December 24, 2022 OP-4 Event and Capacity Scarcity Condition

Vamsi Chadalavada

EXECUTIVE VICE PRESIDENT & CHIEF OPERATING OFFICER

OP-4 and Capacity Scarcity Condition Saturday, December 24, 2022

- Two primary factors led to the implementation of OP-4 and the Capacity Scarcity Condition
  - Generator outages and reductions totaling ~2,150 MW occurred across the operating day
  - Net imports were less than the quantity that cleared the Day-Ahead Energy Market (~1,100 MW less at the time OP-4 actions were implemented)
- 30-minute Reserve Constraint Penalty Factor violated for the following 5-minute intervals: 16:40 – 18:00
  - $1,000/MWh Reserve Constraint Penalty Factor
- 10-minute Reserve Constraint Penalty Factor violated for the following 5-minute interval: 17:10
  - $1,500/MWh Reserve Constraint Penalty Factor
- System conditions required the implementation of M/LCC 2 and OP-4
  - M/LCC 2, Abnormal Conditions Alert: 16:00 – 21:00
  - OP-4, Actions 1, 2: 16:30 – 19:00
  - OP-4, Action 3: 16:45 – 19:00
  - OP-4, Action 5: 17:30 – 18:30

December 24th LMP Finalization and Preliminary Settlement Information

- Finalized Real-Time LMPs for December 24th and the Capacity Scarcity Condition report were published to the ISO website on Wednesday, December 28th at 12:45 p.m.
- Preliminary settlement reports released on Friday, December 30th
  - Balancing Ratios and Performance Scores published
  - The balancing ratio over each 5-min interval ranged from 0.652 – 0.681
  - The average balancing ratio over the period is 0.67
  - Final Settlement will adjust for Capacity Performance Bilateral Contracts
- Estimated Pay-for-Performance penalties*: $39M
  - Pay-for-Performance penalties during the last event on September 3, 2018: $36M

**Estimates based on available data*

Weather Forecast and Preparations for the Operating Day

- Following a winter storm and unseasonably mild weather on December 23rd, below normal temperatures were forecasted across the region on December 24th; forecasted peak hour temperatures for Boston and Hartford were 20°F and 17°F, respectively
- Severe cold weather conditions were impacting neighboring areas;
  - PJM issued a request for conservation throughout its footprint between the hours of 4 a.m. on December 24th and 10 a.m. on December 25th, and in order to obtain relief from potential emissions limitations at some generating stations, filed a request for an Emergency Order Under Section 202(c) of the Federal Power Act with the U.S. Department of Energy
- ISO System Operations staff was in close communication with neighboring Reliability Coordinators, Balancing Areas, and Local Control Centers ahead of and throughout the severe cold weather
- On the morning of December 24th, based on a peak load forecast of 17,510 MW (in HE18), ISO projected a capacity surplus of ~950 MW above load and operating reserve requirements

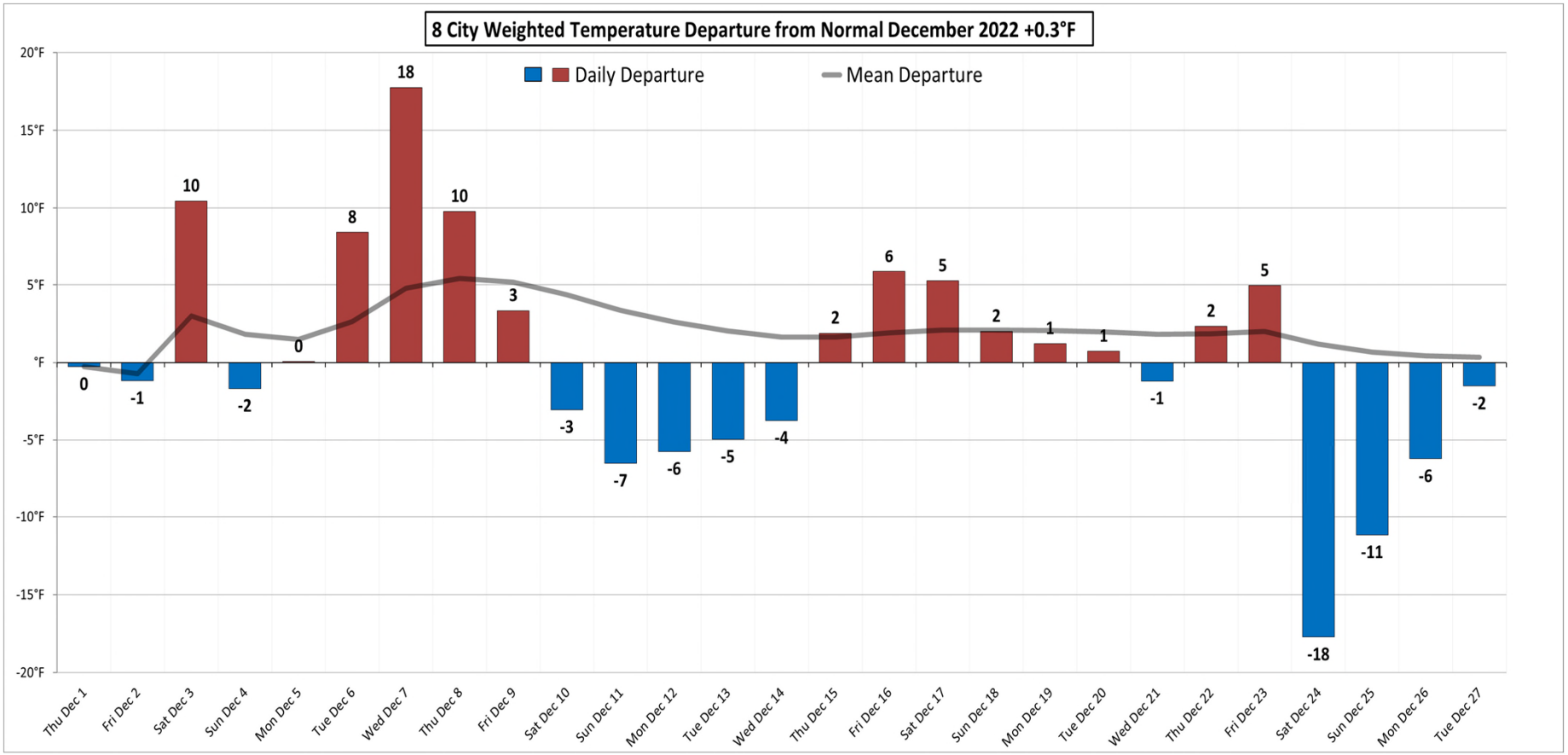
Coordination with Natural Gas Pipelines Was Critical

