# Fuel and Energy Security Study
# Preliminary Results

NYISO ICAPWG/MIWG

August 2, 2019

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# Context and Assignment

- Electricity market trends introduce potential risks, as the system is increasingly reliant on intermittent and natural gas-fired generation
- Analysis Group (AG) task: assess fuel/winter energy security for NYISO under various system scenarios and contingencies; draft a report with approach and findings
- To review:
  - Extended period of cold weather in a future year (winter 2023-2024)
  - Identify circumstances under which resources are insufficient to meet load plus reserves absent emergency actions
  - A range of future scenarios (potential electric and natural gas system conditions), each on its own and subject to a set of disruptions
- The framing of the analysis is important – not trying to predict the future; instead, conducting a scenario analysis
  - Testing the resilience of the electric system to gas and electric system disruptions
  - Cases are not predictive – their development is an analytic tool to assess the implications of adverse conditions for winter power system operations
- Aim for manageable set of cases that highlight potential system vulnerabilities under a range of potential future system conditions

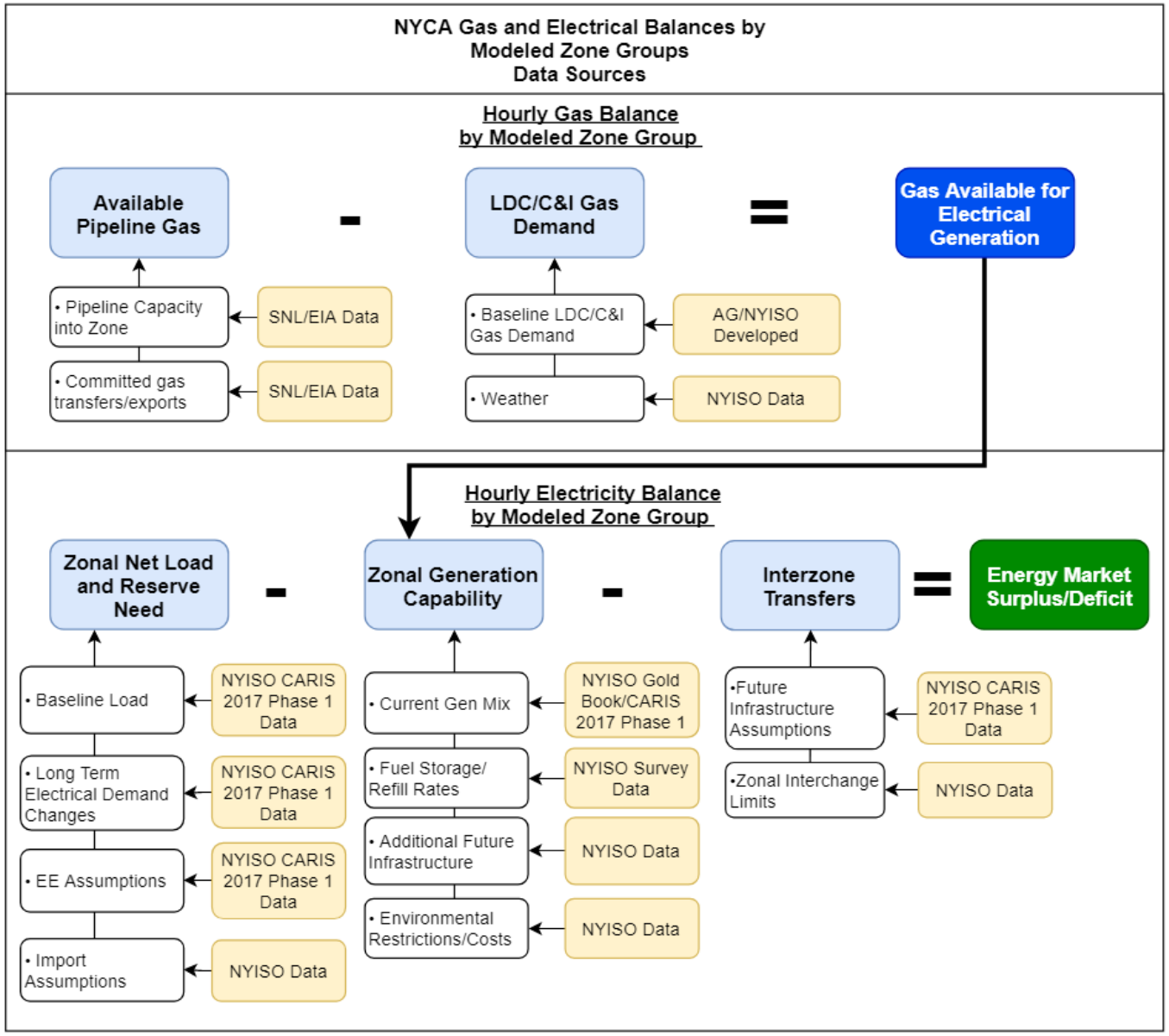
## Discussions to-date

- Project purpose and goals
- Modeling approach/methodology
- Data inputs and assumptions (Appendix contains adjustments to previously discussed inputs/assumptions)
- Initial concepts for scenarios and disruptions
- Output metrics

## Today

- Overview of modeling approach
- Output metrics and demonstratives
- Cases
- Initial results
  - High-level summary for all cases
  - More detailed examples of certain individual case metrics
- Initial observations
- ***Obtain your feedback***

# Model Setup Diagram: Gas and Electric Balance




- Focus on severe, extended (17 day) cold snap
  - Starting point historical, but scaled to severe "design day" conditions
- Gas and electric balance based on public data and NYISO input
- Deterministic, "stacking order" analysis, testing resources vs. demand under varying system conditions and contingencies
- Focus on conditions that present reliability challenges

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## Key Output Metrics

- Two types of NYISO actions are modeled if reserves would be violated without action:
  - Reduction of energy-only exports to ISO-NE (up to 1,600 MW reduction)
  - Call of Special Case Resources/Emergency Demand Response Program (up to 4 hours per activation, and 5 days during the modeling period [by zone/region])

- Cases are analyzed based on **number** of:
  - Hours with required emergency actions
  - Hours with reserve violations after emergency actions
  - Hours with potential deficits where load is not met after emergency actions

- And **severity**:
  - Magnitude of any identified reserve and/or supply deficits
  - Duration and frequency of any identified reserve and/or potential supply deficits

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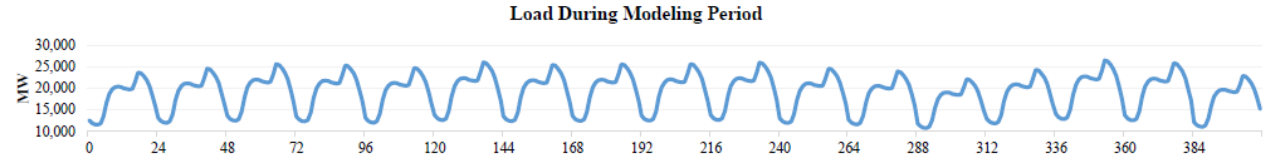
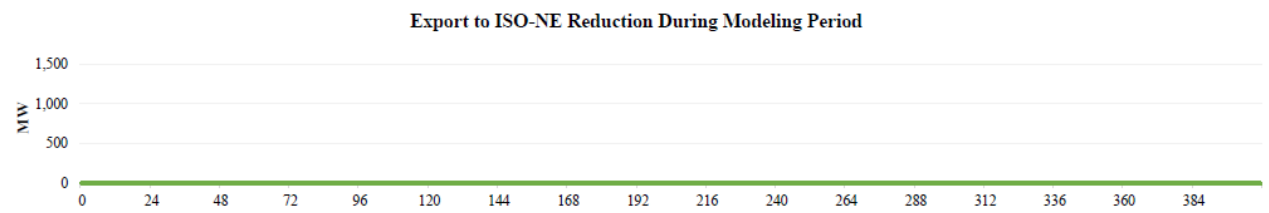
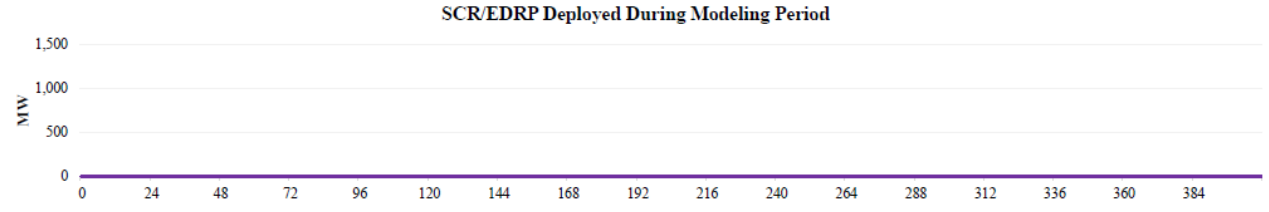
# Sample Output: Case with No Disruptions and No Emergency Actions

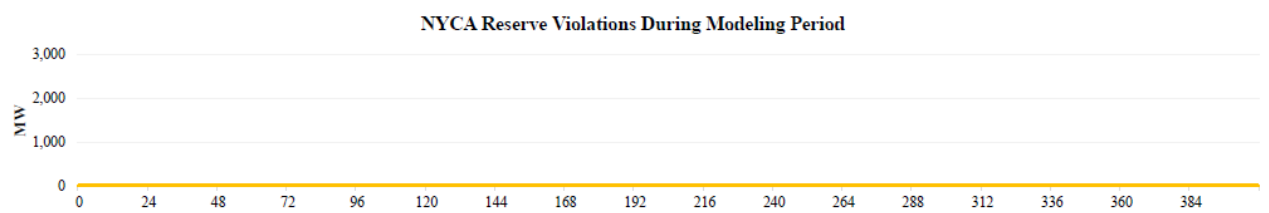
## Hourly Results Summary

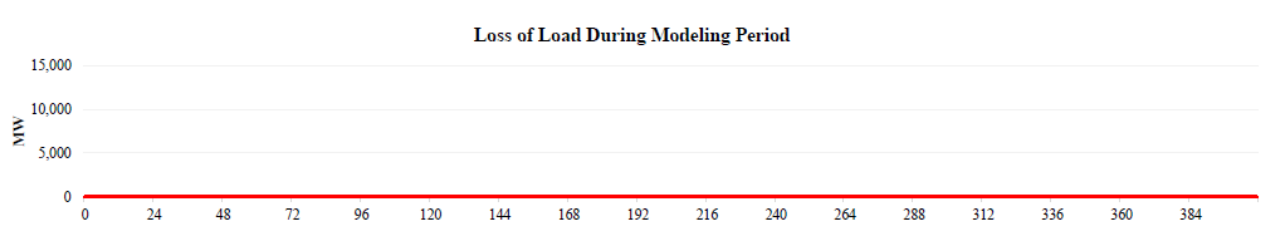
**Case Name:** Scenario 1 - No Disruptions




| Case Summary | |
|---|---|
| Load: | Revised Initial |
| Derate (EFORd) Increase: | Off |
| Renewables: | SRS |
| Peaker Scenario: | Off |
| Starting Storage: | Historical |
| Refill Contingency: | Off |
| Loss of Gas Fired Gen. | Off |
| Nuclear Contingency: | Off |
| Plant Outage: | None |
| Import Scenario: | 900 MW |

| Export Reductions | |
|---|---|
| Total Hrs. | 0 |
| Total MWh | 0 |
| Avg. MW | 0.0 |

| SCR Deployment | |
|---|---|
| Total Hrs. | 0 |
| Total MWh | 0 |
| Avg. MW | 0.0 |

| Reserve Violations | |
|---|---|
| Total Hrs. | 0 |
| Total MWh | 0 |
| Avg. MW | 0.0 |

| Loss of Load | |
|---|---|
| Total Hrs. | 0 |
| Total MWh | 0 |
| Avg. MW | 0.0 |
| First Hour with Losses | |

