Post Winter 2017/18 Review

Planning Advisory Committee

Mark Babula

SYSTEM PLANNING – RESOURCE ADEQUACY

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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

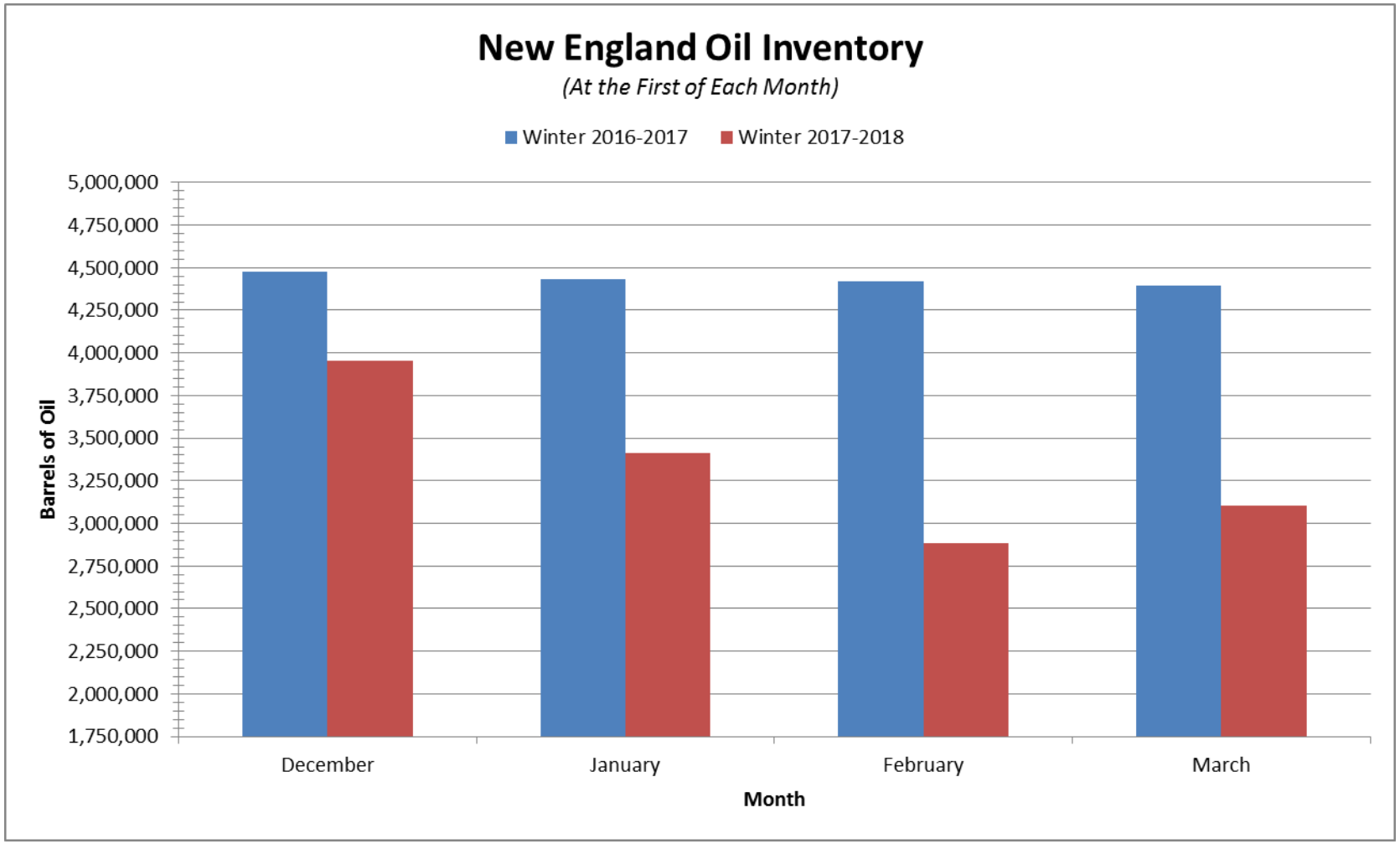
NOTE (A): First of month snapshot of oil inventory
NOTE (B): End of WRP Inventory on March 15, 2018 = Amount used for Billing Calculations

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 March 12-15 March 16 in NSTAR Only March 20-22 (Severe Weather)
Peak Load Date (H.E.)	20,531 MW Dec 28 (18:00)	20,631 MW Jan 5 (18:00)	18,164 MW Feb 7 (18:00)	16,735 MW Mar 7 (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)** **Max: 59°F, Min: 2°F** **Precipitation: 2.47" – Below Normal** **Normal: 3.73"** **Snow: 7.16"**	**Hartford**	**Temperature: Below Normal (-5.9°F)** **Max: 59°F, Min: -3°F** **Precipitation: 2.42" - Below Normal** **Normal: 3.60"** **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)** **Max: 61°F, Min: -2°F** **Precipitation: 4.77" – Above Normal** **Normal: 3.04"** **Snow: 15.4"**	**Hartford**	**Temperature: Below Normal (-1.3°F)** **Max: 60°F, Min: -9°F** **Precipitation: 3.83" - Above Normal** **Normal: 2.91"** **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** **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)** **Max: 72°F, Min: 10°F** **Precipitation: 3.76" – Above Normal** **Normal: 2.86"** **Snow: 9.8"**	**Hartford**	**Temperature: Above Normal (5.0°F)** **Max: 77°F, Min: 9°F** **Precipitation: 5.13" – Above Normal** **Normal: 2.56"** **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)** **Max: 64°F, Min: 16°F** **Precipitation: 5.07" – Above Normal** **Normal: 4.32"** **Snow: 23.3" – Above Normal**	**Hartford**	**Temperature: Below Normal (-0.6°F)** **Max: 60°F, Min: 17°F** **Precipitation: 2.65" - Below Normal** **Normal: 3.62"** **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** **Cancelled: March 9, 2018 HE 21:00**
MLCC2:	**Reason: Severe Weather**	**Declared: March 12, 2018 HE 14:00** **Cancelled: March 15, 2018 HE 12:00**
MLCC2:	**Reason: Severe Weather**	**Declared: Continued in NSTAR only** **Cancelled: March 16, 2018 HE 16:00**
	Reason: Severe Weather	**Declared: March 20, 2018 HE 16:00** **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

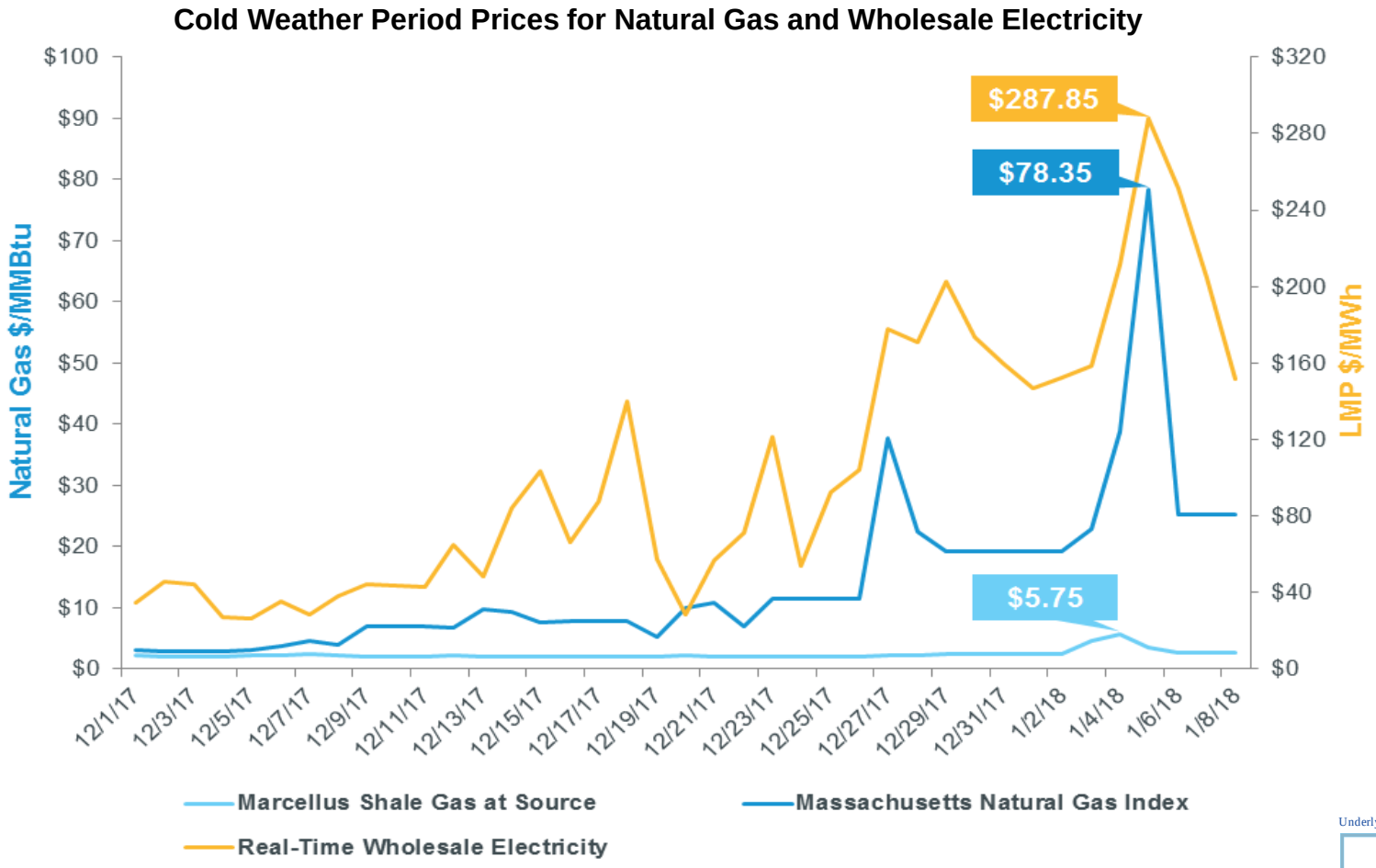
COLD WEATHER OPERATIONS
DECEMBER 25, 2017 – JANUARY 8, 2018

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

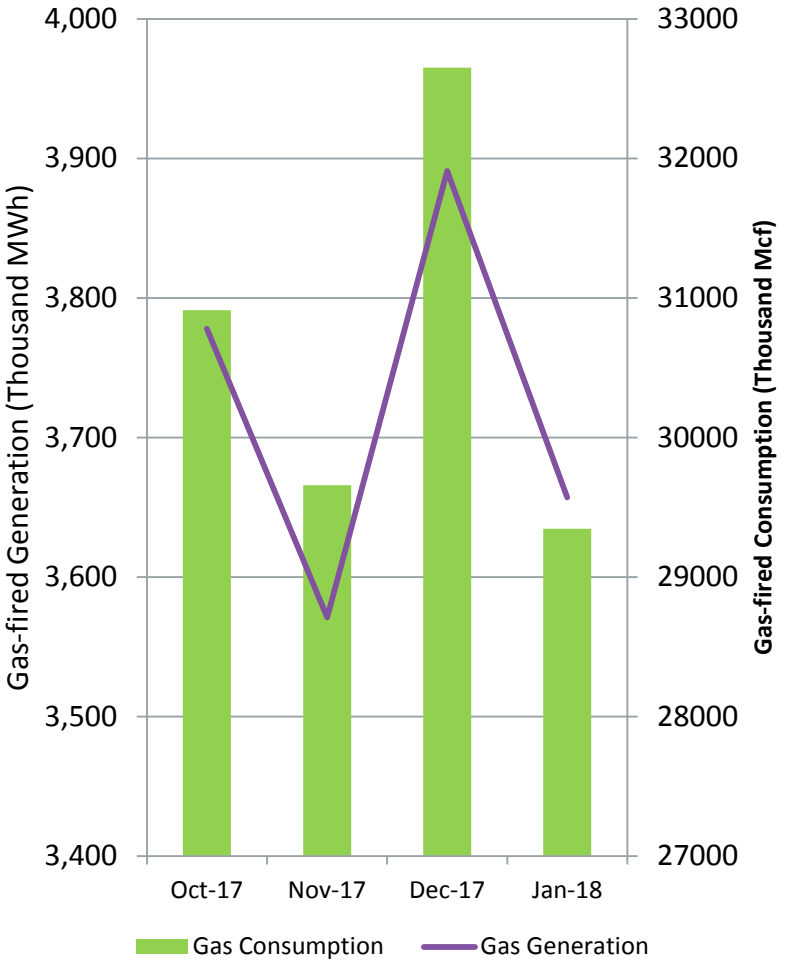
This led to spikes in natural gas prices, which then led to spikes in wholesale electricity prices; with natural gas at a premium, oil generation became economic

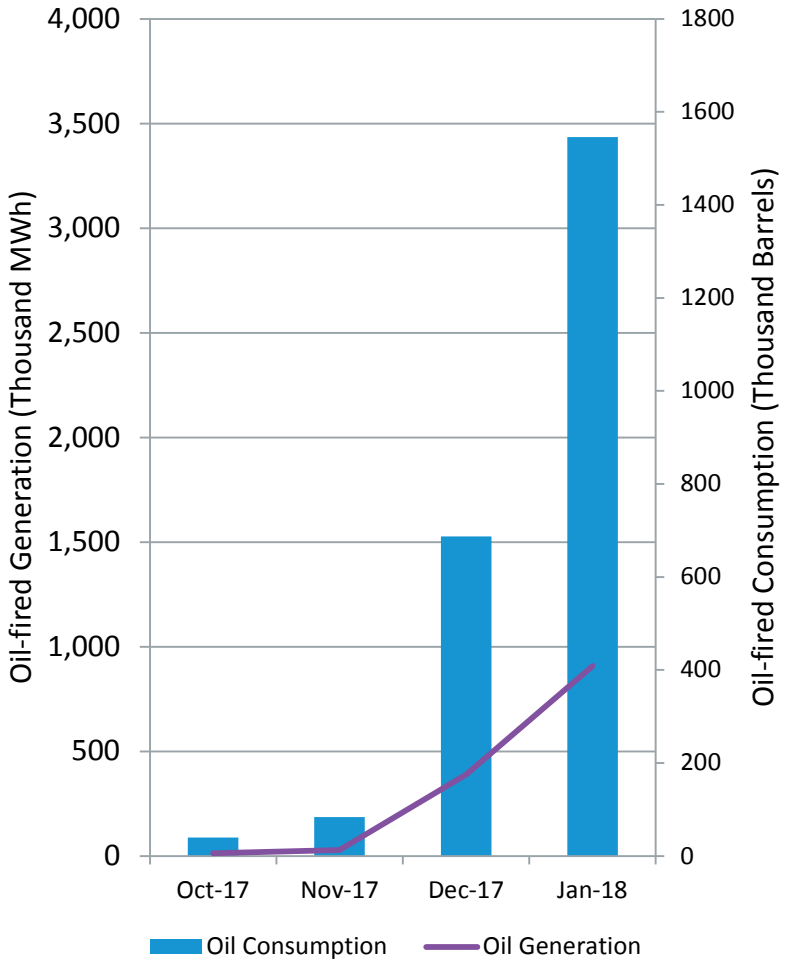


Underlying natural gas data furnished by:

ICE Global markets in clear view

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

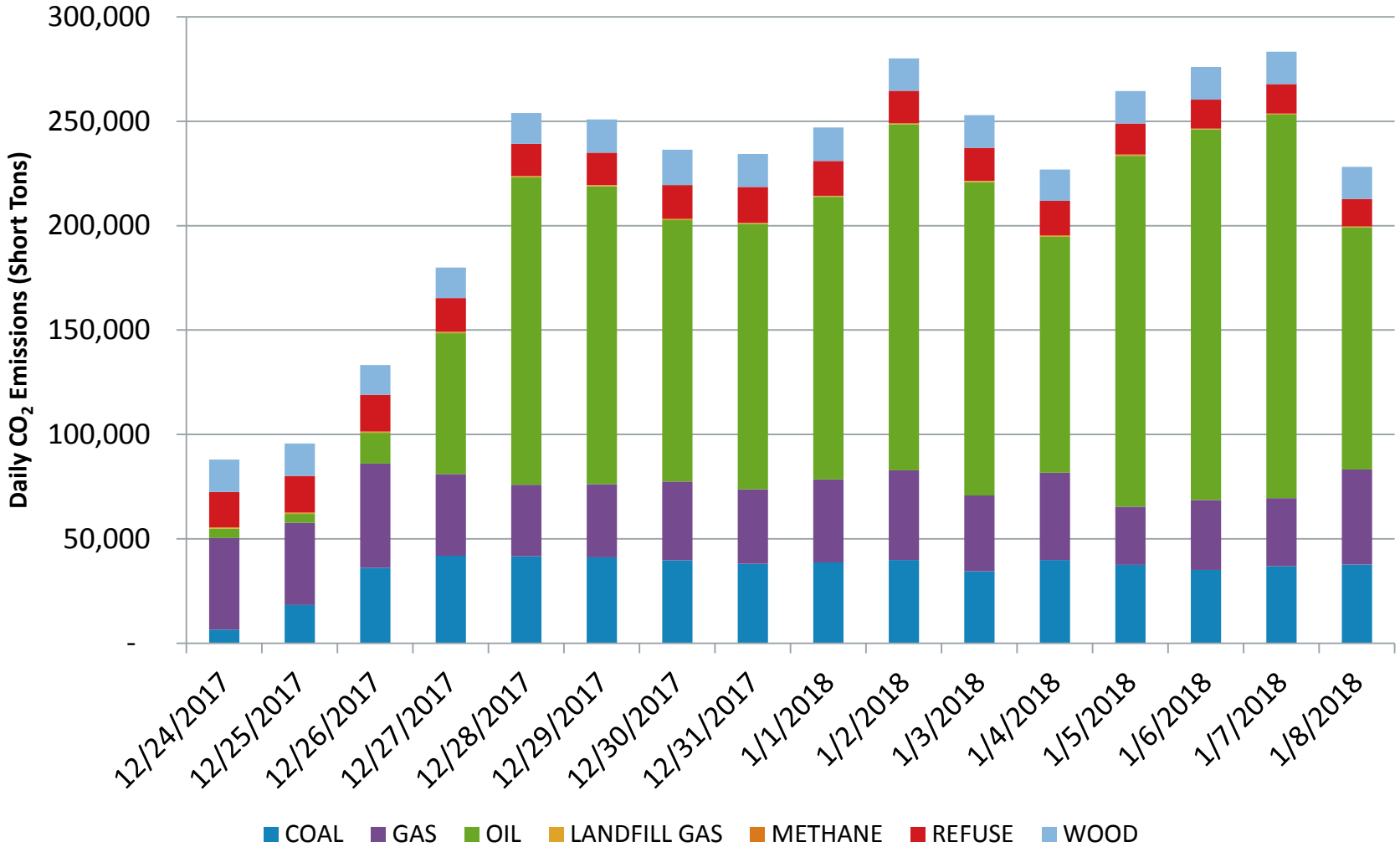




Source: EIA

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

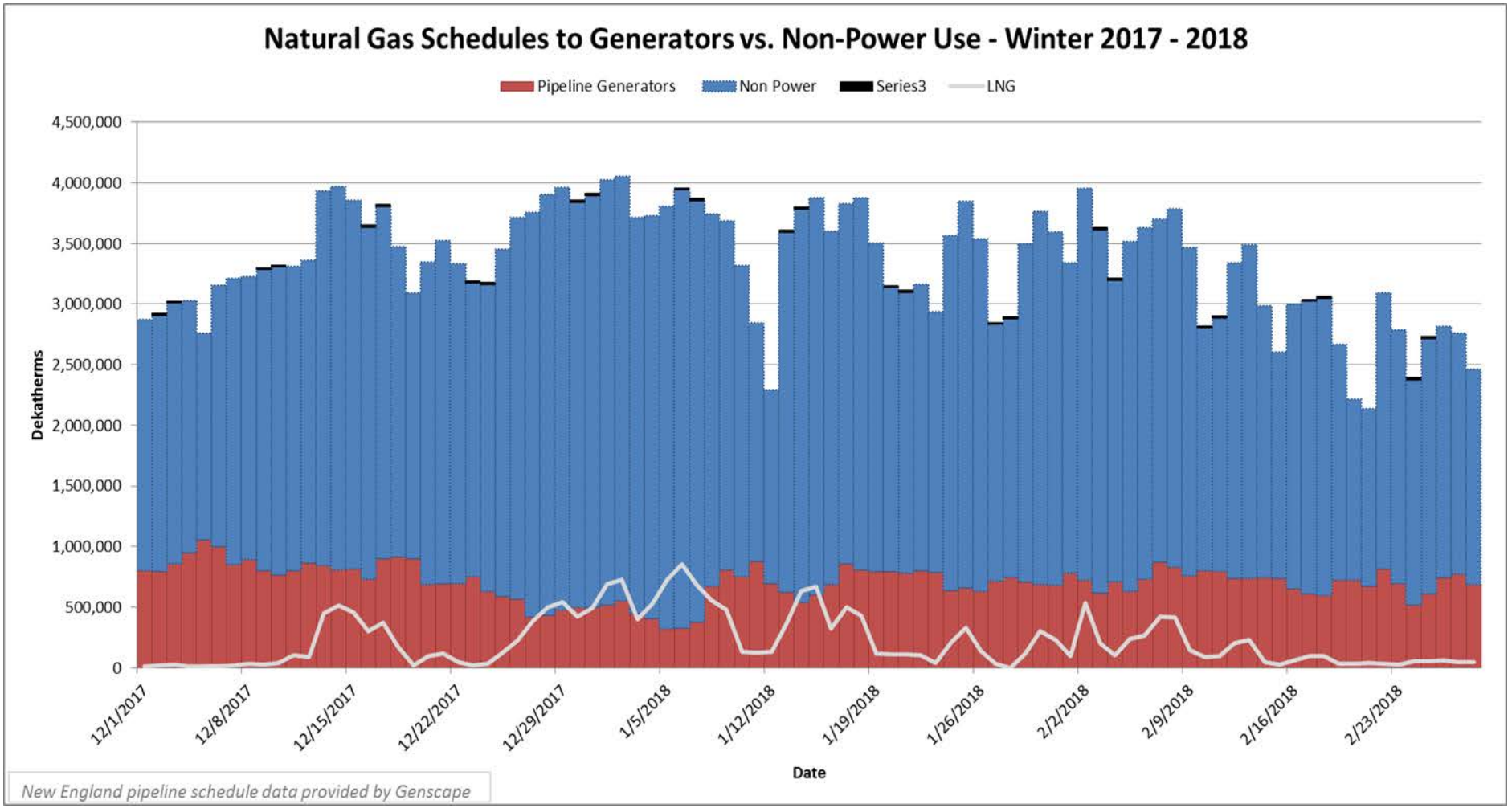
- Portland Natural Gas Transmission System (PNGTS)
  Force Majeure: None
  - However, a cyber security issue with PNGTS' EBB was reported on March 31
- PNGTS OFOs: None

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

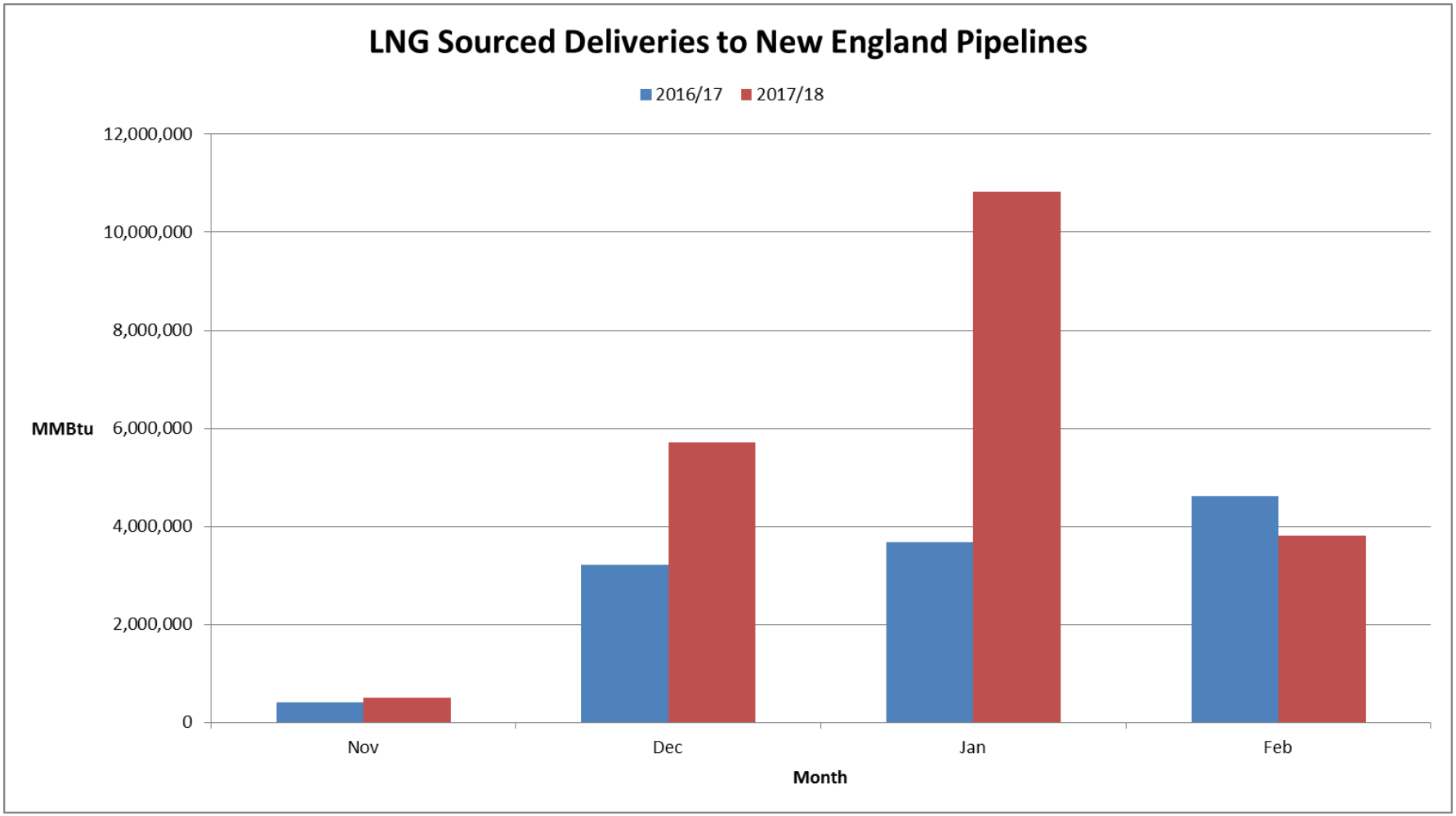
- Tennessee Gas Pipeline (TGP) Force Majeure:
  - Gas restriction on Dec 15 gas-day for a valve control failure near Nassau, NY
  - Station 241–Unit 1B near Syracuse, NY on Jan 8
  - Urgent repair at Agawam compressor station from Feb 7 to Feb 20
- TGP OFOs (All types*):
  - Monthly OFO = 2 (includes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

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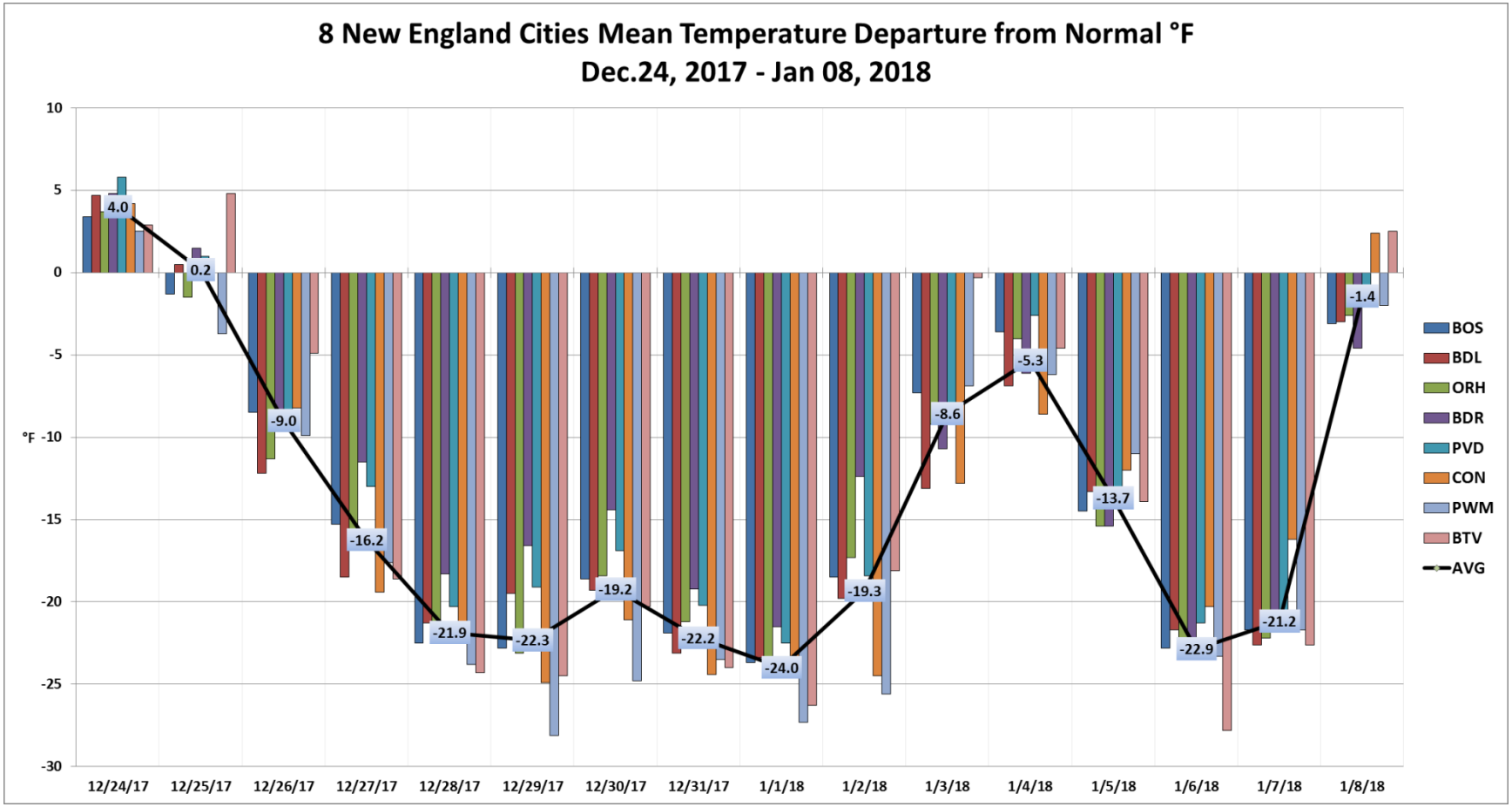
COLD WEATHER OPERATIONS
DECEMBER 24, 2017 – JANUARY 8, 2018

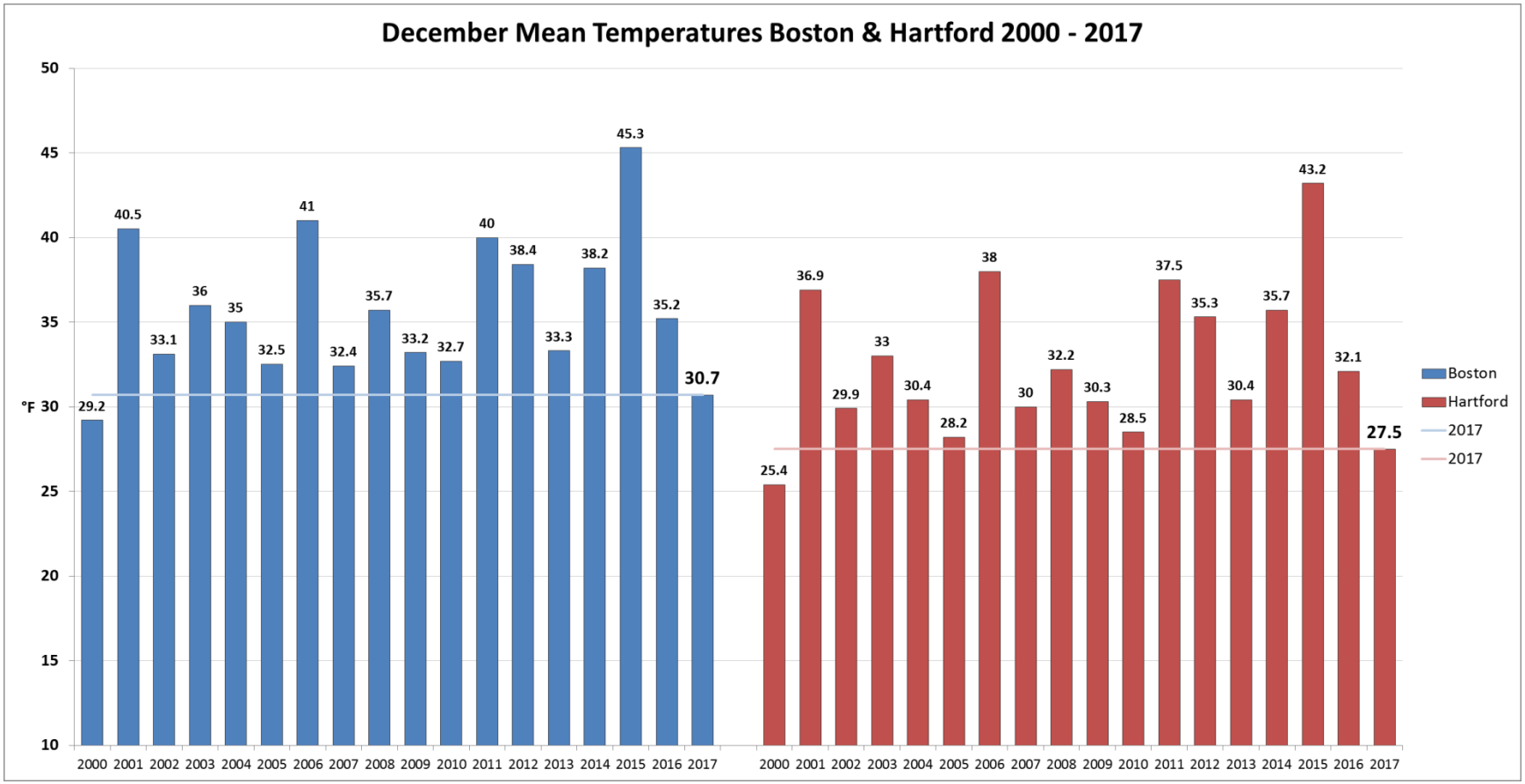
Arctic Outbreak 2017-18

- 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.

