Winter & Spring 2020

Biannual Environmental Report

By ISO New England System Planning

System Planning

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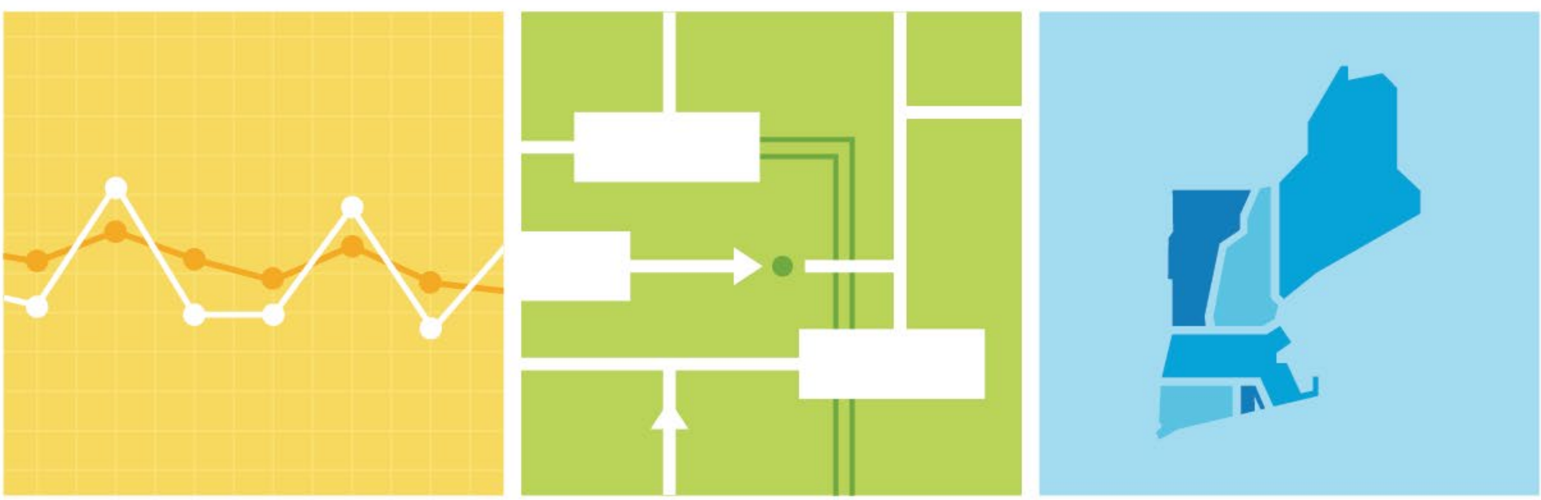

Preface/Disclaimer

The ISO New England Inc. System Planning (ISO) publishes a quarterly environmental report that summarizes environmental performance of the regional electric generating system and regulatory and policy developments that may affect current or future operations.[1]

ISO New England Inc. (ISO) is the not-for-profit corporation responsible for the reliable operation of New England's electric power system. It also administers the region's wholesale electricity markets and manages the comprehensive planning of the regional power system.

The environmental impacts of electricity generation can contribute to large-scale regional environmental concerns as well as localized concerns that affect the area directly surrounding a power plant. Impacts vary based on the energy resource—for example, whether the power plant uses fossil fuel or a renewable resource. In general, the environmental consequences of electric generation may include the following:

- **Air pollution**: emissions including the quantity and type of emissions vary by fuel combustion and other plant characteristics.
    - Air pollution emissions from electric generation may include carbon dioxide, sulfur dioxide, nitrogen oxides, mercury, and particulate matter
- **Water use and Wastewater discharges**: water used for steam production or cooling may be returned at warmer temperatures to water bodies and may contain contaminants. Some water may also be lost to evaporation.
- **Waste generation**: Burning certain fuels results in solid waste such as ash, which must be stored and eventually disposed of properly.
    - Some wastes contain hazardous substances. For example, nuclear power generation produces radioactive waste, while coal ash can contain heavy metals like mercury.
- **Land use**: electric generating and transmission lines facilities require space for their power generation operations.

Air emissions, water contamination and compliance data is obtained from the U.S. Environmental Protection Agency (EPA), and also water intensity and air emissions data from the Energy Information Administration (EIA).[2]

Weather and climate trend data is obtained from the National Oceanic and Atmospheric Administration (NOAA) Climate Resources and National Centers for Environmental Information.

All information and data presented here are the most recent as of the time of publication. Any preliminary generation data presented in this report are subject to change or correction.

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[1] Coverage may include updates of actions affecting the regional electric power system by state environmental protection agencies, executive actions and federal actions by the U.S. Environmental Protection Agency (EPA), and other federal entities including: the Council on Environmental Quality (CEQ); Department of Agriculture (Forest Service, Natural Resources Conservation Service, Office of Environmental Markets); Department of Commerce (National Oceanic and Atmospheric Administration, National Marine Fisheries Service); Department of Defense (U.S. Army Corps of Engineers); Department of Energy; Department of Interior (Bureau of Ocean Energy Management, Bureau of Land Management, Bureau of Reclamation, National Park Service, US Fish and Wildlife Service).

[2] EPA, Air Monitoring Program Data (AMPD), https://ampd.epa.gov/ampd/, and Facility Level Information on Greenhouse Gases Tool (FLIGHT), https://ghgdata.epa.gov/ghgp/main.do?site_preference=normal, and EPA's Enforcement and Compliance History Online, https://echo.epa.gov/; EIA Electricity Power Plant Emissions, https://www.eia.gov/electricity/data/emissions/, and EIA Thermoelectric Cooling Water Data, https://www.eia.gov/electricity/data/water/.

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Section 1
Executive Summary

This bi-annual report summarizes the environmental performance of the ISO New England electric generating system and regulations affecting generators and bulk electric power system for 1st half of 2020 (January 1, 2020 through June 30, 2020).[3] The report notes air emissions and water-usage trends, current and developing environmental requirements impacting the New England electric generating system.

Various elements of the New England bulk electric power system are subject to federal, and state environmental laws and regulations limiting direct air emissions water discharges. Electricity generating technologies use water for different processes, depending on their configuration. Regional electricity demand is driven primarily by weather, as well as economic factors.

In the first half of 2020, the majority of New England's electric energy came from nuclear generation, natural gas-fired generation, and net imports (accounting for exports). During the first half of 2020, natural gas generation was the marginal resource approximately 78% of the time. Regional electricity demand is sensitive to changes in regional weather trends which can materially affect the environmental performance of the New England bulk electric power system. A single one degree Fahrenheit (°F) temperature increase when the dew point exceeds 70 °F will trigger a 500 MW increase in system demand.

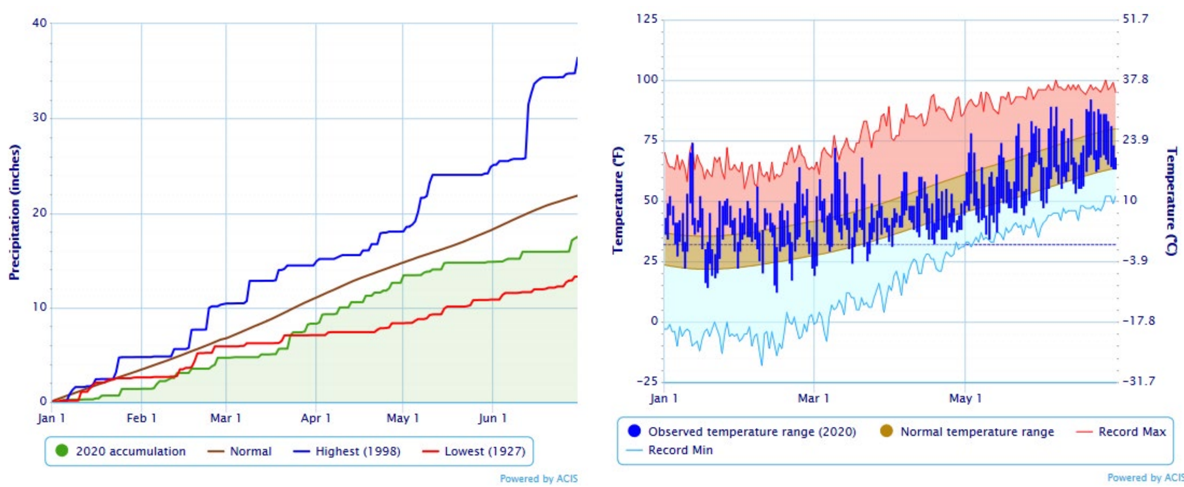

Figure 1-1: Precipitation (Inches) and Temperature (°F-°C) Trends for Boston, MA (January 1 – June 30, 2020)

Notes: NOAA Climate Resources, plot of accumulated of precipitation, snowfall (inches) and plot of daily max/min temperatures (°F-°C), along with the normal temperature range and daily all-time records. Source: National Oceanic and Atmospheric Administration (NOAA) Climate Resources, https://w2.weather.gov/climate/local_data.php?wfo=box.

Regional winter (January-February) precipitation trended lower while temperatures were frequently above normal with fewer very cold days (See Figure 1-1 for Boston trends). Spring (March-May) precipitation varied across the region, below normal across southern New England,

[3] The bulk electric power system includes the interconnected electrical generating resources, transmission facilities, tie lines with neighboring systems, and associated equipment used to produce electric energy, generally operated at 100 kV or higher.

much above normal in Maine and New Hampshire, while temperatures were mostly normal in March and May, but colder than average in April. Portland, ME experienced its earliest 70 °F in March, but then set a record for its coldest highest temperature in April.

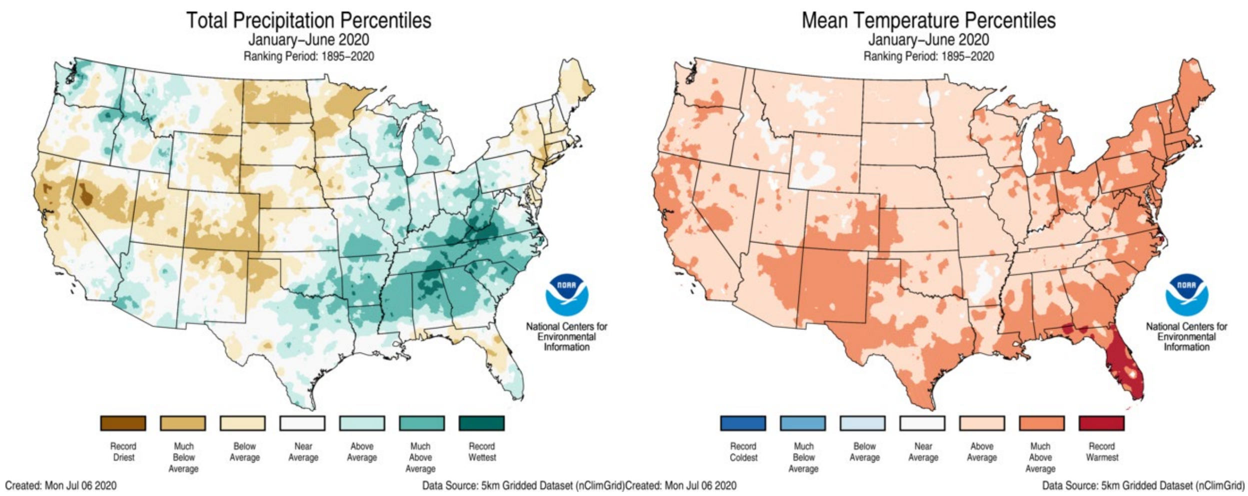

Figure 1-2: Total Precipitation (Percentiles) and Mean Temperature (Percentiles) Trends for Contiguous United States, (January – June, 2020)

Notes: Below-average precipitation occurred across portions of the Southwest, Great Plains, Ohio Valley, Southeast and much of the Northeast. Drought conditions expanded across much of the Northeast during June as a result of above-average temperatures and below-average precipitation. Above-average to record-warm January-June temperatures were observed across most of the Lower 48 states. Rhode Island and Massachusetts ranked fourth warmest on record for this six-month period.
Source: NOAA National Centers for Environmental Information, *June 2020 U.S. Climate Assessment*, https://www.ncei.noaa.gov/news/national-climate-202006

1.1 COVID-19 Estimated Impact on Electricity Demand and Emissions

Lower electricity demand loads were observed during spring 2020 (April-May) across New England, as COVID-19 pandemic responses led to reduced regional economic activity, along with continued increase in behind-the-meter solar generation and energy efficiency.[4] Higher temperatures in June 2020 led to increased air conditioning demand, combined with the end of many pandemic mitigation measures in most New England States, resulted in higher loads than would have otherwise been expected absent COVID-19 responses.[5]

[4] The ISO-NE Internal Market Monitor noted in the Spring 2020 Quarterly Market Report (August 2020) that temperature fluctuations typically drive differences in monthly average load, but this temperature-load relationship unraveled in April and May 2020 when regional responses to theCOVID-19 pandemic resulted in lower electricity demand despite colder temperatures. In April 2020, the average temperature was 4°F colder than in April 2019 (45°F vs. 49°F), but average loads still decreased year-over-year (11,460 MW vs. 12,001 MW).

