2017 ISO-NE Electric Generator Air Emissions Report

Draft Results

Helve Saarela

RESOURCE ADEQUACY

Outline

- Report Background
- 2017 System Conditions
- New England System Emissions
  - Total (kTons)
  - Rates (lb/MWh)
- New England Locational Marginal Unit (LMU) Marginal Emissions
  - Rates (lb/MWh)
  - Heat Rate (MMBtu/MWh)

Annual Electric Generator Air Emissions Report

Background

- NO_X, SO_2 and CO_2 Emissions
  - Total emissions by state (in kTons) and annual system emission rates
  - ISO New England generators, not including behind the meter generators
- Marginal Emission Rates
  - Locational Marginal Unit (LMU), LMP-based method of identifying marginal units
- Data Sources
  - U.S. EPA Clean Air Markets Database (CAMD)
    - 2017 included 34% of total power plant emissions for NO_X, 61% for SO_2, and 74% for CO_2
  - For units without U.S. EPA CAMD emissions
    - NEPOOL Generator Information System (GIS) monthly data
      - GIS combined with EPA data account for >96% of emissions data for all three emission types
    - U.S. EPA's latest eGRID database, or historically assumed emission rates based on unit type and age

Overall Summary

2016 to 2017

- New England System
  - Energy generation in 2017 was 3% lower than in 2016
    - The average Q1 winter temperature, which was approximately the same as in 2016, was relatively warm. The summer was slightly cooler than normal, and the Q4 temperature was slightly colder than normal.
  - Generation in nearly all categories (coal, natural gas, oil, nuclear, and other renewables) decreased in 2017. Only generation from hydro and PV/wind facilities was higher than in 2016.

- System Emissions (ktons and lb/MWh)
  - The decrease in total system emissions was more significant than the rates
    - ktons of NO_X decreased by 6%, SO_2 by 11%, and CO_2 by 7%
    - NO_X and CO_2 rates decreased by 3% and 4% respectively, while the SO_2 rate stayed the same
    - Reductions were primarily driven by the decrease in fossil-fired generation (details shown on slide 7)

Overall Summary (cont.)

2016 to 2017

- Marginal Emission Rates
  - NO_X and SO_2 decreased by 27% and 51%, respectively for all units, and 9% and 37% for emitting units
  - CO_2 decreased by 23% for all units, and 4% for emitting units
    - Primarily driven by reduced time that oil units were marginal and the addition of wind units to the marginal unit calculations*
  - Marginal emission rates were highest in the winter months, but also exhibited an increase in the summer months

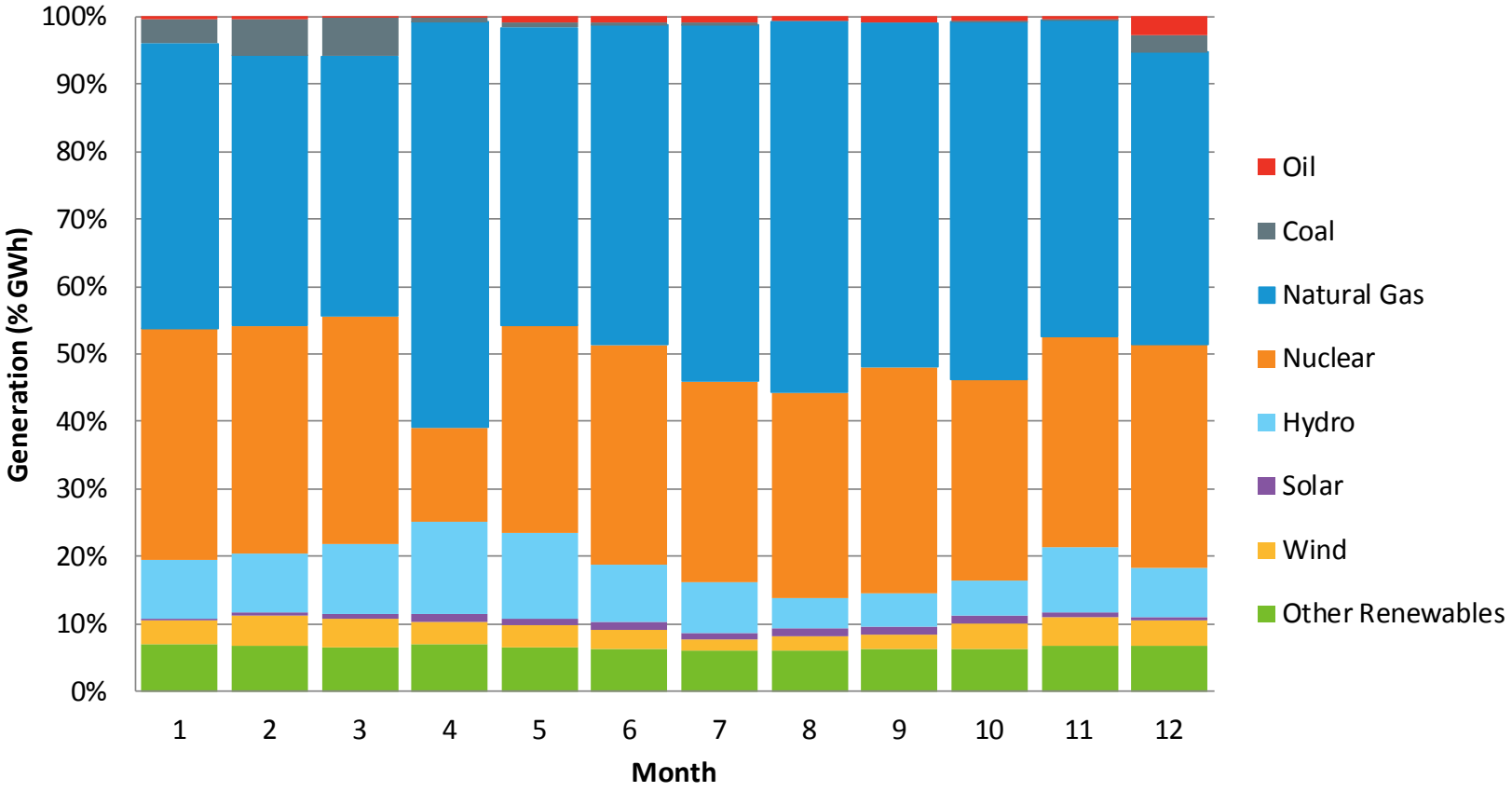
* The increase in wind units on the margin is due to the Do not Exceed dispatch rules which went into effect in May 2016. This means that intermittent units are incorporated into unit dispatch and are eligible to set price.

2017 SYSTEM CONDITIONS

2017 in Summary

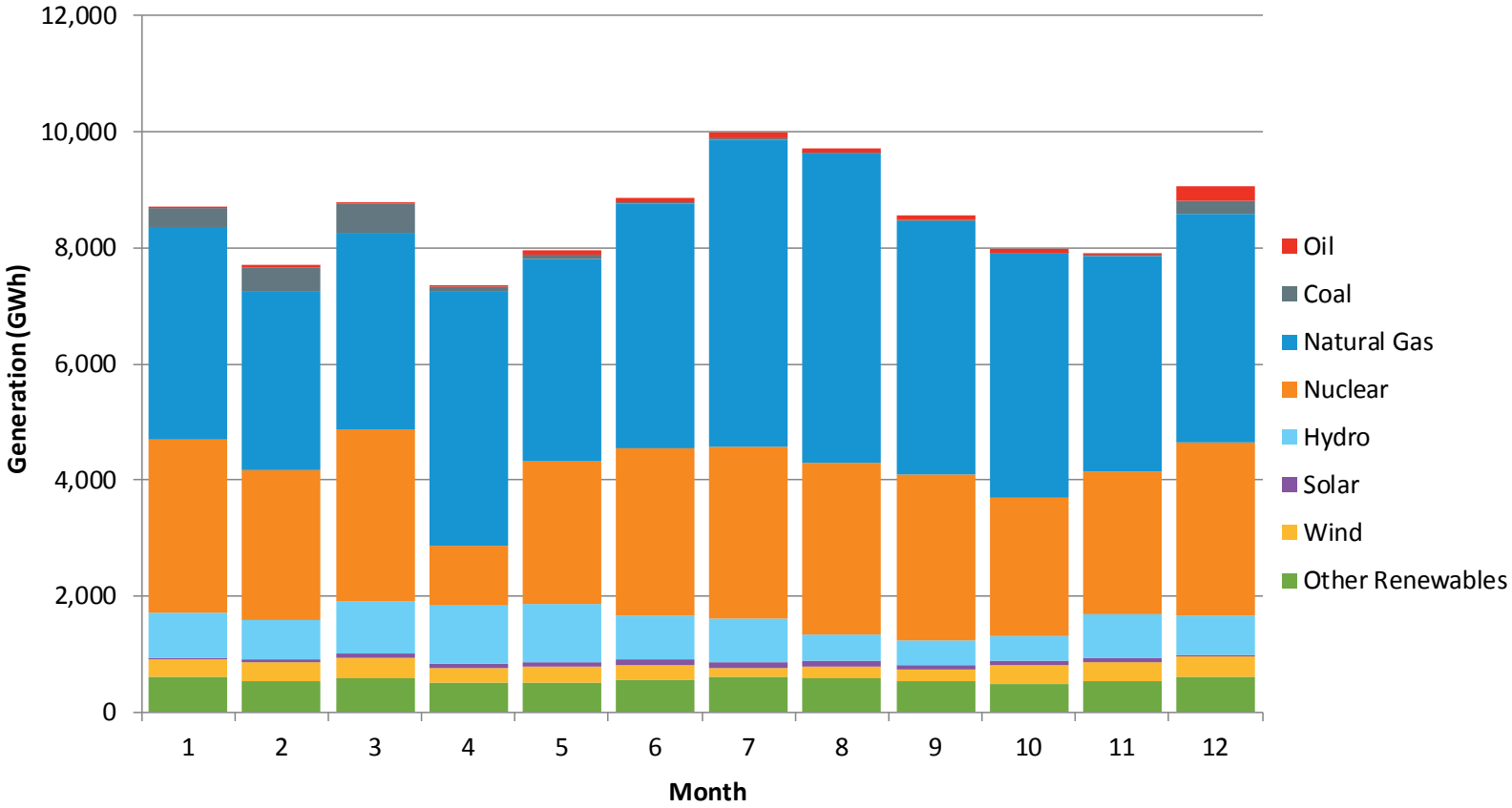
- Net Energy for Load decreased 2.6%
  - 124,416 GWh in 2016 to 121,220 GWh in 2017
- System Generation decreased 2.8%
  - 105,570 GWh in 2016 to 102,562 GWh in 2017
- Net Flow Over External Ties decreased 2.1% (importing)
  - 20,802 GWh in 2016 to 20,373 GWh in 2017
- Summer Peak Demand decreased 6.4%
  - 25,596 MW in 2016 vs. 23,968 MW in 2017
- Energy Generation by Primary Fuel Types (from 2016 to 2017)
  - Decrease in coal, oil, natural gas, and nuclear generation
    - Coal: - 870 GWh (-34%)
    - Oil (residual fuel oil): - 152 GWh (-16%)
    - Natural gas: -2,532 GWh (-5%)
    - Nuclear: -1,207 GWh (-4%)
  - Increase in hydro and PV/wind generation
    - Hydro: + 1,114 GWh (+15%)
    - PV and Wind: + 995 GWh (+31%)

