2022 MAINE ENERGY SUMMARY AND ASSESSMENT

GOVERNOR'S
Energy Office

MARCH 15, 2022

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JANET MILLS
GOVERNOR

DAN BURGESS
DIRECTOR OF GOVERNOR'S
ENERGY OFFICE

Chair Lawrence, Chair Berry and Members of the Energy, Utilities and Technology (EUT) Committee,

As requested by the EUT Committee, and pursuant to statute, I am pleased to provide you with the 2022 Maine Energy Summary and Assessment, a comprehensive overview of our state's energy landscape.

Maine's energy system, like that of most of the world, is undergoing a transformation. Under the leadership from Governor Janet Mills, with broad bipartisan support of the legislature, advocates, and industry, Maine has become a leader among states in decarbonizing its energy system to reduce greenhouse gas emissions and help mitigate the effects of climate change on our communities, people, and environment.

Nevertheless, New England's over-reliance on natural gas for electricity generation and oil to heat our homes puts the state at risk of price swings caused by the global market. Maine people are feeling these effects by way of increased electricity and heating bills as international fossil fuel prices rise - with recent global events adding more uncertainty in the future. To help protect Maine from this volatility, we have put in place some of the nation's most ambitious targets in law to transition to renewable energy, advanced policies to reduce consumption of fossil fuels through energy efficiency measures like heat pumps and weatherization, and become one of the first states in the nation to set targets for energy storage.

As this report notes, Maine has now exceeded its statutory goal of reducing oil consumption by at least 30% from 2007 levels by 2030; Maine is 38% below 2007 levels as of 2019. But even with this considerable progress, Maine remains the most heating oil dependent state in the country, with 60% of Maine's homes reliant on heating oil, and spends more than $4 billion annually on imported fossil fuels.

These goals, targets and requirements establish the direction for Maine's energy future that will deliver clean, affordable energy to Maine people and businesses. For example, we estimated that Maine ratepayers would be saving more than $150 million on electricity costs from the renewable energy projects awarded contracts under the latest energy procurements required by 2019 legislation, if those projects were online right now. This is just one example of how renewable energy remains critical to not only ease our reliance on fossil fuels, but also help offset rising energy costs caused by global fossil fuel markets.

This report uses existing data to provide a snapshot of Maine's energy situation as well as an update of progress toward goals, Maine's energy systems, current trends, and recommendations for continued focus. What is clear is that Maine continues to make progress toward our clean energy future and is meeting the related targets, including reducing emissions, advancing renewable energy and energy efficiency, and growing the clean energy economy.

As Maine's energy system transitions to lower carbon resources, policymakers must ensure that energy costs and equity are at the forefront of decision making. New England continues to have higher electricity prices than the rest of the country, though Maine has historically had some of the lowest electricity prices in the region. As our systems change, and technologies advance, this low carbon transition must be affordable, and benefits need to be distributed equitably. This will require continued intention and careful consideration of each policy decision.

The coming year will offer opportunities to work together to advance Maine's energy policies and to conduct additional modeling and stakeholder work to inform future actions. Maine is well positioned to continue to lead and I look forward to working with you to advance our shared objectives.

Sincerely,

Dan Burgess
Director, Governor's Energy Office

TABLE OF CONTENTS

Background 8
Maine Energy and Emissions Profile 9
Maine Emissions Profile 9
Maine Energy Data Profile 11
Energy Prices 16
Overview & Policy Updates 19
Electricity 19
Electricity Grid Systems 19
Renewable Energy 22
Renewable Portfolio Standard (RPS) 22
Solar 28
Storage 33
Onshore Wind 34
Offshore Wind 35
Other advanced technologies 40
Planning & Grid Modernization 40
Thermal Sector 43
Energy Efficiency & Weatherization 53
Transportation 57
Clean Energy Economy & Workforce 60
Cleantech Innovation 61
Conclusion 62

Figures

Figure 1 - Maine Greenhouse Gas Emissions by Sector, 2017 9
Figure 2 - Total GHG Emissions and Real Gross Domestic Product, Maine DEP 10
Figure 3 - Energy Consumed by Fuel in Maine, 2019 11
Figure 4 - Energy Consumed by Sector and Fuel in Maine, 2019 12
Figure 5 - Distillate Fuel Oil Consumed by the Residential Sector, 2019 12
Figure 6 - Fossil Fuel Expenditures, Maine 13
Figure 7 - Percentage of Total Electric Energy by Resource Type in New England Regional Grid 14
Figure 8 - Electricity Consumed (i.e. retail sales) by sector, Maine 14
Figure 9 - Electricity Generation by Energy Source, Maine, 2019 15
Figure 10 - Net Interstate Flow of Electricity and Associated Losses 15
Figure 11 - Total Energy Average Price 16
Figure 12 - Electricity average price for all sectors 17
Figure 13 - New England hub historic average natural gas and wholesale electricity prices (ISO-NE) through December 2021 18
Figure 14 - Maine Residential Heating Oil Prices, 2004-2021, through December 2021 19
Figure 15 - New England Geographic Transmission Map Through 2031 (ISO-NE) 21
Figure 16 - State Renewable Portfolio Standard (RPS) for Class I 22
Figure 17 - Renewable energy need, assumed baseline RECs, and existing Class II resources (REGMA) 23
Figure 18 - Class I/IA REC need through 2030 (REGMA) 24
Figure 19 - Renewable build comparison in 2030 across scenarios (REGMA) 25

Figure 20 - RECs from all sources for all scenarios in 2030 (REGMA) 25
Figure 21 - Renewable build comparison in 2040 across scenarios (REGMA) 26
Figure 22 - RECs from all sources for all scenarios in 2040 (REGMA) 26
Figure 23 - Net Present Value of costs for each scenario (REGMA) 27
Figure 24 - Solar generation installed in Maine 29
Figure 25 - Total and per-capita operation solar capacity by Maine county, 2021 29
Figure 26 - Distributed Generation solar projects enrolled in net energy billing programs 30
Figure 27 - Solar resources enrolled in net energy billing by status and program, October 2021 31
Figure 28 - Solar resources enrolled in net energy billing by status and size, October 2021 31
Figure 29 - Energy Storage in Maine compared to statutory targets 33
Figure 30 - Operation wind generation by Maine county, 2021 34
Figure 31 - Fuel oil total consumption with 2030 and 2050 goals, Maine; Distillate fuel oil consumed by sector, Maine; Residual fuel oil consumed by sector, Maine 44
Figure 32 - Distillate fuel oil consumed by the residential sector, 2019 46
Figure 33 - Distillate fuel oil consumed by the commercial sector, 2019 46
Figure 34 - Share of energy sources consumed for residential heating, 2019 47
Figure 35 - Share of Energy Sources Consumed for Residential Heating, Maine 47
Figure 36 - Maine Retail Heating Fuel Prices, as of December 27, 2021 48
Figure 37 - Maine Residential Heating Oil Prices, 2004-2021, through December 2021 49
Figure 38 - Maine Residential Propane Prices, 2010-2021, through December 2021 49
Figure 39 - Natural Gas Service Territories 50
Figure 40 - The 2020 ACEEE State Energy Efficiency Scorecard 54
Figure 41 - Efficiency Maine Trust Benefits (lifetime) vs. costs (Efficiency Maine Trust and participant) of all Efficiency Maine Trust programs 54
Figure 42 - Maine's Public Electric Vehicle Charging Stations (Efficiency Maine) 58
Figure 43 - Transportation sector emissions by vehicle type, Maine 59
Figure 44 – Breakdown of Light Duty Vehicles in Maine 59

Tables

Table 1 - Fuel oil consumed by sector and fuel oil type, Maine (2007 vs. 2019) (Billion Btu) 45
Table 2 - 2020 Natural Gas Expansion 51
Table 3 - Natural Gas LDC Customers 51

Unless otherwise indicated by the figure or table title, data is sourced from U.S. Energy Information Administration and presented by the Maine Governor's Energy Office.

BACKGROUND

The 2022 Maine Energy Summary and Assessment is presented by the Governor's Energy Office (GEO) as required by statute[1] and builds upon prior Energy Plans developed by the GEO in 2009 and 2015[2] as well as several other Maine stakeholder-informed reports, studies and working groups, including:

- Maine Won't Wait, the Maine Climate Council's 2020 Climate Action Plan and subsequent One-Year Progress Report
- GEO Energy Independence and Progress Update Final Report
- Strengthening Maine's Clean Energy Economy Report
- State of Maine Renewable Energy Goals Market Assessment Final Report
- State of Maine Clean Transportation Roadmap
- Stakeholder Report Pursuant to Public Law 2019, Chapter 57: Resolve, To Study Transmission Solutions To Enable Renewable Energy Investment in the State;
- Interim Report of the Distributed Generation Stakeholder Group

The GEO used publicly available information from multiple sources, including the U.S. Energy Information Administration (EIA) to produce some of the data in this report – much of this data was only available through 2019 as of the time of this writing, and the GEO plans to update this information on www.maine.gov/energy when 2020 data becomes available. The GEO created this report with the support of funding from the U.S. Department of Energy (DOE), State Energy Program, under Award Number DE-EE0007222. With this funding provided in 2018, the GEO contracted with the Environmental and Energy Technology Council of Maine (E2Tech). E2Tech provided stakeholder engagement support and was instrumental in providing data to support analysis of Maine's energy landscape. While a report was not finalized in 2018, the GEO has used the information collected from that effort and is appreciative of both E2Tech's work as well as the myriad stakeholders involved in the processes that informed previous efforts and reports.

The GEO would like to acknowledge staff who have contributed to the writing of this report, including:

- Melissa Winne, Energy Policy Advisor, GEO and lead author of this report.
- Ross Anthony, Buildings and Efficiency Analyst, GEO
- Ethan Tremblay, Energy Policy Analyst, GEO
- Caroline Colan, Clean Energy Fellow, GEO
- Celina Cunningham, Deputy Director, GEO
- Jessica Scott, Senior Climate Advisor, Governor's Office of Policy Innovation and the Future (GOPIF)
- Anthony Ronzio, Deputy Director, GOPIF

1 https://www.mainelegislature.org/legis/statutes/2/title2sec9.html
2 https://www.maine.gov/energy/studies-reports-working-groups/completed-reports

MAINE ENERGY AND EMISSIONS PROFILE

The State of Maine has unique characteristics that impact the state's energy sector. Maine is large and dispersed, with a total area of 35,380 square miles, about the size of the other five New England states combined.[3] Maine has a population of about 1.3 million people[4] and is the oldest state in the country with a median age of 45 years in 2019, more than six years older than the U.S. state median age of 38.5 years.[5] More than one in ten Mainers lives in poverty.[6]

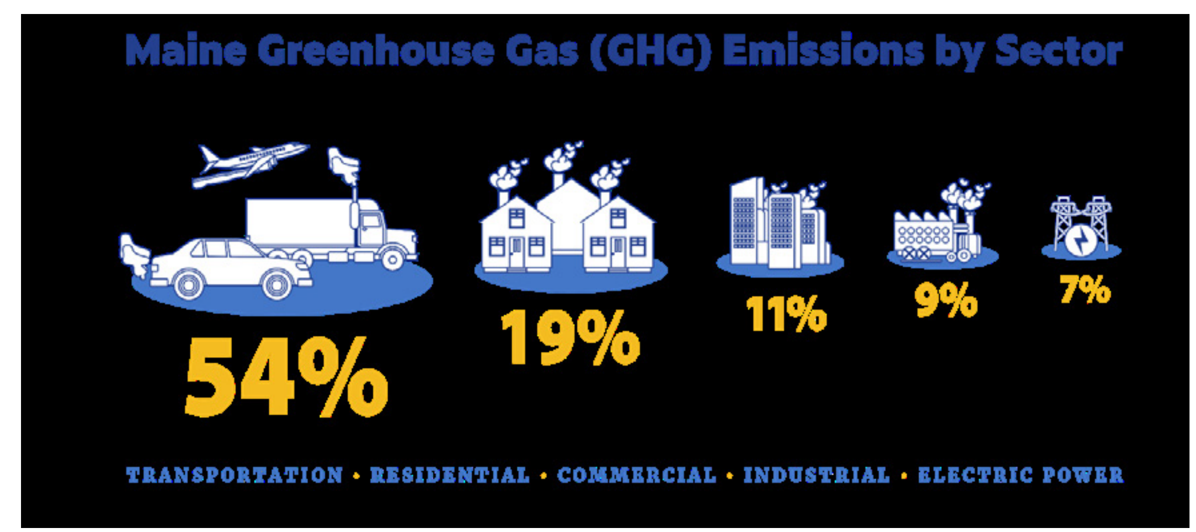
Maine is endowed with ample and valuable natural resources. The State has 17.5 million acres of forested land, is nearly 90% forested, the most of any state.[7] Maine boasts 3,478 miles of tidal coastline, longer than all but three other states in the United States, has over 5,000 rivers and streams, totaling 37,000 miles, and has 6,000 ponds and lakes.[8] Maine's abundant natural wind, water, and biomass resources are economic drivers and position the State as a leader in renewable energy.

