Cold Weather Operations
January 18–23, 2025

Operating Committee
February 6, 2025

Overview

Operations Update

- Key Takeaways
- Communications Timeline
- Emergency Procedures
- Unit Commitment
- Cold Weather Operating Limits (CWOL)
- Generation Commitment and Reserves (DA Markets vs. DA Operations)
- Weather, Temperature and Load Forecast Accuracy
- Scheduled Interchange
- Generation Performance
- Gas Performance
- Transmission Performance
- Outage Coordination

Key Takeaways for Operations

Instantaneous Peak Load 145,060* MW – January 22 @ 08:13

Successes

- Sufficient reserves to serve All-time Winter peak load and exports.
- Effective PJM Emergency Procedures limited to Advisories and Alerts
- Strong generator & transmission performance
- Good load forecasting

Challenges

- Gas-Electric Market Coordination and the need for multiple-day gas commitments during long holiday weekends
- Inflexible gas nominations & ratable take requirements reducing generator dispatch flexibility
- Operational risk is not reflected in markets
- Future resource adequacy concerns (increasing load / decreasing transfer margins).

Unit Commitment

Risk-based scheduling approach – Unit startup and operating risk, natural gas availability	• Units with extended start times were evaluated and started early to ensure units were online before extreme cold weather settled in. Strategy was to have units warm and ready to ramp up. • Evaluated units that have not operated in the past four weeks and potential need for additional start time • Tested CTs that have not ran to ensure operational capability • Minimized cycling of units
Reliability cases were conducted, and units were committed for reliability based on anticipated congestion and capacity projections.	
Advanced commitment to gas only resources, CTs & Steam units considering multi day extended gas nomination period. Sunday – Thursday commitment	• Considerations were given to min. down time on units to determine if they would be able to come back in time for higher projected loads. • CTs were surveyed for fuel availability – value in having fuel status

Emergency Procedures

Generator Maintenance Outage Recall
Jan. 19, 2025 06:00 through Jan. 23, 2025 10:45 (issued Jan 15, 2025)

Low Voltage Alert
Jan. 19, 2025 15:00 through Jan. 23, 2025 10:45

Cold Weather Advisory – PJM RTO
Jan 20, 2025, 00:01 through Jan. 23, 2025, 10:45 (issued Jan. 15, 2025)

Cold Weather Alert – PJM RTO
Jan 20, 2025, 00:01 through Jan. 23, 2025, 10:45 (issued Jan. 15, 2025)

Conservative Operations
Jan. 20, 2025, 00:01 through Jan. 23, 2025, 23:59 (issued Jan. 17, 2025)

Maximum Generation Alert
Jan. 22, 2025 00:01 through 22:30 (issued Jan. 21, 2025)

NERC Transmission Loading Relief
- **TLR 1**: issued Jan. 22, 2025 04:33 through Jan. 24, 2025 08:29
- **TLR 3**: issued Jan 23, 2025 07:28 through 09:32

Communications Timeline

Jan. 15

- SOS-T / Security Conference Call (Inauguration + Cold Weather), SOS-G Cold Weather Conference Call, and DOE Conference Call discussing Cold Weather operations and potential need for 202c order.

Jan. 16

- SOS/OC/MRC Pardot message sent summarizing next week's cold weather and generator owner expectations, including a request that generation owners survey their stations for consumables such as fuel oil inventories and demineralized water.

Jan. 17

- PJM States Conference Call and RF/SERC Conference Call

Jan. 19

- Generation All-call reminding generation owners to staff CT sites, notify PJM of any fuel procurement issues, and update Market's Gateway with unit limitations.

Jan. 20

- SOS-T System Conditions Conference Call and SOS/OC/MRC Pardot message sent notifying generation owners of PJM gas commitment strategy for the Wednesday gas day (Wednesday 10:00 – Thursday 10:00)

Jan. 21

- SOS-G All-Call requesting CTs be staffed Wednesday evening / Thursday morning peaks and SOS-T System Conditions Conference Call

Jan. 22

- SOS-T System Conditions Conference Call.

Cold Weather Operating Limits

PJM collects Operating Limit and Startup temperatures yearly as part of the Cold Weather Preparation Checklist

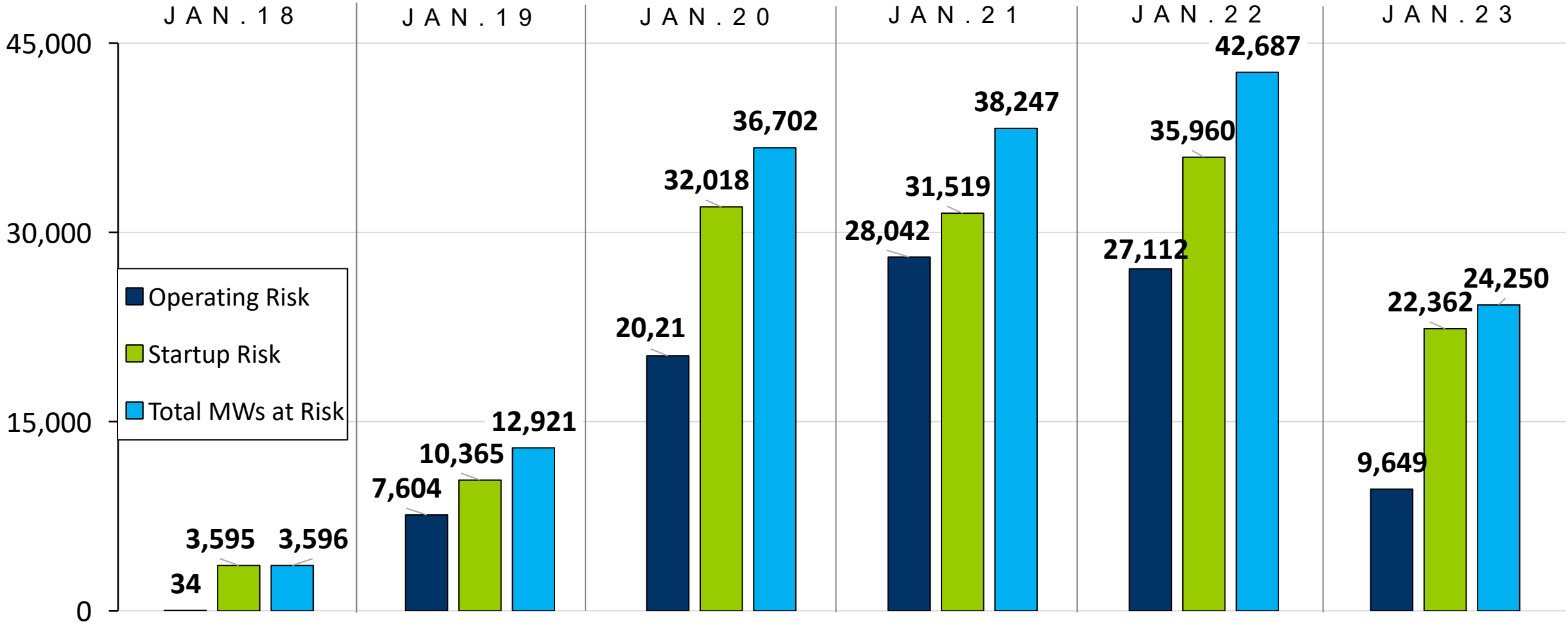
Operating Limit	***Startup Temp***
Ambient temperature that the plant designed to reliably operate down to. Considering all plant systems, components, controls, electrical, mechanical and water systems, including switchyard equipment owned by the Generating Facility.	Minimum temperature at which the plant could start reliably while shut down and in a cold state.

Data is analyzed and passed to PJM Dispatch to inform operations planning and situational awareness

Manual 14D Section 6.3.4: Other Requirements

> Prior to entering commercial operations, and upon any material change affecting cold weather operating limits, all Generating Facilities must provide PJM with design data specific to cold weather. This includes, but is not limited to, the lowest temperature the facility is designed to operate reliably down to, and any procedural or contractual limits that require action when outside temperature reaches a specific low temperature. Additional data is required from inverter based resources.

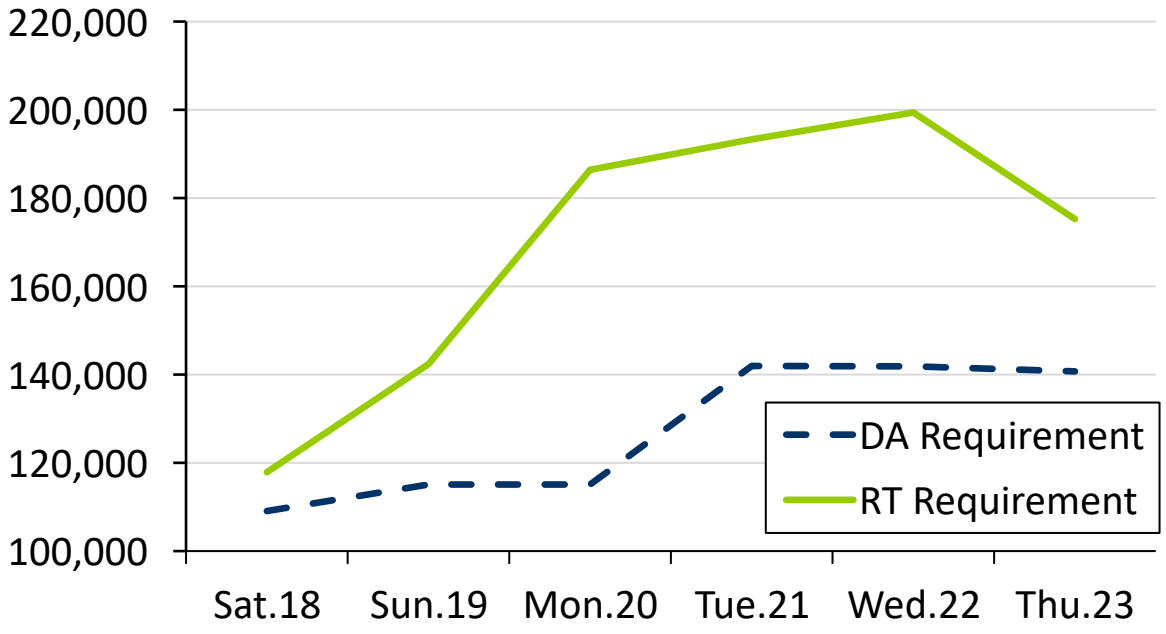
Cold Weather Operating Risk



Generation Commitment and Reserves

Generation Requirements

Day Ahead vs. Real-Time Generation Requirement

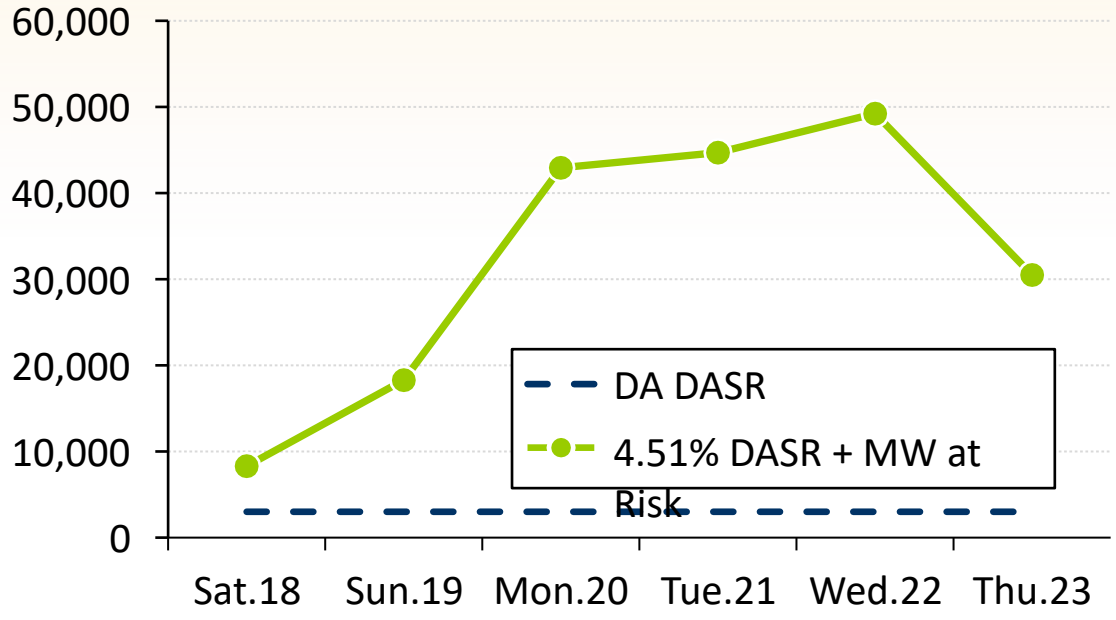


DA = DA Load + DA Exports + 3,000 MW DASR

RT = RT Forecast + DA Exports + 4.51% DASR + MW at Risk *(operating temperature)*

Scheduling Reserve

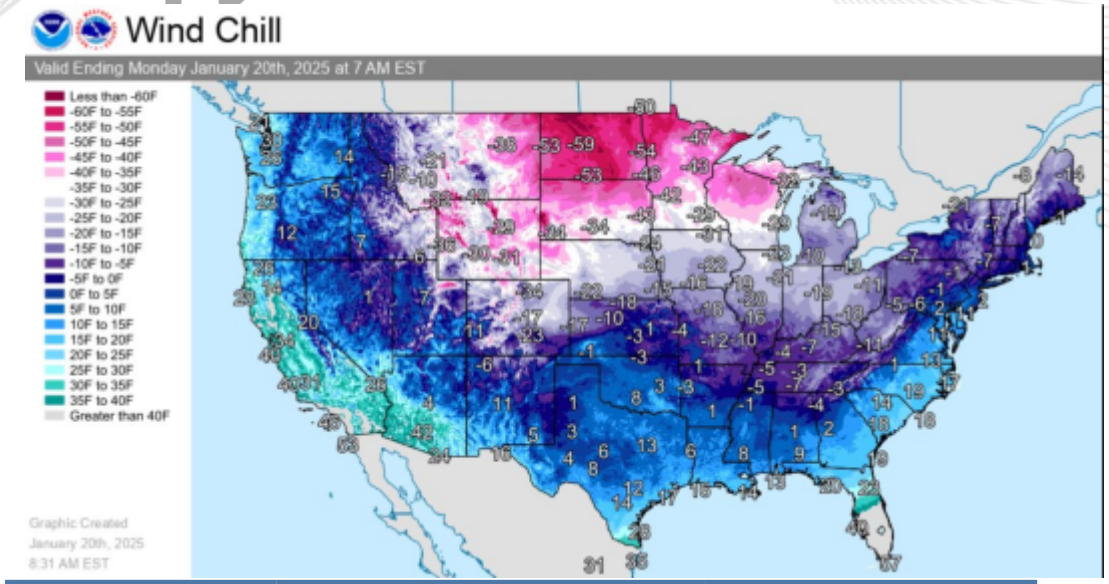
Day Ahead vs. Real-Time Scheduling Reserve



