Surprising Takeaways From A New Power Market Analysis

A recent comparison of offshore and onshore wind prices in New England revealed some surprising discoveries.

By Seth G. Parker & Dr. Angeliki A. Rigos

Regulators need to explicitly consider the market values of the power products provided by onshore and offshore wind projects when setting development policies. The values of those energy and capacity products determined in competitive markets – along with emissions and other key factors such as siting, transmission, supply chain and avian or marine life impacts – are important indicators of ratepayer benefits, assuming that the local system operator "gets the prices right."

In order to compare the power market values of hypothetical onshore and offshore wind projects in New England, hourly wind production and recent power market price data were used for projects of equivalent size. The results demonstrated that an offshore project would have generated more energy (due to the wind resource) annually, with much higher peak-hour deliveries that are critical for capacity (as determined under regional market rules) compared to an onshore project. An offshore wind project would also have benefited from slightly higher energy prices, reflecting the advantage of delivering energy closer to load centers.

Wind resource data and project generation

A number of onshore wind projects have been successfully developed in New England, while offshore projects have had limited development to date. This paper examines the wholesale power market values of hypothetical onshore and offshore wind projects based on historical wind resource data and on energy and capacity prices, with particular focus on wind energy's contribution to meet peak energy demands.

The updated 2012 data set – prepared by the National Renewable Energy Laboratory (NREL) and covering the period from 2004 to 2006 for likely wind project locations throughout New England – was used for the analysis. Most of New England's onshore wind projects have been developed in northern Maine, and further development is possible with transmission upgrades. One offshore wind project is under construction off of Block Island, R.I., and there are other projects under development in Nantucket Sound and off of the eastern Rhode Island/southwestern Massachusetts shoreline.

To facilitate comparisons, the study assumed that an onshore project in northern Maine and an offshore project off of the Rhode Island/Massachusetts coast would be sized to deliver 100 MW (net of collection and cable losses) into the transmission grid administered by the Independent System Operator – New England (ISO-NE), the entity that administers the regional bulk power market. The study recognized that projects could be larger, especially offshore projects that are typically 400 MW or larger, but we assumed projects of equivalent size for the purpose of this analysis. As Figure 1 illustrates, the offshore project would generate 16.7% more energy every year due to stronger and more consistent wind resources at these sites.

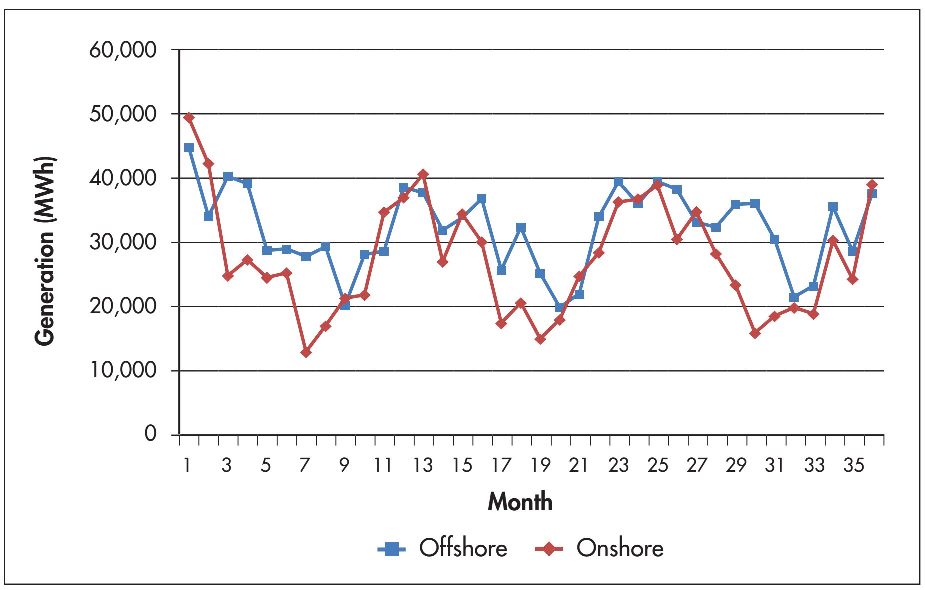
The hypothetical onshore project would generate an average of 330,685 MWh/year, which would be equivalent to a 37.8% capacity factor based on the 100 MW net rating and 36.7% based on a 103 MW gross rating.

