# Post Winter 2017/18 Review

*Electric/Gas Operations Committee*

Mark Babula

SYSTEM PLANNING – RESOURCE STUDIES AND ASSESSMENTS

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# WINTER 2017/18 WEATHER, ENERGY AND PEAK LOADS

# Winter 2017/18 Weather, Energy and Peak Loads*

- **December 2017: Colder than previous December**
  - Monthly Heating Degree Days (HDD) of 1,161 is 14.7% higher than December 2016
  - Energy demand of 11,082 GWh is 1.8% higher than December 2016
  - Peak load of 20,476 MW is 4.2% higher than December 2016
  - Peak occurred on December 28, 2017 at HE 18:00 at 8$^{O}$F and -10$^{O}$DWPT
- **January 2018: Colder than previous January**
  - Monthly HDD of 1,212 is 20.6% higher than January 2017
  - Energy demand of 11,493 GWh is 7.2% higher than January 2017
  - Peak load of 20,599 MW is 5.1% higher than January 2017
  - Peak occurred on January 5, 2018 at HE 18:00 at 8$^{O}$F and -10$^{O}$DWPT

**(*) – All data obtained from the ISO-NE Net Energy and Peak Load Report located at:**
**https://www.iso- ne.com/isoexpress/web/reports/load-and-demand/-/tree/net-ener-peak-load**

# Winter 2017/18 Weather, Energy and Peak Loads* - cont'd

- **February 2018: Milder than previous February**
  - Monthly HDD of 827 is 4.7% lower than February 2017
  - Energy demand of 9,345 GWh is 1.0% lower than February 2017
  - Peak load of 18,256 MW is 0.5% higher than February 2017
  - Peak occurred on February 7, 2018 at HE 18:00 at 29$^{O}$F and 27$^{O}$DWPT
- **March 2018: Milder than previous March**
  - Monthly HDD of 907 is 10.4% lower than March 2017
  - Energy demand of 9,925 GWh is 4.8% lower than March 2017
  - Peak load of 16,855 MW is 3.7% lower than March 2017
  - Peak occurred on March 7, 2018 at HE 18:00 at 33$^{O}$F and 31$^{O}$DWPT

**(*) – All data obtained from the ISO-NE Net Energy and Peak Load Report located at:**
**https://www.iso- ne.com/isoexpress/web/reports/load-and-demand/-/tree/net-ener-peak-load**

# WINTER RELIABILITY PROGRAM

# Winter 2017/18 Reliability Program (As of the Start of the Program on December 1, 2017)

- **Oil Program**
  - Participation from 86 units for a total of 3.868 million barrels of oil
  - 2.867 million barrels of the total inventory on December 1 are eligible for compensation per the winter reliability program rules
  - Total oil program cost exposure is projected to be $29.62 Million (@$10.33/barrel)
- **LNG Program**
  - No Participation
- **DR Program**
  - Participation from 3 assets providing 7.5 MW of interruption capability
  - Total DR program cost exposure is projected to be $23.2K

# Winter 2017/18 Reliability Program Usage

- Winter Program Oil Inventory Use[(A)]
  - Dec 2017: 548,410 BBLs
  - Jan 2018: 524,447 BBls
  - Feb 2018: 192,113 BBls
  - Mar 2018: 48,356 BBls

    TOTAL = 1,313,326 BBls
- Winter Program LNG Use:
  - None
- Winter Program DR Use (Events):
  - None
- Final Program Ending Oil Eligible Inventory[(B)]
  - 2,566,435 BBLs

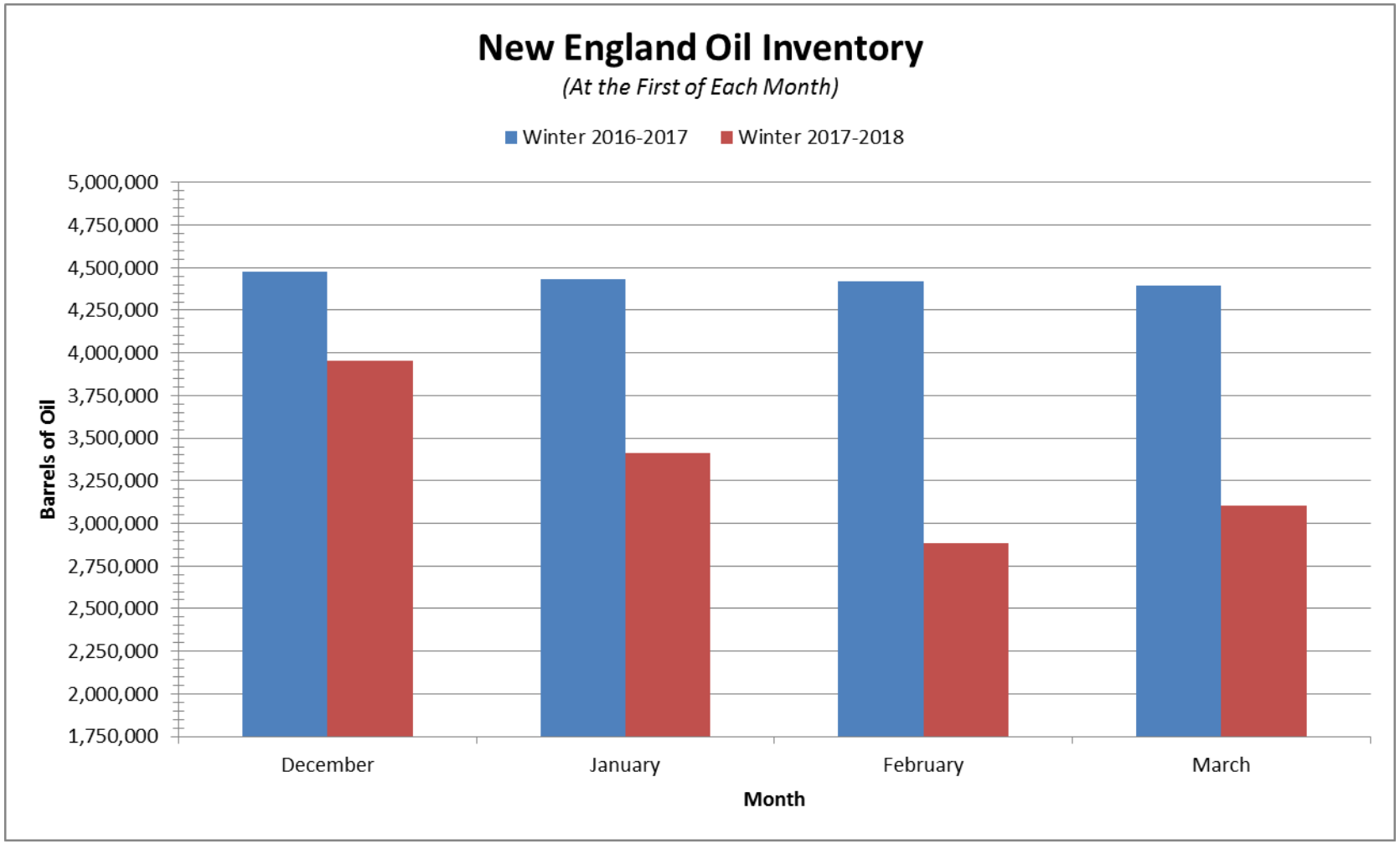
**NOTE (A): First of month snapshot of oil inventory**
**NOTE (B): End of WRP Inventory on March 15, 2018 = Amount used for Billing Calculations**

# Winter Reliability Program Costs & Billing

- Anticipated Program Costs:
  - Oil: $24.4M* ($22.2M collected; $2.2M remains to be collected)
  - DR: $33K ($28K collected; $5K remains to be collected)
- Billing/Payment Schedule:
  - Initial billings were based on 75% of initial inventory
  - Trued-up charges for unused fuel was issued on April 17, 2018
  - Payment to generators for unused fuel inventory will be in May 14, 2018 bill

* Fuel inventory cost with preliminary availability adjustment

# First of the Month Oil Inventory – All Units



# ELECTRIC SYSTEM OPERATIONS REVIEW

# Electric System Operations Review

| Event Type | December 2017 | January 2018 | February 2018 | March 2018 |
|---|---|---|---|---|
| OP4 | None | None | None | None |
| MLCC2 (Reason) | None | January 3 – 9 (Severe Weather) | None | March 7-9<br>March 12-15<br>March 16 in NSTAR Only<br>March 20-22<br>(Severe Weather) |
| Peak Load Date (H.E.) | 20,531 MW<br>Dec 28<br>(18:00) | 20,631 MW<br>Jan 5<br>(18:00) | 18,164 MW<br>Feb 7<br>(18:00) | 16,735 MW<br>Mar 7<br>(19:00) |
| Minimum Gen Warning/Event | None | None | None | None |

**Peak load & dates come from ISO-NE's monthly COO-NPC reports**

# Electric System Operations – December 2017

| | | | | |
|---|---|---|---|---|
| **Weather Patterns** | **Boston** | **Temperature: Below Normal (-6.1°F)**<br>**Max: 59°F, Min: 2°F**<br>**Precipitation: 2.47" – Below Normal**<br>**Normal: 3.73"**<br>**Snow: 7.16"** | **Hartford** | **Temperature: Below Normal (-5.9°F)**<br>**Max: 59°F, Min: -3°F**<br>**Precipitation: 2.42" - Below Normal**<br>**Normal: 3.60"**<br>**Snow: 8.94"** |

| | | | |
|---|---|---|---|
| **Peak Load:** | **20,531 MW** | **Dec 28, 2017** | **18:00 (ending)** |

| | | |
|---|---|---|
| **MLCC2: None** | | |
| **OP-4 : None** | | |
| **NPCC Simultaneous Activation of Reserve Events:** | | |
| **Date** | **Area** | **MW** |
| **December 7** | **NYISO** | **1,240** |

**Minimum Generation Warnings & Events:**

| | | |
|---|---|---|
| **None** | | |

# Electric System Operations – January 2018

| | | | | |
|---|---|---|---|---|
| **Weather Patterns** | **Boston** | **Temperature: Below Normal (-0.4°F)**<br>**Max: 61°F, Min: -2°F**<br>**Precipitation: 4.77" – Above Normal**<br>**Normal: 3.04"**<br>**Snow: 15.4"** | **Hartford** | **Temperature: Below Normal (-1.3°F)**<br>**Max: 60°F, Min: -9°F**<br>**Precipitation: 3.83" - Above Normal**<br>**Normal: 2.91"**<br>**Snow: 13.2"** |

| | | | |
|---|---|---|---|
| **Peak Load:** | **20,631 MW** | **Jan 5, 2018** | **18:00 (ending)** |

| | | |
|---|---|---|
| **MLCC2:** | **Reason: Extreme weather followed by extreme cold temperatures** | **Declared: Jan 3, 2018 16:00**<br>**Cancelled: Jan 9, 2018 12:00** |
| **OP-4 : None** | | |

**NPCC Simultaneous Activation of Reserve Events:**

| Date | Area | MW |
|---|---|---|
| January 1 | PJM | 700 |
| January 3 | PJM | 1,000 |
| January 4 | ISO NE | 680 |
| January 7 | NYISO | 600 |
| January 7 | IESO | 600 |
| January 25 | ISO NE | 700 |

**Minimum Generation Warnings & Events:**

| | | |
|---|---|---|
| **None** | | |

# Electric System Operations – February 2018

| | | | | |
|---|---|---|---|---|
| **Weather Patterns** | **Boston** | **Temperature: Above Normal (5.7°F)**<br>**Max: 72°F, Min: 10°F**<br>**Precipitation: 3.76" – Above Normal**<br>**Normal: 2.86"**<br>**Snow: 9.8"** | **Hartford** | **Temperature: Above Normal (5.0°F)**<br>**Max: 77°F, Min: 9°F**<br>**Precipitation: 5.13" – Above Normal**<br>**Normal: 2.56"**<br>**Snow: 8.3"** |

| | | | |
|---|---|---|---|
| **Peak Load:** | **18,164 MW** | **Feb 7, 2018** | **18:00 (ending)** |

| | | |
|---|---|---|
| **MLCC2: None** | | |
| **OP-4 : None** | | |
| **NPCC Simultaneous Activation of Reserve Events:** | | |
| **Date** | **Area** | **MW** |
| **February 3** | **NYISO** | **1,302** |
| **February 16** | **NYISO** | **1,000** |

**Minimum Generation Warnings & Events:**

| | | |
|---|---|---|
| **None** | | |

# Electric System Operations – March 2018

| | | | | |
|---|---|---|---|---|
| **Weather Patterns** | **Boston** | **Temperature: Below Normal (-1.1°F)**<br>**Max: 64°F, Min: 16°F**<br>**Precipitation: 5.07" – Above Normal**<br>**Normal: 4.32"**<br>**Snow: 23.3" – Above Normal** | **Hartford** | **Temperature: Below Normal (-0.6°F)**<br>**Max: 60°F, Min: 17°F**<br>**Precipitation: 2.65" - Below Normal**<br>**Normal: 3.62"**<br>**Snow: 16.6" – Above Normal** |

| | | | |
|---|---|---|---|
| **Peak Load:** | **16,735 MW** | **March 7, 2018** | **19:00 (ending)** |

| | | |
|---|---|---|
| **MLCC2:** | **Reason: Severe Weather** | **Declared: March 7, 2018 HE 09:00**<br>**Cancelled: March 9, 2018 HE 21:00** |
| **MLCC2:** | **Reason: Severe Weather** | **Declared: March 12, 2018 HE 14:00**<br>**Cancelled: March 15, 2018 HE 12:00** |
| **MLCC2:** | **Reason: Severe Weather** | **Declared: Continued in NSTAR only**<br>**Cancelled: March 16, 2018 HE 16:00** |
| | **Reason: Severe Weather** | **Declared: March 20, 2018 HE 16:00**<br>**Cancelled: March 22, 2018 HE 12:00** |
| **OP-4: None** | | |

# Electric System Operations – March 2018 – cont'd

**Minimum Generation Warnings & Events:**

| | | |
|---|---|---|
| None | | |

**NPCC Simultaneous Activation of Reserve Events**

| Date | Area | MW Lost |
|---|---|---|
| March 8 | ISO-NE | 1,600 |
| March 14 | ISO-NE | 2,006 |
| March 19 | NYISO | 400 |
| March 19 | ISO-NE | 660 |

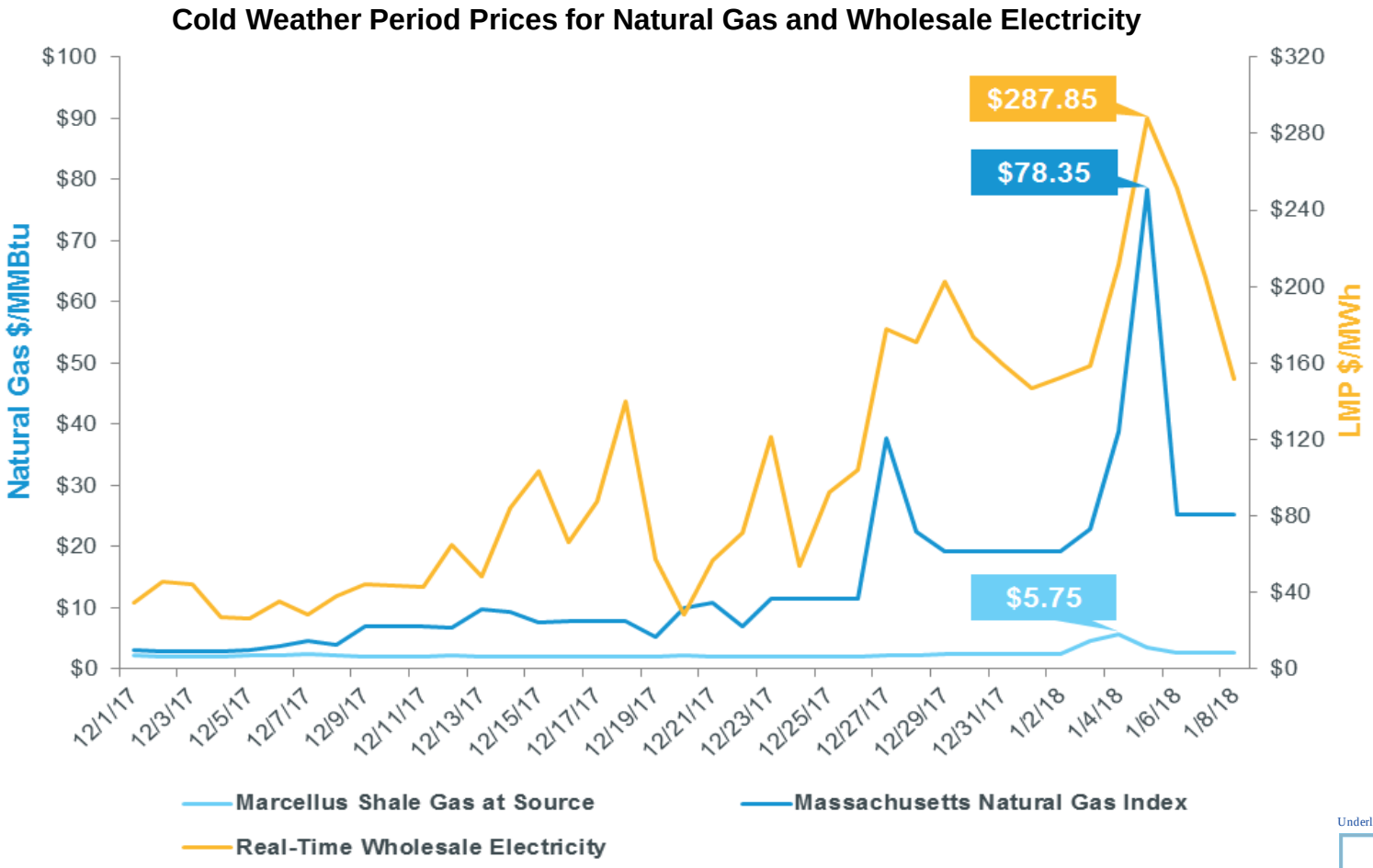
# COLD WEATHER OPERATIONS
# DECEMBER 25, 2017 – JANUARY 8, 2018

# Cold Weather Operations

- New England was gripped by cold weather between December 25, 2017 and January 8, 2018
- Natural gas and fuel oil price inversion led to fuel oil being in economic merit and subsequently base loaded
  - As natural gas prices rose, the entire season's oil supply rapidly depleted. Coal use also increased over normal use
- With extended days of burning oil, several resources had concerns about hitting federal and/or state emissions limitations or were directly impacted by emissions limitations
  - This primarily includes resources in MA, CT and RI
- Sea/river ice affected ship and barge deliveries to fuel oil terminals located in NH, ME and on the Hudson River

# Frigid Cold Drove Up Regional Demand for Natural Gas

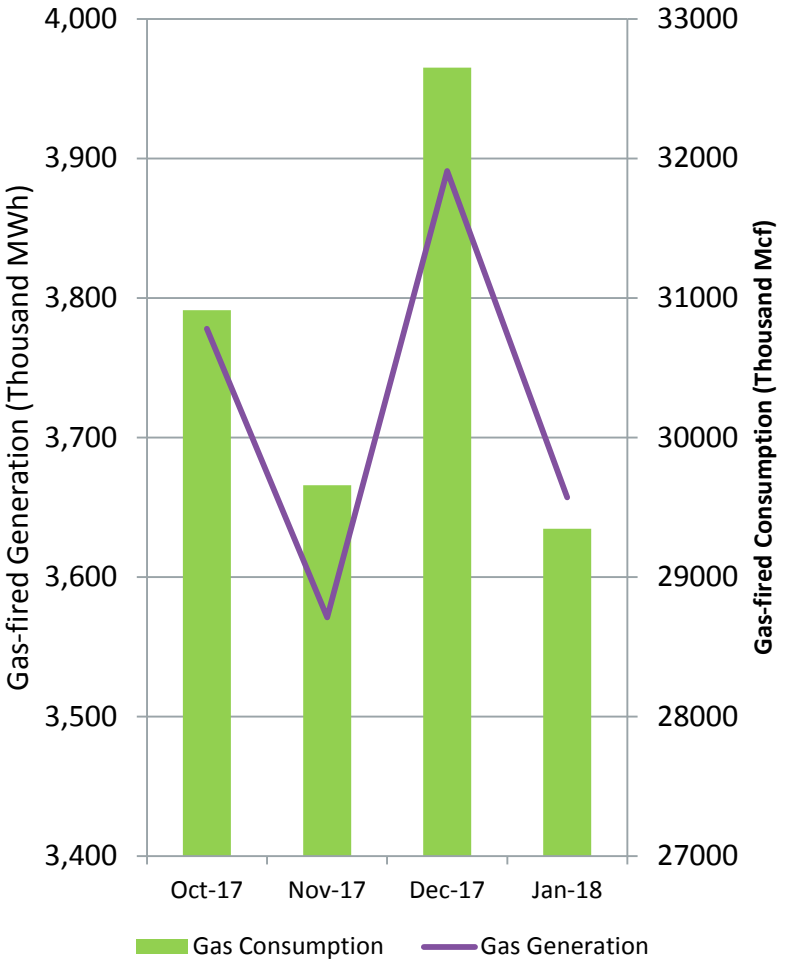
*This led to spikes in natural gas prices, which then led to spikes in wholesale electricity prices; with natural gas at a premium, oil generation became economic*