DA Markets = 3,000 MW DASR

DA Operations = 4.51% DASR + MW at Risk *(operating temperature)*

Temperatures – Jan 18-23, 2025



On Jan. 18: Milder respite after a few very cold prior days in Western Region

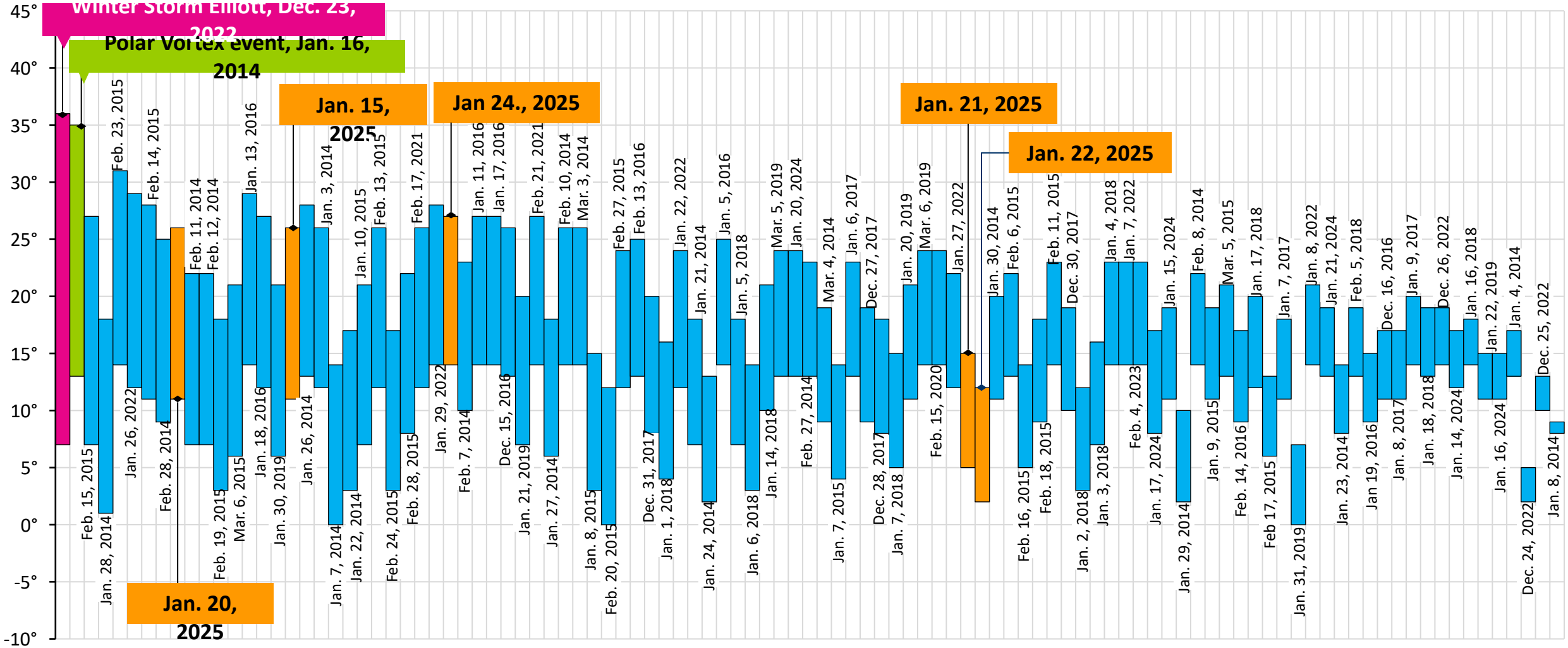
On Jan. 22: Coldest in RTO

From Jan. 19-20: Next surge of Arctic air moved into RTO from west to east

	Winter Storm Elliott Dec. 23–26, 2022		January 13–22, 2024 Cold Wave		January 18-23, 2025 Cold Wave	
Cities	Coldest Air Temperature	Coldest Wind Chill	Coldest Air Temperature	Coldest Wind Chill	Coldest Air Temperature	Coldest Wind Chill
Chicago	-8°F	-35°F	-10°F	-33°F	-8°F	-29°F
Columbus	-7°F	-34°F	6°F	-13°F	-3°F	-18°F
Louisville	-5°F	-31°F	3°F	-12°F	4°F	-12°F
Philadelphia	7°F	-14°F	14°F	2°F	10°F	-6°F
Richmond	8°F	-11°F	14°F	9°F	9°F	2°F

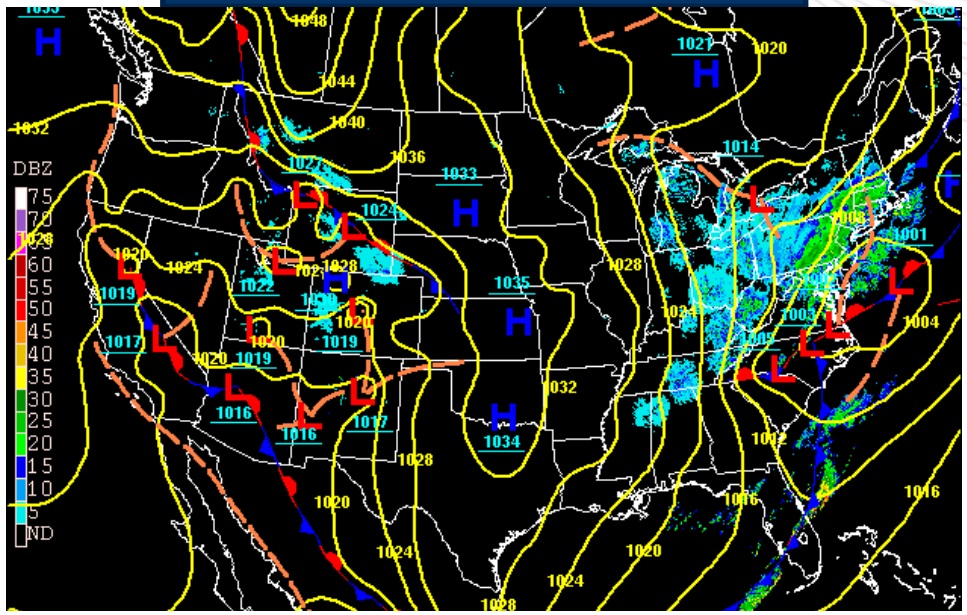
Historical Temperature Drops Under 15°

12-Hour RTO Temperature Drops From Jan. 1, 2014, to Jan. 31, 2025



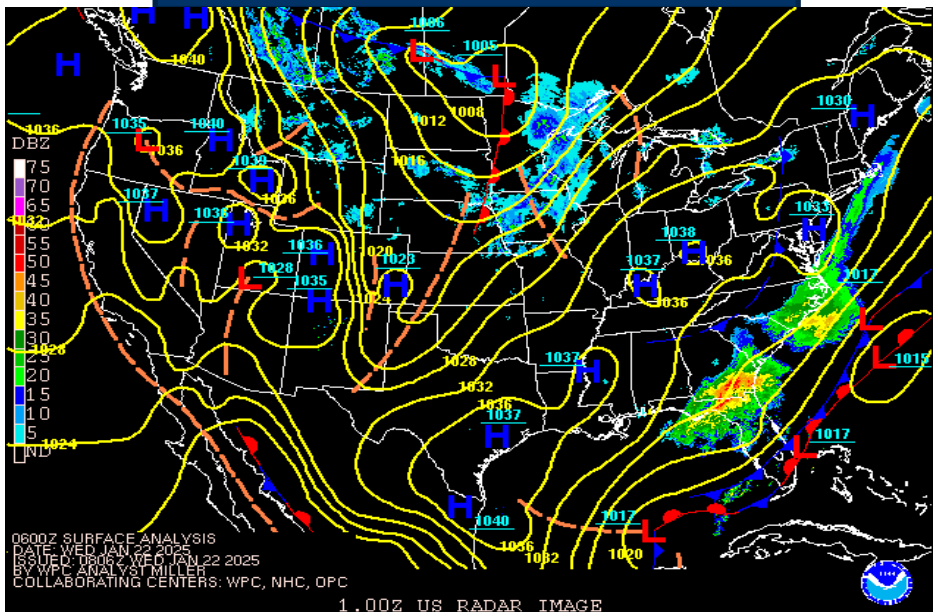
Storm Recaps – Jan. 18-23, 2025

Storm #1 –"Demi" January 19



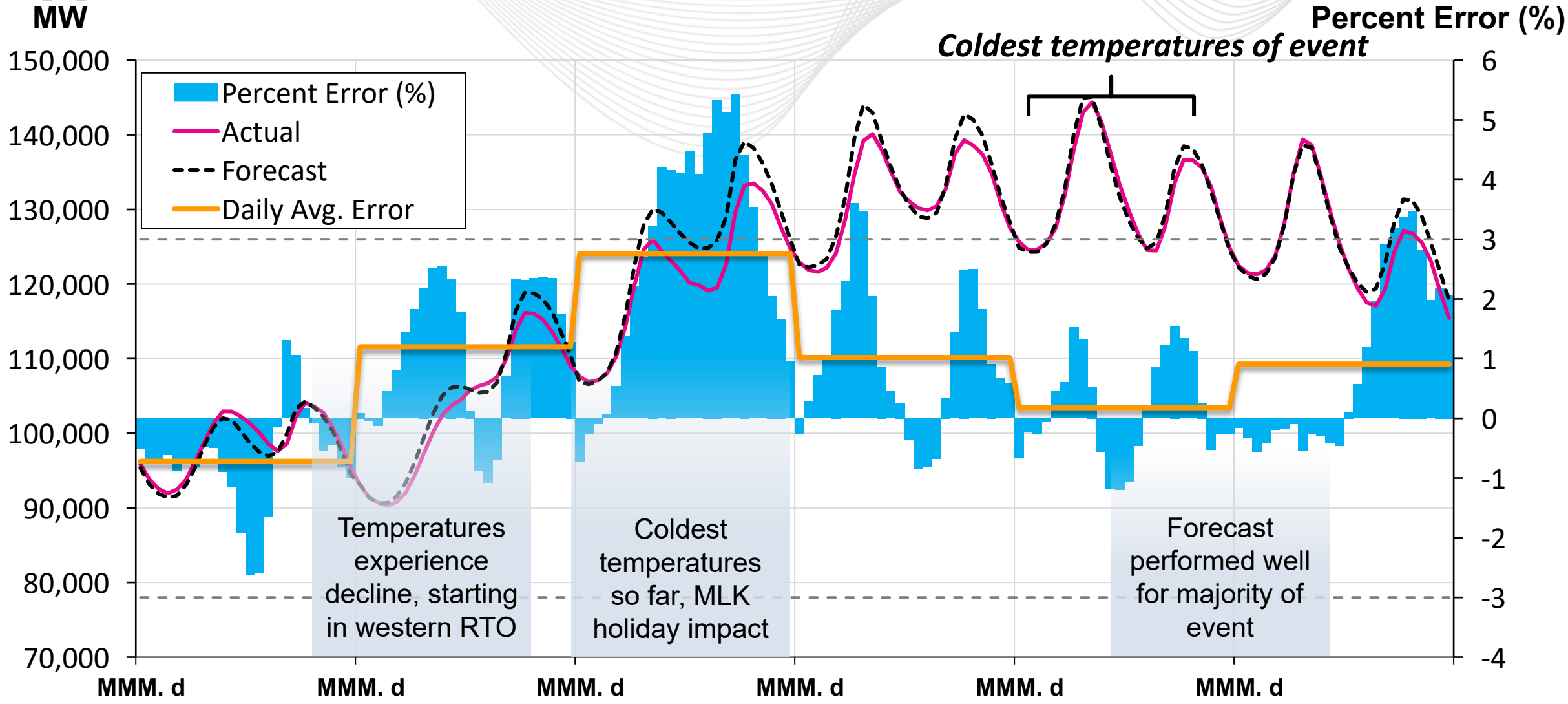
- Heavy snow in Appalachians (>6" accumulation)
- Lighter snows elsewhere

Storm #2 –"Enzo" January 21-22

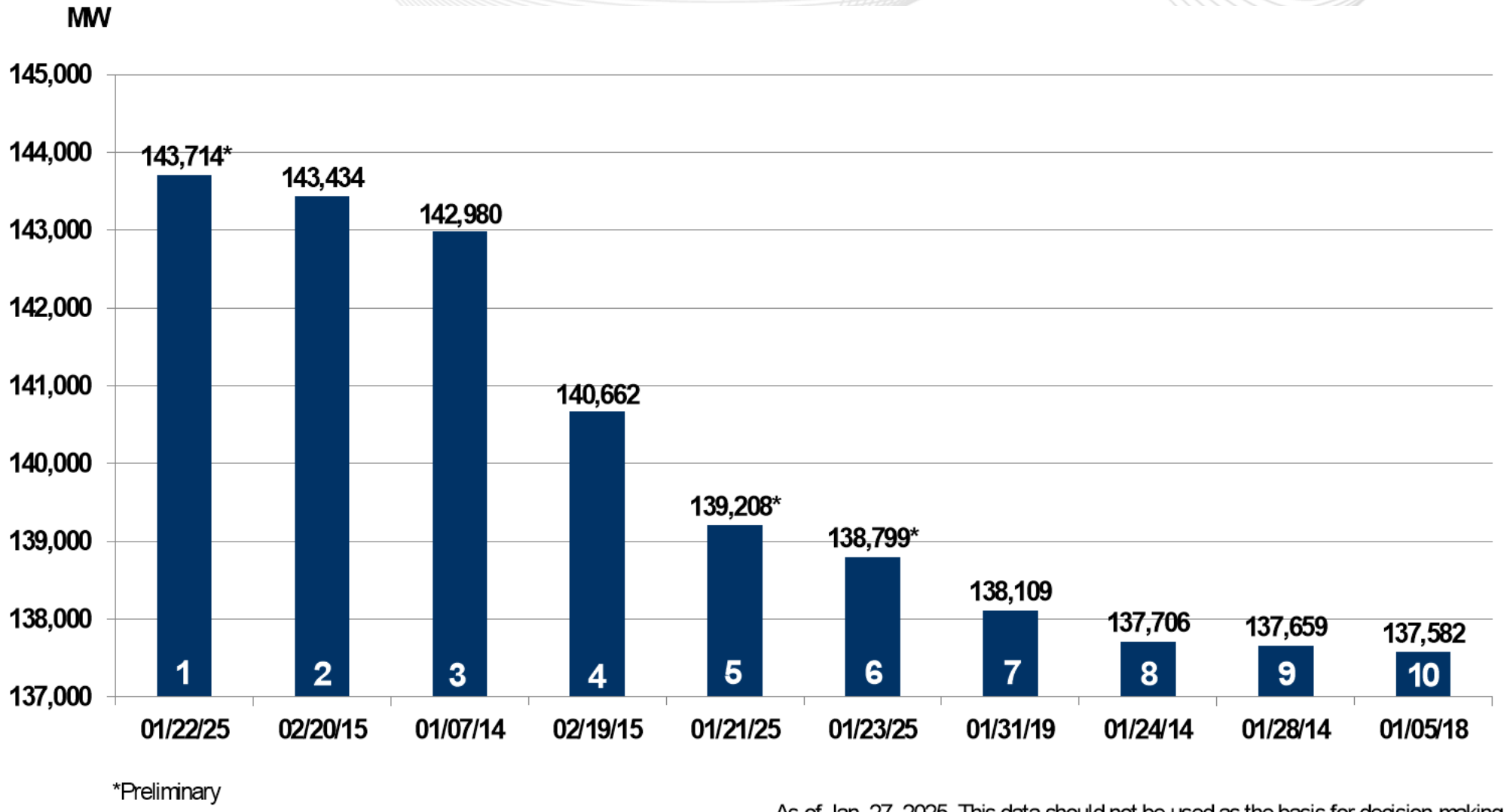


- Heavy snow in southern Dominion (Up to 8" accumulation)
- Storm had greater impacts south of RTO