Both wind project locations have pronounced seasonal patterns with energy generation peaking in the winter months, especially in December (months 12, 24, and 36) and January (months 1, 13, and 25). New England is predominantly a summer-peaking system. However, both locations display markedly lower generation during the summer months. Onshore wind project generation from June through September during peak hours (from 1 p.m. to 6 p.m.) would have an 18.5% capacity factor, while offshore wind project generation would have a 30.5% capacity factor for those same peak hours. These summer-generation profiles have significant reliability and capacity value implications, as explained below.

Energy market values

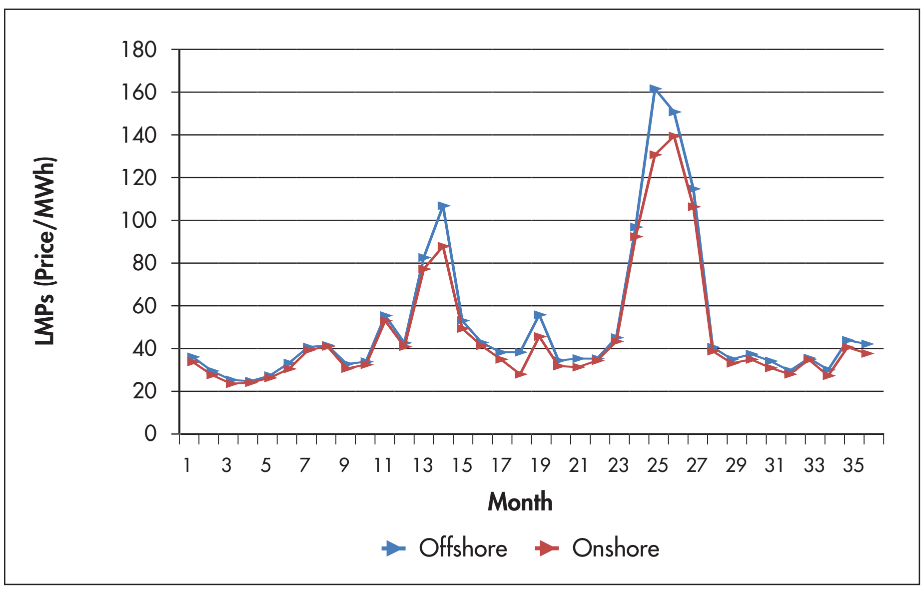
In order to calculate the market energy value of the wind projects, we utilized ISO-NE Real Time Market Locational Marginal Price (LMP) data for 2012 through 2014 at two locations: the Kibby node in Franklin County, Maine, for the onshore project and the Brayton Point node in Bristol County, Mass., for the offshore project. The Kibby node is used

Figure 1: Monthly Onshore and Offshore Wind Generation in New England (2004-2006)



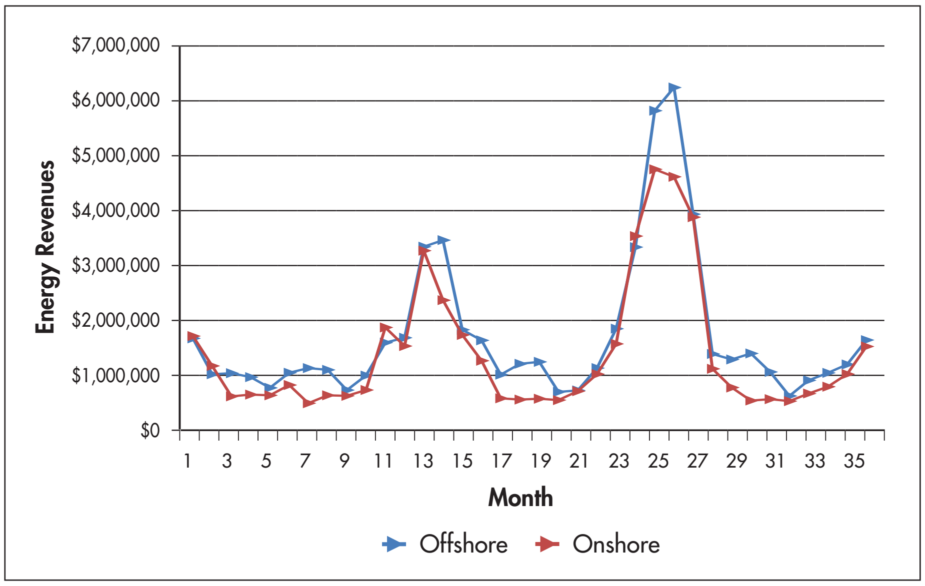
Source: LAI Inc.

