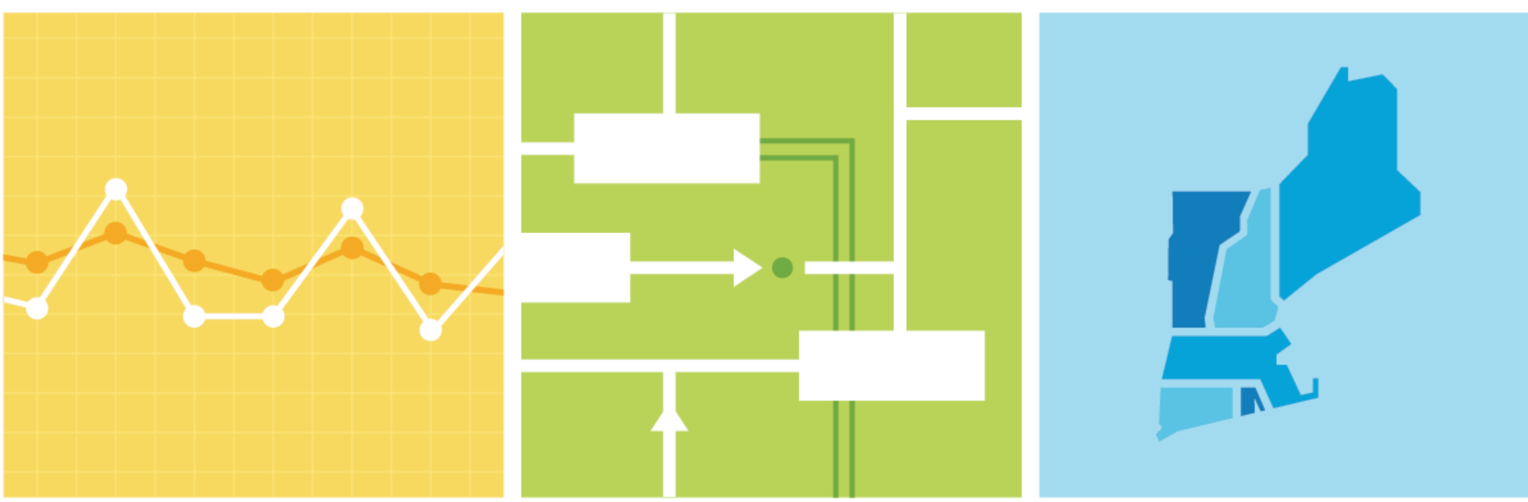
2022 ISO New England Electric Generator Air Emissions Report

DECEMBER 21, 2023



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Executive Summary

1.1 Purpose of ISO New England Emissions Report

The 2022 ISO New England (ISO) *Electric Generator Air Emissions Report* (*Emissions Report*) provides a comprehensive analysis of New England's electric generator air emissions (nitrogen oxides [NO_X], sulfur dioxide [SO_2], and carbon dioxide [CO_2]), along with CO_2 emissions associated with imported energy, load-weighted and time-weighted marginal emissions, and a review of relevant system conditions. The main factors analyzed are as follows:

- Average emissions (ktons) and emission rates (lbs/MWh)
- Marginal emission rates (lbs/MWh and lbs/MMBtu)
- Marginal heat rates (MMBtu/MWh)

This executive summary provides a high-level overview of system conditions and an assessment of key monthly and annual emission trends from the 2022 emissions analysis. A spreadsheet appendix provides comprehensive data on the relevant system conditions, average CO_2 emissions rates for imports/exports, marginal heat rates, and emissions data for the following time periods of interest:

- On-peak versus off-peak hours
- Ozone season versus non-ozone season
- Monthly variations
- 10+ historical years
- High electric demand days (HEDDs)

For a detailed overview on the background, data sources, and methodologies for the Emissions Report, refer to the ISO New England Electric Generator Air Emissions Report: Background and Methodology.

1.2 Methodology

New England generation, by definition, excludes behind-the-meter generators and imports. This report provides two different average CO_2 emissions and emission rates:

- New England generation only
- New England generation plus net imports (i.e. emissions from imports – emissions from exports)

Average emissions and emission rates for NO_X and SO_2 are calculated for New England generation only.

