# Northeast Gas Association

## Regional Market Trends Forum

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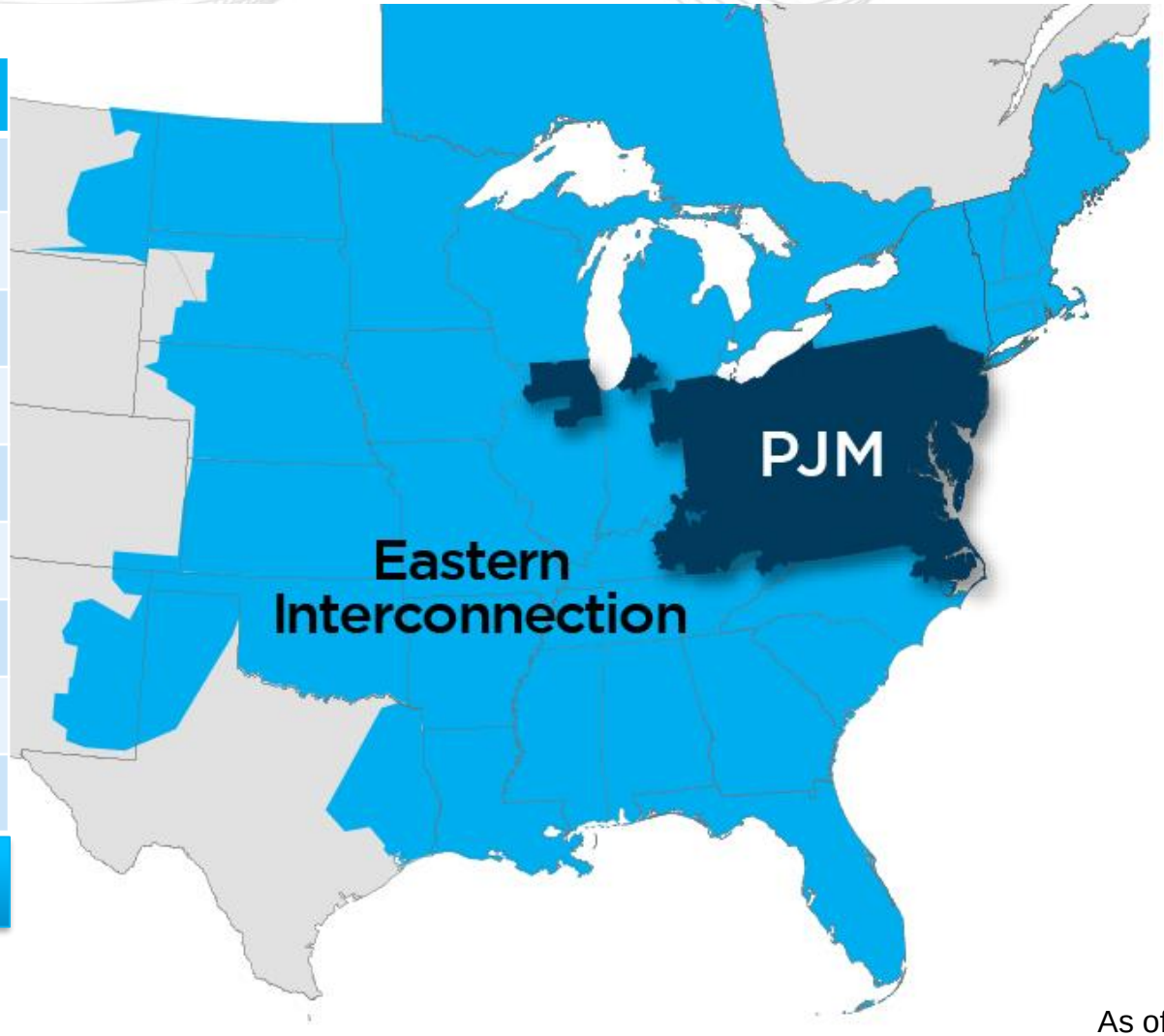
PJM Interconnection

Regional Market Trends Forum
May 2, 2023

# PJM as Part of the Eastern Interconnection

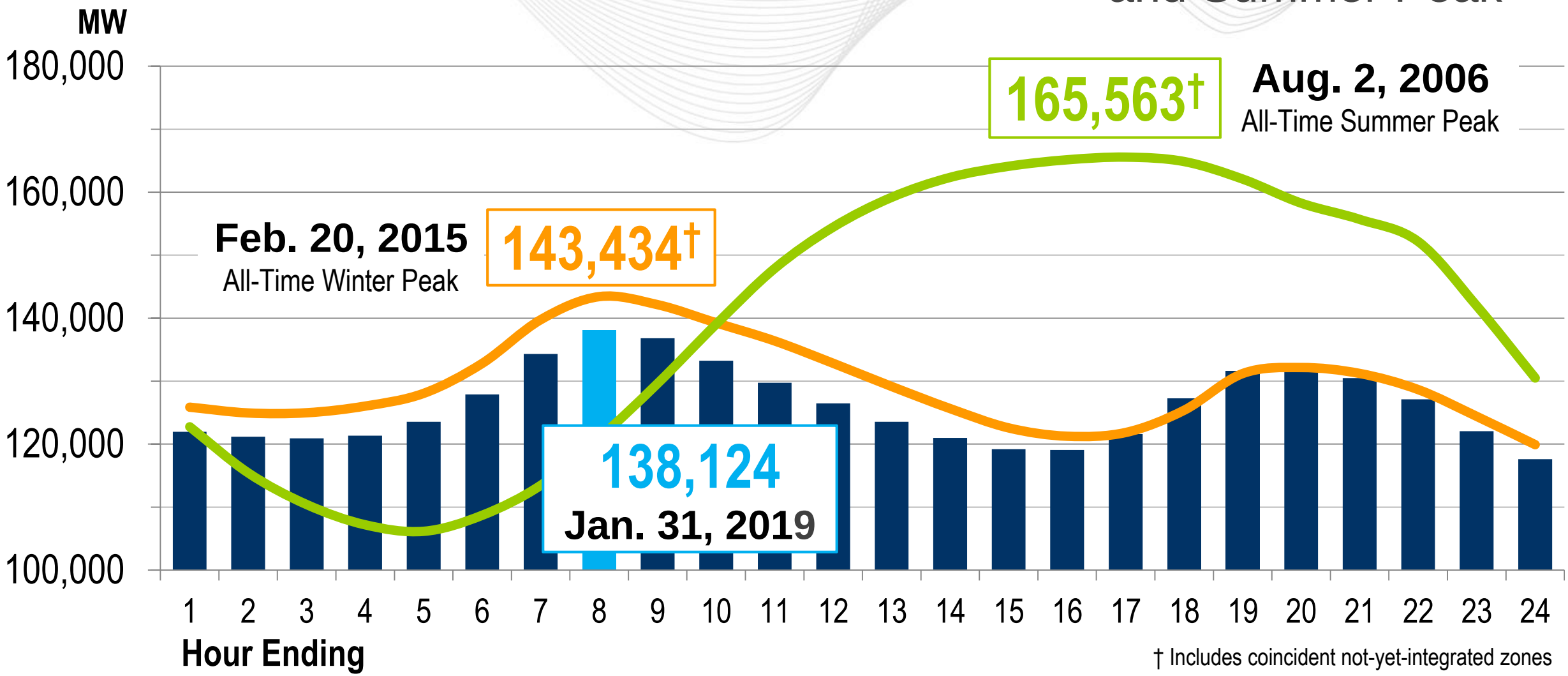
| Key Statistics | |
|---|---|
| Member companies | 1,110+ |
| Millions of people served | 65+ |
| Peak load in megawatts | 165,563 |
| Megawatts of generating capacity | 183,254 |
| Miles of transmission lines | 88,115 |
| Gigawatt hours of annual energy | 795 |
| Generation sources | 1,419 |
| Square miles of territory | 368,906 |
| States served | 13 + DC |

