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Capacity Resource Performance in NYISO Markets

An Assessment of Wholesale Market Options

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Acknowledgments

This report reviews issues associated with the performance of capacity resources participating in NYISO's wholesale electricity markets. Specifically, different wholesale market rules, obligations and incentives that do or may affect the performance of capacity resources are identified, drawing from both the experience in neighboring RTO regions and the unique circumstances in the state of New York. Specific alternatives for changes to market rules in New York related to capacity market resource performance are identified and assessed for further consideration by NYISO and stakeholders.

This is an independent report by Analysis Group, completed through research, discussions with NYISO subject matter experts, and consultation with stakeholders in the NYISO markets. The authors wish to thank NYISO and stakeholders for their input, and Benjamin Dalzell and Grace Howland of Analysis Group for their assistance in the analysis and development of the report.

The report, however, reflects the judgment of the authors only.

About Analysis Group

Analysis Group provides economic, financial, and business strategy consulting to leading law firms, corporations, and government agencies. The firm has more than 700 professionals, with offices in Boston, Chicago, Dallas, Denver, Los Angeles, Menlo Park, New York, San Francisco, Washington, D.C., Montreal, and Beijing.

Analysis Group's energy and environment practice area is distinguished by expertise in economics, finance, market modeling and analysis, regulatory issues, and public policy, as well as significant experience in environmental economics and energy infrastructure development. The practice has worked for a wide variety of clients including: energy producers, suppliers and consumers; utilities; regulatory commissions and other public agencies; tribal governments; power system operators; foundations; financial institutions; and start-up companies, among others.

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I. Executive Summary

The New York Independent System Operator (NYISO) is responsible for reliable operation of New York's bulk power system, administration of efficient and competitive wholesale power markets in New York, and ongoing planning activities to identify future system needs. In meeting these obligations, NYISO continuously evaluates the markets it administers in order to assess the efficiency of New York's wholesale market outcomes, and to identify changes to market structures if and when such changes can improve reliability and/or economic results. This Report is designed to inform this ongoing wholesale market assessment, with a particular focus on requirements and incentives tied to the performance of resources that qualify as Installed Capacity Suppliers,[1] or capacity market resources.

The on-going evaluation of wholesale electricity market designs is business as usual for RTO's since their development nearly two decades ago. Yet in recent years, changes in the electric industry generally (and New York specifically) have elevated system reliability risks and the importance of evaluation and modification of wholesale electricity markets. ***Section II*** of this report provides background on various industry changes that are heightening reliability risks and driving market reform considerations, including (1) factors that limit energy prices ranging from administrative price ceilings in energy and ancillary services markets to a steady and persistent decline in energy market prices due to, among other things, low-cost shale gas and the emergence of low-variable cost generation; (2) the retirement of a significant amount of uneconomic coal, oil, and natural gas generating capacity (as well as some nuclear capacity); (3) a major increase in regions' dependence on natural gas-fired generating capacity at a time of heightened sensitivity to the impacts of natural gas infrastructure development, increasing winter-time natural gas delivery constraints, and weather-related risks; and (4) the rapid growth in "non-traditional" resources - including grid-connected and distributed variable renewable resources and demand response resources - with implications for energy prices and the variability and uncertainty of net load.

While the pace and impact of such changes is uncertain, these trends will likely continue, with New York being at the forefront of many of these industry developments. Thus, it is timely to evaluate market incentives tied to the performance of capacity resources within the New York Control Area (NYCA) with an eye towards preserving power system reliability during times of greatest need.

This Report considers various factors related to the performance of capacity resources in NYISO wholesale markets and system operations, based on a review of New York-specific issues and recent experience in other regions. In presenting these issues we are not suggesting - nor should it be implied - that that there are flaws in the existing market designs that need to be addressed. Nor are we implying that any specific resources or category of resources deserves special review, analysis or consideration in this context. Instead, our purpose is to present and evaluate factors related to capacity market resource

[1] Capitalized terms used herein have the meaning in the NYISO's Market Administration and Control Area Services Tariff.

performance in the context of the obligations, structures and compensation incentives in NYISO's wholesale markets, and do so in a way that may help NYISO and stakeholders consider future market design alternatives against the backdrop of emerging and accelerating changes in the industry and in the resources relied upon for reliable electric service.

Analysis Group undertook several tasks to identify resource performance issues and risks, including: review of past assessments and observations of NYISO and the market monitor related to resource performance; review of the various obligations, requirements and compensation mechanisms tied to participation and operation of capacity market resources in NYISO wholesale markets; discussion of current and potential future resource performance and reliability risks with NYISO subject matter experts; and analysis of market, system and operational data (including review of analyses performed by NYISO).

Based on this review, ***Section III*** identifies a number of factors for consideration related to capacity market resource performance and compensation, including: resource availability calculations used in determining Unforced Capacity (UCAP); NYISO's experience in maintaining reliable system operations during severe winter weather events, particularly in light of the increasing dependence on natural gas-fired generation; and the requirements and obligations for resources offering to supply capacity, including rules by which capacity resources offer energy and demonstrate operational and deliverability characteristics.

Section IV provides a summary of the various ways in which system operators in the Northeast - including NYISO, ISO-NE, and PJM – have addressed (and continue to evaluate) these performance issues in response to reliability concerns driven by the market and industry changes discussed in Section II. It is clear from this review that all the RTOs are active in responding to the challenges of a shifting industry through (1) enhanced industry coordination and information sharing; (2) clarification of capacity market resource eligibility and obligations; (3) monitoring provisions and reporting requirements related to the acquisition, transportation, inventory management and replenishment of fuels for electricity generation; (4) comprehensive changes to energy and reserves markets to improve offer flexibility and better define needs and to enhance the financial incentives for energy and reserve market performance during those times when most needed for reliable system operations; and (5) changes to capacity market designs to provide incentives for performance during times of system stress above and beyond those included in energy and reserves markets.

Finally, ***Section V*** compiles options that may be considered to enhance the obligations of capacity market suppliers and/or improve the financial incentives for capacity market resource performance, particularly under stressed system conditions or otherwise when most needed to meet reliability obligations. The goal in presenting and evaluating these options is to provide information that NYISO and stakeholders may consider when assessing the need for and potential forms of NYISO wholesale electricity market enhancements in coming years.

Many of the changes that the Northeast regional RTOs have considered with these performance issues and risks in mind are already in place in one form or another in the NYISO markets, including

coordination and information sharing, shortage/scarcity pricing in energy and reserves markets, flexible energy market offer rules, dual-fuel capability in downstate New York, and a comprehensive set of fuel management reporting and control room visibility into gas market operations. Further, some of the options identified that go beyond those already in place in NYISO markets may in fact be unnecessary or a poor fit for NYISO, and will need to be evaluated in the context of the state's unique circumstances and market designs.

Table 3 in ***Section V*** contains options that could be considered by NYISO and stakeholders to improve performance during peak summer and/or winter periods. The assessment of NYISO's circumstances and resource performance alternatives developed in this report identify a particular issues that appear to warrant further consideration:

- ICAP to UCAP adjustments currently reflect an 18-month rolling average availability, which may not reliably capture availability during periods of greatest system stress. We recognize that these issues have been recently considered by NYISO and stakeholders, but our review suggests that further consideration may be appropriate. Specifically, our analysis shows variations in resource availability during periods of heightened reliability need that are not captured by current market rule availability metrics. Approaches to a rule based on measuring availability targeting periods of greatest need may improve cost-effectiveness (by targeting payments to resources that provide greater reliability) and/or increase the level of realized resource adequacy and reliability for a given level capacity market procurement.
- Several factors suggest review of the rules by which external resources participate in NYISO capacity market, including eligibility requirements and energy offer obligations and terms. Analysis of energy market offers from external ICAP resources found that some currently offer supply at prices near to (or at) energy bid caps. In recent years, neighboring RTOs have modified the rules by which external resources participate in the respective region's capacity markets to (in part) address similar issues. An assessment of a similar rule for NYISO may be warranted, taking into account the particular circumstances and rules of the NYISO market. For example, modified requirements might require external resources to submit cost-based offers in the energy market and/or demonstrate reserved transmission capacity to the NYCA border.
- Our assessment of internal resources identified performance-related issues that may merit further assessment. For example, deviations between offered and reference startup times for some resources raises questions about the comparability of service provided by these resources. These deviations suggests that a review of existing energy must-offer requirements to determine whether modifications (e.g., maximum start/notification times) are appropriate. The increasing reliability risks associated with dependence on natural gas for electricity generation, against a backdrop of heightened sensitivity to the impacts of natural gas infrastructure development, suggest that consideration of various options for "fuel assurance" may be appropriate, such as expanded dual fuel requirements or winter fuel programs.
- In addition to the evaluation of requirements for these traditional resources, it is appropriate to continue to review of applicable assumptions for the capacity contributions of non-traditional

generation resources (e.g., capacity contributions of variable resources). Demand response (DR) represents a particular category of "non-traditional" resources whose role in providing reliability assurance during stressed system conditions may be structurally different than that provided by other resources. Specifically, temporal limits on energy offer and delivery requirements, such as the fixed and limited duration of performance for DR resources that qualify as capacity market resources (i.e., SCRs), raises questions of comparability and the appropriate context for participation of DR resources in NYISO's wholesale markets. We recognize that NYISO and stakeholders are or will be considering such issues in the context of a broader review of how DR (and other distributed energy resources) participate in NYISO's wholesale markets.

- Finally, rule changes that specifically increase revenues of generating units that perform well during shortage or scarcity conditions are likely the most direct means of incentivizing performance under stressed system conditions. These options include capacity market modifications, further increases in energy price caps, and/or further increases in quantities of reserves procured and the price paid for such reserves. Some of these options may require a significant new market design initiative; others might be developed through incremental changes on existing shortage/scarcity pricing mechanisms.

Our assessment of potential opportunities to improve the performance of NYISO's capacity resources suggests a potential for both improved cost-effectiveness and improved overall reliability. However, further review by NYISO and stakeholders could better quantify the magnitude of reliability challenges, assess the effectiveness and efficiency of opportunities for improvement, better understand practical or administration challenges to implementation, and evaluate the tradeoffs among competing alternatives.

II. Introduction and Overview

NYISO Capacity Market Resources and Reliability

The New York Independent System Operator (NYISO) is responsible for reliable operation of the NYCA bulk power system, administration of efficient and competitive wholesale power markets for the NYCA, and ongoing planning activities to identify future system needs. NYISO is responsible for (1) maintaining and enhancing regional reliability, (2) administering open, fair, and competitive wholesale markets, (3) helping plan the power system for the future, and (4) providing factual information to policy makers, stakeholders, and investors in the power system.

In meeting these obligations, NYISO continuously evaluates the markets it administers in order to assess the efficiency of New York's wholesale markets, and to identify changes to market structures if and when such changes can improve reliability and/or economic outcomes. This Report is designed to inform the on-going assessments of NYISO wholesale markets by both NYISO and its stakeholders, with a focus on requirements and incentives tied to the performance of resources that qualify as Installed Capacity Suppliers.[2]

Capacity market resources have a critical role in helping NYISO ensure power system reliability. In order to maintain reliability there must be capacity market resources in sufficient quantity to meet seasonal peak demands for electricity with an adequate margin of safety (i.e., reserve margin). Capacity markets are designed to fill the gap between expected revenues from energy and ancillary service markets and the full costs of resource development and operations, such that there is sufficient capacity to meet these targets. These resources (and potentially others that opt not to accept capacity obligations), in turn, must meet the various operational reliability needs of the system by providing sufficient energy, reserves and other ancillary services on a continuous basis throughout the year.

To obtain a capacity market obligation, a resource[3] must be designated by a Load Serving Entity (LSE) to meet the LSE's capacity obligations and/or clear in NYISO-administered Installed Capacity (ICAP) market auctions.[4] NYISO has administered ICAP market auctions for over a decade consistent with the requirements of Section 5 of the NYISO's Market Administration and Control Area Services Tariff (Services Tariff). Specifically, NYISO identifies the capacity resource needs of the system and pre-specified areas, and administers seasonal (for winter and summer Capability Periods), monthly and spot

[2] In order to be used by a load serving entity to meet capacity obligations, and to participate in NYISO's capacity market auctions, "traditional" generators must demonstrate its Dependable Maximum Net Capability (DMNC) and fulfill certain additional requirements related to certification; bidding, scheduling and notification responsibilities; reporting operating data; providing notification of maintenance and force outages, and other requirements. Note, however, that not all Installed Capacity Suppliers or generators have to submit DMNCs (e.g., excludes Intermittent Power Resources and Responsible Interface Parties). See NYISO, *Installed Capacity Manual* (hereafter ICAP Manual), Section 4. Throughout this document, resources that qualify as Installed Capacity Suppliers and that obtain capacity supply obligations are referred to as "capacity market resources."