Marginal emission rates and heat rates in this report are calculated based on the locational marginal unit (LMU), or the last unit dispatched to balance the system and sets the price. The rates are divided into two scenarios for both the time-weighted and load-weighted LMUs:

- All LMUs - Includes all Locational Marginal Units (including imports) identified by the 5-minute locational marginal prices (LMPs)
- 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

1.3 Data Sources

Approximately 33% of the total NO_X emissions, 61% of the SO_2 emissions and 78% of the CO_2 emissions were calculated using the emissions data reported in EPA's Clean Air Markets Program (CAMPD) database. Emissions data obtained from NEPOOL GIS and eGRID were used to estimate emissions from generators that do not report to CAMPD. Over 86% of the emissions data used in this report comes from CAMPD, NEPOOL, and eGRID. For the remaining generators, this report uses emissions data from units with similar attributes.

1.4 Overview of 2022 System Conditions

The winter months of 2022 (January and December 2022) were marked by a significant increase in oil-fired resource generation compared to the previous winter. Fast-start oil generators also operated more often in July and August during the top five High Electric Demand Days (HEDD)[1], which were marked by high loads and unplanned outages of natural gas generating facilities. Oil-fired resources generated 1,845 GWh in 2022 compared to 227 GWh in 2021, a 713% increase year-over year. This increase was mainly due to constraints on the natural gas pipeline system and high global and regional natural gas prices. This price spike was driven primarily by the conflict between Russia and Ukraine, which exacerbated global uncertainty in natural gas inventories and prices. Figure 1-1 illustrates the 2022 monthly energy production by resource type, which includes both New England generation and net imports.

[1] High electric demand days (HEDDs) are typically characterized by high temperatures leading to elevated cooling (energy) demand. During peak energy demand periods, such as HEDDs, the ISO relies on peaking units, which are utilized less during the rest of the year but respond quickly to meet system demand. These peaking units are often jet (aero-derivative) or combustion turbines with higher emission rates.