2017 Monthly Generation by Fuel Type (% GWh)



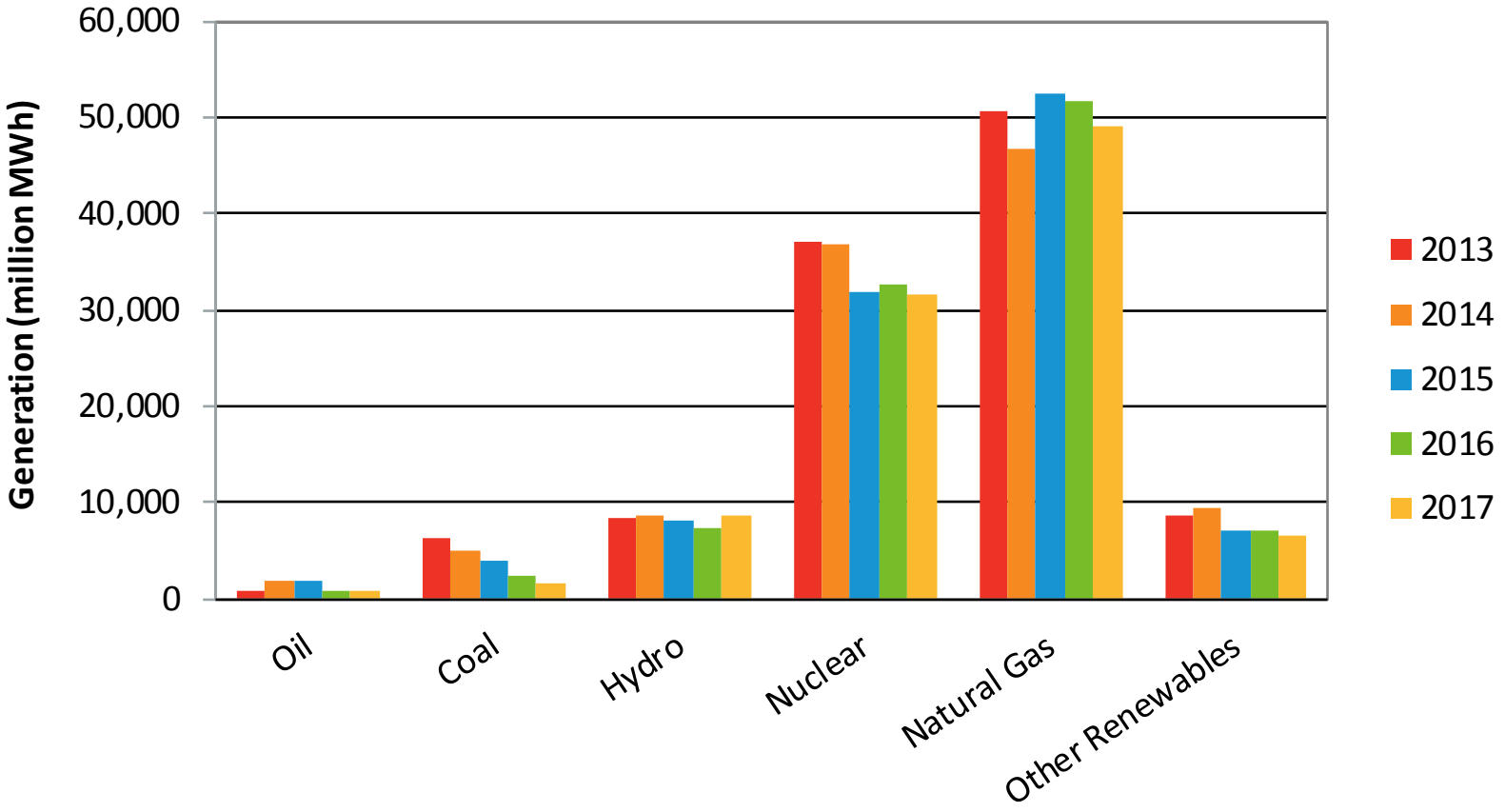
Note: ISO New England generators, not including behind-the-meter (BTM) generators, such as BTM PV

2017 Monthly Generation by Fuel Type (GWh)



Note: ISO New England generators, not including behind-the-meter generators

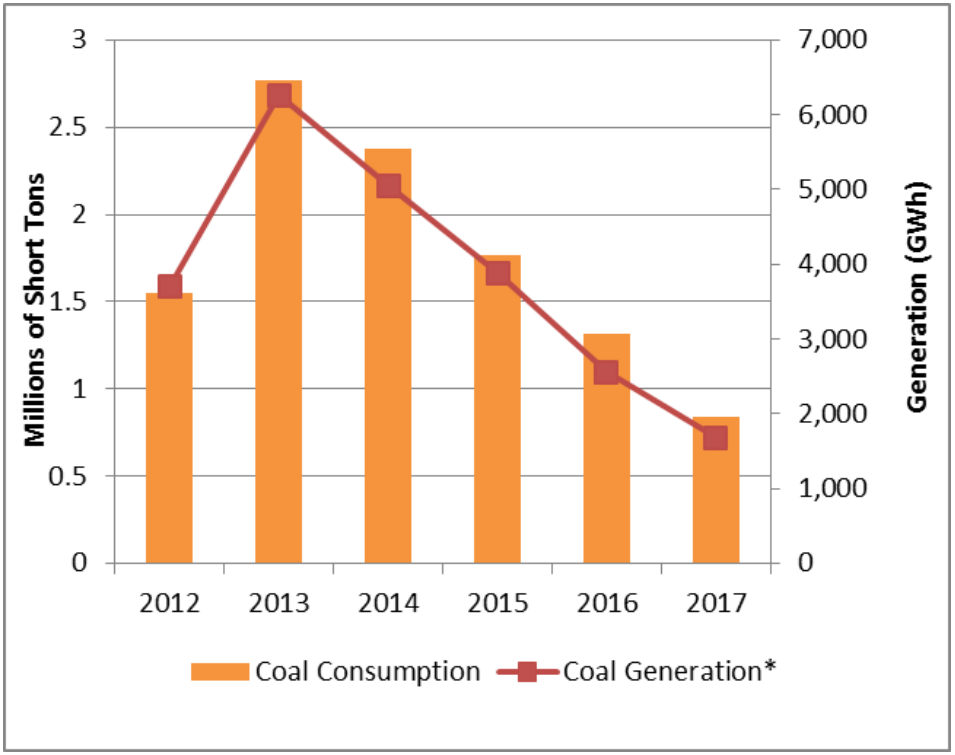
2013 – 2017 Generation by Fuel Types (MWh)