Figure 2: ISO-NE 2012-2014 Monthly Average LMPs for Kibby and Brayton Point Nodes



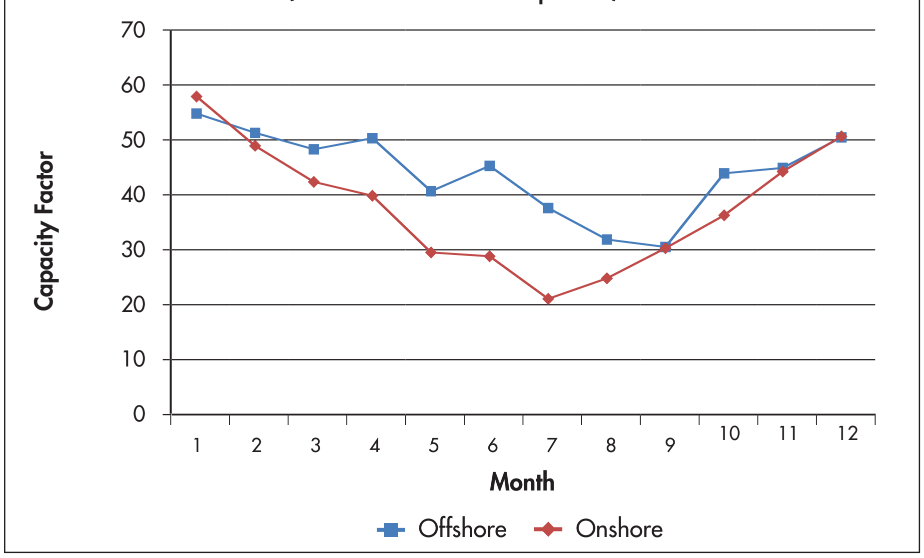
Source: LAI Inc.

Figure 3: Monthly Energy Revenues for Onshore and Offshore Wind Projects (2012-2014)



Source: LAI Inc.

Figure 4: Average Monthly Capacity Factors for Hypothetical Offshore and Onshore Wind Projects (based on 100 MW net capacities)



Source: LAI Inc.

by operating wind projects in Maine. The Brayton Point node is likely to be a future interconnection point for large offshore projects once the Brayton Point power plant retires in 2017; that substation will then be able to accept at least 1,500 MW and deliver it into the ISO-NE transmission grid.

Monthly average LMPs for the two nodes over the three-year period from 2012 to 2014 are illustrated in Figure 2. The LMP spikes from January to February 2013 and from December 2013 to March 2014 reflect high gas and oil prices during cold weather periods.

Market energy prices are typically higher when a project is close to load centers due to lower losses and less transmission congestion. The Kibby and Brayton Point nodes are no exceptions. The Brayton Point energy prices averaged about 9% higher than Kibby's prices. Therefore, an offshore wind project interconnected to the Brayton Point substation (and other locations in southeastern Massachusetts with similar LMPs) would receive slightly higher energy revenues than an onshore project of equivalent size located in northern Maine (see Figure 3).

Capacity market values

ISO-NE market rules require new wind generators to provide

continued on page 21

continued from page 7

"… measured and recorded site-specific summer and winter data …" during intermittent reliability hours to support a claimed qualified capacity and receive capacity market revenues. Summer intermittent reliability hours are 1 p.m. to 6 p.m. in June; September and winter intermittent reliability hours are 5 p.m. to 7 p.m. from October through May. ISO-NE also counts hours in which it experiences shortage events, but those events were ignored for the purpose of this paper. Based on the NREL data, the following capacity values were calculated:

- The hypothetical onshore wind project would have capacity values of 19.0% in the summer and 38.6% in the winter. Based on 100 MW, it would receive 19.0 MW of summer capacity revenues and 38.6 MW of winter capacity revenues at the Franklin County zonal price.
- The hypothetical offshore wind project would have much higher capacity values of 31.2% in the summer and 46.3% in the winter. It would receive 31.2 MW of summer capacity revenues and 46.3 MW of winter capacity revenues at the southeastern Massachusetts/Rhode Island (SEMA/RI) zonal price.