[5] The ISO-NE Operations Forecast group produces a weekly analysis of the impact the response to COVID-19 is having on regionwide system demand. Impact on system demand was first observed in the third week of March when the pandemic response began. Loads were trending lower than would be expected through May. Impact on system demand was first observed in the third week of March when the pandemic response began. See https://www.iso-ne.com/markets-operations/system-forecast-status/estimated-impacts-of-covid-19-on-demand/.

Nationwide COVID-19 pandemic responses temporarily lowered daily economy-wide CO_2 emissions by an estimated -32% in April 2020 (4.5 million metric tons). By June 2020, the decline was reduced to -8% (1 million metric tons). New England saw a similar estimated economy-wide emissions decline of -30% by April 2020, recovery was uneven between States, emissions declines from reduced surface transportation and commercial activity, between -4% to -24%, recovered by June 2020.

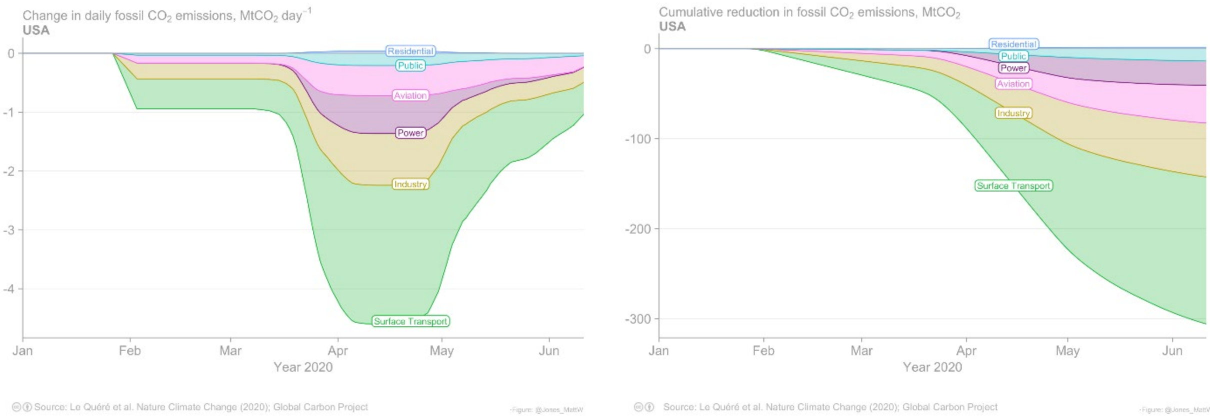

Figure 1-3: Year-to-date (January 1 – June 20) Estimated Decline in Daily CO_2 Emissions and Cumulative Reduction in Fossil CO_2 Emissions in the United States (Million Metric Tons)
Note: *Decline in surface transportation emissions was the largest component in the peak decrease of 32% across the U.S. in April 2020.*
Source: Matt Jones, Senior Research Associate, Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Temporary reduction in daily global CO_2 emissions during the COVID-19 forced confinement, https://mattwjones.co.uk/covid-19/.

Figure 1-3 shows estimated daily CO_2 emissions from the U.S. electric power system fell ~900,000 metric tons by April 2020, and then largely recovered by June 2020, compared to larger declines in U.S. surface transportation and industrial sectors. In New England, the change in estimated daily CO_2 emissions from electric power generation was modest, declining by ~9,000 metric tons in April 2020, and recovered to levels seen in spring 2019 by June 2020.

Early research suggest COVID-19 pandemic mitigation measures had varying impacts on electricity demand across the United States, reflecting in part regional differences in end-use sector electricity consumption.[6] Continued remote working could increase electric power sector emissions nationwide, and in New England, since remote work entails higher power demand, as both offices and homes will be simultaneously requiring electricity for space heating and lighting needs.[7]

The environmental impacts of COVID-19 pandemic responses appeared more pronounced in other economic sectors compared to power generation. During April 2020, on-road vehicle transportation (a significant source of nitrogen dioxide (NO_2) emissions) decreased by roughly 46%

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[6] D. Agdas and P. Barooah, *Impact of the COVID-19 Pandemic on the U.S. Electricity Demand and Supply: An Early View From Data*, in IEEE Access, vol. 8, pp. 151523-151534, 2020, doi: 10.1109/ACCESS.2020.3016912, EIA, *Daily electricity demand impacts from COVID-19 mitigation efforts differ by region*, (May 7, 2020), https://www.eia.gov/todayinenergy/detail.php?id=43636

[7] Steve Cicala, *Powering Work from Home*, National Bureau of Economic Research (NBER), Working Paper No. 27937 (October 2020), http://www.nber.org/papers/w27937. Urban areas are generally more energy efficient than suburbs, requiring more energy to heat and cool detached homes, townhouse and apartments compared to the office and school buildings that people previously congregated in during work days.

across the United States, while freight transportation decreased by approximately 13%.[8] April 2020 NO_2 concentrations averages in ambient monitoring data across the United States trended below the April 2015–2019 averages, and 65% of the ground sites observed NO_2 concentrations in 2020 lower than those in all of the previous five years.[9] Corresponding declines in cellular mobility data suggest a strong relationship with the decline in personal vehicle use and the decline in NO_2 concentrations during April 2020.[10]

Figures 1-4 and 1-5 show the variability of COVID-19 pandemic mitigation measure impacts on fine particulate ($PM_{2.5}$) and nitrogen dioxide (NO_2) emissions using ground monitoring site and satellite monitoring data in April 2020 compared to prior Aprils.

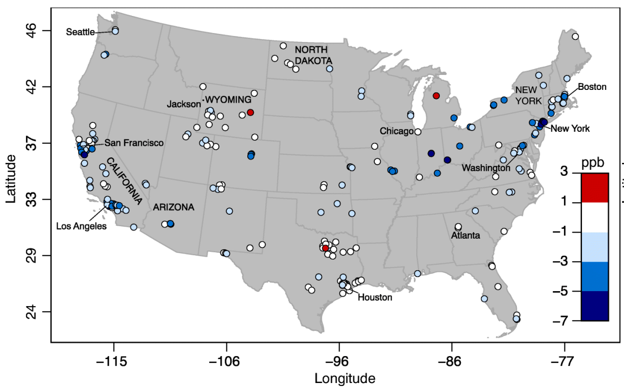

Figure 1-4 : Differences in Monthly Average NO_2 (pbb) concentrations between April 2020 and five previous Aprils (2015-2019)

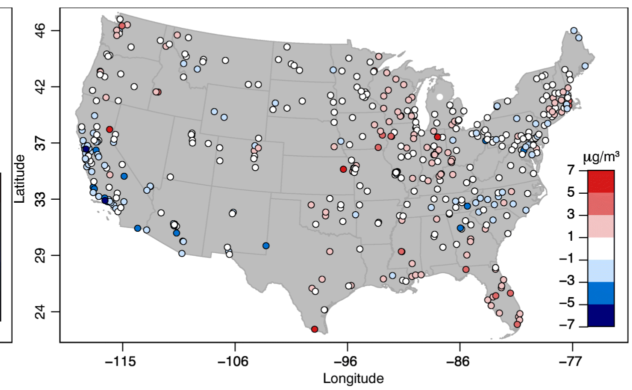

Figure 1-5: Differences in Monthly Average $PM_{2.5}$ (µg/m3) concentrations between April 2020 and five previous Aprils (2015-2019)

Note: Negative values (blue) indicate a decrease in NO_2 (left, parts per billion (ppb)) $PM_{2.5}$ (right, micrograms per cubic meter (µg/m3)) concentrations in April 2020, vice versa positive values (red) indicate an increase. Latitude and longitude are in degrees.
Source: Archer, C.L., Cervone, G., Golbazi, M. et al. *Changes in air quality and human mobility in the USA during the COVID-19 pandemic*. Bull. of Atmos. Sci.& Technol. (2020). https://doi.org/10.1007/s42865-020-00019-0

Commercial freight transportation (generally diesel powered) and electricity demand did not decline significantly in April 2020, and $PM_{2.5}$ concentrations nationwide in April 2020 were similar to past Aprils. $PM_{2.5}$ concentrations from the ground monitoring sites, were not significantly lower in 2020 than those in the past 5 years and were more likely to be higher than lower in April 2020 when compared with those in the previous 5 years.

[8] Plumer B, Popovich N (2020) *Traffic and pollution plummet as U.S. cities shut down for coronavirus*, https://www.nytimes.com/interactive/2020/03/22/climate/coronavirus-usa-traffic.html?smid=url-share. NO_2 is emitted during fuel combustion by cars, trucks and airplanes and ambient concentrations at monitoring can indicate the intensity of nearby transportation-related activity. EPA, https://www.epa.gov/no2-pollution.

[9] Archer, C.L., Cervone, G., Golbazi, M. et al. *Changes in air quality and human mobility in the USA during the COVID-19 pandemic*. Bull. of Atmos. Sci.& Technol. (2020). https://doi.org/10.1007/s42865-020-00019-0. See also Figures A 4 1, A 2 in the appendix of this report (page 32) for a comparison of January to May 2020 nitrogen dioxide (NO2) daily maximum concentrations for Boston, MA & Providence RI, compared to earlier years.

[10] Google COVID-19 Community Mobility Reports, https://www.google.com/covid19/mobility/; Apple COVID-19 Mobility Trends Reports, https://covid19.apple.com/mobility.

1.2 Year-to-Date Power System Environmental Performance Trends

In New England, a comparison of year-to-date (January 1 – June 30) net generation between 2019 and 2020 shows a decline in 2020 native generation (44,385 GWh), 94% of 2019 YTD (47,340 GWh). The shifts in generation by fuel type in Figure 1-2 show a decline in nuclear generation, offset by increases natural gas generation (21,456 GWh, +4%), solar (1,039 GWh, +29%), and net imports (11,719 GWh, +7%). Other fuel types 2020 generation declined: hydro (4,792 GWh, -11%), wind (1,887 GWh, -1%), and wood (1,129 GWh, -6%).[11]

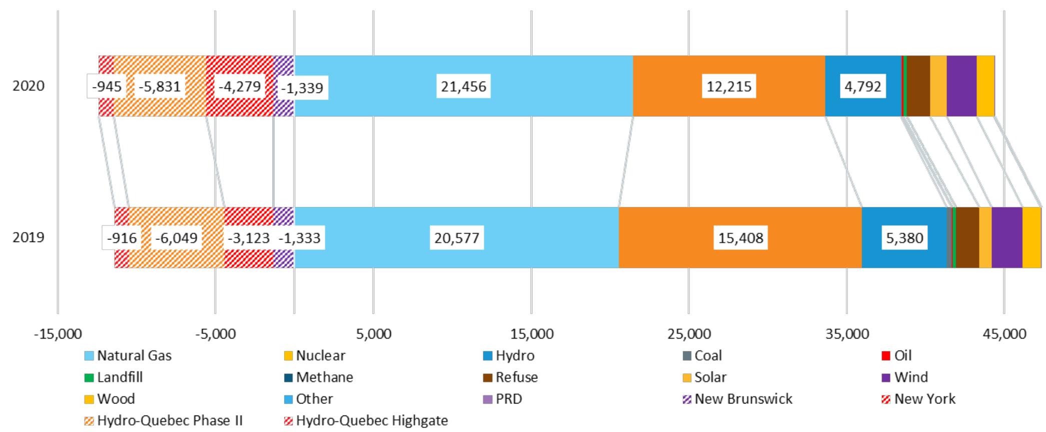

Figure 1-6 Year-to-date (January 1 -- June 30) Net Native Generation and Net Imports by Fuel Type, Point of Import (GWh)
Notes: "GWh" stands *for gigawatt hours*.

Nuclear generation, gas-fired generation, and net imports accounted for 77% of total energy production over the first half of 2020. Nuclear generation fell from 27% (3,300 MW per hour) in spring 2019, to 20% (2,400 MW per hour) in spring 2020.[12] And nuclear outages increased from an average of 700 MW in spring 2019 to 1,000 MW in spring 2020 primarily due to planned refueling outages. Net imports increased from 17% to 23%, in 2020 vs. 2019.[13]

1.2.1 New England Electric Generating System Emissions

Electric generating units combusting solid, gaseous or liquid fuels in New England emit various air pollutants that can be harmful to the local or regional environment and public health. The ISO tracks system-wide air emissions as to support comprehensive planning activities which include evaluating the environmental impacts of resource and transmission facilities needed to maintain the reliability of New England's power system.

Electric generating units with a nameplate capacity 25 MW or greater and combusting natural gas, petroleum liquids, coal, or biomass (wood), or some combination thereof, to generate electricity,

[11] ISO-NE *2019, 2020 Net Energy and Peak Load by Source Reports*, https://www.iso-ne.com/isoexpress/web/reports/load-and-demand/-/tree/net-ener-peak-load. Other fuel types had smaller contributions to total generation in the first half of 2020: oil (59 GWh, +7%), coal (62 GWh, -79%).

[12] This was primarily due to the retirement in June 2019 of Pilgrim Nuclear Plant, a 680 MW generator in southeastern Massachusetts.