**No Emergency Actions, Reserve Violations or Potential for Loss of Load**

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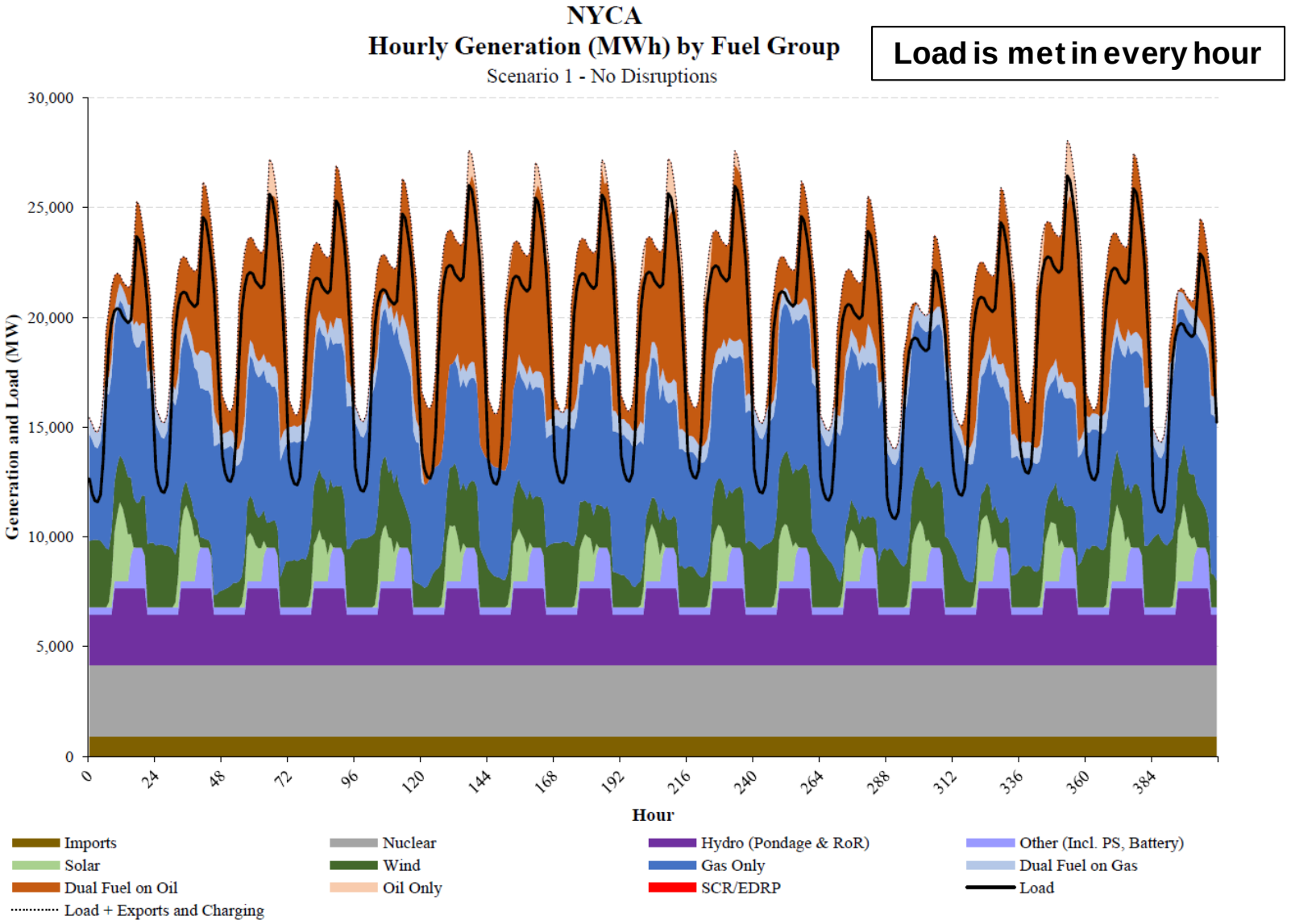
## Sample Output (NYCA): Case with No Disruptions and No Emergency Actions



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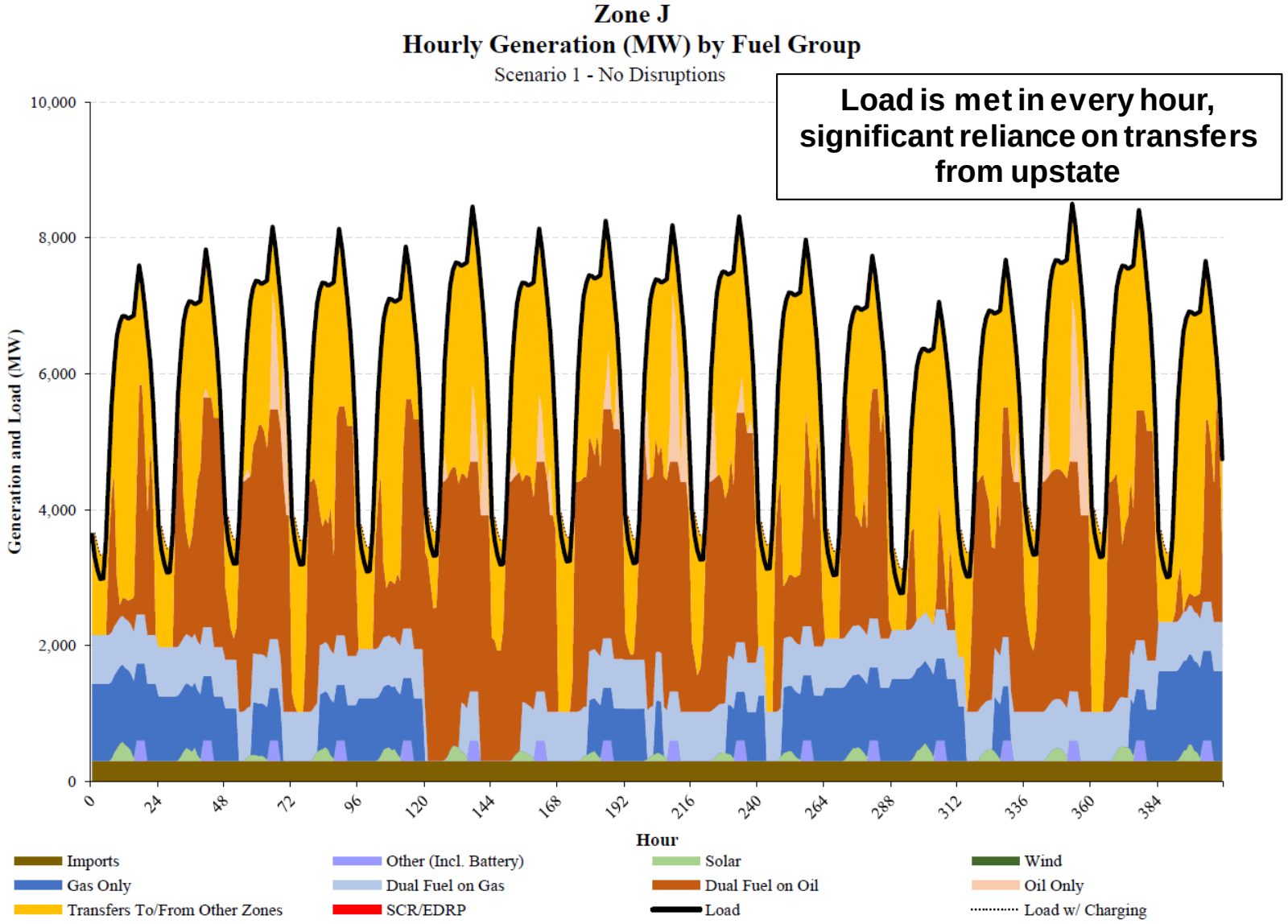
## Sample Output (NYC): Case with No Disruptions and No Emergency Actions



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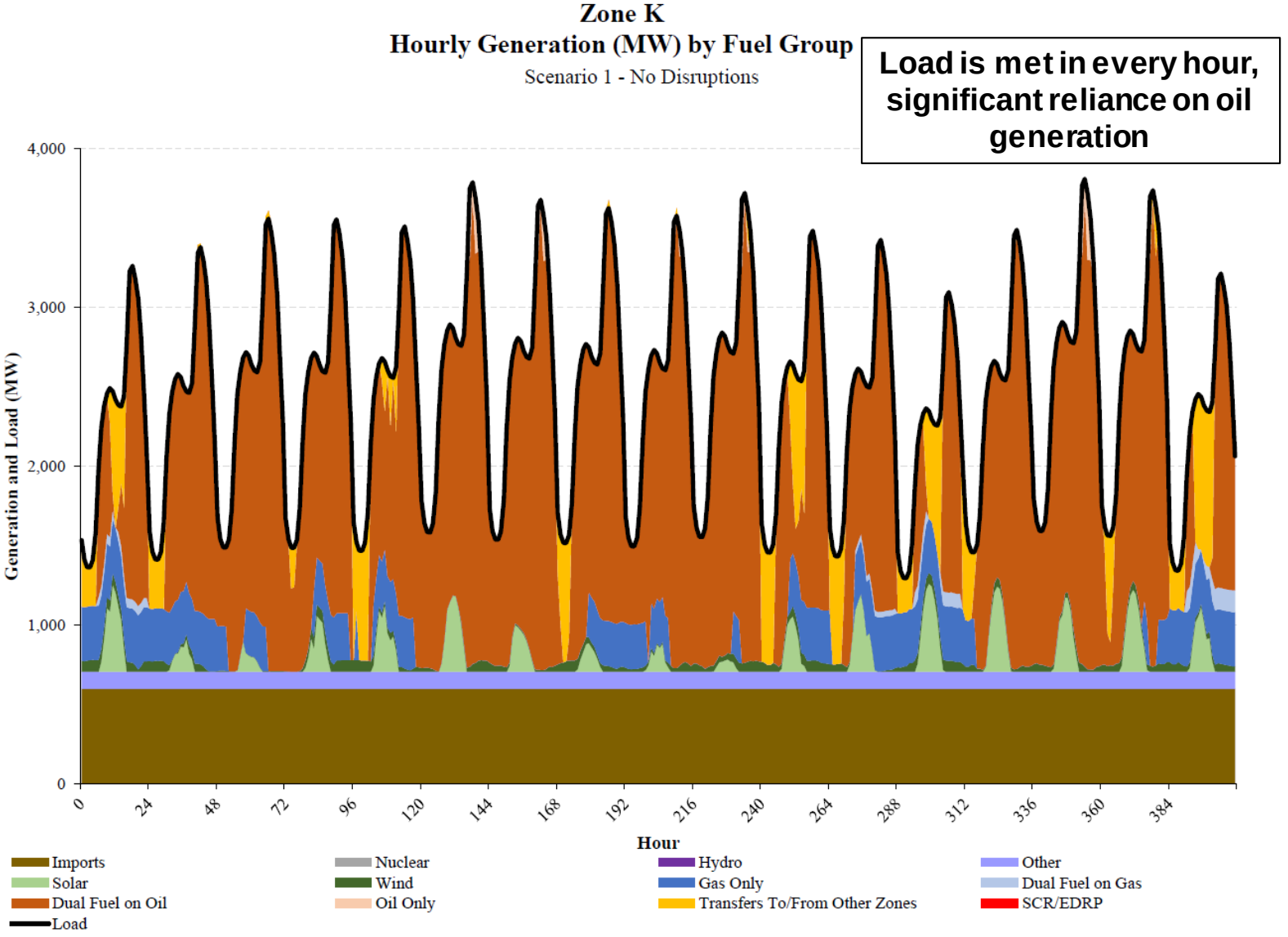
## Sample Output (LI): Case with No Disruptions and No Emergency Actions



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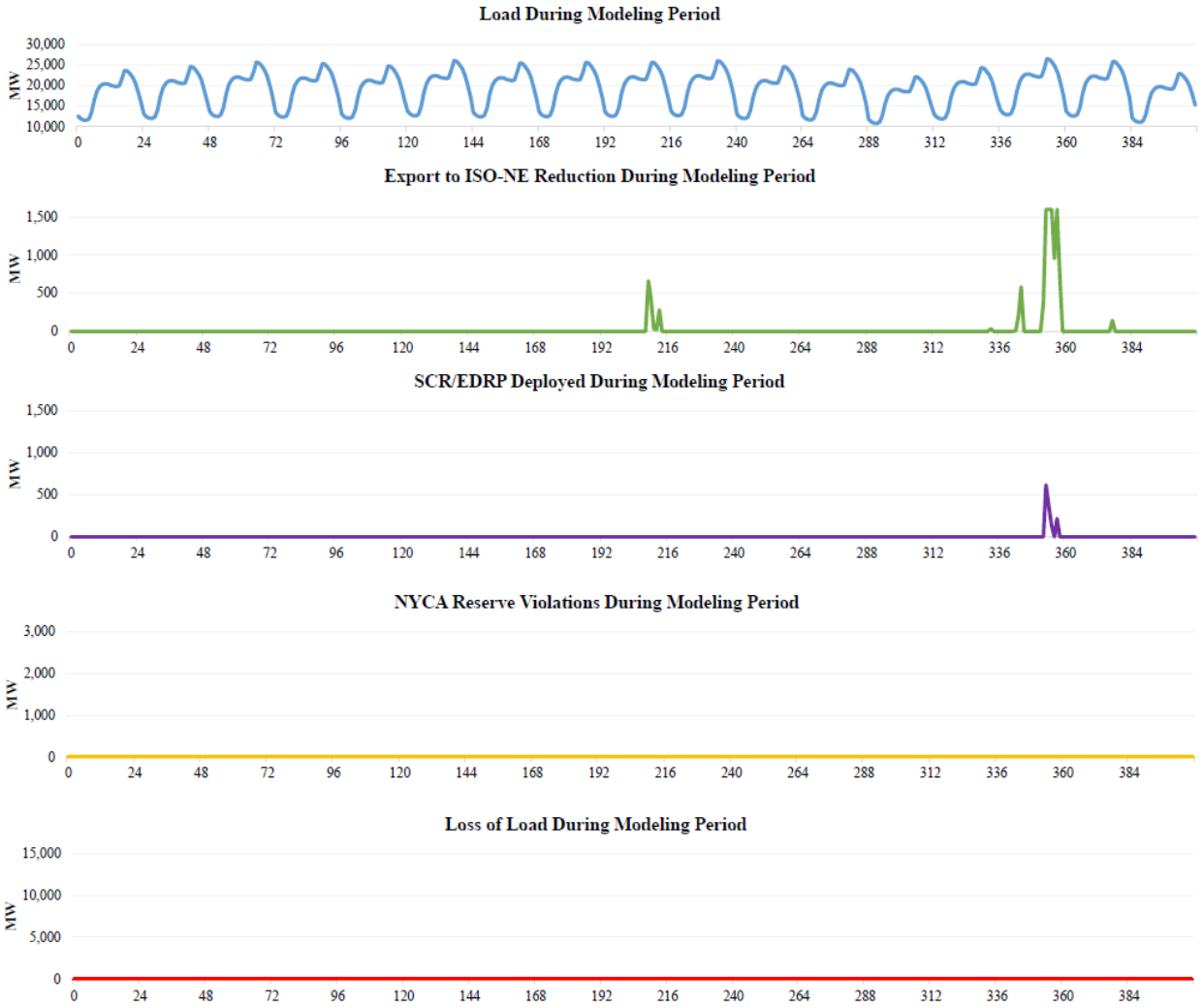
# Sample Output: Case with Moderate Disruptions and Emergency Actions