[3] "Resources" include, for example, a power plant within the NYISO control area, an "external resource" (power plant outside the NYISO control area), and demand-response (DR) resources.

[4] See NYISO, ICAP Manual, Section 4.

auctions to ensure the procurement by LSEs of sufficient quantities of Unforced Capacity (UCAP) to meet the LSEs' electrical load obligations.[5] LSEs may procure UCAP from capacity market resources on a bilateral basis, or through one or more of the NYISO-administered auctions. The spot market auction is cleared using locational and NYCA-wide Demand Curves established pursuant to Section 5.14.1.2 of the Services Tariff, which specify auction clearing prices as a function of the quantity of capacity that clears. Resources in NYISO markets must adhere to certain operational and scheduling requirements of the Services Tariff.

Market Design in a Changing Landscape

Maintaining power system reliability is a system operator's primary responsibility, but the role of wholesale markets is critical in carrying out this responsibility. The purpose of wholesale market design efforts is to establish the most competitive and efficient path possible to meeting the reliability mandate, in order to provide consumers reliable electric service at the lowest possible cost. Thus, an important objective of market design is establishing a set of rules that provides financial incentives for resource investment and operational decisions that lead to meeting the system's reliability needs at the least-cost.

From an operational perspective, what is needed to meet the system's reliability needs is the production of energy and reserves on a real-time basis throughout the year in sufficient quantity and with the right characteristics to meet the electrical needs of the system. From a practical perspective, this means that markets must ensure (1) sufficient generating and demand resource capacity is available to meet demand in all hours with a margin of safety, including the seasonal peak demands for power (often called "resource adequacy"), and (2) resources operate to provide various "essential reliability services", given their resource-specific characteristics, in the quantities needed to manage real-time system needs (e.g., voltage, frequency response, reserves, ramping capability) (often called "operational reliability" or "system security").[6]

In New York and neighboring regions, capacity markets are viewed as meeting resource adequacy needs, while energy and ancillary services markets (along with system operation rules and procedures) are viewed as the primary vehicles for ensuring operational reliability. This alignment is consistent with good market design principles, with the incentives for performance based on the continuous energy

[5] UCAP is a measure of the amount of capacity that capacity resources may offer in the capacity market, and on a seasonal basis, represents the capability of the resource reflect the potential unavailability of the unit based on historical performance data. See Section 4.5 of the ICAP Manual.

[6] NERC defines the two major reliability concepts in the following way: First, resource adequacy is "[t]he ability of the electric system to supply the aggregate electrical demand and energy requirements of the end-use customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements." Second, system security, or "reliable operation" requires "[o]perating the elements of the [Bulk-Power System] within equipment and electric system thermal, voltage, and stability limits so that instability, uncontrolled separation, or cascading failures of such system will not occur as a result of a sudden disturbance, including a cybersecurity incident, or unanticipated failure of system elements." See http://www.nerc.com/files/glossary_of_terms.pdf.

markets outcomes designed to reflect shortage and scarcity, and the incremental incentives for new investments to ensure resource adequacy through the less-frequent capacity market.

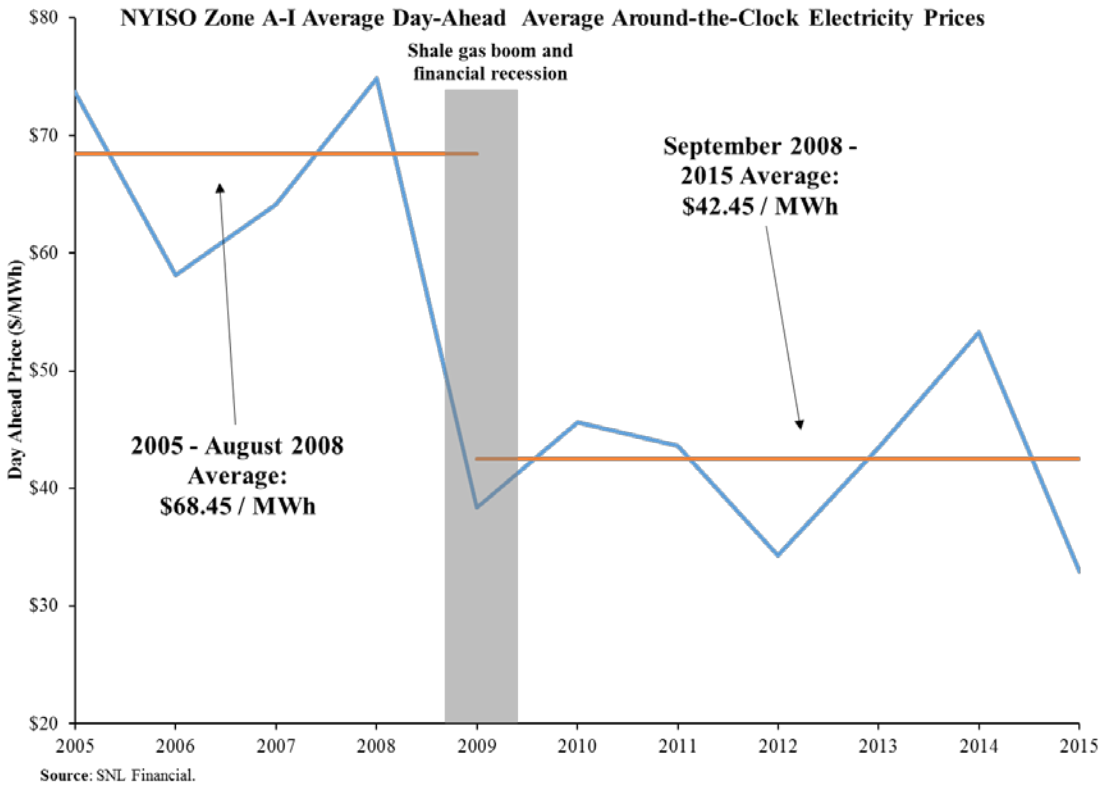
In New York, the financial incentives that link capacity market outcomes to real-time operational reliability primarily include (1) the obligation for capacity market resources to participate in the energy and ancillary service markets by submitting hourly offers to provide energy and/or reserves in day-ahead markets and following operators' dispatch instructions (or coordinating outage scheduling with NYISO if this obligation cannot be met), and (2) capacity market compensation that accurately reflects the quantity of capacity actually made available by the resource (by adjusting the potential capacity it can deliver by the actual amounts is has made available as reflected in a measure of equivalent forced outage rate, or EFORd). Until recently, the ISO-NE and PJM capacity market constructs carried a similar system of incentives for capacity market resource operational performance.

In recent years, potential opportunities to tighten the links between capacity markets and operational reliability have emerged, and the structure of capacity (and other) markets has been the focus of scrutiny – and change – in virtually every U.S. wholesale electricity market region. A key focus of review has been the weakness that can appear in the link between *monthly* availability-based capacity market incentives and *hourly* system operator reliability needs, particularly during times of scarcity or stressed system conditions. These efforts to evaluate resource performance and enact changes in wholesale markets are attributable to a number factors that have elevated system reliability performance risks, including market structures and pricing factors, and the challenges of designing and administering wholesale electricity markets in the context of a power system that is in a state of significant change. These factors include at least the following:

- The presence of administrative price ceilings in energy and ancillary services markets, even during times of shortage or scarcity;
- Due to a combination of factors, elaborated on below, an ongoing decline in the portion of total market revenues derived from energy and ancillary services markets, which have greater incentives for operational performance. Revenue recovery is thus increasing in capacity markets, which have less incentives for performance.
- This steady and persistent decline in energy market prices (and thus revenues earned by resources in energy and ancillary services markets) is due to many market and regulatory factors, including: the decline in the cost of natural gas as a fuel and the cost of grid-connected and distributed variable (wind and solar) resources; the proliferation of higher-efficiency, new natural gas-fired generating capacity; a reduction in demand growth driven by the economic recession towards the end of the last decade, continued growth in investments in energy efficiency and behind-the-meter resources; and various state and federal policies supporting the development of low-variable cost resources (see Figure 1);
- The retirement of a significant amount of uneconomic coal, oil, and natural gas generating capacity (as well as some nuclear capacity), due primarily to the energy price factors discussed above;

- A concurrent increase in dependence on generating capacity requiring real-time fuel delivery (i.e., natural gas), on a transportation system that does not always have capacity dedicated for electricity generation, and that has competing uses (e.g., home and commercial heating), particularly at the time of winter season power system peak demand;
- The emergence of resources that potentially contribute to resource adequacy and system security, but vary considerably from "traditional" in-region grid-connected generating resources, such as (1) demand response resources whose capacity contributions are based on complex "baseline" measurement and performance verification, and whose availability for performance is limited in time and frequency, and (2) external resources, whose capacity contributions depend on transmission and system circumstances outside the importing region's purview;
- An increase in the variability and uncertainty of net load, due to both an increase in output from grid-connected variable resources and an increase in distributed variable resources;
- The incidence of major weather-related events - particularly during the winter season - that have surfaced issues associated with capacity resource performance under these more stressed conditions, including operational challenges (e.g., plant operations in cold weather) and/or fuel supply challenges; and
- The design of wholesale markets to directly compensate for certain resource characteristics (e.g., fast start, voltage regulation), while not directly compensating for other capacity resource characteristics that may add value from reliability (e.g., flexibility, ramping, fuel certainty) and policy (e.g., CO_2 emissions) perspectives.

Figure 1: Change in NYISO Electricity Prices Since 2008



While the pace and impact of such changes varies considerably from region to region and year to year, these trends will likely continue to push most regions towards lower energy market prices, greater load uncertainty and variability, greater dependence on resources with different fuel supply challenges (i.e., more natural gas and less traditional generating resources, such as coal and nuclear), and potentially significant changes in production (and load management) at the distribution level, with the expectation of participation in the NYISO wholesale markets. New York is , in fact, at the forefront of many of these industry developments.

The combined effect of these changes, along with on-going interest in improving market efficiency, is seen as increasing operational risks that may deteriorate system reliability, particularly during periods of stressed system conditions. In response, some regions have undertaken market design changes focused on the financial incentives for resource performance during such conditions. In recent years, most regions (including NYISO, ISO-NE, and PJM) have instituted multiple market design adjustments in energy and/or ancillary services markets targeted to addressing the various fuel and resource performance challenges discussed above. Most are focused on allowing for accurate reflection of underlying fuel costs in real time and increases in payments for reserves and energy during times of scarcity.

In some regions, attention has also turned to the set of incentives and obligations on capacity market resources. For example, and as described further in this Report, ISO-NE and PJM have implemented

capacity market reforms that include a real-time capacity payment adjustment based on actual resource performance during scarcity conditions. Capacity payments are adjusted based on performance that is (1) measured strictly in terms of resources' actual output in specific hours, relative to their proportional contribution to total capacity market resources, and (2) exclusively in those hours when the systems are most stressed or vulnerable - in New England's case during specific ten- or thirty-minute reserve shortages, and in PJM's case a slightly more expansive set of hours corresponding to PJM's declaration of emergency conditions. From a practical standpoint, the PJM and ISO-NE capacity market performance incentive programs add to the value of real time operation during scarcity by increasing payments during shortage hours to resources that perform, at a cost to resources that do not.

Along with these recent initiatives, the regions continue to evaluate whether market designs have achieved performance cost-effectively by, for example, ensuring that each resource is appropriately compensated for its contribution to achieving aggregate resource adequacy. Rules that fail to appropriate quantify the capacity provided by each resource for resource adequacy purposes may harm reliability (if in aggregate rules tend to assign more capacity than is delivered), or raise costs (if a resource that receives compensation for more capacity than it truly delivers clears in place of another resource with a lower unit bids (dollars per MW capacity)).