- Due to the severe cold weather across the region, Operational Flow Orders (OFOs) were in effect on the Algonquin, Iroquois, M&N, and Tennessee Pipelines
- ISO Operations staff closely monitored pipeline conditions and remained in close contact with pipeline operators throughout the day

Regional Weather Was Colder than Forecast

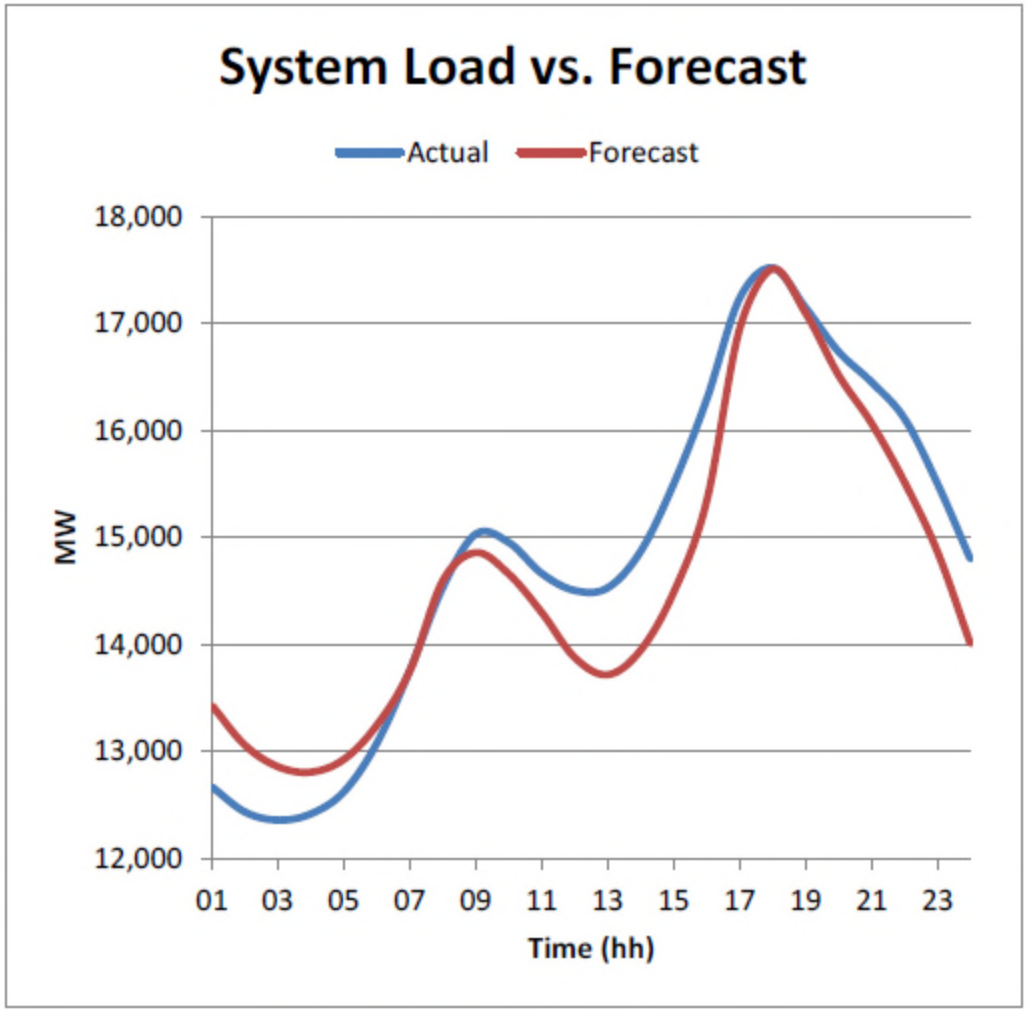
- Temperatures across the region were quite a bit colder than forecast; temperatures in all 8 of ISO's reference cities were below the forecast throughout the day
- Following the storm that impacted the region on December 23rd, an arctic air mass to the west of New England moved a bit further east than had been projected, resulting in temperatures on December 24th below forecast across the region
- Actual temperatures were colder than forecast by ~3-6 degrees throughout the day; peak hour temperatures were ~4°F lower than forecast

