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Gas Constraints Modeling Whitepaper

ICS Meeting #290 (6/5/2024)

Executive Summary

As reliability risks during the winter season become more prominent across the New York Control Area (NYCA) system, the availability of gas and oil during winter conditions becomes a critical input in the Installed Reserve Margin (IRM) study. This whitepaper leverages analysis using available historical data, and additional considerations to estimate a quantity of gas and oil assumed to be available for power generation under various potential winter system conditions. As shown in Table 1, a six-tiered fuel availability constraint model for affected units in Load Zones F-K was developed with the initial estimate of available fuel. Beyond the initial estimate, further analysis to quantify the potential reliability impacts with varying quantities of "available oil" was also conducted to assess the potential impacts on the IRM study if there are changes to the estimated available oil. Given the identified sensitivity between the potential IRM impact and available oil assumption, as well as the ongoing evolution of the capacity market to establish a means for assessing different capacity accreditation factors for "firm" and "non-firm" fuel supply arrangements, it is recommended to implement the initial fuel constraint modeling as a series of sensitivity cases in the 2025-2026 IRM study. Beyond the 2025-2026 IRM study, an approach to update fuel constraint modeling assumptions during the IRM study cycle will be developed to support the adoption of the modeling in the base case of the study. This future modeling approach will be documented in a phase 2 of this Gas Constraint Modeling Whitepaper.

*Table 1 – Total Fuel Available in Load Zones F-K based on NYCA Load Conditions***

Tier	NYCA Load Conditions (MW)	Available Gas (MW)	Available Oil (MW)	Total Available Fuel (MW) (Gas + Oil)	Illustrative Modeled Derate (Rounded MW)***
1	>26,000	375	11,000	11,375	8,600
2	25,000 - 26,000	750		11,750	8,225
3*	24,000 - 25,000	2,750		13,750	6,225
4*	23,000 - 24,000	4,500		15,500	4,475
5	22,000 - 23,000	5,500		16,500	3,475
6	<22,000	No Constraint		No Constraint	0

* Tier 3 and 4 load levels comprise the actual peak loads observed in recent winter operating conditions. The illustrative MW derates are generally consistent with the typical reduction in generator capability experienced during such operating conditions.
**Includes gas-only and dual fuel units located in Load Zones F-K.
*** "Illustrative Modeled Derate" values are calculated using the gas-only and dual fuel fleet modeled in Load Zones F-K in the 2024-2025 IRM Final Base Case (FBC) (ICAP: ~21,770 MW; UCAP: ~19,975 MW)

It is important to understand that while the initial modeling recommendation contains specific, recommended load and constraint levels for use in sensitivities cases as part of the 2025-2026 IRM study, the modeling structure aims to represent a range of risks that could present limitations on the availability of gas and oil for power generation during winter periods. A number of important considerations should be noted:

- The historical data used in this whitepaper does not fully address all potential factors that can impact the availability of gas and oil for power generation under various weather conditions during winter periods.
    - Additional factors that could impact fuel availability include economic fuel switching between gas and oil, imports of liquefied natural gas (LNG), pipeline constraints on gas availability, local distribution company (LDC) demand as well as the potential for additional replenishment capability on oil storage beyond what is already captured in historical fuel survey data reported by generators.
- The gas availability levels in the higher load condition tiers are based on extrapolation beyond available data points. Ongoing research and analysis will be needed to identify additional data and to refine the assumptions used in these tiers.
- The oil availability level is based on historical reported storage levels reflecting pre-season filling of storage facilities and in-season replenishment actions. In practice, there is potential for additional capability of replenishing on-site storage that could further increase oil availability levels. Ongoing research and analysis will be needed to refine the oil availability assumptions over time, including the identification and quantification of replenishment capability available to units and additional evaluation of oil storage levels leading into and through cold weather events.
- The specific load levels defining the individual tiers and associated fuel constraint assumptions recommended herein are intended for use in sensitivity cases as part of the 2025-2026 IRM study. However, changes in system conditions are anticipated to impact both winter load levels and fuel availability for power generation. Monitoring the winter load growth, fuel availability and market behavior changes is needed to refine and evolve the modeling of winter period fuel availability constraints in future IRM studies.

Today, the reliability risk presented in the IRM study (i.e., the loss of load expectation (LOLE)) is concentrated in the summer season. Implementing the fuel constraint modeling seeks to integrate the necessary elements to capture and reflect fuel availability risk during the winter season as conditions evolve. Based on the impact assessment, the initial modeling recommendation shown in Table 1 would have increased the IRM determined by the 2024-2025 IRM study Final Base Case (FBC) by 0.3%. The analysis conducted also demonstrates that the magnitude of the IRM impact, as well as the reliability risk in the winter season, could significantly increase with lower assumed levels of available oil. Therefore, the fuel constraint model is intended to serve as a critical first step to capture winter reliability risk in the IRM study. Other elements, such as seasonal load forecast and topology transfer limits, should be considered as part of the complete package to reflect winter conditions as noted in the Resource Adequacy Modeling Improvement Strategic Plan.[1]

Objective

This whitepaper provides research on the potential impact of fuel constraints on New York electric power generators located in Load Zones F-K during varying winter load conditions, primarily focusing on

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[1] https://www.nysrc.org/wp-content/uploads/2023/08/RA-Modeling-Improvement-Strategic-Plan-2024_v7_clean21459.pdf

determining how to best incorporate practical levels of fuel constraints in the IRM study. Initially, consideration of fuel availability constraints is recommended for modeling as sensitivity cases for the 2025-2026 IRM study.

The scope of the whitepaper addresses three major questions:

- What are the characteristics of the winter gas and oil constraints as reflected on availability of electric generators?
- What are reasonable levels of such gas and oil constraints to be initially reflected in the IRM study as sensitivity cases for the 2025-2026 IRM study?
- What is the best modeling approach to represent these characteristics in the resource adequacy models?

Background

The NYCA grid is forecasted to transition from a summer-peaking system to a winter-peaking system over the next decade. It is essential to start properly reflecting winter risk in the IRM model to ensure reliability is maintained as this transition occurs. Researching and implementing practical levels of fuel constraints in the IRM model is an important first step in beginning to properly account for winter risk in the model.