Forecast Performance During January Cold Spell



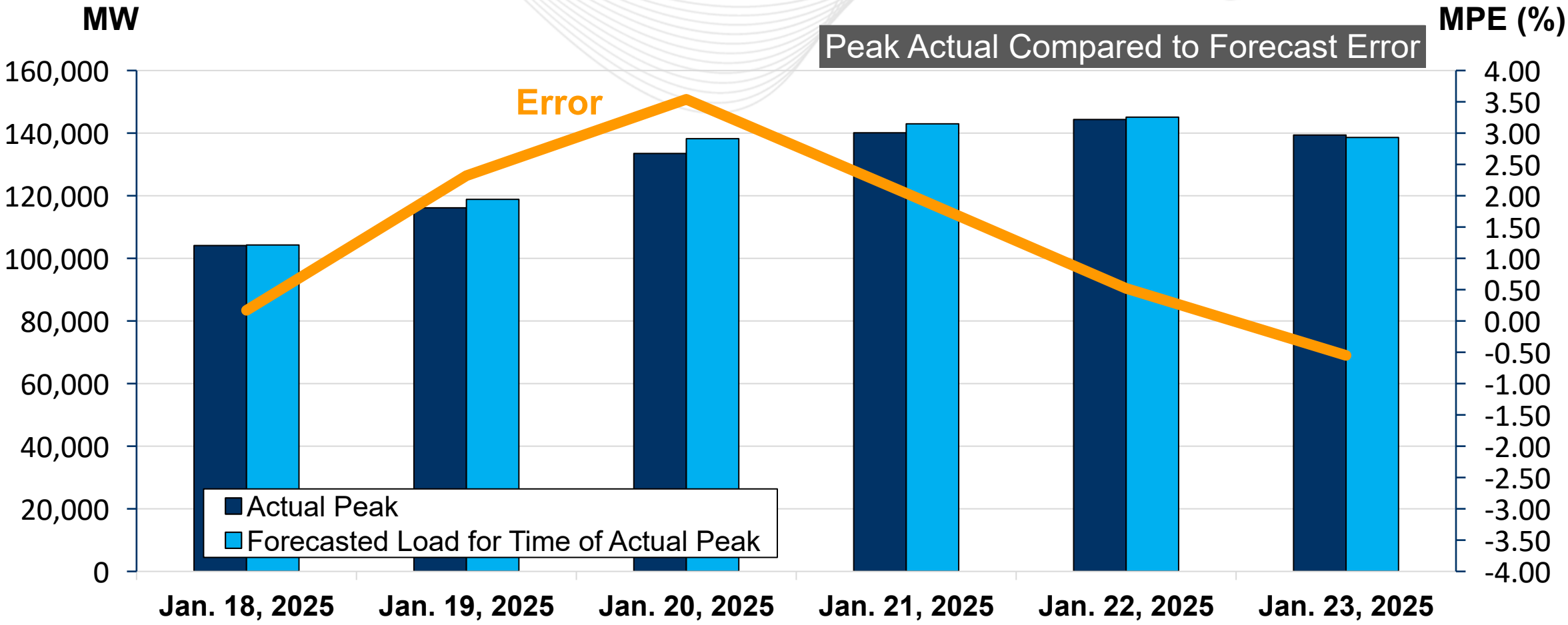
Top Ten Winter Peaks



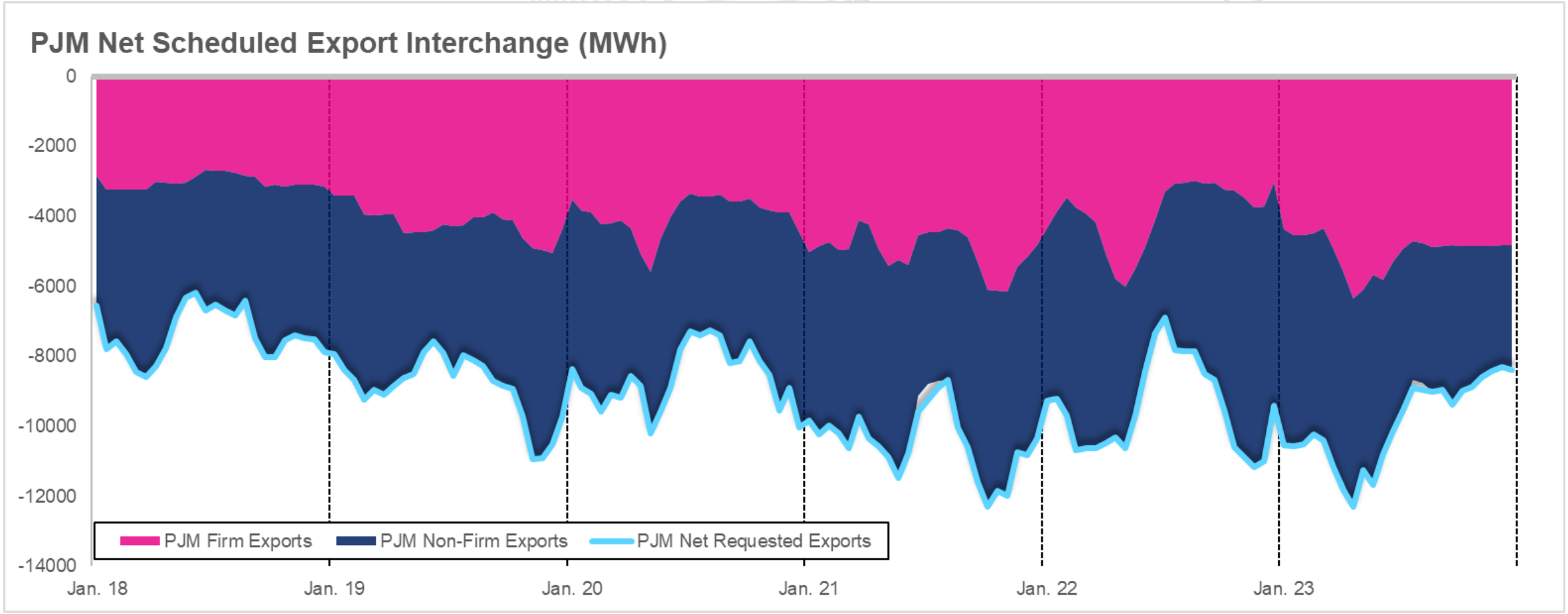
*Preliminary

As of Jan. 27, 2025. This data should not be used as the basis for decision-making.

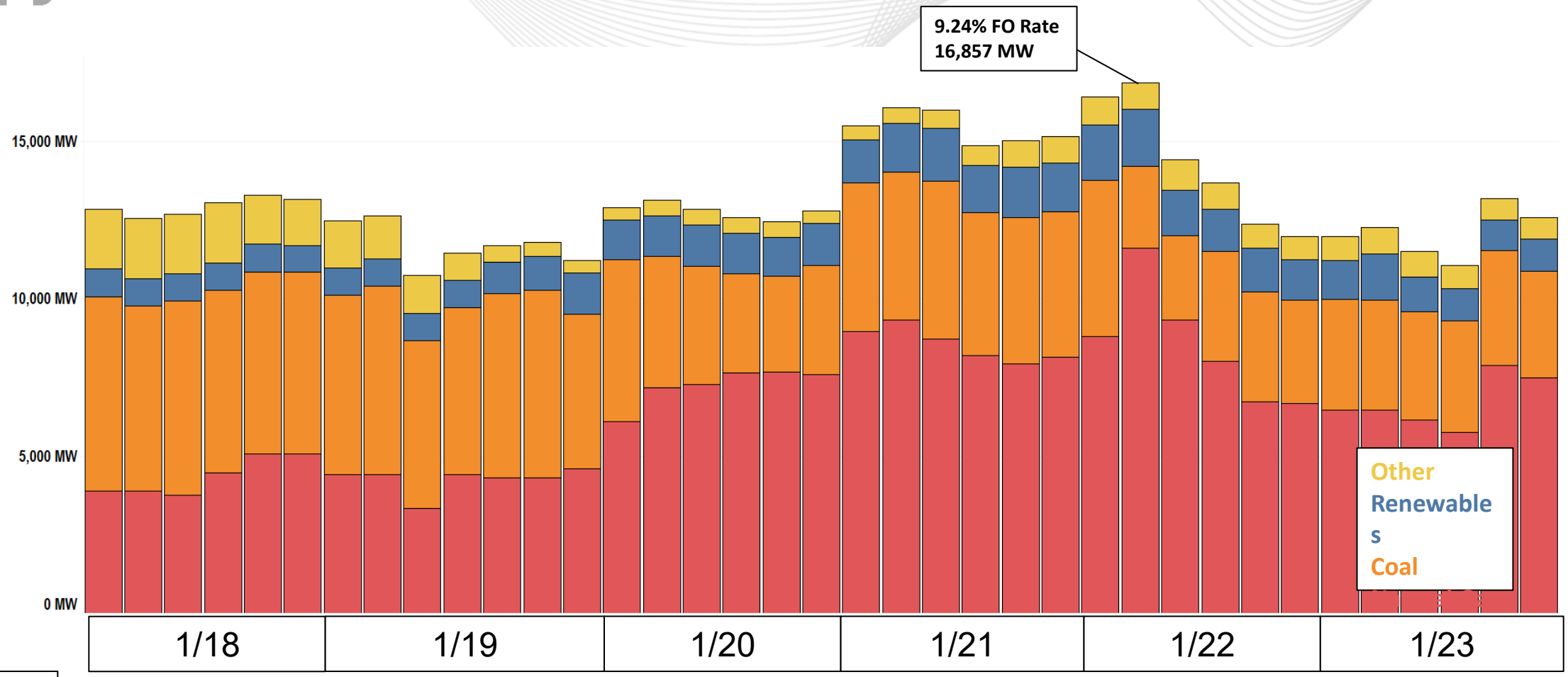
Forecast Error Trend for Jan. 18–23, 2025



Scheduled Interchange

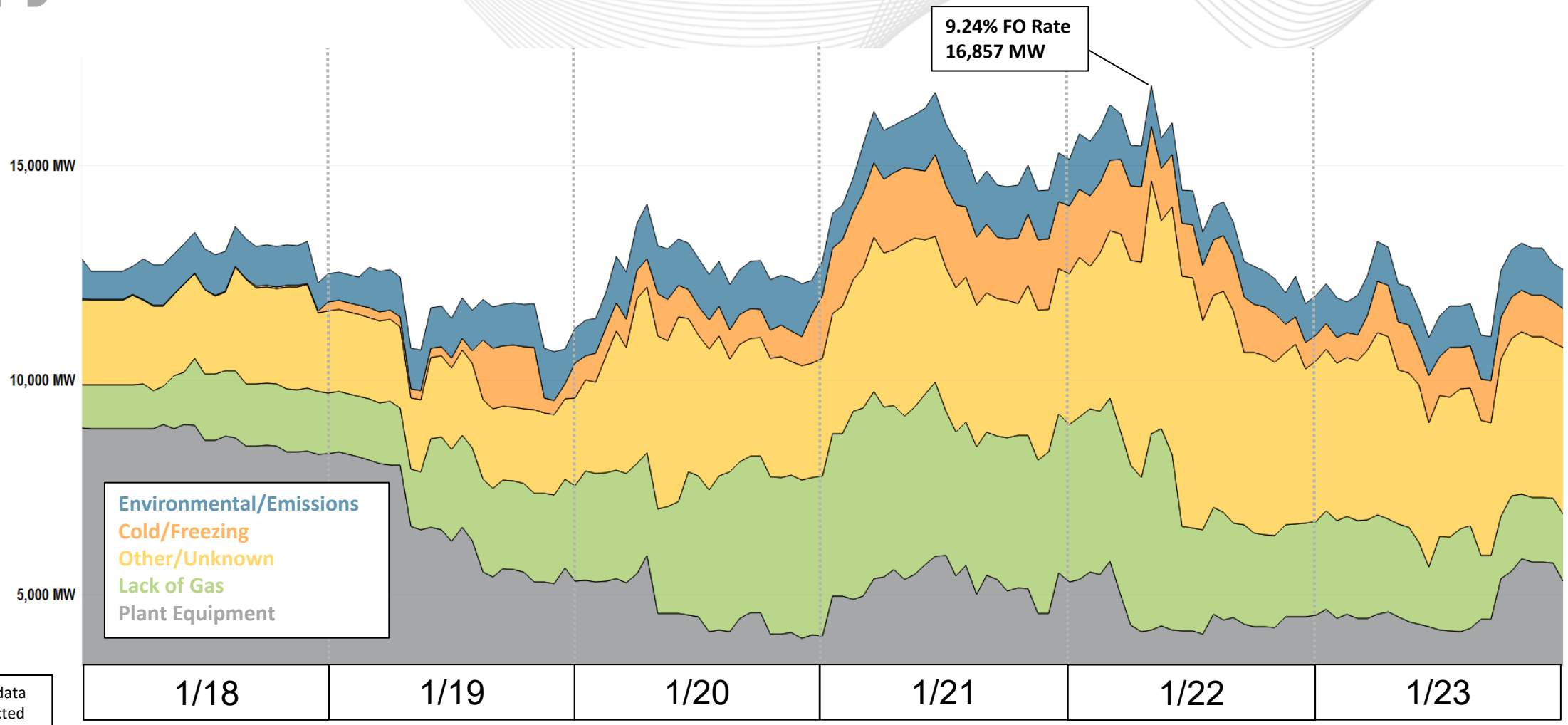


Generation Performance



Note: Outage data shown is collected from eDART and considered preliminary.

Generation Performance



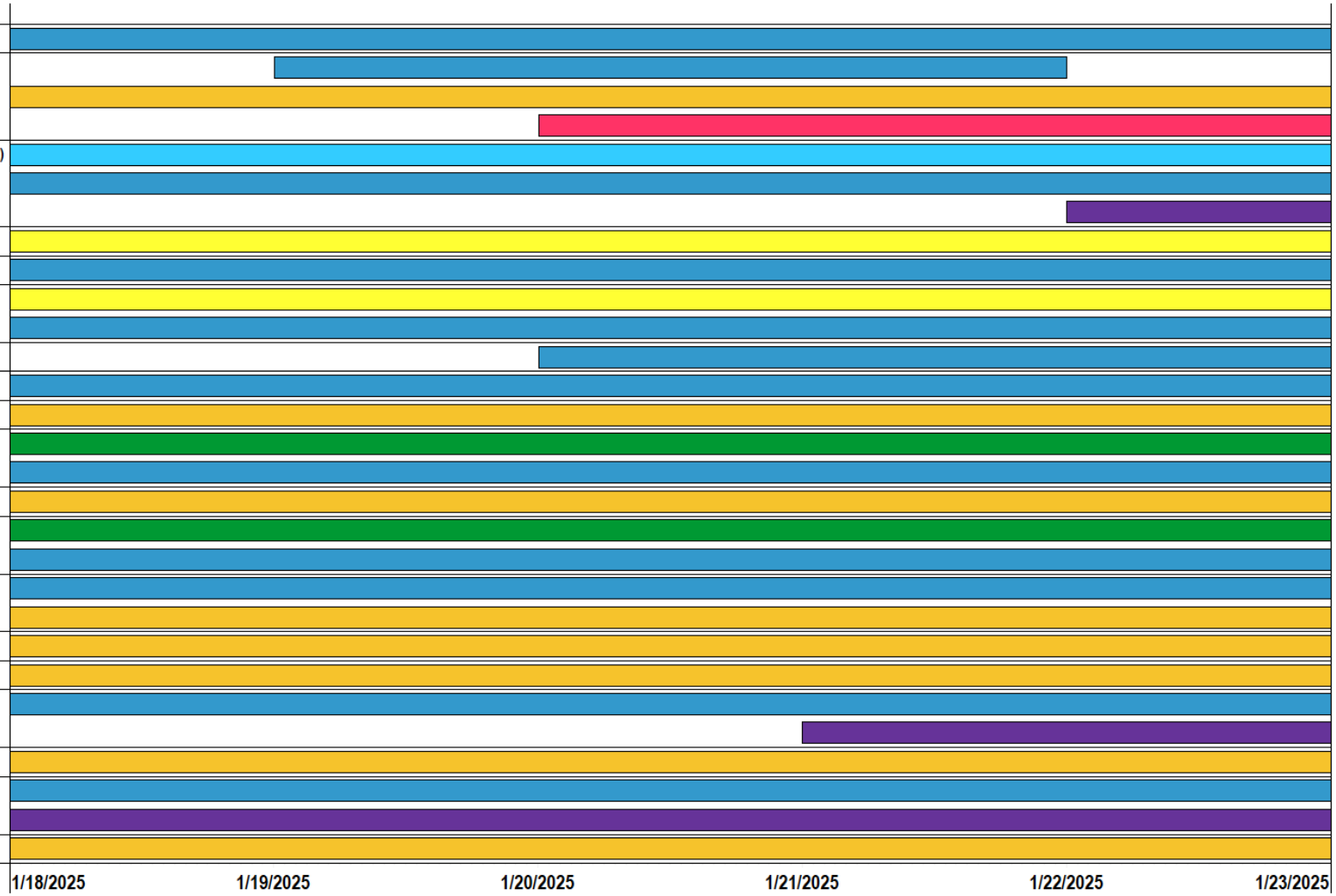
Note: Outage data shown is collected from eDART and considered preliminary.