Maine Emissions Profile

The energy sector will continue to play a key role in ensuring Maine meets its updated greenhouse gas emission reduction targets enacted in 2019. As reported by the Maine Department of Environmental Protection (DEP), 54% of Maine's energy-related carbon emissions come from the transportation sector and nearly 30% are from the built environment of the residential and commercial sectors.

In June 2019, Governor Janet Mills signed LD 1679 into law, with strong bipartisan support from the Maine Legislature, to establish increased greenhouse gas emissions reduction requirements of 45% below 1990 levels by 2030 and 80% by 2050. Additionally, LD 1679 established the Maine Climate Council and charged it with developing a four-year Climate Action Plan to put Maine on a trajectory to meet these requirements. Backed by the first comprehensive scientific and technical assessment of the impacts of climate change on Maine in a decade, the Maine Climate Council's

Figure 1 – Maine Greenhouse Gas Emissions by Sector, 2017



Data source: Maine Department of Environmental Protection 8th Biennial Greenhouse Gas Emissions Report

3 U.S. Census Bureau. (2010). https://www.census.gov/geographies/reference-files/2010/geo/state-area.html
4 U.S. Census Bureau. (2019). https://data.census.gov/cedsci/profile?g=0400000US23
5 Ibid.
6 Ibid.
7 USDA. (2019). https://www.fs.fed.us/nrs/pubs/ru/ru_fs236.pdf
8 NOAA Office of Coastal Management. (2017). https://coast.noaa.gov/data/docs/states/shorelines.pdf

four-year climate action plan, *Maine Won't Wait*, provides recommendations for mitigation and adaptation strategies for combatting climate change, while simultaneously addressing how climate change presents transformational economic opportunities.[9]

As required by 38 MRSA § 576-A, Maine must reduce gross annual greenhouse gas emissions to certain levels, as follows:

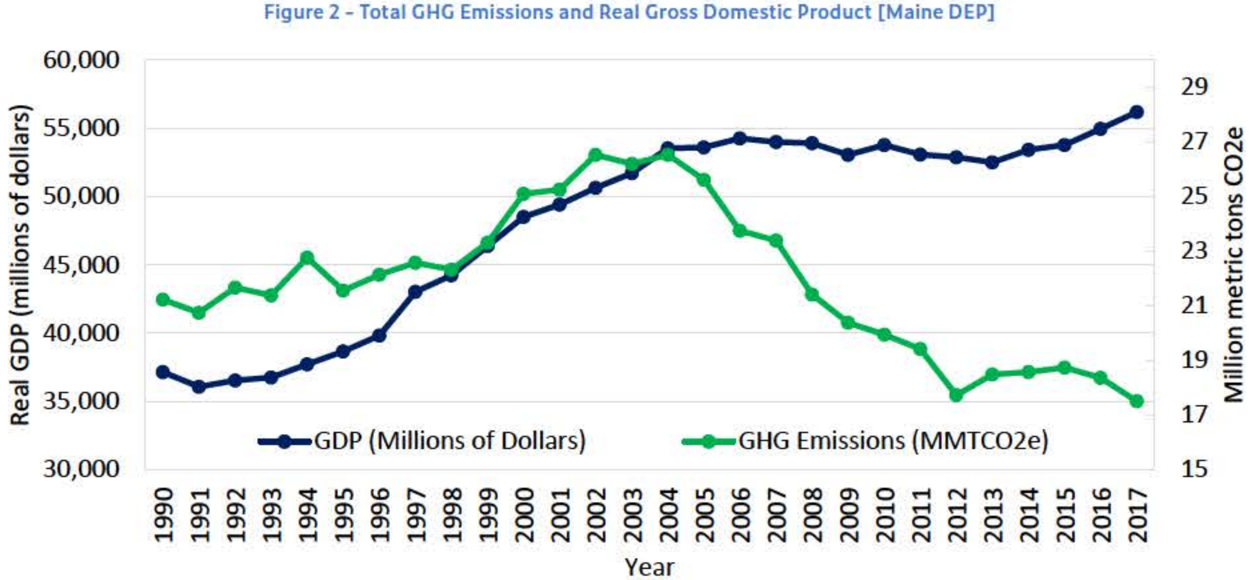
- By January 1, 2030, the State shall reduce gross annual greenhouse gas emissions to at least 45% below the 1990 gross annual greenhouse gas emissions level.
- By January 1, 2040 the gross annual greenhouse gas emissions level must, at a minimum, be on an annual trajectory sufficient to achieve the 2050 annual emissions level.
- By January 1, 2050, the State shall reduce gross annual greenhouse gas emissions to at least 80% below the 1990 gross annual greenhouse gas emissions level.

Additionally, Maine is required by Executive Order to achieve carbon neutrality by 2045.

Maine must pursue a variety of decarbonization strategies in order to reduce emissions. This includes the primary strategy of beneficial electrification, which is the efficient switch to electricity usage in place of fossil fuel consumption. For this to be an effective strategy for reducing greenhouse gas emissions, it is vital that electricity production uses low or zero carbon sources. Therefore, the state must focus its efforts on both transitioning away from fossil fuel consumption to electricity while simultaneously supporting the growth of clean energy resources for electricity generation that can meet this growing demand.

According to the latest reporting from the Maine DEP, the state continues to make progress in reducing emissions. As of 2017, emissions were 17.5% lower than 1990 levels, on track to meet the medium-term goal of reducing greenhouse gas emissions to 10% less than 1990 levels by January 2020.[10] As can be seen in Figure 2, Maine's real gross domestic product (GDP) has increased while overall emissions have decreased.[11]

Figure 2 - Total GHG Emissions and Real Gross Domestic Product [Maine DEP]



9 https://www.maine.gov/climateplan/

10 According to the Maine Department of Environmental Protection 8th Report on Progress toward GHG Reduction Goals released in January 2020. The next report is expected in early 2022.

11 Maine Department of Environmental Protection, 8th Report on Progress toward GHG Reduction Goals (2020). https://www.maine.gov/dep/news/news.html?id=1988154

Next Steps

The GEO will continue engagement in the Maine Climate Council process and pursue the recommendations of the Maine Climate Council's Climate Action Plan. The GEO will continue to consider strategies and related processes that help to ensure Maine's electric grid is capable of effectively and reliably meeting future needs as Maine decarbonizes, particularly as related to expected load growth from beneficial electrification. Further, recommendations should be considered from the Maine Climate Council's newly formed Equity Subcommittee to ensure the transition to a decarbonized energy sector is equitable and allows for benefits to reach all Maine people.

Maine Energy Data Profile

The following section offers a snapshot of Maine's energy sector, with a more complete data profile available in the Appendix.

Overall Energy

From an overall energy sector perspective in Maine in 2019, total energy consumption of fuels not used to generate electricity is 48% petroleum, 18% wood, and 8% natural gas, and then 25% of total energy consumption is electricity consumption, as shown below in Figure 3.

As seen in Figure 4, most of the petroleum consumed in the state is in the transportation sector, followed by the residential sector.

Petroleum consumption is primarily gasoline and diesel in the transportation sector, and heating oil in the residential sector. Maine is the most heating oil dependent state in the country, with the highest residential distillate fuel oil usage per capita in 2019, as shown below in Figure 5.

Maine's dependence on petroleum products in transportation and the residential sector results in high expenditures in those sectors, with just over $4 billion being spent on out of state fossil fuels in 2019, as shown below in Figure 6.

Aside from wood, including wood pellets, and some biofuels, Maine produces little energy besides generating electricity. There are no extracted sources of coal, crude oil, or natural gas in the state, so Maine must import all the fossil fuels it consumes.

