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Attachment #1.5
Return to Agenda

Fuel and Energy Security Study Results and Observations

NYISO ICAPWG/MIWG/PRLWG

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Analysis Group

September 26, 2023

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Reminder: Context, Assignment, and Terminology

- Purpose: Assess winter fuel/energy security for NYISO over 17-day cold weather period under intentionally challenging conditions that stress the resilience of the system
  - Studying winters 2023/2024 (period also studied in the 2019 report), 2026/2027, and 2030/2031
  - Analyzing and identifying circumstances under which resources may be insufficient to meet load plus reserves absent emergency actions
- Framing: The analysis is not trying to predict the future, but rather to analytically assess the implications of adverse weather conditions and the evolving landscape of electricity demand/supply for winter power system operations
- Since the 2019 study, adverse winter storm conditions have challenged the power grid elsewhere, warranting additional study, review, and planning by FERC, NERC, and neighboring regions
  - Specifically, the January 2018 Cold Weather Event, January 2021 Winter Storm Uri, and December 2022 Winter Storm Elliott
- Modeled "cases" are constructed to include a "scenario" and a "disruption," varying expectations about potential conditions and events during the modeled cold weather conditions:
  - Scenarios: consist of potential combinations of future system configurations
    - Varying energy import levels from neighboring regions
    - Varying oil storage levels at the start of the modeling period
    - Varying timing of renewable generation buildout
  - Disruptions: consist of events that do not represent permanent system conditions
    - Loss or higher level of outages of generation assets
    - Disruptions to oil supply
    - Disruptions to gas supply

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Summary of Scenarios, All Winters

	Imports	Oil	Infrastructure
Scenario Description	**IM All**: 1,200 MW capacity imports / minimum 300 MW capacity exports **IM Net0**: 300 MW capacity imports / minimum 300 MW capacity exports	**HFS**: Higher starting oil tank levels, 50% increase in starting storage levels	**REN**: Delayed construction of renewables as follows: *Winter 2026/2027:* 33% decrease of utility-scale solar and land-based wind capacity from 2021-2040 Outlook “Contract Case” additions *Winter 2030/2031:* 20% decrease of utility-scale solar, land-based wind, and offshore wind capacity from 2021-2040 Outlook “Policy Case 1” additions
Scenario 1	IM All		
Scenario 2	IM Net0		
Scenario 3	IM All	HFS	
Scenario 4	IM Net0	HFS	
Scenario 5	IM All		REN
Scenario 6	IM Net0		REN
Scenario 7	IM All	HFS	REN
Scenario 8	IM Net0	HFS	REN

- Note: For the upcoming winter 2023/2024 period, only scenarios one through four are applicable.

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Summary of Disruptions, All Winters

Disruption Name	Description
1. Starting Conditions	No physical disruptions
2. High Outage	Double unit forced outage rate compared to historical averages
3. SENY Deactivation	Loss of significant capability (1,000 MW) in SENY (specifically, zones G-I)
4. Nuclear Station Outage	Loss of major nuclear facility upstate (i.e., Nine Mile Point 1 and 2)
5. No Truck Refill	Unavailability of truck oil fuel delivery based on historical events such as snow storms
6. No Barge Refill	Unavailability of barge oil fuel delivery based on historical events such as NYC rivers freezing
7. No Refill	Unavailability of any oil fuel delivery due to severe fuel limitations affecting both barge and truck refueling
8. Non-Firm Gas Unavailable F-K	No non-firm gas-fired generation capability available in zones F-K
9. Non-Firm Gas Unavailable NYCA	No non-firm gas-fired generation capability available anywhere in NYCA
10. Non-Firm Gas Unavailable 4 days	No non-firm gas-fired generation capability available anywhere in NYCA over the cold snap weekend, model days 6-9
11. Combination Disruption	50% gas available NYCA-wide + 50% increased lead time for oil refill + High Outage Disruption 2

- Disruptions apply to all three modeled winters
- Disruptions 1-9 are the same as the 2019 study
- Disruptions 10-11 are new/revised for 2023 study
- A "*case*" represents a combination of a scenario and a disruption

Reminder: Output Metrics

- Two types of NYISO actions are modelled if otherwise applicable reserve requirements would otherwise be violated:
  - Reduction of energy-only exports to ISO-NE (up to 1,300 MW reduction)
  - Activation of Special Case Resources/Emergency Demand Response Program (SCR/EDRP)

- Cases are analyzed based on number of:
  - Hours with required emergency actions (i.e., reduction of energy-only exports to ISO-NE and/or SCR/EDRP activations)
  - Hours with reserve violations after emergency actions
  - Hours with potential for loss of load

- And severity:
  - Magnitude of any identified reserve violations and/or potential loss of load
  - Duration and frequency of any identified reserve violations and/or potential loss of load

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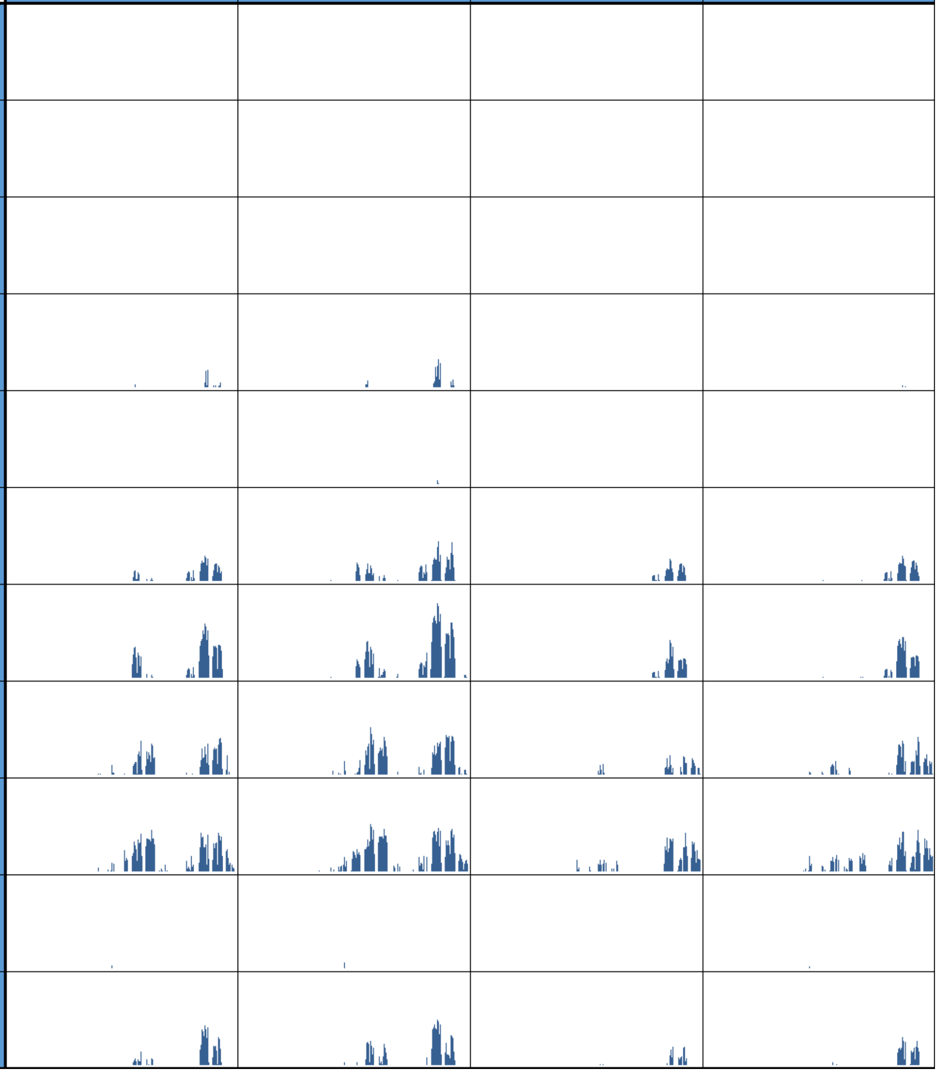
Winter 2023/2024 Cross-Case Comparison: Hourly Potential Loss of Load (MW) by Case

Disruptions	Winter 2023/2024 Scenarios: Scenario 1: Initial Conditions + IM All	Scenario 2: Initial Conditions + IM Net0	Scenario 3: Initial Conditions + IM All + HFS	Scenario 4: Initial Conditions + IM Net 0 + HFS
1. No Disruptions (Starting Conditions)				
2. High Outage				
3. SENY Deactivation				
4. Nuclear Station Outage				
5. No Truck Refill				
6. No Barge Refill				
7. No Refill				
8. Non-Firm Gas Unavailable (F-K)				
9. Non-Firm Gas Unavailable (NYCA)				
10. Non-Firm Gas Unavailable (4 days)				
11. Combination Disruption				



Note: The scale of the axes are equal in all cells. The y-axis is set to have a maximum of 10,000 MW

Scenario Key:

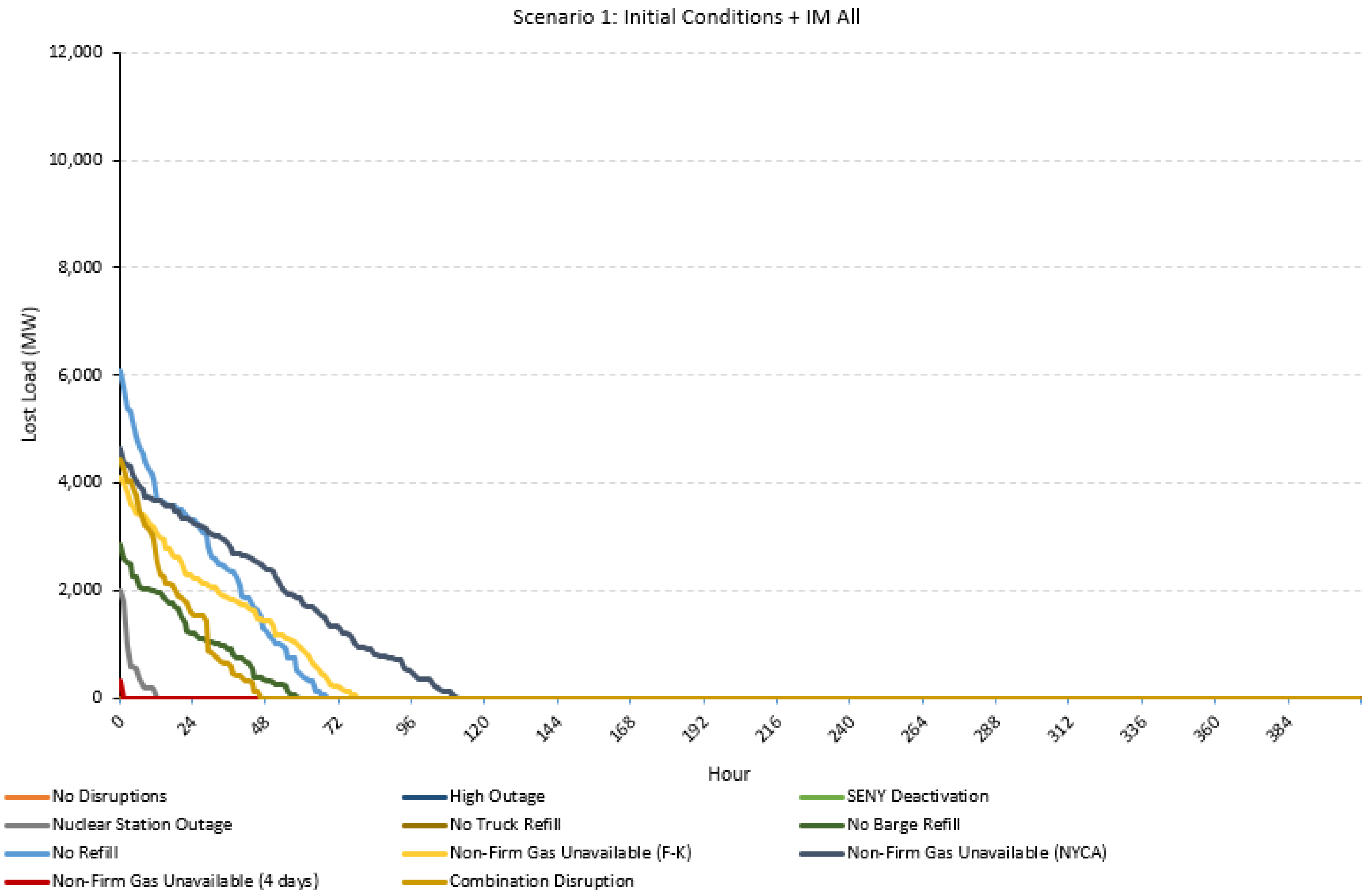
IM All = 1,200 MW capacity imports / minimum 300 MW capacity exports

IM Net0 = 300 MW capacity imports / minimum 300 MW capacity exports

HFS = Higher starting oil tank levels, 50% increase in starting storage levels

Combination Disruption = 50% gas available NYCA-wide + 50% increased lead time for oil refill + High Outage (Disruption 2)

Winter 2023/2024 – Scenario 1 Loss of Load Duration Curve, All Disruptions



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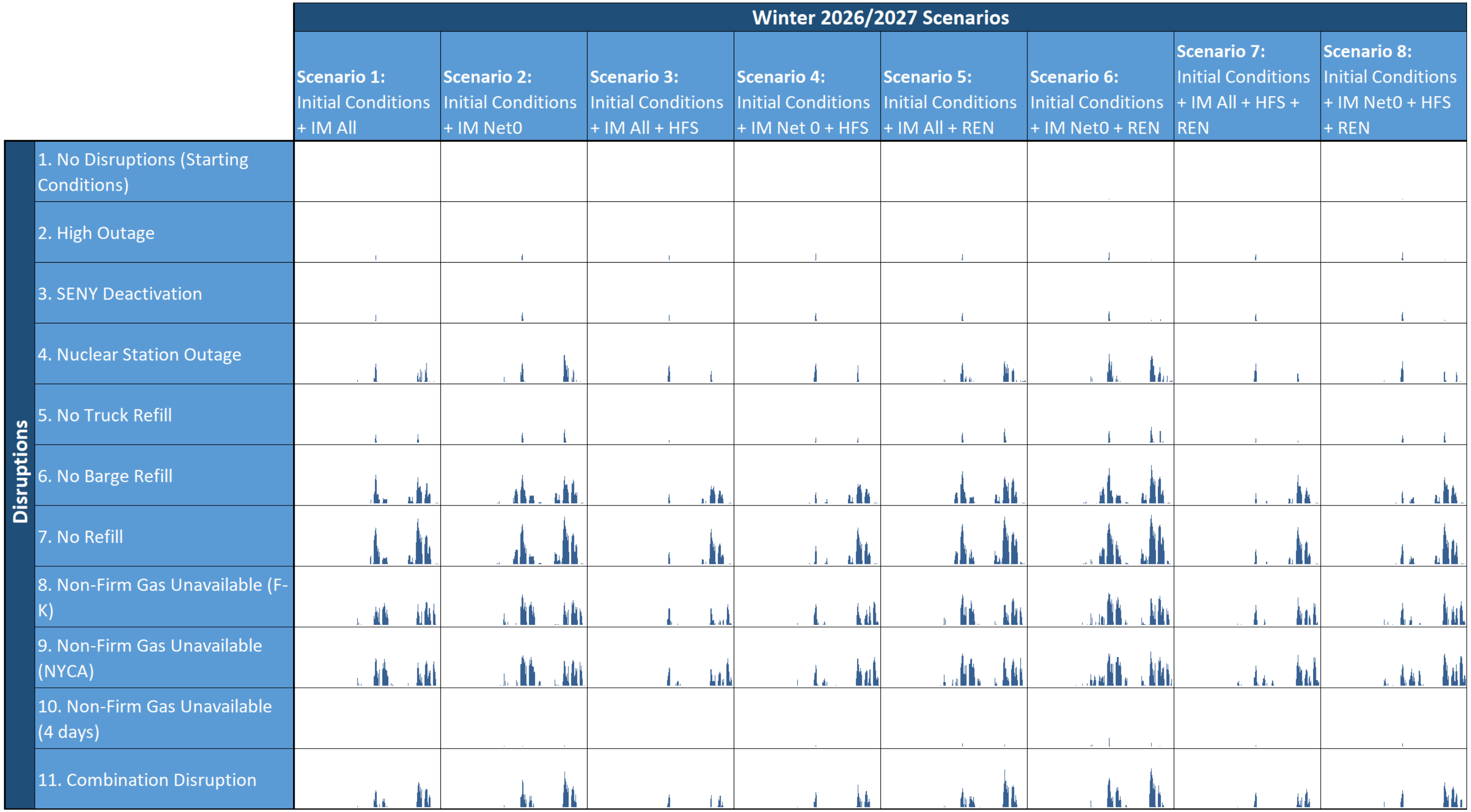
Winter 2026/2027 Cross-Case Comparison: Hourly Potential Loss of Load (MW) by Case