[13] ISO-NE Internal Market Monitor, Spring 2020 Quarterly Market Report (August 2020), https://www.iso-ne.com/static-assets/documents/2020/07/2020-spring-quarterly-markets-report.pdf.

report hourly emissions to the EPA according to monitoring requirements for various Clean Air Act programs (an electric generating unit may be subject to multiple programs and reporting requirements), submitting the data on a quarterly basis.[14] In 2020, 189 electric generating units at 79 facilities reported some emissions data to EPA, roughly 80% of emitting generating capacity in New England.[15]

Carbon dioxide (CO_2), nitrogen oxides (NO_X), and sulfur dioxide (SO_2) emissions reported by electric generating units in New England comparing monthly trends in 2019 and 2020 are presented in Figure 1-7.

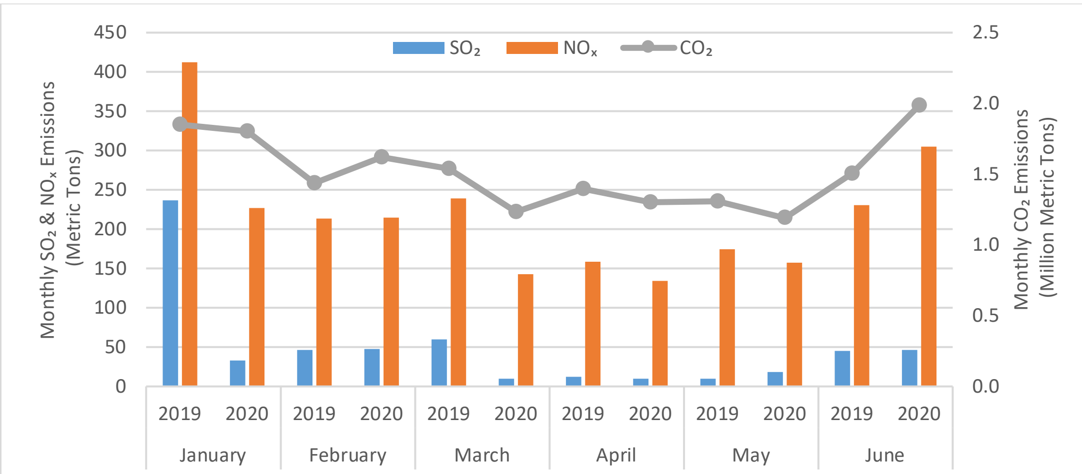

Figure 1-7: Monthly SO_2, NO_x and CO_2 Emissions, 2019 vs. 2020 (Metric Tons)
Note: Unit level emissions for Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont for January – June 2020. Includes reported data from 189 electric generating units at 79 facilities.
Source: EPA, Air Monitoring Program Data, https://ampd.epa.gov/ampd

According to data reported to EPA, operating time decreased 18.2% for steam boilers in the first half of 2020 compared to the same period in 2019, while combined cycle operation increased 1.1% and combustion turbine operation increased 32.9%.[16]

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14 ISO New England tracks operating requirements and emissions limits for some 213 individual electric generating units relying on a fossil-fired prime mover of other combustion process (fuel types include coal, black liquor, distillate fuel, jet fuel, kerosene, landfill gas, municipal solid waste, natural gas, residual oil, wood/wood waste).

15 EPA Air Monitoring Program Data, https://ampd.epa.gov/ampd/. Most emitting electric generators in New England report emissions to EPA under the Acid Rain Program, which covers generators 25 MW or greater. Fossil electric generators over 25 MW in nameplate capacity in New England also report CO_2 emissions to EPA under the Regional Greenhouse Gas Initiative. Additional details for the monitoring, recordkeeping, and reporting requirements of SO_2, NO_X, and CO_2 emissions are available at https://ampd.epa.gov/ampd/.

16 Unit operating time means the portion of any hour during which a unit combusts any fuel. 40 C.F.R. § 72.2. Generators report emissions to EPA under the Acid Rain Program, which covers generators 25 MW or greater. Generators subject to RGGI also report CO_2 emissions to EPA. Additional details for the monitoring, recordkeeping, and reporting requirements of SO_2, NO_X, and CO_2 emissions available at EPA Air Monitoring Program Data, https://ampd.epa.gov/ampd/.

1.2.2 CO_2 Emissions from the New England Electricity Generating Sector

New England electric generating units reported CO_2 emissions in 2020 (January – June) of 8,984,516 metric tons (9,903,722 short tons), a -0.5% decline compared to 2019 (9,033,512 metric tons; 9,957,731 short tons). Natural gas generation was 90% of year-to-date 2020 emissions.

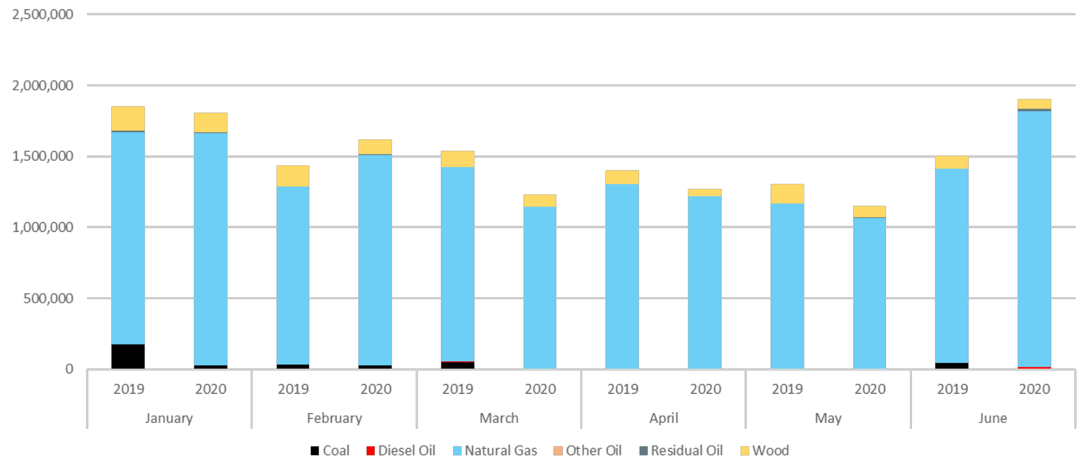

Figure 1-8 Year-to-date (January 1 - June 30) Monthly CO_2 Emissions by Fuel Type 2019 vs. 2020 (Metric Tons)

Note: Unit level emissions for Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont for January – June 2020. Includes reported data from 189 electric generating units at 79 facilities.

Source: EPA, Air Monitoring Program Data, https://ampd.epa.gov/ampd

Electric generating units combusting solid, gaseous or liquid fuels in New England may also be required to report CO_2 emissions to the EPA Greenhouse Gas Reporting Program (GHGRP).[17] In 2019, 55 electric generating facilities reported emitting 19.5 million metric tons of CO2eq. to the EPA GHGRP Another 43 electric generating facilities, including solid waste combustors (refuse), municipal landfills and industrial landfills reported 3.22 million metric tons in direct CO2eq emissions in 2019 (the latest reporting year available).

1.3 Fuel Consumption for Electric Generation

Fuel consumption trends for the New England power system trended toward the bottom of the ten year (2010-2020) historical range for all fossil fuels according data collected by EIA and shown in Figure 1-8 for the first half of 2020. There was slight decline in natural gas consumption A comparison of the latest available 2020 data (January 1, 2020 to May 31, 2020) to the same period in 2019 shows declines in coal and oil fuel stock consumption in 2020, while natural gas consumption for power generation in New England was largely unchanged.

[17] The EPA GHGRP requires all electric generating facilities with stationary fuel combustion units and either emit 25,000 metric tons or greater annually or report emissions to EPA under 40 CFR Part 75, Must also report CO_2, CH_4, and N_2O mass emissions from each stationary fuel combustion unit. In 2019, 55 electric generating facilities reported emitting 19.55 million metric tons of CO2eq. (19.53 million metric tons CO_2 emissions, 10,640 metric tons methane (CH4) emissions and 16,881 metric tons nitrous oxide (N2O) emissions.

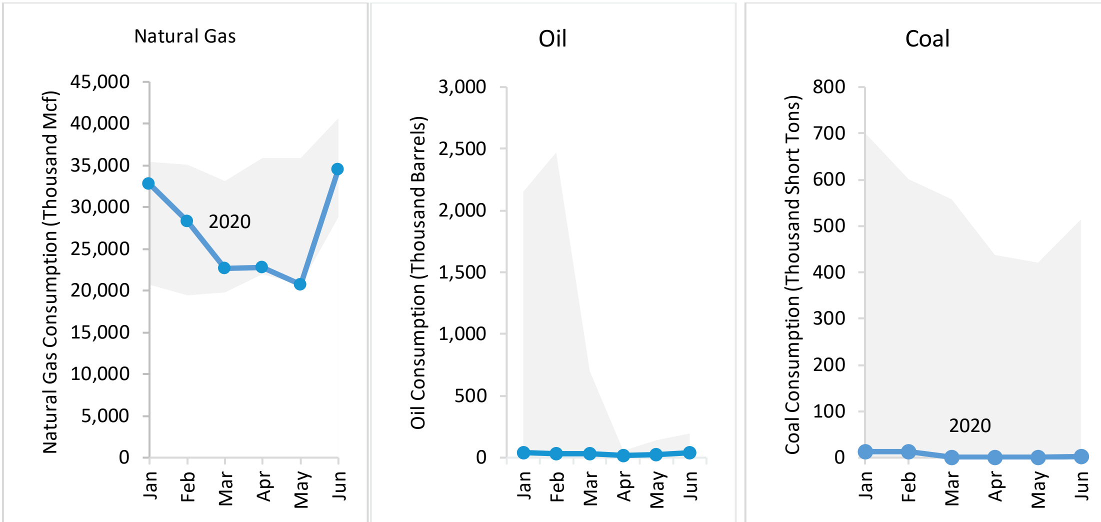

Figure 1-9 Monthly Consumption of Fossil Fuels by Type (Natural Gas, Coal and Oil)

Note: 2020 monthly fossil fuel consumption vs. ten year historical minimum and, maximum monthly reported consumption for all electricity generation for all sectors.

Source: EIA, *2010-2020 Consumption for electricity generation for all sectors in New England,* https://www.eia.gov/beta/electricity/data/browser/

Other fuel stocks combusted to generate electricity in New England include municipal solid waste and wood and wood waste.[18] Existing MSW capacity consumes roughly 552,000 short tons of municipal waste per month. In the first half of 2020, biogenic municipal solid waste combustion averaged 260,000 short tons, for a year-to-date total tonnage of 1,617,000 short tons.[19] Fuel stock combustion data for wood and wood waste electric generation is not readily available.

1.4 Water Use for Electric Generation

The water use of the New England power system are one of the largest environmental consequences of its operation. Operational water use includes cleaning, cooling, and other process-related needs that occur during electricity generation. The water withdrawal and consumption requirements of individual thermal electric generators vary significantly across the region, depending on the cooling technology, fuel type, prime mover, pollution controls, and ambient conditions. [20]

[18] Municipal Solid Waste (MSW) contains biomass (or biogenic) materials like paper, cardboard, food waste, grass clippings, leaves, wood, and leather products, as well as nonbiogenic materials such as plastics, metals, and petroleum-based synthetic materials. EIA, *Waste-to-energy electricity generation concentrated in Florida and Northeast* (April 8, 2016), https://www.eia.gov/todayinenergy/detail.php?id=25732.

[19] EIA, August 2020 Electric Power Monthly, Tables 2.13.A & 2.13.B, Consumption of Biogenic Municipal Solid Waste For Electricity Generation by State, by Sector Year-to-Date, https://www.eia.gov/electricity/monthly/.

[20] USGS, *Summary of Estimated Water Use in the United States in 2015* (June 2018), https://pubs.usgs.gov/fs/2018/3035/fs20183035.pdf. Water withdrawals are water volumes diverted from a surface-water source or removed from a ground source (aquifer) for use. In 2015, total U.S. water withdrawals for thermoelectric generation were estimated by the United States Geological Survey at 133 billion gallons per day (41% of all daily withdrawals across the United States (322 billion gallons per day). USGS assumes less than 3% of water withdrawn for thermoelectric power was consumed through evaporation.

Thermal electricity technologies (e.g. coal, oil, nuclear and natural gas) generally require water as the working fluid (and as the cooling medium to condense steam). The cooling technology at thermoelectric generators in New England range from once-through (or open loop) cooling systems withdrawing large volumes of water, used once to condense steam exiting a steam turbine, while closed-loop (or recirculating) cooling systems withdraw smaller volumes per unit of generation by recirculating water continuously.[21]

In New England, 5.85 GW of existing fossil thermal electric capacity rely on once-through cooling systems, another 4.13 GW of existing capacity have recirculating cooling systems, and 2.12 GW of existing capacity (mainly newer facilities with combined-cycle units) have dry cooling systems.