Figure 3 - Energy Consumed by Fuel in Maine, 2019

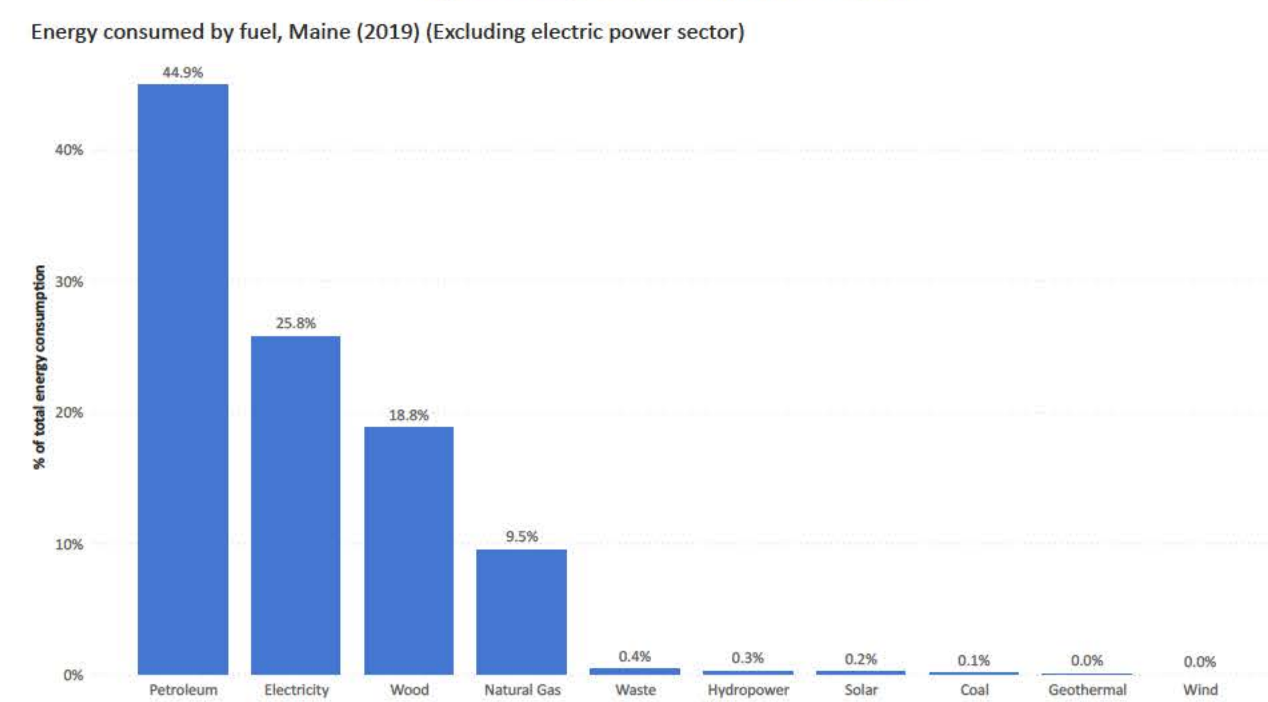


Figure 4 - Energy Consumed by Sector and Fuel in Maine, 2019

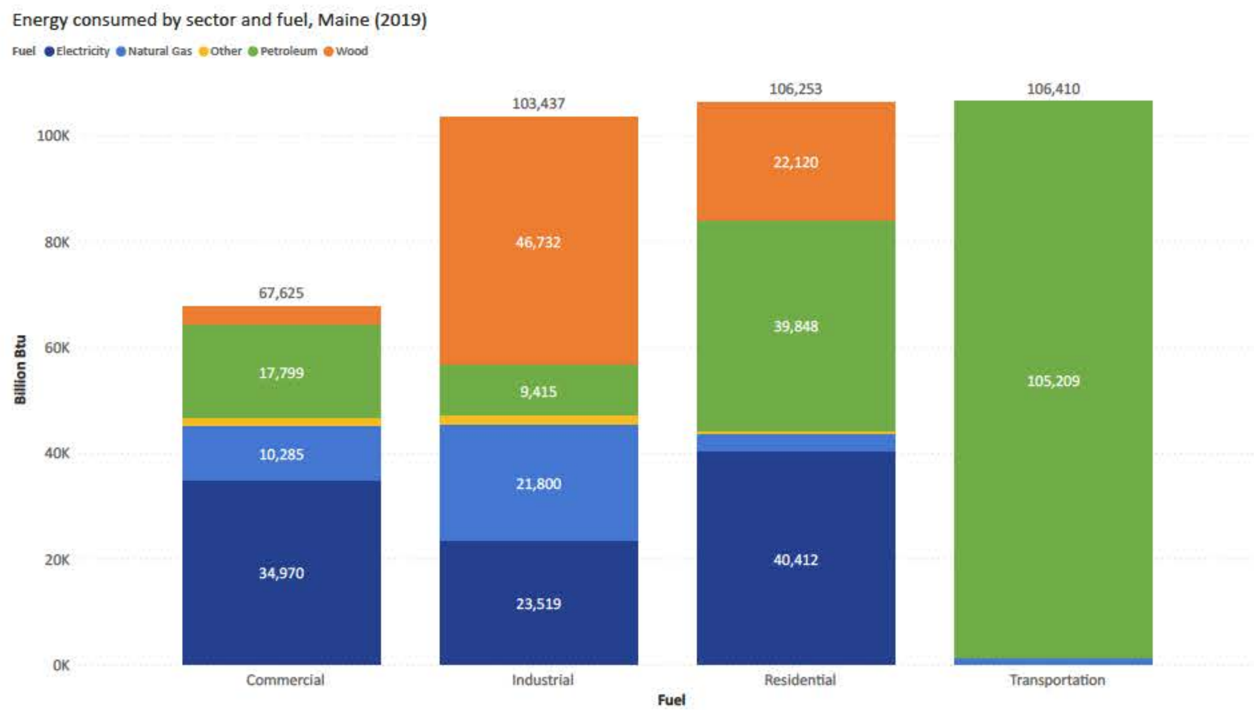


Figure 5 - Distillate Fuel Oil Consumed by the Residential Sector, 2019

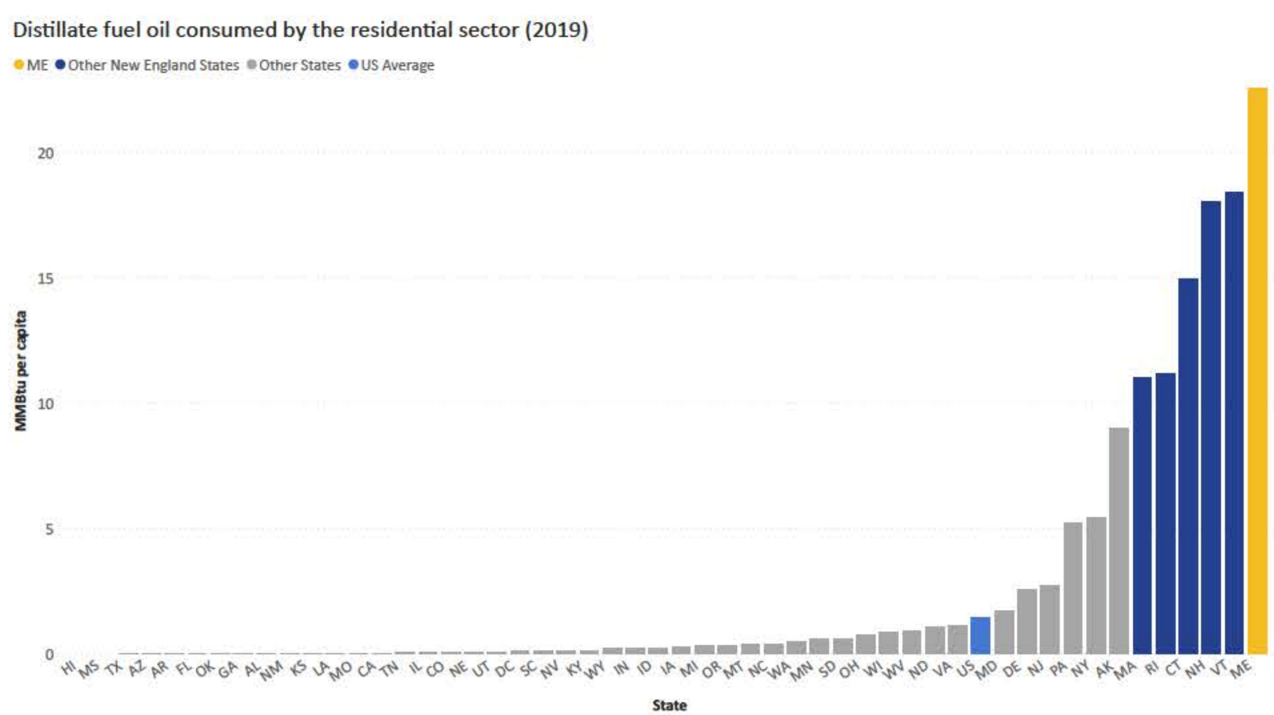
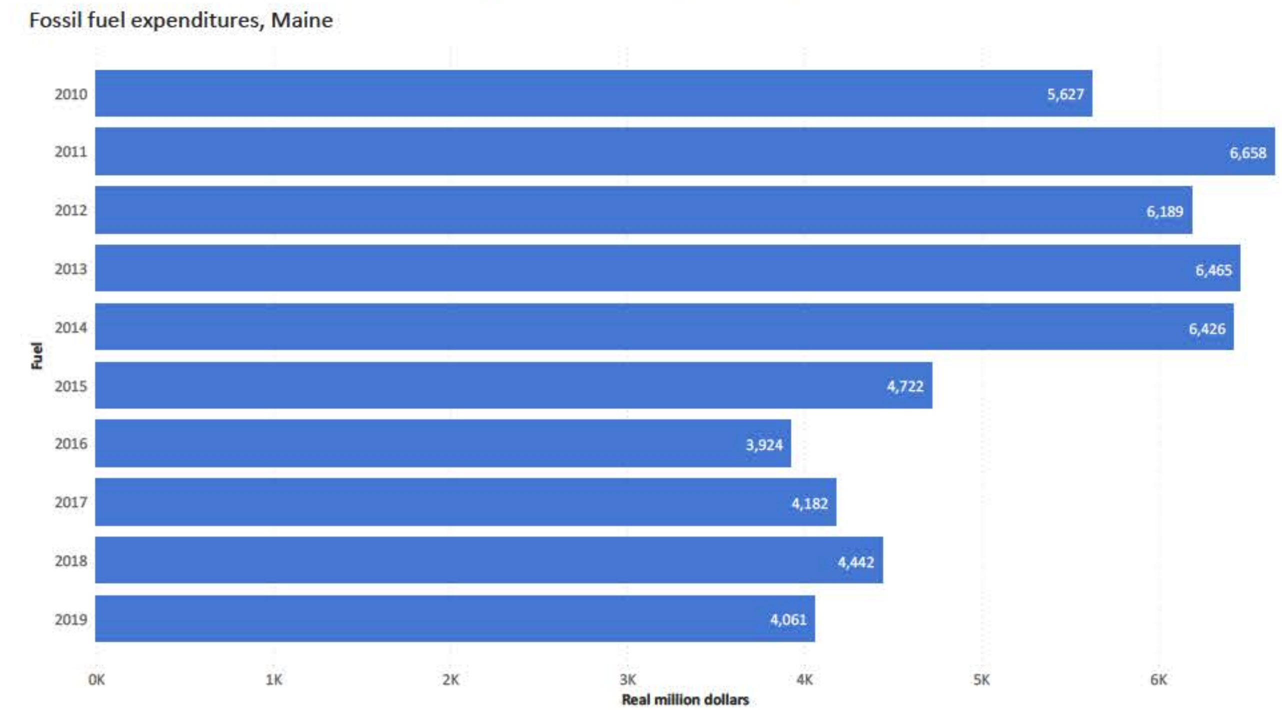


Figure 6 - Fossil Fuel Expenditures, Maine



Electricity

Over the last two decades the New England region has seen a shift in electric energy produced by oil and coal, with natural gas-powered generation becoming a significant resource, as depicted in Figure 7 from ISO New England (ISO-NE) the regional grid operator. ISO-NE states that "since 2013, roughly 7,000 megawatts (MW) of mostly coal, oil, and nuclear generation have retired or have announced plans for retirement in the coming years" and that "another 5,000 MW of oil and coal, which now run only during peak demand or periods of gas pipeline constraints, are likely to retire soon".[12] Recent EIA analysis indicates that this follows a national trend when it comes to power plant retirements, with 85 percent of electric generation capacity retirements in the U.S. expected to be coal plants.[13]

In regards to Maine electricity consumption and generation specifically within the state, Figure 8 shows that in 2019 Maine consumed about 11,700 GWh of electricity (based on retail sales), which is roughly 10% of New England's total electricity consumption. In that same year, Maine generated about 10,500 GWh of electricity.

Of that in-state generation, about 78 percent comes from renewable resources: 33 percent hydroelectric, 24 percent wind, 20 percent wood and wood-derived fuels, and 1 percent other biomass. Natural gas comprises about 17 percent of electricity generation in Maine (Figure 9).

Although roughly 78 percent of Maine's total electricity generation comes from renewable resources, not all of that generation is attributed to Maine's renewable energy policy goals. Renewable electricity generation is assigned a Renewable Energy Certificate (REC) for every megawatt-hour of electricity produced. RECs can be sold by a Maine generator to an entity in Maine or in another state. Additionally, Maine is part of a regional electricity grid and not all the electrons generated within Maine are necessarily consumed within Maine.

12 https://www.iso-ne.com/about/key-stats/resource-mix/
13 https://www.eia.gov/todayinenergy/detail.php?id=50838

Figure 7 - Percentage of Total Electric Energy by Resource Type in New England Regional Grid [ISO-NE]

