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Annual Electric Generator Air Emissions Report Public Webinar

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Outline

- About ISO New England
- Annual Emissions Report – Background and Overview
- 2023 Annual Electric Generator Air Emissions Report – Key Takeaways
- 2023 System Conditions
- 2023 Average Emissions
- 2023 Load-Weighted Emissions
- 2023 Time-Weighted Emissions
- Next Steps
- Resources

ISO New England Has More Than Two Decades of Experience Overseeing the Region's Restructured Electric Power System

- **Regulated** by the Federal Energy Regulatory Commission
- **Reliability Coordinator** for New England under the North American Electric Reliability Corporation
- **Independent** of companies in the marketplace and **neutral** on technology

ISO New England's *Mission and Vision*

Mission: *What we do*

Through collaboration and innovation, ISO New England plans the transmission system, administers the region's wholesale markets, and operates the power system to ensure reliable and competitively priced wholesale electricity

Vision: *Where we're going*

To harness the power of competition and advanced technologies to reliably plan and operate the grid as the region transitions to clean energy

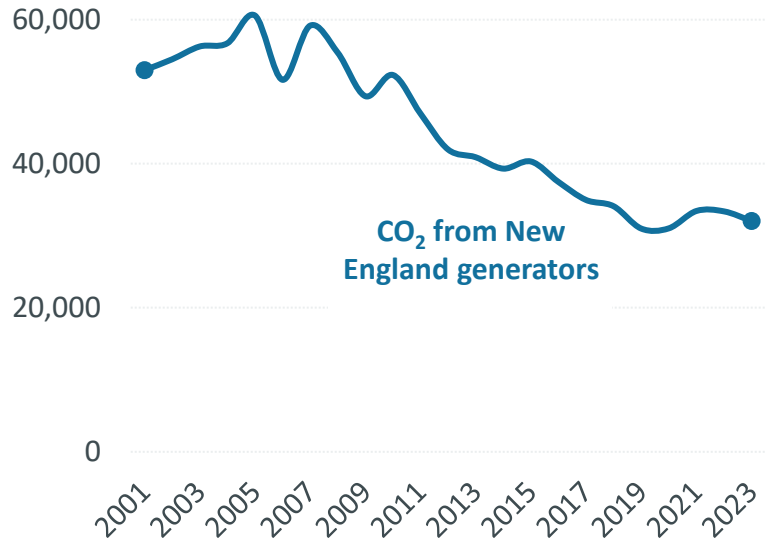
State Laws Target Deep Reductions in CO_2 Emissions and Increases in Renewable and Clean Energy

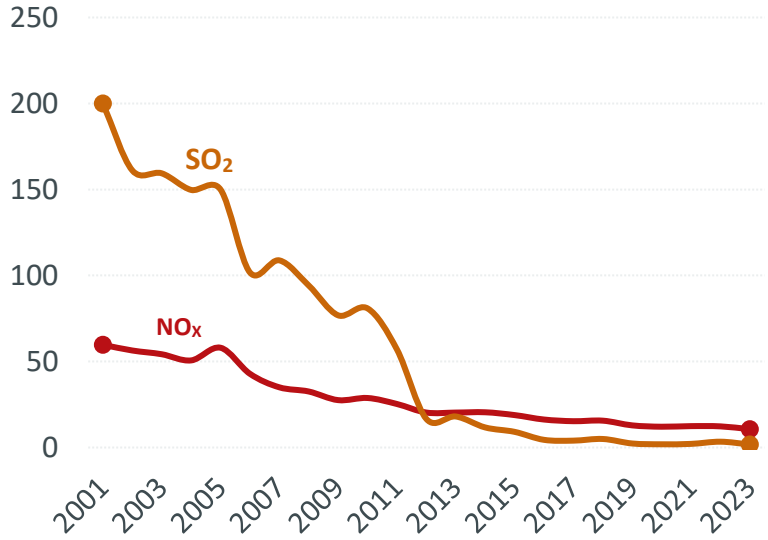
≥80% by 2050	Five states mandate greenhouse gas reductions economy wide: MA, CT, ME, RI, and VT (mostly below 1990 levels)
Net-Zero by 2050 80% by 2050	MA emissions requirement MA clean energy standard
100% by 2035	VT renewable energy requirement
100% by 2050 Carbon-Neutral by 2045	ME renewable energy goal ME emissions requirement
100% by 2040	CT zero-carbon electricity requirement
100% by 2033	RI renewable energy requirement

Major Emissions Reductions

Emissions from regional generators have fallen significantly since 2001

Annual New England System Generator Emissions, 2001-2023 (Thousand Short Tons)



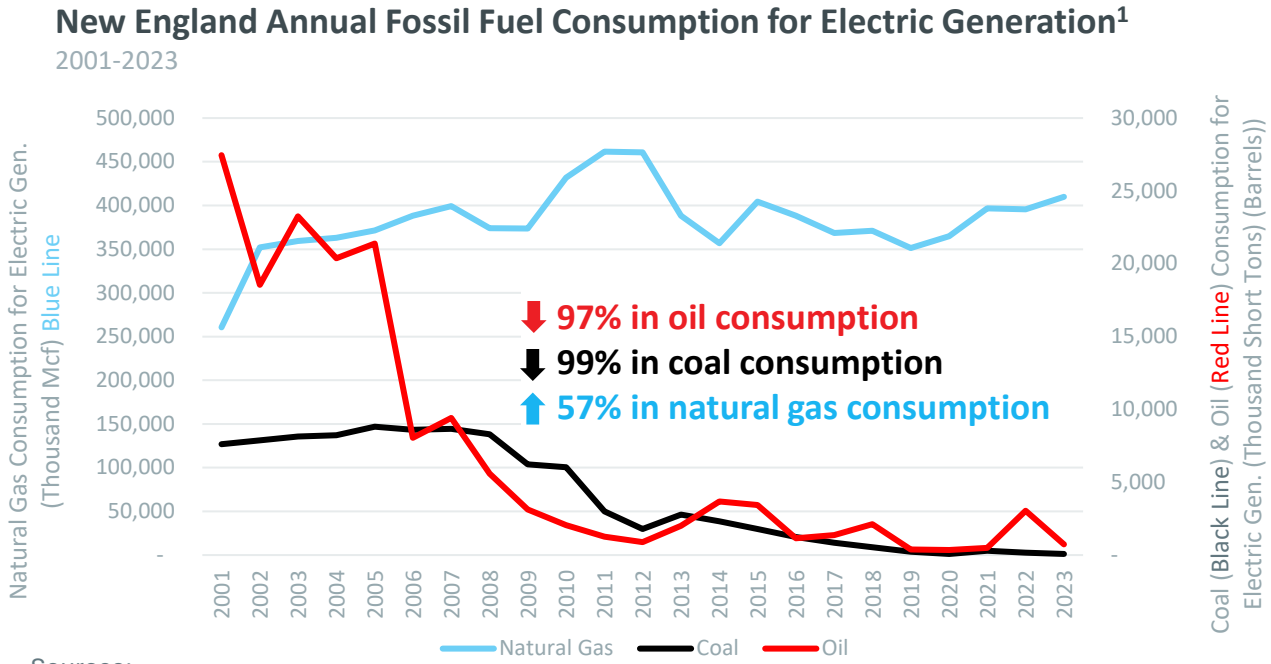


Carbon Dioxide (CO_2) ↓40% **Nitrogen Oxide (NOx) ↓82%** **Sulfur Dioxide (SO_2) ↓99%**

Source: ISO New England, *New England Electric Generators Air Emissions Report*

Major Reduction in Oil and Coal Consumption

Significant drop in oil and coal consumption for electric generation and shift towards cleaner resources contributed to major emission reductions



In 2023, **wind and solar** resources combined accounted for **6%** of the region's energy generation, up from zero in 2001.[2]

Sources:

1) U.S. Energy Information Administration, *Consumption for electricity generation for all sectors*
2) ISO-NE, *Net Energy Net Energy and Peak Load Reports*

ISO Emissions Reporting

- ISO's New England Electric Generator Air Emissions Report helps determine emission reductions from demand-side management programs, energy efficiency programs, and renewable resource projects within region
- Tracking power system emissions is of interest to New England stakeholders, including policy makers, generators, and consumers
- The Electric Generator Air Emissions Report is just one way that the ISO shares data about New England air emissions with stakeholders
  - ISO to Go users can view estimated real-time carbon dioxide (CO_2) emissions from New England's power plants in the app
  - The ISO publishes data on estimated CO_2 emissions from New England power plants in a monthly recap of the wholesale electricity markets

ANNUAL EMISSIONS REPORT

Background and Overview

Annual Emissions Report

Evolution of reporting

The annual ISO New England (ISO) *Electric Generator Air Emissions Report* provides a comprehensive analysis of New England electric generator air emissions from NO_X, SO_2, and CO_2 and a review of relevant system conditions for the study year

1994
First *Marginal Emission Rate Analysis (MEA)* Report assessed impact of demand side management (DSM) programs on marginal emissions

2008
Inclusion of average emissions *MEA Report* renamed to *Electric Generator Air Emissions Report*

2011
New marginal emission rates based on the locational marginal unit (time-weighted)

2018
Incorporated load-weighted marginal emission analysis

2020
Incorporated estimated CO_2 emissions from imports* (updated for 2019-2022)

* https://www.iso-ne.com/static-assets/documents/2022/06/estimating_envtl_attributes_imports_2022625.pdf

Air Pollutant Characterization

- Carbon Dioxide (CO_2)
  - The primary greenhouse gas (i.e. gases that trap heat in the atmosphere) emitted through burning of fossil fuels
  - Five New England states have established economy-wide CO_2 emission reduction targets of at least 80% by 2050 (mostly below 1990 levels)
- Sulfur Dioxide (SO_2)
  - One of the six criteria air pollutants regulated under the EPA's National Ambient Air Quality Standards (NAAQS)
  - Primarily emitted through burning of fossil fuels and is an indicator for SO_X
  - Contributes to acid rain and particulate matter (PM) formation
- Nitrogen Oxide (NO_X)
  - Poisonous and highly reactive gas formed when fossil fuel is burned at high temperatures
  - Contribute to PM formation and ground-level ozone on hot summer days
  - NO_2 (indicator for NO_X), ozone, and PM are criteria air pollutants regulated under NAAQS

Emissions Report Coverage

- NO_X, SO_2, and CO_2 Emissions
  - ISO New England generation, which, by definition, **excludes** behind-the-meter generators
  - Total generation emissions by state (in ktons*)
  - Annual and monthly average emission rates, including imports (in ktons)
    - Emissions associated with imports are only calculated for CO_2
- Locational Marginal Emission Rates
  - Locational Marginal Unit (LMU), locational marginal price (LMP)-based method of identifying marginal units

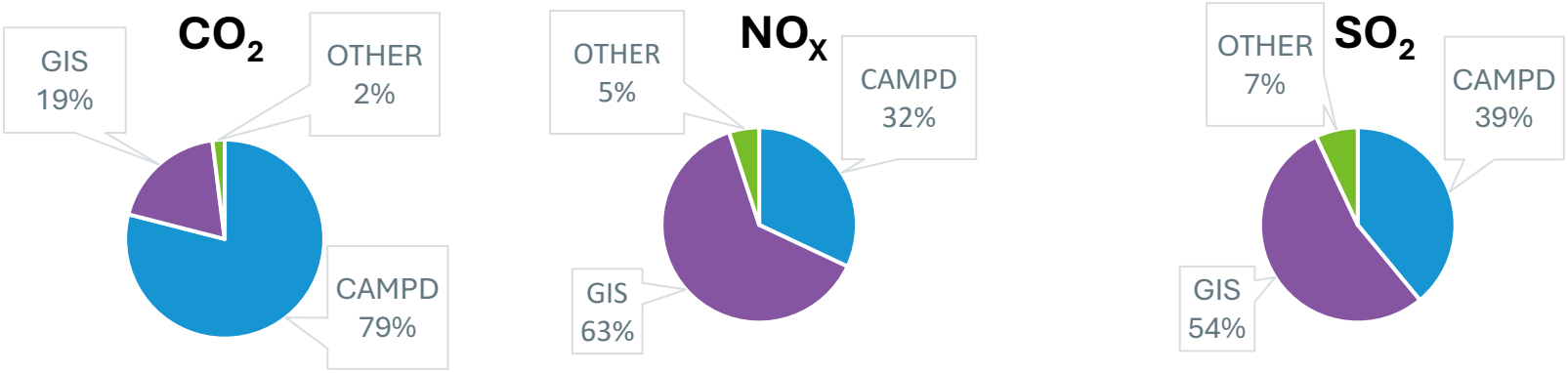
* The mass value of “tons” is equivalent to a U.S. short ton, or 2,000 lbs, and “ktons” is equivalent to 2,000,000 lbs. The emissions report also shows values in metric tons, where one metric ton = 2,204.6 lbs.