Gas-fired, dual-fueled, and oil-fired generation are very important in maintaining the reliability of the electric system in winter for the current resource fleet. These resources are expected to continue to be critical for maintaining reliability throughout the transition to a clean energy grid. Concerns have been raised regarding the availability of natural gas for electricity production as winter load conditions increase. For example, as illustrated by Potomac Economics (i.e., the independent market monitor for the New York Independent System Operator, Inc. (NYISO)), in a presentation titled "MMU Analysis of Gas Availability in Eastern New York,"[2] recent winter operating experience suggests that gas-fired electric power generators located within Load Zones F through K face constraints on the availability of gas for power generation during peak winter conditions. Therefore, it is necessary to begin properly accounting for the likelihood that gas availability limitations arise as winter load conditions increase.

While researching gas availability for power generation, it became apparent that analyzing the availability of secondary fuels for dual fuel resources was also necessary to properly account for winter risk related to fuel availability.

As supported by the New York State Reliability Council, L.L.C. (NYSRC) and stakeholders, research was conducted analyzing the potential impact of varying winter load conditions on fuel availability to New York electric power generators to determine an appropriate methodology to account for such impact in the IRM database.

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[2] https://www.nyiso.com/documents/20142/33916814/MMU%20Gas%20Availability%20Presentation__20221020.pdf

Key Assumptions

There are several key assumptions made when researching this whitepaper:

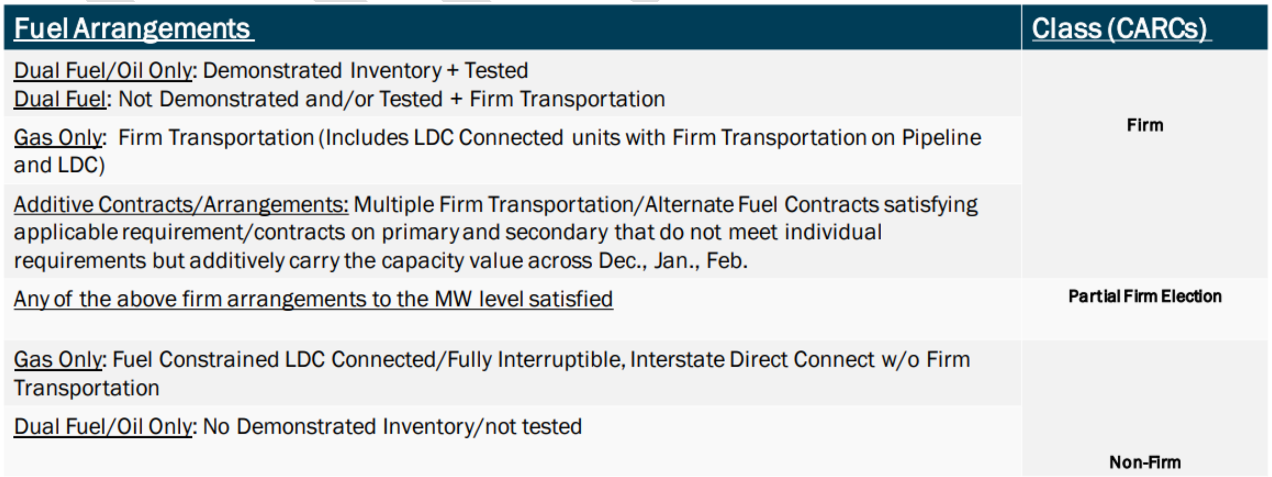
- Fuel availability constraints are to be applied to certain thermal units in Load Zones F-K
- Fuel availability constraints are to be applied in December, January, and February
- Winter load levels will be used as a proxy for temperature to trigger the application of fuel constraints in the IRM model
    - Demand for gas is closely related to temperature during winter
- Gas constraint magnitude levels should vary under different winter load/seasonal conditions
    - Gas constraints increase as winter load levels increase

Modeling Improvements for Capacity Accreditation

Concurrent with the efforts to develop modeling assumptions for the inclusion of winter season fuel availability constraints in the IRM study, significant work was undertaken regarding the development of proposed improvements for capacity accreditation in the NYISO-administered capacity market, including an effort regarding consideration of fuel availability. This effort focused on creating classifications for individual generators based on "fuel characteristic elections." These "fuel characteristic elections" include classifying generators into varying levels of fuel availability commitments (i.e., firm, partial-firm, or non-firm). These classifications are based on how much of a unit's capacity it has elected and demonstrated to be met by "firm" fuel supply arrangements.

The proposed capacity accreditation resource classes (CARCs) associated with such fuel availability commitments[3] are depicted below.

Figure 1 – Proposed Fuel Arrangements and CARC Classification Overview



Fuel Arrangements	Class (CARCs)
Dual Fuel/Oil Only: Demonstrated Inventory + Tested Dual Fuel: Not Demonstrated and/or Tested + Firm Transportation	Firm
Gas Only: Firm Transportation (Includes LDC Connected units with Firm Transportation on Pipeline and LDC)	
Additive Contracts/Arrangements: Multiple Firm Transportation/Alternate Fuel Contracts satisfying applicable requirement/contracts on primary and secondary that do not meet individual requirements but additively carry the capacity value across Dec., Jan., Feb.	
Any of the above firm arrangements to the MW level satisfied	Partial Firm Election
Gas Only: Fuel Constrained LDC Connected/Fully Interruptible, Interstate Direct Connect w/o Firm Transportation	Non-Firm
Dual Fuel/Oil Only: No Demonstrated Inventory/not tested	

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[3] https://www.nyiso.com/documents/20142/40085480/Natural%20Gas%20Constraints_9_20_2023_v4.pdf

Resource fuel availability elections and associated CARC assignments provide important information to consider in modeling the fuel constraints in the IRM study, as discussed further in the coming sections of this whitepaper.

Current Modeling Assumptions

Thermal generators (e.g., gas-only, dual fuel, and oil-fired units) are currently modeled in the IRM study without any limitations due to fuel availability in winter months. The current approach models generators using the lesser of each unit's Capacity Resource Interconnection Service (CRIS) value or Dependable Maximum Net Capability (DMNC) value for the winter season. These values are available in the annual Load & Capacity Data report (Gold Book) published by the NYISO. Each generator's Equivalent Demand Forced Outage Rate (EFORd) is modeled in the IRM study to reflect its historical availability. The EFORd is determined based upon the most recent 5 years of outage data submitted to Generating Availability Data System (GADS), which is the system utilized by NYISO for generators to report unit specific outages. A generator's EFORd effectively reduces the modeled capacity of a unit in the IRM study to reflect each generator's available capacity more accurately.