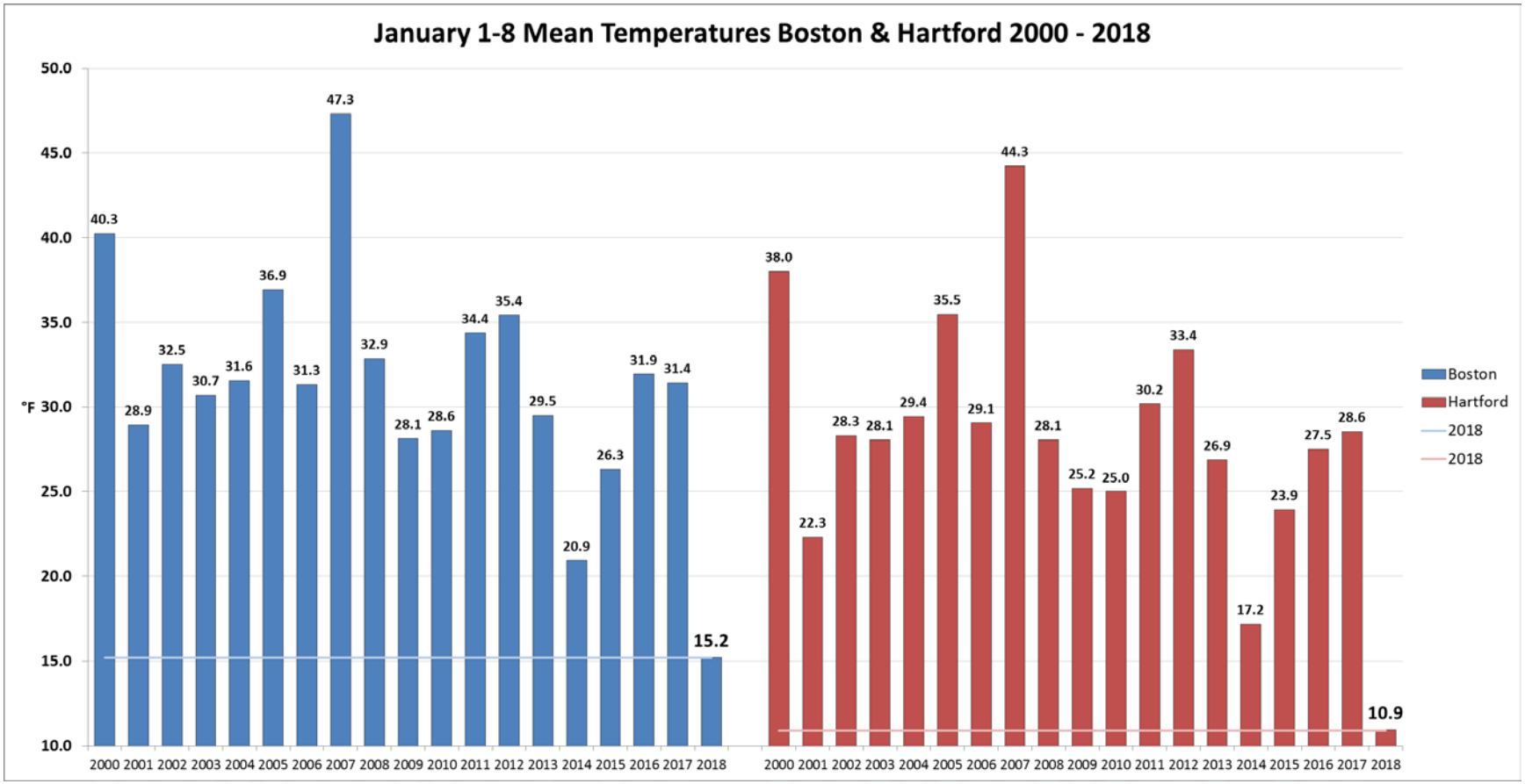
Mean Temperatures Depart from Normal



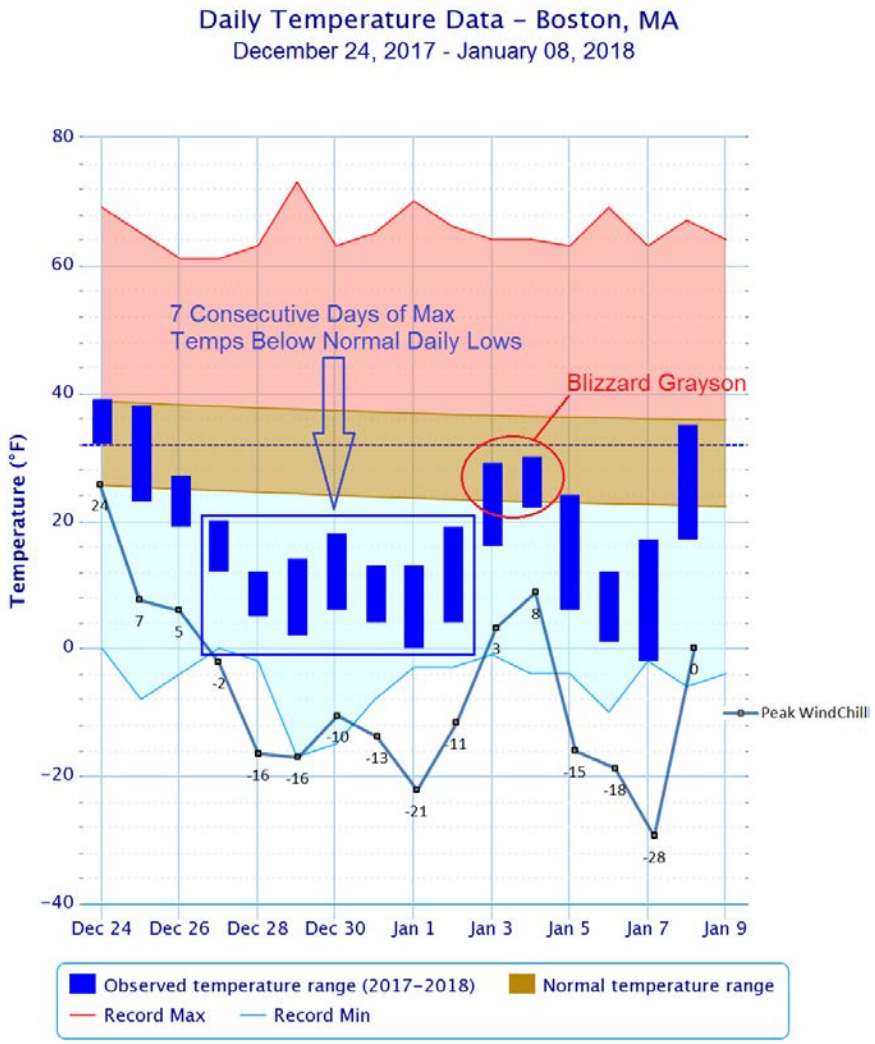
Coldest December Mean Temps since at least 2000



Coldest January 1-8 since at least 2000

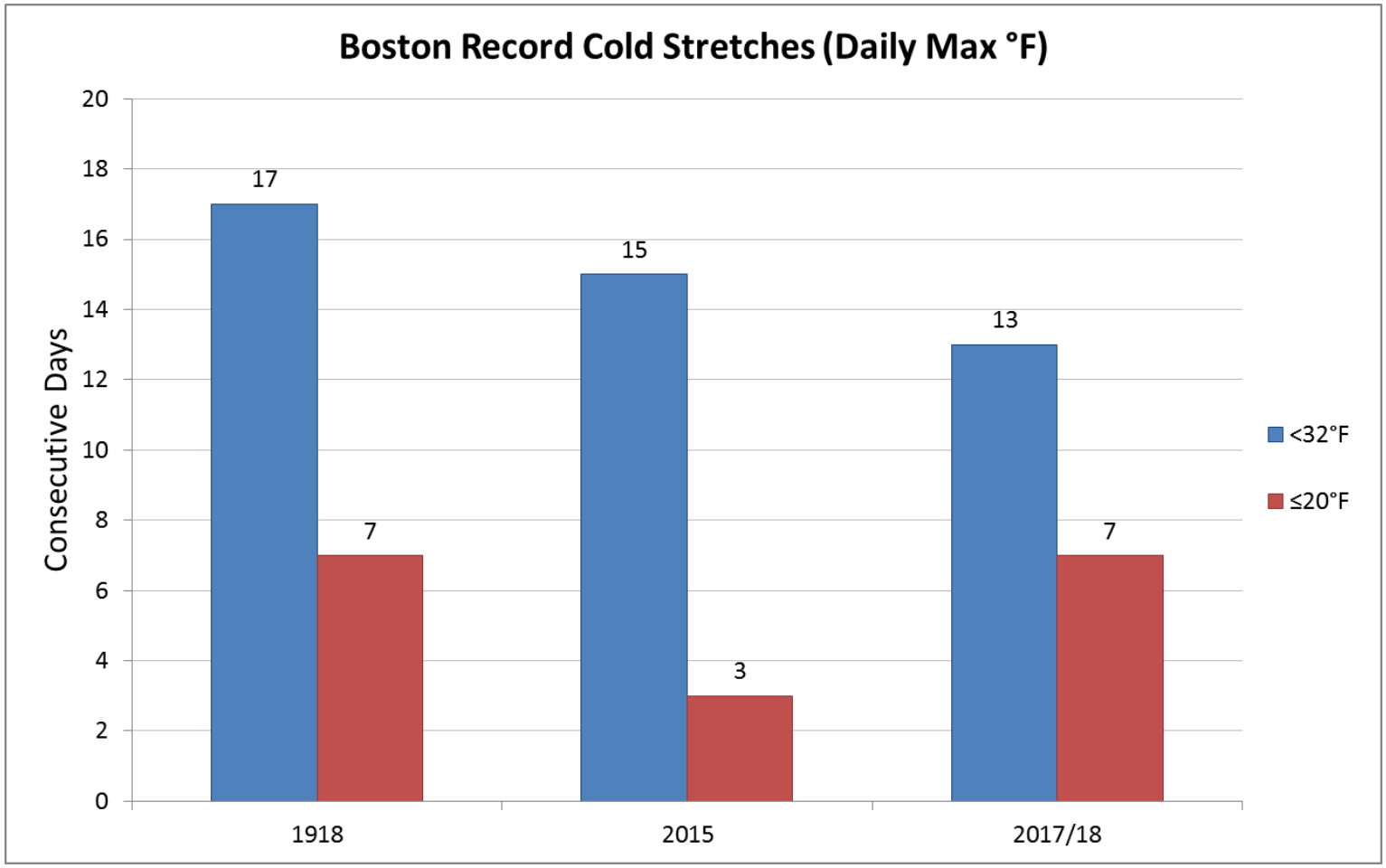


Arctic Outbreak 2017-18 Boston Temperatures



- 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



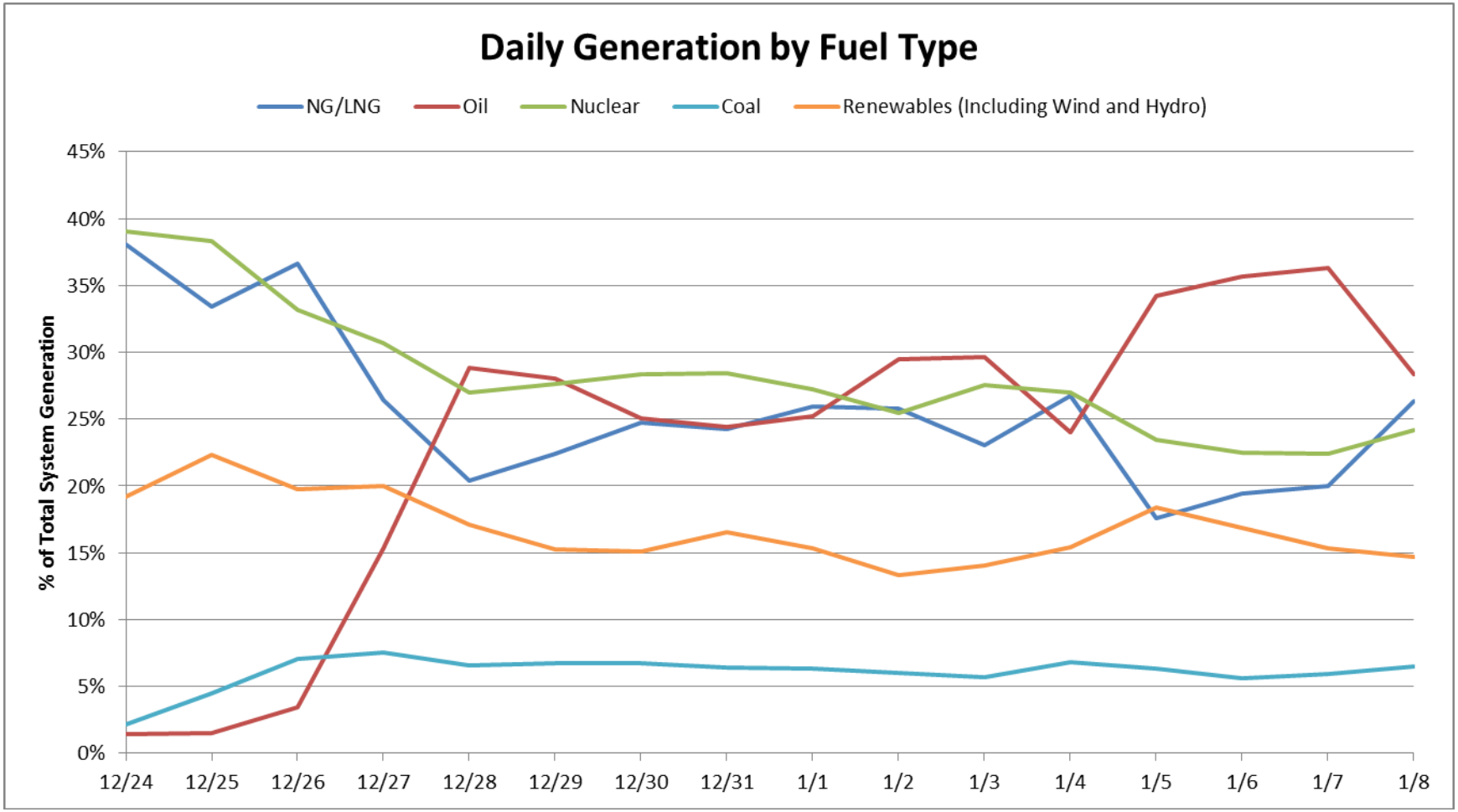
Historical Consecutive Cold Days in Boston
Coldest Stretch (Daily Max ≤20°F) In 100 Years Dating Back To 1918

FUEL MIX

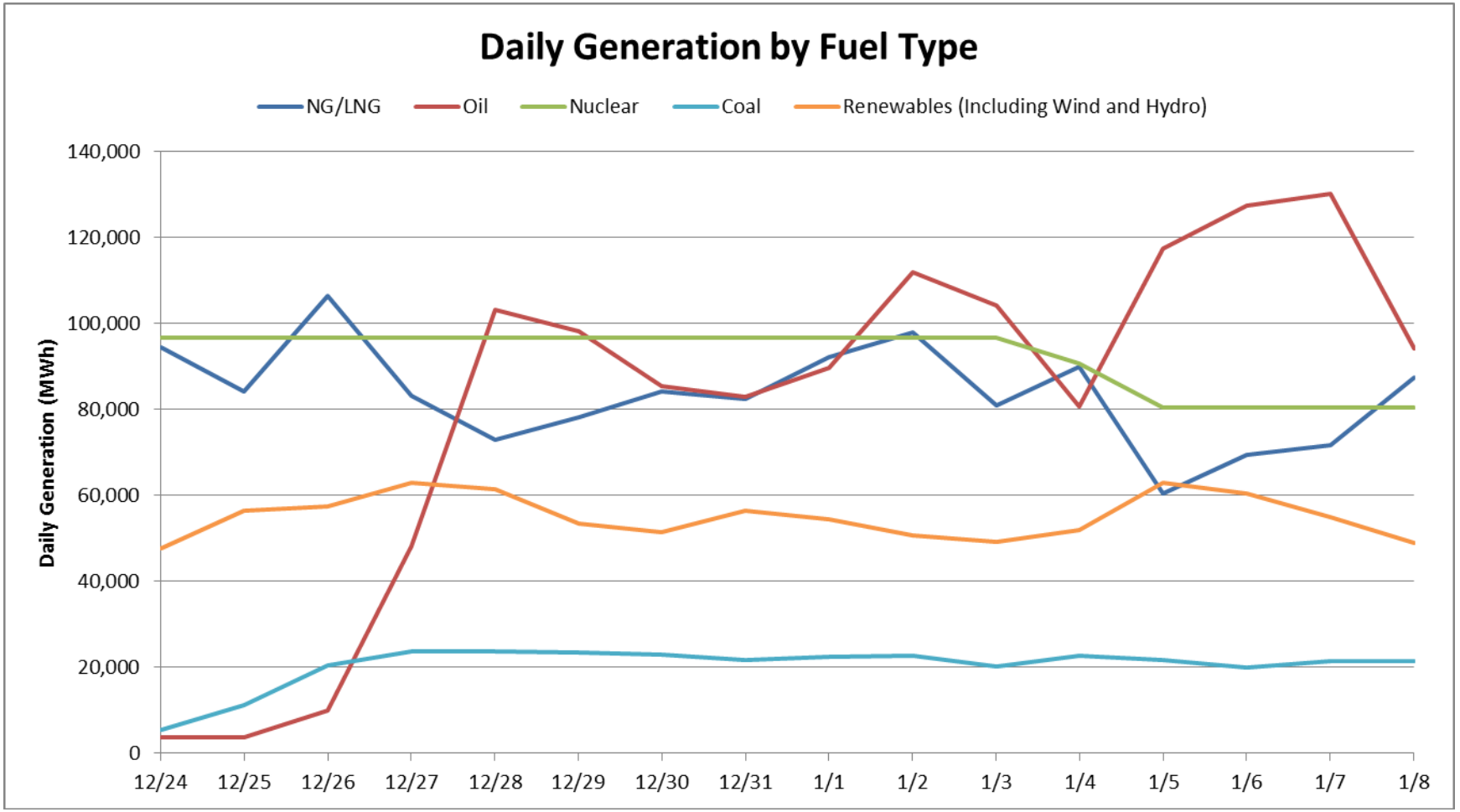
New England Fuel Mixture

- 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

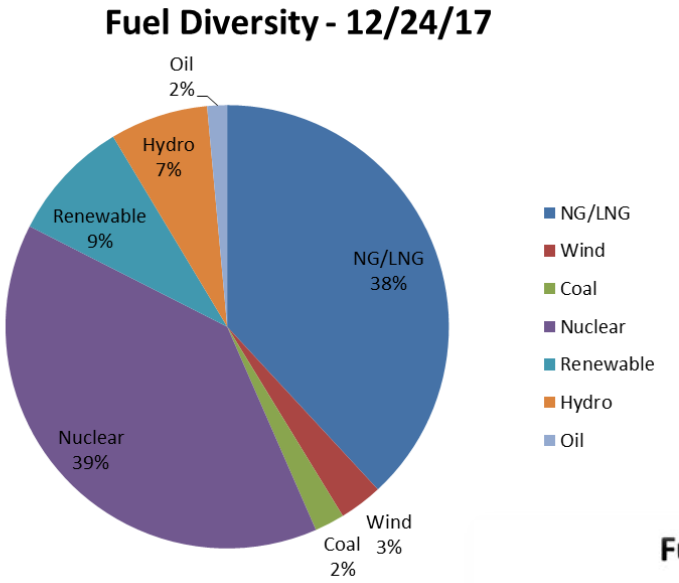
Daily Generation by Fuel Type (Percent of total)

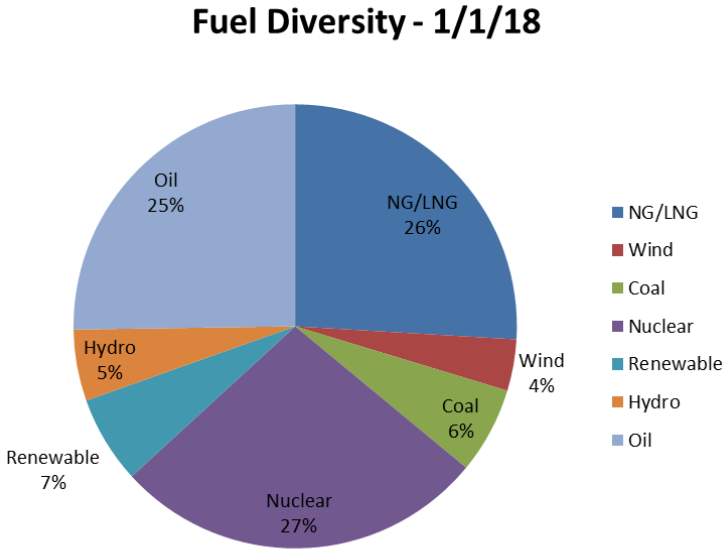


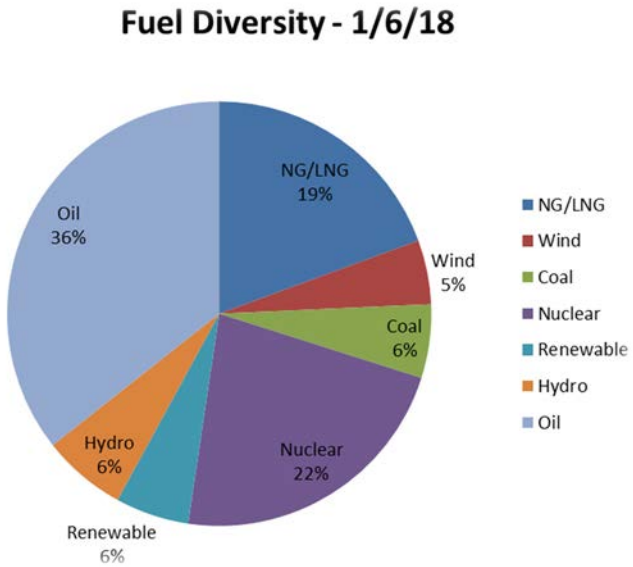
Daily Generation by Fuel Type (MWh)