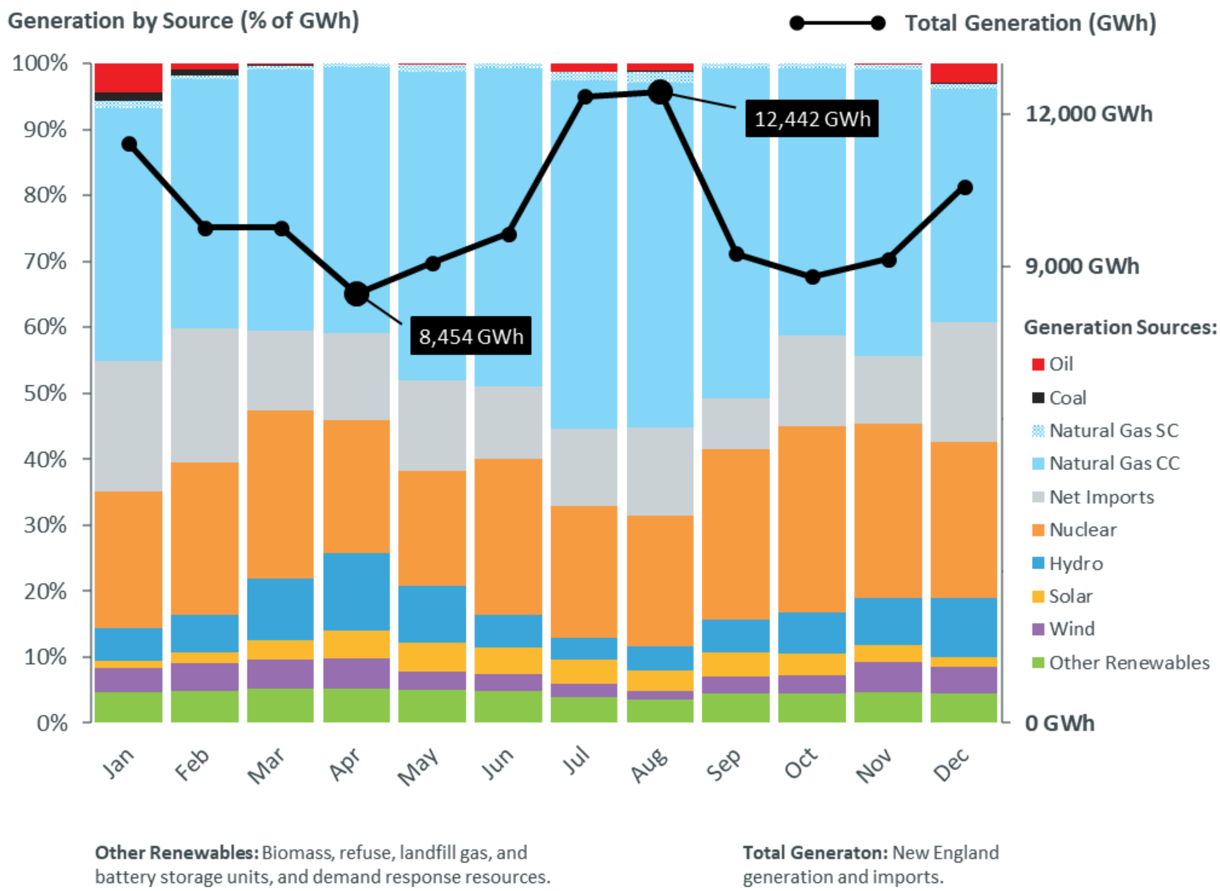

Figure 1-1: 2022 ISO New England monthly generation by resource type, including imports (%,GWh, GWh)

The black line represents the total energy for each month, corresponding with the right axis. April had the lowest total generation, while total generation peaked in August due to the heat waves. Because New England's energy markets select the lowest-priced resources to meet consumer demand, oil-fired generators were dispatched more frequently, particularly during the cold weather this winter when natural-gas-fired generators became more expensive to run.

Three distinct periods in 2022 were marked by increased oil-fired generation and consequently higher emission rates, which could be attributed to the following:

1. High global and regional natural gas prices and pipeline constraints in January, despite the fact that the region did not experience any extended cold snaps, and periods when temperatures were colder than usual were often punctuated by isolated warmer days;
2. Heat waves and unplanned outages of natural gas facilities in July and August during the five HEDDs;
3. A December 24th cold snap and high natural gas prices after a period of unseasonably mild weather.

Despite high gas prices and pipeline constraints, natural gas generation only decreased by 0.7%, from 54,225 GWh in 2021 to 53,868 GWh in 2022. Natural gas was still the primary source of energy production (52%).

The 2022 New England wholesale electricity demand, or Net Energy Load (NEL) was only 0.1% higher than the 2021 NEL, and annual New England generation increased by just 2% year-over-year, largely due to similar weather conditions.[2] Conversely, the 2022 summer peak load declined by 5% year-over-year, which could be attributed to state policies promoting the installation of energy efficiency measures and the increase in behind-the-meter generation, as well as cooler temperatures during the top five HEDDs. In 2022, the top five HEDDs were July 20-21, August 4, and August 8-9. The temperatures in New England during these days ranged from 89^0 to 91^0F, approximately 2^0 to 4^0F cooler than the top-five HEDDs in 2021.

Net interchange (imports minus exports) from Canada and New York also declined year-over-year, due primarily to increased exports to New York following the retirement of the New York Indian Point nuclear generator in 2021 and planned regional transmission work during 2022. For more in-depth review of the New England system conditions, refer to the ISO New England's 2022 Annual Markets Report.

1.5 Results and Observations

This section describes results for ISO New England's 2022 New England generation emissions, the marginal emission rates and heat rates for the all-LMU and emitting-LMU scenarios, using both the time-weighted and load-weighted approaches. The spreadsheet appendix provides additional figures and tables on the historical, annual, and monthly emissions data.

1.5.1 Average Emissions

The region has experienced a significant decline in SO_2, CO_2, and NO_X average annual emissions (ktons) from electric generation over the last decade (2013 to 2022). SO_2 has decreased by 81%, CO_2 by 18%, and NO_X by 39%. The annual average emission rates (lbs/MWh) also decreased for all three pollutants: SO_2 by 80%, CO_2 by 12%, and NO_X by 34%.