EFORd Double Counting

During the research phase of this project, a concern was raised that the EFORd may already capture the impact of fuel constraints as generators are able to report outages due to "lack of fuel" events in GADS. If already captured by EFORd values, additional constraints in the IRM model may be unnecessary. In researching this concern, the NYISO determined that the "lack of fuel" cause code has historically been reported infrequently by generators. Further analysis was performed comparing the historical GADS data and operational reports on unavailability of gas, concluding that the GADS data does not adequately capture the fuel constraints faced by generators during winter. As a result, the addition of fuel constraints during the winter period to the modeling for the IRM study would be unlikely to result in significant concerns for double counting with the EFORd assumptions used in the IRM modeling. Nevertheless, EFORd double counting could potentially arise as winter conditions and/or if GADS reporting practices change. To mitigate this concern, the NYISO has committed to update the GADS data processing tools to exclude any reported "lack of fuel" events during the winter season from the EFORd calculation used for IRM modeling.

Research Approach

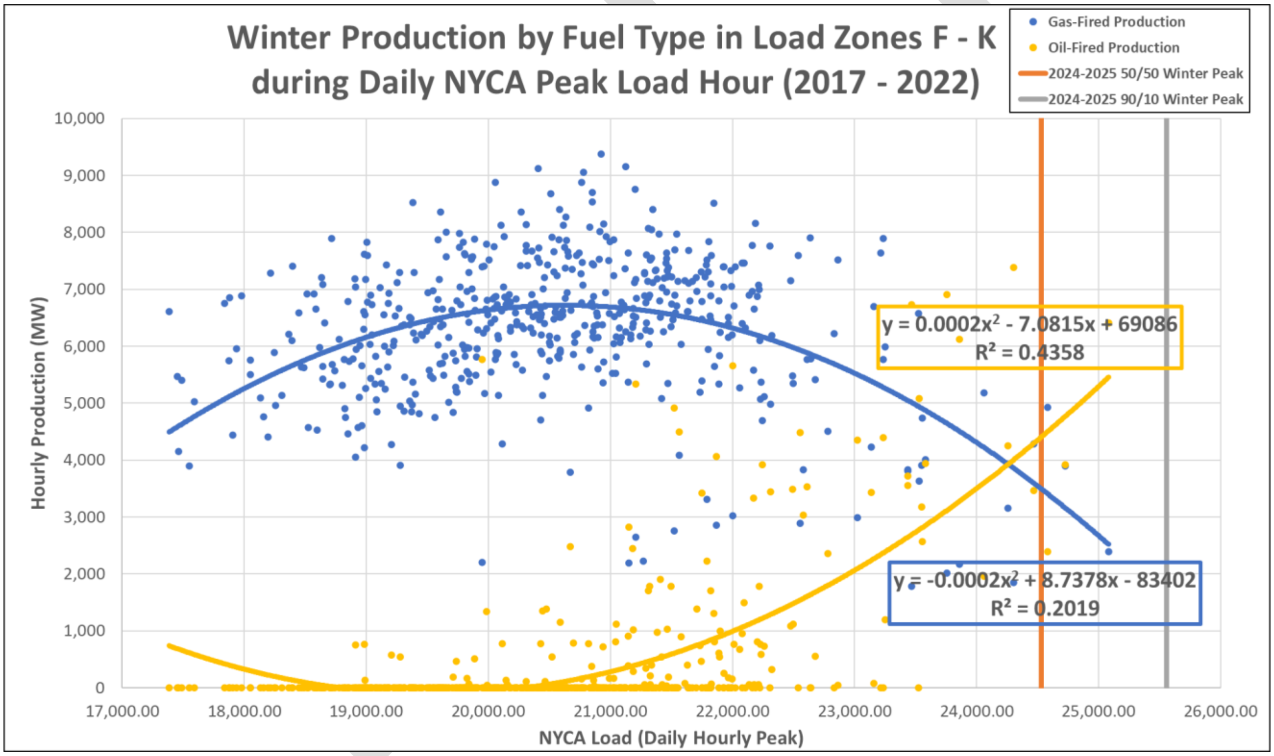
Available historical data is used to estimate the level of available gas and oil storage for power generation. As the availability of the fuel can vary depending on the weather conditions, the correlation between historically available fuel and NYCA winter load level was developed. It is recognized that the historical data may not contain sufficient granularity to quantify all the factors that contribute to the availability of fuel. In addition, for modeling purposes, the extreme load conditions may not be reflected in the historical data. Nonetheless, the data analytics provide a starting point estimation of potential available fuel, which is an important input to the recommended modeling. Ongoing research to refine and improve the model and assumptions in future studies should be pursued.

Gas Availability

This whitepaper analysis began by attempting to quantify the amount of gas that historically has been available under varying winter load conditions. NYCA load data and historical hourly production by fuel type for gas-only and dual fuel units in Load Zones F-K were compiled to assess the statistical relationship between winter load and gas-fired production in Load Zones F-K. The historical hourly production by fuel type data was compiled using a NYISO dataset that utilizes fuel reference levels to evaluate the type of fuel (i.e., gas or oil) that each generator is likely using during each hour of production.

The chart below shows the compiled datapoints and trendline between NYCA load and production by fuel type for gas-only and dual fuel units in Load Zones F-K during the daily peak load hour for the past several winters (2017 – 2022).

Figure 2 – Winter Production by Fuel Type in Load Zones F-K during Daily NYCA Peak Load Hour (2017-2022)



The chart shows that, historically, as the NYCA load conditions increase, the winter gas-fired production initially increases before beginning to decrease with peak load levels in excess of approximately 21,000 MW. The gas-fired production under these different conditions provides indicative information to assess potential fuel availability to generators in Load Zones F-K under varying winter load conditions. The visible link between decreases in gas-fired production and oil-fired production increasing as NYCA winter loads increase also highlights the importance of accounting for both fuel types in the initial modeling recommendations.

There are potential factors, such as the impact of LNG and dual fuel generators switching from gas to oil for economic reasons, that may be contributing to the historical trendlines. This means, under certain conditions, the reduction of gas-fired production could be occurring due to oil prices being lower than gas prices, not necessarily due to constraints on the availability of gas. However, as there is limited available data to quantify these economic fuel switching factors at this time, the correlation between gas-fired production and load level is utilized to provide an input for developing assumptions regarding gas availability assumptions to be modeled in the IRM study. Conversely, LNG imports into the Northeast U.S. (especially long-term contracts that are established before the demand and economics of the season are well understood) can result in more natural gas being available for power generation. It is recommended that these factors continue to be evaluated in future IRM cycles to determine their potential impact and the need for adjustments or refinements to the modeling of fuel availability.