Shifting Generation Mix Before and During the Cold Snap





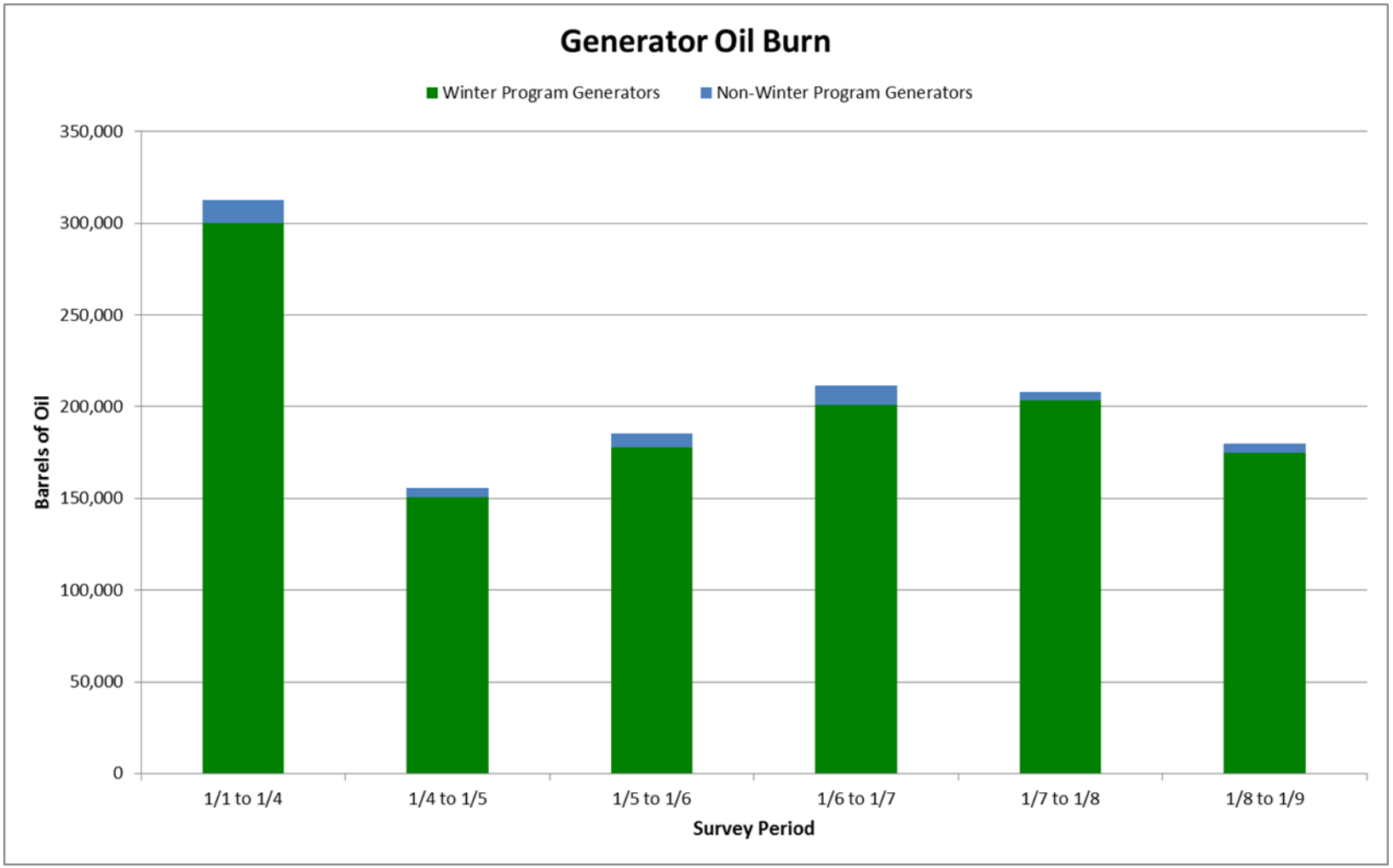


COLD WEATHER OIL USAGE

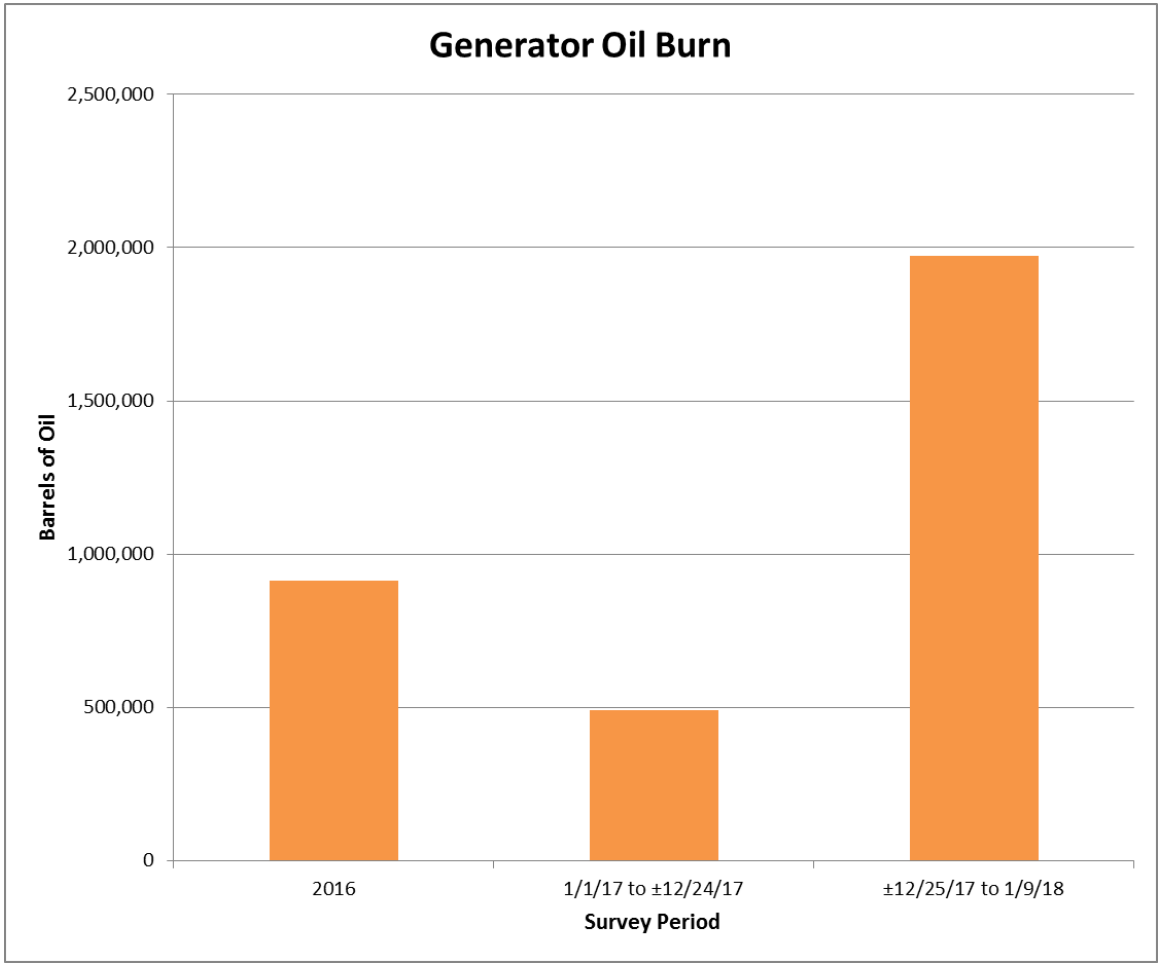
Winter Reliability Program vs Actual Oil Burn

- 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

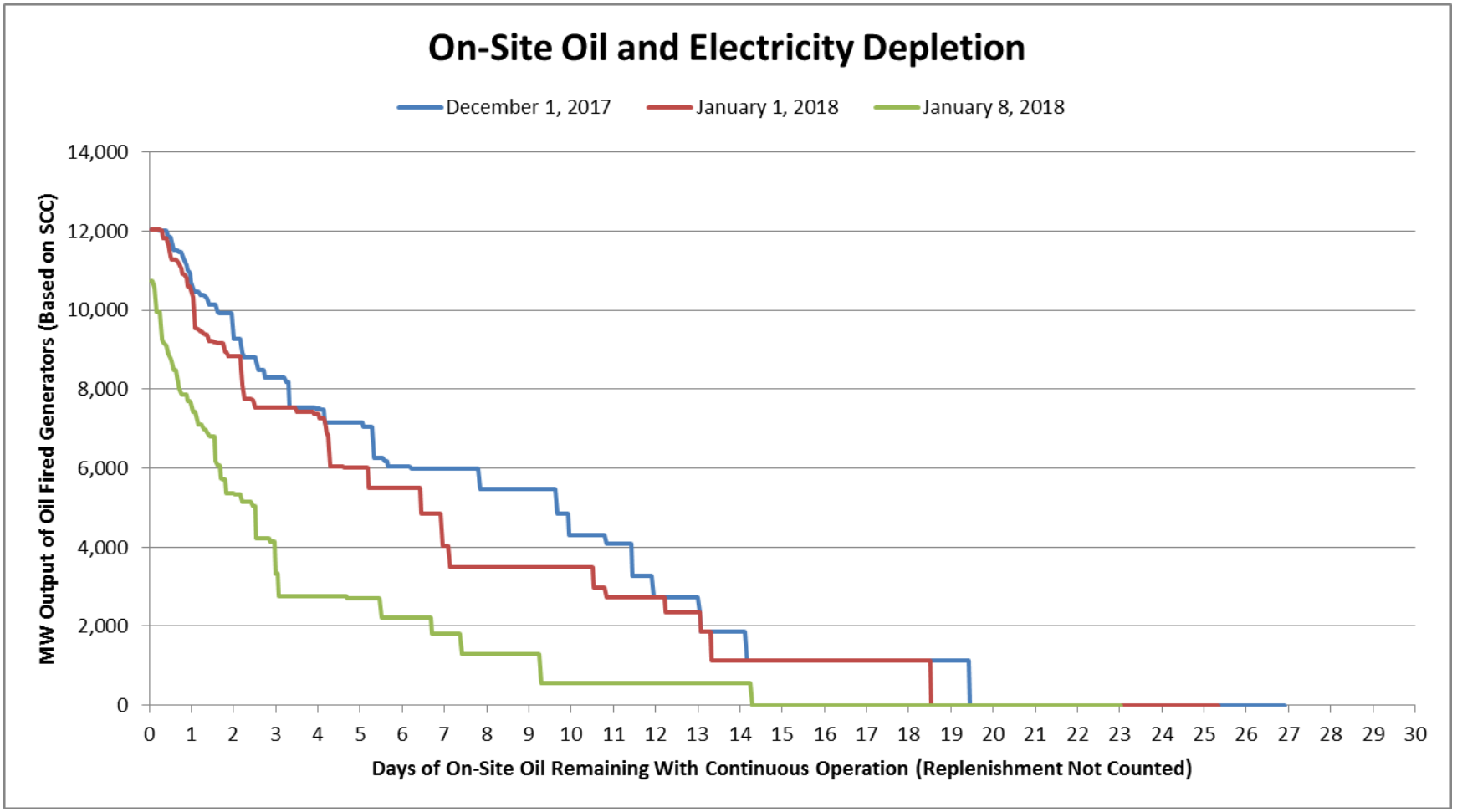
Generator Oil Burn – January 2018



Generator Oil Burn – Yearly Comparison

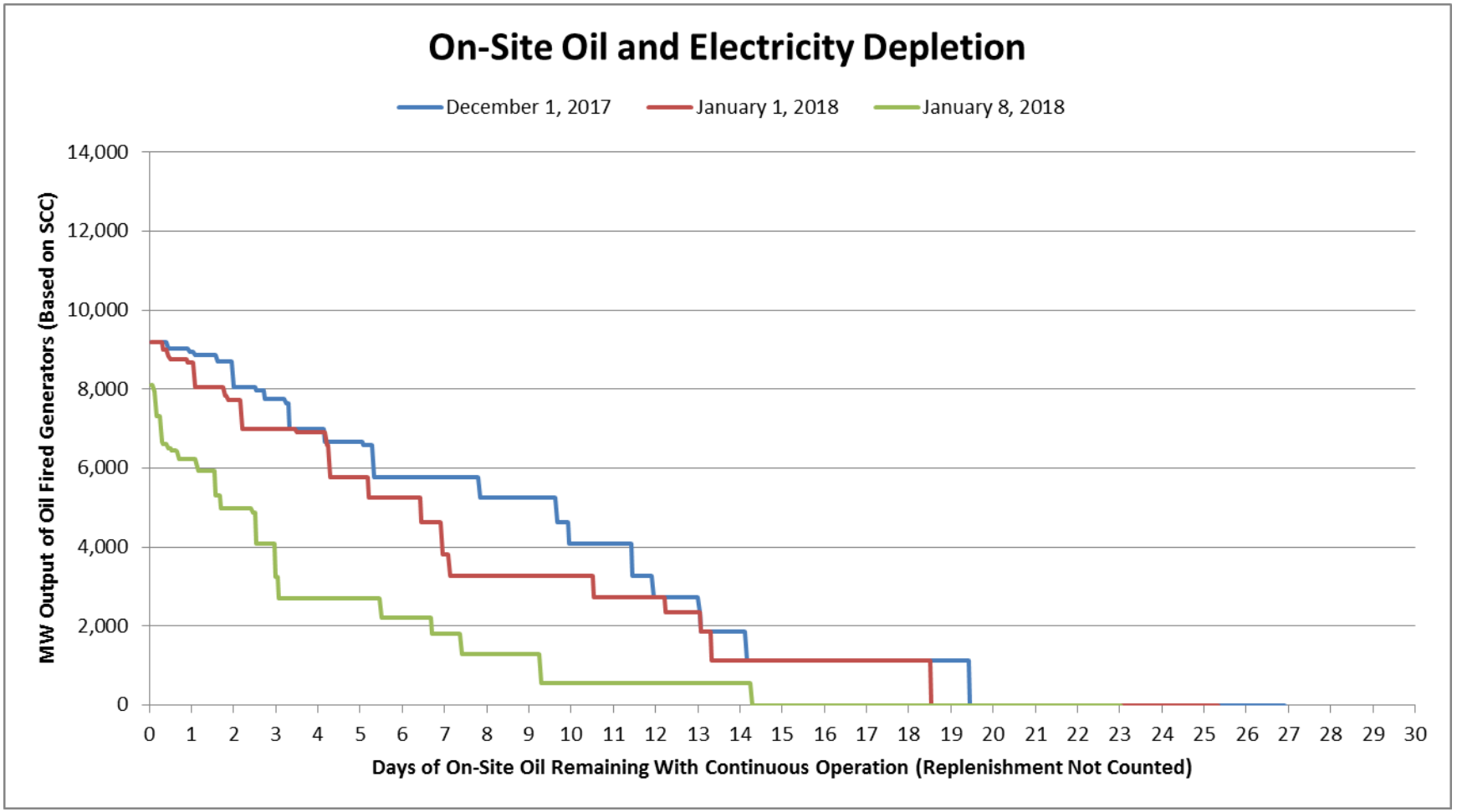


On-Site Oil and Electricity Depletion



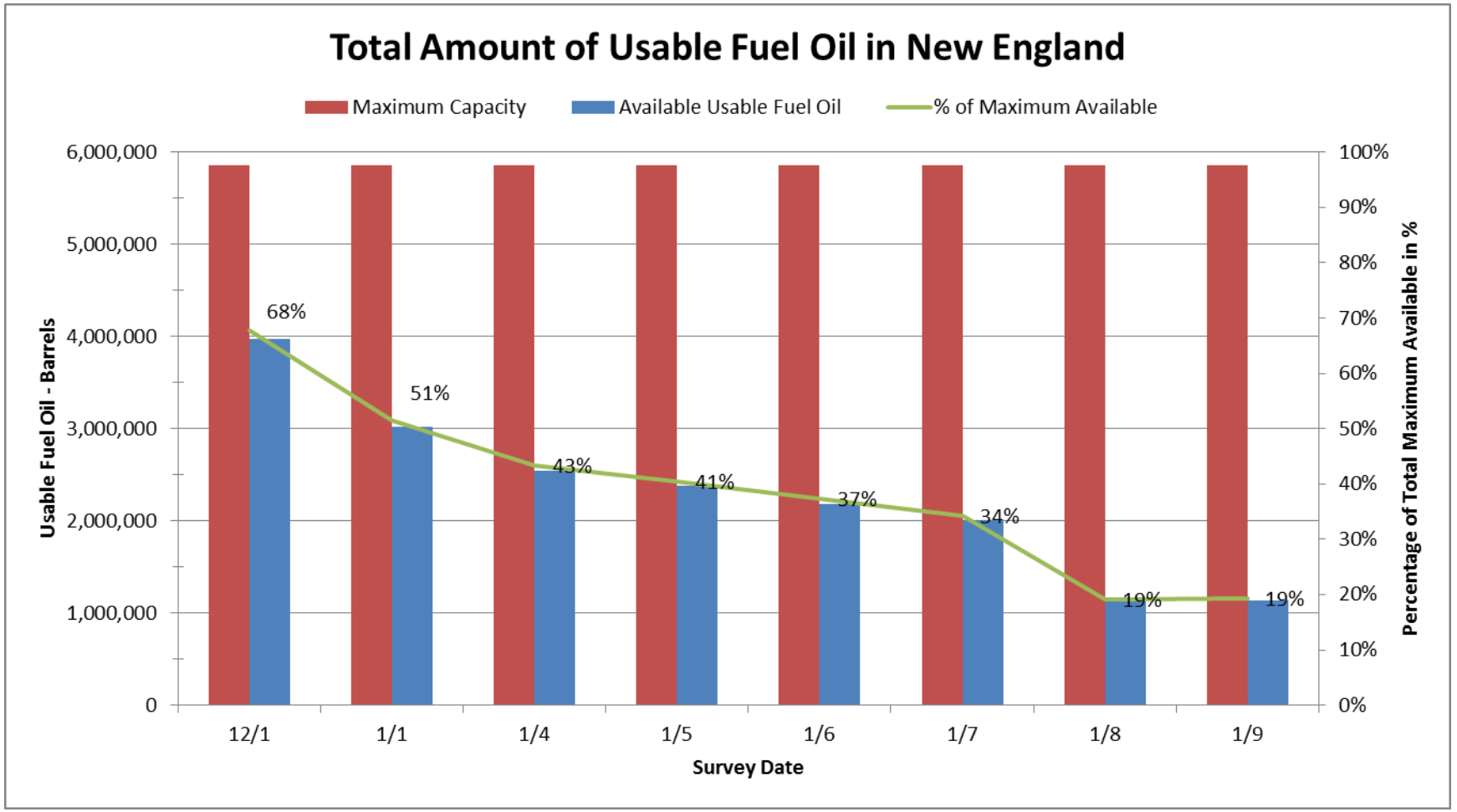
This chart is the ISO's best approximation of usable oil discounting for unit outages, reductions, or emissions