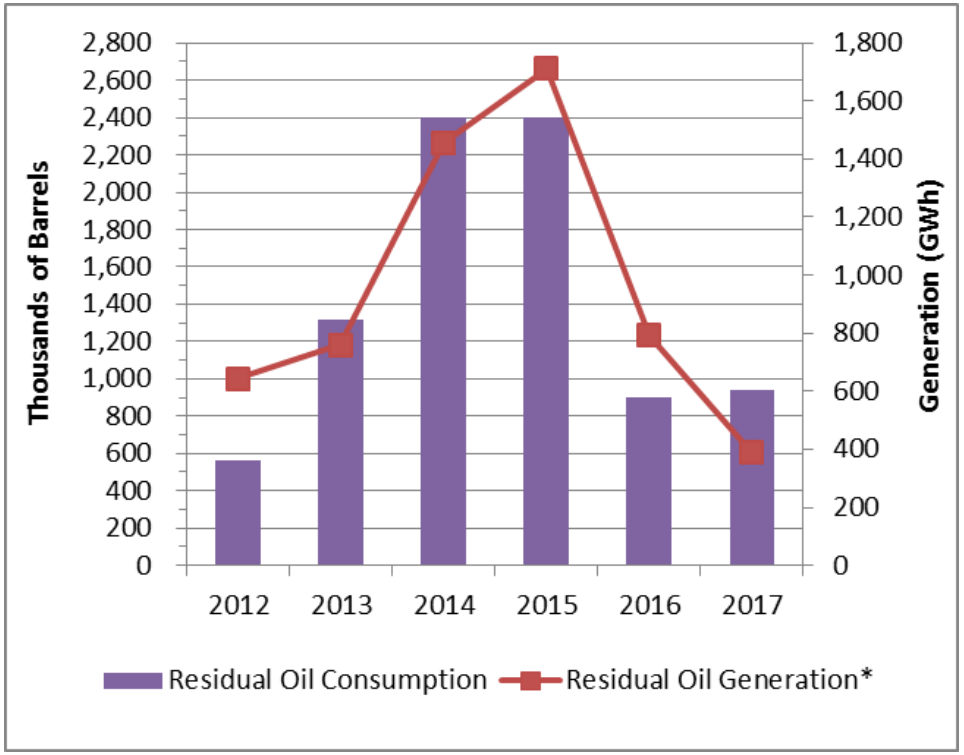


Based on Primary Fuel Type of generators from the 2017 CELT Report

2012 – 2017 New England

Coal and Oil Consumption vs. Generation



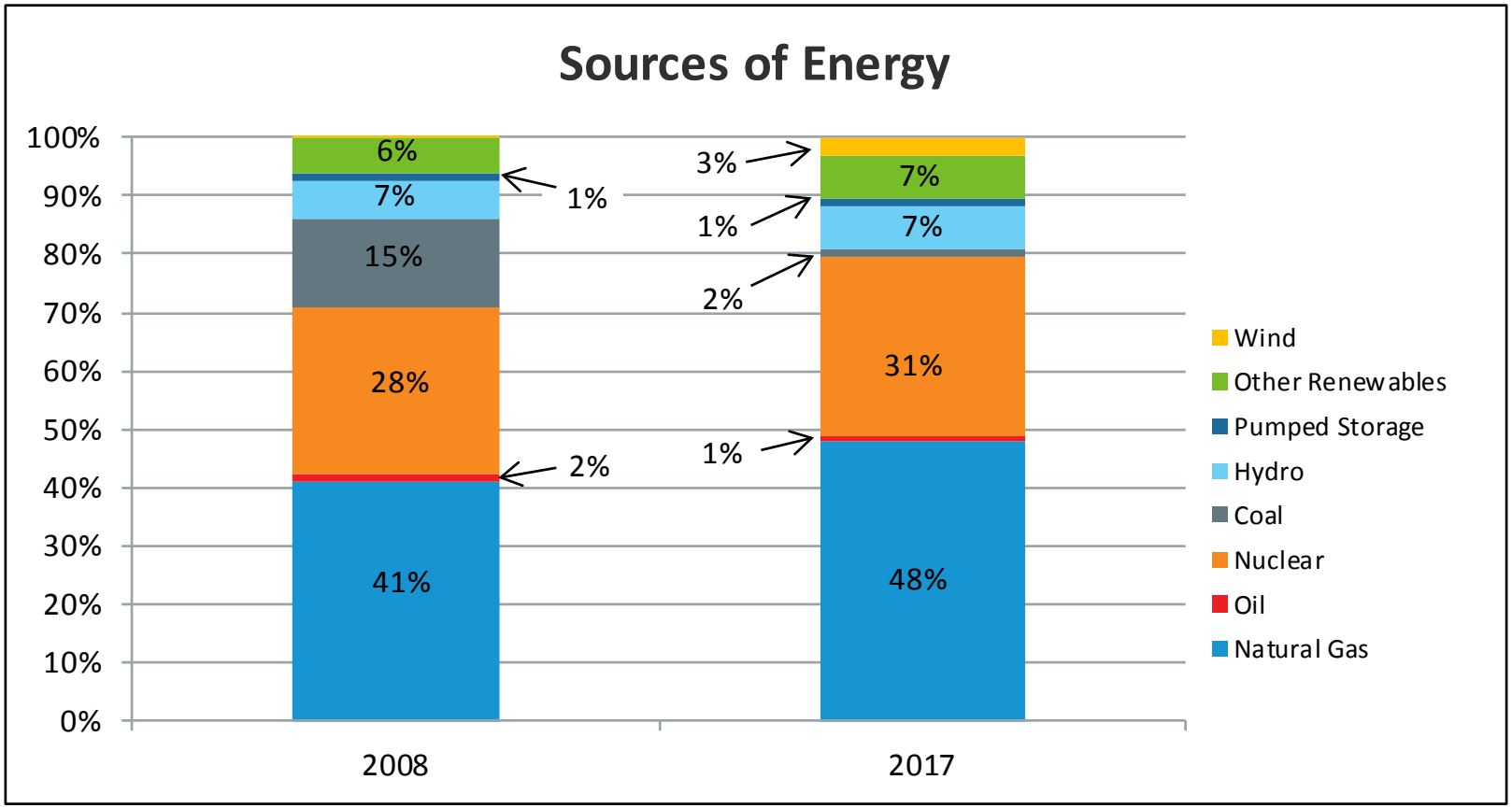


* Generation (GWh) is based on CELT Primary Fuel Type

Data is from EIA-923 Schedule 3, located at http://www.eia.gov/electricity/data/eia923/

Shift in New England's Generator Fuel Mix

2008 to 2017



124,748 GWh **102,562 GWh**

2017 ISO NEW ENGLAND SYSTEM EMISSIONS

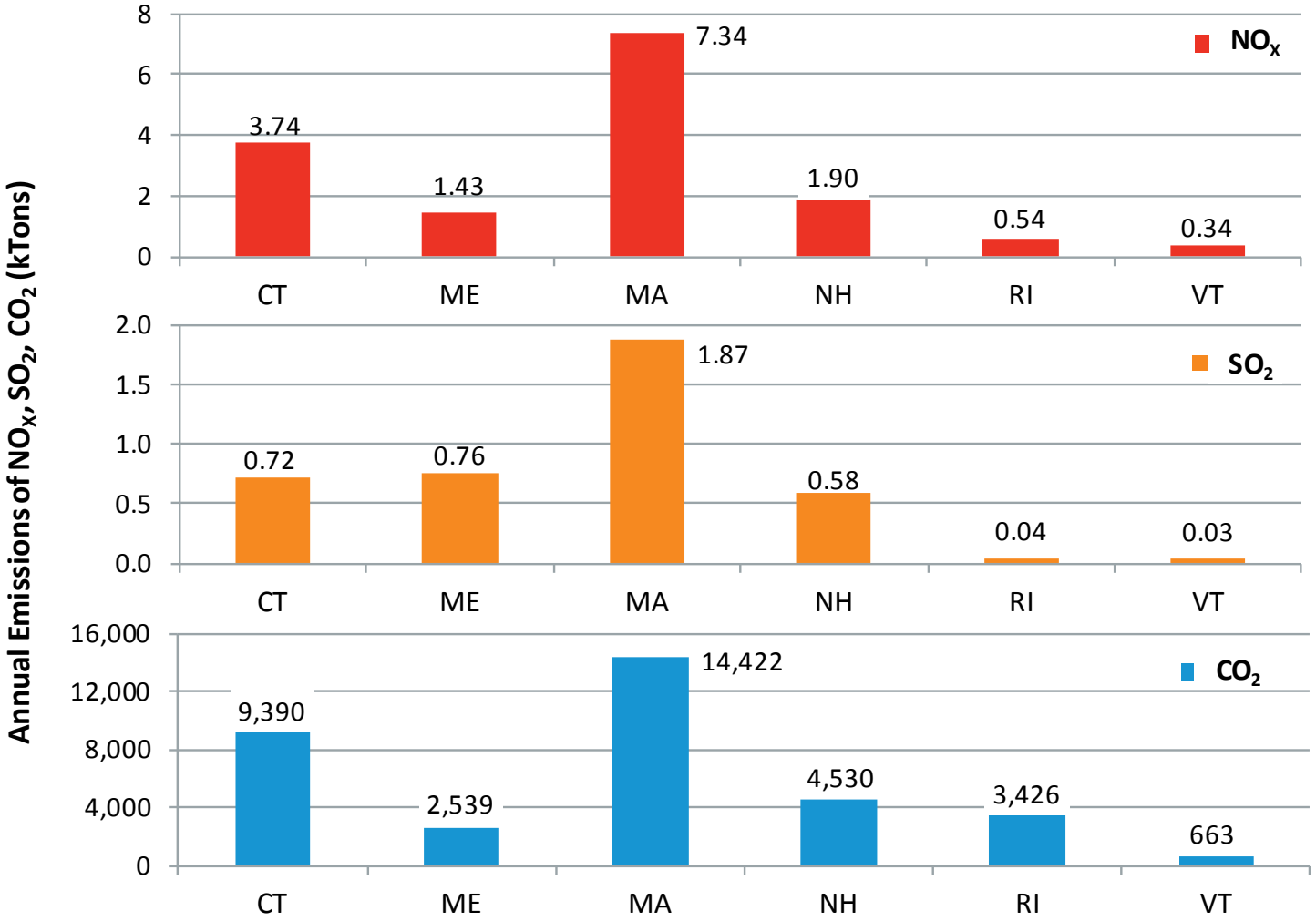
2016 & 2017 Total System Emissions and Emission Rates

Total System Emissions			
	2016 Emissions (kTons)	2017 Emissions (kTons)	Total Emissions % Change
NO_X	16.26	15.30	-5.9
SO_2	4.47	4.00	-10.5
CO_2	37,468	34,969	-6.7

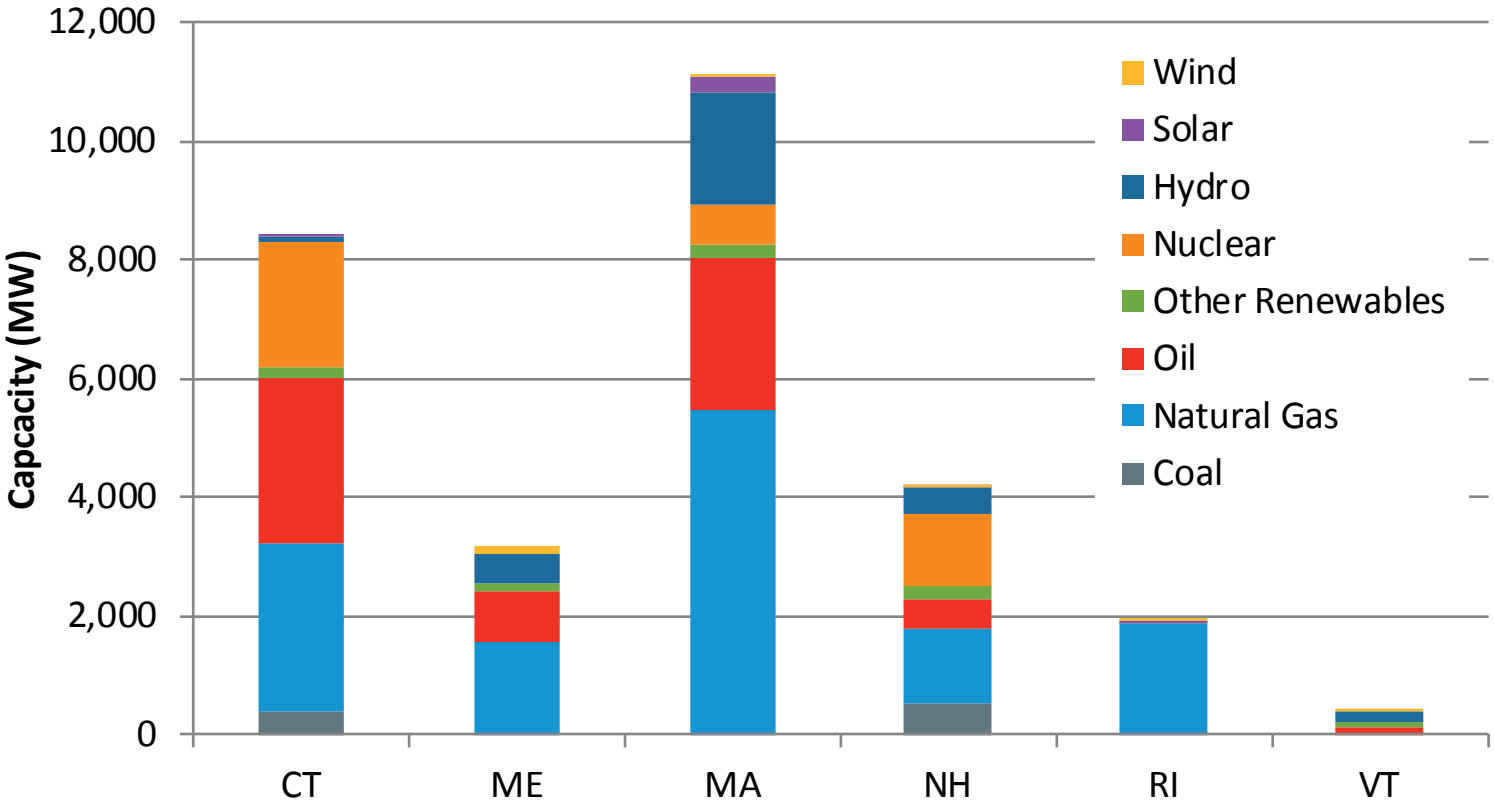
	2016 Emission Rate (lb/MWh)	2017 Emission Rate (lb/MWh)	Emission Rate % Change
NO_X	0.31	0.30	-3.2
SO_2	0.08	0.08	0.0
CO_2	710	682	-3.9

