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Fuel and Energy Security Study Assumptions and Data

NYISO ICAPWG/MIWG/PRLWG

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Analysis Group

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Context and Assignment

- This presentation will provide further detail on the proposed input assumptions and sources of data that feed into the fuel security model, along with alternative assumptions and system stress scenarios
- Data inputs include a combination of publicly-available data and internal NYISO data, with a preference for assumptions vetted previously by stakeholders (where possible)

Winter Periods Modeled

- AG will model three winter periods

1. 2023/24 Winter
   - The same winter period modeled in the 2019 study
   - Refresh reflects updated input data, discussed further below
   - Input data assumptions based on the 2023 Gold Book and/or 2021-2040 Outlook Baseline Case
2. 2026/27 Winter
   - Input data starting point assumptions based on the 2023 Gold Book and/or 2021-2040 Outlook Contract Case, with offshore wind online dates aligned with currently projected in-service dates reported by developers
3. 2030/31 Winter
   - Input data starting point assumptions based on the 2023 Gold Book and/or 2021-2040 Outlook Policy Case 1

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Gas Demand

- Model of anticipated daily LDC (retail) gas demand by heating degree day (HDD)
  - Using New York weather data provided by NYISO from winters 2020/21, 2021/22, and 2022/23
  - Using historical winter gas flow data from S&P Global, Intraday 3 nominations
  - Estimating gas demand separately for upstate and downstate regions
- Residual gas (available for electric generation) assumed ratable during study period – i.e., available hourly quantity for electric generation is 1/24th of daily residual quantity
  - Conservative assumption to align with the cold weather conditions being modeled in the study
- LDC gas demand is scaled in the model developed for the study so that predicted retail gas system pipeline demand for ~65-75 HDD matches documented totals for peak design day demand
  - LDCs set design-day demand to 65-75 HDD
  - Only net gas available through pipeline (not from storage or LNG) is considered as available for electric generation
    - Additional supplies available to LDCs are assumed to be reserved to meet retail demand
- Future winter period gas demand modeling in 2026/27 and 2030/31 will be adjusted to reflect estimated policy driven changes in future gas usage (e.g., impacts resulting from the ongoing implementation of the CLCPA)

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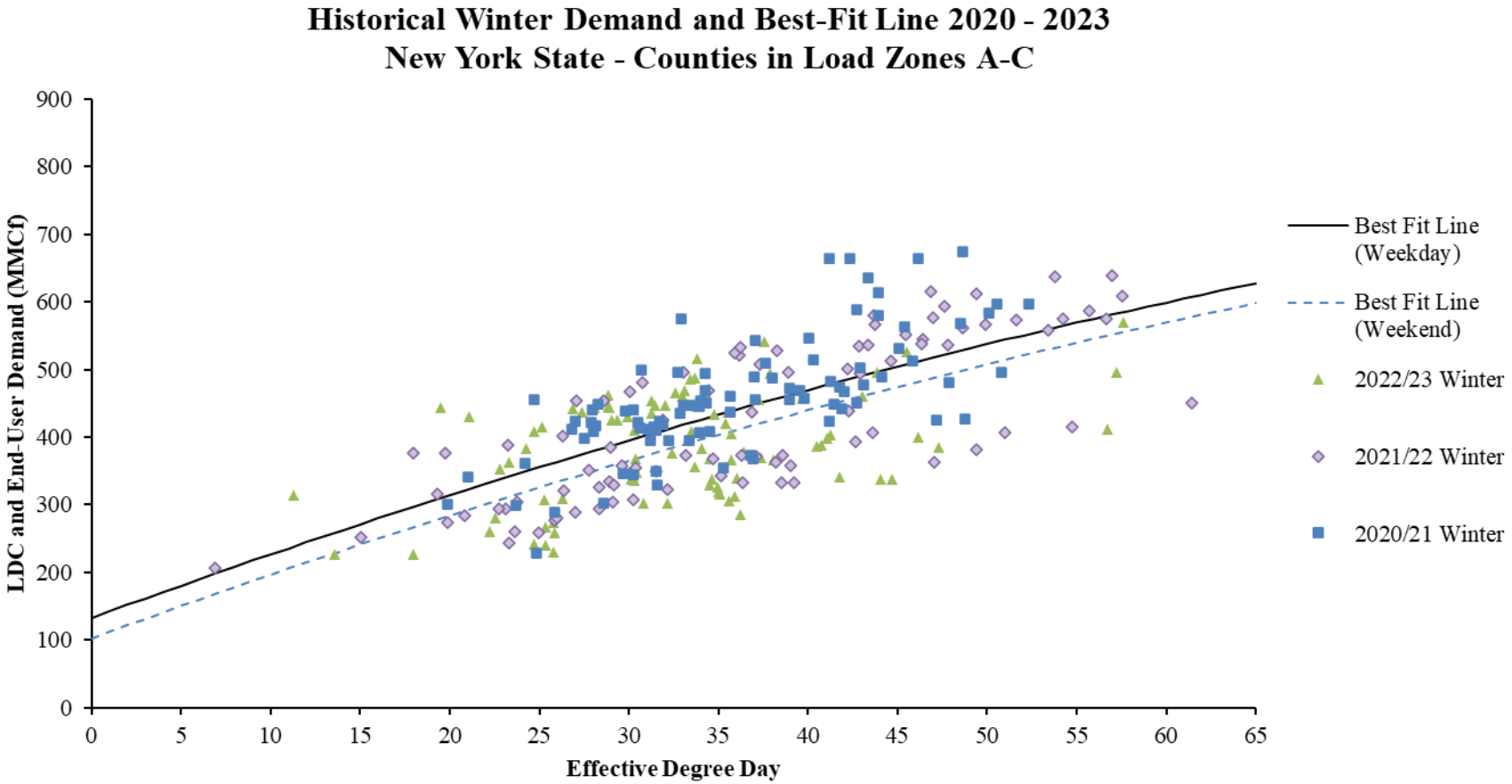
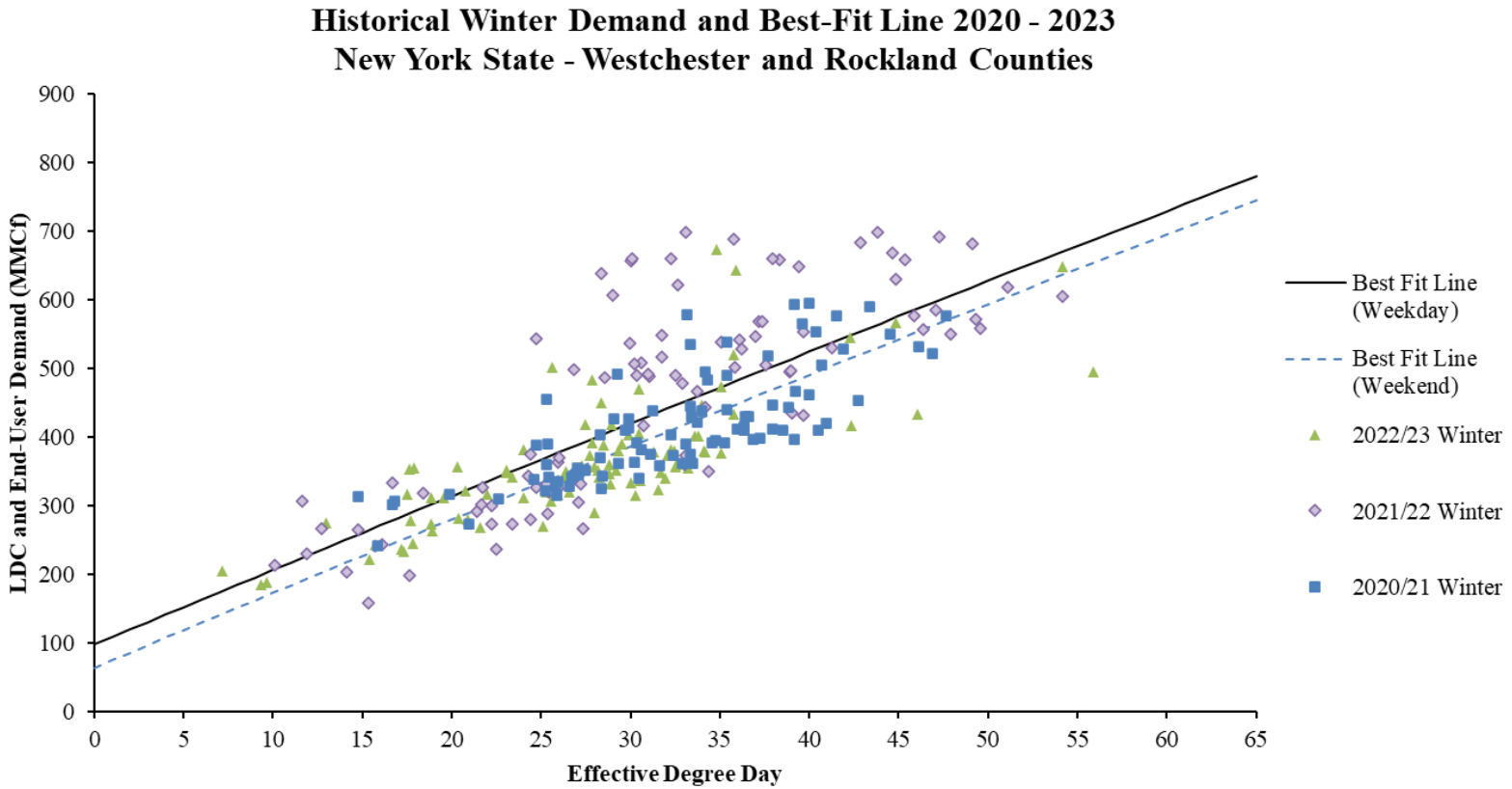
LDC Demand vs Degree Day - Upstate