The trendline for the gas-fired production was analyzed under varying load conditions for affected generators in Load Zones F-K, shown in Table 2 below.

Table 2 – Estimated Gas Available in Load Zones F-K based on Historical Data Regression

NYCA Load Conditions (MW)	Estimated Available Gas Based on Regression (MW)
>26,000	0
25,000 - 26,000	750
24,000 - 25,000	2,750
23,000 - 24,000	4,500
22,000 - 23,000	5,500
<22,000	No Constraint

The estimated available gas in the upper tiers is based on extrapolation beyond available data points, but is directionally consistent with observed operational experiences. Although the regression analysis indicated 0 MW of gas available at highest load level (i.e., 26,000 MW or greater) there is currently no actual operational data available to corroborate this finding. In other words, this finding is the result of extrapolation and may not represent actual available gas under these conditions. Accordingly, as reflected in Tables 1 and 4, for purposes of the initial modeling in sensitivity cases as part of the 2025-2026 IRM study, it is recommended that an assumed level of 375 MW of available gas be utilized for load conditions in excess of 26,000 MW. Continuous research will be needed to identify additional data and to refine the assumptions used, especially in cases where actual historical data is unavailable to directly inform the assumptions.

Oil Availability

While researching gas availability, it became evident that evaluating the amount of oil available to thermal generators in Load Zones F-K was also important (see Figure 2) for developing a reasonable representation of potential fuel availability constraints during winter months. Many of the generators in this area have dual fuel capability providing the ability to switch between using gas or oil to produce electricity.

While the historical data presented in Figure 2 shows an increase in oil-fired production as gas-fired production declines, such historical production only indicates the utilization of the stored oil, but not the availability of the oil storage. Subsequent analysis was conducted to determine reasonable assumptions regarding the amount of oil likely available to dual fuel generators in the Load Zones F-K. This was accomplished by using historical weekly fuel surveys submitted by generators to the NYISO. These surveys track the amount of oil storage along with certain information regarding fuel procurement arrangements/contracts.

The weekly fuel surveys from recent winters (2018 – 2023) were evaluated to estimate the quantity of oil storage historically available to the dual fuel generators in Load Zones F-K. The estimated quantity of oil production capacity was calculated based on the capability of each affected generator to sustain its maximum output for 16 hours per day for a period of 6 consecutive days, based on the reported oil storage levels. This calculation is based on the proposed requirements[4] (more information on classification in “Modeling Improvements for Capacity Accreditation” section) of a resource being classified as “firm” by using an alternative fuel source (e.g., oil). Analysis of the historical data reported in weekly fuel surveys showed that, on average, approximately 11,000 MW of capacity would have likely qualified as “firm” capacity with a range of approximately 9,000 MW – 11,500 MW across all of the surveys. The weekly surveys provide an estimate for the amount of oil-fired capacity available in recent winters. The average value (i.e., 11,000 MW) was selected to represent an initial assumed quantity of oil available for power generation across varying winter load conditions, as shown in Table 3 below.

Table 3 – Estimated Oil Available in Load Zones F-K based on Historical Fuel Survey Data

NYCA Load Conditions (MW)	Estimated Available Oil (MW)
>26,000	11,000
25,000 - 26,000	
24,000 - 25,000	
23,000 - 24,000	
22,000 - 23,000	
<22,000	

The estimated available oil is based on historical reported oil storage levels. While the analysis does capture some oil storage replenishment due to the nature of analyzing multiple surveys over time, in practice, the full capability of replenishing on-site storage is likely higher and may further increase the available oil level. Ongoing research will be needed to identify and quantify oil replenishment capability and refine the available oil assumptions over time, including the assessment of replenishment leading into and through cold weather events when significant quantities of oil may be burned.

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[4] https://www.nyiso.com/documents/20142/40085480/Natural%20Gas%20Constraints_9_20_2023_v4.pdf

Initial Recommendation Based on Total Available Fuel

An initial fuel constraint model was developed based on the assumptions for available fuel resulting from the analysis of historical data. To implement a fuel availability constraint in GE MARS, evaluation of potential modeling options and methods was conducted with support from GE and the Installed Capacity Subcommittee. The fuel constraints will initially be modeled using “Modeling Concept 1: Gas Constraint Triggered by Load Condition via Dummy Profile” and derates will initially be calculated utilizing the “UCAP Method” (refer to the appendix for additional information regarding the various modeling, inputs, and methods analyzed during the whitepaper research).

Based on the evaluation of different modeling approaches and concepts, the initial recommendation of a six-tiered fuel constraint model grouped by different NYCA winter load conditions and associated constraints was developed. The recommended model is intended to reflect the available fuel, from both gas and oil, under different NYCA load levels, and will initially be implemented through sensitivity cases for the 2025-2026 IRM study with appropriate derates among the existing units, as shown in Table 4 below:

*Table 4 – Initial Recommended Fuel Constraints Modeling (Load Zones F-K)***

Tier	NYCA Load Conditions (MW)	Available Gas (MW)	Available Oil (MW)	Total Available Fuel (MW) (Gas + Oil)	Illustrative Modeled Derate (Rounded MW)***
1	>26,000	375	11,000	11,375	8,600
2	25,000 - 26,000	750		11,750	8,225
3*	24,000 - 25,000	2,750		13,750	6,225
4*	23,000 - 24,000	4,500		15,500	4,475
5	22,000 - 23,000	5,500		16,500	3,475
6	<22,000	No Constraint		No Constraint	0

* Tier 3 and 4 load levels comprise the actual peak loads observed in recent winter operating conditions. The illustrative MW derates are generally consistent with the typical reduction in generator capability experienced during such operating conditions.

**Includes gas-only and dual fuel units.

*** “Illustrative Modeled Derate” calculated based off of gas-only and dual fuel fleet modeled in Load Zones F-K in the 2024-2025 IRM FBC (ICAP: ~21,770 MW; UCAP: ~19,975 MW)

The assumed available gas levels were determined using historical production data, as described in the “Gas Availability” section above. For the load conditions in Tier 1 where there is limited/no historical data to corroborate the trendline, an adjustment to the estimated available gas based on the regression is recommended to increase the available gas from 0 MW to 375 MW. This allows for the likelihood that there is potentially some amount of gas available to generators in extreme conditions. Inputs to the available gas modeling assumptions should be assessed and, as necessary, updated over time based on additional analysis of historical data.