2017 ISO-NE Annual System Emissions

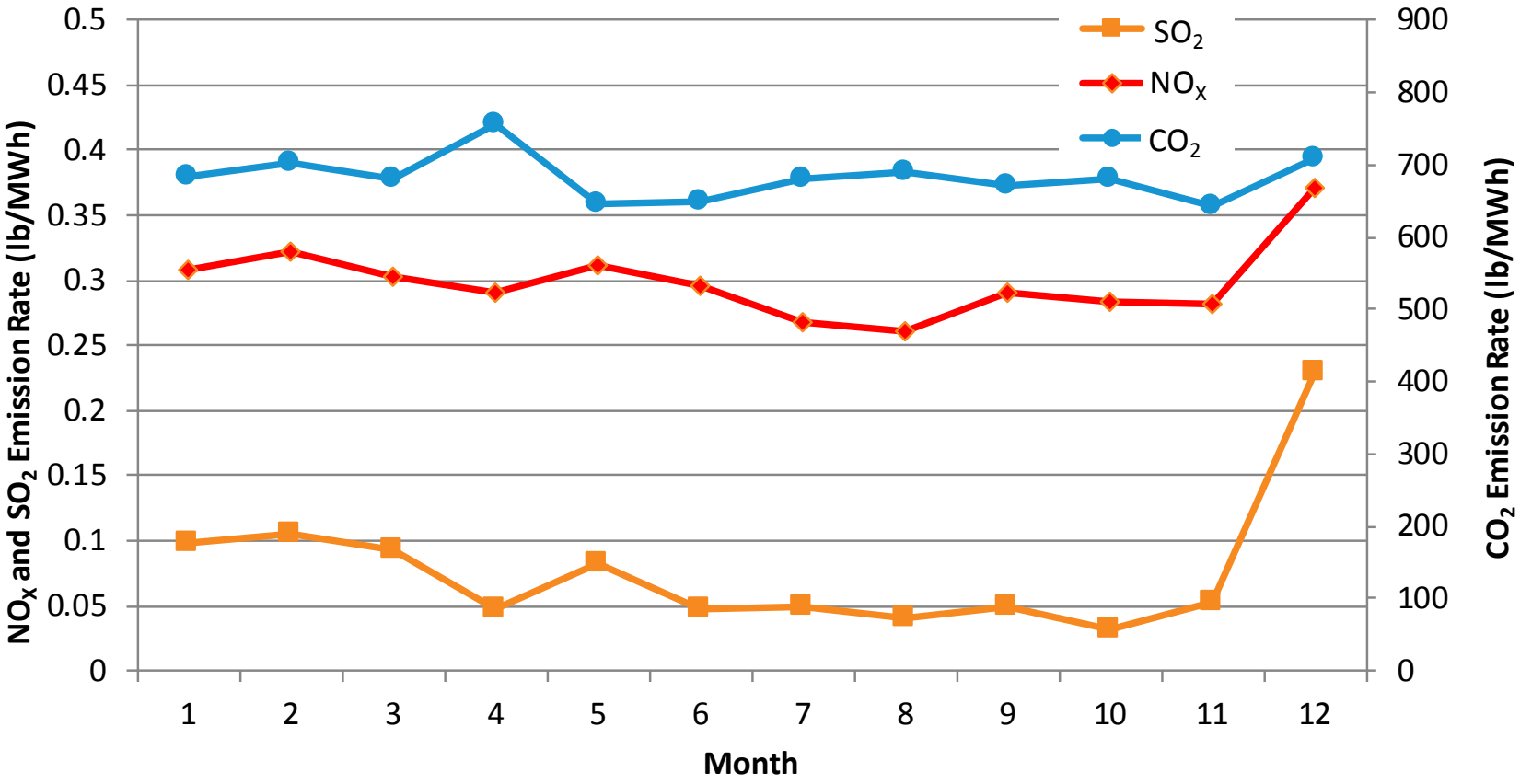
By State (kTons)



2017 New England Summer Claimed Capability by State (MW)

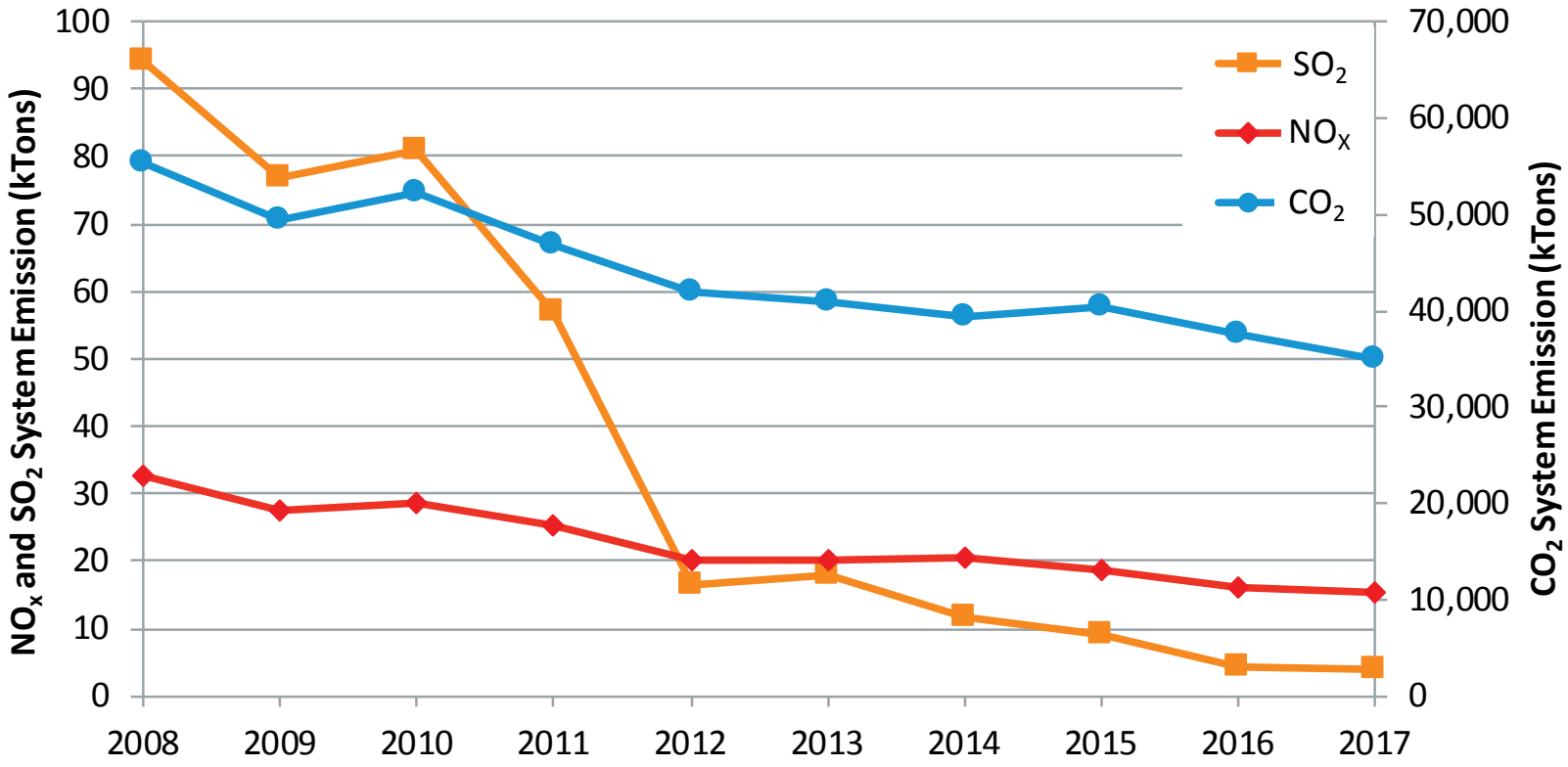


2017 ISO-NE Average Monthly System Emission Rates (lb/MWh)



See Slides 8 and 9 to compare to monthly generation by fuel type

2008 – 2017 ISO-NE Annual System Emission (kTons)



