ISO-NE Cold Weather Operations

December 24, 2017 – January 8, 2018

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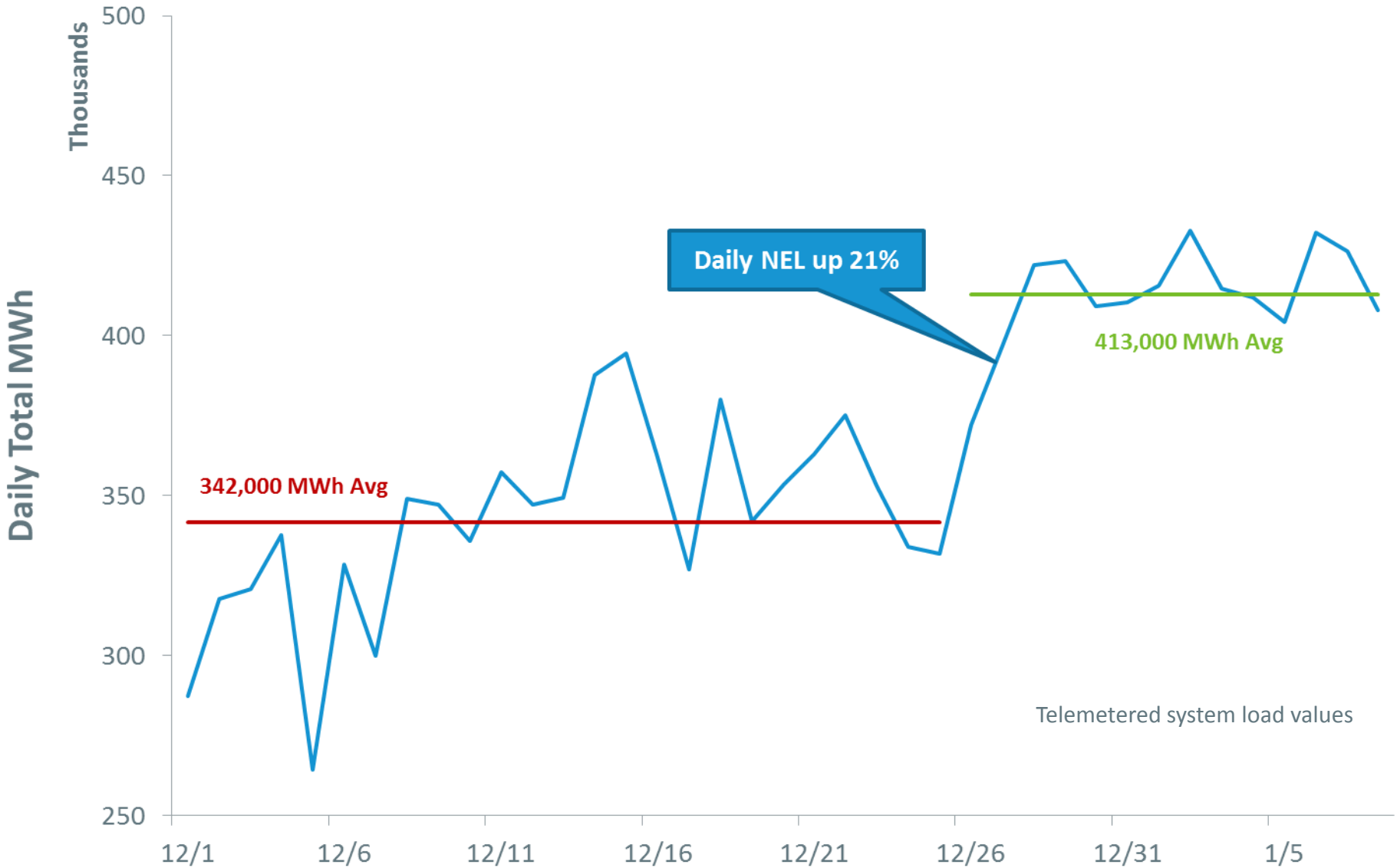
COLD WEATHER CONDITIONS