The available oil level is determined using historical fuel survey data, as described in the “Oil Availability” section above. Continued analysis of the weekly fuel survey data and fuel availability election decisions (i.e., firm, partial-firm, or non-firm) should be utilized to assess and, as necessary, update the recommended available oil modeling assumptions over time.

Assumption updates to initial modeling will be developed beyond this whitepaper and will leverage the experience with sensitivity cases in the 2025-2026 IRM study. Some initial considerations for assumption updates are noted. The “Available Gas” and “Available Oil” assumptions can be updated as new information becomes available. Specifically, the available gas assumptions can be reviewed annually by analyzing historical production data during the development of the IRM Preliminary Base Case (PBC). The “available oil” assumption can be updated based on consideration of the firm fuel election decisions of generators as part of the NYISO’s capacity accreditation rules. It is expected that a process for updating model input assumptions will be developed prior to the full adoption of the fuel constraint model in the IRM study base case and the final assumptions will be documented in the IRM study Assumptions Matrix.

Understanding the Recommended Model and Fuel Constraints

The initial modeling recommendation and its specific constraint levels are based on recent historical data. While it is reasonable to use the specific values from the recent trends, it should be noted that the risk of the fuel constraints is dynamic and varies across a range of factors including weather, fuel supply arrangements, oil storage and replenishment, and future fuel switching due to electrification. Ongoing analysis, updates and refinements of the modeling assumptions are recommended to maintain a reasonable reflection of winter fuel available risks.

Impact Analysis of Initial Recommended Modeling for Fuel Constraints

Preliminary impact analysis was conducted on the 2024-2025 IRM technical study’s FBC. Implementing the initial recommended fuel constraints modeling into the database resulted in an approximately 0.3% increase to the IRM and minimal changes to the locational requirements identified by the Tan45 methodology.

Table 5 – Initial Recommended Fuel Constraint Modeling: Impact Analysis on 2024-2025 IRM FBC

Case	IRM (Delta)	J LCR (Delta)	K LCR (Delta)	G – J (Delta)
2024 – 2025 IRM FBC (Base Case)	23.1%	72.7%	103.2%	84.6%
Initial Fuel Constraint Recommendation (Tan45)*	23.4% (+0.3)	72.7% (-)	103.1% (-0.1)	84.6% (-)

* Fuel constraints applied in the modeling using the “UCAP Method” (see “Percentage Derate Calculation Considerations” section within the appendix)

An additional impact analysis was conducted based on the sensitivity case conducted during the 2024-2025 IRM FBC process to consider the transmission security limit (TSL) floor values used in the NYISO’s Locational Minimum Installed Capacity Requirements (LCR) study for the 2024-2025 Capability Year.[5] This sensitivity case examined what the IRM would be if the TSL floor values of 81.7% for Load Zone J, 105.3% for Load Zone K, and 81.0% for the G-J Locality were implemented as fixed parameters and the LOLE

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[5] https://www.nysrc.org/wp-content/uploads/2023/10/TSL-Floor-Assessment-ICS-11012023-Draft-v5-Market-Sensitive22933.pdf

criterion of 0.100 event-days/year was maintained.[6] The sensitivity resulted in a starting point of 21.5% for the IRM. Implementing the initial recommended fuel constraints modeling in the database for this sensitivity resulted in a similar increase to the IRM.

Table 6 – Initial Recommended Fuel Constraints Modeling: Impact Analysis on 2024-2025 IRM TSL Floor Values Sensitivity

Case	IRM (Delta)	J LCR (Delta)	K LCR (Delta)	G – J (Delta)
2024 – 2025 IRM FBC Sensitivity (Respecting TSL floor values)	21.5%	81.7%	105.3%	81.0%
Initial Fuel Constraint Recommendation (Respecting TSL floor values)*	21.7% (+0.2)	81.7% (-)	105.3% (-)	81.0% (-)

* Fuel constraints applied in the modeling using the "UCAP Method" (see "Percentage Derate Calculation Considerations" section within the appendix)

Additional Analysis of Initial Recommended Modeling for Fuel Constraints with Varying "Available Oil" Levels

As noted in the previous section, proposed enhancements are being developed for the NYISO-administered capacity market to classify generators based on fuel availability elections. These enhancements may result in changes to historical fuel supply arrangements which could affect fuel availability assumptions, such as oil storage levels. Further analysis was conducted with varying amounts of "available oil" to assess potential impacts that could result from changes in historical fuel procurement decisions. Table 7 below shows the potential impact to the 2024-2025 IRM FBC and associated locational capacity requirements, and the summer/winter risk if the "available oil" amount assumed in the initial recommendation is varied. All other assumptions (i.e., NYCA Load Conditions, Available Gas) were held constant for this analysis. These results were computed using the Tan45 methodology.

Table 7 – Initial Recommended Fuel Constraints Modeling: Additional Analysis of Varying "Available Oil" Amounts on the 2024-2025 IRM FBC

Available Oil Assumed (MW)	IRM	IRM Delta	J LCR	J LCR Delta	K LCR	K LCR Delta	G - J	G - J Delta	Summer LOLE Risk (%)	Winter LOLE Risk (%)
Base Case	23.10%	-	72.73%	-	103.21%	-	84.58%	-	100.0%	0.0%
12,000	23.10%	+0.00%	72.73%	+0.00%	103.27%	+0.06%	84.58%	+0.00%	99.7%	0.3%
11,000	23.40%	+0.30%	72.68%	-0.05%	103.15%	-0.05%	84.54%	-0.04%	97.2%	2.8%
10,000	24.30%	+1.20%	72.75%	+0.02%	102.98%	-0.23%	84.59%	+0.01%	89.1%	10.9%
9,000	25.80%	+2.70%	73.27%	+0.54%	102.98%	-0.23%	84.98%	+0.40%	73.8%	26.2%
8,000	28.10%	+5.00%	75.18%	+2.45%	103.37%	+0.16%	86.37%	+1.79%	53.2%	46.8%
7,000	31.00%	+7.90%	78.68%	+5.95%	104.57%	+1.36%	88.93%	+4.35%	35.6%	64.4%
6,000	34.30%	+11.20%	82.55%	+9.82%	107.15%	+3.94%	91.76%	+7.18%	18.6%	81.4%

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[6] This analysis was conducted prior to the identification of an error in calculating the TSL floor value for Load Zone J. Correcting for this error, the TSL floor value for Load Zone J should have been 80.4%. The Load Zone J LCR was also subsequently corrected to 80.4% for the 2024-2025 Capability Year.