Purpose of this Report and Analytic Approach

As noted above, NYISO continuously evaluates market designs in light of system changes, its observations of system and resource performance, the evolution of market designs and experiences gained in other market regions, and its assessment of future industry, policy, and system conditions. With this in mind, NYISO asked Analysis Group to conduct an independent assessment of market design alternatives tied to incentives for capacity market resource performance. We evaluate options in light of the emerging changes in the industry, the reliability challenges and risks realized in the NYISO control area in past years, and the growing experience with capacity market design changes in neighboring regions.

We specifically review these factors in the context of NYISO's unique system and market structures. Importantly, our goal was not to recommend specific market design changes for use in New York; rather, we sought to evaluate the performance of New York capacity market resources at a high level, assess the context for and details of changes in other regions' market structures, and (based on this) identify alternatives for future consideration. We thus attempt to present a set of practical alternatives in the New York context, and provide high-level observations to support continued discussion among NYISO and stakeholders on whether and, if so, how to alter NYISO capacity, energy, and/or ancillary service market designs to provide better incentives for NYISO capacity market resource performance.

In order to carry out this review, Analysis Group conducted an assessment of NYISO resource performance issues and market design alternatives through a combination of the following:

- Review of past NYISO reports and analyses of unit performance under stressed system conditions, and discussions on NYISO resource performance and reliability challenges with NYISO subject matter experts (SME);
- Independent analysis of certain capacity market resource operational, bidding, and performance data;
- Review of NYISO current market structures that affect market resource performance;
- Review of literature on market performance designs and the performance-related designs of other electricity market operators (ISO-NE and PJM);
- Assessment of current conditions and likely changes (over 5-10 years) to NYISO load levels and shape, and bulk power system infrastructure due to the combination of market economics and state and federal energy & environmental policies;
- Comparative analysis of market design alternatives in the NYISO context, based on items (1) - (6) above, and on AG's experience; and
- Discussions with NYISO stakeholders.

In this Report, we summarize our review of these factors and issues, and present and evaluate market design alternatives. The goal of this Report is to support ongoing consideration by NYISO and stakeholders of potential design changes to address capacity market resource performance in the context of changes underway in the State of New York.

III. Review of NYISO Capacity Resource Performance Issues

In order to provide background information and context for review of potential market design changes by NYISO and stakeholders, Analysis Group has reviewed certain issues related to the obligations, compensation, and performance of capacity market resources in the context of current NYISO wholesale market designs, particularly in light of changes underway in the industry that may exacerbate certain performance-related reliability risks. The purpose of undertaking this review is to set the context for assessing the need for or relevance in the NYISO context of potential performance-related market design alternatives presented in subsequent sections.

In presenting and discussing these issues we are not suggesting and it should not be implied that we are suggesting that there are flaws in the existing market designs (particularly given the effectiveness, costs and other tradeoffs involved in any potential remedy). Nor do we mean to imply that any specific resources or category of resources deserves special review, analysis or consideration in this context. Instead, our goal is to review factors related to the issue of resource performance in the context of the obligations, structures and compensation incentives in NYISO's wholesale markets.

Analysis Group undertook several tasks to identify resource performance issues and risks. First, we reviewed past assessments and observations of NYISO and the market monitor related to resource performance in general and reliability challenges faced under particular events or circumstances (e.g., cold snap conditions). Second, we reviewed the various obligations, requirements and compensation mechanisms tied to participation and operation of capacity market resources in NYISO wholesale markets. Third, we discussed current and potential future resource performance and reliability risks with NYISO subject matter experts in market design and administration, market monitoring, and operations functions. Finally, we reviewed various analyses undertaken by NYISO related to resource performance, and conducted additional analyses using market, system and operational data.

Below we present and discuss various resource performance and compensation factors that stem from our review of resource performance data, operational experience, and the definitions, responsibilities, obligations and compensation mechanisms built into wholesale market design and administration. Certain of the issues are indicative of differences among resources in operational capabilities and resource performance experience. Others may be viewed as more closely tied to resource comparability, or the differences among resources in how they deliver capacity and measure or verify potential capacity market contributions. Yet all issues bear on the degree of certainty that sufficient resources will be available when needed by NYISO to maintain power system reliability, particularly under shortage/scarcity or stressed system conditions. Importantly, given the variety of different types of resource performance issues and associated reliability risks, we have not attempted to present them in any particular order of importance.

Resource Availability

The value of a resource in supporting reliable system operations is closely tied to its availability when it is economic to operate, or when it is needed to help meet reliability objectives. In the New York

capacity market, generally, a resource may offer capacity equal to its demonstrated output adjusted for historic availability. Specifically, the resource may offer its unforced capacity (UCAP), which is calculated as its Dependable Maximum Net Capability (DMNC) reduced by an Equivalent Demand Forced Outage Rate (EFORd).[7] NYISO calculates the EFORd that applies to each generator for capacity market purposes as a rolling average of monthly generator EFORds for specific months associated with each seasonal capacity period.[8] Different measures of UCAP are calculated for non-traditional resources (e.g., Special Case Resources, intermittent resources, and behind the meter generation).

Many RTOs have relied on some measure of reported availability to adjust resources' capacity market quantity and/or payments. In principle, adjusting capacity resource compensation for the resource's actual availability, rather than its potential availability, creates the incentive for resource owners and operators to take steps to improve availability to increase compensation. As **Figure 2** shows, availability can vary significantly from resource-to-resource (and from year-to-year), which suggests that the actual quantity of capacity delivered to maintain resource adequacy varies from resource-to-resource.

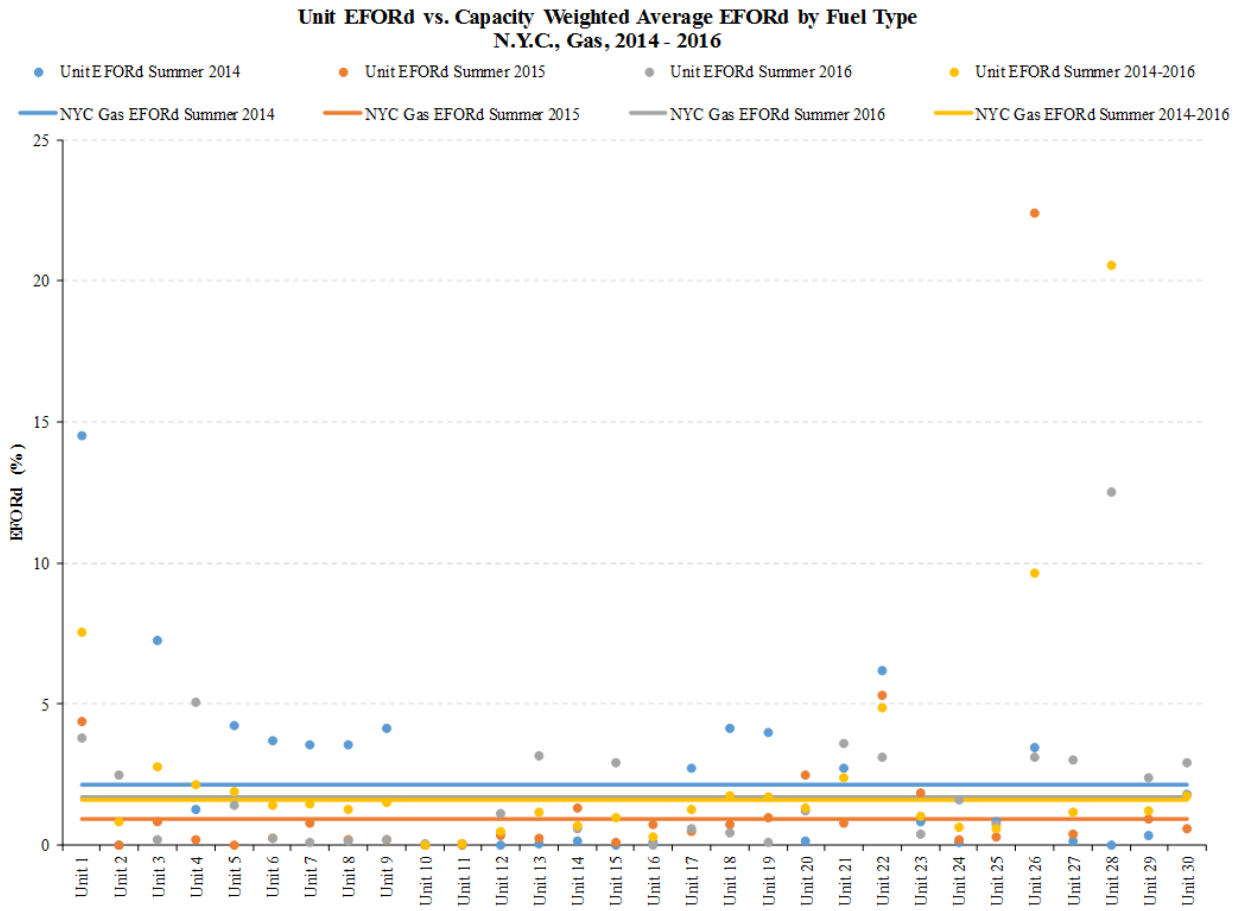
However, when viewed through the lens of reliability - with a focus on those times when the system operator most needs a resource to be available to support reliable operations - reliance on only monthly average availability can be an incomplete measure of capacity/reliability value.[9] There are a number of reasons why reliance only on historical resource monthly EFORd values may be a suboptimal measure of resource performance:

- Monthly EFORd calculations do not accurately capture unit availability at times within each month when resources have their highest reliability value - namely, during hours when the system is stressed and/or reduction in operating reserves or emergency reliability actions are initiated. In theory a unit with low monthly EFORd values may in fact be unavailable when reliability is valued most.
- Average availability could be a relatively good measure of the resource adequacy benefit a capacity resources provides in any given hour, provided that outages are randomly distributed across resources and across the month, and when unit outages are not more generally linked to common factors that affect multiple resources at the same time (such as a lack of natural gas transportation availability, or outages tied to storms or severe weather conditions). However, it may not be a sufficient measure for planning reliable operations if outages are more highly correlated across resources.
- Availability calculations are based on rolling averages across multiple months, where each month can involve different circumstances with respect to system operations. The current process weights availability in all months equally regardless of whether the expected or actual systems risks are the same from month-to-month. For example, a resource outage in a shoulder

[7] See NYISO ICAP Manual, v. 6.36, Section 4.5, and Attachment J.
[8] See NYISO ICAP Manual, v. 6.36, Section 4.5, and Attachment J. Note that there is also an adjustment for resource deliverability.
[9] As discussed in *Section IV*, below, this is one reason that ISO-NE and PJM moved to measures tied more closely to performance specifically during stressed system conditions.

month counts the same from a capacity market perspective as an outage that occurs during the week or day or peak system load in the summer (or winter). However, **Figure 3** shows that, in fact, even at the aggregated level of fuel type, resource availabilities can differ significantly between shoulder months and peak demand months. In some cases, resource availability is higher in summer (and winter) periods (e.g., gas-fired resources), whereas other resources have lower availability during summer periods (e.g., coal-fired resources). UCAP requirements reflecting performance during periods of need would improve the cost-effectiveness of the capacity market by ensuring incentives for performance during periods of greatest need.