**21% of U.S. GDP produced in PJM**

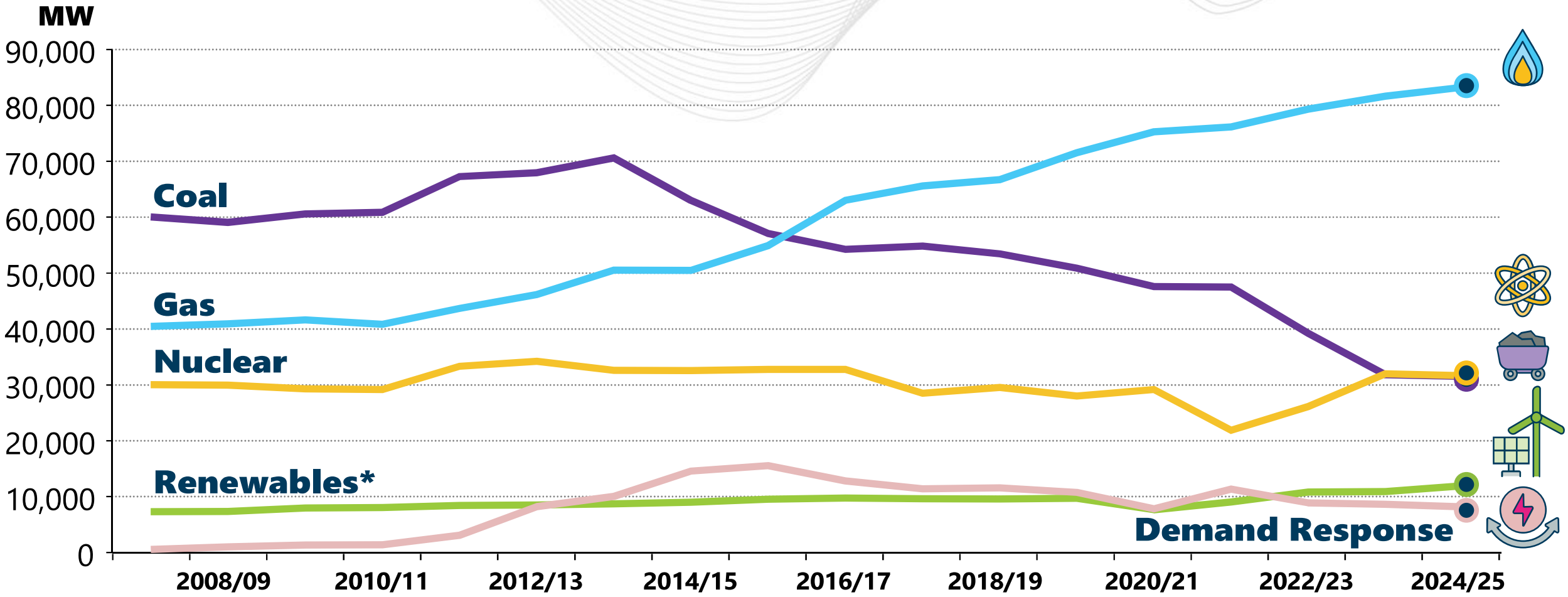



As of 2/2023

# Jan. 31, 2019 Winter Peak Versus All-Time Winter and Summer Peak



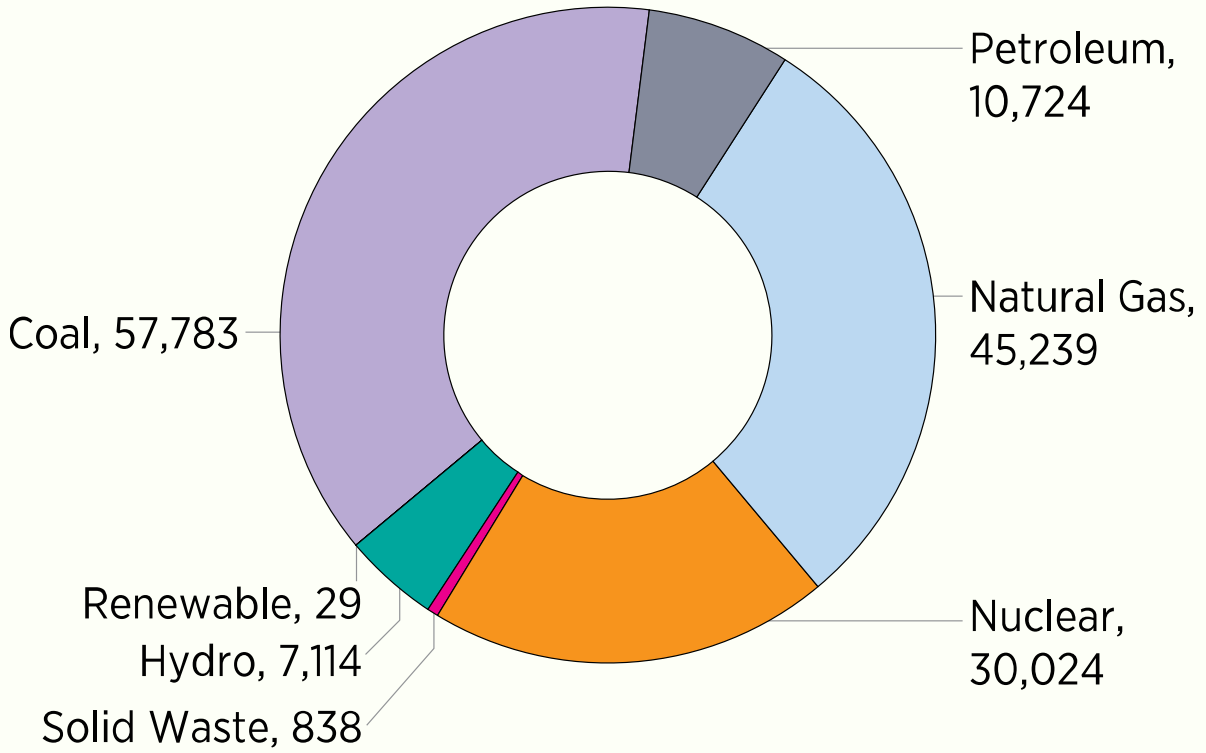
# Committed Unforced Capacity



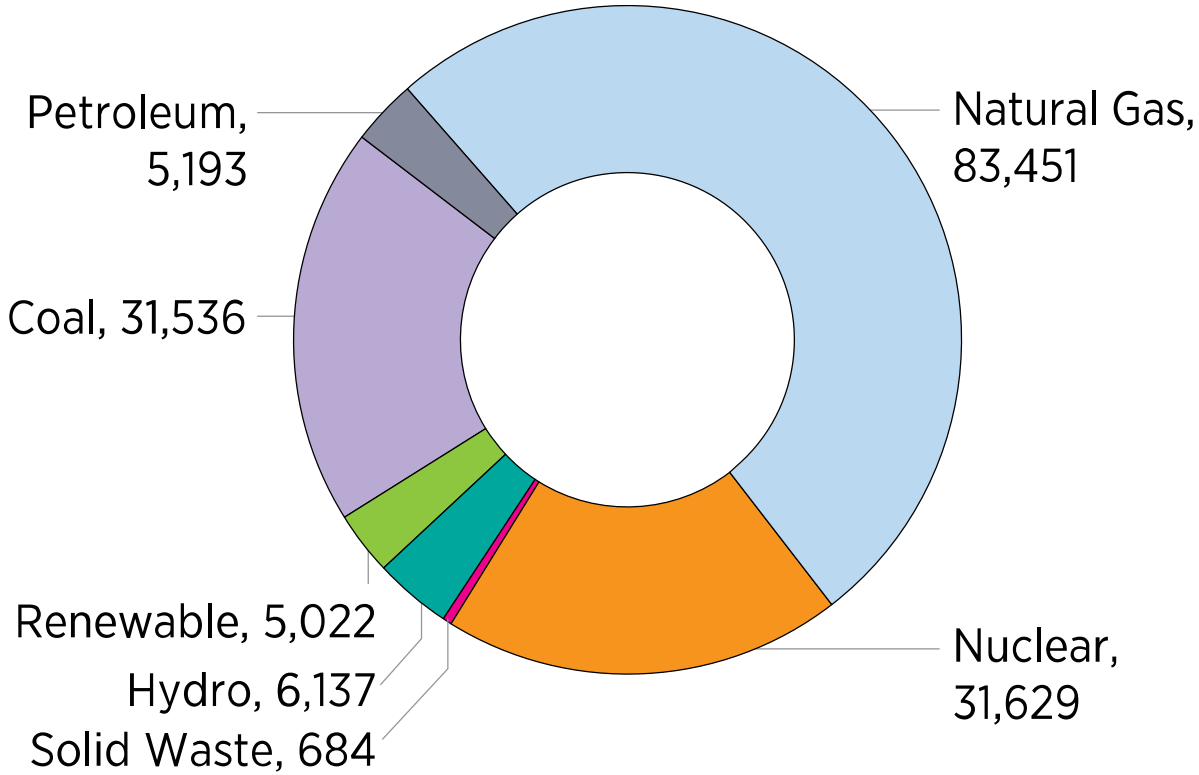

*Renewables include solar, wind, hydro and wood. Note: All values include capacity cleared in RPM BRA or committed in FRR plan