Arctic Outbreak 2017-2018

- 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, Arctic air-mass brought some of the most extreme cold in 100 years with above average winds causing extended periods of frigid wind chill temperatures.
- A powerful blizzard (Grayson) briefly moderated temperatures on 1/3-1/4, but left 13 inches of snow in Boston with varying amounts across the region

Daily System Load Increased 21% after Christmas



FUEL MIX

2017/18 Winter Reliability Program

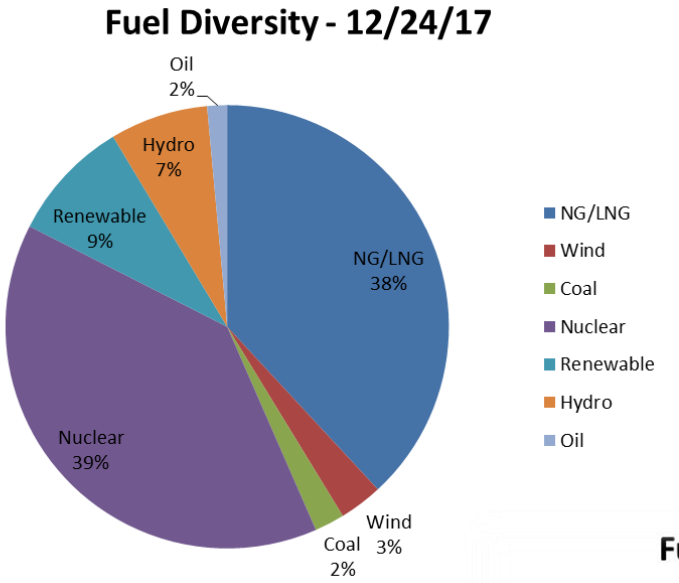
- The ISO-NE Winter Reliability Program was instrumental in helping maintain system reliability during this event.
  - The program was designed to incent plants to stockpile fuel reserves
  - acquire additional DR

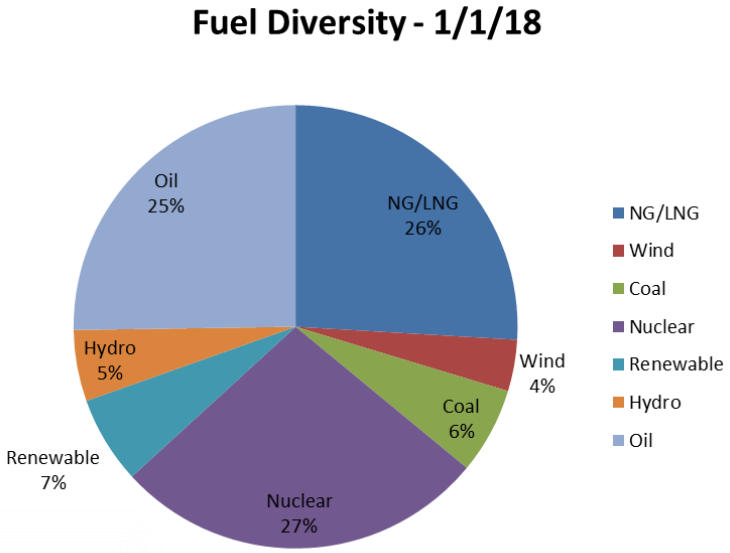
- Oil Program Participation
  - 86 units participated procuring total of 3.9 million barrels of oil
  - 2.9 million barrels of the total inventory was eligible for compensation per the winter program rules
- DR Program Participation
  - Acquired additional DR providing 7.5 MW of interruptible capability

