memo

To: NECPUC, NESCOE and NEPOOL

From: ISO New England

Date: June 3, 2015

Subject: Discussion paper on New England's capacity markets and a renewable energy future

ISO New England is releasing a draft paper, titled "The Importance of a Performance-Based Capacity Market to Ensure Reliability as the Grid Adapts to a Renewable Energy Future," for discussion with stakeholders at the upcoming NECPUC and NEPOOL meetings in June. The paper describes the magnitude of renewable energy coming onto the system and the interaction of related state policies with the region's wholesale electricity markets.

ISO New England Inc.
One Sullivan Road, Holyoke, MA 01040-2841
www.iso-ne.com **T** 413 535 4000

The Importance of a Performance-Based Capacity Market to Ensure Reliability as the Grid Adapts to a Renewable Energy Future

ISO New England Discussion Paper

June 2015

Introduction

New England has small, but rapidly growing levels of renewable energy resources—notably wind power and solar power. This growth is being spurred by state and federal policies that seek to introduce cleaner, lower-carbon-emitting resources into the energy mix.[1] In New England, the states desire to see these policies influence the design and outcomes of the wholesale electricity markets.

Because the resources the states are supporting have no fuel costs, they are generally dispatched ahead of conventional generation, such as gas-, coal-, and oil-fired resources that must include fuel costs in their offers to sell electricity into New England's wholesale electric energy market. State subsidies for renewable resources will put downward pressure on energy-market prices, but this action is not without consequences: it will put upward pressure on prices in the capacity market. The capacity market will help balance the revenue needs for resources as the energy market provides fewer opportunities for resources to recover their fixed costs.

This paper describes the magnitude of renewable energy coming onto the system and the interaction of related state policies with the region's wholesale electricity markets. The capacity market will play a key role in ensuring that reliability is maintained as increasing levels of renewables are integrated onto the system. Additional renewables are expected to decrease wholesale electric energy prices, which will result in increased capacity prices to ensure resource adequacy. The shift in revenues from the energy to the capacity market will also affect the resource mix, putting additional financial pressure on energy-market dependent resources.

[1] Mechanisms to implement these policies include, but are not limited to: state renewable portfolio standards and similar renewable energy goals; state initiatives to reduce greenhouse gas emissions (e.g., global warming solutions acts) and regional carbon cap-and-trade programs, such as the Regional Greenhouse Gas Initiative; state-sponsored, long-term contracts to develop renewable resources; and federal production and investment tax credits.

Renewable Energy in New England

By the end of 2014, the region had achieved 800 MW of wind power (nameplate capacity), which produced nearly 1% of the region's electricity that year. By 2015, developers have proposed 4,000 MW of additional wind power.[2] Furthermore, ISO studies have shown that New England has vast wind power potential that could generate nearly a quarter of the region's electricity under high wind penetration scenarios (up to 12,000 MW of onshore and offshore wind power resources).[3]

By the end of 2014, the region had achieved 900 MW of solar photovoltaic (PV) resources (AC nameplate capacity) and ISO New England's solar PV forecast projects the region will realize nearly 2,500 MW by 2024.[4]

Capacity and Energy Markets

The capacity market is a forward market intended to ensure New England will have adequate resources to meet all electricity demand plus reserve requirements three years into the future. Beginning in June 2018, capacity payments will be based on an individual resource's performance during scarcity conditions (times when the system is unable to meet its energy or reserve requirements), and the capacity market will fulfill two primary objectives: ensuring resource adequacy and providing appropriate incentives for resource performance. The ISO obtains the resources needed through annual forward capacity auctions; bidders reduce their offers by the expected net energy market revenues in the capacity delivery period. The two markets (capacity and energy) are linked; higher energy-market net revenue reduces competitive capacity market offers. As such, changes in the fundamentals in one market will affect the other.

Interaction of Subsidized and Conventional Resources

Stakeholders are asking the ISO what will be the impact of increasing levels of subsidized renewable resources (i.e., wind and solar) on resources participating in the wholesale market. In particular, we are asked: Will this drive conventional generation out of the market by suppressing energy market prices and thereby making conventional generation uneconomic?

[2] ISO New England Generator Interconnection Queue, June 2015.