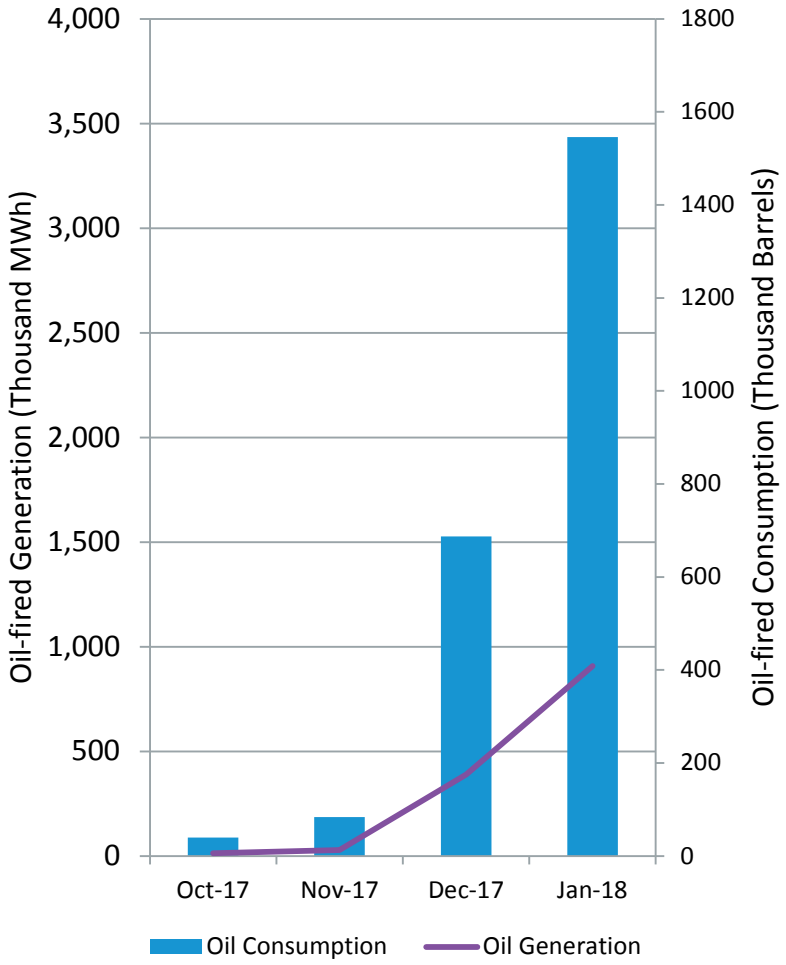



Underlying natural gas data furnished by:

ICE Global markets in clear view

# Winter Natural Gas vs. Oil Consumption (Thousand Mcf, Barrels) and Net Generation (Thousand MWh)

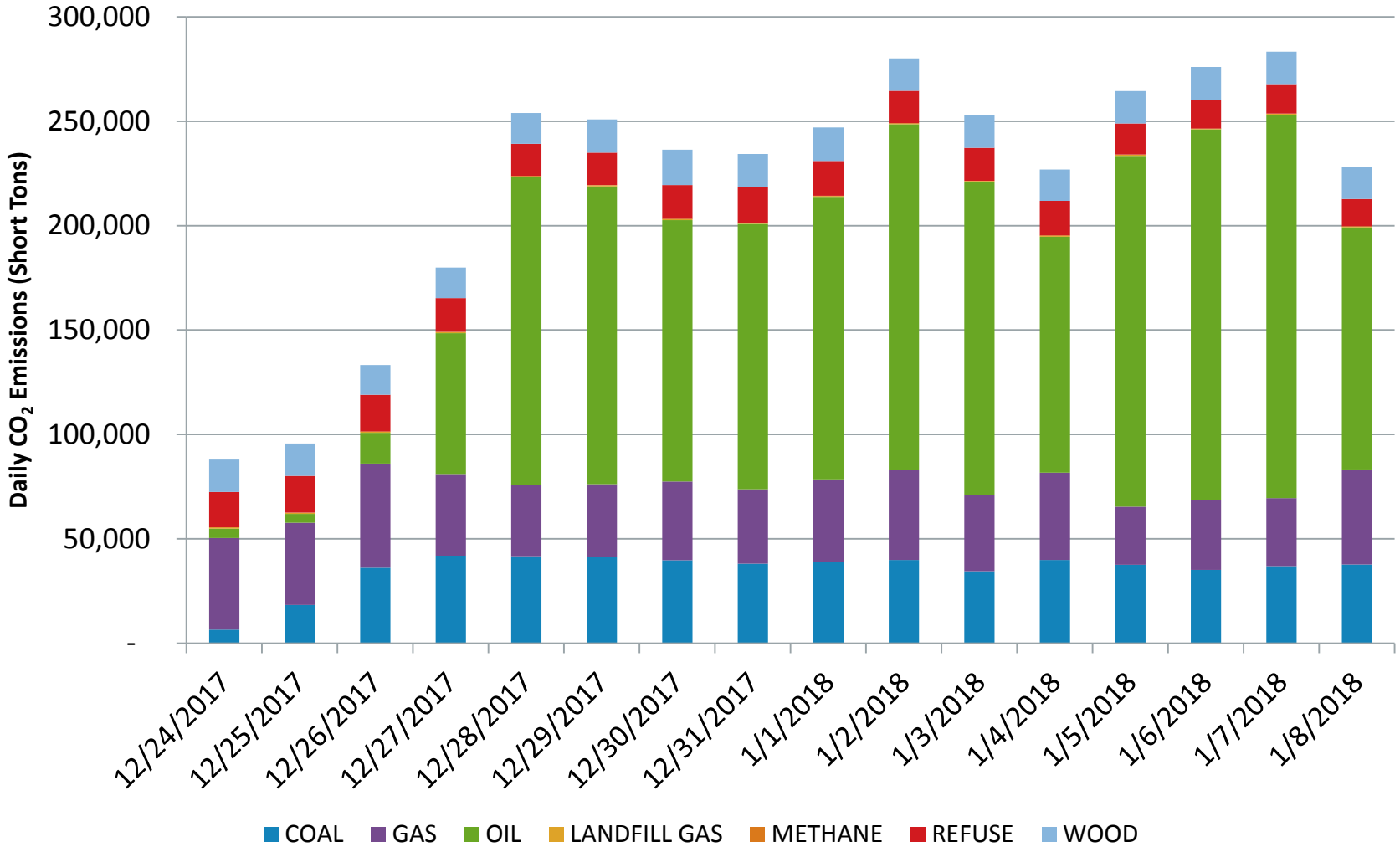



Source: EIA

# Estimated $CO_2$ System Emissions During Cold Snap

***Daily Average 220,680, total reached 3.5 million Short Tons***




Source: ISO-NE

# Cold Weather Operations – cont'd

- Trucking transport of fuel oil was the primary refueling constraint
- Massachusetts Governor Baker signs hours-of-service waivers to provide fuel deliveries for residential and commercial customers, and power plants
- To increase situational awareness, the ISO initiated semi-weekly then daily fuel surveys of oil-fired generation
- 37 natural gas issues were reported for the period, primarily Operational Flow Orders (OFOs) on Algonquin, Iroquois, and Tennessee Gas Pipelines; 2 in-region force majeure declared
  - ISO-NE requested two conference calls with the Northeast Gas Association's - Gas Supply Task Force
  - ISO-NE was in daily communications with interstate pipeline operators

# Cold Weather Operations – cont'd

- Emergency conference calls were held with both NPCC Reliability Coordinators and the six Local Control Centers to review current and emerging issues
- M/LCC 2 was declared on January 3 for all of New England due to; extreme weather, extreme cold, and fuel supply concerns. Subsequently cancelled on January 9
- The system operated reliably through the extended cold weather event. It relied heavily on oil to meet demand
  - The aggregate performance of the available generation fleet over the duration of the cold spell was good
- Reference Appendix 1 of this presentation for ISO-NE's COO-NPC presentation

# Electric System Operations Review – Conclusions

- Aside from the cold weather event that occurred over the winter holiday, system operations this winter was also impacted by additional severe coastal weather and snowstorms;  challenges remain for future winters with regard to fuel security and retirements
- World LNG prices and futures' contracts impact on how much LNG shows up in New England
  - Increased LNG injections maintain both electric and gas grid reliability
  - No LNG volumes participated in the Winter Reliability Program
- The Winter Reliability Program was instrumental in augmenting liquid fuel security for the region
  - The Pay-For-Performance market design becomes effective in June 2018

# NATURAL GAS SYSTEM OPERATIONS REVIEW

# Natural Gas System Operations Review – Summary of Issues and Incidents

- December 2017:
  - 19 gas system issues and 2 incidents at generating stations
- January 2018:
  - 15 gas system issues and 2 incidents at generating stations
- February 2018:
  - 2 gas system issues and 4 incidents at generating stations
- March 2018:
  - 1 gas system issue and 1 incident at generating stations

Total Winter Period:

- 37 gas system issues and 9 incident at generating stations

# Natural Gas System Operations Review – Declarations of Force Majeure & OFOs

- Algonquin Gas Transmission (AGT) Force Majeure:  None
- AGT OFOs:
  - Dec 7 to Dec 31
  - Jan 1 to Jan 10, Jan 13 to Jan 19, Jan 24 to Jan 26, Jan 29 to Feb 5
  - Feb 8 to Feb 9
  - Mar 2 to Mar 27

- Iroquois Gas Transmission System (IGTS) Force Majeure:
  - Interruption at Milford, CT compressor station from Jan 14 to Jan 15
- IGTS OFOs:
  - Dec 13 to Dec 18, Dec 27 to Dec 31
  - Jan 4 to Jan 9 and Jan 9 to Jan 10
  - Feb 1 to Feb 2

# Natural Gas System Operations Review – Declarations of Force Majeure & OFOs – cont'd

- Maritimes & Northeast (M&N) Pipeline Force Majeure: None
- M&N OFOs: None

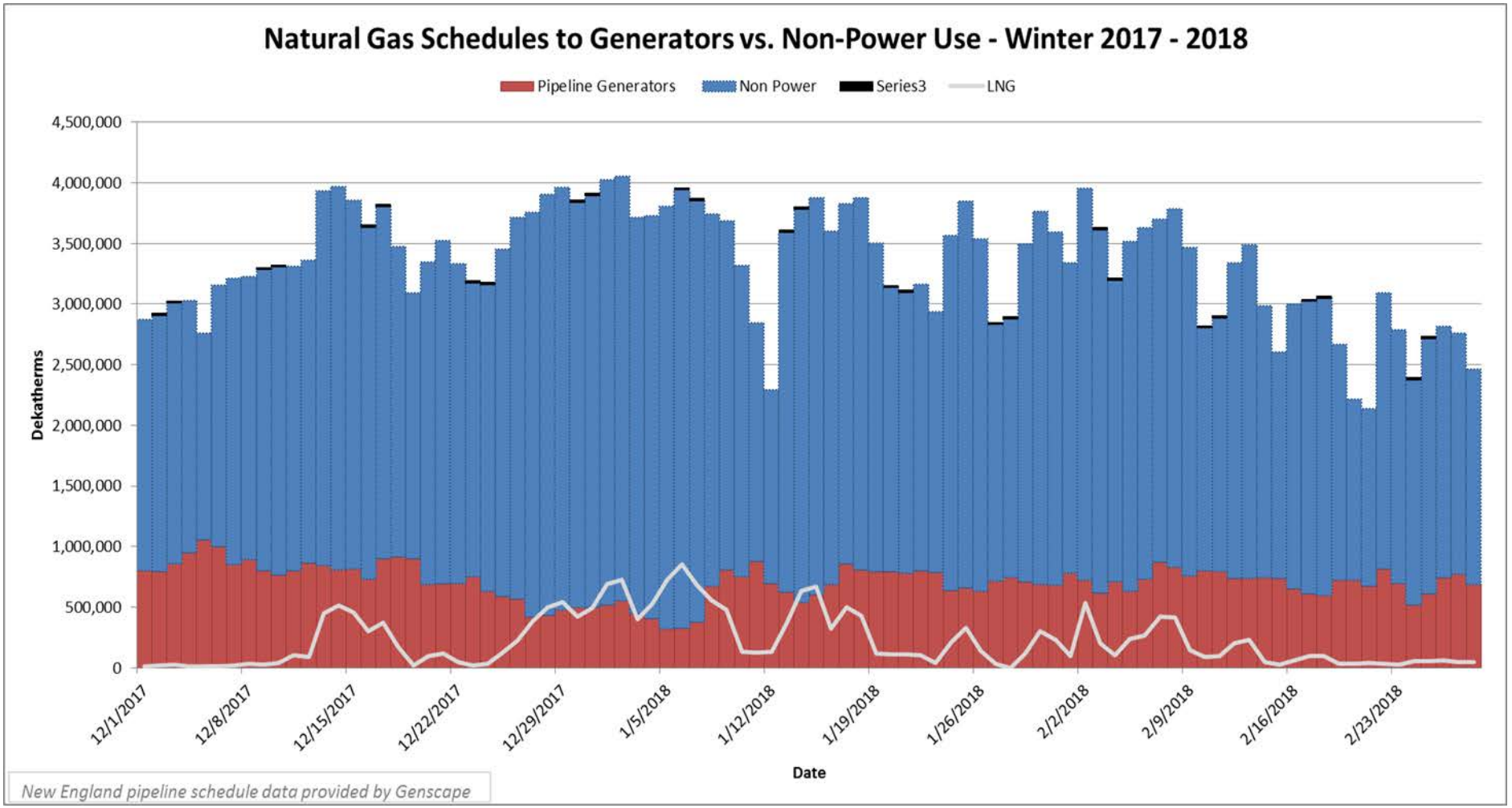
- Portland Natural Gas Transmission System (PNGTS)
  Force Majeure: None
  - However, a cyber security issue with PNGTS' EBB was reported on March 31
- PNGTS OFOs: None

# Natural Gas System Operations Review – Declarations of Force Majeure & OFOs – cont'd

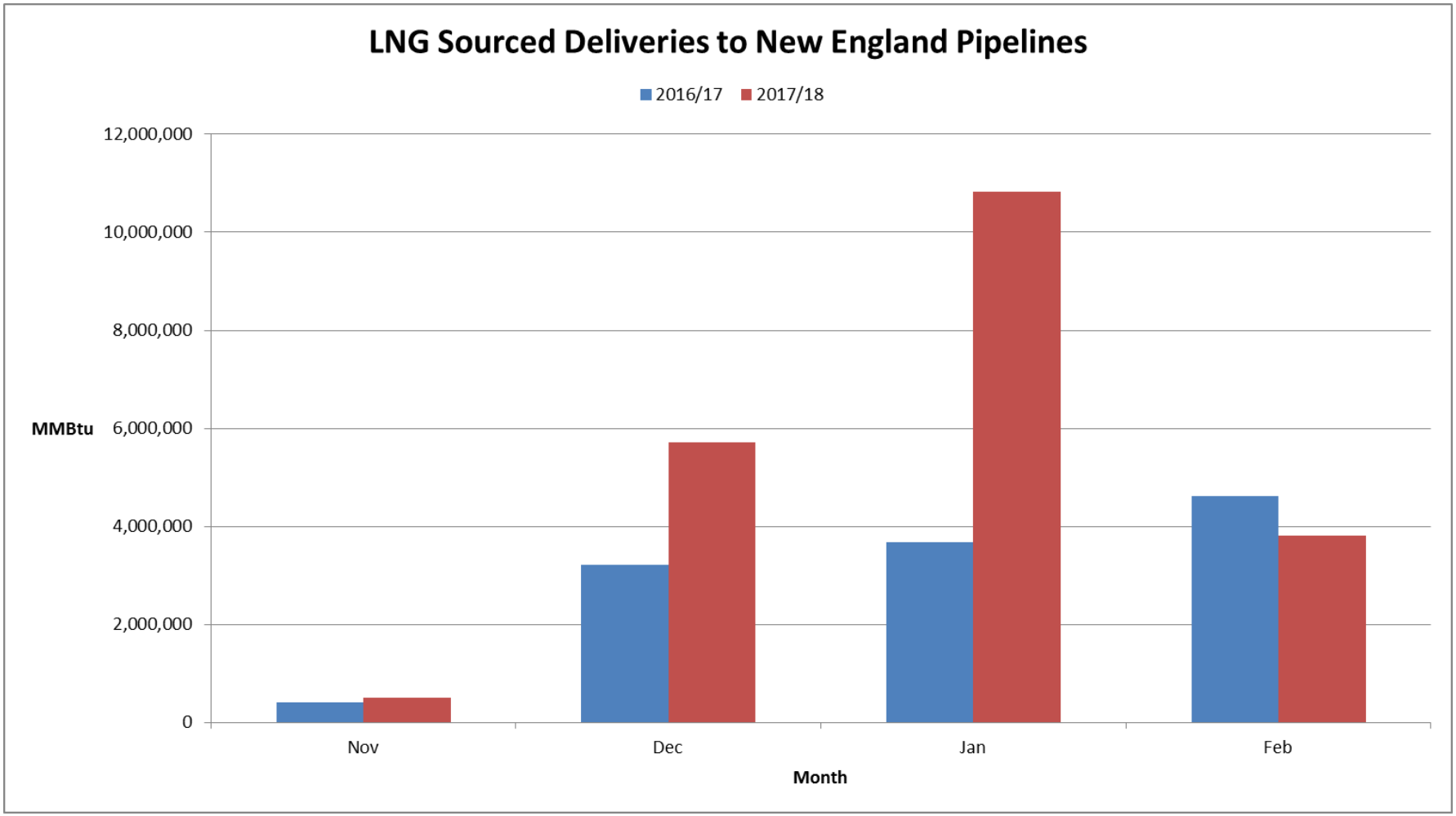
- Tennessee Gas Pipeline (TGP) Force Majeure:
  - Gas restriction on Dec 15 gas-day for a valve control failure near Nassau, NY
  - Station 241–Unit 1B near Syracuse, NY on Jan 8
  - Urgent repair at Agawam compressor station from Feb 7 to Feb 20
- TGP OFOs (All types*):
  - Monthly OFO = 2 (includes carry over OFO)
  - Action OFO = 1
  - Critical Day 1 OFO = 31
  - Critical Day 2 OFO = 0
  - Balancing OFO – 6
  - Hourly OFO = 0
  - Meter Specific OFO = 1

**(*) – Does not indicate the number of days that any OFO may have been in place.**

# Natural Gas Schedules – December 1, 2017 Through March 1, 2018



# Canaport and Distrigas Send-Out to New England Gas Pipelines



# Natural Gas System Operations Review - Conclusions

- Natural gas pipeline operators provided vital information to ISO-NE Forecasters with regards to the operational integrity and flexibility of their systems to serve non-core power plant demands

- Regional LNG import terminal owners/operators provided vital information to ISO-NE Forecasters with regards to daily send-out capabilities and LNG tanker resupply logistics

- The Northeast Gas Association (NGA) was responsive to ISO-NE's request to convene two ad-hoc meetings of its Gas Supply Task Force (GSTF) to inform ISO-NE Staff of overall system conditions in the New Jersey, New York, and New England regions.