Figure 2: Summer EFORd by Unit and Year

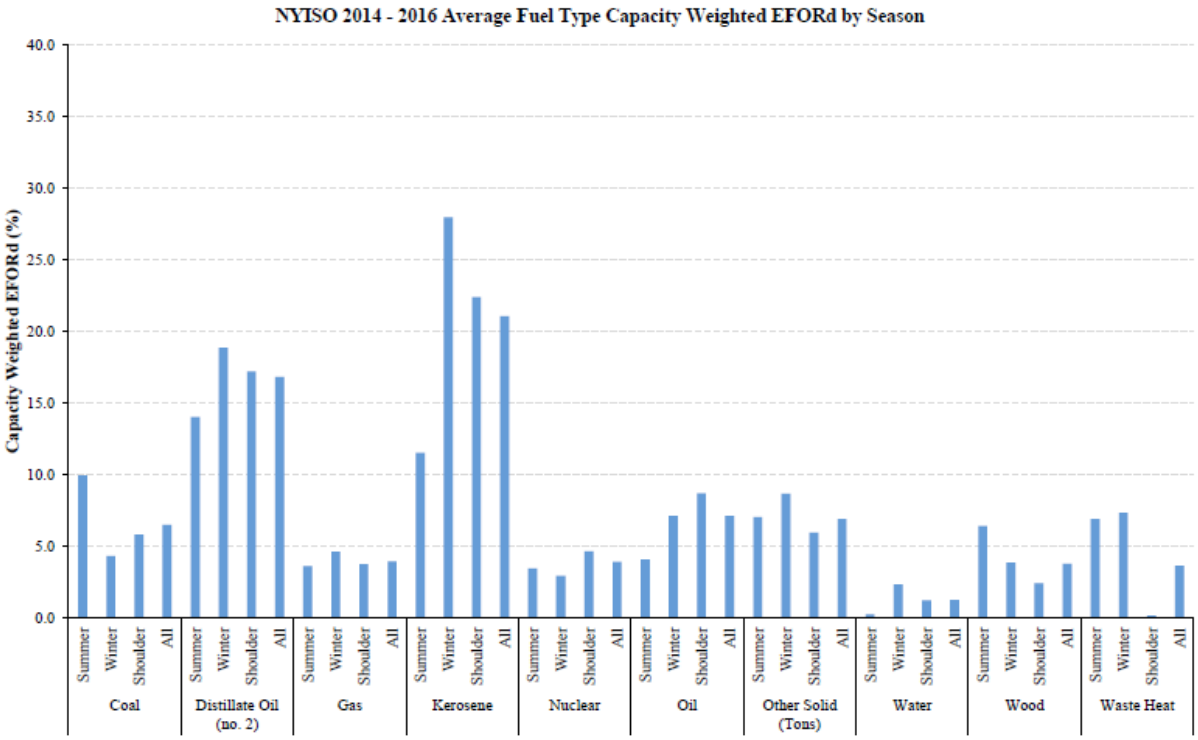


Notes:
[1] EFORd is weighted for each technology type by Net Dependable Capacity (MW).
[2] Summer months include June, July, and August. Winter months include December, January, and February. Shoulder months include March, April, May, September, October, and November.
Source:
[1] EFORd-2014-2016.xls.xlsx.

As discussed in *Section IV*, NYISO and stakeholders have recognized that there could be opportunities for a better method than relying only on the current availability metric (calculated as an equally weighted monthly rolling average), and have had previous discussions regarding different availability metrics that might improve the relationship between availability calculations in the capacity market and the timing of

NYISO reliability needs to improve the incentives for resources to make their resource most-available during these periods of greatest reliability need.

Figure 3: Average EFORd by Season and Fuel Type for NYISO



Notes:
[1] EFORd is weighted for each technology type by Net Dependable Capacity (MW).
[2] Summer months include June, July, and August. Winter months include December, January, and February. Shoulder months include March, April, May, September, October, and November.
Source:
[1] NYISO EFORd-2014-2016.xls.xlsx.

Fuel-Related Performance Considerations

There are several issues related to resource performance tied to the procurement, delivery and storage of fuels for electricity generation. Concern over fuel-related risks - particularly with respect to the transportation of natural gas - will likely increase over time given current trends in the costs to build and operate power plants, which favor development and operation of gas-fired generating capacity, and given the prospects of ongoing retirement of non-gas fired assets.[10] Generally speaking, to date fuel procurement and transportation are key performance-related issues primarily during severe winter conditions. While New York has faced operating challenges at the time of winter peak due in part to fuel-related issues, this has generally not been the case during summer peak loads. However, in addition to increasing winter time reliability risks, fuel supply could become a more pressing issue outside of winter months in future years, as the state's dependence on natural gas for generation

[10] See, for example, NYISO, "Power Trends 2017: New York's Evolving Electric Grid" (pp. 35-38).

increases while the development of supporting natural gas transportation infrastructure faces increasing financial and siting challenges.

While the risks associated with decreased resource performance due to fuel availability have not led to adverse reliability outcomes to date, NYISO's experience with electricity and natural gas market operations generally, and with winter operations over the past several years in particular, highlights various performance-related challenges tied to fuel-related factors and risks associated with increasing dependence on natural gas-fired capacity that could pose system or local reliability risks in the future:

- Electricity and natural gas markets are not perfectly aligned. For example, at times, resources not committed in the day-ahead market do not procure fuel or nominate gas transportation and thus may not be available for supplemental resource evaluation commitments after the close of the day-ahead market.
- Not all gas-fired resources in New York are required to have dual-fuel capability. Further, while this is a requirement in downstate New York, those units with dual-fuel capability may not have sufficient fuel in on-site storage for extended operations, or provisions for active replenishment of oil inventory, and may suffer from delays or operational challenges during the period of switching from one fuel to another. Additionally, some resources may have structural or contractual challenges associated with procuring fuel for full operation.
- During the January 2014 Polar Vortex event (January 6-8), NYISO set a new winter peak load record of 25,738 MW, while neighboring regions faced similarly challenging winter operating conditions. Over the peak period, there were a total of 4,135 MW of generation derates, including fuel unavailability, cold temperature, and hydro ice dam-related outages. Additional outages were experienced at other times during the cold snap period, totaling approximately 7,000 MW both from units with day-ahead schedules and some that were expected to operate in real time. NYISO issued public appeals for curtailment and activated DR resources to maintain operating reserves. Later in January, sustained cold weather conditions caused natural gas prices to exceed oil prices, leading to a run-down of oil inventories at several oil-fired or dual-fuel resources, and difficulties with oil replenishment.[11]
- During January 7-8, 2015 the region again faced severe cold weather conditions, reaching a peak demand of 24,648 MW. NYISO experienced approximately 2,100 MW of forced outages across both the day-ahead and real-time markets, mostly related to cold weather and/or inability to obtain fuel (natural gas). This was followed by extensive cold weather conditions in February 2015, with natural gas prices exceeding oil prices on 21 days, and roughly 3,000 MW of derated capacity unavailable most of the month.[12]
- While overall a relatively mild winter, there were several cold periods during January and February 2016, including severe cold weather on February 14-15. During the various cold snaps

[11] *See, e.g.*, NYISO, *January 2014 Cold Snap Operations*, Operating Committee presentation by Wes Yeomans, January 16, 2014.
[12] *See, e.g.*, NYISO, *January 7-8 2015 Cold Snap Operations*, Operating Committee presentation by Wes Yeomans, January 15, 2015.

in January and February NYISO experienced between approximately 1,500 and 3,000 MW of generation capacity derates, both fuel-related and non-fuel-related.[13]

The potential for growing future reliance on gas-fired resources suggests that further attention to fuel-related performance many be important to preventatively addressing potential system reliability risks.

Offer and Operational Parameters

The requirements that come with obtaining a capacity supply obligation in New York include (among other things): submitting offers to supply energy and/or reserves in day-ahead markets; providing and updating operational parameters, such as minimum loads, ramp rates (the rate at which output may be ramped up or down) and start-up times; and coordinating with NYISO on the generating unit's maintenance schedules (i.e., periods when it cannot fulfill its must-offer obligation).[14] These various offer and operating parameters can affect or limit the use of a resource to meet system load, even when the resource is technically available for operation as a capacity market resource. While they have no impact on a resource's capacity market compensation, a resource's offer and operating parameters can potentially affect its contributions to meeting system reliability needs.

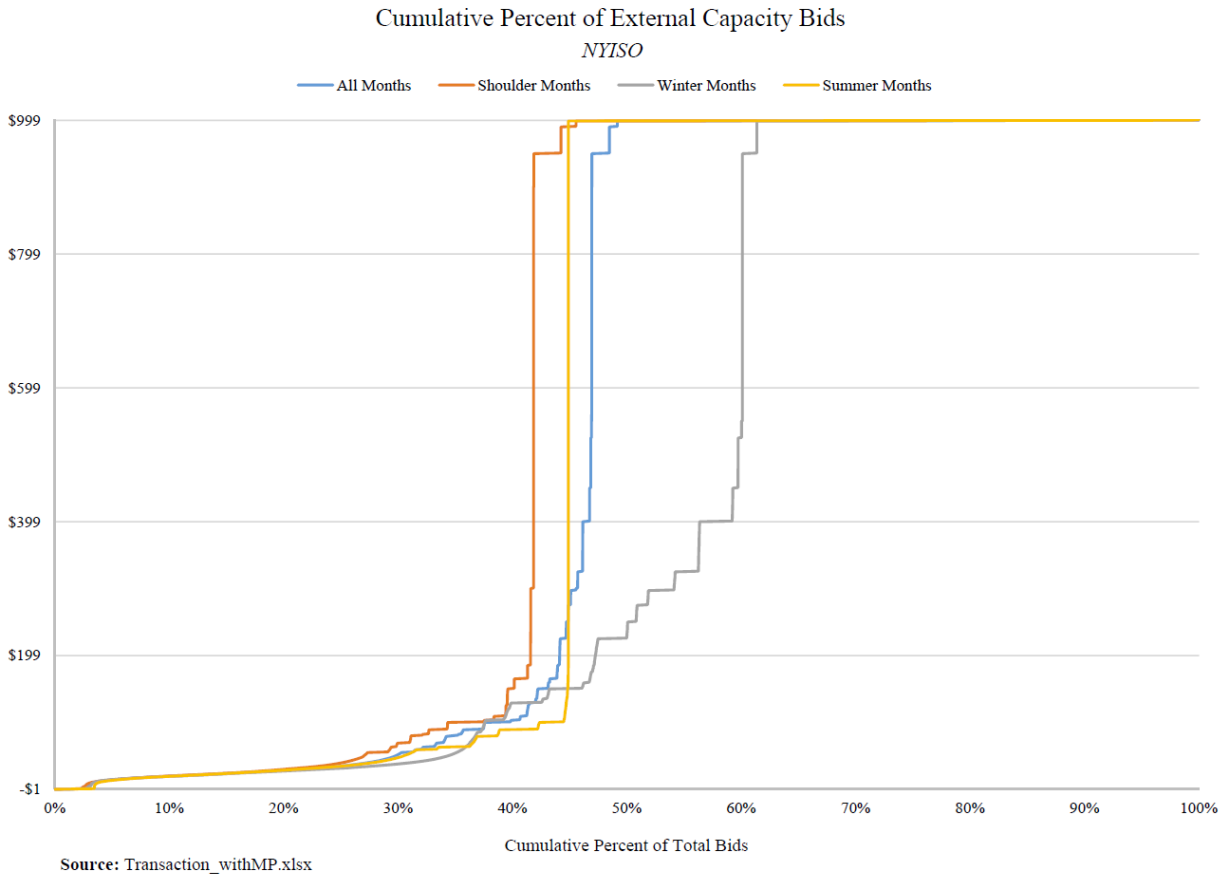
There are a number of examples that indicate the challenges associated with the possible shortcomings of resource offer and operational parameter requirements tied to the capacity market obligation, including the following:

- *Energy market offers* - Under current rules, resources may technically meet the must-offer requirement to of the capacity obligation by submitting offers at high prices into daily into energy/reserve markets. For example, Figure 4 portrays the day-ahead energy market offers of external capacity market resources, showing that over 50 percent of the hourly offers of external capacity market resources are effectively at the $1000/MWh bid cap, and roughly 60 percent exceed $100/MWh. The average size of the nearly 44,000 hourly day-ahead energy market offers exceeding $990/MWh in this period from external capacity resources is 376 MW.

  While these resources may technically meet the current must-offer requirements, in practice, these resources are infrequently (if ever) scheduled to deliver energy due to the offers near or at the price cap. Thus, it is uncertain whether these resources are able to deliver supply and provide the type of performance needed by system operators because these resources are effectively never called upon to supply.[15] As a result, the concern arises is that these resources may participate in NYISO capacity markets to earn capacity market revenues without delivering supplies when needed.

[13] *See, e.g.*, NYISO, *Winter 2016 Cold Weather Operations*, Operating Committee presentation by Aaron Markham, March 17, 2016.
[14] NYISO, NYISO ICAP Manual, March 2017, Section 4.
[15] Concerns about reliability would be distinct, but not unrelated, to concerns about the impact of these offers on economic (price) outcomes in NYISO wholesale markets, to the extent that these offers do not reflect the true underlying resource and opportunity costs.