[3] *New England 2030 Power System Study: Report to the New England Governors*, February 2010; http://www.iso-ne.com/static-assets/documents/committees/comm_wkgrps/prtcpnts_comm/pac/reports/2010/economicstudyreportfinal_022610.pdf

[4] Final 2015 PV Forecast, April 2015; http://www.iso-ne.com/static-assets/documents/2015/05/final_2015_pv_forecast.pdf

This concern has been raised in the context of specific nuclear unit retirements (e.g., Vermont Yankee) and potential retirements (e.g., resources in Illinois and New York)[5] [6]. And it is easy to understand why this concern arises: wind and solar resources generally produce zero (or even negative) marginal cost energy.

Adding wind and solar to the grid should be expected to result in lower energy prices when the wind is blowing or the sun is shining. This will reduce the inframarginal rents earned by all resources during those hours, and may have significant effects on the net revenues of baseload resources for which the energy market is the primary revenue source. It may also be expected to increase the price of reserves, and the revenues of flexible, reserve-providing resources.

In New England today, the total resource mix comprises a small percentage of renewables, but that percentage is expected to grow substantially over the next decade. This growth in renewables is being driven by both the falling cost of installing these resources (by some estimates wind is already a low-cost provider in certain areas), and by sizeable direct and indirect state subsidies.

For example, in 2015, Connecticut, Rhode Island and Massachusetts, and certain of their electric distribution companies, plan to issue an RFP to help fulfill these states' clean energy goals. This action is in addition to having instituted Renewable Portfolio Standards (RPSs) and other mechanisms for clean energy over the last fifteen years.

As the penetration of wind and solar resources grows, the price-reducing effects of renewables on electric energy prices will increase. This will in turn increase the financial pressure on energy-market dependent resources, often baseload resources such as nuclear and coal. These sorts of projections have caused industry participants to worry about a wave of forthcoming retirements of baseload resources that will harm reserve margins and reliability. Some argue that this concern warrants changes to the market designs of the RTOs, or policy changes to prevent these retirements and their associated reliability impacts. These suggestions range from carbon taxes, to requiring a "baseload" tranche in the capacity market, to unit-specific reliability agreements to preserve reliability in the absence of an explicit market mechanism to support these resources.

[5] http://www.renewableenergyworld.com/rea/news/article/2014/06/old-reactors-v-new-renewables-the-first-nuclear-war-of-the-21st-century

[6] http://www.rochesterhomepage.net/story/d/story/the-future-of-ginna-nuclear-power-plant-uncertain/48117/YHLnyTmFt0StlE4Xth_4VA

Such market interventions should not be needed to ensure reliability, or efficient market responses to an increased penetration of renewable resources. The current market design should ensure adequate resources to meet the reliability standards for which the markets are designed. It also should ensure that the resulting resource mix appropriately complements the capabilities and limitations of the renewable resources entering the market.

The Capacity Market Will Ensure Resource Adequacy

Under the current New England market construct, the capacity market is designed to ensure resource adequacy. The supply in the market is determined by offers from competitive suppliers of both new and existing resources. Demand in the market is determined by an administratively defined downward sloping demand curve, which is calculated to ensure adequate resources to meet expected operating needs. Price and quantity are determined by the intersection of the two curves, just as in any market.

Two important elements of the capacity market design ensure that the market is “calibrated” to reflect both the region’s capacity needs and the price needed to induce the required amount of capacity. These elements are the Installed Capacity Requirement (ICR) and the Cost of New Entry (CONE). The ICR combined with the demand curve determine the amount of resources that the ISO procures through the capacity market. The CONE calculation is an estimate of the cost of building an efficient new generating resource. These elements are expanded upon below.

ICR and CONE

The ICR is calculated by the ISO’s System Planning department. Using system load and outage data, System Planning calculates the expected frequency of outages on the bulk power system due to inadequate available capacity resources. From these calculations, System Planning is able to determine the quantity of resources that should be adequate to ensure that a loss of load does not occur more frequently than once every ten years. The ICR increases as the region’s demand for electricity grows over time. Similarly, if the outage rate were to increase for resources unexpectedly forced out of service (i.e., an unplanned outage), the ICR would also increase.