## Hourly Results Summary

**Case Name:** Scenario 1 - No Refill




| Case Summary | |
|---|---|
| Load: | Revised Initial |
| Derate (EFORd) Increase: | Off |
| Renewables: | SRS |
| Peaker Scenario: | Off |
| Starting Storage: | Historical |
| Refill Contingency: | No Refill |
| Loss of Gas Fired Gen. | Off |
| Nuclear Contingency: | Off |
| Plant Outage: | None |
| Import Scenario: | 900 MW |

| Export Reductions | |
|---|---|
| Total Hrs. | 17 |
| Total MWh | 10,839 |
| Avg. MW | 26.6 |

| SCR Deployment | |
|---|---|
| Total Hrs. | 4 |
| Total MWh | 1,328 |
| Avg. MW | 3.3 |

| Reserve Violations | |
|---|---|
| Total Hrs. | 0 |
| Total MWh | 0 |
| Avg. MW | 0.0 |

| Loss of Load | |
|---|---|
| Total Hrs. | 0 |
| Total MWh | 0 |
| Avg. MW | 0.0 |
| First Hour with Losses | |

**Emergency Actions at End of Modeling Period, No Reserve Violations or Potential for Loss of Load**

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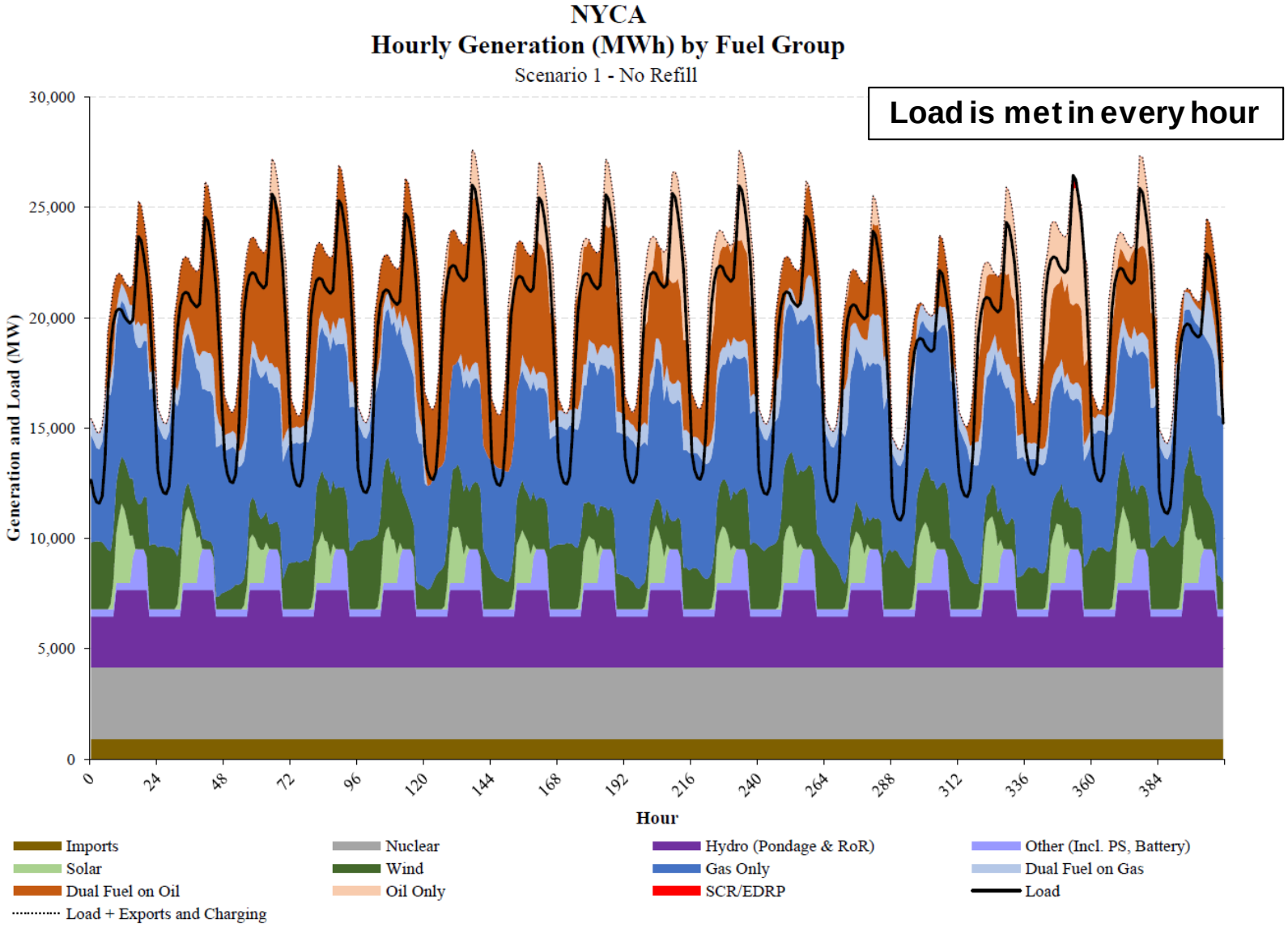
## Sample Output (NYCA): Case with Moderate Disruptions and Emergency Actions



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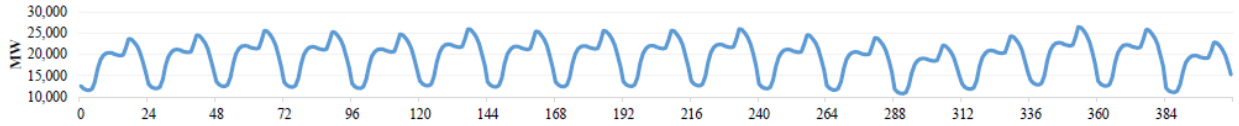
# Sample Output: Case with Severe Disruptions and Emergency Actions

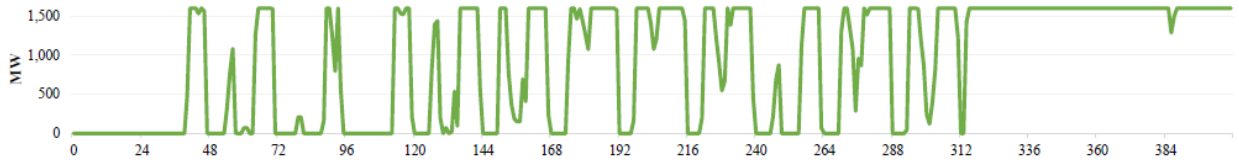
## Hourly Results Summary

**Case Name:** Scenario 7 - No Refill

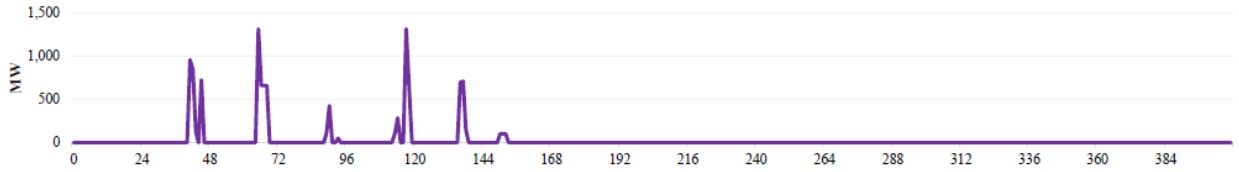
### Load During Modeling Period



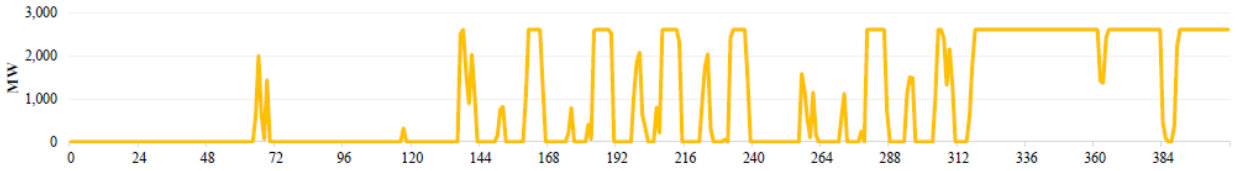

### Export to ISO-NE Reduction During Modeling Period



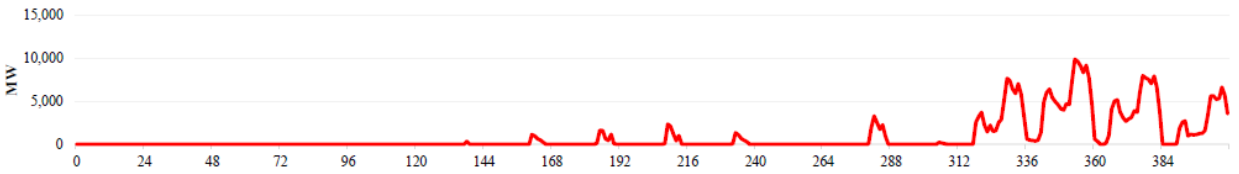

### SCR/EDRP Deployed During Modeling Period




### NYCA Reserve Violations During Modeling Period




### Loss of Load During Modeling Period




| Case Summary | |
|---|---|
| Load: | Revised Initial |
| Derate (EFORd) Increase: | Off |
| Renewables: | SRS |
| Peaker Scenario: | On |
| Starting Storage: | Historical |
| Refill Contingency: | No Refill |
| Loss of Gas Fired Gen. | Operational Experience |
| Nuclear Contingency: | Off |
| Plant Outage: | None |
| Import Scenario: | 0 MW |

| Export Reductions | |
|---|---|
| Total Hrs. | 268 |
| Total MWh | 365,097 |
| Avg. MW | 894.8 |

| SCR Deployment | |
|---|---|
| Total Hrs. | 21 |
| Total MWh | 10,753 |
| Avg. MW | 26.4 |

| Reserve Violations | |
|---|---|
| Total Hrs. | 177 |
| Total MWh | 366,196 |
| Avg. MW | 897.5 |

| Loss of Load | |
|---|---|
| Total Hrs. | 118 |
| Total MWh | 375,013 |
| Avg. MW | 919.1 |
| First Hour with Losses | 138 |

**Emergency Actions and Reserve Violations Throughout, Significant Potential for Loss of Load at End of Modeling Period**