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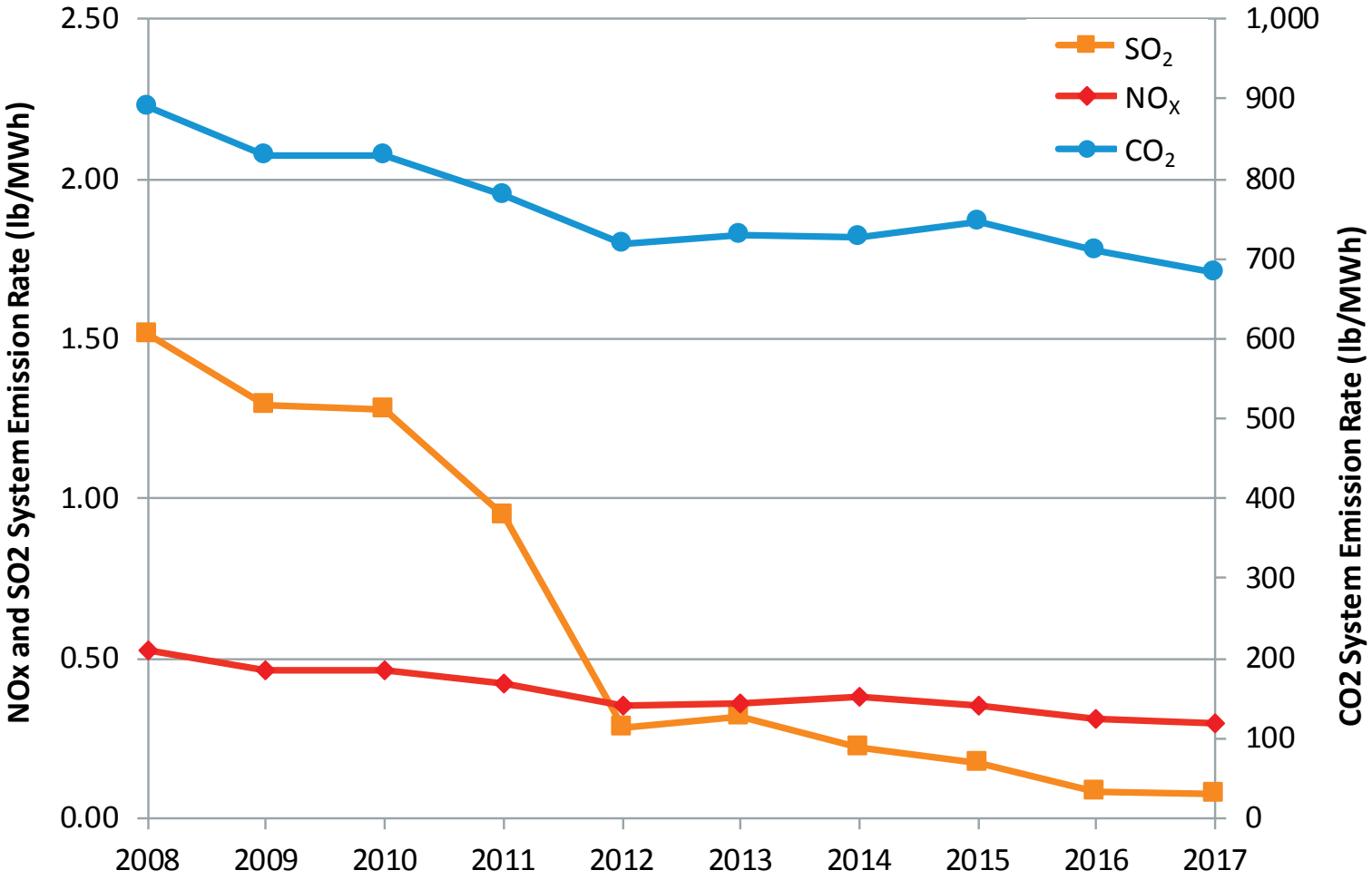


2017 ISO NEW ENGLAND MARGINAL EMISSIONS ANALYSIS

Locational Marginal Unit (LMU)

- *Percent Marginal by Fuel Type*
- *Marginal Emission Rates*
- *Marginal Heat Rate*

Marginal Emissions Analysis

Overview

- Locational Marginal Units (LMUs) are identified by Locational Marginal Price (LMP)
  - Based on historical real-time generation dispatch records
- Marginal emissions calculated for two scenarios:
  - All LMUs
  - Emitting LMUs

Marginal Emissions Analysis

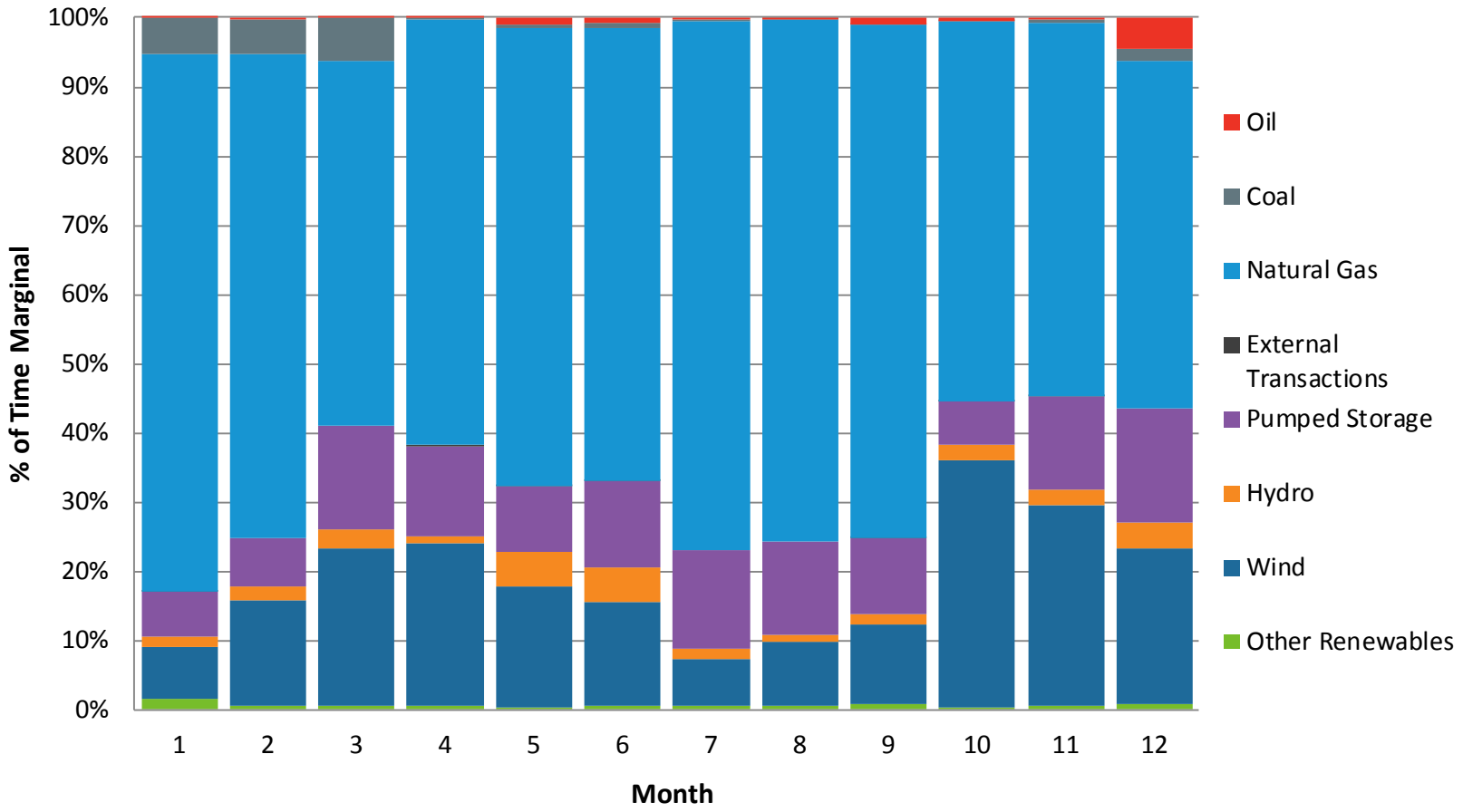
Marginal Unit Scenarios

Marginal Emission Analysis results for 2010 through 2016 have been calculated for the following scenarios:

1. All LMUs
   - Includes all Locational Marginal Units (including imports) identified by the LMP
   - Reflects all hours in a calendar year and units with and without associated air emissions
2. Emitting LMUs
   - Excludes all non-emitting units, such as nuclear, pumped storage, hydro-electric generation, external transactions, and other renewables (such as wind, etc.) with no associated air emissions
   - Reflects only hours in a calendar year when emitting units are marginal and excludes the impact of non-emitting units on the margin

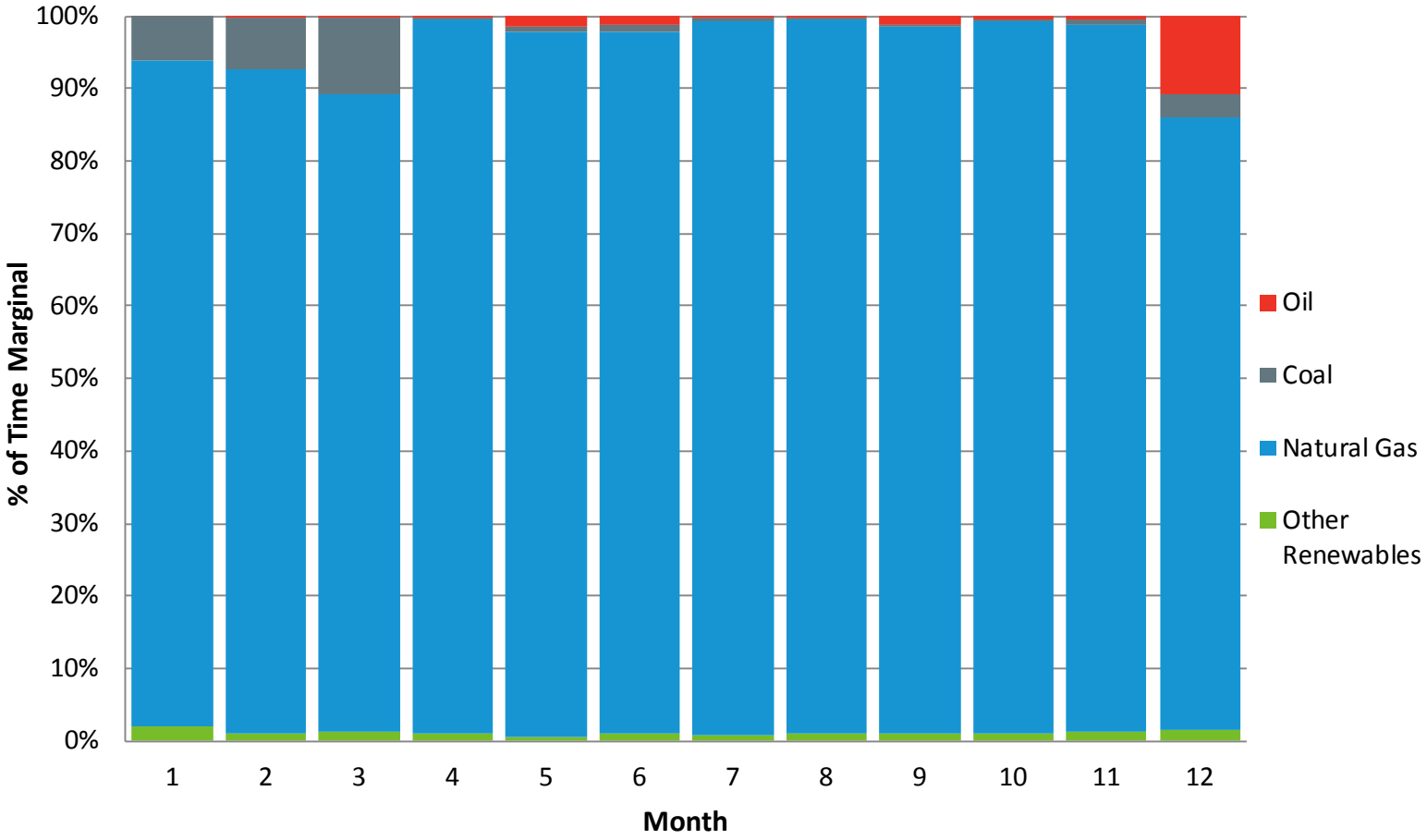
2017 Monthly Percent of Time Unit Types Are Marginal