Figure 1-10 shows estimated water withdrawals for thermoelectric power generation declined roughly 44% in 2020 (averaging 5.3 billion gallons per day) compared to the same period in 2019 (averaging 9.4 billion gallons per day) (January 1 – June 30). The decline reflects decreased water withdrawal demand from nuclear generation (771 billion gallons) in 2020, -49% of 2019 YTD (1,500 billion gallons) after the retirement of Pilgrim Nuclear Power Station on May 31, 2019.[22]

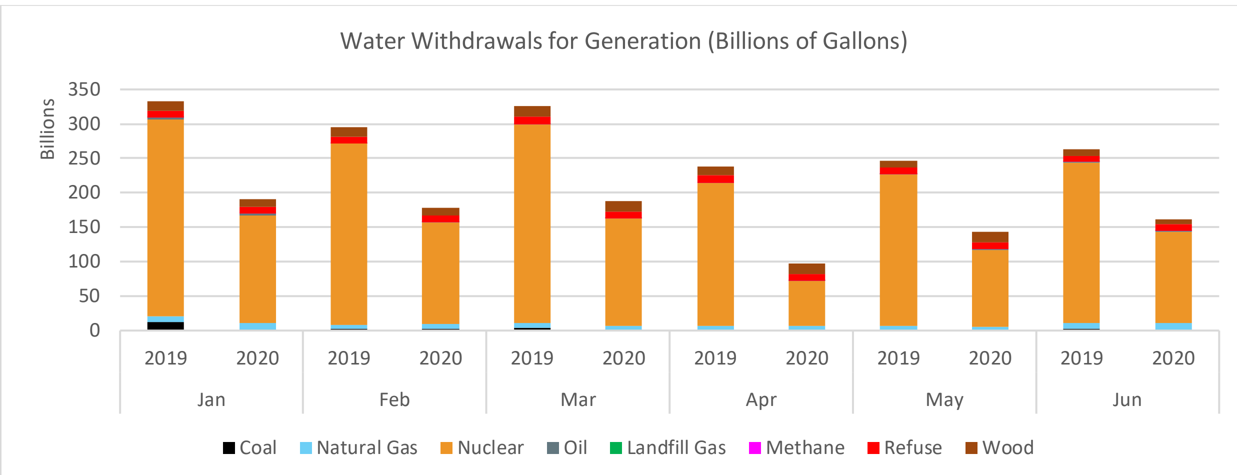

Figure 1-10 2019 vs. 2020 Year-to-date (January 1 – June 30) Estimated Water Withdrawals for Power Generation in New England (Billions of Gallons)
Note: Calculated with daily generation data using U.S. Energy Information Administration water withdrawal intensity rates (gallons/MWh) for the largest generating facilities in New England equipped with cooling water intakes.
Sources: EIA, *2019 Thermoelectric Cooling Water Data* (2020), **https://www.eia.gov/electricity/data/water/**; EIA, *2019 Form EIA-860 Detailed Generator Data* (2020), https://www.eia.gov/electricity/data/eia860/

[21] Rebecca A M Peer and Kelly T Sanders, *Characterizing cooling water source and usage patterns across US thermoelectric power plants: a comprehensive assessment of self-reported cooling water data*, 2016 Environ. Res. Lett. 11 124030. https://doi.org/10.1088/1748-9326/aa51d8. Water use for power generation is reported in terms of water withdrawals and water consumption, which are defined as the total volume of water removed from a source (river, reservoir, ocean, etc.) and the volumetric subset of withdrawn water that is not returned to the source (i.e. consumed via evaporative losses).

[22] EIA estimated Pilgrim Nuclear Power Station (728 MW), which retired on May 31, 2019, had water withdrawal rate of 34,139 gallons/MWh, roughly 1/3 of the 2019 regional nuclear water intensity rate of 97,272 gallons/MWh. For 2020, the nuclear water intensity rate has declined to 63,133 gallons/MWh.

Section 2
Environmental Regulations Update

Compliance obligations for generators from existing and pending federal and state environmental requirements differ by resource age, economics, location, fuel type, and available pollution control technologies. In the region, existing and new generators using combustion to generate electricity (natural gas, refuse, wood, coal, and oil, in order of utilization) generally operate advanced pollution control technologies that reduce air emissions and wastewater discharges. Older combustion generators (greater than 30 years in operating life) generally operate more limited pollution control technologies and may have limits on types of fuel combusted and hours of operation. Non-emitting generators (nuclear, hydro, wind, solar and pumped storage) are also subject to various environmental requirements.

The EPA has principal responsibility for administering the Clean Air Act (CAA), the Clean Water Act (CWA) and the Resource Conservation and Recovery Act (RCRA), along with other federal environmental legislation, to address air, water and solid waste pollution generated by the operation of the New England power system.

The status of some federal air pollution requirements and compliance options are uncertain at present. According to the spring 2020 Regulatory Agenda, EPA has over 140 major rulemakings in some stage of development. At least 19 of them may alter permitting requirements or compliance obligations for electric generating units with various prime movers regarding air pollution, water discharges and solid waste, and are summarized in Tables 2-1 (air), 2-2 (permitting), 2-3 (water & solid waste) and 3-1 (greenhouse gas) below.[23] Significant programmatic and budgetary changes at other federal departments and agencies with environmental oversight responsibilities affecting the power sector are also under consideration or implementation.[24]

Pursuant to various executive orders and legislation, EPA is reconsidering several major air and water quality rules in the following areas that affect various classes of existing and new generators:

- Surface water withdrawals (for cooling water use and consumption)
- Wastewater discharges into surface waters
- Mercury, acid gas, and other toxic air emissions
- Ozone (O_3) transport and precursor nitrogen oxide (NO_X) emissions
- Fine particulate matter ($PM_{2.5}$)
- Sulfur dioxide (SO_2) emissions
- Greenhouse gases (GHGs), especially CO_2 emissions

Changes in applicable air, water, wildlife protection, and greenhouse gas emission standards, could affect the economic performance of non-emitting and combustion generators by imposing operational constraints or result in additional capital costs for installing environmental

[23] White House Office of Management & Budget, Office of Information and Regulatory Affairs, Environmental Protection Agency Rule List Spring 2020, https://www.reginfo.gov/public/do/eAgendaMain.

[24] See the White House Office of Information and Regulatory Affairs, Unified Agenda of Regulatory and Deregulatory Actions, https://www.reginfo.gov/public/do/eAgendaMain, for actions affecting the power sector by: Council on Environmental Quality (CEQ); Department of Agriculture (Forest Service, Natural Resources Conservation Service, Office of Environmental Markets); Department of Commerce (National Oceanic and Atmospheric Administration, National Marine Fisheries Service); Department of Defense (U.S. Army Corps of Engineers); Department of Energy; Department of Interior (Bureau of Ocean Energy Management, Bureau of Land Management, Bureau of Reclamation, National Park Service, US Fish and Wildlife Service).

remediation measures. Generators and transmission resources may also be at risk for future operational constraints due to changes in air quality, land-use, wildlife and water quality protection requirements.

2.1 Air

The federal Clean Air Act[25] requires the development of comprehensive federal and state regulations to limit emissions from both stationary (industrial) sources and mobile sources, and imposes a range of differing compliance obligations on electric generating units, based on their prime mover, fuel type and when they started operation. Those compliance obligations can include seasonal operational constraints, volumetric caps on emissions of certain pollutants, emission limits for nitrogen oxides, sulfur dioxide, air toxics and measures to protect visibility.[26]

2.1.1 Clean Air Act Compliance Obligations

In New England, new and existing emitting electric generating units (natural gas, refuse, wood, coal, and oil,) air subject to various Clean Air Act requirements. The ISO tracks the development and enforcement of regulations by EPA implementing such requirements to understand the cumulative impact on current and future operations of the New England power system. Tables 2-1 and 2-2 below summarize recent EPA regulatory actions that may affect emitting electric generating units.

Table 2-1 Air Pollution Standards, Long Range Transported Pollution and Haze Rules

Rule	Regulatory Activity (Proposed or Final Rules)	Major Provisions	Status (in bold) & Litigation Update
National Ambient Air Quality Standards (NAAQS) & Transported Air Pollution			
2015 Ozone Standard	Final Rule 10/2015 (80 FR 65291)	EPA set the primary and secondary O_3 standards to 0.070 parts per million (ppm) 8/2019: D.C. Circuit upheld stringency of 2015 ozone NAAQS; remanded parts of secondary standard and vacated the rule's grandfathering provision. (D.C. Circuit No. 15-1385)	**Rule Effective** D.C. Cir. decision requires EPA revisions
2015 Ozone Standard Implementation Rule	Final Rule 12/2018 (83 FR 62999)	3/2018: EPA published final nonattainment area classifications approach (83 FR 10376) 12/2018: EPA published final implementation rule 2/2019: 2015 Ozone NAAQS implementation rule challenged. (D.C. Circuit No. 19-1024)	**Rule Effective** 9/22/20: Oral argument held
2020 Ozone Standard	Proposed Rule 7/2020 (85 FR 49830)	7/2020: EPA proposed to retain the primary and secondary ozone NAAQS without revision to 2015 standards 8/2020: EPA extended the comment period to 10/20220	**Proposed Rule**

[25] 42 U.S.C. §§ 7401 et seq. The Clean Air Act (CAA) requires EPA to set National Ambient Air Quality Standards (NAAQS) for six common air pollutants: Carbon Monoxide (CO), Ground-level Ozone (O_3), Lead (Pb), Nitrogen Dioxide (NO_2), Particulate Matter (PM), and Sulfur Dioxide (SO_2). See Appendix Table 4-1 for details on specific NAAQS. See also Congressional Research Service, *Clean Air Act: A Summary of the Act and Its Major Requirements*, RL 30853 (Updated February 25, 2020), www.crs.gov.

[26] This section focuses on the environmental compliance obligations of coal-, oil-, and gas-fired (fossil fuel) generators greater than 25 MW, since they comprise the largest portion of installed system capacity (25,697 MW of nameplate capacity). Other fuel types (e.g., refuse, wood) are subject to overlapping, and sometimes separate environmental requirements including municipal solid waste (541 MW), biomass/wood (420 MW), and landfill gas (107 MW) with more stringent requirements on certain generators.

Rule	Regulatory Activity (Proposed or Final Rules)	Major Provisions	Status (in bold) & Litigation Update
Cross-State Air Pollution Rule (CSAPR) Update Rule	Proposed Rule Remand 10/2020 (85 FR 68964) Final Rule 10/2016 (81 FR 74504)	CSAPR program requires reductions of SO_2, annual NO_x, and ozone season NOx emissions from fossil-fired generators in certain states in the eastern U.S. (excludes New England) that affect the ability of downwind states to comply with O_3 and PM NAAQS	**Partial Remand** 9/2019: EPA directed add deadlines for upwind States consistent downwind States' attainment deadlines
CSAPR Close Out	Final Rule 12/2018 (83 FR 65878)	12/2018: EPA asserted the CSAPR Closeout Rule fully addressed interstate air pollution transportation obligations for the 2008 ozone standard in 20 states (D.C. Circuit 19-1019)	**Rule vacated** 10/2019: Rule vacated
Regional Haze Rule	Final Rule 1/2017 (82 FR 3078)	1/2017: EPA revised 2nd implementation period (2018-2028) state plan requirements for visibility around national parks and wilderness areas. 1/2018: responding to challenges and requests for reconsideration, EPA granted petitions for review	**Rule Effective** Litigation held in abeyance pending EPA review of 2017 rule (D.C. Circuit 17-1021)

Sources: MJB&A; EPA; CRS, updated by ISO New England (October 2020).

Ground-level ozone is harmful to public health, and sensitive vegetation and ecosystems.[27] The 2015, and proposed 2020 ozone standards, require seasonal operational limits for emitting electric generating facilities, particularly in southern New England which continues to experience high ground-level ozone concentrations over the summer. The 2018 Cross State Air Pollution Rule (CSAPR) addresses transported air pollution, including ozone precursors such as NO_X from upwind States.[28] They are subject to the Regional Haze Rule, and recent progress reports indicate visibility has improved across the Northeast at national parks and wilderness areas from 2014 to 2018 compared to a baseline period in 2000 and 2004.[29]

Table 2-2 Major Air Permitting & Air Toxics Regulations Impacting Generators

Rule	Regulatory Activity (Proposed or Final Rules)	Major Provisions	Status (in bold) & Litigation Update
New Source Review			
Nonattainment New Source Review	Final Rule 3/2007 (72 FR 1036)	3/2007: Updated requirements for obtaining a preconstruction permit for a new or modified generator located in a nonattainment area. 2/2008: Rule challenged. (D.C. Circuit No. 08-1065)	**Rule Effective** 9/2020: Arguments scheduled for 11/2020
Hourly Emissions Test for Power Plants	Proposed Rule 8/2018 (83 FR 44746)	8/2018: EPA adds preliminary hourly emissions test as screen for determining whether modifications at generator trigger NSR review	**Proposed Rule**

[27] Emissions from emitting electric generating facilities, industrial facilities and various types of motor vehicles in New England are major sources of nitrogen oxides (NOX) and volatile organic compounds (VOCs), which are the precursors to ground-level ozone.

[28] CSAPR program requires in certain states in the eastern U.S. to reduce SO_2, annual NO_x, and ozone season NO_x emissions that affect the ability of downwind states to attain and maintain compliance with certain ozone and PM NAAQS. Fossil-fired electric generators in New England are not subject to CSAPR requirements. See https://www.epa.gov/csapr.

