



Environmental Update

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LEAD ANALYST | SYSTEM PLANNING



Presentation Overview

- **Shift in Federal Environmental Priorities**
- **Regional Energy Usage Trends**
- **Regional Environmental Trends**
- **Regional Air Pollution Monitoring Trends**
- **Regional COVID-19 Environmental Impacts**
- **Monthly Power System Emission Trends**
- **Marginal Unit by Fuel Type**



Key Points

- In 2020, fossil, nuclear, renewable and other generating resources and transmission assets in compliance with federal and state environmental requirements
 - In 2021, state requirements are evolving and are in a state of flux at the federal level
- Air emissions from regional power system are near historic lows
 - Seasonal winter and summer pollution spikes continue to occur due to reliance on oil- and coal-fired generators for peaking service
 - Stubborn summer ground-level ozone episodes across southern New England may require further reductions in emissions or limits on operation
- Power system water use and wastewater discharges have also declined
 - Retirements of steam thermal generation, shift toward less water-intensive thermal generation
 - Permit modifications and renewals for steam thermal and hydroelectric generators may affect future operations
- Siting energy infrastructure remains challenging across the region, affecting fossil, nuclear, renewable and other generating resources, and new or upgraded transmission resources, all needed to maintain reliability



Shift in Federal Environmental Priorities

Prior Actions under Review, Vacated by Courts or Reversed By Executive Orders

Trump Administration actions on air, water, land use, species protection, climate:

- 170 completed
- 40 incomplete

170 Environmental Actions

48 Actions Affect Power Sector

~20 Actions Reversed or Vacated

Biden Administration initial executive orders or court rulings on environmental actions affecting power sector:

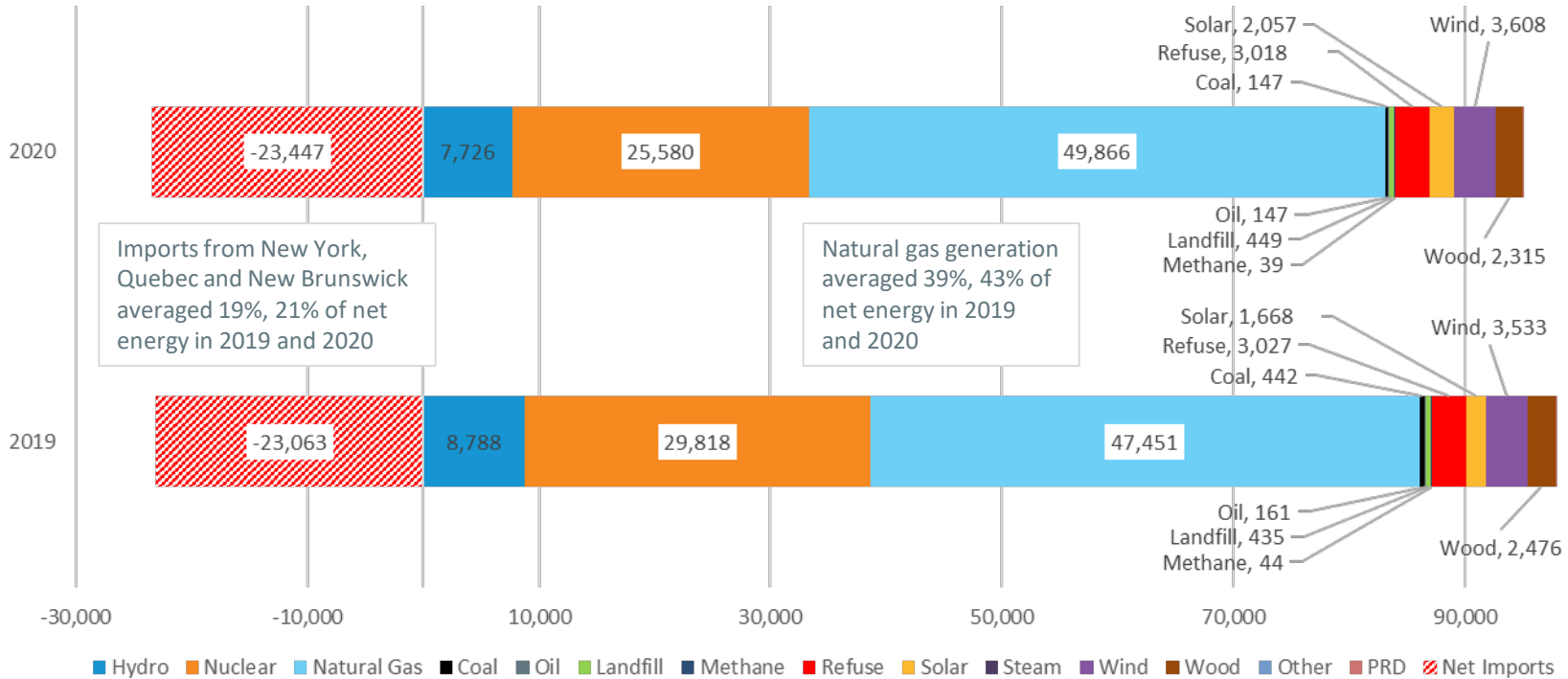
- ~48 under review
- ~20 reversed or vacated

- **Enforcement:** EPA may prioritize enforcement where low-income or minority populations are affected
- **Permitting and Environmental Review:** environmental equity and cumulative burden on host communities expected to have greater weight
- **New and Revised Regulations:** federal agencies already reexamining Trump Administration environmental regulatory actions

REGIONAL ENERGY USAGE TRENDS

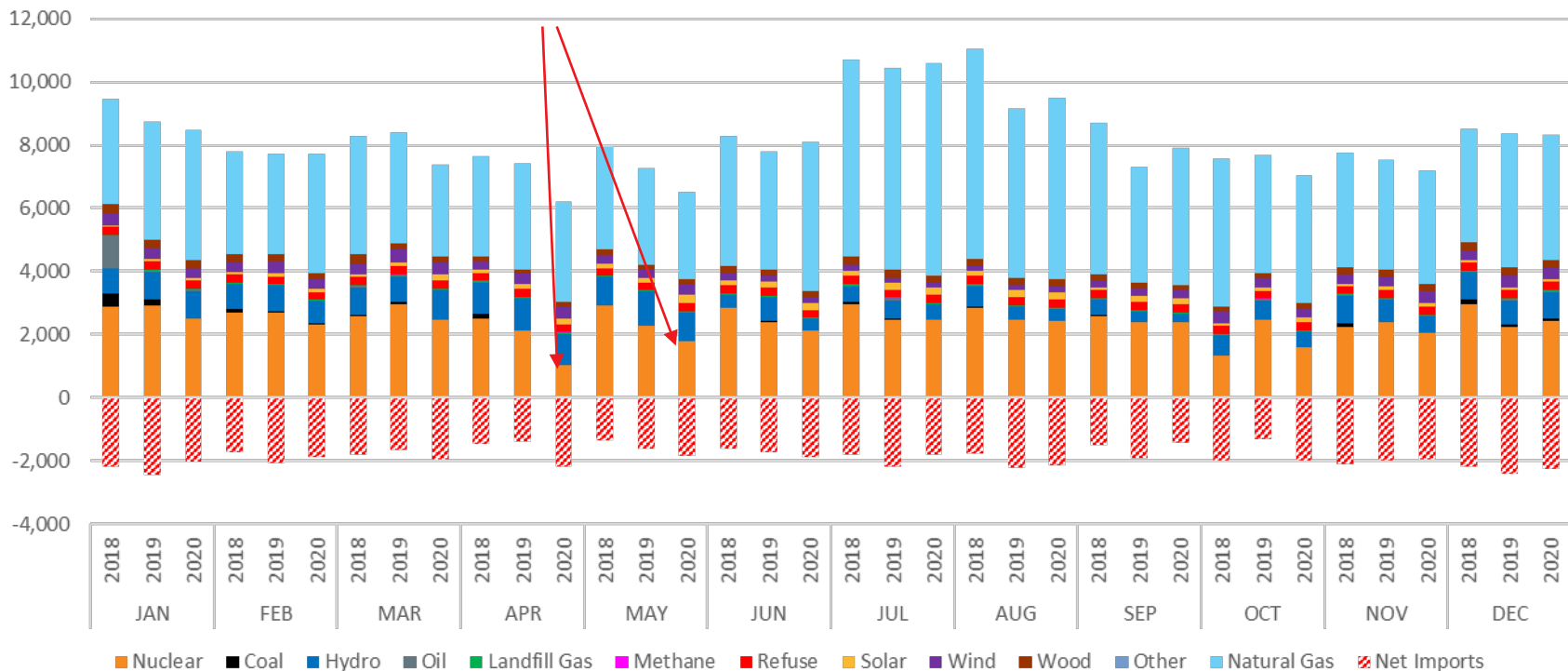
Net Generation & Imports, 2019 vs. 2020 (GWh)

In 2020, natural gas output increased, nuclear output decreased



Net Energy for Load by Fuel Type, 2018-2020 (GWh)

Difficult to isolate environmental impact of COVID-19 pandemic on power system with lower nuclear output and outages early in 2020

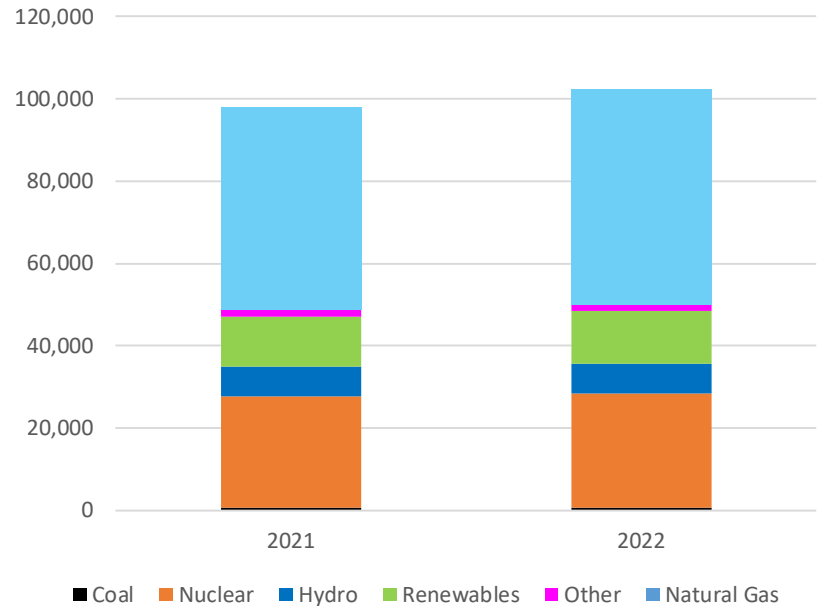


Key Takeaways

New England System Annual Emissions Expected to Remain Near Current Trends

- Shifts in energy consumption, most likely due to the pandemic, has resulted in lower monthly net energy demand in 2020, but net system emissions increased compared to 2019
- EIA and other short term projections suggest annual emissions will increase through 2022 given increased natural gas generation, despite increased nuclear and renewable output
- Using short term forecasts, annual system emissions, until a major generation mix change occurs, could range between:
 - 25-36 million metric tons CO₂ (2019 - 27)
 - 200 – 4,000 metric tons SO₂ (2019 –
 - 8,000 – 12,000 metric tons NO_x (2019 -

EIA Forecast New England System Generation, 2021-2022 (GWh)



