states within common regions (New England and PJM) are linked to varying degrees. Over the course of 2012, REC spot-market prices continued to rise among four Northeastern markets (Connecticut, Massachusetts, New Hampshire, and Rhode Island), after their nadir in 2010 and early 2011, and ended the year above $50/MWh. Elsewhere, however, REC prices for compliance markets generally fell (e.g., for Ohio's in-state RPS requirements) or remained below $5/MWh due to a continued surplus of eligible renewable energy supply relative to RPS-driven demand. Prices for RECs offered in the voluntary market remained at or fell below $1/MWh.



Sources: Evolution Markets (through 2007) and Spectron (2008 onward). Plotted values are the last monthly trade (if available) or the mid-point of monthly bid and offer prices, for REC vintages from the current or nearest future year traded in each month.