Key Takeaways on Gas Delivery Performance

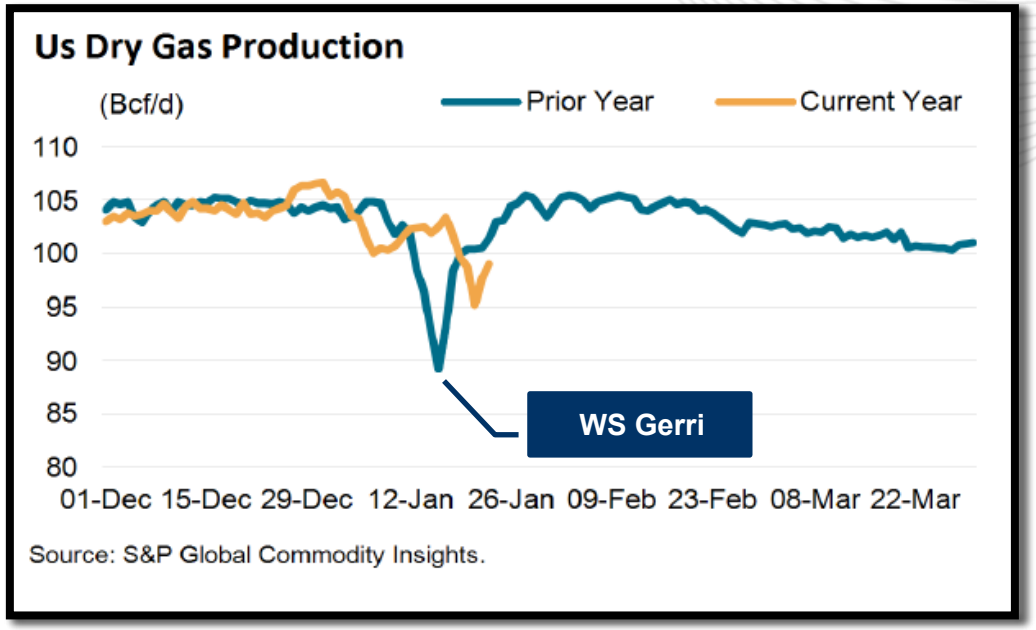
Interstate Pipelines	•Overall strong performance under high utilization rates •Hourly and Daily capacity restrictions in place through the cold period •Two brief compressor station outages resulting in localized pressure drops with only minimal impact on generation •Pipeline lateral leak resulted in approximately 300 MW of gas generation taking a forced outage for several days
Local Gas Distribution Companies	•Approximately 1,500 MW of gas-only generation unavailable due to LDC interruptions
Gas Production	•Production remained strong with minimal losses associated with well freeze offs •~ 2 bcf/day (5%) decline in daily production in Appalachian region •~11 bcf/day decline during WS Elliott
Gas Availability/Liquidity	•Weekend gas market remains an ongoing challenge with supply uncertainty once past Friday trading •Some generators reported inability to find sellers during the weekend
Gas Prices	•4 Day Weekend (Saturday 10am through Wednesday 10am) gas strip spot prices much higher in eastern PJM compared to western zones. Eastern trading hubs averaged around $35/mmbtu to $10/mmbtu at western PJM hubs. However, individual reported trades peaked between $50 and $100/mmbtu with highest price over $100/mmbtu at Transco Z6NY

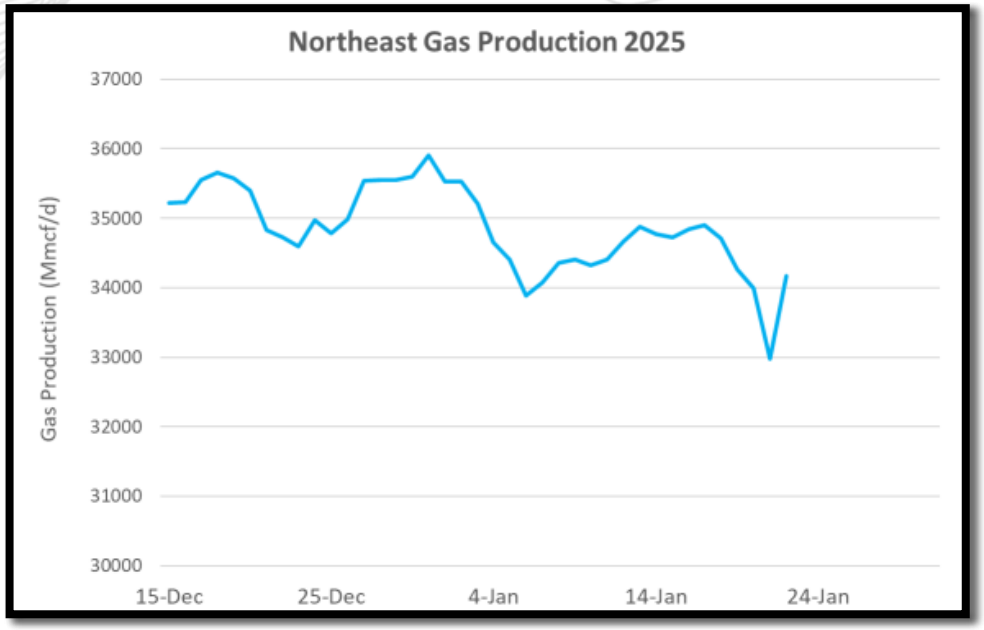
Interstate Pipeline Operational Notices

Pipeline Name	Pipeline Notice
Algonquin Gas Transmission	Daily Balancing OFO
ANR Pipeline	Daily Balancing OFO
	Weather Alert
	Force Majeure
Columbia Gas Transmission	Critical Day (Transport Deliveries/Storage Withdrawals)
	Daily Balancing OFO
	Reciept Point Underperformance/Production Drop
Cove Point LNG, LP	Restrictions on Non-Firm Contracts
East Tennessee Natural Gas	Daily Balancing OFO
Eastern Gas Transmission & Storage	Restrictions on Non-Firm Contracts
	Daily Balancing OFO
EasternShore Natural Gas Comp..	Daily Balancing OFO
Equitrans, L.P.	Daily Balancing OFO
Guardian Pipeline, L.L.C.	Weather Alert
Horizon Pipeline	Ratable Take Requirement
	Daily Balancing OFO
Midwestern Gas Transmission	Weather Alert
Natural Gas Pipeline of America	Ratable Take Requirement
	Daily Balancing OFO
Northern Border Pipeline	Daily Balancing OFO
	Weather Alert
Panhandle Eastern Pipeline Com..	Weather Alert
Tallgrass Interstate Gas Transmi..	Weather Alert
Texas Eastern Transmission	Daily Balancing OFO
	Reciept Point Underperformance/Production Drop
Texas Gas Transmission	Weather Alert
Transco	Daily Balancing OFO
	Reciept Point Underperformance/Production Drop
Trunkline Gas Company, LLC	Weather Alert



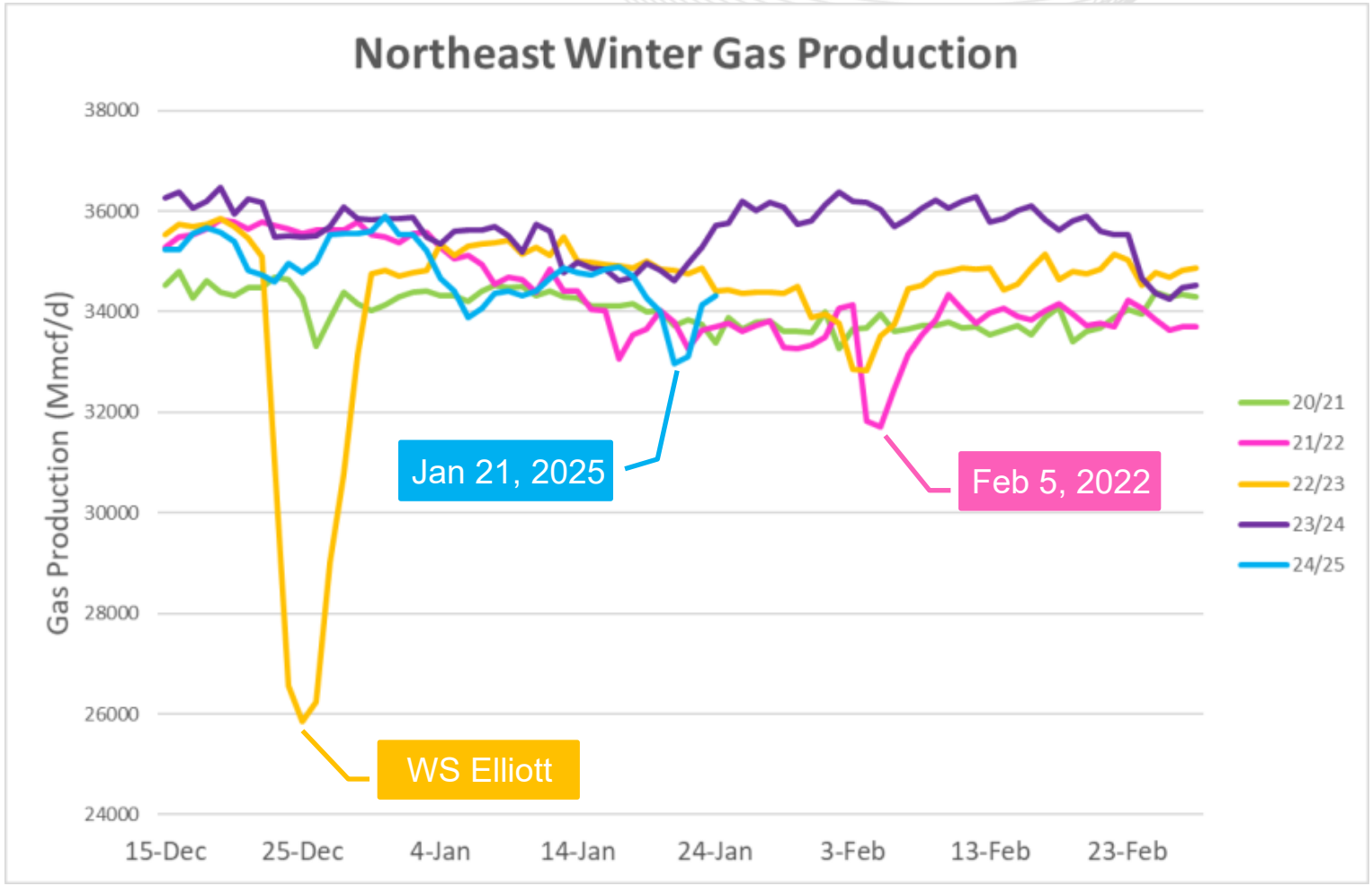
Gas Production





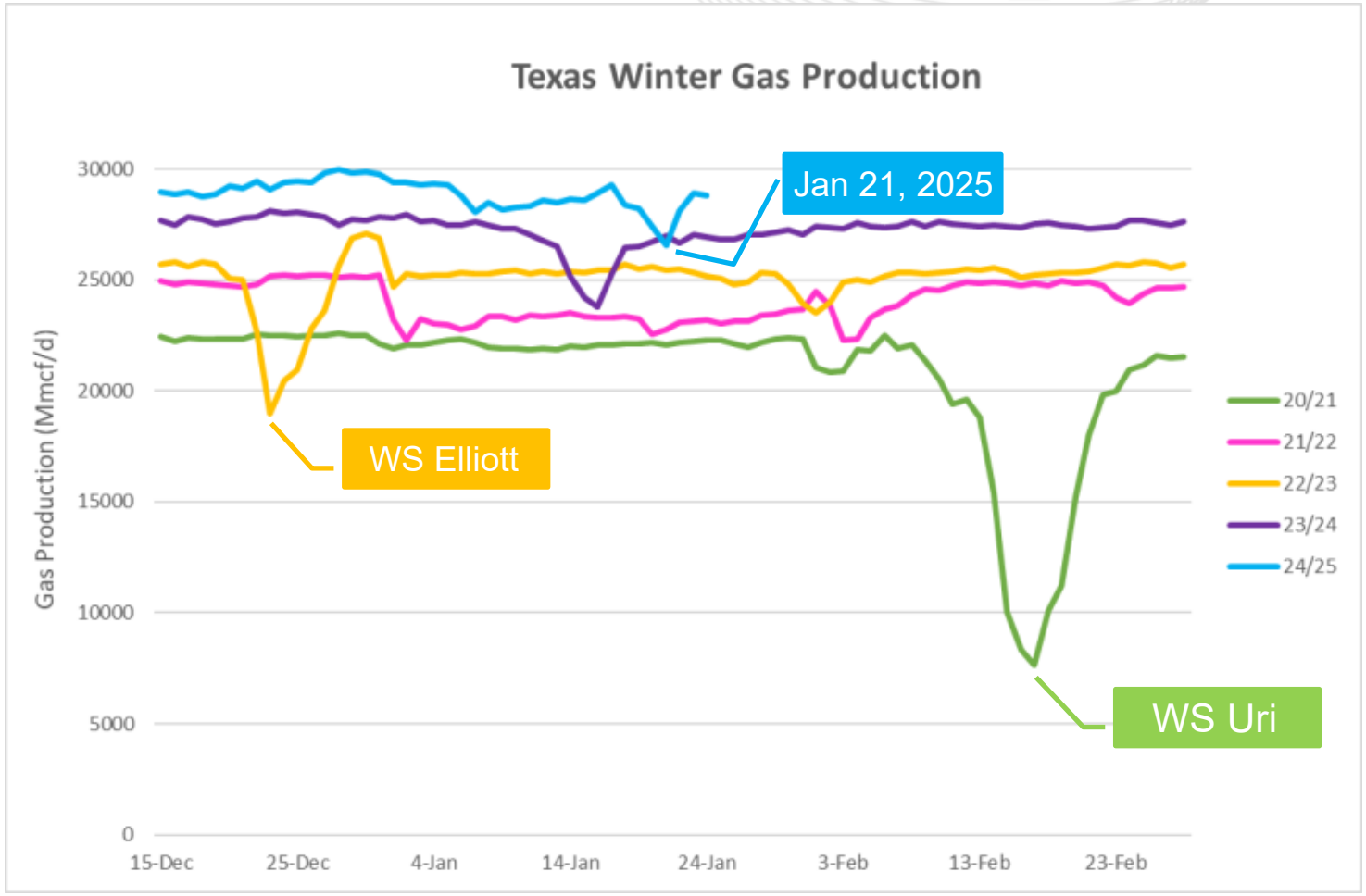
- Total US domestic production and Northeast production have remained strong through recent cold weather events compared to the losses seen during Winter Storm Uri and Winter Storm Elliott
- General consensus is that the upstream gas sector (producers, gatherers, and processors) has ramped up their winter preparedness and equipment winterization efforts since Winter Storm Elliott, which will hopefully mitigate large gas freeze off losses

Regional Production - Northeast



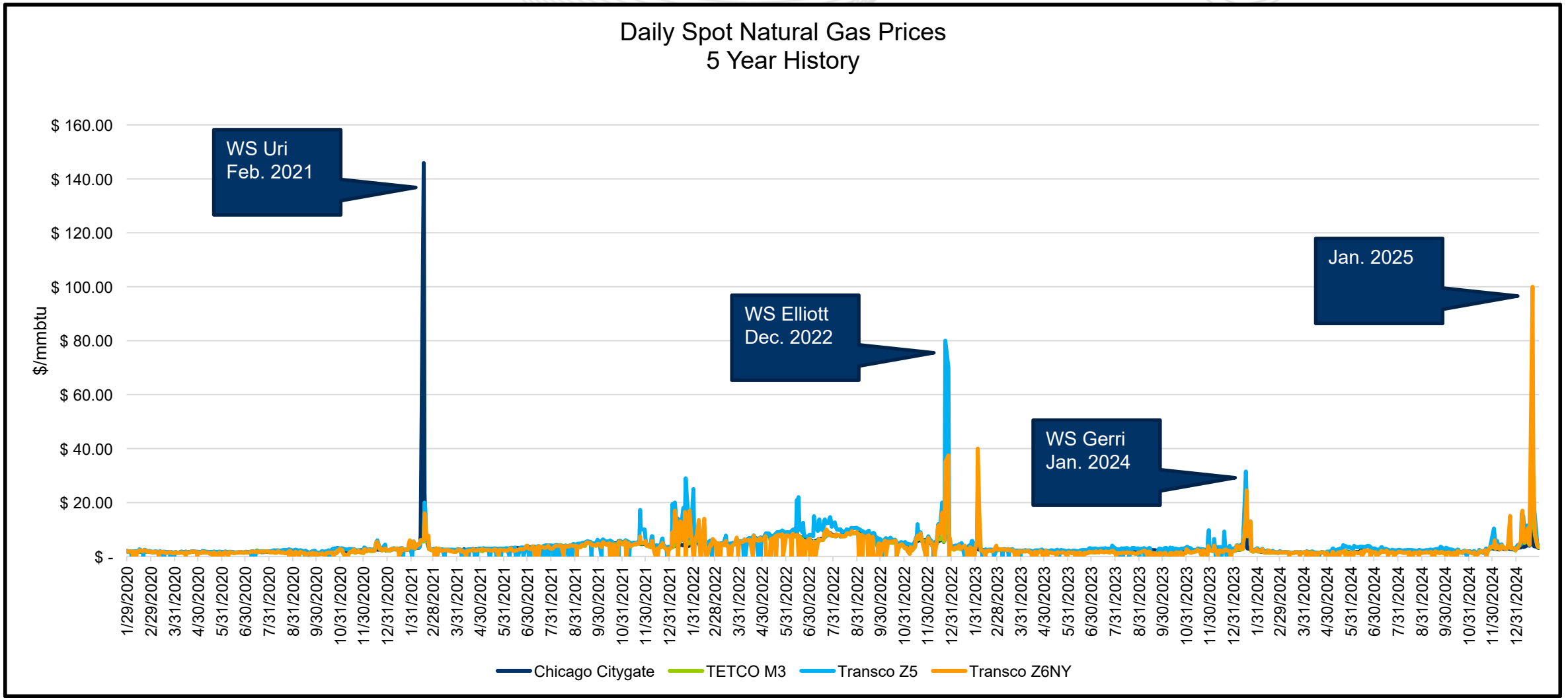
- Gas production remained fairly strong during recent cold weather event (Jan 17-22)
- Northeast gas production dropped approximately 2 Bcf/d
- For comparison, Northeast gas production dropped ~11 Bcf/d during Winter Storm Elliott