All LMUs



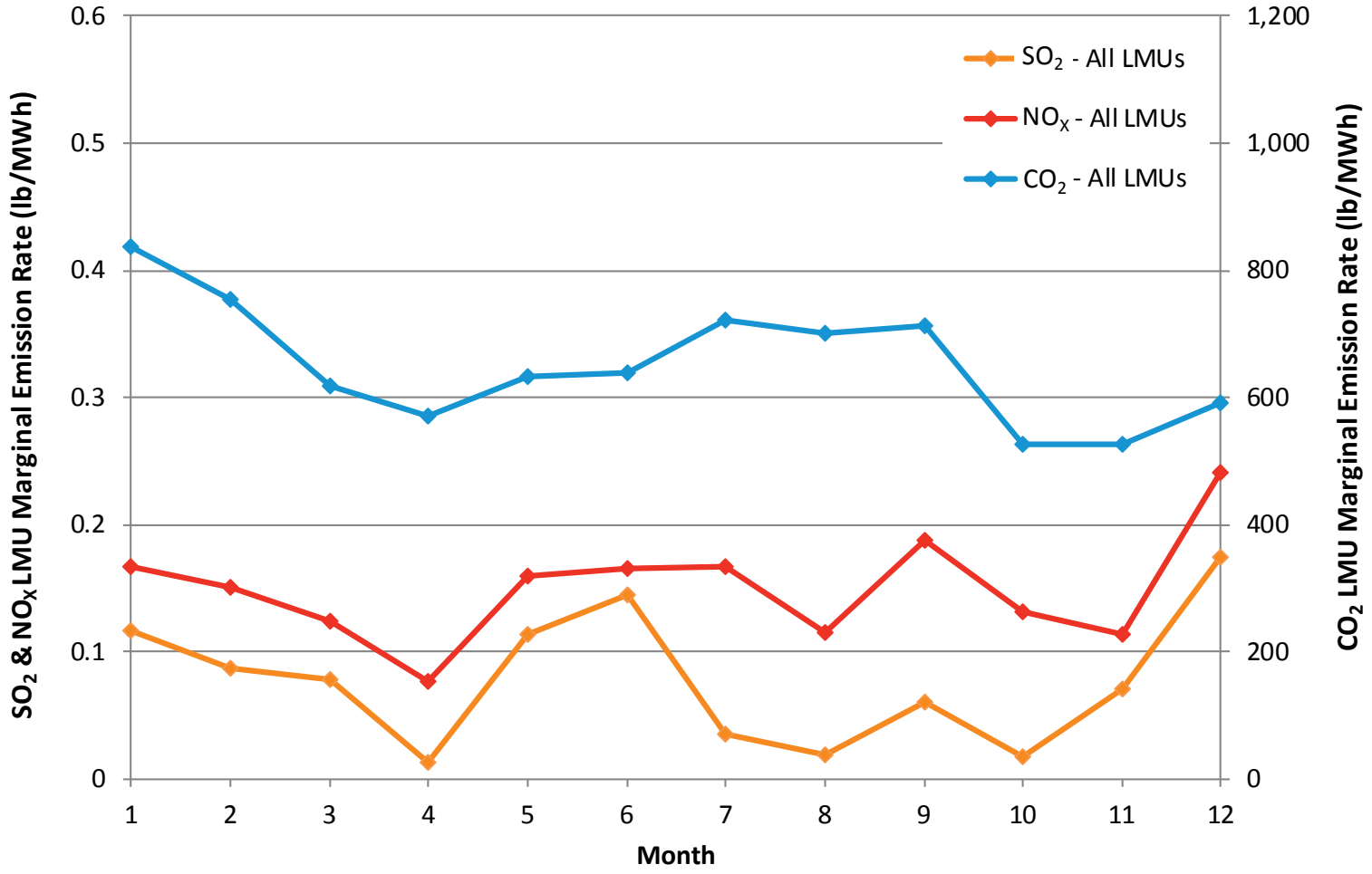
2017 Monthly Percent of Time Unit Types Are Marginal

Emitting LMUs



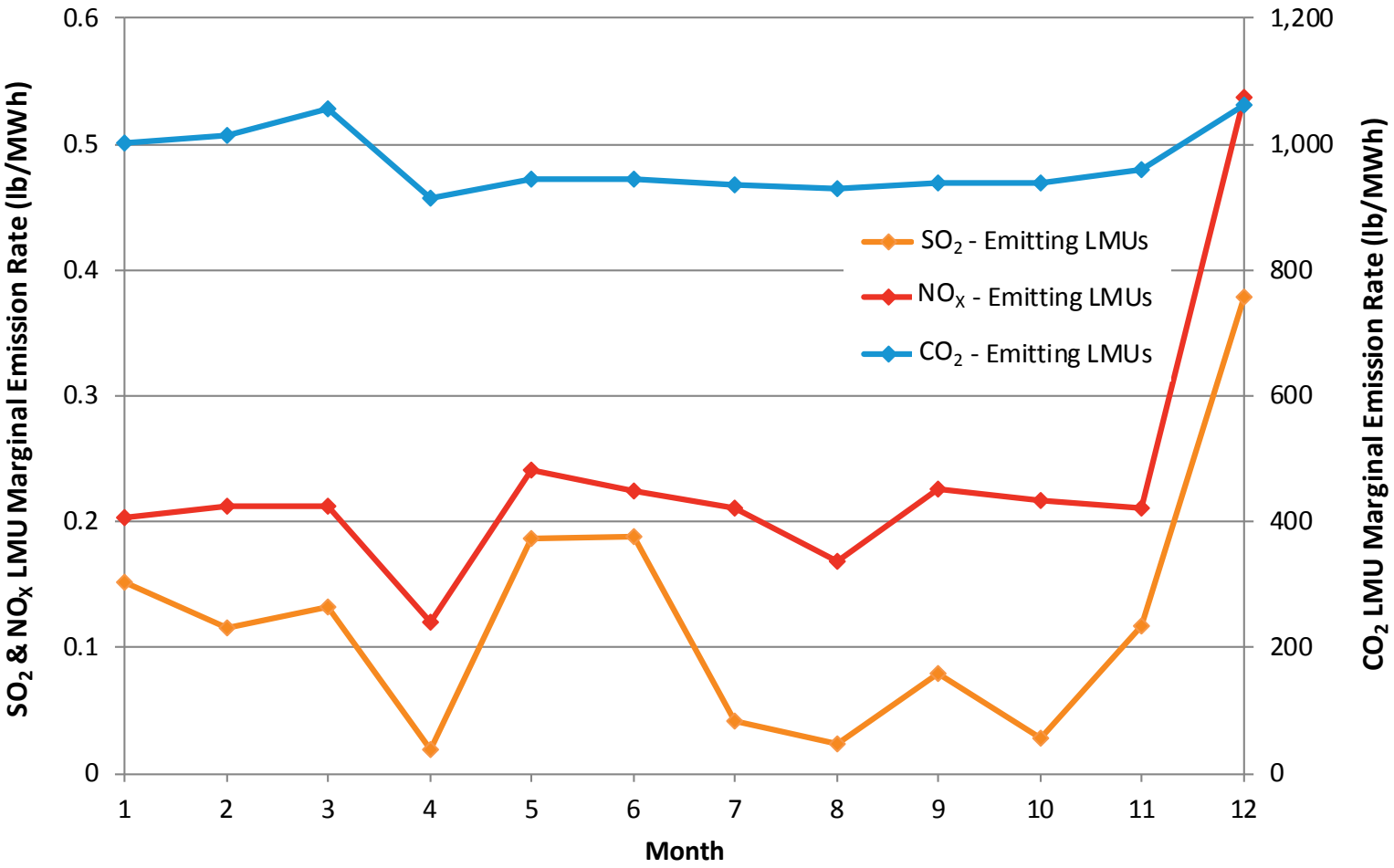
2017 Monthly Marginal Emission Rates (lb/MWh)