Emissions Data

- The report's emissions estimates for generation within New England are based on data from the US Environmental Protection Agency's Clean Air Markets Program Database (CAMPD) and the agency's eGRID database, New England Power Pool Generator Information System monthly data, or the ISO's calculation of emission rates based on unit type and age
- CO_2 emission rates for imports are based on data from the eGRID database for the New York ISO and on Canada's Greenhouse Gas Inventory Report
- Some data sources are not available until several months after the end of a calendar year

Emissions Data

2023 Emissions Report Data Sources



- U.S. EPA Clean Air Markets Program Database (**CAMPD**) is the main source of emissions data
- For units without CAMPD emissions*:
  - NEPOOL Generator Information System (**GIS**) monthly data
  - U.S. EPA's latest eGRID database or assumed emission rates based on unit type and age (**OTHER**)
- CO_2 emissions from imports
  - eGRID CO_2 total output emission rate (lb/MWh) from NYISO balancing authority
  - Canada's Greenhouse Gas Inventory Report

2023 ANNUAL ELECTRIC GENERATOR AIR EMISSIONS REPORT

Key Takeaways

Year-over-year Emissions Decrease

Overall Summary – 2022 to 2023 Average New England Generation Emissions

-48%
in SO_2 *total emissions* (ktons)

-4%
in CO_2 *total emissions* (ktons)

-13%
in NO_X *total emissions* (ktons)

- Annual load, energy prices, and peak demand decreased in 2023 compared to 2022, resulting in year-over-year emission reductions for all three pollutants
  - New England load in 2023 was lower than in 2022 due to mild weather conditions and growth of behind-the-meter (BTM) solar
  - Oil and coal generation decreased while natural gas generation increased in 2023 largely due to planned and unplanned outages of nuclear generators and reductions in net interchange

2023 SYSTEM CONDITIONS

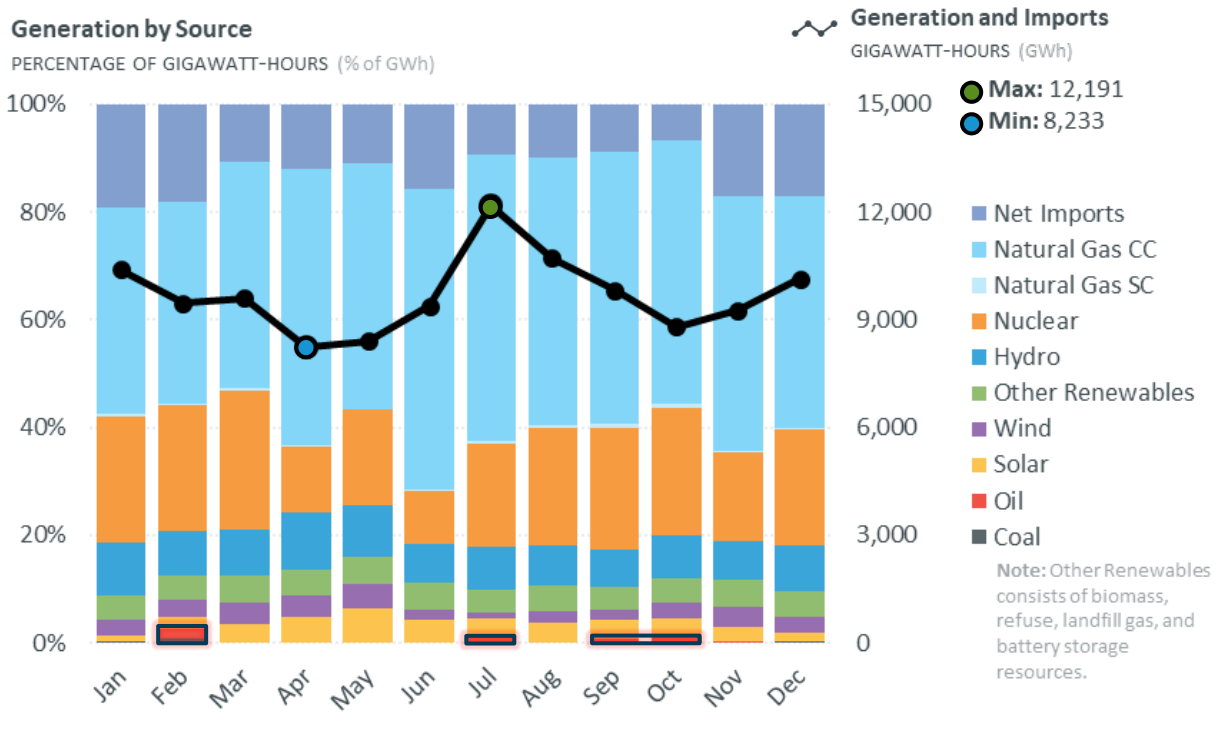
2023 ISO-NE Monthly Generation by Resource Type, including Net Imports

Percent of Total Generation (% GWh) and GWh

A 2-day cold snap in February led to high natural gas prices resulting in more coal and oil generation. Despite sub-zero temperatures, demand was low since the winter peak occurred on a weekend.

Heat waves in July increased oil and coal generation to meet cooling demand

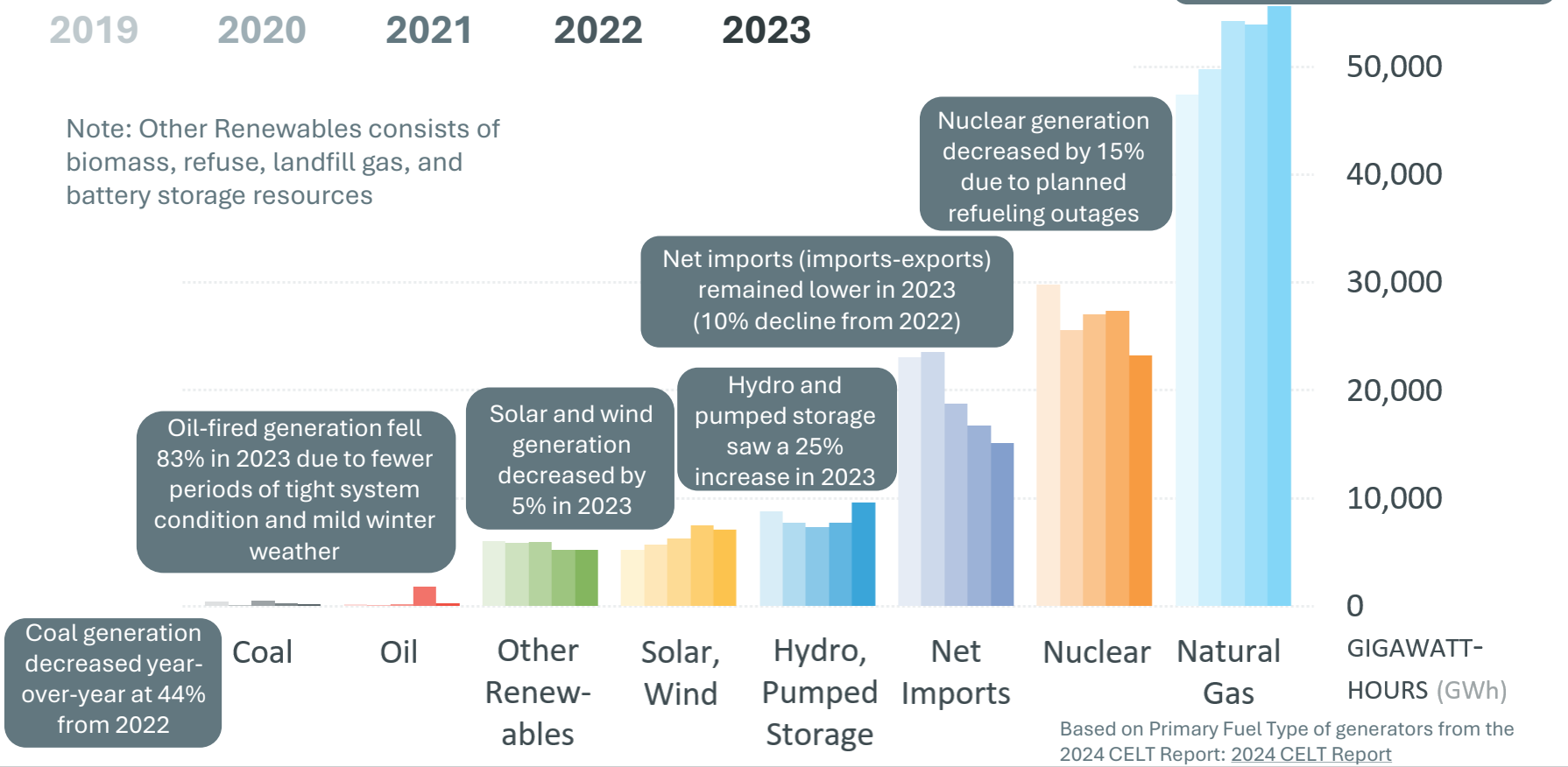
A heat wave in September following a mild summer led to a slight uptick in oil generation. Tight system conditions in October due to unplanned outages also increased oil and coal generation



Annual Generation by Resource Type

2019 2020 2021 2022 2023

Note: Other Renewables consists of biomass, refuse, landfill gas, and battery storage resources



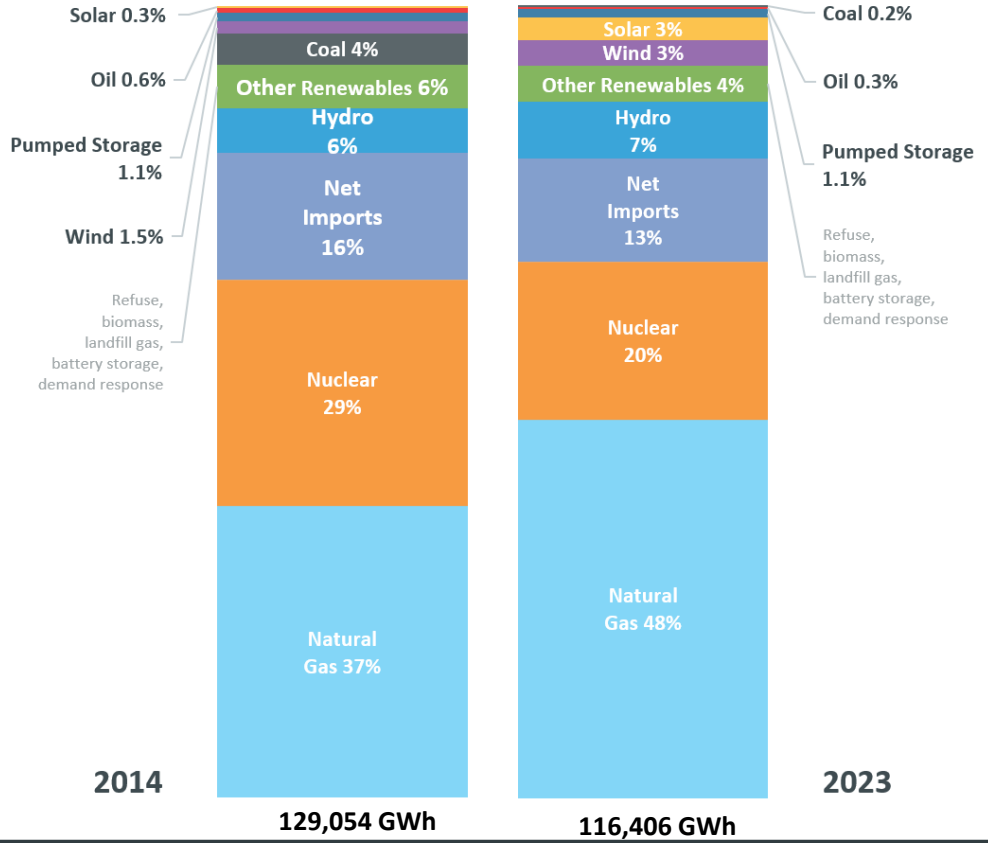
Based on Primary Fuel Type of generators from the 2024 CELT Report: 2024 CELT Report

Shift in New England's Sources of Energy

2014 vs. 2023

Since 2014, the generation mix has shifted away from high carbon emitting resources (i.e. oil and coal) to lower-carbon-emitting resources like natural gas and carbon free resources such as solar and wind.

Notably, nuclear generation and net imports have decreased in the last 10 years, which was offset by an increase in natural gas generation.

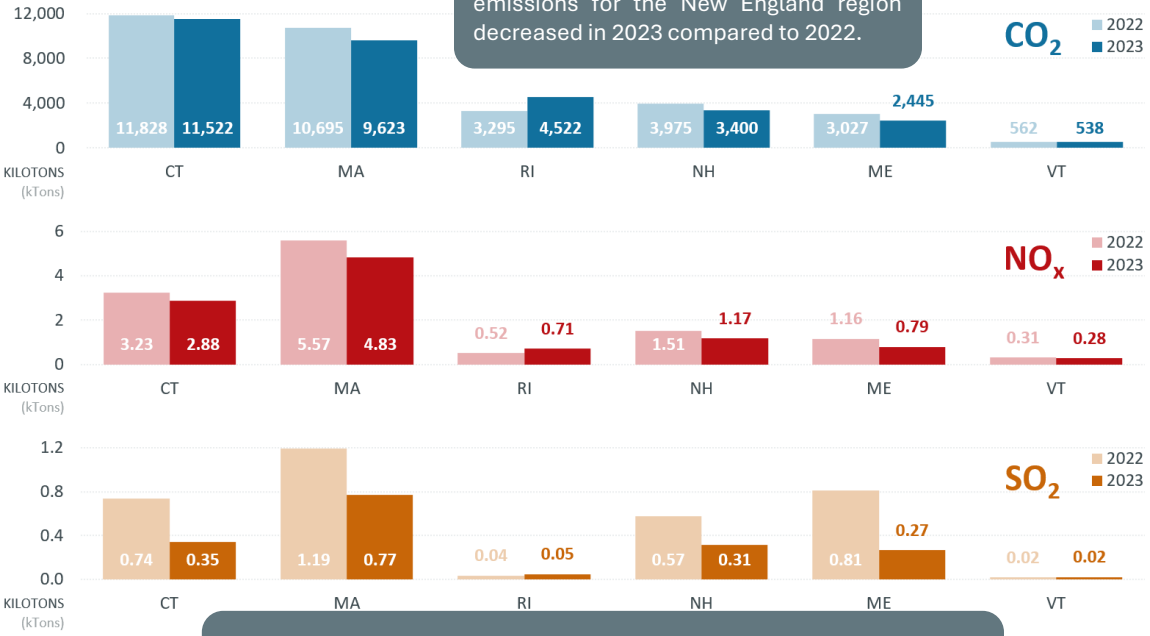


2023 ISO NEW ENGLAND AVERAGE EMISSIONS

2022 & 2023 Average Annual New England Generation Emissions

By State (ktons)

The average CO_2, NO_X, and SO_2 emissions for the New England region decreased in 2023 compared to 2022.



New England total CO_2
32,050 (2023)
33,382 (2022)

New England total NO_X
10.66 (2023)
12.30 (2022)

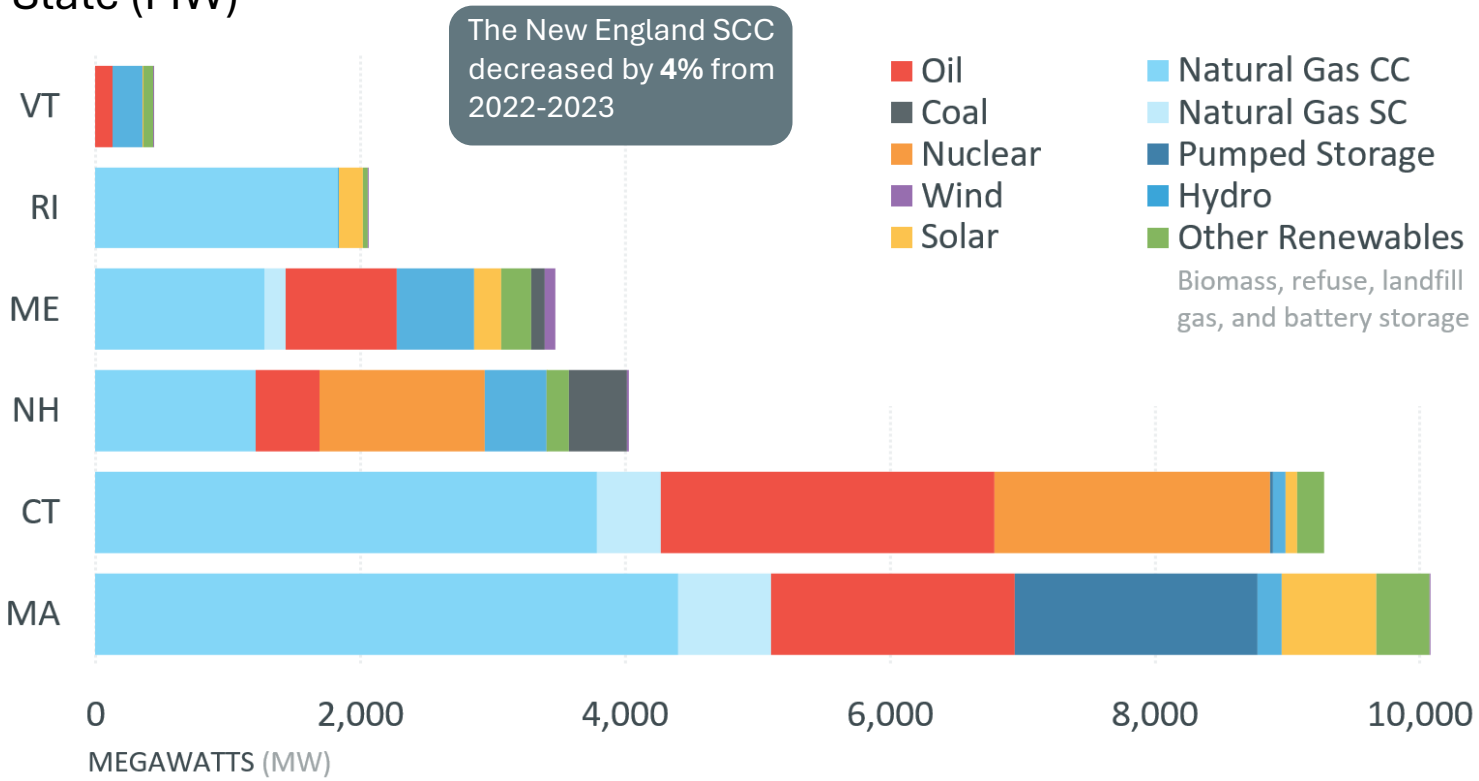
New England total SO_2
1.77 (2023)
3.38 (2022)