Notes:
[1] Total deliveries are the sum of scheduled capacity during the intraday 3 nomination cycle to LDCs, End Users, and select Pool points. Chart includes all Load 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.
[3] Effective degree day is defined as 65 degrees - Dry Bulb Temperature, and is taken as the simple average of Load Zones A, B, and C temperature data.
Sources:
[A] LDC and End-User Demand: S&P Global Market Intelligence.
[B] Temperature: NYISO.

LDC Demand vs Degree Day – Lower Hudson Valley



Notes:
[1] Total deliveries are the sum of scheduled capacity during the intraday 3 nomination cycle to LDCs, End Users, and select Pool points. Chart includes all Westchester and Rockland county gas points not located right next to a gas power plant.
[2] Winter is defined as December, January, and February.
[3] Effective degree day is defined as 65 degrees - Dry Bulb Temperature, and is taken as the simple average of Load Zone H and Zone I temperature data.
Sources:
[A] LDC and End-User Demand: S&P Global Market Intelligence.
[B] Temperature: NYISO.

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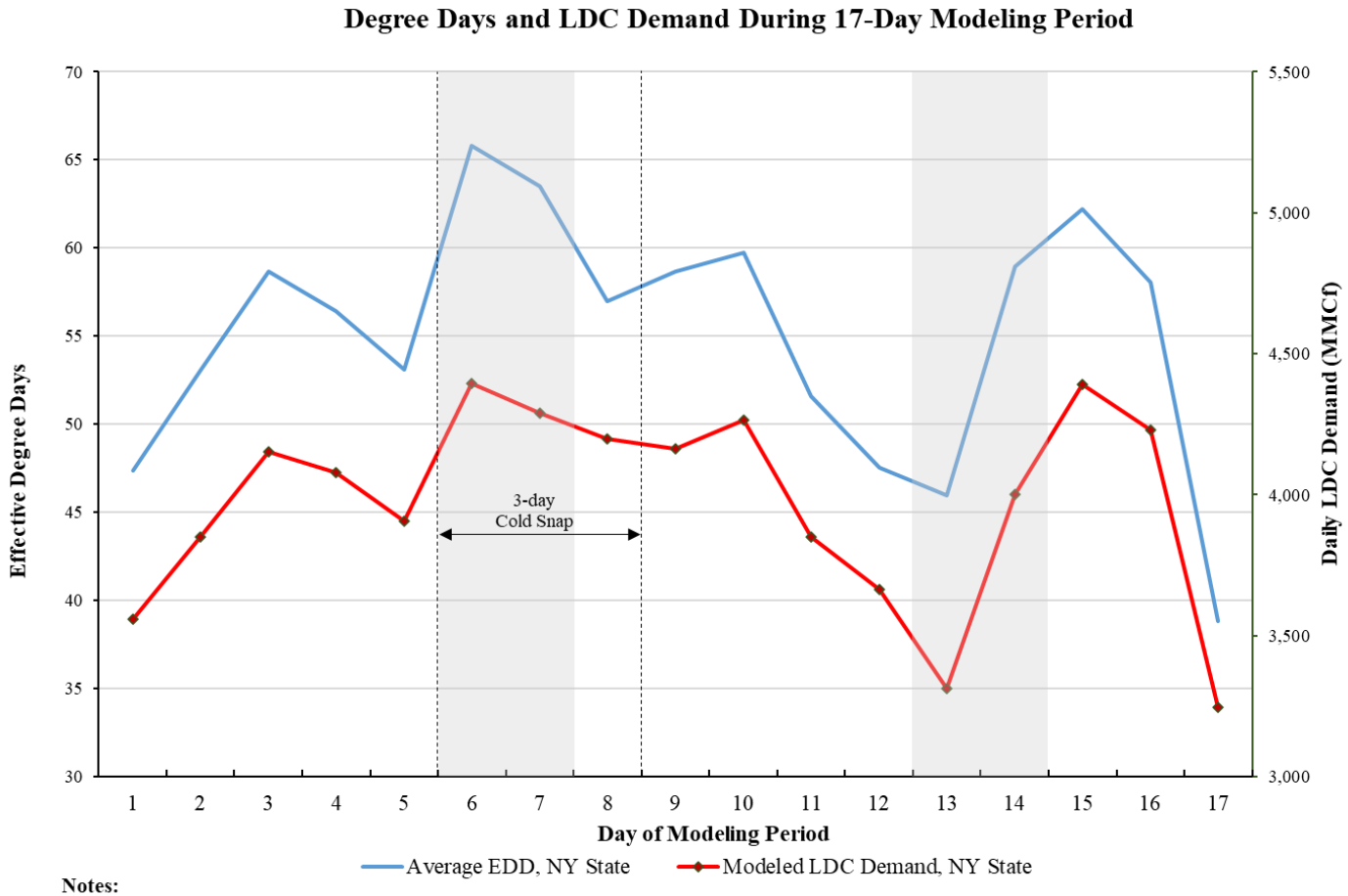
LDC Demand vs Degree Day – Modeling Period (Winter 2023/24)



Notes:
[1] Weekends are shaded in gray.
[2] Effective degree day is defined as 65 degrees F - Temperature.
Sources:
[1] NYISO Weather and Load Data 1993-2023.
[2] S&P Global Market Intelligence.

Gas Pipeline Supply

- Based on review of LDC documents, essentially all of pipeline export capacity from New York to New England is assumed to be under firm contract to deliver flowing gas or transport stored gas
- Gas available for electric generation on LDC Design Day = [Expected Pipeline Imports
  - Max Pipeline Exports to NE
  - LDC Design Day Demand]
- No LNG or storage capacity is assumed to be available for delivery to generators
- Gas supply is assumed to be transferable within New York; except for certain assumed limitations downstate
  - Specifically, in Load Zones J and K, gas availability is reduced starting at effective degree days greater than 50
- Model will reflect limitations of supply to gas generators based on temperature

New York State Modeling Period Gas Supply and Demand (MMCF/d)

Gas Supply/Demand	MMCF/d	Calculation	Source
Modeling Period Supply			
Max New York State Imports from PJM	10,186	[A]	EIA
Expected New York State Imports from Ontario	400	[B]	NYISO
Gas Available within New York	***10,586***	***[C] = [A] + [B]***	
Modeling Period Demand			
Expected New York State Exports to Ontario	(100)	[D]	NYISO
Max Exports to New England	(4,087)	[E]	EIA
New York Design Day LDC Demand from Pipeline Gas	(4,805)	[F]	NYDPS
Total Outflows/LDC Demand	***(8,992)***	***[G] = [D]+[E]+[F]***	
Max Gas Available for Electric Generation in New York	**1,594**	**[H] = [C] + [G]**	
Equivalent MW of Gas Generation Capacity each Hour at 9 MMBtu/MWh Heat Rate	**7,651**	**[I] = [H] * 4.8**	

Note:
[1] Design Day LDC Demand aggregated from Winter Supply forms for New York State LDCs.

Sources:
[1] EIA, State to State Pipeline Capacity, January 31, 2023.
[2] NYDPS/NYPSC, Case 22-M-0247 - Winter Supply 2022-2023 Forms, Table 1.