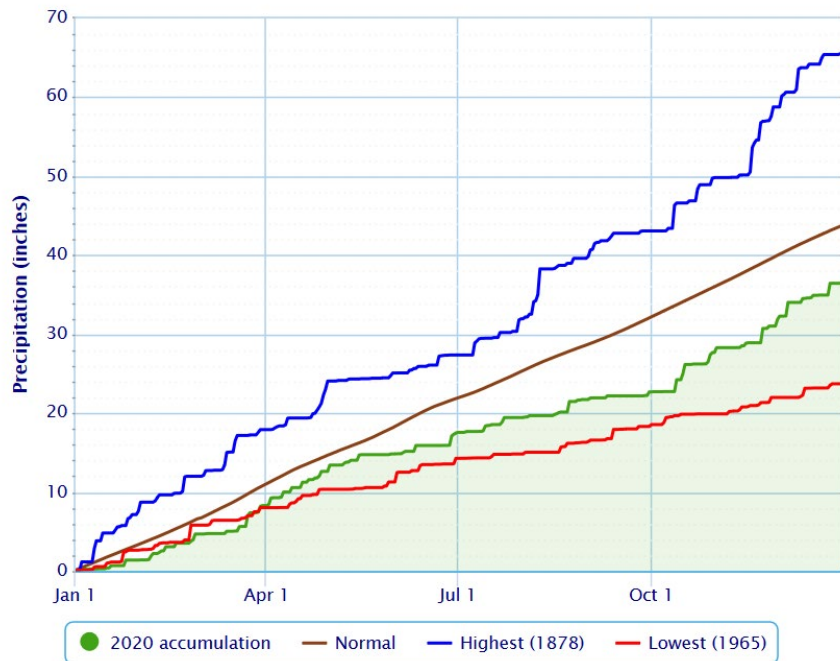
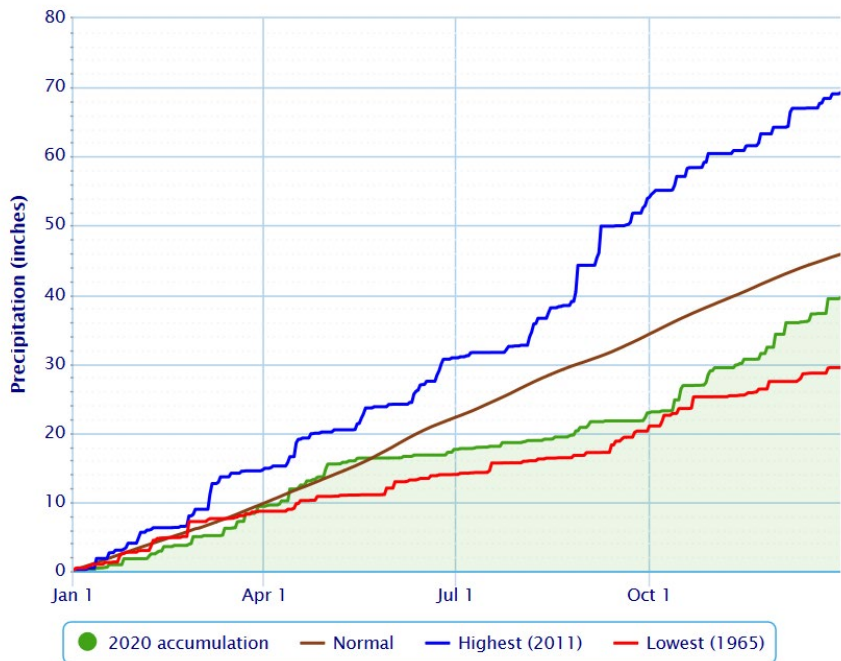
REGIONAL ENVIRONMENTAL TRENDS

Precipitation and Temperature

National Weather Service 2020 Cumulative Rainfall (Hartford, Boston) (Inches)

Accumulated Precipitation – Hartford Area, CT (ThreadEx)

Accumulated Precipitation – Boston Area, MA (ThreadEx)



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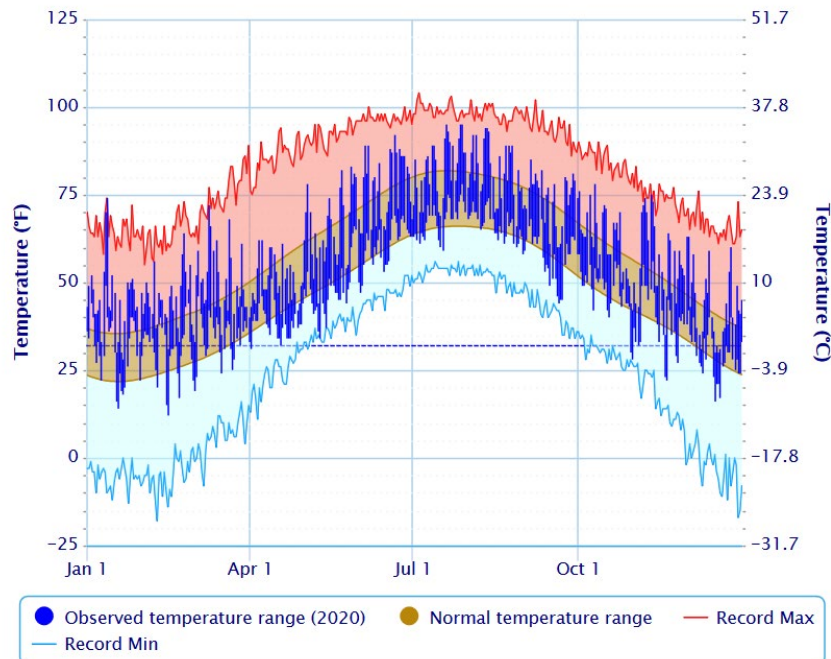
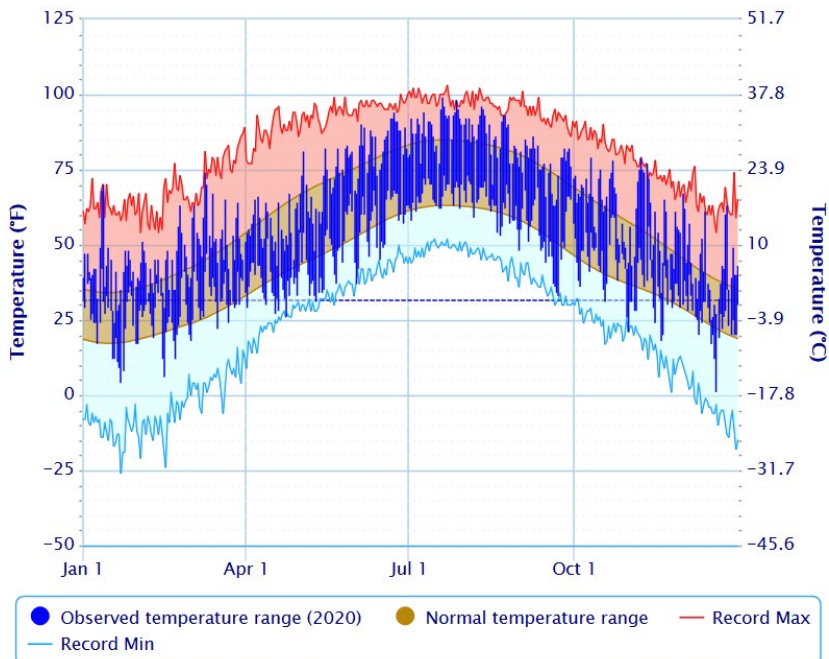
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National Weather Service 2020 Daily Temperature (Hartford, Boston)

Daily Temperature Data – Hartford Area, CT (ThreadEx)

Daily Temperature Data – Boston Area, MA (ThreadEx)



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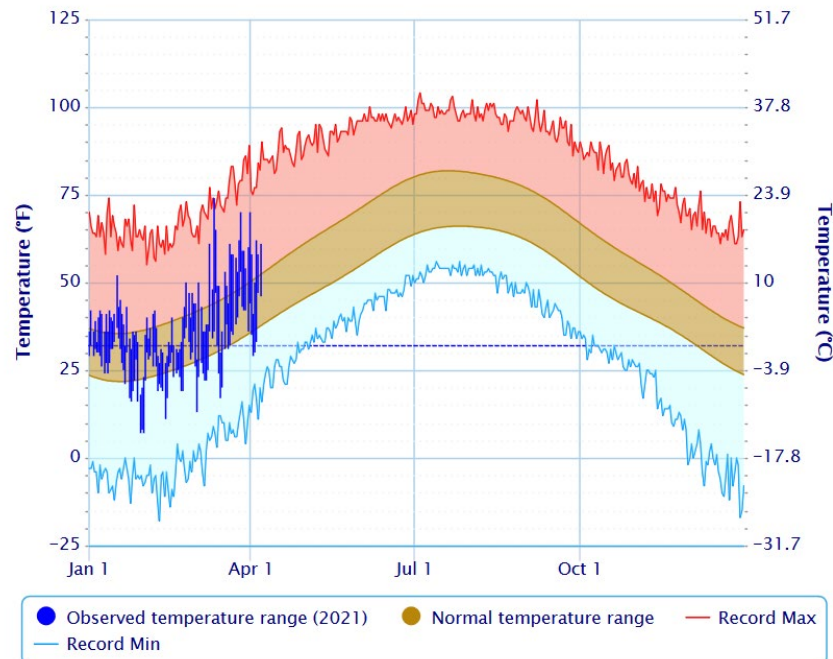
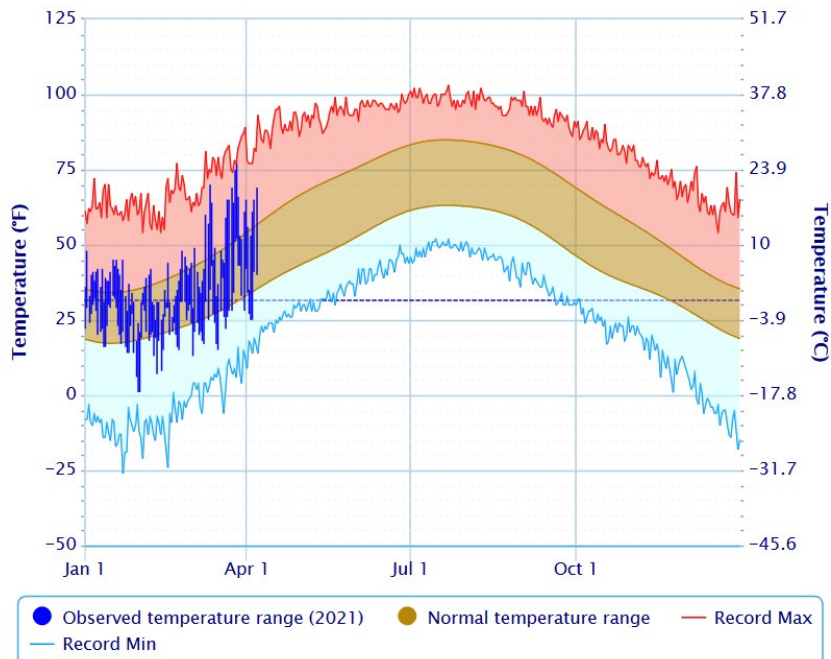
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National Weather Service Daily Temperature Data, Dec. 2020 – Feb. 2021 (Hartford, Boston)

Daily Temperature Data – Hartford Area, CT (ThreadEx)

Daily Temperature Data – Boston Area, MA (ThreadEx)



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ISO-NE PUBLIC

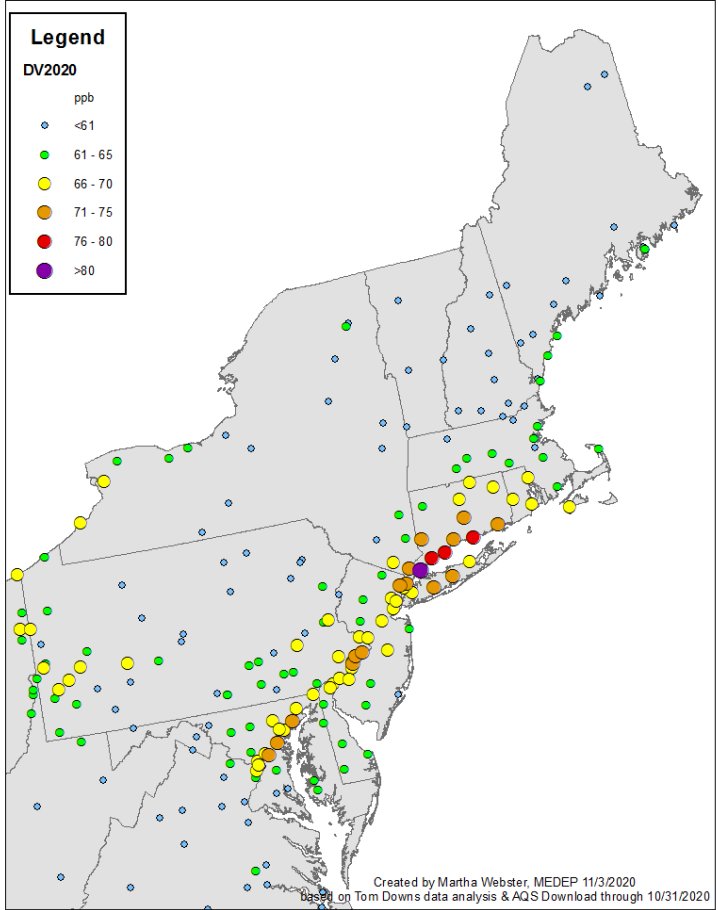
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REGIONAL AIR POLLUTION MONITORING TRENDS