# Questions

# APPENDIX 1 - COLD WEATHER OPERATIONS DECEMBER 24, 2017 – JANUARY 8, 2018

# Cold Weather Operations

*December 24, 2017 – January 8, 2018*

Vamsi Chadalavada

EXECUTIVE VICE PRESIDENT AND CHIEF OPERATING OFFICER

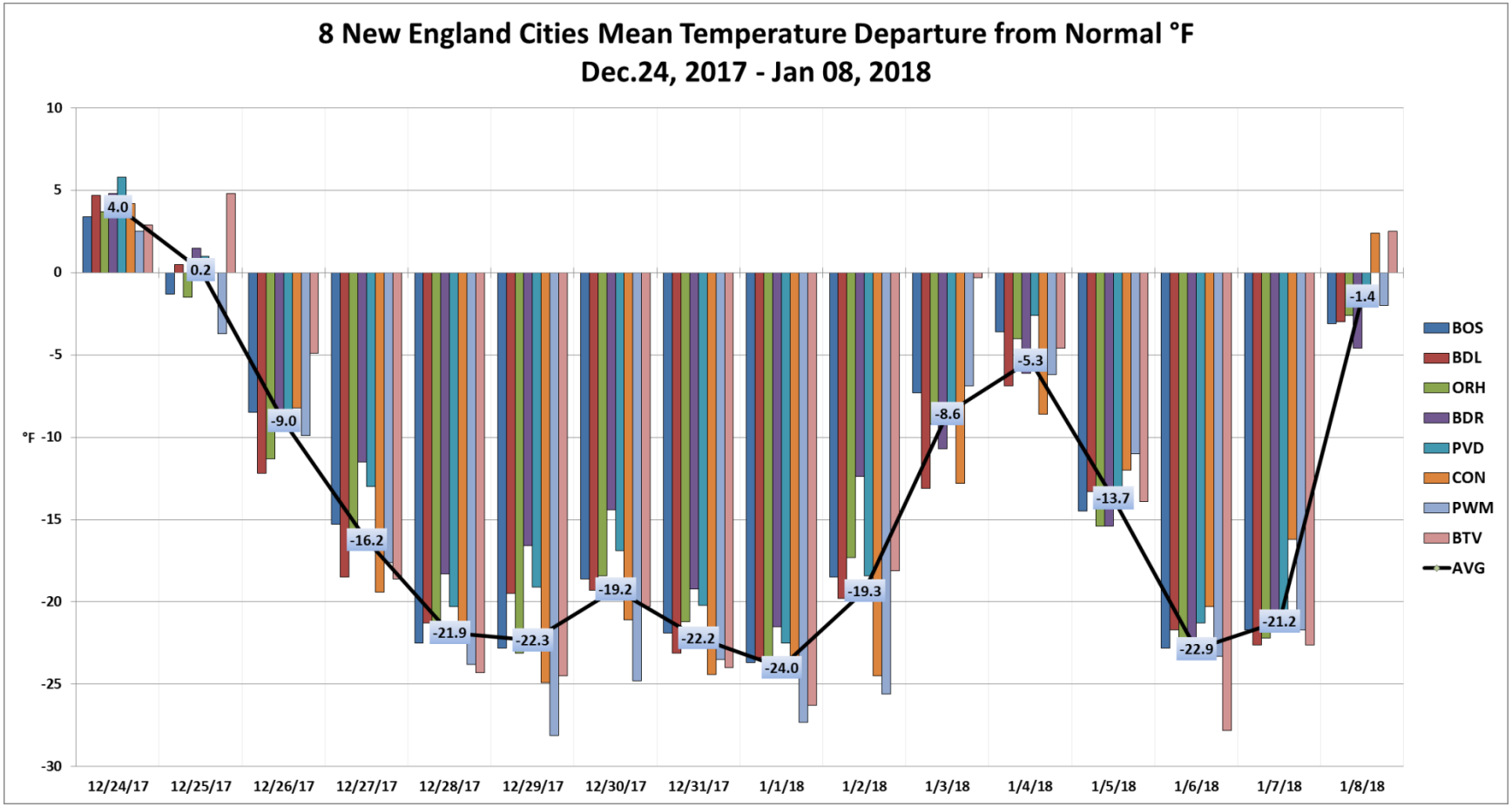
# Appendix 1 - Table of Contents

# COLD WEATHER OPERATIONS
# DECEMBER 24, 2017 – JANUARY 8, 2018

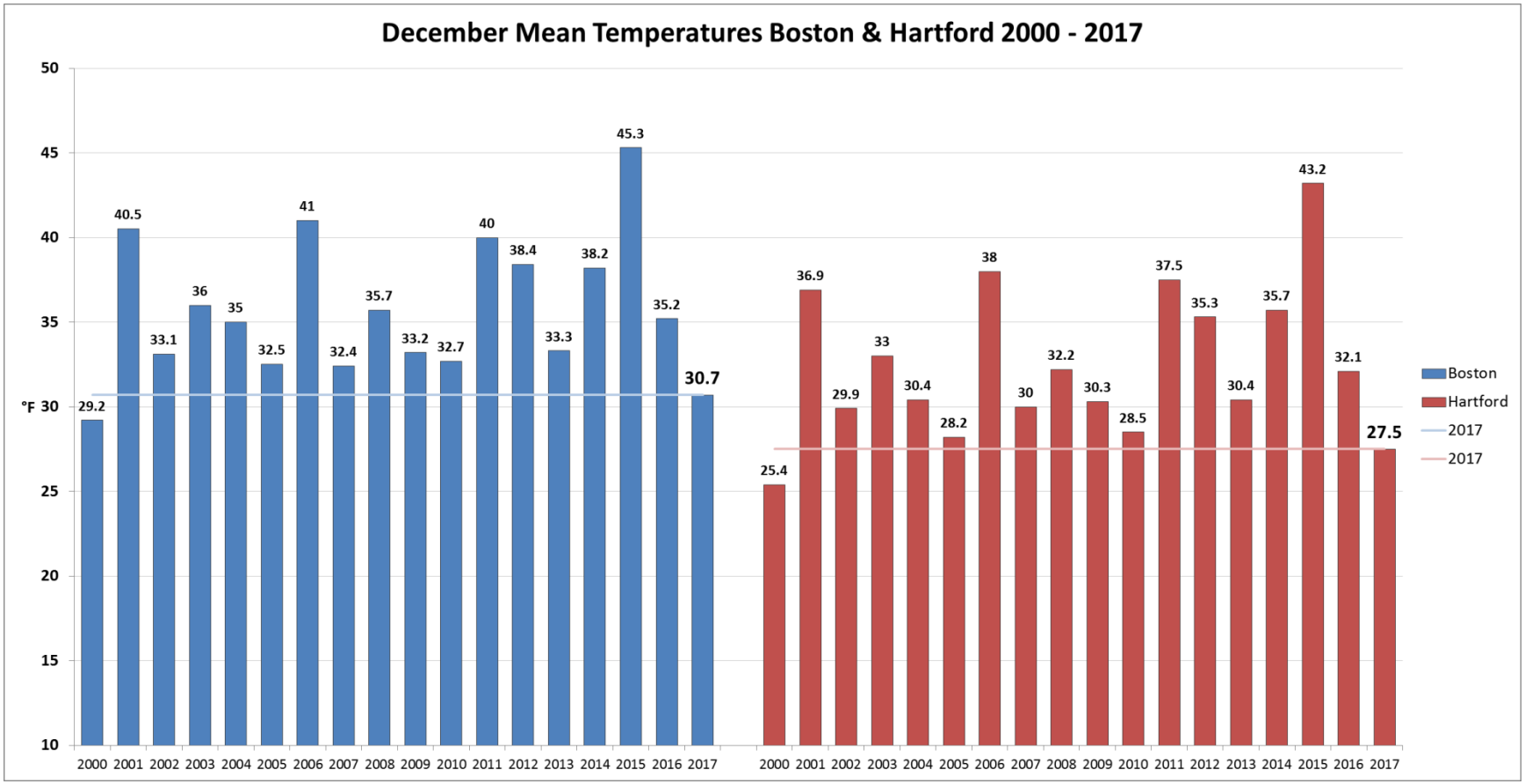
# Arctic Outbreak 2017-18

- New England was gripped by a cold weather stretch for an extended duration between December 25 and January 8
- All major cities in New England had average temperatures below normal for at least 13 consecutive days, of which 10 days averaged more than 10°F below normal
- In Boston, for example, an Arctic air-mass brought one of the most extreme cold waves in 100 years with above average winds causing extended periods of frigid wind chill temperatures.

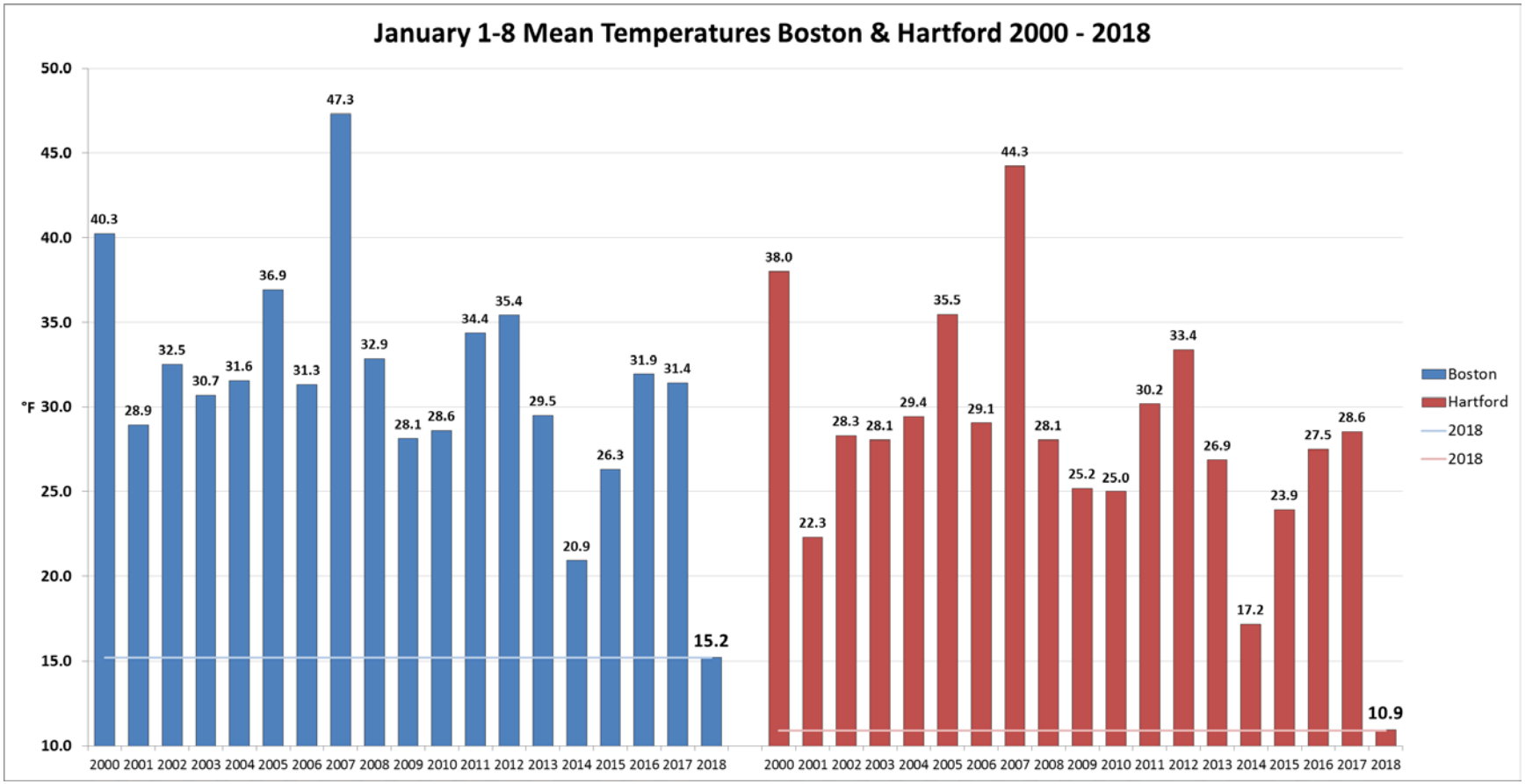
# Mean Temperatures Depart from Normal



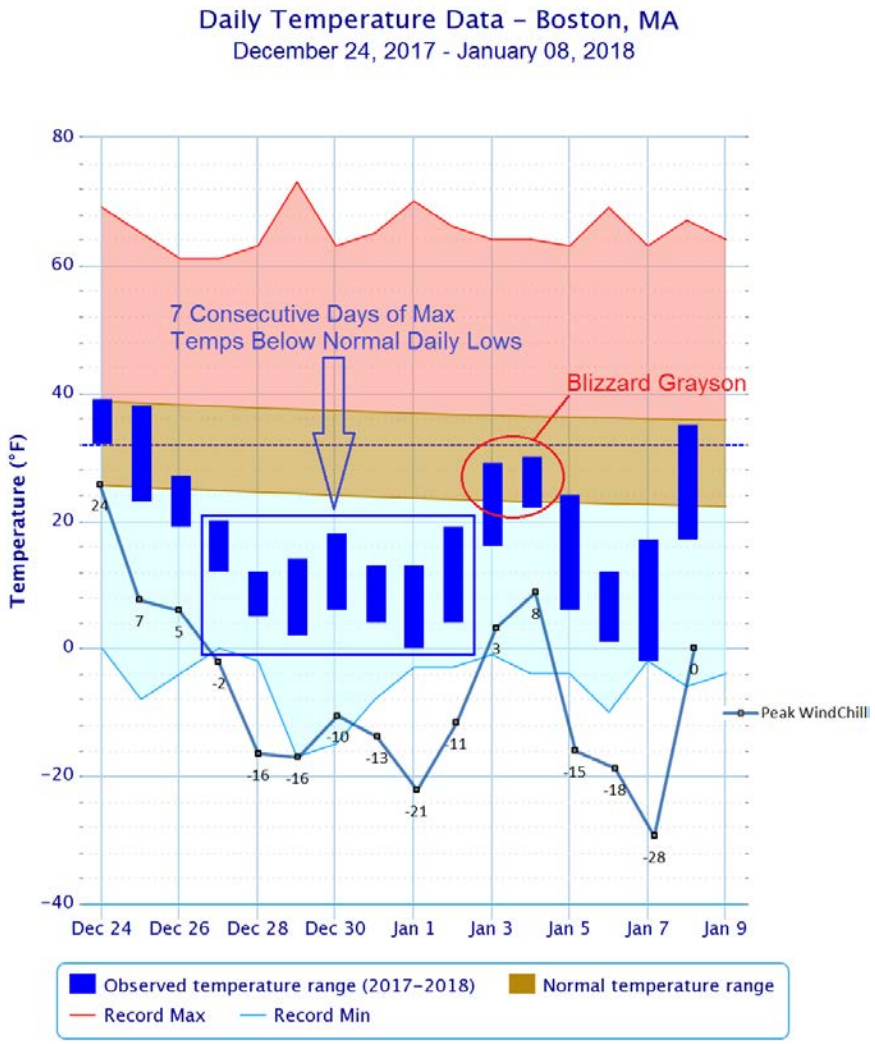
# Coldest December Mean Temps since at least 2000



# Coldest January 1-8 since at least 2000

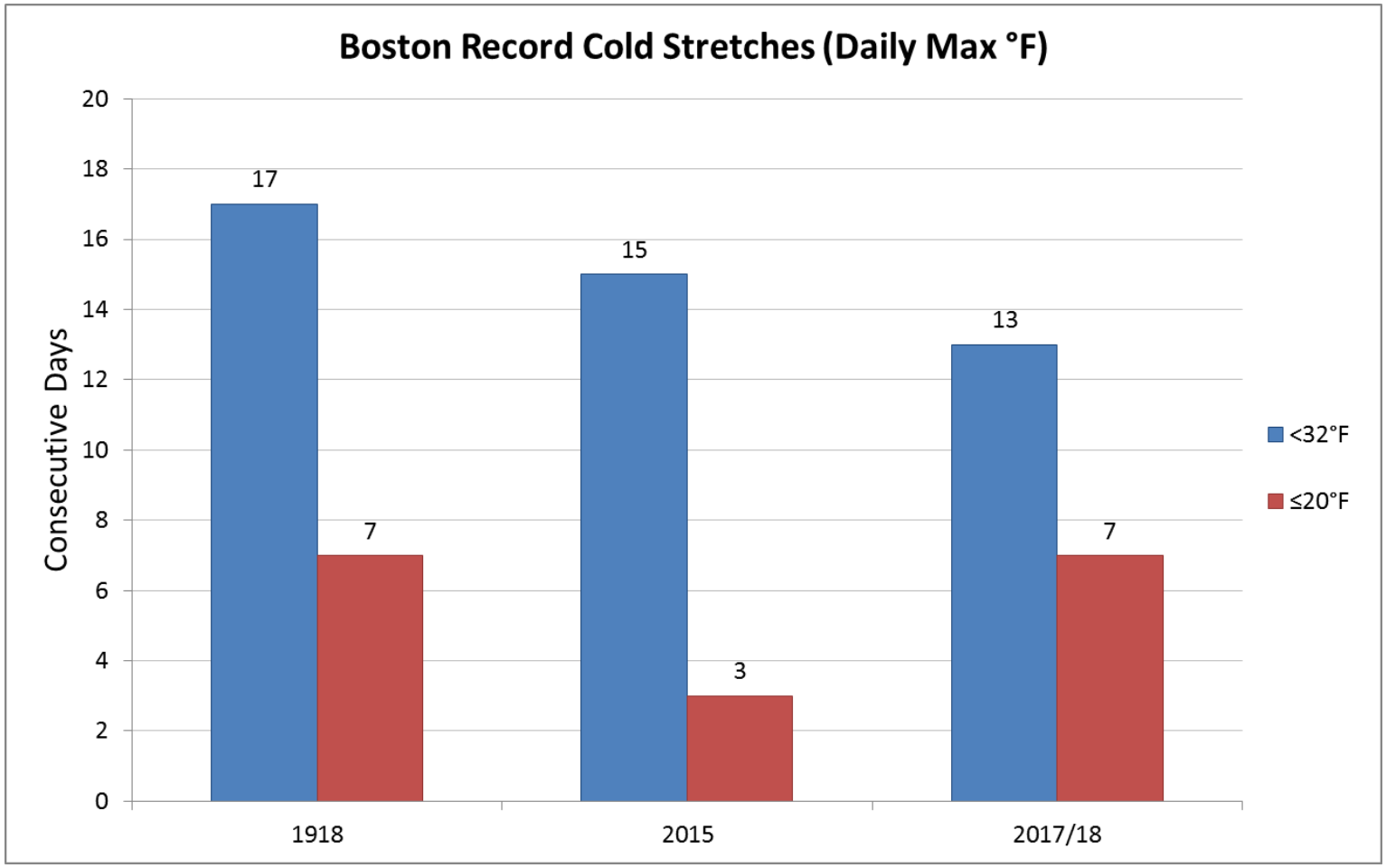


# Arctic Outbreak 2017-18 Boston Temperatures




- Record length of frigid temperatures occurred in Boston from 12/27/17-1/7/18, separated by a Blizzard on 1/4/18 which slightly moderated temperature
- 7 consecutive days with daily maximum temperature below the normal low for the date
- 15 consecutive days with minimum temperature below normal
- Winds were frequently stronger than average during the outbreak, which caused extended periods of frigid wind chill temperatures

# Boston: Coldest Stretch In 100 Years



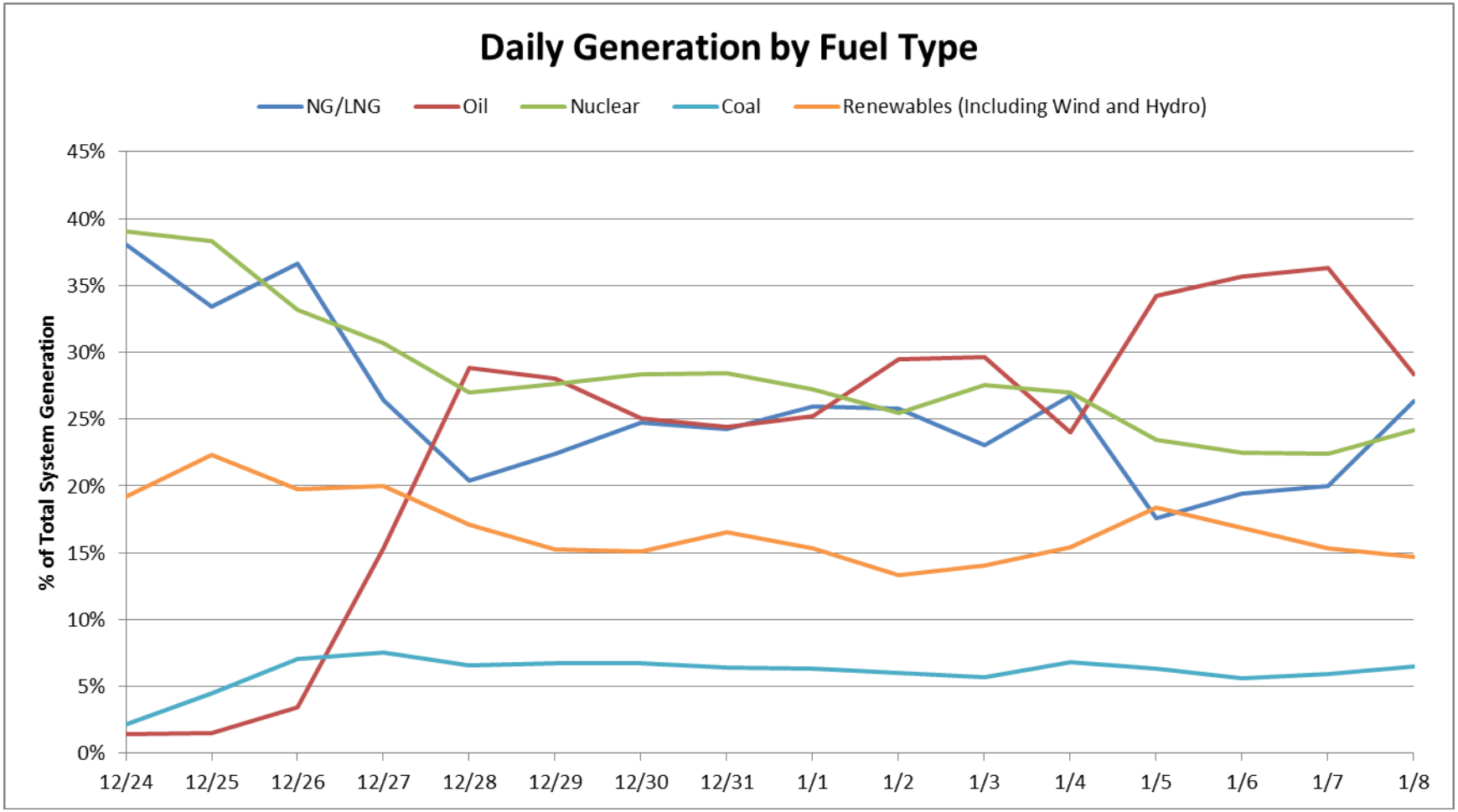

Historical Consecutive Cold Days in Boston
Coldest Stretch (Daily Max ≤20°F) In 100 Years Dating Back To 1918