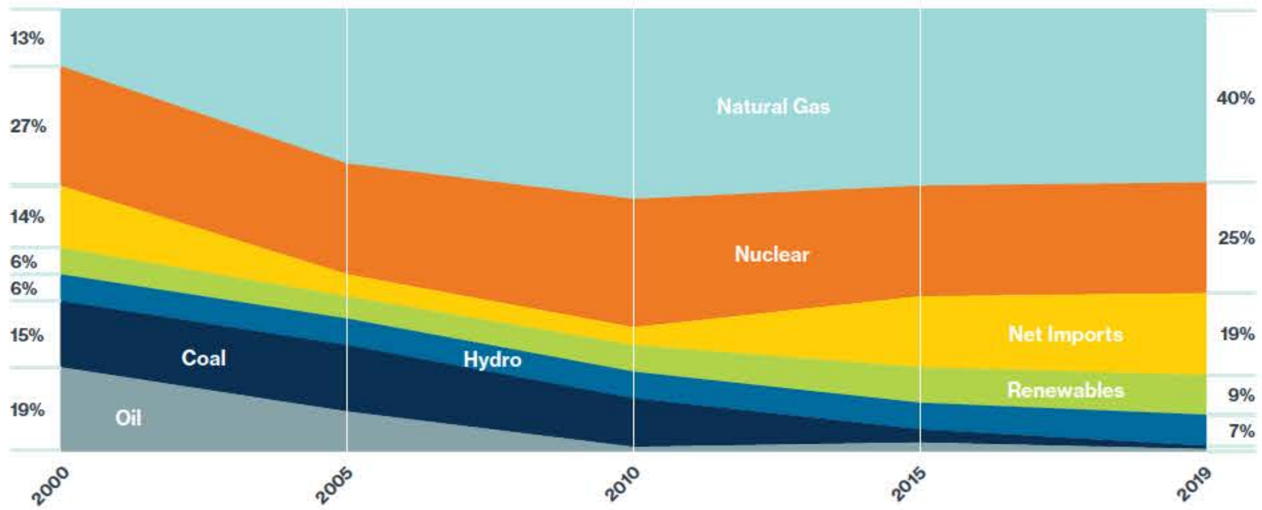


Figure 8 - Electricity Consumed (i.e. retail sales) by sector, Maine

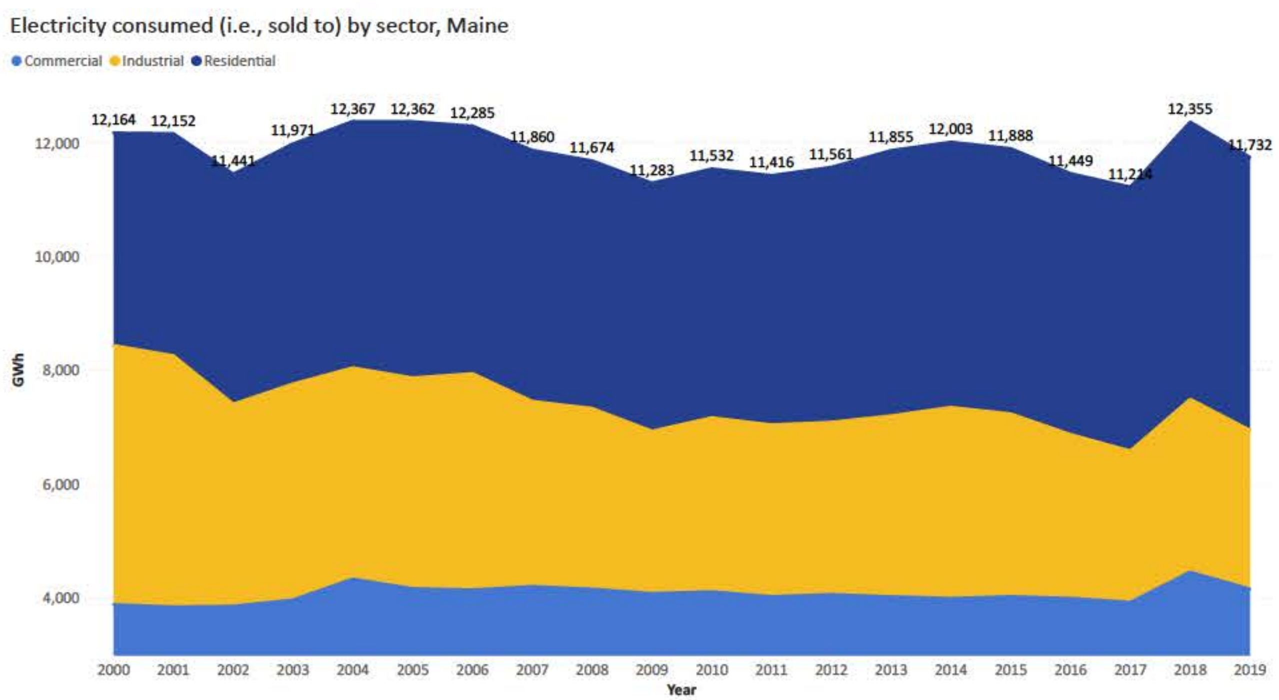


Figure 9 - Electricity Generation by Energy Source, Maine, 2019

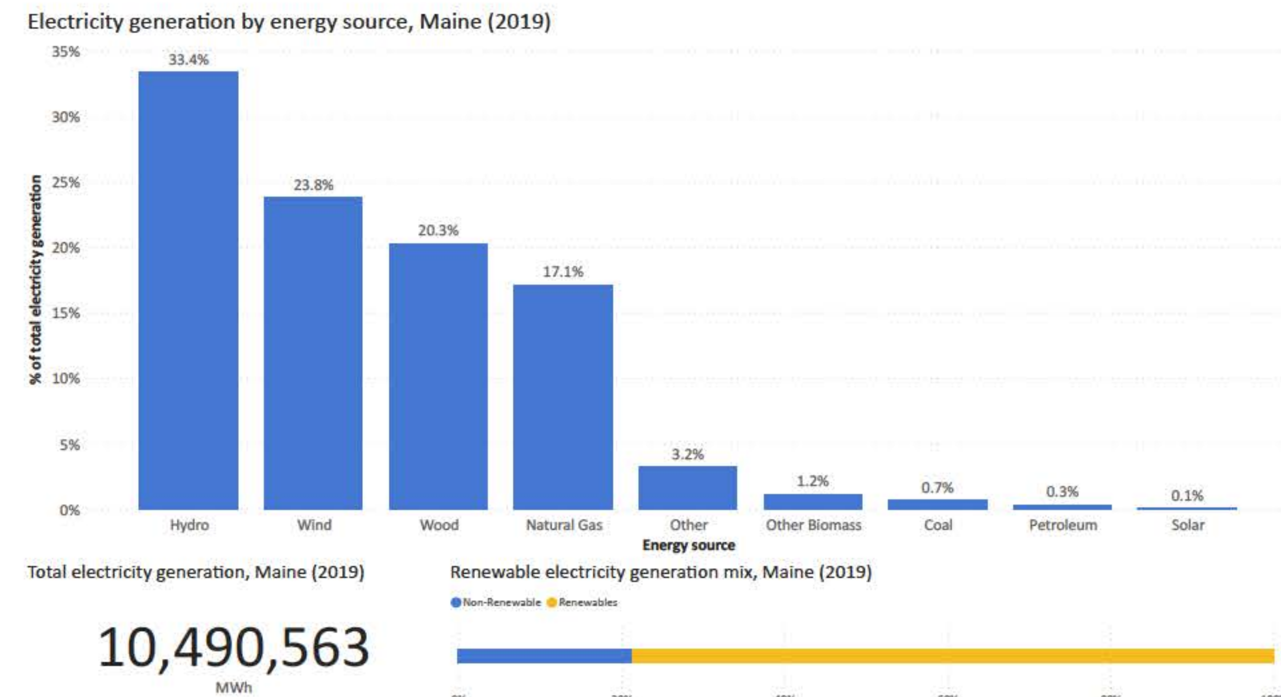


Figure 10 - Net Interstate Flow of Electricity and Associated Losses

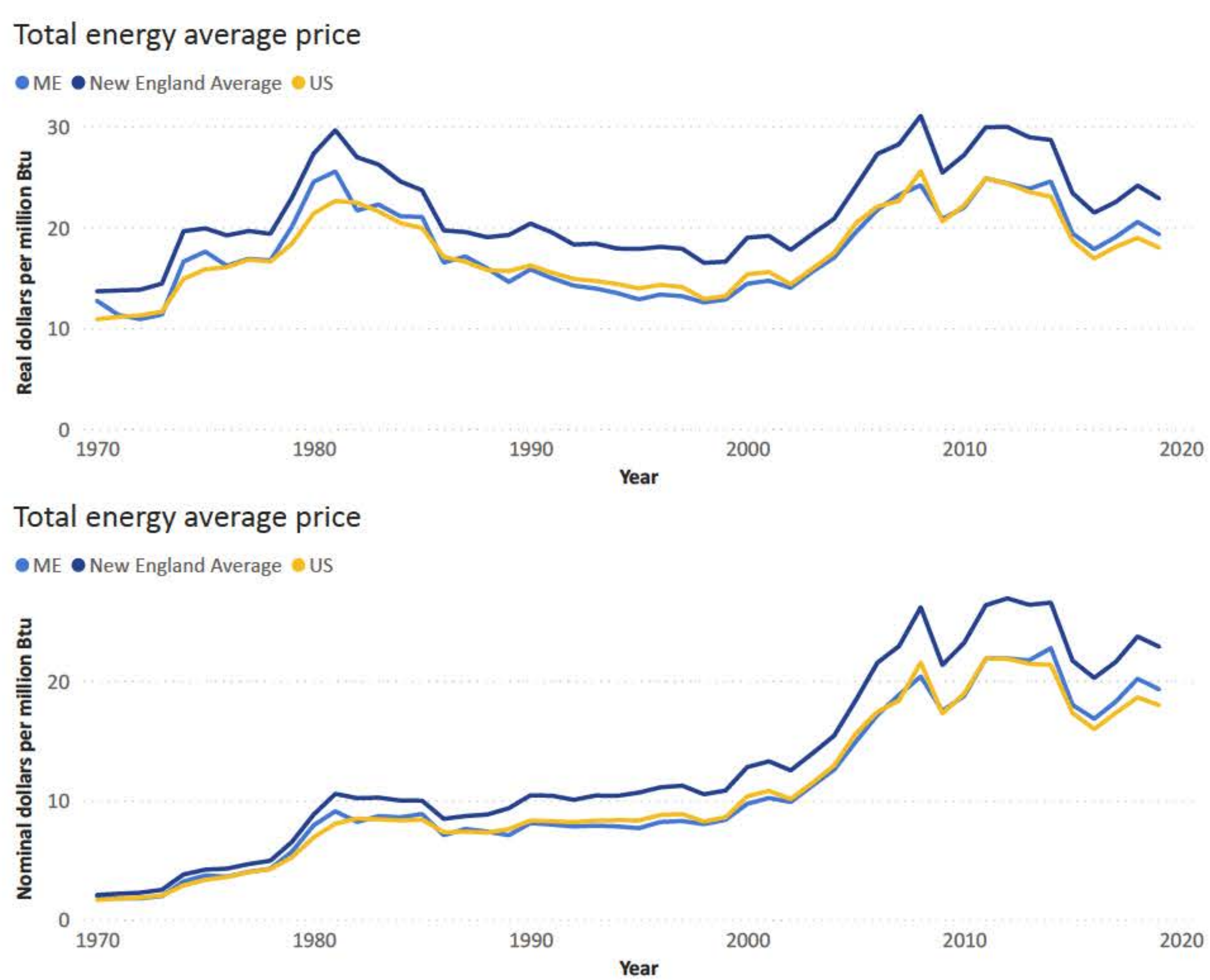
When considering the flow of electricity throughout the New England grid, net interstate flows of electricity represent the difference between the sum of electricity sales and losses within a state and the total amount of electricity generated within that state. A positive number indicates that more electricity (including associated losses) was sold or consumed than was generated within the state during the year; conversely, a negative number indicates that more electricity (including associate losses) was generated than sold or consumed in the state during that year. Figure 10, page 15, comparing in-state electricity sales to generation, shows that within this simplistic calculation, Maine has been a net exporter of electricity from 2010-2018. In 2019, Maine was a slight net importer, by 0.33% of Maine's total electricity load. GEO is monitoring this trend and will update figures when new EIA data is available.

The full status of Maine's energy generation, consumption, efficiency, and pricing can be found in the **Appendix – The Maine Energy Data Profile**.

Energy Prices

When looking specifically at electricity prices, the US EIA provides data on average electricity price, utilizing a simplified calculation of total state expenditures on electricity (based on retail sales) over the total amount of electricity consumed. Maine has experienced higher electricity prices than the U.S. average; however, has been consistently below the New England average as shown in Figure 12.