This calculation also takes into account the expected availability of renewable resources (or any variable resource). The less frequently a variable resource is expected to operate during a year, the less the resource contributes to ensuring reliability. Thus a 100 MW wind resource which operates 20% of the time, when the wind blows, contributes less to meeting capacity needs than a 100 MW combined-cycle generator that operates 80% of the time, and on demand.[7] The total quantity of resources needed should be expected to grow as more variable and renewable resources are added to the system; these resources typically make contributions to reliability that are only a fraction of the value of their nameplate capacity. For this reason, intermittent resources like wind have their capacity severely discounted when counted toward meeting the ICR.

The second important element used for calibrating the capacity market is the Cost of New Entry (CONE). CONE is an estimate of the competitive offer that would be submitted into the capacity market by a prospective new entrant such that, if the market cleared at that price, it would just be sufficient to induce entry into the market.

CONE is calculated by estimating the total cost of a new resource (including permitting, siting and construction costs, and a competitive return on capital), and then calculating a levelized annual cost for the resource (similar to the mortgage payments on a home). These annual costs are then reduced by any forecast net revenues from the energy and ancillary service markets. The remaining revenue requirement is the Cost of New Entry, which is the amount that the resource would need to earn from the capacity market in order to be induced to enter the market.[8]

The simplest calculation would be for a peaking unit with a high marginal cost. Such a unit would be expected to earn no money in the energy market, and only a modest amount in the reserve market, so its capacity market offer would be close to its levelized capital cost. This is the amount that a for-profit developer would require in order to build the resource.

The ICR and CONE are used in determining the precise nature of the sloped demand curve. The sloped demand curve helps to determine the purchase quantity and price in the forward capacity auction, causing the FCA to procure less capacity at high prices and more at low prices. This reflects both the fact that the desired level of reliability changes with the price of reliability and that elasticity of demand helps to control market power. The ICR determines how far “right” the demand curve is positioned. CONE is used to set the “height” of the demand curve.

[7] The difference between resources that operate on-demand versus those that operate when the wind is blowing (or the sun is shining) is important to reliability, but this paper does not focus on those differences and instead only addresses the differences currently relevant for ICR calculation purposes.

[8] There are additional complexities, like variable revenues from year to year and a whole range of operating and market risks which are not discussed here, but which would be expected to both influence an actual resource’s offer as well as any calculation of CONE.

The "target" procurement is the ICR at an expected price of CONE.[9] That is, the demand curve is set to procure enough to meet the reliability target assuming that CONE is a reasonable estimate of the price that a new resource would require to enter the market.

Interaction of subsidized resources and the FCM

From this discussion, it is straightforward to see how the capacity market would respond to an influx of subsidized renewable resources with zero marginal cost energy. This would affect both the amount of capacity installed in the region and CONE, with the change in CONE consistent with expected changes in bidding behavior by market participants. The total amount of capacity (i.e., nameplate capacity) would increase with the addition of more renewables relative to a system populated entirely by conventional resources. The ICR calculation discounts the nameplate value of renewable resources as an input, so this increase would not be directly reflected in the ICR.

As an example, 1,000 MW of additional wind resources might only count 200 MW toward meeting the ICR. The gross capacity required to meet the ICR would therefore rise as the proportion of variable generation increased. It might take five 1,000 MW wind facilities to equal the contribution of one 1,000 MW combined-cycle generator.[10]

The introduction of larger quantities of renewable resources would also be expected to increase both CONE and offers from competitive capacity suppliers. CONE would increase because additional renewable resources, which typically act as price takers in the energy market, would be expected to decrease energy prices and therefore net revenues for all resources in the energy market. This expected reduction would be reflected in reduced net energy market revenues calculated for the hypothetical new entrant as part of the CONE calculation. A reduction in net energy market revenues would increase the amount that a new entrant would require from the capacity market in order to move forward.

What is true for the CONE calculation would also be expected to be true for the offers submitted by capacity resource owners: capacity market offers should rise as energy market revenues decrease.

Both elements of the capacity market that calibrate it to reflect reliability needs and market conditions would reflect the addition of renewable resources (as they have to-date).