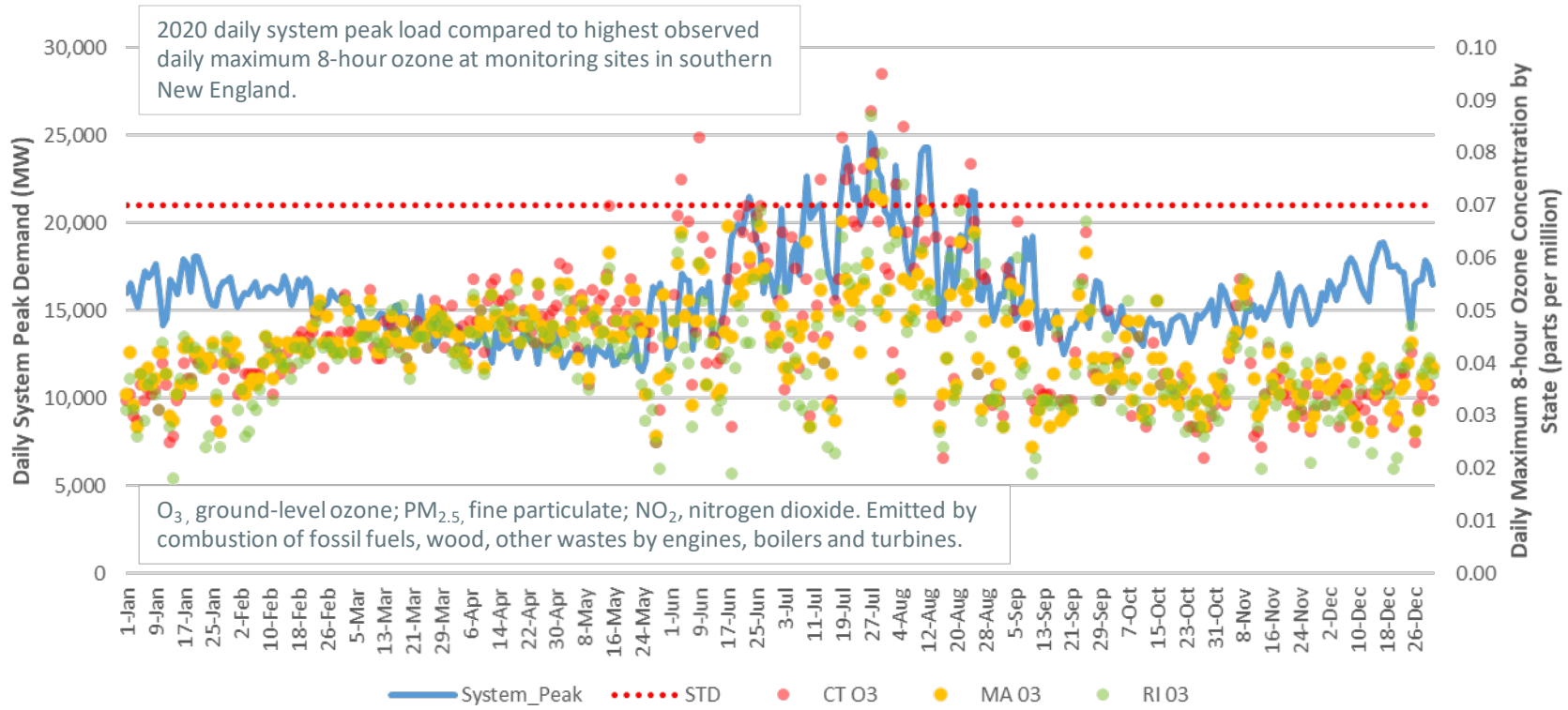
Ozone, Fine Particulate Trends

2020 Ozone Season Update

- **Weather:** across New England higher than normal average temperatures, drier and rainfall, optimal conditions for robust ground-level ozone formation
 - Southerly wind patterns during several days mixed the boundary layer and lowered the ozone levels
- **Ground-level Ozone:** despite milder 2020 ozone season, parts of southern New England not on track to attain either the 2008 or more stringent 2015 ozone standards:
 - Connecticut 17 days of ozone exceedances
 - Rhode Island: 4 days
 - Massachusetts: 3 days
 - Maine: 1 day



2020 Daily Peak System Load (MW) vs. Highest Daily Observed Surface Ozone (ppm) in New England



Sources: ISO-NE (load); EPA (emissions)

Potential Changes in Ozone Rules

Ozone Standard

Trump: Retained standard, allowed states, tribes and localities more flexibility in complying with limits on smog-forming ozone

Biden: reconsidering whether O3 standard protects public health, requests for expanding air monitoring network

Cross-State Air Pollution Rule

Trump: declined to reduce cross-state air pollution involving soot and smog contributors. Court vacated rule as too weak

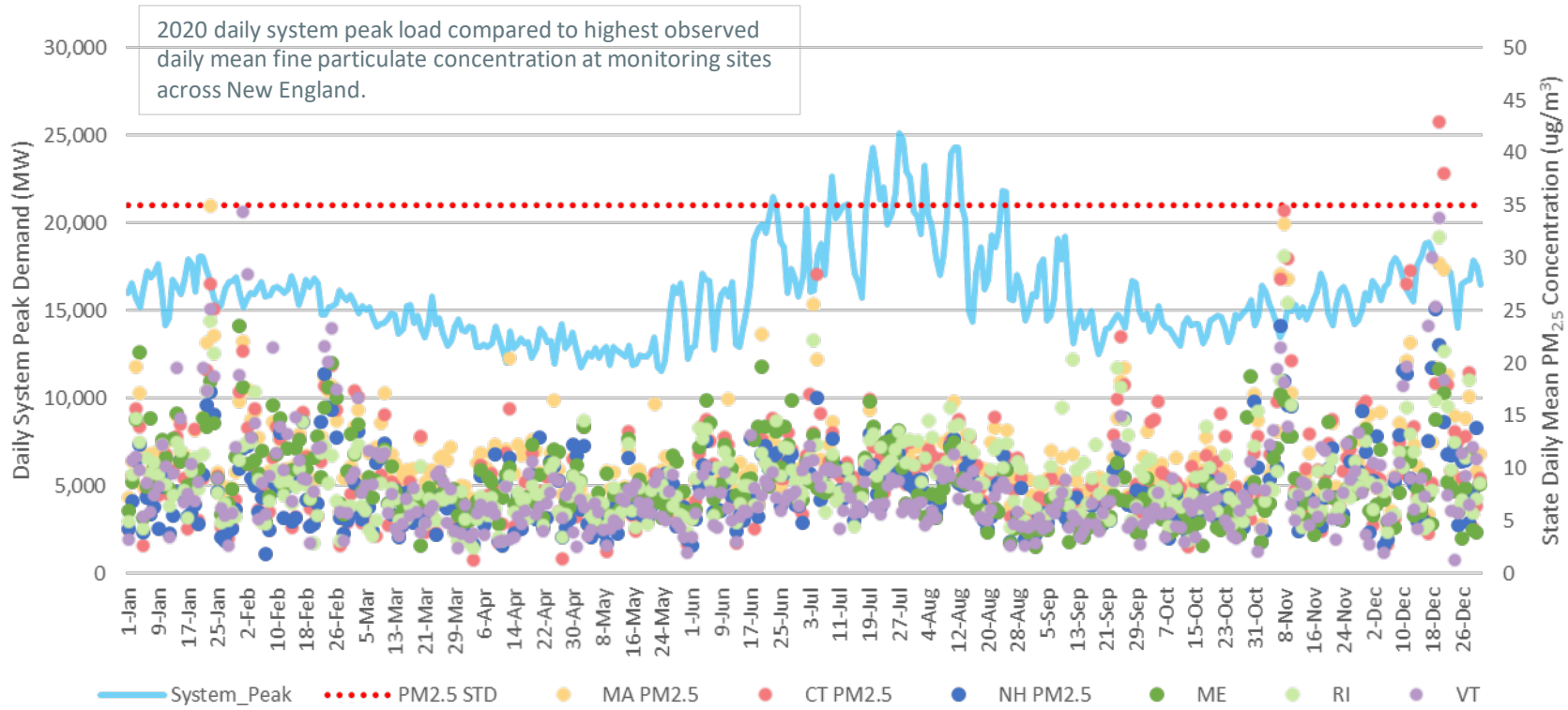
Biden: Updated final rule requires additional air pollution reductions from power plants outside New England starting in 2021

Upwind Air Pollution

Trump: denied petitions from several Northeast states to regulate air pollution coming from upwind states

Biden: denials under reconsideration

2020 Daily Peak System Load (MW) vs. Highest Daily Observed Surface Fine Particulates ($\mu\text{g}/\text{m}^3$)



MA, CT, RI and VT joined other States petitioning EPA to withdraw 12/18/20 PM_{2.5} standard, in light of health research show harm at lower concentrations

COVID-19 PRELIMINARY AIR QUALITY & REGIONAL ECONOMIC IMPACTS

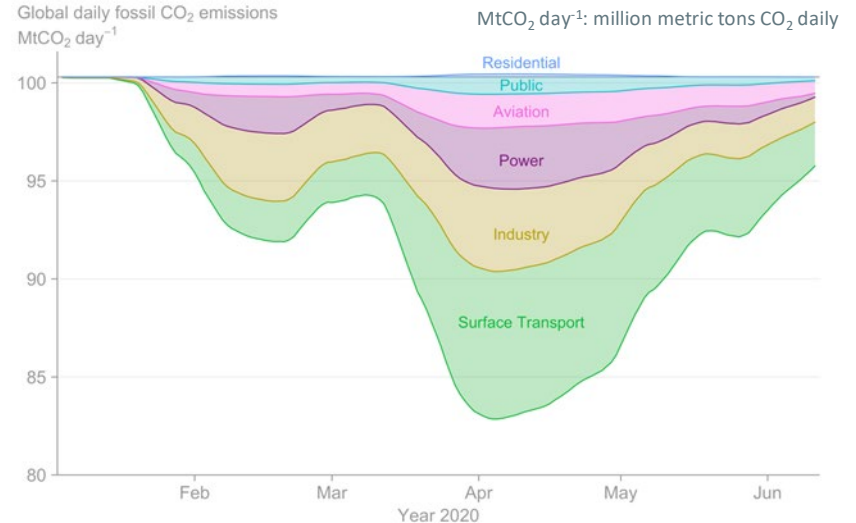
2020 Global Changes in CO₂ Emissions due to COVID-19 Pandemic Mitigation Measures

Temporary Reduction in Global CO₂ Emissions Due to COVID-19 pandemic mitigation measures

- Daily global CO₂ emissions decreased by ~17% by early April 2020 before recovering in June 2020 to within 5% of the mean 2019 levels
 - Roughly half the total emissions attributed to decline in surface transportation activities
- At their peak, emissions in individual countries decreased by ~26% on average

Le Quéré, C., Jackson, R.B., Jones, M.W. et al. Temporary reduction in daily global CO₂ emissions during the COVID-19 forced confinement. *Nat. Clim. Chang.* 10, 647–653 (2020). <https://doi.org/10.1038/s41558-020-0797-x>

Reductions from Surface Transport, Industry and Power Sectors Drove Global Daily CO₂ Emissions Decline