All LMUs



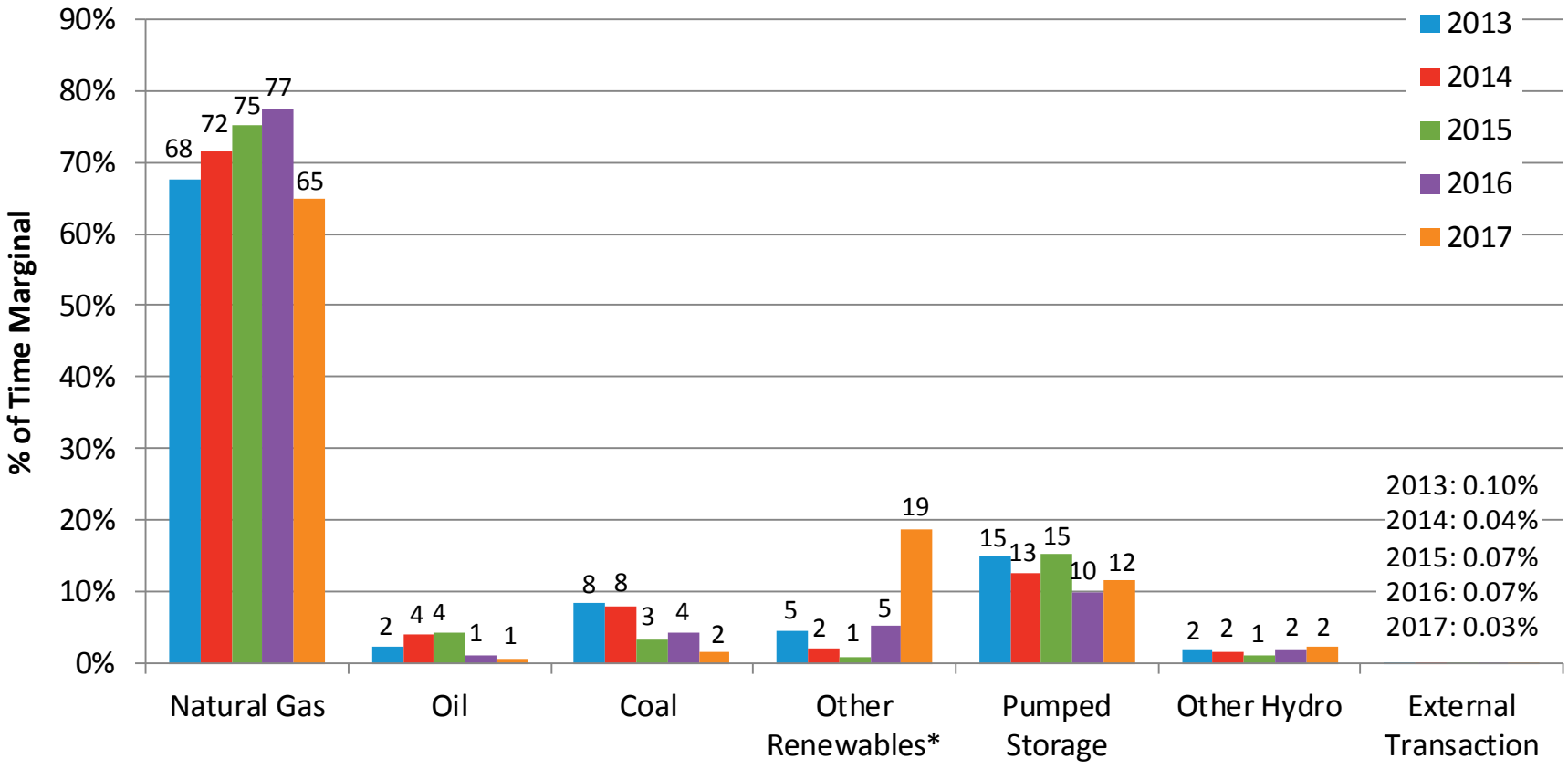
2017 Monthly Marginal Emission Rates (lb/MWh)

Emitting LMUs



2013 – 2017 Percent of Time Unit Type is Marginal

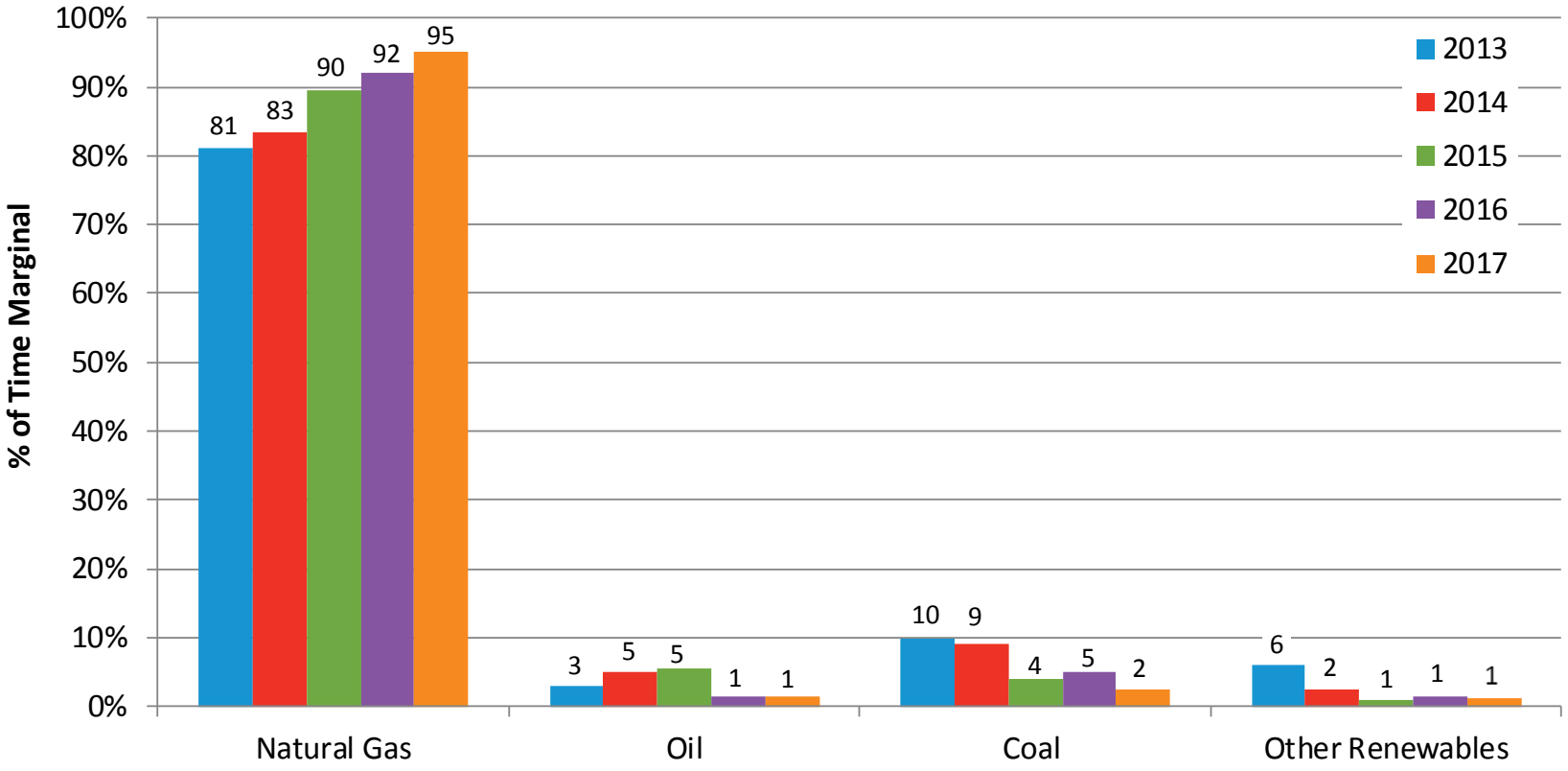
All LMUs



* The Other Renewables category (All LMUs) usually includes landfill gas, biomass gases, wind, solar, refuse (municipal solid waste, wood and wood-waste solids, tire-derived fuels) and fuel cells. In 2013 - 2015, only wood/wood-waste solids unit(s) were identified to be marginal. However, beginning in 2016, wind was also marginal (18% of the time in 2017).

2013 – 2017 Percent of Time Unit Type is Marginal

Emitting LMUs



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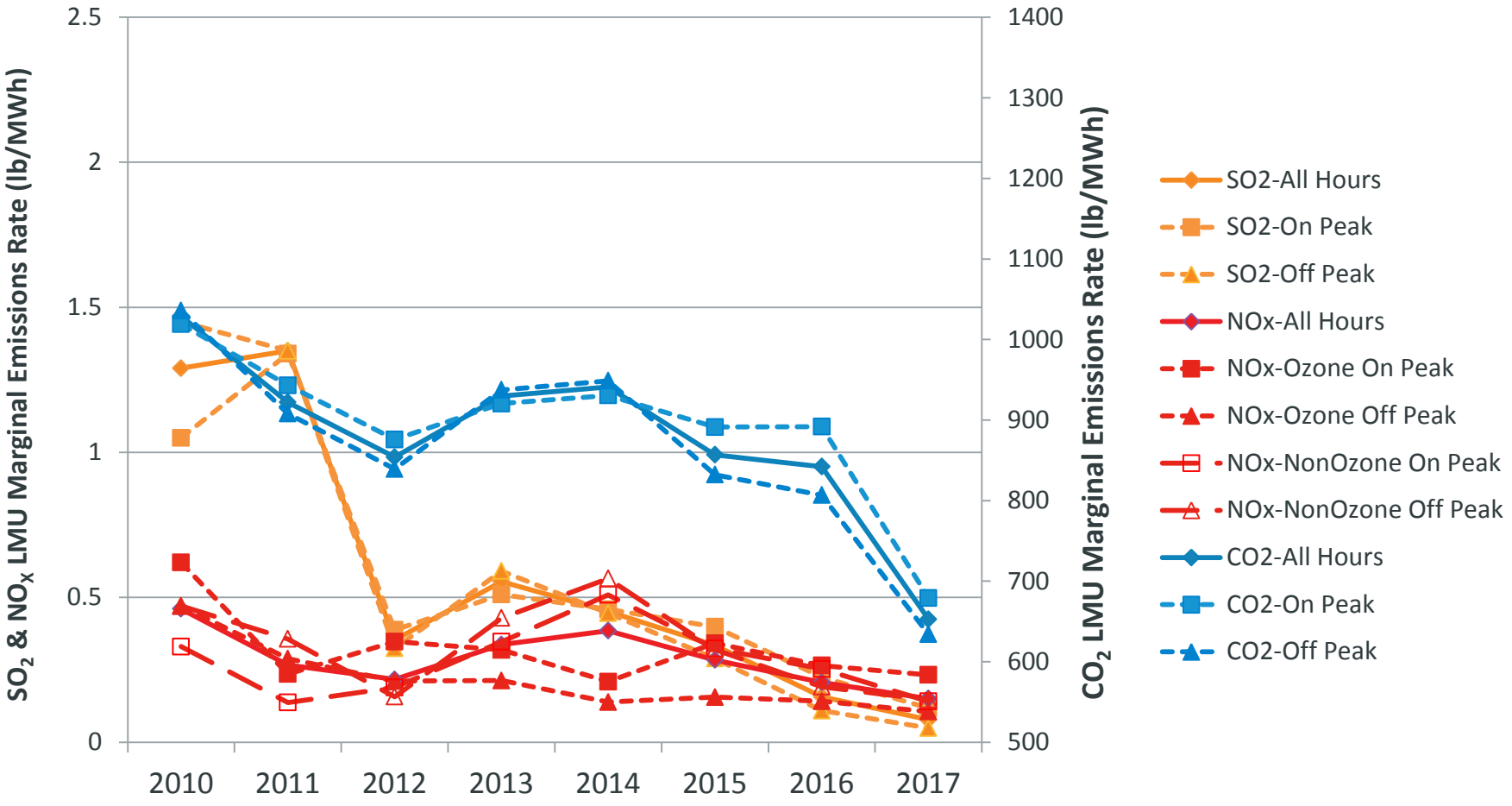
Marginal Emission Rates (lb/MWh)