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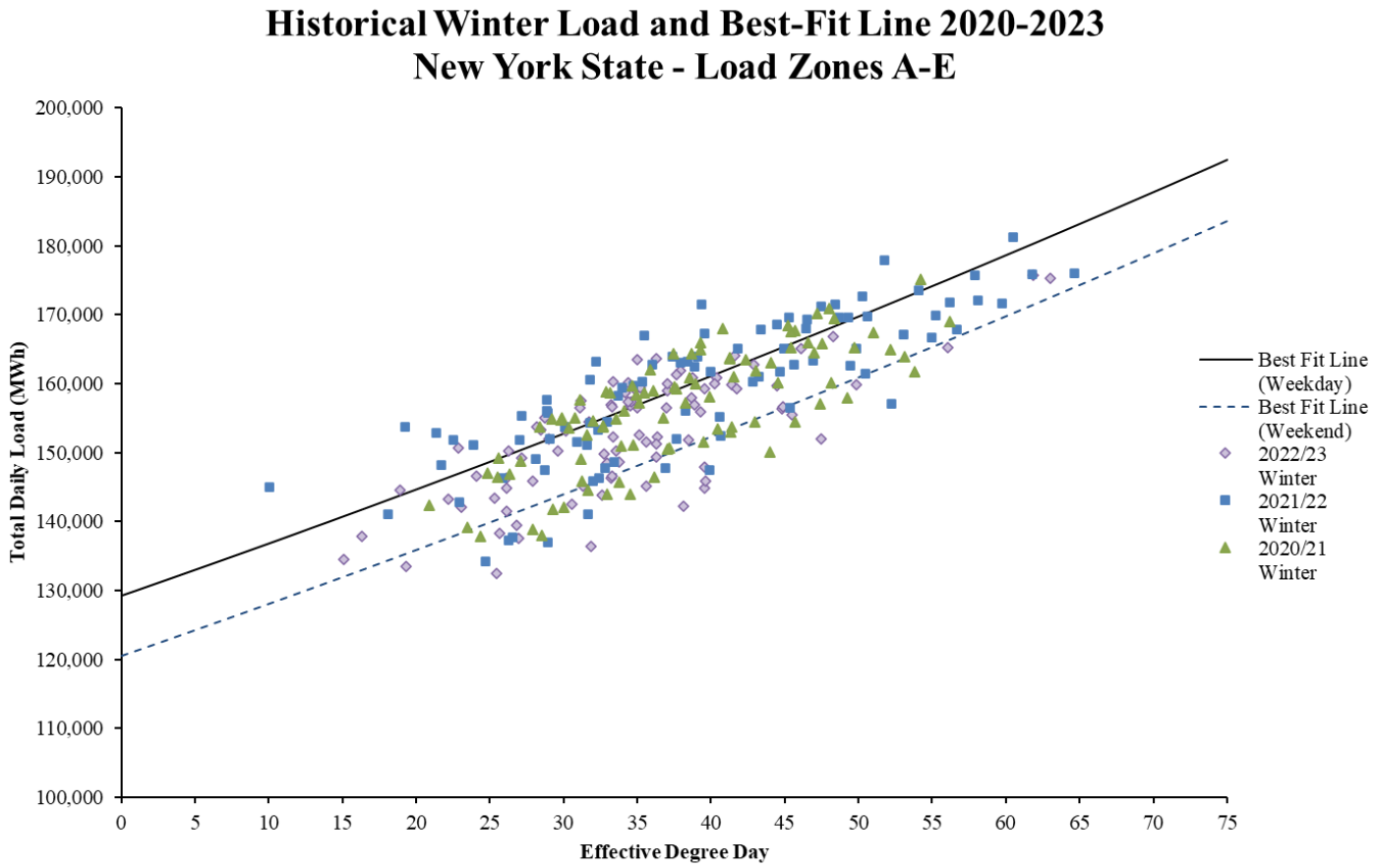
Electric Demand, Supply, and Reserves

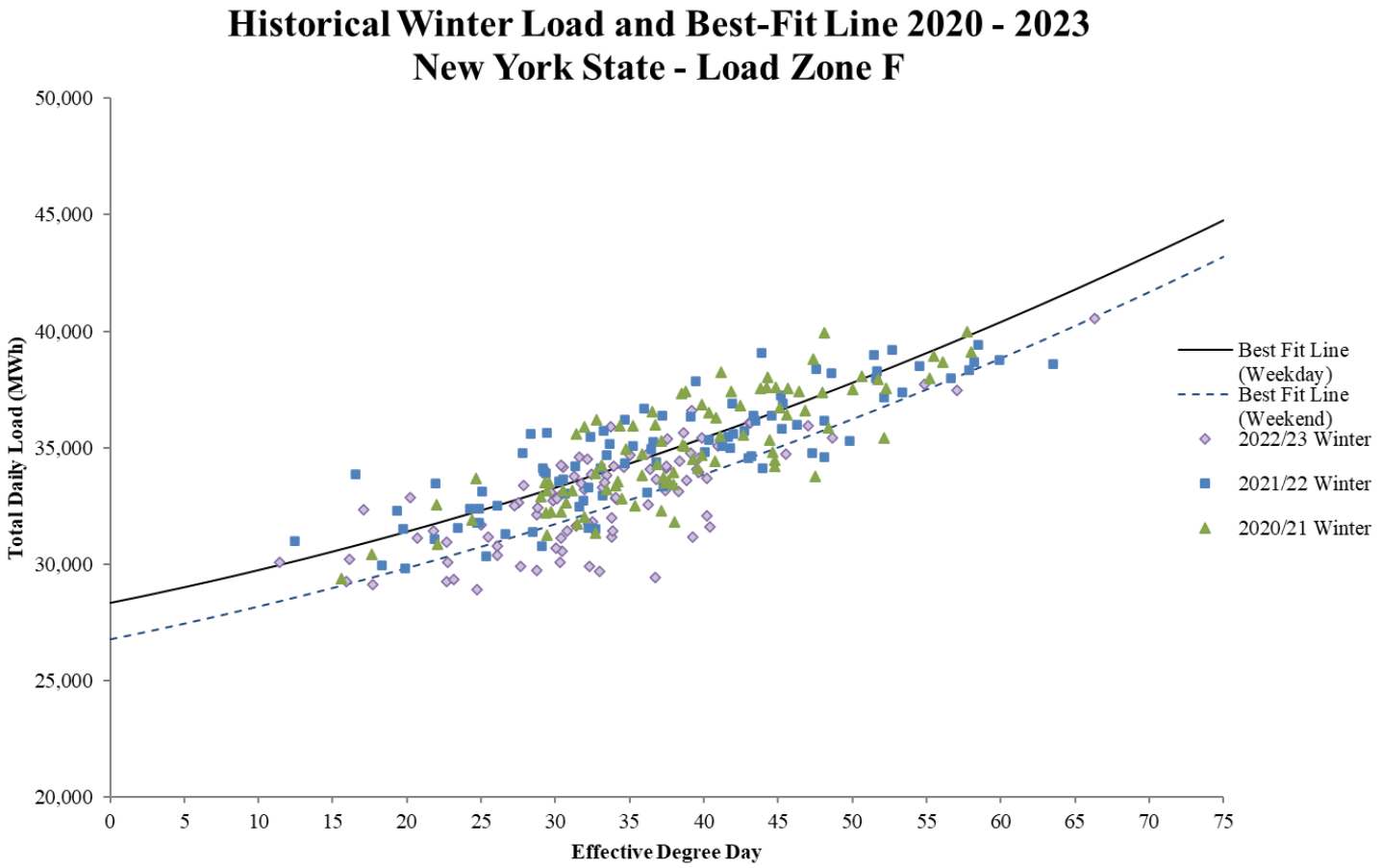
- Model of daily energy usage (in MWh) by heating effective degree day (EDD)
  - Use New York load and weather data provided by NYISO for winters 2020/21, 2021/22, and 2022/23
  - Estimated separately for each of the following regions
    - 1: Load Zones A-E
    - 2: Load Zones F
    - 3: Load Zones G-I
    - 4: Load Zones J
    - 5: Load Zones K
  - Reduced electric load estimated for weekends and holidays
- For each day in 17-day modeling period, total daily energy demand by region is scaled based on EDD from daily temperature profile