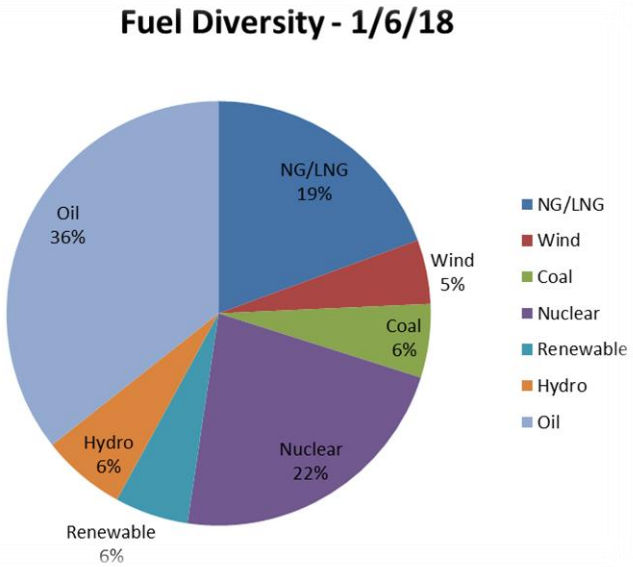
New England Fuel Mixture

- Overall, there was significantly higher than normal use of oil both as primary fuel and in dual fuel units
  - 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