Figure 4: Offers of External Capacity Resources by Season and Price



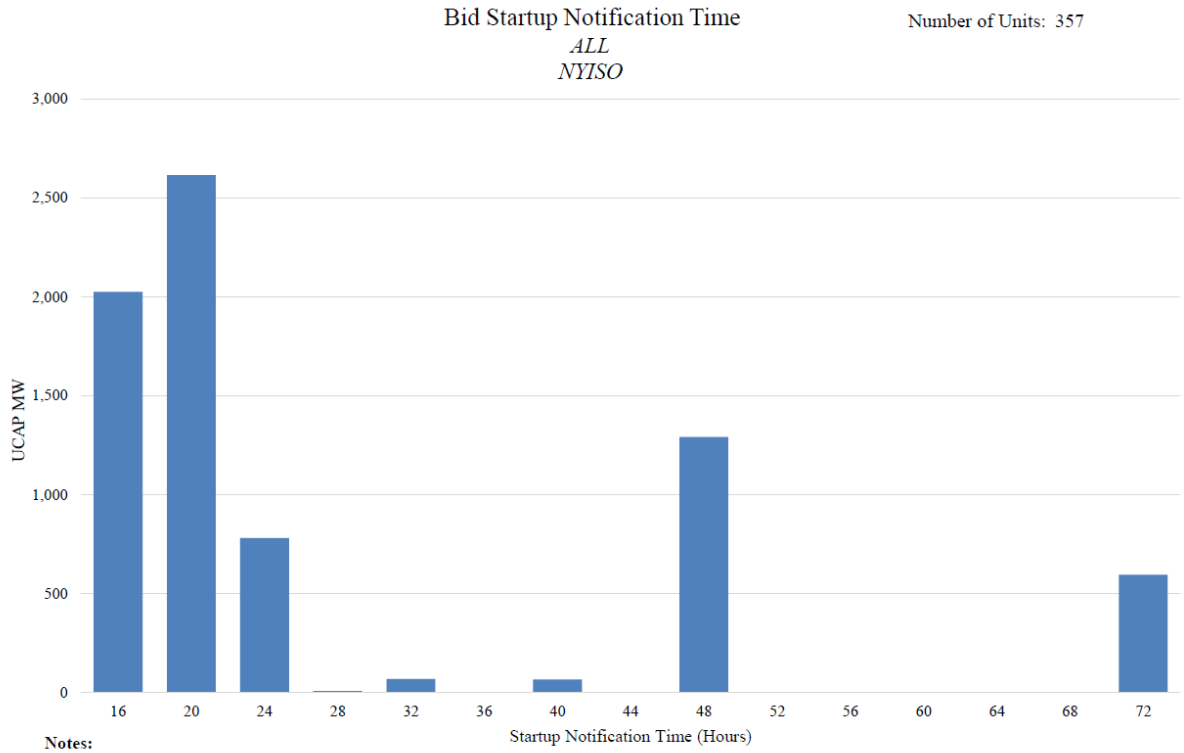
Source: Transaction_withMP.xlsx

- *Outage frequency and duration* - Units with equal UCAP capacity value and compensation can differ substantially in the frequency and duration of scheduled outages, and also differ in the timing of when outages are requested or performed (including some during potential high-load periods). For example, from the standpoint of capacity market resource performance and compensation, a resource with outages of long-duration (3-5 months) and/or higher frequency receives the same compensation as resources with less frequent and/or shorter duration outages. In addition, certain generating units (likely for economic reasons) schedule outages outside of shoulder month periods, requiring that NYISO evaluate expected load and resource levels to estimate capacity margins before issuing maintenance schedule approvals.
- *Operational restrictions* - Certain resources have operational limitations due to fuel/resource restrictions or emission-related constraints, yet are fully compensated in the capacity market in the same manner as resources that do not have such operational limitations. Examples include:
    - resources with air emission operating permit limitations;
    - resources with limitations on energy production over time due to resource availability or use restrictions; and

- facilities with multiple units and "common mode" limitations, such as restrictions on operational parameters (e.g., startup time) or energy production associated with the combined capacity of co-located units that share limited fuel delivery capacity or effluent treatment facilities;

- *Start-time/notification requirements* - Some resources may require excessive notification lead times, essentially precluding the commitment of such units in the day-ahead market due to minimum start up times that exceed the period between day-ahead market commitment and commencement of resource operation associated with a market offer. For example, see Figure 5, below, which shows the distribution of start time parameters exceeding twelve hours in the NYISO control area over the period 2014-2016. While the vast majority of startup notification requirements are fewer than twelve hours, Figure 5 shows that a significant number of startup times specified by capacity market resources exceed 24 hours, with a number of unit offers indicating startup times of two to three days.

Figure 5: Bid Startup Notification Time



Notes:
[1] Bids with startup notification times less than 16 hours are not included.
[2] Startup Notification Times are bucketed such that each bucket includes all bids between it and the next bucket. For example, the "16" bucket includes all bids with startup notification times between 16 and 19 hours.
[3] Bids from units without an associated UCAP value are not included.
Sources: Gen_Parameter_IE.xlsx; Min Run Time and Startup Notification Time.xlsx.

Eligibility/Comparability

Centralized wholesale electricity markets are generally designed to procure standardized commodities that meet specified eligibility requirements and definitions. Product standardization can improve efficiencies in trade and market design that can lower costs of meeting resource adequacy goals. To this end, capacity markets aim to both allow participation of all resources and define capacity in a manner that accurately reflects the benefits provided to meeting the system's reliability needs for each type of technology (and fuel). However, in practice, the unique technical characteristics of different types of resources can create challenges in accurately quantifying the relative benefits offered in a manner that achieves comparability across different resource types. In particular, certain resources that that can provide a capacity product raise unique capacity market design and administration considerations, notably DR, external resources, and intermittent resources.

The vast majority of resources that participate in NYISO's capacity market are "traditional" - fossil, nuclear, hydro and other resource types that have been used in power system operations for decades, and are inside the New York Control Area. While there are meaningful differences (discussed in prior sections) with respect to age, operational parameters, fuel supply and availability performance, by and large internal generating capacity market resources have a set of features important to reliable operations: for the most part they can be called upon to turn on and off as needed, to increase or decrease output, to generate energy throughout the year, and to be deliverable to load within the NYISO control area or local reliability zone.

External and demand response resources are in some ways qualitatively different with respect to some or most of these factors. This does not mean that they cannot support reliable operations and help maintain resource adequacy - it simply introduces a set of different factors with respect to defining resource eligibility and ensuring comparability in the measurement of capacity market contributions. Success in achieving the identified market design objectives will either uniquely address these differences in a way that is fair to all resources, which may involve rendering the differences inconsequential through product definition and market participation rules. Challenges noted with respect to participation of these resources in capacity markets are described for each below.

External Resources - NYISO, ISO-NE, and PJM capacity markets allow for the participation of generating resources outside the region's control area. Provided there are no asymmetries introduced by differences in capacity market designs and/or import/export requirements, this can introduce efficiencies in the combined outcomes of capacity markets across the three regions, and in the long run lower costs for consumers. In addition, the sharing of resources across neighboring control areas increases system operator flexibility to meet operational challenges, and potentially lowers the overall cost to meet operational reliability needs.

Table 1 presents various eligibility, deliverability and energy offer requirements for participation as an external resource in the three RTOs' capacity markets. Various factors related to deliverability and offer requirements can introduce challenges in establishing the comparability of external resources to other (internal) resources participating in the NYISO capacity market. In addition, as Table 1 shows, there are

differences in the rules and requirements for the participation of external resources between NYISO and neighboring RTO's. Differences between the rules by which external resources participate in capacity markets are not necessarily problematic, although such differences could lead to differential incentives for participation in capacity markets in neighboring regions. Given such competition with neighboring markets, the implications of these differences may merit attention as NYISO and stakeholders consider issues of comparability *across* the various resources participating in the NYISO capacity market. The challenges associated with equalizing such factors - as much as is feasible and necessary - have been and are the subject of ongoing deliberations and coordination between neighboring RTOs.

We have identified below several factors associated with external resource participation in NYISO's capacity market based on our review of this issue:

- As described above, it can be challenging for NYISO to have visibility into the actual resources backing external capacity offers.
- External resources could in theory participate in the capacity market, and receive capacity market compensation comparable to internal resources, but for whatever reason offer into day-ahead or real-time energy and reserve markets at prices that effectively preclude in nearly all hours the need to generate energy for import into New York. While market rules are designed to support delivery of external energy if a resource deficiency occurs, such conduct raises questions about the reliability and cost-effectiveness of such service.[16]
- NYISO requires that external resources demonstrate deliverability of the external capacity resource, and that it will not be recalled or curtailed. In addition, deficiency charges apply for capacity not delivered. However, resources can offer at prices exceeding prevailing energy market clearing prices and not schedule energy or transmission service to support the capacity obligation.
- Ultimately, it is possible that neighboring systems may face stressed system conditions at the same time that NYISO would call upon external capacity resources to help meet reserve requirements; while external capacity resources are supposed to be non-curtailable, the deliverability of an external capacity resource when the source region is short of reserves or otherwise in emergency conditions has not been tested.
- Eastern RTO's continue to modify procedures by which external resources fulfill their obligations to participate in the day-ahead and real-time markets, including obligations (by the RTO) to deliver energy from exporting resources, rules for scheduling of flows from the exporting resource (by the host RTO), transaction settlement, enforcement of must-offer requirements, and how the resources are modelled within the respective systems (i.e., the system where the imported resource is physically located, and the system importing the resources).[17]

[16] External ICAP resources have the obligation to responsibility facilitate delivery of ICAP energy to the NYCA if their energy can resolve a resource deficiency arising from a Supplemental Resource Evaluation. NYISO, Transmission and Dispatching Operations Manual, Manual 12, June 2017, pp. 83-84.

[17] For example, for a discussion of PJM Pseudo-Tie requirements, *see* Bowring, Joe, John Dadourian, Monitoring Analytics, "External Capacity: Pseudo Ties," PJM/MISO JCM, November 18, 2015; a more general framework is

Table 1: Eligibility and Deliverability Provisions for External Capacity Resources

NYISO[18, 19, 20] ("External Installed Capacity")	ISO-NE[21] ("Import Capacity Resource")	PJM[22] ("External Generation Capacity Resources")
Resource Eligibility		
• External CRIS Rights are "[a] determination of deliverability within the Rest of State Capacity Region…awarded by the NYISO for a term of five (5) years or longer, to a specified number of Megawatts of External Installed Capacity that satisfy [certain requirements] and that can be certified in a Bilateral Transaction…or sold into the NYCA for an Installed Capacity auction" • DMNC testing, 24-months of operating data; maintenance schedule requirements; notification of outages. • External UCAP Deliverability Rights (UDRs): granted to transmission projects receiving CRIS, with a terminus in a NYCA Locality and another terminus in a neighboring external control area. (Rights holders pair UDRs with Unforced Capacity to provide capacity to the Locality to contribute to an LSE's LCR.)	• Capacity Supply Obligation ("CSO") can be backed by External Resource or an External Control Area. • Minimum commitment duration varies with offer type, multi-year in some cases. • External nodes shall be established and mapped to Capacity Zones. After meeting the qualification requirements, required to obtain Elective Transmission Upgrade/Interconnection Request. Verify/confirm the interface it will be delivered with, and that it will otherwise meet its CSO.	• Must reside in resource portfolio of a signatory of the PJM Operating Agreement • 12 months of unit performance data, operating and maintenance information required; complies with summer and winter testing criteria; communication channel with PJM dispatchers • Must demonstrate generation deliverability by (1) obtaining firm point-to-point transmission service from the border into the PJM transmission system or (2) obtaining "Network External Designated" transmission service.
Deliverability		
• Demonstrate deliverability of the installed capacity equivalent of the unforced capacity supplied to NYCA. • External Control Area to assure it will not recall or curtail exports, or will afford the same curtailment priority. • Assess deficiency charges if External Unforced Capacity is not delivered. • Transmission limitations with respect to the maximum amount of External Installed Capacity.	• Procedures within Forward Capacity Auction to ensure that cleared resources do not exceed intertie capacity. • Subject to Performance Incentives. • Special requirements for "imports" backed by an External Control Area (e.g., demonstrate the region has excess capacity) and "imports" crossing intervening Control Areas (e.g., remote Control Area must show the same curtailment priority as its native load).	• Subject to Capacity Import Limits (CIL) (locational constraints that limit the delivery of capacity to PJM from areas outside of PJM). • Exception to CIL requires: firm transmission; RPM must-offer requirements; and pseudo-tie requirements (e.g., treated like internal generation by PJM, subject to recall in emergency with no constraints from original Balancing Authority).

provided in, Complaint of Potomac Economics, Potomac Economics, Ltd. v. PJM Interconnection, LLC, Docket EL17-62-000, April 5, 2017.