Regional Production - Texas

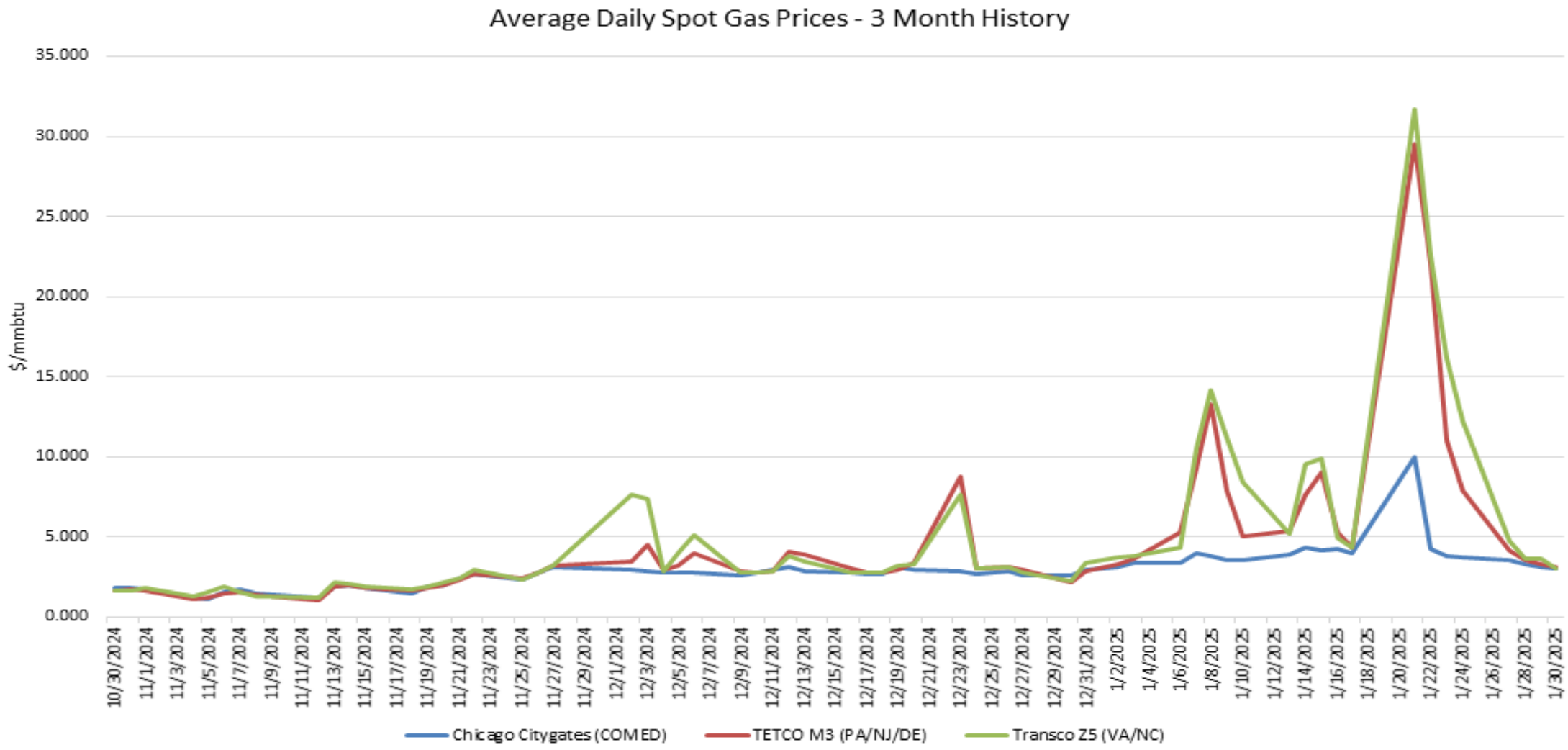


- Texas gas production dropped approximately 1-2 Bcf/d in the recent cold weather event
- Production losses in the Texas region were more significant during Winter Storm Uri than compared to the Northeast region
- Production continues to perform better during cold weather events

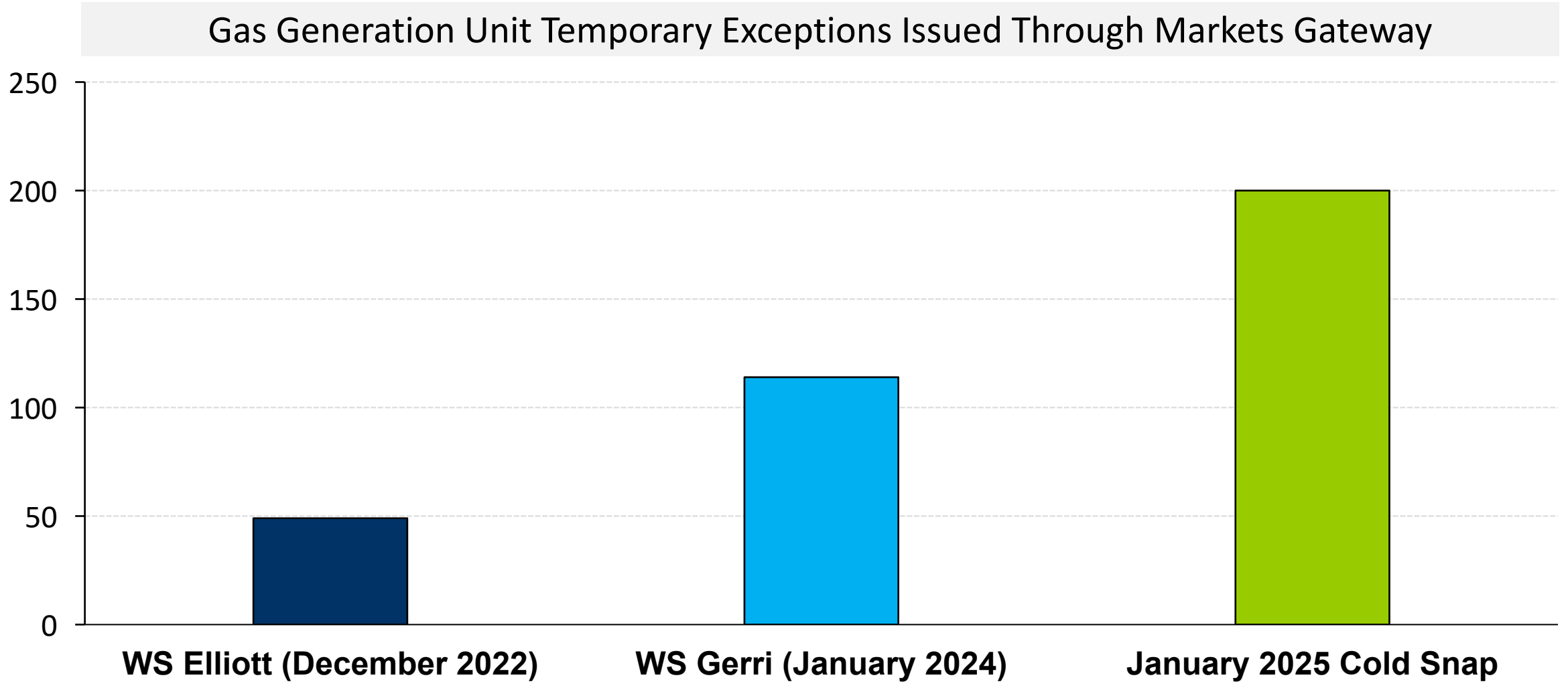
Spot Natural Gas Prices (Highest Prices)



Spot Natural Gas Prices (Average Prices)



Temporary Exceptions – Natural Gas Units



Transmission Outage Coordination

- PJM and Transmission Owners coordinated to reschedule 135 transmission outages
- PJM recalled several transmission jobs to help improve transfer capability with neighbors, provide redundant feed to the distribution system, and help improve the voltage profile
- Discussed need for hands off approach for the cold weather period on SOS-T call
  - — Emergency work only

Transmission Performance

- Transmission system performance was very good considering peak winter load conditions
- Issued 25 unique PCLLRWs
  - — Local thermal and voltage
  - — List of January PCLLRWs:

  PJM System Operations Summary – January 2025

Transmission Performance

Transmission Performance

Generation Deliverability

- High flows across the AEP/DOM Transfer Interface
  - High demand in BGE, PEPCO, and Dominion Zones
  - Interchange to Balancing Authorities south of PJM
- Exhausted non-cost options
- Utilized off-cost operation
- Issued TLR 1 and TLR 3 on AEP/DOM transfer interface
  - TLR 1 effective as of 01/22 04:45 – 01/24 08:45
  - TLR 3 issued 01/23 07:45 – 10:00

Transmission Performance

Generation Deliverability

Dune Acres – Michigan 13839 138kV line loss of Dumont – Wilton Center 12215 765kV line

- Unrecallable MISO transmission outages:
  - Babcock - Stillwell 345kV line outage (5/20/24 – 5/31/25)
  - Green Acres – Olive 345kV line outage (1/13/25 – 2/7/25)
- Gas fired generation commitment in COMED
- Manually dispatched approximately 2700 MW of COMED wind generation offline

Transmission Performance

Generation Deliverability

Conastone – Northwest 2322 230kV line loss of Brighton – Conastone 5011 500kV line

- High demand in BGE, PEPCO, and Dominion Zones
- Gas fired generation commitment in the Northeast

Contact

Presenter/SME:
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Member Hotline

(610) 666-8980

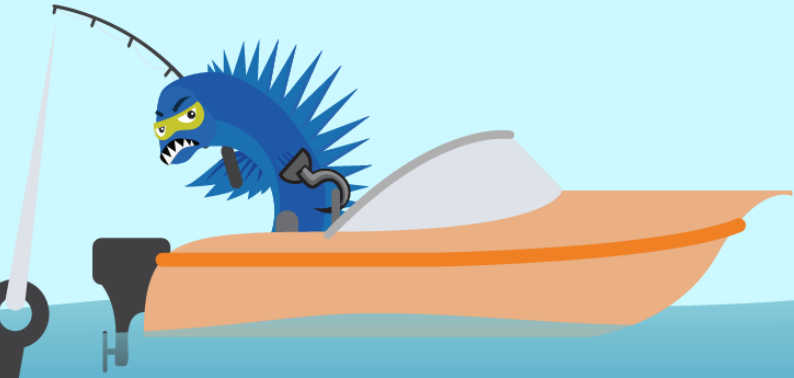
(866) 400-8980

custsvc@pjm.com

PROTECT THE POWER GRID

THINK BEFORE YOU CLICK!

pjm



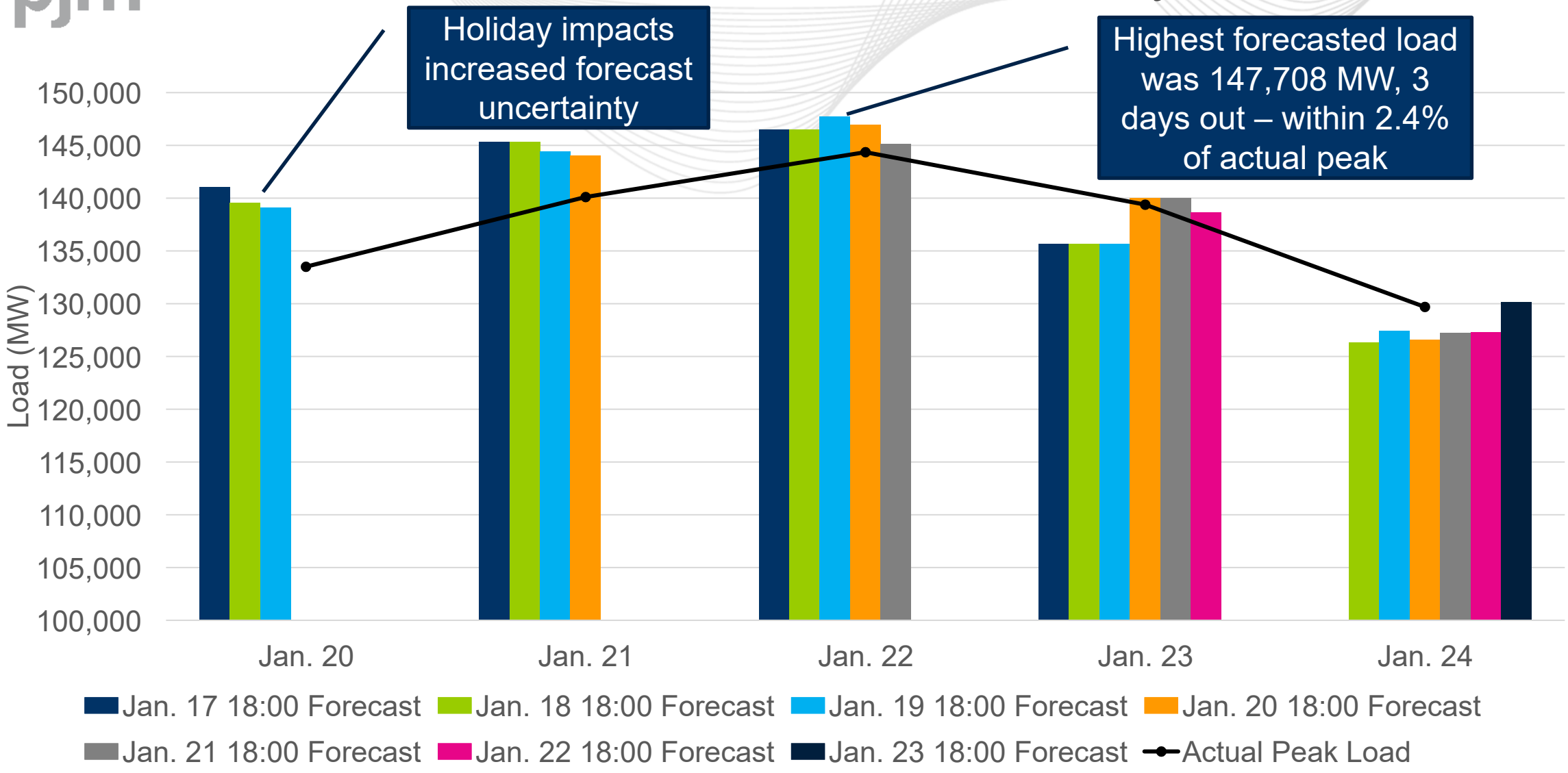
BE ALERT TO MALICIOUS PHISHING EMAILS

Report suspicious email activity to PJM.