As shown in Table 7 above, the potential impact to the IRM and the shift towards winter LOLE risk increase significantly as the assumed level of "available oil" decreases. Key observations from this additional analysis are as follows:

1) An observed 1,000 MW decrease from the initial recommended assumption of 11,000 MW of available oil increases the IRM by over 1% and results in 10% of the LOLE risk shifting to the winter season.
2) Beyond 3,000 MW decrease in the assumed level of "available oil" from the initial recommendation (i.e., below 8,000 MW available oil), the NYCA system risks will be predominately in the winter season, along with an IRM increase by over 5%.
3) With 5,000 MW or less of assumed "available oil," the Tan45 methodology was not able to establish an IRM.

Final Recommendations

Based on the research and analysis conducted, it is recommended that the initial fuel constraint model be included in a series of sensitivity cases for the 2025-2026 IRM study. The sensitivity cases will be performed with varying amounts of "available oil" to reflect the potential impact due to varying assumptions regarding expected fuel availability. Beyond the 2025-2026 IRM study, an approach to update fuel constraint modeling assumptions during the IRM study cycle will be developed to support the adoption of the modeling in the base case of the study. A phase 2 of the Gas Constraint Modeling Whitepaper is expected to be developed to evaluate various approaches and document the recommended process for incorporating the fuel constraints model in the base case of the IRM study along with the procedures for establishing and updating the associated fuel availability assumptions.

The initial recommended fuel constraints modeling is an important first step in properly reflecting winter risk in the IRM study, but ongoing research and refinement is also recommended to continuously refine the modeling approach and inputs assumptions. Some areas of focus for ongoing research and refinement include, but are not limited to:

- Aligning the IRM database to properly reflect winter load conditions and winter peak load levels
  - Efforts to improve the current IRM load shape adjustment process to better reflect the winter load forecast are already underway
- Monitoring changing market behavior of firm fuel procurement and reassessing the methodology using the historical data trends
- Assessing if potential additional factors (i.e., impact of LNG, economic considerations for fuel switching by dual fuel generators, LDC demand, oil replenishment capability, generator emissions restrictions) that may impact the historical production data need to be accounted for when determining the modeled fuel constraint assumptions
- Aligning the IRM database to reflect additional winter-related modeling assumptions (e.g., winter transmission limits)
- Monitoring the load growth during winter and adjusting load levels "tiers" accordingly to represent changing winter conditions over time
- Assessment of firm fuel elections as part of the NYISO's capacity accreditation rules and reported fuel inventories

- Need for research to potentially extend the modeling of fuel constraints to resources statewide based on fuel constraints beyond Load Zones F-K (i.e., extend to Load Zones A-E)
- Enhancements to the modeling of fuel constraints as future GE MARS improvements are implemented

Appendix

Modeling Approaches

To implement fuel constraint modeling assumptions into the IRM study, two primary approaches were considered: (1) modeling availability, and (2) modeling unavailability.

Modeling availability calls for the constraints to be modeled as specifying the amount of capacity that is "*available*" when a condition is triggered. In practice, this would mean that the affected generators would be able to provide capacity up to a specified level and not beyond that level, essentially limiting the amount of capacity that these units could provide to the system. This approach appears to align naturally with the impact of fuel constraints, which operate to limit the amount of fuel available for electric generation. Implementing the availability approach would, however, require significant changes to the underlying GE MARS program and/or IRM database.

Modeling unavailability calls for the constraints to be modeled as specifying the amount of capacity that becomes "*unavailable*" when a condition is triggered. In practice, this would mean that affected generators would have their capacity reduced by a specified amount to limit the total capacity that the generators could provide to the system. This approach aligns better with the existing capability of the GE MARS program in modeling generator derates and outages. The unavailability approach, however, can present concerns regarding precision with modeling the identified constraints. The forced outage scenarios in each GE MARS simulation impact the precision of the constraints to be applied.

After reviewing both approaches, modeling unavailability was identified as the preferred approach at this time. This approach offers simplicity in modeling construct development in the near term and allows for flexibility in applying different constraint levels under varying winter load conditions. In the longer-term, potential solutions to further improve the initial modeling construct, such as correlated outages if introduced into the GE MARS program, can continue to be evaluated.

Modeling Concepts

After reviewing the modeling approaches, the NYISO worked with GE to develop modeling concepts for further evaluation. The four modeling concepts (refer to "Modeling Concepts Overview" section below for additional information on each concept) ultimately considered were as follows:

- Modeling Concept 1: Gas Constraint Triggered by Load Condition via Dummy Profile
- Modeling Concept 2: Gas Constraint Triggered by Load Condition via Specific Dates
- Modeling Concept 3: Gas Constraint Modeled with Dummy Bubbles and Topology Limits
- Modeling Concept 4: Gas Constraint Modeled with Negative Emergency Operating Procedure (EOP) Step