# FUEL MIX

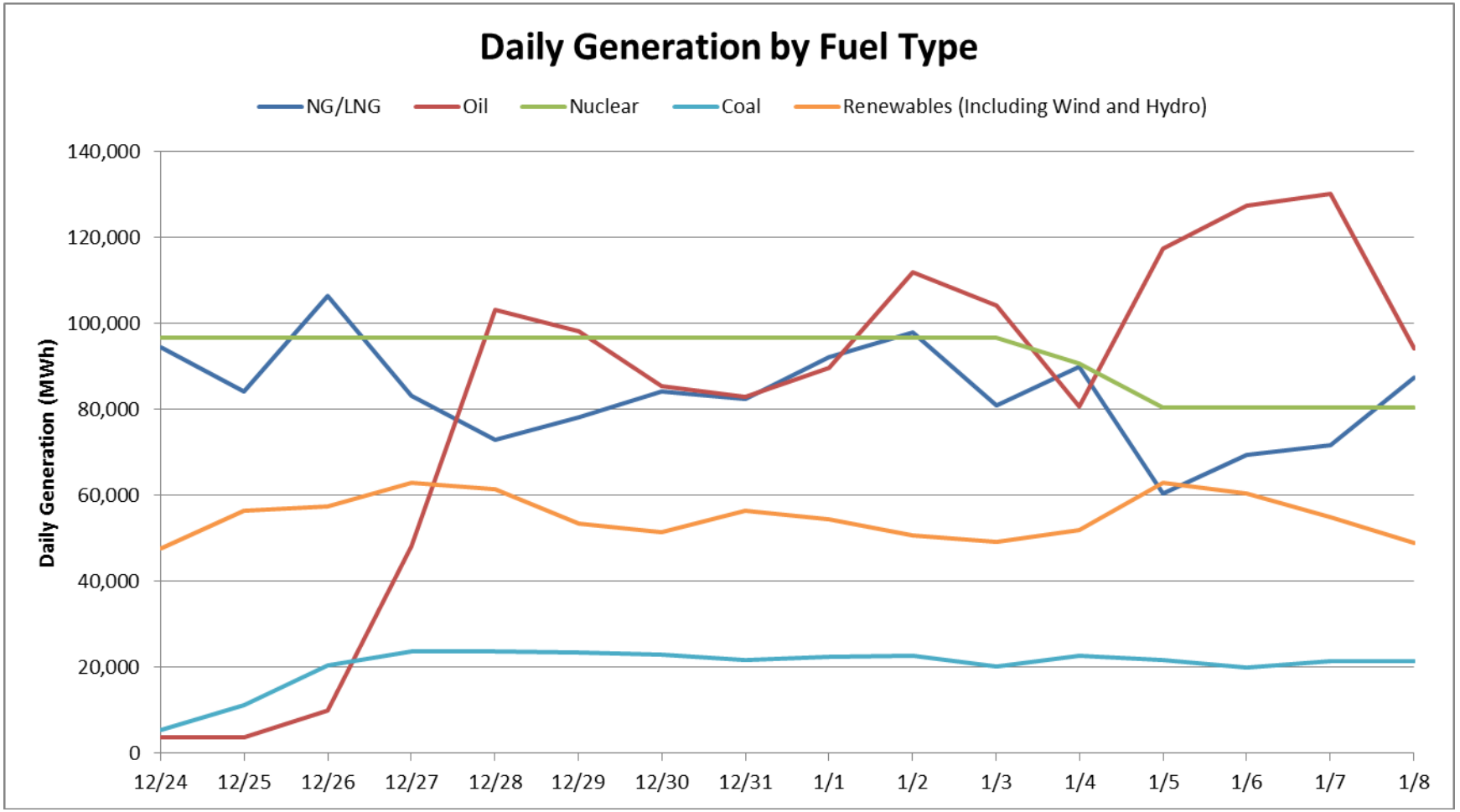
# New England Fuel Mixture

- Overall, there was significantly higher than normal use of oil
  - Coal use also increased over normal use
- Gas and Oil fuel price inversion led to oil being in economic merit and base loaded
- As gas became uneconomic, the entire season's oil supply rapidly depleted

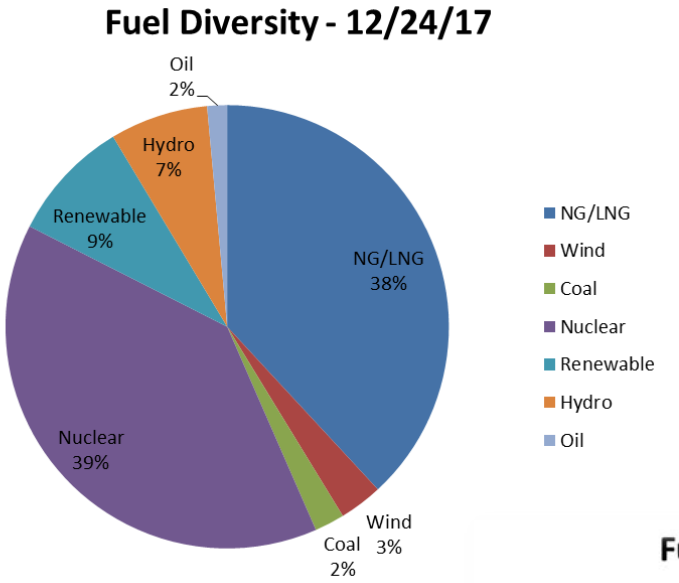
# Daily Generation by Fuel Type (Percent of total)

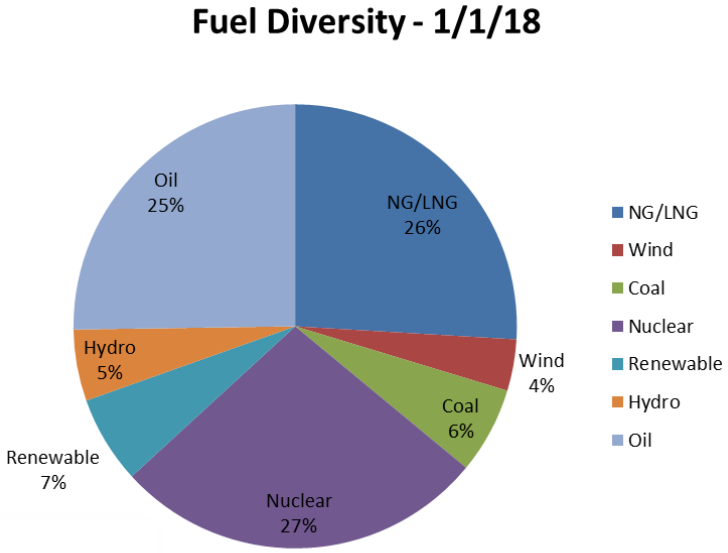


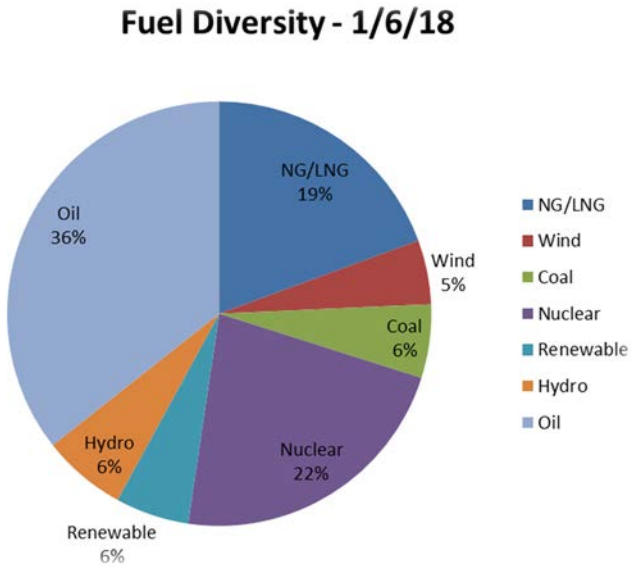
# Daily Generation by Fuel Type (MWh)



# Shifting Generation Mix Before and During the Cold Snap



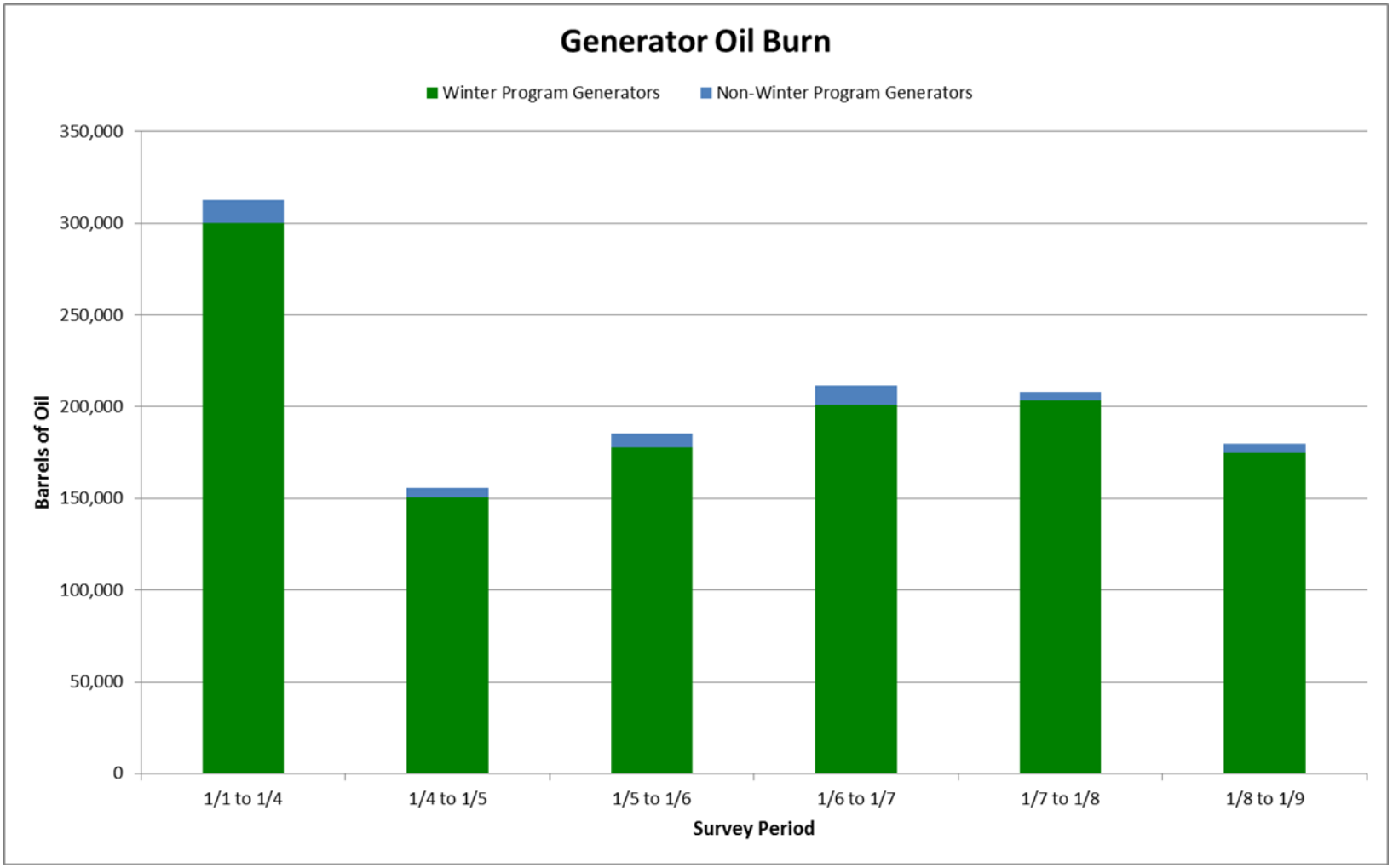



# COLD WEATHER OIL USAGE

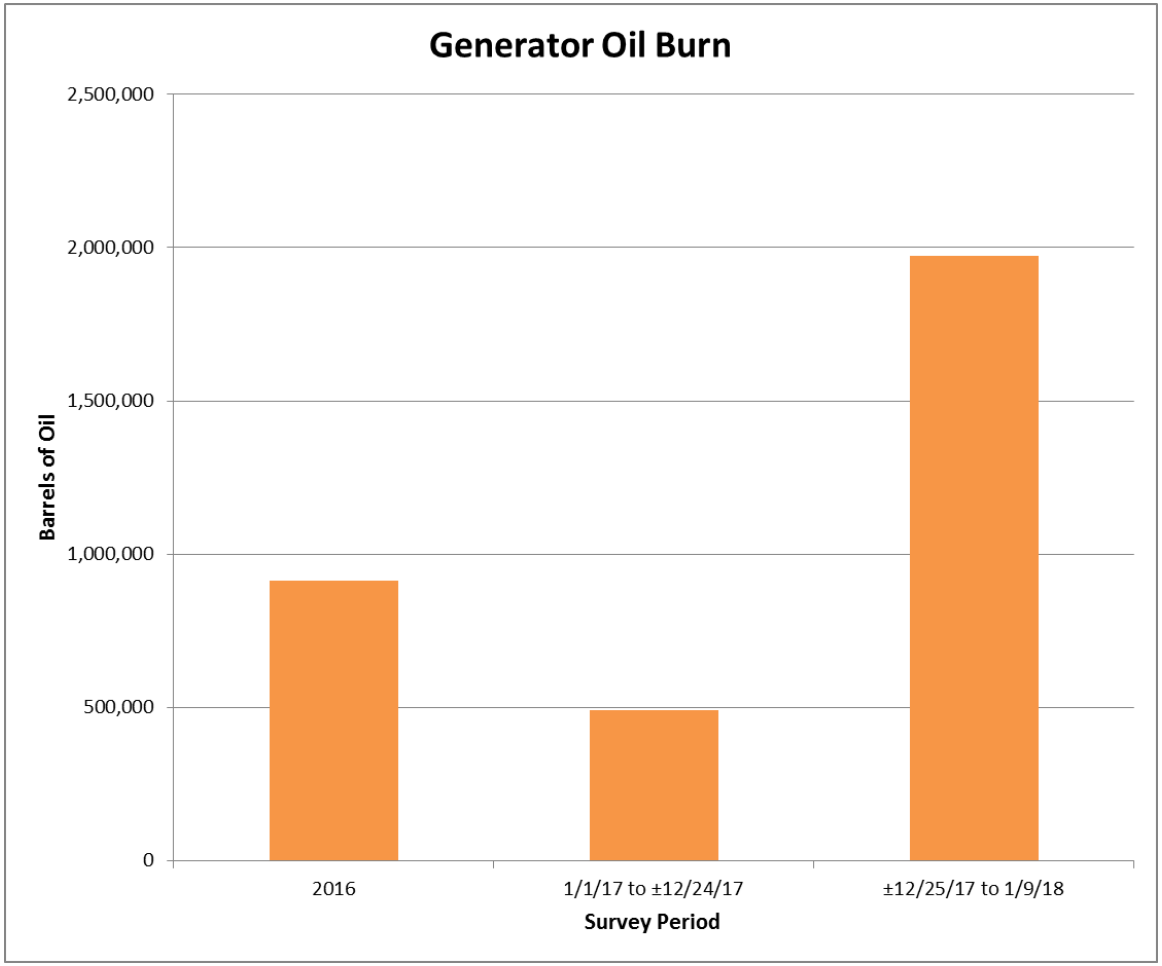
# Winter Reliability Program vs Actual Oil Burn

- The Winter Reliability Program data is reported on a monthly basis only and December 2017 data is in the regular NPC report
- Please note that the winter program oil inventory will differ from the actual oil burned during the cold weather for the following reasons
  - Not all units that burn oil participate in the Winter Reliability Program
  - Winter program oil participation is capped at stations, so a station that has a winter program participation of 100K barrels, but has burned 150K barrels is still counted at the original number
  - Actual oil burn numbers reflect the total oil burn and include ongoing replenishments at both dual fuel and oil only stations