[29] Mid-Atlantic/Northeast Visibility Union, *Tracking Visibility Progress Mid-Atlantic/Northeast U.S. 2004-2018 (1st RH SIP Metrics)* (May 1, 2020), https://otcair.org/MANEVU/Upload/Publication/Reports/MANEVU%20Trends%202004-18%20Report%201st%20SIP%20Metrics%20-5-1-2020%20Update.zip

Project Emissions Accounting for Preconstruction Permitting	Proposed Rule 8/2019 (84 FR 39244) Guidance 3/2018	3/2018: EPA released guidance revising project accounting methodology 8/2019: EPA published proposed rule regarding project aggregation (D.C. Circuit No. 18-1149)	**Guidance available** 5/2018: Challenged guidance, but case held in abeyance
Hazardous Air Pollutants			
Mercury and Air Toxics Standards	Final Rule 2/2012 (77 FR 9304)	Limited mercury, arsenic, acid gases, and other toxic pollutants emissions from coal- and oil-fired generators, starting in 2015 2018 EPA proposes rollback	**Rule Effective**
MATS Reconsideration of Supplemental Finding on Costs	Proposed Rule 2/2019 (84 FR 2670) Final Rule 3/22/2020 85 FR 31286)	3/2020: EPA reverses 4/2016 MATS Cost Finding (81 FR 24420), finding it not appropriate and necessary to regulate air toxics emissions from coal- and oil-fired generators, after comparing the cost of compliance relative to the benefits of HAP emission reductions	**Rule Effective**

Sources: MJB&A; EPA; CRS, updated by ISO New England (October 2020).

As January 1, 2020, 5,065 MW of residual oil- and coal-fired summer claimed capability are subject to the Mercury and Air Toxics Standards (MATS), and must limit certain hazardous air pollutants emissions or, if oil-fired, maintain an annual capacity factor of less than 8% on rolling basis to avoid additional compliance requirements.

2.2 Water

Various federal environmental laws administered by a range of entities impact power generation. The Clean Water Act (CWA) prohibits discharges of pollutants into waters of the United States without a permit. States have delegated authority to set and enforce water quality standards-designated uses for water bodies (e.g., water must be swimmable or fishable) with criteria to protect the designated uses. Other federal laws, including, the Rivers and Harbors Act, which prohibits the unauthorized obstruction or alteration of any navigable water of the United States, regulate activities at power plants and within right-of-ways for transmission lines that affect adjacent wetlands or waterbodies.[30]

Clean Water Act

The Clean Water Act (CWA) regulates water withdrawals and discharges from power plants and other sources that affect water quality and temperature into protected waters of the United States.[31] Thermal power plants equipped with cooling water intake systems capable of withdrawing 2 million gallons per day generally have more complex permit requirements, which can include operational constraints during certain times of the year.

Section 316(a) deals with thermal variances with National Pollution Discharge Elimination System (NPDES) permits, and Section 316(b) regulates the design and operation of cooling water intake structures.[32] The 2014 Cooling Water Intake Rule requires the best technology available for the

[30] Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).

[31] 33 U.S.C. Chapter 26, Sections 1251-1387. See 40 CFR §122.2 for the complete definition of waters of the United States. EPA regulates cooling water intake systems and thermal discharges under Sections 316 and 402 of the Clean Water Act.

[32] National Pollutant Discharge Elimination System, a Clean Water Act permitting program, with shared administration with many states, which regulates point sources that use water from or discharge pollutants into waters of the United States. Certain power plants with cooling water discharges are subject to NPDES regulations. See, https://www.epa.gov/npdes/npdes-regulations.

location, design, construction, and operation of cooling water intake structures capable of withdrawing greater than 2 million gallons per day for cooling purposes, to minimize adverse environmental impacts.[33] See Table 2-3, for details of major water use and wastewater discharge regulations affecting electric generating units.

Table 2-3 Water and Solid Waste Rules Affecting Generators

Rule	Regulatory Activity (Proposed or Final Rules)	Major Provisions	Status (in bold) & Litigation Update
Clean Water Act Section 401 Certification Rule	Final Rule 7/2020 85 FR 42210	Limits state review to consideration of water quality discharges, not entire activity subject of federal license or permit	**Rule effective** Summer 2020: rule challenged in various courts
Cooling Water Intake Rule	Final Rule 79 FR 48299 (August 15, 2014)	Requires review to reduce mortality to fish and other aquatic organisms in cooling water intake design and operation (2nd Cir. 14-4645)	**Rule effective 9/2018: rule upheld**
Steam Electric Effluent Limitation Guidelines	Propose Revisions 11/2019 (84 FR 64620) Final Rule 11/2015 (80 FR 67838)	11/2019: revises discharge limits, add exemptions and exempt units retiring or repowering by 2028 2015 Rule limited discharge of toxic, other chemical pollutants and thermal discharges from existing and new steam electric generating units, added pretreatment standards	**Rule effective** 9/2017: EPA delays compliance deadline until 11/2020
Coal Combustion Residuals Rule (under RCRA)	Final Rule 4/2015 (80 FR 21302)	Revised 2015 groundwater contamination risks from disposal of coal combustion residuals (i.e., "coal ash") disposal in unlined landfills and surface impoundments by establishing national standards for disposal.	**Rule remanded** 8/2018: 2015 rule struck down for not closing unlined coal ash landfills (D.C. Cir. 15-1219

Sources: MJB&A; EPA; CRS, updated by ISO New England (October 2020)...

Implementation of certain Clean Water Act requirements on existing and new cooling water structures for thermal generation is proceeding on a case-by-case basis, but retirements have reduced the number of electric generating facilities subject to these waste water discharge requirements. In New England, permitting oversight is divided between States with delegated federal authority to implement Clean Water Act requirements (Connecticut, Maine, Rhode Island and Vermont) non-delegated States (Massachusetts and New Hampshire).

Clean Water Act Section 402 requires NPDES permits that implement limitations to control pollutants such as thermal based upon technology and water quality standards. Water quality standards and the thermal effluent limitations vary by state, but they typically require that thermal discharges remain below 90°F.

Electric generators in New England may be subject to other EPA water use or wastewater discharge regulations or guidelines for generators combusting coal, oil, natural gas, wood, refuse or a nuclear reaction to generate steam and drive a turbine, for limiting wastewater discharges of toxic metals

33 EPA, *National Pollutant Discharge Elimination System-Final Regulations To Establish Requirements for Cooling Water Intake Structures at Existing Facilities and Amend Requirements at Phase I Facilities*, Final Rule, 79 FR 48299 (August 15, 2014), https://www.federalregister.gov/d/2014-12164. Affects existing and new power generating facilities that are designed to withdraw more than 2 million gallons per day (mgd) of water from waters of the United States and use at least 25% of the water they withdraw exclusively for cooling purposes.

(e.g., arsenic, lead, mercury, selenium, chromium, and cadmium), particulate matter, other pollutants, and thermal pollution into surface waters and wastewater treatment plants.[34]

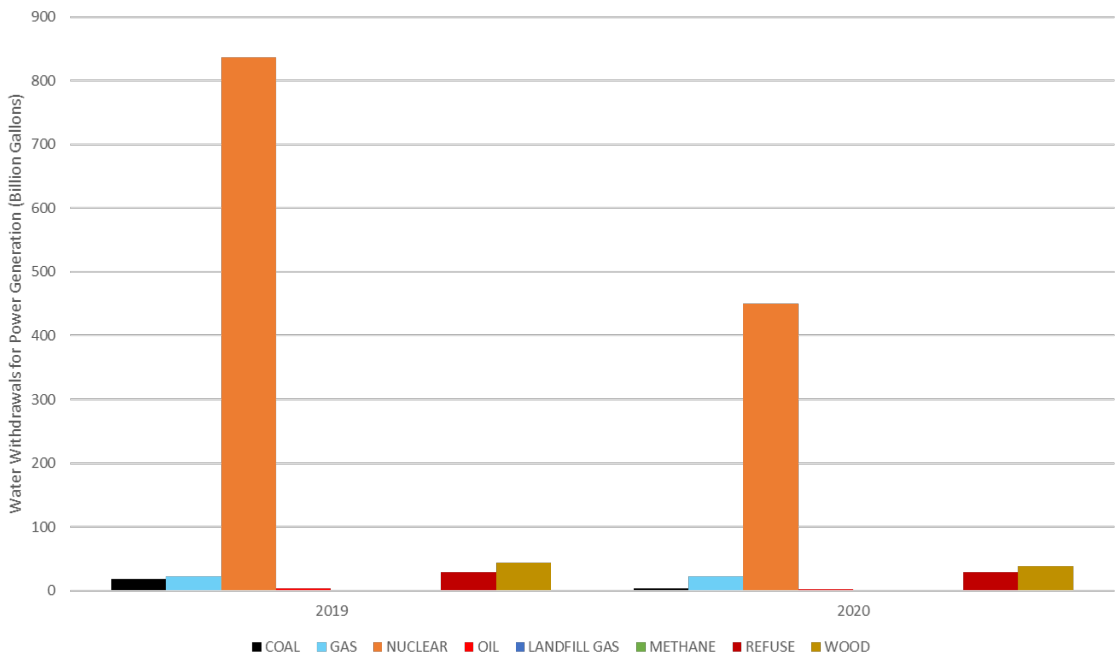

Figure 2-1: Estimated Water Use for Native Power Generation in New England, 2019-2020 (Billion gallons)

Note: EIA collects cooling water data for plants with a combustible-fueled thermoelectric generating capacity of 100 megawatts (MW) or more. Thermoelectric power plants include units fueled by natural gas, coal, nuclear, and oil, as well as renewable sources, such as biomass and solar thermal plants, which also require cooling.

Source: EIA, Electricity Data Browser, https://www.eia.gov/electricity/data/browser/. Monthly water use, withdrawal intensity (gallons/MWh), consumption intensity (gallons/MWh), water source, location and maximum intake temperature available for 40 electric generating facilities in New England.

The Army Corps of Engineers (Corps) authorizes certain activities, including construction of high-voltage transmission infrastructure that affect rivers, streams and wetlands under the Clean Water Act and the Rivers and Harbors Act.[35] Recent litigation curtailed the ability of the Corps to issue general nationwide permits (NWP 12) for certain activities adjacent to wetlands and waterbodies including development of transmission lines. Transmission project developers frequently rely on NWP 12 for stream crossings and other wetland impacts (typically authorized for five years, and

[34] EPA Steam Electric Power Generating Effluent Guidelines https://www.epa.gov/eg/steam-electric-power-generating-effluent-guidelines.

[35] 33 U.S.C. 403

scheduled to expire in March 18, 2022). In response, the Corps is proposing to divide NWP 12 and separate transmission line activities into two new NWPs.[36]

Clean Water Act and Endangered Species Act requirements also impact the relicensing of some existing hydro-electric units and new renewable resources. The ISO is monitoring regulatory developments and permit renewals to assess the impacts of operational restrictions (e.g., maintenance of minimum flows) on the ability of electric generators to offer regulation and reserve services or curtailment of wind resources during migratory travel of protected bird species.

2.3 Solid and Hazardous Waste

The Resource Conservation and Recovery Act regulates the disposal of solid and hazardous waste.[37] Regulation of coal ash or coal combustion residuals affects coal-fired electric generating units in New England, impacting <1,000 MW of existing capacity. The Coal Combustion Residue Rule, adopted in 2015, with amendments through 2018, establishes requirements for coal-fired power plants for the disposal of coal combustion residuals, or coal ash, in landfills and surface impoundments.[38] Compliance information for all coal combustion residual disposal sites in New England is available through EPA's national inventory webpage.[39]

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[36] Department of the Army, Corps of Engineers, Proposal to Reissue and Modify Nationwide Permits, Notice of Proposed Rulemaking (Prepublication version) August 3, 2020, https://www.usace.army.mil/Missions/Civil-Works/Regulatory-Program-and-Permits/National-Notices-and-Program-Initiatives/. This action would renew and revise 52 nationwide permits regulating activities in, and adjacent to, wetlands and other waters that are regulated by Clean Water Act Section 404 and, or, the Rivers and Harbors Act of 1899 Section 10. The Corps proposed new nationwide permit subcategories that would separate electric utility line and telecommunications activities from other utility line activities.

[37] 42 U.S.C. §§ 6901 et seq.

[38] EPA, *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 Fed. Reg. 36435 (July 30, 2018). The U.S. Court of Appeals for the D.C. Circuit invalidated certain 2015 rule provisions and remanded it to EPA. *Utility Solid Waste Activities Group, et al. v. EPA*, No. 15-1219 (D.C. Cir. August 21, 2018); *Waterkeeper Alliance Inc. et al. v. EPA*, No. 18–1289 (D.C. Cir. March 13, 2019). In February 2020, EPA proposed a new rule to implement a federal CCR permit program in non-participating states. EPA, *Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Federal CCR Permit Program*, 85 Fed. Reg. 9940 (Feb. 20, 2020).

[39] EPA, *List of Publicly Accessible Internet Sites Hosting Compliance Data and Information Required by the Disposal of Coal Combustion Residuals Rule*, https://www.epa.gov/coalash/list-publicly-accessible-internet-sites-hosting-compliance-data-and-information-required

Section 3 Greenhouse Gas Emissions Reduction Update

Fossil fuel-fired electric generating units in the United States are subject to federal CO_2 emission limits and or performance standards of varying stringency applicability over the last decade. The uncertainty resulting from changing federal efforts complicate efforts to assess their impact on existing and future operational constraints on certain classes of emitting generating units that are part of the New England power system. In contrast, state efforts to mitigate CO_2 emissions have been relatively consistent and collaborative, focusing primarily on fossil-fired electric generating units over 25 MWe in capacity in the region.