The average annual emissions (ktons) for SO_2 increased by 60% from 2021 to 2022, since oil-fired generation (GWh) in 2022 was greater than in the previous four years combined, and oil has a high sulfur content. However, the average annual emissions for CO_2 and NO_X decreased slightly, by 0.2% and 1% respectively. The CO_2 and NO_X emissions decreases are largely attributable to a 43% decline in coal generation compared to 2021. Figure 1-2 shows the monthly variation in emission rates. It is important to note that, even though SO_2 emissions significantly increased from 2021 levels, the emissions of SO_2 are still on a much smaller scale compared to CO_2 and NO_X, as shown in Figure 1-2. In 2022, the three major spikes in emission rates for SO_2, CO_2, and NO_X coincided with the same three events that triggered increases in oil-generation discussed in section 1.4. Outside of those isolated events, the SO_2 and NO_X emission rates remained relatively constant throughout the year, while the CO_2 rates had more fluctuations.

[2] NEL = New England Generation – Pumping Load + Net Imports

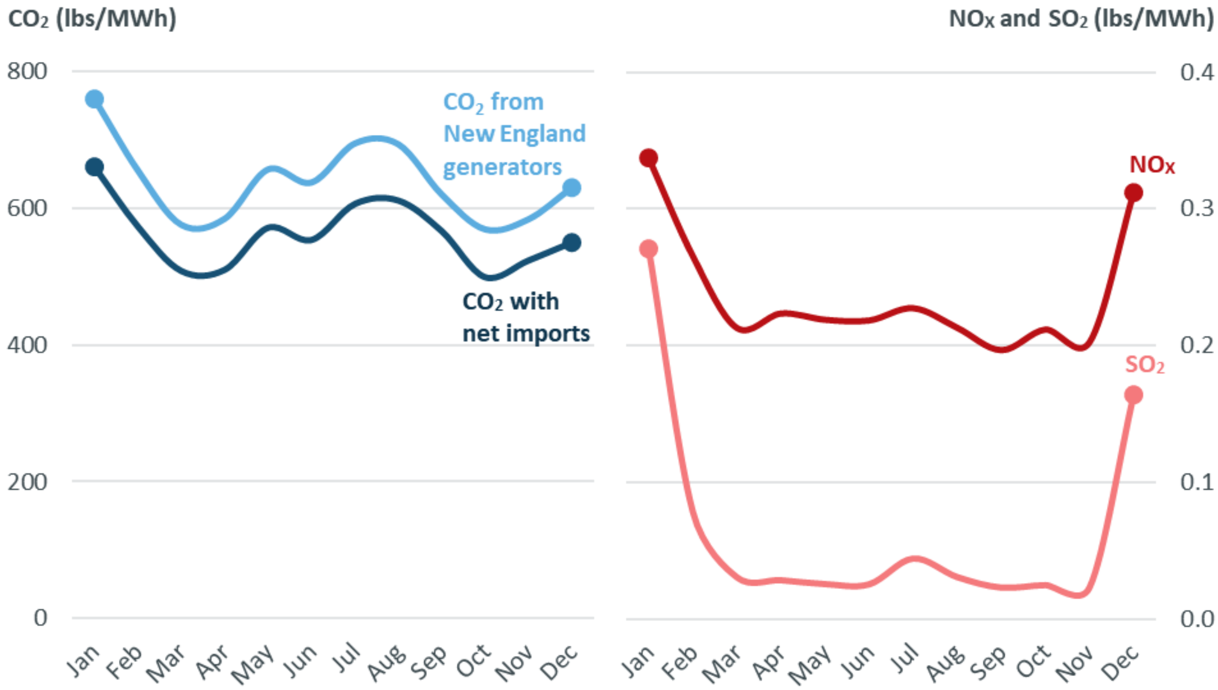

Figure 1-2: 2022 ISO New England monthly average emission rates (lbs/MWh)

1.5.2 Marginal Emission Rates

Marginal emission rates were calculated using the time-weighted and load-weighted approach outlined in section 1.2 and are based on the locational marginal units (LMU). Time-weighted marginal emission rates for SO_2, CO_2, and NO_X have steadily decreased over the last 10 years. Compared to 2013, the 2022 LMU SO_2 annual marginal rates have declined by 87% and 85% respectively for the all-LMU and emitting-LMU scenarios. With regard to marginal NO_X emission rates, the all-LMU scenario has decreased by 53% and the emitting-LMU scenario has decreased by 42% over the same time period. CO_2 marginal emission rates since 2013 have declined less dramatically than for SO_2 and NO_X, with a 24% decline for the all-LMU scenario and 16% decline for the emitting-LMU scenario. The marginal emission rates trend for the load-weighted approach is not available for the 10-year timeframe, since this method was first incorporated into the emissions analysis in 2018.

