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NYISO 2025-2029 ICAP Demand Curve Reset

Initial Modeling Discussions

ICAP Working Group

November 8, 2023

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Agenda

- Review of net energy and ancillary services (Net EAS) revenue models (thermal/fuel-fired, storage)
- Process for selecting gas hubs for pricing in the thermal/fuel-fired Net EAS revenue model

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Review of Net EAS Revenue Models

Review of Net EAS Revenue Model

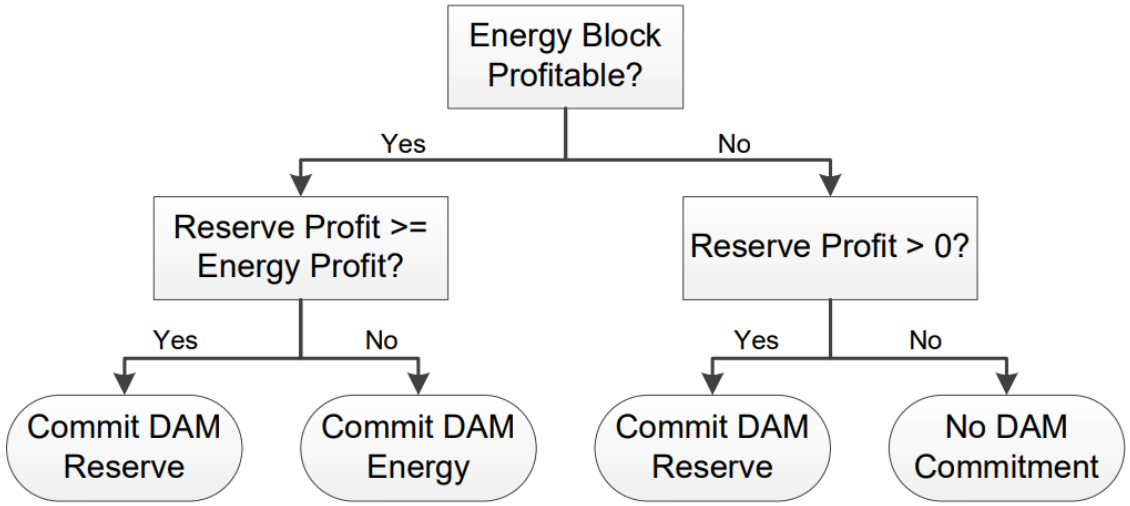
Fuel-Fired Generators

- Model estimates the net EAS revenues earned by the hypothetical peaking plant over a rolling three-year historical period, assuming dispatch of the plant and market offers set at the opportunity cost of producing energy or providing reserves
- Peaking plant can earn revenues through supplying in one of four markets:
  1. DAM commitment for energy
  2. DAM commitment for reserves
  3. RTM dispatch for energy
  4. RTM supply of reserves
- Hourly net revenues are calculated to ensure that fixed startup fuel and other costs are recovered, and dual-fuel capability (if applicable) is accounted for through the option to generate on available fuel options (e.g., natural gas or ultra-low sulfur diesel) based on a comparison of fuel prices
- Model calculates the annual average net EAS revenues as the simple average of all revenues over the three-year period, plus a flat adder for providing voltage support service (VSS)
  - The "raw" average annual Net EAS revenues values are escalated based on change in the general component of the composite escalation factor (i.e., GDP deflator) over the nominal three-year historical period used to determine such revenues