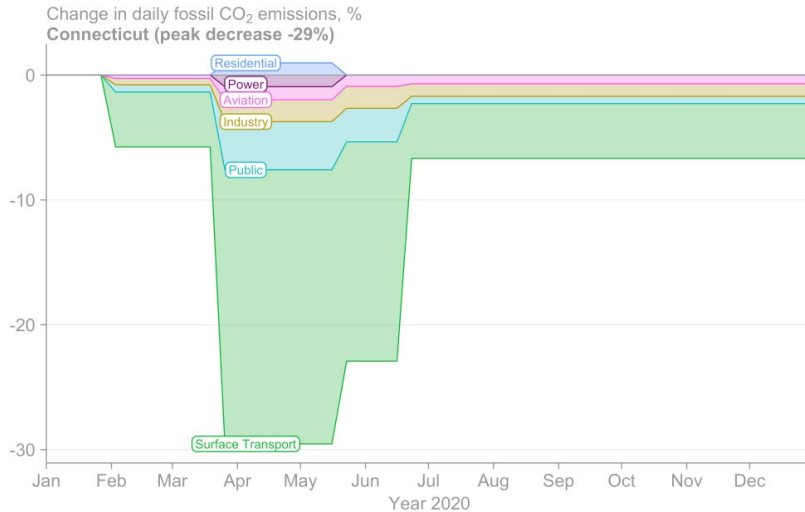
© Source: Le Quéré et al. *Nature Climate Change* (2020); Global Carbon Project

Figure: @Jones_MattW

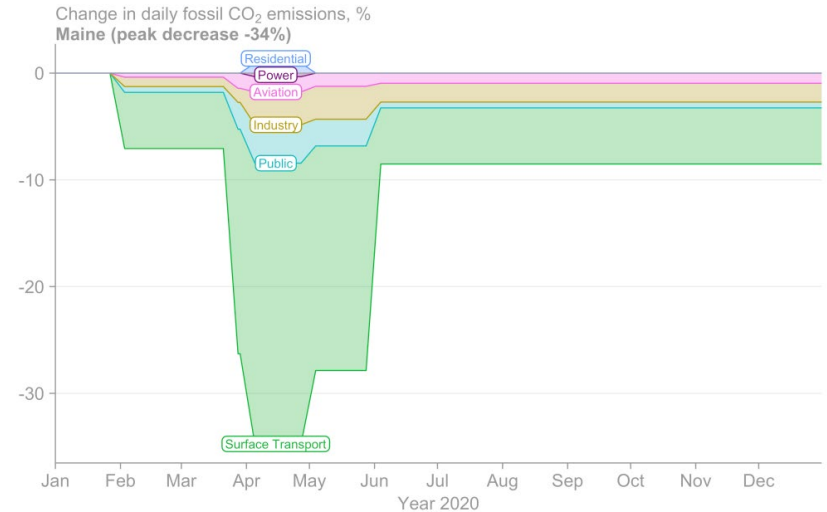
Matt Jones, Senior Research Associate, Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, *Temporary reduction in daily global CO₂ emissions during the COVID-19 forced confinement* <https://mattwjones.co.uk/covid-19/>

2020 State % Changes in CO₂ Emissions due to COVID-19 Pandemic Mitigation Measures

Connecticut Change in Daily CO₂ Emissions (Decrease Peaked at -29%)



Maine Change in Daily CO₂ Emissions (Decrease Peaked at -34%)



© Updated from Le Quéré et al. Nature Climate Change (2020); Global Carbon Project

-Figure: @Jones_MattW

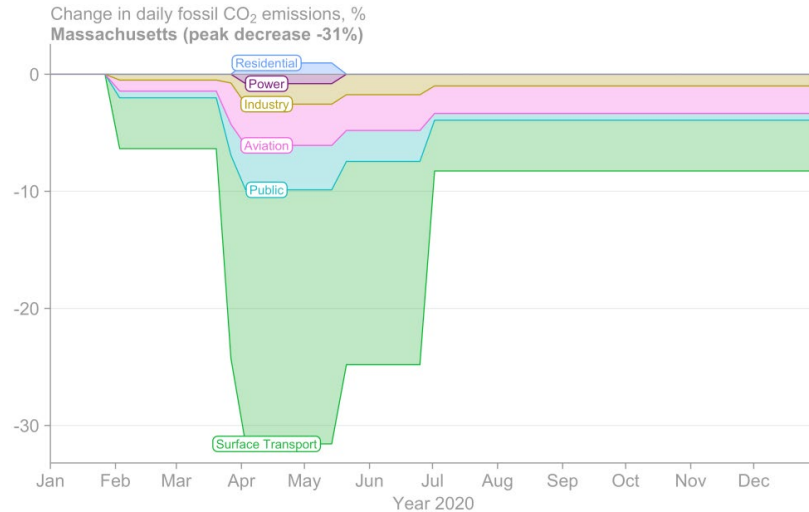
© Updated from Le Quéré et al. Nature Climate Change (2020); Global Carbon Project

-Figure: @Jones_MattW

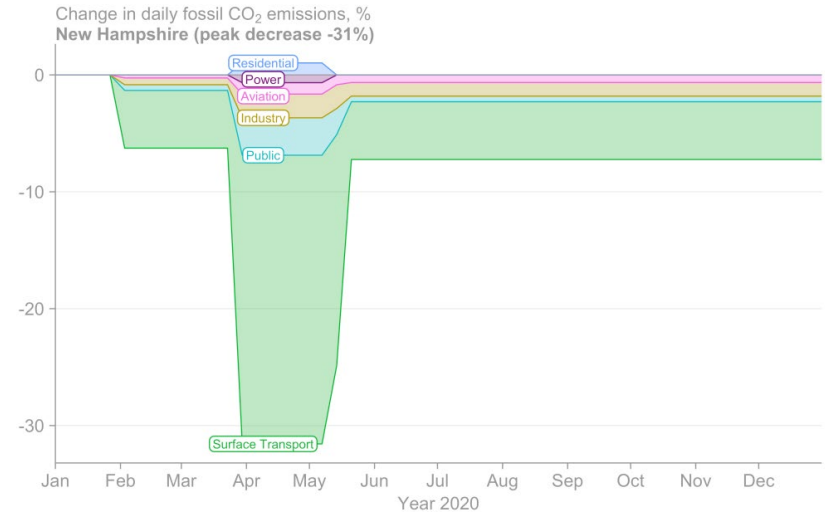
Matt Jones, Senior Research Associate, Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Temporary reduction in daily global CO₂ emissions during the COVID-19 forced confinement <https://mattwjones.co.uk/covid-19/>

2020 State % Changes in CO₂ Emissions due to COVID-19 Pandemic Mitigation Measures

Massachusetts Change in Daily CO₂ Emissions (Decrease Peaked at -32%)



New Hampshire Change in Daily CO₂ Emissions (Decrease Peaked at -32%)



© Updated from Le Quéré et al. Nature Climate Change (2020); Global Carbon Project

-Figure: @Jones_MattW

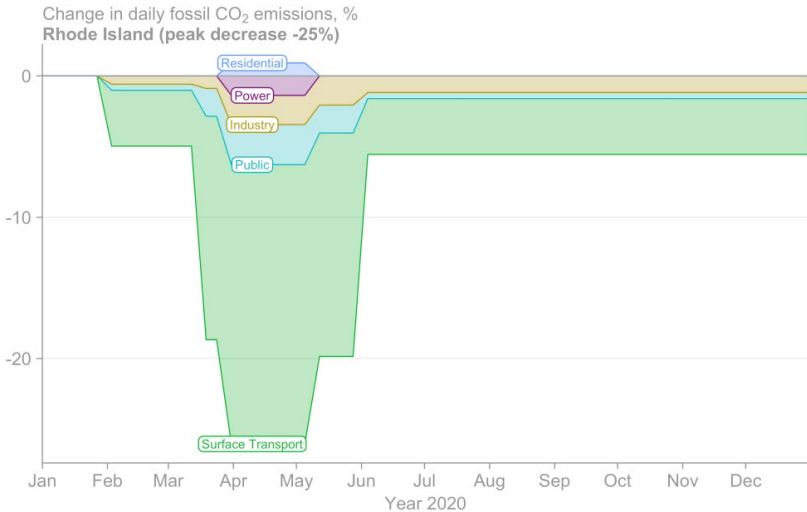
© Updated from Le Quéré et al. Nature Climate Change (2020); Global Carbon Project

-Figure: @Jones_MattW

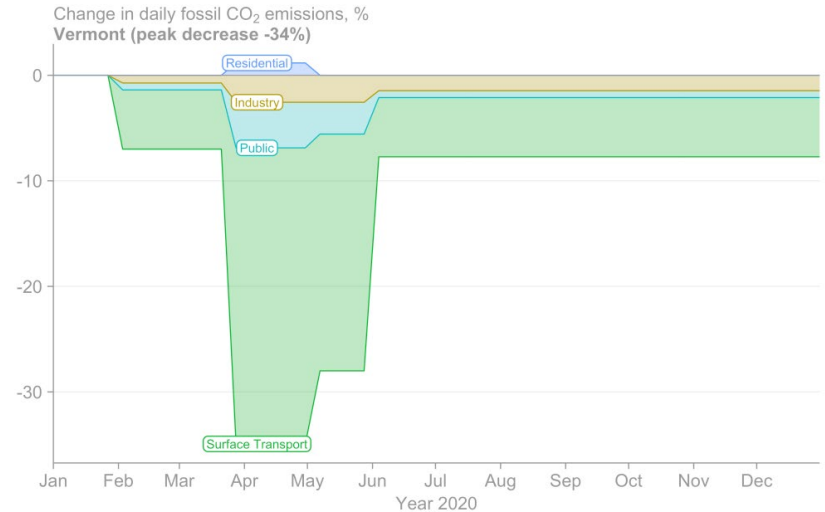
Matt Jones, Senior Research Associate, Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Temporary reduction in daily global CO₂ emissions during the COVID-19 forced confinement <https://mattwjones.co.uk/covid-19/>

2020 State % Changes in CO₂ Emissions due to COVID-19 Pandemic Mitigation Measures

Rhode Island Change in Daily CO₂ Emissions (Decrease Peaked at -28%)



Vermont Change in Daily CO₂ Emissions (Decrease Peaked at -34%)



© Updated from Le Quéré et al. Nature Climate Change (2020); Global Carbon Project

Figure: @Jones_MattW

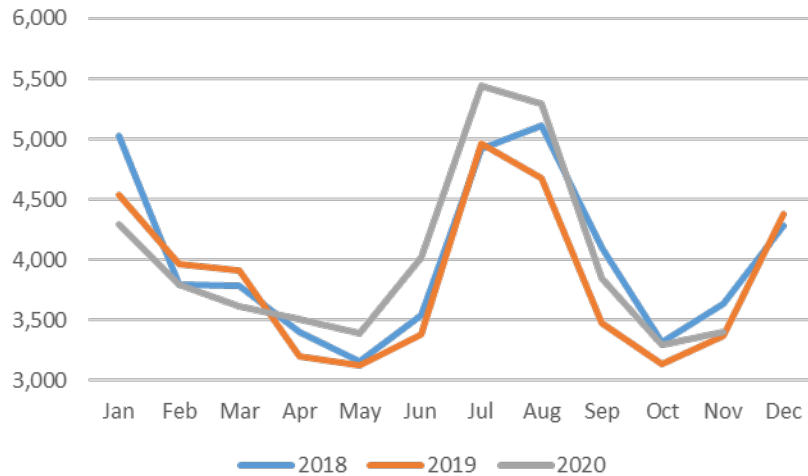
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Figure: @Jones_MattW

Matt Jones, Senior Research Associate, Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Temporary reduction in daily global CO₂ emissions during the COVID-19 forced confinement <https://mattwjones.co.uk/covid-19/>

COVID-19 Impact: Residential Demand Rose, Regional Unemployment Lags U.S.