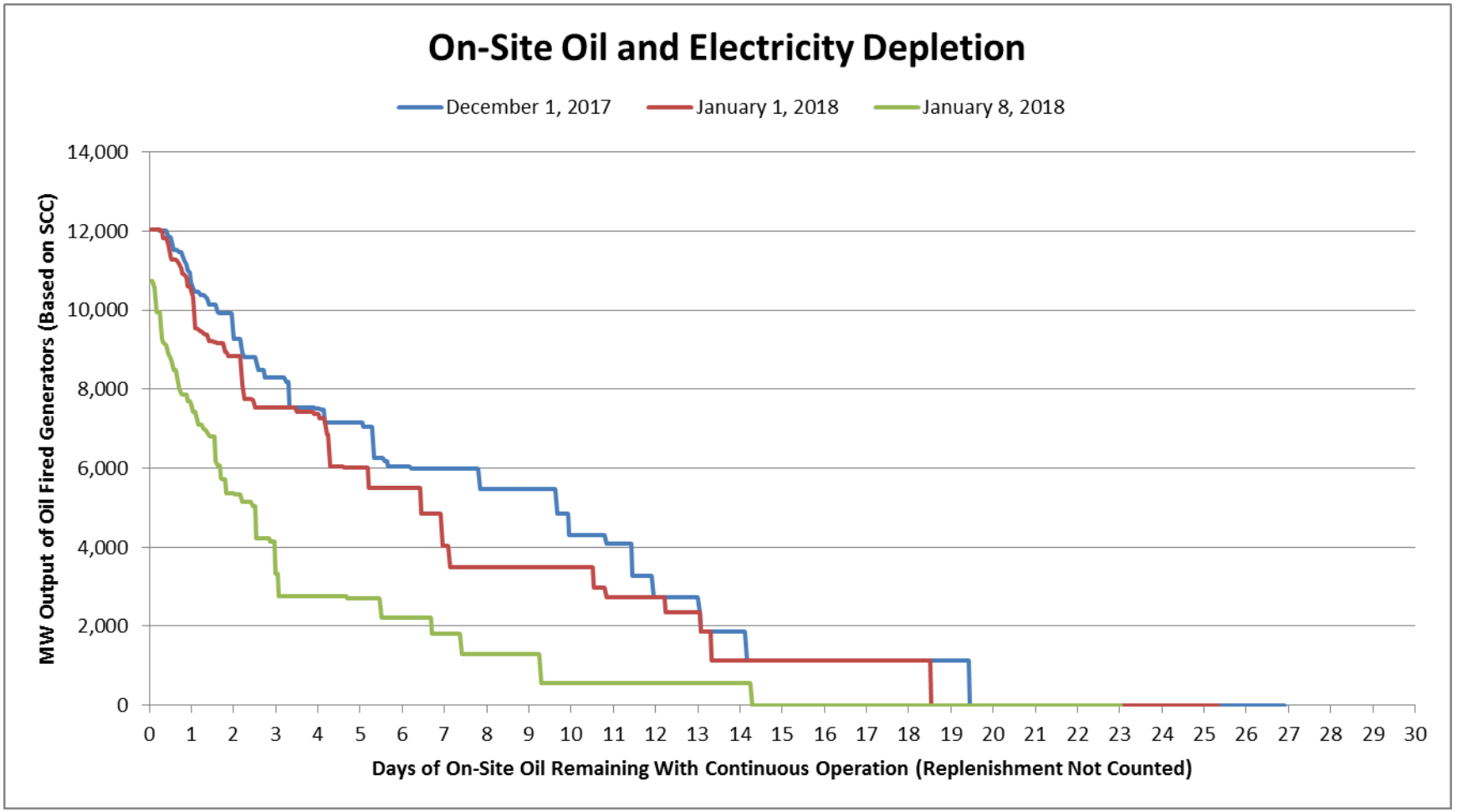
# Generator Oil Burn – January 2018



# Generator Oil Burn – Yearly Comparison

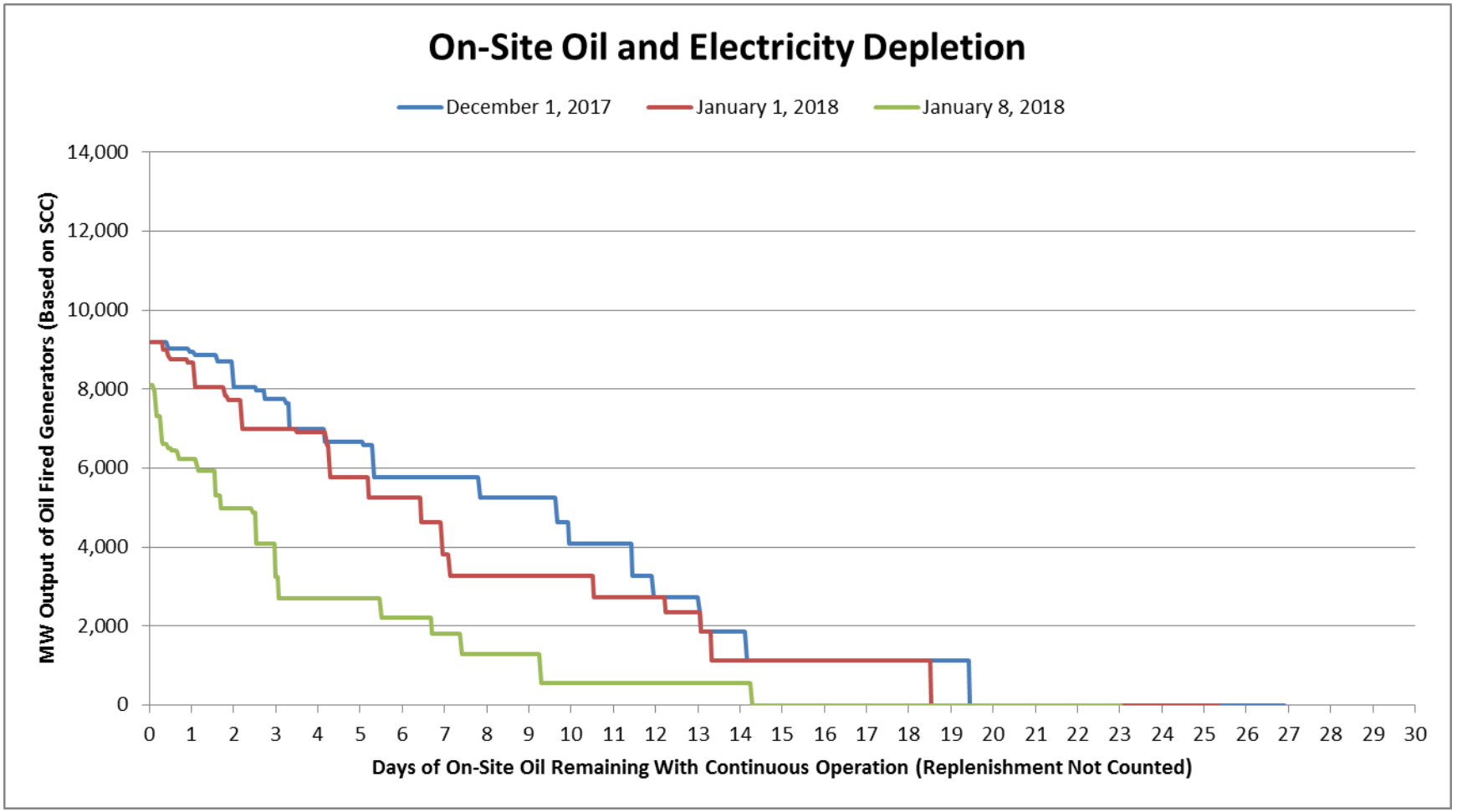


# On-Site Oil and Electricity Depletion



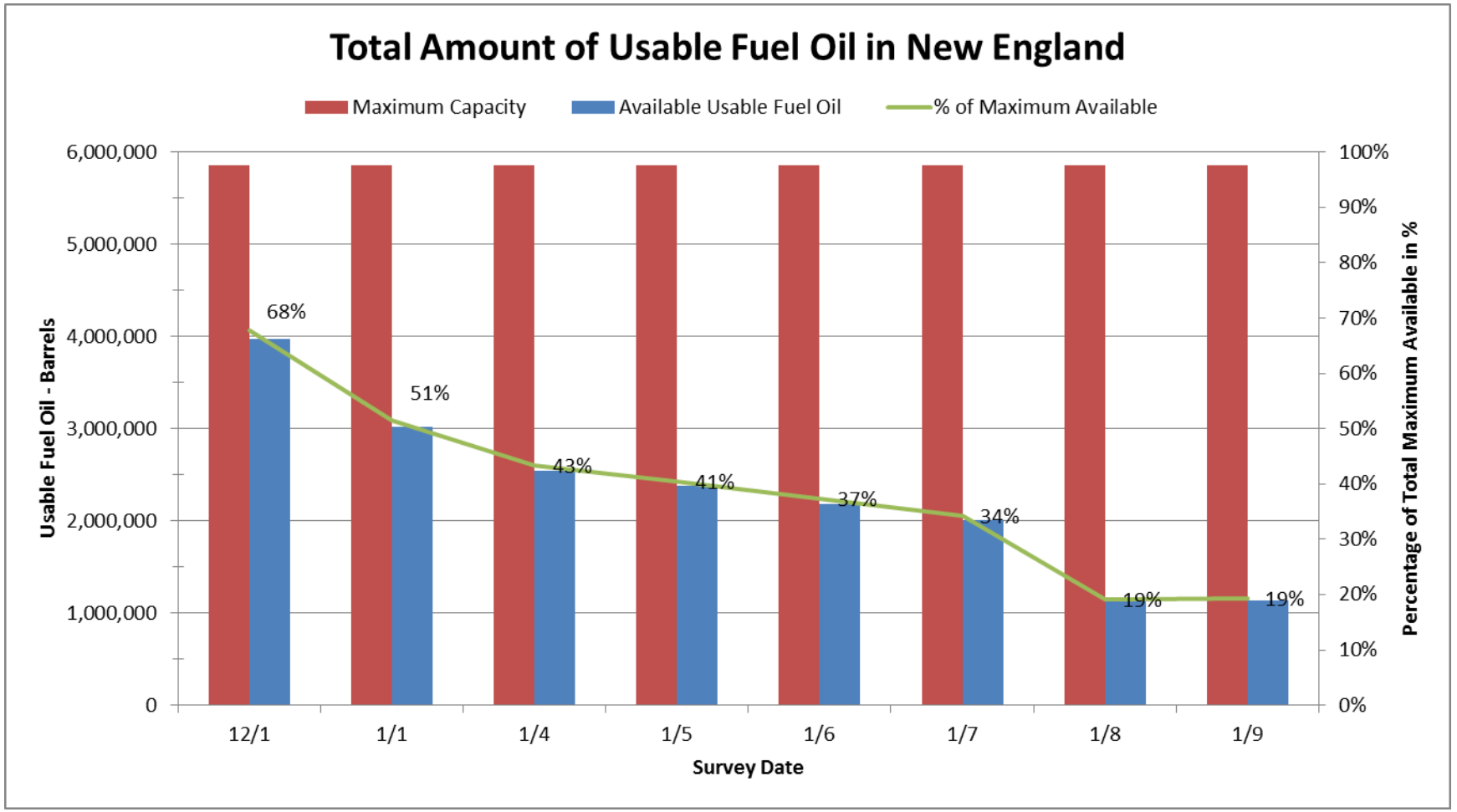

This chart is the ISO's best approximation of usable oil discounting for unit outages, reductions, or emissions

# On-Site Oil and Electricity Depletion – Not Including Fast Start Units



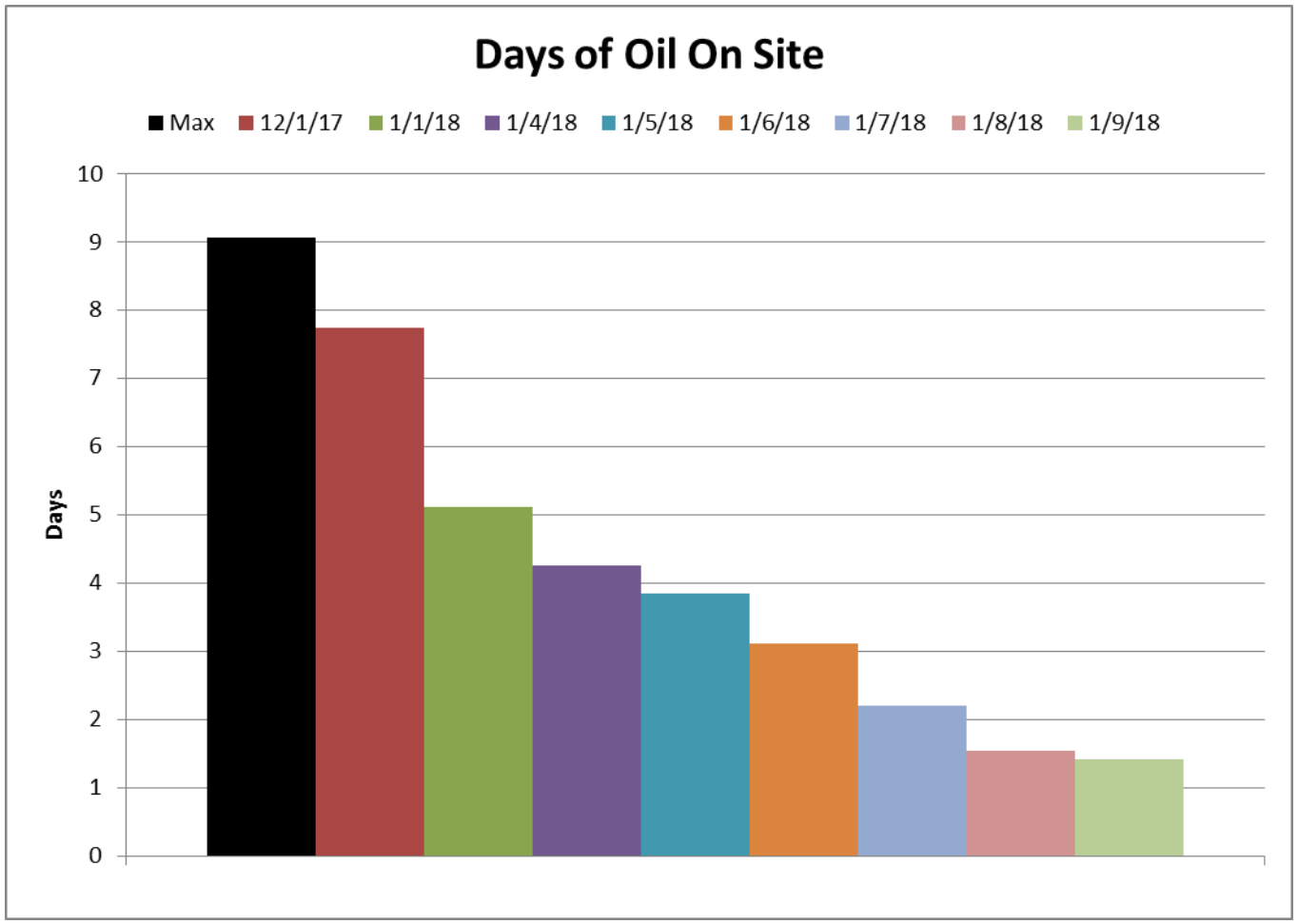

This chart is the ISO's best approximation of usable oil discounting for unit outages, reductions, or emissions

# Total Amount of Usable Fuel Oil in New England




This chart is the ISO's best approximation of usable oil discounting for unit outages, reductions, or emissions

# Oil Depletion at a Specific Station – An Example



# Environmental and Emissions Issues

- With extended days of burning oil, several resources either had concerns about hitting federal and/or state emissions limitations or were impacted by emissions limitations
  - This primarily includes resources in MA, CT and RI
- The ISO is concerned about the availability of the oil burning fleet as it relates to emissions limitations on cold days during the rest of the winter

# COLD WEATHER FUEL LOGISTICS

# Liquid Fuels Logistics – Oil Terminals (As of Jan 9)

- Most large oil terminals in northern New England have low inventories
- Southern New England terminals are in better conditions
- Sea/river ice has been affecting terminals in NH, ME and Hudson River
- U.S. Coast Guard (USCG) Cutters that are homeported in Maine have been braking ice on NH and ME rivers since mid-December
- The USCG is allowing the Weymouth Fore River Bridge to open to vessel traffic during weekday rush-hours in order to facilitate vital fuel deliveries

# Liquid Fuels Logistics – Trucking (As of Jan 9)

- Trucking transport of fuel oil remains the main constraint
  - Trucking of liquid fuels resumed on Friday, January 5th after interruption due to Winter Storm Grayson on January 4th
  - Carriers are at their physical limits
  - Drivers need time off to rest, even with State Waivers in effect
  - The break in the weather this week will provide much needed relief

# Liquid Fuels Logistics – Generators (As of Jan 9)

- Power generators who had previously scheduled and paid for fuel oil deliveries are receiving their fuel first, but those who have not are put on a waiting list
- Fuel oil supplies are destined for arrival in northern New England by the end of this week; however, it is expected that power plant demand will quickly consume those re-supplies
- A few smaller power stations have cancelled fuel orders due to lack of trucking

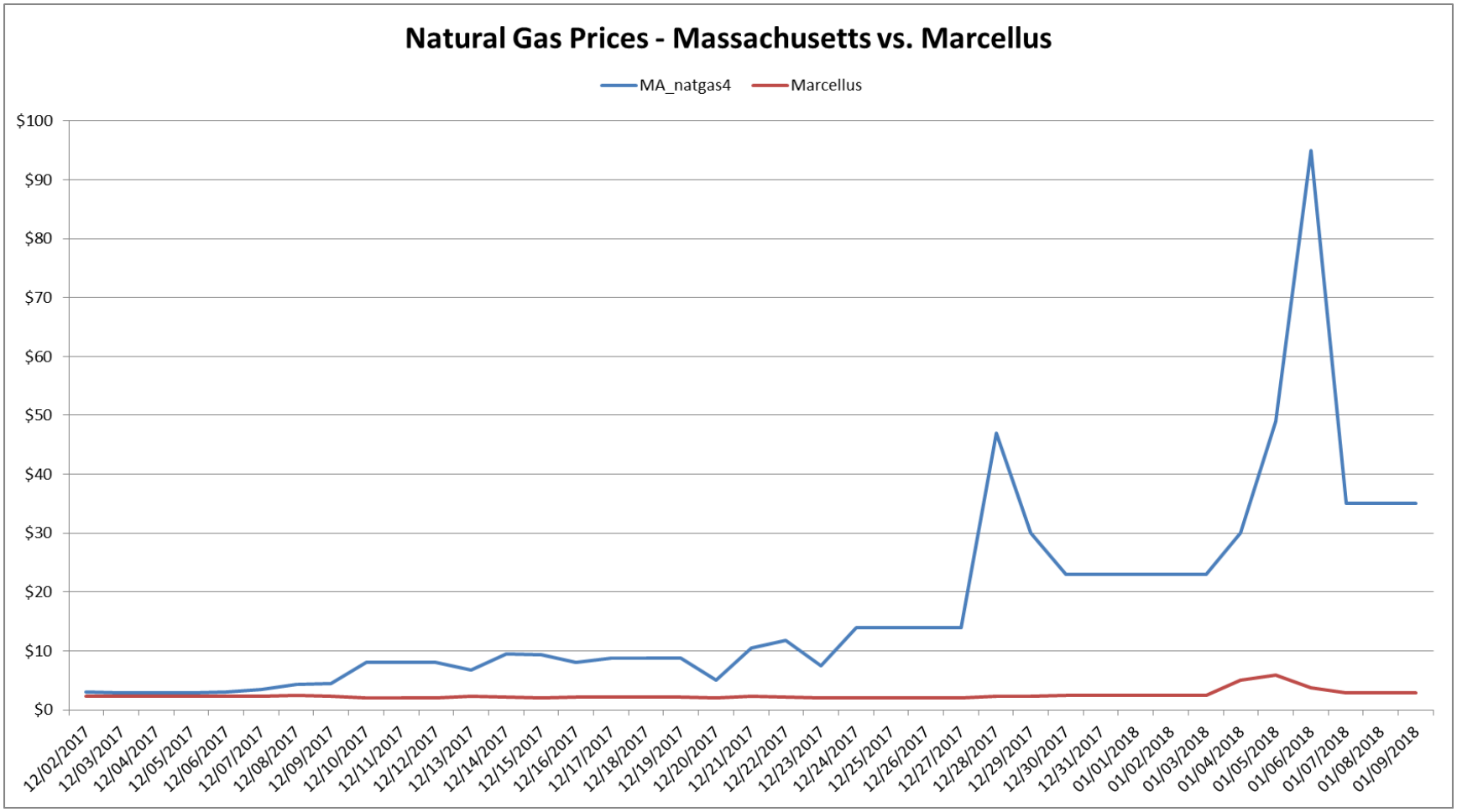
# MA Governor Provides Relief for Fuel Deliveries

- On Friday afternoon, January 5, Governor Baker signed a revised declaration of emergency that provides relief for fuel deliveries to electric generating facilities until January 19
  - The original declaration, dated December 28, covered fuel deliveries for heating but not electric generating facilities

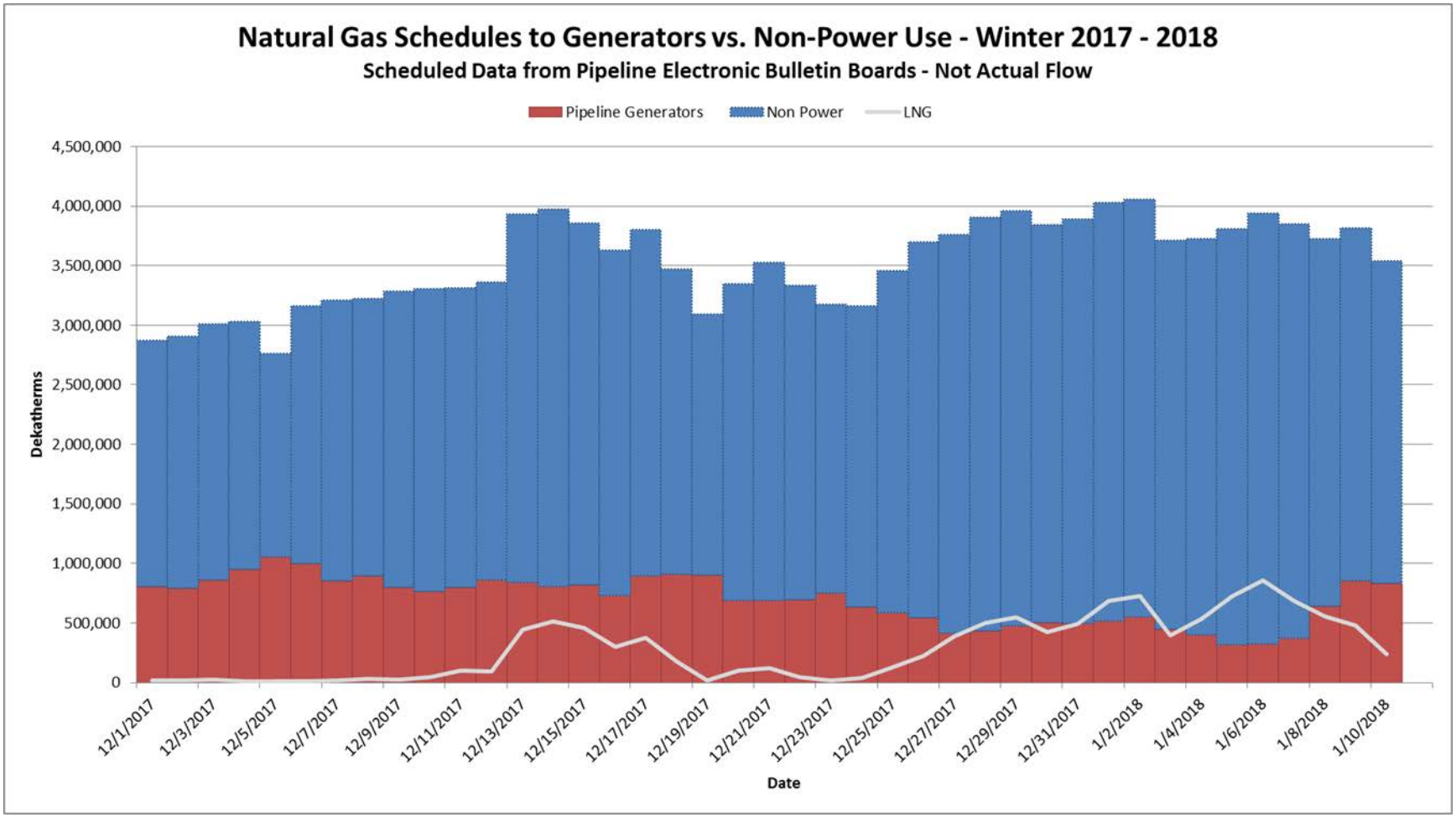
# Fuel Surveys

- To increase situational awareness, the ISO initiated twice weekly fuel surveys of oil fired generation beginning on 1/4/18
- Based on system conditions, the periodicity of the fuel surveys was changed to daily beginning on 1/5/18
- Daily fuel surveys are scheduled to continue on a daily basis (Monday-Friday) until further notice
- The Daily Fuel Survey asked participants of oil fired generators questions regarding:
  - Usable Oil Inventory
  - Oil Burn Since Last Survey
  - Plans for Refueling
  - Replenishment Strategies
  - Procurement and Transportation Issues
  - Environmental/Emissions Issues

# Natural Gas Prices



# Natural Gas Schedules



# Natural Gas Issues

- There were 17 reported gas issues for the period between 12/24/17 and 1/8/18
  - Issues were either procurement related or pipeline related
- An Operational Flow Order (OFO) was issued on 12/22/17 with an effective date of 12/25/17 for the Tennessee Gas Pipeline
- An OFO was issued on 12/23/17 for the Algonquin Gas Transmission Pipeline
- An OFO was issued on 12/26/17 for the Iroquois Pipeline
- All three OFOs are still in effect as of 1/10/18

# LNG Delivery & Canadian Gas Supply

- LNG send-outs at the Distrigas and Canaport facilities are critical to winter operations
  - Both Distrigas and Canaport received LNG cargos during the cold weather event (or) shortly thereafter
- Sable Island and Deep Panuke are operating at low levels, producing approximately 130,000 MMBTU/day

# SYSTEM OPERATIONS

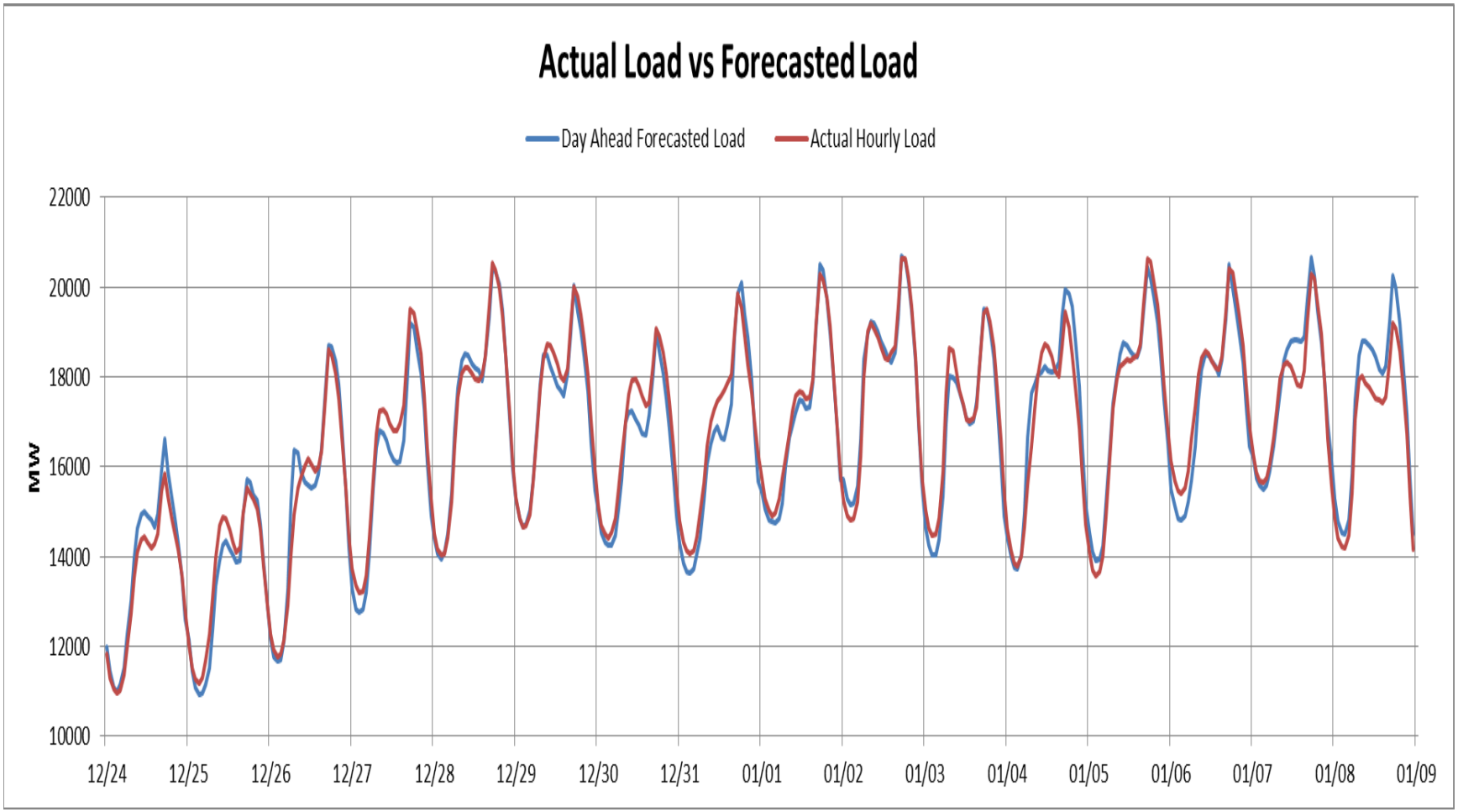
# System Operations: Communications

- Emergency conference calls were held with NPCC Reliability Coordinators to review the following:
  - Expected weather and peak loads for the current and next day
  - Expected MW surplus above the operating reserve requirements
  - Confirmed expected interchange schedules
  - Conditions of natural gas supply and fuel oil inventory
  - Dates of calls: 12/24, 12/28, 12/29, 1/1, 1/2, 1/3, 1/5, 1/7
- Emergency conference calls with the six Local Control Centers in New England to discuss the following:
  - Expected peak load conditions in New England and known issues with generation units
  - Known concerns with the natural gas interstate pipes
  - Known concerns with fuel oil inventory and transportation limitations
  - Dates of calls: 12/24, 12/29, 1/3, 1/5, 1/7, 1/8