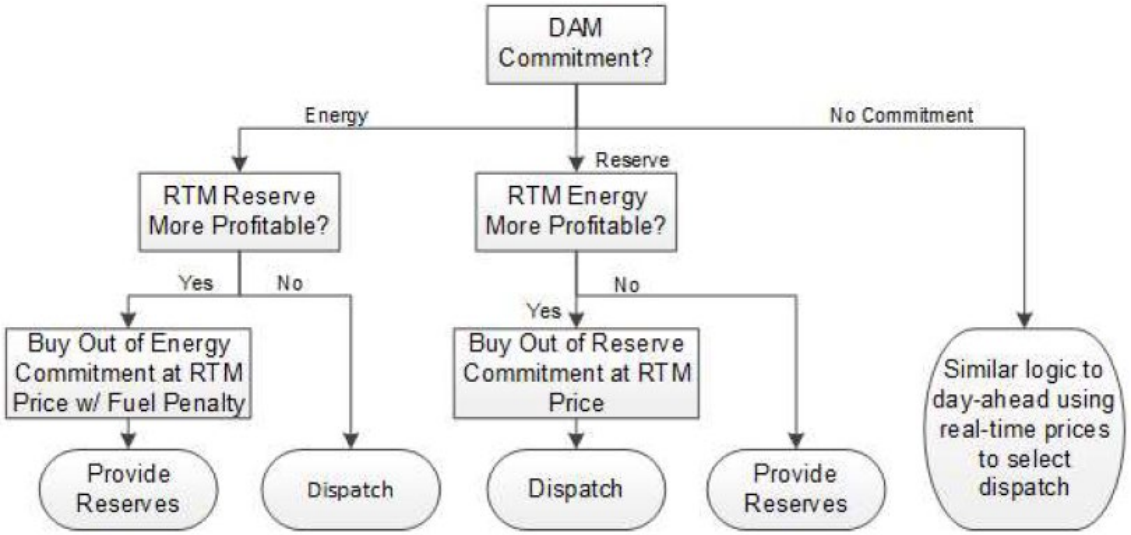
Review of Net EAS Revenue Model

Fuel-Fired Generators

Day-Ahead Commitment Logic



Real-Time Commitment Logic



Review of Net EAS Revenue Model

Battery Storage Resources

- Although the battery storage model is conceptually similar to the fuel-fired generator model, the logic is modified to account for battery technology's unique technical properties, including:
  - Limited energy storage capacity
  - Need for a balancing of energy charges and discharges
  - Energy losses during charging
  - Operational practices that can reduce battery degradation.
- To account for these factors, the model simultaneously determines hour-pairs in which the battery purchases energy (to charge the battery) and supplies energy (through discharge of the battery) in a manner that seeks to maximize revenue in the DAM and RTM
- Batteries are assumed to be capable of providing spinning reserves when it has no DAM or RTM energy discharge position but has at least one hour capability of stored energy or is charging

Review of Net EAS Revenue Model

Battery Storage Resources

- The storage model identifies the revenue-maximizing charging and discharging sequence in three steps:
  - **First**, determine daily DAM positions by identifying the set of hour-pairs to charge and discharge energy that maximize net revenues in the energy and reserve markets for a given cycle-day
  - **Second**, determine whether DAM net revenues are maximized by emptying the battery each day or maintaining stored energy between cycle-days, given the daily DAM positions from the first step
  - **Third**, determine any incremental RTM market positions given the daily DAM positions resulting from the first and second steps. To ensure reasonable RTM market behavior, incremental RTM market positions must earn additional profits greater than an assumed "*hurdle rate*" reflecting the *opportunity cost of limited available energy* and an assumed *risk premium*.
    - In the 2021-2025 Installed Capacity Demand Curve reset (DCR), the opportunity cost of limited available energy was determined empirically by varying the assumed bid offer hurdle rate and choosing the rate that maximized revenues. The risk premium was assumed to be $10/MWh.
    - Total hurdle rates were $20 per MWh in Load Zone C and Load Zone F, and $25 per MWh in Load Zone G (Dutchess County), Load Zone G (Rockland County), Load Zone J, and Load Zone K.

Review of Net EAS Revenue Model

Potential changes to the fuel-fired generator and battery storage net EAS models

- AG is currently assessing whether potential changes/enhancements to the net EAS revenue models for fuel-fired resources and battery storage resources are appropriate. For example:
  1. Reducing computational runtime associated with the battery storage net EAS model through increased parallelization and other coding efficiencies
  2. Re-estimating the opportunity cost of limited available energy to maximize battery operator revenues (i.e. the "perfect foresight" assumption)
  3. Reassess the degree to which dual fuel capability and oil burn requirements under cold weather conditions fully address potential gas availability limitations

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Process for Selecting Natural Gas Hubs for Pricing

Natural Gas Hub Selections for Pricing

Review of approach used in the 2021-2025 DCR

- In the 2021-2025 DCR, the choice of natural gas hub in each zone was considered 4 factors:
  1. Market dynamics (how closely LBMPs followed that hub's gas prices);
  2. Liquidity of trading (hub has deep historical data);
  3. Geographic location of the gas hub;
  4. Precedent for the hub being used in other evaluations.

Location	2021-2025 DCR
Load Zone C	Niagara (December - March) & Tennessee Zone 4 200L (April – November)
Load Zone F	Iroquois Zone 2
Load Zone G (Dutchess)	Iroquois Zone 2
Load Zone G (Rockland)	TETCO M3
Load Zone J	Transco Zn 6 NY
Load Zone K	Iroquois Zone 2