SO_2 emissions in 2023 were almost half of 2022 emissions (2022 was a year marked by increased oil-fired generation due to natural gas pipeline constraints that made oil and sometimes coal more economical to run)

NOTE:
Values shown may not sum correctly due to rounding

2023 ISO-NE Summer Claimed Capability (SCC)

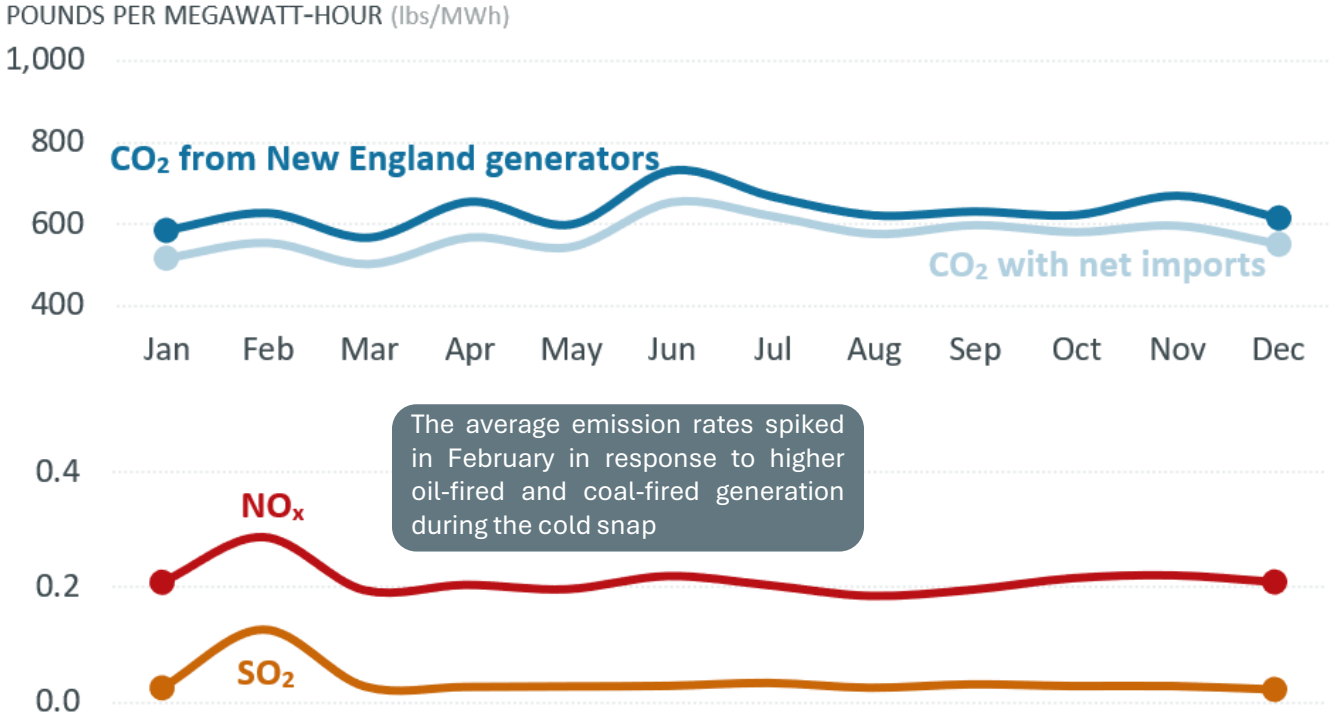
By State (MW)



Note: The claimed capability (MW) is a generator's maximum production or output.

2023 ISO-NE Monthly Average Emission Rates (lbs/MWh)

New England Generation Only for SO_2, NO_X, and CO_2, and with Imports for CO_2



Impact of Imports and Exports on 2023 Average Annual CO_2 Emissions and Emission Rates

32,050 ktons (New England)
+ 2,048 ktons (imports)
– 883 ktons (exports)

→ **+4%** in CO_2 *total emissions* (ktons)

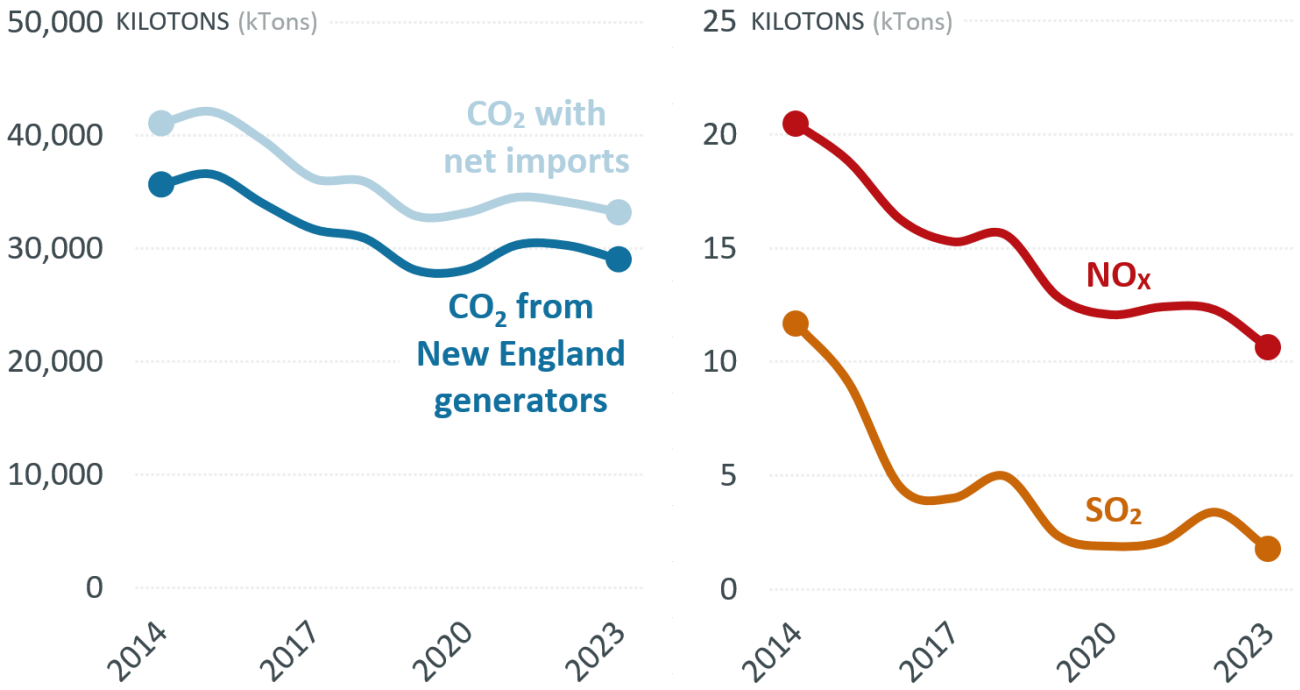
633 lbs/MWh (New England generators only)
571 lbs/MWh (New England generators plus net imports)

→ **-11%** in CO_2 *Emission rate* (lbs/MWh)

- Assumed emission import rates (based on annual averages):
  - New Brunswick and Quebec values are the average of the 2020-2022 rates, and New York is the eGRID2022 value
    - New Brunswick: 680 lbs/MWh
    - New York: 504 lbs/MWh
    - Quebec: 3.9 lbs/MWh

2014 – 2023 ISO-NE Annual Average Emissions (ktons)

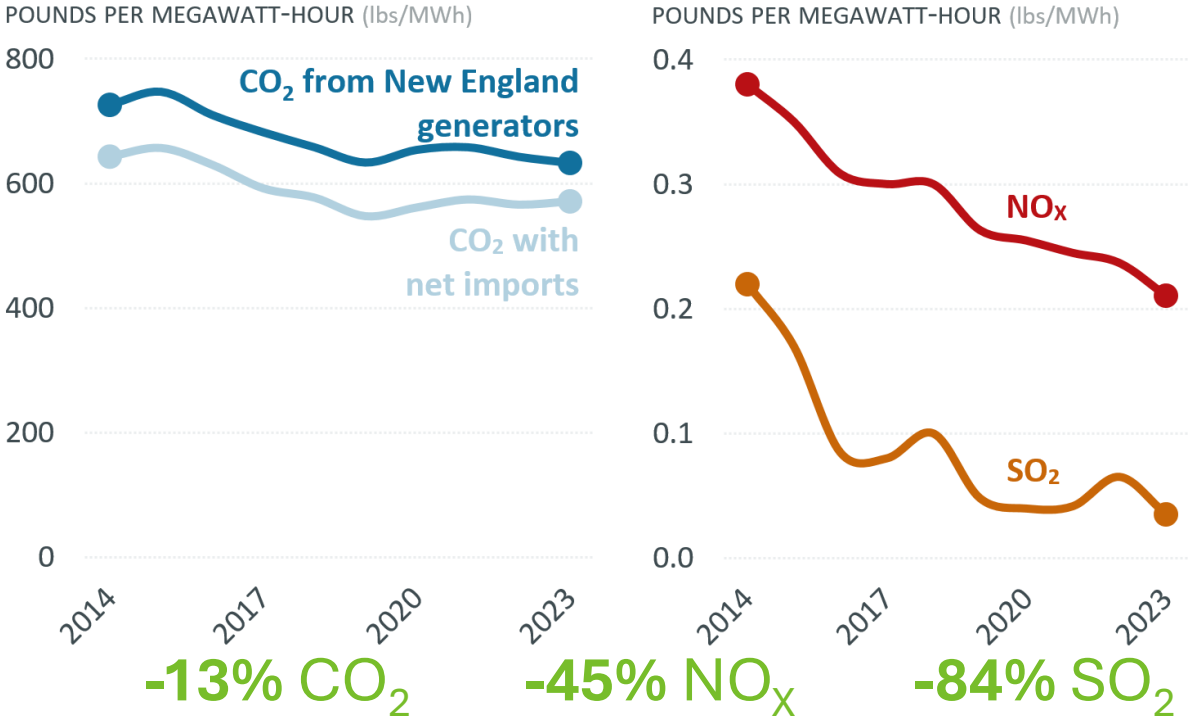
New England Generation Only for SO_2, NO_X, and CO_2, and with Imports for CO_2



-18% CO_2 **-48% NO_X** **-85% SO_2**

2014 – 2023 ISO-NE Annual Average Emission Rates (lbs/MWh)

New England Generation Only for SO_2, NO_X, and CO_2, and with Net Imports for CO_2



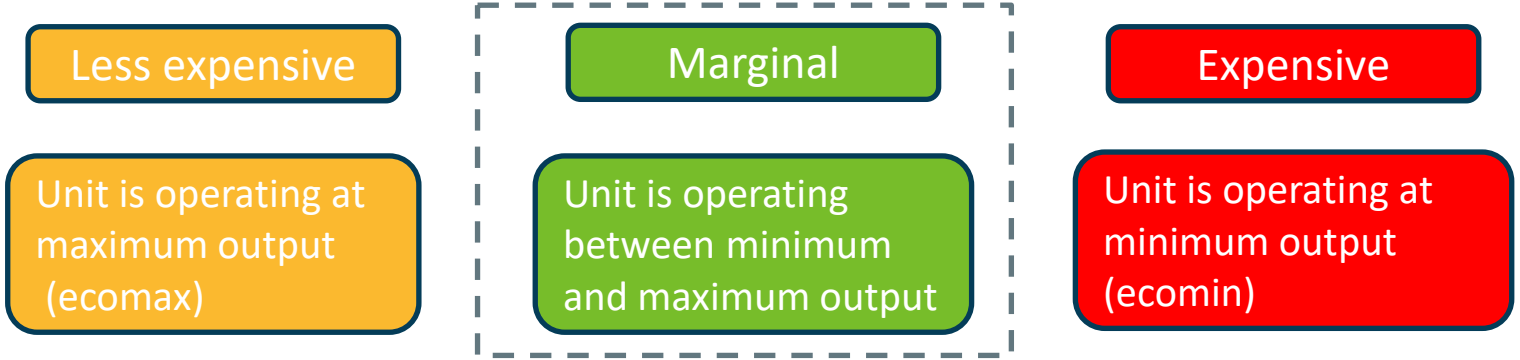
2023 ISO NEW ENGLAND MARGINAL EMISSIONS ANALYSIS

- *Locational Marginal Unit (LMU)*
- *Percent Marginal by Fuel Type*
- *Marginal Emission Rates*

Locational Marginal Unit (LMU)

- To operate a safe and cost-effective grid, the ISO must:
  - Balance supply and demand
  - Determine least-cost security-constrained **commitment** and **dispatch** of resources to serve load at different locations (economic dispatch)
  - Minimize cost of electricity production (maximize social welfare)

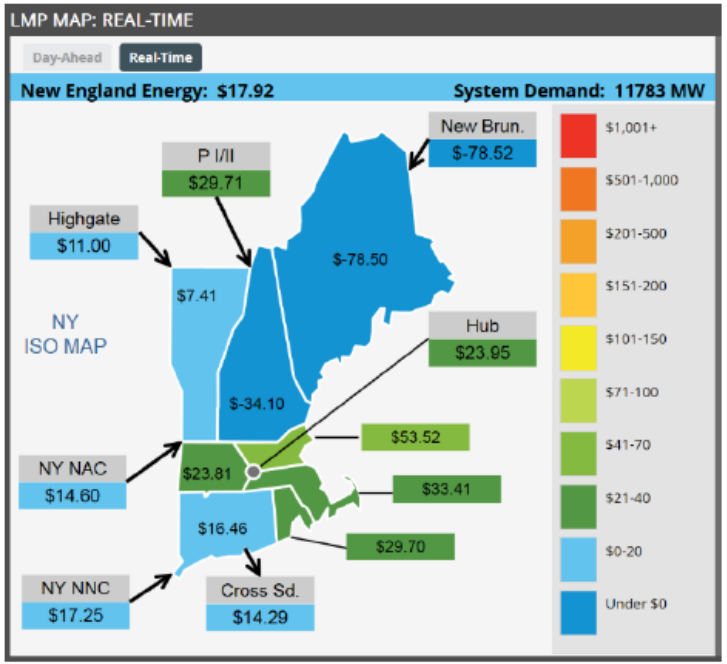
Resources that can be dispatched will fall into one of three groups:



*Economic dispatch selects the **marginal unit** to provide the next increment of supply and set the price at the location.*

Locational Marginal Price (LMP)

- LMP is the cost of supplying an increment of load at a particular location
  - Produced as a result of economic dispatch
  - Marginal unit sets the LMP
  - LMPs are updated every five-minutes in the Real-Time Market
- LMPs can vary depending on the location:
  - Node
  - Load Zone
  - Hub
  - External Node



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Locational Marginal Price (LMP)

Node

- Point on the transmission system where electricity is generated or consumed and for which nodal prices are calculated

Load Zone

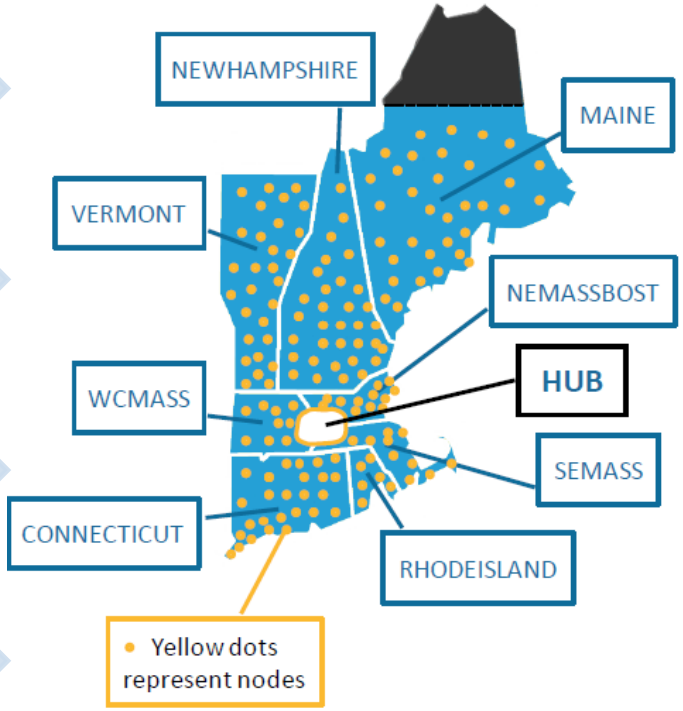
- Aggregation of nodes
- 8 load zones in New England

Hub

- Set of nodes (32) for which LMP is calculated

External Node (*not on map*)

- Proxy location on transmission system
- Establishes prices for power sold to or bought from outside NE



Constrained System

- If there is no congestion and no losses, the LMP would be the same at each location, but in reality, transmission lines are limited by how much power they can transfer
- When a limit is reached, the system becomes congested or **constrained** and it is not possible to use energy from low-cost generators to serve all loads
- Higher-cost resources must be dispatched to serve load in constrained locations resulting in higher LMPs at these locations

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 are calculated by summing the monthly percentage (of time or load) marginal from identified LMUs, then multiplying by relevant individual generator emission rates, and dividing by the total on-peak or off-peak hours in the year
- The percentage that each generator is marginal was calculated using two approaches:
  - **Load-weighted LMUs**, reflecting the load associated with the marginal unit
    - Assumes that under a constrained system, marginal resources do not equally contribute to meeting load
  - **Time-weighted LMUs**, reflecting the time for which a resource was marginal
    - Assumes if there are multiple marginal resources within a time interval (constrained system), then the resource equally contribute to meeting the load

Marginal Emissions Analysis

Marginal Unit Scenarios

1. All-LMUs
   - Includes all Locational Marginal Units (including imports) identified by 5-minute LMPs
   - 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, 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

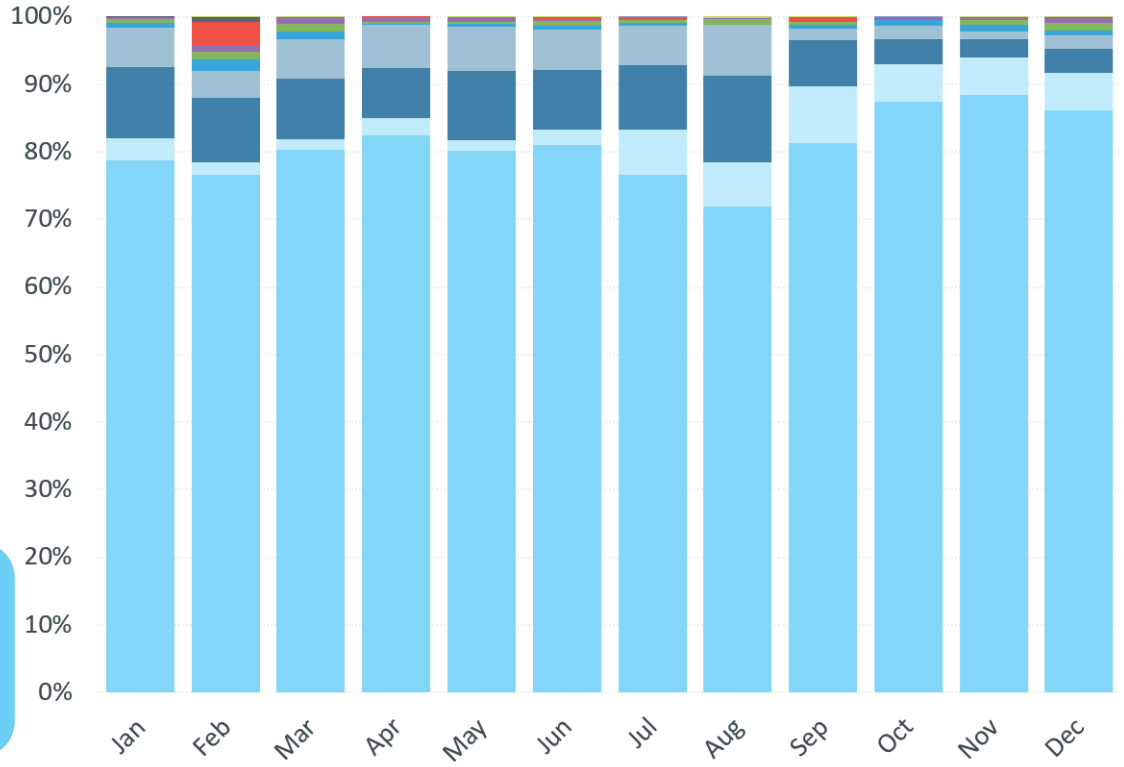
2023 Monthly % of Load Unit Types Were Marginal

All-LMUs – Load-Weighted

Oil was marginal for **0.6%** of the load (down from 4% in 2022)

Wind was marginal for only **0.4%** of the load since many wind resources are located in export-constrained areas

Natural gas was the primary marginal fuel type, serving **84%** of the load in 2023



Note: Other Renewables consists of biomass, refuse, landfill gas, and battery storage resources.

2023 Monthly % of Time Unit Types Were Marginal

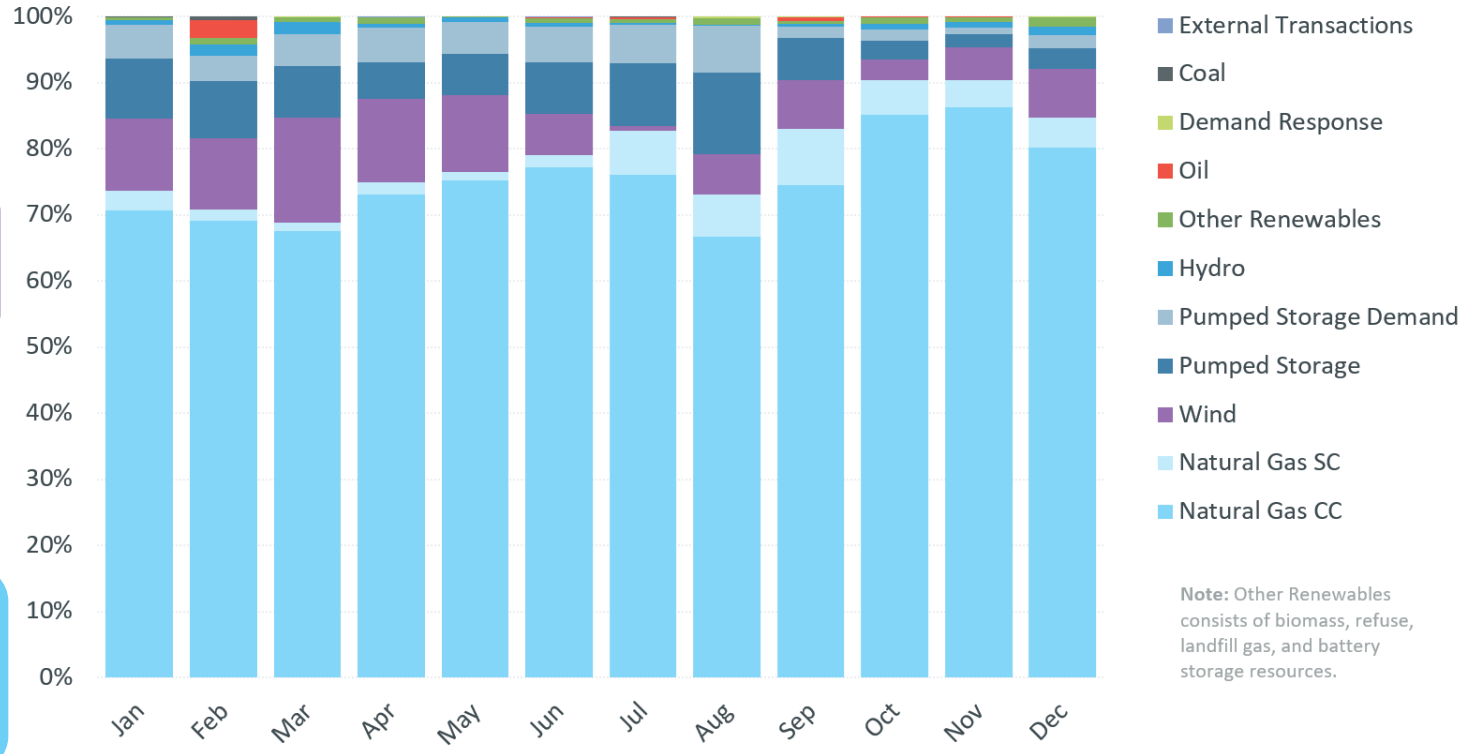
All-LMUs – Time-Weighted

Oil was marginal for only **0.3%** of the time (down from 3% in 2022)

Wind was marginal **8%** of the time (vs. **0.4%** using the load-weighted approach)

Other renewables was marginal for **0.8%** of the time

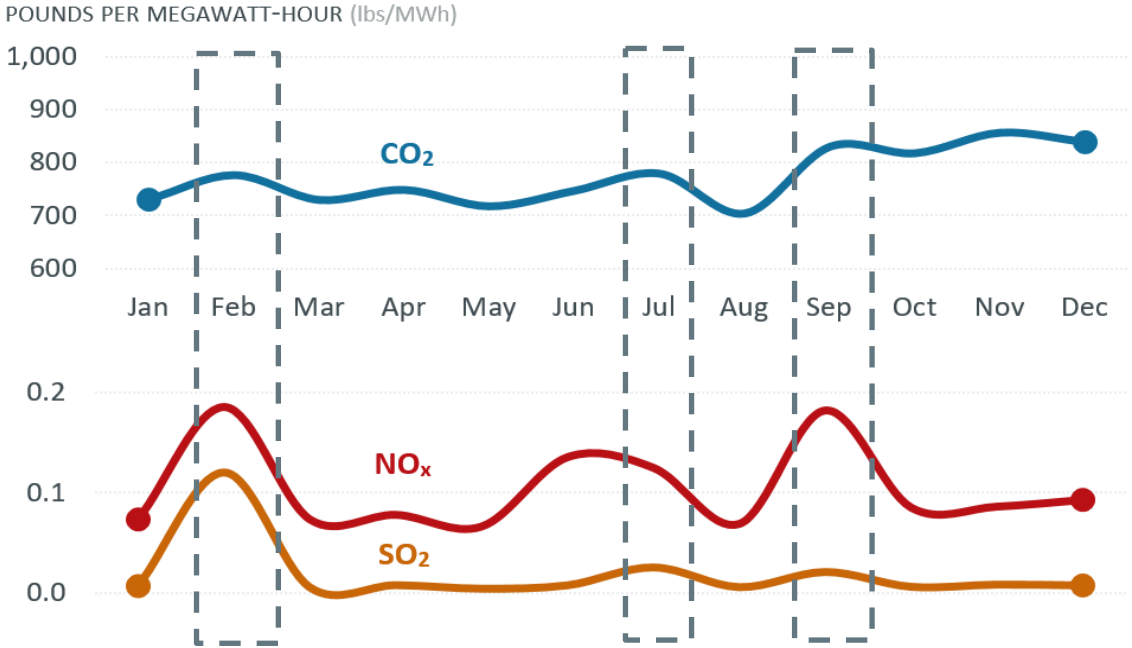
Natural gas was the primary marginal fuel type for **79%** of the time



Note: Other Renewables consists of biomass, refuse, landfill gas, and battery storage resources.