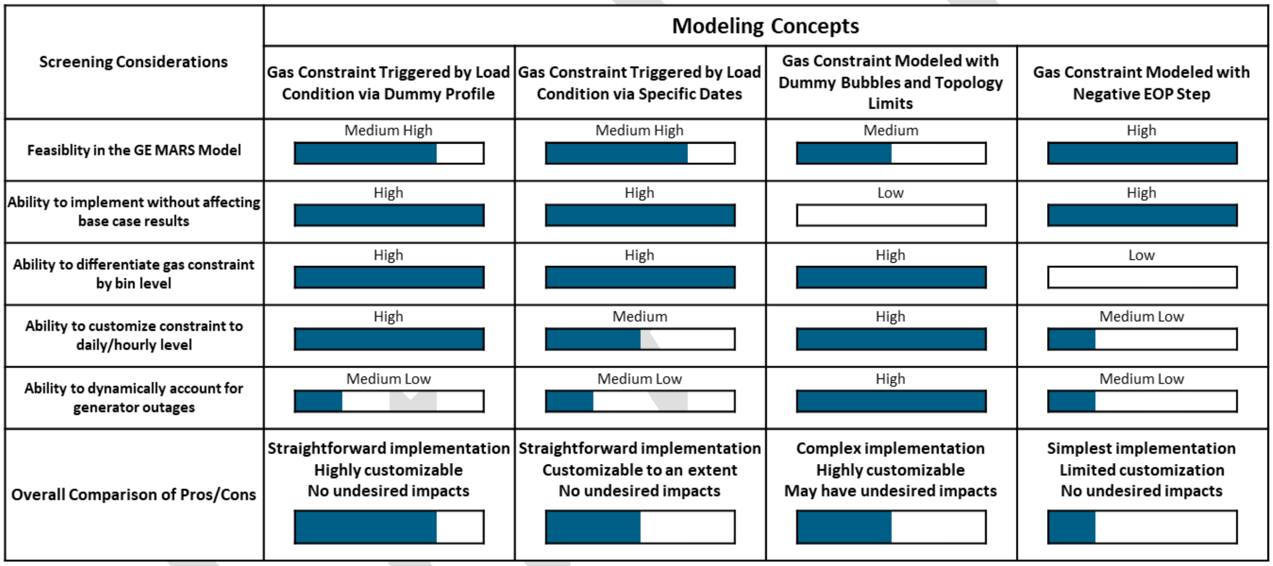
Screening of the four modeling concepts was conducted to identify a preferred option for further modeling development. The screening considerations utilized were:

- Feasibility to implement the modeling concept in GE MARS
- Ability to implement without affecting base case results
- Ability to differentiate fuel constraint magnitudes by bin level
- Ability to customize the constraint to the daily/hourly level
- Ability to dynamically account for generator outages

Ultimately, the four concepts were graded from “low” to “high” for each of the above-identified screening considerations. A “low” grade means that the modeling concept was unable to meet that screening consideration whereas a “high” grade means that the modeling concept was fully able to meet that screening consideration. There were also three categories in between “low” and “high”: “medium low”, “medium”, and “medium high.” These categories showed varying levels of being able to meet the screening consideration.

The chart below identifies the results of the initial screening of the four modeling concepts evaluated.

Figure 3 – Modeling Concepts Screening



Screening Considerations	**Modeling Concepts**			
	Gas Constraint Triggered by Load Condition via Dummy Profile	**Gas Constraint Triggered by Load Condition via Specific Dates**	**Gas Constraint Modeled with Dummy Bubbles and Topology Limits**	**Gas Constraint Modeled with Negative EOP Step**
Feasiblity in the GE MARS Model	Medium High	Medium High	Medium	High
Ability to implement without affecting base case results	High	High	Low	High
Ability to differentiate gas constraint by bin level	High	High	High	Low
Ability to customize constraint to daily/hourly level	High	Medium	High	Medium Low
Ability to dynamically account for generator outages	Medium Low	Medium Low	High	Medium Low
Overall Comparison of Pros/Cons	**Straightforward implementation** **Highly customizable** **No undesired impacts**	**Straightforward implementation** **Customizable to an extent** **No undesired impacts**	**Complex implementation** **Highly customizable** **May have undesired impacts**	**Simplest implementation** **Limited customization** **No undesired impacts**

Based on the results of the initial screening, “Modeling Concept 1” (i.e., triggering the assumed fuel constraints by load condition via dummy profile) was identified as the preferred approach. This modeling concept is feasible in the current GE MARS model, does not adversely impact prior base case results, is customizable by bin/load level, and is customizable down to the hourly level. The only screening criteria that this modeling concept did not have a medium high or high grade on was its ability to dynamically account for generator forced outages as modeled in MARS. Notably, this limitation applies to all “unavailability” based modeling approaches. The NYISO anticipates that potential future enhancements can continue to be evaluated to possibly improve the dynamic capability of this modeling approach.

Modeling Inputs and Implementation

To properly reflect anticipated fuel constraints at different winter load levels, changes to the IRM database were required. These changes include adding dummy generators to the model which act to trigger the identified derates (i.e., the modeled fuel constraints) and then adding the winter load conditions triggers and amounts of the actual derates for each of the impacted generators.

A dummy generator is added to the model in a dummy zone in each of the top four LFU bins, which are impacted by the constraint based on the corresponding winter load levels. These load levels can be reassessed in the future as the system conditions evolve, and changes to the model implementation can be made accordingly. The use of dummy zones prevents impacts to base case results. One dummy generator is needed per load bin because the load shapes vary by bin. The hourly production profiles for these dummy generators are then developed on a bin-by-bin basis. The daily peak hour in each bin for the winter months is utilized to categorize each day into the different NYCA load condition tiers (i.e., Tiers 1-6 as identified in Table 4). Based upon the applicable tier for each winter day, the hourly production profile is assigned a specific value that will trigger the fuel constraint-related derate that accompanies that tier for each impacted generator.

The derates are applied in the model on a unit-by-unit basis based on the hourly production profile of the dummy generator for each load bin. The percentage derates for each unit are calculated based on the assumed level of available fuel and are applied as follows for the initial modeling implementation:

- The assumed quantity of "available oil" is distributed across the dual fuel units located in Load Zones F-K
- The assumed quantity of "available gas" is distributed across the gas-only units located in Load Zones F-K and any remaining capacity of the dual fuel units located in Load Zones F-K (i.e., the capacity of affected dual fuel units that remains unserved after the allocation of "available oil" to such units).

Percentage Derate Calculation Considerations

To implement Modeling Concept 1, additional work was necessary to convert the fuel constraint modeling assumptions into derate percentages to be applied to affected generators located in Load Zones F-K.

Two methodologies for calculating the derate percentage were considered:

- "ICAP Method": Calculating the fuel constraint-related derate based on modeled capacity values of affected units
- "UCAP Method": Calculating the fuel constraint-related derate based on unforced capacity (UCAP) values (modeled capacity factoring in the impact of EFORd) of affected units

The example below illustrates the application of the two options based on the Tier 1 assumed fuel constraint values identified in Table 4. This illustrative example applies the options using an estimate of the potential level of expected capacity from affected units in Load Zones F-K. The capacity values used in the illustrative example are intended to be representative of the capacity available in an "average" GE MARS iteration. In actuality, the derate would vary based on the different simulated forced outages in each GE MARS iteration. The modeled winter capacity and EFORd values used for this illustrative comparison are based on the dual fuel and gas-only generators located in Load Zones F-K as modeled in the 2024-2025 IRM study.