[9] This is a simplification in that the demand curve is set to procure slightly more than the ICR at CONE to allow for error in the CONE calculation.

[10] This is an illustrative example only.

These two elements would ensure that sufficient additional nameplate capacity was built to meet reliability requirements (by discounting the capacity value of intermittent renewable resources), even with the relatively low energy capability of many renewable resources. These elements also would ensure that the price set by the demand curve at the reliability target is increased to reflect any expected reduction in energy market revenues caused by increased levels of renewable resources.

The capacity market would continue to ensure that the reliability target is met just as it does today. If necessary, the capacity market could set a CONE that reflects new entrant capital costs with no energy market revenue offset because expected energy market net revenues are zero.

The Combined Capacity and Energy Markets Will Shape the Resource Mix

While the capacity market will ensure that the region's reliability target is met, the addition of large quantities of renewable resources that reduce energy market prices will influence the long-run resource mix in New England beyond just the quantity of renewables. It will affect what resources retire and what types of resources get built in the future; not all resource types will be affected equally.

Energy market revenues affect retirements

New England has already experienced a number of retirements of coal, oil, and nuclear units in recent years. While it is not possible to know if all of these retirements would have occurred with fewer renewables as part of the resource mix, they are certainly indicative of the expected future retirements in New England. They include baseload coal and nuclear units that depend relatively heavily on consistent inframarginal rents in the energy market. Vermont Yankee, the recently retired nuclear unit, has made clear that low energy market margins were the driver for its retirement.[11]

With the expected increased penetration of renewable resources, more such retirements should be expected in the future. For example, at current energy and capacity prices, nuclear units might earn almost ten times more revenue from the energy market than they earn from the capacity market.[12] Modest changes in energy market revenues could have large impacts on the bottom line of a nuclear unit, or baseload coal unit. This may be especially true for nuclear units, which have very high fixed operating costs and typically operate at very high capacity factors.

[11] *Entergy to Close, Decommission Vermont Yankee*, Entergy press release, August 27, 2013; http://www.entergy.com/News_Room/newsrelease.aspx?NR_ID=2769

[12] 8760*$65*.95=$540,930 vs. $4.75/kW-mo.*12*1000=$57,000

Energy market shifts could affect technology types

Lower energy market margins are also likely to shift the new generation mix away from energy market-dependent resources to capacity market-dependent resources. In the current environment, that might mean a shift from gas-fired combined cycles toward gas-fired peaking resources. For example, a combined-cycle (CC) resource is currently expected to earn double the net revenues from the energy and ancillary markets when compared with a combustion turbine (CT), but a decrease in available energy revenues may cause combined-cycle generators to become less competitive.[13] This shift is also consistent with the expected increase in reserve market needs as the penetration of variable renewable resources grows.

Generator retirements will affect carbon emissions

The expected future increase in renewable resources, and the consequent reduction in energy prices, will put increased pressure on existing baseload units. This financial pressure will likely cause them to retire sooner than otherwise. While this is an expected market response given the changing resource mix and incentives, it will have side effects. In addition to accelerating the retirement of otherwise reliable resources, to the extent that nuclear units are shuttered it will likely result in increased CO_2 emissions as fossil resources fill at least some of the energy gap. This is almost certainly an unintended consequence given that much of the rationale for the subsidization of renewable resources is the reduction of CO_2 emissions.

The Increased Importance of the Capacity Market Will Make the ISO's Execution of Administrative Functions Even More Important

Capacity markets include complex administrative elements. They rely on accurate calculations of the cost of new entry, sloped demand curves, the installed capacity requirement, offer review trigger prices, and scrutiny of the prices at which resources seek to exit the market (i.e., delist bids are reviewed and potentially capped by the market monitor). While this overhead is necessary because of administratively-imposed reliability standards and lack of substantial demand-side price response by electricity consumers, the reduction in energy margins and greater reliance on the capacity market to assure resource adequacy will *increase* the importance of these administrative determinations.

[13] For example: http://www.iso-ne.com/static-assets/documents/committees/comm_wkgrps/mrkts_comm/mrkts/mtrls/2014/mar192014/a02_iso_net_cone_capital_budgeting_model_03_14_14.xlsx. See column "E&AS Offsets"

If they are allowed to operate as designed, these administrative calculations will be successful in ensuring a reliable system and an orderly transition as the share of renewable energy grows rapidly over the next decades.