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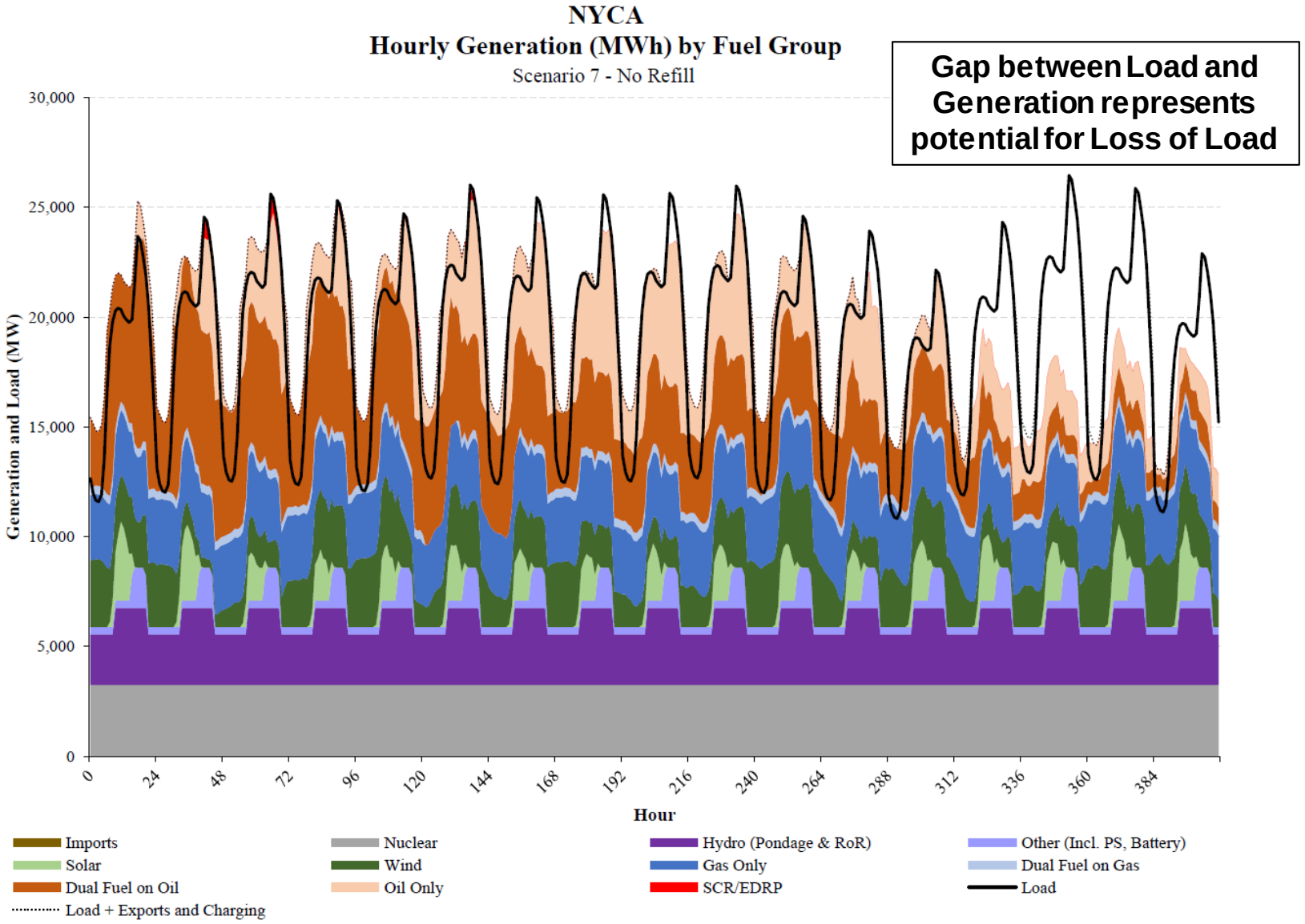
## Sample Output (NYCA): Case with Severe Disruptions and Emergency Actions



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## Cases: Scenarios With No Disruptions

- 8 Scenarios were identified to represent different potential future system conditions
- AC and WNY PPTN upgrades are assumed in-service in all case runs
- Additionally, in response to stakeholder feedback, a "benchmarking" case was run

| Case | Infrastructure | Imports | Oil | Natural Gas |
|---|---|---|---|---|
| Scenarios | **REN:** delayed construction of new renewables, such that solar capacity is reduced to 38.5% and wind capacity is reduced to 48% of System Resource Shift assumed levels | **IM900:** 900 MW Capacity Imports<br>**IM0:** 0 MW Capacity Imports | **PK:** NYSDEC "Peaker Rule" retirements | **NGR:** Reduced non-firm gas availability to support ~2000 MW of gas generation in Zones A-F, ~1000 MW of gas generation in Zones G-I, and no non-firm gas generation in Zones J and K |
| | | | | |
| **Scenario 1** | | **IM900** | | |
| **Scenario 2** | | **IM900** | **PK** | |
| **Scenario 3** | | **IM0** | | |
| **Scenario 4** | | **IM0** | **PK** | |
| **Scenario 5** | | **IM900** | **PK** | **NGR** |
| **Scenario 6** | **REN** | **IM0** | **PK** | |
| **Scenario 7** | | **IM0** | **PK** | **NGR** |
| **Scenario 8** | **REN** | **IM0** | **PK** | **NGR** |

## Cases: Scenarios with Disruptions

- In each of the 8 scenarios, the same 11 disruptive event conditions were modeled:
  1. No disruptions
  2. Double unit forced outage rate compared to historical averages
  3. Loss of significant dual fuel capability (1,000 MW) in SENY (specifically, zones G-I)
  4. Loss of major nuclear facility upstate
  5. Reduction of initial oil storage by unit and oil fill max tank quantity to half of historical averages
  6. Unavailability of truck oil fuel delivery based on historical events such as snow storms
  7. Unavailability of barge oil fuel delivery based on historical events such as NYC rivers freezing
  8. Unavailability of any oil fuel delivery due to severe fuel limitations affecting both barge and truck refueling
  9. No gas-fired generation capability available in downstate zones F-K
  10. No gas-fired generation capability available anywhere in NYCA
  11. Combination of no gas-fired generation capability available anywhere in NYCA, loss of significant dual fuel capability in SENY, and unavailability of any oil refill capability

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- **Cases: Scenarios With Few or No Reliability Risks**
  - Cases with imports of 900 MW generally see few emergency actions, even with severe oil refill and non-firm gas availability restrictions
  - Barge and truck refill restrictions individually do not cause the potential for loss of load events, unless there are other system disruptions or non-firm gas availability restrictions.
  - Potential impact of the NYSDEC "Peaker Rule" in 2023 does not by itself cause the potential for load losses; transfers from upstate can replace much of the retired capacity as long as fuel is available.

- **Cases: Scenarios With Meaningful Fuel Security/Reliability Risks**
  - Generally, cases with the following disruptions related to oil storage and refill have more emergency actions, reserve violations, and potential for load losses:
    - Reduction of initial oil storage
    - Refill restrictions on both trucks and barges
    - Loss of non-firm gas for generation in F-K or NYCA
  - Potential for Loss of Load events is more pronounced in cases where capacity imports are restricted, especially on Long Island.

# Cross-Case Heat Map

| Disruptions | Winter 2023/2024 Scenarios | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Scenario 1:** Initial Conditions + IM900 | **Scenario 2:** Initial Conditions + IM900 + PK | **Scenario 3:** Initial Conditions + IM0 | **Scenario 4:** Initial Conditions + IM0 + PK | **Scenario 5:** Initial Conditions + IM900 + PK + NGR | **Scenario 6:** Initial Conditions + REN + IM0 + PK | **Scenario 7:** Initial Conditions + IM0 + PK + NGR | **Scenario 8:** Initial Conditions + REN + IM0 + PK + NGR |
| No Disruptions (Starting Conditions) | | | | | | Day 15 | Day 15 | Day 9 |
| SENY Deactivation | | | | | Day 8 | Day 15 | Day 9 | Day 6 |
| High Outage | | | Day 15 | Day 15 | Day 2 | Day 7 | Day 3 | Day 3 |
| Nuclear Outage | | Day 9 | | Day 15 | Day 2 | Day 14 | Day 2 | Day 2 |
| No Truck Refill | | | Day 10 | Day 14 | Day 8 | Day 15 | Day 9 | Day 3 |
| No Barge Refill | | Day 15 | Day 17 | Day 17 | Day 9 | Day 15 | Day 9 | Day 6 |
| No Refill | Day 15 | Day 15 | Day 15 | Day 15 | Day 8 | Day 9 | Day 6 | Day 3 |
| Non-Firm Gas Unavailable (F-K) | Day 15 | Day 8 | Day 14 | Day 15 | Day 8 | Day 6 | Day 15 | Day 6 |
| Low Fuel Inventory | Day 15 | Day 16 | Day 10 | Day 10 | Day 15 | Day 9 | Day 9 | Day 6 |
| Non-Firm Gas Unavailable (NYCA) | Day 9 | Day 2 | Day 3 | Day 2 | Day 2 | Day 2 | Day 2 | Day 2 |
| Non-Firm Gas Unavailable (NYCA) + SENY Deactivation + No Refill | Day 2 | Day 2 | Day 2 | Day 2 | Day 2 | Day 1 | Day 2 | Day 1 |

No identified concerns

Curtailing of energy-only exports to IS0-NE

SCR/EDRP activation

Reserve shortage

Potential for loss of load (first occurring after Day 7)

Potential for loss of load (first occurring on or before Day 7)

*Note: White text indicates a concern that is confined to occurring on LI only*

**Scenario Key**

REN = Delayed construction of new renewables, such that solar capacity is reduced to 38.5% and wind capacity is reduced to 48% of System Resource Shift assumed levels.

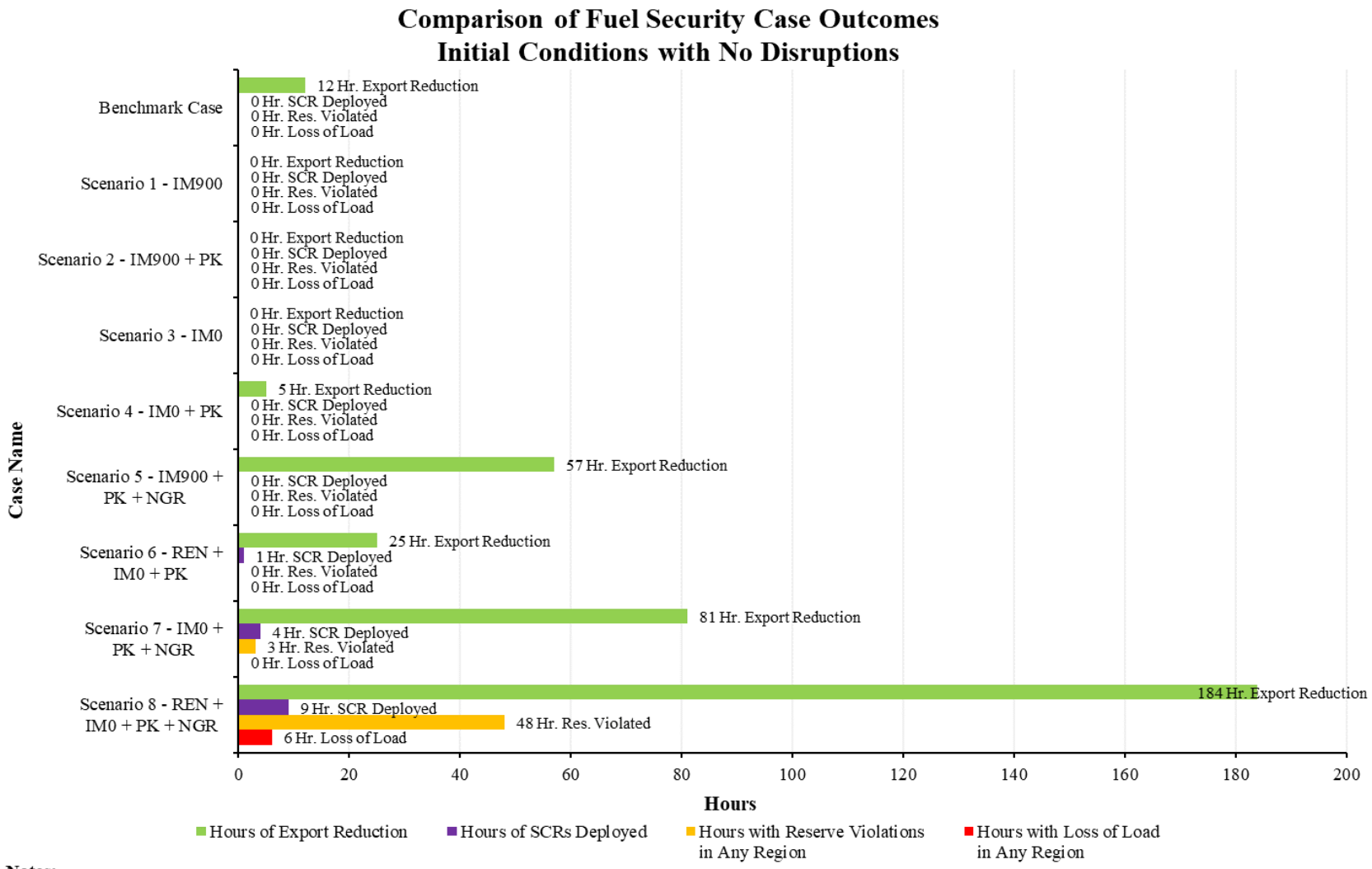
IM900 = 900 MW Capacity Imports.

IM0 = 0 MW Capacity Imports.

PK = NYSDEC "Peaker Rule" Retirements.

NGR = Reduced non-firm gas availability to support ~2000 MW of gas generation in Zones A-F, ~1000 MW of gas generation in Zones G-I, and no non-firm gas generation in Zones J and K.