[18] NYISO, NYISO ICAP Manual, March 2017, Section 4.9.1 (p. 4-32), Section 4.10 (p. 4-44), Section 4.14 (pp. 4-88, 4-90).

[19] NYISO, Open Access Tariff (OATT), Attachment S, p. 6.

[20] NYISO, Market Administration and Control Area Services Tariff (MST), Section 5.12.2.1 (pp. 6-11), Section 5.12.12.2 (p. 43).

[21] ISO-NE, Market Rule 1, Section III.13.1.3, Section III.13.1.3.5.3.1, Section III.13.6.1.2.1.

[22] PJM, Manual 18: PJM Capacity Market, Section 2.3.4 (p.16), Section 4.2.2 (p.54), Section 4.6.4 (p. 81).

NYISO[18, 19, 20] ("External Installed Capacity")	ISO-NE[21] ("Import Capacity Resource")	PJM[22] ("External Generation Capacity Resources")
Must-Offer Requirements		
• DA offers required • Maintenance schedules must be coordinated with NYISO	• RT and DA offers required, at intertie for which the offer cleared • Offers must be below a daily threshold set at source regional LMP (for NYISO) or benchmark (Forward Reserve Heat Rate x fuel oil price)	• DA offers required • Maintenance schedules must be coordinated with PJM

Demand Response Resources - NYISO market rules provide for the participation of Special Case Resources (SCR) in the capacity market. SCRs that have cleared the capacity market are obligated to reduce their demand on the system when called upon by NYISO, provided NYISO gives the resource provider with a one-day notice and when instructed at least two hours prior to activation.[23] SCRs with a capacity supply obligation demonstrate their capability through either performance during a call by NYISO, or through testing, at least once per Capability Period.[24] Roughly 1,200 MW of SCRs was enrolled as capacity market resources over the past year. While SCRs are compensated as a capacity market resource,[25] there are a number of challenges in ensuring that SCRs represent a comparable resource in the NYISO capacity market:

- Measurement of the eligible capacity (load reduction response) for SCRs requires identifying a participant's local generation source and/or load reduction capability through performance testing, comparing metered load to average coincident load. Associated energy payments when participation is called involves comparing actual load to a recent-months baseline calculation. SCR available capacity is thus tied to changing participant conditions and actions.
- SCRs have different market offer, notification and availability requirements than generating resources. Specifically, SCRs are only called when NYISO expects to experience a shortage of reserves. NYISO provides SCRs with a 21-hour advance notification of a potential (if before 3:00 pm), and must provide SCRs with a 2-hour intra-day notification of an actual SCR activation.[26]
- It is challenging for load participants to anticipate the impact on their operations of their participation in the SCR program, given how highly variable NYISO calls on SCR resources are year-to-year. Similarly, the relative infrequency of SCR calls means there is little information on how more frequent calls might affect the level of SCR participation.
- The SCR program must be manually activated by system operators based on generation and load forecasts.

[23] NYISO, NYISO ICAP Manual, March 2017, Section 4.12.4 (p. 4-69).
[24] NYISO, NYISO ICAP Manual, March 2017, Section 4.12.4.5 (pp. 4-76-4-78).
[25] NYISO, NYISO ICAP Manual, March 2017, Section 4.12.4.5 (pp. 4-86-4-88).
[26] NYISO, NYISO ICAP Manual, March 2017, Section 4.12.4 (p. 4-69).

- SCRs may be called on for an unlimited number of days, and NYISO can call on resources to perform for more than 4 hours, but DR performance is based on only the best 4 hours of the activation (synonymous to a 4 hour requirement).[27]

All regions are moving towards further integration of demand response resource types in wholesale markets as comparable resources. Specifically, NYISO is currently engaged in a process to transition DR resources (including those that participate in the capacity market, and those that do not participate as capacity market resources) towards inclusion in a more fully integrated Distributed Energy Resource (DER) program structure over the next two to five years.[28]

[27] NYISO, NYISO ICAP Manual, March 2017, Section 4.12.2.1.2 (p. 4-60).
[28] See NYISO, *Distributed Energy Resources Roadmap for New York's Wholesale Electricity Markets*, January 2017.

IV. Performance-Related Designs and Initiatives in the Northeast RTO Regions

As noted previously, various emerging trends in power market pricing, technological change, and energy/environmental policy are introducing new challenges in the design and administration of wholesale electricity markets, and in meeting the reliability needs of the power system. A key driver is the existence of excess gas-fired capacity and continued dominance of natural gas-fired technology for new resource development, combined with relatively low and stable natural gas pricing. On top of this, technological change, cost declines, and energy/environmental policies are accelerating the uptake of near-zero variable cost resources at the grid-connected and distributed levels. Finally, the proliferation of distributed resource options, including renewables, demand response, and (potentially) energy storage are shifting the industry's patterns of supply and demand.

These factors continue to put downward pressure on energy market prices, increasing the importance of capacity and ancillary services revenues for generating unit profitability, and hastening the retirement of older less efficient resources. They will also continue the trend of more dependence on natural gas and associated pipeline transportation infrastructure against a backdrop of increasing opposition to the development and siting of new natural gas infrastructure, creating power system reliability risks during peak periods. Finally, the technology and policy drivers towards greater distributed supply and load management are creating a more complicated relationship between bulk power system and distributed grid operations.

Different sets of risks are important in different wholesale market regions. In Texas, the rapid proliferation of variable wind resource development led to a set of grid management and transmission investment initiatives. In New England, dramatic increases in dependence on natural gas for a region frequently subject to natural gas delivery constraints has led to a suite of temporary and long-term market adjustments. In California, the proliferation of solar resources has spurred the development of market designs to encourage investment in flexible ramping resources. RTOs now routinely face the need to assess risks along multiple dimensions associated with the changing nature of resources on the system and the shape of bulk power system demand, and not surprisingly different answers are appropriate at different times in different regions.

Table 2 presents the ways to address these various challenges that have been established or considered by the organized wholesale market RTOs in the Northeast, including NYISO, ISO-NE, and PJM. Appropriately, the main thrust of many of the changes is to increase market prices and revenues to be earned by operating resources during times of scarcity or stressed system conditions. This common element in many of the mechanisms can be viewed as, in effect, a lifting of energy prices during times of scarcity in ways that do not directly violate the cap on prices in energy markets. This in turn provides the clearest financial signal to improve the performance of capacity market (and other) resources when they are needed the most.

Yet the list also includes a wide array of coordination and information flow solutions, close reporting and monitoring of fuel inventory, and ways to better define resource eligibility and obligations to improve the comparability of capacity market resources. In **Table 2** the various tools and design options are grouped into five different categories, each of which is summarized below.

1. ***Information and Coordination*** - Concerns over fuel availability and capacity resource performance, particularly under specific stressed system conditions, have spurred a number of efforts to improve the flow of information, and to establish and improve coordination between bulk power system operators, system operators and generating asset owners, and system operators and natural gas pipeline operators. Examples include the establishment and now regular scheduling of daily and sometimes more frequent calls during cold weather conditions between power system operators and natural gas pipeline owners/operators. The purpose of these coordination calls is for power system operators to get a sense of available natural gas transportation capacity for generator operations, and for pipeline operators to understand the likely dispatch of power plants along their routes.

   System operators have also created new tools to independently assess the amount of natural gas likely to be available for power generation, helping them understand what is happening in the markets for fuel and transportation, and to be able to anticipate potential reliability challenges that do not necessarily reveal themselves in the development of day-ahead unit commitment and dispatch scheduling. Similarly, system operators are actively developing or obtaining high-resolution forecasts of wind and insolation to better predict and anticipate generation from grid-connected and distributed solar and wind generating facilities on day-ahead and intraday bases. This is in addition to the expansion of solar/wind output forecasting used in system planning studies. Finally, RTOs have increased the obligations of generators leading into stressed system events with respect to the reporting, confirming, or updating of operational restrictions and any changes in generation limits, startup/ramp timing, or other operational parameters.

2. *Eligibility and Obligations* - RTOs continue to refine the eligibility requirements for generating and demand response resource to participate in capacity and energy markets, and the obligations of resources that accept a capacity market resource obligation. For example, ISO-NE sought and obtained clarification from FERC on a generation owner's obligation to procure fuel if scheduled day-ahead, and if dispatched in the real-time market.[29] RTOs have similarly taken steps over time to continuously refine how and under what conditions demand response resources may participate in capacity markets, how the load reduction capability is determined (including how a DR provider's "baseline" is calculated and adjusted over time), how this capability is verified (through testing or dispatch), and how the payment obligations are established during DR call events. More recently, DR's participation in wholesale markets is

[29] *New England Power Generators Association, Inc. v. ISO New England Inc.*, 144 FERC ¶61,157, August 27, 2013.

undergoing comprehensive changes to enable (and require) full participation across wholesale markets, with a focus on comparability to the obligations and opportunities of generating resources.

Rules and requirements for the participation of external resources have also been undergoing changes, as concerns about deliverability have increased and capacity markets have expanded performance requirements. These rules have sought to simultaneously ensure the deliverability of capacity imports, achieve efficiencies in capacity imports (e.g., by allowing open, non-discriminatory access to capacity markets in neighboring RTOs, and allowing enforcement of capacity market performance provisions), and avoiding unintended impacts to operational reliability or dispatch efficiency (in source or destination markets).

Finally, regions have taken steps to significantly increase the frequency and conditions under which generating resources are audited or conduct self-audits to confirm and establish operating parameters, specific operations under cold (or hot) weather conditions, ability to perform in reserve markets from off-line status, and operational capabilities of dual-fuel units on the secondary fuel, including fuel switching times, and min/max generation and ramping specifications on the secondary fuel.

3. *Fuel Monitoring* - RTOs have all established fairly comprehensive systems for monitoring the fuels used for electricity generation, and in particular generators' plans for purchase, delivery, storage, and inventory replenishment during severe weather conditions. Requirements for regular reporting are typically in place year-round, but become more frequent and more detailed under conditions where fuel delivery or replenishment becomes a reliability concern (e.g. when the pipeline system is constrained, or when extended oil burns will require active inventory replacement). Other fuel monitoring/reporting provisions include allowing for increasing required start up notification times during constrained delivery system conditions (subject to demonstration of need) and, in downstate New York, the requirement that gas-fired generation have dual-fuel capability and follow dispatch instructions to burn on the secondary fuel when deemed necessary for reliability reasons.

4. *Energy and Reserve Markets* - The primary goal of market design changes focused on unit performance is to improve pricing in energy/reserve markets, particularly, but not exclusively, during times of scarcity. Such improvements aim to increase the value of providing energy or reserves during those times when resources are needed the most - or have the highest value - from the perspective of power system reliability. In New York, energy and reserve market pricing reflects both rules for energy markets offers (particularly bid caps) and shortage and scarcity pricing, which arises when there are reserve shortages and demand response resources are utilized. The market design particulars that drive this pricing include energy market bid caps, the level of reserve quantities purchased, and levels of scarcity and shortage prices.

In recent years, regions have made market changes to strengthen shortage/scarcity pricing during stressed system conditions.[30] To a certain extent, while the ISO-NE and PJM pay-for-performance capacity market programs are generally viewed as a capacity market mechanisms, the create similar incentives for performance to the shortage/scarcity prices (by compensating resources for performance during the same scarcity conditions targeted in the various energy and reserve markets).

One type of energy/reserve market modification was increasing the quantity of ten-minute and/or thirty-minute reserves procured to better reflect the risks associated with operations under certain conditions, or to reflect the fact that under stressed system conditions some resources tend to operate less reliably due to fuel or operational challenges associated with weather conditions. For example, system operators may adjust the quantities of reserves purchased based analysis of generating unit performance during such stressed system conditions (e.g., during contingency events). In combination with increases in the caps on reserve market prices, adjusted reserve quantities can both increase revenues for responsive resource and potentially affect the likelihood that reserve shortages occur.