Call (610) 666-2244 or email it_ops_ctr_shift@pjm.com

Additional slides requested at February 6, 2025 Operating Committee Meeting

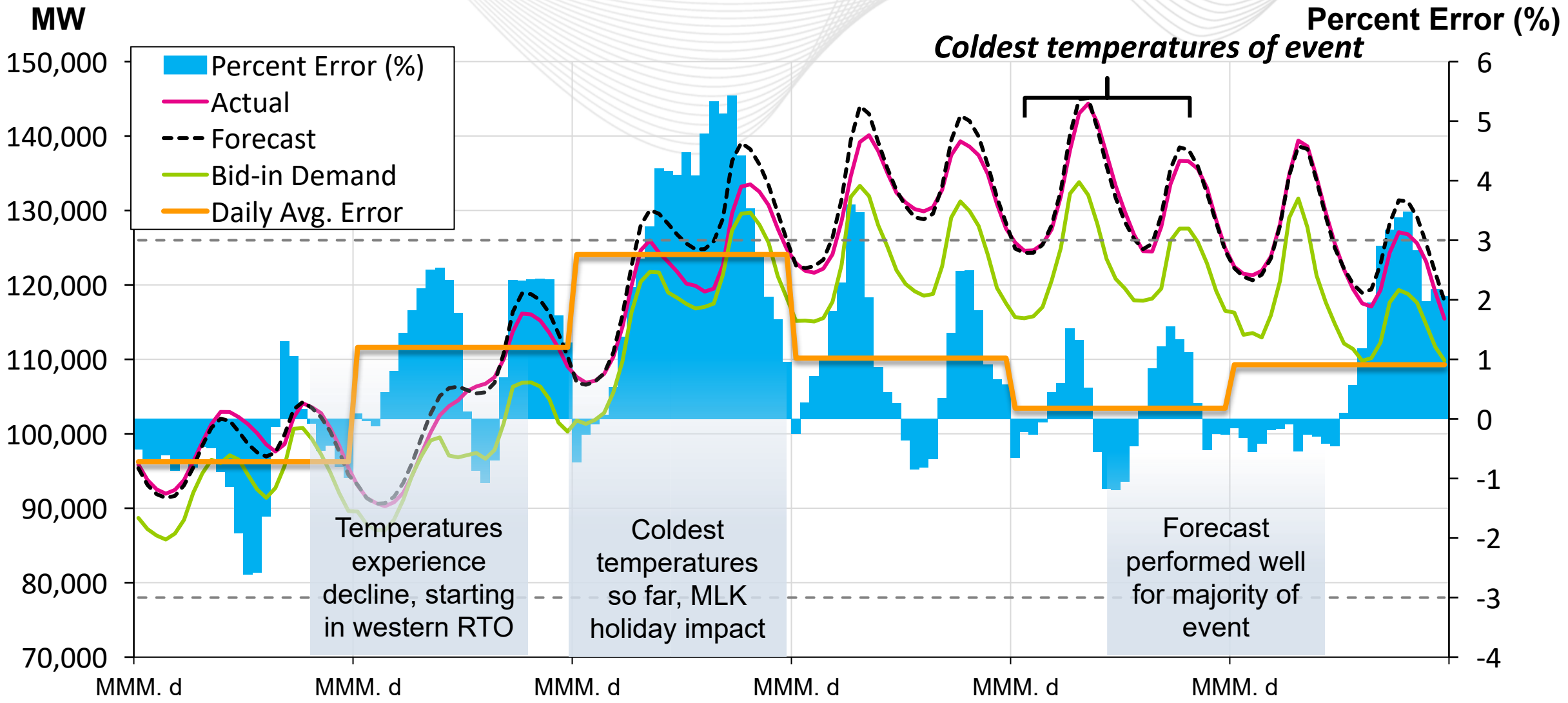
Load Forecast in Advance of January 2025 Cold Wave



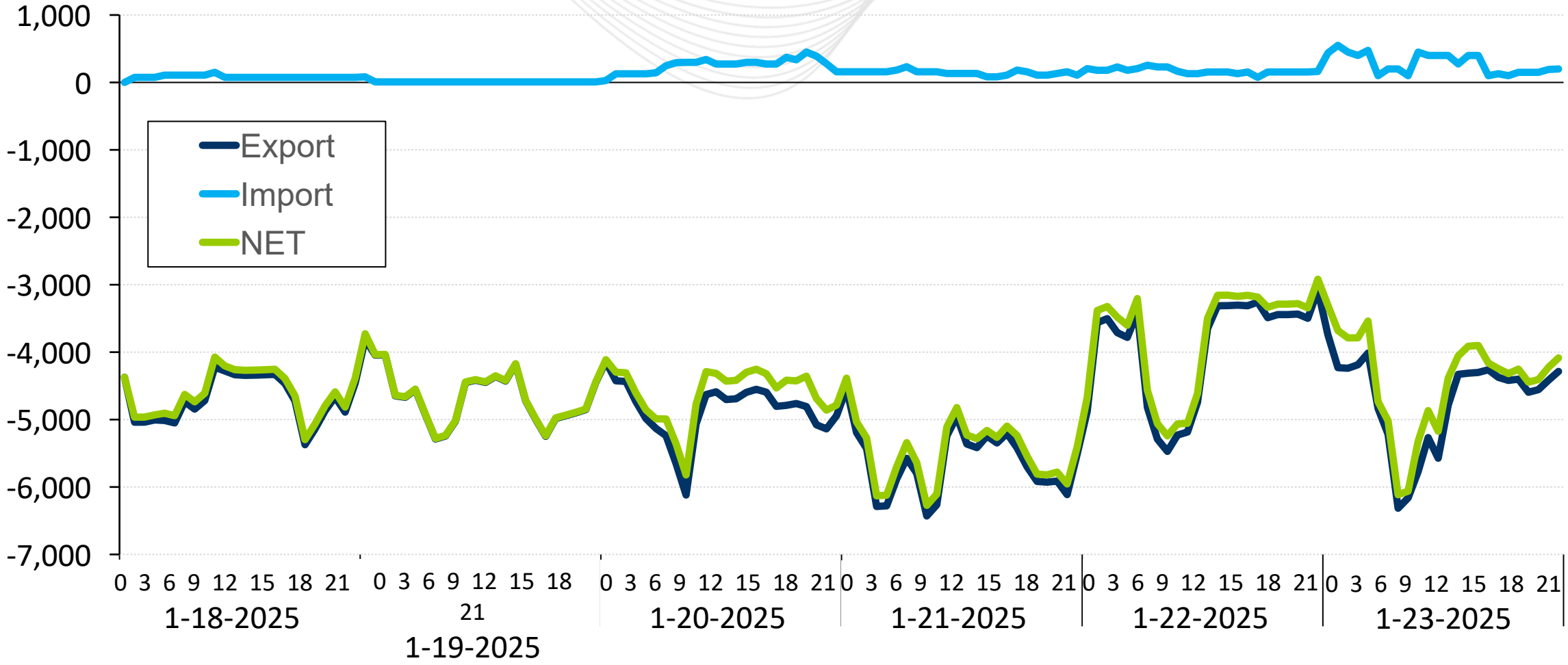
January 2025 Cold Event – Extended Load Forecast

Date	Actual Load (MW)	18:00 Forecast (MW)						
		Jan. 17	Jan. 18	Jan. 19	Jan. 20	Jan. 21	Jan. 22	Jan. 23
Jan. 20	133,503	141,047	139,537	139,089				
Jan. 21	140,109	145,334	145,334	144,415	144,024			
Jan. 22	144,355	146,468	146,468	147,708	146,908	145,104		
Jan. 23	139,388	135,674	135,674	135,674	139,974	139,974	138,618	
Jan. 24	129,691		126,304	127,417	126,570	127,188	127,294	130,133

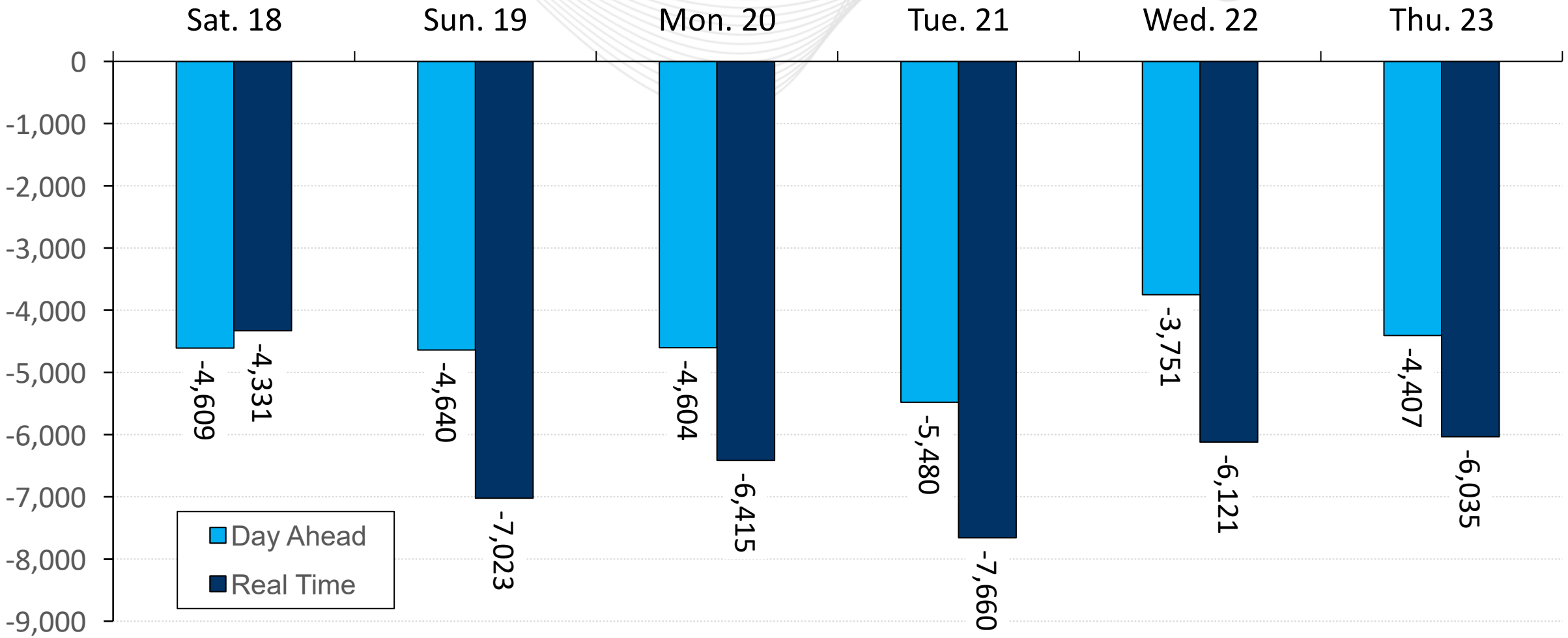
Forecast Performance During January Cold Spell



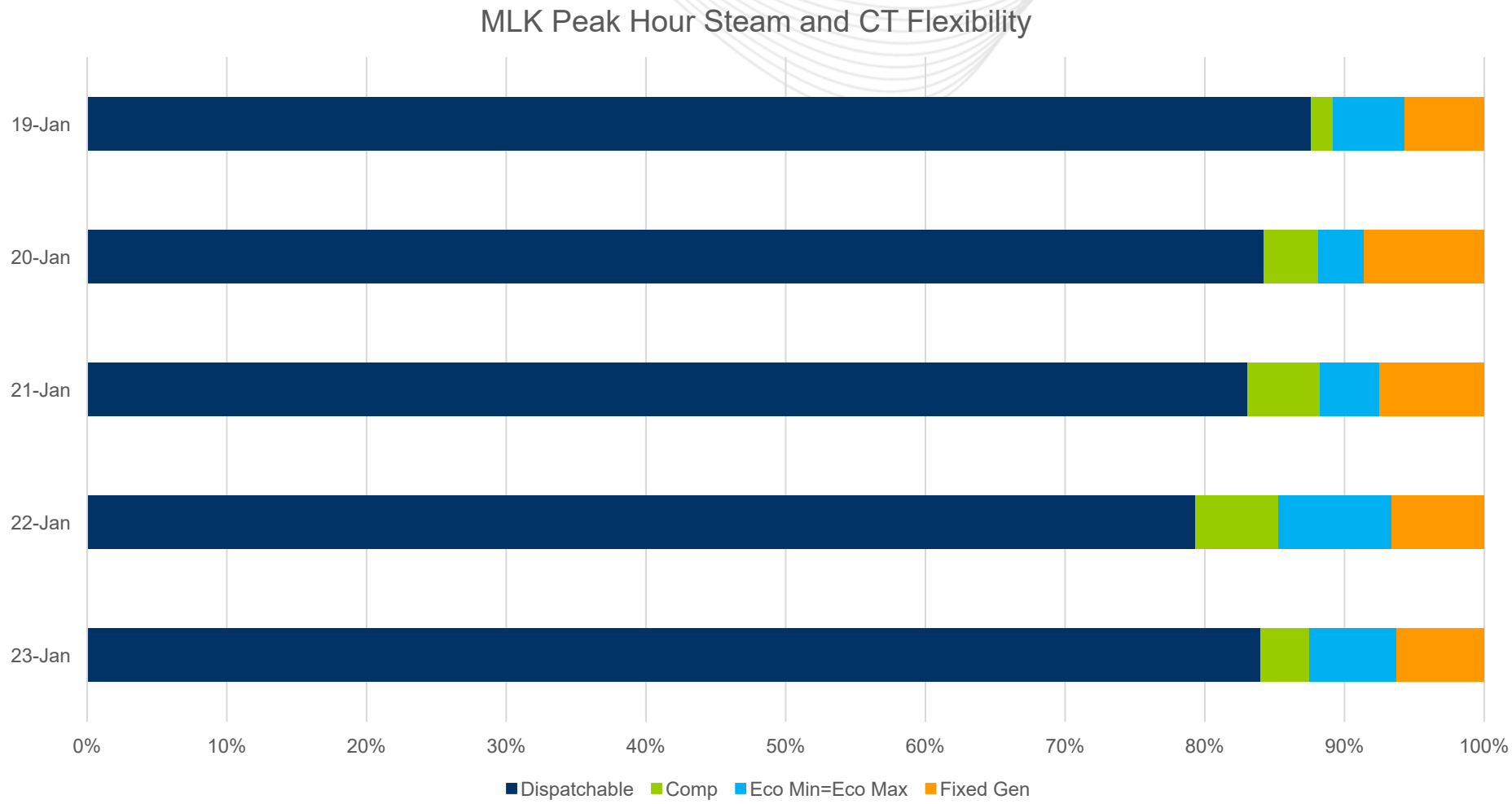
Day-Ahead Interchange



Interchange Day-Ahead vs. Real-Time



Unit Flexibility



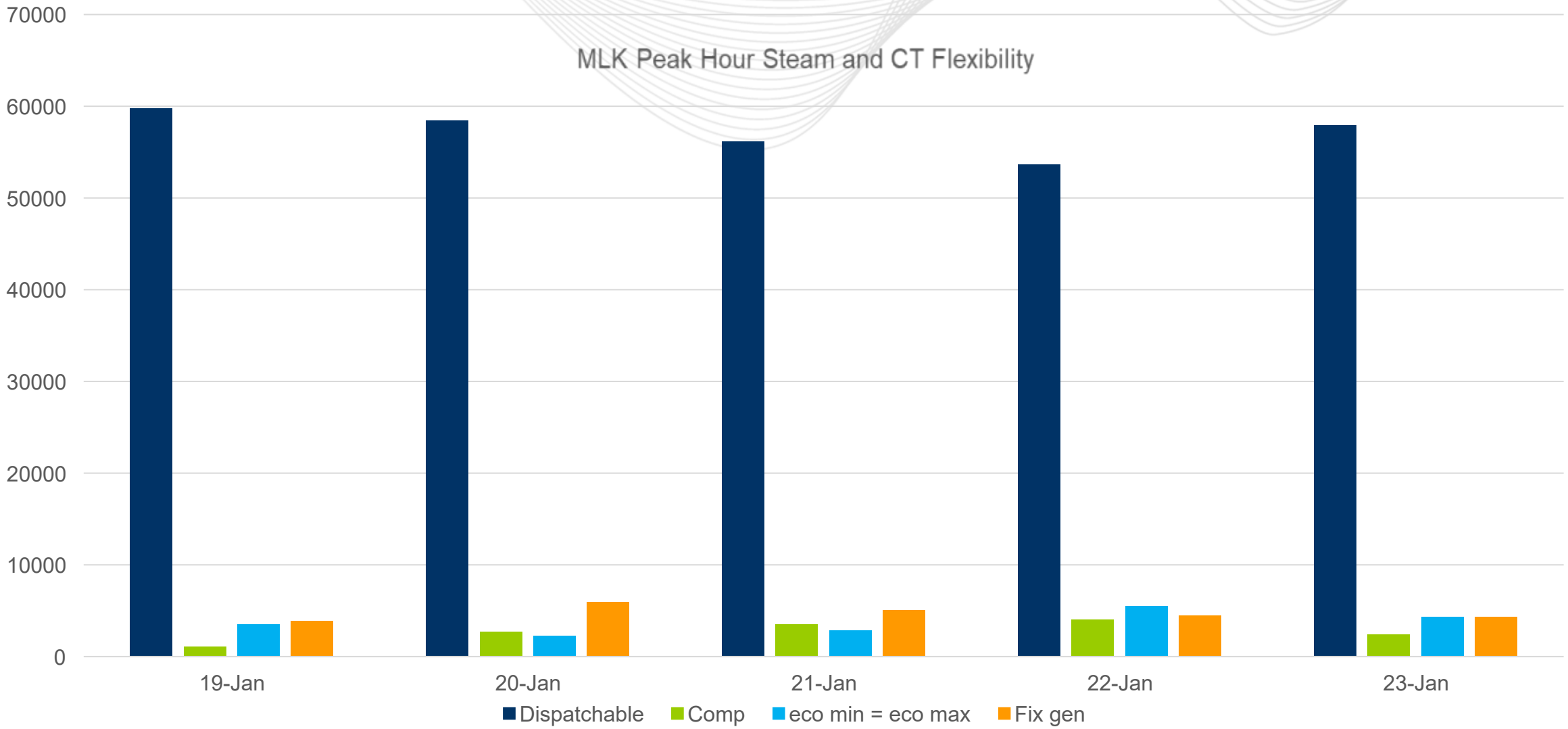
Dispatchable = Ability to follow basepoint between eco min & eco max