Figure 4 illustrates the monthly average capacity factors under ISO-NE rules for the two projects and highlights the significant difference between them during summer hours.

ISO-NE sets capacity market prices for annual capacity commitment periods (from June 1 to May 31) through forward capacity auctions (FCAs). Therefore, capacity revenues for a calendar year are based on the last five months (January through May) of one FCA and the first seven months (June through December) of the following FCA. The FCA results for the relevant years were the administratively determined floor prices and the Maine and SEMA/RI zonal prices were identical, as shown in Table 1, and are not proper indicators now that ISO-NE has adopted changes to how FCAs are tabulated.

Table 1: ISO-NE Wholesale Capacity Prices (Price Per kW/Month)

Wind Project	FCA Zone	2011-12 (FCA 2)	2012-13 (FCA 3)	2013-14 (FCA 4)	2014-15 (FCA 5)
Onshore	ME	$3.60	$2.95	$2.951	$3.209
Offshore	SEMA/RI	$3.60	$2.95	$2.951	$3.209

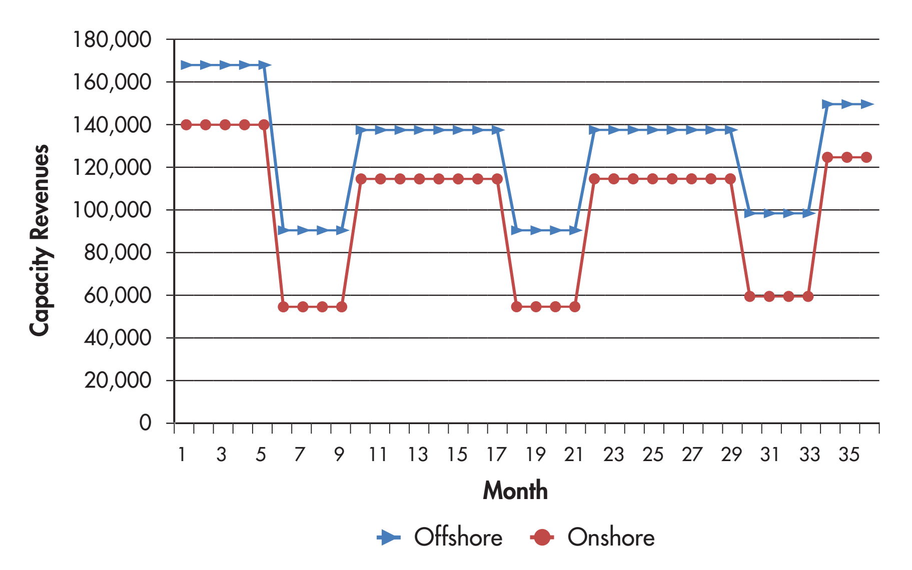
Source: LAI Inc.

The capacity revenues for the two wind projects were calculated based on their respective capacity values and the ISO-NE capacity prices for the calendar years 2012 through 2014, as illustrated in Figure 5. The higher capacity value for the offshore wind project would have provided an extra $28,100 per month. Moreover, the most recent auction, FCA 9 for 2018 through 2019, resulted in much higher prices, particularly for the SEMA/RI zone, which would magnify the capacity market value advantage for future offshore wind projects.