Note: The scale of the axes are equal in all cells. The y-axis is set to have a maximum of 10,000 MW

Scenario Key:

IM All = 1,200 MW capacity imports / minimum 300 MW capacity exports

IM Net0 = 300 MW capacity imports / minimum 300 MW capacity exports

HFS = Higher starting oil tank levels, 50% increase in starting storage levels

REN = 33% decrease of utility-scale solar and land-based wind capacity 2021-2040 Outlook Contract Case Additions

Combination Disruption = 50% gas available NYCA-wide + 50% increased lead time for oil refill + High Outage (Disruption 2)

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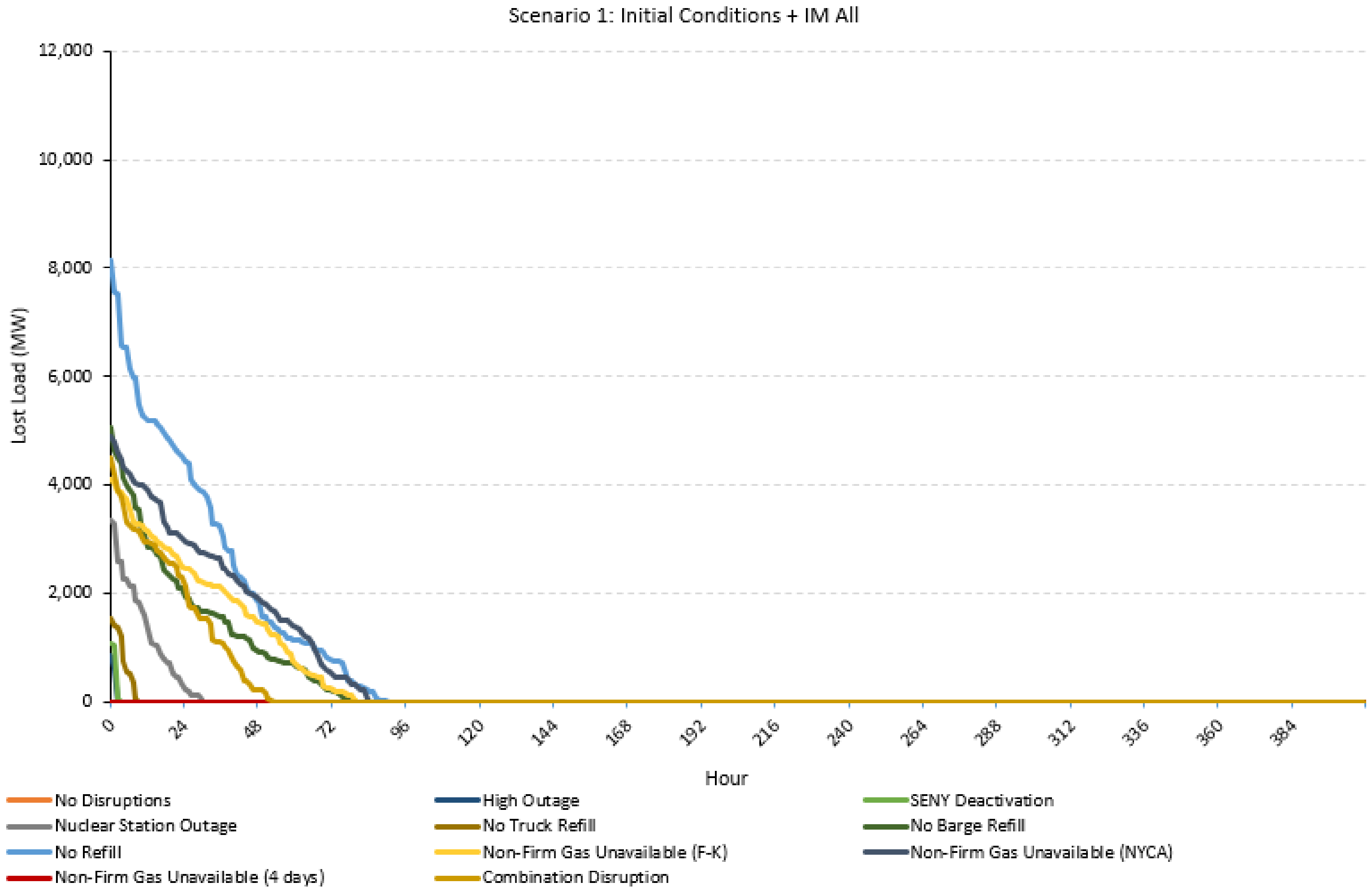
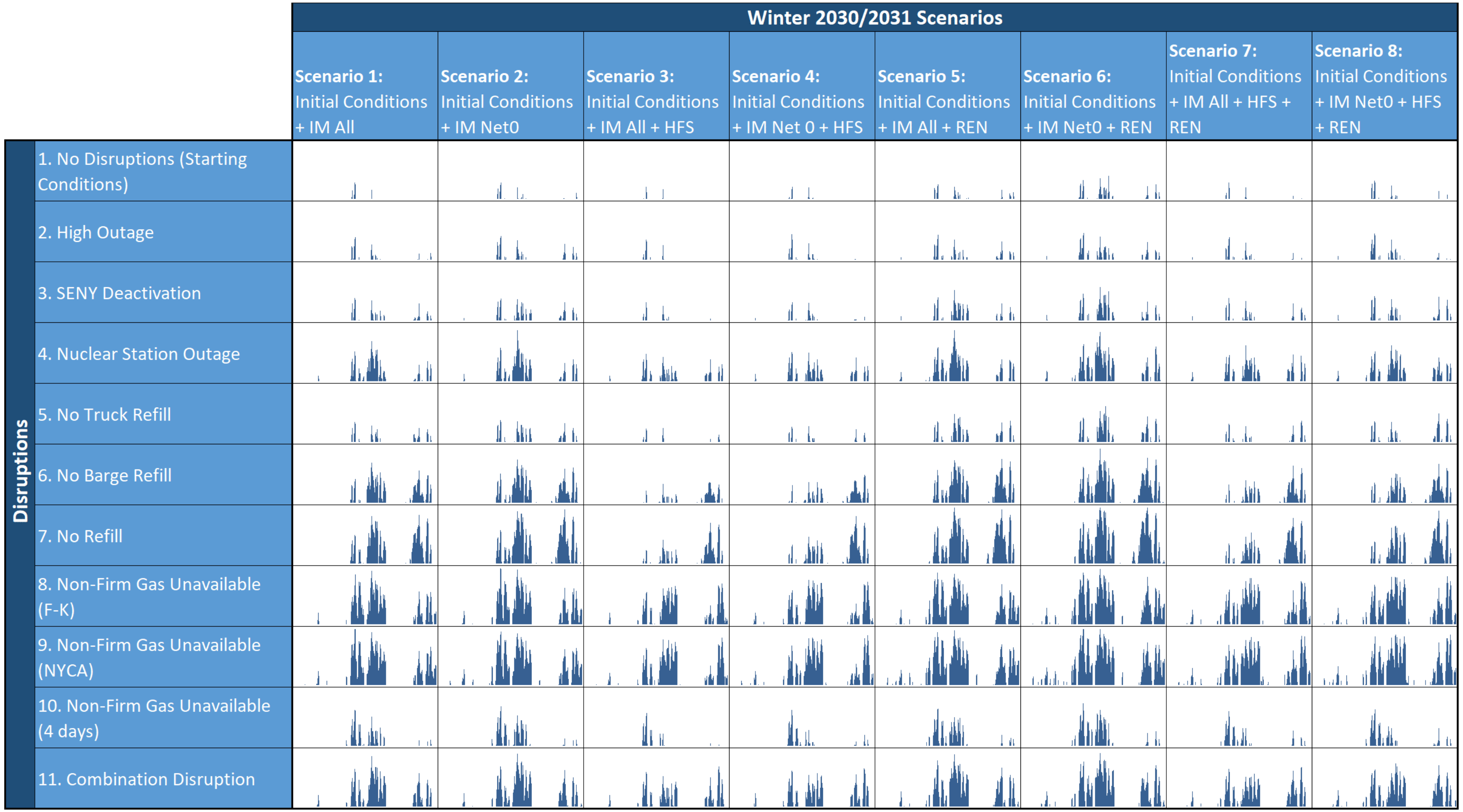
Winter 2026/2027 – Scenario 1 Loss of Load Duration Curve, All Disruptions



Winter 2030/2031 – Cross-Case Comparison: Hourly Potential Loss of Load (MW) by Case



Scenario Key:

IM All = 1,200 MW capacity imports / minimum 300 MW capacity exports

IM Net0 = 300 MW capacity imports / minimum 300 MW capacity exports

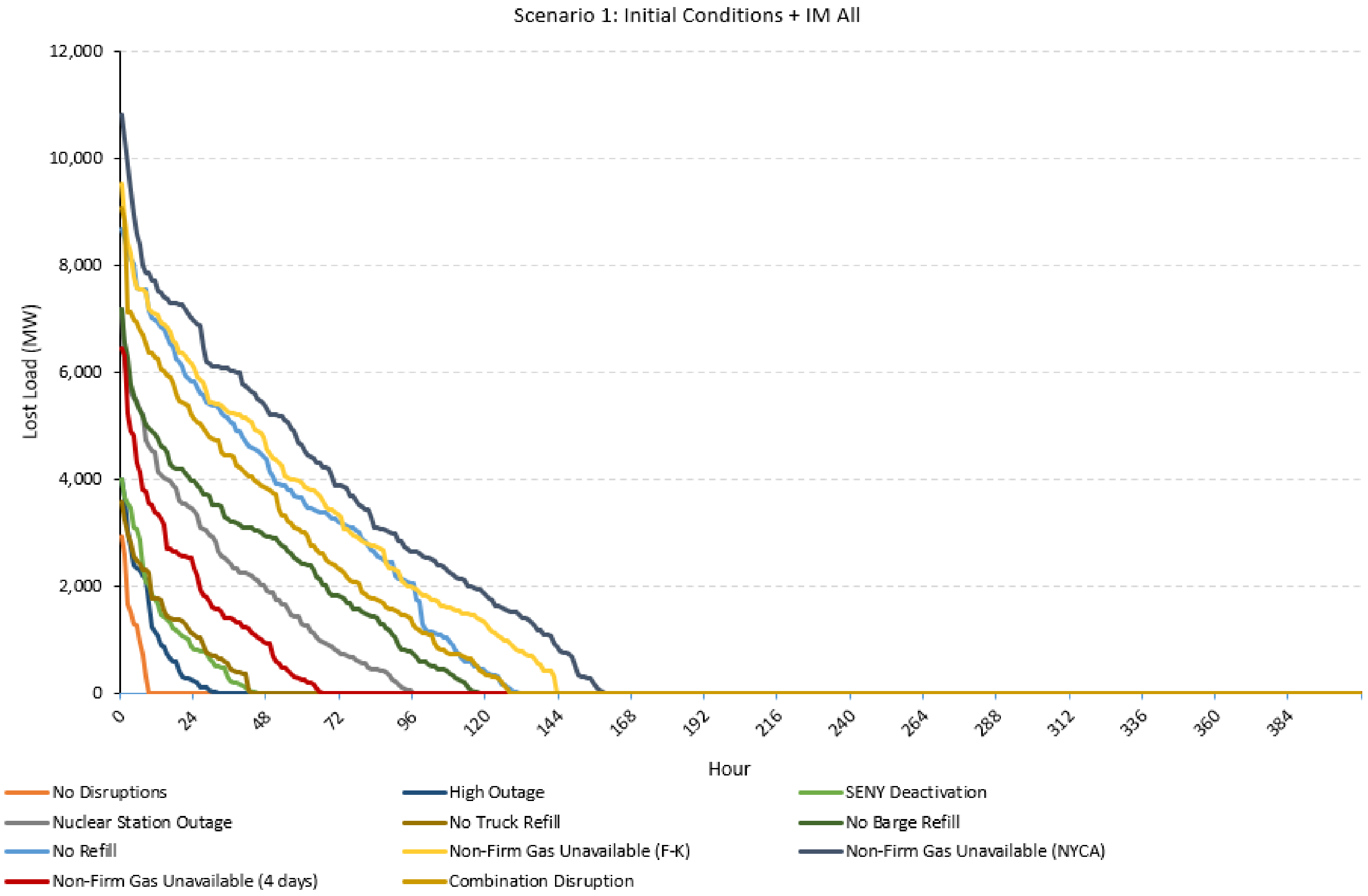
HFS = Higher starting oil tank levels, 50% increase in starting storage levels

REN = 20% decrease of utility-scale solar, land-based wind, and offshore wind capacity 2021-2040 Outlook Policy Case 1 Additions

Combination Disruption = 50% gas available NYCA-wide + 50% increased lead time for oil refill + High Outage (Disruption 2)

Notes: [1] The scale of the axes are equal in all cells. The y-axis is set to have a maximum of 10,000 MW.
[2] In the winter 2030/2031 only, there are instances where potential loss of load exceeds 10,000 MW in a given hour. The following five cases exhibit potential maximum hourly loss of load that exceeds 10,000 MW, falling between 10,000 MW to 11,500 MW: Scenario 1 – PD 9, Scenario 2 – PD 8, Scenario 5 – PD 7, Scenario 6 – PD 7, Scenario 6 – PD 9.