New England Residential Electricity Sales Recovering (Million Kwh)

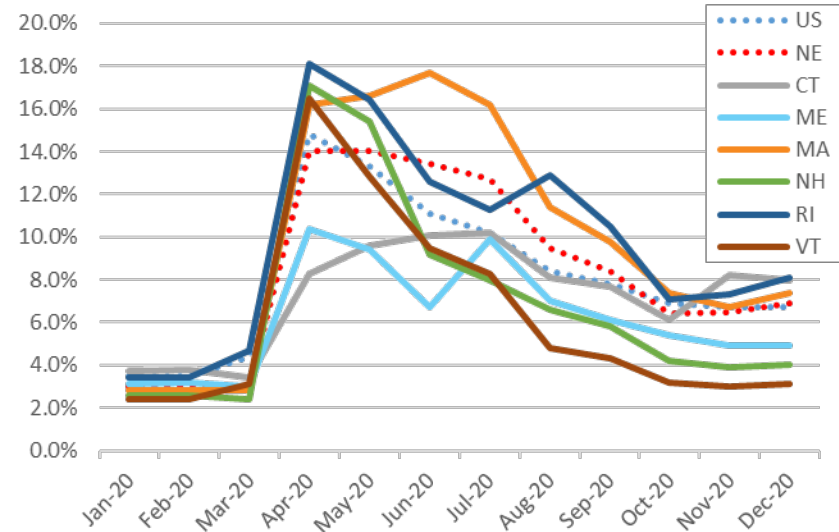


New England Monthly Residential Electricity Sales, not seasonally adjusted.

Note: Year-to-year changes in commercial and industrial electricity sales should be viewed with caution, as utilities may reclassify consumers, moving them from the commercial to the industrial sector or the reverse.

Sources: Boston Federal Reserve Bank, New England Economic Indicators; U.S. Dept. of Energy.

Monthly Total Unemployment Rate (%) Seasonally Adjusted

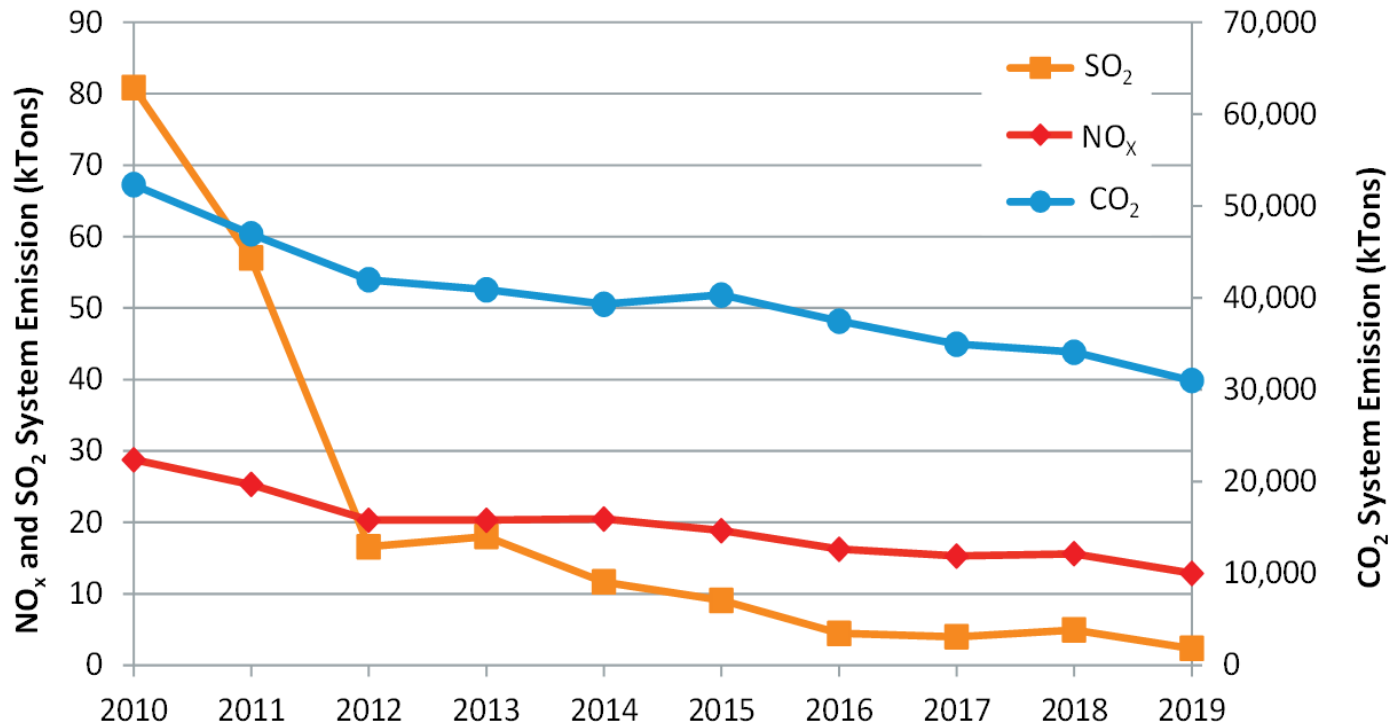


New England Monthly Total Unemployment Rate (%) seasonally adjusted. As of Dec-20, 535,400 remain unemployed, 6.9% of available workforce.

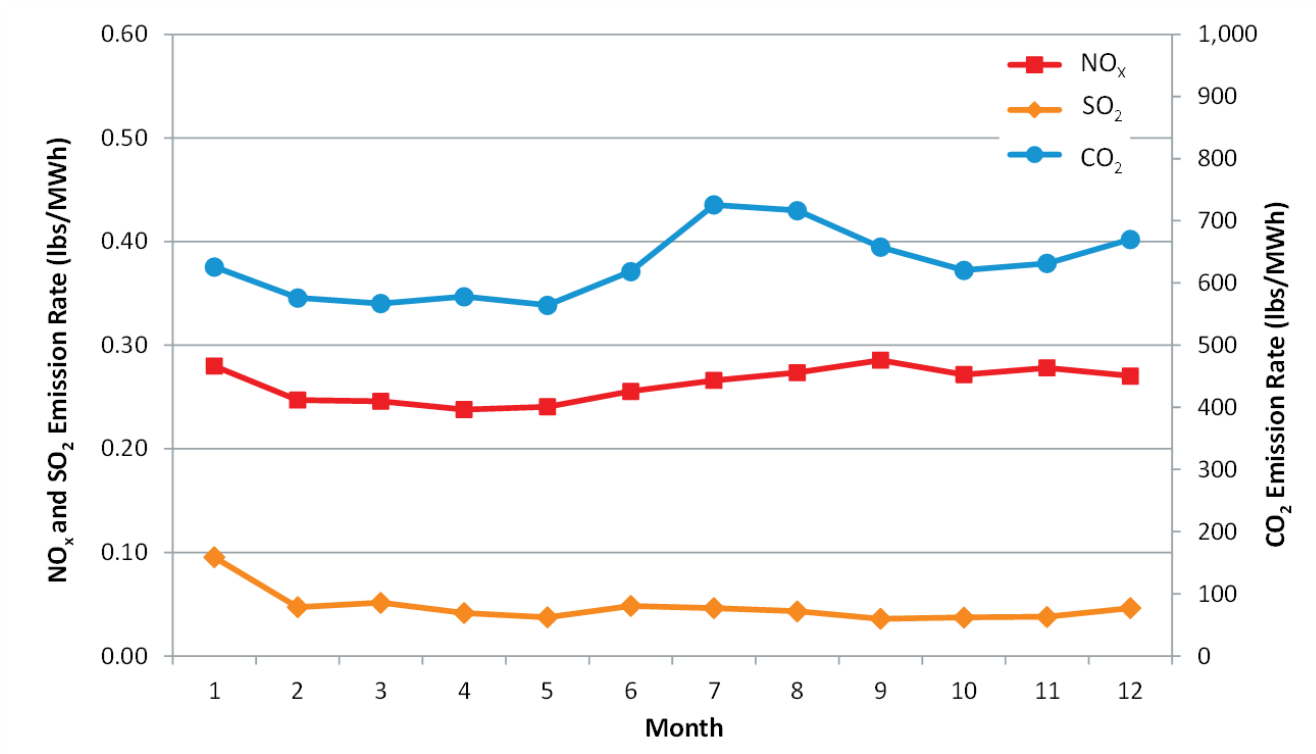
Sources: Boston Federal Reserve Bank, New England Economic Indicators; Bureau of Labor Statistics

POWER SYSTEM EMISSION TRENDS

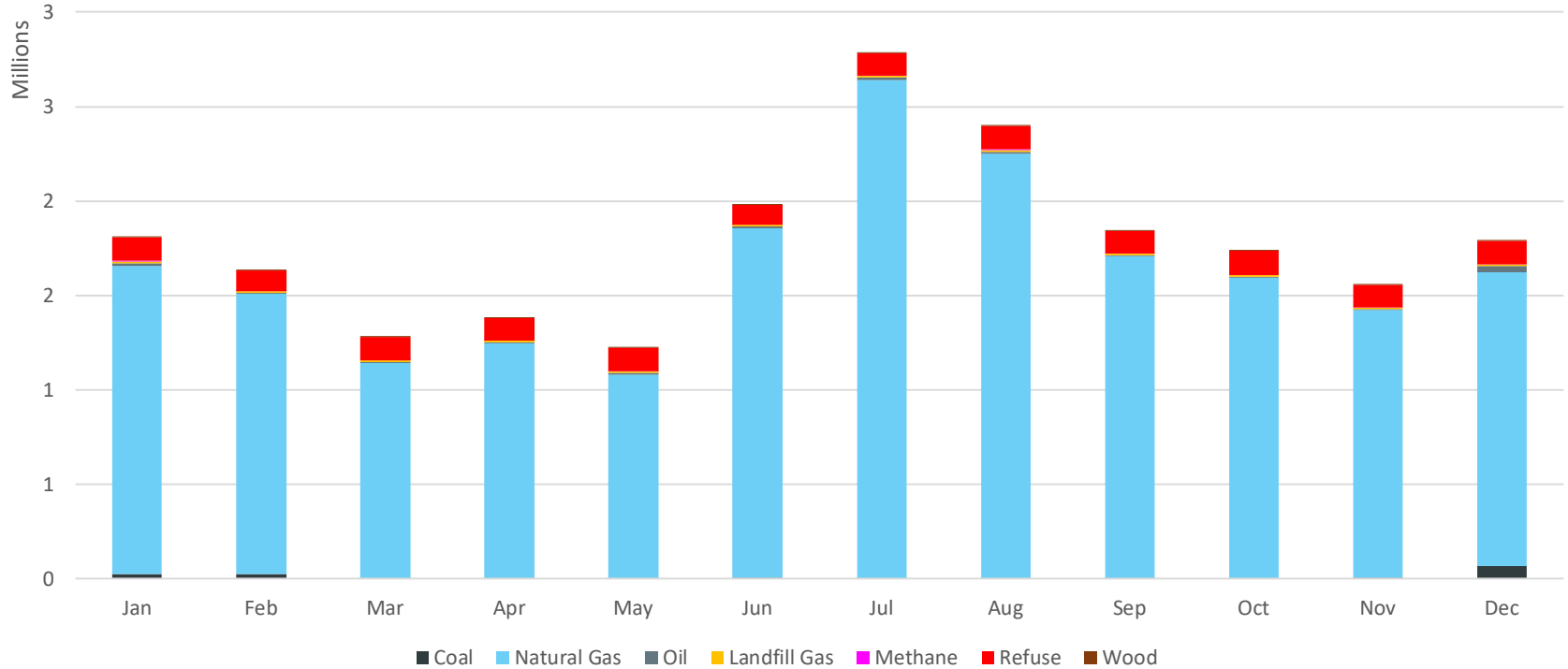
2010-2019 Annual Native System Emissions (Thousand Short Tons)