Other considerations

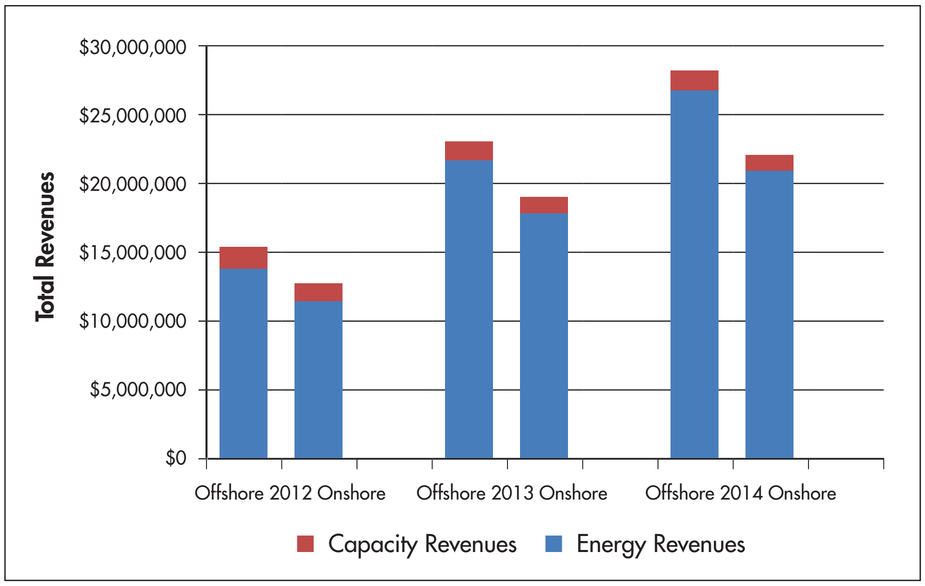
There are a number of financial, environmental and other factors that should be considered in any policy (and investment) decisions regarding onshore and offshore wind projects. First and foremost are the significant capital cost and operations and maintenance cost differences between onshore and offshore projects that reflect different design, access, equipment and construction methods. The net result of the power market revenue and project cost differences are manifested in renewable energy certificate (REC) and offshore REC prices. Air emissions considerations are also important for policymakers – neither wind technology emits carbon or other air pollutants, nor requires water for cooling or for emissions control,

Figure 5: Monthly Capacity Revenues for Hypothetical Offshore and Onshore Wind Projects (2012-2014)



Source: LAI Inc.

Figure 6: Energy and Capacity Revenues for Hypothetical Onshore and Offshore Wind Projects (2012-2014)



Source: LAI Inc.

which is a consideration in regions with limited water resources. However, there are many other important considerations:

Footprint. Although the individual footprint of an onshore or offshore turbine is relatively small, the area covered by the wind farm is much larger because the turbines have to be spaced far enough from each other to minimize interference of the wind wake.

Siting. Though builders of offshore wind projects can minimize siting issues by building them in federal waters and situating them more than three miles from shore, there may be opposition from local residents or other stakeholders.

Visual impact. Onshore and offshore projects can be sited to minimize visual impact, but eliminating impact completely may not be possible. Eventually, offshore projects may be able to utilize floating wind turbine technology that would enable them to be built in deeper waters farther offshore.

Transmission lines. Onshore projects often require new or upgraded transmission lines to interconnect them to the existing grid, and offshore projects typically utilize underwater cables to interconnect them to coastal substations. So, both technologies may require system upgrades to accommodate the wind energy without triggering reliability violations.

However, offshore wind is typically closer to load centers and may reduce overall transmission costs and losses for the region in the long run.

Acoustic impacts. Onshore projects that are located in remote areas may not avoid noise issues; projects situated closer to populated areas may have problems, despite the background noise to mask their sounds. Sounds generated by offshore wind farms should not be problematic given the distance to population centers.

Supply chain. Due to the large onshore wind market, turbine manufacturers have invested heavily in domestic manufacturing capability. Offshore turbines will likely be imported until manufacturers have a reasonably steady domestic demand. Offshore wind is very conducive to building a local industry, however, given size and transportation considerations.

Avian and marine life. There have been instances of migratory bird mortalities from onshore and offshore projects, as well as harm during construction. Offshore projects may also have both negative and positive marine wildlife impacts, such as small protected zones around their bases. **NWP**

Seth Parker is vice president and principal of Levitan & Associates (LAI). Dr. Angeliki Rigos is an executive consultant at LAI and an associate professor at Merrimack College. They are part of the LAI team implementing Maryland's Offshore Wind Energy Act of 2013 for the Public Service Commission. They can be reached at sgp123@lai.com and dar@levitan.com, respectively.