Figure 1-3, Figure 1-4, and Figure 1-5 illustrate the differences between the load-weighted and time-weighted LMU monthly marginal emission rates for the all-LMU and emitting-LMU scenarios. For the all-LMU scenario, the load-weighted CO_2 marginal emission rates (dashed lines) are typically higher than the time-weighted rates. This is most pronounced in the winter months, when wind generators are on the margin (i.e. they are the resource that sets the price for a specific time interval) more often. During these months, wind shared a small percentage of the calculated load, since the load-weighted approach reflects the fact that most wind generators in the region are located in export-constrained areas of northern New England. These areas are considered "export-constrained" because the transmission network that moves electricity out of their constrained area is at maximum capacity. Therefore, wind generators often cannot set the price outside of the constrained area and do not contribute significantly to systemwide production. Conversely, the time-weighted approach assumes that all resources share the load equally and therefore the higher contribution of wind effectively lowers the time-weighted marginal emission rates.

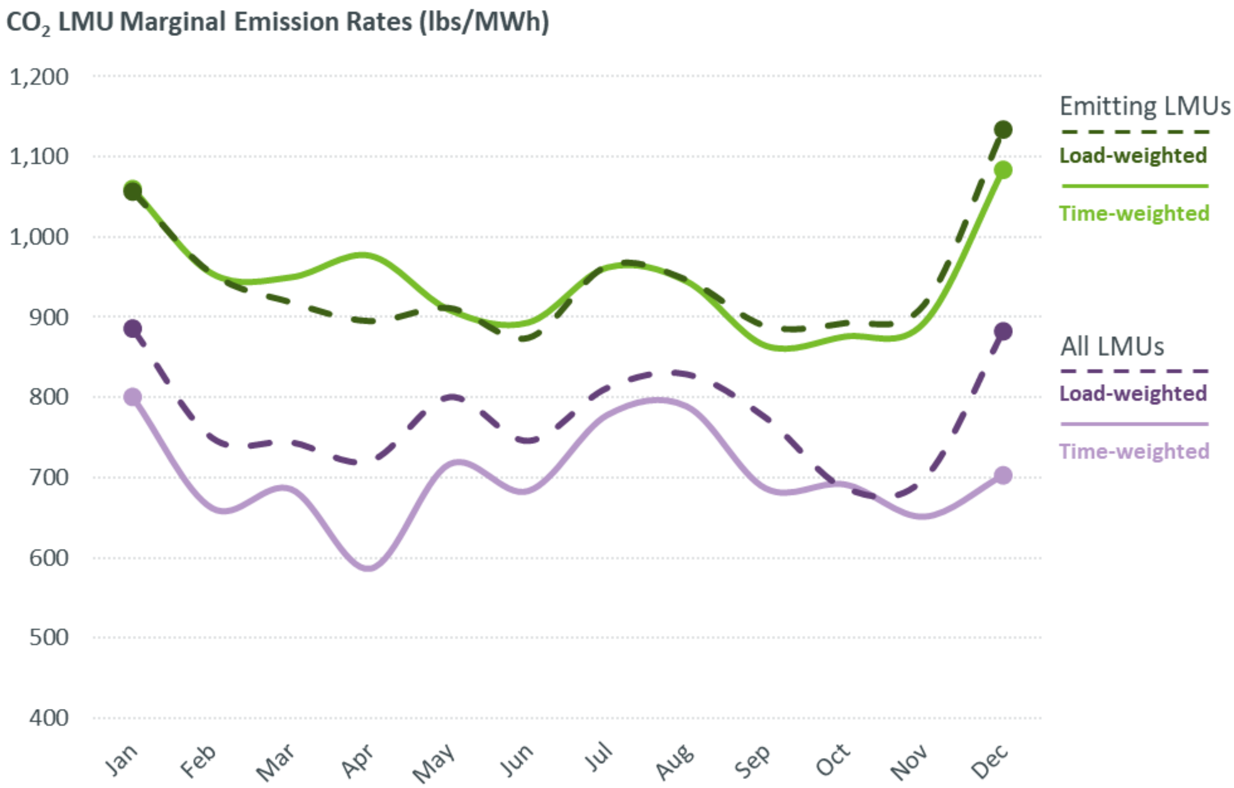

Figure 1-3: 2022 time- and load-weighted monthly LMU marginal CO_2 emission rates