Winter 2030/2031 – Scenario 1 Loss of Load Duration Curve, All Disruptions



Qualitative Risk Assessment of Cases

- Occurs in three steps:
  1. *Characterize cases by probability of occurrence*
     - Relative to circumstances and contingency combinations similar to those evaluated in system operational assessments
  2. *Characterize cases by severity of potential loss of load*
     - Relative to potential loss of load events that may be avoided by existing system response options
  3. *Combine #1 and #2 to reduce to cases for further review that may be characterized as:*
     - Having a probability similar to conditions that may be evaluated in system operational assessments
     - Have potential loss of load outcomes that would be significant enough to warrant consideration of additional mitigating actions
- Purpose: to qualitatively assess which cases represent higher level of risk combining likelihood and impact; facilitate the identification of cases that may warrant additional review to determine whether further mitigating action is necessary

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Qualitative Assessment and Categorization of Results, For Winter 2023/2024

Step 1: Probability of Occurrence

<u>**Scenario Key:**</u>

IM All = 1,200 MW capacity imports / minimum 300 MW capacity exports

IM Net0 = 300 MW capacity imports / minimum 300 MW capacity exports

HFS = Higher starting oil tank levels, 50% increase in starting storage levels

REN = 20% decrease of utility-scale solar, land-based wind, and offshore wind capacity 2021-2040 Outlook Policy Case 1 Additions

Combination Disruption = 50% gas available NYCA-wide + 50% increased lead time for oil refill + High Outage (Disruption 2)

	Winter 2023/2024 Scenarios			
Disruptions	**Scenario 1:** Initial Conditions + IM All	**Scenario 2:** Initial Conditions + IM Net0	**Scenario 3:** Initial Conditions + IM All + HFS	**Scenario 4:** Initial Conditions + IM Net 0 + HFS
1. No Disruptions (Starting Conditions)	Red	Red	Red	Red
2. High Outage	Red	Red	Red	Red
3. SENY Deactivation	Red	Red	Red	Red
4. Nuclear Station Outage	Yellow	Yellow	Yellow	Yellow
5. No Truck Refill	Red	Yellow	Red	Yellow
6. No Barge Refill	Red	Yellow	Red	Yellow
7. No Refill	Yellow	White	Yellow	White
8. Non-Firm Gas Unavailable (F-K)	Red	White	Red	White
9. Non-Firm Gas Unavailable (NYCA)	Yellow	White	Yellow	White
10. Non-Firm Gas Unavailable (4 days)	Red	Red	Red	Red
11. Combination Disruption	Yellow	White	Yellow	White

<u>**Consequence: Assessed based on magnitude, duration, and frequency of loss of load, grouped as follows:**</u>

- [White] Highly unlikely to occur - probability far outside typical conditions used in system operational assessments
- [Yellow] Probability *meaningfully less likely than* tpyical conditions used in system operational assessments
- [Red] Probability on the order of typical conditions used in system operation assesments

Note: The scale of the axes are equal in all cells. The y-axis is set to have a maximum of 10,000 MW

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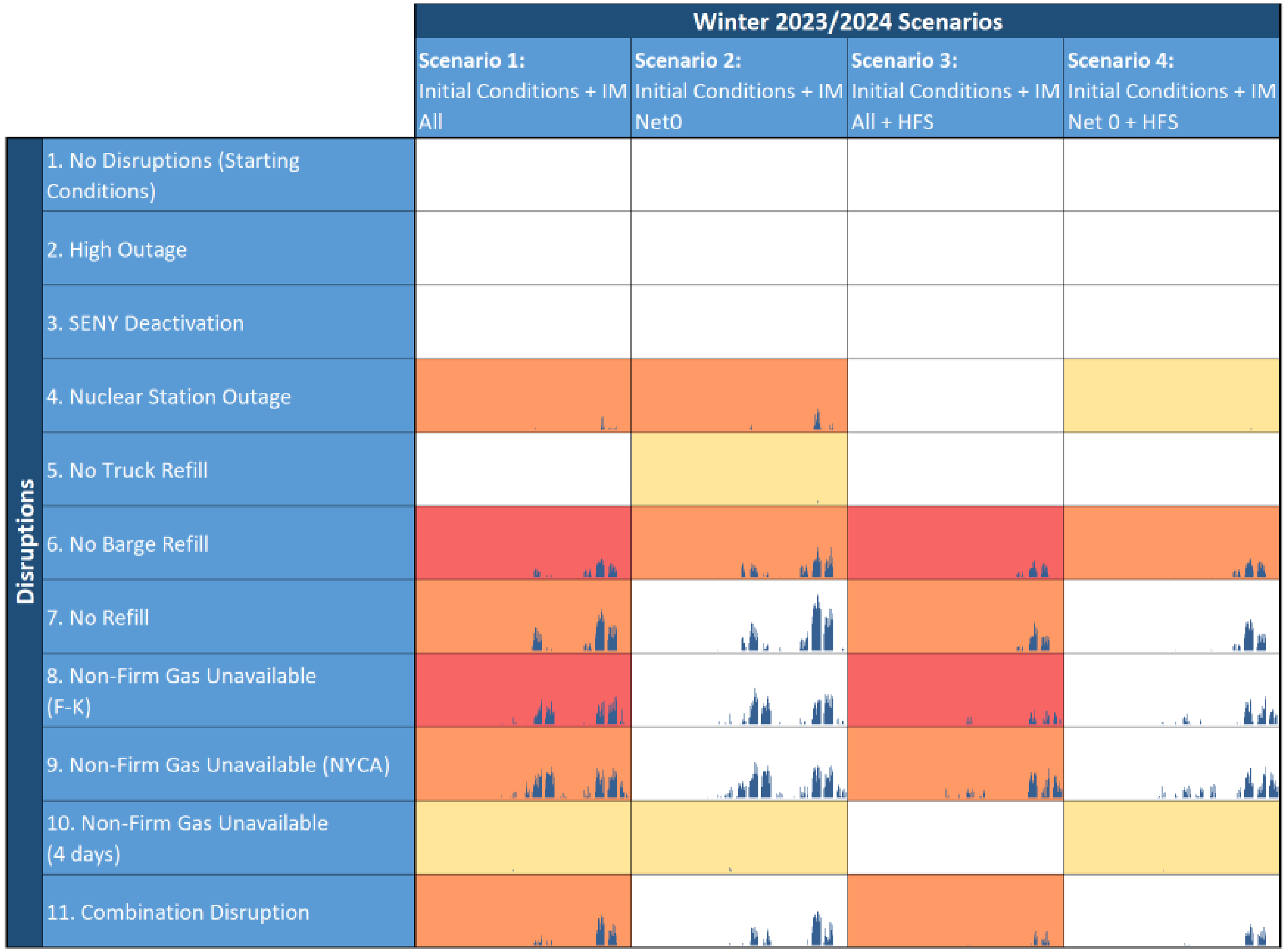
Qualitative Assessment and Categorization of Results, For Winter 2023/2024

Step 3: Combined Assessment and Development of Cases of Interest



Scenario Key:

IM All = 1,200 MW capacity imports / minimum 300 MW capacity exports

IM Net0 = 300 MW capacity imports / minimum 300 MW capacity exports

HFS = Higher starting oil tank levels, 50% increase in starting storage levels

REN = 20% decrease of utility-scale solar, land-based wind, and offshore wind capacity 2021-2040 Outlook Policy Case 1 Additions

Combination Disruption = 50% gas available NYCA-wide + 50% increased lead time for oil refill + High Outage (Disruption 2)

- Consequence 0-100 MW or probability extremely low (far outside normal operational assessments)
- Consequence 100 - 1,500 MW, of moderate duration/frequency, and probability low or on the order of normal operational assessments
- Consequence greater than 1,500 MW, and probability low (meaningfully less likely than normal operational assessments)
- Consequence greater than 1,500 MW, and probability on the order of normal operational assessments

Note: The scale of the axes are equal in all cells. The y-axis is set to have a maximum of 10,000 MW

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Qualitative Assessment and Categorization of Results, For Winter 2026/2027

Step 3: Combined Assessment and Development of Cases of Interest

Scenario Key:

IM All = 1,200 MW capacity imports / minimum 300 MW capacity exports

IM Net0 = 300 MW capacity imports / minimum 300 MW capacity exports

HFS = Higher starting oil tank levels, 50% increase in starting storage levels

REN = 20% decrease of utility-scale solar, land-based wind, and offshore wind capacity 2021-2040 Outlook Policy Case 1 Additions

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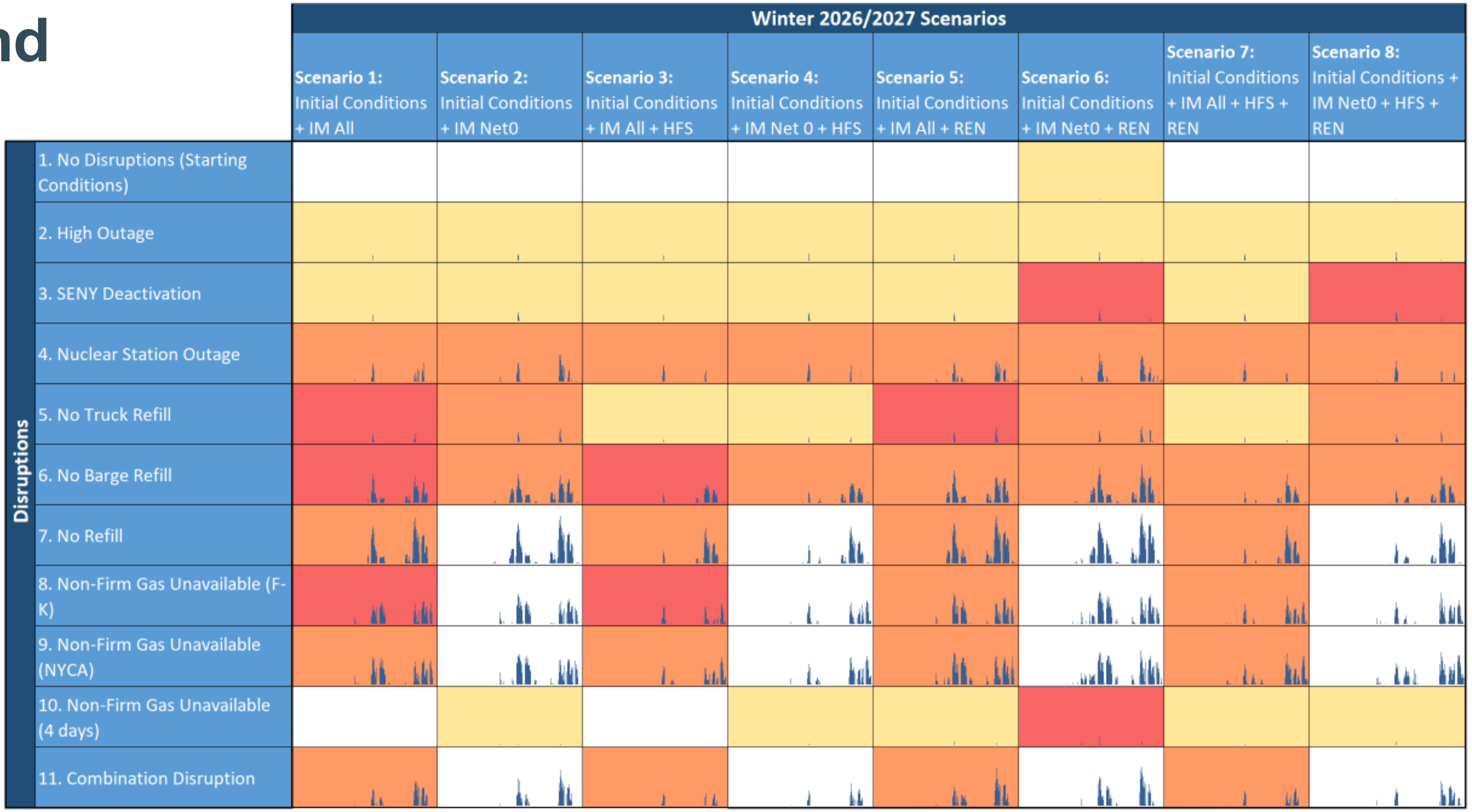

- Consequence 0-100 MW or probability extremely low (far outside normal operational assessments)
- Consequence 100 - 1,500 MW, of moderate duration/frequency, and probability low or on the order of normal operational assessments
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- Consequence greater than 1,500 MW, and probability on the order of normal operational assessments

Note: The scale of the axes are equal in all cells. The y-axis is set to have a maximum of 10,000 MW

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Review Summary of Key Results by Winter Modeled

- Winter 2023/2024
  - “No Disruptions” (Starting Conditions) cases in all scenarios show reductions of assumed ISO-NE exports
- Winter 2026/2027
  - Observe an increase in potential loss of load events compared to Winter 2023/2024, including minor potential loss of load events in two “No Disruptions” (Starting Conditions) cases
- Winter 2030/2031
  - Potential loss of load events observed in all cases, including "No Disruptions" (Starting Conditions)
  - Potential loss of load events primarily driven by projected increased electricity demand, limited energy transfers from upstate to NYC, greater reliance on non-firm generation (gas only w/o firm transportation contracts, intermittent renewable resources), and limited excess renewable supply to charge batteries
- Themes applicable in all winters:
  - Reduced energy available from non-firm generation (gas only w/o firm transportation contracts) during cold weather/greater firm gas demand stresses utilization of resources with limited stored fuel/energy (dual fuel and oil only).
  - Scenarios with net positive energy imports (Scenarios 1, 3, 5 and 7) help decrease the severity of potential loss of load events
  - Higher starting oil inventory helps alleviate emergency actions and potential loss of load events relative to scenarios with historical starting oil inventory
  - The addition of offshore wind production in NYC and Long Island provides reliability support, however, wind lulls become a critical winter reliability consideration as the resource mix evolves

Observations

- **The modeling results show the potential for operational challenges and loss of load events across all three winters studied**
- **In comparison with the 2019 study, the results show that the NYISO power system has grown more sensitive to fuel disruptions in recent years**
  - The following updated model inputs drive the differences in potential for system reliability risk:

    (1) estimated gas available for electricity generation is reduced based on updated data and information from New York's LDCs

    (2) fewer renewable and other clean energy resources have come online relative to the projections in 2019

    (3) peaker retirements proceeded at the fastest pace assumed in the 2019 study, and are included in all modelling scenarios

    (4) certain generators have reported increased oil refill lead times in the NYISO fuel surveys, as well as observing lower starting inventory for certain generators compared to observation at the time of the 2019 study

    (5) energy imports from ISO-NE to Long Island are assumed in all cases
- **Significant potential for loss of load events appear in cases involving reduced operation of both gas and oil-fired generating assets**
  - The availability of oil and gas generation resources is critical to alleviate potential loss of load events
  - Higher starting oil tank inventory levels help alleviate operational challenges and potential loss of load events
    - Particularly for generators refilled by barge units, starting the modelling period with a 50% higher starting fuel storage assumption means the tanks at those units are either full or almost full
  - Significant interruptions in the availability of natural gas for power generation can introduce challenges for reliable operations, both NYCA-wide, or only in load zones F-K.
    - Gas disruption for a shorter 4-day period has a lower impact than gas disruptions applied over the entire 17-day modelling period

Observations, cont.

- **Dual fuel capability – with oil as a backup fuel to natural gas – is vital for maintaining reliability during the ongoing system transition**
- **A number of circumstances leading to potential loss of load events are observed for New York City**
  - Cases with potential loss of load greater than 1,500 MW with a probability of occurrence similar to operational assessments are observed in New York City
  - The load zone's vulnerability is driven by reliance on oil-fired generation, energy transfers from upstate (in hours when excess energy is not available for transfer downstate, or the transmission limit binds), and growing reliance on offshore wind that can face periods of wind lulls
- **The state's renewable and clean energy resources can provide valuable reliability support**
  - Injections of offshore wind help preserve oil inventory drawdown for longer in the modelling period
  - Additional energy storage capacity in targeted locations can alleviate the magnitude and duration of potential loss of load events
- **Over the longer term, the projected magnitude and pace of change to system supply and demand stemming from requirements under the CLCPA grows in importance**
  - Careful consideration is warranted to manage the simultaneous impacts of the decarbonization of the electricity supply, and increase in demand from the electrification of transportation and heating from the perspective of reliable winter operations
  - Timely development of dispatchable, emission-free resources (DEFRs) with operational capabilities in the winter at least equivalent to those of the current thermal generation fleet will be necessary to facilitate deactivation of fossil generation while maintaining reliable winter operations

Observations, cont.