Figure 11 - Total Energy Average Price

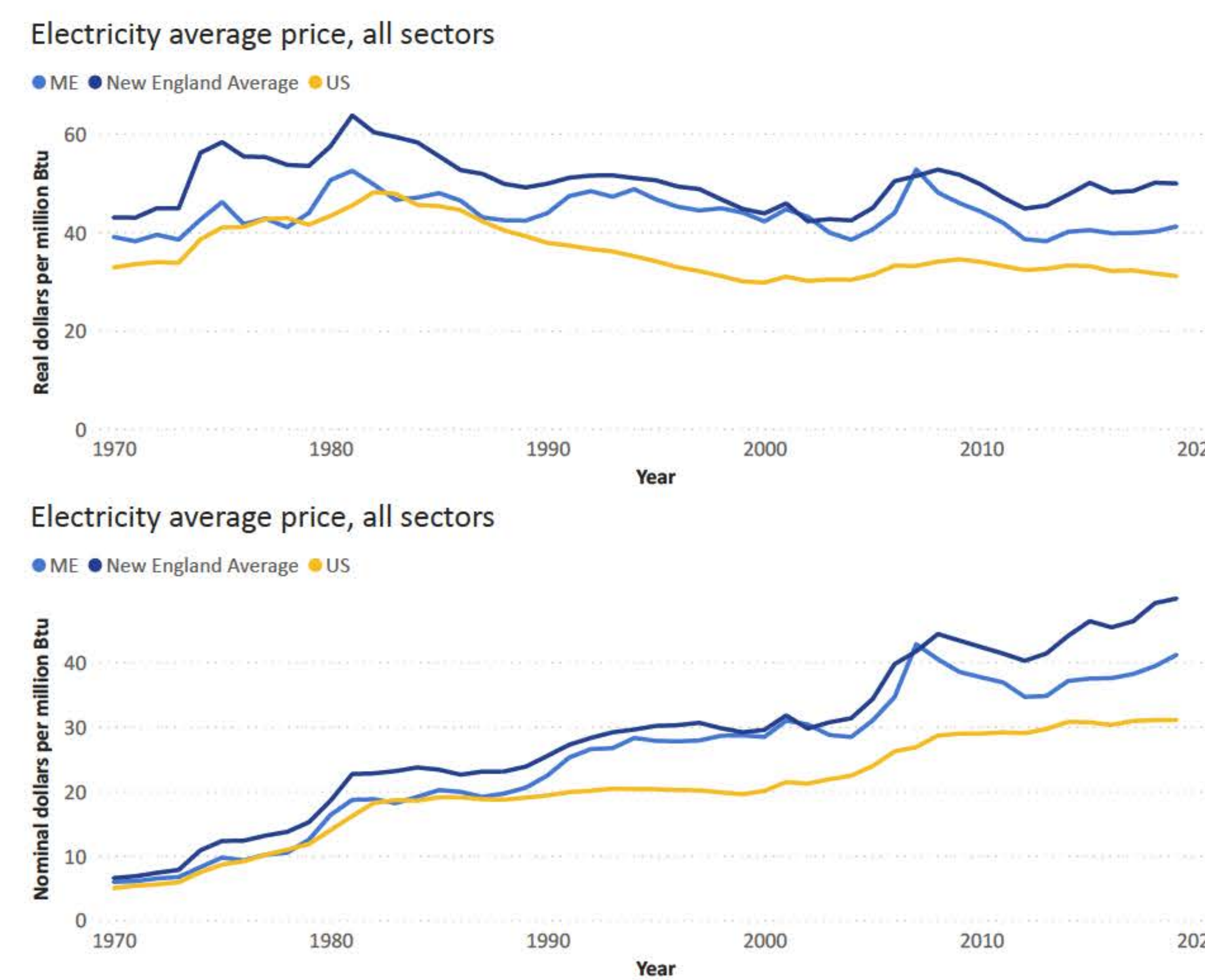


Another approach to analyzing electricity prices is by looking at the standard offer price trends. Electricity customers have the option of choosing an electricity supplier or using the default supplier, which is commonly referred to as the standard offer service. The standard offer suppliers are chosen in a competitive bidding process conducted by the PUC.

The COVID-19 pandemic has had unprecedented impacts on our way of life as well as our energy systems. Around the world energy demand decreased significantly, resulting in an "historic energy demand shock that led to lower greenhouse gas emissions, decreases in energy production, and sometimes volatile commodity prices" according to EIA.[14] New England experienced these impacts as well with decreased electricity consumption and lower than average fuel prices.

The result of recent standard offer prices demonstrate the impacts of the pandemic on the electric system, in addition to regional reliance on natural gas. Following two years of low standard offer rates when compared to prior years, in late 2021, the Maine PUC announced increased standard offer rates ranging from approximately 66-89% depending on the utility and customer class (i.e., small, medium, or large customers). This

Figure 12 - Electricity average price for all sectors



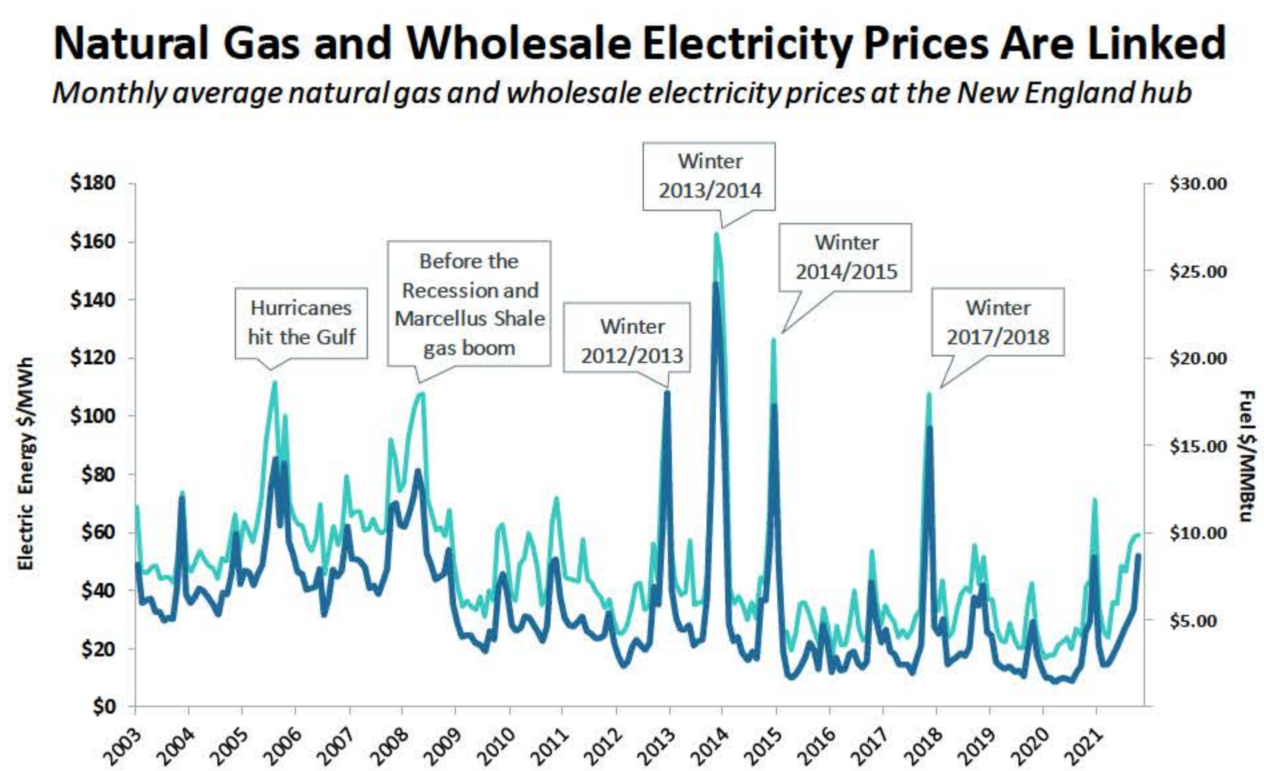
14 https://www.eia.gov/todayinenergy/detail.php?id=46636

increase is due primarily to the increased global market prices of natural gas and fossil fuels as the economy recovers from the initial impacts of the pandemic, as well as the New England grid's reliance on said fuels. The 2013-2021 standard offer rates for residential and small commercial customers[15] ranged from $0.06-0.09 per kWh. In 2021, the standard offer rate for 2022 increased to roughly $0.11-0.12 per kWh as a result.

As can be seen in Figure 13 from ISO-NE, below, natural gas prices have historically and continue to follow the regional average natural gas price trends at the New England hub. This further demonstrates that as long as the regional system continues to rely heavily on natural gas, prices will be subject to volatility driven by global fossil fuel markets.

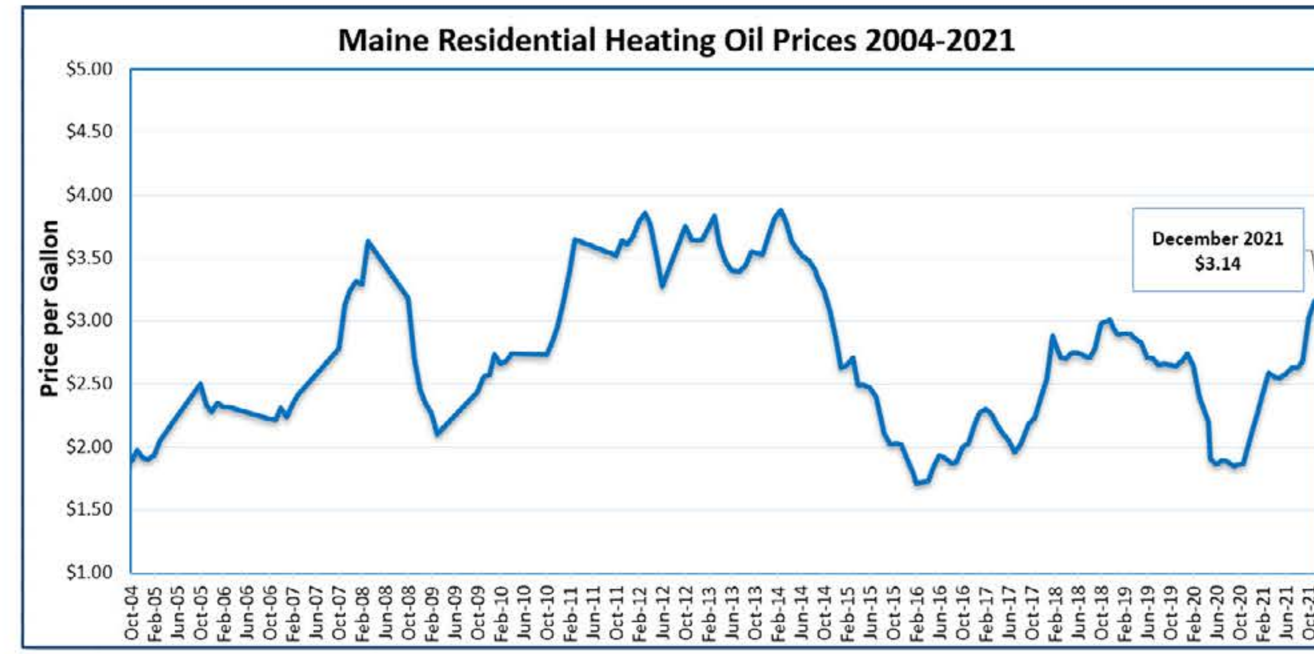
Similar trends of pandemic impacts can be seen in heating fuel prices in Maine that are tracked weekly by the GEO, particularly for home heating oil prices as shown in Figure 14. As this report was being finalized, global energy prices were experiencing unprecedented volatility following the Russian invasion of Ukraine, including significant increases in the global price of oil.

Figure 13 - New England hub historic average natural gas and wholesale electricity prices through December 2021 [ISO-NE]



15 Detailed information regarding medium and large commercial customer can be found at https://www.maine.gov/mpuc/regulated-utilities/electricity/standard-offer-rates

Figure 14 – Maine Residential Heating Oil Prices, 2004-2021, through December 2021 [GEO SHOPP Survey]



OVERVIEW & POLICY UPDATES

Electricity

Electricity Grid Systems

Maine is part of one regional electric grid, managed by ISO New England (ISO-NE), and a northern Maine grid managed by the Northern Maine Independent System Administrator (NMISA).