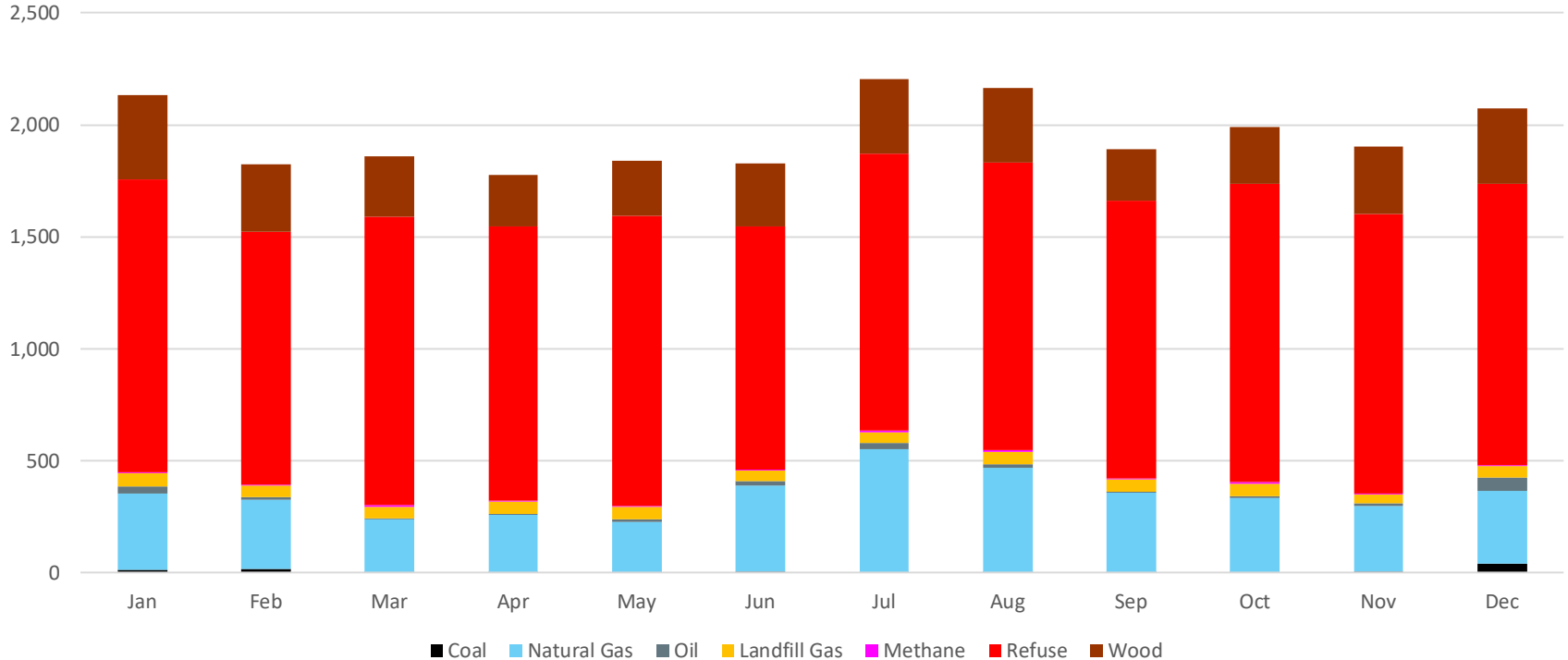
2019 ISO-NE Average Monthly Native System Emission Rates (lbs/MWh)



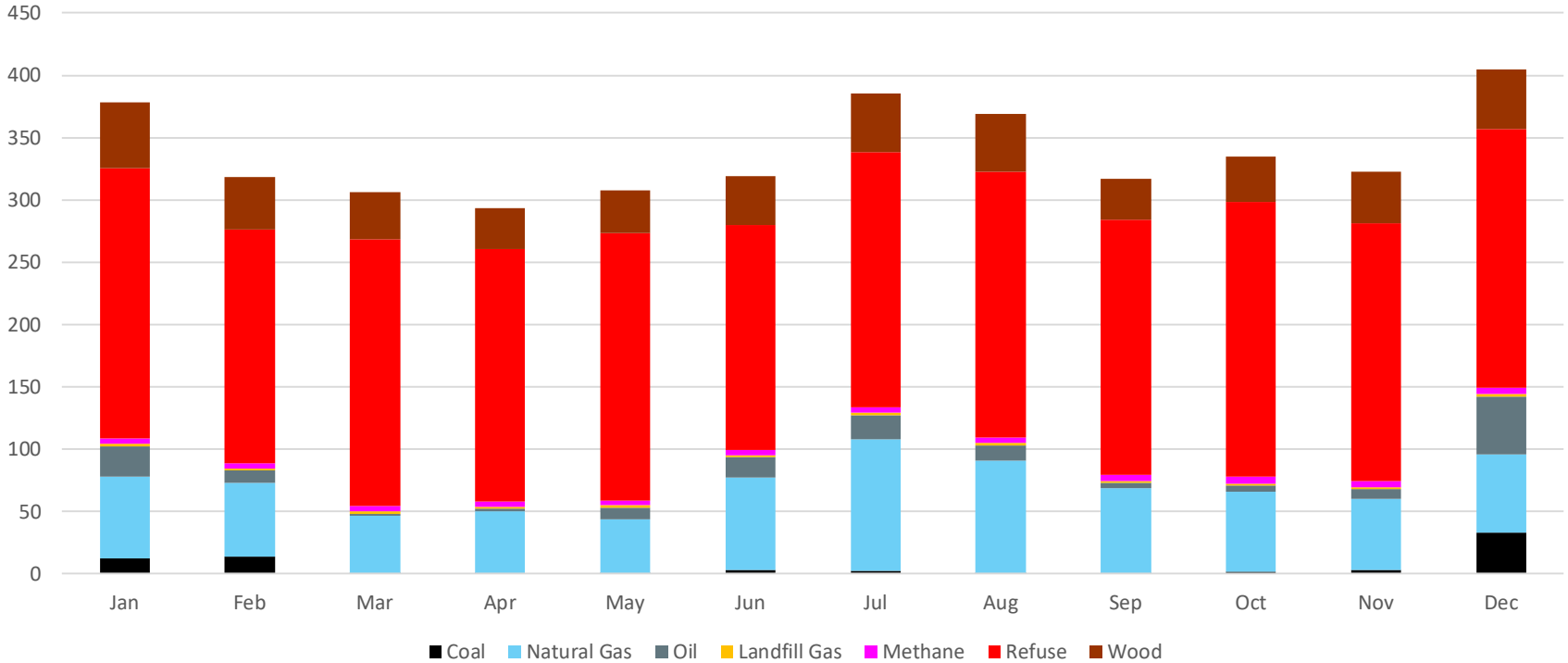
2020 Monthly Estimated Native CO₂ Emissions (Million Metric Tons)



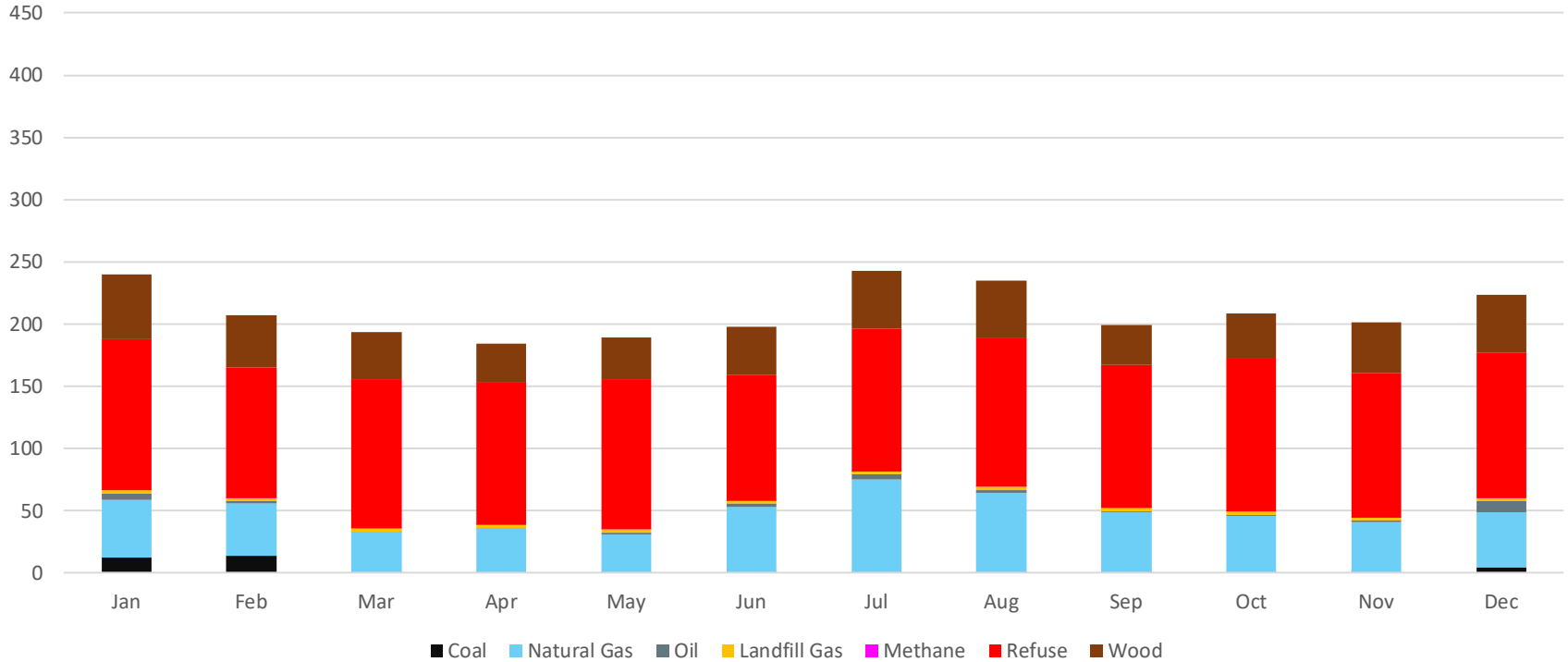
2020 Monthly Estimated Native NO_x Emissions (Metric Tons)



2020 Monthly Estimated Native SO₂ Emissions (Metric Tons)



2020 Monthly Estimated Native PM_{2.5} Emissions (Metric Tons)



Key Takeaways

- From 2010 through 2019, native system emissions decreased:
 - NO_x by 55%;
 - SO₂ by 97%; and
 - CO₂ by 41%
- The emissions decline reflects shifts in the regional generation mix, with increasing natural gas-fired, solar and wind generation offsetting declines in coal- and oil-fired generation, while other combustion sources remained unchanged
- Estimated native power system CO₂ emissions in 2020 (21.4 million metric tons) increased 3% compared to 2019 (20.8 million metric tons)
 - System-wide emission factors are used for these estimates to provide a snapshot comparison, unlike the more detailed analysis available in the annual emissions reports

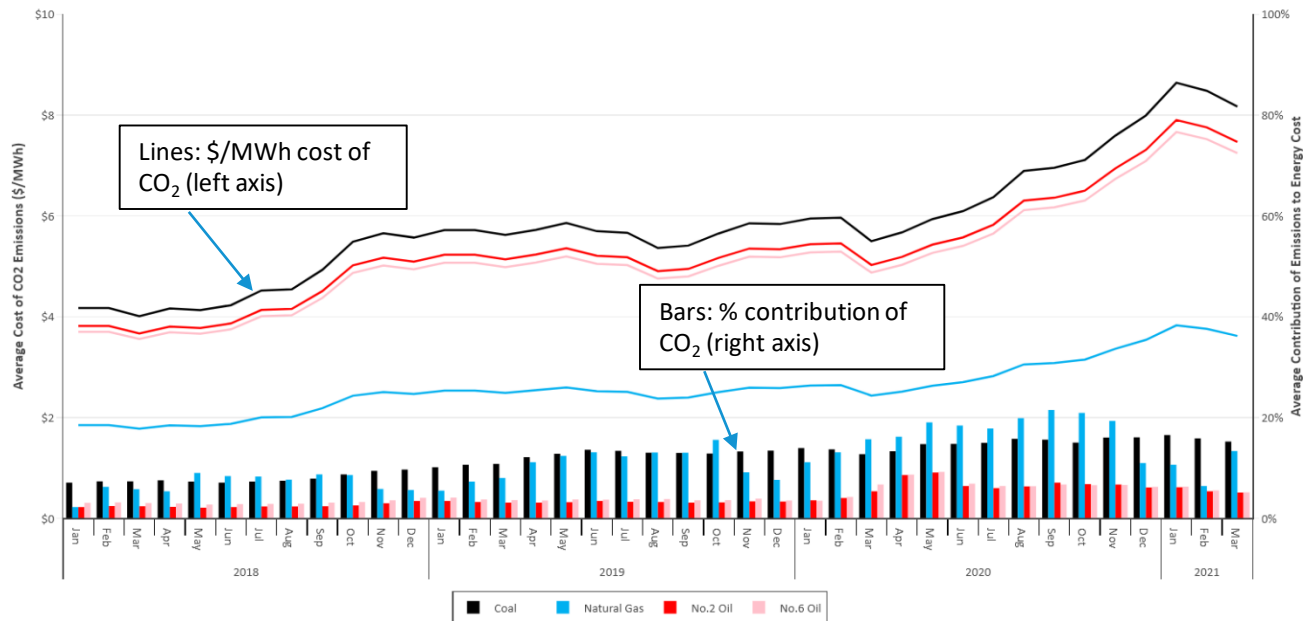


ENVIRONMENTAL COMPLIANCE COSTS

Impact of CO₂ Emissions Pricing on Regional Energy Costs

Stable CO₂ Allowance Prices over Previous 18 Months, but Growing Contribution to Energy Costs