# Committed Unforced Capacity

## 2007/08 PJM Uninstalled Capacity (MW)
(UCAP)

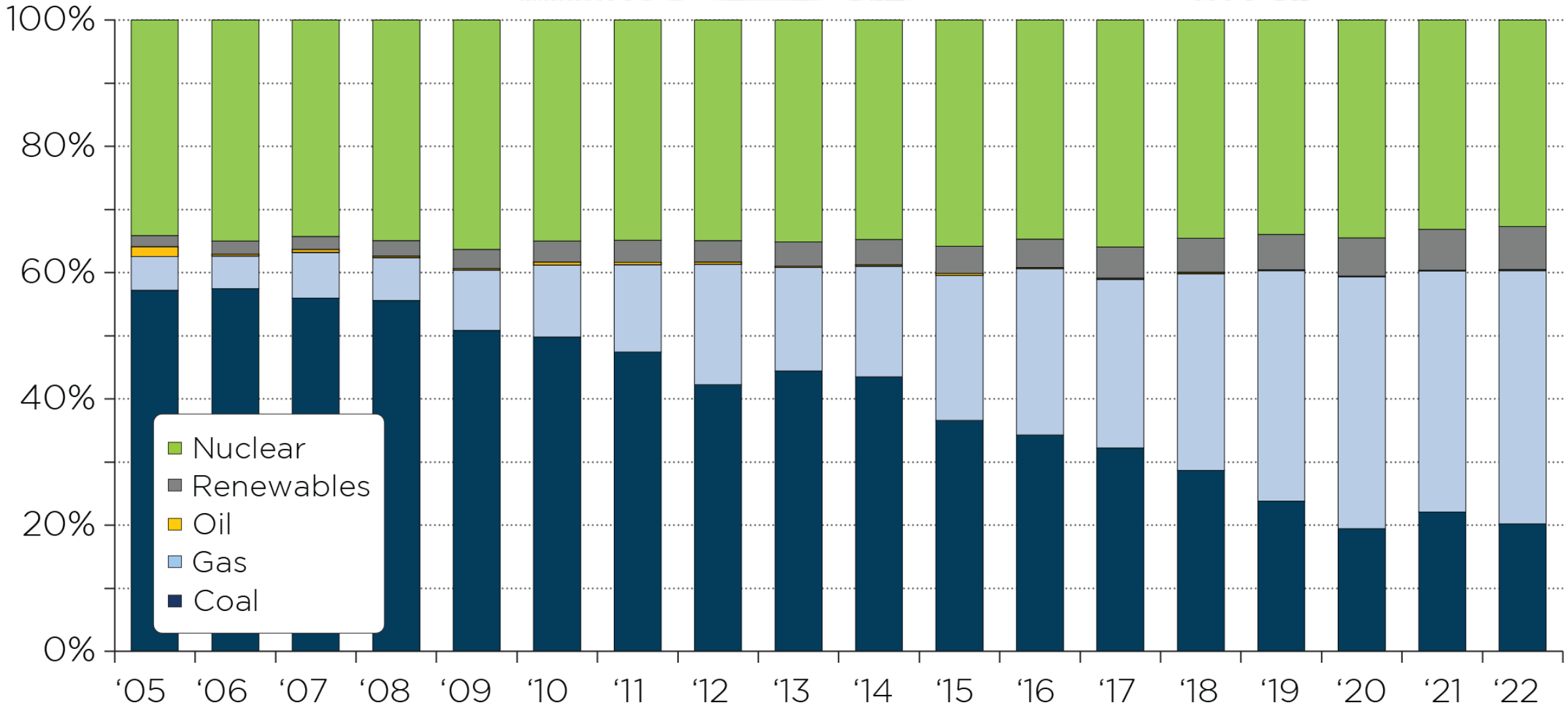



## Cleared Capacity for 2024/25 Delivery Year (MW)
(UCAP)

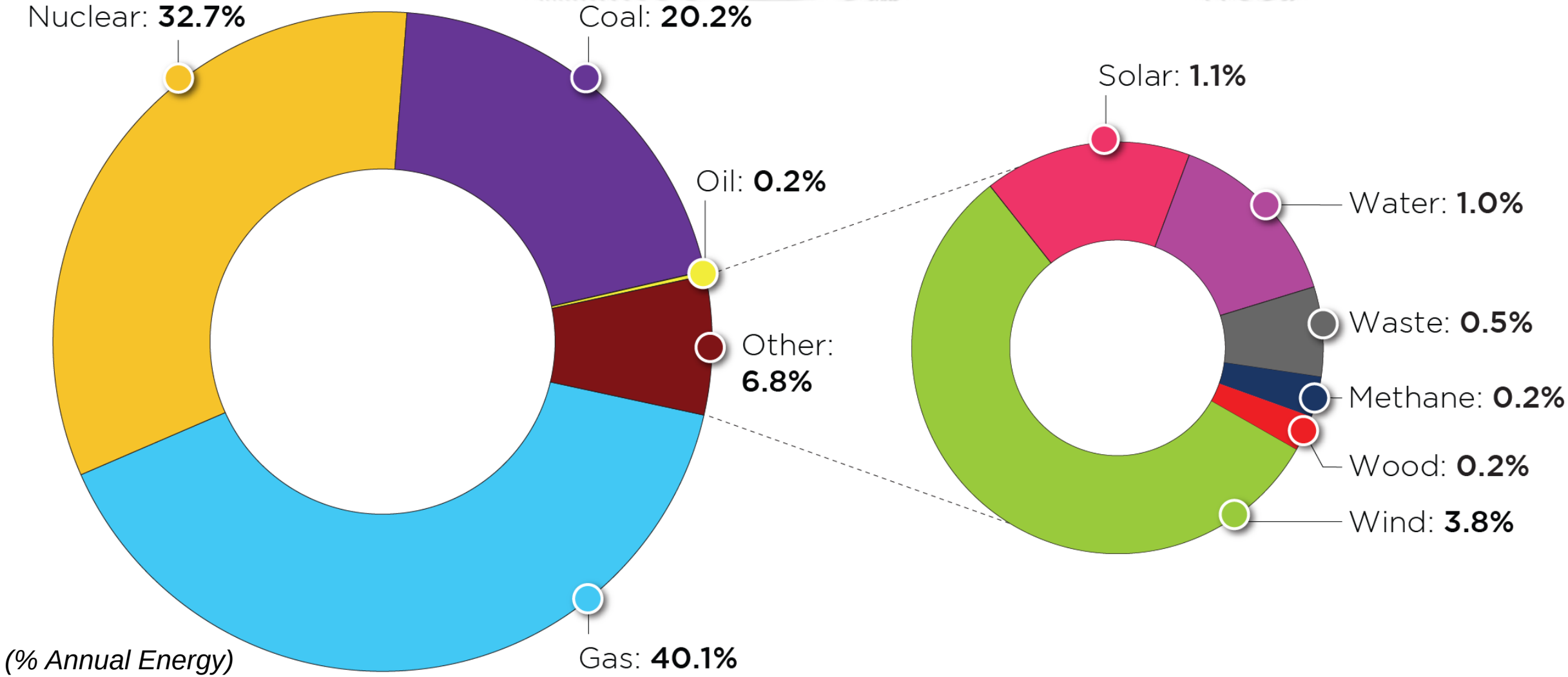



*Includes capacity cleared in RPM BRA or committed in FRR plan

# 2005–2022 Annual Fuel Mix

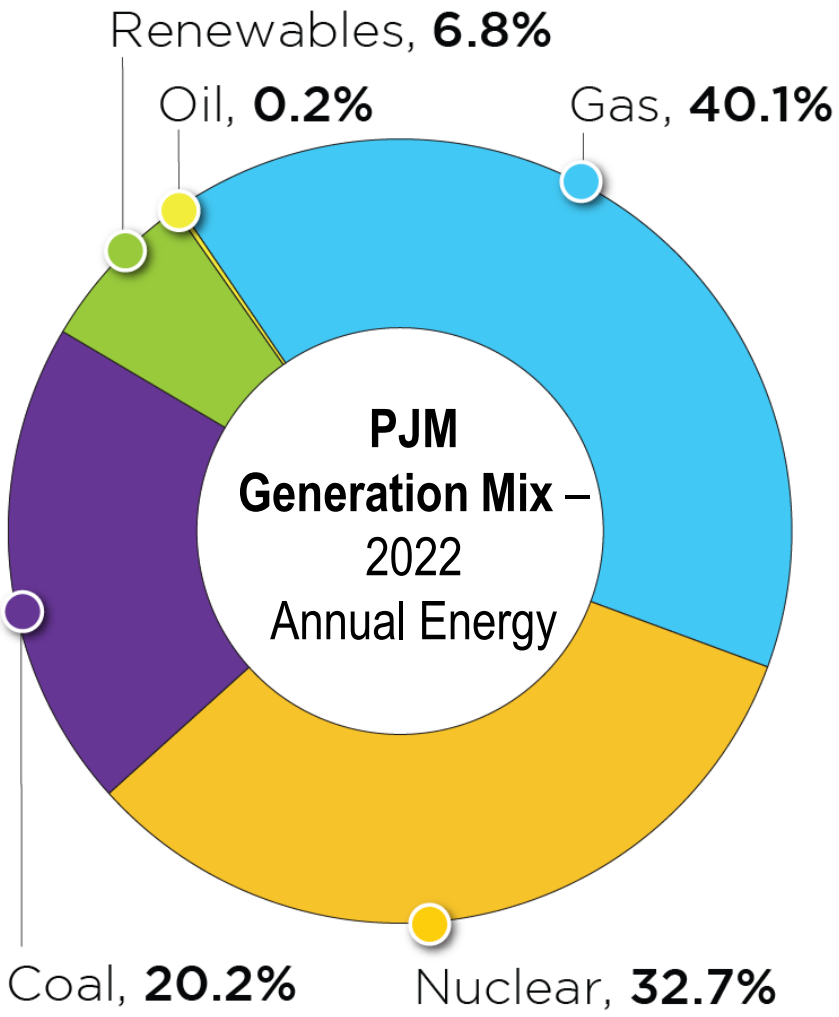


# 2022 PJM Fuel Mix

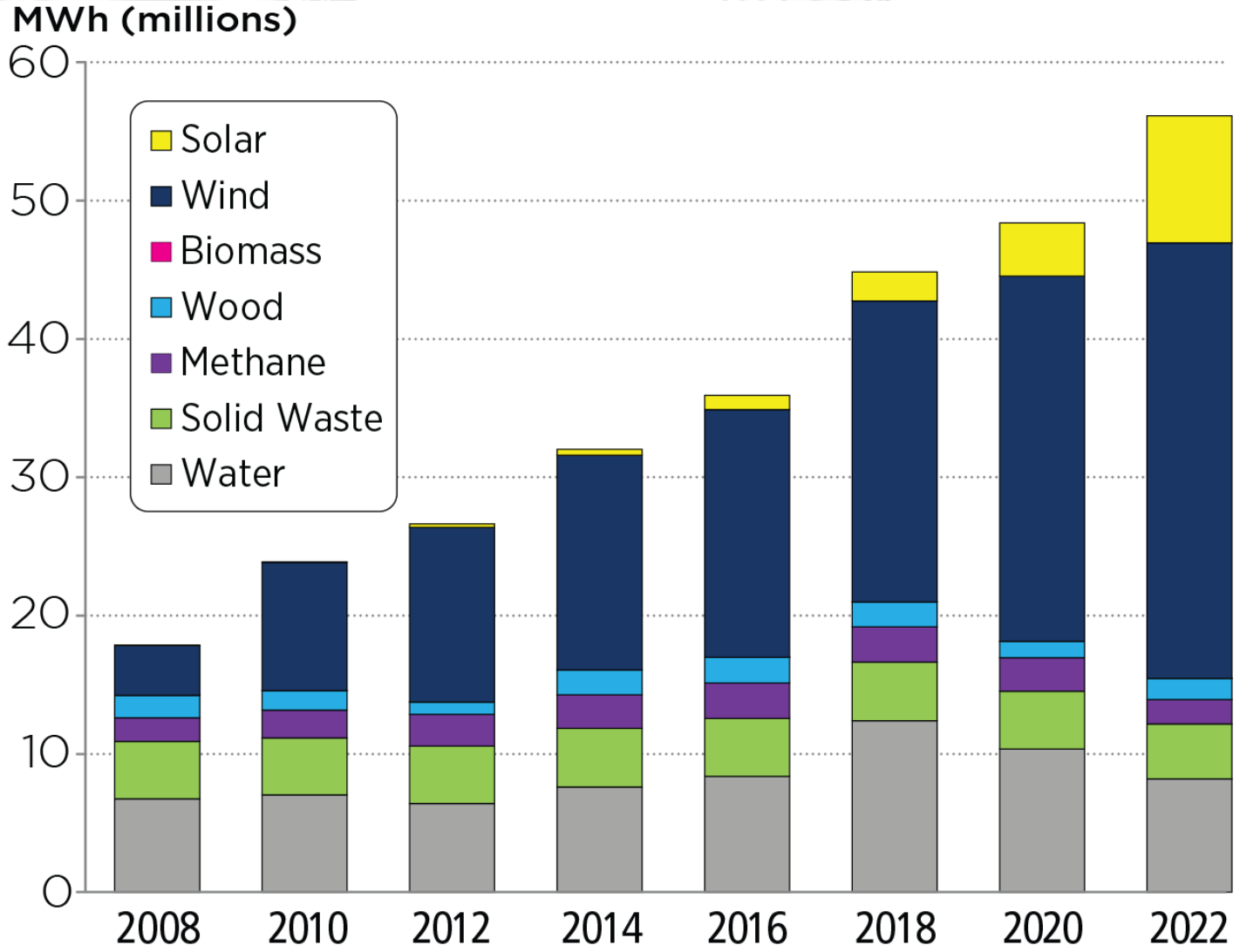



*(% Annual Energy)*

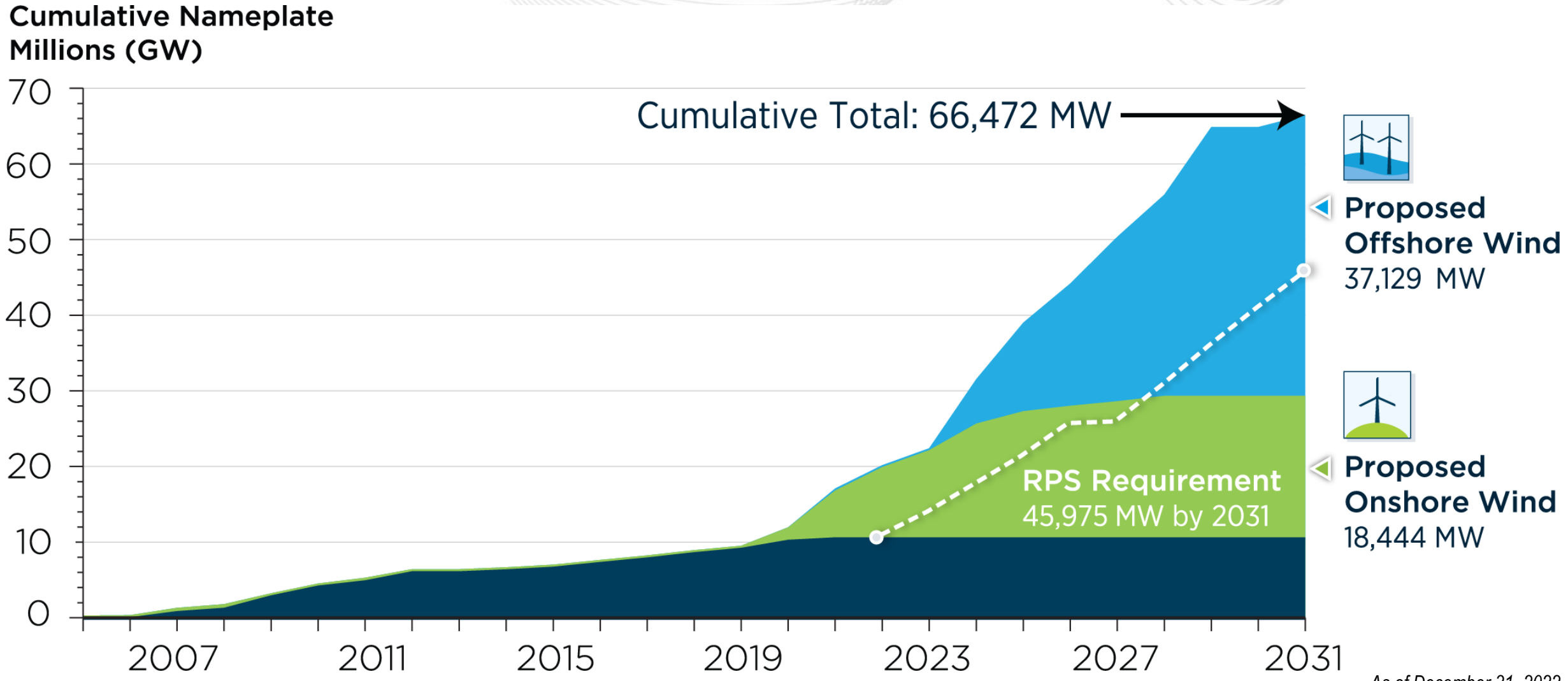
# Percentage of Renewable Energy Is Small but Growing




As of 12/2022

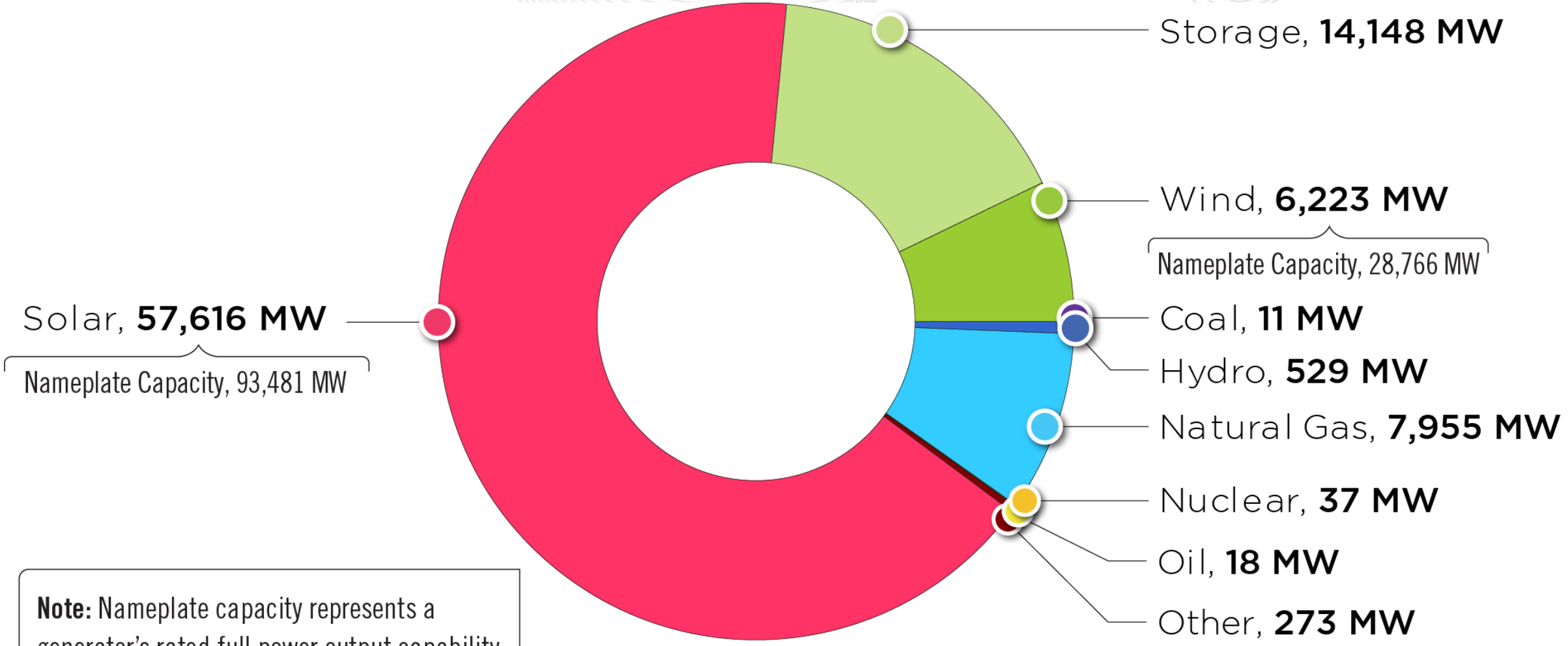


# Wind Installed Capacity in PJM: Operational & Proposed




*As of December 31, 2022*

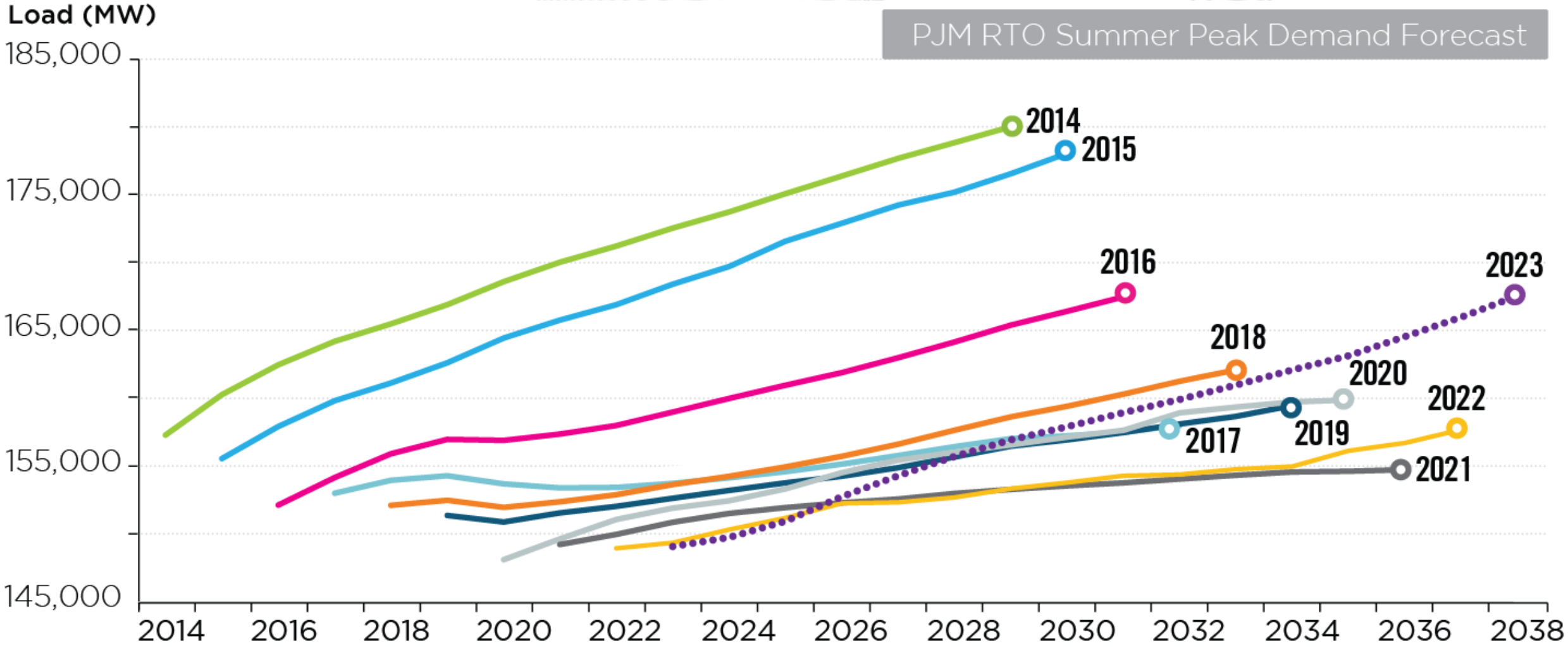
# Queued Generation Fuel Mix – Requested Capacity Interconnection Rights