Northern Maine is unique in that it is the only region in the country that is not directly connected to the U.S. regional grid system. Instead, it is directly connected to New Brunswick and is managed by NMISA. NMISA is a non-profit entity responsible for the administration of the northern Maine transmission system and electric power markets in Aroostook and Washington counties, with a load of approximately 130 MW. As stated on the NMISA website:

> The NMISA is responsible for providing an independent, objective and non-discriminatory administration of all transmission access, transmission information access, and related functions, and will monitor and operate the markets in Northern Maine for energy, ancillary, and other services. The NMISA administers the transmission systems of the investor-owned and cooperatively-owned utilities in Northern Maine, and its members also include all municipally-owned utilities, generators, suppliers of energy, and large retail customers operating in the service area.[16]

The remainder of the state is connected to a New England regional electric grid, managed by ISO-NE, the independent, not-for-profit corporation authorized by the Federal Energy Regulatory Commission (FERC) to perform three critical, complex, and interconnected roles for the region spanning Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and most of Maine. According to ISO-NE, its three critical roles are: (1) grid operation (coordinating and directing the flow of electricity over the region's high-voltage transmission system); (2) market administration (designing, running, and overseeing the billion-dollar markets that attract a large and diverse mix of participants to buy and sell wholesale electricity

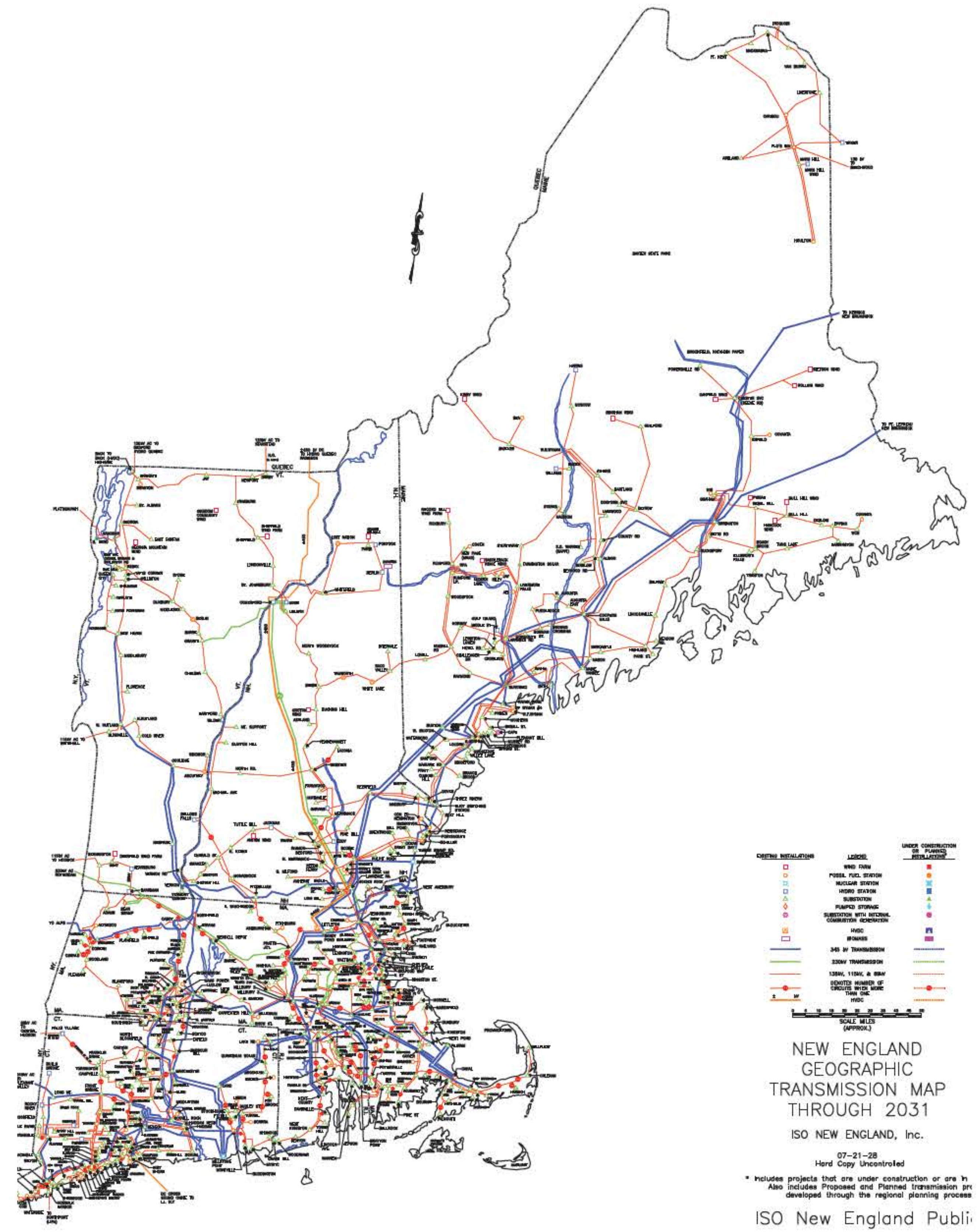
16 https://www.nmisa.com/

at the most competitive prices); and (3) power system planning (conducting studies, analyses, and planning to make sure New England's electricity needs will be met over the next 10 years). ISO-NE does not, however: (1) oversee retail electricity sales or delivery; (2) own, maintain, or repair any of the power grid's infrastructure including power plants, power lines, and substations; (3) enact or establish energy policy; or (4) have a financial stake in companies that own the grid infrastructure.[17]

Given the complex nature of electricity within a regional grid, generation in one state is not necessarily consumed within that state. Additionally, renewable energy generation is assigned a Renewable Energy Certificate (REC) for every megawatt-hour of electricity produced, and RECs can be sold by a Maine generator to an entity in Maine or in another state to meet Renewable Portfolio Standards (RPS) or private industry or individual renewable energy goals.

17 ISO-NE. (n.d.). Our Three Critical Roles. Retrieved from https://www.iso-ne.com/about/what-we-do/three-roles

Figure 15 - New England Geographic Transmission Map Through 2031 [ISO-NE][18]



18 Geographic locations are approximate and in some cases are stylized for simplicity.

Renewable Energy

Renewable Portfolio Standard (RPS)

In 2019, Governor Mills signed legislation (P.L. 2019 Ch. 477) with bipartisan support for a Renewable Portfolio Standard (RPS) policy that increased Maine's RPS to 80% by 2030, an increase from 40%, and set a goal of 100% by 2050. Maine's RPS establishes the portion of electricity sold in the state that must be supplied by renewable energy resources.

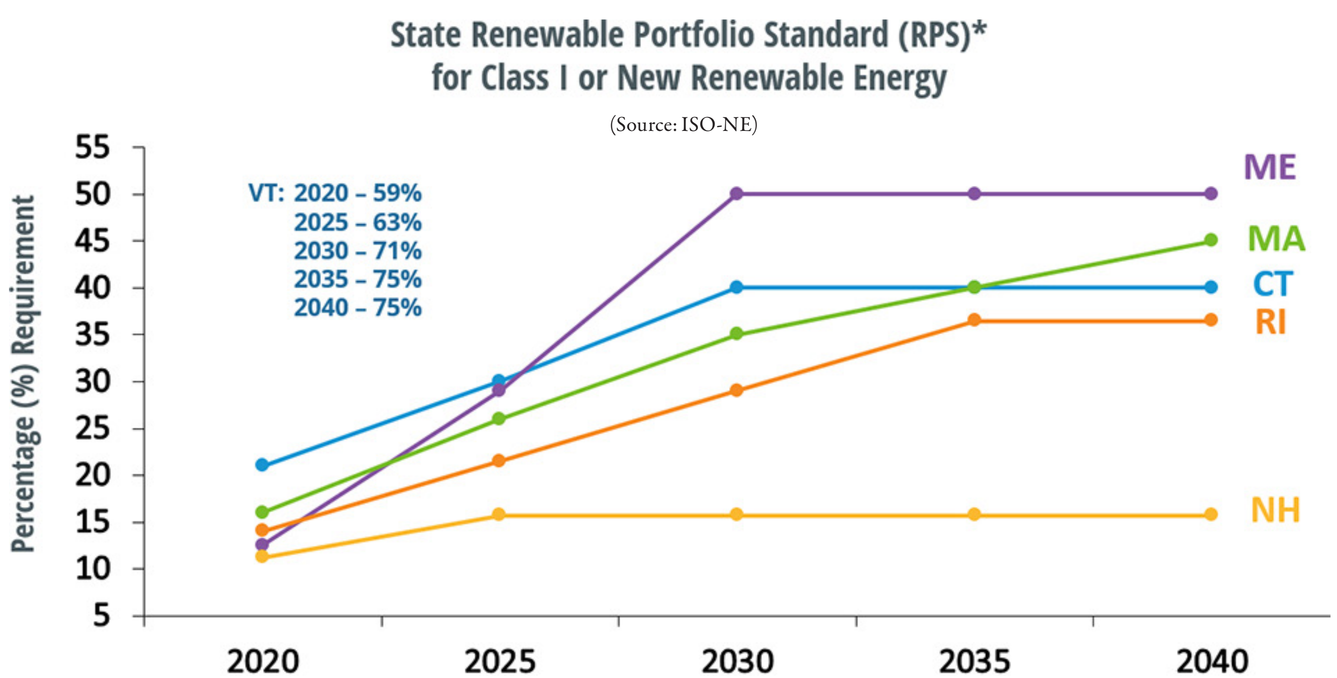
Maine now has some of the most ambitious renewable energy requirements in the country, and the highest in the New England region. The below ISO-NE chart (Figure 16) shows the requirements for Class I, or new renewable energy, by New England states through 2040.

As the state meets greenhouse gas emissions reduction requirements, the electric sector will be expected to support rapid load growth due to electrification of end uses, particularly in the transportation and building sectors. This load growth will increase the amount of renewable energy generation needed to meet the state's RPS requirements.

In 2021, Maine will have reached 45% of retail sales of electricity provided by renewable resources, on track with statutory requirements.[19]

In February 2021, the GEO released a ten-year Renewable Energy Goals Market Assessment (REGMA). This study, as required by statute, assesses the renewable energy market and its ability to meet the state's clean energy requirements.

Figure 16 – State Renewable Portfolio Standard (RPS) for Class I [ISO-NE][20]



Notes: State RPS requirements promote the development of renewable energy resources by requiring electricity providers (electric distribution companies and competitive suppliers) to serve a minimum percentage of their retail load using renewable energy. Connecticut's Class I RPS requirement plateaus at 40% in 2030. Maine's Class I/IA RPS requirement increases to 50% in 2030 and remains at that level each year thereafter. Massachusetts' Class I RPS requirement increases by 2% each year between 2020 and 2030, reverting back to 1% each year thereafter, with no stated expiration date. New Hampshire's percentages include the requirements for both Class I and Class II resources (Class II resources are new solar technologies beginning operation after January 1, 2006). New Hampshire's Class I and Class II RPS requirements plateau at 15.7% in 2025. Rhode Island's requirement for 'new' renewable energy plateaus at 36.5% in 2035. Vermont's 'total renewable energy' requirement plateaus at 75% in 2032; it recognizes all forms of new and existing renewable energy and is unique in classifying large-scale hydropower as renewable.

19 https://www.maine.gov/tools/whatsnew/attach.php?id=4433818&an=1. It is anticipated that the PUC will issue its 2021 report in March 2022.