# System Operations: Communications, cont.

- ISO New England requested conference calls with the Northeast Gas Association/Gas Supply Task Force (NGA/GSTF)members to discuss the following:
  - The overall condition of each interstate pipeline supplying New England
  - The overall condition of LNG supplying New England
  - Dates of calls:  12/27, 1/5
- ISO New England was in daily communications with interstate pipeline operators

# System Operations: Actual vs. Forecasted Load



# System Operations: M/LCC 2

- M/LCC 2, Abnormal Conditions Alert, was declared on 1/3/18 @ 16:00 for all of New England due to the extreme weather followed by forecasted extreme cold as well as fuel supply concerns
- M/LCC 2 was cancelled on 1/9/18 @ 12:00

# System Operations: Maintenance

- Impact on Transmission and Generation Maintenance:
  - 2 significant generation resources (approx. 800MW of capability) had planned outages/reductions rescheduled
  - 2 transmission line outages were rescheduled for a later date

# System Operations: Transmission

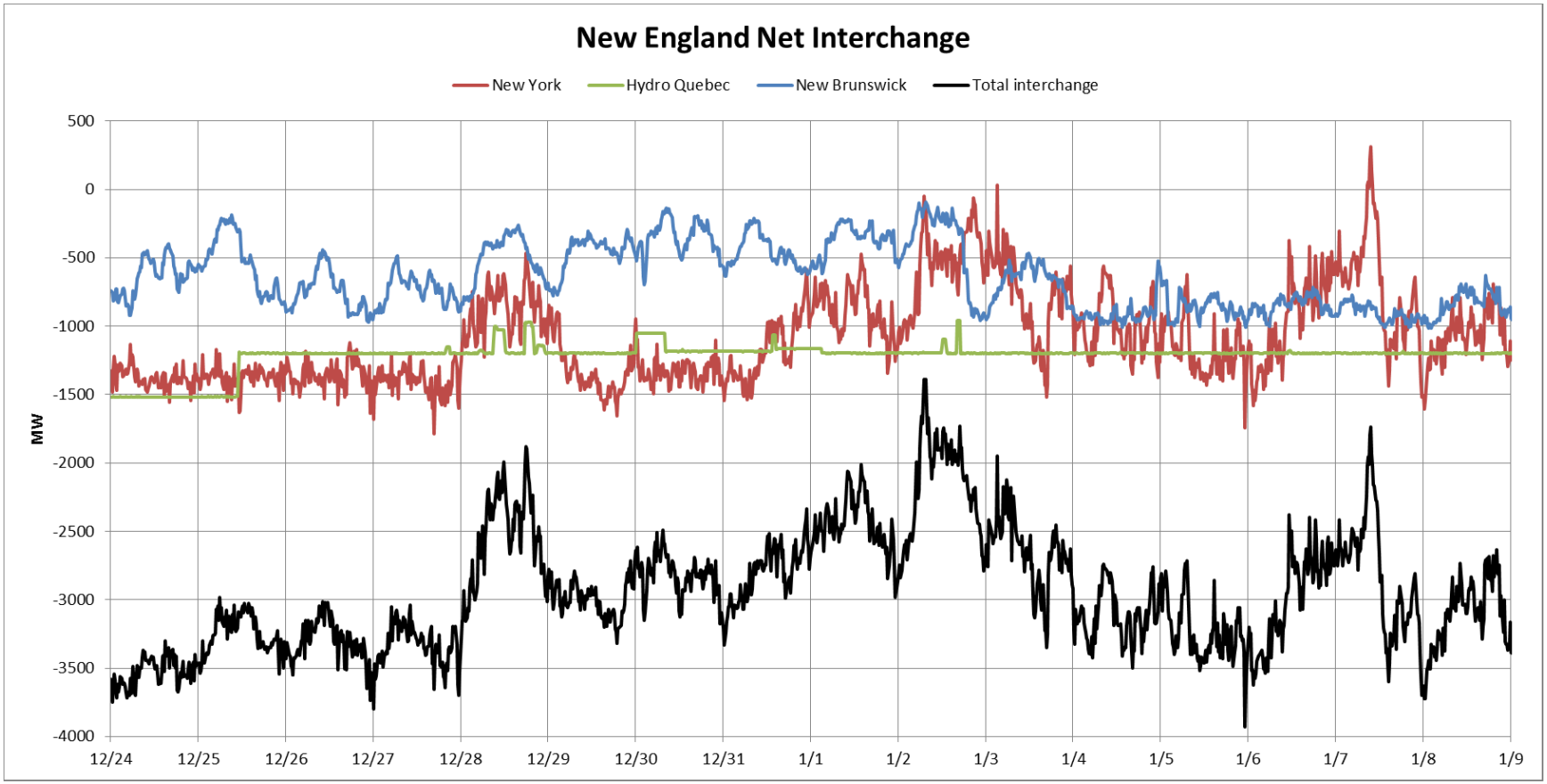
Significant Transmission Events:

| Facility | Zone | Start Date | Return Date | Reason/Impact |
|---|---|---|---|---|
| HQ Phase II Pole 2 | | 12/25/17 | 1/14/18 (expected) | TTC reduction by 1000MW/Reduced to ½ capacity |
| 345 kV line | SEMA/RI | 12/25/17 | 12/29/17 | Replace failed structure |
| 345 kV line | SEMA/RI | 12/29/17 | 12/30/17 | Structure fire |
| 345 kV line | SEMA/RI | 1/4/18 | 1/7/18 | Storm Grayson/Loss of Pilgrim plus 300MW reduction on nearby generation facility |
| 345 kV line | SEMA/RI | 1/5/18 | 1/7/18 | Equipment trip |

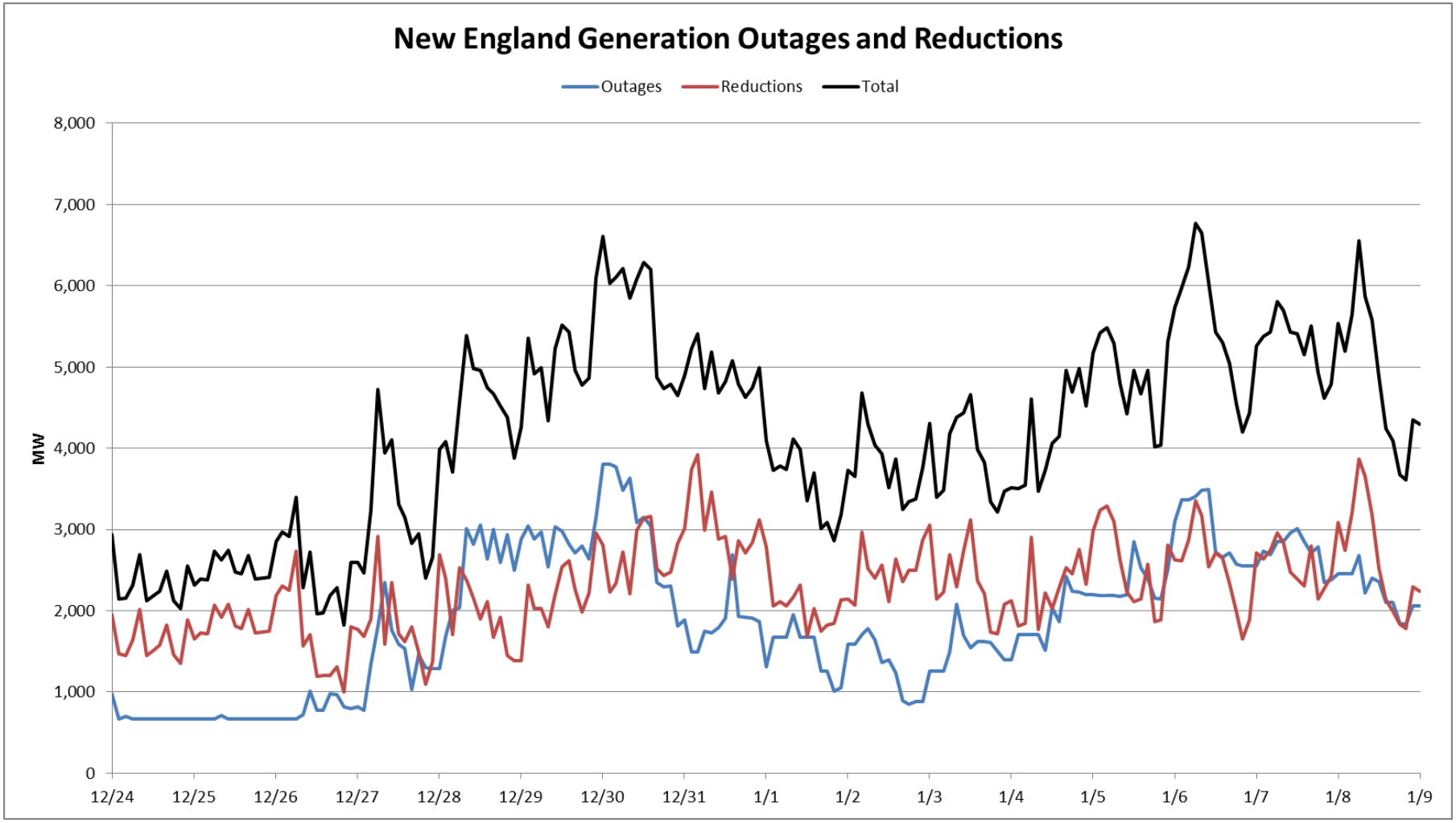
# System Operations: Interchange

- Increase in Scheduling Limit with NYISO
  - At 16:00 on 1/3/18, the scheduling limit on the NY A.C. ties was increased from 1,400 to 1,600MW
  - The increased limit was made possible by the cold conditions which helped to improve thermal transfer capability

# Actual Interchange – By Scheduling Region (Negative values indicate Imports)



# Generation Outages and Reductions



# Generation Fleet Performance

- The aggregate performance of the available generation fleet over the duration of the cold spell was good
- Communication with generator Designated Entities was very good and was key to maintaining situational awareness
- The cold weather has subsided, however oil inventories are still depleted in New England
- In preparation for the next round of cold weather, it is essential that oil inventories are replenished

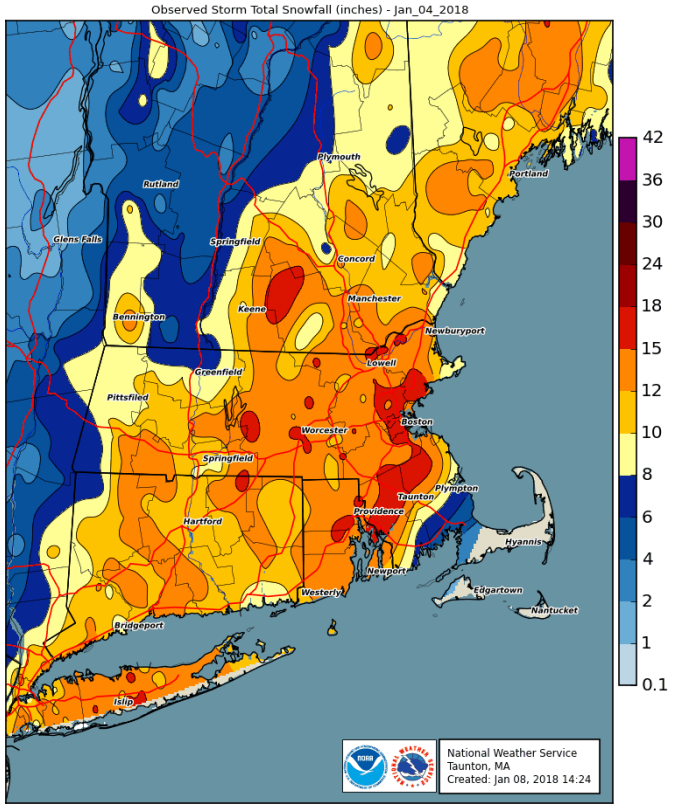
# System Operations: Commitment Challenges

- Significant challenges associated with the continuous monitoring of the fuel inventories of oil-fired generation to ensure commitments did not jeopardize the long term availability of resources
- Several oil-fired generators were postured to conserve oil and ensure system reliability
- On numerous occasions, high load projections in Hydro Quebec created uncertainty in the availability of deliveries over the Phase II and Highgate interfaces

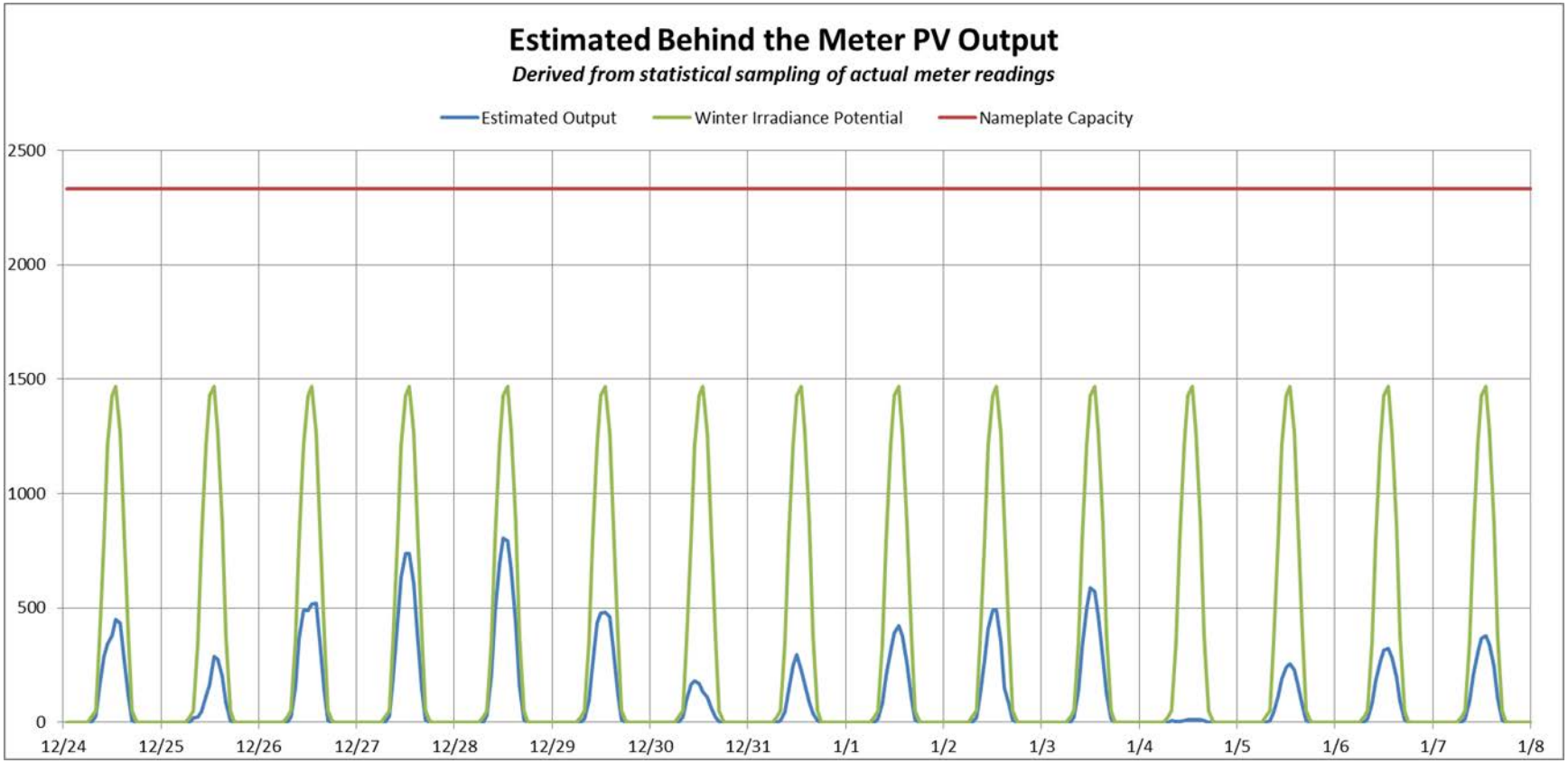
# PV AND WIND OUTPUT

# Impact of Snowfall on Energy from PV

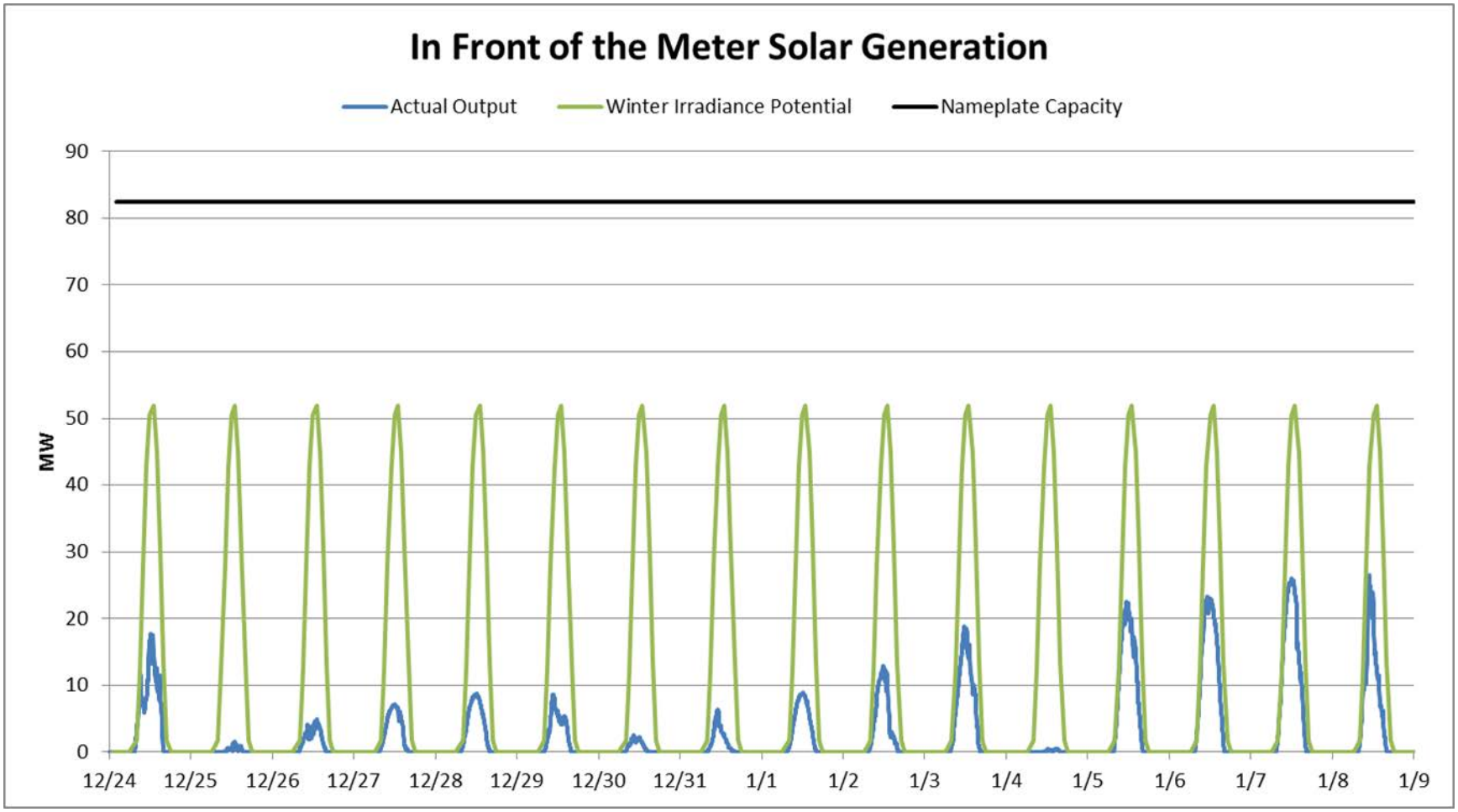
- Snowfall followed by cold weather led to uncertainty of load forecast accuracy
- It is necessary to continue to improve the understanding of snowfall on PV resources in New