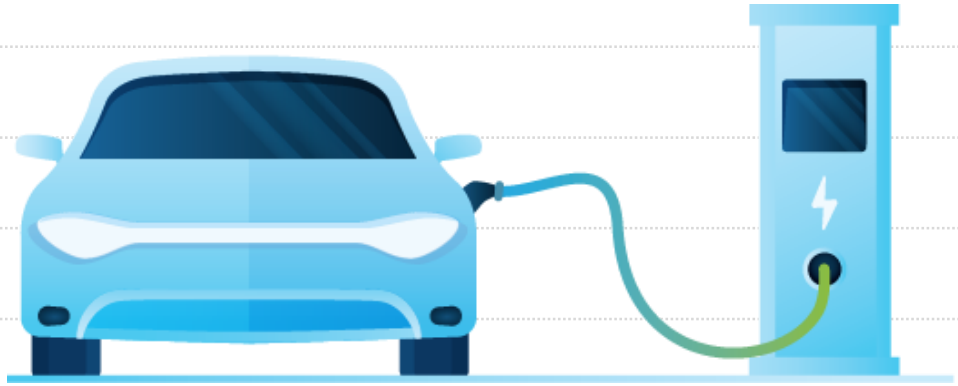

**Note:** Nameplate capacity represents a generator's rated full power output capability.

As of Dec. 31, 2022

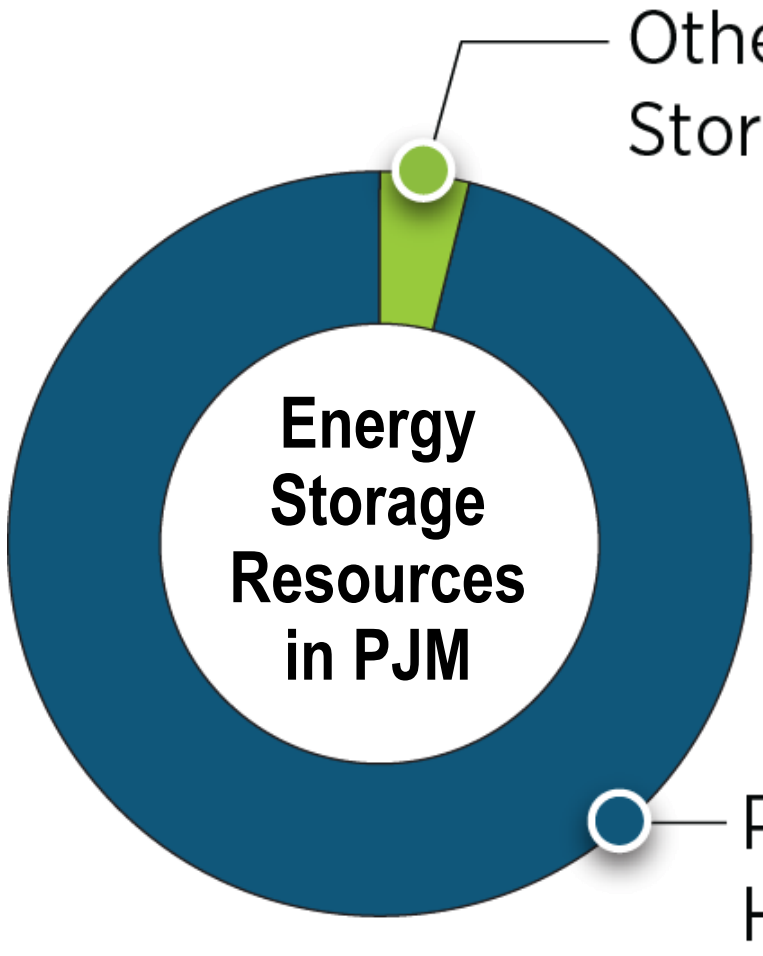
# Electricity Demand Growth



# Electric Vehicle Growth in PJM



# Over 5,300 MW of ESR Currently in PJM

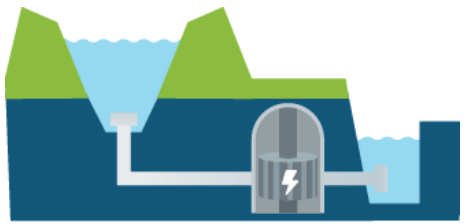



**Other Storage** is about ~300 MW of mostly batteries

**50%** of batteries connected on the distribution system

**50%** connected to the bulk electric system

**Pumped Hydro** currently participates in capacity, energy, regulation and reserves



*** Data taken from Generation Queue and EIA 860*

- Energy Transition Report
  - Resource Retirements, Replacements and Risk
  - Highlights through 2030
    - Thermal retirements outpacing new (primarily intermittent) resource entry
    - Resource adequacy and Reserve margins at significant risk
    - PJM continuing to work with stakeholders through several initiatives to address these risks
      - Resource Adequacy Senior Task Force/Critical Issue Fast Path
        - » Capacity Accreditation Reform
      - Interconnection Process Subcommittee
      - Clean Energy Attribute Procurement Senior Task Force

# Key Trends Impacting Reliability Risk

- The growth rate of electricity demand is likely to continue to increase from electrification coupled with the proliferation of high-demand data centers in the region.
- Thermal generators are retiring at a rapid pace due to government and private sector policies as well as economics.
- Retirements are at risk of outpacing the construction of new resources, due to a combination of industry forces, including siting and supply chain, whose long-term impacts are not fully known.
- PJM's interconnection queue is composed primarily of intermittent and limited-duration resources. Given the operating characteristics of these resources, we need multiple megawatts of these resources to replace 1 MW of thermal generation.

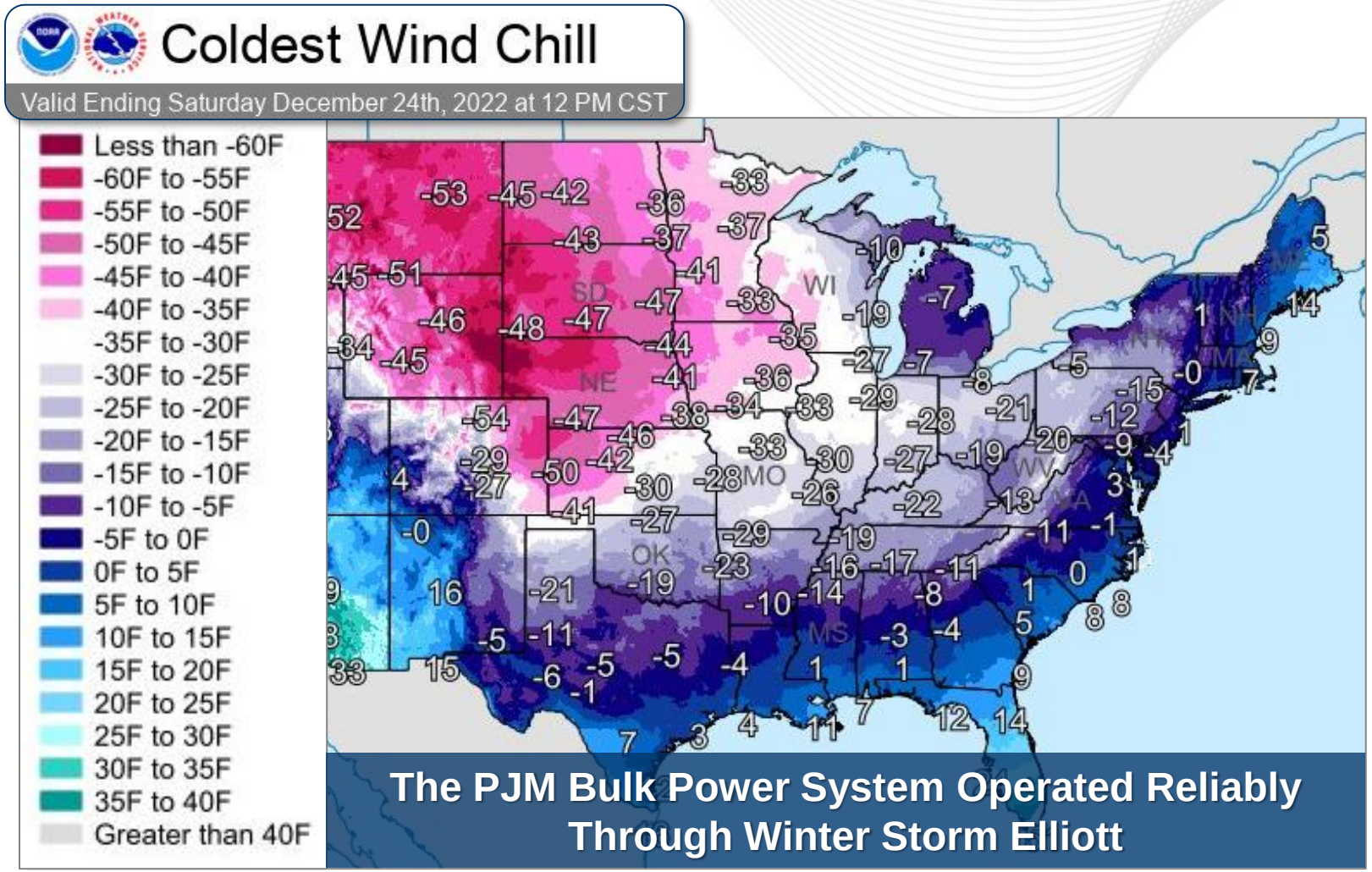
## Balance Sheet Summary (2022–2030)

| Retirements | New Entry Wind/Solar[6] | New Entry Standalone Storage | New Entry Thermal | Load Growth |
|---|---|---|---|---|
| **40 GW**<br>**60% Coal**<br>**30% Natural Gas**<br>**10% Other** | **Low =**<br>48 GW-nameplate /<br>8 GW-capacity<br>**High =**<br>94 GW-nameplate /<br>17 GW-capacity | **Low =**<br>3 GW<br>**High =**<br>4 GW | **Low =**<br>4 GW<br>**High =**<br>9 GW | **2023 Forecast =**<br>11 GW<br>**Electrification Forecast =**<br>13 GW |

Unless otherwise noted, thermal capacity values are expressed in ICAP, without adjustment for EFORd.

# Winter Storm Elliott

# Winter Storm Elliott



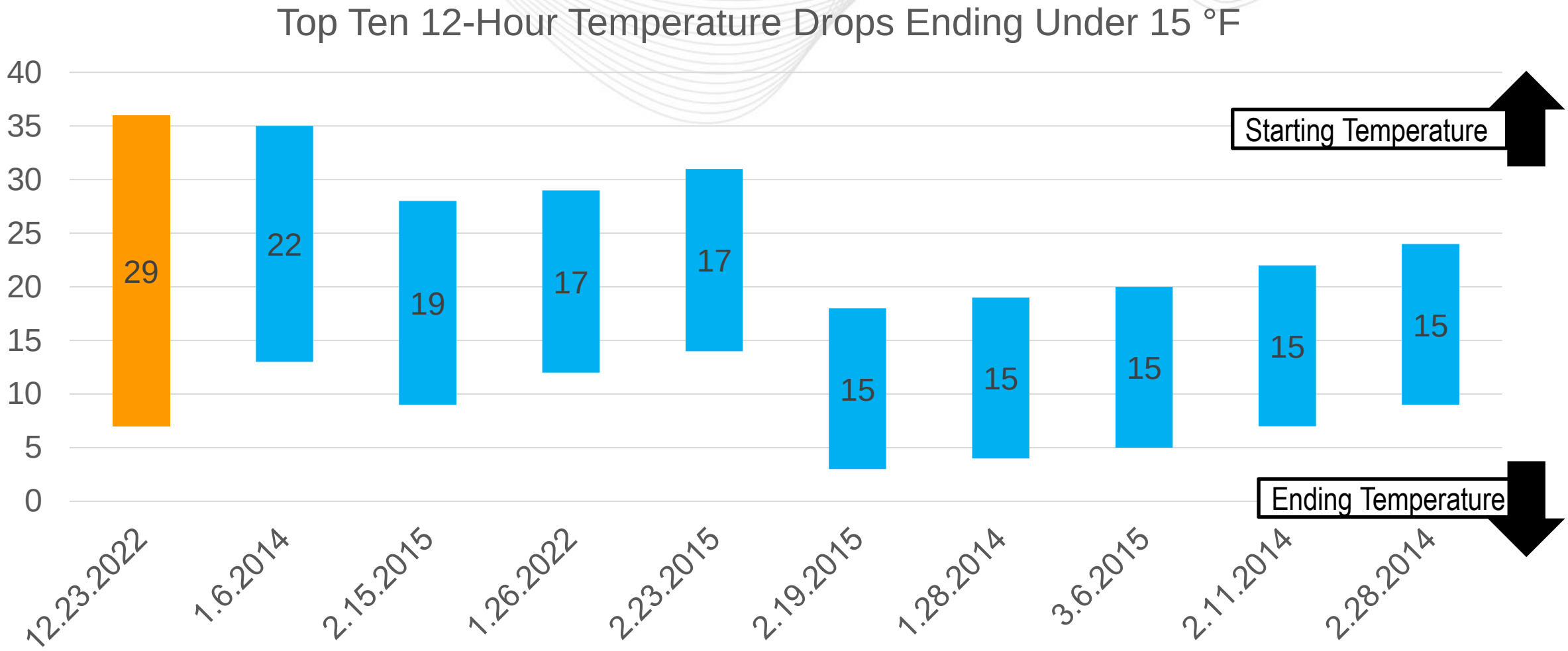

*Source: NOAA and the National Weather Service; Graphic created on Dec. 21, 2022.*