2023 Monthly Marginal Emission Rates (lbs/MWh)

All-LMUs – Load-Weighted



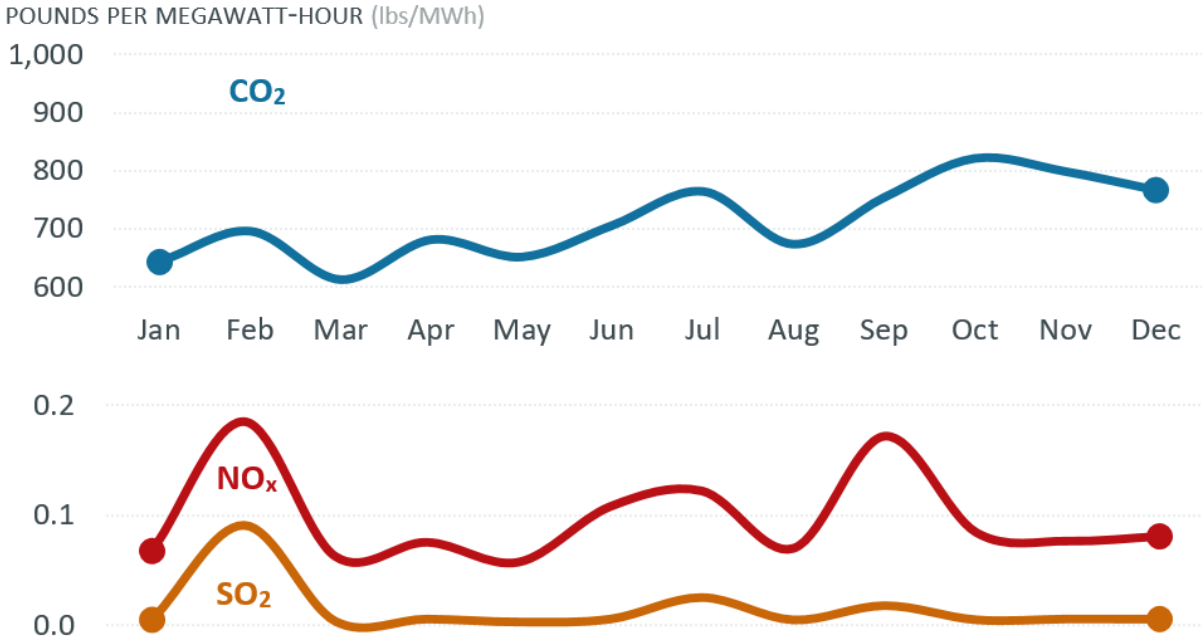
2-day cold snap in February resulted in higher natural gas prices that made oil and coal resources on the margin for more of the load resulting in higher marginal emission rates

Heat waves in July lead to more oil on the margin resulting in higher marginal emission rates

The highest peak demand in 2023 occurred in September during a heat wave that lead to oil resources on the margin more frequently

2023 Monthly Marginal Emission Rates (lbs/MWh)

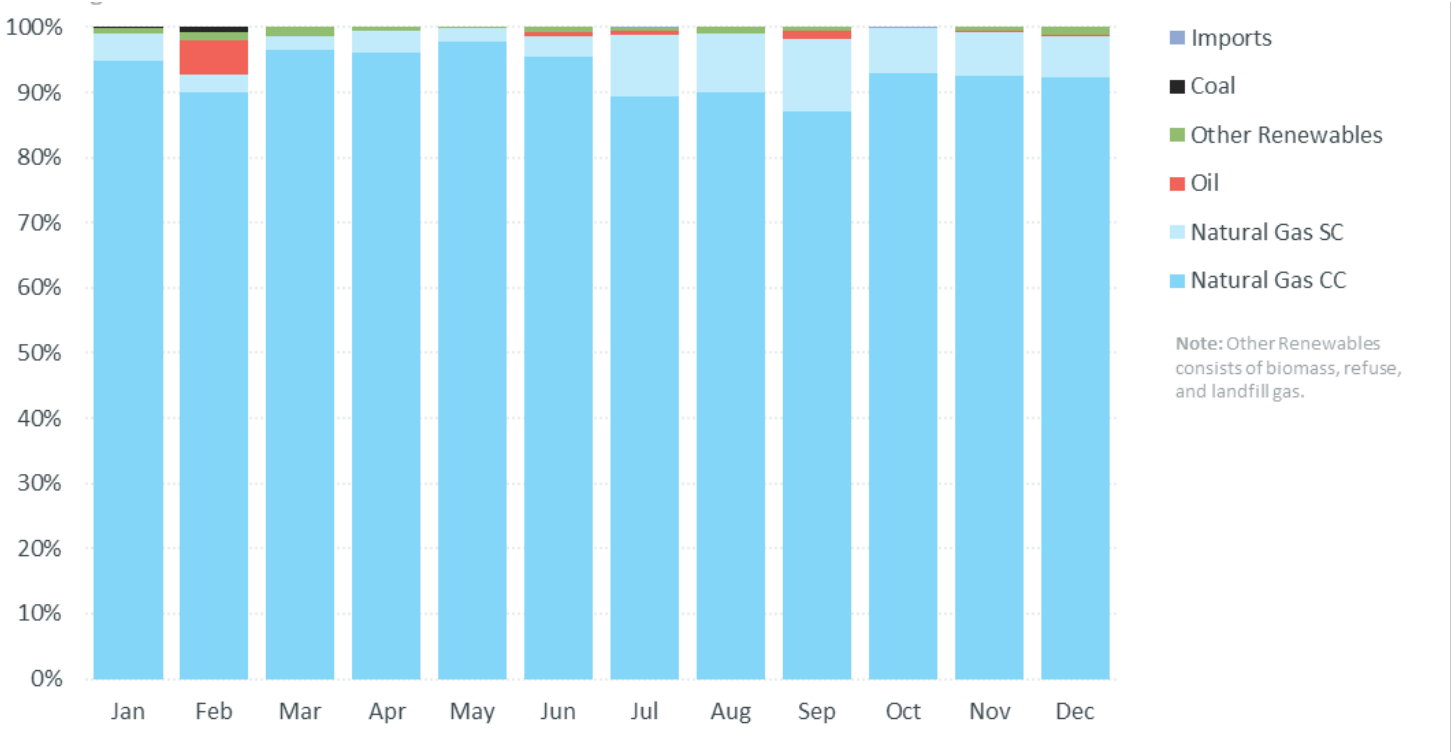
All-LMUs – Time-Weighted



Time-weighted marginal emission rates exhibited the same trend as the load-weighted rates, except, the time-weighted rates are slightly lower due to increased contribution of wind generators

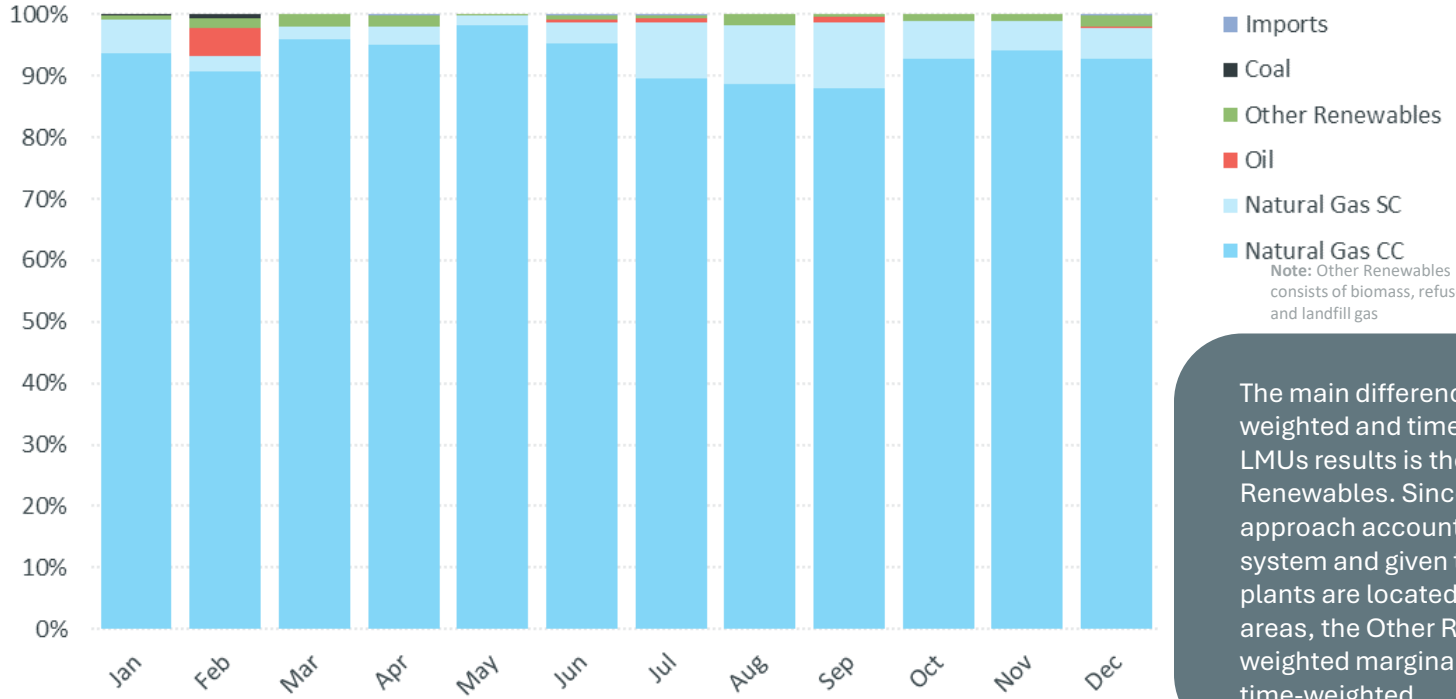
2023 Monthly % of Load Unit Types Were Marginal

Emitting-LMUs – Load-Weighted



2023 Monthly % of Time Unit Types Were Marginal

Emitting-LMUs – Time-Weighted

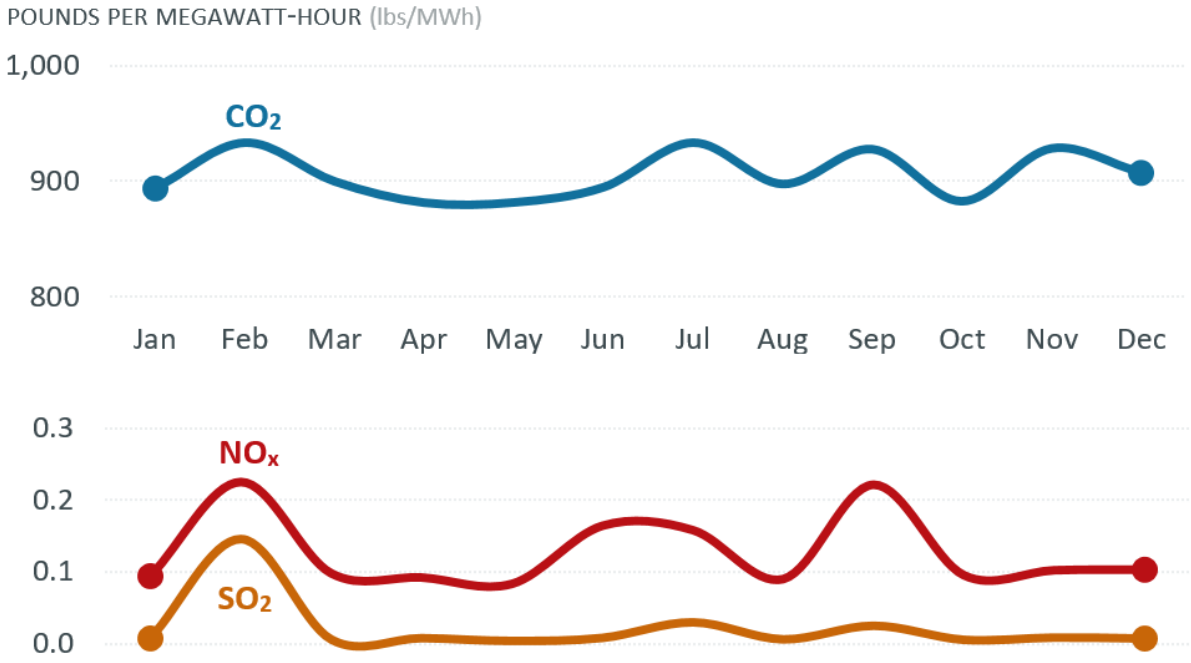


Note: Other Renewables consists of biomass, refuse, and landfill gas

The main difference between the load-weighted and time-weighted emitting-LMUs results is the marginality of Other Renewables. Since the load-weighted approach accounts for congestion on the system and given that many biomass plants are located in export-constrained areas, the Other Renewables' load-weighted marginality was less than the time-weighted.