Table 7 – Illustrative Capacity Derate Calculation Methodology Comparison

Derate Methodology	Modeled Winter Capacity (MW)	EFORd	Modeled Winter UCAP (MW)	Total Available Fuel (MW) (Gas + Oil)	Derate (%)	Derated Capacity (MW)
ICAP Method	21,769	8.2%	19,979	11,375	1 – (11,375/21,769) = 48%	10,440
UCAP Method					1 – (11,375/19,979) = 43%	11,375

The "UCAP Method" is recommended to calculate the fuel constraint-related derates to apply in the IRM model. This method should better align the amount of capacity on average in each GE MARS iteration with the amount of capacity intended with modeled fuel-related constraints applicable to each winter load tier.

Modeling Concepts Overview

Modeling Concept 1: Gas Constraint Triggered by Load Condition via Dummy Profile

Modeling Concept 1 would use a dummy intermittent resource added to the GE MARS model with hourly production profiles. The dummy resource would be added to a dummy zone to avoid impacting the base case results. The hourly production profiles are used to derate the affected generators to remove the specified amount of capacity associated with the applicable fuel constraint-related derate. When the hourly production profile is above certain specified load level condition thresholds, the impacted generators would have their capacity derated by a specified percentage to account for the applicable fuel constraint-related derate.

Figure 4 – Modeling Concept 1 Pros and Cons

Pros	Cons
• No GE MARS development needed • Straightforward modeling implementation • No impact to base case results • Able to have different fuel constraint magnitudes at different load bins • Able to customize constraint down to the daily or hourly level	• Unable to dynamically account for generator outages

Modeling Concept 2: Gas Constraint Triggered by Load Condition via Specific Dates

Modeling Concept 2 would rely on the addition of date-related conditions to the GE MARS model. These date conditions would trigger fuel constraint-related derates on the capacity of the impacted generators. If the date fell into a specified range, set based on the load level conditions, the capacity of the affected generators would be derated by a specified percentage to account for the applicable fuel constraint-related derate.

Figure 5 – Modeling Concept 2 Pros and Cons

Pros	Cons
• No GE MARS development needed • Straightforward modeling implementation • No impact to base case results • Able to have different fuel constraint magnitudes at different load bins • Able to customize constraint down to the daily level	• Unable to customize constraint down to the hourly level • Unable to dynamically account for generator outages

Modeling Concept 3: Gas Constraint Modeled with Dummy Bubbles and Topology Limits

Modeling Concept 3 would add dummy bubbles connected to existing zones in the GE MARS model (e.g., zone G is connected to zone G_Dummy). All impacted generators would be moved in the model from the original zone to the dummy bubble. Interface limits would then be applied during specified periods of time, set based on the load level conditions, to limit the amount of capacity that could flow from the dummy bubble to the original zone. This would essentially reduce the amount of capacity that the impacted generators could provide to the system to account for the applicable fuel constraint-related derate. Modeling Concept 3 is the only availability-based method that was considered in testing.

Figure 6 – Modeling Concept 3 Pros and Cons

Pros	Cons
• No GE MARS development needed • Able to have different fuel constraint magnitudes at different load bins • Able to customize constraint down to the daily or hourly level • Able to dynamically account for generator outages	• Complex modeling implementation • May impact base case results (undesired impacts have been identified in initial testing when moving large numbers of generators to dummy bubbles)

Modeling Concept 4: Gas Constraint Modeled with Negative EOP Step

Modeling Concept 4 would add a negative emergency operating procedure (EOP) step to the GE MARS model. This would effectively remove generation from the system to account for the applicable fuel constraint-related derate. This is the simplest, but least customizable, of the four modeling concepts considered.

Figure 7 – Modeling Concept 4 Pros and Cons

Pros	Cons
• No GE MARS development needed • Simplest modeling implementation • No impact to base case results	• Unable to have different fuel constraint magnitudes at different load bins • Unable to customize down to the daily or hourly level • Unable to dynamically account for generator outages

Previous Presentations

- 2/1/2023 ICS: Gas Constraints Whitepaper: Scope
    - https://www.nysrc.org/wp-content/uploads/2023/05/Gas-Constraints-Whitepaper_Scope_2023.02.01_revised13443.pdf
- 5/30/2023 ICS: Gas Constraints Whitepaper Update
    - https://www.nysrc.org/wp-content/uploads/2023/07/11_ICS_GasConstraintsWhitepaperUpdate_2023.05.30_v415826.pdf
- 8/29/2023 ICS: Winter Constraints Sensitivities – 2024 - 25 IRM
    - https://www.nysrc.org/wp-content/uploads/2023/08/WinterConstraintsSensitivities_2023.08.2921424.pdf
- 10/4/2023 ICS: Gas Constraints Whitepaper Update
    - https://www.nysrc.org/wp-content/uploads/2023/10/IRM24_GasConstraintsWhitepaperUpdate_2023.10.0422503.pdf
- 11/1/2023 ICS: Gas Constraints Whitepaper Update
    - https://www.nysrc.org/wp-content/uploads/2023/10/GAS-Constraint-Whitepaper-Update-ICS-110122936.pdf
- 11/28/2023 ICS: Gas Constraints Whitepaper Update
    - https://www.nysrc.org/wp-content/uploads/2023/11/Gas-Constraints-Modeling-11282023-ICS23376.pdf
- 1/3/2024 ICS: Gas Constraints Whitepaper Update
    - https://www.nysrc.org/wp-content/uploads/2023/12/Gas-Constraints-Whitepaper-Update-01032024-ICS25831.pdf
- 1/30/2024 ICS: Gas Constraints Whitepaper Update
    - https://www.nysrc.org/wp-content/uploads/2024/02/Gas-Constraints-Whitepaper-Update-01302024-ICS-REVISED27279.pdf
- 4/3/2024 ICS: Gas Constraints Whitepaper Update
    - https://www.nysrc.org/wp-content/uploads/2024/03/Gas-Constraints-Whitepaper-Update-04032024-ICS30723.pdf
- 5/1/2024 ICS: Gas Constraints Whitepaper Update
    - https://www.nysrc.org/wp-content/uploads/2024/04/Gas-Constraints-Whitepaper-Update-05012024-ICS30916.pdf
- 5/10/2024 EC: Gas Constraints Whitepaper Update

- https://www.nysrc.org/wp-content/uploads/2024/05/4.1.3-Gas-Constraints-Whitepaper-Update-05102024-EC-Attachment-4.1.3.pdf