*Source: NOAA*

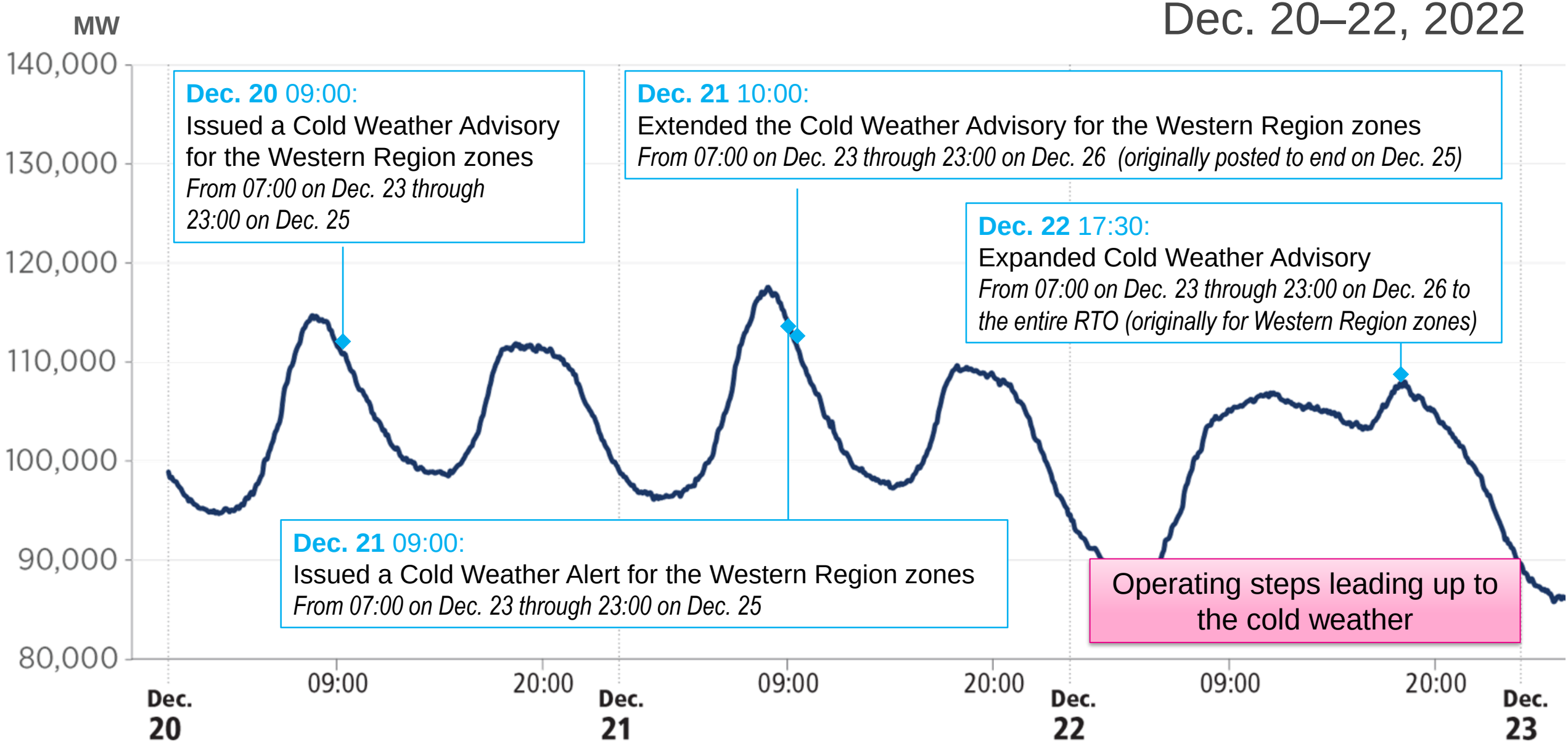
Temperatures across the RTO plummeted beginning on Dec. 23 and lasted into the morning of Dec. 25 with record lows in some areas as well as record drops in some regions.

# Most Drastic Temperature Drop in PJM Ops. Records

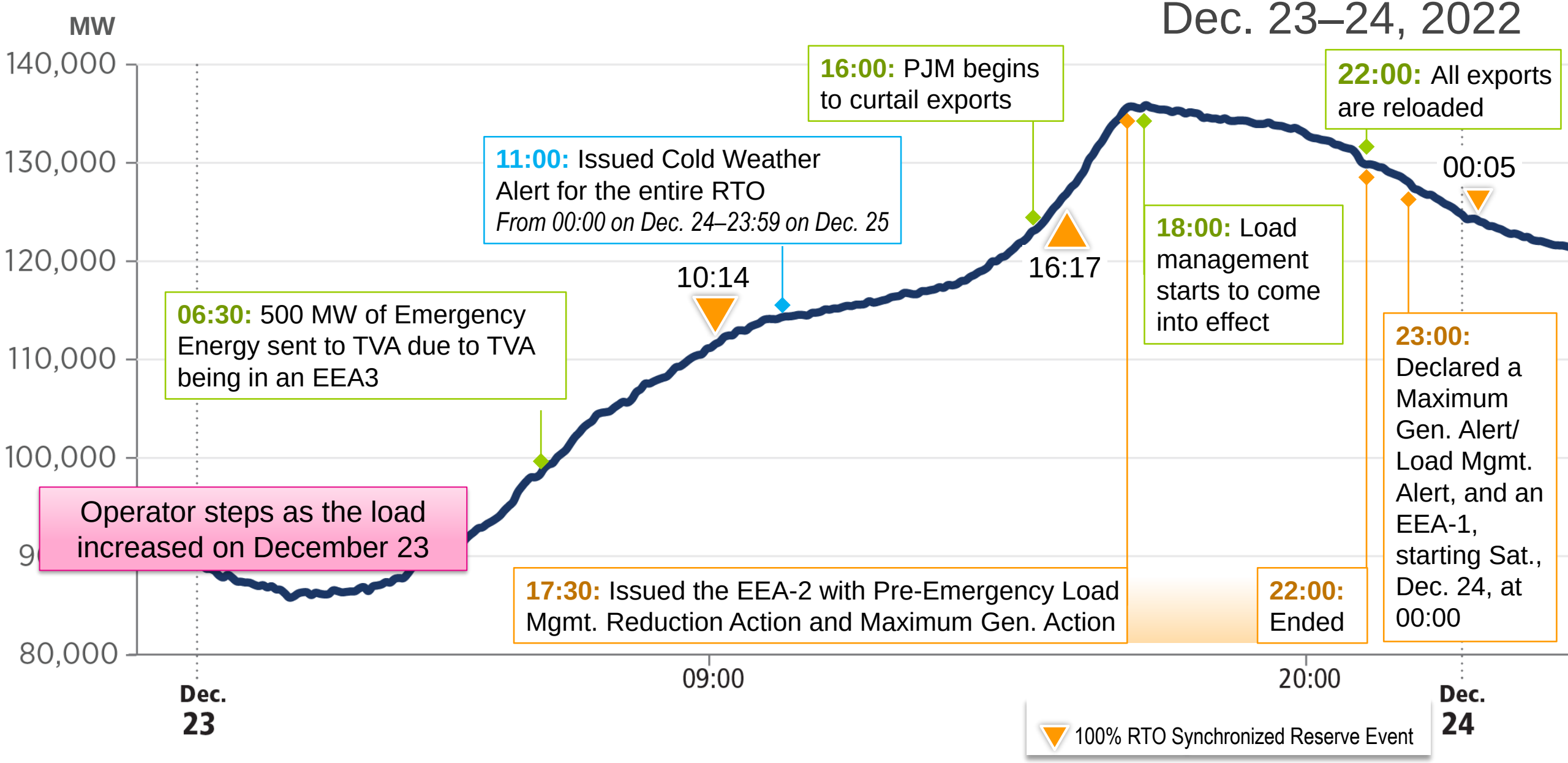
***January 2014 to Present***



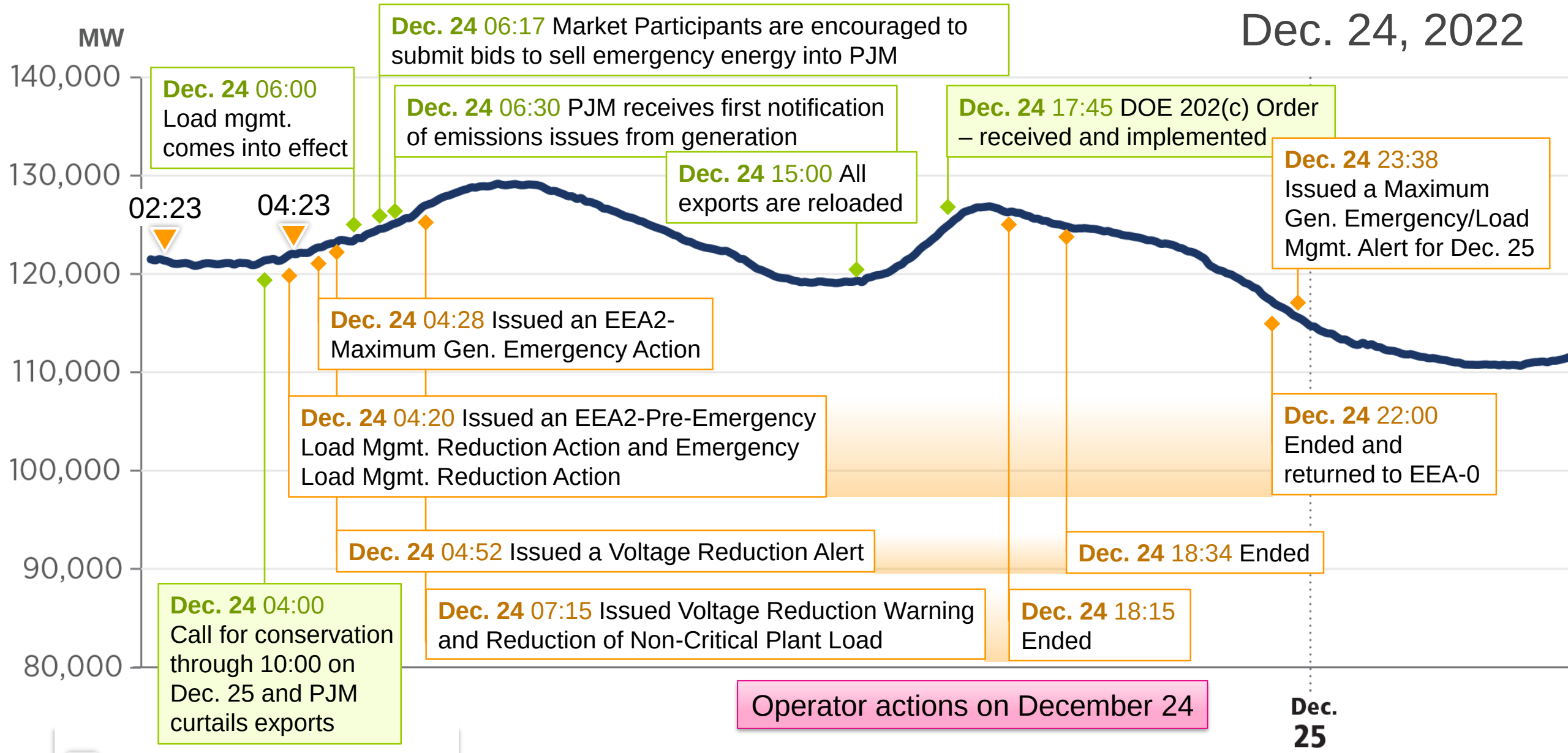
# Dec. 20–22, 2022



# Dec. 23–24, 2022



# Dec. 24, 2022



# A Significant Portion of the Generation Fleet Failed to Perform

**On Saturday morning, over 46,000 MW of generation failed to perform.**

- Besides forced outages, ~6,000 MW of steam generators were called but were not online for their expected start time for the Dec. 24 morning peak.

  *The vast majority of these resources were gas-fired resources.*

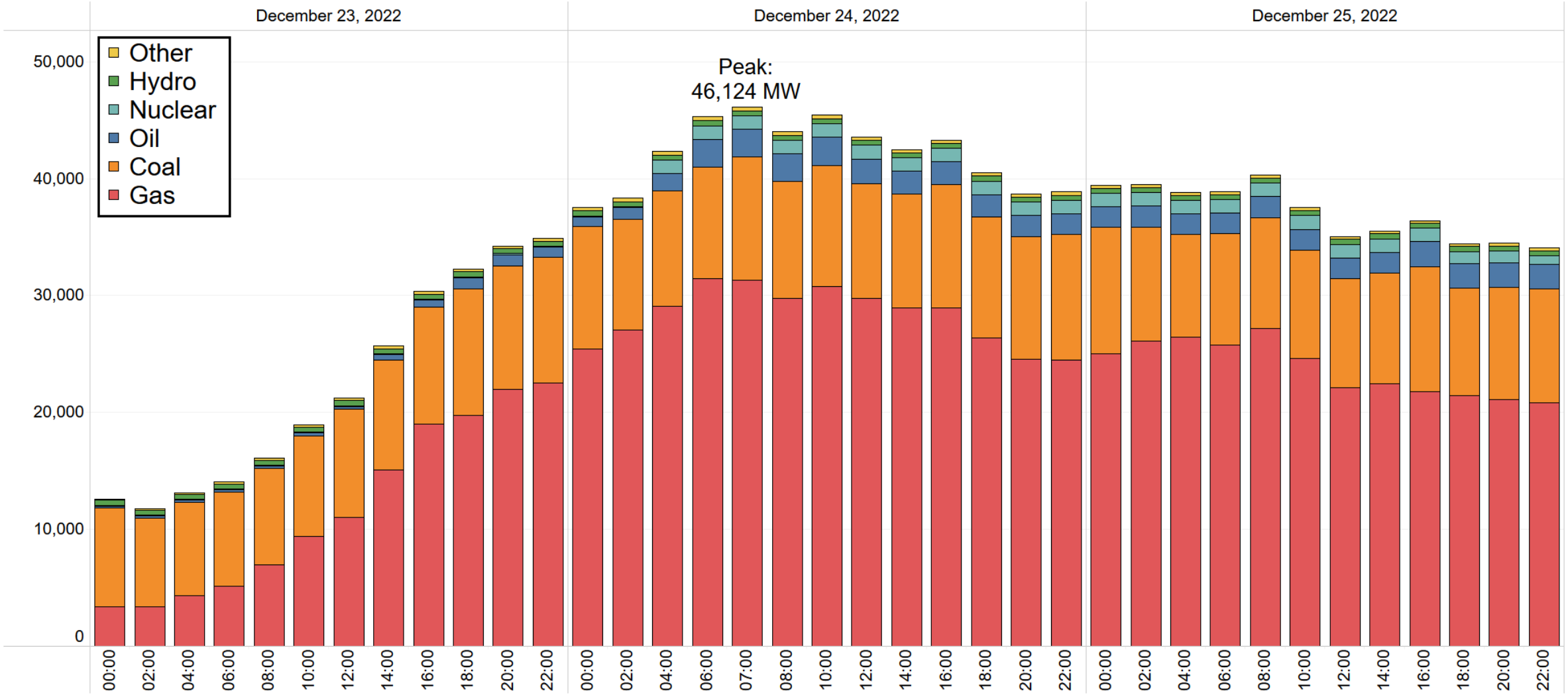
- The high rates of generator outages also limited our ability to replenish pond levels for pumped storage hydro prior to the morning peak on Dec. 24.