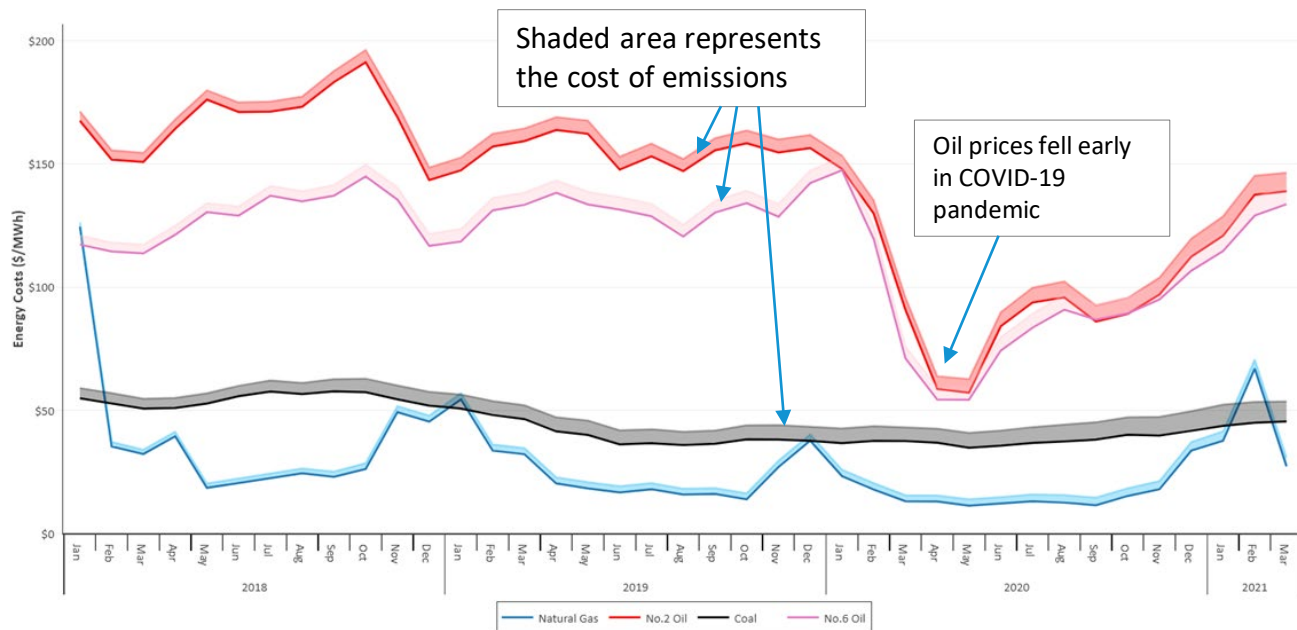
In mid-2020 lower natural gas costs and higher CO₂ prices increased the % contribution of emission compliance costs to energy costs until December (right axis-bars at bottom)



CO₂ Allowance Prices Tend to have Little Impact on Economic-Merit Order

Energy costs increased in mid-2020 due to lower fuel costs and higher CO₂ prices

CO₂ prices have minor impact on economic merit order





RGGI OVERVIEW

Regional Greenhouse Gas Initiative Summary

- The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont and Virginia to cap and reduce CO₂ emissions from the power sector:
 - RGGI cap declining at 2.275% annually through 2030
 - RGGI allowances = authorization to emit 1 short ton of CO₂
 - RGGI allowances are available in quarterly auctions (RGGI States pool their share of annual RGGI cap) or secondary market
- In 2021, affects 678 fossil fuel-fired electric generators at 226 facilities, across 11 States
 - Virginia (90) and New York (65) added affected facilities
- Each RGGI State adopts the RGGI model rule developed and then updated every 3 years, RGGI States determine
 - Each RGGI State accepts a valid vintage RGGI allowance



MASSACHUSETTS GLOBAL WARMING SOLUTIONS ACT

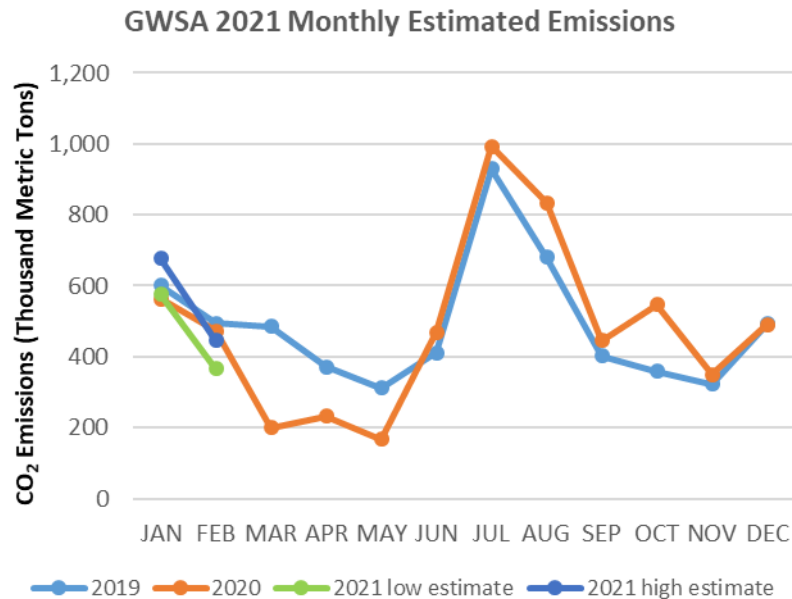
Generator Emissions Cap (310 CMR 7.74) Update

Massachusetts CO₂ Generator Emissions Cap

Electric Generation CO₂ Cap Estimated Emissions for 2021 following 2019-2020 quarterly trend

- Feb. 2021 month-to-date emissions estimated between 365,600 and 445,620 metric tons
 - Feb. 2019, 2020: 494,547, 473,007 metric tons
- Jan. 2021 emissions estimated between 575,890 and 676,770 metric tons
 - Jan. 2019, 2020: 601,079, 563,174 metric tons
- 2021 cap is 8.23 million metric tons (MMT)
- 2020 CO₂ emissions estimated between 5.1 – 6.1 MMT
- Actual 2020 emissions reported to EPA by affected GWSA generators: 5.76 MMT
- 2020 cap was 8.5 MMT

2021 Estimated, Past Monthly Emissions (Thousand Metric tons)



APPENDIX

US Environmental Protection Agency Actions Impacting Power Generation Under Review

Agency (Actions Under Review)	Federal Register Citation	Date
US ENVIRONMENTAL PROTECTION AGENCY		
Pollutant-Specific Significant Contribution Finding for Greenhouse Gas Emissions From New Modified and Reconstructed Stationary Sources: Electric Utility Generating Units and Process for Determining Significance of Other New Source Performance Standards Source Categories	86 FR 2542	(Jan. 13 2021)
Strengthening Transparency in Pivotal Science Underlying Significant Regulatory Actions and Influential Scientific Information	86 FR 469	(Jan. 6 2021)
Review of the Ozone National Ambient Air Quality Standards	85 FR 87256	(Dec. 31 2020)
Increasing Consistency and Transparency in Considering Benefits and Costs in the Clean Air Act Rulemaking Process	85 FR 84130	(Dec. 23 2020)
Review of the National Ambient Air Quality Standards for Particulate Matter	85 FR 82684	(Dec. 18 2020)
Reclassification of Major Sources as Area Sources Under Section 112 of the Clean Air Act	85 FR 73854	(Nov. 19 2020)
Hazardous and Solid Waste Management System: Disposal of CCR; A Holistic Approach to Closure Part B: Alternate Demonstration for Unlined Surface Impoundments	85 FR 72506	(Nov. 12 2020)
NPDES Electronic Reporting Rule—Phase 2 Extension	85 FR 69189	(Nov. 2 2020)
EPA Guidance; Administrative Procedures for Issuance and Public Petitions	85 FR 66230	(Oct. 19 2020)
Steam Electric Reconsideration Rule	85 FR 64650	(Oct. 13 2020)
US Environmental Protection Agency Memorandum Regarding Inclusion of Provisions Governing Periods of Startup Shutdown and Malfunctions in State Implementation Plans (Oct. 9 2020)		(Oct. 9 2020)
Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; A Holistic Approach to Closure Part A: Deadline To Initiate Closure	85 FR 64650	(Oct. 13 2020)
Streamlining Procedures for Permit Appeals	85 FR 51650	(Aug. 21 2020)
Clean Water Act Section 401 Certification Rule	85 FR 42210	(July 13 2020)
National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units—Reconsideration of Supplemental Finding and Residual Risk and Technology Review	85 FR 31286	(May 22 2020)
The Navigable Waters Protection Rule: Definition of 'Waters of the United States'	85 FR 22250	(Apr. 21 2020)
Accidental Release Prevention Requirements: Risk Management Programs Under the Clean Air Act	84 FR 69834	(Dec. 19 2019)
Findings of Failure To Submit a Clean Air Act Section 110 State Implementation Plan for Interstate Transport for the 2015 Ozone National Ambient Air Quality Standards (NAAQS)	84 FR 66612	(Dec. 5 2019)
Adopting Requirements in Emission Guidelines for Municipal Solid Waste Landfills	84 FR 44547	(Aug. 26 2019)
Repeal of the Clean Power Plan; Emission Guidelines for Greenhouse Gas Emissions From Existing Electric Utility Generating Units; Revisions to Emission Guidelines Implementing Regulations	84 FR 32520	(July 8 2019)
Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; Amendments to the National Minimum Criteria (Phase One Part One)	83 FR 36435	(July 30 2018)

Federal Agency Actions Impacting Power Generation Under Review (cont.)