Regional Average Temperatures Departed Significantly from Normal



ISO's Peak Hour Load Forecast Was Accurate

- Lower than forecasted daytime temperatures contributed to higher than expected energy demand throughout the daylight hours, however ISO's peak hour load forecast was highly accurate
  - The absolute percent error of ISO's daily load forecast was ~3%; peak load was within ~25 MW of forecast
- Peak integrated load of 17,524MW occurred in HE18



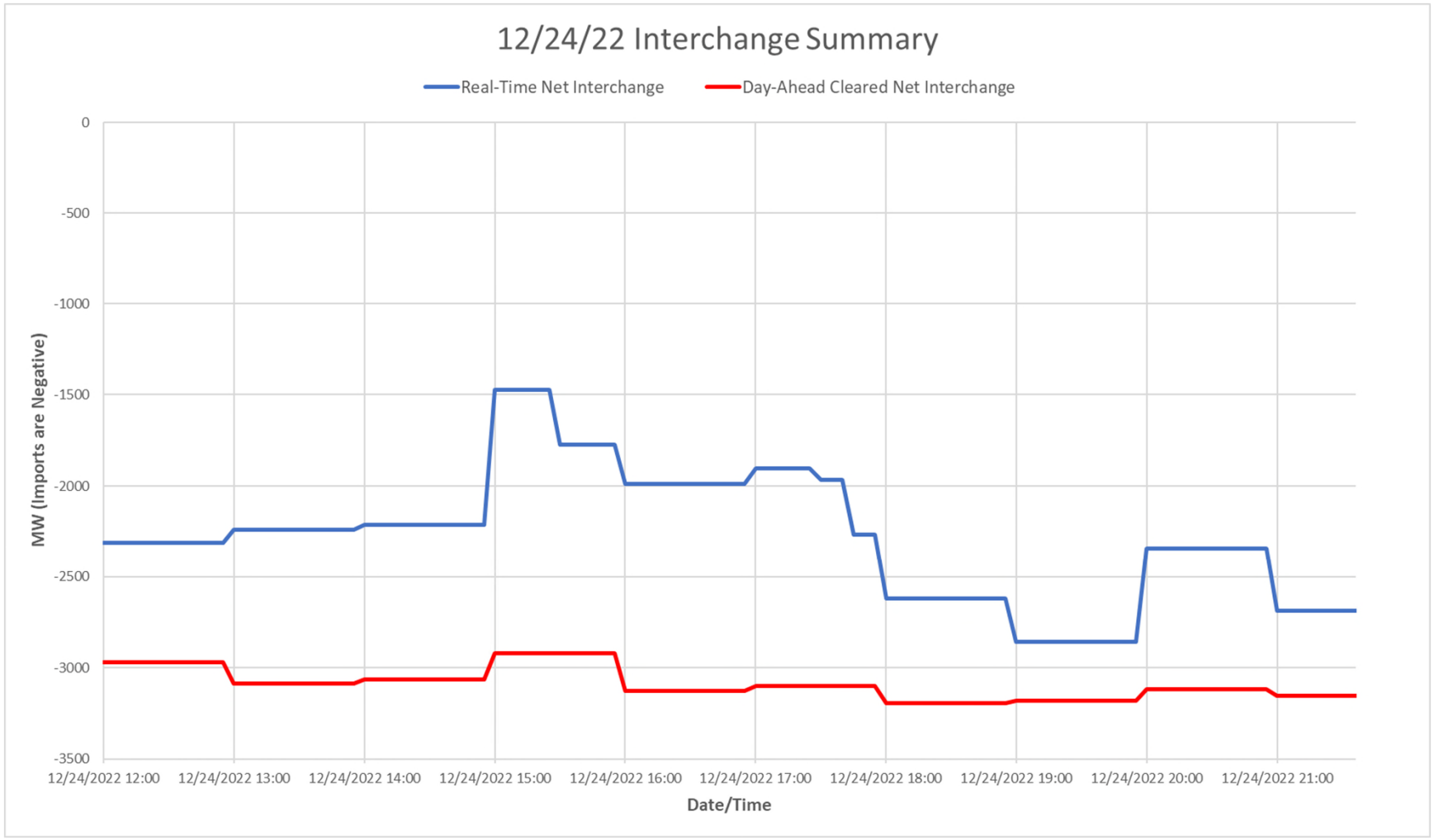
Unplanned Generator Outages and Reductions Occurred Prior to and During OP-4