# Case Results



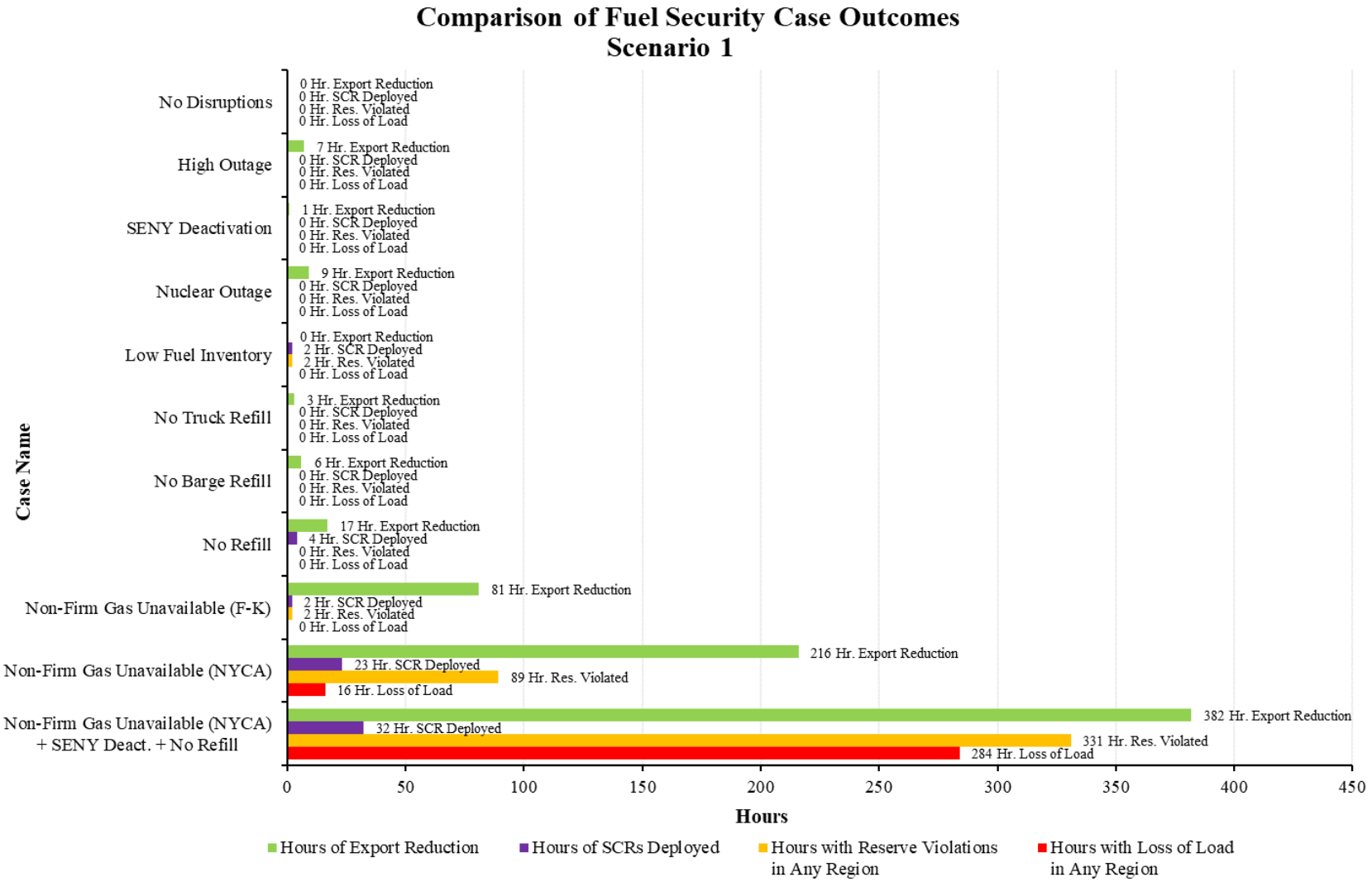

**Notes:**

[1] Initial conditions include System Resource Shift levels of renewables.

[2] REN = Delayed construction of new renewables, such that solar capacity is reduced to 38.5% and wind capacity is reduced to 48% of System Resource Shift assumed levels, IM900 = 900 MW Capacity Imports, IM0 = 0 MW Capacity Imports, PK = NYSDEC "Peaker Rule" Retirements, NGR = Reduced non-firm gas availability to support ~2000 MW of gas generation in Zones A-F, ~1000 MW of gas generation in Zones G-I, and no non-firm gas generation in Zones J and K.

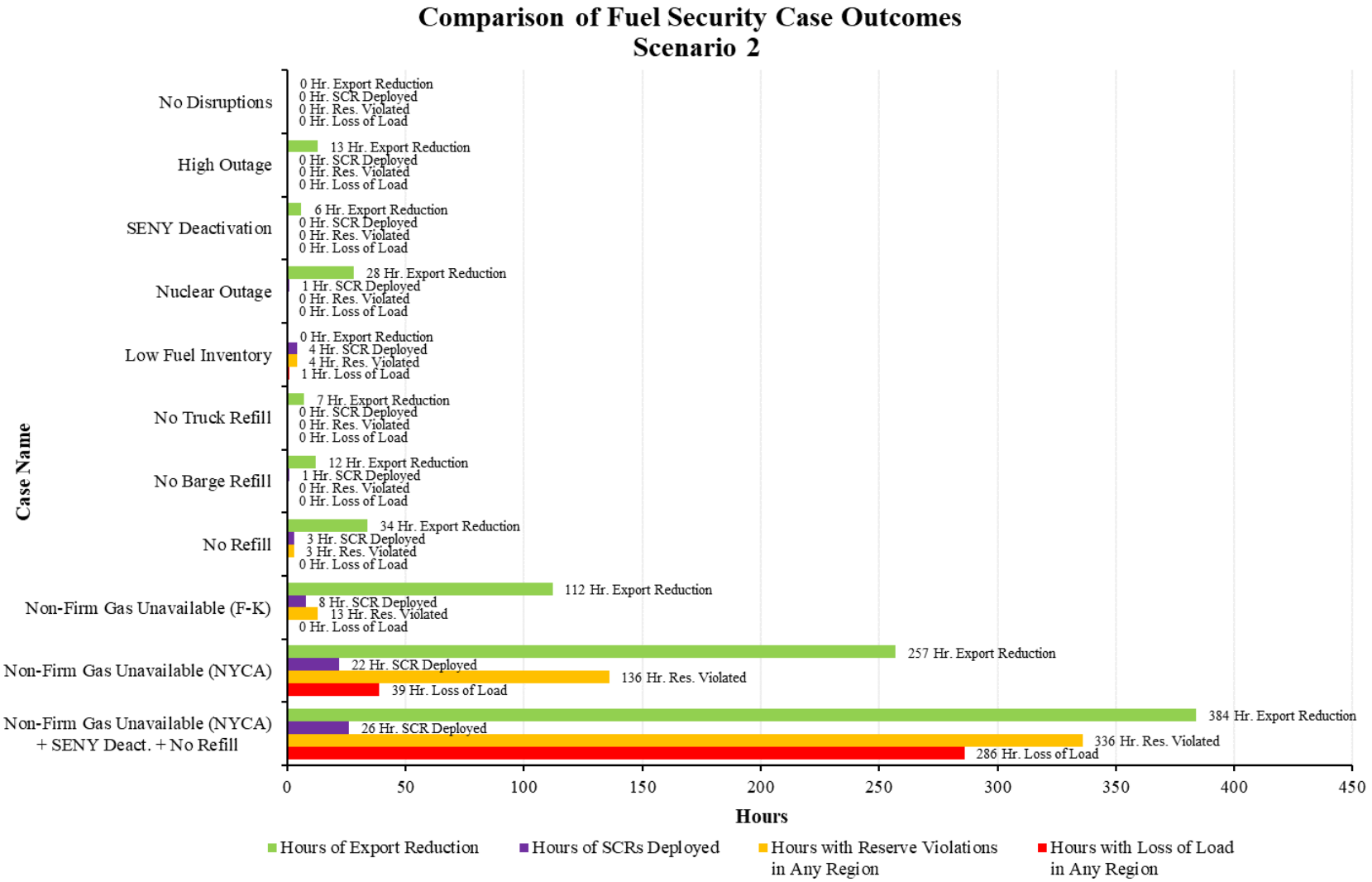
[3] Benchmark case includes delayed construction of new renewables, non-firm gas unavailable in zones G-K, and 1,600 MW of capacity imports.

# Case Results



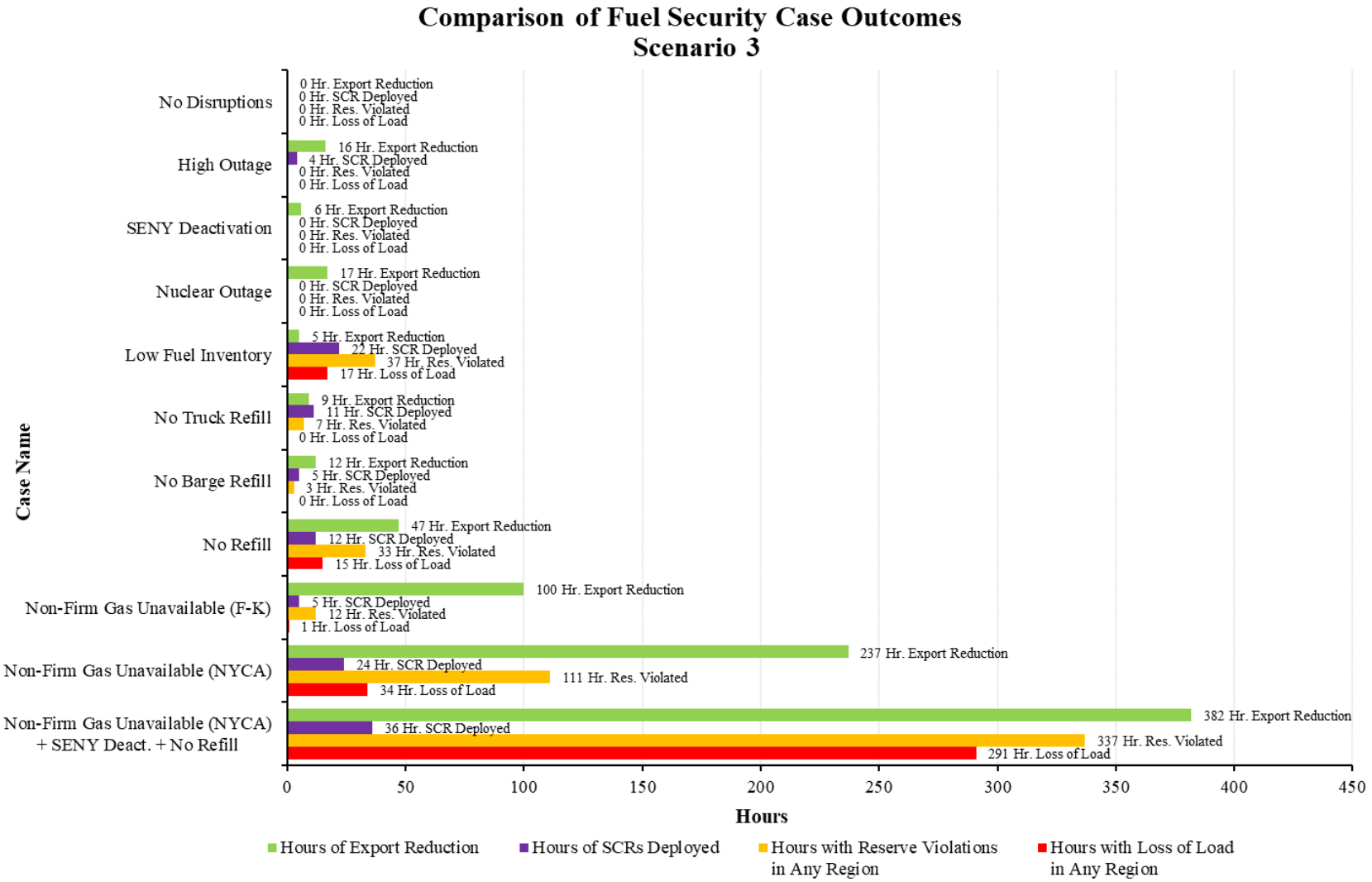

**Notes:**
[1] Initial conditions include System Resource Shift levels of renewables.
[2] Scenario 1 includes inital conditions plus 900 MW of imports, 300 MW to Zone J, and 600 MW to Zone K.