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



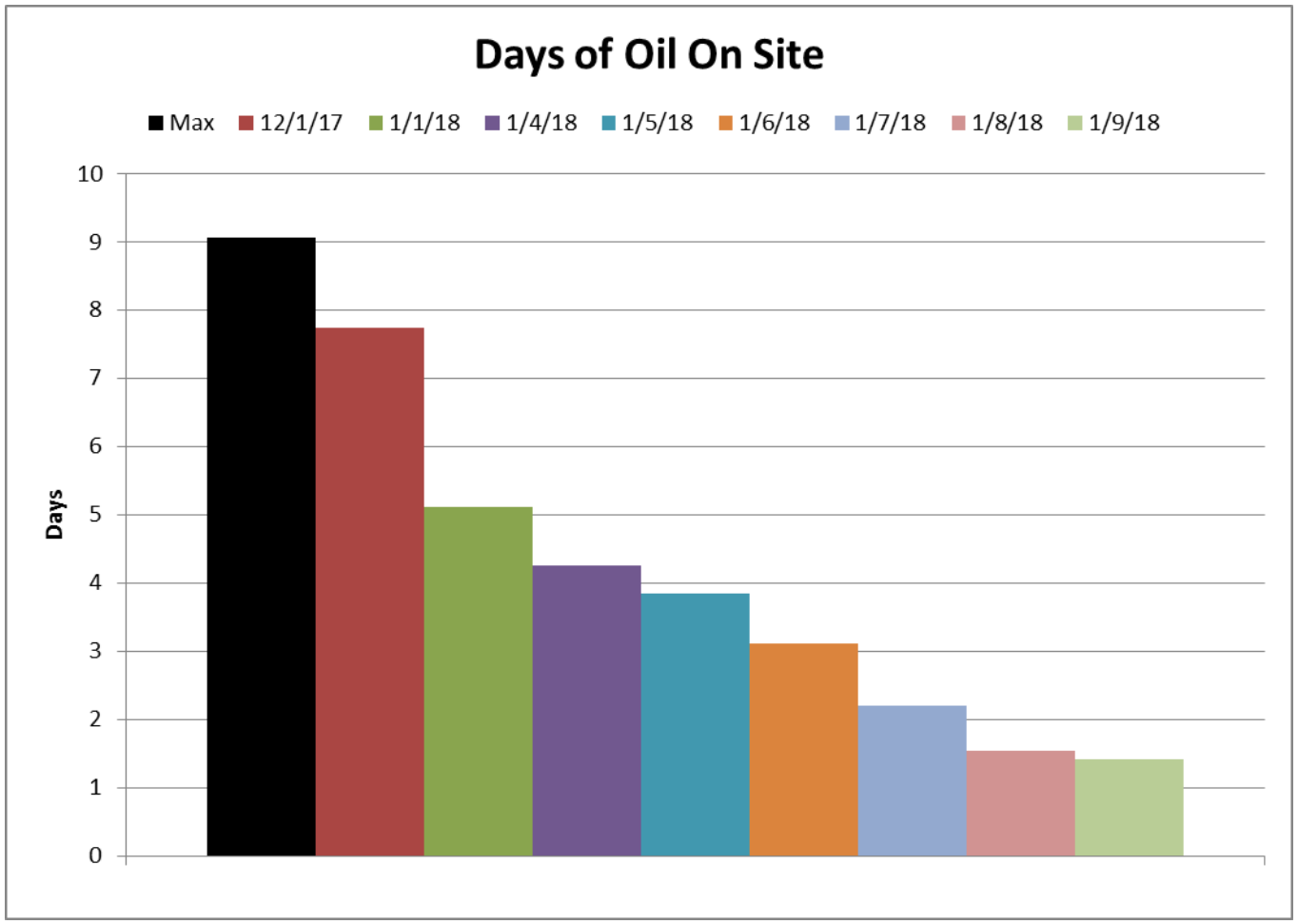
This chart is the ISO's best approximation of usable oil discounting for unit outages, reductions, or emissions

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

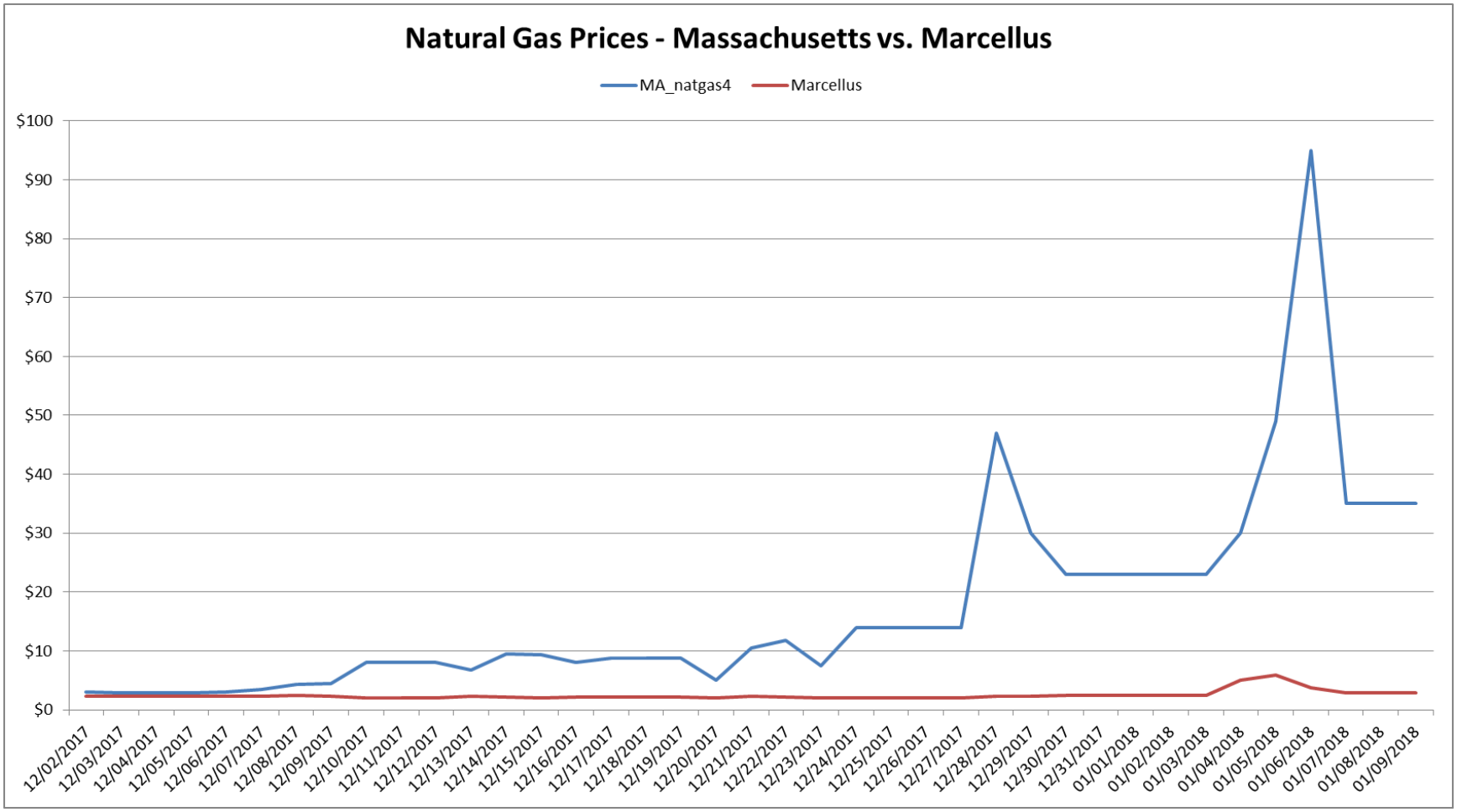
MA Governor Provides Relief for Fuel Deliveries

- 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

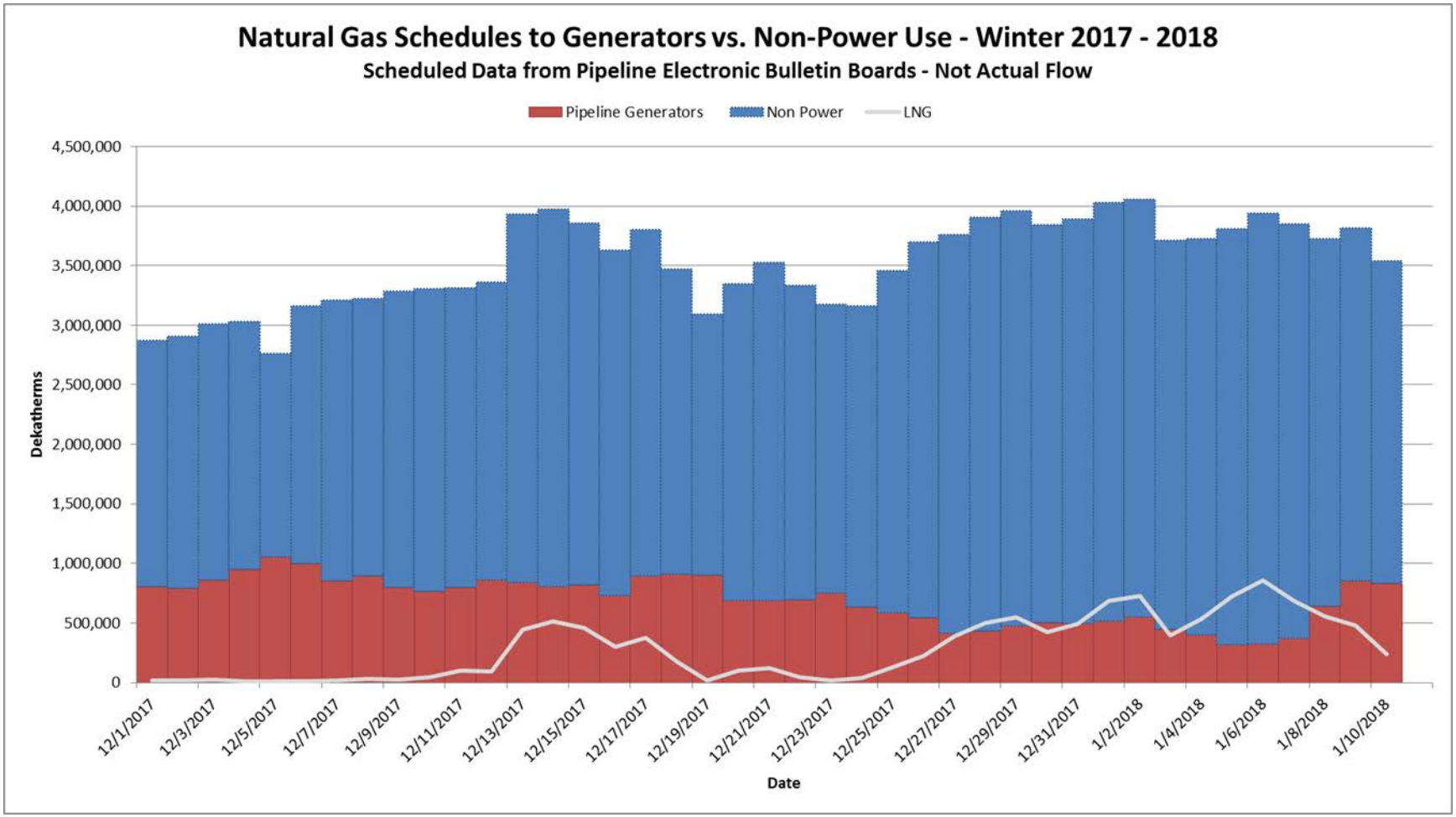
Fuel Surveys

- 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

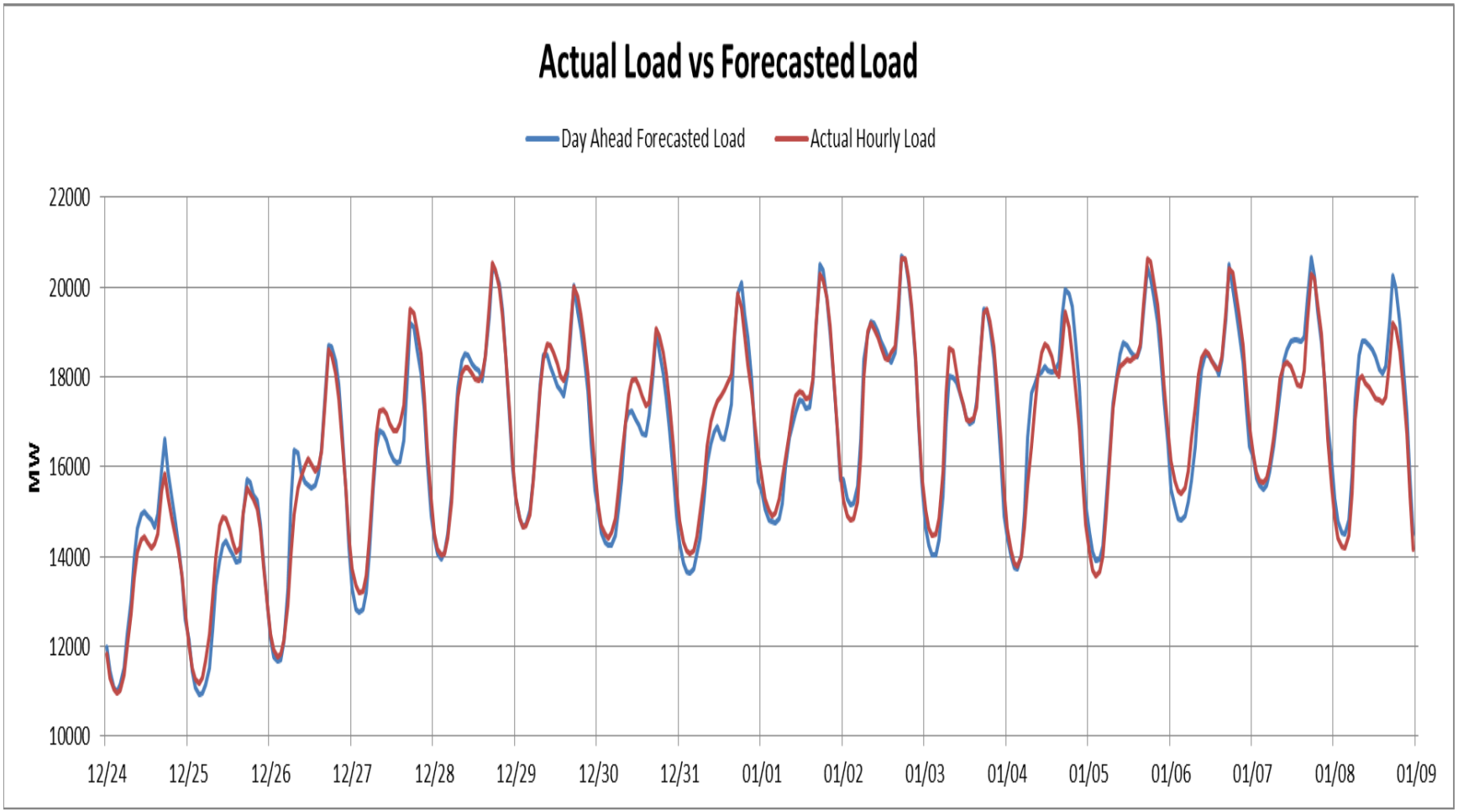
System Operations: Communications

- 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

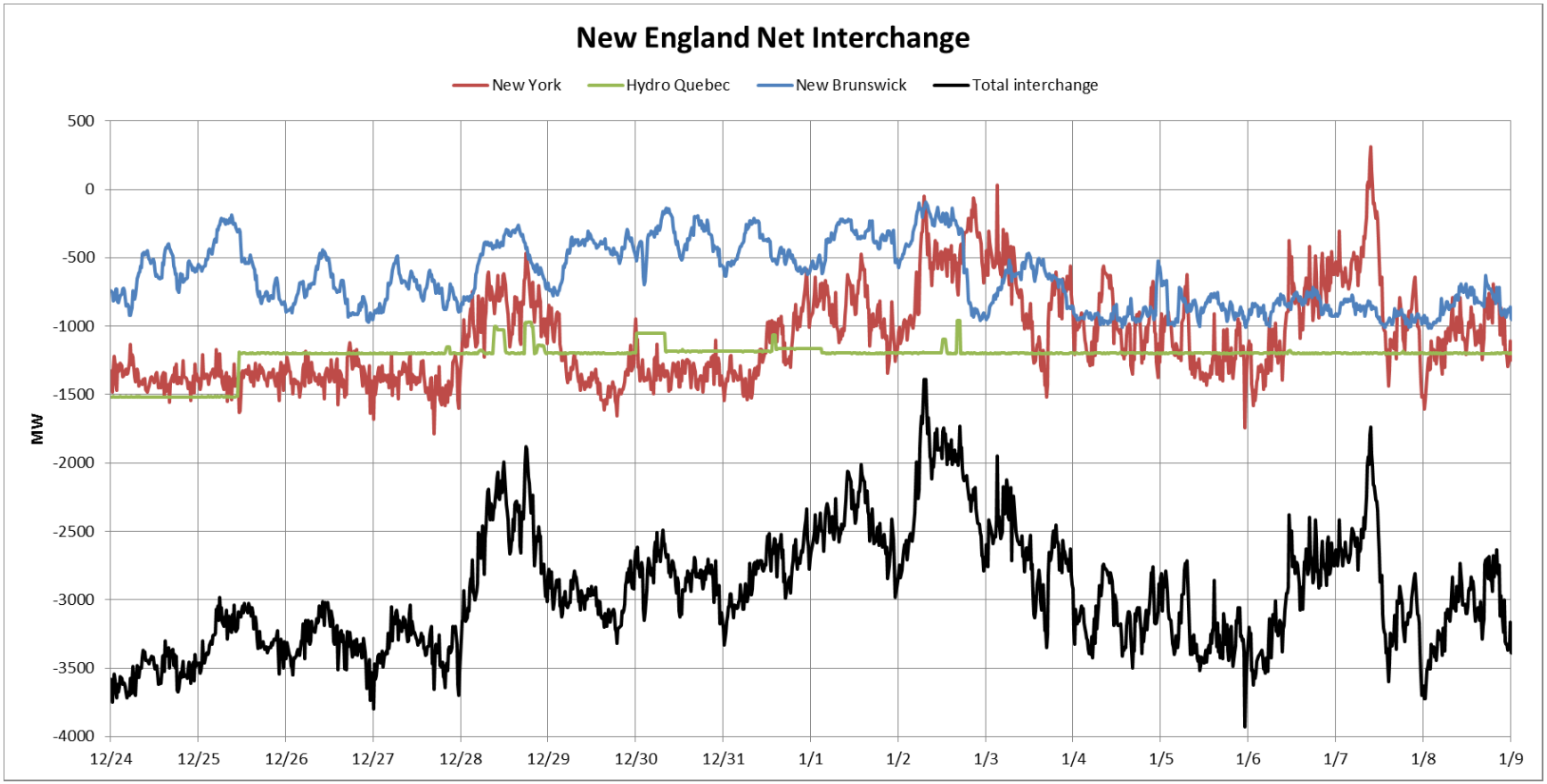
Significant Transmission Events:

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

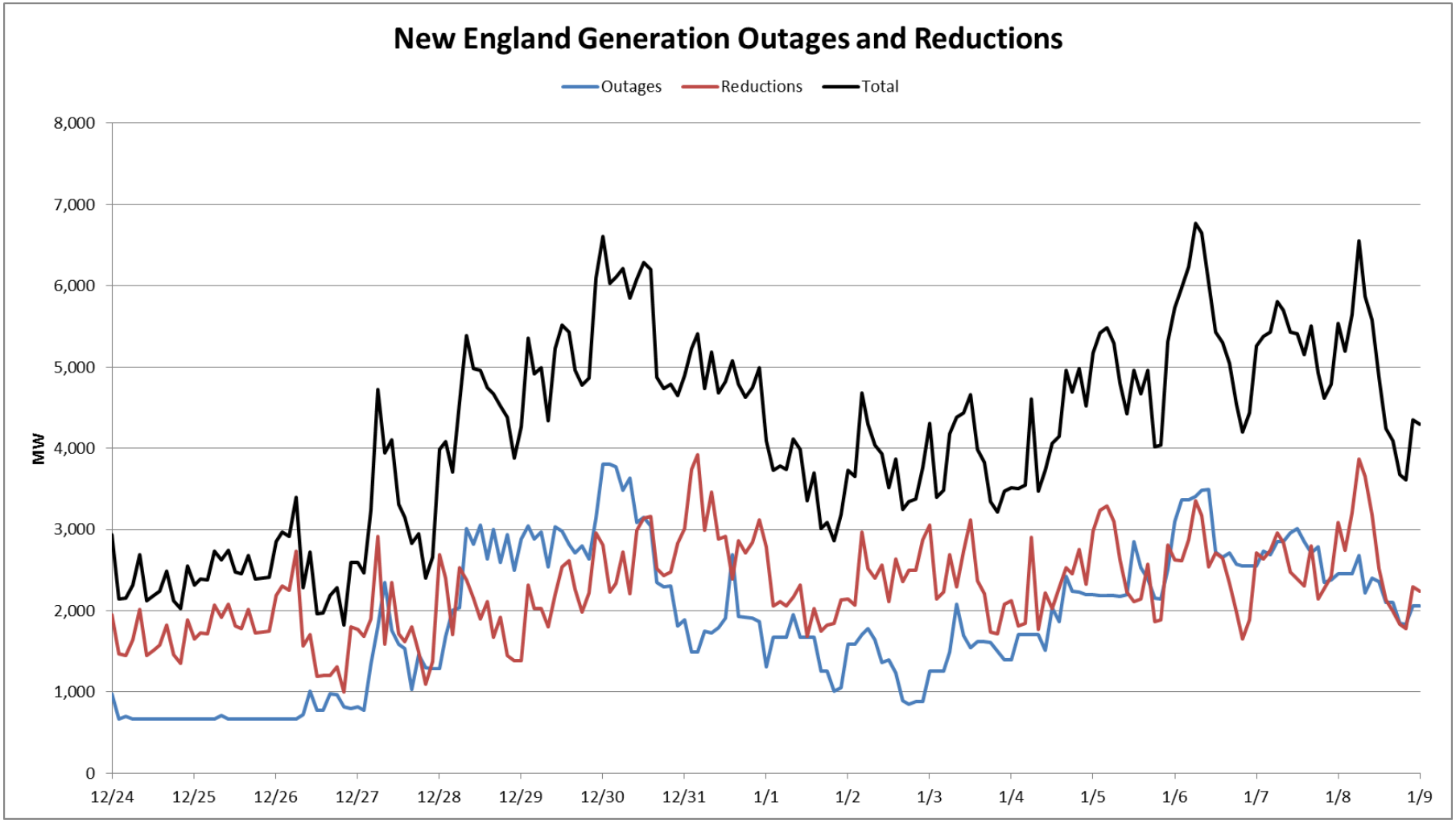
System Operations: Interchange

- 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

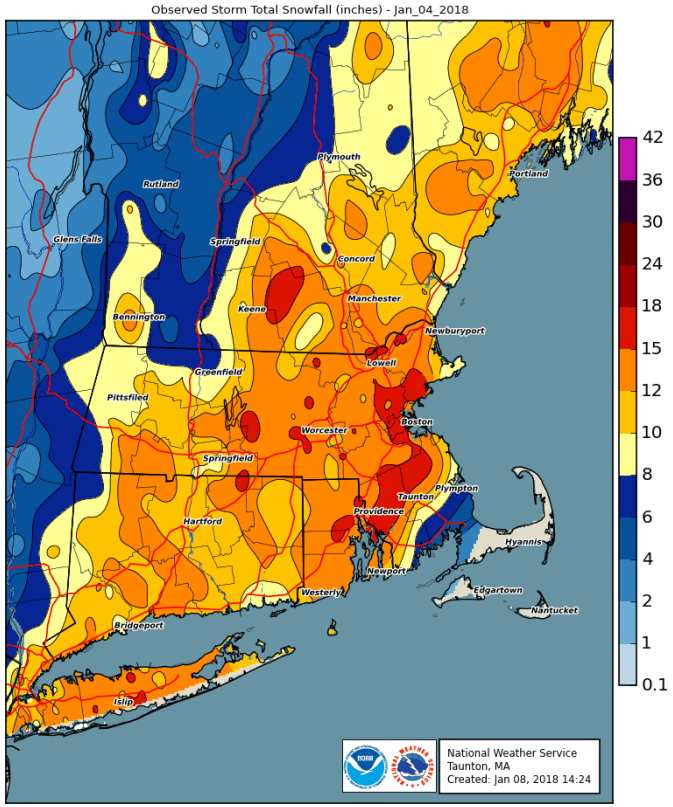
System Operations: Commitment Challenges

- 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

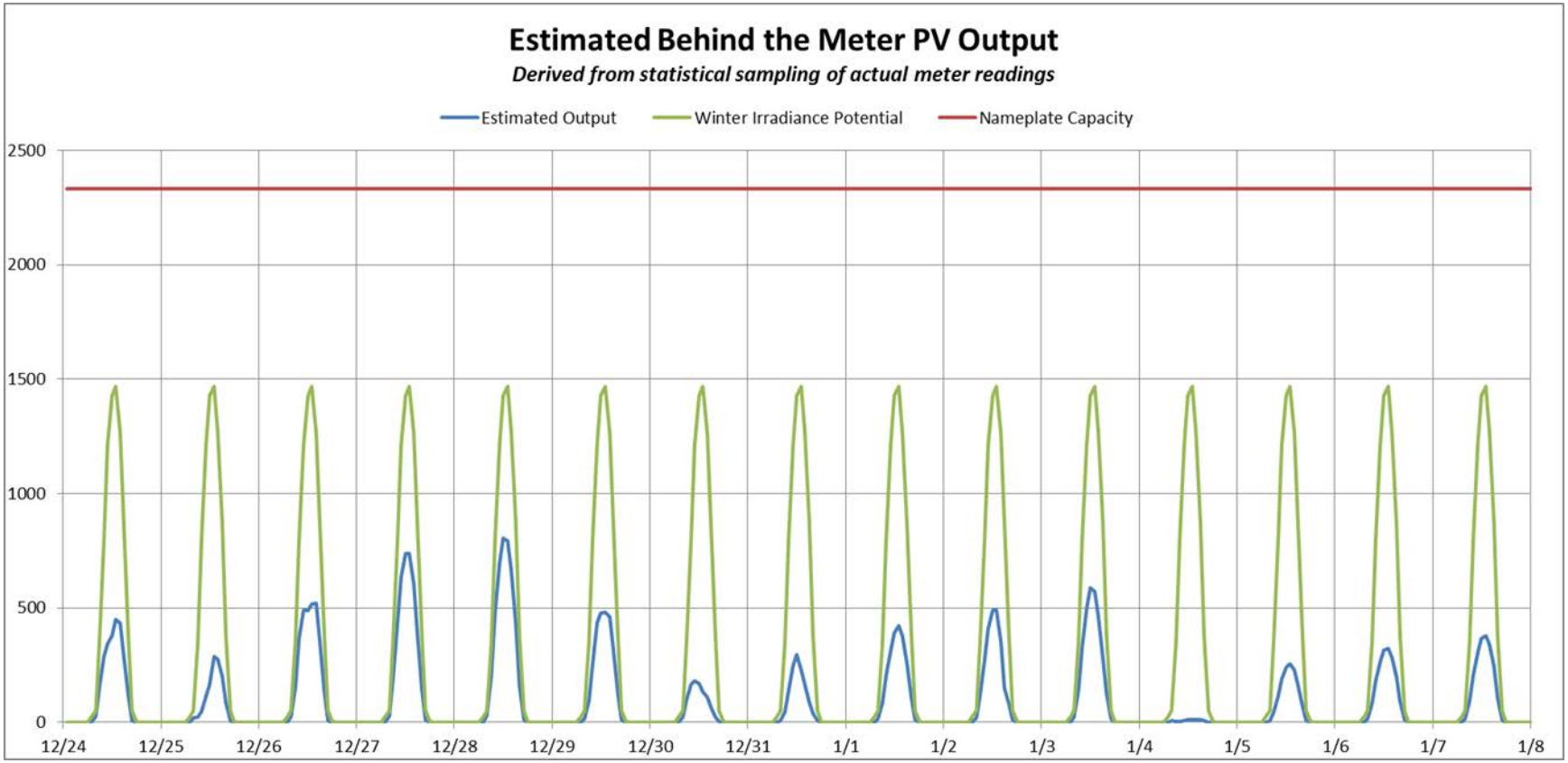
PV AND WIND OUTPUT

Impact of Snowfall on Energy from PV

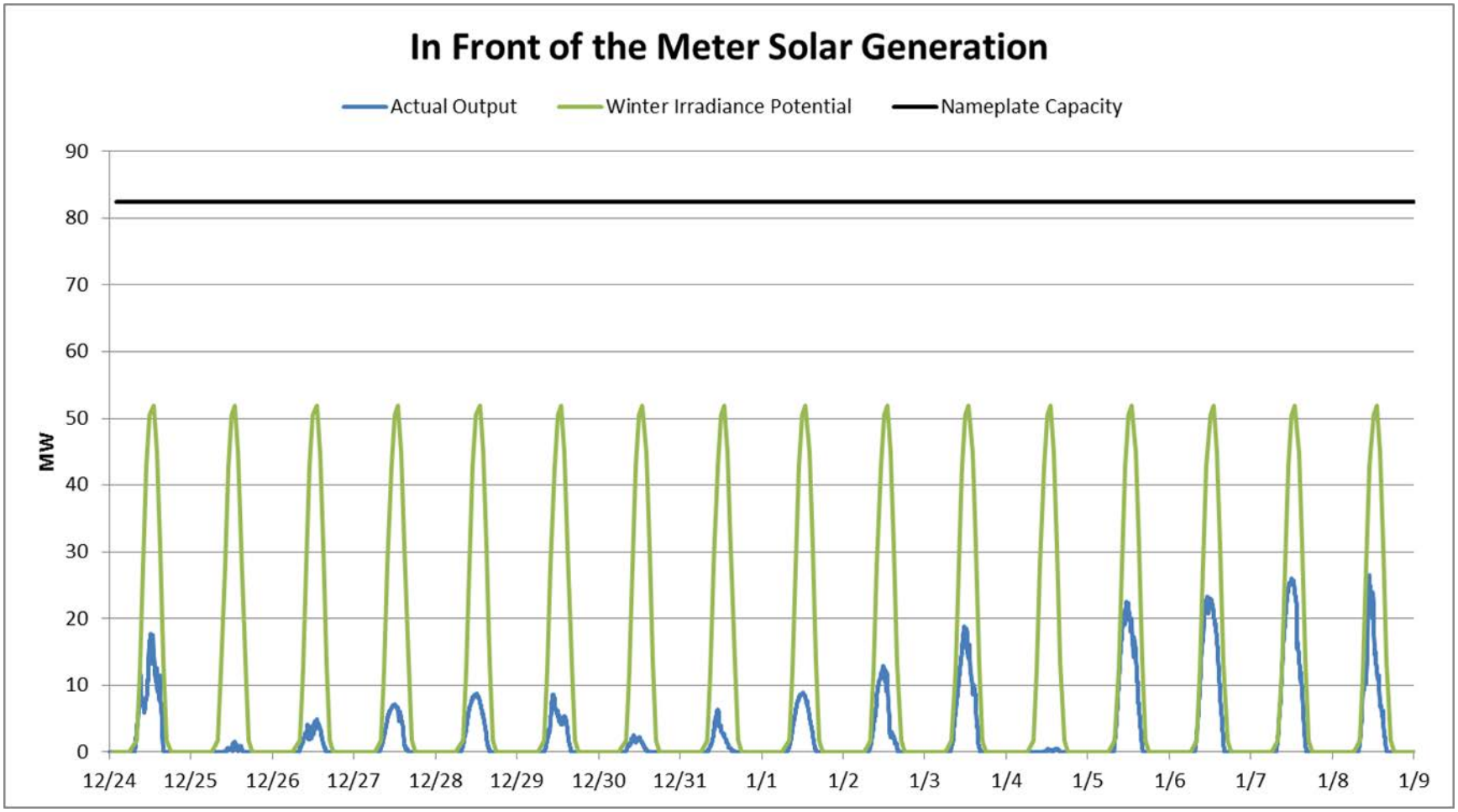
- Snowfall followed by cold weather led to uncertainty of load forecast accuracy
- It is necessary to continue to improve the understanding of snowfall on PV resources in New