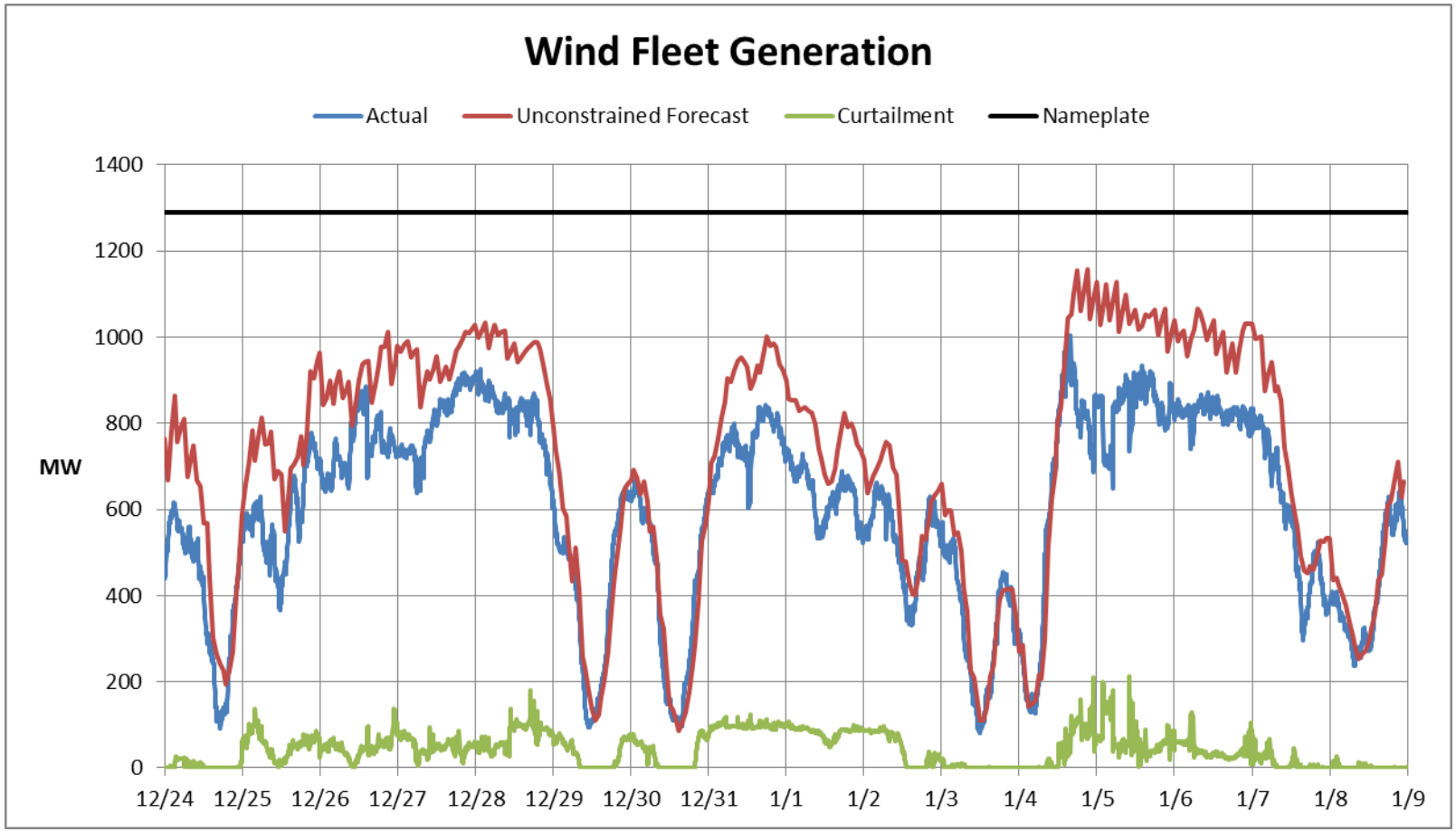
# PV Generation – Behind the Meter



# PV Generation – In Front of the Meter



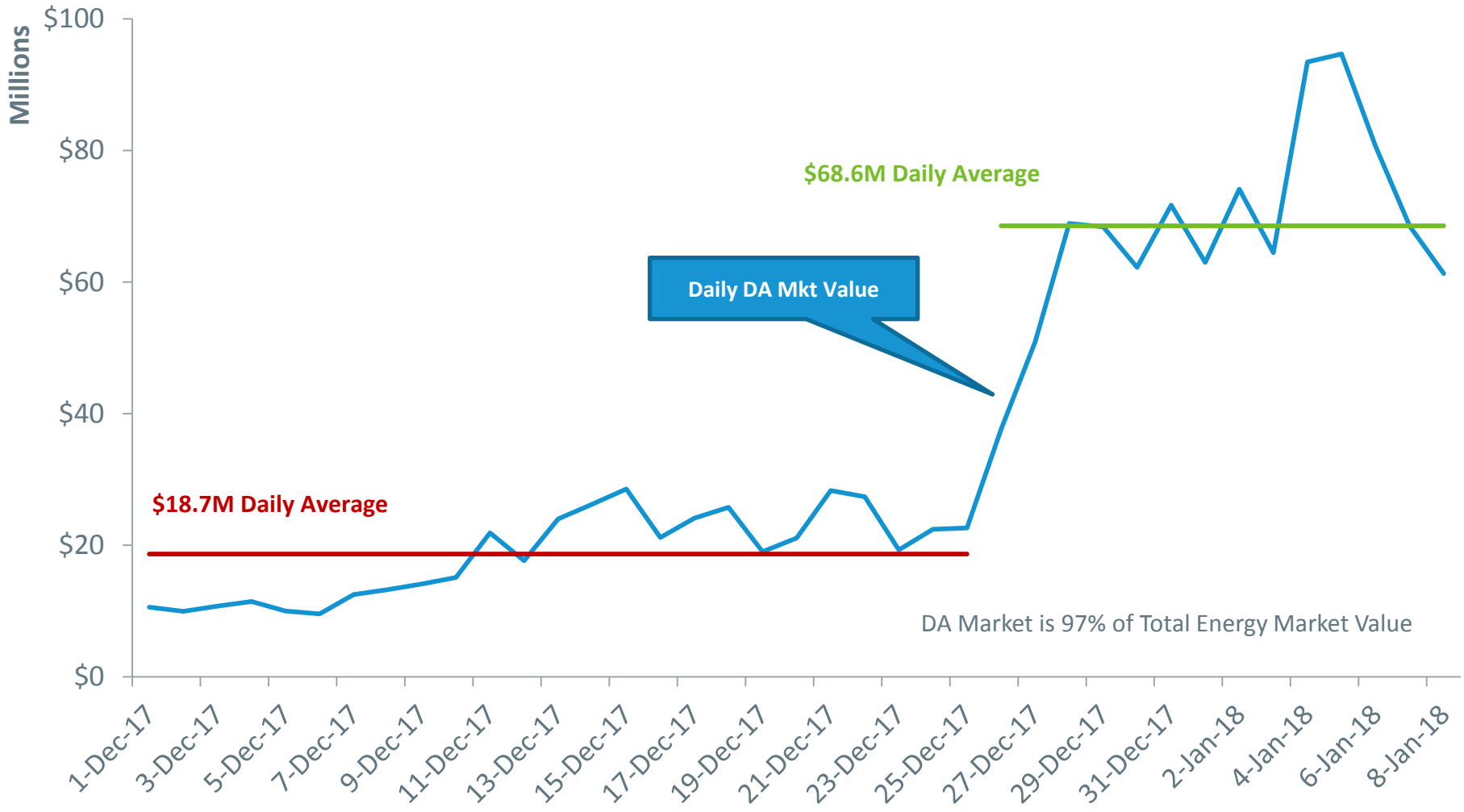
# Wind Generation



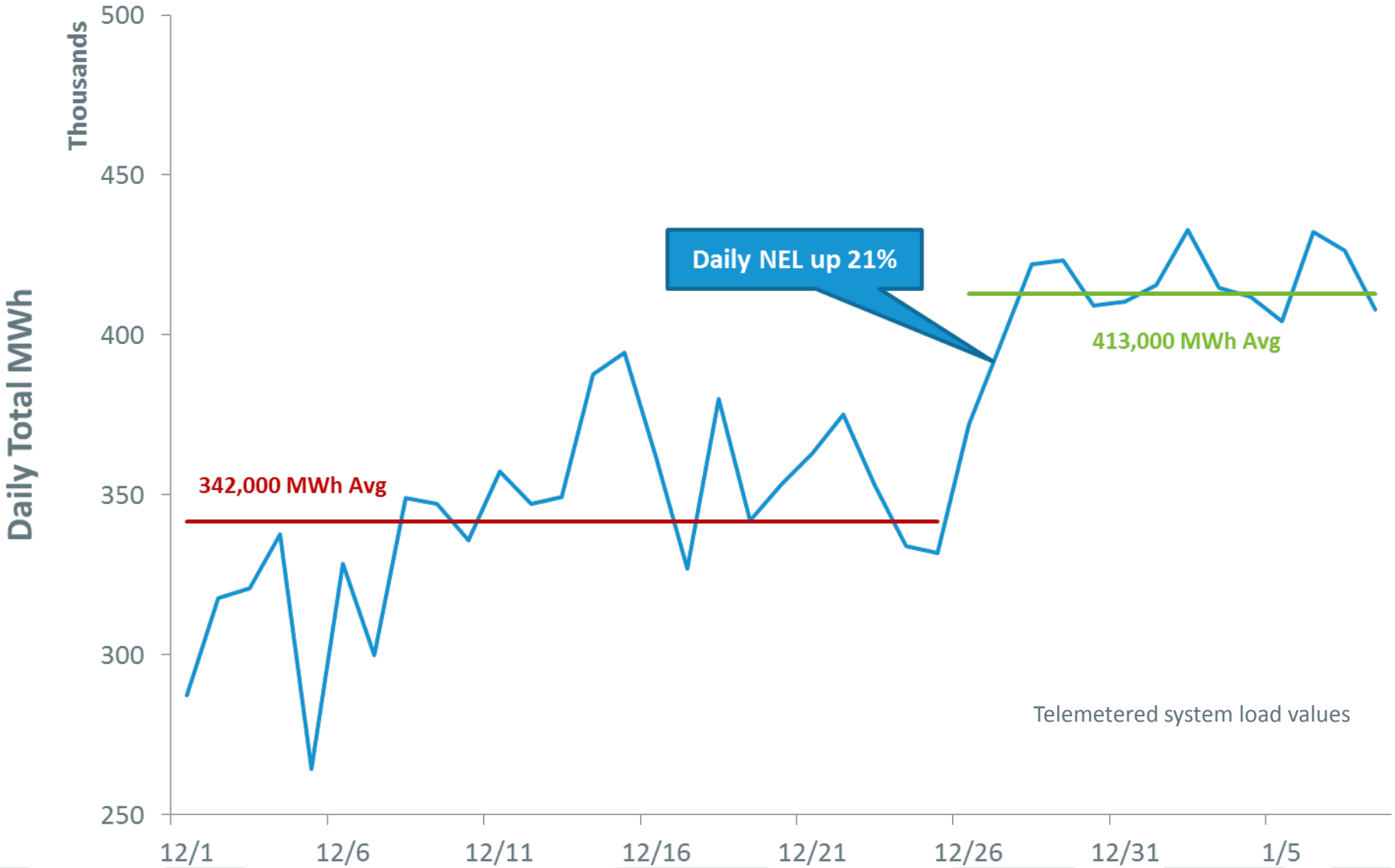

After 00:01 on 1/5/18, several wind plants in the region experienced intermittent high speed wind cutout events. Curtailments are due to transmission congestion.

# MARKET DATA

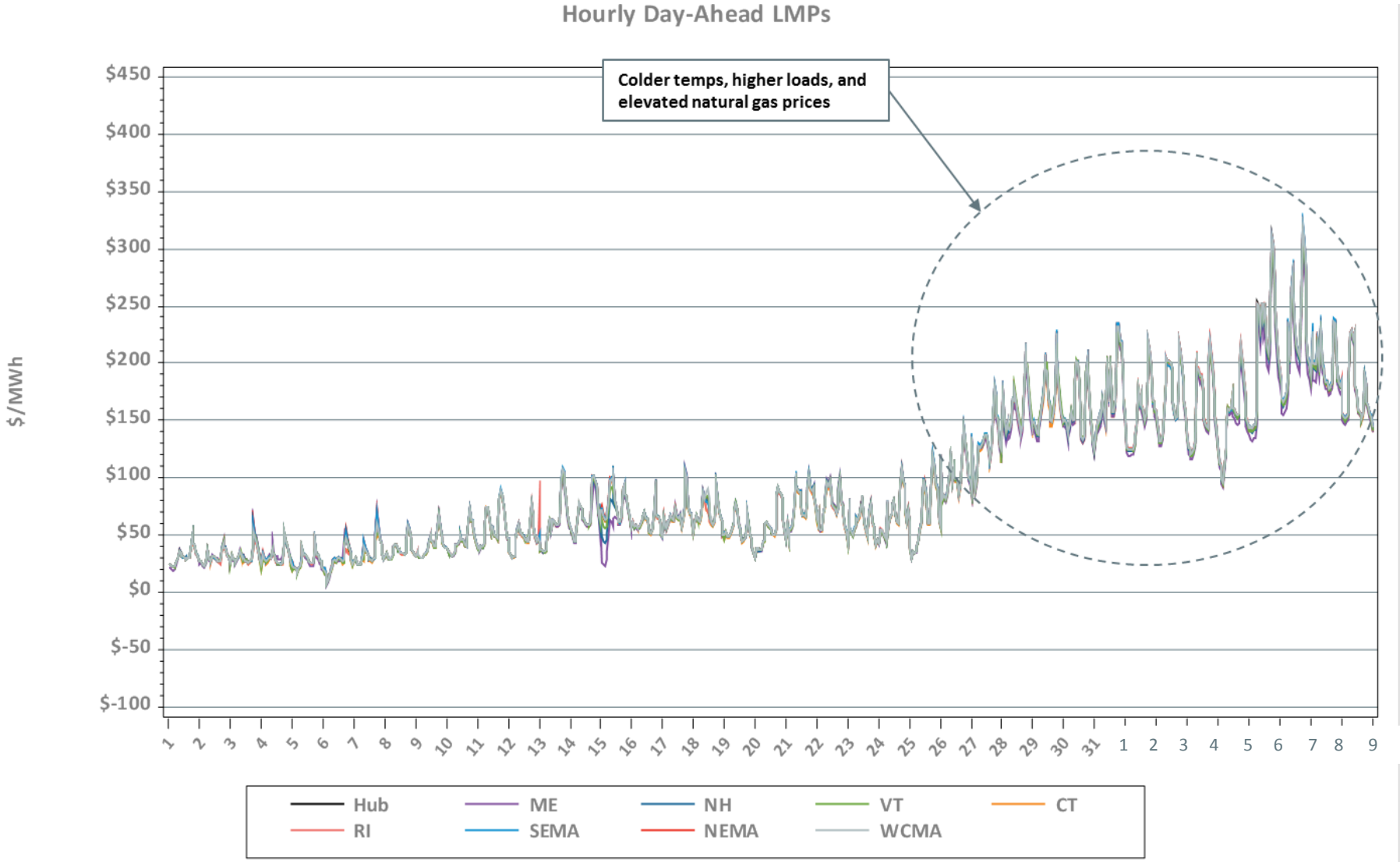
# Daily DA Market Cost Before and During the Cold Snap



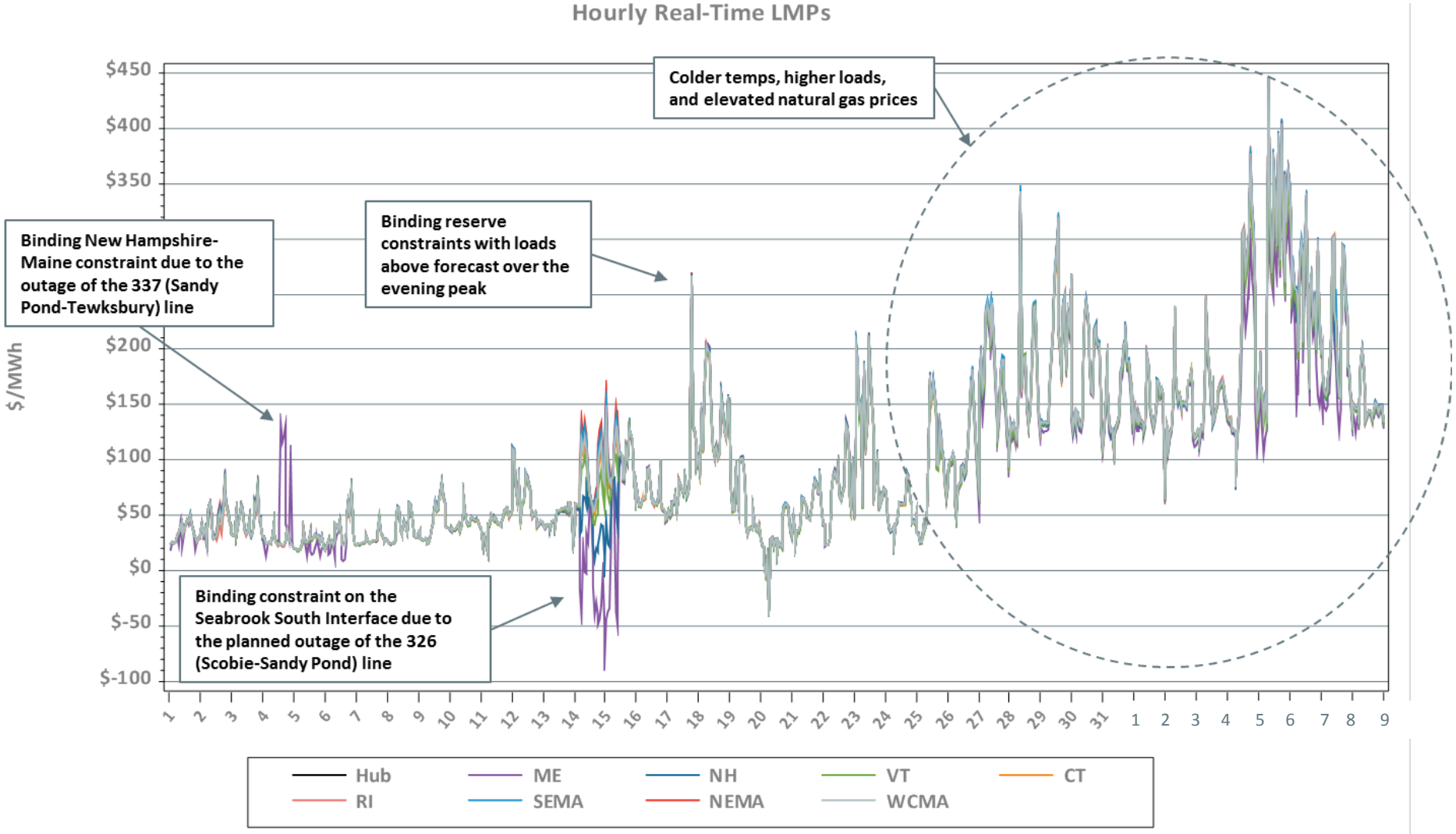
# Daily System Load Increased 21% after Christmas



# Hourly DA LMPs, December 1-January 8

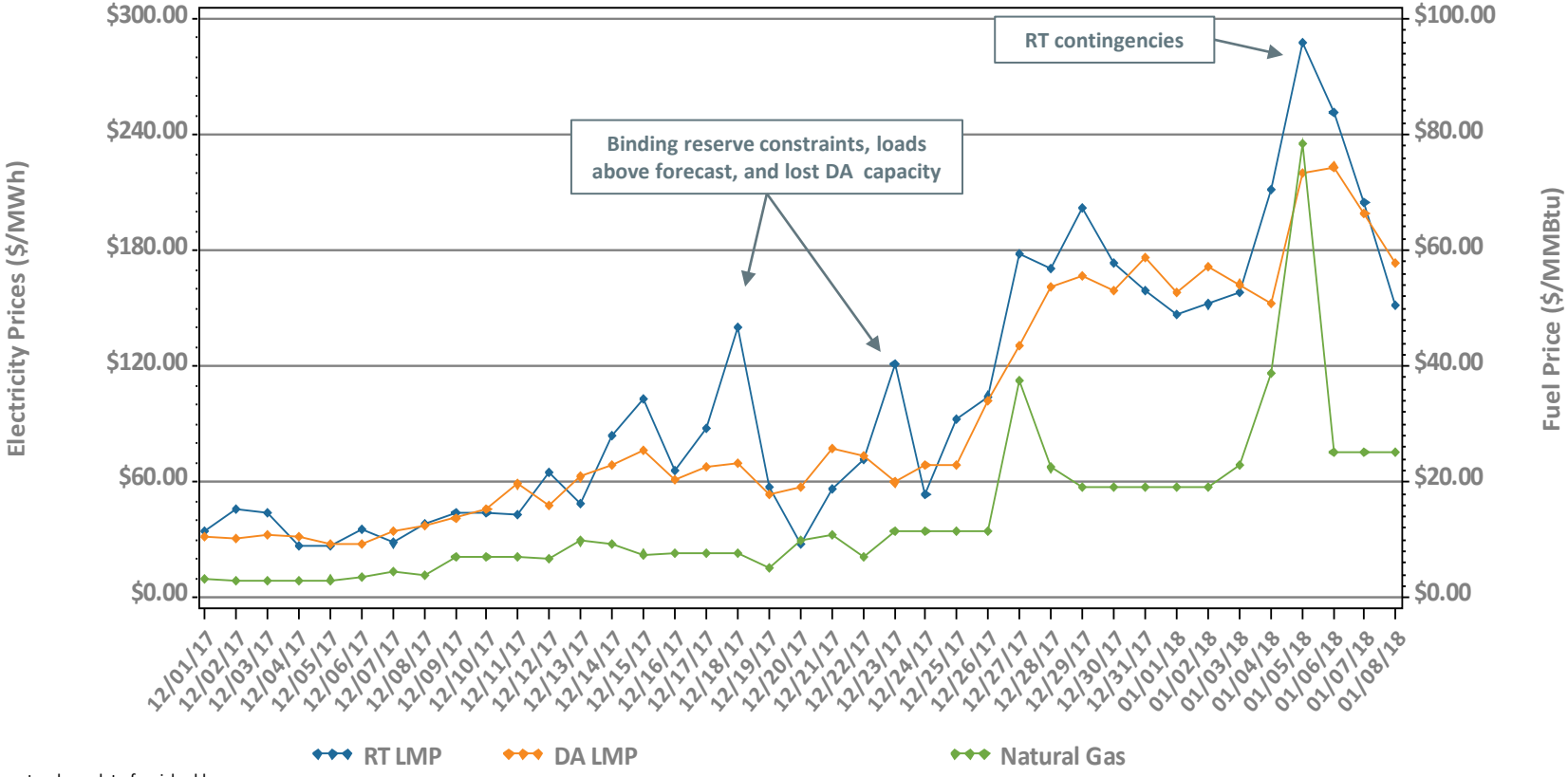


# Hourly RT LMPs, December 1-January 8




* No Minimum Generation Emergencies were declared during the period.