- **The NYISO has taken many steps to address potential risks associated with fuel and energy security concerns**
  - A variety of practices and requirements intended to ensure continuous monitoring of assets and fuel inventories, and visibility into the operations, capacities and constraints of interstate pipelines and local natural gas LDC systems
  - Allow generation resources the ability to account for fuel-oil opportunity costs in offers
  - Existence of requirements on certain downstate generators related to the capacity to operate on multiple fuels and switching fuels if and as needed based on prevailing temperature conditions
  - Inclusion of dual-fuel specifications for peaking plant technologies in the setting of the ICAP Demand Curves downstate
  - Establishment of reserve requirements statewide and downstate that reflect locational reserve needs

The set of steps already taken through changes in market rules and/or operating procedures have the effect of both increasing situational awareness of the risks and instituting requirements and providing incentives supporting the availability of fuel and the operation of assets important for reliable winter operations

Options

- **Continued monitoring and analysis**
  - The analysis identifies potential areas of vulnerability that are consistent with the findings of other studies and regions and the evidence of recent winter weather reliability events; NYISO should continuously monitor potential vulnerabilities, and expand, update, and refine fuel security analysis as needed
  - Key factors and modelling assumptions to monitor and refine include:
    - Changes to the level and hourly shape of demand, and corresponding load forecasts
    - Expected availability of natural gas for electric generation going forward
    - Expected oil capability going forward, including fuel inventories and access to refills
    - Levels of energy import/export from neighbouring regions
    - Intra-state transmission capability to facilitate power flows to load centers
- **Assessment of the adequacy of incentives for appropriate pre-season fuel oil inventory levels and/or replenishment arrangements**
  - Appropriate market signals for asset owners to have sufficient fuel to support continued operations throughout an extended period of cold-weather conditions are important for managing reliability risks
- **Ongoing proactive scenario analysis of the potential impacts of the CLCPA**
  - Including review of the potential for geographically-targeted development of new renewable and energy storage resources associated with implementation of the CLCPA to help reduce or mitigate fuel-security-related risks, and ongoing assessment of progress in the development of DEFRs

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Next Steps

- Tentative Schedule
  - Today: AG presentation of study report, including key observations and recommendations
  - Posting of final report expected early October

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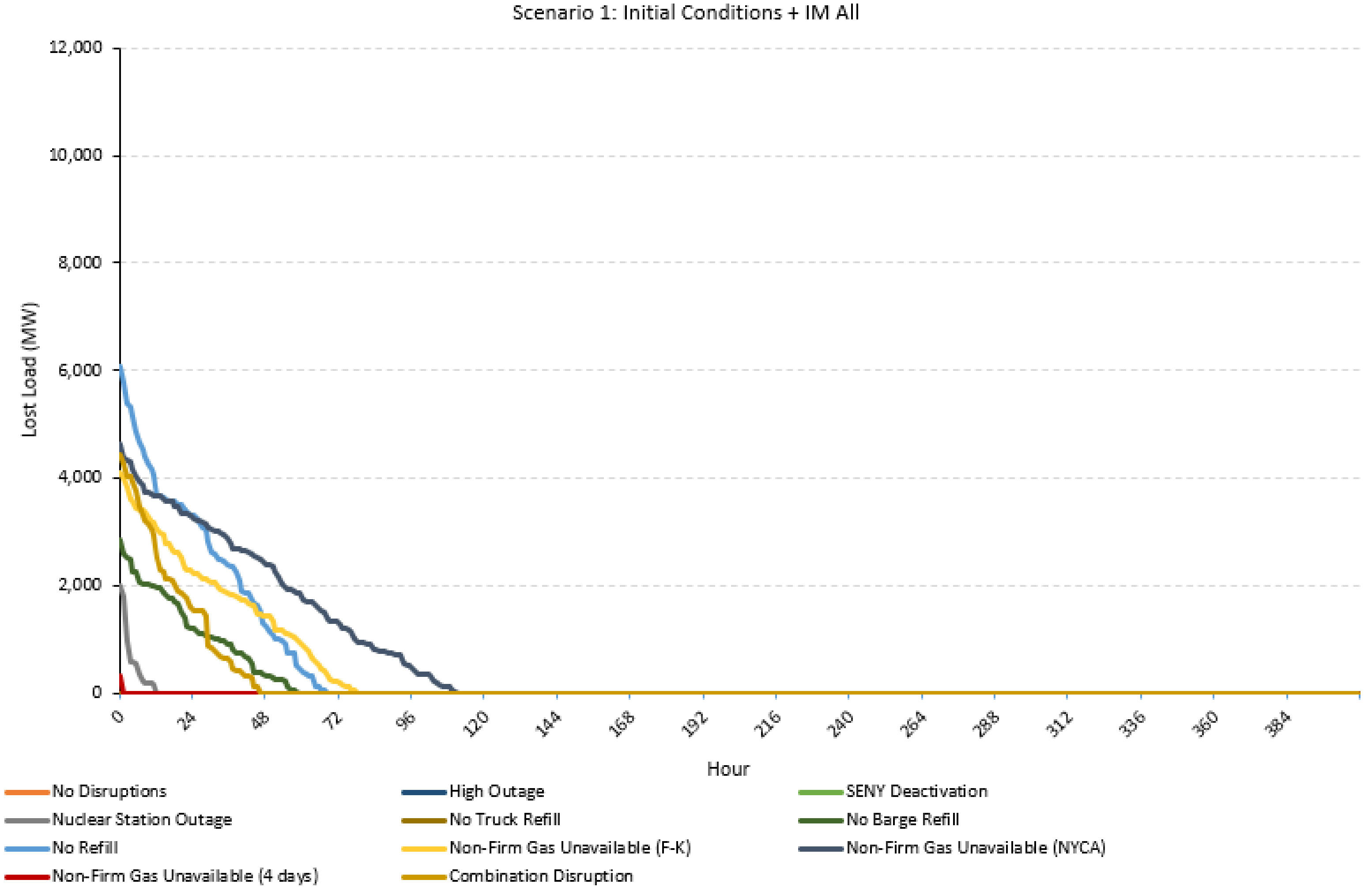
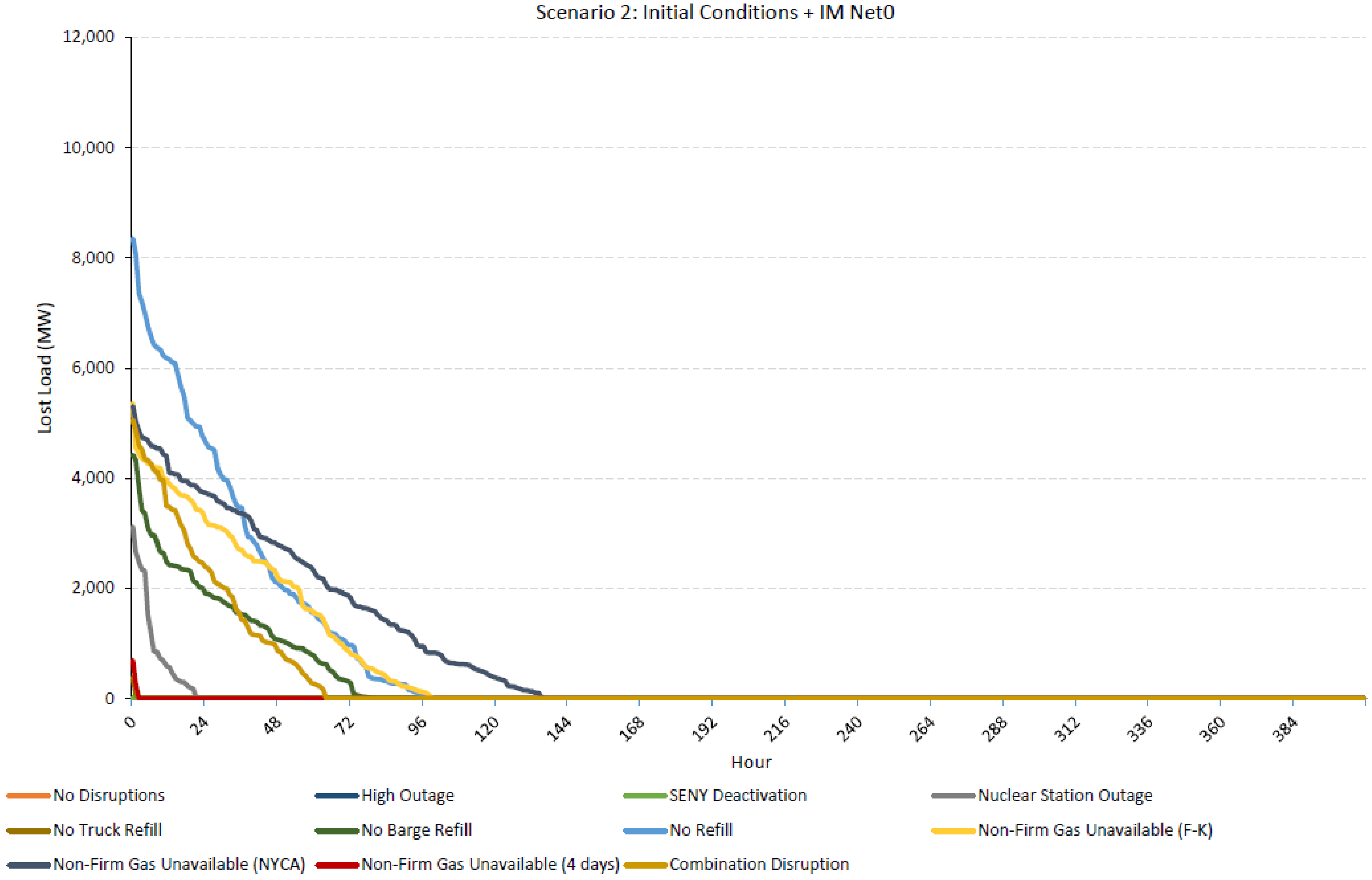
Combined Loss of Load Duration Curves by Winter

Winter 2023/2024

Winter 2023/2024 – Scenario 1 Loss of Load Duration Curve, All Disruptions



Winter 2023/2024 – Scenario 2 Loss of Load Duration Curve, All Disruptions



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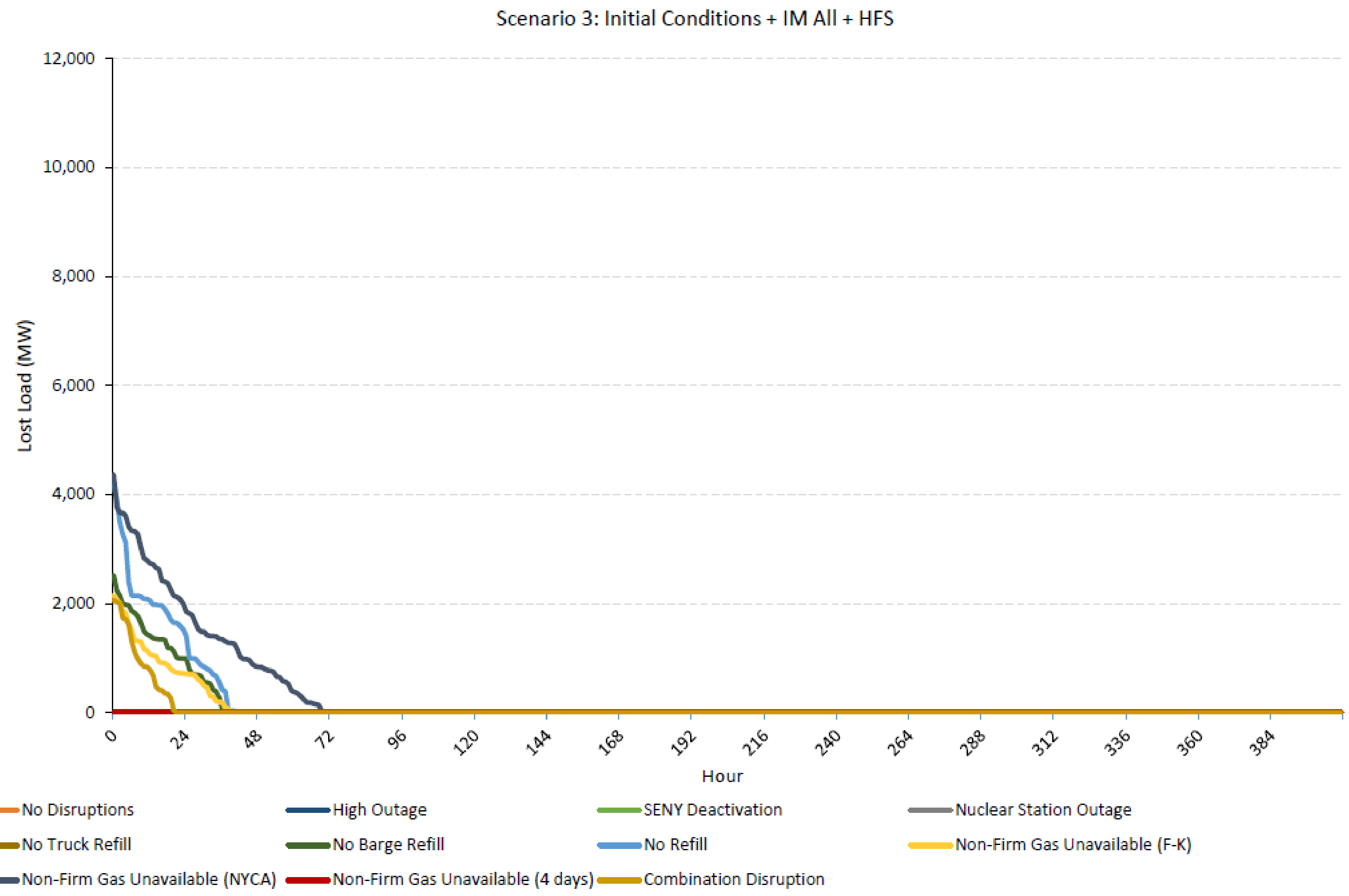
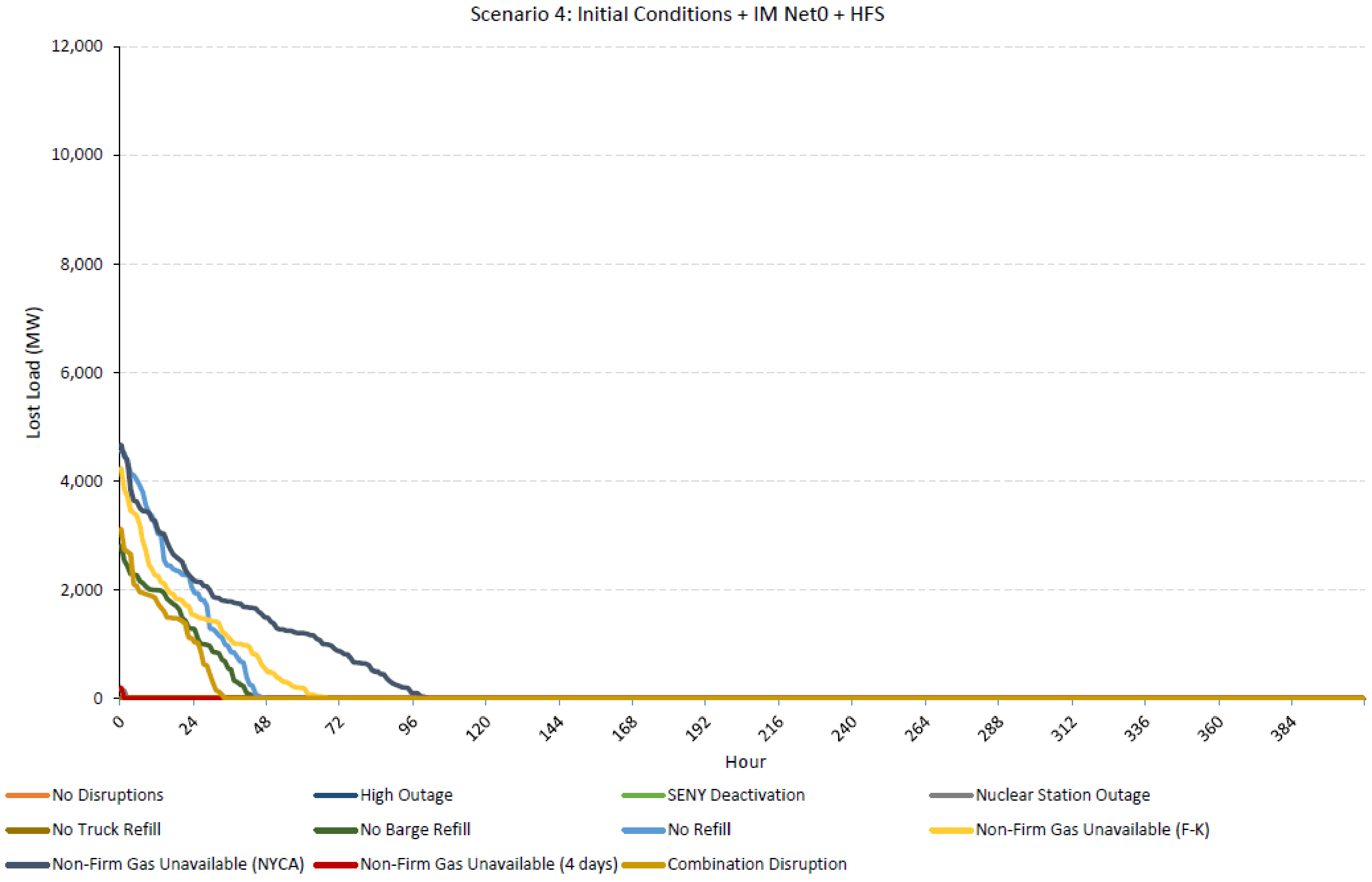
Winter 2023/2024 – Scenario 3 Loss of Load Duration Curve, All Disruptions