NO_X and CO_2 marginal emission rates for the emitting-LMU scenario reflect the opposite trend. These load-weighted emission rates are slightly lower than the corresponding time-weighted emissions rates; as with wind, many biomass plants (contributors to NO_X and CO_2) are located in export-constrained areas. Therefore, the load-weighted approach reflects the lower amount of biomass on the margin and subsequently shows a reduced NO_X and CO_2 marginal emission rate for the emitting-LMU scenario.

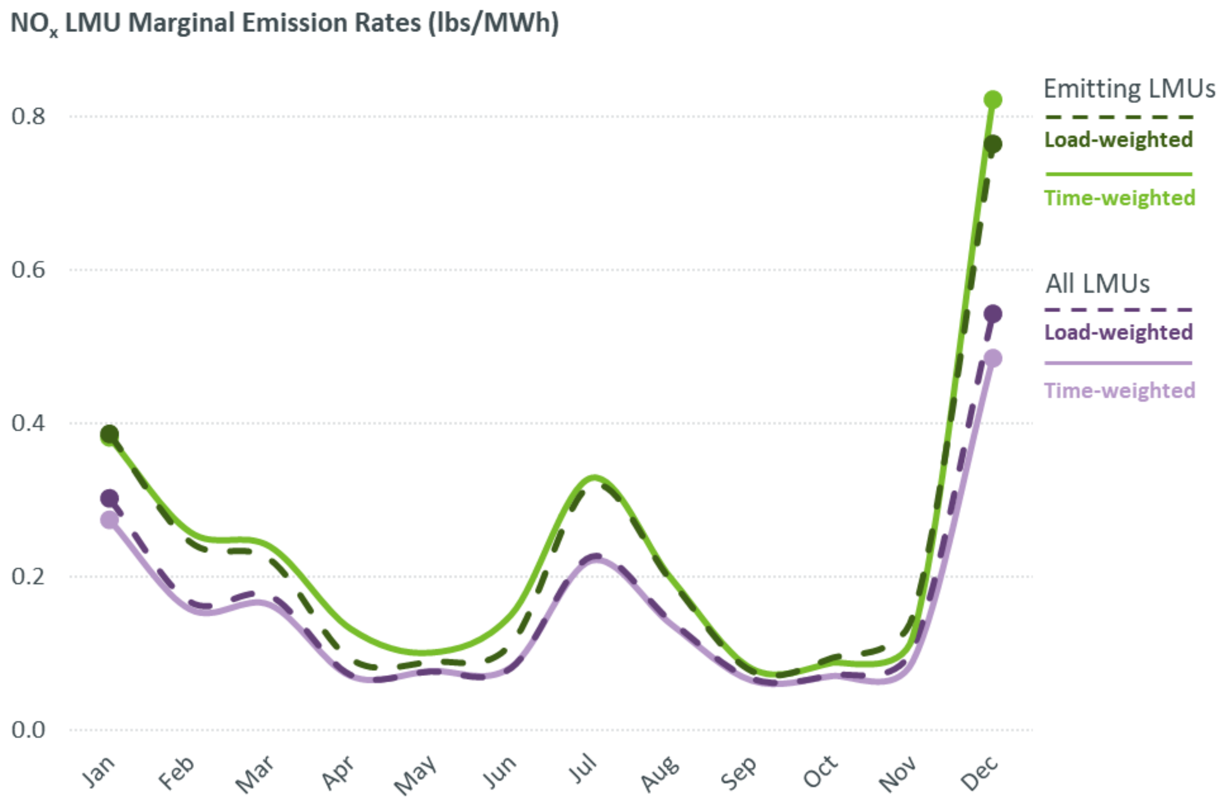

Figure 1-4: 2022 time- and load-weighted monthly LMU marginal NO_X emission rates

The load-weighted and time-weighted SO_2 marginal emission rates are very closely correlated, since oil had the same time and load marginal percentage throughout the year.