# Daily Avg. DA and RT ISO-NE Hub Prices and Input Fuel Prices: December 1-January 8

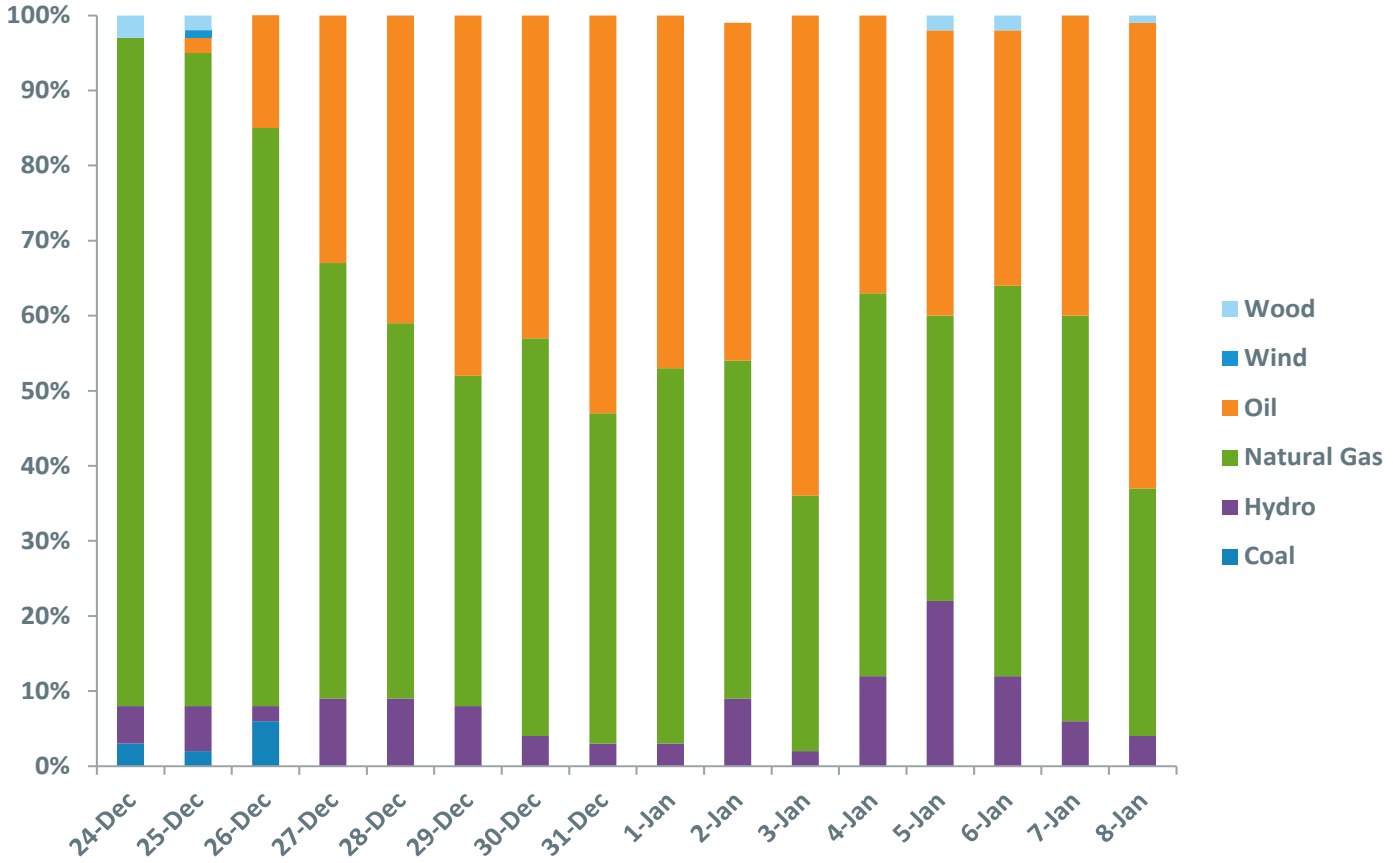



Underlying natural gas data furnished by:

ICE Global markets in clear view

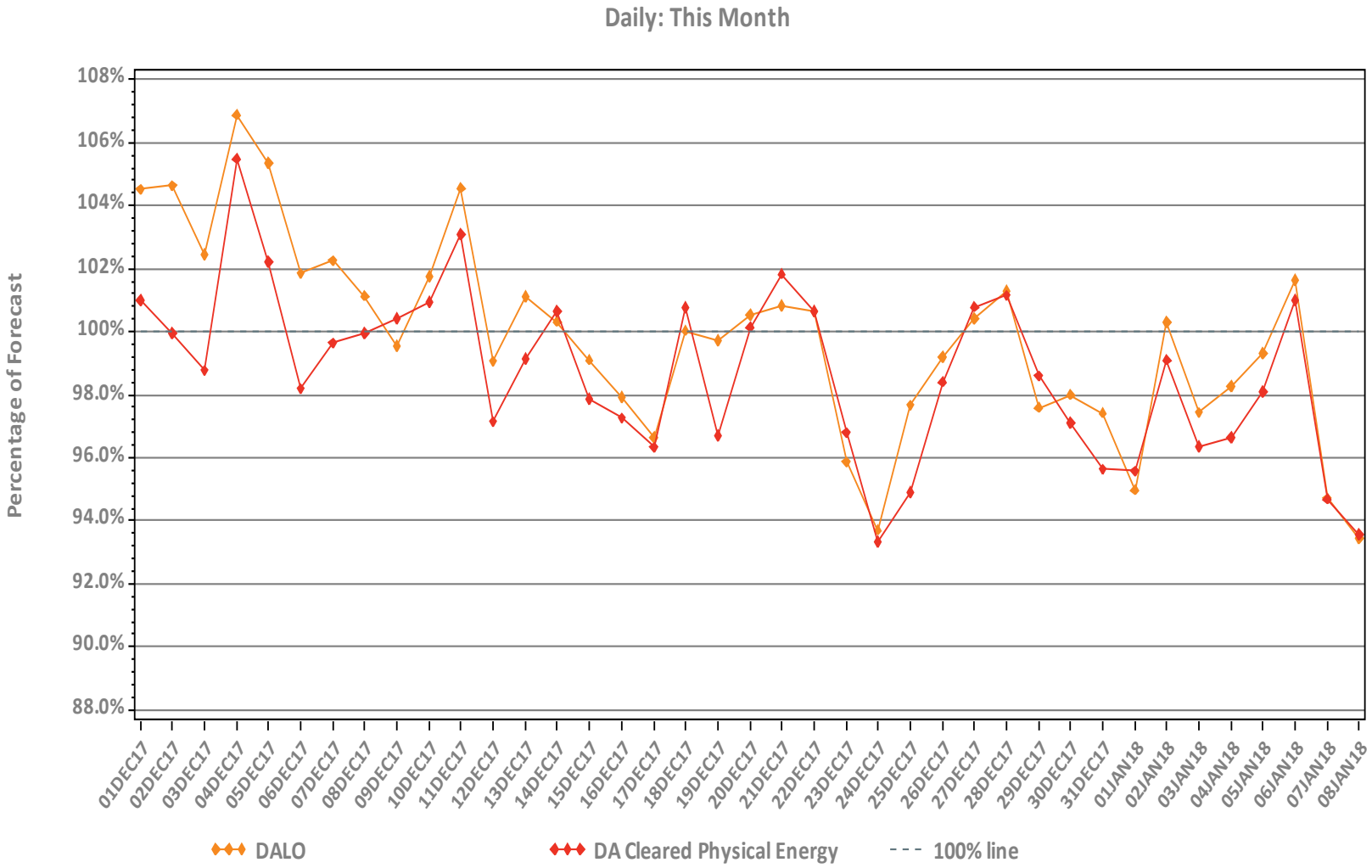
Average price difference over this period (DA-RT): $-12.91
Average price difference over this period ABS(DA-RT): $27.19
Average percentage difference over this period ABS(DA-RT)/RT Average LMP: 14%
Gas price is average of Massachusetts delivery points

# Oil Increasingly on the Margin during Dec. 24-Jan. 8



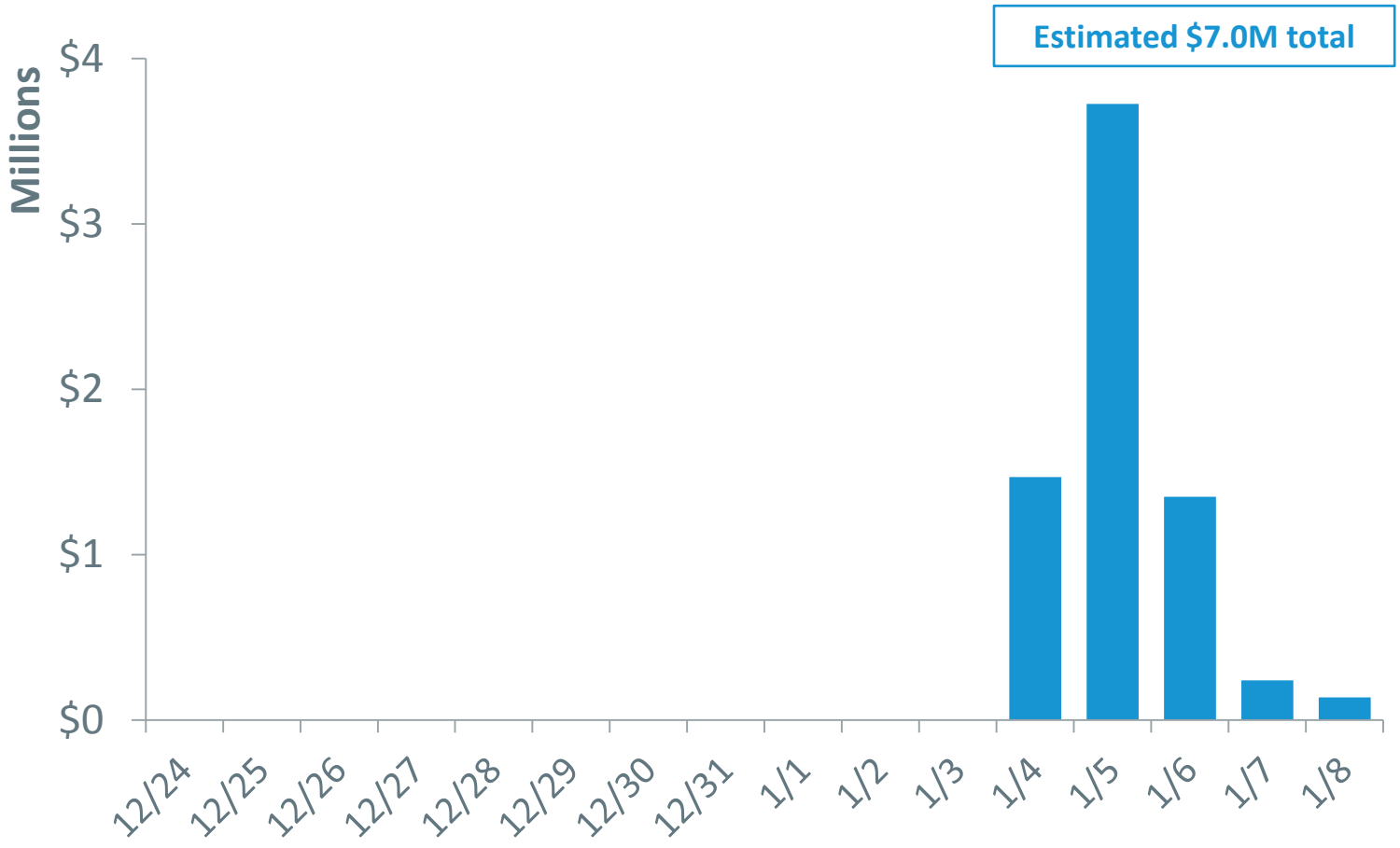

Note: Reflects price-setting by fuel-type during all intervals when the transmission system was unconstrained

# DA Volumes as % of Forecast in Peak Hour



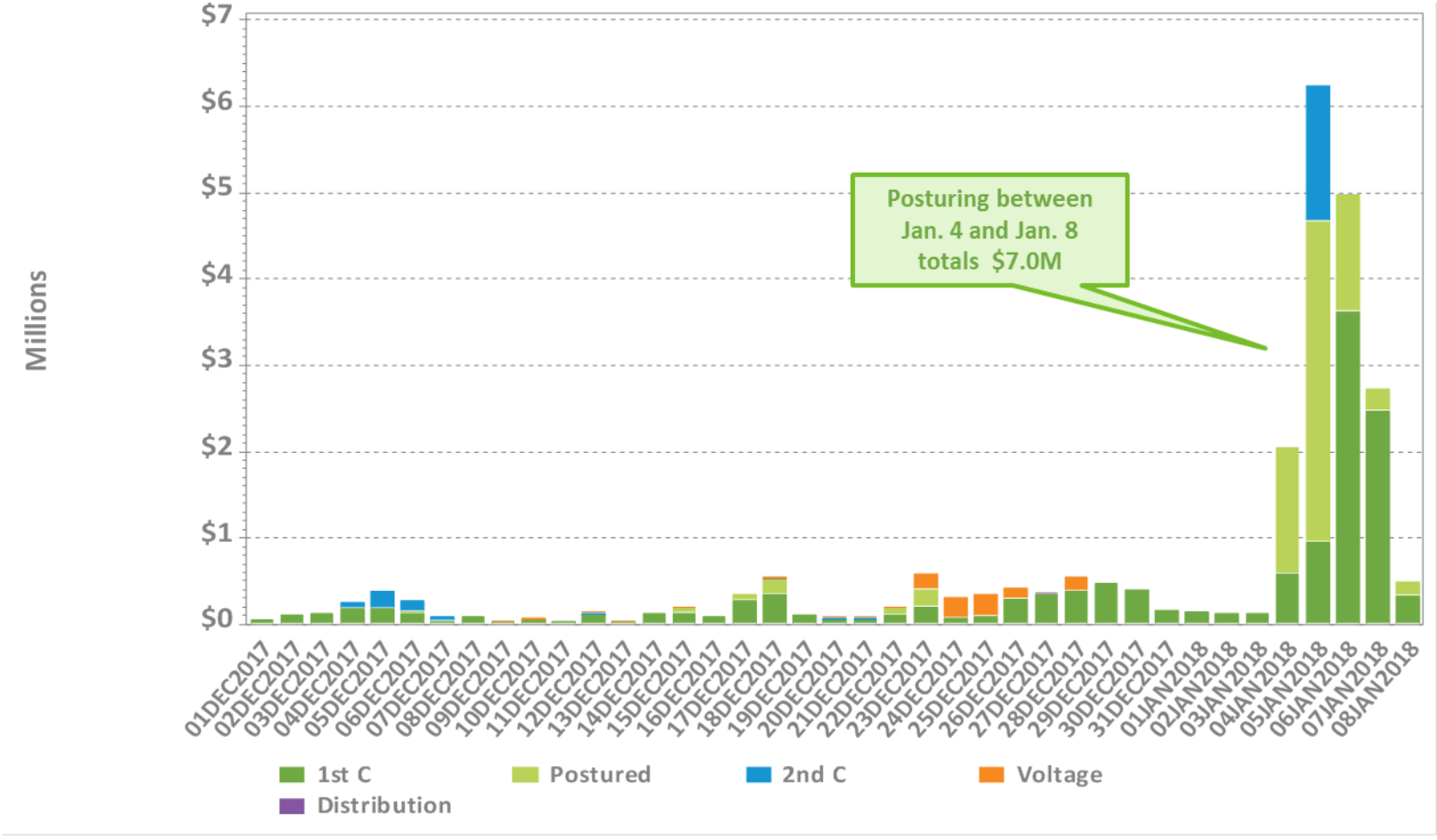

Note: DA Cleared Physical Energy includes DA generation and net imports

# Real-Time Posturing NCPC



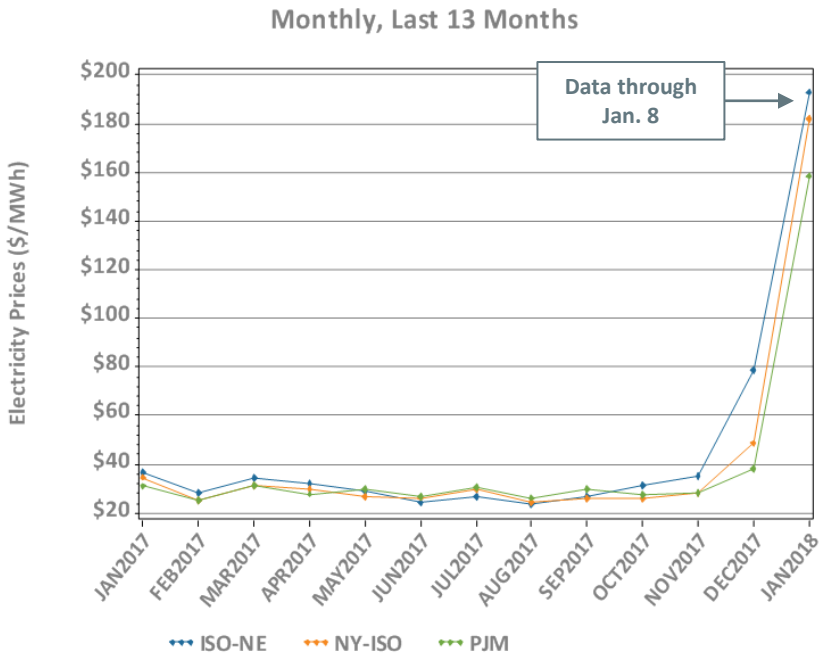

Does not show 'totals' of generation deviations charged to postured resources

# Daily NCPC Charges by Type

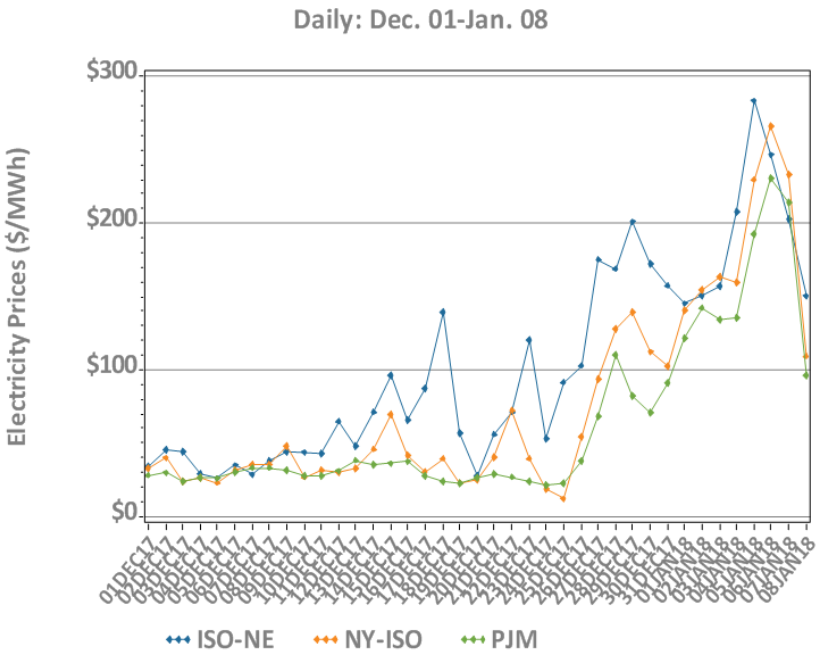



Note: Data for January 5-8 reflect preliminary settlements

# New England, NY, and PJM Hourly Average Real Time Prices by Month




*Note: Hourly average prices are shown.




*Note: Hourly average prices are shown.

# Summary and Next Steps

- The system operated reliably through the extended cold weather event and was relying heavily on oil to meet load and reserves
- The ISO is working with individual asset owners to understand their replenishment logistics and outstanding emissions concerns
- It is essential that fuel inventories are sufficiently replenished for the rest of the winter period
- The ISO will further assess the performance of the market during the cold weather event, and looks forward to discussing these topics with stakeholders