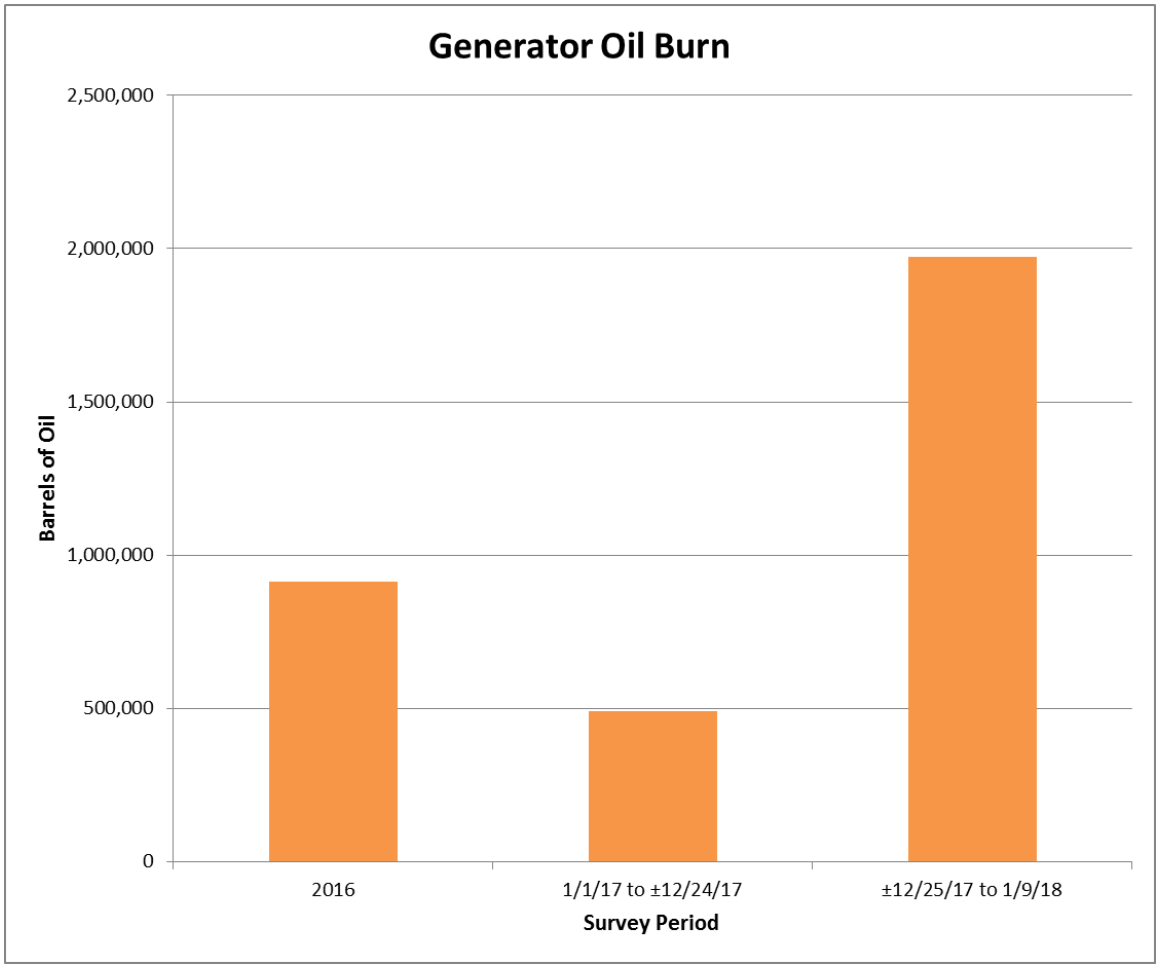
Fuel Diversity Pie Chart Summary



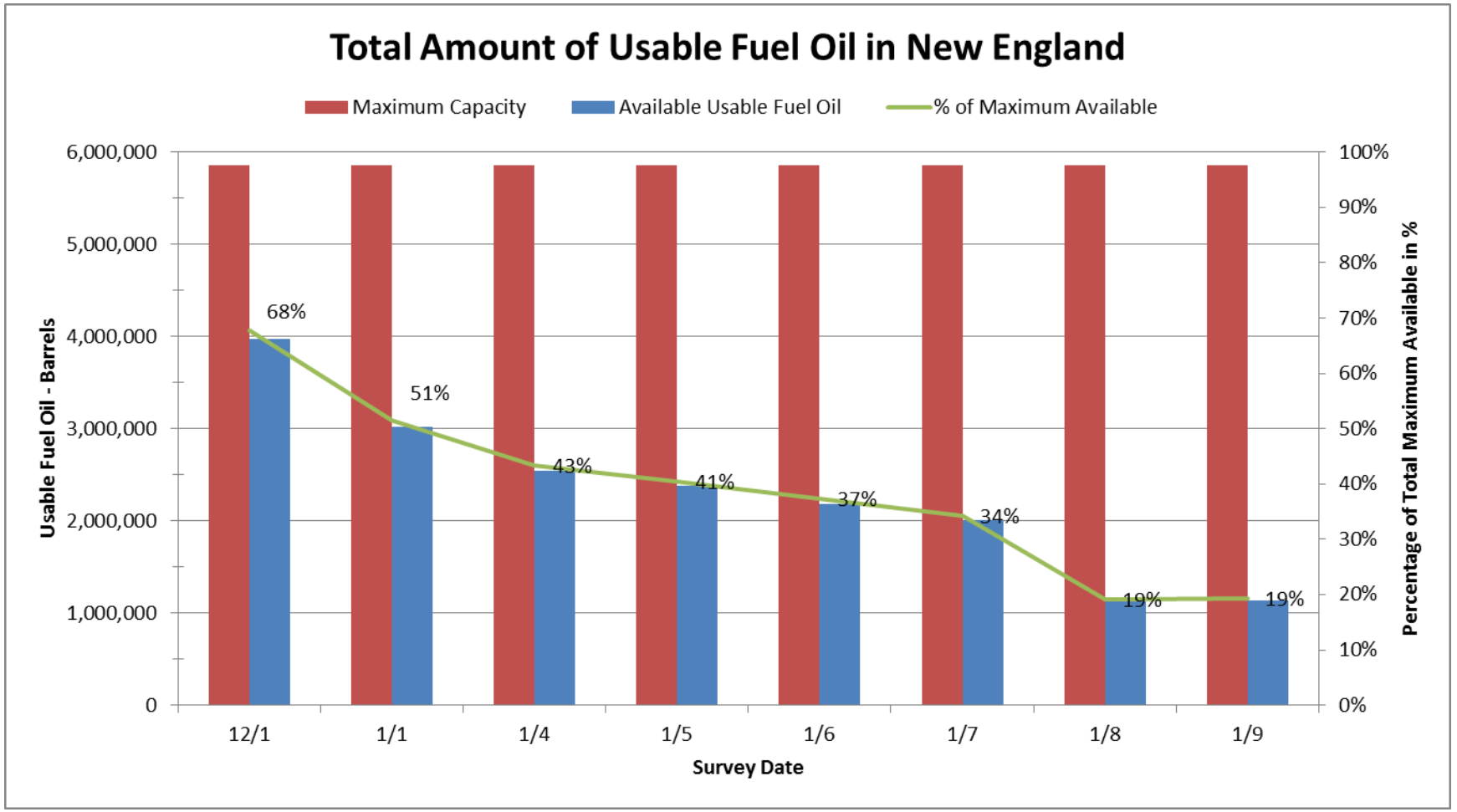




Generator Oil Burn – Yearly Comparison



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

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
- The ISO has implemented a process to track emission limitations

COLD WEATHER FUEL LOGISTICS

Liquid Fuels Logistics – Oil Terminals

- Most large oil terminals in northern New England had low inventories by the end of the cold spell
- Southern New England terminals were in better condition
- Sea/river ice had affected terminals in NH, ME and Hudson River, U.S. Coast Guard (USCG) Cutters that are homeported in Maine were braking ice on NH and ME rivers during the event
- As an example of federal cooperation, the USCG allowed 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

- Trucking transport of fuel oil was a very real concern
  - Trucking of liquid fuels suffered a severe reduction as a result of Nor'easter Grayson
  - Some drivers pulled double duty as snowplow drivers
  - Carriers were at their physical limits
  - Drivers needed time off to rest, even with State Waivers in effect
  - The break in the weather provided much needed relief