Load vs Degree Day – Load Zones A-E



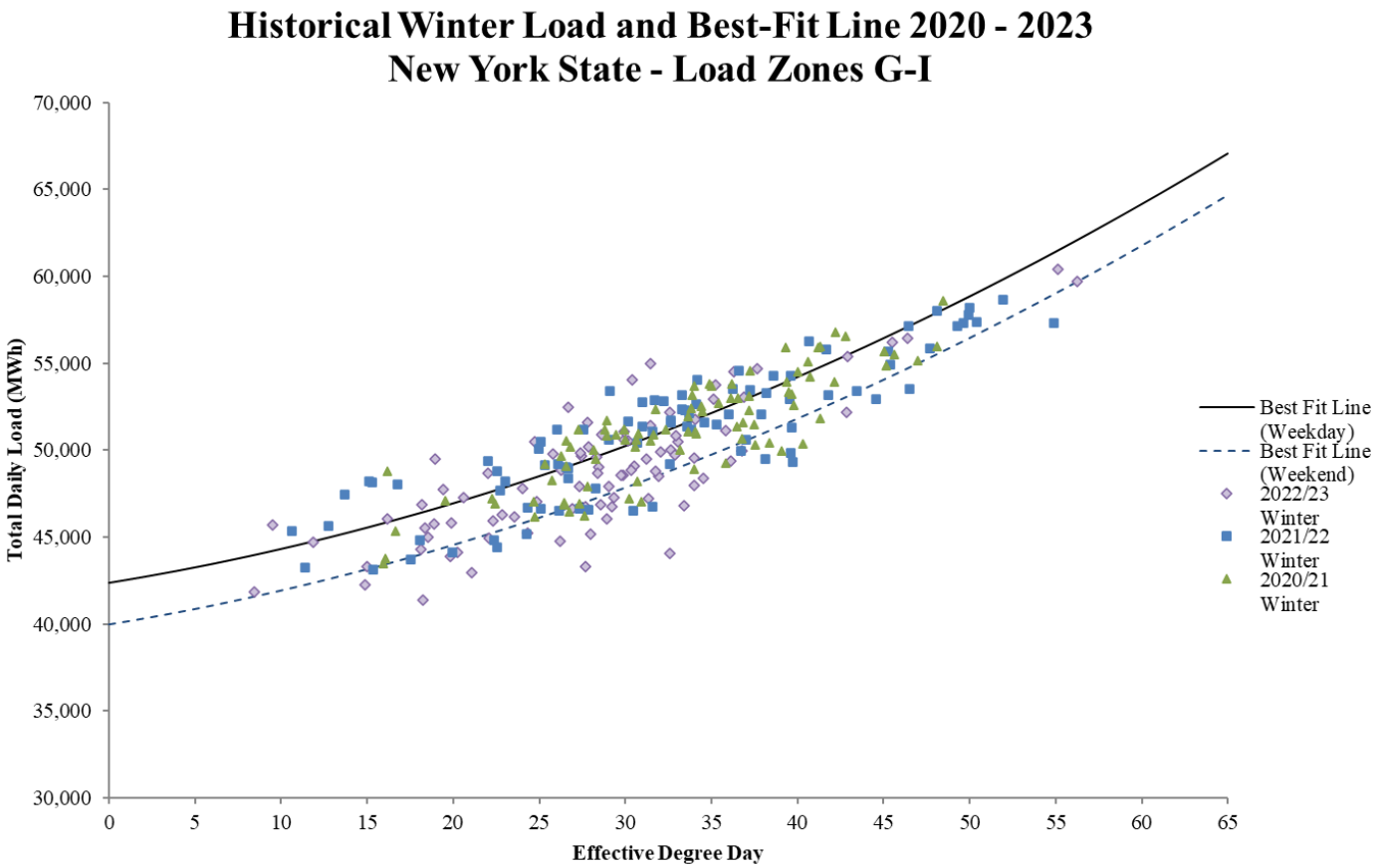
Notes:
[1] Winter is defined as December, January, and February.
[2] Effective degree day is defined as 65 degrees - Temperature.
Source:
[A] Load and Temperature: NYISO.

Load vs Degree Day – Load Zone F



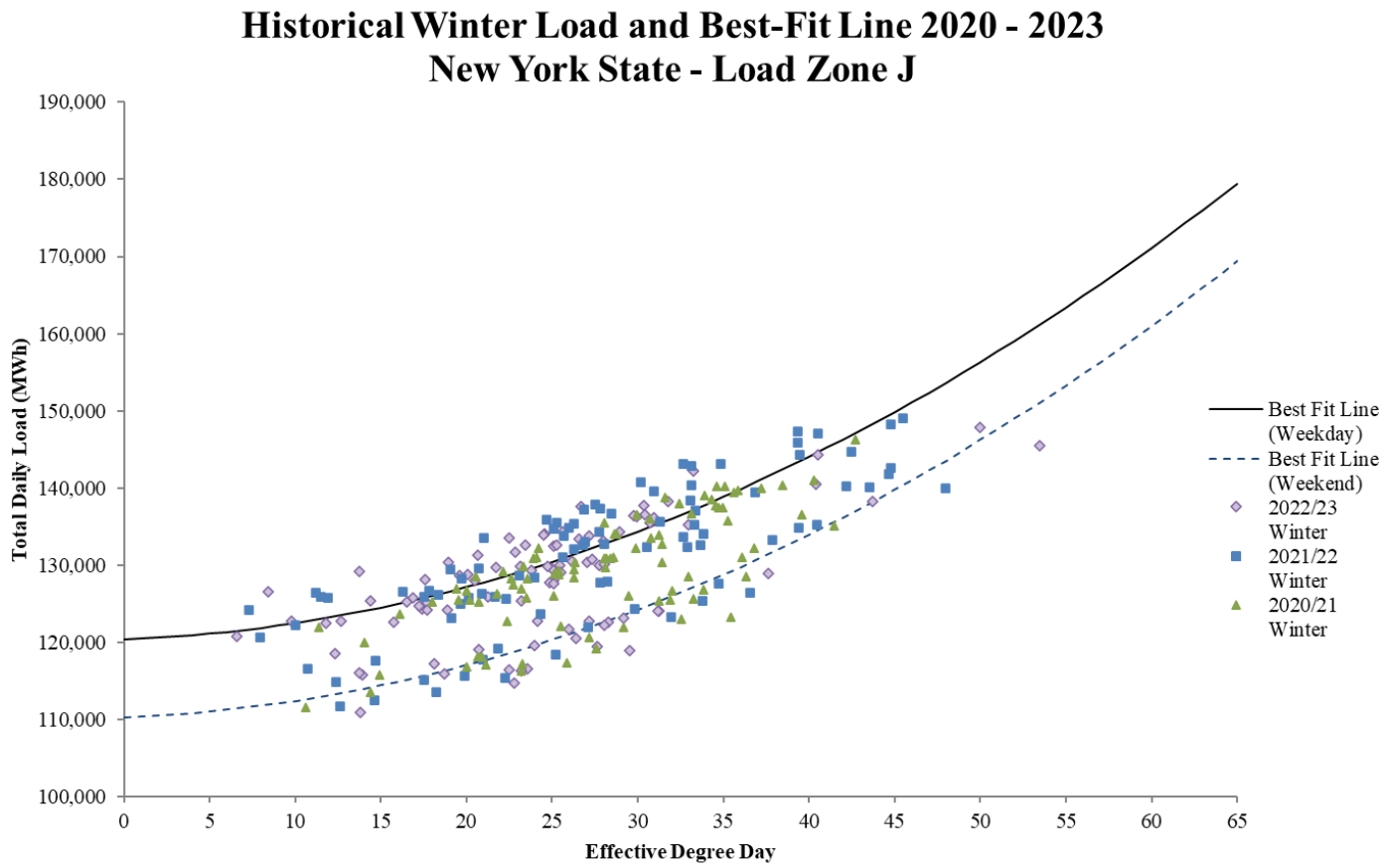
Notes:
[1] Winter is defined as December, January, and February.
[2] Effective degree day is defined as 65 degrees - Temperature.
Source:
[A] Load and Temperature: NYISO.