Market design changes focused primarily on electricity-natural gas market disconnects have included (a) changes to the timing of offers, settlement, and commitment in the day-ahead market to better match the timing of purchases and nominations in the natural gas market;[31] (b) allowing resource owners to offer at different prices in different hours,[32] (c) allowing resource owners to change price offers (as soon as thirty minutes prior to the operating hour) to allow offers to more closely reflect real-time (intra-day) natural gas prices;[33] and (d) implementing sub-hourly (5-minute) settlement in the energy market.[34]

[30] For example, ISO-NE increased its Reserve Constraint Penalty Factors, which represent caps on reserve prices. FERC, Order on Compliance Filing, ISO New England, ER14-2419-000, October 2, 2014.
[31] See PJM, Gas-Electric Coordination, May 11, 2016; FERC, Order No. 809, Coordination of the Scheduling Processes of Interstate Natural Gas Pipelines and Public Utilities, 151 FERC ¶ 61,049 (2015).
[32] See ISO-NE, ISO New England Implements Major Enhancements to Wholesale Energy Market, December 18, 2014, accessed at https://www.ISO-NE.com/static-assets/documents/2014/12/emof_final_12182014.pdf; UtilityDive, "PJM may consider hourly pricing as generators lobby for market changes," April 2, 2015, accessed at http://www.utilitydive.com/news/pjm-may-consider-hourly-pricing-as-generators-lobby-for-market-changes/382400/.
[33] See ISO-NE, ISO New England Implements Major Enhancements to Wholesale Energy Market, December 18, 2014, accessed at https://www.ISO-NE.com/static-assets/documents/2014/12/emof_final_12182014.pdf; UtilityDive, "PJM may consider hourly pricing as generators lobby for market changes," April 2, 2015, accessed at http://www.utilitydive.com/news/pjm-may-consider-hourly-pricing-as-generators-lobby-for-market-changes/382400/.
[34] ISO-NE, 2015 Regional Energy Outlook, p. 35; Power Markets Today, "ISO-NE moves ahead with plan for 5-minute settlement", June 6, 2016, accessed at https://www.powermarketstoday.com/public/ISO-NE-moves-ahead-with-plan-for-5minute-settlement.cfm; PJM, 5-Minute Settlements, accessed at http://www.pjm.com/markets-and-operations/billing-settlements-and-credit/5-minute-settlements.aspx.

Regions have also implemented administrative or procedural provisions related to participation in energy and reserve markets to increase the flexibility and improve operational performance incentives in the short-term markets. Such changes include increasing the cap on prices and payments in the energy market (e.g., from $1,000 to $2,000 per MWh) under certain conditions, allowing full recovery of fuel costs during periods when price spikes occur or when a generator is required to switch to a higher cost fuel (e.g., to fuel oil) to mitigate natural gas delivery constraints,[35] and establishing long lead time price guarantees for resources with startup/notification times exceeding 24 hours. Finally, regions have recently considered potential fast ramping product designs to better value resources' abilities to help address steep ramps that may arise from increased renewable integration.

5. *Capacity Markets* - ISO-NE and PJM recently adopted forward capacity market changes focused on improving resource performance during scarcity conditions, moving to a two-settlement performance-based design. Specifically, capacity market resources are paid the forward clearing price, but are provided additional revenues or charges depending upon unit performance (as reflected in energy supplied) during pre-defined stressed system conditions.[36] In ISO-NE, the bonus/charge provisions are triggered during "shortage hours," when the system is short on reserves.[37] Since original approval of the New England Performance Incentive ("PI") program, the shortage event trigger has been refined to cover a broader set of stressed system conditions. In PJM, the event trigger is tied to PJM determinations of emergency conditions, which may go beyond events involving reserve shortages. These changes to capacity markets directly increase or decrease capacity market payments to resources as a function of their performance during stressed system conditions, relative to resources' capacity market obligations and expectations. Thus, in effect, these programs create incentives for performance in the RTO energy markets that are very similar to those created by shortage/scarcity pricing.

   In addition to this long-term market design change, ISO-NE has implemented in recent years a "Winter Reliability Program" to procure (and pay for) oil, liquefied natural gas, and/or DR prior to the winter season to ensure reliable winter operations. This program is viewed as an interim out-of-market measure to ensure winter period reliability prior to full implementation of the pay for performance capacity market design.

[35] See PJM, *FERC Order 831 Offer Cap Verification Update,* April 12, 2017; FERC, Order No. 831, *Offer Caps in Markets Operated by Regional Transmission Organizations and Independent System Operators*, 157 FERC ¶ 61,115 (2016).
[36] See ISO-NE Forward Capacity Market (FCM) Manual M-20, Section III.13.7.2.
[37] ISO-NE, 2015-2016 Winter Preparedness (presentation to FERC), September 17, 2015 (p. 5).

Table 2: Mechanisms to Incent Resource Performance in Northeast RTOs

Market/Rule	
Eligibility and Obligations	
	Clarify the obligations of resources with respect to fuel availability when committed or dispatched[38]
	Modify timing and notifications that trigger a DR event, and the procedures to establish and measure/verify baseline levels[39]
	Increase frequency and cost recovery for auditing of dual-fuel capability with respect to fuel swap time, start up, min/max gen levels, ramping[40]
Fuel Procurement, Delivery, and Inventory	
	Require gas-fired units to have dual-fuel capability in certain zones[41]
	Adjust start up notification times considering gas nomination cycles[42]
Energy and Reserve Market Modifications	
	Shift day-ahead energy market timeline to align electricity and natural gas markets and nomination schedules[43]
	Increase energy market offer and price cap (e.g., $2,000 for LMP, with generator cost recovery in excess of this amount)[44]
	Enhance shortage/scarcity pricing during tight operating conditions[45]
	Establish energy market offer flexibility allowing offers to vary by hour of the day, and updating of offers in real-time (e.g., 30 minutes before operating hour) to reflect changing fuel costs[46]
	Allow recovery of higher fuel costs (based on fuel oil prices) when oil is burned to mitigate natural gas delivery constraints[47]
	Improve fast-start resource pricing and reflection of fast-start resource costs in LMPs[48]

[38] See NYISO, *State of the Market Report 2016*, Section XI (p. 100); NE-ISO, *State of the Market Report 2016*, Section II (pp. 28-29).
[39] See NYISO, *Demand Response Presentation*, June 8, 2017; NE-ISO, *Demand Resources in ISO New England Markets*, April 3-7, 2017; PJM, *State of the Market Report 2016* (pp. 79-80).
[40] See Power Markets Today, "NYISO asks FERC to OK tests for dual-fuel generators," August 15, 2017, accessed at https://www.powermarketstoday.com/public/NYISO-asks-FERC-to-OK-tests-for-dualfuel-generators.cfm.
[41] For example, New York City and Long Island reliability rules sometimes require dual-fuel capability (NYISO, *State of Market Report 2016*, Appendix A-8).
[42] See NYSIO, *NYISO Expectations of Generator Operation During a Gas Restriction or Interruption User's Guide*, May 2017; ISO-NE, *Changing Resources: How New England Has Responded to Challenges Associated with the Expanded Role of Natural Gas*, May 18, 2016 (p. 19).
[43] See PJM, *Gas-Electric Coordination,* May 11, 2016; FERC, Order No. 809, *Coordination of the Scheduling Processes of Interstate Natural Gas Pipelines and Public Utilities,* 151 FERC ¶ 61,049 (2015).
[44] See PJM, *FERC Order 831 Offer Cap Verification Update,* April 12, 2017; FERC, Order No. 831, *Offer Caps in Markets Operated by Regional Transmission Organizations and Independent System Operators*, 157 FERC ¶ 61,115 (2016).
[45] See NYISO, *Comprehensive Shortage Pricing,* August 26, 2014; PJM, *Shortage Pricing*, April 14, 2017; FERC, *Staff Analysis of Shortage Pricing in RTO and ISO Markets*, Docket No. AD14-14-000, October 2014.
[46] See ISO-NE, *ISO New England Implements Major Enhancements to Wholesale Energy Market,* December 18, 2014; UtilityDive, "PJM may consider hourly pricing as generators lobby for market changes," April 2, 2015, accessed at http://www.utilitydive.com/news/pjm-may-consider-hourly-pricing-as-generators-lobby-for-market-changes/382400/.
[47] See NYISO, *Market Services Tariff Updates: Fuel Cost Adjustments and Min Oil Burn Compensation Program*, August 25, 2017;
[48] ISO-NE, 2015 Regional Energy Outlook, accessed at https://www.ISO-NE.com/static-assets/documents/2015/02/2015_reo.pdf, pp. 34-35.

	Enact sub-hourly settlement for energy and reserve markets (5-minute pricing)[49]
	Create multi-hour system ramp pricing product to convey the costs incurred when the system must be re-dispatched in advance of a sustained load ramp[50]
	Fully integrate demand response in energy, reserve and capacity markets[51]
	Improve ability of storage to provide frequency regulation services[52]
	Increase price caps in reserve markets[53]
Capacity Market Performance Incentives	
	Develop two-tiered capacity market that rewards or penalizes capacity market resources depending on actual performance during stressed system conditions ("Performance Incentive" or "PI" program)[54]
	Tighten "shortage event trigger" used to define stressed system conditions for PI program[55]

[49] ISO-NE, 2015 Regional Energy Outlook, p. 35; Power Markets Today, "ISO-NE moves ahead with plan for 5-minute settlement", June 6, 2016, accessed at https://www.powermarketstoday.com/public/ISO-NE-moves-ahead-with-plan-for-5minute-settlement.cfm;PJM, 5-Minute Settlements, accessed at http://www.pjm.com/markets-and-operations/billing-settlements-and-credit/5-minute-settlements.aspx.

[50] ISO-NE, 2015 Regional Energy Outlook, p. 35.

[51] ISO-NE, 2015 Regional Energy Outlook, p. 45; FERC, *Demand Response Compensation in Organized Wholesale Energy Markets,* Docket No. RM10-17-000, Order No. 745, Issued March 15, 2011; Walton, Robert, "What the Supreme Court decision on FERC Order 745 means for demand response and DERs," *Utility Dive*, February 3, 2016, accessed at http://www.utilitydive.com/news/what-the-supreme-court-decision-on-ferc-order-745-means-for-demand-response/413092/.

[52] FERC, *Frequency Regulation Compensation in the Organized Wholesale Power Markets,* Docket No. RM11-7-000 and AD10-11-000m Order No. 755, Issued October 20, 2011; NREL, "Energy Storage: Possibilities for Expanding Grid Flexibility," February 2016, accessed at https://www.nrel.gov/docs/fy16osti/64764.pdf.

[53] NYISO, *Comprehensive Shortage Pricing Presentation*, August 26, 2014; FERC, *Staff Analysis of Shortage Pricing in RTO and ISO Markets*, Docket No. AD14-14-000, October 2014.

[54] See ISO-NE Forward Capacity Market (FCM) Manual M-20, Section III.13.7.2; PJM Capacity Market Manual, Revision 37, Section 9.4.

[55] ISO-NE, *2015-2016 Winter Preparedness* (presentation to FERC), September 17, 2015 (p. 5).

V. Observations: Performance-Related Market Design Alternatives

RTO regions are considering or implementing market design changes focused broadly on addressing power system reliability risks arising from the changing industry context. Prior sections summarized this changing industry context and its implications for reliability, resource performance, and market design, and discussed the setting in New York and other regions. Prior sections also identified certain issues related to the performance of particular resources in the NYCA footprint that may warrant consideration of changes to market designs to address these particular issues, although these empirical analyses were not intended to identifying the full scope of issues that might merit further consideration. This section provides context for thinking about potential enhancements to NYISO's market designs going forward, recommends principles to consider in evaluating resource performance incentives, and presents various alternatives NYISO and stakeholders might consider.

In *Section III*, we summarize various features of NYISO's current market designs that relate to the performance and comparability of capacity market resources, and existing resource performance-related factors that could affect the reliability of power system operations under stressed system conditions. Importantly, identifying a given issue is not any indication that there is a market design flaw, or an opportunity for an improved rule, or that the issue can or should be addressed. Instead, the purpose of including a discussion of issues at this stage is to support a broad evaluation by NYISO and stakeholders of potential performance-related issues that might be assessed and - if any are found to be concerns that merit further review - whether there is a potential way to feasibly address the identified issue in a manner consistent with principles for reliable and efficient system operations.