  *That left PJM with extremely limited run hours for pumped storage generation.*

- Between forced outages, derates, generators not starting on time, and the inability to fill pumped storage hydro ponds, PJM was dealing with ~57 GW of generator unavailability for the Dec. 24 morning peak.

***Over 92%** of the outages were reported to PJM with less than an hour's notice or no notice at all.*

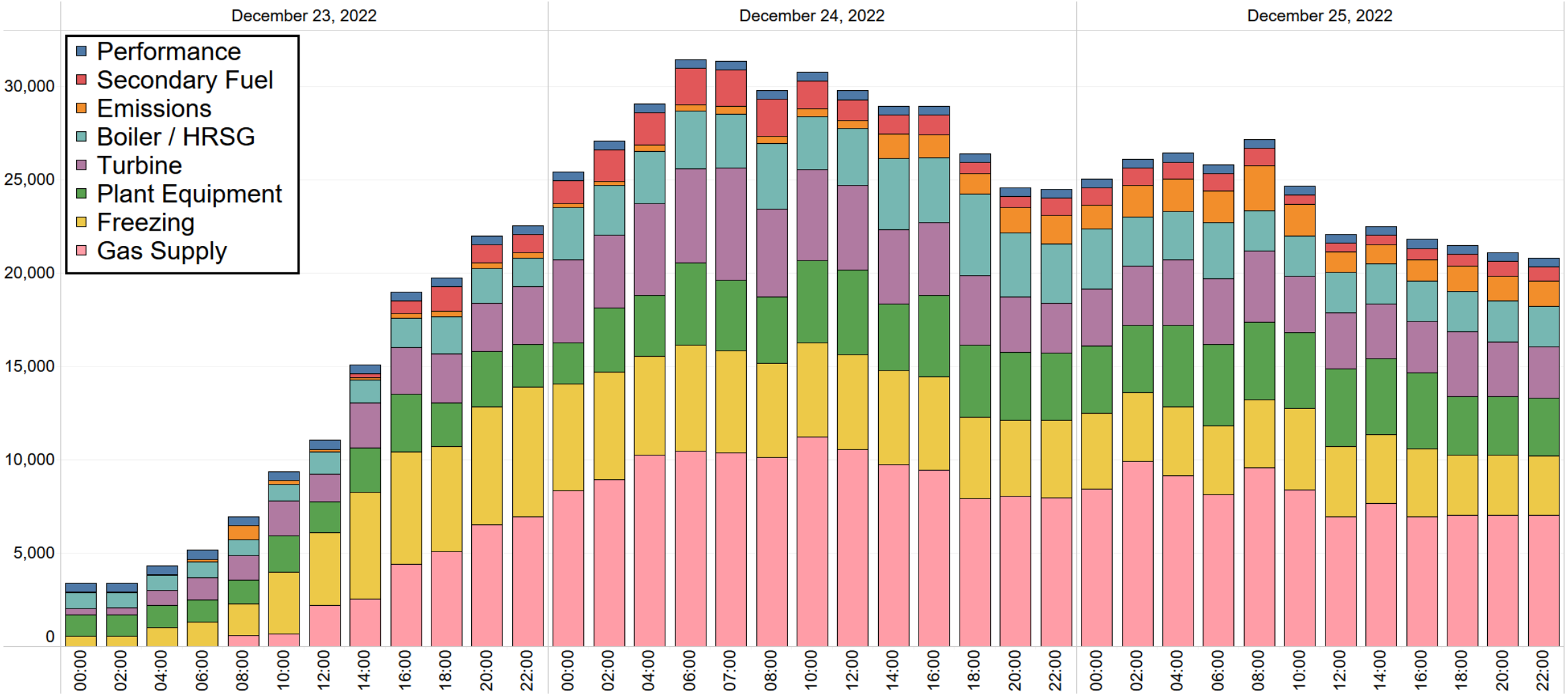
# Forced Outages/Derates by Fuel Type




**Note:** Only even hours are shown for readability with the exception of 12/24/2022 07:00 which was the hour with the largest amount of forced outages and derates

**Slide uses GADS data pulled 03/01/2023**

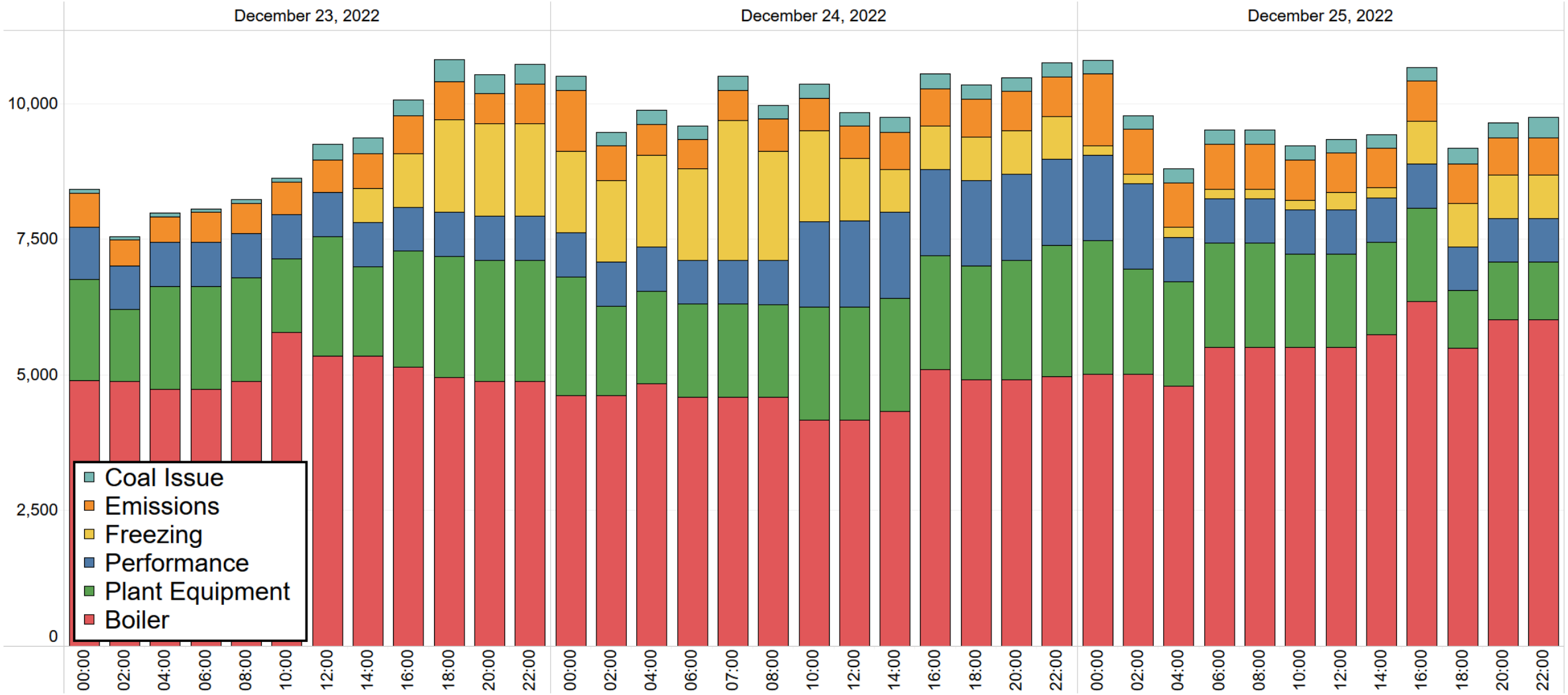
# Gas - Forced Outages/Derates by Cause




**Note:** Only even hours are shown for readability with the exception of 12/24/2022 07:00 which was the hour with the largest amount of forced outages and derates

**Slide uses GADS data pulled 03/01/2023**

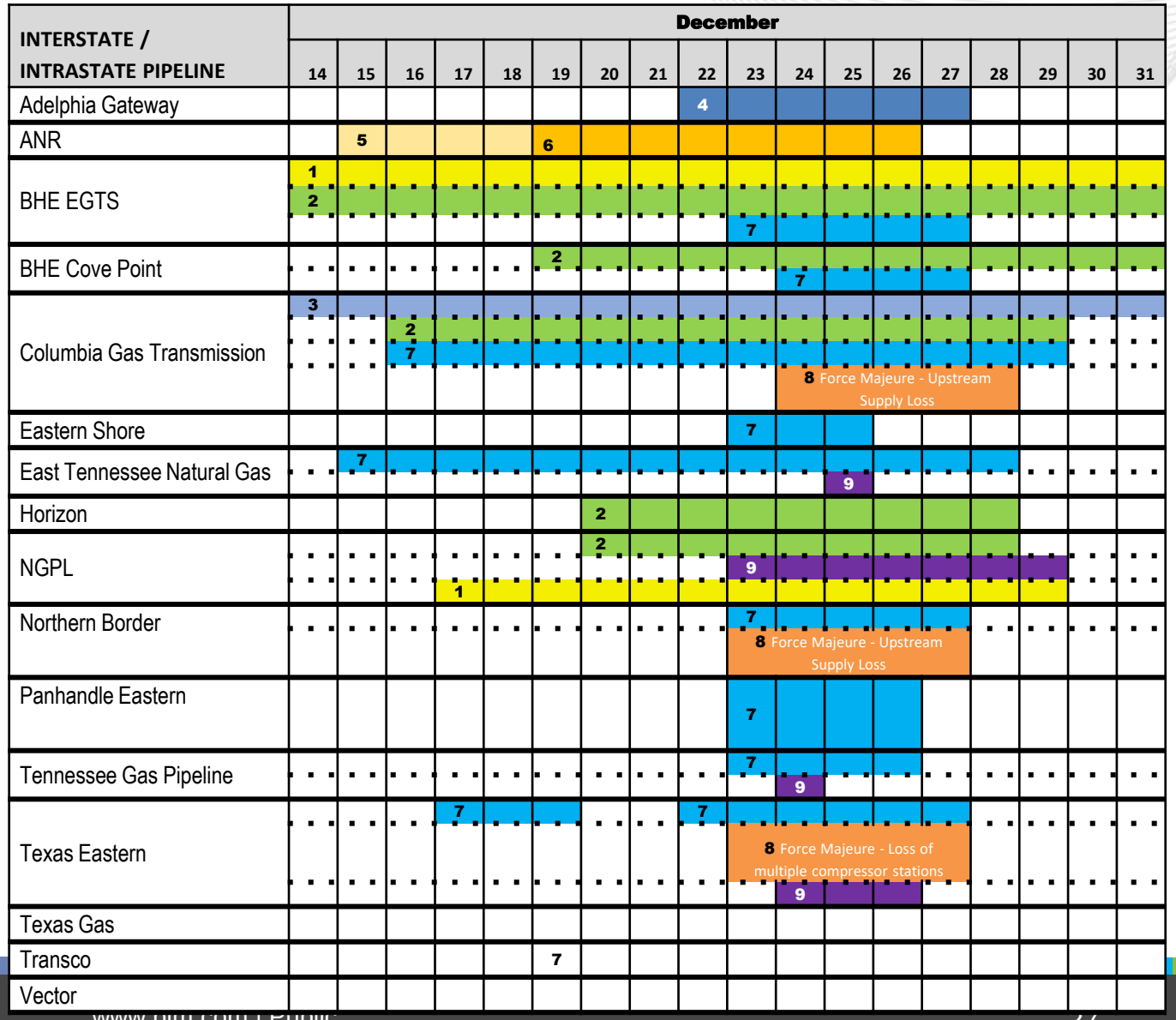
# Coal - Forced Outages/Derates by Cause




**Note:** Only even hours are shown for readability with the exception of 12/24/2022 07:00 which was the hour with the largest amount of forced outages and derates