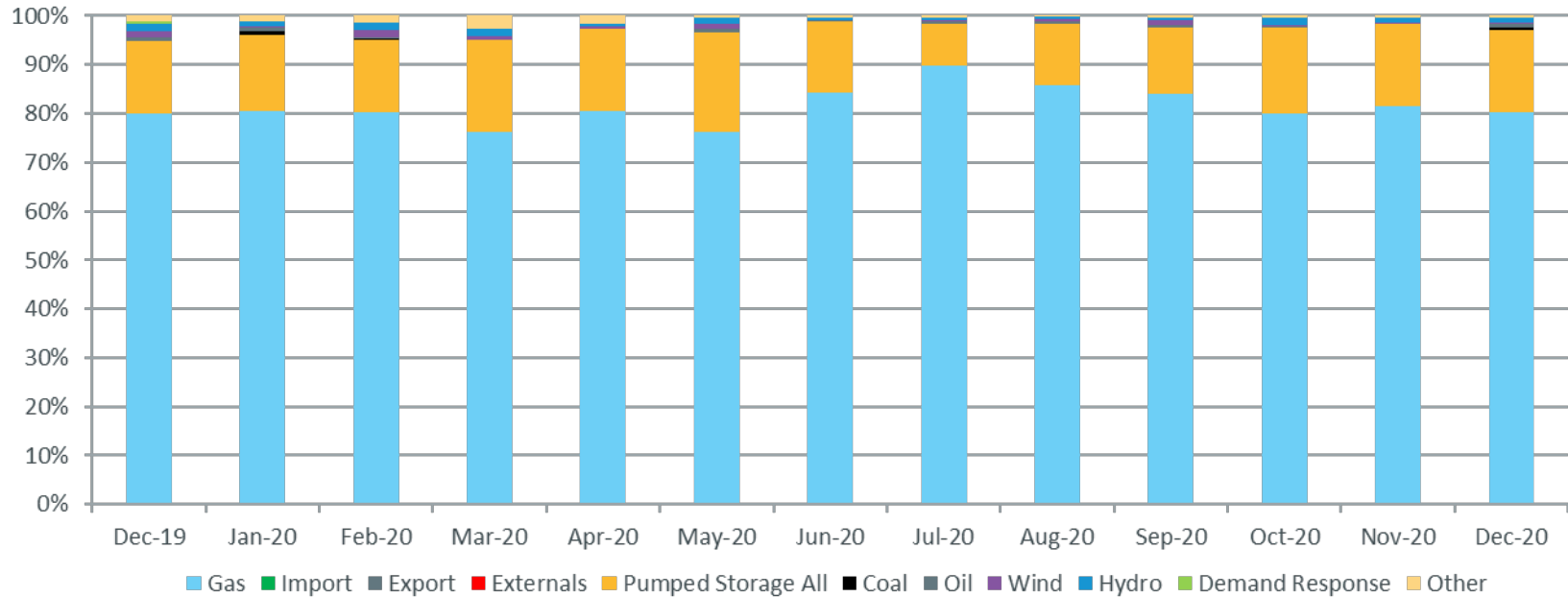
Agency (Actions Under Review)	Federal Register Citation	Date
COUNCIL ON ENVIRONMENTAL QUALITY		
Guidance Document Procedures	86 FR 1279	(Jan. 8 2021)
Update to the Regulations Implementing the Procedural Provisions of the National Environmental Policy Act	85 FR 43304	(July 16 2020)
US DEPARTMENT OF COMMERCE		
Endangered and Threatened Wildlife and Plants; Regulations for Listing Endangered and Threatened Species and Designating Critical Habitat	85 FR 81411	(Dec. 16 2020)
Endangered and Threatened Wildlife and Plants; Regulations for Listing Species and Designating Critical Habitat	84 FR 45020	(Aug. 27 2019)
Endangered and Threatened Wildlife and Plants; Regulations for Interagency Cooperation	84 FR 44976	(Aug. 27 2019)
US DEPARTMENT OF DEFENSE		
Reissuance and Modification of Nationwide Permits	86 FR 2744	(Jan. 13 2021)
The Navigable Waters Protection Rule: Definition of 'Waters of the United States'	85 FR 22250	(Apr. 21 2020)
US DEPARTMENT OF THE INTERIOR		
Regulations Governing Take of Migratory Birds	86 FR 1134	(Jan. 7 2021)
Endangered and Threatened Wildlife and Plants; Regulations for Designating Critical Habitat	85 FR 82376	(Dec. 18 2020)
Forest Management Decision Protest Process and Timber Sale Administration	85 FR 82359	(Dec. 18 2020)
Endangered and Threatened Wildlife and Plants; Regulations for Listing Endangered and Threatened Species and Designating Critical Habitat	85 FR 81411	(Dec. 16 2020)
Procedures for Issuing Guidance Documents	85 FR 67666	(Oct. 26 2020)
US Fish and Wildlife Service Biological Opinion for the Reinitiation of Consultation on the Coordinated Operations of the Central Valley Project and State Water Project (Oct. 21 2019)		(Oct. 21 2019)
Endangered and Threatened Wildlife and Plants; Regulations for Listing Species and Designating Critical Habitat	84 FR 45020	(Aug. 27 2019)
Endangered and Threatened Wildlife and Plants; Regulations for Interagency Cooperation	84 FR 44976	(Aug. 27 2019)
US Department of the Interior M-37050: The Migratory Bird Treaty Act Does Not Prohibit Incidental Take		(Dec. 22 2017)

Non-exclusive list of agency actions that relevant agencies will review in accordance with the January 21, 2021 Executive Order: “*Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis.*” Additional agency actions also will be reviewed to determine consistency with Section 1 of the Executive Order. *Note that actions published in the January 20 Federal Register will be added to this list.*

MARGINAL UNIT BY FUEL TYPE

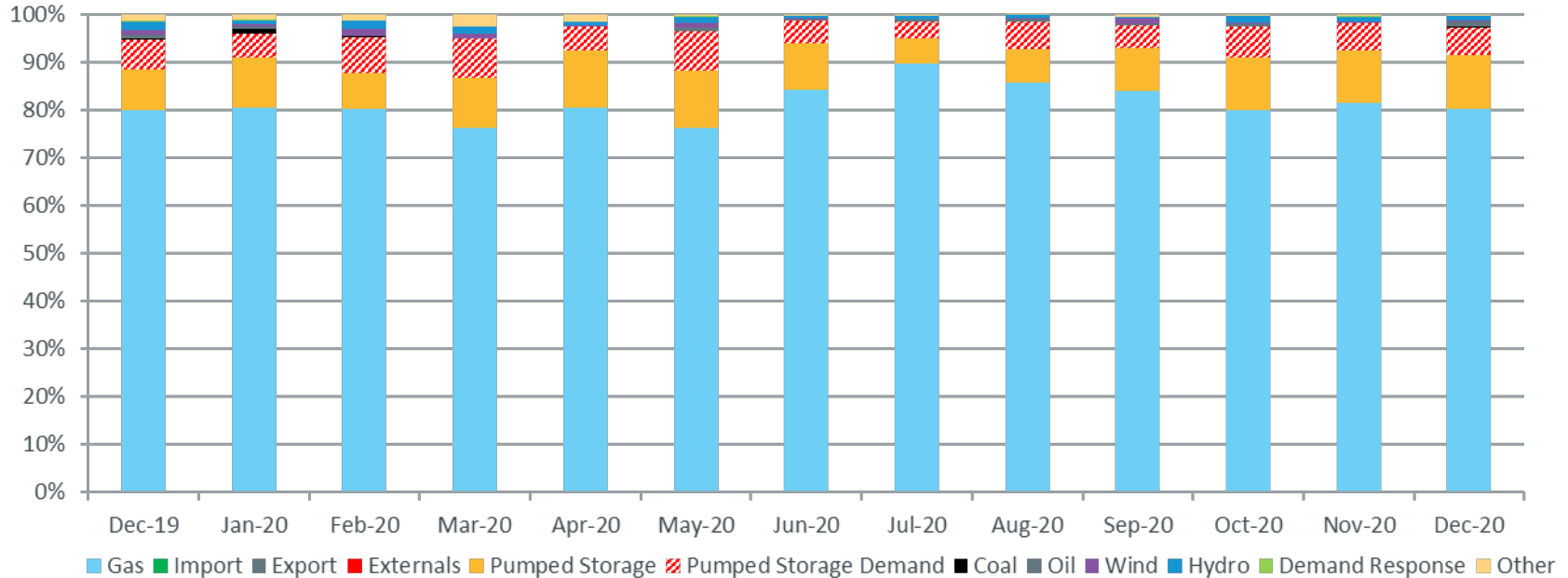
Reference: 2019 Electric Generator Air Emissions Report

Load-Weighted Marginal Units by Fuel Type (Summed)



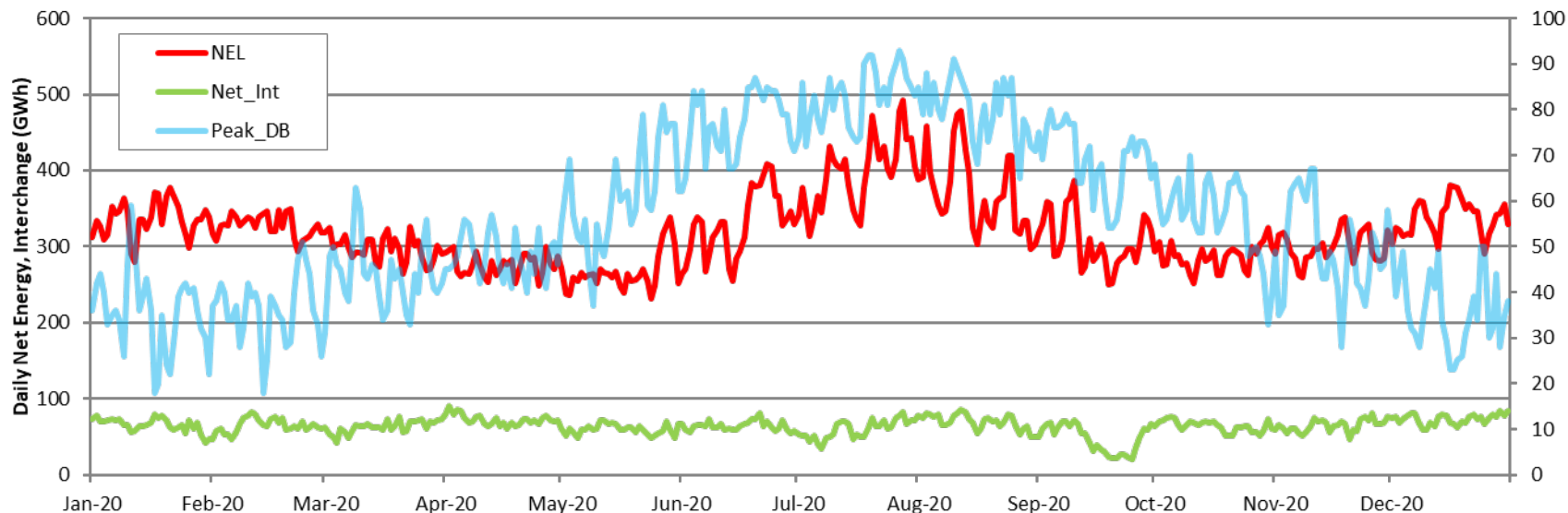
Marginal emission rates are calculated using system data that identifies at least one locational marginal unit for each five-minute period, which is associated with meeting the energy requirements on the system during that pricing interval. Using system data on the magnitude and direction of power flows, load in constrained areas and the marginal generators in the same constrained areas are matched. Since these marginal generators can only serve load in the constrained area, weighting by the load in the constrained area against the overall load on the system provides a more accurate representation of the system impact of load weighted marginal units.

Load-Weighted Marginal Units by Fuel Type (Detailed)



Marginal emission rates are calculated using system data that identifies at least one locational marginal unit for each five-minute period, which is associated with meeting the energy requirements on the system during that pricing interval. Using system data on the magnitude and direction of power flows, load in constrained areas and the marginal generators in the same constrained areas are matched. Since these marginal generators can only serve load in the constrained area, weighting by the load in the constrained area against the overall load on the system provides a more accurate representation of the system impact of load weighted marginal units.

2020 Daily Net Energy for Load, Interchange & Peak Temperature for New England



Net Energy for Load (NEL): actual daily total New England Net Energy for Load in GWh as determined by metering; sum of metered generation and net interchange less demand from pumped storage units.

Net Interchange (Net_Int): is the total net interchange with neighboring control areas in GWh.

Peak Dry Bulb (Peak_DB): the dry-bulb temperature in Fahrenheit (°F) at the peak demand hour for the weather station corresponding to the load zone or Trading Hub.

Output-based Emission Rates Used for Estimating New England System Emissions (kilograms/MWh)

	Coal	Natural Gas	Oil	Landfill Gas	Methane	Refuse	WOOD
CO ₂	1,009	393	739	257	257	477	11
NO _x	0.610	0.082	1.374	1.411	1.411	4.994	1.510
SO ₂	0.492	0.016	1.074	0.047	0.047	0.819	0.212
PM _{2.5}	0.065	0.011	0.207	0.067	0.010	0.460	0.208