2016 vs. 2017

LMU Marginal Emissions						
	All LMUs			Emitting LMUs		
	2016 Annual Rate (lb/MWh)	2017 Annual Rate (lb/MWh)	Percent Change 2016 to 2017 (%)	2016 Annual Rate (lb/MWh)	2017 Annual Rate (lb/MWh)	Percent Change 2016 to 2017 (%)
NO_X	0.21	0.15	-27.3	0.25	0.23	-8.5
SO_2	0.16	0.08	-50.5	0.19	0.12	-37.2
CO_2	842	653	-22.5	1,007	969	-3.8

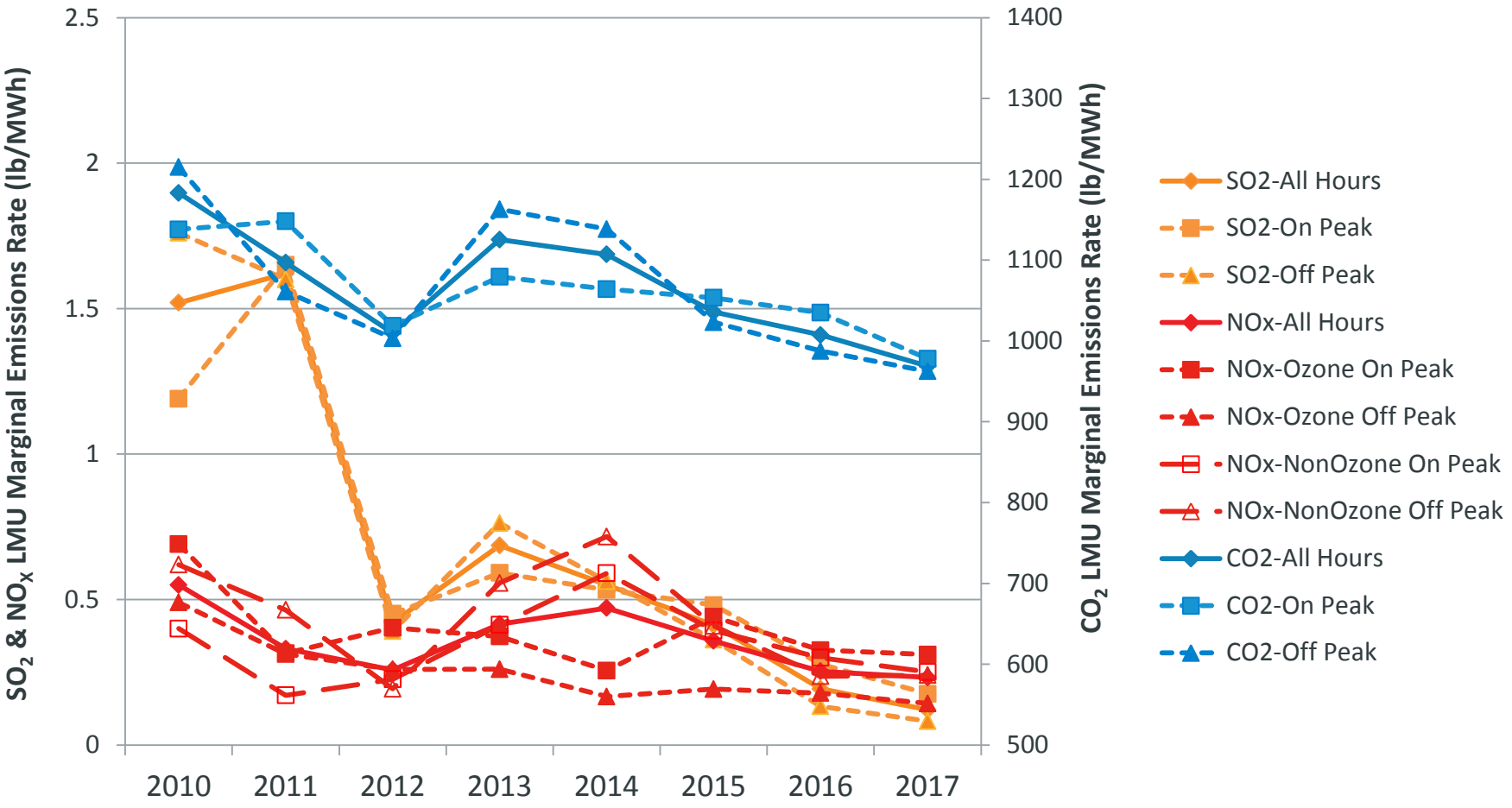
2010 – 2017 Marginal Emission Rates (lb/MWh)

All LMUs

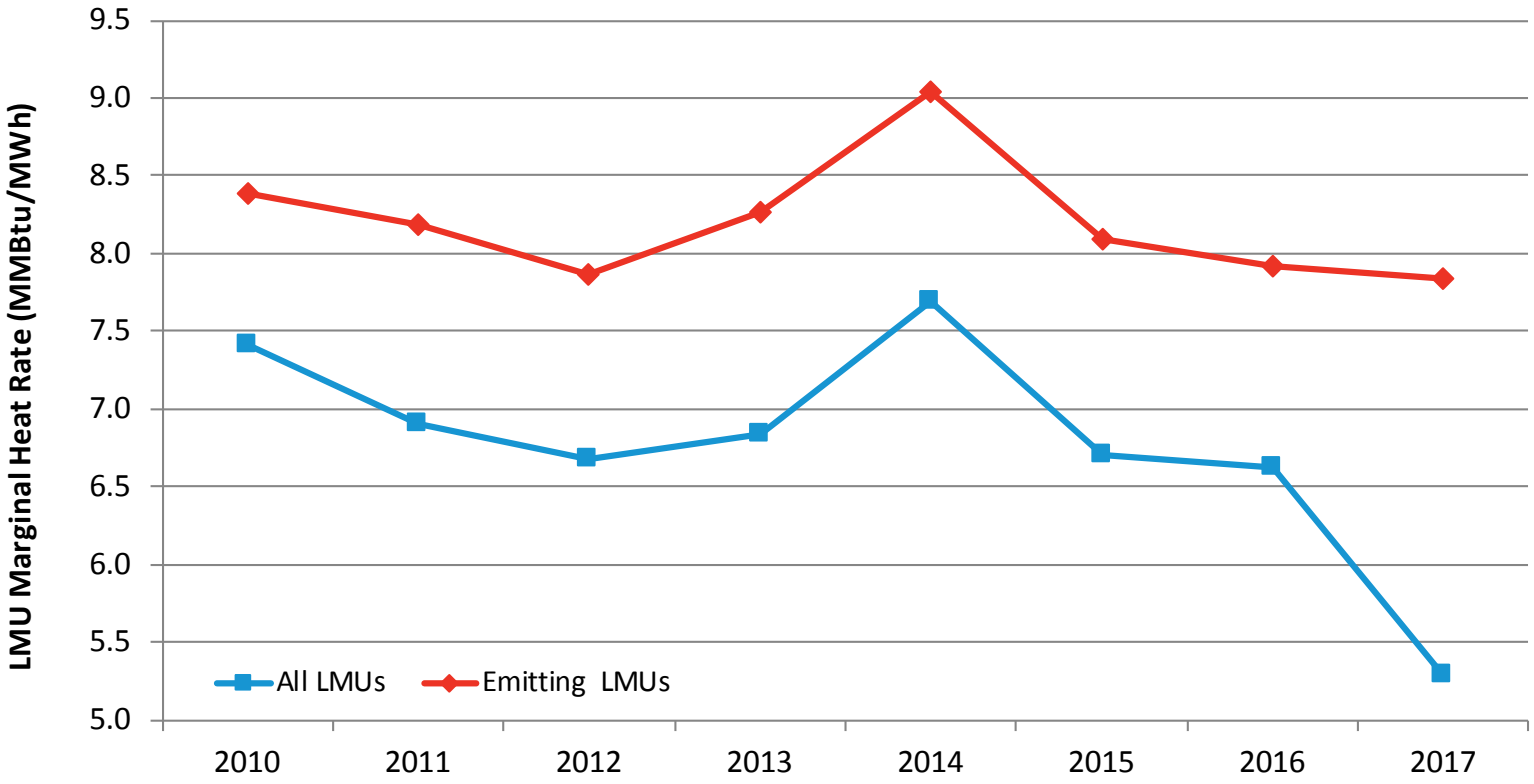


2010 – 2017 Marginal Emission Rates (lb/MWh)

Emitting LMUs



2010 – 2017 Marginal Heat Rates (MMBtu/MWh)



LMU Marginal Heat Rate (MMBtu/MWh)

Year	All LMUs	Emitting LMUs
2011	6.907	8.190
2012	6.678	7.870
2013	6.841	8.271
2014	7.692	9.034
2015	6.707	8.096
2016	6.625	7.925
2017	5.291	7.844

Next Steps

- EAG will be notified when draft report is posted
- Review stakeholder comments on presentation and draft report
  - Requesting comments on presentation by December 18th

Questions