# Case Results



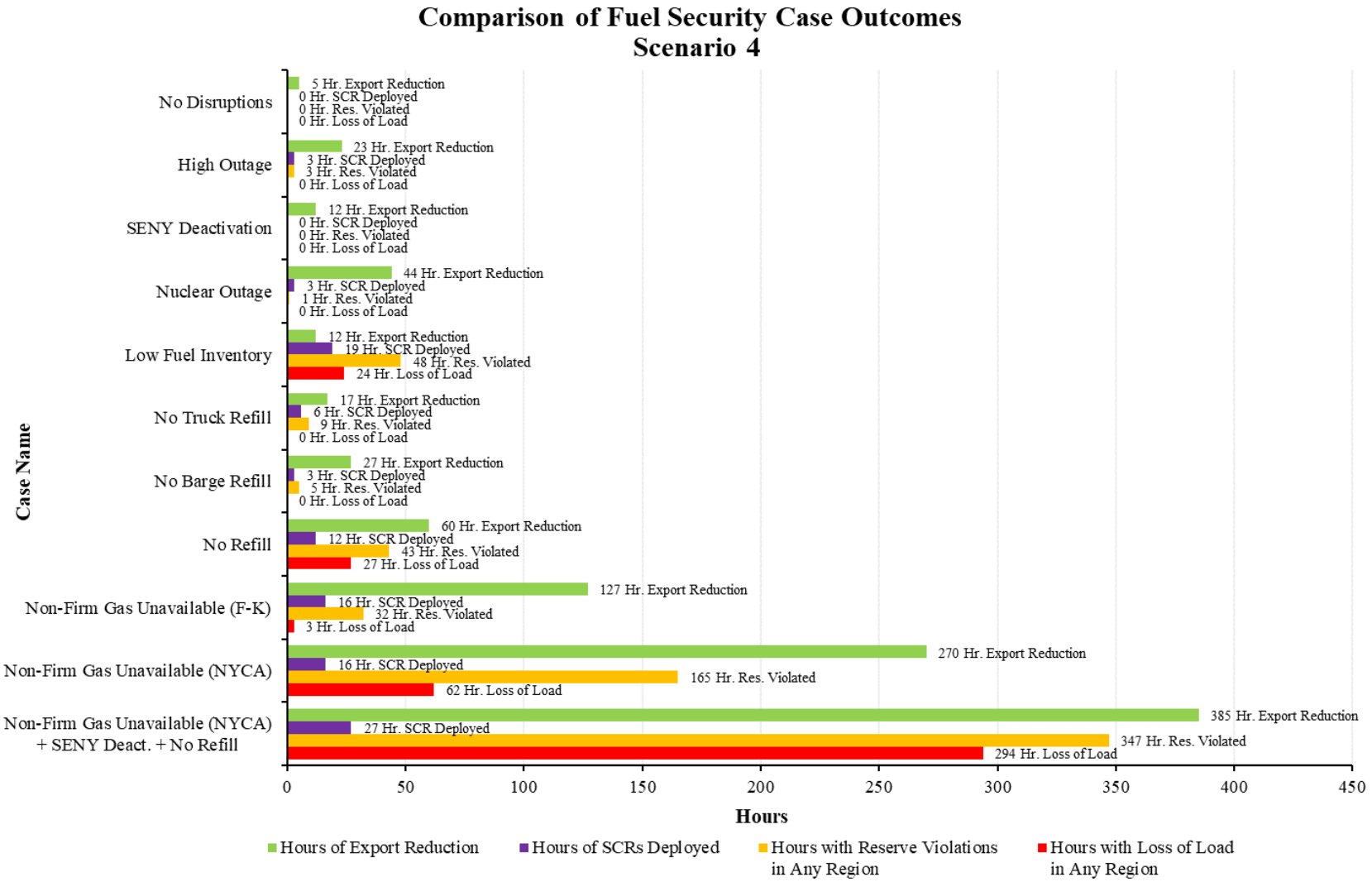

**Notes:**
[1] Initial conditions include System Resource Shift levels of renewables.
[2] Scenario 2 includes inital conditions with 900 MW capacity imports and assumed retirements due to the NYSDEC "Peaker Rule".

# Case Results



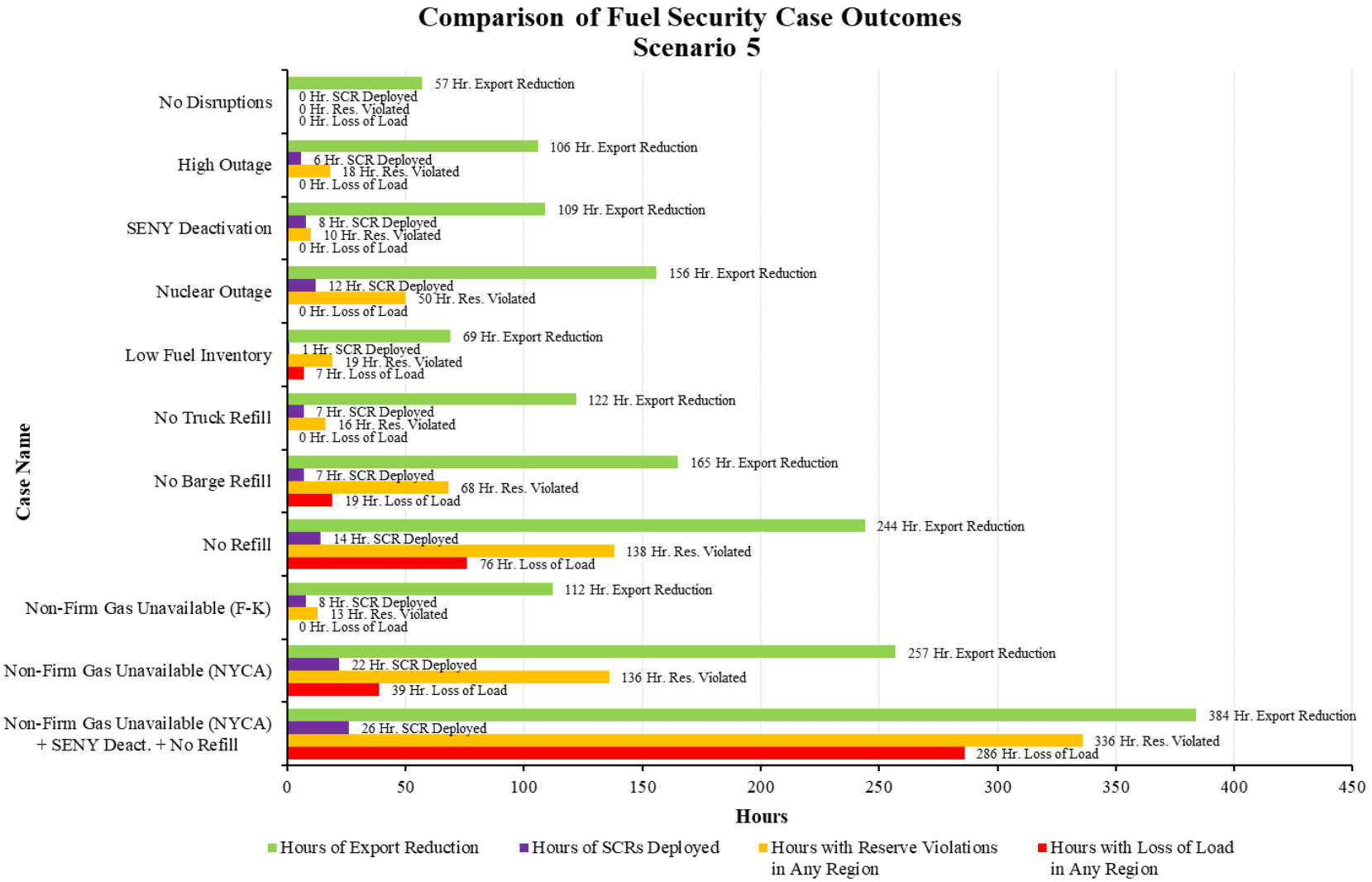

**Notes:**
[1] Initial conditions include System Resource Shift levels of renewables.
[2] Scenario 3 includes inital conditions with 0 MW capacity imports.

# Case Results




**Notes:**
[1] Initial conditions include System Resource Shift levels of renewables.
[2] Scenario 4 includes inital conditions with 0 MW capacity imports and assumed retirements due to the NYSDEC "Peaker Rule".

# Case Results

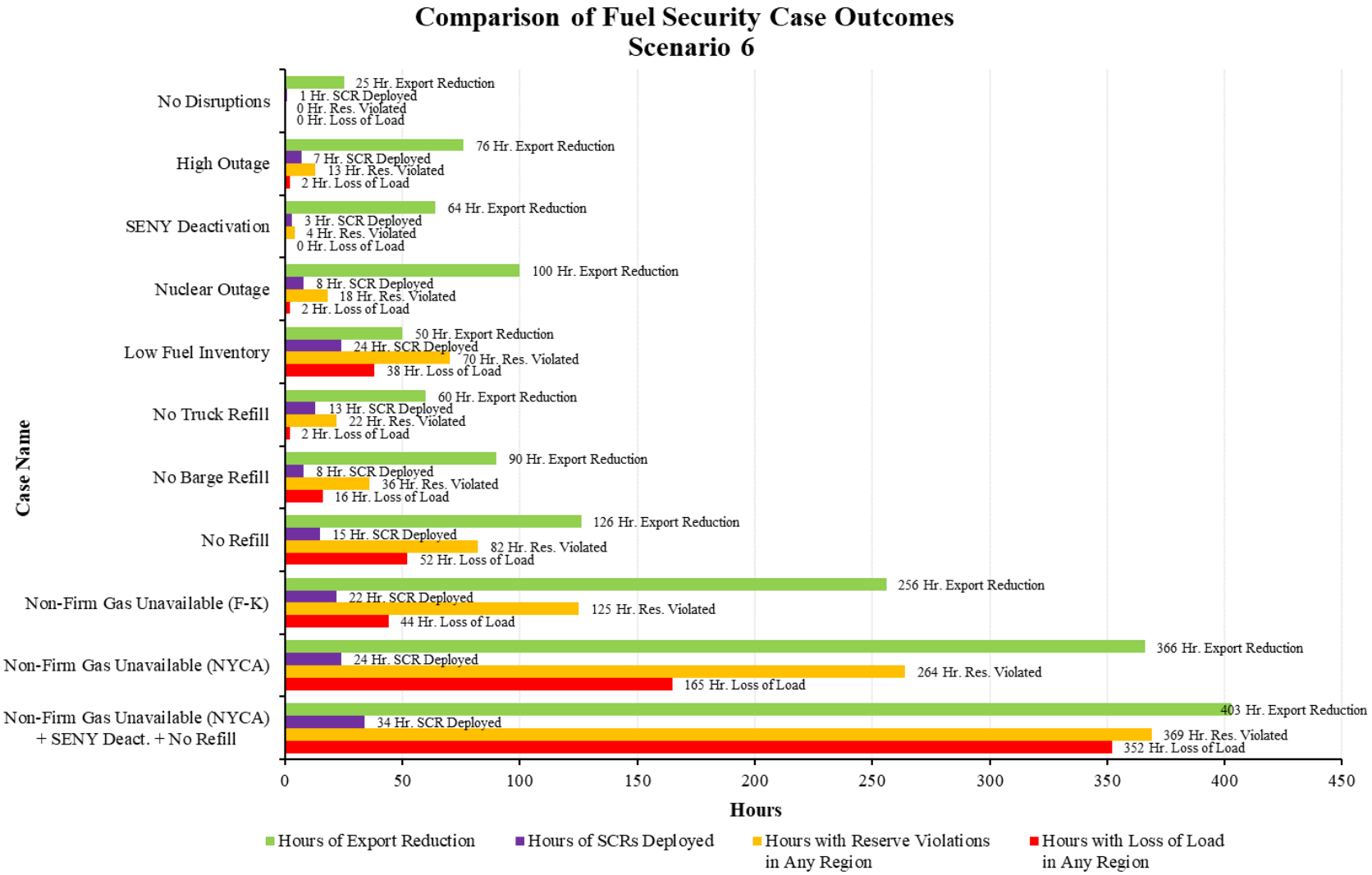



**Notes:**

[1] Initial conditions include System Resource Shift levels of renewables.

[2] Scenario 5 includes inital conditions with 900 MW capacity imports, assumed retirements due to the NYSDEC "Peaker Rule", and reduced non-firm gas availability to support ~2000 MW of gas generation in Zones A-F, ~1000 MW of gas generation in Zones G-I, and no non-firm gas generation in Zones J and K.