Winter 2023/2024 – Scenario 4 Loss of Load Duration Curve, All Disruptions



Combined Loss of Load Duration Curves by Winter

Winter 2026/2027

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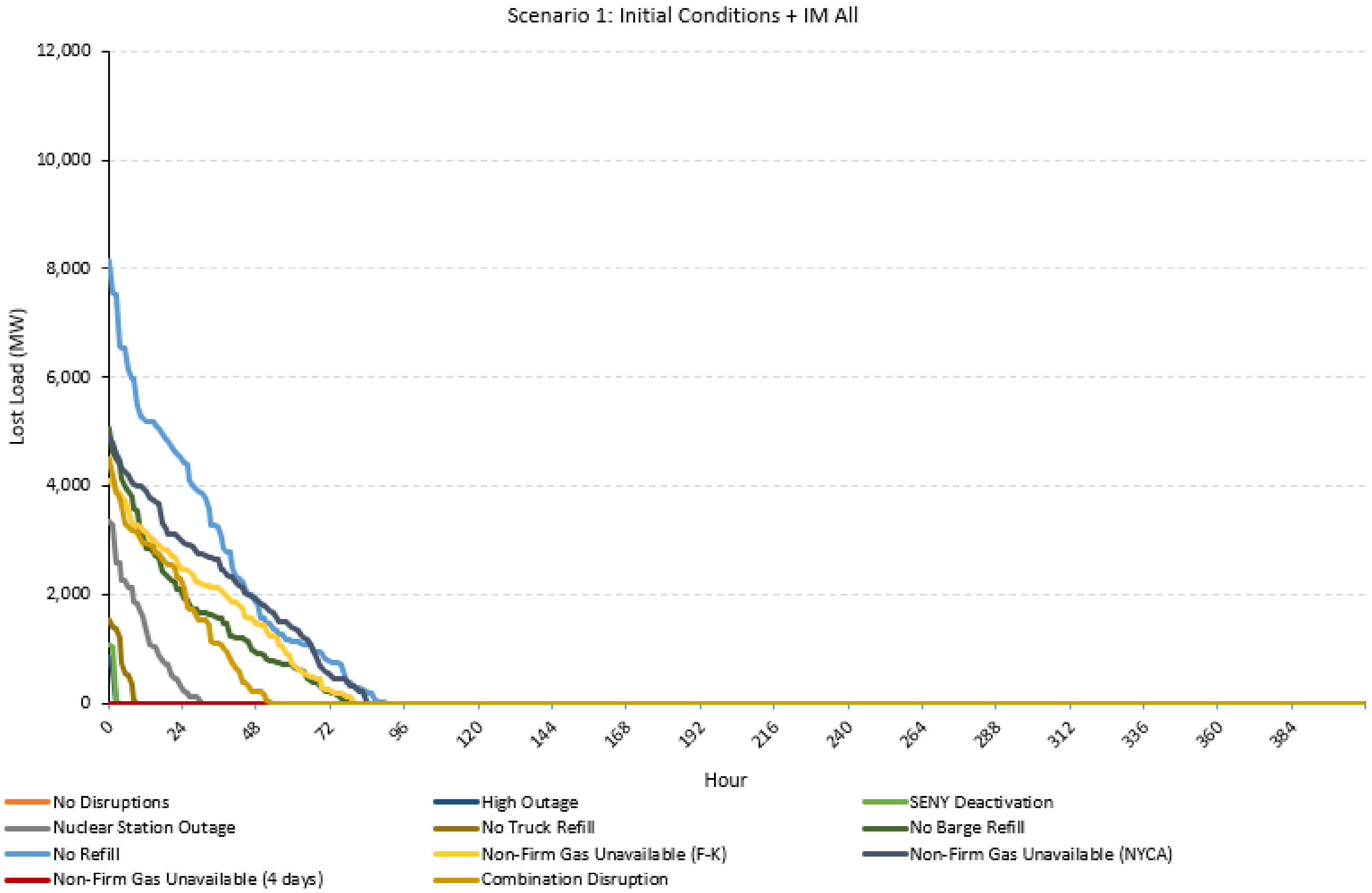
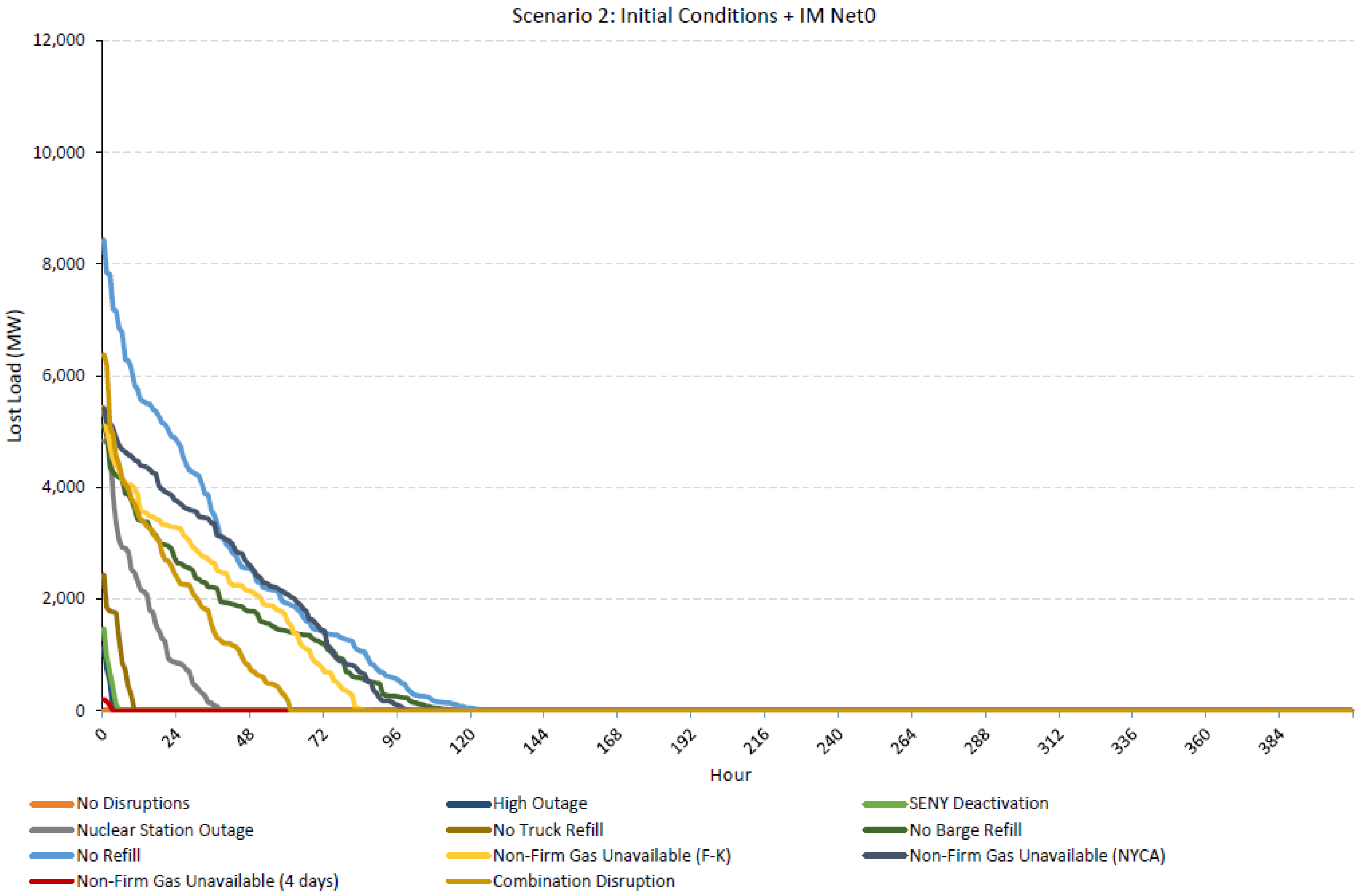
Winter 2026/2027 – Scenario 1 Loss of Load Duration Curve, All Disruptions



Winter 2026/2027 – Scenario 2 Loss of Load Duration Curve, All Disruptions



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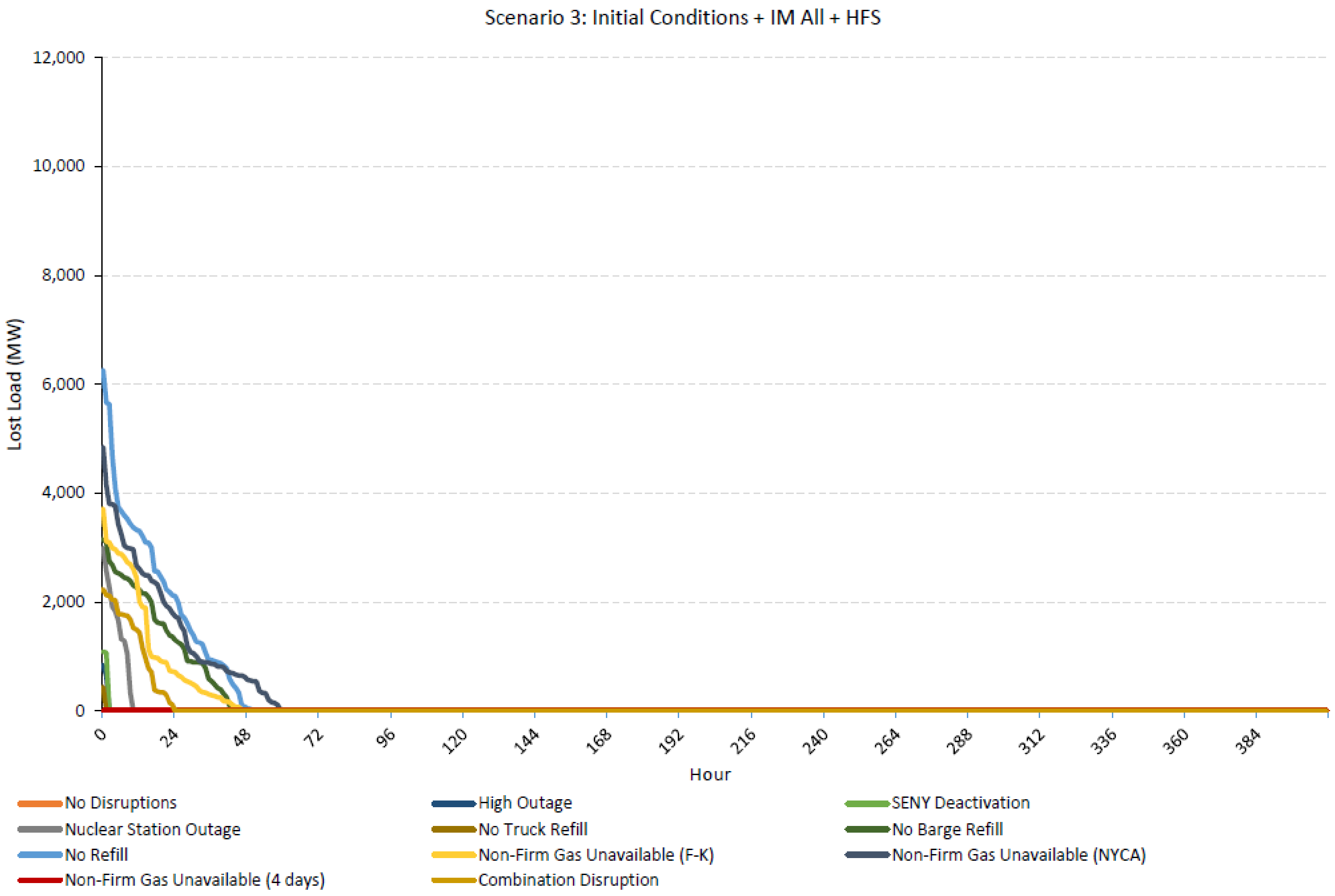
Winter 2026/2027 – Scenario 3 Loss of Load Duration Curve, All Disruptions



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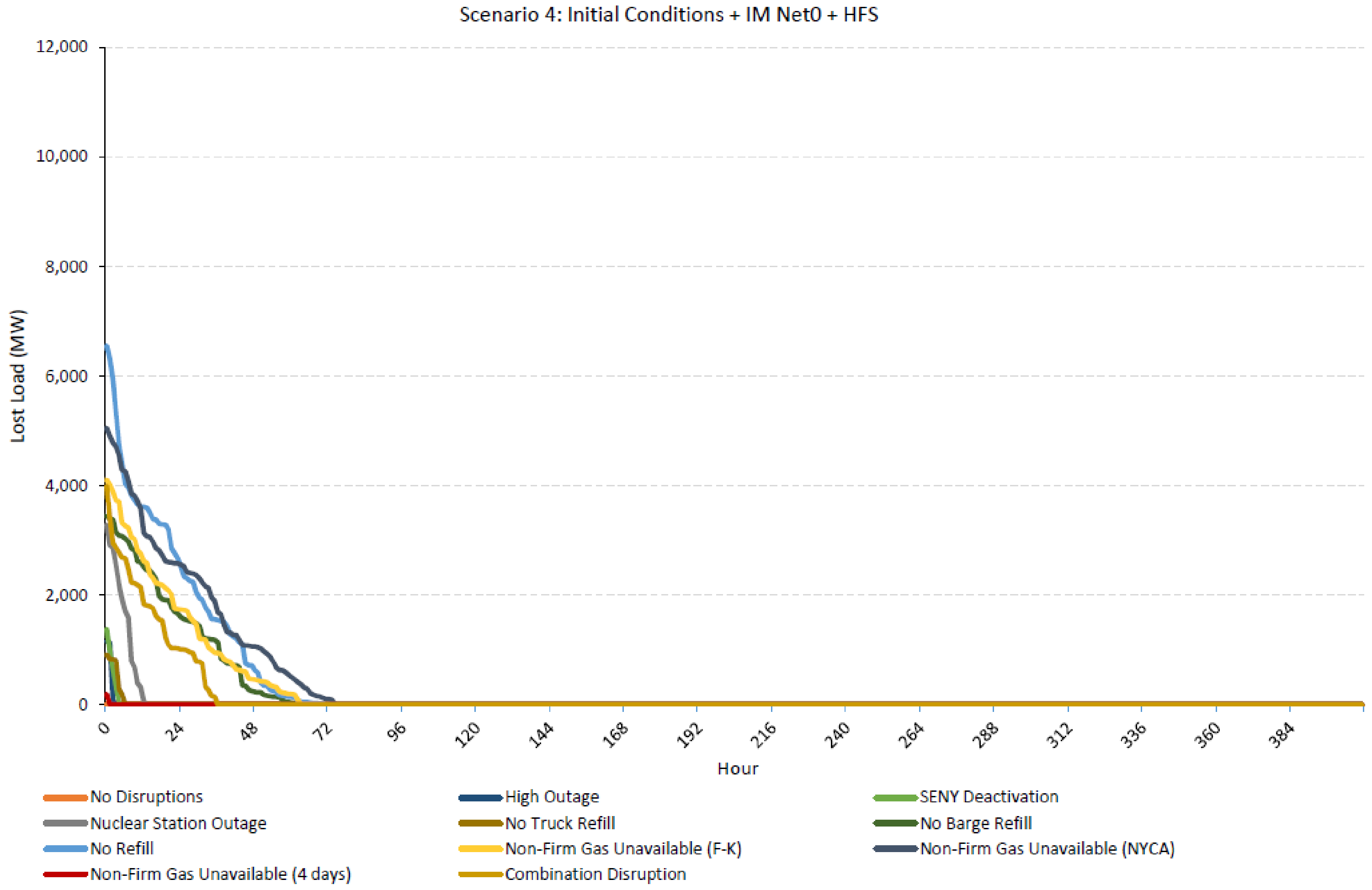
Winter 2026/2027 – Scenario 4 Loss of Load Duration Curve, All Disruptions