Comp = units running for company non dispatchable

Eco min = eco max units that have a eco min = eco max at varying points

Fixed Gen – units at full load – non dispatchable

Unit Flexibility



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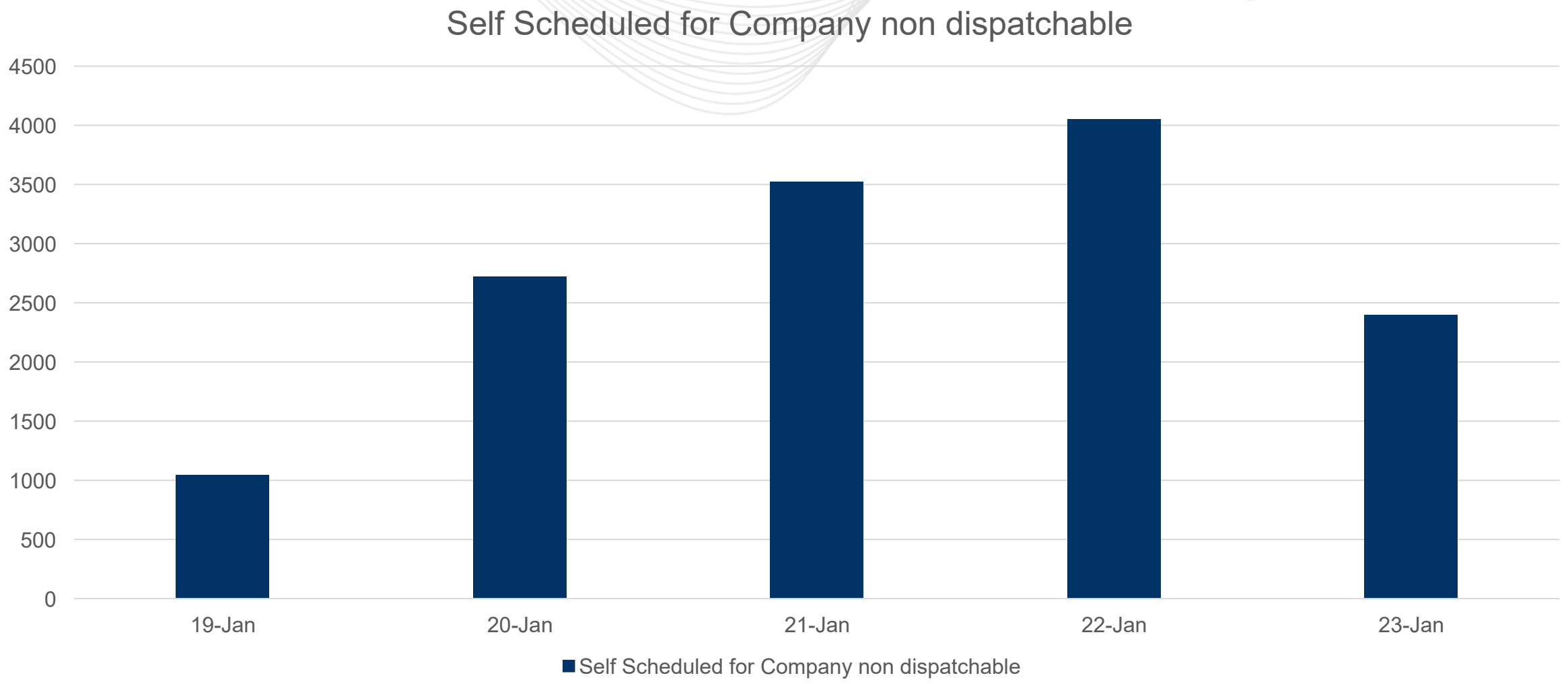

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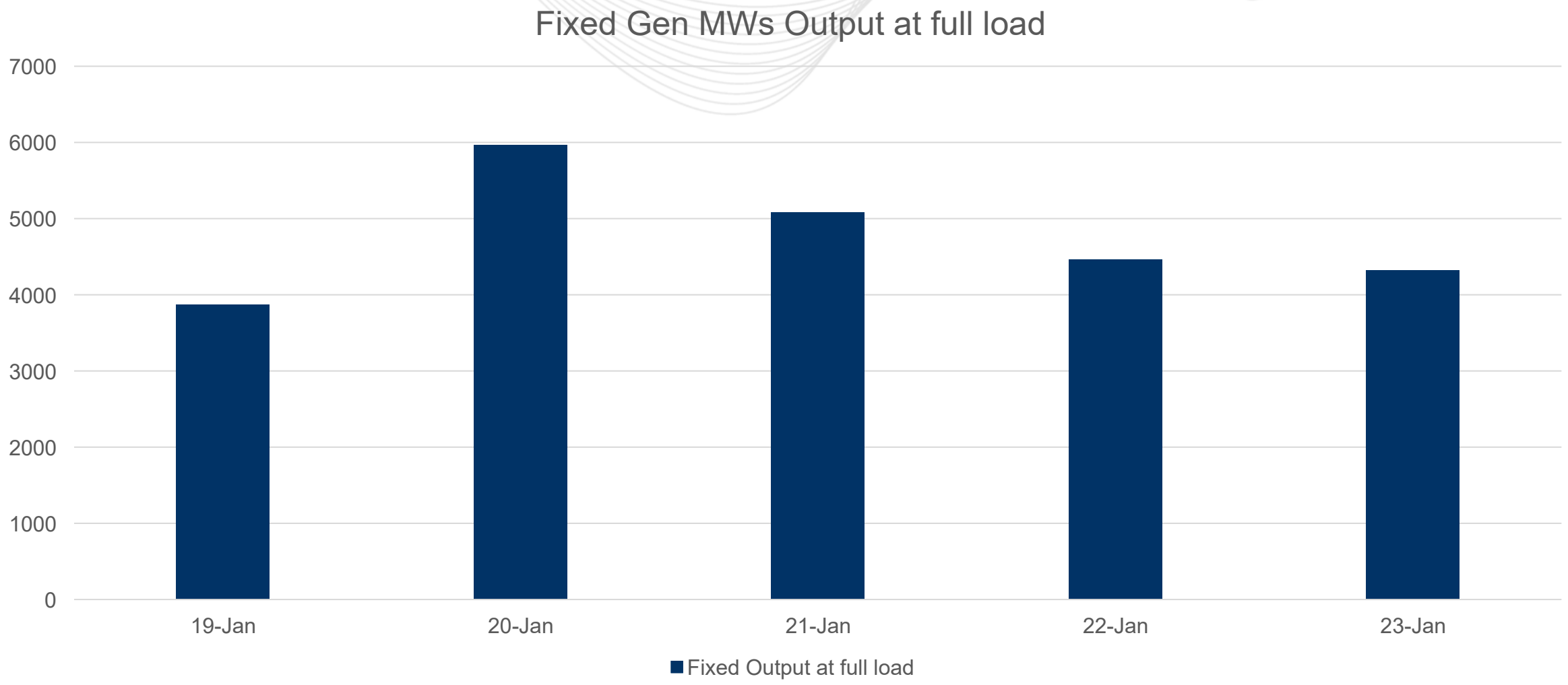

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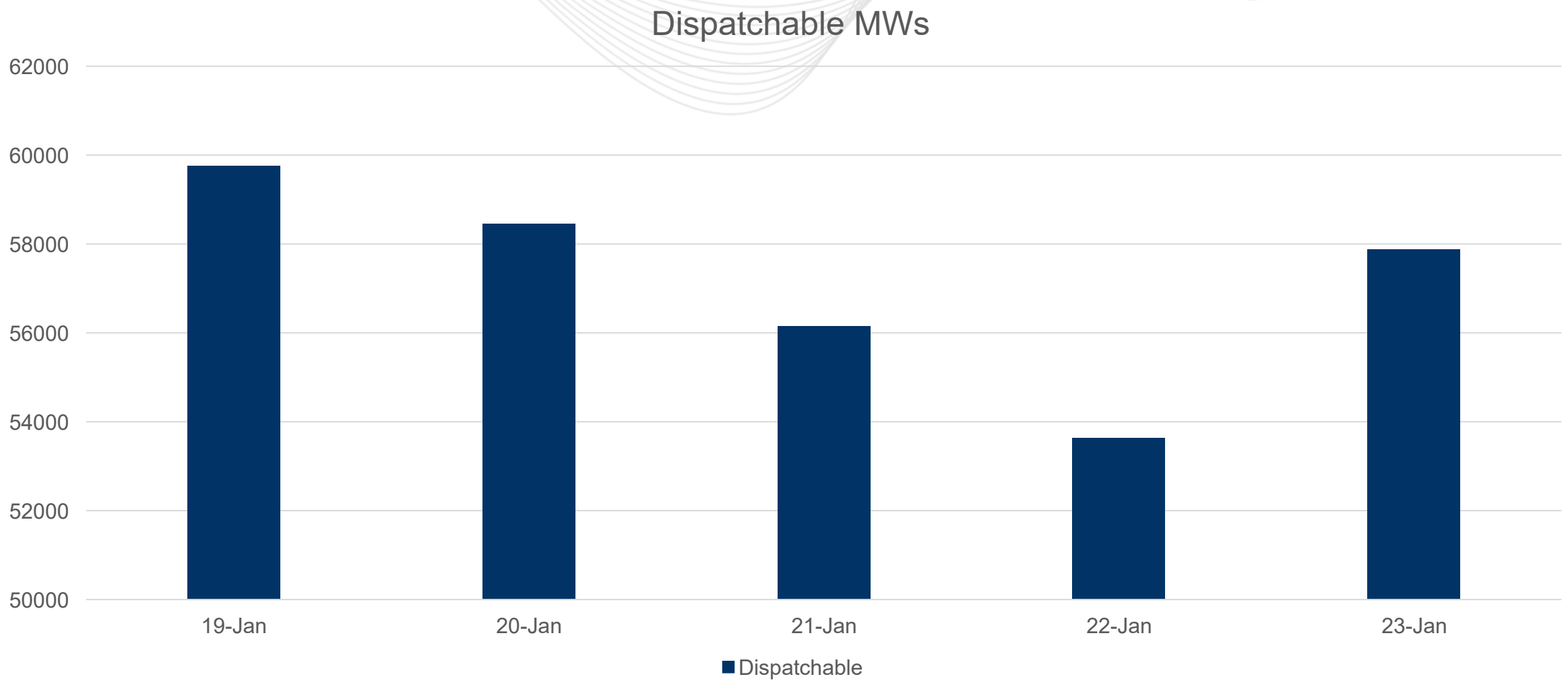

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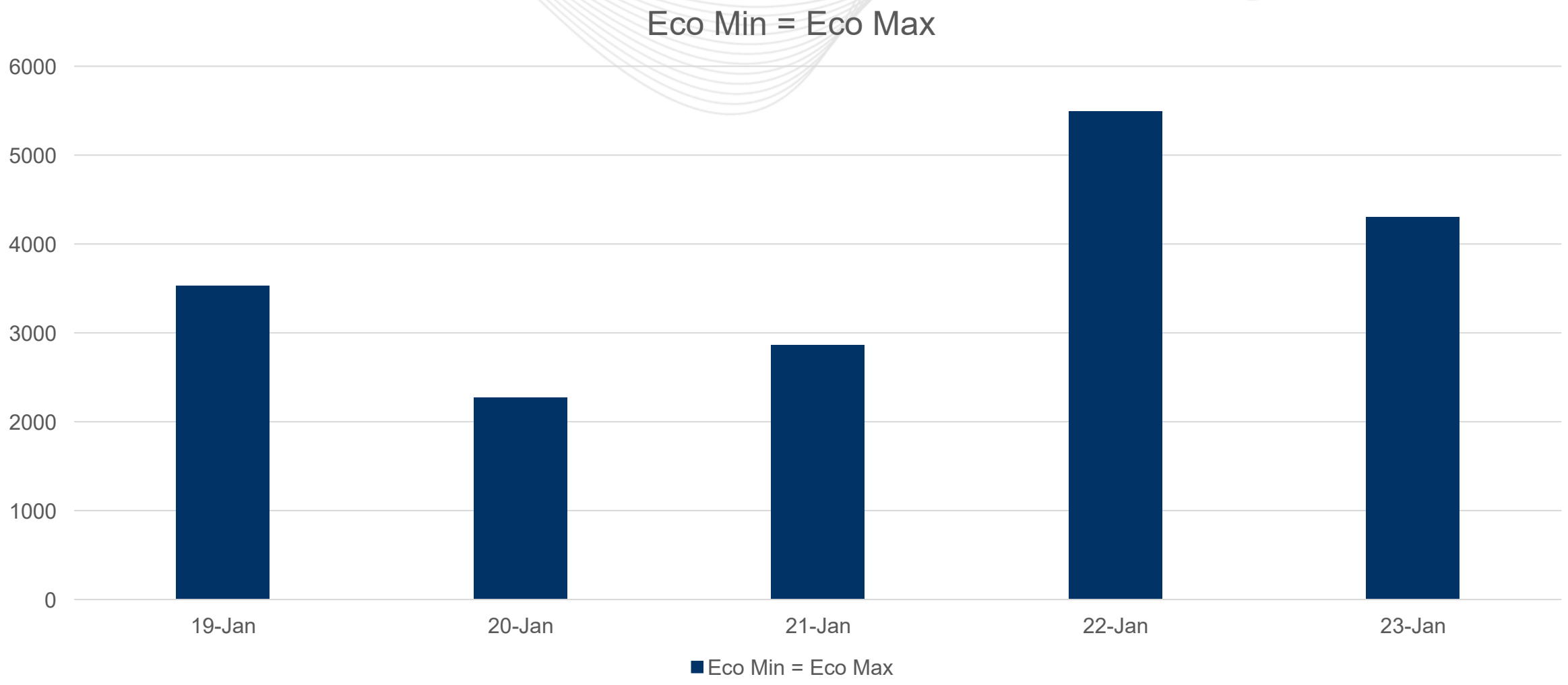


Appendix

Interchange - Education and Background

Physical interchange is governed by FERC Open Access Orders (888, 889, 890)

1996/97 FERC mandate for open access to transmission systems and organized markets

FERC Orders are further refined by regulatory requirements

- NAESB WEQ Business Practice Standards
- NERC INT Standards
- Code of Federal Regulations

Transmission Service Provider and Market Participant Responsibilities

- TSP: Maintain Open Access Same-Time Information System (OASIS)
- TSP: Calculate and post on OASIS transfer capability between transmission systems
- MP: Obtain access to markets via Transmission Service Reservations (TSR) on OASIS
  - Market Participant must acquire service on both source and sink OASIS nodes
- MP: Physical BA to BA interchange realized by 'tagging' the TSR

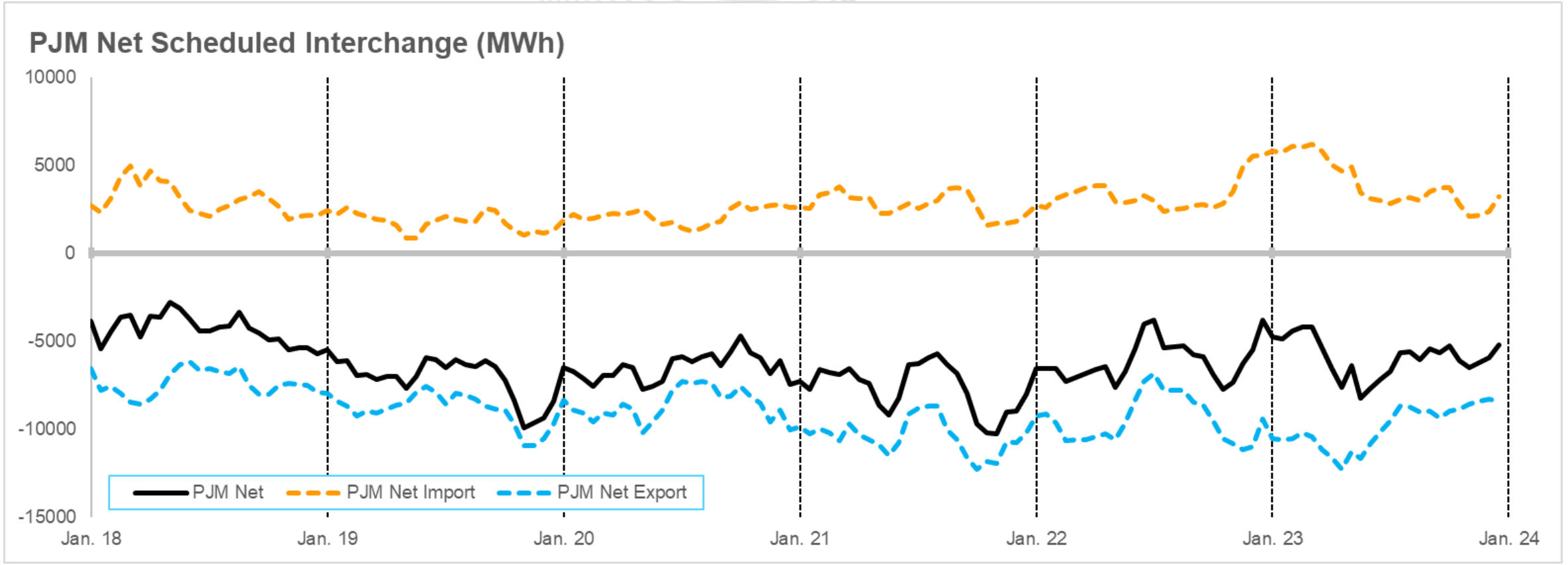
PJM Governing Documents

• Open Access Transmission Tariff	• Regional Transmission and Energy Scheduling Practices	• Manual 2, Transmission Service