Some of these functions are relatively new to the market, or will take on greater importance. In particular, getting CONE right and guarding against uneconomic new entry through realistic offer review trigger prices (ORTPs) will be necessary to attract the resources necessary to operate reliably.

Cost of New Entry

CONE is a key parameter because, when calculated correctly, it causes the demand curve to induce new entry when quantities fall below the ICR. If CONE is too low, there will be insufficient new entry and the region's reliability targets will not be met. Because of the complexity of the CONE calculation, sensitivity to key assumptions like internal rates of return, and the necessary projections of energy, capacity and ancillary service market revenues, CONE is particularly vulnerable to miscalculation.

Offer Review Trigger Prices

ORTPs are also important components to a successful capacity market. The ORTP is intended to prevent uneconomic or subsidized new entry from distorting market prices by setting a price floor below which new entrants must demonstrate their costs or be withdrawn from the capacity auction. Entry by subsidized new resources will lower the capacity price for all existing resources, which will reduce the incentives for new, market-rate resources in the future. Because the volume of new entry needed in any particular year is generally small relative to the total capacity need, even a modest amount of subsidized new entry could depress capacity prices.

Features in FCM that address entry by new renewable resources

To address this, the New England capacity market has two complementary features that address capacity-market entry by new, renewable resources: ORTPs designed to prevent uneconomic entry, and a 200 MW per year exemption from the ORTP for renewable resources. The exemption allows, within limits, the resources being developed as a consequence of state policy to enter the market and count as capacity resources.

The exemption is limited in that it allows new resources to enter the market each year at a level that does not exceed expected annual load growth. This is appropriate to avoid creating a large quantity of state-backed resources that do not count to meet the region's reliability requirements. Ignoring these resources would be costly and inefficient. Allowing unlimited entry by such resources, however, would undermine long-term price expectations and confidence in the capacity market. This would make it more difficult for the market to attract new resources, and would increase the price necessary to attract those that do come forward.

The ORTPs are necessary to ensure that resources that do enter the market, including renewables, do so at a competitive price. This acts as a filter to ensure consistently competitive pricing in the capacity market and provides appropriate long-term price signals to new entrants. If renewables are economic at quantities that exceed the renewables exemption, the ORTPs will allow them to enter the market at a competitive level. If they are not, the ORTPs will ensure that more economically efficient new entrants clear in the auction.

Calculating class-specific ORTPs is an involved task, but doing these calculations correctly is important to ensure that uneconomic resources do not depress the capacity price and that economic resources are not inappropriately excluded from the market. Either would reduce efficiency and ultimately increase costs to consumers.

While the renewables exemption and ORTPs contribute both to the administrative nature of the capacity market and the difficult set of calculations that must be performed by the ISO for each capacity auction, they have emerged as accommodations to state programs and policies outside the control of the ISO. If government policies were to reduce the emphasis on targeted mechanisms, such as direct contracting and picking specific preferred technologies, and instead focus on broad-based mechanisms such as regional carbon-cap-and-trade markets, these types of administrative safeguards might be relaxed.

The interaction of competitive wholesale electricity market design and state policy objectives requires a delicate balance.

Conclusion

The development of large quantities of state-sponsored renewable resources will present opportunities and challenges for New England.[14] The current markets are equipped to respond appropriately to the entry of these resources, maintaining reliability and market efficiency. However, this new entry will likely drive down energy prices, but lead to an increase in capacity prices. Capacity market revenues will become even more critical to the continued operation of existing resources and the entry of new resources. This entry also will likely incent some existing baseload resources to retire earlier than they otherwise would.

In the medium- to long-term, the capacity market will enable the region to achieve necessary levels of resource adequacy and resource performance while transitioning toward a system with greater levels of renewable resources. In the near term, the entry and exit of specific resources will continue to be monitored to ensure reliability needs are met.

[14] The introduction of similar quantities of renewable resources because of naturally occurring, private-sector investment (without state subsidies) would have the same effect, but state policies and subsidies appear to be the primary driver of this type of investment, not private investment.