# Case Results

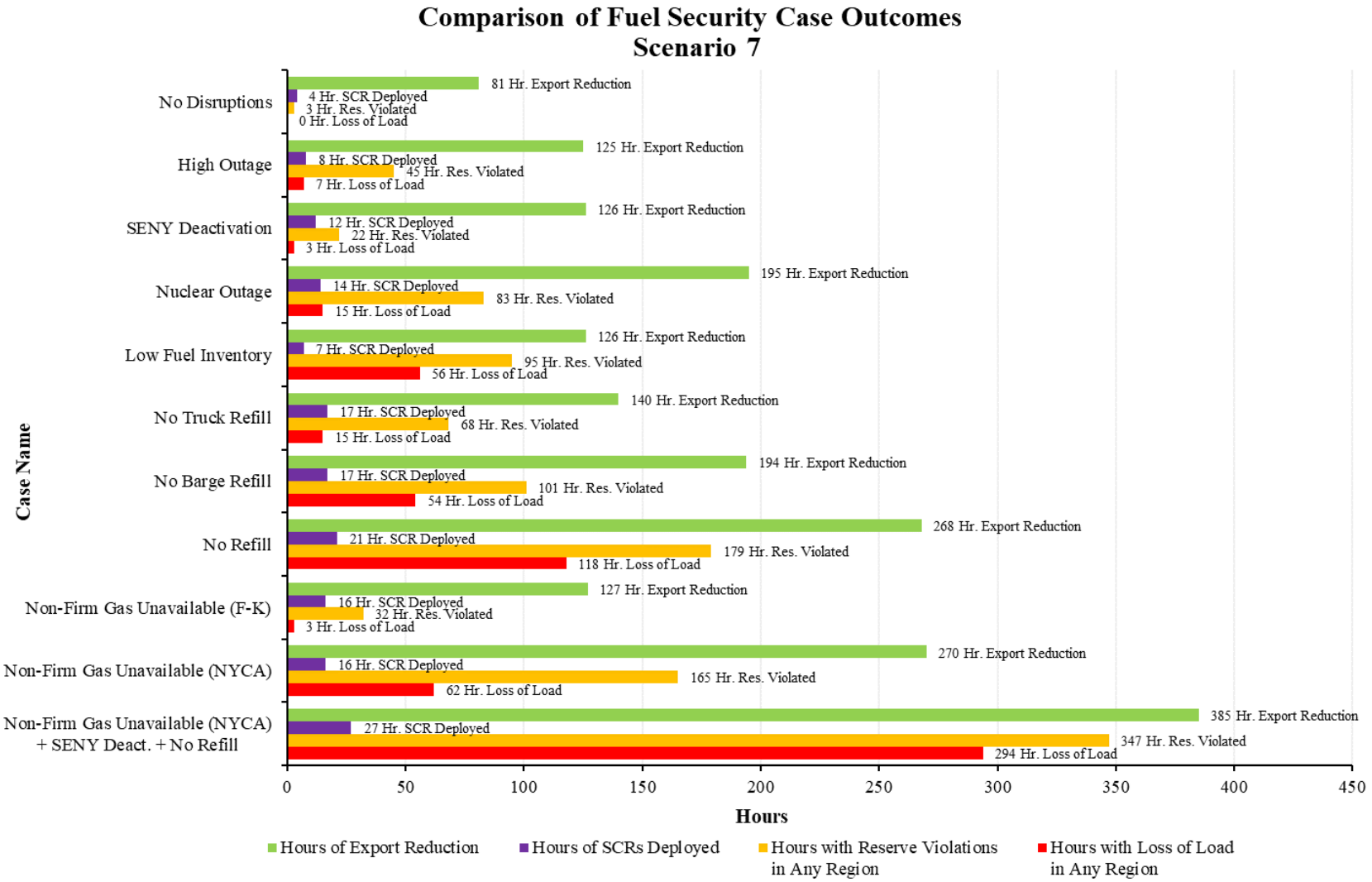



**Notes:**

[1] Initial conditions include System Resource Shift levels of renewables.

[2] Scenario 6 includes inital conditions with 0 MW capacity imports, assumed retirements due to the NYSDEC "Peaker Rule", and delayed construction of new renewables, such that solar capacity is reduced to 38.5% and wind capacity is reduced to 48% of System Resource Shift assumed levels.

# Case Results

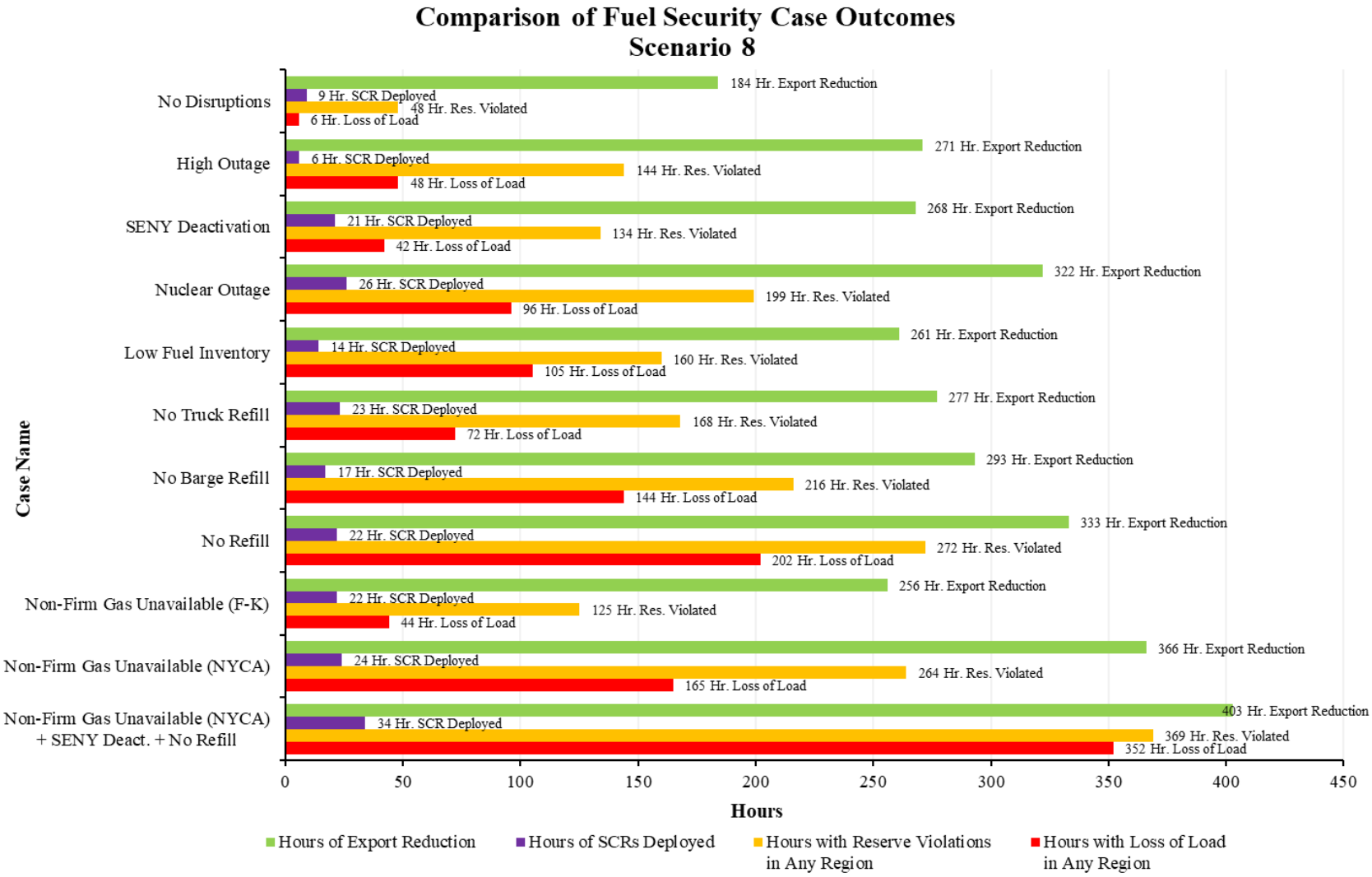



**Notes:**

[1] Initial conditions include System Resource Shift levels of renewables.

[2] Scenario 7 includes inital conditions with 0 MW capacity imports, assumed retirements due to the NYSDEC "Peaker Rule", and reduced non-firm gas availability to support ~2000 MW of gas generation in Zones A-F, ~1000 MW of gas generation in Zones G-I, and no non-firm gas generation in Zones J and K.

# Case Results




**Notes:**

[1] Initial conditions include System Resource Shift levels of renewables.

[2] Scenario 8 includes inital conditions with 0 MW capacity imports, assumed retirements due to the NYSDEC "Peaker Rule", reduced non-firm gas availability to support ~2000 MW of gas generation in Zones A-F, ~1000 MW of gas generation in Zones G-I, and no non-firm gas generation in Zones J and K, and delayed construction of new renewables, such that solar capacity is reduced to 38.5% and wind capacity is reduced to 48% of System Resource Shift assumed levels.

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# Next Steps

- Review Case Outcomes Based on Stakeholder Feedback
- Complete Additional Modeling Runs (If Any)
- Consider Key Takeaways Based on Analysis
- Presentation of Additional Findings and Observations

# Contact

Paul Hibbard, Principal
617 425 8171
paul.hibbard@analyisgroup.com

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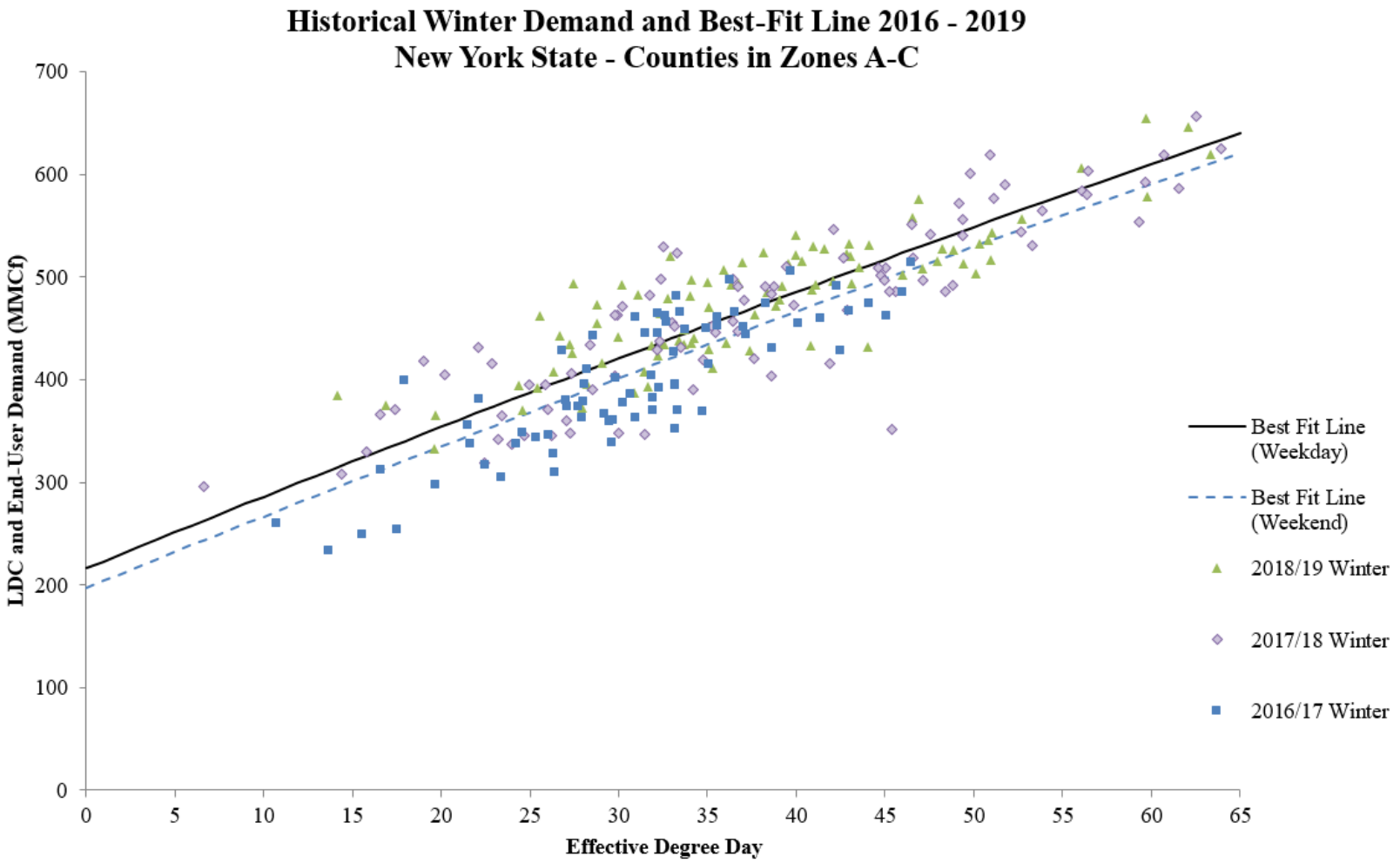
# Appendix: Adjustments to Model Data/Assumptions