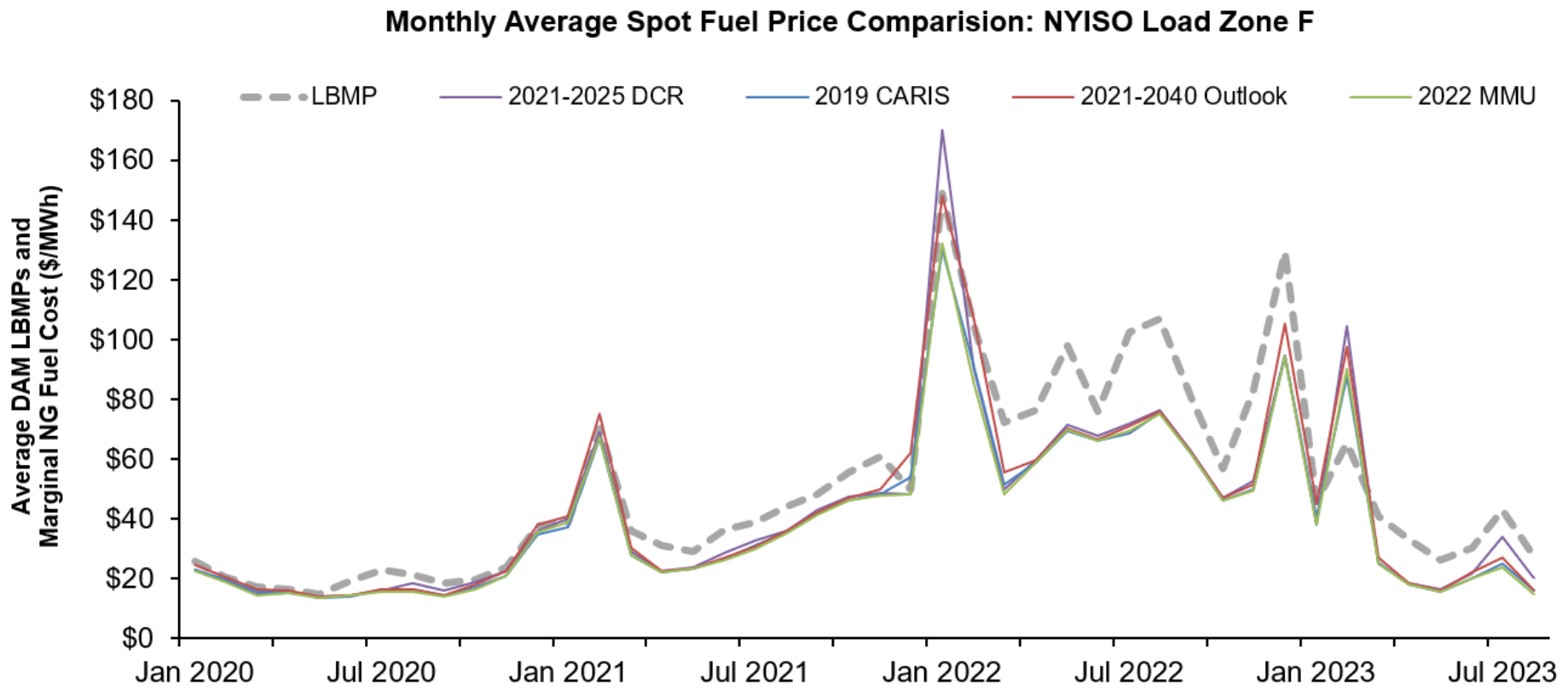
Gas Hub Choices in Previous Studies

Location	2021-2025 DCR	2022 Potomac State of the Market	2019 CARIS Phase I	2021-2040 Outlook
Load Zone C	Niagara (December - March) & Tennessee Zone 4 200L (April – November)	Niagara (December - March) & Tennessee Zone 4 200L (April – November)	Dominion South (65%), Columbia (5%), & Dawn (30%)	Dominion South (91%), Tetco M3 (7%), & Columbia (2%)
Load Zone F	Iroquois Zone 2	Minimum of Tennessee Zone 6 and Iroquois Zone 2	Iroquois Zone 2 (30%), Tennessee Zone 6 (45%), Tetco M3 (20%), & Iroquois Waddington (5%)	Tennessee Zone 6 (62%), Iroquois Zone 2 (28%), Algonquin (7%), & Tetco M3 (3%)
Load Zone G (Dutchess)	Iroquois Zone 2	Average of Iroquois Zone 2 and the Tetco M3		
Load Zone G (Rockland)	TETCO M3			
Load Zone J	Transco Zn 6	Transco Zn 6	Transco Zone 6 (100%)	Transco Zone 6 (100%)
Load Zone K	Iroquois Zone 2	Iroquois Zone 2	Iroquois Zone 2 (60%) & Transco Zone 6 (40%)	Iroquois Zone 2 (51%) & Transco Zone 6 (49%)