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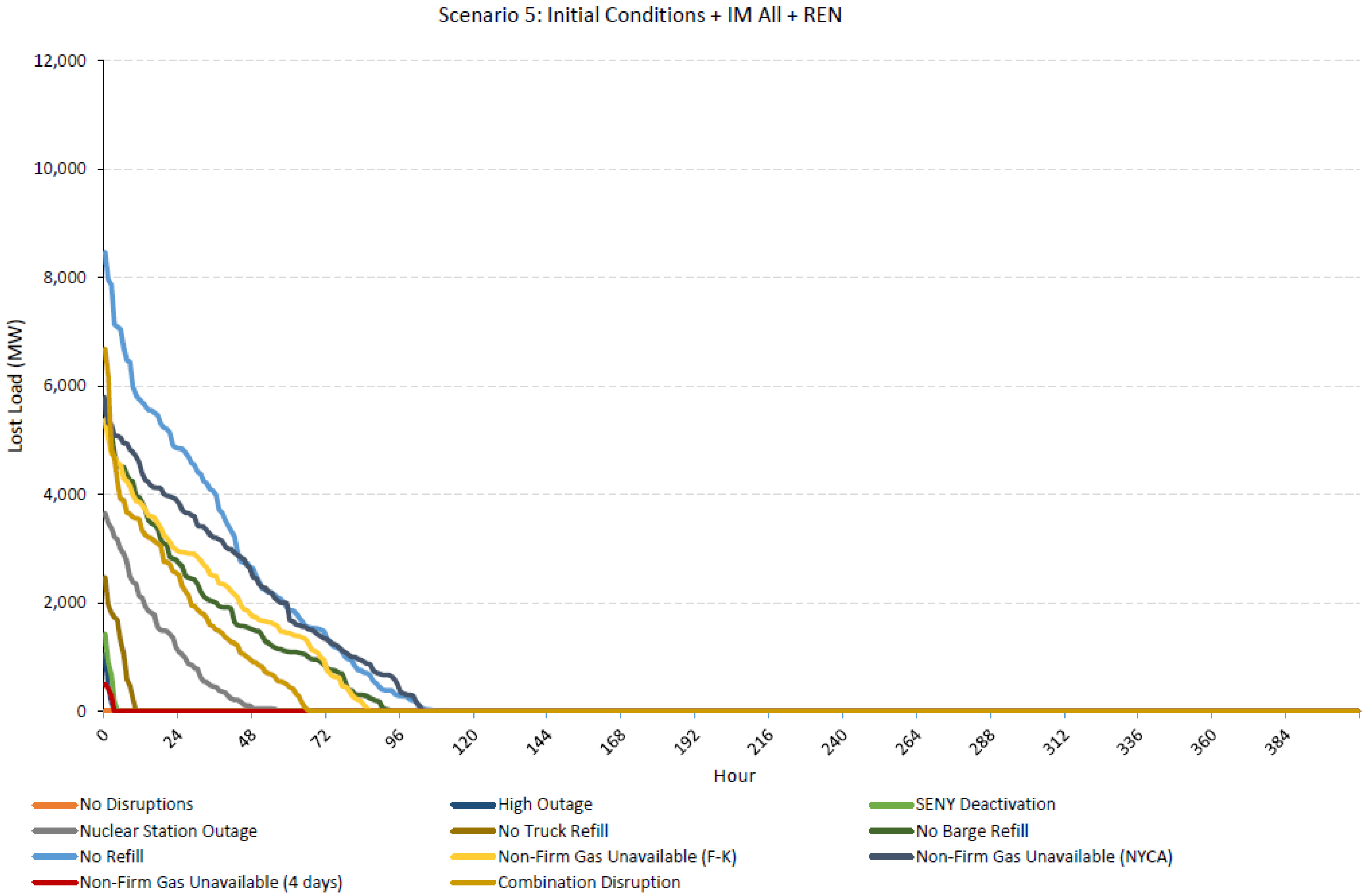
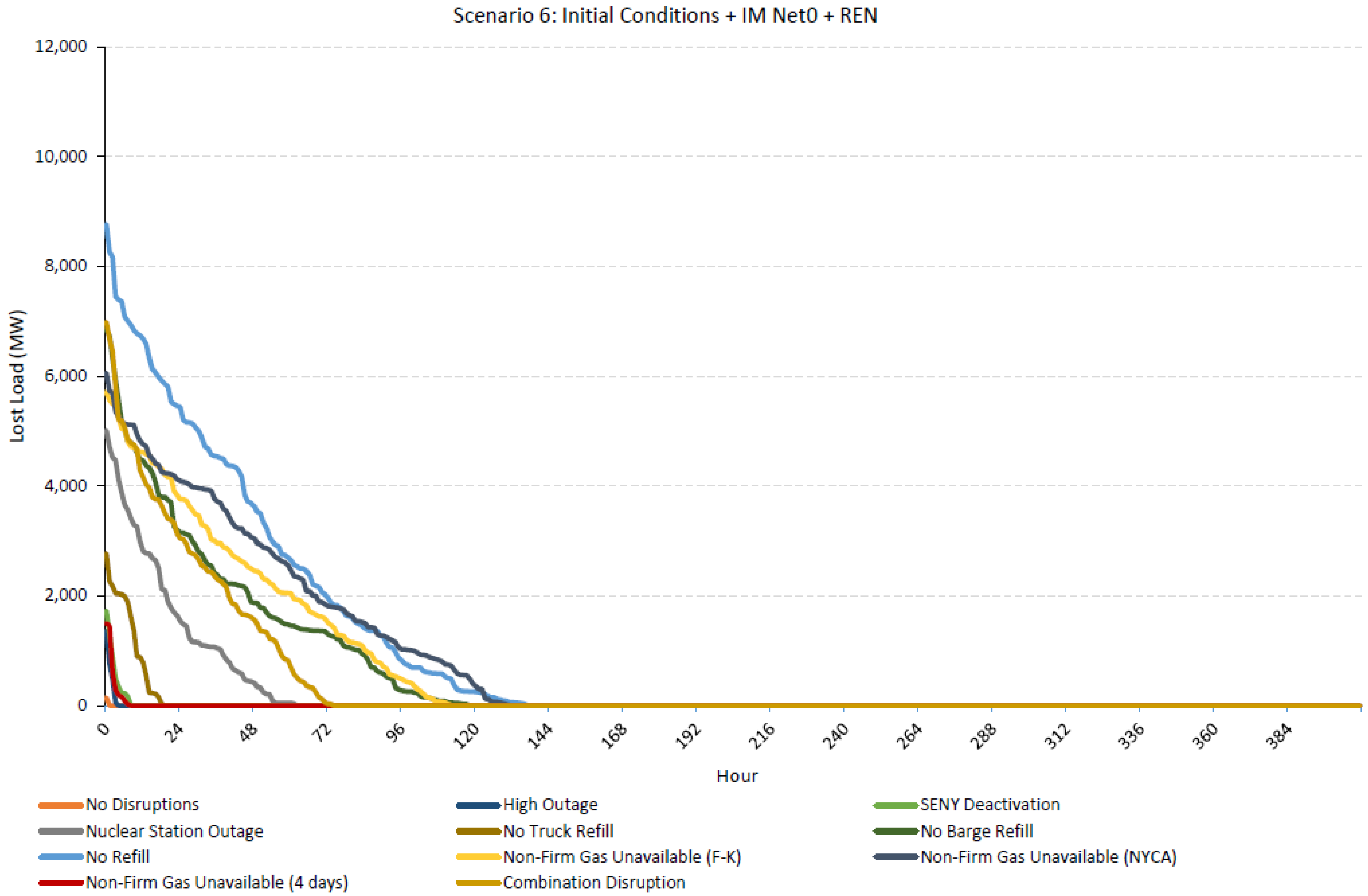
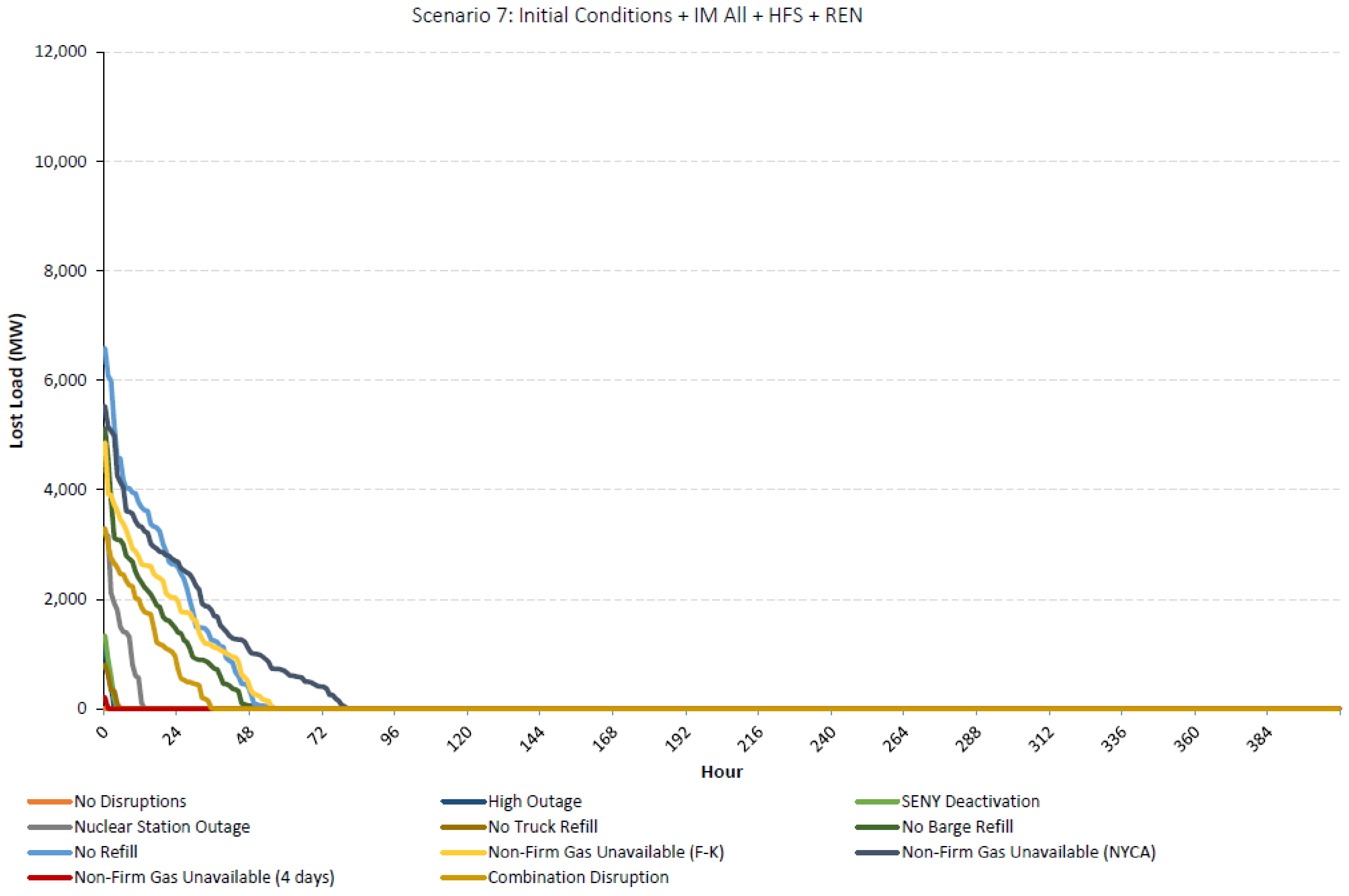
Winter 2026/2027 – Scenario 5 Loss of Load Duration Curve, All Disruptions