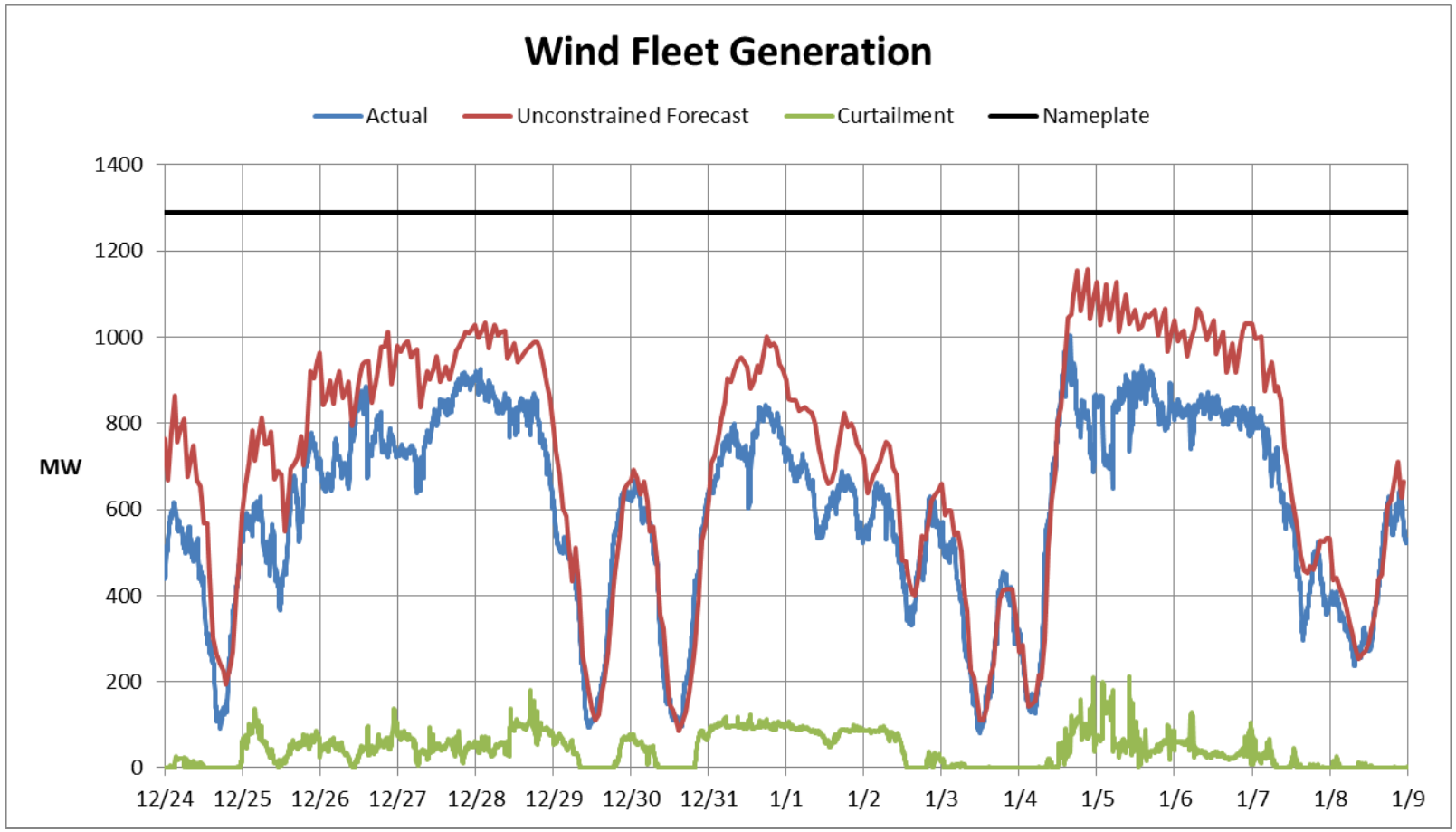
PV Generation – Behind the Meter



PV Generation – In Front of the Meter



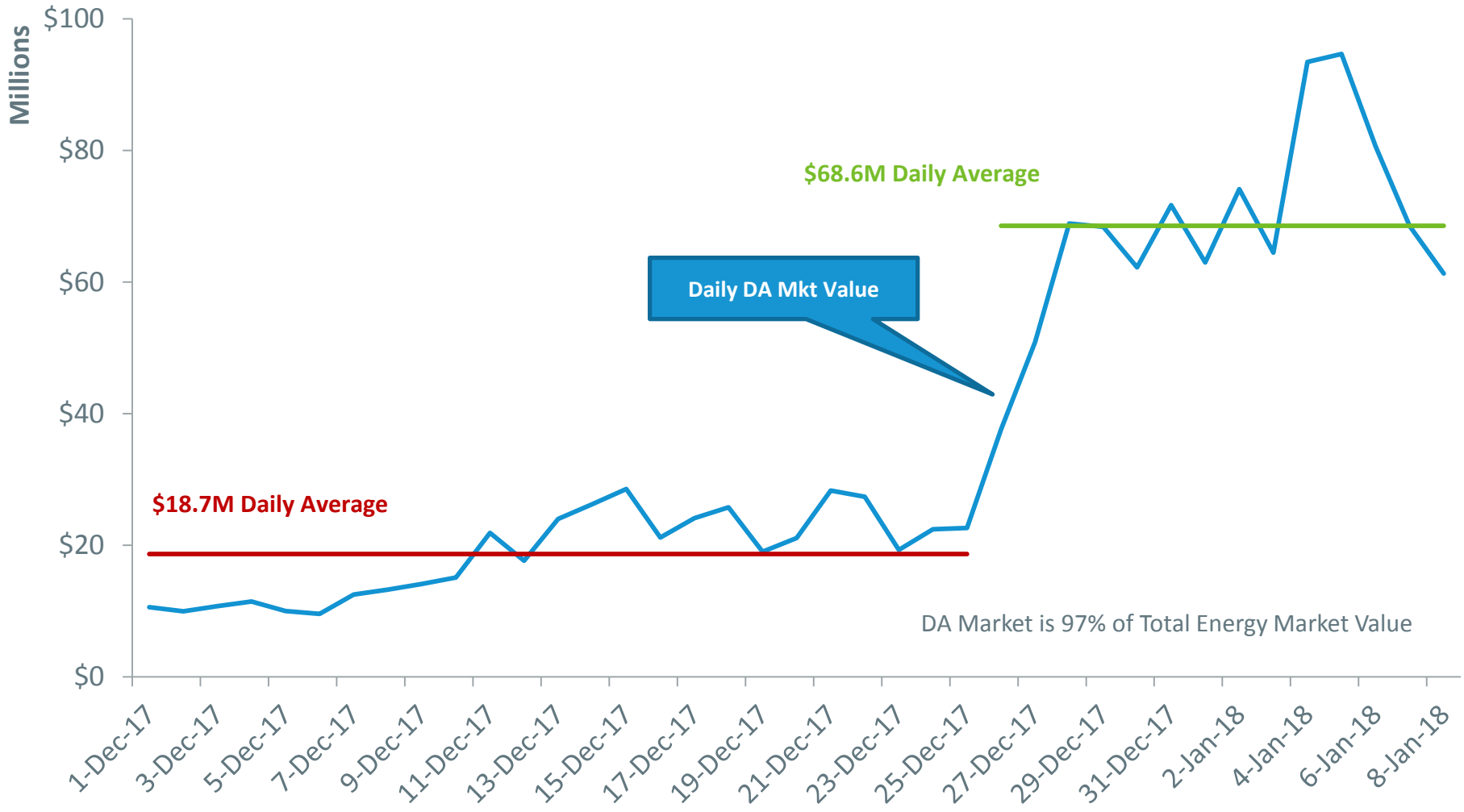
Wind Generation



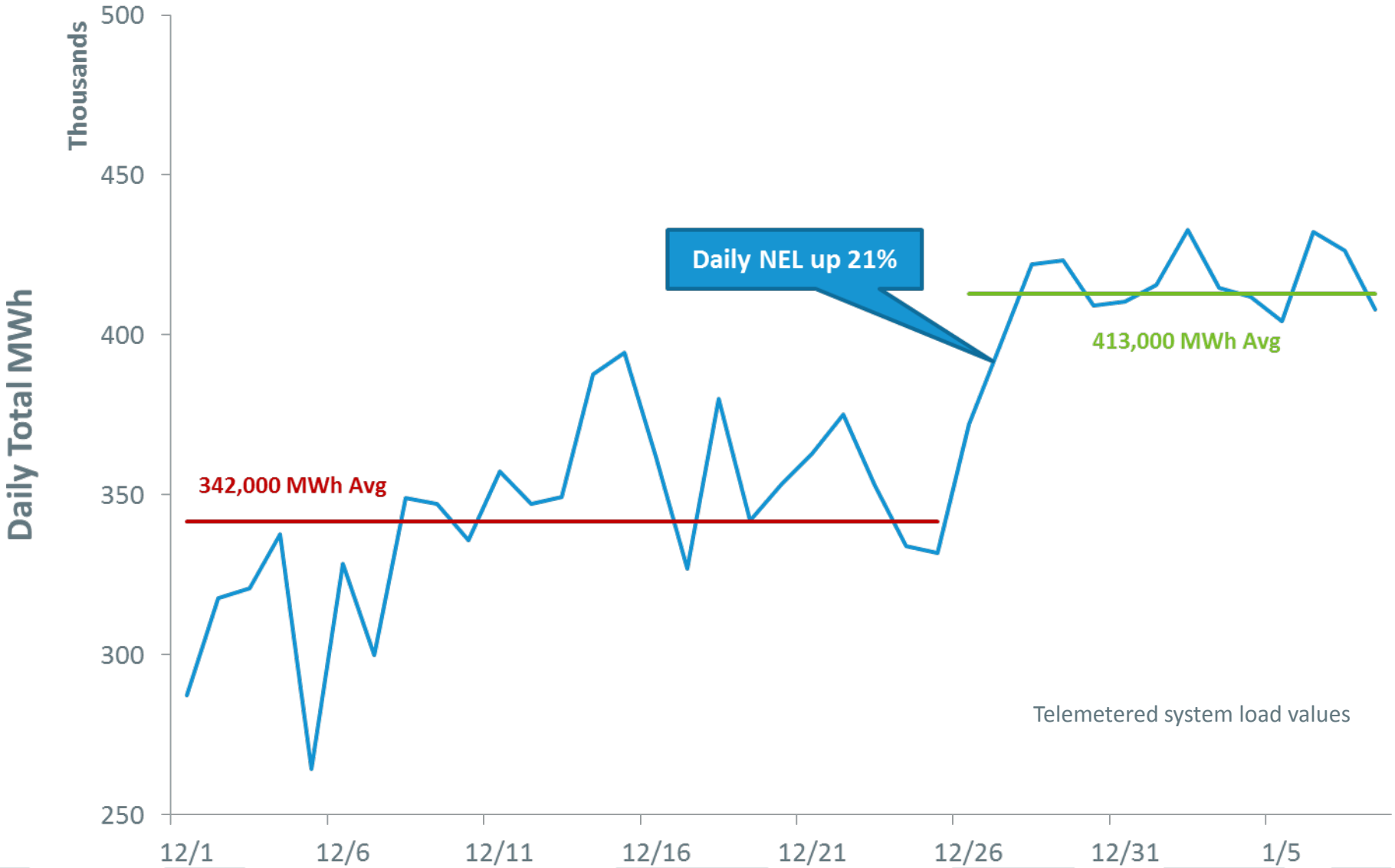
After 00:01 on 1/5/18, several wind plants in the region experienced intermittent high speed wind cutout events. Curtailments are due to transmission congestion.

MARKET DATA

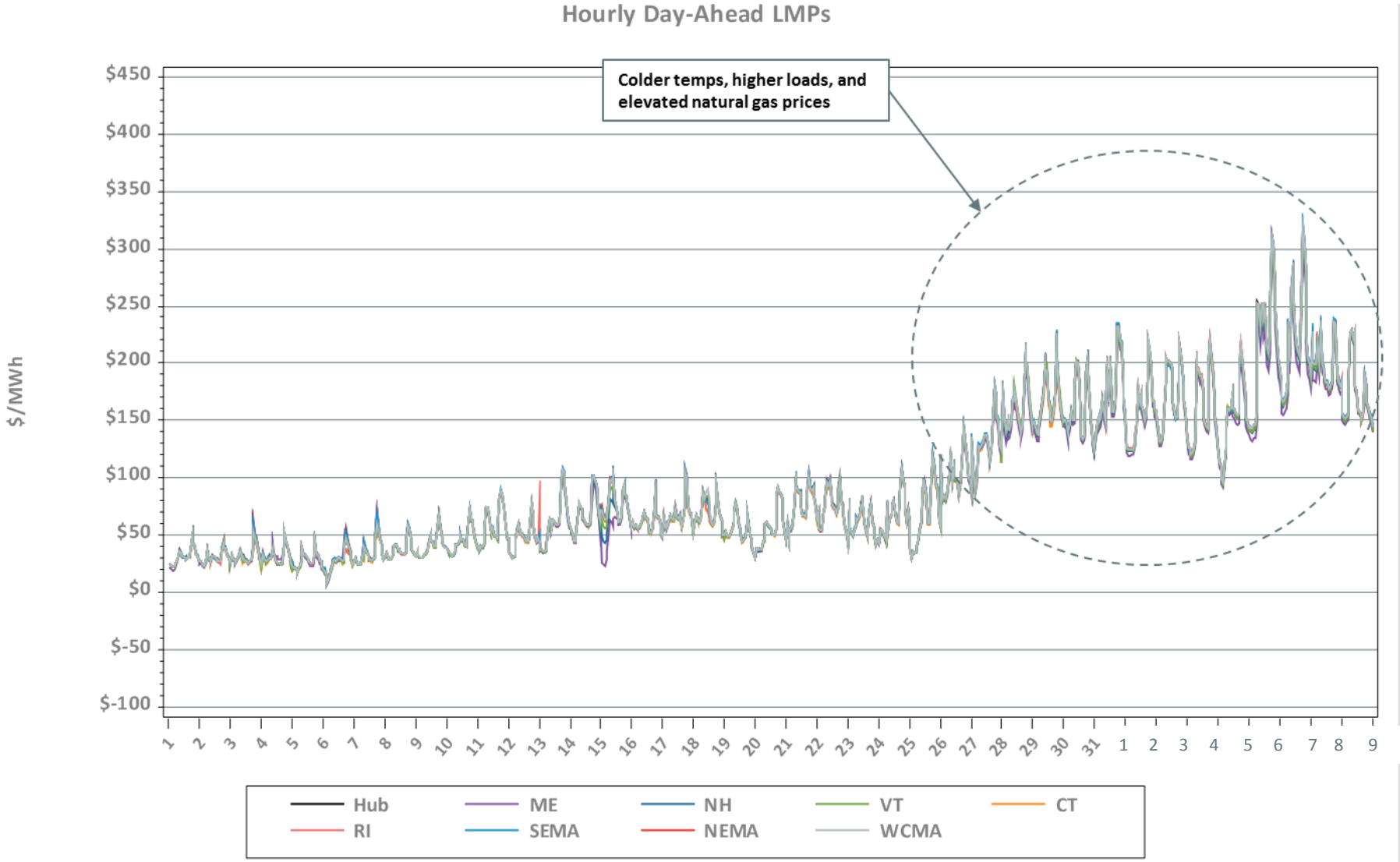
Daily DA Market Cost Before and During the Cold Snap



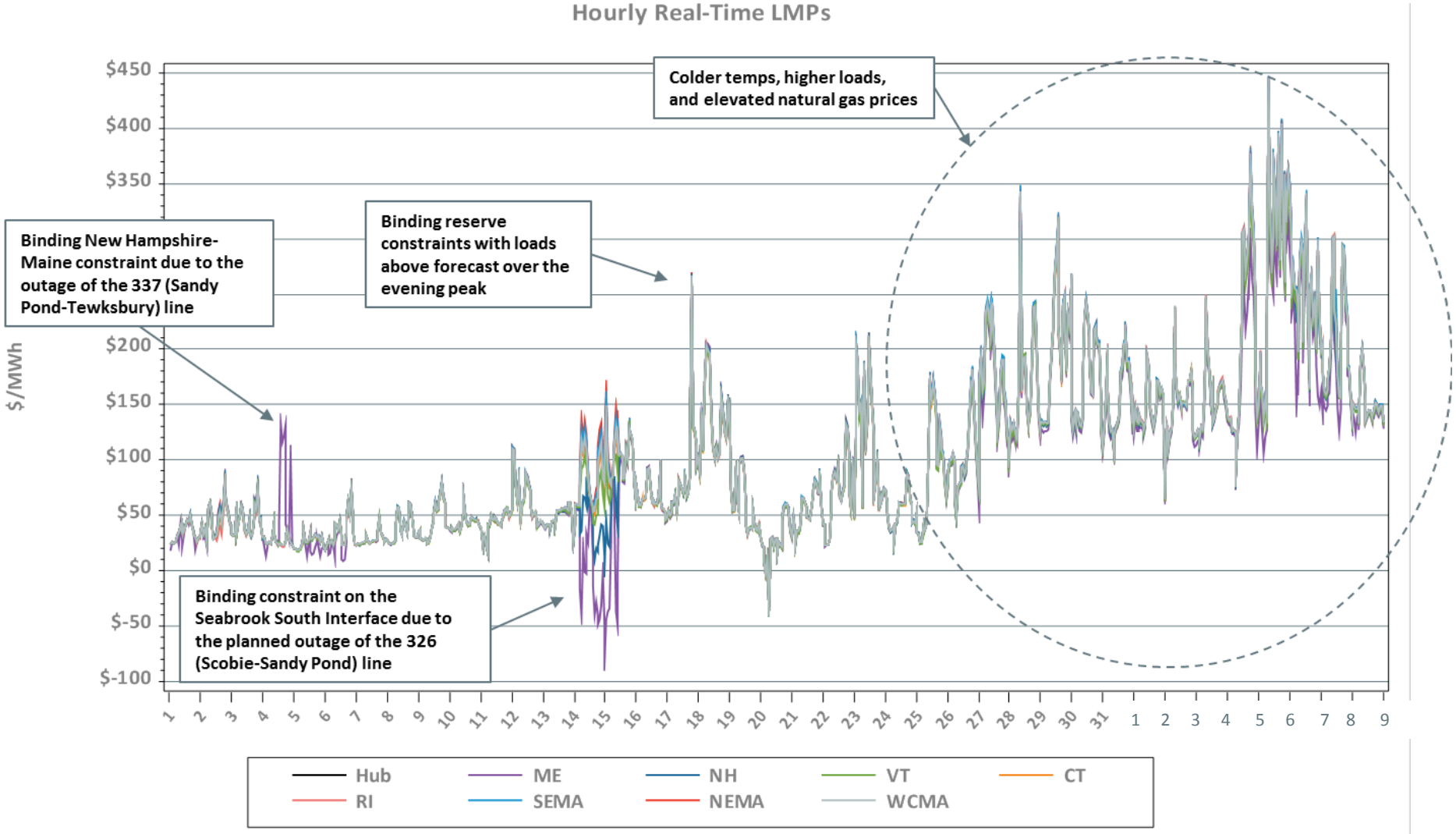
Daily System Load Increased 21% after Christmas