Geographic Locations of New York Natural Gas Hubs

Natural Gas Hub Market Dynamics

Review of natural gas pricing trends since 2020



Notes: [1] "Marginal NG Fuel Cost" is calculated as the product of the natural gas price index and the heat rate of a GE 7HA.02 turbine, the 2021-2025 DCR reference peaking plant. The assumed heat rate is 8,890 Btu/kWh. [2] The 2021-2040 Outlook Index is comprised of a weighted average of spot prices at Tennessee Zone 6 (62%), Iroquois Zone 2 (28%), Algonquin (7%), and Tetco M3 (3%). [3] The 2019 CARIS Index is comprised of a weighted average of spot prices at Iroquois Zone 2 (30%), Tennessee Zone 6 (45%), Tetco M3 (20%), and Iroquois Waddington (5%). [3] The 2022 MMU Index uses the minimum of Tennessee Zone 6 and Iroquois Zone 2 indices for the Capital Zone (Zone F); and uses the average of Iroquois Zone 2 index and Tetco M3 index for Lower Hudson Valley (Zone G). **Sources:** [A] S&P CapIQ (Fuel Prices). [B] NYISO, Potomac Economics (DAM LMBPs).

Natural Gas Hub Market Dynamics

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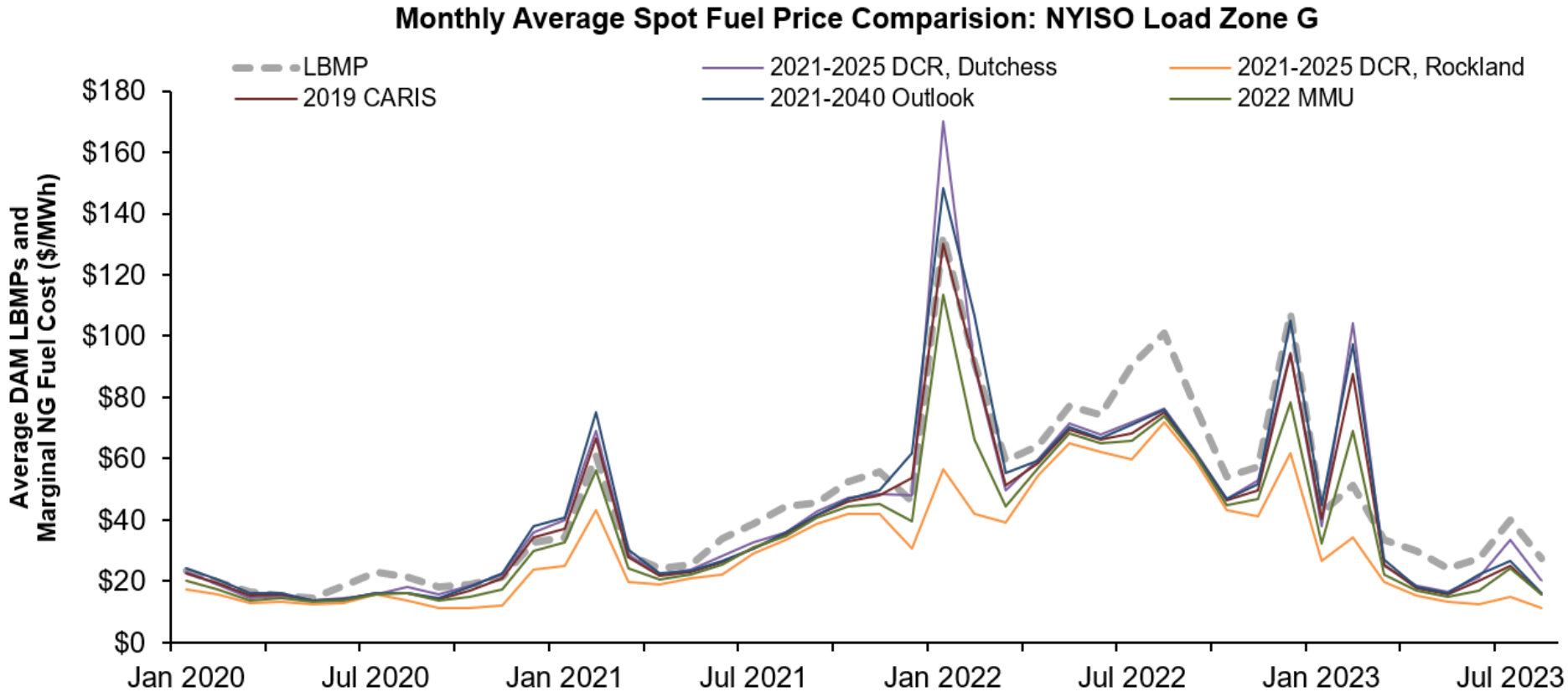