2023 Monthly Marginal Emission Rates (lbs/MWh)

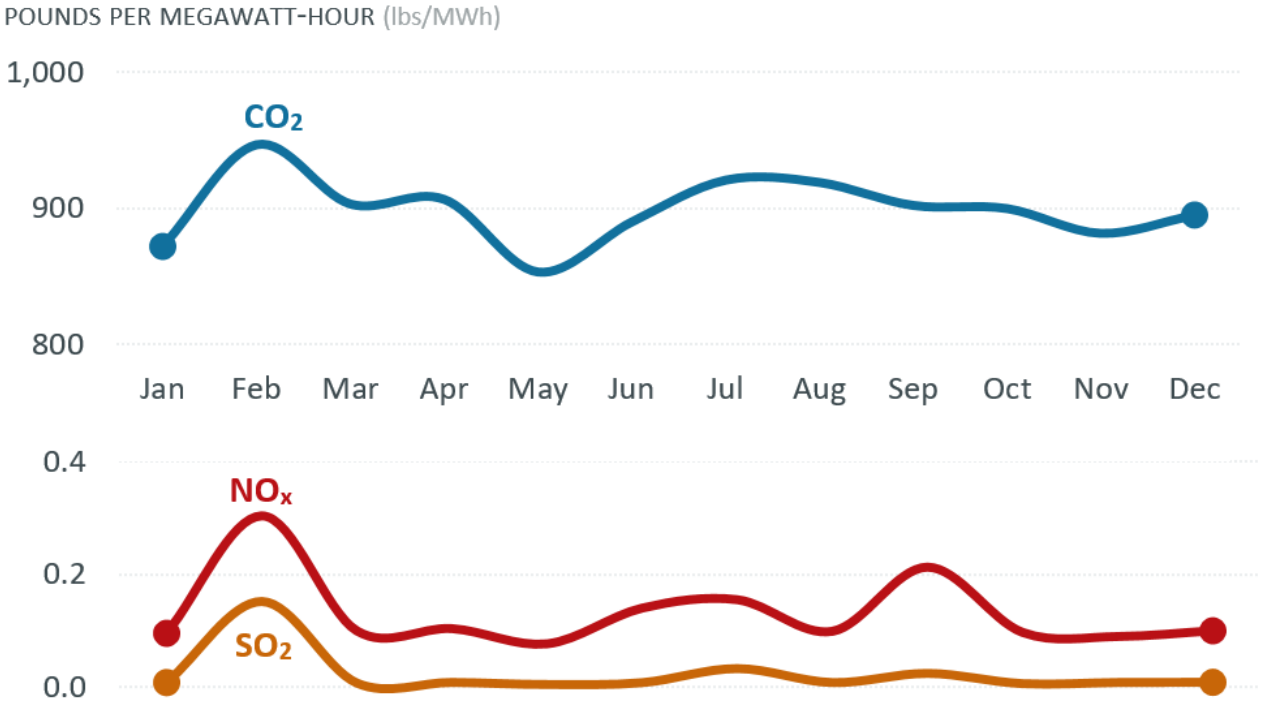
Emitting-LMUs – Load-Weighted



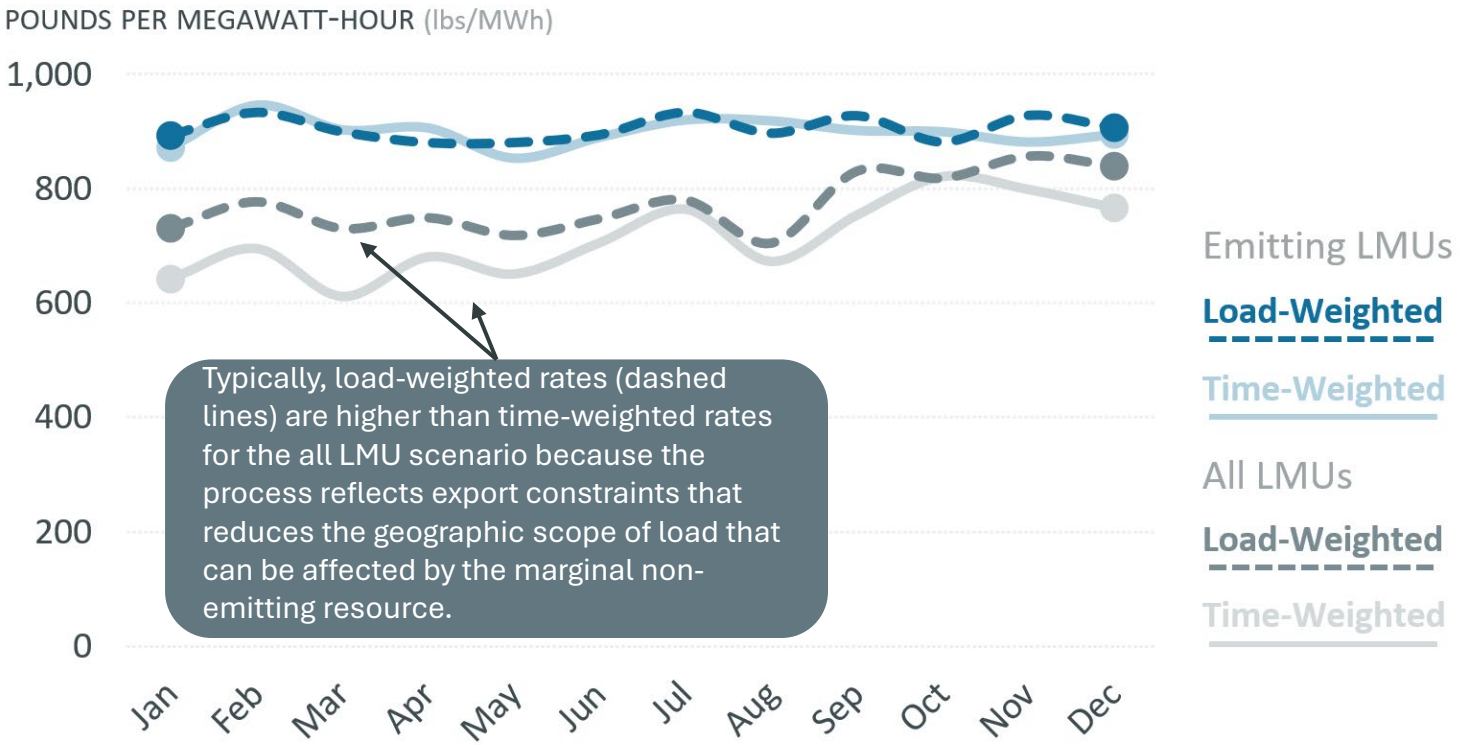
Since the emitting-LMU scenario excludes non-emitting resources from the marginal emission rate calculation, this resulted in higher emission rates compared to the "all-LMU" scenario.

2023 Monthly Marginal Emission Rates (lbs/MWh)

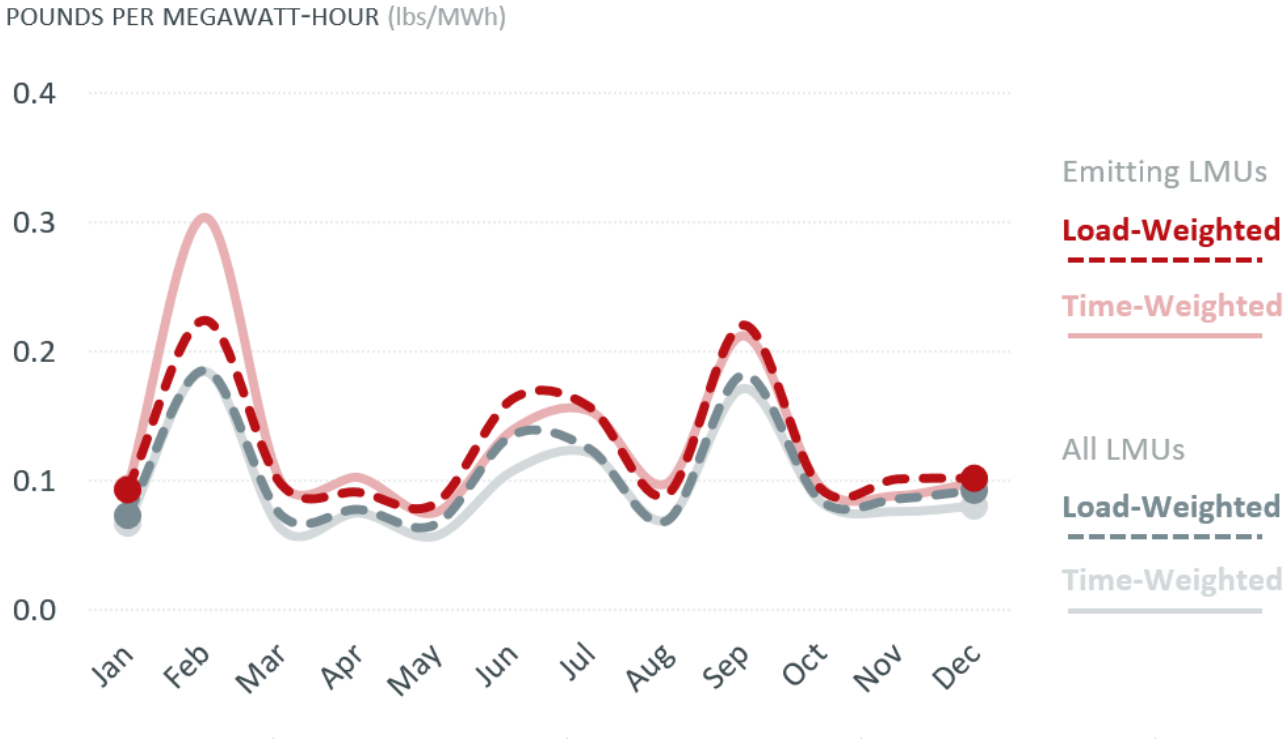
Emitting-LMUs – Time-Weighted



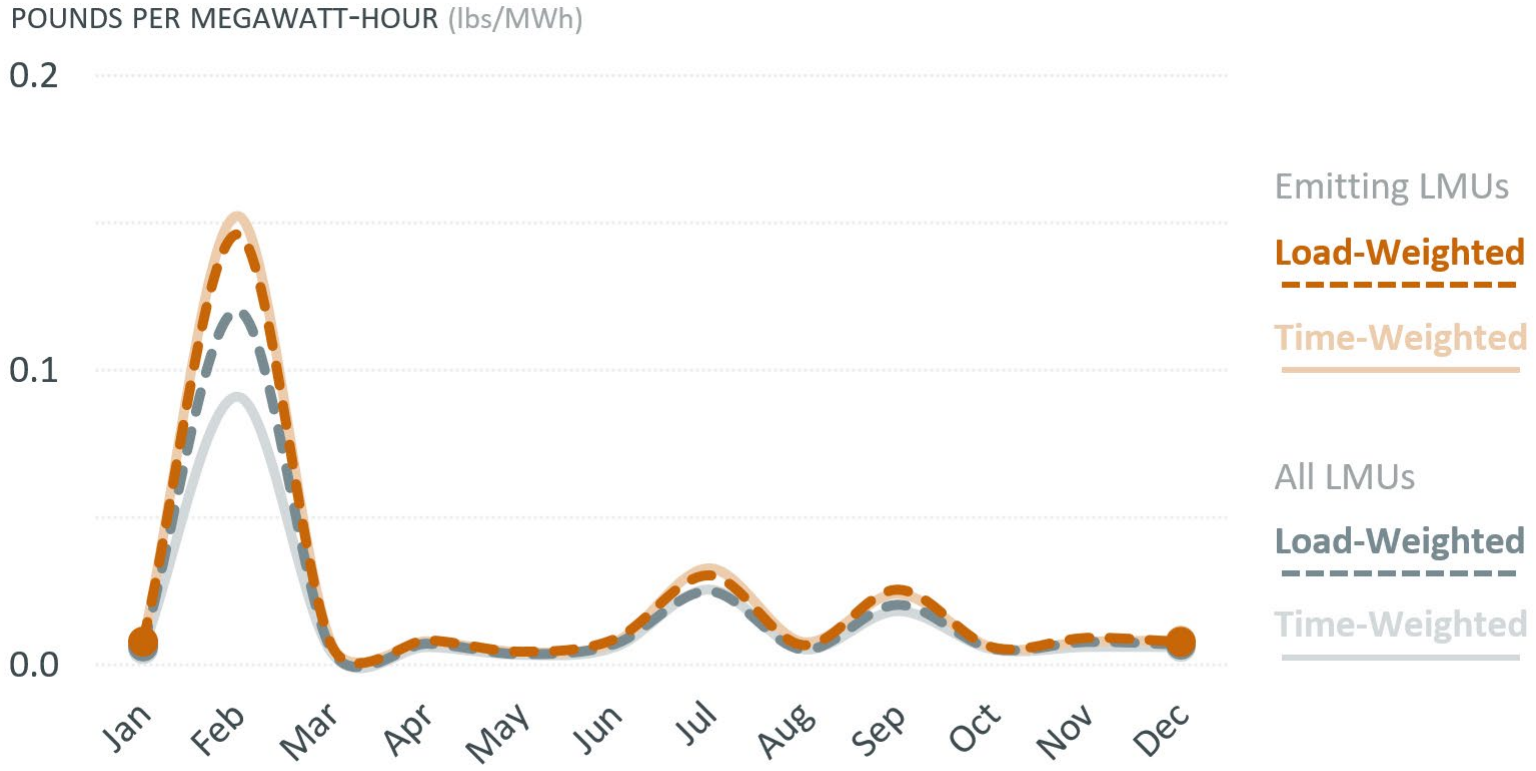
2023 Monthly Marginal CO_2 Rates (lbs/MWh)



2023 Monthly Marginal NO_X Rates (lbs/MWh)



2023 Monthly Marginal SO_2 Rates (lbs/MWh)

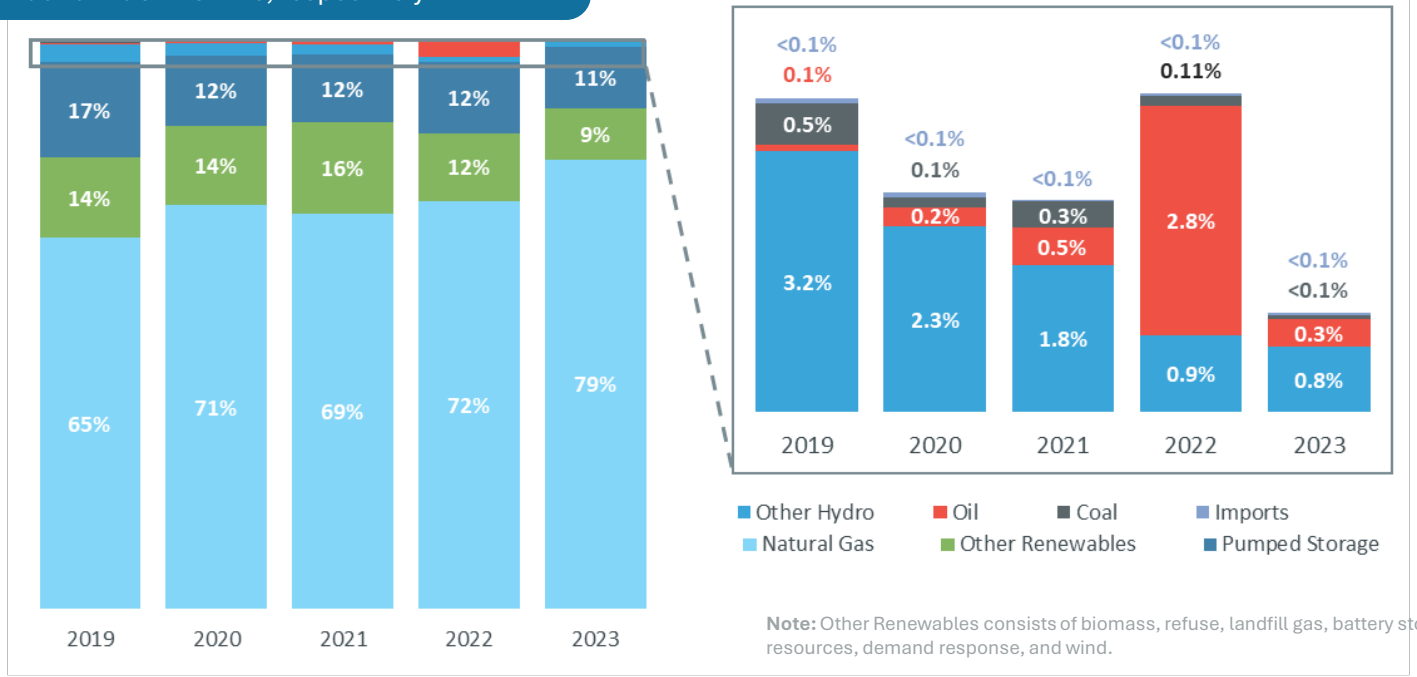


2019 – 2023 Percent of Time Unit Type Was Marginal

All-LMUs – Time-Weighted

The Pumped Storage category includes both pumped storage generation and pumped storage demand. In 2023, the generation and demand components were marginal 7% and 4% of the time, respectively.

In 2023, wind was marginal for 8% of the time. Biomass, refuse, landfill gas, battery storage resources, and demand response were also marginal at times.

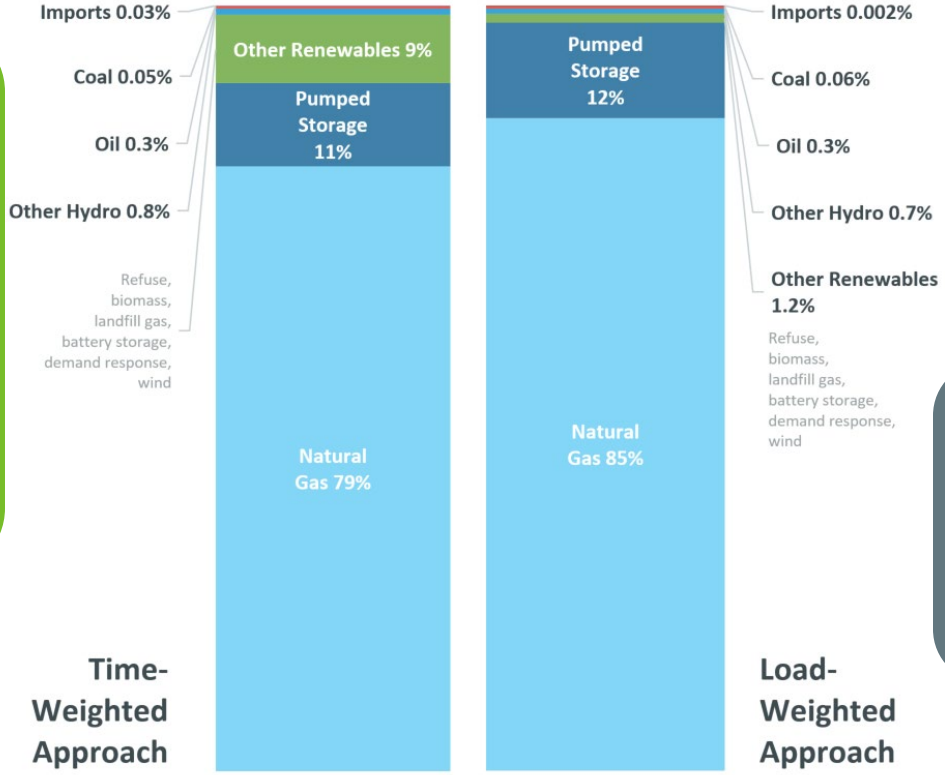


Note: Other Renewables consists of biomass, refuse, landfill gas, battery storage resources, demand response, and wind.