- Throughout the day and prior to the declaration of M/LCC-2 at 16:00
  - Several generators experienced unplanned outages or reductions resulting in a net loss of ~1,000 MW of generating capacity
  - One resource (~275 MW) self-scheduled and ran through the peak hour
- Following declaration of M/LCC-2, and prior to the implementation of OP-4 at 16:30
  - Several additional generators experienced outages or reductions totaling ~400 MW of generating capacity
  - ISO initiated the commitment of all remaining offline resources that were available to come online for the peak hour (~380 MW)
- Following the implementation OP-4, during HE17-18, ~750 MW of additional generating capacity experienced outages or reductions
- Causes of generator outages and reductions (~2,150 in total) varied; some reported cold weather-related outages or reductions, and ISO expects to follow up with these resources on a case-by-case basis to gather additional details

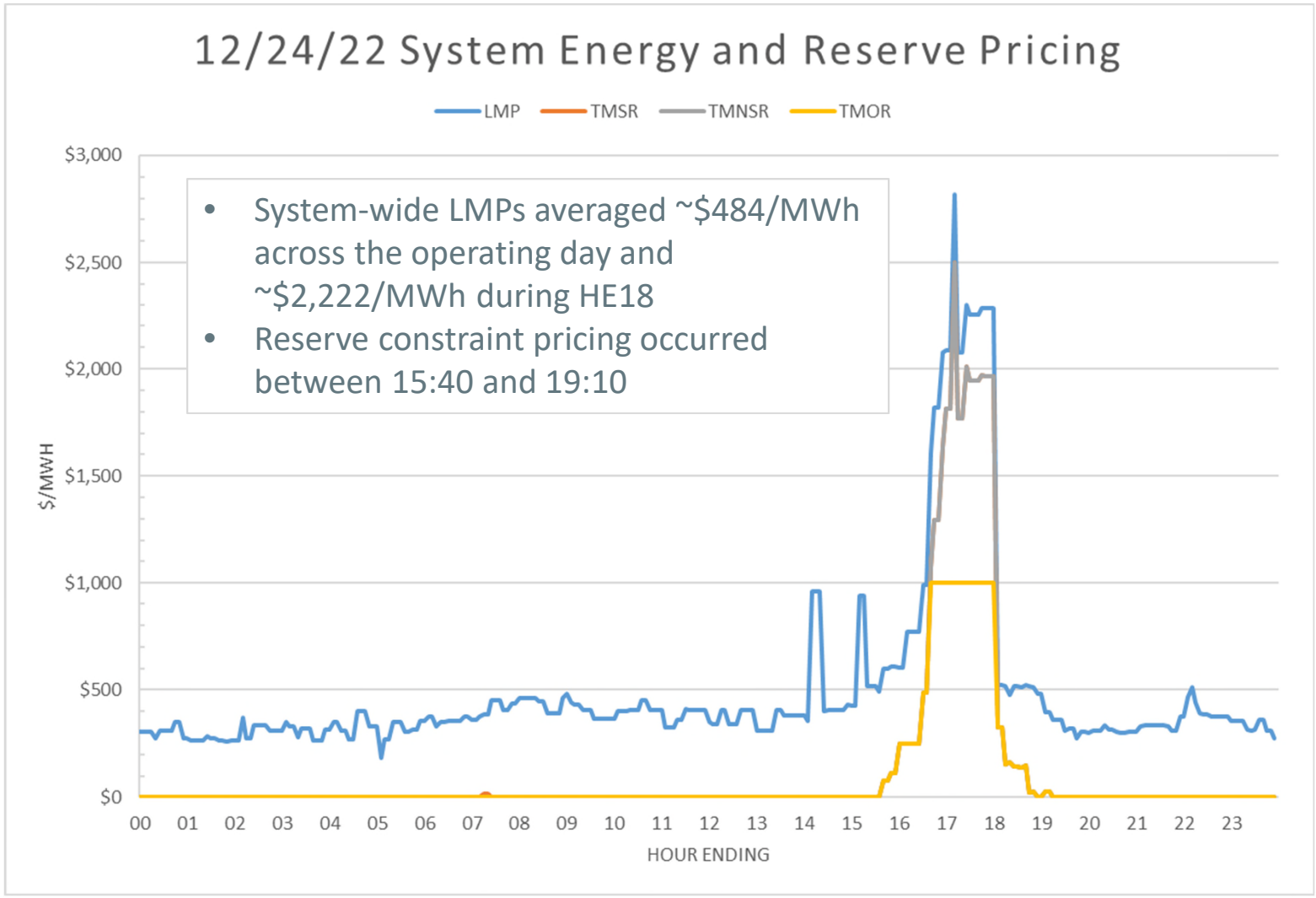
Energy Imports Were Below Day-Ahead Values