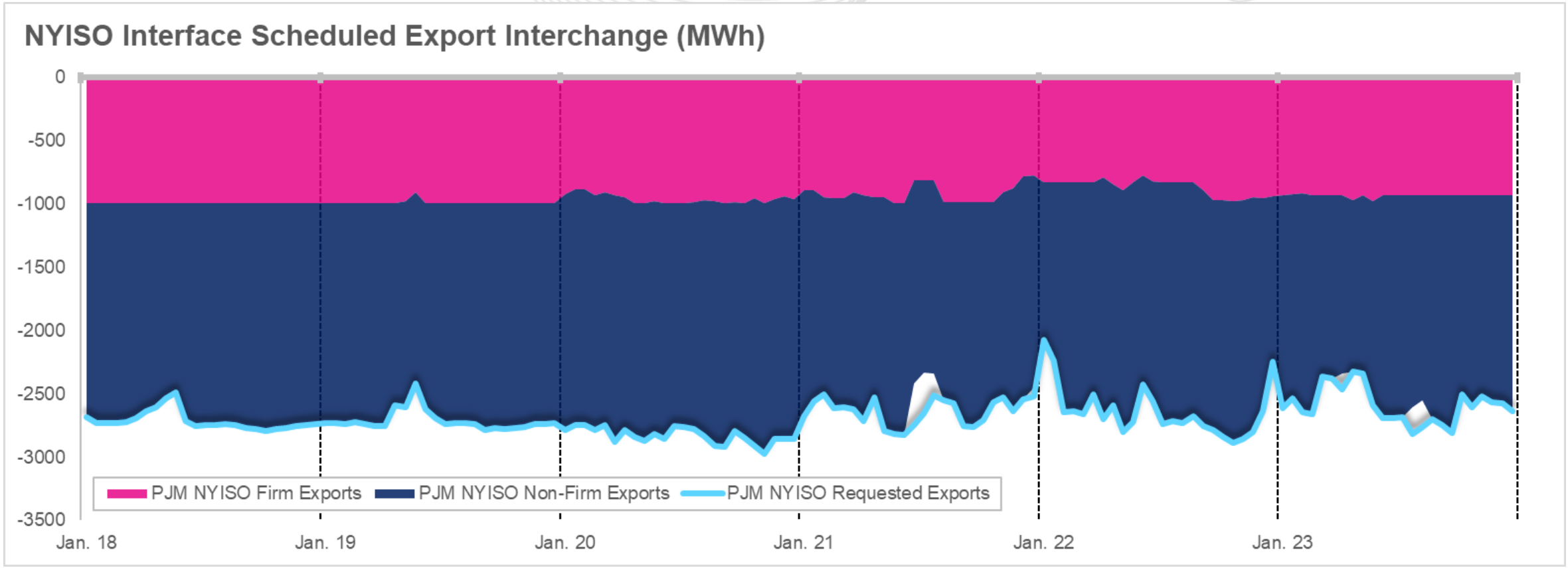
PJM ***Facilitates*** the PJM Interchange Energy Market

- Interchange transactions are scheduled by market participants in accordance with applicable PJM requirements, NERC Standards and NAESB Business Practices
  - If needed, PJM can directly schedule emergency energy consistent with the JOAs
- PJM enables the market via LMP signals and business rules that ensure reliable operations - most transactions are self-scheduled and not dispatched by PJM
- PJM only intervenes (i.e. curtailments) to prevent or mitigate emergency conditions in accordance with PJM, NERC and NAESB requirements

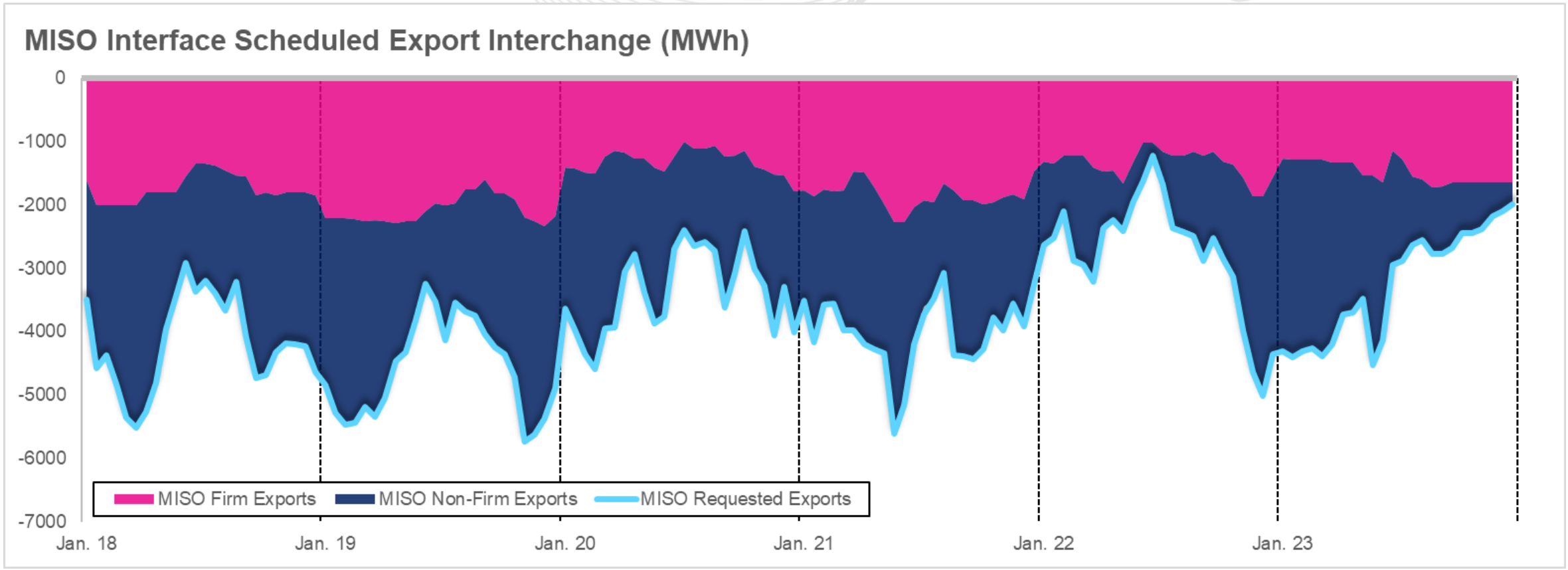
PJM Net Schedule Interchange



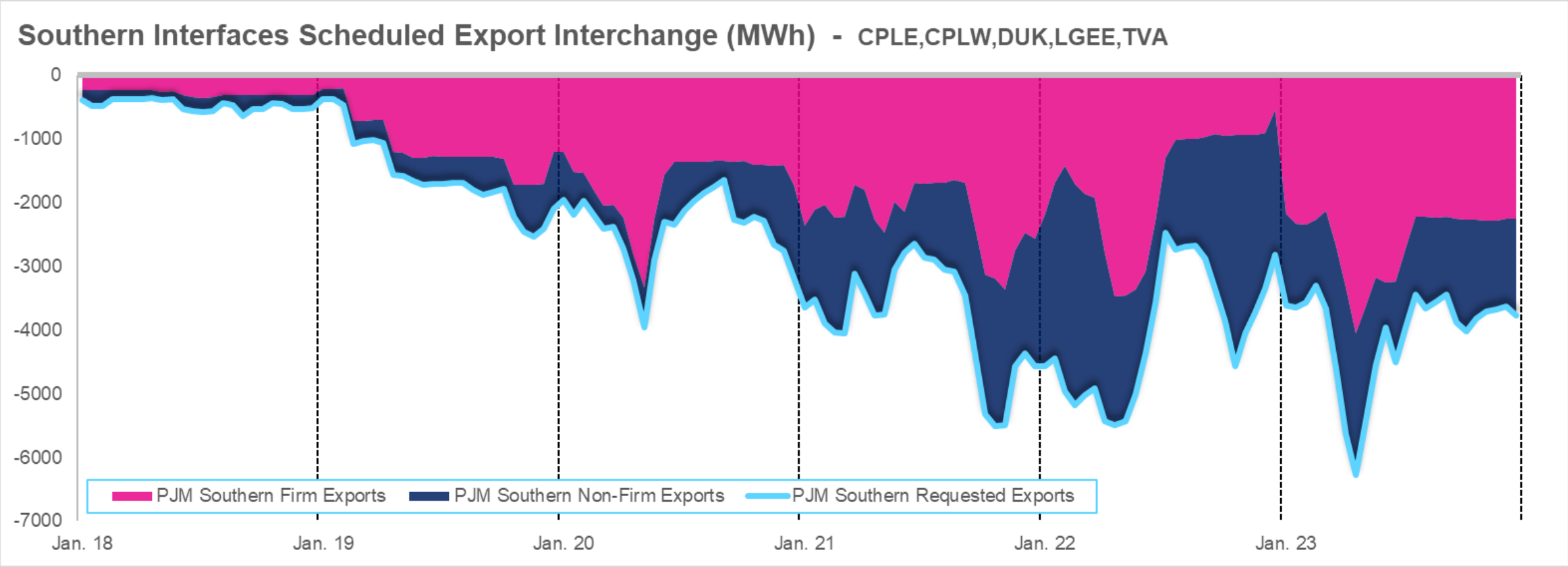
PJM Exports to NYISO



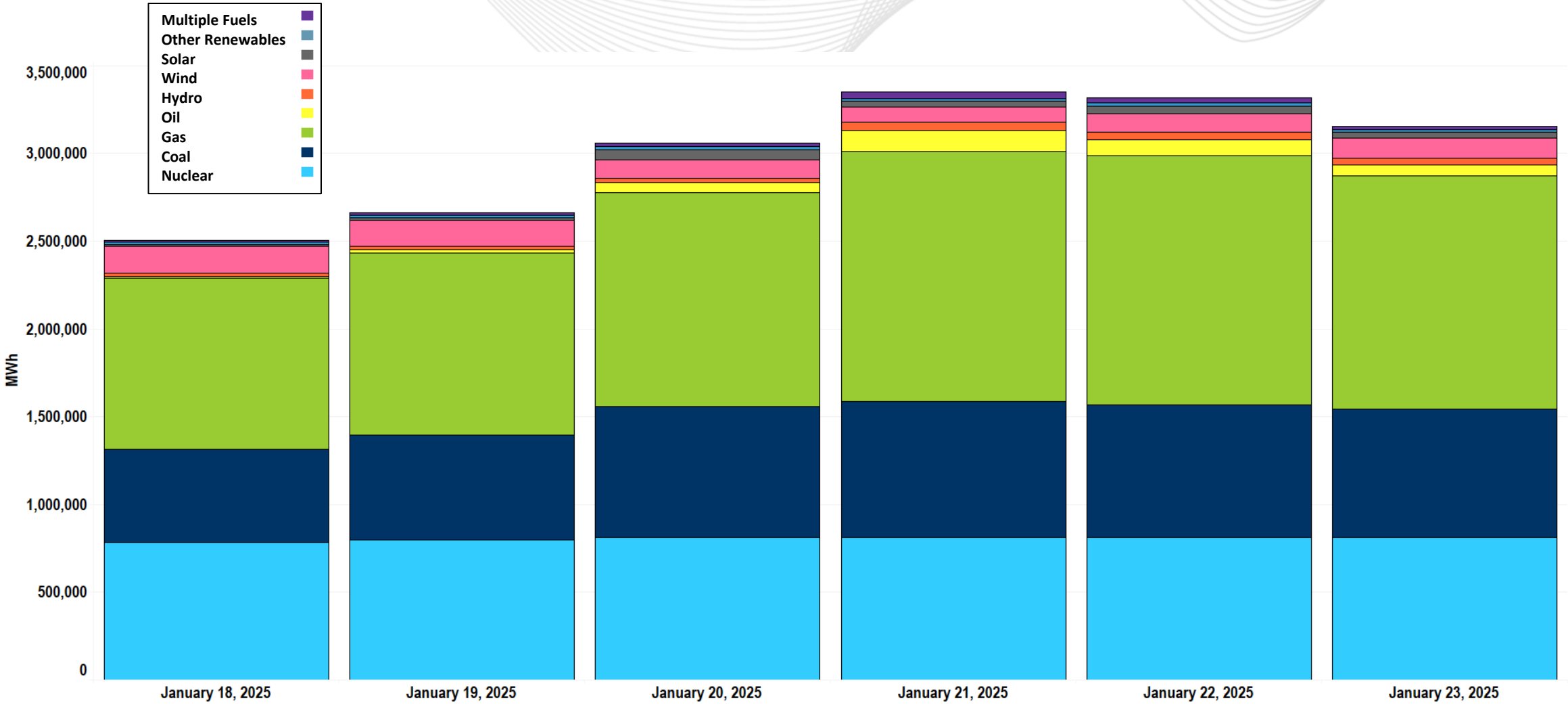
PJM Exports to MISO



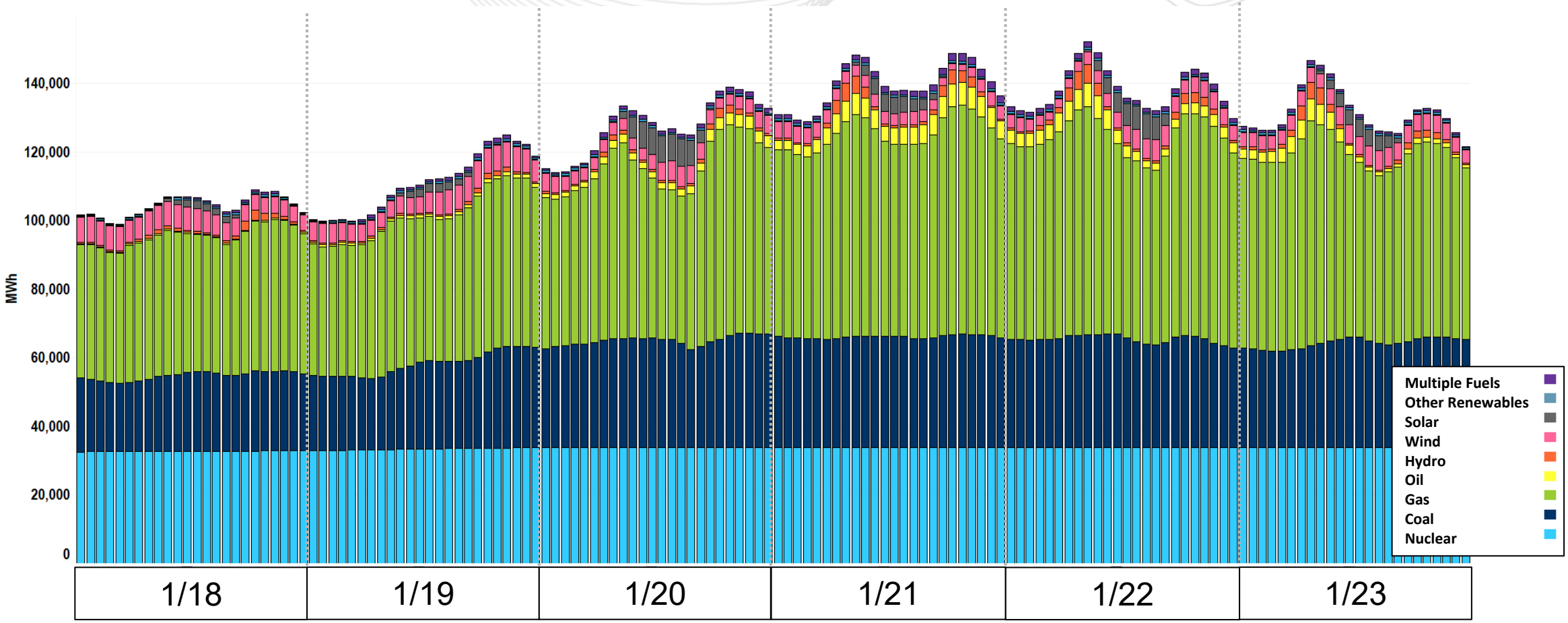
PJM Exports to the South



Daily Generation by Fuel



Hourly Generation by Fuel



Load Management Availability

Jan. 18–24, 2025

Load Management CSP Reported Expected Energy Reductions, RTO by Lead Time (Avg MW over Mandatory Period, HE07-HE21)