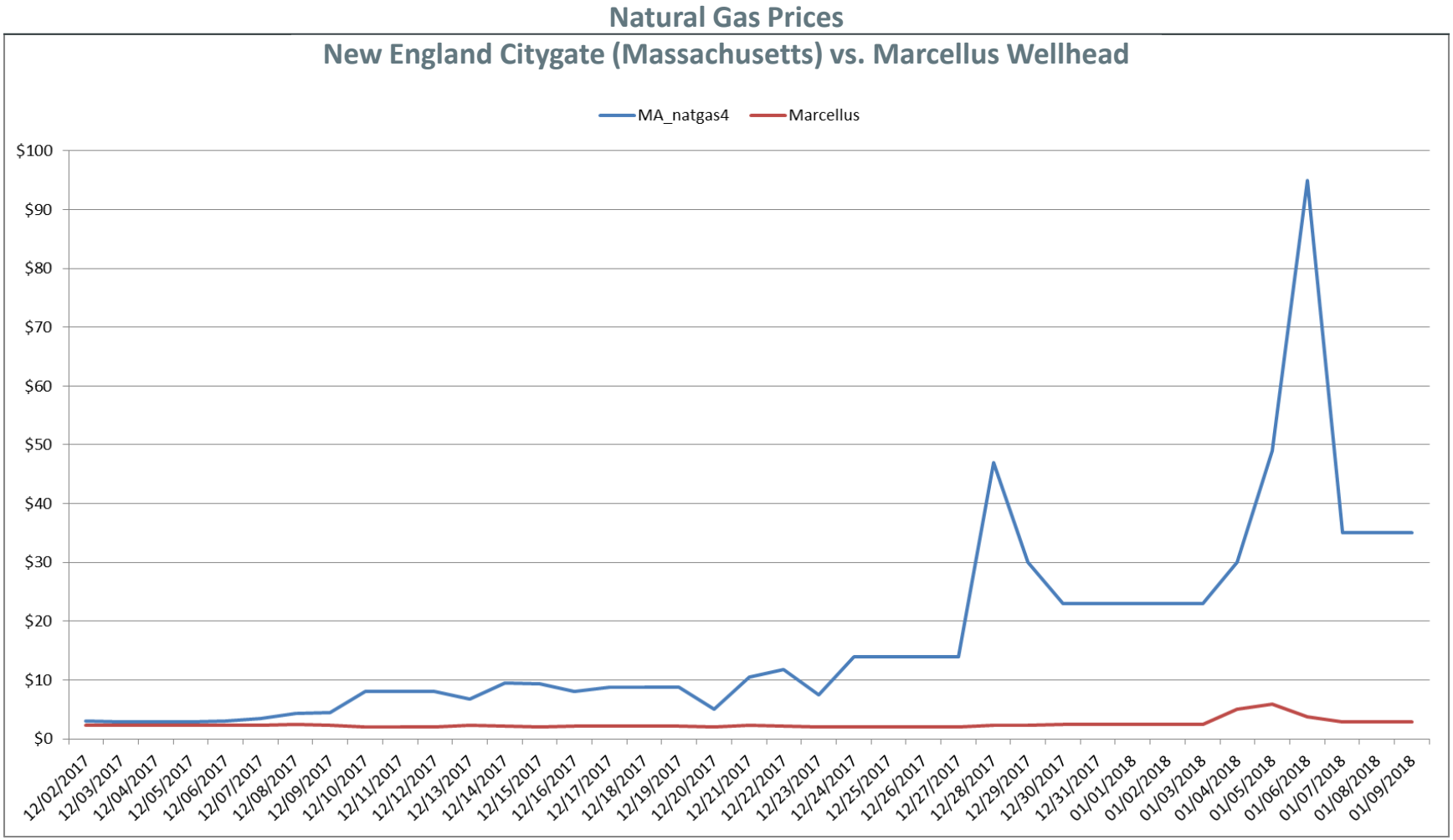
Liquid Fuels Logistics – Generators

- Power generators who had previously scheduled and paid for fuel oil deliveries did receive their fuel first, but those who did not were put on waiting lists
- Fuel oil suppliers were loading fuel in New York and New Jersey that was destined for arrival in northern New England by the end of that week; however, heavy power plant demand quickly consumed those re-supplies
- A few smaller power stations had to cancel fuel orders due to lack of trucking
- Some deliveries complicated by Nor'easter Grayson

Fuel Surveys

- To increase situational awareness, the ISO initiated twice weekly fuel surveys of oil fired generation at the beginning of the event
- With deteriorating conditions, the periodicity of the surveys was changed to daily to improve situational awareness
- 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 Issues

- There were 17 reported gas issues for the period between 12/24/17 and 1/8/18
  - Issues were either procurement (contractual) or pipeline (physical limitations) related
- Operational Flow Orders (OFO) were issued during this extreme weather event for the Tennessee Gas Pipeline, the Algonquin Gas Transmission Pipeline and the Iroquois Pipeline
- All OFOs were in affect most of the extreme weather event