20 https://www.iso-ne.com/about/key-stats/resource-mix

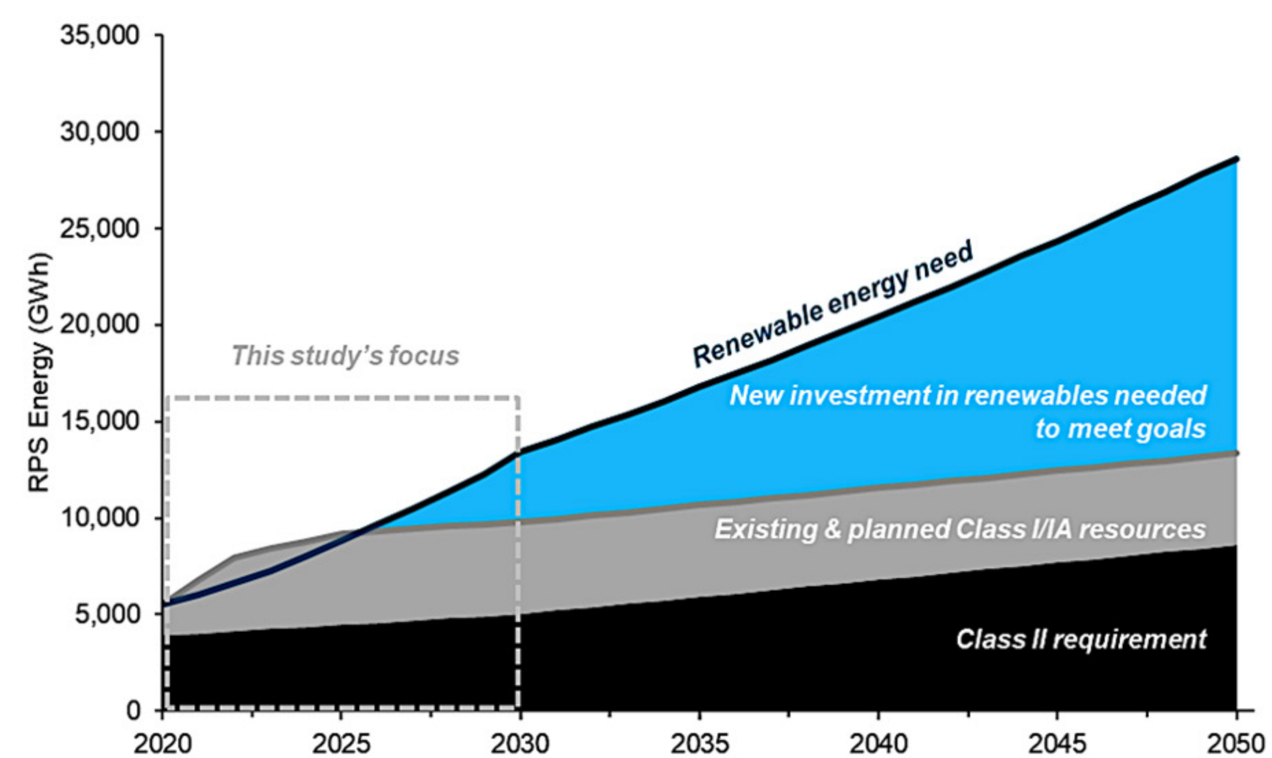
This includes analysis and review of the opportunities, potential, and challenges facing the state in reaching Maine's 80% RPS by 2030. The GEO retained Energy & Environmental Economics (E3) and Applied Economics Clinic (AEC) to develop this assessment.

The REGMA analyzes six future scenarios to explore plausible renewable portfolios that would enable Maine to meet its 2030 RPS requirement. The scenarios were informed by stakeholder feedback and were meant to reflect unique characteristics in Maine – onshore resource potential, land use considerations, transmission availability, offshore wind potential, and coordination with the rest of New England. Comparing the resource portfolios, costs, and equity impacts across the scenarios provides insight into the possible effects of each of these unique characteristics on Maine's electric sector and population. Taken together, these individual efforts paint a larger picture of the opportunities and challenges that Maine may face as it works towards achieving the RPS.

Key findings of the REGMA that provide insight into how Maine may achieve its RPS target in the next decade include:

- Maine has multiple pathways to meet its RPS;
- Maine is on track to meet its near-term RPS requirement through 2026, but new resources will need to be online to meet increasing goals thereafter;
- Transmission will be a key driver of renewable development;
- Storage paired with solar provides value to Maine's grid;
- A technologically diverse portfolio helps lower risk;
- Regional coordination on building transmission can help lower the costs of meeting Maine's RPS; and
- Energy equity considerations cut across four dimensions: resource diversity, customer-sited resources, geographic resource distribution, and cost.

Figure 17 – Renewable energy need, assumed baseline RECs, and existing Class II resources [REGMA]



The scenarios and their results, summarized in the tables below, are not meant to be prescriptive and are instead intended to highlight various considerations to support policy discussions and decisions related to the RPS.

The analysis used the load forecast from the Maine Climate Council's Electric Sector modeling analysis, which demonstrates a load forecast that meets Maine's 2030 GHG reduction targets.[21] The focus of the study was the Class IA requirement that is expected to drive the need for new renewables in Maine. Class II RECs are assumed to continue to be available to Maine and are not expected to drive significant investment in new renewables in the short-term.

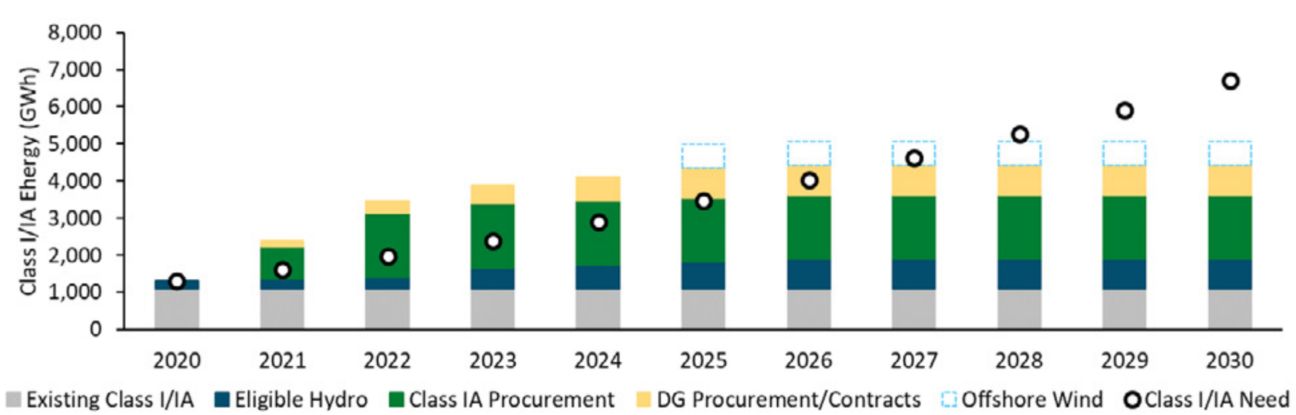
Class I/IA resources are new renewable resources with specified requirements around the resource type, capacity limit and the vintage requirements for the new renewable resource requirement. Class I/IA resources can be: fuel cells; tidal power; solar arrays and installations; wind power installations; geothermal installations; hydroelectric generators that meet all state and federal fish passage requirements; and biomass generators, including generators fueled by landfill gas. Except for wind power installations, the generating resource must not have a nameplate capacity that exceeds 100 MW. Class II resources can include existing renewable resources listed above, as well as efficient resources, as defined by statute.

Using the Maine Climate Council's Electric Sector modeling load forecast and anticipated REC needs, Figure 17 on page 23, shows the renewable energy need (dark blue line) and assumed baseline RECs provided by existing and planned Class I/IA resources (gray band, excludes offshore wind) and existing Class II resources (black band).

In Figure 18 below, the Class I/IA REC need is indicated by the black circle, and RECs from existing and planned procurements are also shown. Maine is projected to have a sufficient supply of I/IA RECs through 2026, and new REC-generating resources are required by 2026 for most scenarios. While the exact mixture of REC sources used to satisfy Maine's RPS may not be precisely what is shown in this figure, it is anticipated that as Class I/IA REC need increases in Maine, their price will also increase, in turn driving the sale of RECs to Maine.

The modeling projects that by 2030, onshore wind can play a critical role in helping Maine meet its RPS, as demonstrated in Figures 19 and 20 below. It is the largest resource in four of the six scenarios and is part of the portfolio in five out of six scenarios, due to its low

Figure 18 – Class I/IA REC need through 2030 [REGMA]



21 https://www.maine.gov/future/initiatives/climate/climate-council/reports

Figure 19 – Renewable build comparison in 2030 across scenarios [REGMA]

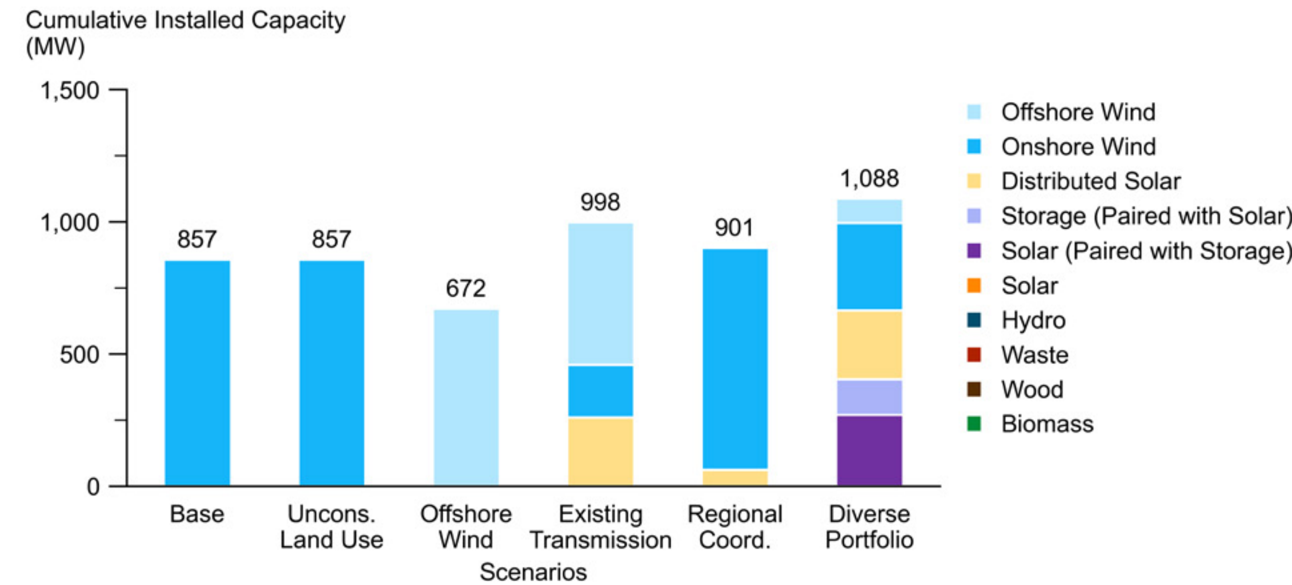
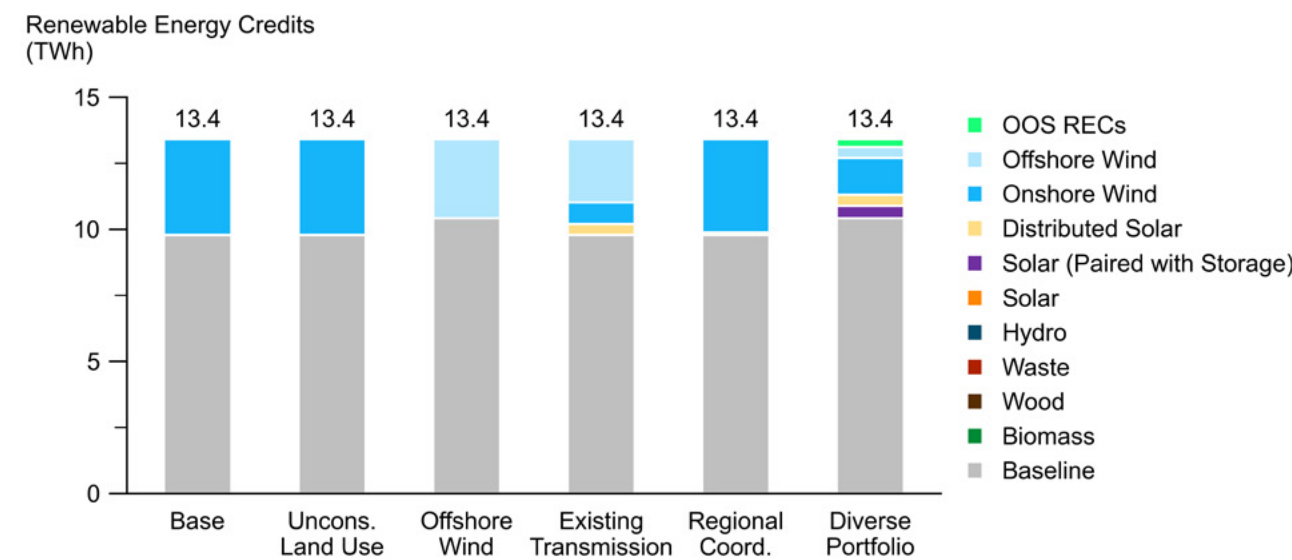


Figure 20 – RECs from all sources for all scenarios in 2030 [REGMA]



cost and high-capacity factor. Building onshore wind to the capacities seen in most scenarios would require transmission to be developed. The results indicate that offshore wind, distributed generation, and pairing solar with storage will likely play an important role in meeting the near-term RPS requirement.