Load vs Degree Day – Load Zones G-I



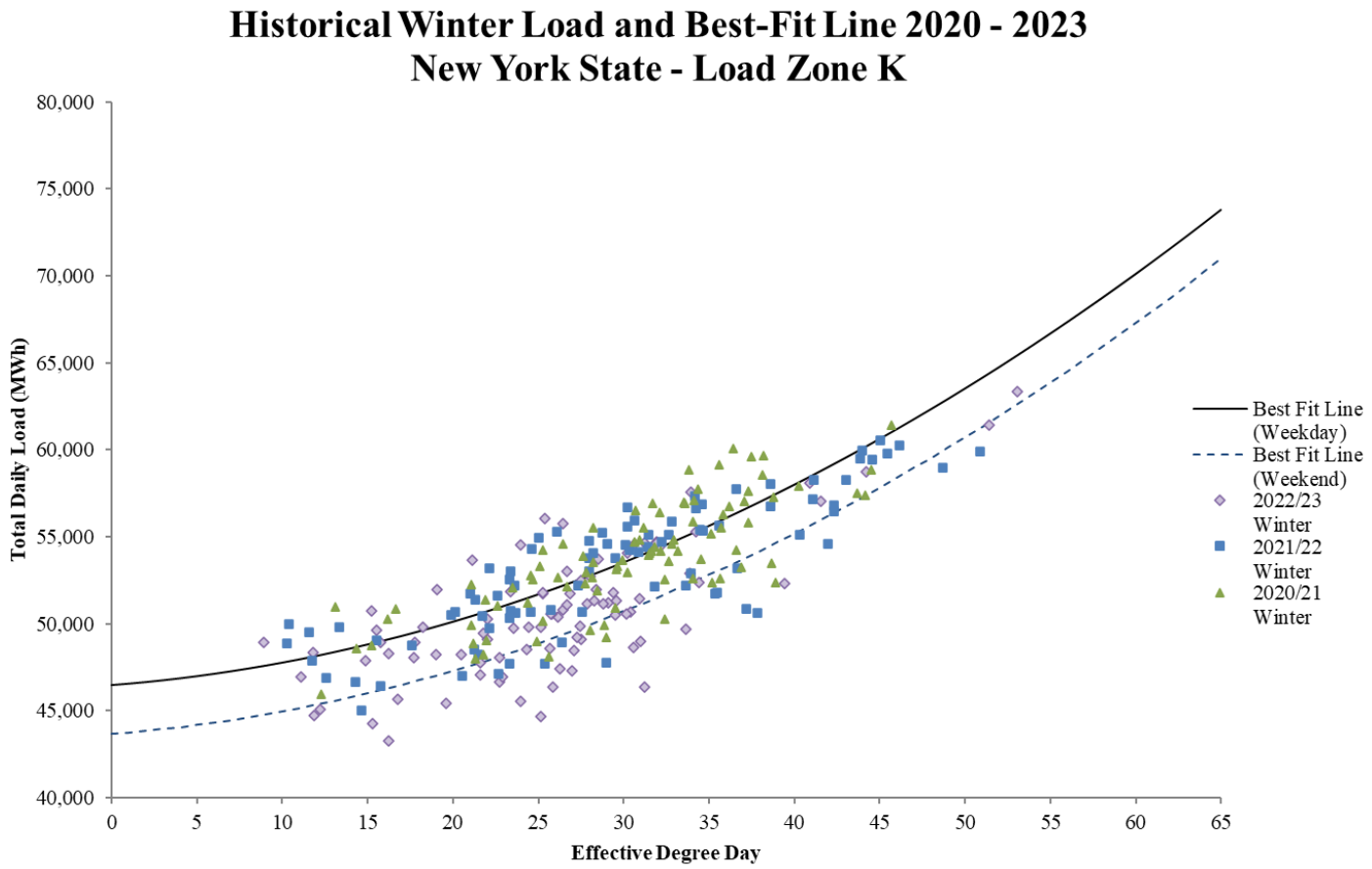
Notes:
[1] Winter is defined as December, January, and February.
[2] Effective degree day is defined as 65 degrees - Temperature.
Source:
[A] Load and Temperature: NYISO.

Load vs Degree Day – Load Zone J



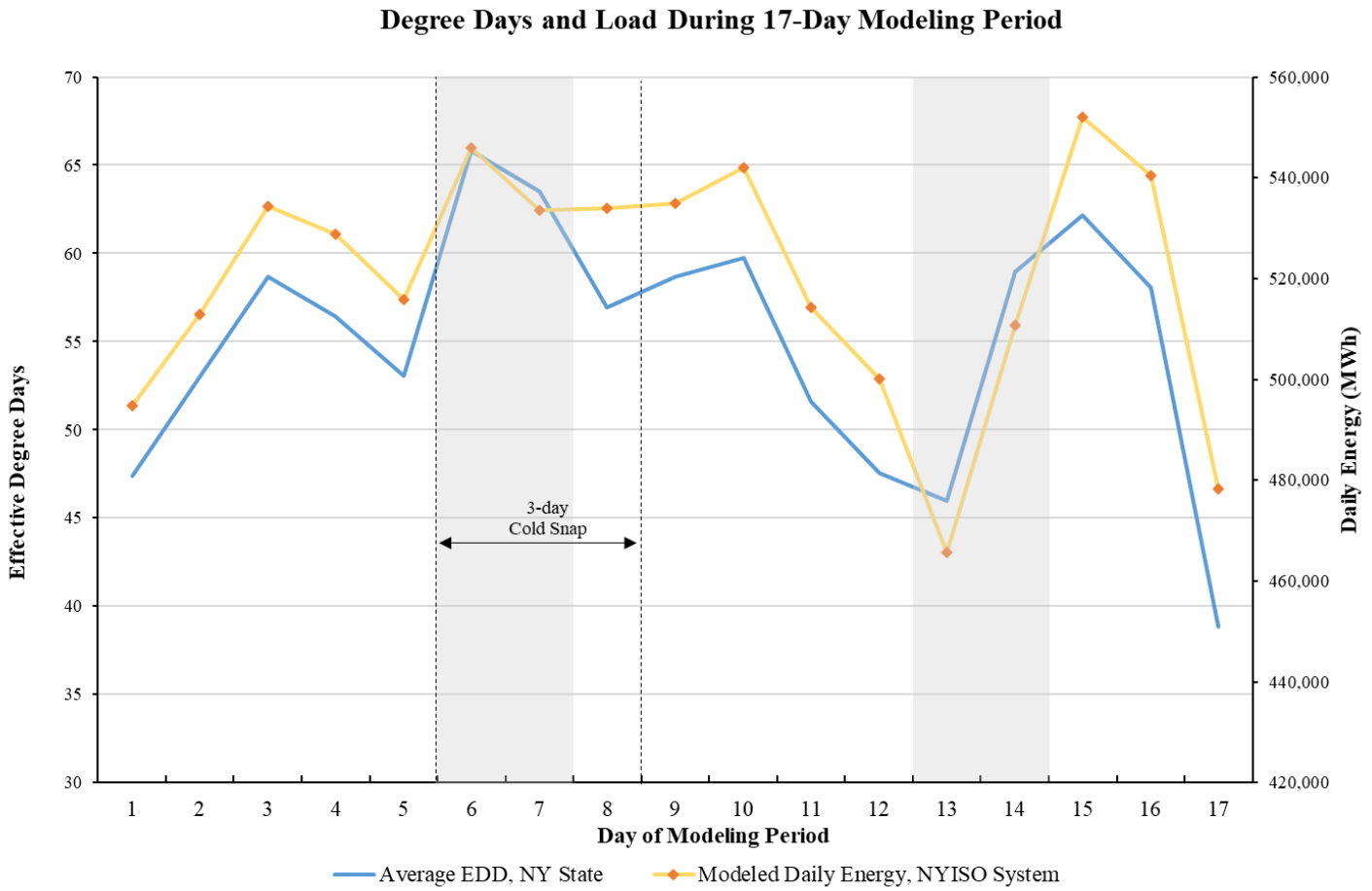
Notes:
[1] Winter is defined as December, January, and February.
[2] Effective degree day is defined as 65 degrees - Temperature.
Source:
[A] Load and Temperature: NYISO.

Load vs Degree Day – Load Zone K



Notes:
[1] Winter is defined as December, January, and February.
[2] Effective degree day is defined as 65 degrees - Temperature.
Source:
[A] Load and Temperature: NYISO.

Load vs Degree Day – NYS Modeling Period (Winter 2023/24)