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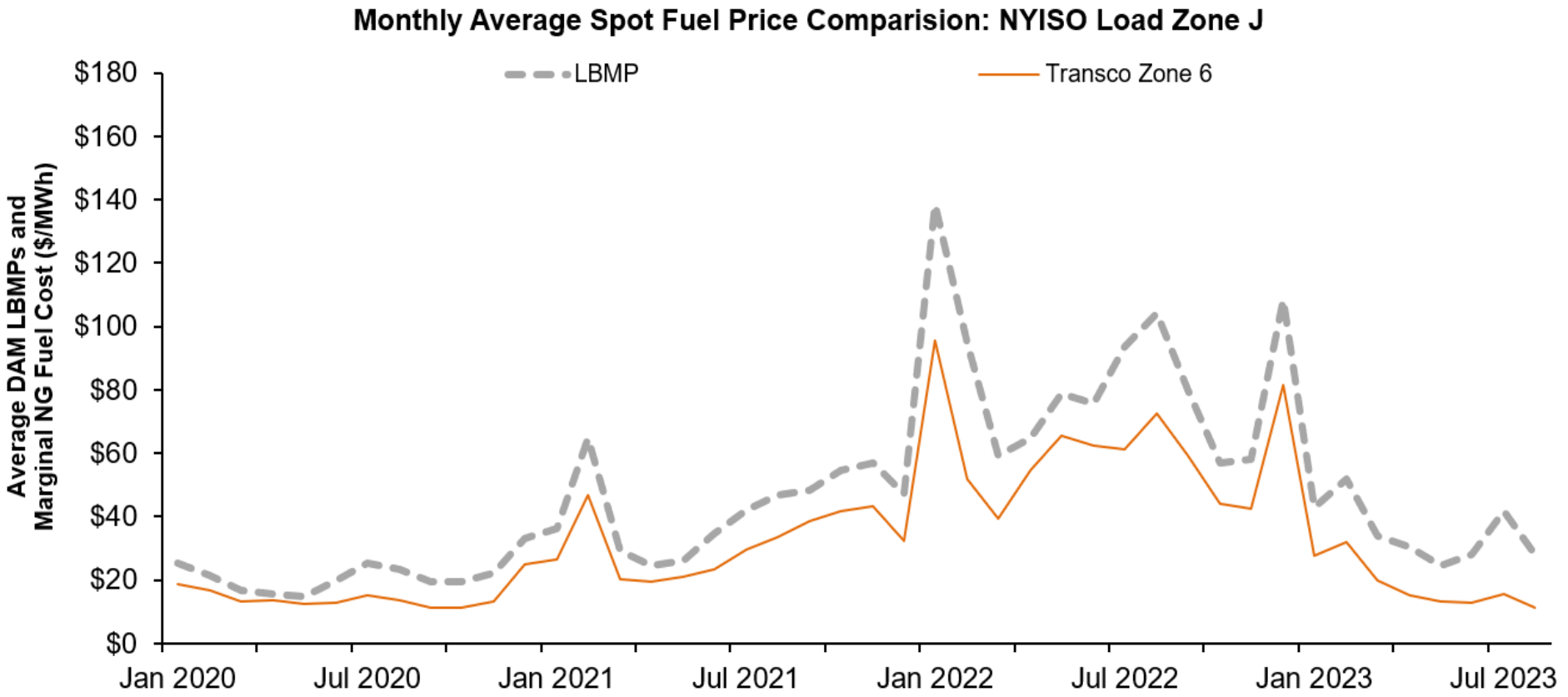