Winter 2026/2027 – Scenario 6 Loss of Load Duration Curve, All Disruptions



Winter 2026/2027 – Scenario 7 Loss of Load Duration Curve, All Disruptions



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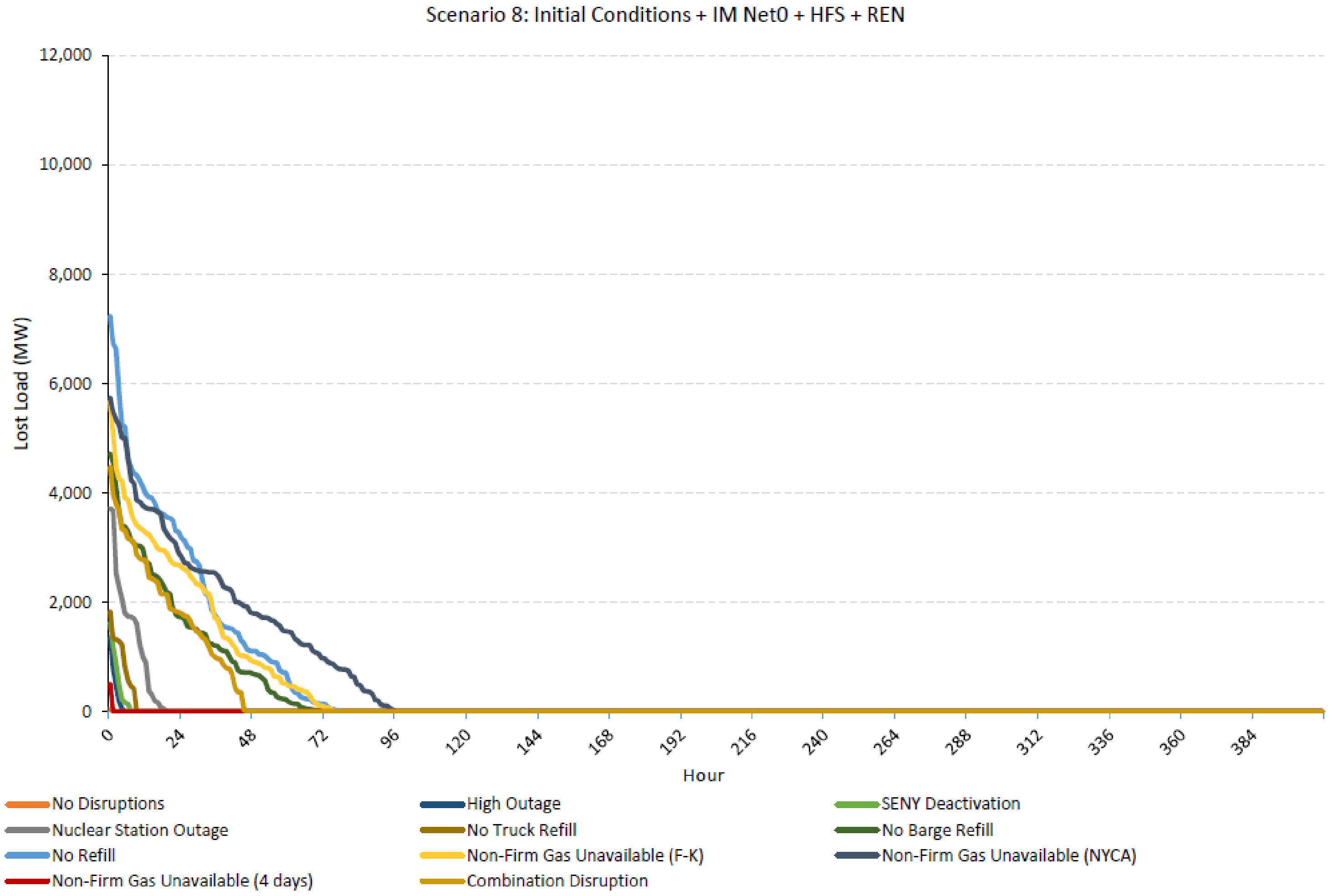
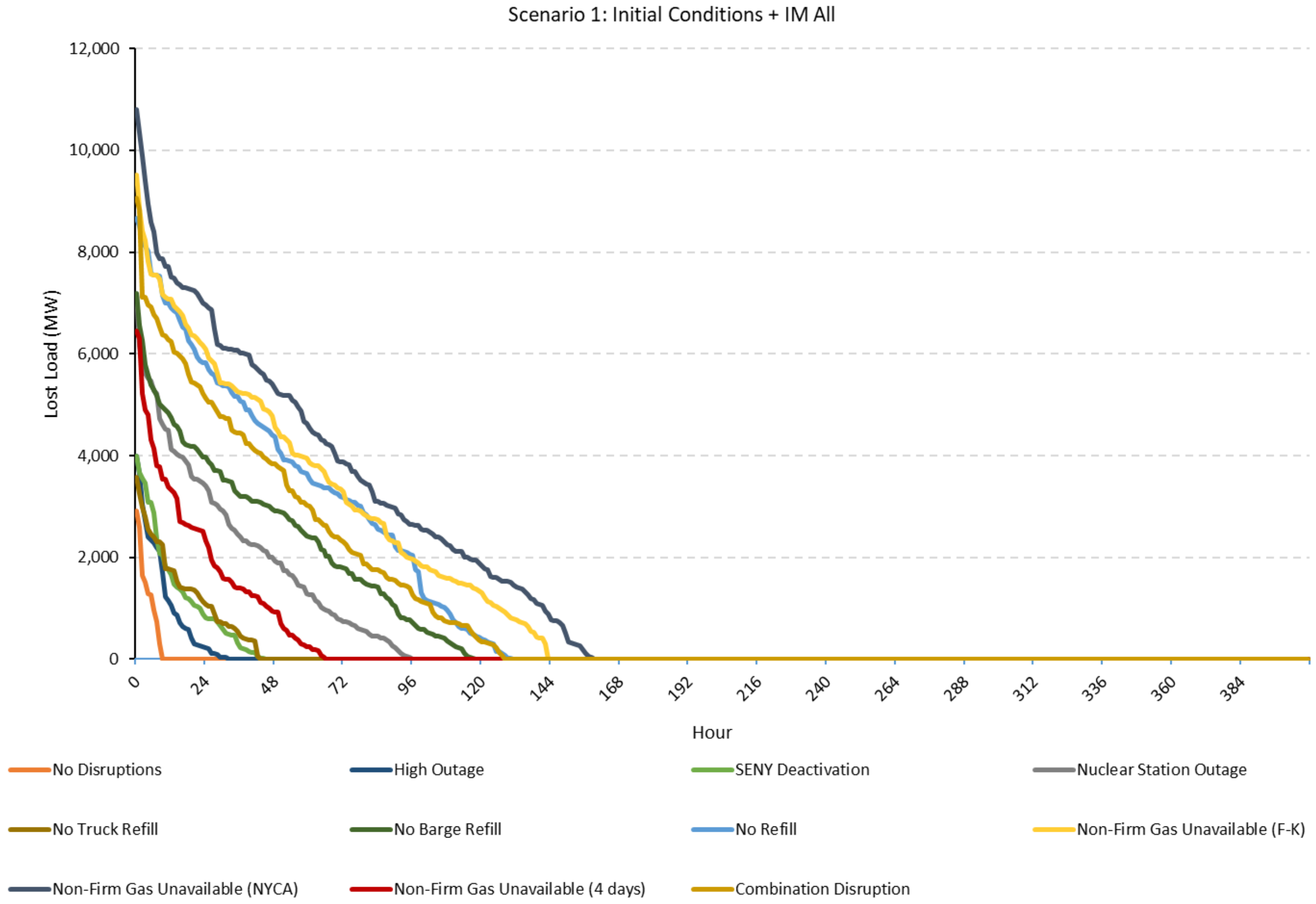
Winter 2026/2027 – Scenario 8 Loss of Load Duration Curve, All Disruptions



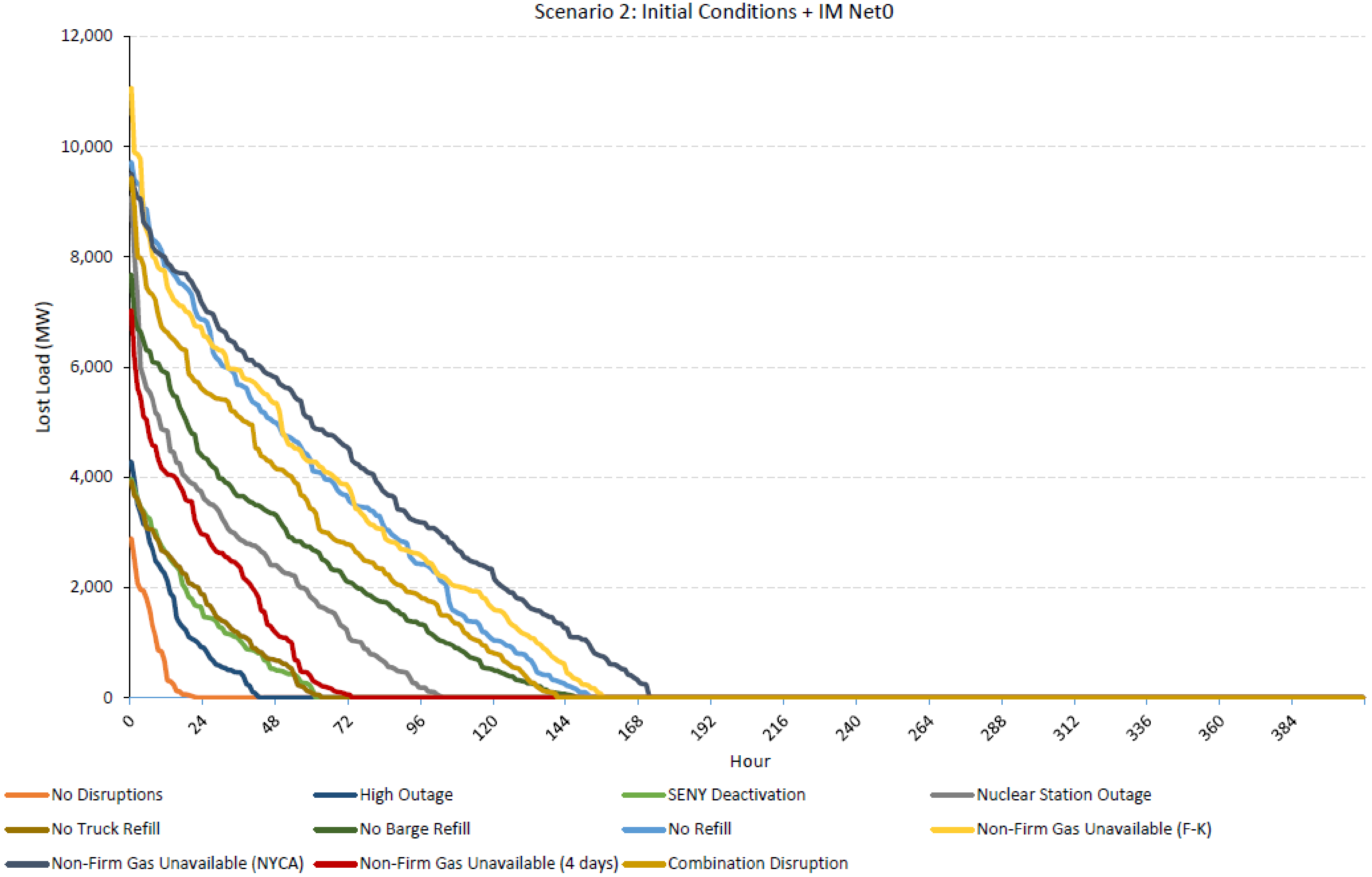
Combined Loss of Load Duration Curves by Winter

Winter 2030/2031

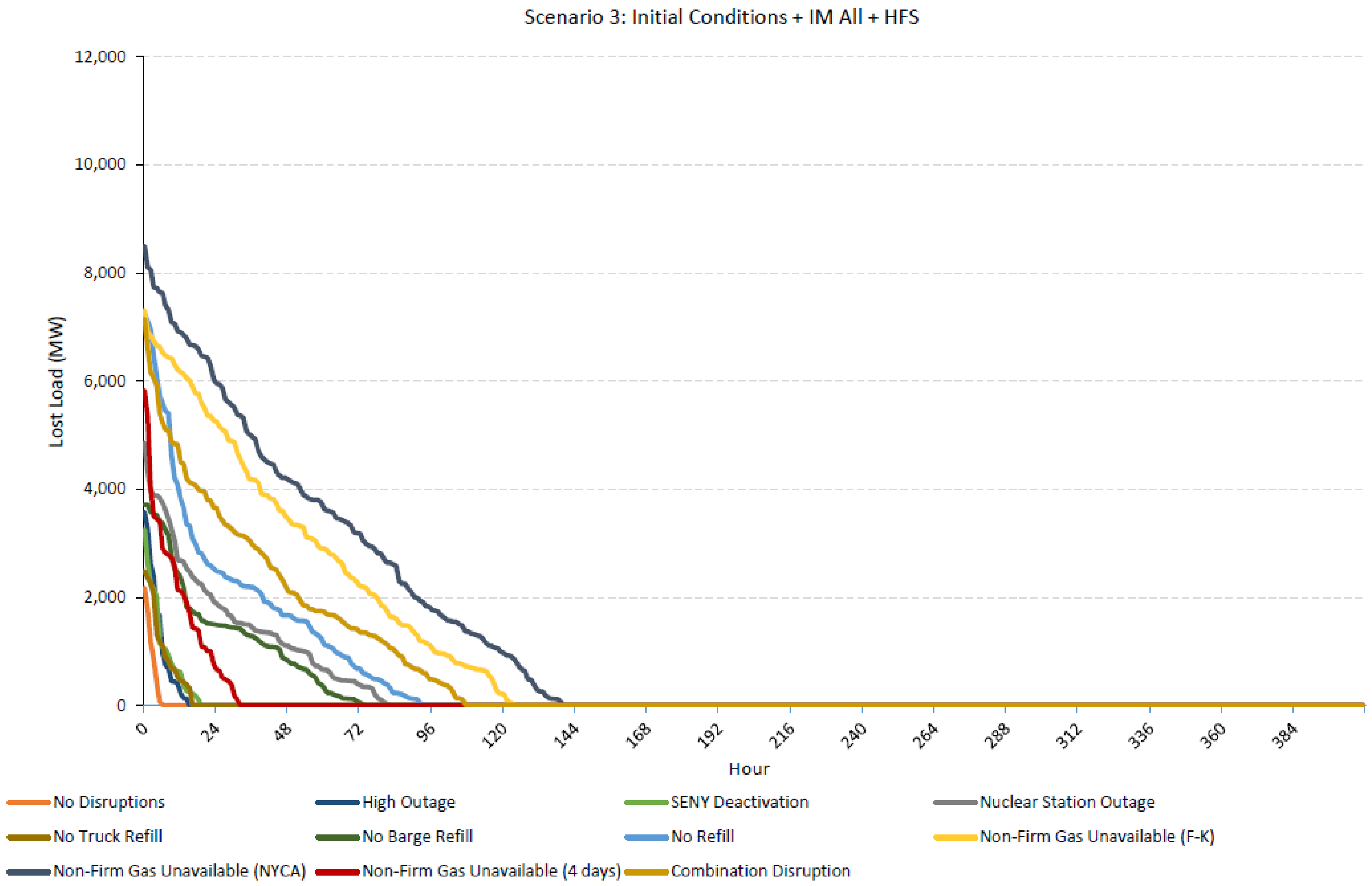
Winter 2030/2031 – Scenario 1 Loss of Load Duration Curve, All Disruptions



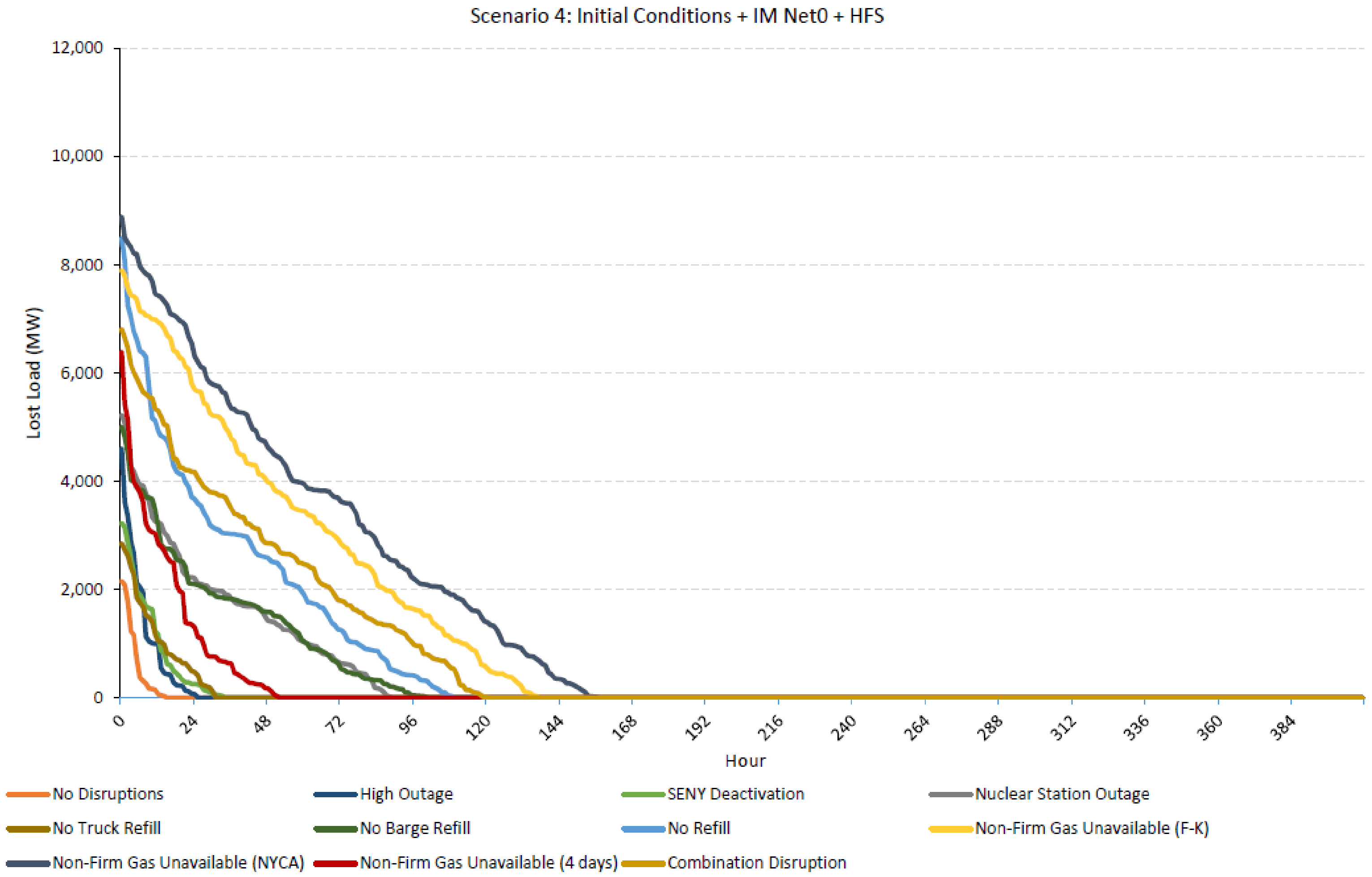
Winter 2030/2031 – Scenario 2 Loss of Load Duration Curve, All Disruptions