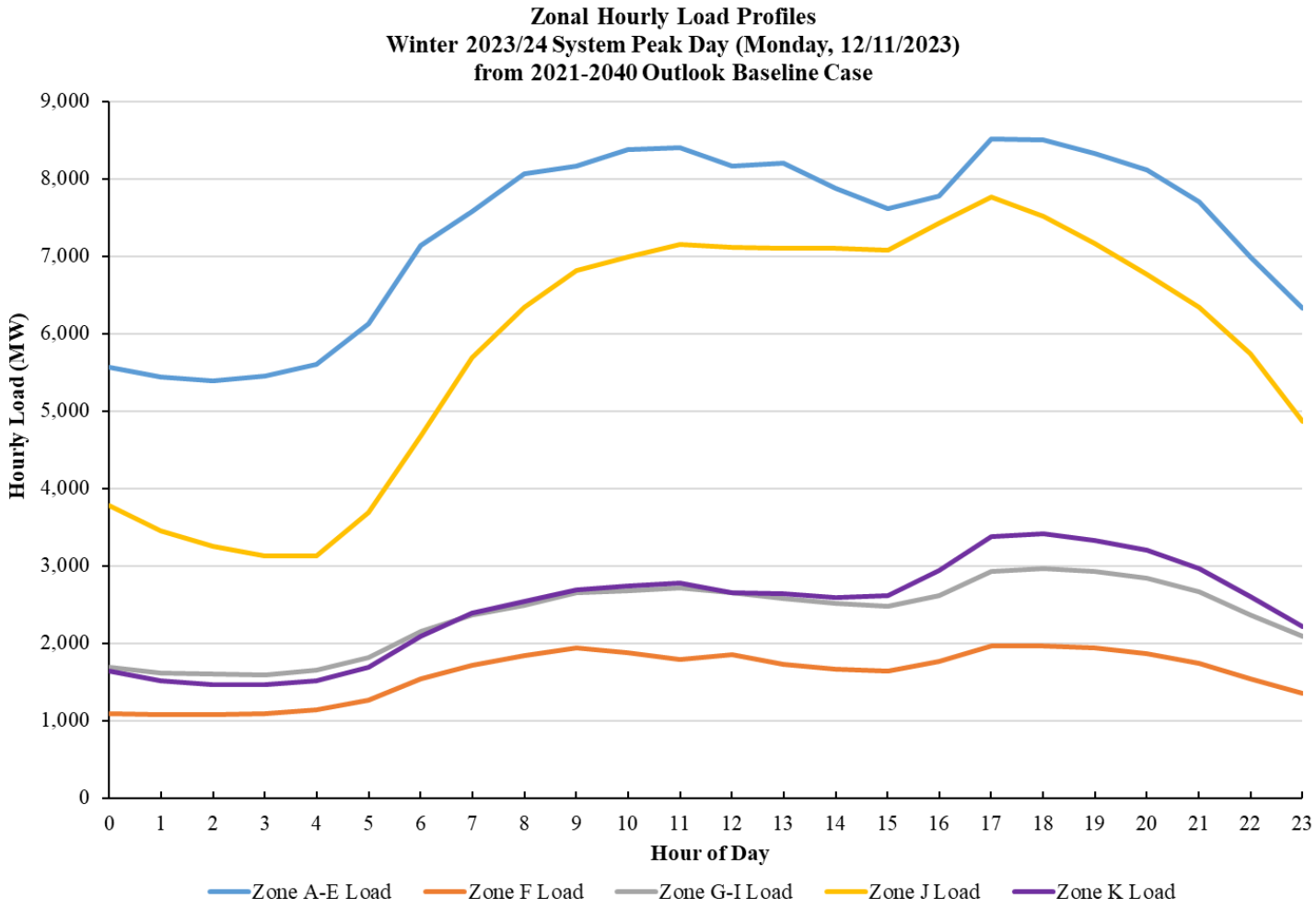


Notes:
[1] Weekends are shaded in gray.
[2] Effective degree day is defined as 65 degrees F - Temperature.
Source:
[1] NYISO Weather and Load Data 1993-2023.

Electric Demand Hourly Shape

- Load/Temperature model calibrated to Winter 2023/24 peak day from 2021-2040 Outlook Baseline Case: December 11, 2023.
- For each day in 17-day modeling period, total daily energy by region (as defined in the prior slides) is scaled based on EDD from daily temperature profile
  - Intraday load shape preserved from the 2021-2040 Outlook analysis
- The hourly load shape for future winters 2026/27 and 2030/31 will be similarly calibrated based on the appropriate 2021-2040 Outlook load forecasts in each year and include the projected 90/10 winter peak demand

Winter 2023/24 System Peak Day Intraday Hourly Profile



Source:
[1] NYISO 2021-2040 Outlook Baseline Case Load Data for 2023.

Winter 2023/24 System Peak Day Summary Statistics

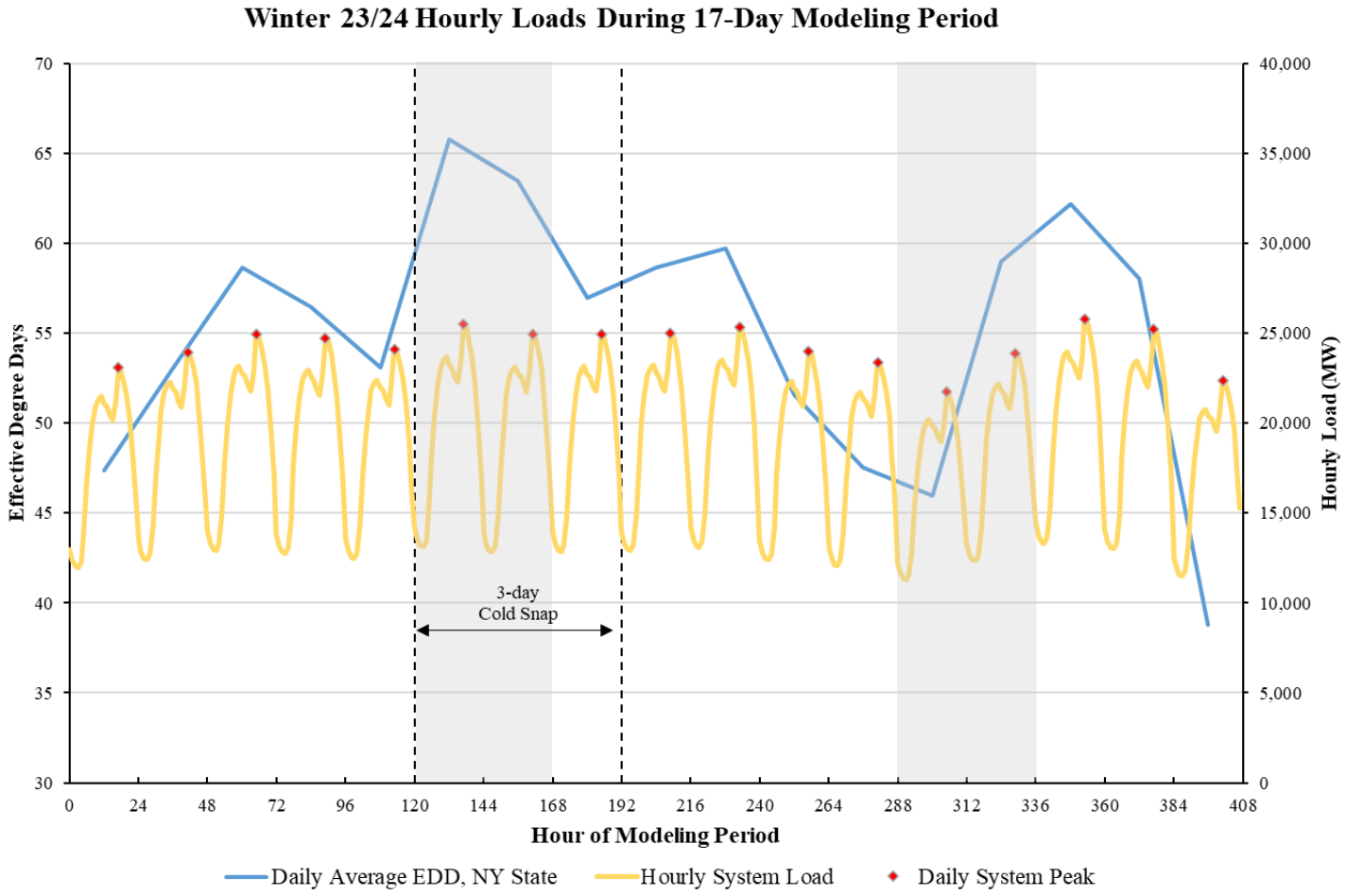
Statistics for 2023/24 Winter Peak Day

Zone Group	Values for Monday, December 11, 2023		
	Implied Average Temp.	Implied Daily Average EDD	Total Daily Energy, Baseline 2023/24 (MWh)
A-E	12.0	53.0	175,385
F	12.4	52.6	38,428
G-I	18.3	46.7	56,608
J	24.8	40.2	140,046
K	22.6	42.4	59,074

Note:
[1] Daily Average EDD is defined as 65 - Dry Bulb Temperature.

Source:
[1] NYISO 2021-2040 Outlook Baseline Case Load Data for 2023.

Load vs Temperature during 17 Day Modeled Period (Winter 2023/24)



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 1993-2023.