**Slide uses GADS data pulled 03/01/2023**

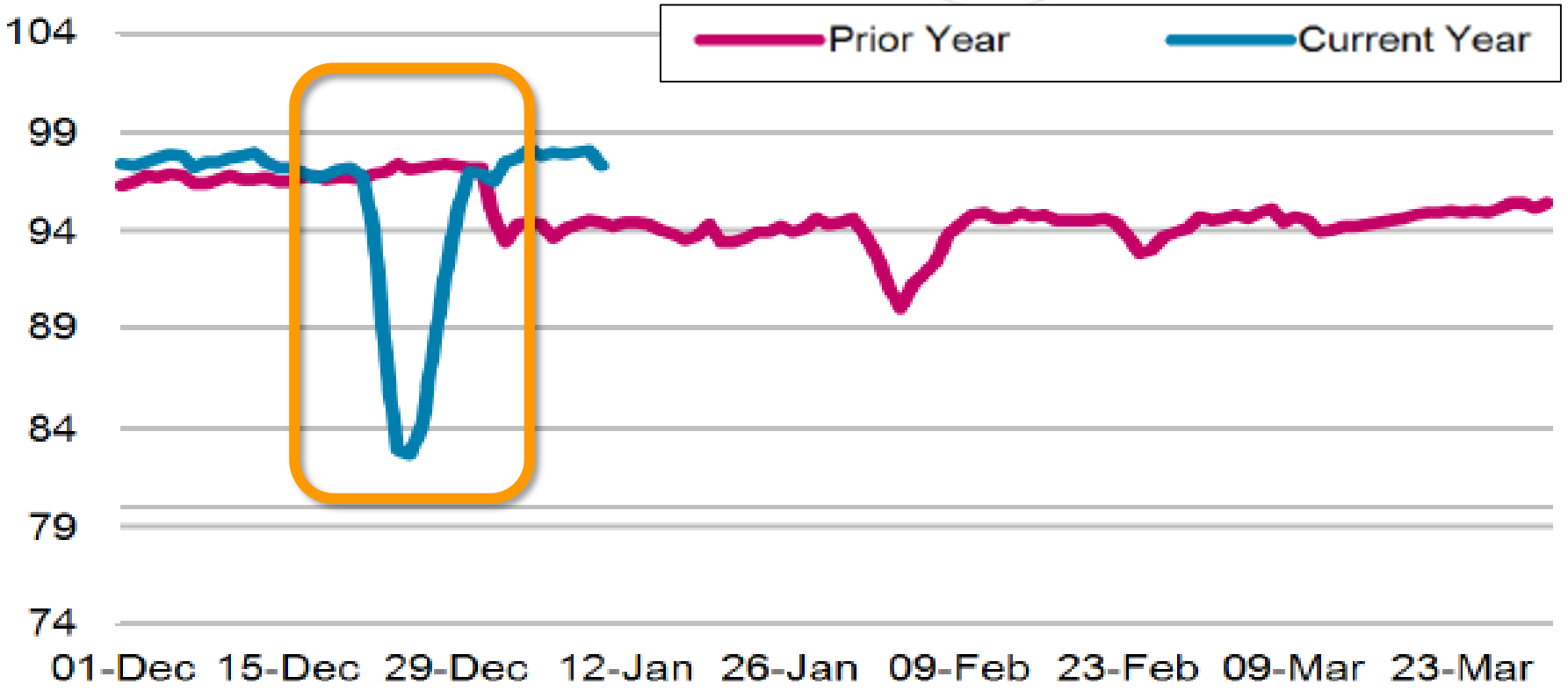
# Pipeline Operating Conditions




| | Pipeline Notice |
|---|---|
| 1 | **Restrictions on Non-Firm Contracts**<br>Customers with interruptible transportation contracts at higher risk of not being able to schedule adequate pipeline capacity |
| 2 | **Ratable Take Requirement**<br>Pipeline requiring customers to supply and burn gas at uniform hourly rates to avoid excessive pressure fluctuations |
| 3 | **Critical Day** (Transport Deliveries/Storage Withdrawals)<br>Pipeline requiring customers to stay within their transportation and storage contractual requirements |
| 4 | **Action Alert** (Daily Balancing)<br>Requires customers to ensure that their supply and demand is balanced at the end of each 24 hour gas day within the tolerances provided by the pipeline tariff provisions |
| 5 | **Phase 1 Cold Weather Advisory**<br>Alerting customers of pending cold temperatures and tightening system conditions |
| 6 | **Phase 2 Cold Weather Extreme Conditions**<br>Requires customers to abide by their specific contract and rate provisions and to burn gas on a uniform hourly basis as their contracts direct. Interruptible contracts at greater risk of having service cut |
| 7 | **Daily Balancing OFO**<br>Requires customers to ensure that their supply and demand is balanced at the end of each 24 hour gas day within the tolerances provided by the pipeline tariff provisions |
| 8 | **Force Majeure**<br>Declared when there is an event outside of the pipeline's control occurs which may render service unavailable to certain customers regardless of contractual arrangements (ex. Loss of compressor station) |
| 9 | **Loss of Upstream Supply**<br>As a result of less gas coming into the pipeline due to upstream supply failures, pipelines provide notice that risk of downstream pressure loss and customer nomination cuts are increasing. |

# Natural Gas Production

## U.S. Dry Gas Production (Bcf/d)

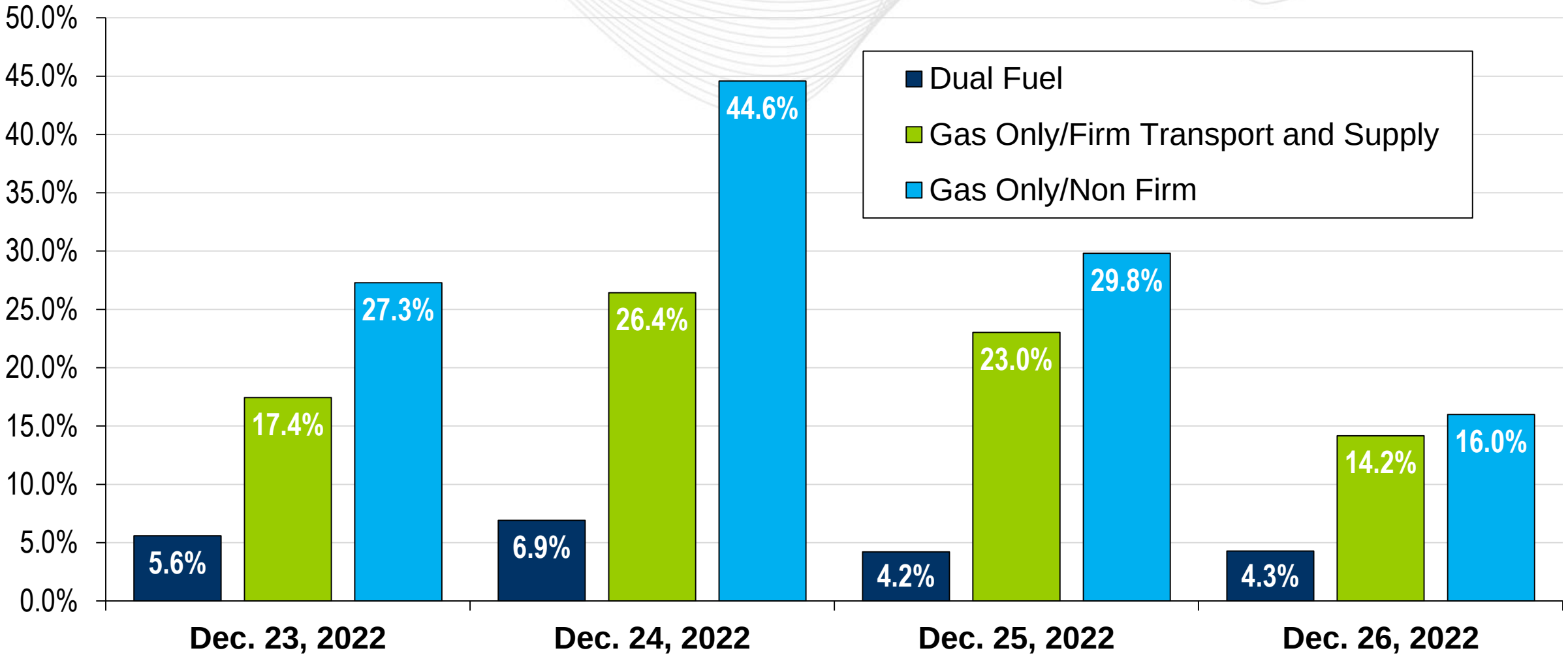



**Well Freeze Offs**

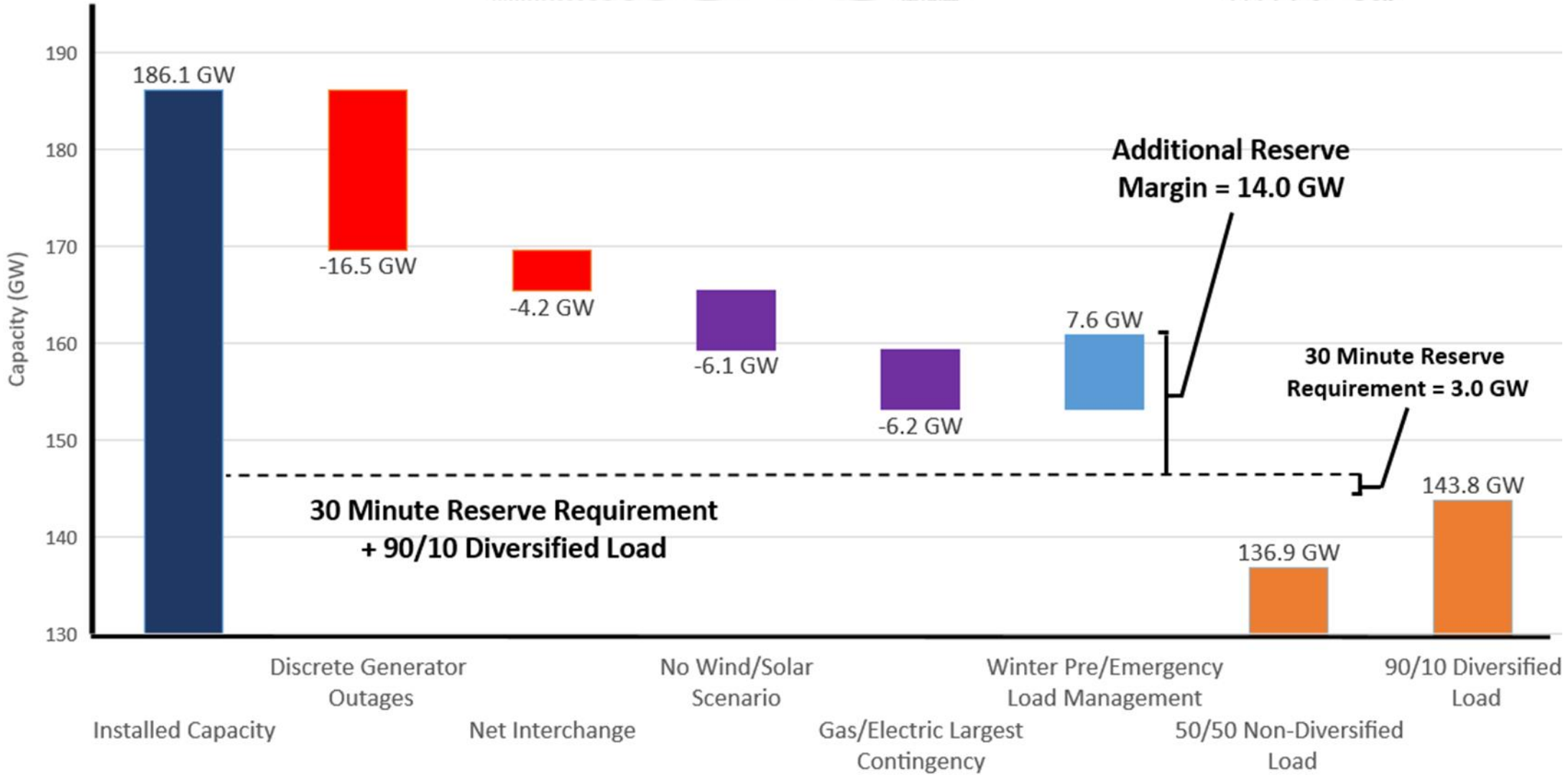
**~20%**

Production Loss
Dec. 23 – 26, 2022

# Gas Fuel Related Outages by Category by Percent of ICAP



# Winter 2022–2023 Capacity Projections

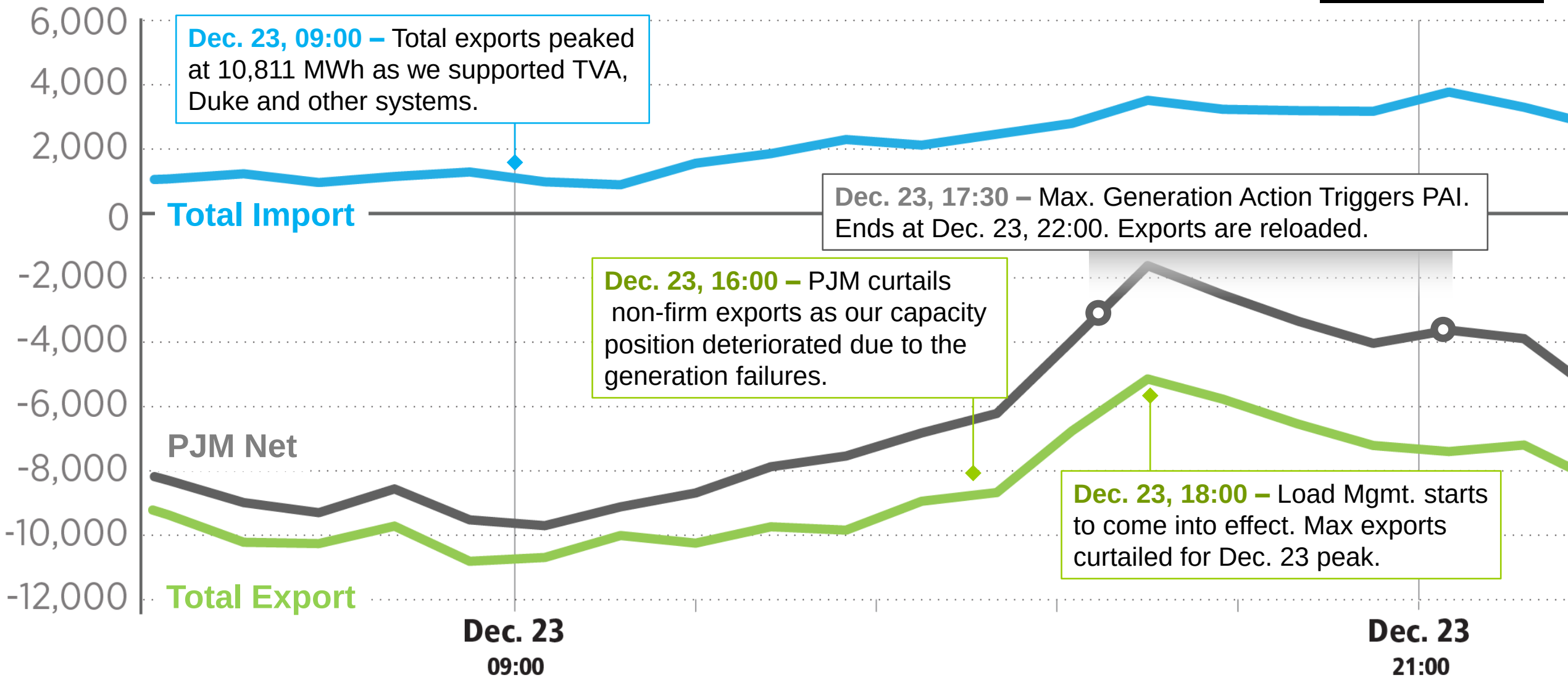


# Winter Prep – Summary of Activities

| | | | |
|---|---|---|---|
| Cold Weather Exercise | Cold Weather Checklist | Pre-Winter Reactive Capability Verification | Seasonal Fuel Inventory and Emissions Data Request |
| External Coordination | Seasonal Assessment | Generator Minimum Operating Limit Data Request | |