EPA is required to regulate CO_2 emissions from fossil-fired electric generating units under Section 111of the Clean Air Act (CAA).[40] In 2015, EPA developed, and then later replaced, rules to limit CO_2 from existing sources (Section 111(d)) and new source performance standards (NSPS) for new sources under 111(b), see Table 3-1.

Table 3-1 US Greenhouse Gas Regulations Affecting Electric Generating Units

Title	Regulatory Activity (Proposed or Final Rules)	Major Provisions	Status (in bold) & Litigation Update
Clean Power Plan	Final Rule 10/2015 (80 FR 64661)	10/2015: EPA set CO_2 emission guidelines for reducing greenhouse gas (GHG) emissions from existing fossil fuel-fired electric generators	**Repealed**[41]
Affordable Clean Energy Rule (111(d))	Proposed Rule 8/2018 (83 FR 33746) Final Rule 7/2019 (84 FR 32520)	8/2018: EPA published proposed rule (83 FR 33746) 7/2019: EPA published final ACE rule (84 FR 32520), effective 9/2019 7/2020: EPA releases ACE implementing guidance Challenges being litigated. (D.C. Cir. 19-1140)	**Rule Effective**
GHG NSPS (111(b))	Proposed Rule 12/2018 (83 FR 65424)	12/2018: EPA proposes changes best system of emission reduction (BSER) for new coal-fired steam generating units is higher efficient	

Sources: EPA; MJBA; updated by ISO New England.

In 2019, EPA replaced the 2015 Clean Power Plan (CPP), which specified CO_2 emission standards for existing coal-, oil- and natural gas-fired electric generators with the Affordable Clean Energy (ACE) Rule. In the same Federal Register finalizing the ACE rule, EPA repealed the CPP on the basis that EPA only had authority to impose a best system of emissions reductions (BSER), which EPA

[40] *Massachusetts v. EPA*, 549 U.S. 497 (2007). The U.S. Supreme Court overruled the EPA's determination that it was not authorized to regulate greenhouse gas emissions under the CAA, finding that GHGs fall within the definition of air pollutant under the CAA and remanded the matter to the EPA to determine whether greenhouse gases endanger public health and welfare.. In December 2009, the EPA determined that greenhouse gases, including carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, endanger public health and welfare. See Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66496, 66497 (Dec. 15, 2009).

[41] In 2016, the U.S. Supreme Court stayed CPP implementation pending resolution of the lawsuit challenging its legality. Order in Pending Case, *West Virginia v. EPA* (S. Ct. No. 15A773, Feb. 9, 2016). The Court dismissed the litigation challenging the CPP as moot, ending the stay, after EPA finalized its CPP repeal and the ACE rule in July 2019. See Order, *West Virginia v. EPA*, No. 15-1363 (D.C. Cir. Sept. 17, 2019).

defined as requiring technological or operational measures that can be applied to, or at, a single source.[42]

EPA also determined in the ACE rule that it "currently does not have adequate information to determine a BSER" for oil- or natural gas-fired utility boilers, or fossil fuel-fired stationary combustion turbines.[43] The 2015 CPP rule affected 17, 715 MW of existing coal-, oil- and natural gas-fired electric generating capacity in New England (based on the 2015 CELT), while the 2019 ACE rule affects only coal-fired electric generating capacity (< 1,000 MW) in New England and is not expected to materially affect system reliability once implemented.[44]

Under ACE, states have the primary role in developing standards of performance for CO_2 emissions for existing coal-fired electric generators, limited to a range of heat rate improvement (HRI) measures. State plans under the ACE Rule are due by July 8, 2022. EPA will have six months to determine completeness and then one year to determine whether to approve the plans, and if a state plan is not submitted or approved, EPA will have two years to promulgate a Federal Implementation Plan (FIP). The final rule also revises regulations for this, ongoing, and future actions under CAA section 111(d).

3.1.1 State Greenhouse Gas Reduction Goals and Targets

Several New England states have adopted comprehensive greenhouse gas reduction strategies including, individual state goals or multi-states binding mandates, reducing greenhouse gas emissions from the electric power sector and are founding members of the Regional Greenhouse Gas Initiative (RGGI), the first mandatory cap-and-trade program in the United States to limit carbon dioxide (CO_2) in the power sector.

Several New England States have adopted economy-wide greenhouse gas reduction goals within a range of 40–45% by 2030 and 80–85% by 2050 from a baseline of 1990 emission levels. Similar to the regulatory activities in neighboring areas for controlling other air pollutants, the GHG control activities may affect native generation, either increasing or decreasing compliance obligations.

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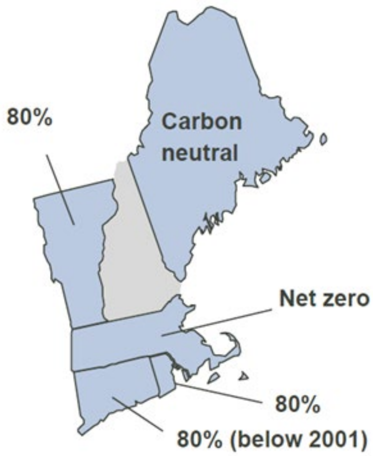
[42] EPA, *Repeal of the Clean Power Plan; Emission Guidelines for Greenhouse Gas Emissions From Existing Electric Utility Generating Units; Revisions to Emission Guidelines Implementing Regulations*, Final Rule 84 FR 32520 (July 8, 2019), repealing *Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units*, Final Rule, 80 FR 64661 (October 23, 2015). The CPP would have required CO_2 reductions of 30% below 2005 levels by 2030 from existing power plants.

[43] ACE Final Rule, at 32533.

[44] Affected ACE sources (coal-fired electric generating units, greater than 25 MW-net and commenced operation before January 8, 2014) require state plan submittal or negative declarations (expected retirements prior to the compliance deadline



State	2020 Interim Target/Goal	2030 Interim Target/Goal	Long-Term Target/Goal
Connecticut	10% below 1990 levels	45% below 2001 levels	2050: 80% below 2001 levels
Maine		45% below 1990 levels	2045: Carbon neutral[45]
Massachusetts	25% below 1990 levels	TBD	2050: 85% below 1990 levels and net zero[46]
New Hampshire			
Rhode Island	10% below 1990 levels	45% below 1990 levels	2050: 80% below 1990 levels
Vermont	2025: 26% below 2005 levels	45% below 1990 levels	2050: 80% below 1990 levels

Figure 3-1: State GHG Reduction Goals and Targets (September 2020)

Notes: Massachusetts' emissions limit for 2050 is net zero statewide emissions annually, "provided, however, that in no event shall the level of emissions be greater than a level that is 85 percent below the 1990 level." https://www.mass.gov/doc/final-signed-letter-of-determination-for-2050-emissions-limit/download. New Hampshire has not established a state specific GHG emission reduction target.

Sources: MJB&A, *State GHG Reduction Goals and Targets* (September 2020); *National Conference of State Legislatures, Greenhouse Gas Emissions Reduction Targets and Market-based Policies* (December 2019).

3.1.2 Regional Greenhouse Gas Initiative

Since 2009, the Regional Greenhouse Gas Initiative (RGGI), a multi-state program across the Northeast and Mid-Atlantic regions, requires fossil power plants 25 MW and larger to acquire and surrender allowances equal to their CO_2 emissions during three-year control periods.[47] RGGI is implemented through CO_2 Budget Trading Program rules in each participating state. The RGGI CO_2 cap is a regional budget for CO_2 emissions from the power sector and represents the total of all 10 state program targets.[48] The New England RGGI States share of the 2020 RGGI CO_2 budget is

[45] Maine 2019 Executive Order, https://www.maine.gov/governor/mills/sites/maine.gov.governor.mills/files/inline-files/Executive%20Order%209-23-2019_0.pdf. Carbon zero, carbon neutral or net zero refers to achieving net zero carbon dioxide emissions by balancing greenhouse gas emissions with removal (through carbon offsetting) or simply eliminating carbon dioxide emissions altogether. Carbon zero status can be achieved in two ways: (1) balancing carbon dioxide emissions with carbon offsets, often through carbon offsetting - the process of reducing or avoiding greenhouse gas emissions or sequestering (removing) carbon dioxide from the atmosphere to make up for emissions elsewhere; (2) reducing carbon emissions to zero through changing energy sources and industry processes. Also includes other greenhouse gases (GHGs), measured in terms of their carbon dioxide equivalence.

[46] Massachusetts 2020 Determination, https://www.mass.gov/doc/final-signed-letter-of-determination-for-2050-emissions-limit/download

[47] Regional Greenhouse Gas Initiative Program Overview and Design, https://www.rggi.org/program-overview-and-design/elements. The RGGI CO_2 budget (cap) is equal to the total number of CO_2 allowances issued by RGGI states in a given year. A CO_2 allowance represents a limited authorization for an affected RGGI electric power generating unit to emit one short ton of CO_2, as issued by a participating state.

[48] States participating in RGGI in 2020: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, New Jersey, and Vermont. New Jersey rejoined and Virginia will participate beginning in 2021.

roughly 32%. RGGI's 2020 adjusted cap is 74.3 million short tons and the 2021 adjusted cap is 75.15 million short tons (68.2 million metric CO_2). The RGGI cap declines at a rate of 2.275% annually through 2030.

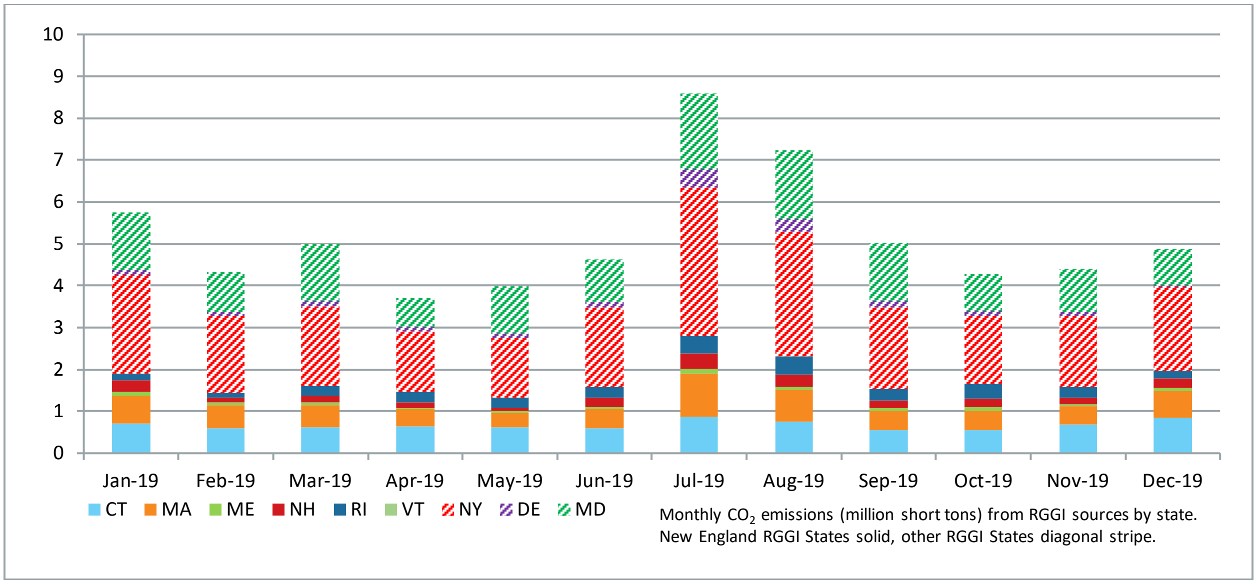


Figure 3-2: RGGI 2019 Monthly Emissions by Participating State (Million Tons)

Notes: In 2019, RGGI affected units included 425 electric generating units at 161 facilities across the nine State region and 148 electric generating units at 61 facilities within the New England Control Area.

Sources: EPA Air Monitoring Program Data, https://ampd.epa.gov/ampd/; RGGI CO_2 Allowance Tracking System (RGGI COATS), https://www.rggi.org/allowance-tracking/rggi-coats.