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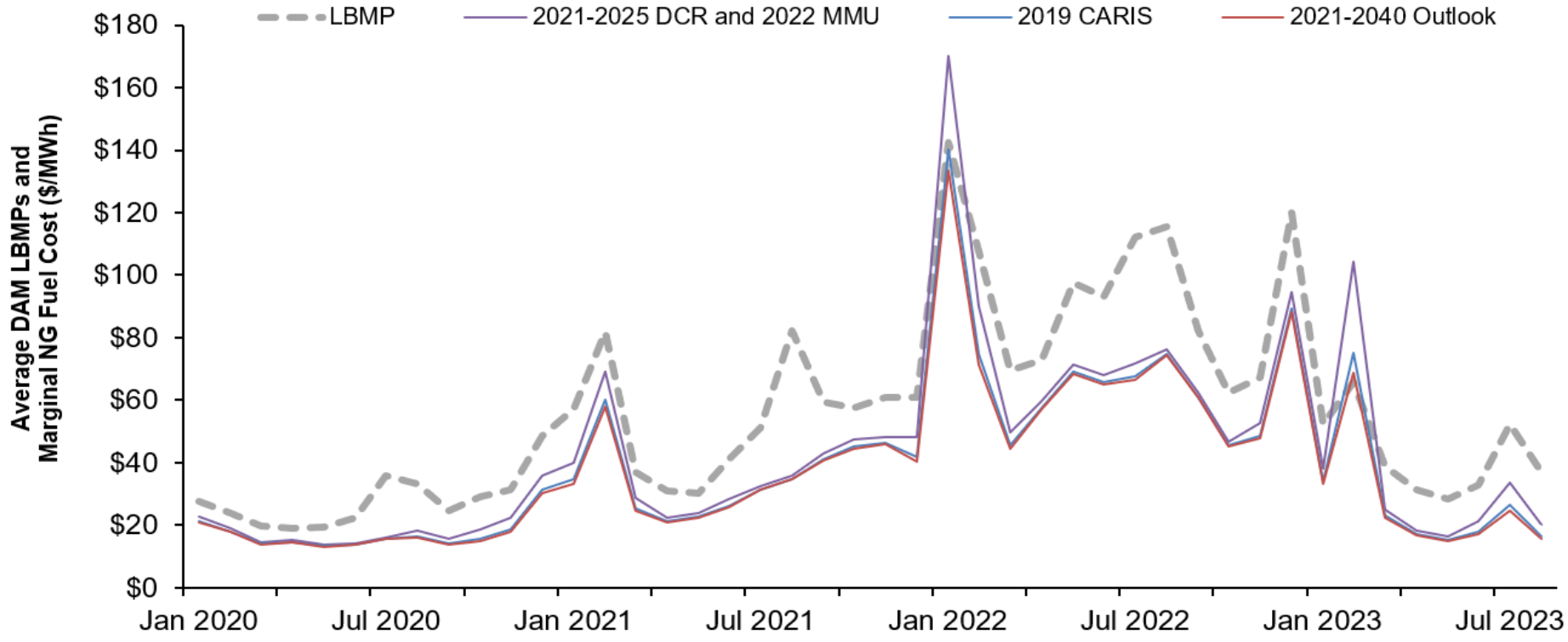
Natural Gas Hub Market Dynamics

Review of natural gas pricing trends since 2020

Monthly Average Spot Fuel Price Comparision: NYISO Load Zone K



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Sources: [A] S&P CapIQ (Fuel Prices). [B] NYISO, Potomac Economics (DAM LMBPs).

Natural Gas Hub Market Dynamics

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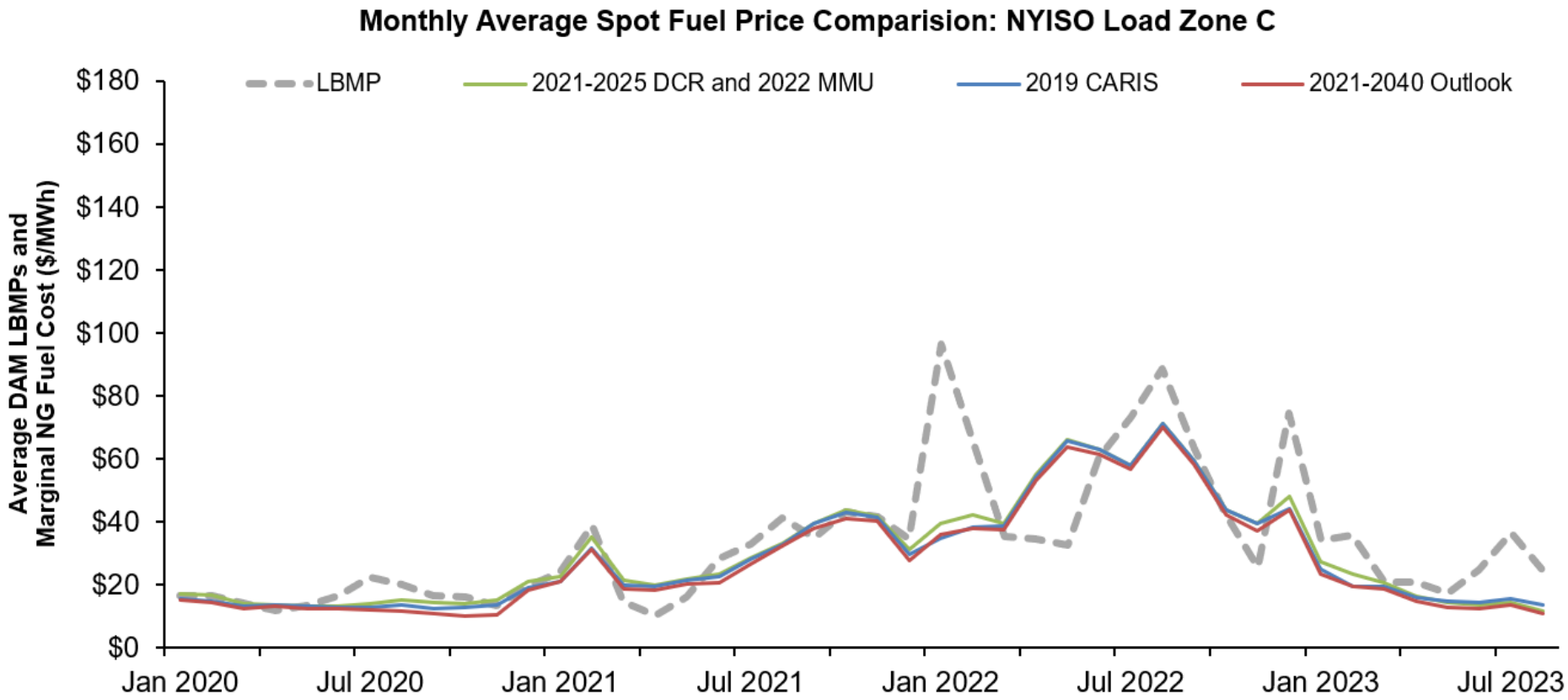