# Dec. 23

## Net Scheduled Interchange (MWh)




**Dec. 23, 09:00 –** Total exports peaked at 10,811 MWh as we supported TVA, Duke and other systems.

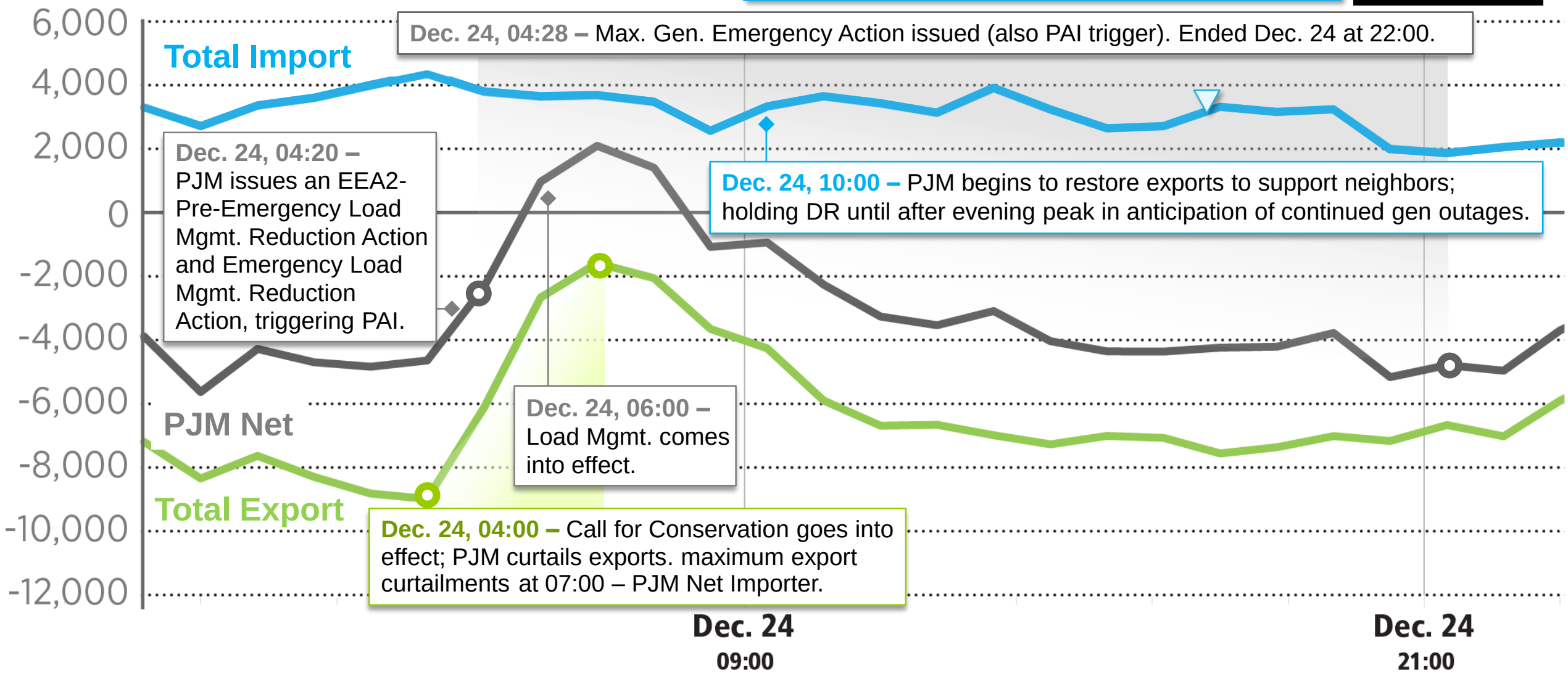
**Dec. 23, 17:30 –** Max. Generation Action Triggers PAI. Ends at Dec. 23, 22:00. Exports are reloaded.

**Dec. 23, 16:00 –** PJM curtails non-firm exports as our capacity position deteriorated due to the generation failures.

**Dec. 23, 18:00 –** Load Mgmt. starts to come into effect. Max exports curtailed for Dec. 23 peak.

# Dec. 24

## Net Scheduled Interchange (MWh)



# Prior to Storm, PJM Issued Winter Advisory and Alerts

## Dec. 20, 2022

### Cold Weather Advisory for Western Region From Dec. 23–26 (Later Expanded to Entire RTO)

- Prepare to take freeze-protection actions, such as erecting temporary windbreaks or shelters, positioning heaters, verifying heat trace systems, or draining equipment prone to freezing.
- Review weather forecasts, determine any forecasted operational changes, and notify PJM of any changes.
- Members are to update PJM with operation limitations associated with cold weather preparedness. Operating limitations include: generator capability and availability, fuel supply and inventory concerns, fuel switching capabilities, environmental constraints, generating unit minimums.

## Dec. 21, 2022

### Cold Weather Alert Issued for the Western Region for Dec. 23

- Generation dispatchers review fuel supply/delivery schedules in anticipation of greater-than-normal operation of units.
- Generation dispatchers monitor and report projected fuel limitations to PJM dispatcher and update the unit Max Run field in Markets Gateway if less than 24 hours of run time remaining.
- Generation dispatchers contact PJM Dispatch if it is anticipated that spot market gas is unavailable, resulting in unavailability of bid-in generation.

## Dec. 23, 2022

### Second Cold Weather Alert Issued for the Entire RTO for Christmas Eve, Dec. 24

# PJM's Dec. 23 Operating Plan Was Conservative

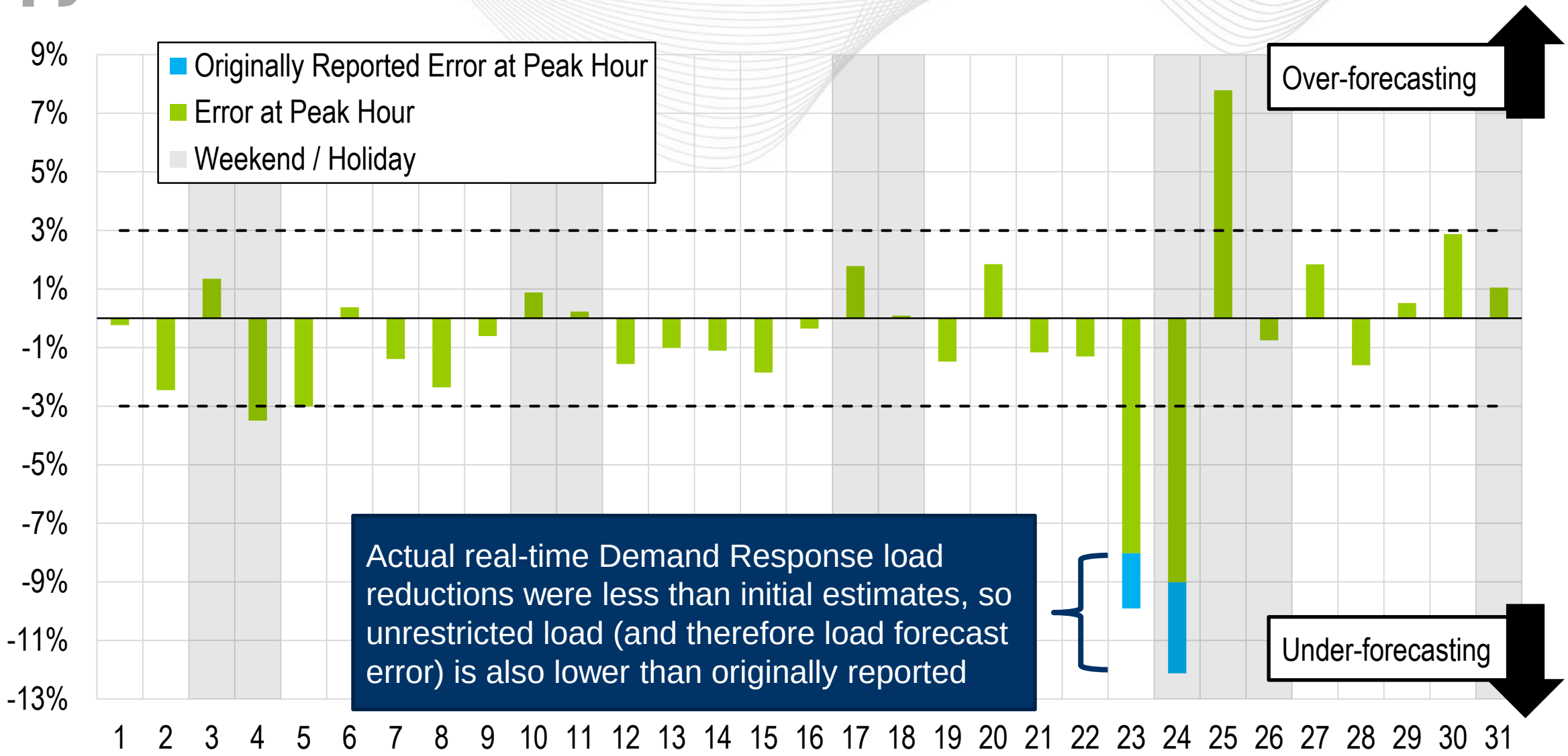
**PJM accounts for uncertainty and unplanned events as it develops the operating plan for every day.**

- Given the expected weather, PJM was conservative in developing the operating plans for Dec. 23.
- Forecast load was 126,968 MW.
- PJM had over 155,750 MW in the operating capacity for the day.

Based on generator availability data submitted to PJM, we believed we had almost 29 GW of reserve capacity available to absorb load and generation contingencies and to support our neighboring systems.

*Preliminary Data*

# Daily Peak Forecast Error (December)



# Drivers of Load Forecast Error

Extreme weather

Holiday impacts

Severe cold and blizzard conditions

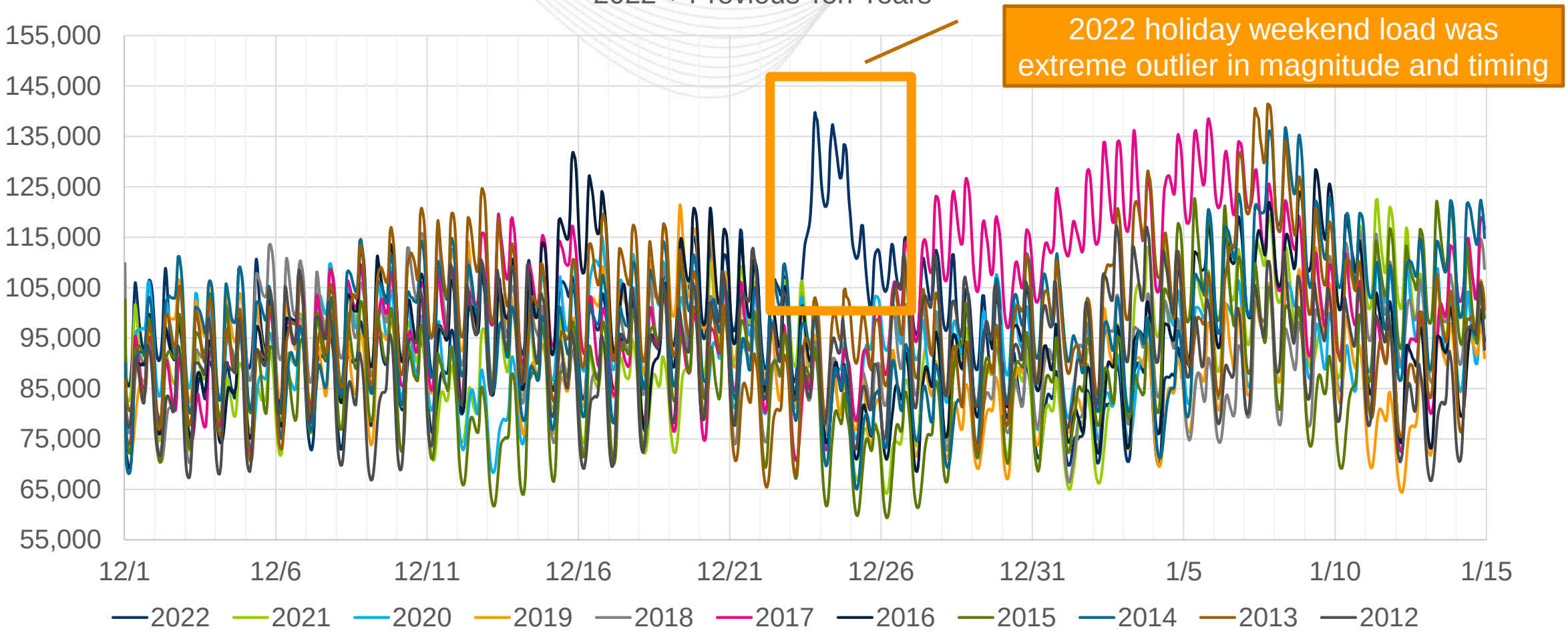
Most drastic temperature drop in at least 10 years

Early occurrence of cold weather

Rare instance of under-forecasting

# 2022 Holiday Load

Dec. 1 – Jan. 15 Loads (with Demand Response added back)
2022 + Previous Ten Years



# 2022 Holiday Load