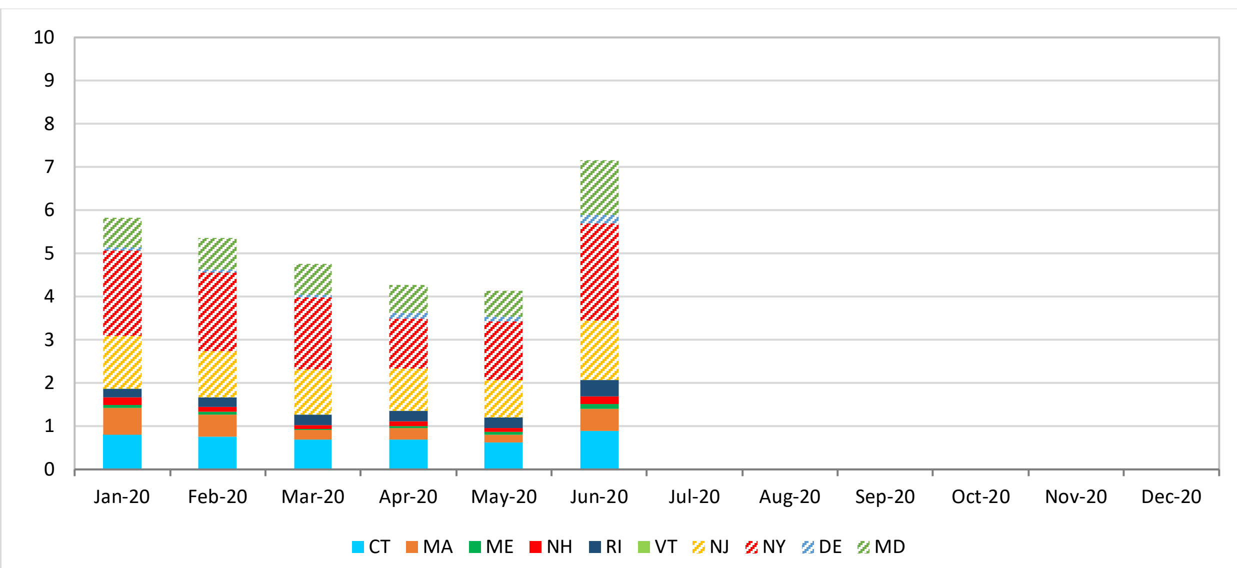


Figure 3-3: RGGI 2020 Monthly Emissions by Participating State (Million Tons)

Notes: In 2020, RGGI affected units included 517 electric generating units at 193 facilities across the ten State region and 148 electric generating units at 61 facilities within the New England Control Area.

Sources: EPA Air Monitoring Program Data, https://ampd.epa.gov/ampd/; RGGI CO_2 Allowance Tracking System (RGGI COATS), https://www.rggi.org/allowance-tracking/rggi-coats.

CO_2 allowances are issued by each RGGI state and distributed through quarterly regional CO_2 allowance auctions using a single-round, sealed-bid uniform-price format, with a reserve price for auctions, which acts as a price floor. The reserve price in 2020 is US$2.32, and is multiplied by 1.025 each year, rounded to the nearest whole cent. Also available during quarterly auctions is a Cost Containment Reserve (CCR), which releases additional allowances during an auction if the clearing price surpasses a pre-determined threshold, set at $10.77 in 2020, then rising to $13 in 2021 and increasing annually by 7% thereafter.

The 48th RGGI allowance auction, held on June 3, 2020, sold all 16.3 million allowances offered.[49] A minimum reserve, or floor price, of $2.32/ton will be used throughout 2020. The cost containment reserve, which consists of 11.8 million allowances, will be available for the September auction. The cost containment reserve is a fixed additional supply of allowances that is available for sale only if prices exceed certain levels. This year's level is $10.77/ton, up from $10.51/ton in 2019.[50]

3.1.3 Transportation and Climate Initiative

The New England states also participate in the Transportation and Climate Initiative, a regional collaboration of Northeast and Mid-Atlantic States and the District of Columbia that seeks to improve transportation, develop the clean-energy economy, and reduce carbon emissions from the transportation sector. The goal of the initiative is the design of a proposal for a regional low-carbon transportation policy using a cap-and-invest program or other pricing mechanism to reduce carbon emissions from transportation fuels. Proposed solutions include electrification of portions of surface transportation fleets and incentives for battery electric passenger vehicles which could increase future regional loads.[51]

3.1.4 Massachusetts Global Warming Solutions Act Power Plant CO_2 Cap

Adopted in 2018, by the Massachusetts Department of Environmental Protection, 310 CMR 7.74, creates a cap-and-trade program to reduce carbon dioxide emissions from electricity generating facilities located in Massachusetts. The Massachusetts CO_2 cap declines by 223,876 metric tons (tCO_2e) per year until it reaches a cap of 1.8 MtCO2e by 2050. In 2019, the cap was set at 8.74 million metric tons ($MtCO_{2e}$) and the cap declined to 8.50 $MtCO_{2e}$ in 2020.[52]

[49] Regional Greenhouse Gas Initiative Auction Results, https://www.rggi.org/auctions/auction-results. The clearing price was $5.75. A minimum reserve, or floor price, of $2.32/ton is in place for all 2020 quarterly auctions. In 2020, the cost containment reserve, consisting of 11.8 million allowances, will be available for the September auction. The cost containment reserve is a fixed additional supply of allowances that is available for sale only if prices exceed certain levels. This year's level is $10.77/ton, up from $10.51/ton in 2019

[50] Regional Greenhouse Gas Initiative, 48th Auction Materials, https://www.rggi.org/sites/default/files/Uploads/Auction-Materials/49/Auction_Notice_Jul_7_2020.pdf, (July 7, 2020).

[51] ISO-NE, Final 2020 Transportation Electrification Forecast (April 30, 2020), The 2020 electrification forecast focuses on light duty vehicles (LDV), including cars and light duty trucks, electrification of other, non LDV vehicle classes (e.g., freight vehicles, electric buses, rail, trolley) not included. Assumes battery electric vehicles (BEV) and plug in hybrid electric vehicles (PHEV) reach 515,000 vehicles by 2029, with expected annual energy demand increasing from 73 GWh in 2020 to 1,728 GWh in 2029.

[52] Massachusetts Executive Office of Energy and Environmental Affairs (EEA) and Department of Environmental Protection (MassDEP), 310 CMR 7.74: *Reducing CO_2 Emissions from Electricity Generating Units* (August 2017), https://www.mass.gov/guides/electricity-generator-emissions-limits-310-cmr-774, establishes a declining limit on carbon dioxide (CO2) emissions from large power plants in Massachusetts.

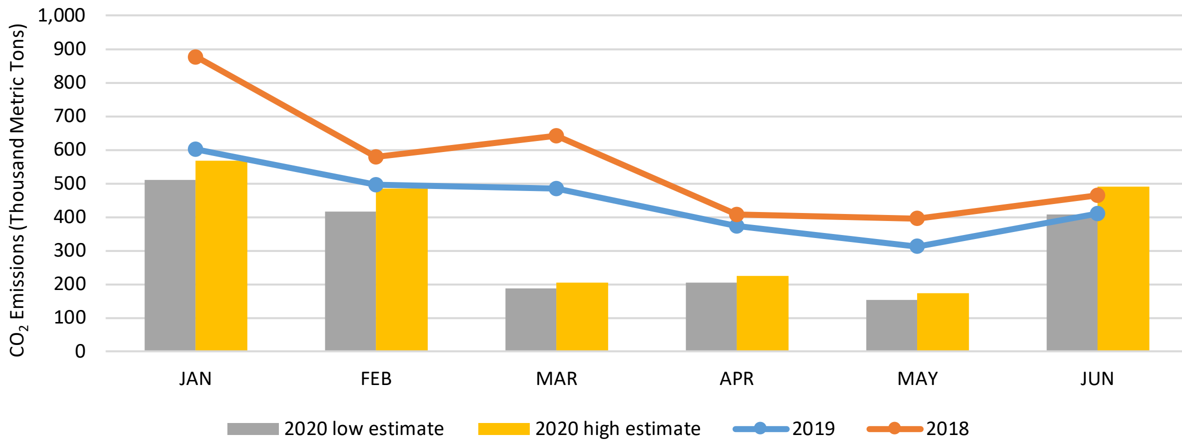


Figure 3-4: Massachusetts Generator Estimated 2020 Monthly Emissions vs. Historical Monthly Trends (Thousand Metric Tons)

Notes: Estimated CO_2 emissions (metric tons) calculated using individual generator CO_2 emission rates (kg/MWh) multiplied by daily generation data (MWh) for fossil generators subject to the Massachusetts Global Warming Solutions Act (GWSA) CO_2 cap, 310 CMR 7.74. Total affected capacity 8,958 MW (49 generating units), affected combined cycle 6,126 MW, affected gas turbine 1,072 MW, and affected steam turbine 1,760 MW (2020 CELT Summer Peak SCC).

Section 4 Appendix

2020 vs. 2019 System Emission Trends

Tables A-1 through A-3 compare monthly emissions for the first half of 2019 and 2020 from native electric generating units (located within New England) serving the New England power system reported directly to EPA Air Markets Monitoring Programs.

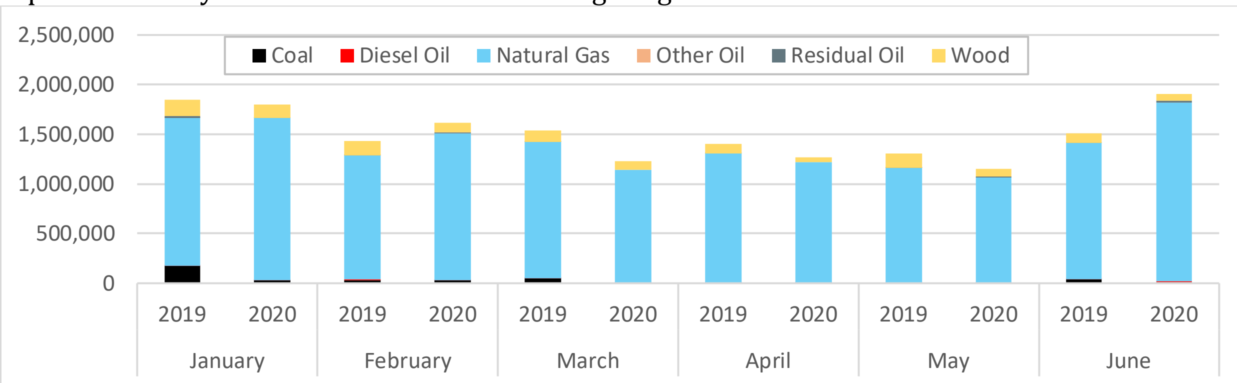


Figure A-1: New England Monthly CO_2 Emissions by Fuel Type 2019 vs. 2020 (Metric Tons)

Note: Unit level emissions for Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont for January – June 2020. Includes reported data from 189 electric generating units at 79 facilities. **Source**: EPA Air Markets Program Data, https://ampd.epa.gov/ampd/.

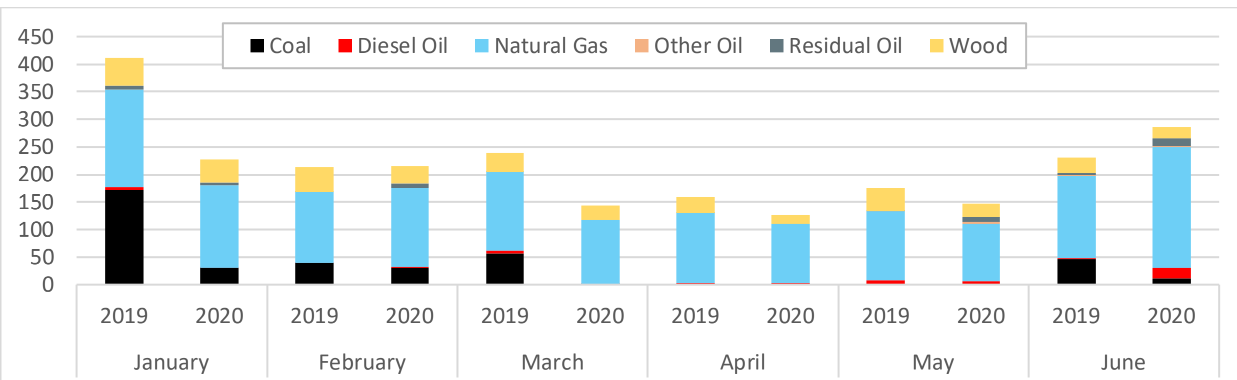


Figure A-2: New England Monthly NO_X Emissions by Fuel Type 2019 vs. 2020 (Metric Tons)

Note: Unit level emissions for Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont for January – June 2020. Includes reported data from 189 electric generating units at 79 facilities. **Source**: EPA Air Markets Program Data, https://ampd.epa.gov/ampd/.

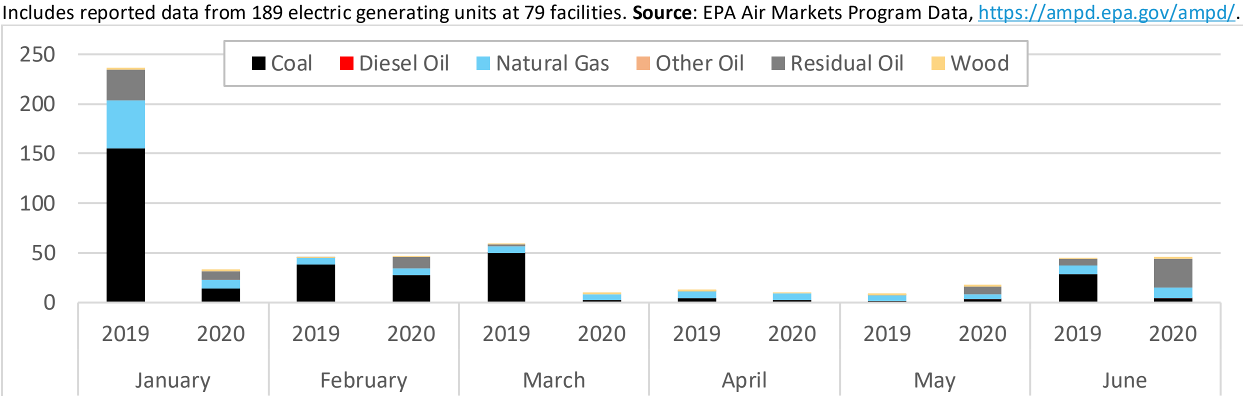


Figure A-3: New England Monthly SO_2 Emissions by Fuel Type 2019 vs. 2020 (Metric Tons)

Note: Unit level emissions for Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont for January – June 2020. Includes reported data from 189 electric generating units at 79 facilities. **Source**: EPA Air Markets Program Data, https://ampd.epa.gov/ampd/.