- At the time OP-4 actions were implemented (16:30), net imports were ~1,100 MW less than the amount that cleared the Day-Ahead Energy Market
- System Operators took action to curtail export transactions in accordance with Operating Procedures
  - New York North (NYN) interface
    - HE17: 707 MW
    - HE18: 300 MW (beginning at 17:40)
  - Norwalk – Northport Cable (NNC) interface
    - HE17: 124 MW
    - HE18: 164 MW (99 MW beginning at 17:00, an additional 65 MW at 17:35)
  - Cross Sound Cable (CSC) interface
    - HE18: 50 MW (beginning at 17:35)

Energy Imports Were Below Day-Ahead Values



Real-Time System Energy and Reserve Pricing



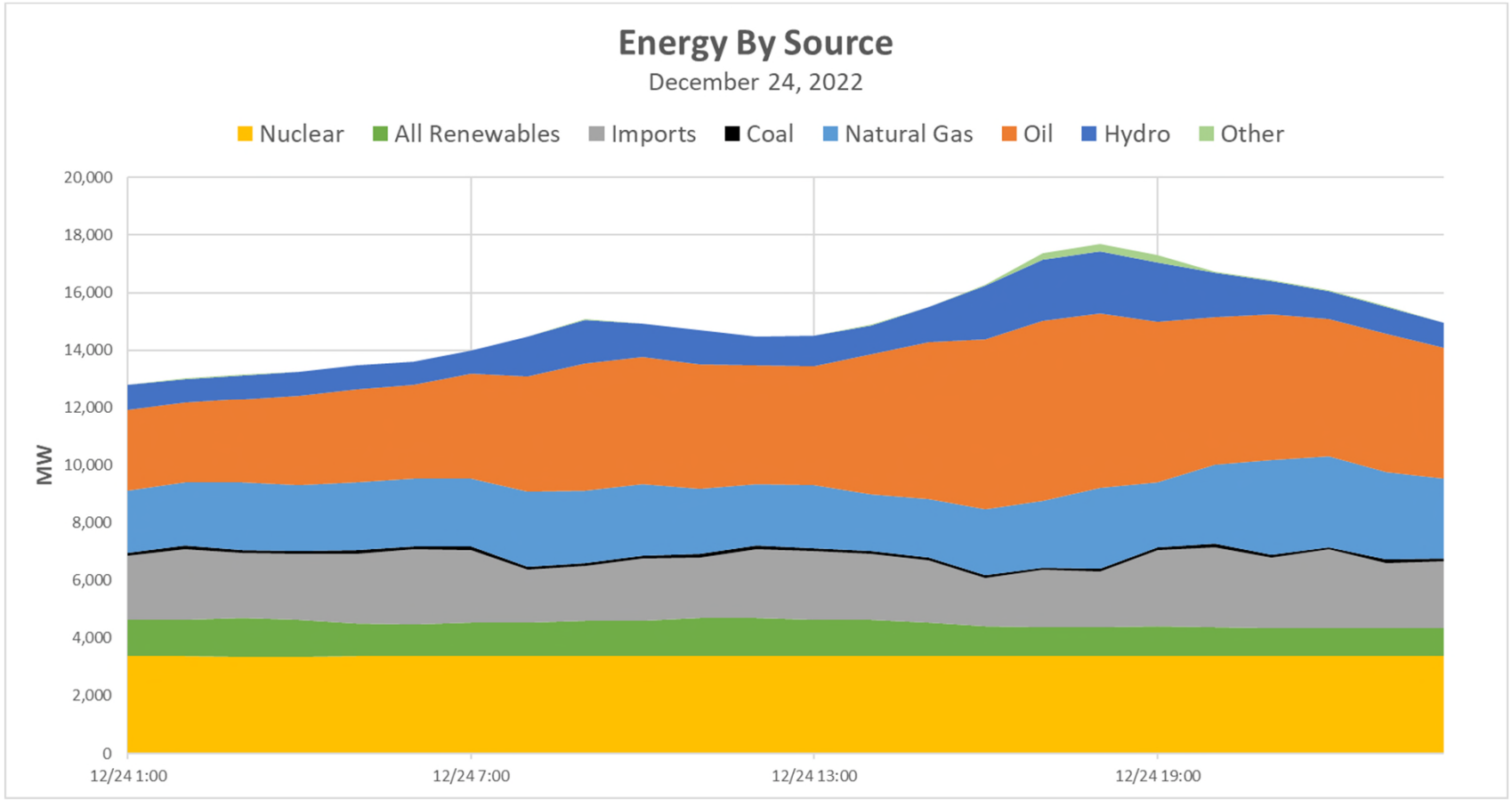
Summary of Capacity Scarcity Condition Intervals