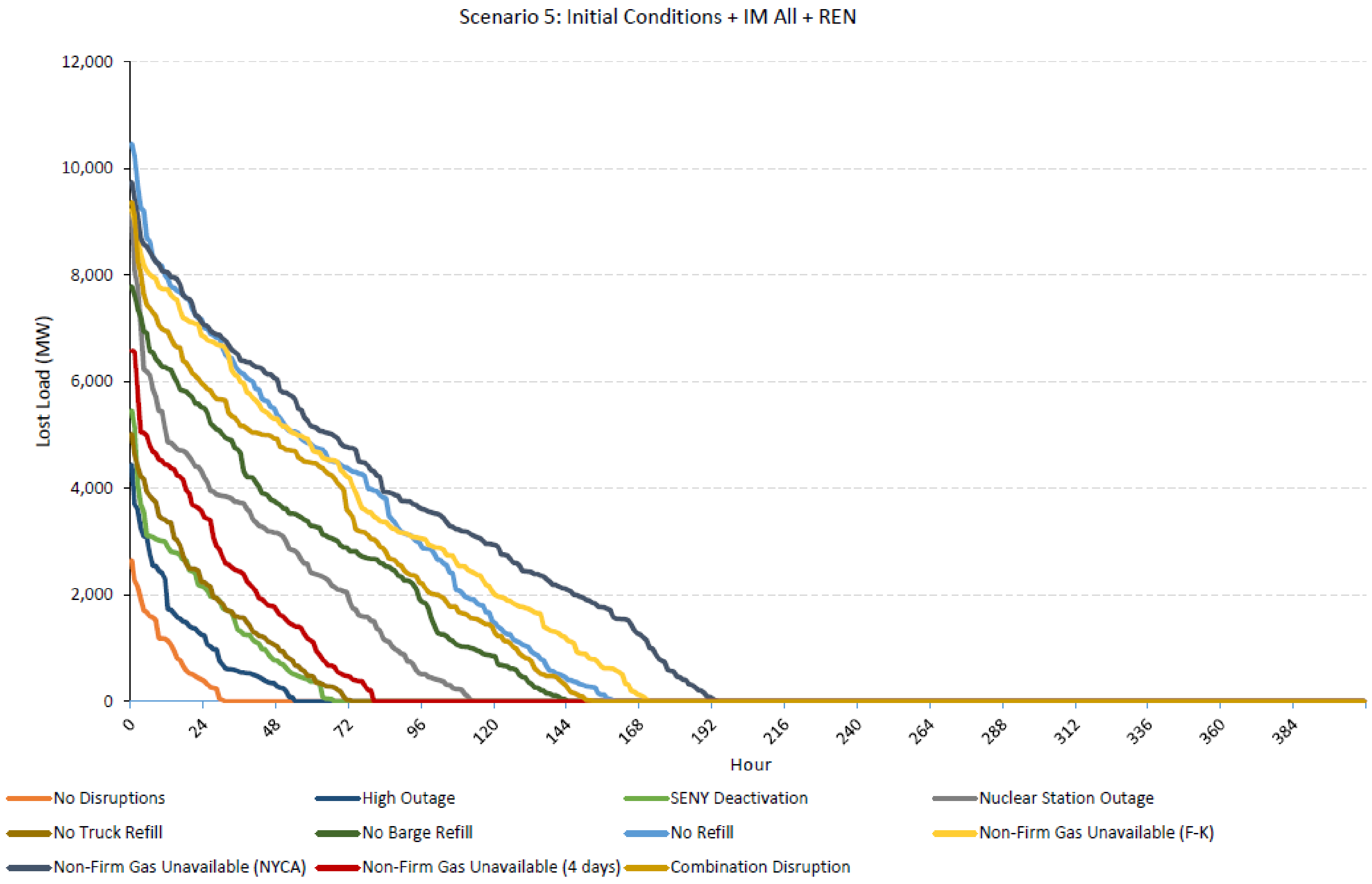
Winter 2030/2031 – Scenario 3 Loss of Load Duration Curve, All Disruptions



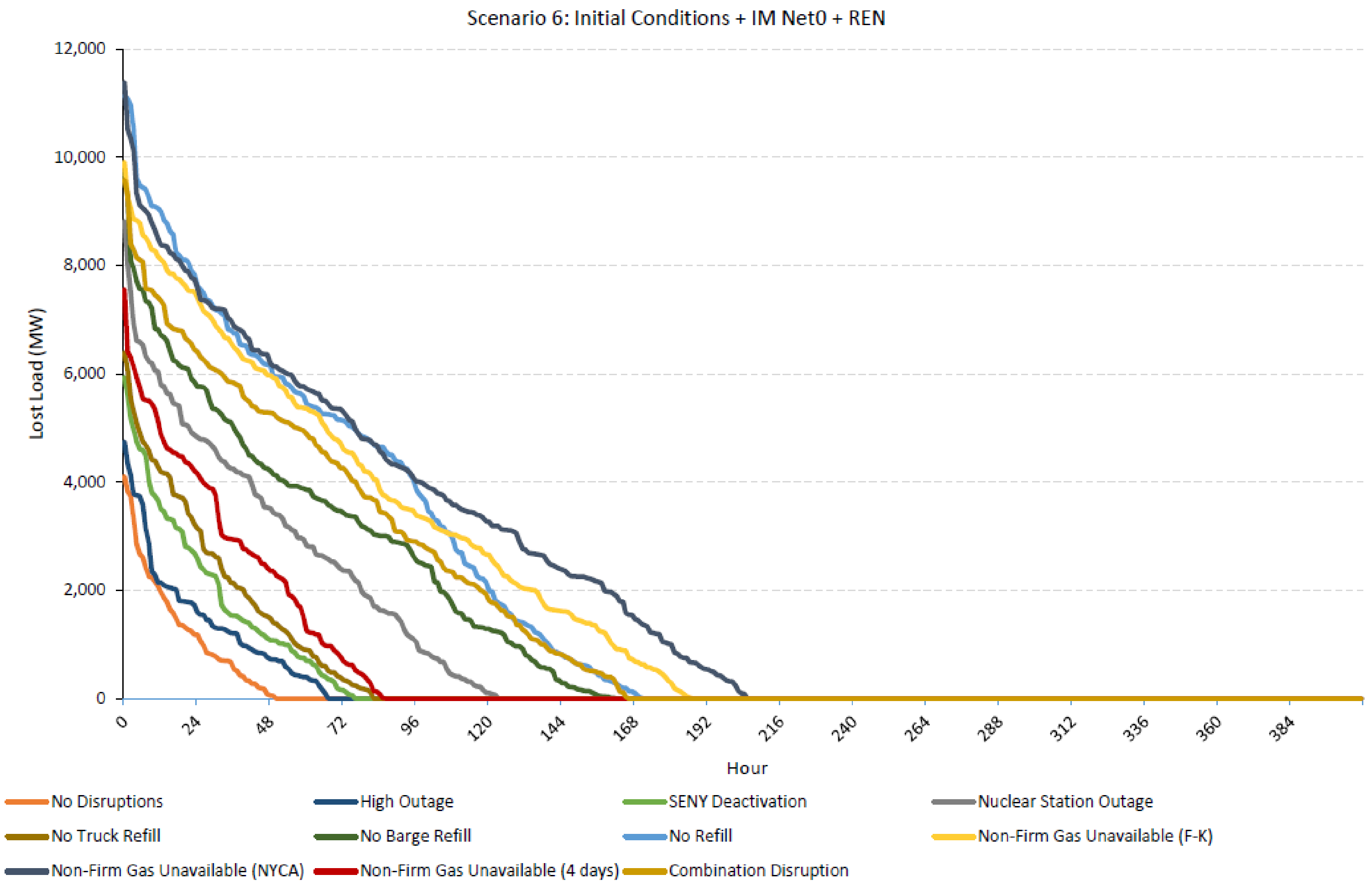
Winter 2030/2031 – Scenario 4 Loss of Load Duration Curve, All Disruptions



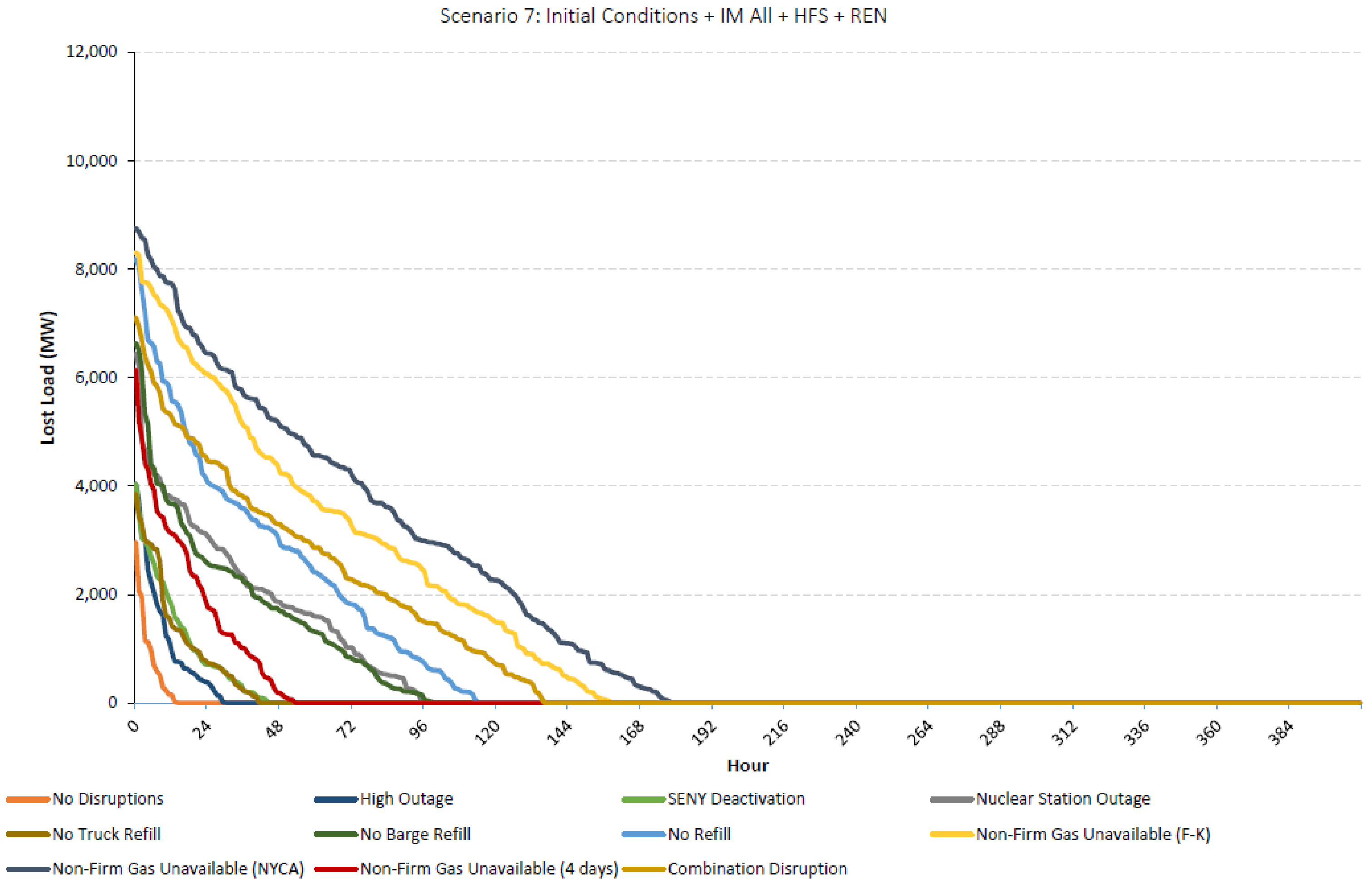
Winter 2030/2031 – Scenario 5 Loss of Load Duration Curve, All Disruptions



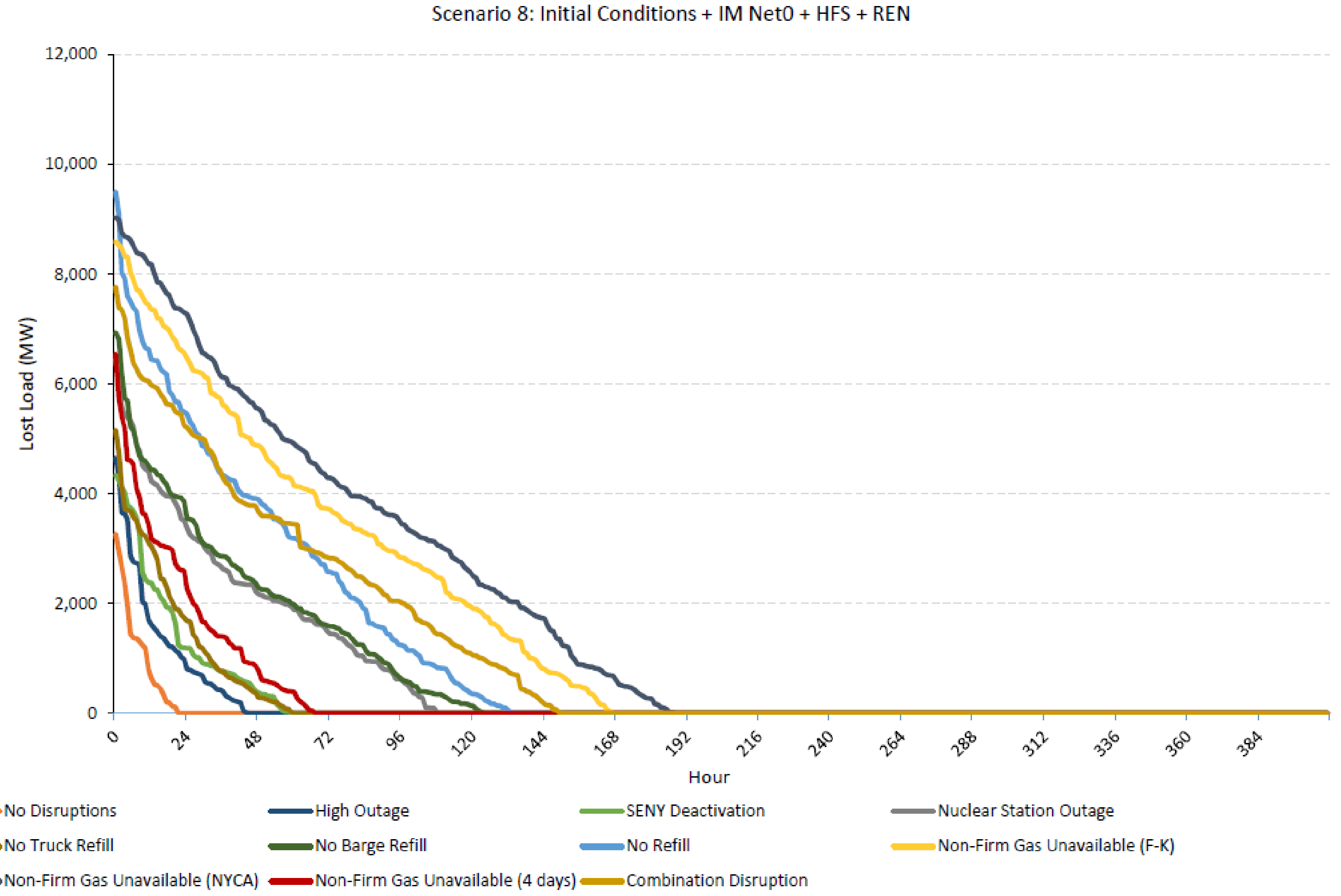
Winter 2030/2031 – Scenario 6 Loss of Load Duration Curve, All Disruptions



Winter 2030/2031 – Scenario 7 Loss of Load Duration Curve, All Disruptions



Winter 2030/2031 – Scenario 8 Loss of Load Duration Curve, All Disruptions



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