In **Table 3**, we identify several categories of changes that could be considered to address identified performance or comparability issues, and provide benefits and drawbacks for NYISO's and stakeholders' consideration. While the nature and extent of the issues vary widely, our assessment of each issue and potential response is based on consideration of a set of principles tied to reliability, efficiency, and feasibility. Specifically, we consider the following:

1. Reliability: Does the identified issue present a real risk with respect to the reliable operation of the NYCA bulk power system with a particular focus on stressed system conditions on summer and winter peak days? Do potential solutions have the potential to reduce or eliminate the risk without introducing new or unintended operational risks or challenges?
2. Efficiency: Does the issue reduce the competitiveness and/or efficiency of wholesale market operations, or have the potential to do so as the industry evolves over time? Do potential solutions provide transparent, effective and efficient incentives for improved performance and/or reduced reliability risks? Are potential solutions fair and not inappropriately discriminatory against any particular technology or fuel type?
3. Suitability: There is diversity in the nature of consumer demand throughout the state and in the resources that are relied upon for meeting system need, and both are constantly changing. Is the issue reviewed a region-wide or localized concern? Is the proposed solution targeted appropriately to the nature of the risk in form, timing, and geography?

4. Feasibility: Methods for addressing an identified issue must represent practical solutions that can be designed, processed and approved by required regulatory authorities, and administered over time without excessive costs or administrative burdens that do not correspond to the enhanced value provided.

While we have focused on specific challenges and a wide view of performance-related market designs, it is important to recognize at the outset that NYISO is not starting from scratch. NYISO already has in place many of the resource obligations, reporting requirements and energy/reserve market design mechanisms that have been considered or implemented in other regions to provide the appropriate operational standards and financial incentives for resource performance. For example, NYISO market rules and operating procedures already include the following:

- Close coordination with neighboring Control Areas, including on peak summer and winter days or otherwise under stressed system conditions;
- Fuel supply, transportation, and inventory management monitoring and reporting;
- Requirements in downstate zones for gas-fired units to have dual-fuel capability, and to operate on the secondary fuel if or as needed for system reliability;
- Control room monitoring of gas system operations and power plant needs under cold weather conditions;
- Enhanced forecasting to incorporate solar and wind output expectations;
- Required reporting of changed operating parameters and/or operational restrictions associated with burning oil;
- Ongoing evolution of the participation of DR resources in energy, reserve and capacity markets through the DER roadmap;
- Generation unit auditing;
- Adjustment of the timing of the day-ahead energy market to better match the timing of natural gas supply/nomination schedules;
- Flexible energy market pricing allowing for unique hourly offers in the day-ahead and real-time markets, and adjustments to offers in real-time to account for changing fuel price conditions;
- Shortage and scarcity pricing increasing energy/reserve/ancillary services market payments when shortage actions are taken and on critical operating days;
- Imposition of financial sanctions/deficiency charges on capacity market suppliers that fail to meet obligations;
- Reduction in capacity market payments for poor resource availability;

Further, in 2014/2015 NYISO considered the potential for enhancements in the critical operating day performance incentive in capacity markets, including establishing an availability metric used in setting capacity market payments that has more seasonal resolution than the rolling average monthly mechanism under current use. While these changes were not enacted, the process identified potentially useful considerations with respect to capacity market modifications.

Section III identified certain performance-related issues associated with different types of resources within the NYCA. In many cases, the identified issues reflected circumstances in which the quantity of capacity for which resources were compensated might not be directly proportionate to the reliability

benefits provided by these resources from the perspectives of both resource adequacy and reliable system operations.

The issues we identified throughout this review raise a number of potential implications that may merit further exploration by NYISO and stakeholders. Consideration of potential new market designs should reflect on the magnitude of the issue and associated risks in relation to the effectiveness of potential solutions, and the suitability and feasibility of designing, processing and administering new market design approaches. Some of the alternatives identified in **Table 3** potentially address specific performance-related issues identified in *Section III*, and thus may merit consideration in any subsequent stakeholder discussions. For example:

- ICAP to UCAP adjustments currently reflect an 18-month rolling average availability, which may not reliably capture availability during periods of greatest system stress. We recognize that these issues have been recently considered by NYISO and stakeholders, but our review suggests that further consideration may be appropriate. Specifically, our analysis shows variations in resource availability during periods of heightened reliability need that are not captured by current market rule availability metrics. Approaches to a rule based on measuring availability targeting periods of greatest need may improve cost-effectiveness (by targeting payments to resources that provide greater reliability) and/or increase the level of realized resource adequacy and reliability for a given level capacity market procurement.
- Several factors suggest review of the rules by which external resources participate in the NYISO capacity market, including eligibility requirements and offer obligations and terms. Analysis of energy market offers from external ICAP resources found that some currently offer supply at prices near to (or at) energy bid caps. In recent years, neighboring RTOs have modified the rules by which external resources participate in the respective region's capacity markets to (in part) address similar issues. An assessment of a similar rule for NYISO may be warranted, taking into account the particular circumstances and rules of the NYISO market. For example, modified requirements might require external resources to submit cost-based offers in the energy market and/or demonstrate reserved transmission capacity to the NYCA border.
- Our assessment of internal resources also highlights several performance-related issues that may merit further assessment. For example, deviations between offered and reference startup times for some resources raises questions about the comparability of service provided by these resources. These deviations suggests that a review of existing energy must-offer requirements to determine whether modifications (e.g., maximum start/notification times) are appropriate. In addition, the increasing reliability risks associated with dependence on natural gas for electricity generation, against a backdrop of heightened sensitivity to the impacts of natural gas infrastructure development, suggest that consideration of various options for "fuel assurance" may be appropriate, such as expanded dual fuel requirements or winter fuel programs.
- In addition to the evaluation of requirements for these traditional resources, it is appropriate to continue to review of applicable assumptions for the capacity contributions of non-traditional generation resources (e.g., capacity contributions of variable resources). In addition, DR

represents a particular category of "non-traditional" resources whose role in providing reliability assurance during stressed system conditions may be structurally different than that provided by other resources. Specifically, temporal limits on offer and delivery requirements, such as the fixed and limited duration of performance for DR resources that qualify as capacity market resources (i.e., SCRs), raises questions of comparability and the appropriate context for participation of DR resources in NYISO's wholesale markets. We recognize that NYISO and stakeholders are or will be considering such issues in the context of a broader review of how DR (and other distributed energy resources) participate in NYISO's wholesale markets.

- Finally, rule changes that specifically increase revenues of generating units that perform well during shortage or scarcity conditions are likely the most direct means of incentivizing performance under stressed system conditions. These options include capacity market modifications, further increases in energy price caps, and/or further increases in quantities of reserves procured and the price paid for such reserves. Some of these options may require a significant new market design initiative; others could be developed through incremental changes on existing shortage/scarcity pricing mechanisms.

Many of the issues stem from disparate operational capabilities of a diverse set of generating resources, and the challenges associated with designing markets that fully and precisely equate resource capabilities and performance to the level of compensation they receive as capacity market resources. Since divergence from this ideal is inevitable, the end result is in effect either a lower level of reliability for the price paid or, conversely, a higher price paid for a given level of reliability. That is, in some cases the lower capacity benefits provided by particular resources may reduce the aggregate resource adequacy benefits (and reliability more generally) achieved through NYISO capacity markets than assumed for a given level of cost. Alternatively, differences in the (marginal) capacity benefits provided by different types of resources may raise the cost to New York consumers of achieving any given level of resource adequacy.

The ultimate reliability objective is certainty around the operational capability of the fleet of supply and demand resources to NYISO in all hours of the year, but particularly during times of system stress under summer and winter peak load conditions. This level of certainty can be most efficiently achieved through market designs that successfully compensate resources for their true levels of capacity and for their operational performance during these stressed system conditions. The goal of market design - or market redesign - efforts should be to match capability and performance to market compensation as efficiently and effectively as feasible, recognizing that achieving perfection is neither practical nor possible.

Based on our review of the challenges associated with capacity market resource comparability and performance (and associated reliability risks) in New York, and our assessment of various design alternatives considered by RTOs, we present and evaluate a set of options that may warrant further consideration by NYISO and stakeholders. The options, summarized in **Table 3**, could be considered by NYISO and stakeholders if and to the extent there is a determination that resource performance during

peak summer and/or winter periods could be further supported through effective and feasible market design changes.

Some options would be effective at encouraging resource investment to increase performance under stressed system conditions, and are essentially variations on the theme of increased revenues to generating units that perform well during shortage or scarcity conditions. This would include capacity market performance mechanisms, further increases in energy price caps, and/or further increases in quantities of reserves procured and the price paid for such reserves. The former would require a significant new market design initiative; the others represent incremental changes on existing shortage/scarcity pricing mechanisms. Another variation on an existing capacity market design would be a more granular assessment of unit availabilities, focused more on times of need (e.g., seasonal or some more specific definition).

Other alternatives would be effective in helping improve the relationship between capacity market compensation and tighten the link with the capacity value of resources. These would include setting requirements on operating parameters as a condition of capacity market eligibility (e.g., maximum start/notification times), requiring external resources to submit cost-based offers in the energy market and/or demonstrate reserved transmission capacity to the NYCA border, and requiring dual-fuel capability for gas-fired generating resources.

Table 3: Alternatives Related to Capacity Market Resource Performance

	Options	Description	Benefits	Drawbacks
Capacity Market				
	Critical period performance incentive	Institute a performance incentive mechanism in NYISO's capacity market, similar to that in ISO-NE and PJM; define shortage hours consistent with NYISO determination of critical period hours	• Incentives for resource performance tailored to when needed the most • Efficient vehicle for investments in performance • Efficient retirement of poor-performing capacity • Can "borrow" design from other regions	• Requires assessment of performance value/"rate" • Capacity market offers would increase for some units • May increase capacity market risks for variable resources • Difficult for MM to assess risk component of capacity market offers
	Tailored availability mechanism	Changes to the current ICAP to UCAP conversions to account for more granular assessment of performance (e.g., peak periods, seasonal variations)	• Availability decrement to capacity market revenues would more closely capture when resources are needed • Relatively simple calculation • Does not require setting of "rate"	• Data are less certain than observed operations • Availability is different than performance, not what matters during shortage conditions
	Separate winter fuel purchase	Institute a separate product purchase (e.g., fuel) for winter months	• Can increase certainty of fuel (oil, gas) availability during critical winter period	• Requires determination of quantity to procure • Requires out-of-market purchase and collection of costs • Has not been used as a permanent design change
Energy/Reserves Markets				
	Increase energy price cap and payment limit	Pursue allowance of higher prices in energy market, and collection by generators of costs	• To some extent already in regulatory review • Allows prices to increase, in particular during high-load periods • Increases revenues to generators and incentives for operation during times of scarcity	• Increased energy market prices not ideal from the viewpoint of some stakeholders
	Increase reserve quantities	Allow reserves purchased to increase in consideration of NYISO needs (e.g., critical load periods; due to short-term availability statistics; under certain weather conditions, etc.)	• Allows for greater reserves at times when needed the most, and/or when unit performance expected to otherwise decline • Could lead to higher prices and revenues to generators, increasing incentives for operation during scarcity	• Requires establishing metric for increase in reserve quantities and determination of system conditions that trigger increase
	Increase reserve pricing	Increase reserve prices	• Allows prices to increase, in particular during high-load periods • Increases revenues to generators and incentives for operation during times of scarcity	• Increased reserve market prices not ideal from the viewpoint of some stakeholders
	External resource energy offer requirements	Require cost-based energy offers for capacity market resource imports	• Opportunity for increased accountability and efficiency gain from external resources • Improves comparability of obligations for internal and external resources • Promote efficient price formation	• Challenges associated with monitoring and verification

	Options	Description	Benefits	Drawbacks
Eligibility/Comparability Requirements				
	Fuel Assurance, including Dual-fuel capability	Rules or programs targeting fuel assurance, including a statewide dual-fuel capability requirement	• Reduces risk of gas transportation constraints upstate • Improves consistency of locational demand curve calculations	• Would require changes in existing reliability rules • May not be technology neutral
	24-hour notice requirement	Do not allow resources with greater than 24 hour notice/start up requirements to qualify as capacity market resources	• Improve comparability of resources • Ensure all capacity resources can be called upon to meet demand on a day-ahead basis without out of market payments	• May not be technically possible for some resources that serve capacity/reliability functions • Could prompt resource retirements
	Outage scheduling requirements	Preclude outage maintenance during pre-defined periods and/or enable call back for units on outage under critical period conditions	• Would augment existing scheduled maintenance expectations • Provide NYISO ability to add capacity in critical situations	• May not be worth the effort considering that NYISO can reject outage scheduling requests that would cause reliability risks
	External Resources Performance	Provide comparable level of service as internal resources when called upon by NY Operator	• Able to response to DARU/SRE • Ensuring external Capacity during stressed conditions • Ensure comparable performance as internal resources during stress system condition	• Would create challenges with administration and might affect level of participation of imports