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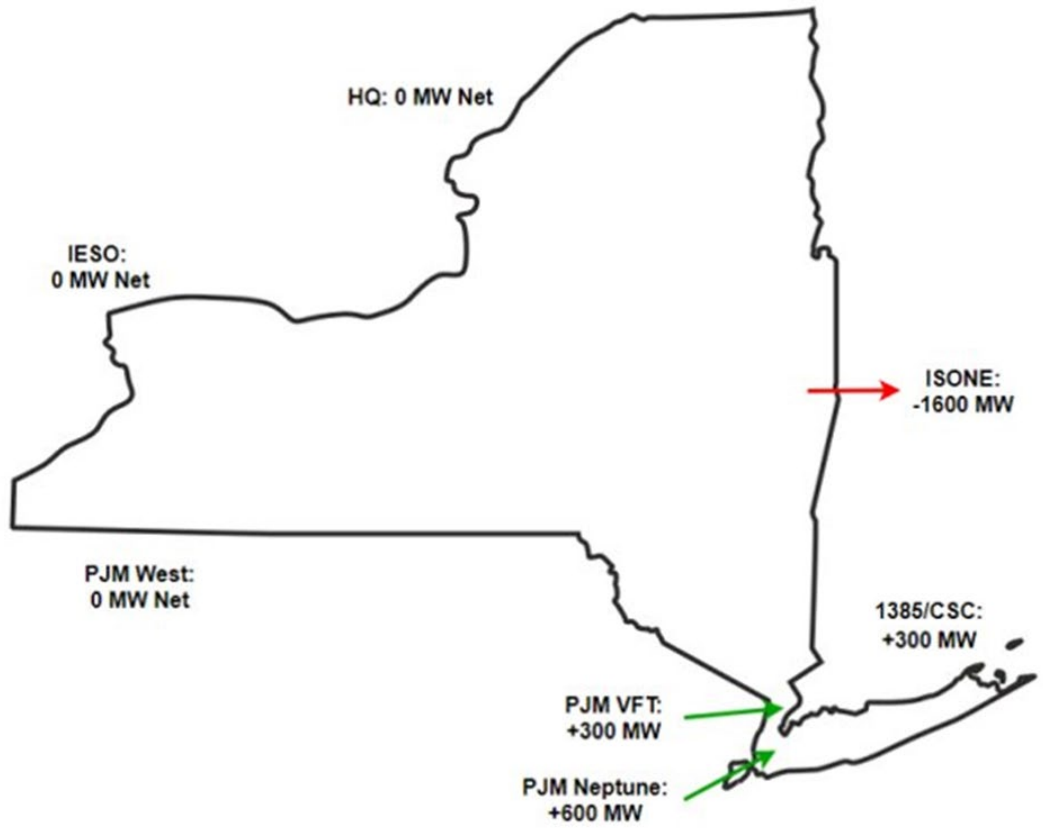
Assumed Energy Imports/Exports during Modeling Period (Starting Point Assumptions)

- Imports/exports fixed unless reserve shortage limit binds



Electric Demand, Supply, and Reserves

- Supply resource capability derates applied during the 17-day modeling period based on historical data from NYISO. Derates used are winter-specific.
- Transmission Limits between internal regions (see Slide 11) based on N-1-1 contingency analysis; will include transmission upgrades in response to Western and AC Transmission Public Policy Transmission Needs.
  - Continuing to monitor the NYISO's ongoing Long Island Offshore Wind Export Public Policy Transmission Need process for consideration of potential implications for winter 2030/31 modeling assumptions
- Assumptions regarding simple cycle gas turbine deactivations in response to the proposed NYSDEC "peaker rule" developed based on Gold Book Tables IV-4, 5, and 6.
  - Peakers that have announced retirement as of 2023 (711 MW) are retired for winter 2023/24
  - Remaining incremental peakers are assumed to retire as of winter 2026/27 (1,270 MW), with the exception of any resources that may potentially be identified as needing to be retained for reliability
    - Continuing to monitor the results of the NYISO's short-term reliability process with respect to any identified reliability needs and any resulting resource retention requirements to model as part of the future winter periods

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Literature Review Update

- Types of sources reviewed: cold weather reports and rules from NERC, FERC, NYISO, ISO-NE, and PJM
- Main themes include:
  - The importance of studying winter reliability and generator preparedness
  - NERC reliability standards and alerts emphasize the need for winter preparedness data collection and evaluation
  - Emphasis on the importance of generator access to fuel, and the value of fuel switching capability
  - Fuel disruption scenarios are important, taking into account applicable environmental/regulatory limits
  - Consider the impact of regional cold weather on model inputs such as temperature, pipeline gas availability, etc.
  - Characterize and study both high-probability, low-impact (HPLI) and high-impact, low-probability (HILP) cases
  - Emphasis on the importance of adding transmission to mitigate congestion issues and load loss in extreme weather conditions
  - Winter Storm Elliott load losses were largely caused by plant equipment failures, gas well freeze-offs, and losses of pipeline compression
- We have considered take-aways from the literature in developing the initial recommendations for scenarios and disruptions discussed on the following slides

Combination Case Construction

- Develop a manageable set of cases to run and evaluate
- Case = Scenario + Physical Disruptions
- Goal – capture a plausible range of futures, and a representative set of extreme events to “bookend” results, informed by historical experience and the literature review conducted by AG
- For consideration and feedback, the following set of scenarios and disruptions represent the initial recommendations for the study

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Scenario Construction: Disaggregated Conditions (Initial Recommendations)

2019 FES Study Conditions	Winter 2023/24	Winter 2026/27	Winter 2030/31
Initial Conditions	PK retirements fixed per model year	PK retirements fixed per model year	PK retirements fixed per model year
IM900/IM0 900MW vs. 0MW capacity imports	No Change	No Change	No Change
PK NYSDEC "Peaker Rule" requirements			
NGR Reduced non-firm gas availability	Replace with fuel storage conditions, tackle gas in disruptions	Replace with fuel storage conditions, tackle gas in disruptions	Replace with fuel storage conditions, tackle gas in disruptions
	Fuel Storage: Historical/High oil in tanks at the start of the period	Fuel Storage: Historical/High oil in tanks at the start of the period	Fuel Storage: Historical/High oil in tanks at the start of the period
REN Delayed construction of new renewables		Delay in 2021-2040 Outlook Contract case 2026 renewables	Delay in 2021-2040 Outlook Policy 1 case 2030 renewables

Proposed Scenario Combinations (Initial Recommendations)

2019 FES Study	2023/24	2026/27	2030/31
Scenario 1: Initial Conditions + IM900	Scenario 1: Initial Conditions + IM900	Scenario 1: Initial Conditions + IM900	Same as 2026/27, with a different definition of REN
Scenario 2: Initial Conditions + IM900 + PK	Scenario 2: Initial Conditions + IM0	Scenario 2: Initial Conditions + IM0	
Scenario 3: Initial Conditions + IM0	Scenario 3: Initial Conditions + IM900 + High Fuel Storage	Scenario 3: Initial Conditions + IM900 + High Fuel Storage	
Scenario 4: Initial Conditions + IM0 + PK	Scenario 4: Initial Conditions + IM0 + High Fuel Storage	Scenario 4: Initial Conditions + IM0 + High Fuel Storage	
Scenario 5: Initial Conditions + IM900 + PK + NGR		Scenario 5: Initial Conditions + IM900 + REN	
Scenario 6: Initial Conditions + REN + IM0 + PK		Scenario 6: Initial Conditions + IM0 + REN	
Scenario 7: Initial Conditions + IM0 + PK + NGR		Scenario 7: Initial Conditions + IM900 + High Fuel Storage + REN	
Scenario 8: Initial Conditions + REN + IM0 + PK + NGR		Scenario 8: Initial Conditions + IM0 + High Fuel Storage + REN	

Gas Physical Disruptions (Initial Recommendations)

Propose 3 gas disruptions to address the full range of discussed and reviewed potential gas disruptions

1. Non-firm gas unavailable F-K

To simulate localized gas market disruption

Representative of the following gas system contingencies (considering stakeholder input and lit review):

- Complete outage/derate of a compressor station or local pipeline capacity

2. Non-firm gas unavailable NYCA

To simulate loss of a major pipeline, or more serious regional inability to get gas

Representative of the following gas system contingencies (considering stakeholder input and lit review):

- Complete outage/derate of a pipeline
- Gas freeze offs

3. Non-firm gas unavailable NYCA for 3-4 Days

To simulate shorter-term system disruptions due to weather-driven outages

Representative of the following gas system contingencies (considering stakeholder input and lit review):

- Gas supply disruptions experienced in Uri/Elliott
- Temporary loss of major pipeline/compression
- Other temporary unavailability of gas due to physical disruptions and/or market factors

Proposed Physical Disruptions (Initial Recommendations)

- Recommended disruptions would apply to all three modeled winters.

	2019 FES Study Disruptions	Recommended Disruptions
	Starting Conditions (No Disruptions)	No Change
Gas	Non-Firm Gas Unavailable F-K	No Change
	Non-Firm Gas Unavailable NYCA	No Change
		Non-firm gas unavailable NYCA for 3-4 days
Oil	No Truck Oil Refill	No Change
	No Barge Oil Refill	No Change
	No Oil Refill	No Change
	Low Fuel Inventory	
Infrastructure	High Outage	No Change
	SENY Deactivation	No Change
	Nuclear Outage	No Change
	Combination Disruption	Reduced non-firm gas NYCA + reduced refill capability + High Outage

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Initial Recommendations: Proposed Scenarios and Disruptions (Winter 2023/24)

- All combinations of scenarios and disruptions will be modeled.