5-Minute Intervals	System 30 Min Reserve Constraint Penalty Factor ($1,000 MW/hr)	System 10 Min Reserve Constraint Penalty Factor ($1,500 MW/hr)
16:40 – 17:05 (6 Intervals)	**Violated**	Binding
17:10 (1 Interval)	**Violated**	**Violated**
17:15 – 18:00 (10 Intervals)	**Violated**	Binding

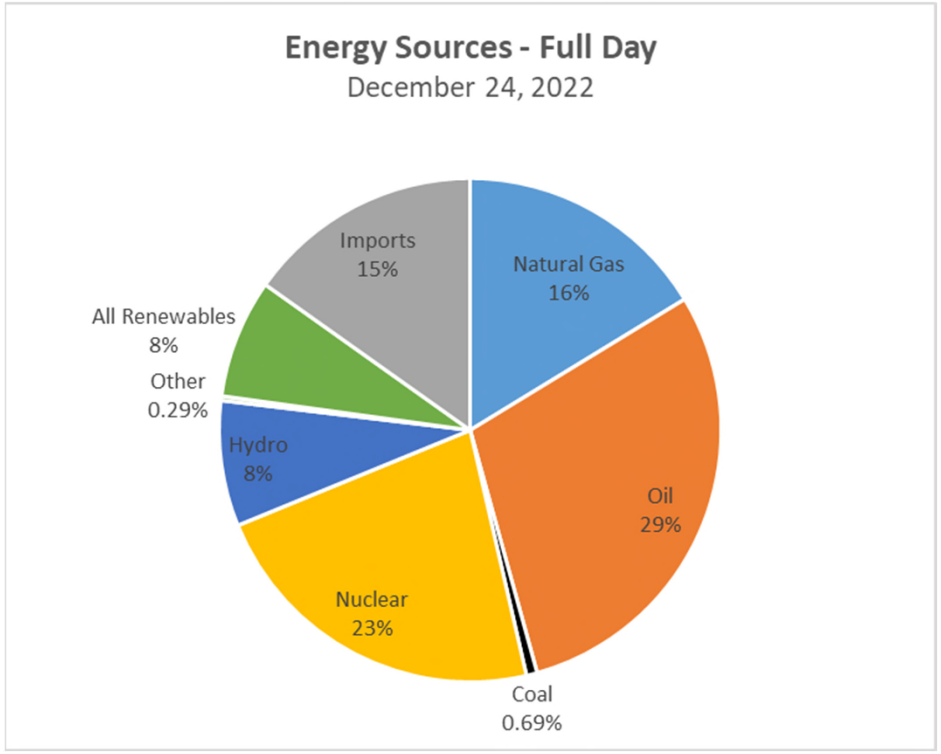
- A Capacity Scarcity Condition results from the **violation** of the System 30 Minute Operating Reserve constraint or the System 10 Minute Operating Reserve constraint in any one 5-minute interval

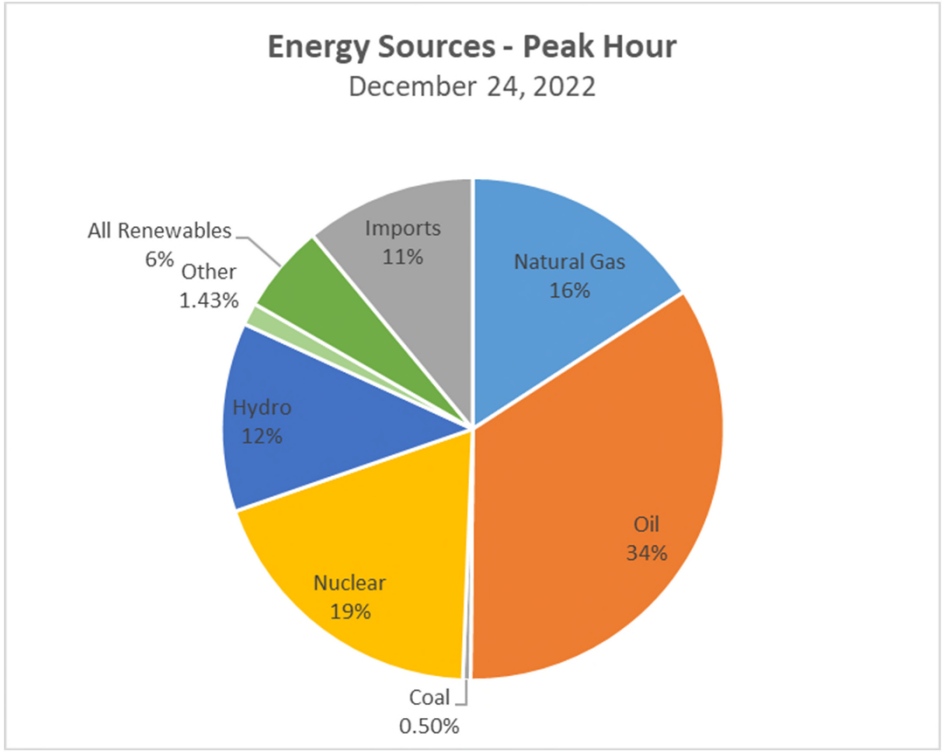
Energy by Source Type –Increased Use of Oil-Fired Generation