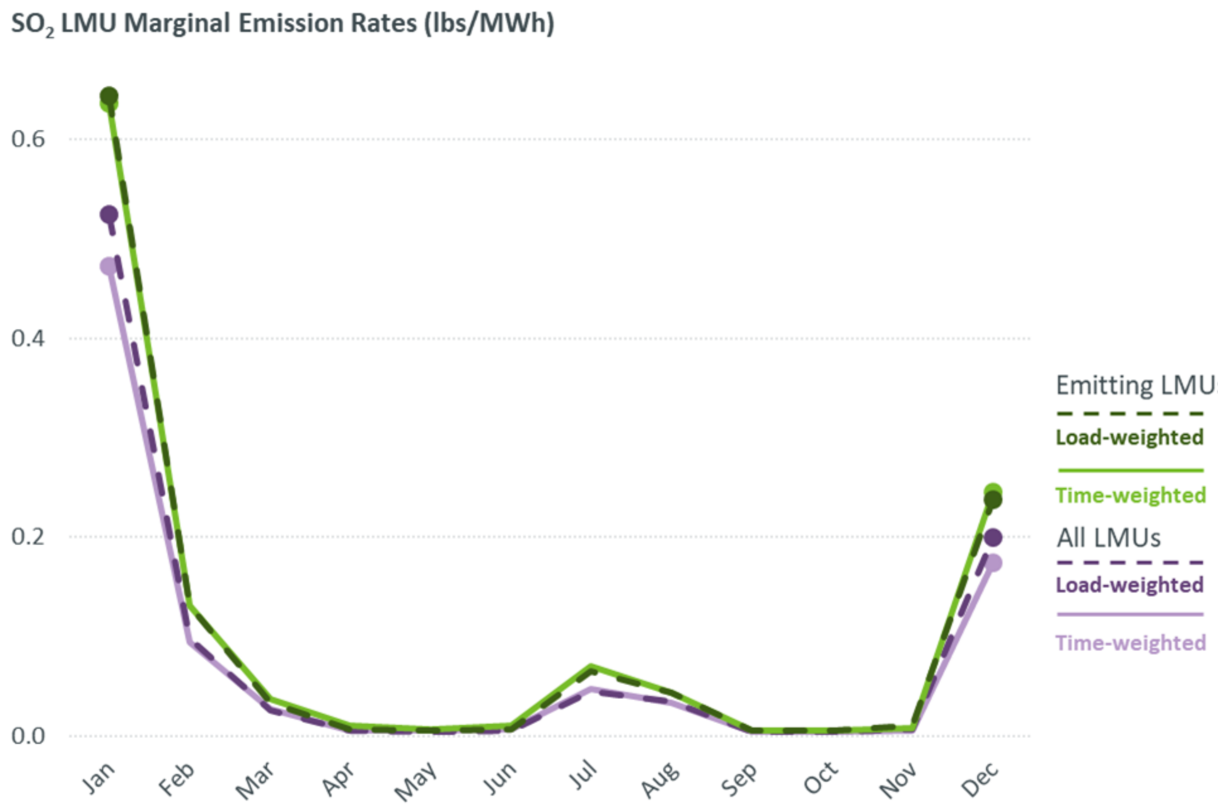

Figure 1-5: 2022 time- and load-weighted monthly LMU marginal SO_2 emission rates

1.5.3 Marginal Heat Rates

The annual marginal heat rate reflects the average annual efficiency of all the marginal emitting units dispatched. Figure 1-6 illustrates declining heat rates from 2013 through 2019 using the time-weighted all-LMU approach, with the exception of a spike in 2014. The 2017 heat rate in the all-LMU scenario showed a steep drop due to the large amount of wind generators on the margin, a result of the Do Not Exceed (DNE) dispatch rules implemented in May 2016.[3] However, between 2019 and 2020, the marginal heat rates for the all-LMU scenario experienced an 8% uptick under the time-weighted approach and a 4% uptick under the load-weighted approach. This increase in marginal heat rates coincided with a major nuclear plant retirement in 2019 and the addition of several new gas-fired generators in 2019 that consistently offered energy lower than pumped-storage generators throughout 2020[4], which displaced pumped-storage generators as the marginal units. The all-LMU time-weighted marginal heat rates eventually leveled out after 2020, and the year-over-year increase since then has been around 1%.

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[3] DNE incorporates wind and hydro intermittent units into economic dispatch, making the units eligible to set price. Previously, these units had to self-schedule their output in the real-time market and, therefore, could not set price.