	Scenario 1: Initial Conditions + IM900	Scenario 2: Initial Conditions + IM0	Scenario 3: Initial Conditions + IM900 + High Fuel Storage	Scenario 4: Initial Conditions + IM0 + High Fuel Storage
No Disruptions (Starting Conditions)				
Non-Firm Gas Unavailable F-K				
Non-Firm Gas Unavailable NYCA for 3-4 days				
No Truck Oil Refill				
No Barge Oil Refill				
No Oil Refill				
High Outage				
SENY Deactivation				
Nuclear Outage				
Combination Disruption				

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Initial Recommendations: Proposed Scenarios and Disruptions (Winter 2026/27 and Winter 2030/31)

- All combinations of scenarios and disruptions will be modeled.

	Scenario 1: Initial Conditions + IM900	Scenario 2: Initial Conditions + IM0	Scenario 3: Initial Conditions + IM900 + High Fuel Storage	Scenario 4: Initial Conditions + IM0 + High Fuel Storage	Scenario 5: Initial Conditions + IM900 + REN	Scenario 6: Initial Conditions + IM0 + REN	Scenario 7: Initial Conditions + IM900 + High Fuel Storage + REN	Scenario 8: Initial Conditions + IM0 + High Fuel Storage + REN
No Disruptions (Starting Conditions)								
Non-Firm Gas Unavailable F-K								
Non-Firm Gas Unavailable NYCA for 3-4 days								
No Truck Oil Refill								
No Barge Oil Refill								
No Oil Refill								
High Outage								
SENY Deactivation								
Nuclear Outage								
Combination Disruption								

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Next Steps

- Tentative Schedule
  - Today: further discussion of study assumptions/data and development of scenarios
  - July 2023: finalize discussion of study assumptions/data and scenarios/cases (if necessary)
  - July/August 2023: AG presentation of fuel security analysis results/findings and initial recommendations
  - August/September 2023: AG presentation of final report

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Appendix A: Resource Additions and Retirements Winter 23/24

Incremental Generating Resource Additions for Winter 23/24[A]

Load Zone	Utility-Scale Solar	Land Based Wind	Offshore Wind	Dispatchable Emission-Free Resources	Storage	Total
A	40	100	-	-	-	140
B	-	-	-	-	-	-
C	40	272	-	-	-	312
D	-	-	-	-	-	-
E	40	106	-	-	-	146
F	100	-	-	-	-	100
G	30	-	-	-	-	30
H	-	-	-	-	-	-
I	-	-	-	-	-	-
J	-	-	-	-	-	-
K	-	-	130	-	-	130
Total	**250**	**478**	**130**	**-**	**-**	**858**

Incremental Generating Resource Retirements for Winter 23/24[B]

Load Zone	Kerosene	Natural Gas	No. 2 Fuel Oil	Dispatchable Emission-Free Resources	Storage	Total
A	-	-	-	-	-	-
B	-	-	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	-	-	-
E	-	-	-	-	-	-
F	-	-	-	-	-	-
G	43	-	-	-	-	43
H	-	-	-	-	-	-
I	-	-	-	-	-	-
J	37	599	-	-	-	636
K	-	-	32	-	-	32
Total	**80**	**599**	**32**	**-**	**-**	**711**

Notes:
[A] Incremental resource additions coming online as of Winter 23/24.
[B] Incremental resource retirements going offline as of Winter 23/24.

Sources:
[1] 2021-2040 System & Resource Outlook, Data Catalog, Contract Case Renewable Projects.
[2] 2023 Gold Book.

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Appendix B: Resource Additions and Retirements Winter 26/27

Incremental Generating Resource Additions for Winter 26/27[A]

Load Zone	Utility-Scale Solar	Land Based Wind	Offshore Wind	Dispatchable Emission-Free Resources	Storage	Total
A	1,135	340	-	-	215	1,689
B	510	147	-	-	5	662
C	820	181	-	-	8	1,009
D	180	-	-	-	-	180
E	739	221	-	-	5	965
F	750	-	-	-	19	769
G	140	-	-	-	330	470
H	-	-	-	-	18	18
I	-	-	-	-	6	6
J	-	-	816	-	285	1,101
K	-	-	880	-	9	889
Total	**4,275**	**888**	**1,696**	**-**	**899**	**7,758**

Incremental Generating Resource Retirements for Winter 26/27[B]

Load Zone	Kerosene	Natural Gas	No. 2 Fuel Oil	Dispatchable Emission-Free Resources	Storage	Total
A	-	-	-	-	-	-
B	-	-	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	-	-	-
E	-	-	-	-	-	-
F	-	-	-	-	-	-
G	-	88	-	-	-	88
H	-	-	-	-	-	-
I	-	-	-	-	-	-
J	-	709	-	-	-	709
K	18	125	329	-	-	472
Total	**18**	**923**	**329**	**-**	**-**	**1,270**

Notes:

[A] Incremental resource additions coming online after Winter 23/24 and as of Winter 26/27.

[B] Incremental resource retirements going offline after Winter 23/24 and as of Winter 26/27.

[C] Based on developer reported dates, 2,490 MW of Offshore Wind capacity is excluded from the Winter 26/27 additions. This contracted capacity is assumed online for the 2030/31 modeling period.

Sources:

[1] 2021-2040 System & Resource Outlook, Data Catalog, Contract Case Renewable Projects.

[2] 2023 Gold Book.

Appendix C: Resource Additions and Retirements Winter 30/31

Policy Case Scenario 1 - Capacity Expansion Cumulative Additions (MW) - 2030[A]

Load Zone	Utility-Scale Solar	Land Based Wind	Offshore Wind	Dispatchable Emission-Free Resources	Storage	Total
A	-	2,104	-	-	24	2,128
B	-	690	-	-	109	799
C	-	1,646	-	-	374	2,020
D	-	199	-	-	-	199
E	-	962	-	-	387	1,349
F	-	202	-	-	105	307
G	-	147	-	-	-	147
H	-	-	-	-	306	306
I	-	-	-	-	44	44
J	-	-	1,230	-	1,286	2,516
K	-	-	1,980	420	355	2,755
Total	**-**	**5,948**	**3,210**	**420**	**2,990**	**12,568**

Notes:

[A] The additions are reflective of generation expansion specific to the Policy Case (i.e., does not include capacity associated with generators included in the Contract Case) and are cumulative for 2025.

Source:

[1] 2021-2040 System & Resource Outlook, Data Catalog, Outlook Policy Additions by Pocket-Bus.

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Appendix D: 2019 Study Scenarios and Disruptions

Table ES-1: System Scenarios

Scenario Type	Infrastructure	Imports	Oil	Natural Gas
Description	**REN:** delayed construction of new renewables, such that solar capacity is reduced to 38.5% and wind capacity is reduced to 48% of 2017 CARIS Phase 1 "System Resource Shift" case assumed levels	**IM900:** 900 MW capacity imports **IM0:** 0 MW capacity imports	**PK:** potential retirements in response to the requirements for 2023 set forth in the proposed "peaker rule"	**NGR:** Reduced non-firm gas availability to support ~2000 MW of gas-fired generation in zones A-F, ~1000 MW of gas-fired generation in zones G-I, and no non-firm gas to support 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**

Table ES-2: Physical Disruptions

#	Disruption Name	Description
1	**Starting Conditions**	No physical disruptions
2	**SENY Deactivation**	Loss of significant capability (1,000 MW) in SENY (specifically, zones G-I)
3	**High Outage**	Double unit forced outage rate compared to historical averages
4	**Nuclear Outage**	Loss of major nuclear facility upstate
5	**No Truck Oil Refill**	Unavailability of truck oil fuel delivery based on historical events such as snow storms
6	**No Barge Oil Refill**	Unavailability of barge oil fuel delivery based on historical events such as rivers freezing
7	**No Oil 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 gas-fired generation capability available in zones F-K
9	**Low Fuel Inventory**	Reduction of initial oil storage by unit and oil fill max tank quantity to half of historical averages
10	**Non-Firm Gas Unavailable NYCA**	No gas-fired generation capability available anywhere in the New York Control Area (NYCA)
11	**Extreme Disruption**	Combination of no gas-fired generation capability available anywhere in NYCA, loss of significant dual fuel capability in zones G-I, and unavailability of any oil refill capability

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