- Oil-fired generation operated at high levels throughout the day as many dual-fuel generators switched to burning fuel-oil; ~29% of the region's energy demand was met by oil-fired generation



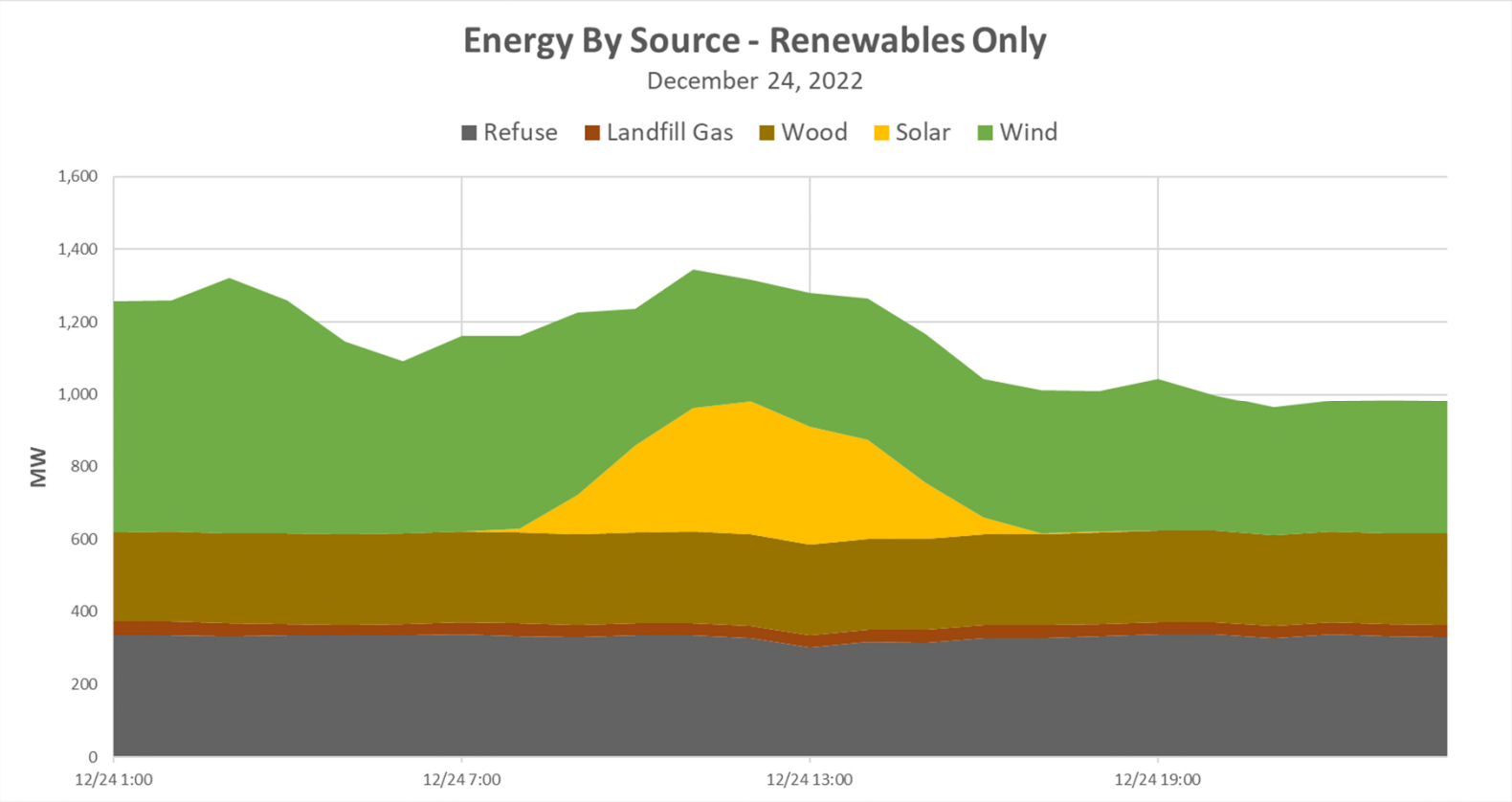
Energy by Source, Daily and Peak Hour





Energy from Renewable Resources

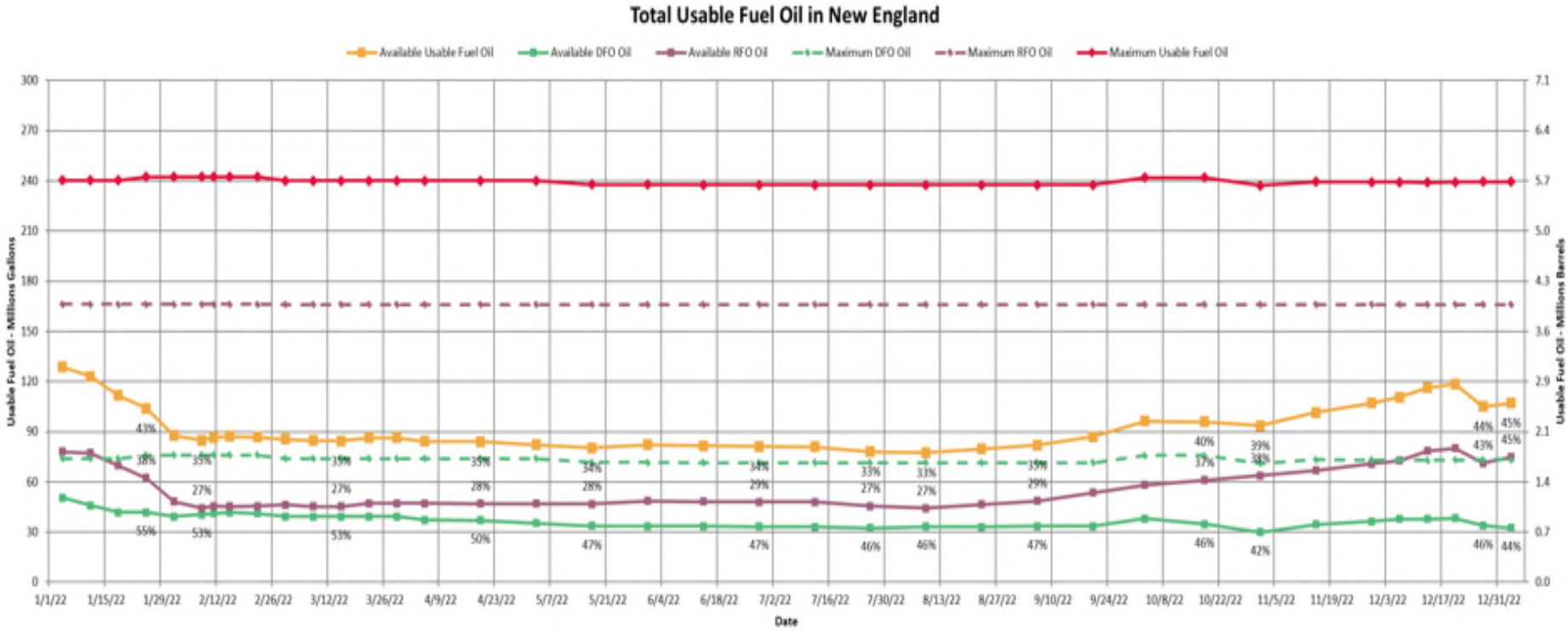
- Renewable resources met ~8% of the region's daily energy demand[1]; energy from wind resources peaked during overnight hours, then remained relatively steady (avg. ~400 MW/hr) during peak hours of the operating day (HE 08-23)



1 – in this figure, "solar" does not include contributions of behind-the-meter or settlement only solar resources. Impacts of behind-the-meter and settlement only solar resources is reflected in the net load.

Following Recent Oil Burn, Regional Usable Fuel-Oil Inventory Is Down ~4% From Pre-Cold Weather High

- Based on recent generator surveys, ISO estimates that ~31.5M gallons of fuel-oil was burned and ~20M gallons of replenishment occurred between December 20th and January 3rd



ISO Anticipates Near-Term Fuel-Oil Replenishment; 21-Day Energy Supplies Remain Adequate

- ISO anticipates fuel-oil replenishment of ~8M gallons over the next week (an increase of ~3% of maximum fuel-oil storage capacity)
- Recent cold weather did not result in significant depletion of regional LNG inventories; based on forecasted weather and energy demand as well as expectations for regional energy supplies, ISO forecasts normal system conditions in its most recent 21-Day Energy Assessment

Questions