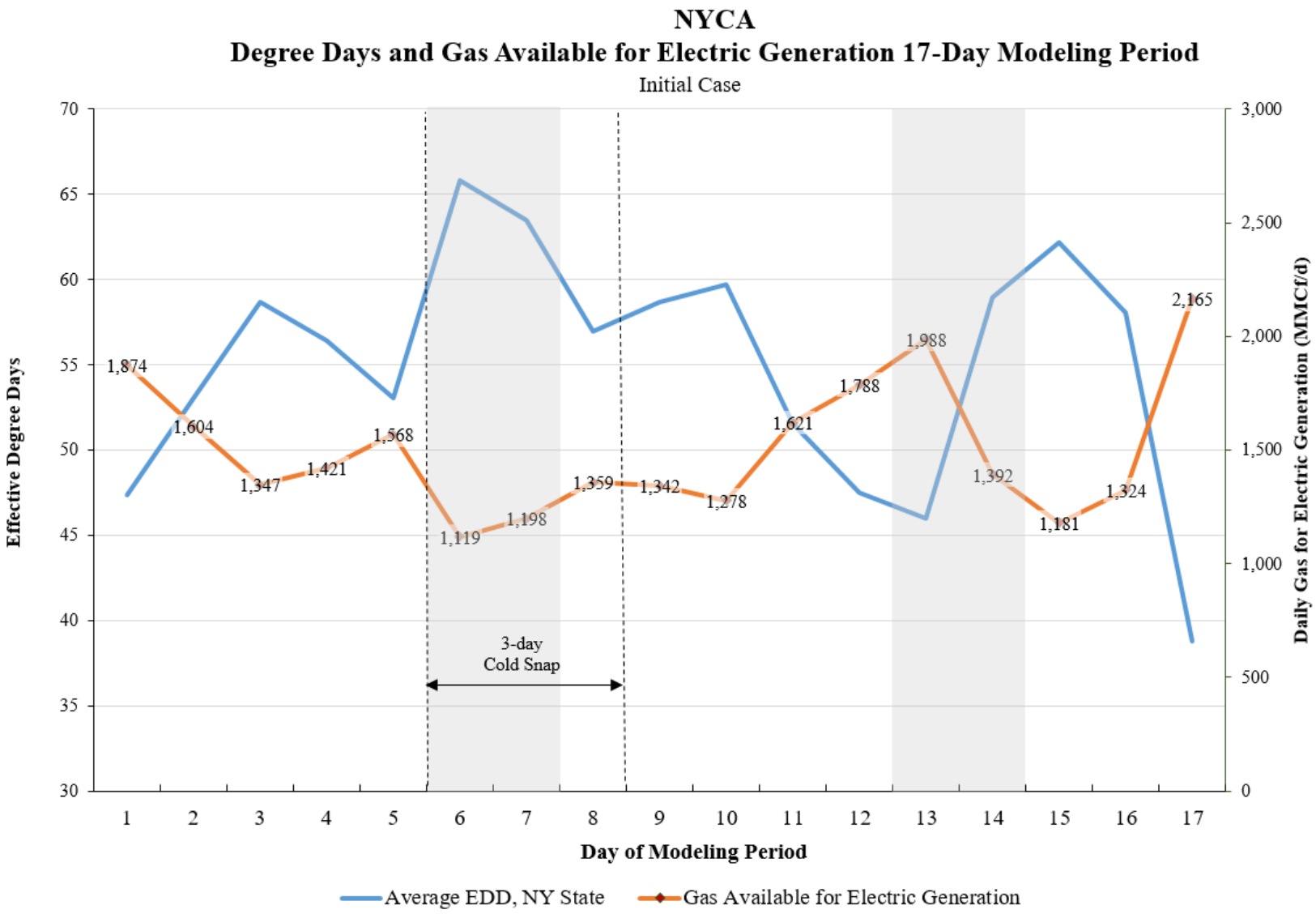
## Gas LDC Demand

- Model of daily LDC gas demand by heating effective degree day (EDD)
  - Estimated with historical winter 16/17-18/19 gas flow data using Intraday 3 nominations for upstate and downstate
  - Reduced gas demand estimated for weekends and holidays
- Upstate relationship revised to use data from all counties in Load Zones A-C, not just Erie and Niagara counties
- For each day in modeling period, total LDC gas demand for upstate and downstate is scaled based on LDC Design Day documentation
- Revised LDC demand model changes the amount of gas available for electrical generation

# LDC Demand vs Degree Day - Upstate




**Notes:**
[1] Total deliveries are the sum of scheduled capacity during the intraday 3 nomination cycle to LDCs and End Users. Chart includes all Zone A, B, and C gas points not located right next to a gas power plant.
[2] Winter is defined as December, January, and February. 16 outlier dates in winter 2016/17 were dropped due to missing data.
[3] Effective degree day is defined as 65 degrees - Dry Bulb Temperature, and is taken as the simple average of Zones A, B, and C temperature data.
**Sources:**
[A] LDC and End-User Demand: S&P Global Market Intelligence.
[B] Temperature: NYISO.




**Notes:**
[1] Weekends are shaded in gray.
[2] Effective degree day is defined as 65 degrees F - Temperature.

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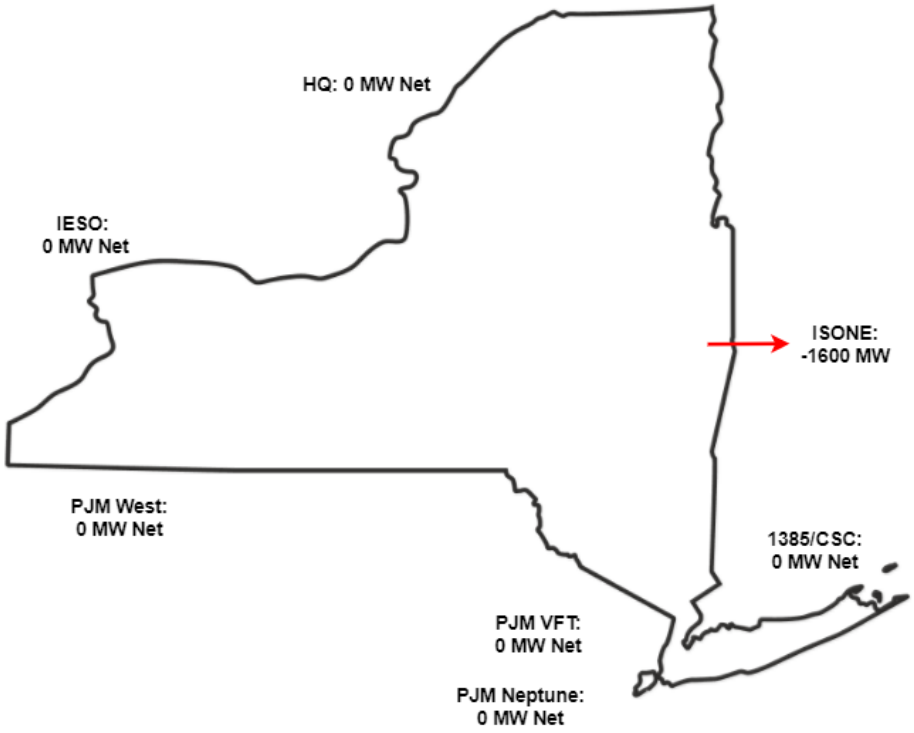
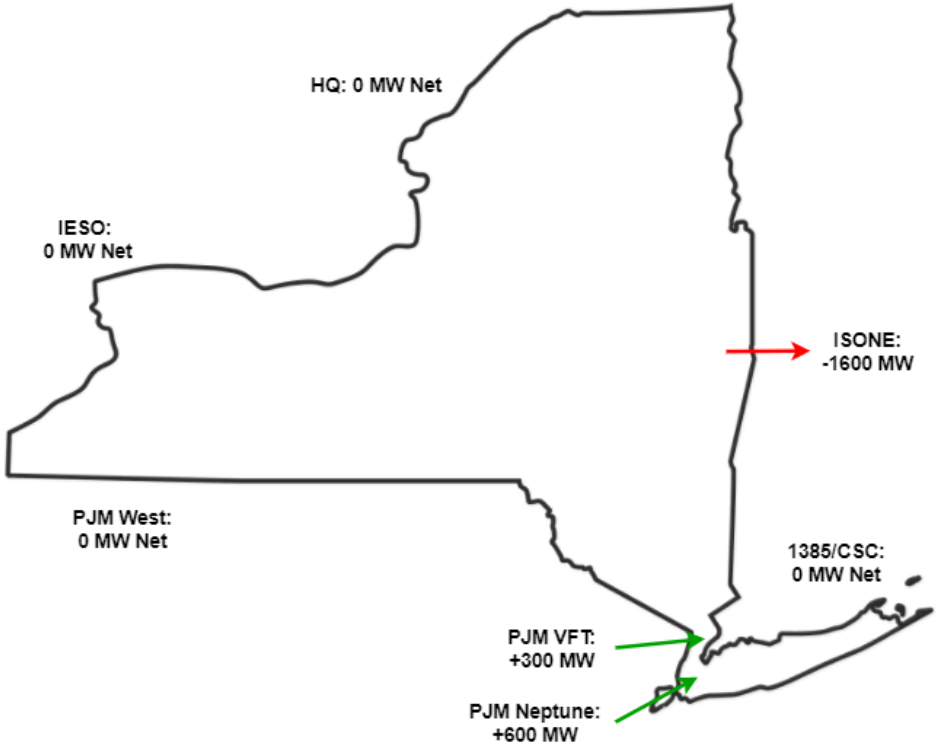
## Net Imports/Exports

- Two alternative assumptions applied with respect to external capacity imports, depending on the scenario
  - 0 MW external capacity imports; or
  - 900 MW external capacity imports

**0 MW Imports Scenario**




**900 MW Imports Scenario**



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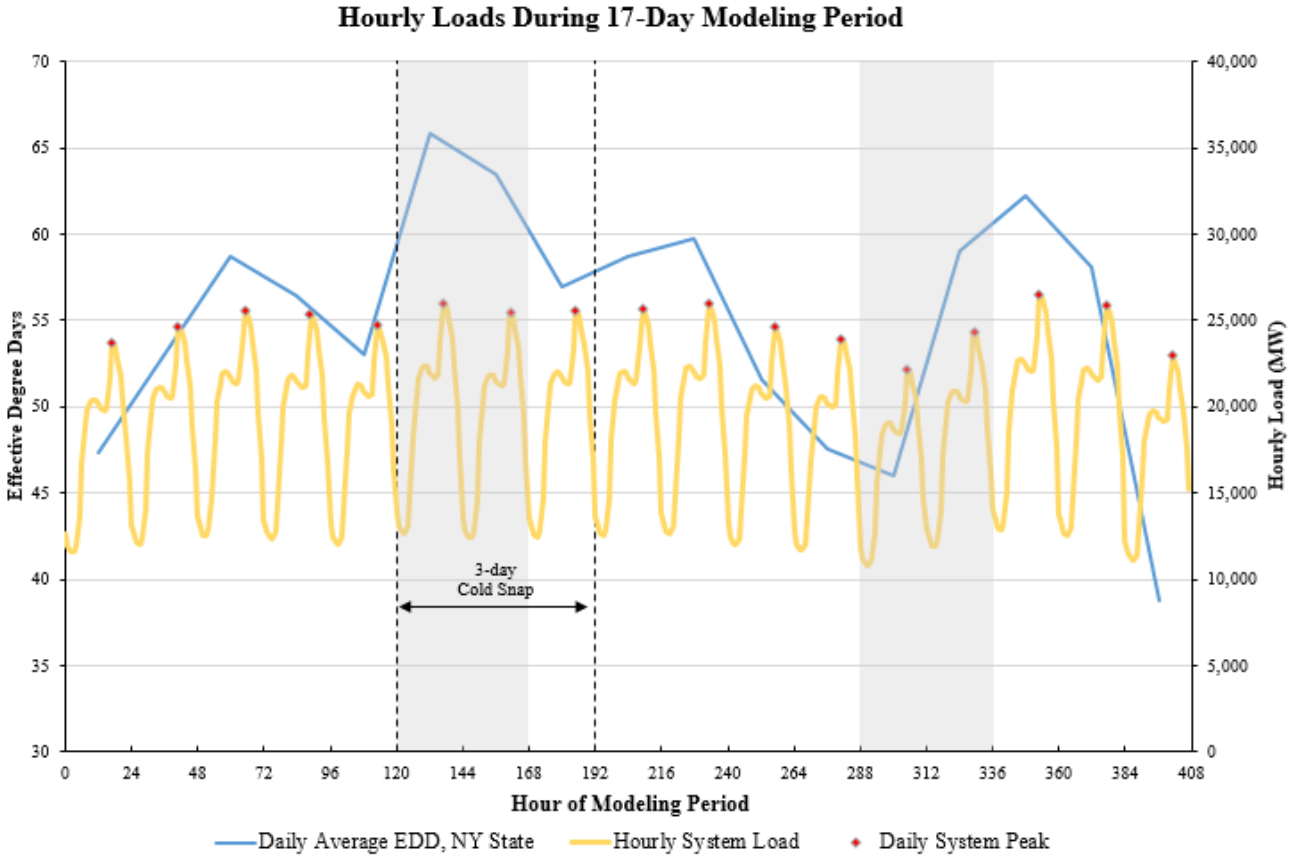
# Revised Hourly Loads

- Hourly Loads and daily peaks reduced by 7.5% to better align with operational experience
- Modeling period maximum peak hour load: 26,458 MW




**Notes:**
[1] Weekends are shaded in gray.
[2] Effective degree day is defined as 65 degrees F - Temperature.
**Source:**
[1] NYISO Weather and Load Data 1993-2018.

## Energy Storage

- Energy storage using an assumption of 4-hour resource capability and daily cycle was added to the model
  - 300 MW in NYC
  - 20 MW in zones G-I
  - 30 MW in zones A-F