National Ambient Air Quality Standards

The Clean Air Act requires EPA to set National Ambient Air Quality Standards (40 CFR part 50) for pollutants considered harmful to public health and the environment. Two types of national ambient air quality standards are specified under the Clean Air Act:

- Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly.
- Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

Table 4-1 National Ambient Air Quality Standards

Pollutant [links to historical tables of NAAQS reviews]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb)		primary and secondary	Rolling 3 month average	0.15 μg/m^3 [1]	Not to be exceeded
Nitrogen Dioxide (NO_2)		primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb [2]	Annual Mean
Ozone (O_3)		primary and secondary	8 hours	0.070 ppm [3]	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	12.0 μg/m^3	annual mean, averaged over 3 years
		secondary	1 year	15.0 μg/m^3	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		primary	1 hour	75 ppb [4]	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

Notes: [1] In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m^3 as a calendar quarter average) also remain in effect.

[2] The level of the annual NO_2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

[3] Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O_3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O_3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

[4] The previous SO_2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2)any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO_2 standards or is not meeting the requirements of a SIP call under the previous SO_2 standards (40 CFR 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

Source: https://www.epa.gov/criteria-air-pollutants/naaqs-table#2

Under the Clean Air Act, each jurisdiction is tasked with developing State Implementation Plans (SIPs), the collection of regulations and documents a state, territory, or local air district uses to reduce air pollution of criteria air pollutants (i.e., widespread common pollutants known to be harmful to human health) in areas that do not meet the National Ambient Air Quality Standards (NAAQS) established under the Clean Air Act.

Regional Air Pollution vs. Peak Demand Trends

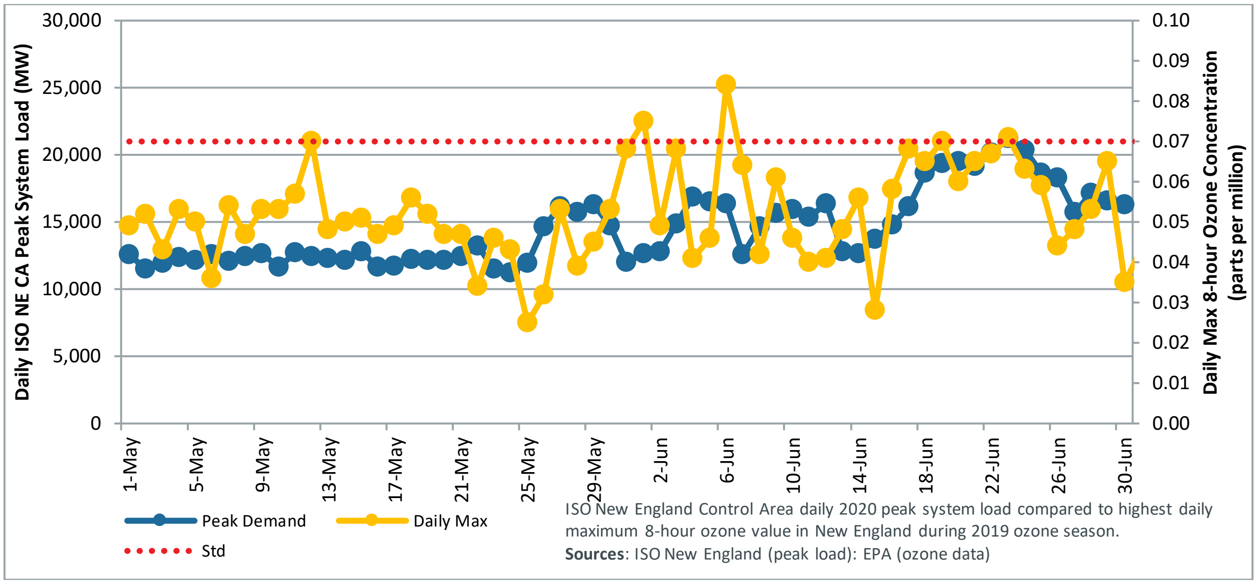


Figure A-6: New England 2020 Daily Peak System Load (MW) vs. Highest Daily Ozone Value (ppm) in New England (Ozone season, May-September).
Note: EPA Daily Air Quality Data, https://www.epa.gov/outdoor-air-quality-data.

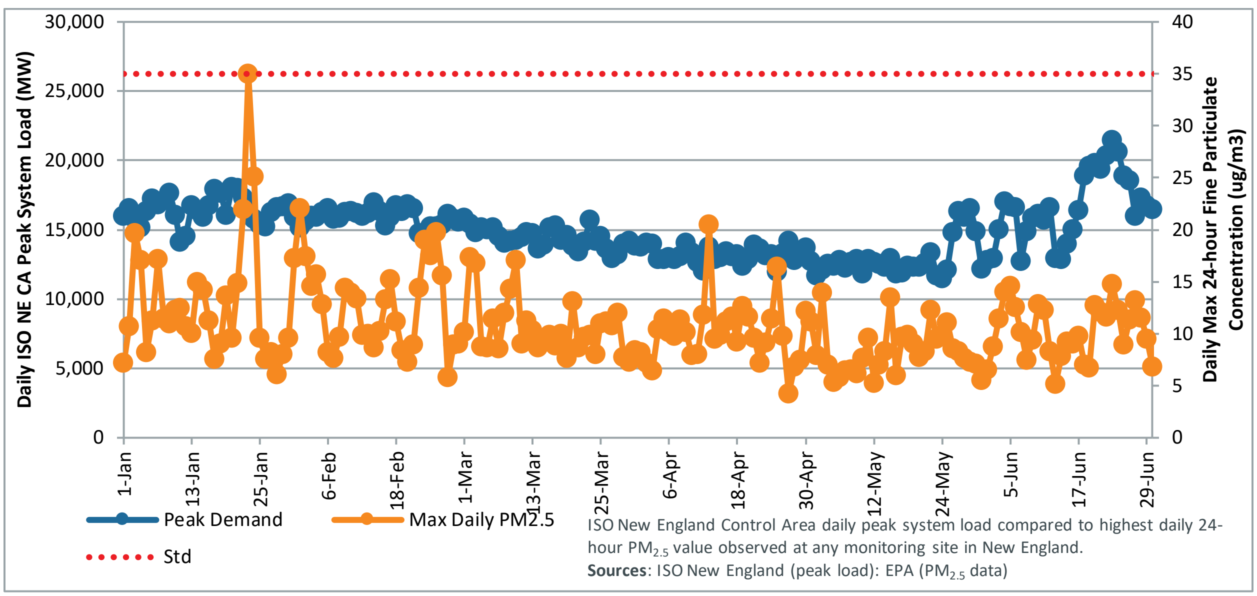
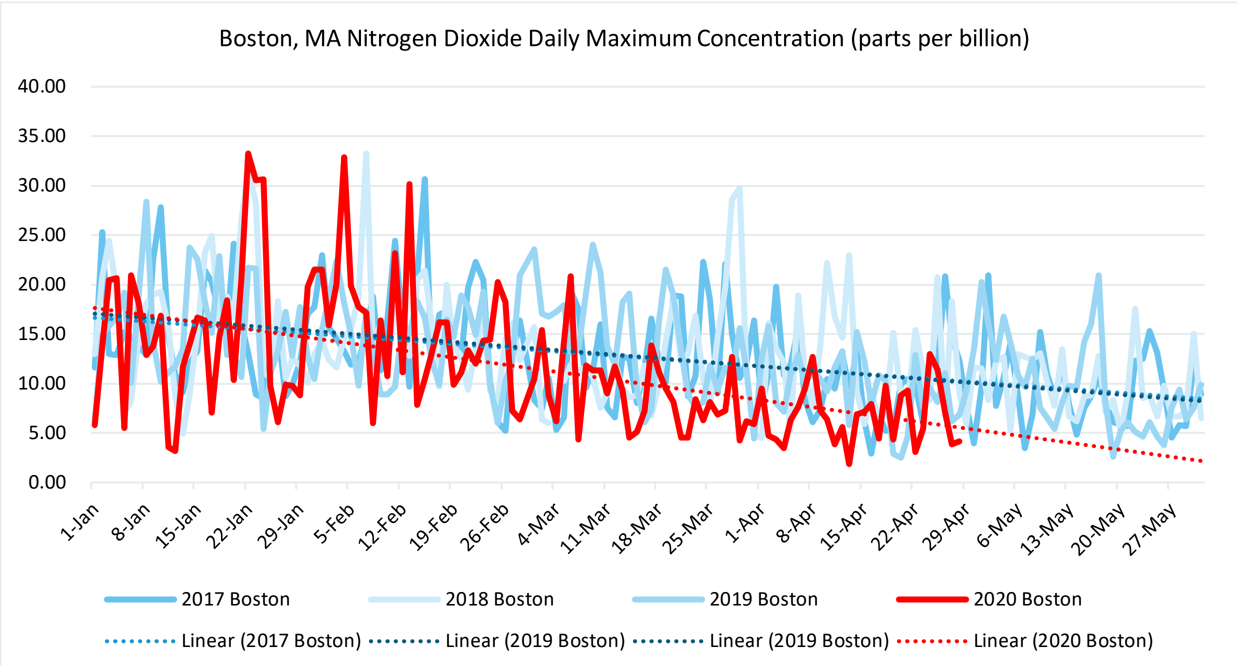
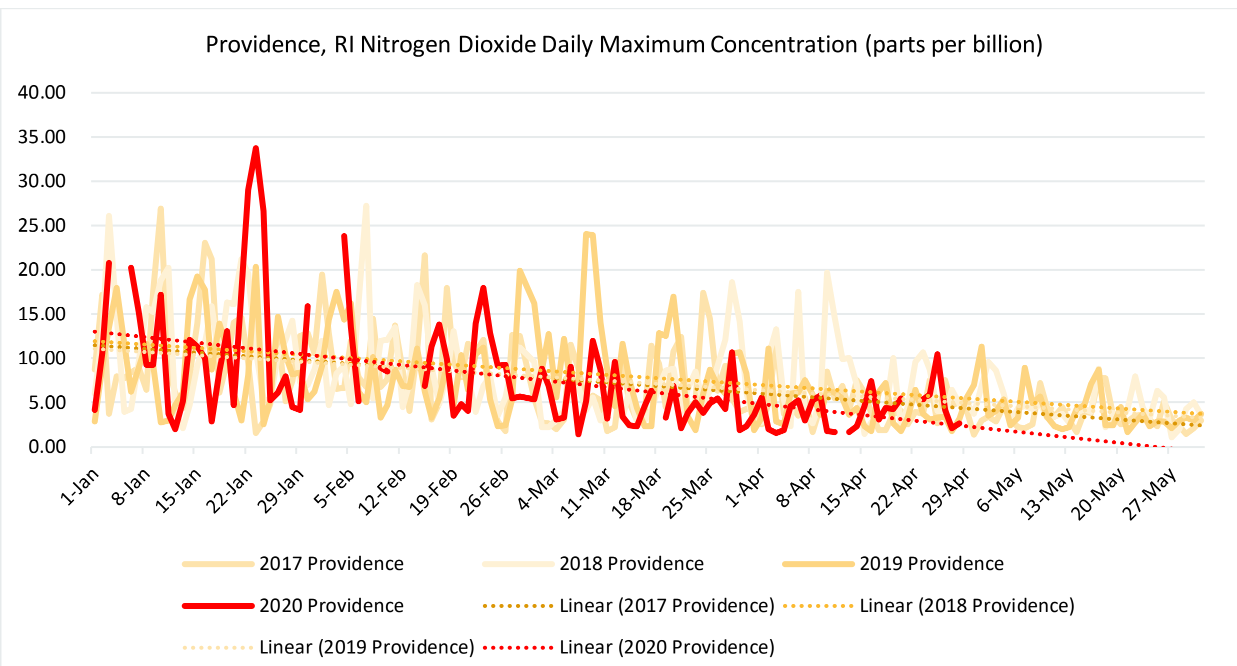


Figure A-7: New England 2020 Daily Peak System Load (MW) vs. Highest Daily $PM_{2.5}$ (µg/m^3) Values in New England.
Note: EPA Daily Air Quality Data, https://www.epa.gov/outdoor-air-quality-data.





Figures A-4-1, A-2: 2020 Nitrogen Dioxide Daily Maximum Concentration (parts per billion) for Boston, MA & Providence RI

Note: L.-W. Antony Chen, Lung-Chang Chien, Yi Li, Ge Lin, *Nonuniform impacts of COVID-19 lockdown on air quality over the United States*, Science of The Total Environment, Volume 745, 2020, 141105, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2020.141105.
Source: Air quality data from US EPA NCore sites 2017-2020, https://data.mendeley.com/datasets/kwbkmrh4tb/1.