Hourly DA LMPs, December 1-January 8

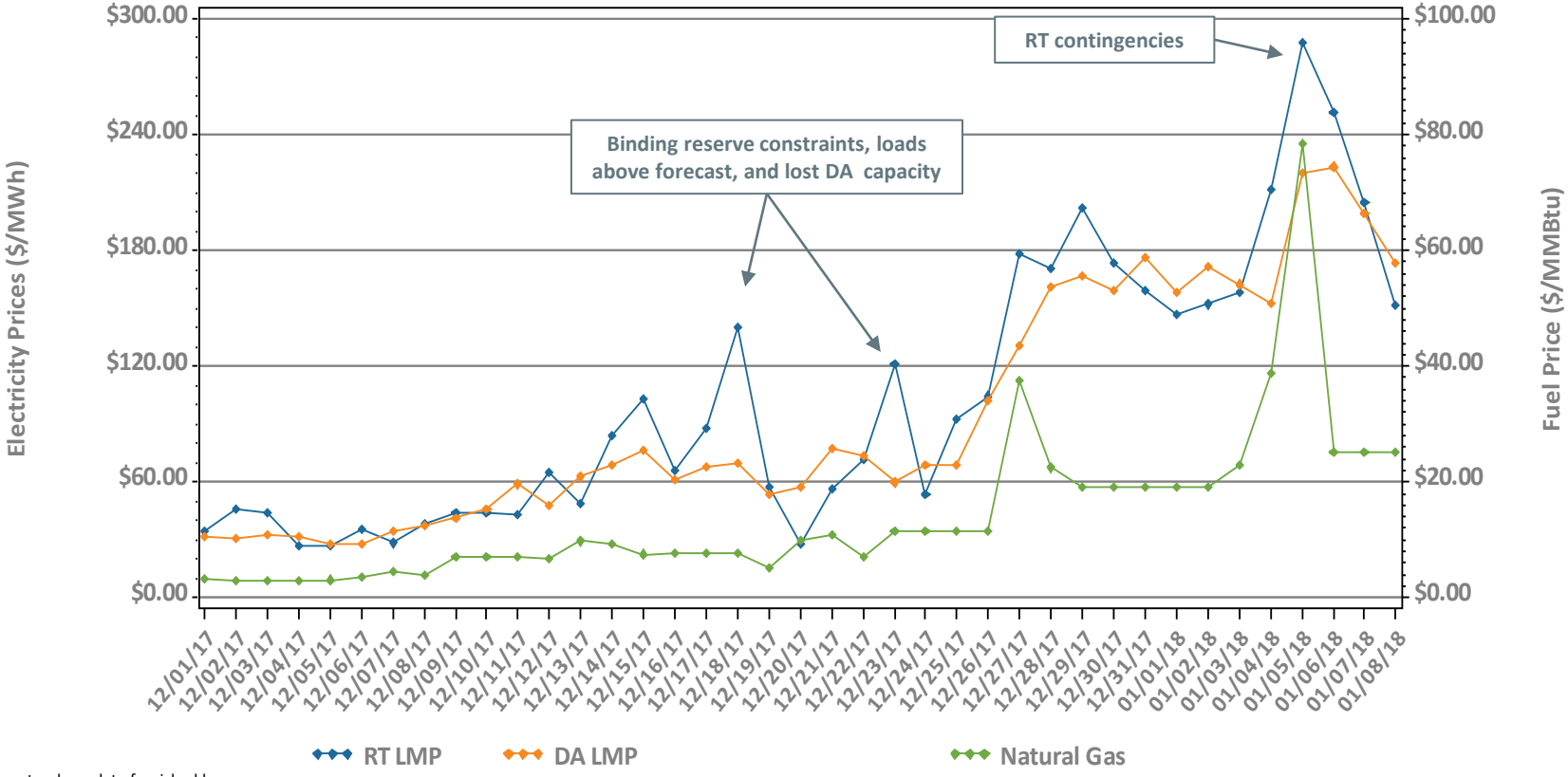


Hourly RT LMPs, December 1-January 8



* 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

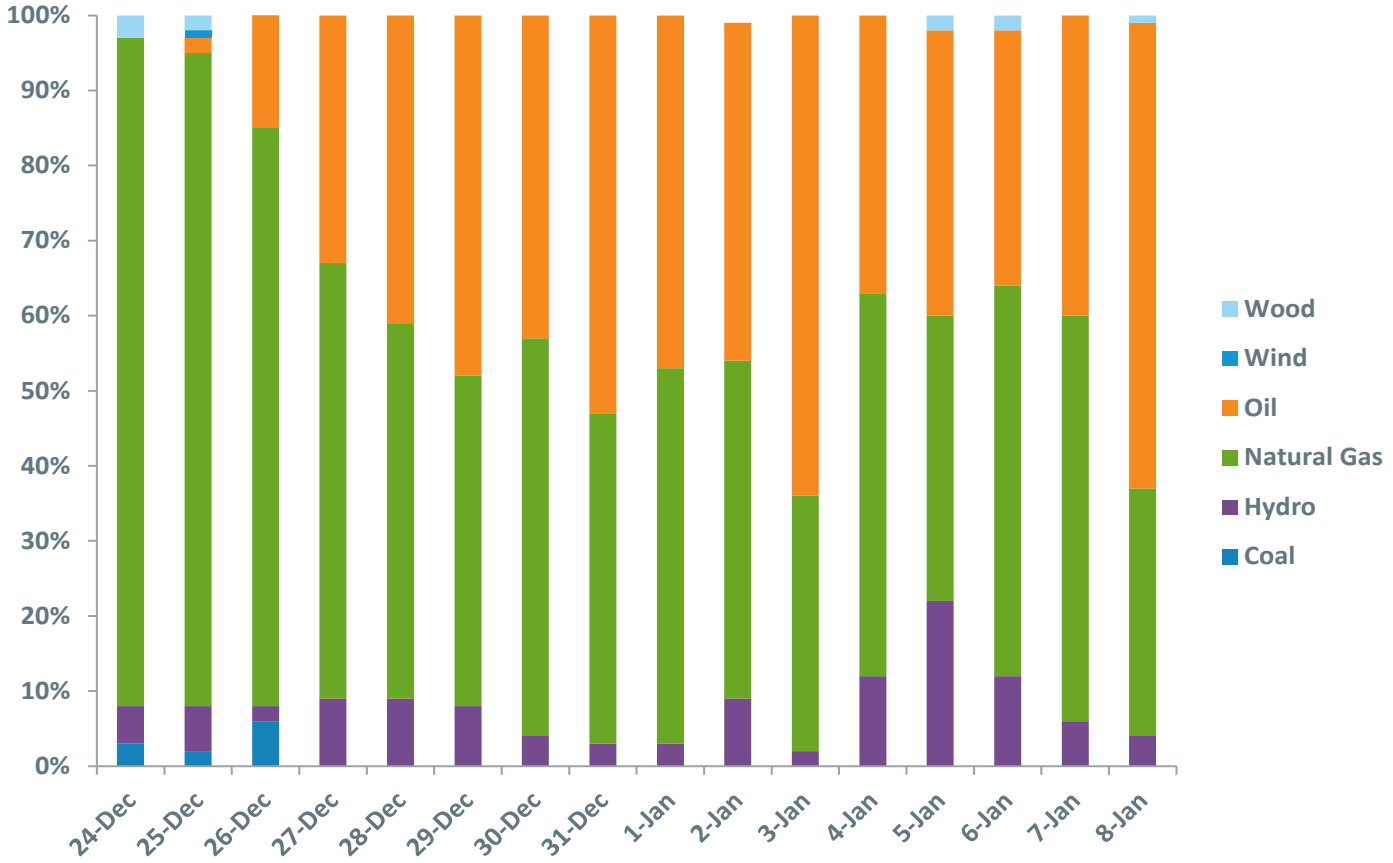


Underlying natural gas data furnished by:

ICE Global markets in clear view

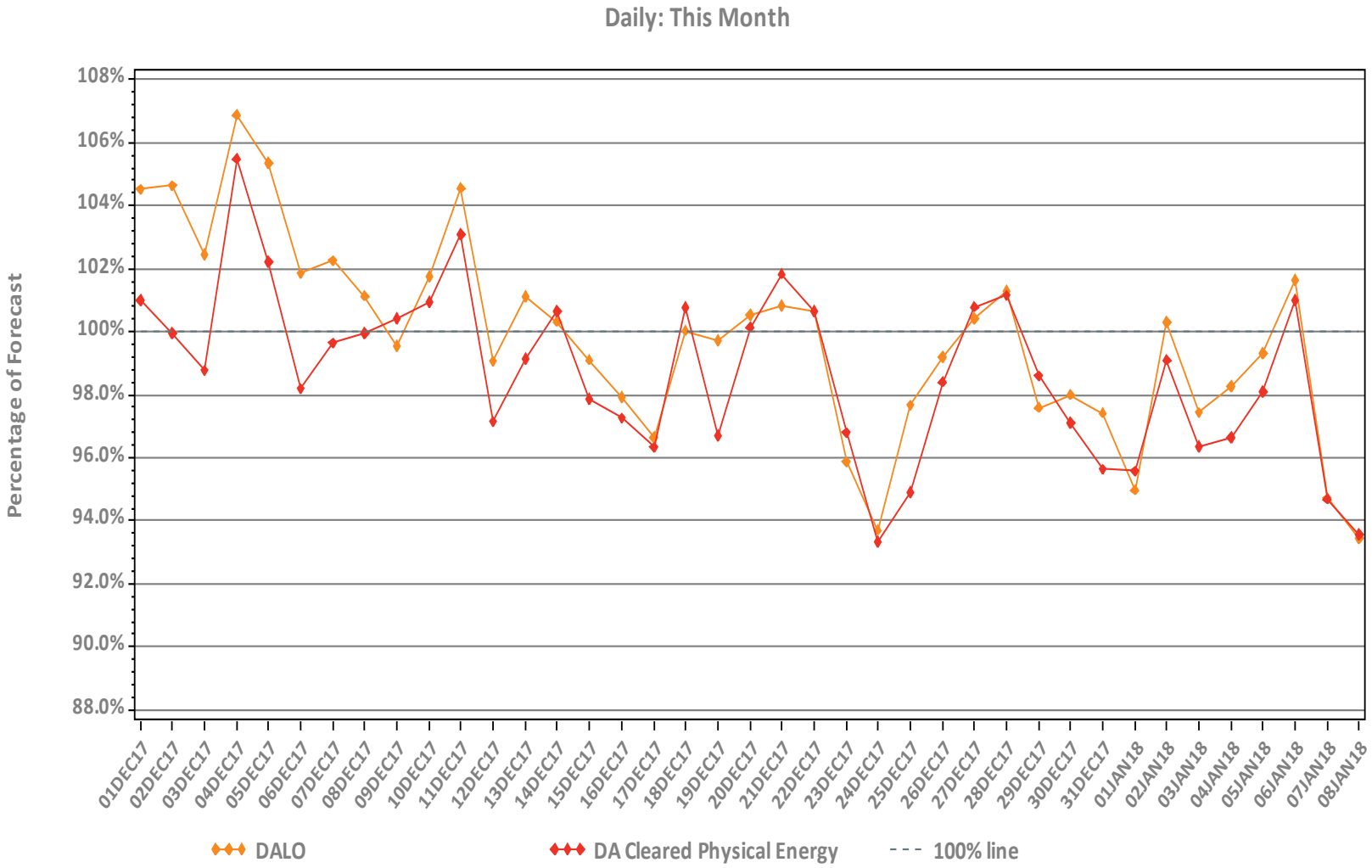
Average price difference over this period (DA-RT): $-12.91
Average price difference over this period ABS(DA-RT): $27.19
Average percentage difference over this period ABS(DA-RT)/RT Average LMP: 14%
Gas price is average of Massachusetts delivery points

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



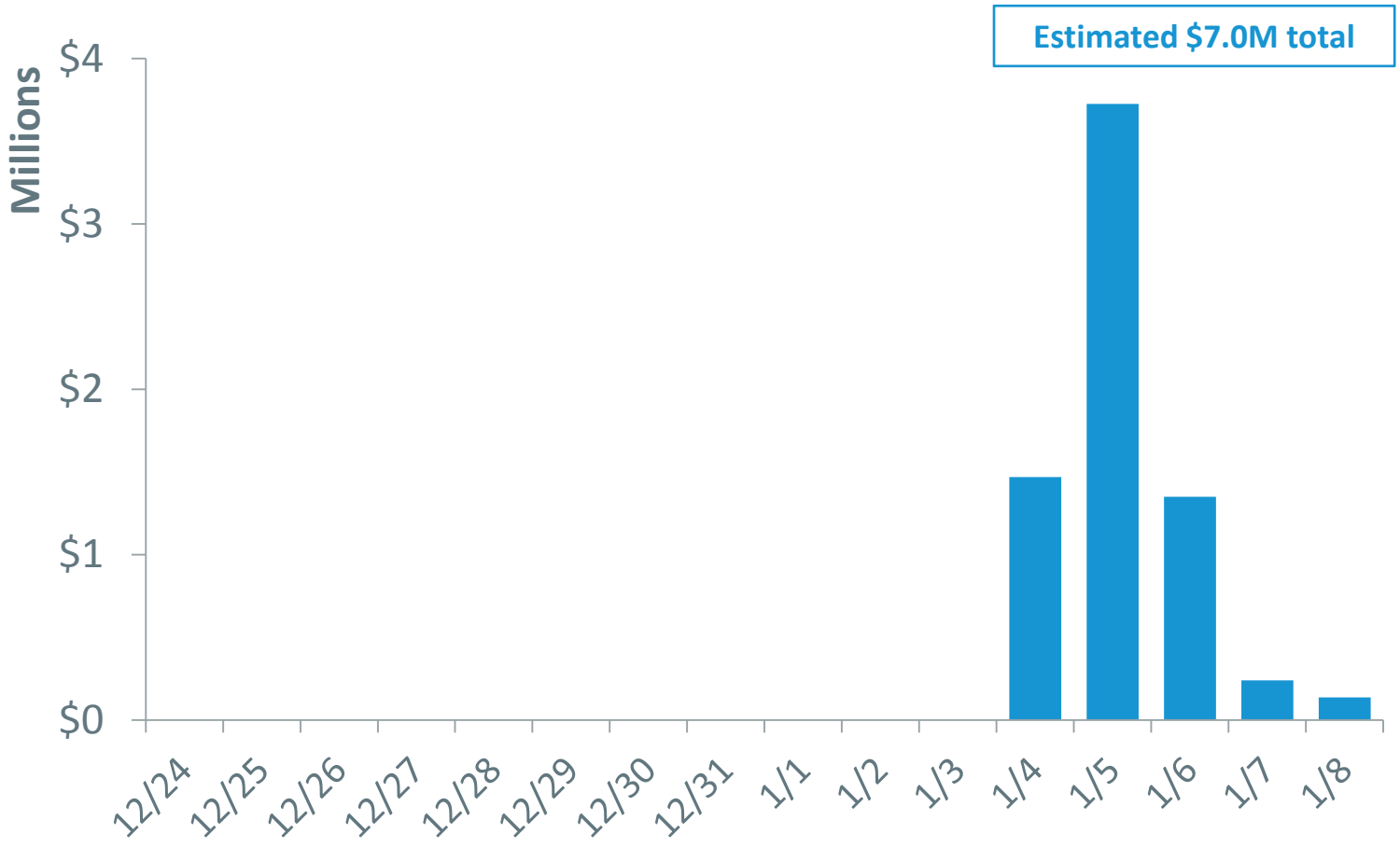
Note: Reflects price-setting by fuel-type during all intervals when the transmission system was unconstrained

DA Volumes as % of Forecast in Peak Hour



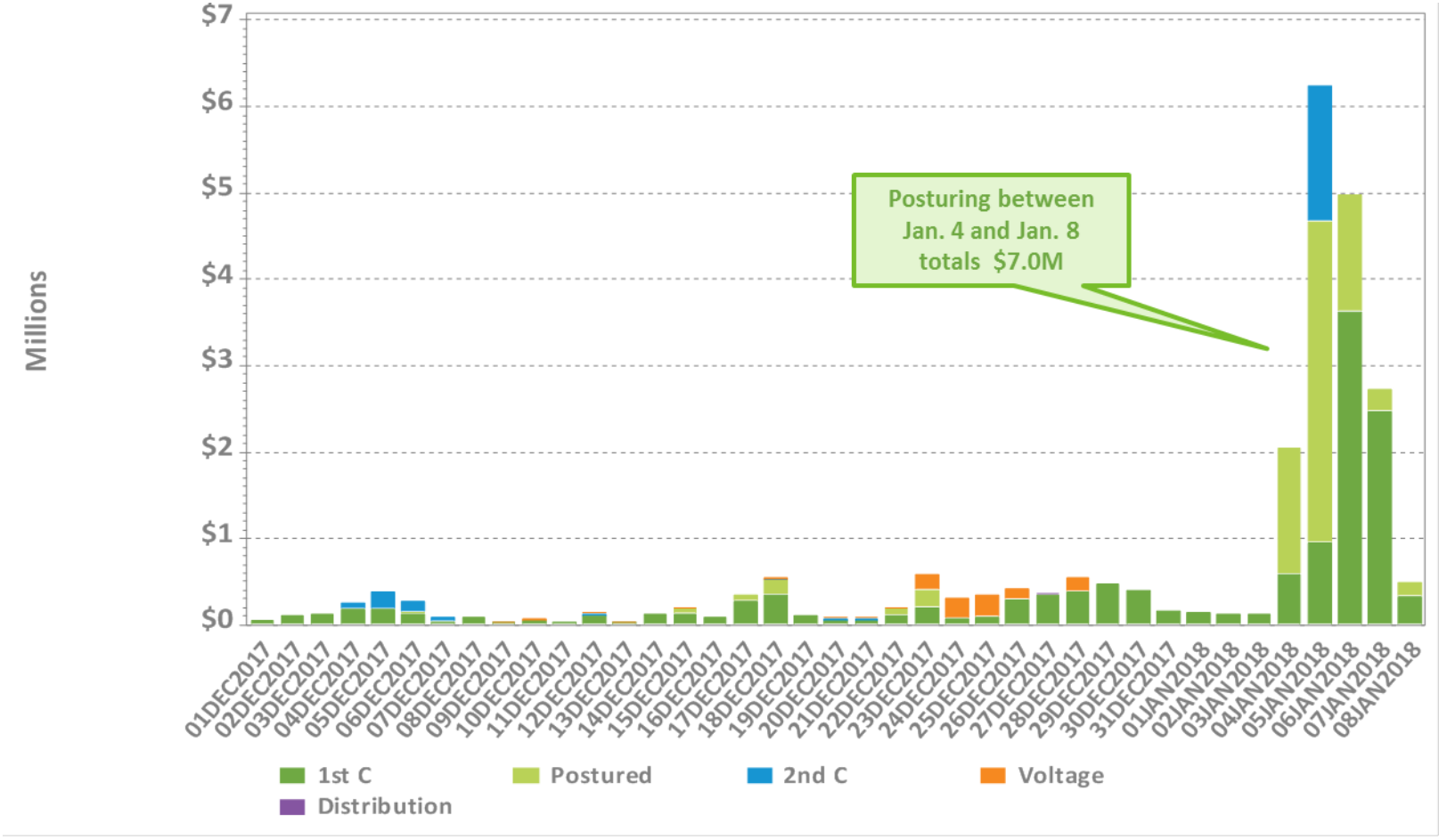
Note: DA Cleared Physical Energy includes DA generation and net imports

Real-Time Posturing NCPC



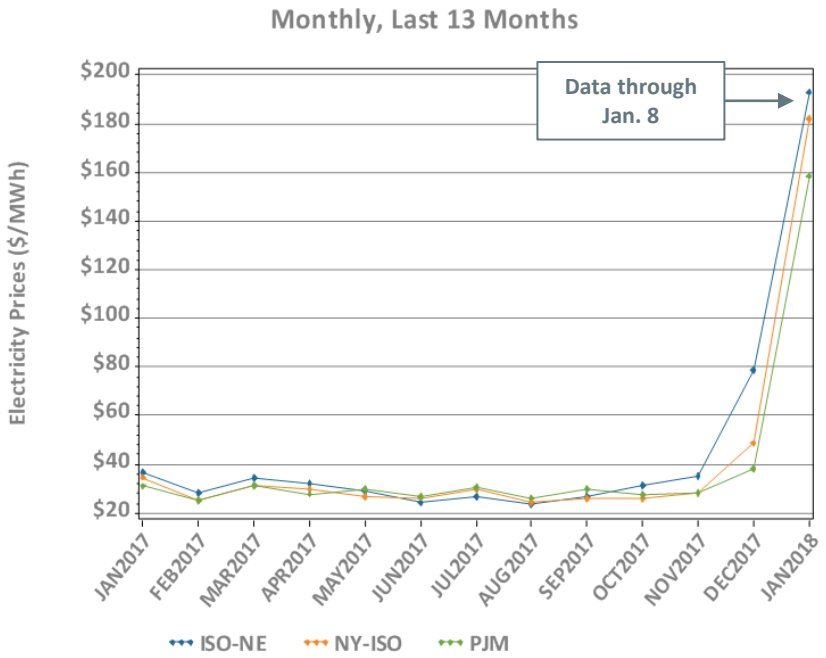
Does not show 'totals' of generation deviations charged to postured resources

Daily NCPC Charges by Type

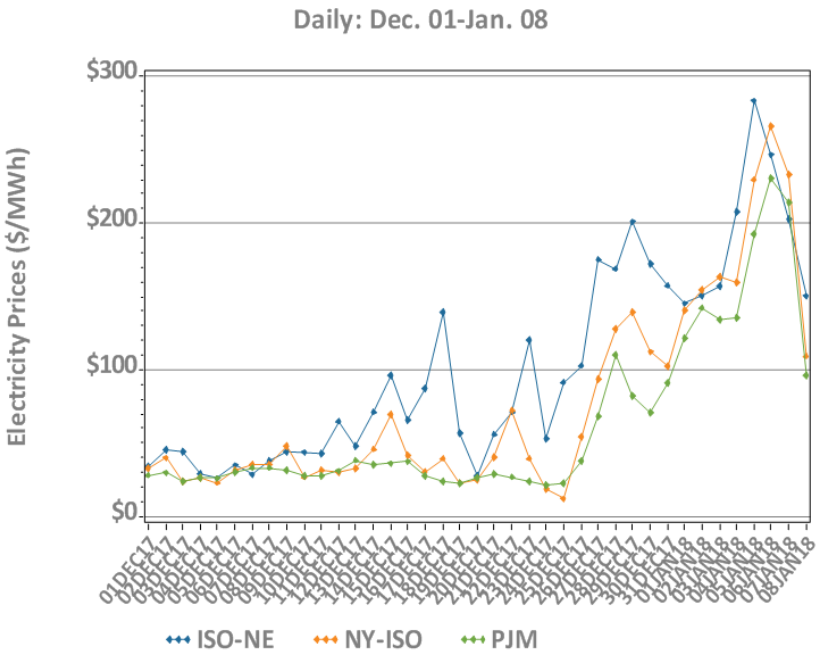


Note: Data for January 5-8 reflect preliminary settlements

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