2023 Percent of Time/Load Unit Type Was Marginal

All-LMUs – Time- and Load-Weighted

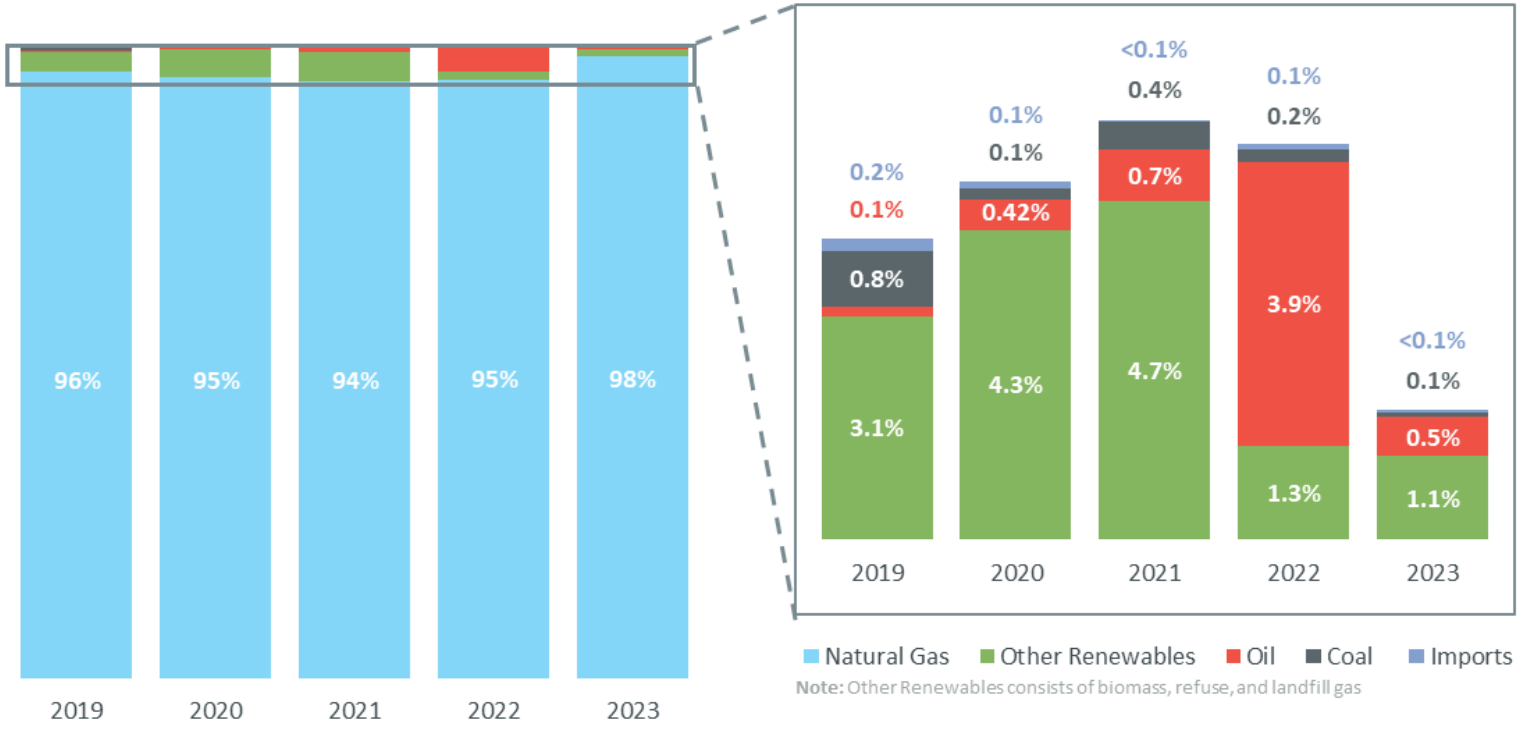
In the Other Renewables category, wind was marginal 8% of the time based on the time-weighted approach, but only 0.4% for the load-weighted. The remaining marginal units in that category consists of wood/wood waste solids, refuse plants, and demand response resources.



Fossil fuel resources and pumped storage are typically more marginal under the load-weighted approach since they are not located in export constrained areas like other renewables and imports.

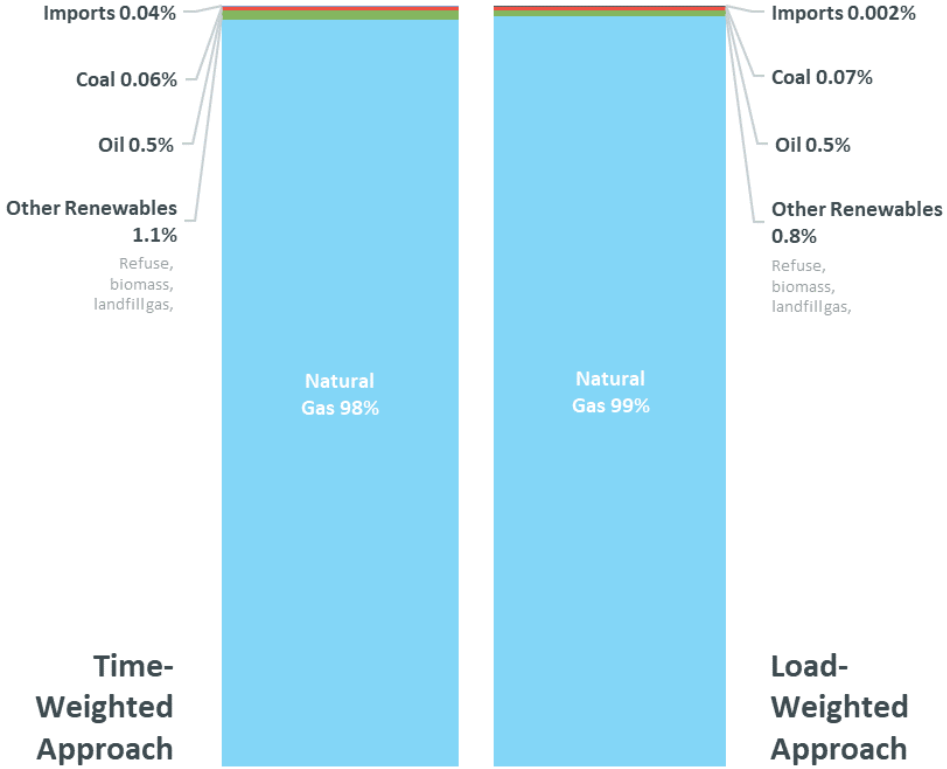
2019 – 2023 Percent of Time Unit Type Was Marginal

Emitting-LMUs – Time-Weighted



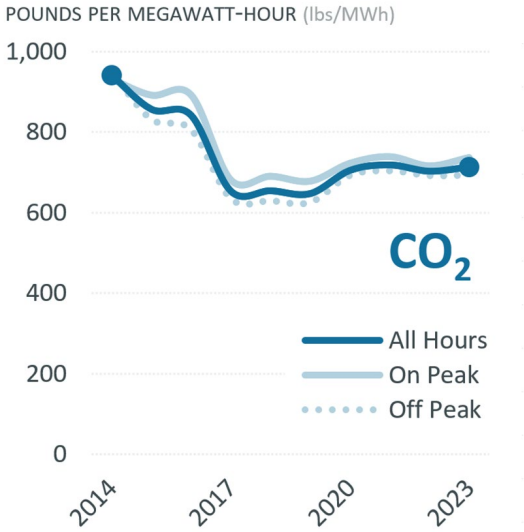
2023 Percent of Time/Load Unit Type Was Marginal

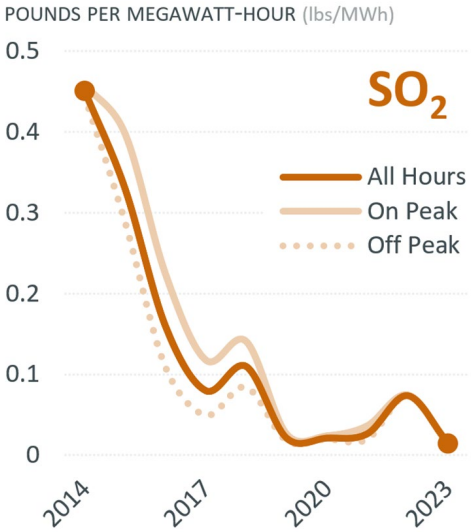
Emitting-LMUs – Time- and Load-Weighted



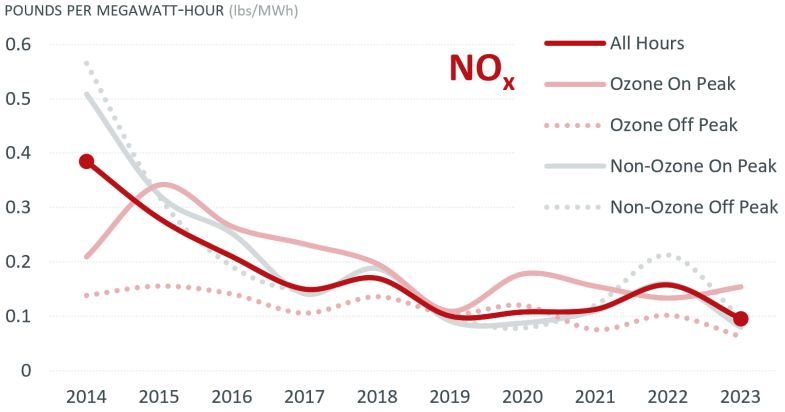
2014 – 2023 Marginal Emission Rates (lbs/MWh)

All-LMUs – Time-Weighted



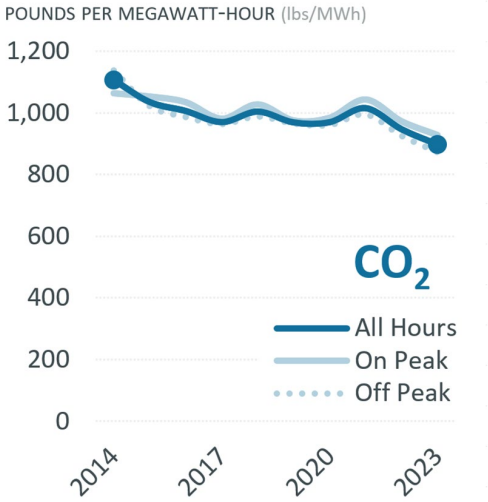


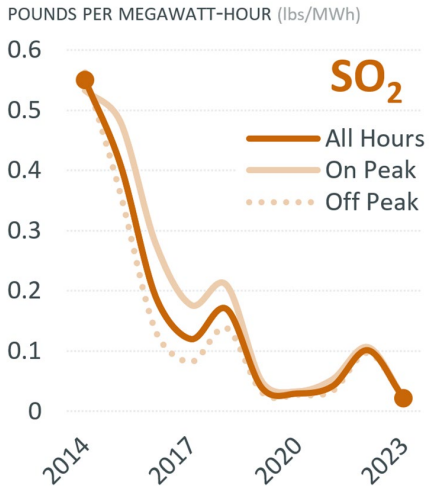
Overall decreasing trend in the marginal emission rates for SO_2, NO_X, and CO_2 in the past 10 years



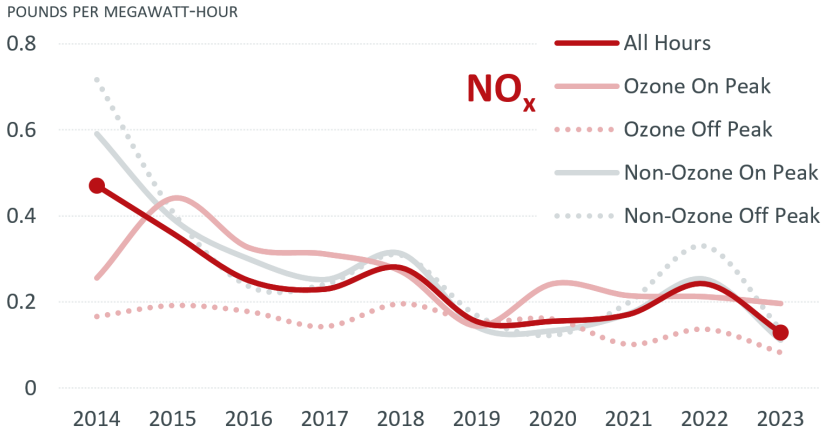
2014 – 2023 Marginal Emission Rates (lbs/MWh)

Emitting-LMUs – Time-Weighted



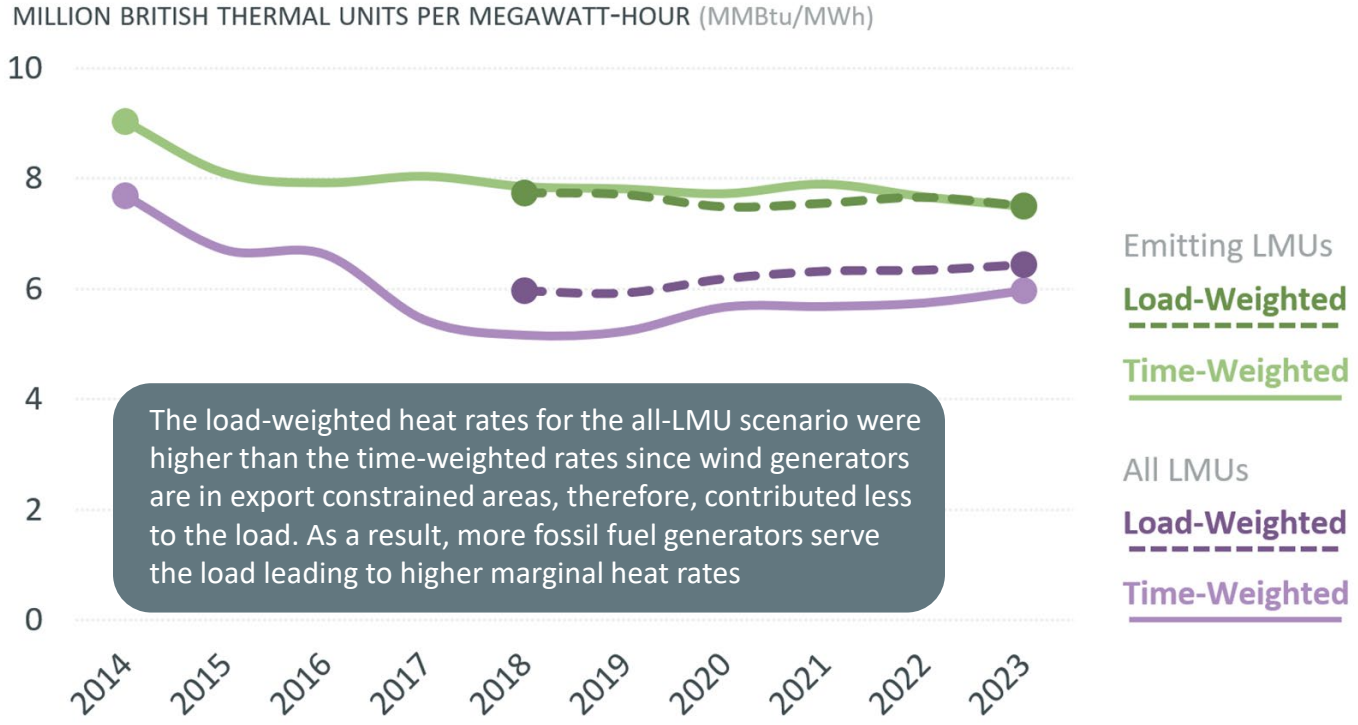


The emitting-LMU emission rates are higher than the all-LMU because the all-LMU scenario includes zero-air-emission resources that lower the marginal emission rate