SYSTEM OPERATIONS

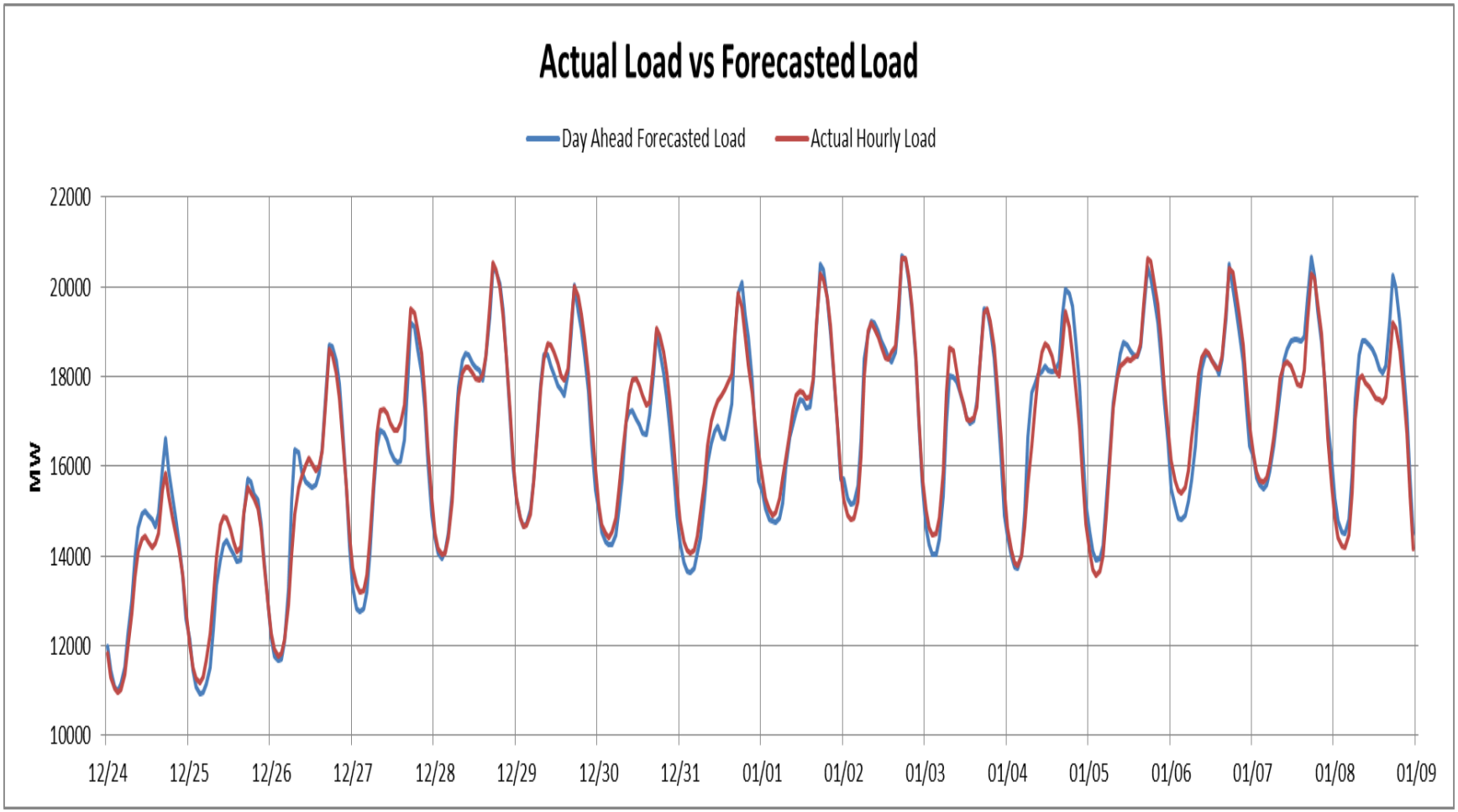
System Operations: Communications

- Emergency conference calls with NPCC Reliability Coordinators reviewed:
  - 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
- Emergency conference calls with the six Local Control Centers in New England discussed:
  - 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

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
- ISO New England was in daily communications with interstate pipeline operators

System Operations: Actual vs. Forecasted Load



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 subsided, however oil inventories were still at low levels in New England
- Replenishing oil inventories became essential to prepare for the balance of winter

System Operations: Maintenance

- Transmission Impact:
  - The ISO cancelled all planned maintenance and recalled work where possible
- Generation Impact:
  - The ISO cancelled all planned maintenance and recalled work where possible
  - There was minimal planned generation OOS during the event <1000MW
  - There were some significant generation resources that were forced out or reduced (unit trip, tube leaks, etc.)

System Operations: Interchange

- Increase in Scheduling Limit with NYISO
  - The two RCs agreed to modify the scheduling limit on the New York/New England AC ties which allowed an increase from 1,400 to 1,600MW
  - The increased limit was made possible by the cold conditions which helped to improve thermal transfer capability

System Operations: Challenges

- Significant challenges associated with the continuous monitoring of the fuel inventories of oil-fired generation to ensure that generation commitments did not jeopardize the long term availability of resources
- ISO-NE has improved forward fuel tracking capabilities
- Several oil-fired generators have to be postured to conserve oil and ensure system reliability so ISO-NE is reviewing Market impacts
- On numerous occasions, high load projections in Hydro Quebec created uncertainty in the availability of deliveries over the Phase II and Highgate HVDC interfaces

Questions?