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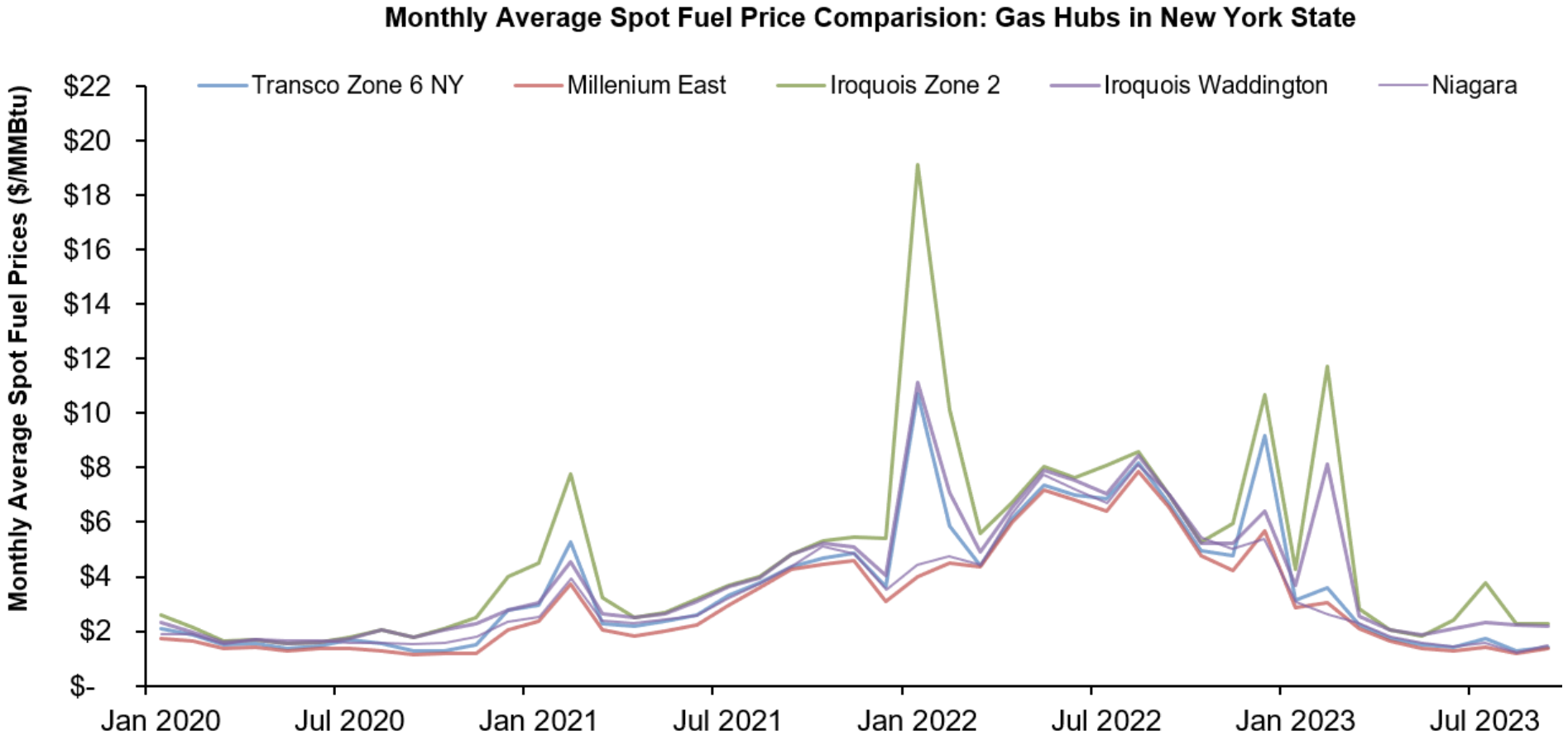
Appendix