2014 – 2023 Time-Weighted Marginal Heat Rates (MMBtu/MWh)

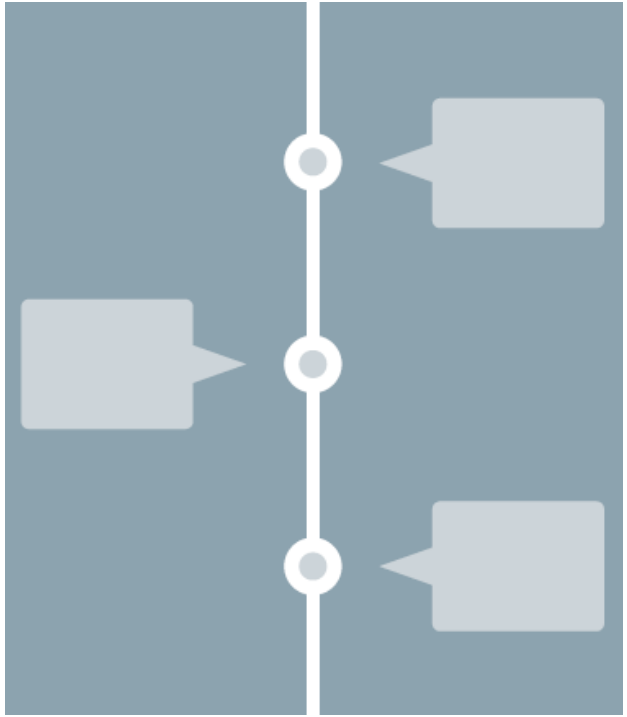
Load-Weighted values shown for 2018 - 2023



NEXT STEPS

Next Steps

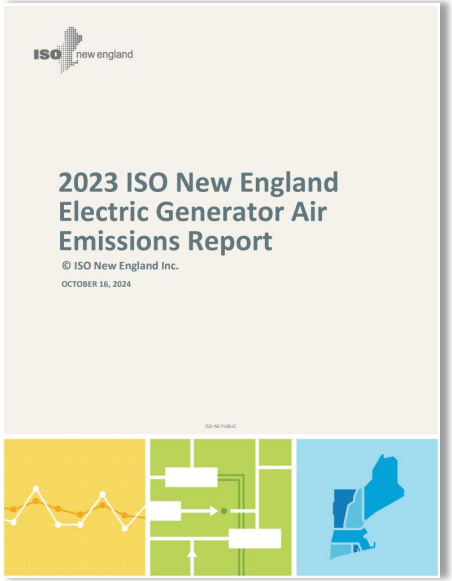
- The 2024 Electric Generator Air Emissions Report is anticipated to be published in Q4 2025



RESOURCES

2023 Electric Generator Air Emissions Report

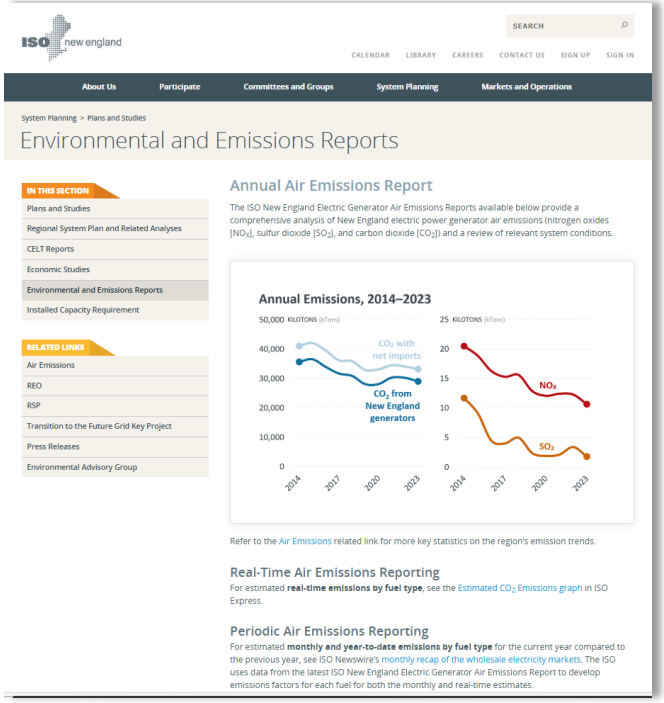
- The 2023 Electric Generator Air Emissions Report is comprised of three documents:
  - Background and Methodology: Provides a detailed overview on the background, data sources, and methodologies for the Emissions Report
  - Executive Summary: Provides a high-level overview of system conditions and an assessment of key monthly and annual emission trends from the 2023 emissions analysis
  - Appendix Spreadsheet: Excel spreadsheet provides comprehensive data tables and figures on the relevant system conditions, average emission rates for imports/exports, marginal heat rates, and emissions data for various time periods



Environmental and Emissions Reports

- The Environmental and Emissions Reports page on the ISO website provides updates on the Annual Air Emissions Report, Real-Time Air Emissions Reporting, and links to periodic air emissions reporting resources including quarterly Regional Greenhouse Gas Initiative (RGGI) auction results and estimated monthly CO_2 emissions from Massachusetts generators

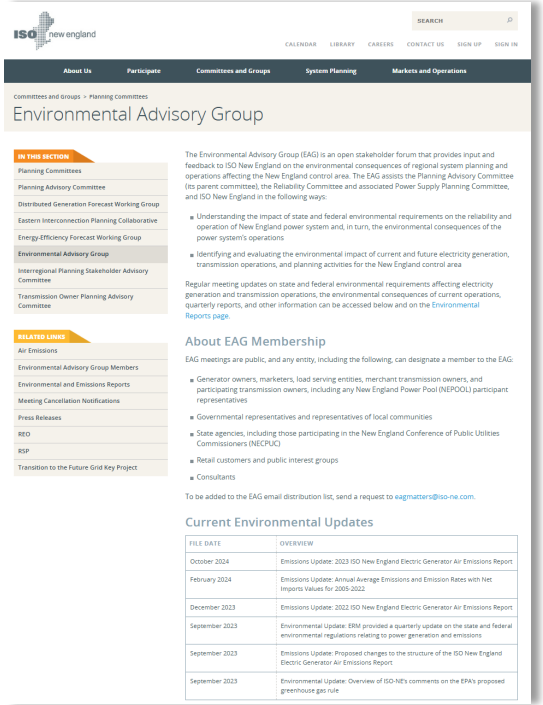
- The ISO also publishes data on estimated CO_2 emissions from New England power plants in a monthly recap of the wholesale electricity markets, and real-time estimates are available on ISO Express



Environmental and Emissions Reports

Environmental Advisory Group

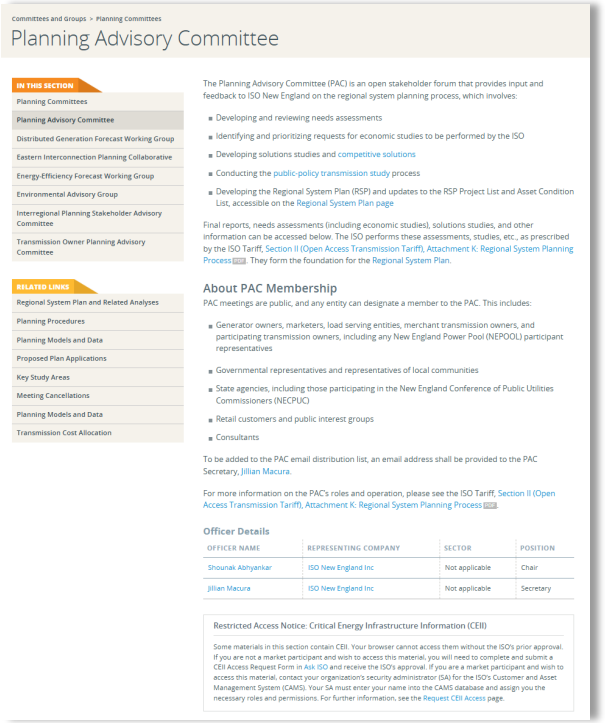
- The Environmental Advisory Group (EAG) is an open forum to provide stakeholders an opportunity to learn about, and provide input on, environmental matters related to the region's power system
- EAG meetings are free and open to the public
- To be added to the EAG email distribution list, or to receive updates when new documents are posted, please visit to the EAG webpage to subscribe



Environmental Advisory Group

Planning Advisory Committee

- The Planning Advisory Committee (PAC) is an open stakeholder forum that provides input to ISO on the regional system planning process, which involves:
  - Developing and reviewing needs assessments
  - Identifying and prioritizing requests for economic studies to be performed by the ISO
  - Developing solutions studies and competitive solutions
  - Conducting the public-policy transmission study process
  - Developing the Regional System Plan (RSP) and updates to the RSP Project List and Asset Condition List, accessible on the Regional System Plan page
- PAC meetings are free and open to the public
- To be added to the PAC email distribution list, or to receive updates when new documents are posted, please visit to the PAC webpage to subscribe


Committees and Groups > Planning Committees

Planning Advisory Committee

IN THIS SECTION

Planning Committees
Planning Advisory Committee
Distributed Generation Forecast Working Group
Eastern Interconnection Planning Collaborative
Energy-Efficiency Forecast Working Group
Environmental Advisory Group
Interregional Planning Stakeholder Advisory Committee
Transmission Owner Planning Advisory Committee

RELATED LINKS

Regional System Plan and Related Analyses
Planning Procedures
Planning Models and Data
Proposed Plan Applications
Key Study Areas
Meeting Cancellations
Planning Models and Data
Transmission Cost Allocation

The Planning Advisory Committee (PAC) is an open stakeholder forum that provides input and feedback to ISO New England on the regional system planning process, which involves:

- Developing and reviewing needs assessments
- Identifying and prioritizing requests for economic studies to be performed by the ISO
- Developing solutions studies and competitive solutions
- Conducting the public-policy transmission study process
- Developing the Regional System Plan (RSP) and updates to the RSP Project List and Asset Condition List, accessible on the Regional System Plan page

Final reports, needs assessments (including economic studies), solutions studies, and other information can be accessed below. The ISO performs these assessments, studies, etc., as prescribed by the ISO Tariff, Section II (Open Access Transmission Tariff), Attachment K: Regional System Planning Process. They form the foundation for the Regional System Plan.

About PAC Membership

PAC meetings are public, and any entity can designate a member to the PAC. This includes:

- Generator owners, marketers, load serving entities, merchant transmission owners, and participating transmission owners, including any New England Power Pool (NEPOOL) participant representatives
- Governmental representatives and representatives of local communities
- State agencies, including those participating in the New England Conference of Public Utilities Commissioners (NECPUC)
- Retail customers and public interest groups
- Consultants

To be added to the PAC email distribution list, an email address shall be provided to the PAC Secretary, Jillian Macura.

For more information on the PAC's roles and operation, please see the ISO Tariff, Section II (Open Access Transmission Tariff), Attachment K: Regional System Planning Process.

Officer Details

OFFICER NAME	REPRESENTING COMPANY	SECTOR	POSITION
Shounak Abhyankar	ISO New England Inc	Not applicable	Chair
Jillian Macura	ISO New England Inc	Not applicable	Secretary

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Planning Advisory Committee

Consumer Liaison Group Provides a Forum for Consumers to Learn about Regional Electricity Issues

- A forum for sharing information between the ISO and electricity consumers in New England
- The CLG Coordinating Committee consists of 14 members who are elected every two years
- Quarterly meetings are free and open to the public, with in-person and virtual options to participate

2025 CLG Meeting Dates and Locations:

- Thursday, March 27 – Providence, Rhode Island
- Wednesday, June 4 – Massachusetts
- Thursday, September 11 – New Hampshire
- Wednesday, December 3 – Boston, MA

2023 CLG Annual Report

More information on the CLG is available at: https://www.iso-ne.com/committees/industry-collaborations/consumer-liaison/

For More Information

Subscribe to *ISO Newswire*

ISO Newswire is your source for regular news about ISO New England and the wholesale electricity industry within the six-state region

Log on to ISO Express

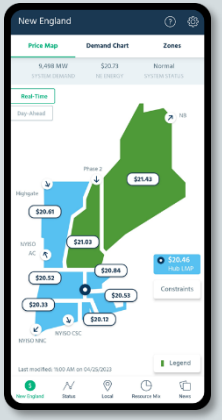
ISO Express provides real-time data on New England's wholesale electricity markets and power system operations

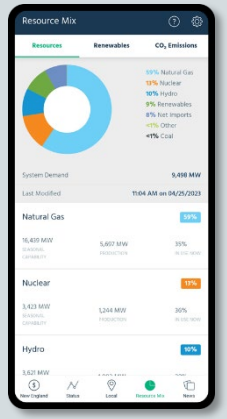
Follow the ISO on Social Media

www.iso-ne.com/social

Download the ISO to Go App

ISO to Go is a free mobile application that puts real-time wholesale electricity pricing and power grid information in the palm of your hand





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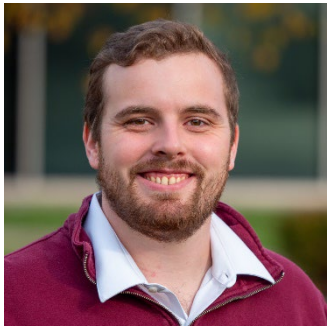
Questions

About the Presenters

Kim Quach

Engineer, Economic Studies & Environmental Outlook
ISO New England
kquach@iso-ne.com



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https://www.linkedin.com/in/rkornitsky/