[4] Refer to the Marginal Resources in the Real-time Market section of the 2020 Annual Markets Report for an in-depth discussion on the 2019-2020 marginal resource trends.

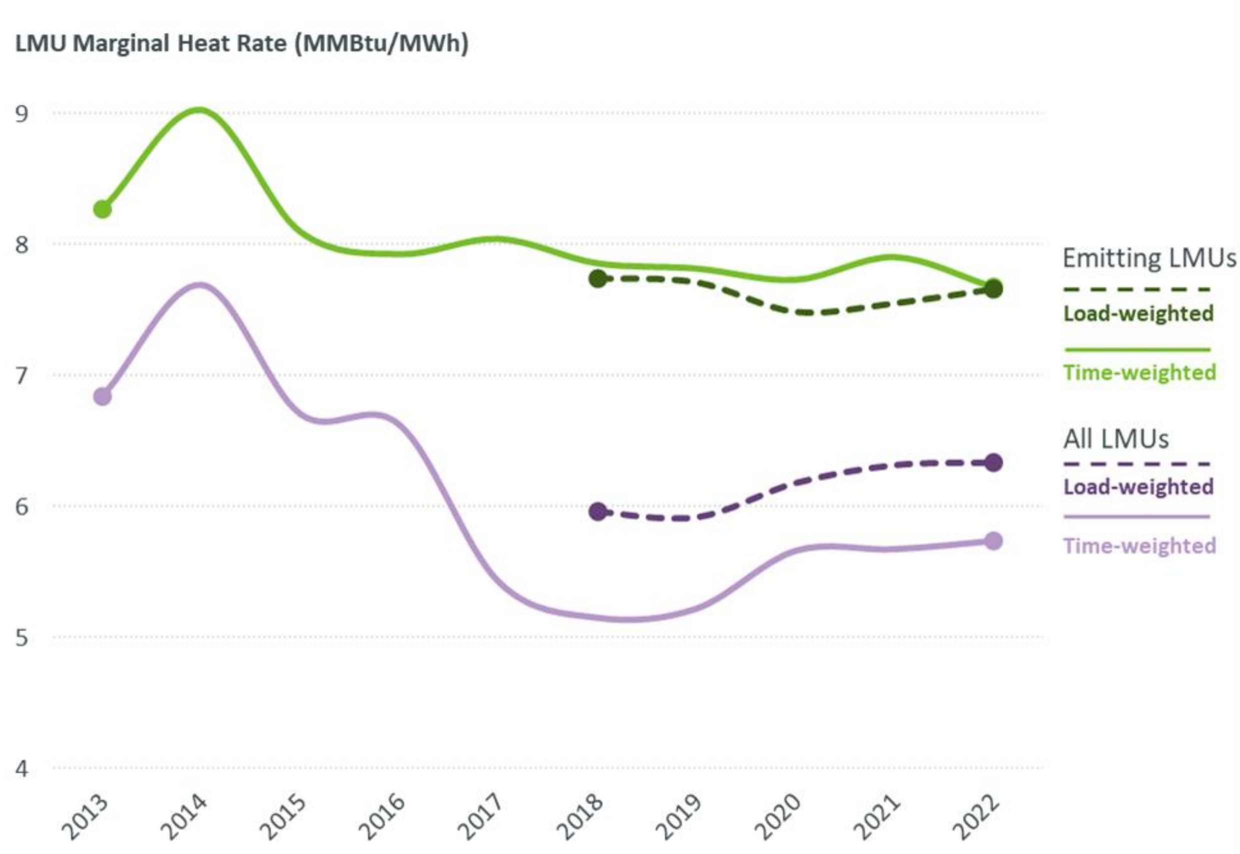

Figure 1-6: LMU annual marginal heat rate, 2013-2022 (MMBtu/MWh)

1.6 Conclusion

SO_2 emissions in 2022 significantly increased from 2021 levels, driven largely by the increase in production of oil-fired generators, despite a mild winter and similar load year-over-year. The increase in oil-fired production was largely caused by record high natural gas prices associated with the Russia-Ukraine conflict, and thus an increase in regional reliance on oil versus natural gas. This increased oil-generation did not have a major impact on the average CO_2 and NO_X emissions, which were largely offset by an overall decline in coal generation.