Natural Gas Hub Market Dynamics

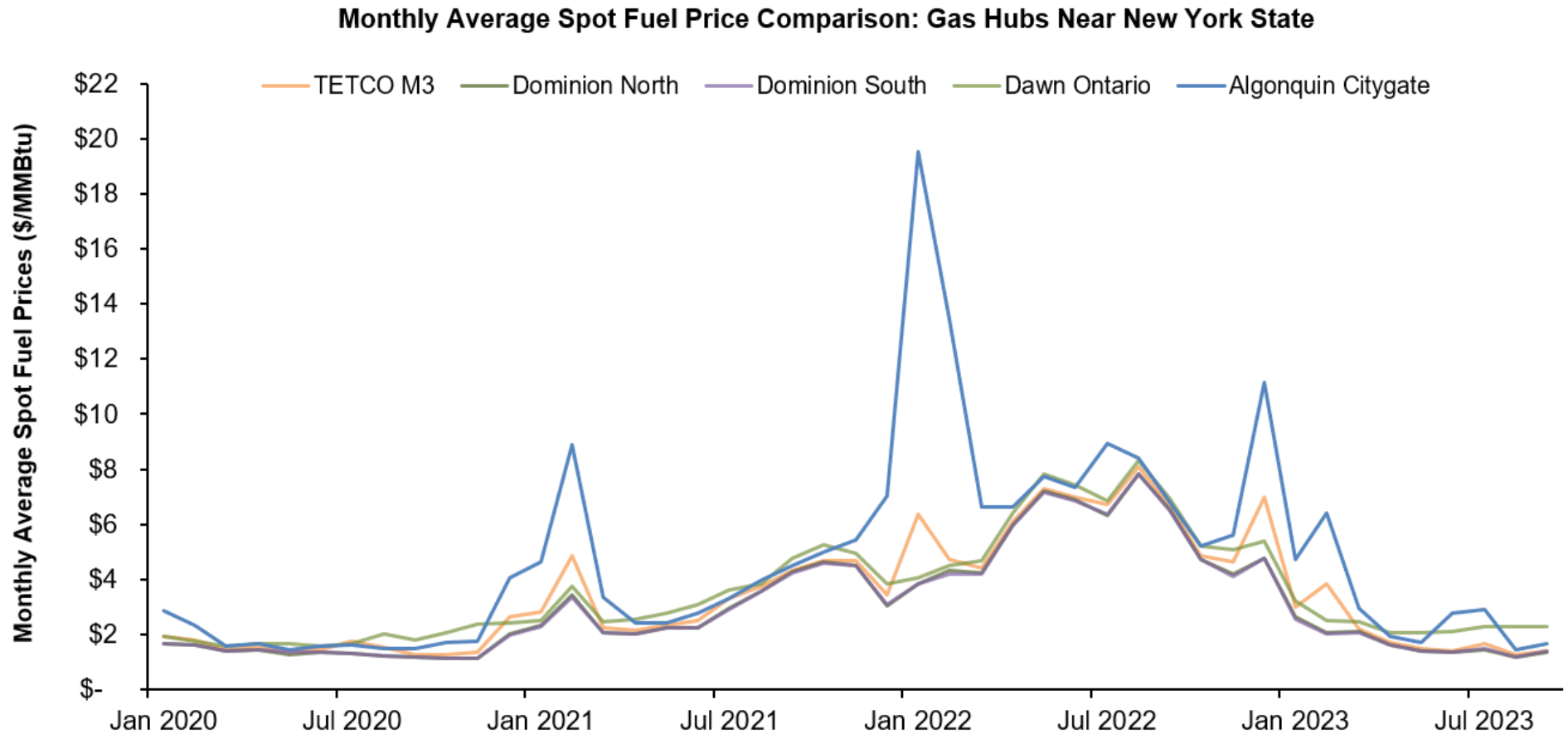
Raw Natural Gas Prices: New York Gas Hubs



Sources: S&P CapIQ

Natural Gas Hub Market Dynamics

Raw Natural Gas Prices: Additional Relevant Gas Hubs



Sources: S&P CapIQ