The modeling projects that by 2040, onshore wind still makes up most of the resource portfolio in four of the six scenarios, as demonstrated in Figures 21 and 22 below. However, a larger amount of distributed generation and offshore wind may be important, particularly as they help to avoid expensive transmission upgrades in southern Maine. In addition, as the best wind resources are utilized in Western Maine, solar paired with storage may play a role in supplying the incremental RECs needed for Maine to meet its RPS in 2040. While most RECs are sourced from baseline resources, they represent a smaller percentage of total RECs in comparison to 2030. It's important to note that additional new resources should be planned and built, in the case that RECs from existing and planned resources do not materialize as expected.

Figure 21 – Renewable build comparison in 2040 across scenarios [REGMA]

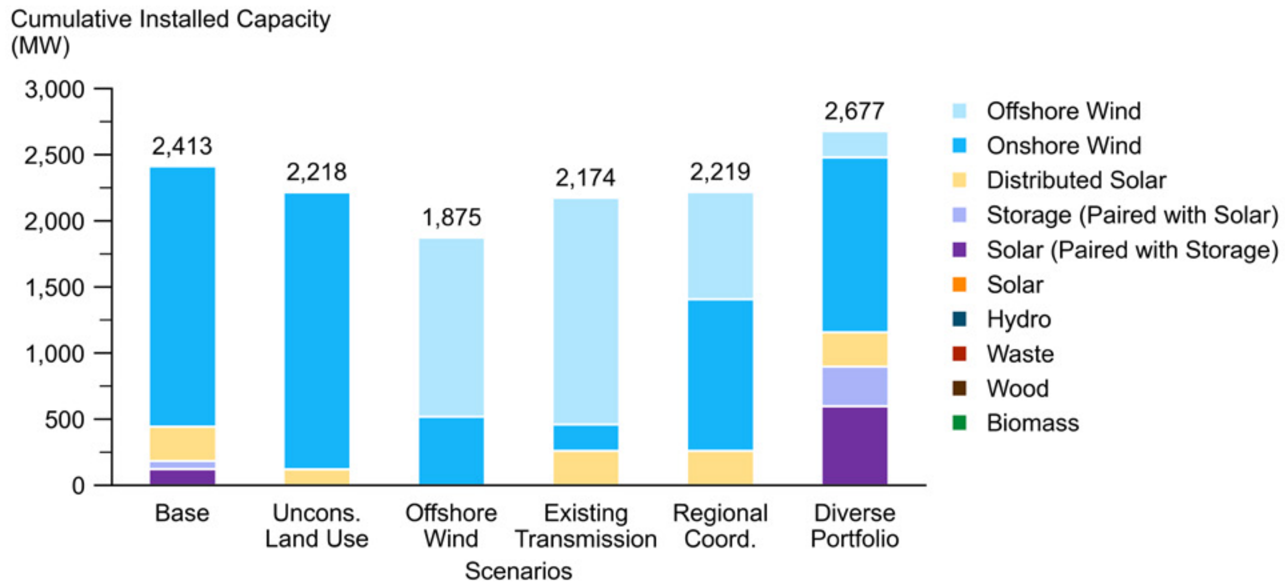
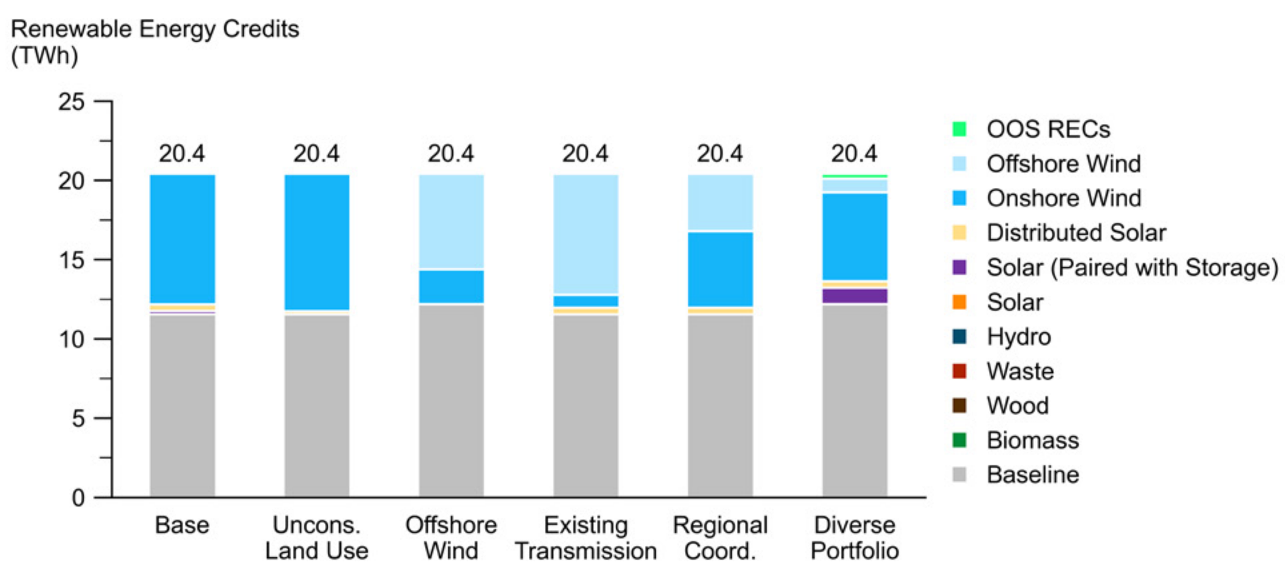
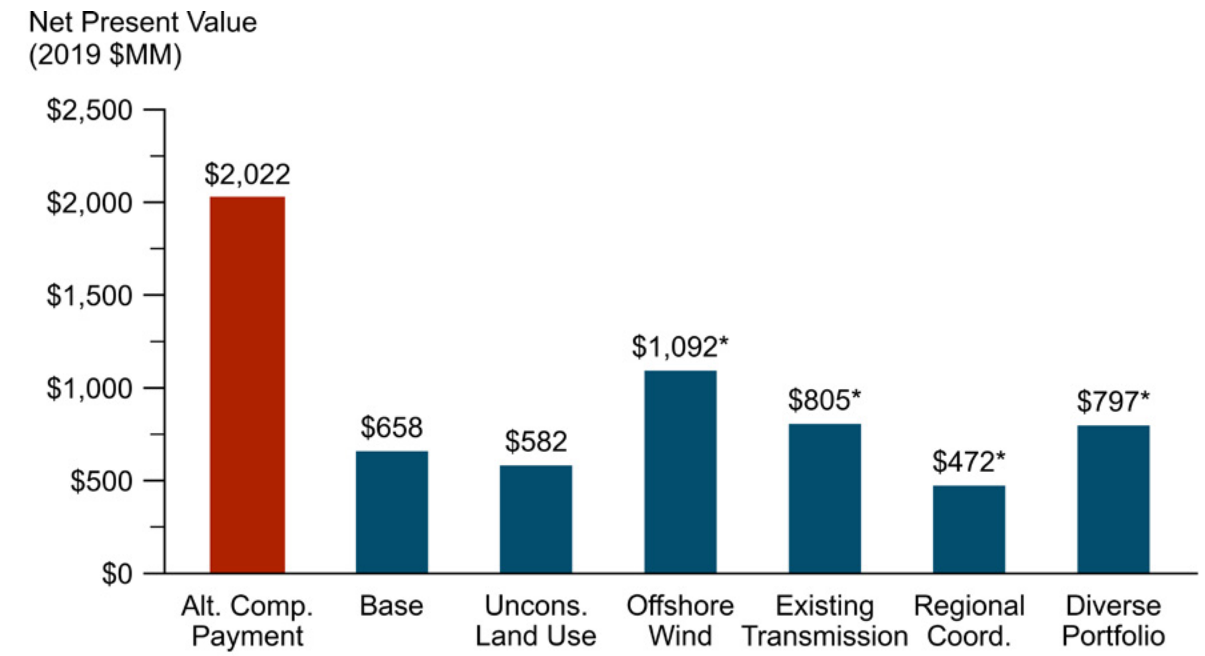


Figure 22 – RECs from all sources for all scenarios in 2040 [REGMA]



The report includes assumptions for cost and potential for each of the technologies considered in the study that are deemed eligible in Maine's legislation to meet the state's RPS. The study aims to find economical strategies for Maine to meet its RPS requirements. Figure 23 below shows the net present value of costs from 2025 to 2045 of each of these strategies. For the modeled scenarios, this is the net present value of the resultant portfolio. As a point of comparison, the cost of using the Alternative Compliance Payment (ACP, assumed to be 2019 \$49.02/MWh) to meet the RPS is shown. It is by far the most expensive method to comply with the RPS when compared to costs of the six scenarios analyzed.

Figure 23 – Net Present Value of costs for each scenario [REGMA][22]



Maine PUC RPS Procurements

In addition to increasing Maine's RPS, LD 1494 also directed the Public Utilities Commission (PUC) to procure 14% of Maine's electricity load via long-term contracts. The legislation directed the PUC to review the bids through a weighted cost-benefit analysis scheme, with 70% consideration to ratepayer benefits or overall cost and 30% consideration towards the economic benefits that the project would provide the state and host community. These economic benefits could include, but were not limited to: capital investments to improve long-term viability of an existing facility; employment; payments to host communities; excise, income, property and sales taxes; purchases of goods and services; and avoided emissions. Selected projects are required to prove compliance with the economic benefits they guarantee.

The procurement was broken into two tranches. The first tranche in 2020 resulted in long-term contracts with 17 facilities (15 new facilities, 2 existing facilities) with a total commitment of 546 megawatts (MW) of procured capacity of solar, onshore wind, biomass, and hydro. The weighted average energy price of these projects was a competitive \$35 per MWh. Some of the economic benefits include more than 450 full-time equivalent jobs during construction, initial capital spending of at least \$145 million, additional spending of \$3 million annually, tax payments averaging \$4.7 million annually, and a reduction of greenhouse gas emissions by 500,000 tons per year.[23] The second tranche in 2021 resulted in contracts with 7 projects (6 new facilities, 1 existing facility) with a total commitment of 422 MW of procured capacity from solar and onshore wind. The weighted average energy price of these projects was an even more competitive price of \$31 per MWh. The economic benefits of this second selection includes more than 175 full-time equivalent jobs during construction, initial capital spending of at

22 Starred bars are those scenarios with high amounts of offshore wind in their portfolios and thus have significant uncertainty in the onshore transmission costs associated with interconnecting offshore wind

23 Maine PUC Docket 2021-00033

least $86 million, additional spending of $2.6 million annually, tax payments averaging $4.1 million annually, and a reduction of greenhouse gas emissions by 260,000 tons per year as of 2021.[24] If these low-cost projects were online today, Maine ratepayers would be saving more than $150 million on electricity costs this year.

Next Steps

The GEO will continue to work with the legislature and the PUC to consider procurements, as necessary, that result in low-cost, competitively priced long-term contracts for renewable generation to meet our clean energy needs. In structuring any future procurements, it is important to consider benefits of bundled vs. unbundled contract design as well as the economic benefits of projects. The GEO will continue to monitor regional RPS trends and pursue further analysis of how to accomplish the statutory goal of 100% clean electricity by 2050, beyond the 80% by 2030 requirement.

In addition consideration should be given to recommendations and scenario analysis from the Renewable Energy Goals Market Assessment[25] (REGMA), and options to meet future need to ensure resources are operational when needed. As recommended by REGMA, anticipatory transmission planning and development can be utilized as a tool by policymakers to help ensure that cost-effective, high-quality resources are built to meet on time to meet our need, given the amount and cost of transmission required for renewable development in Maine. The potential for regional coordination should be actively considered in all future transmission planning and related policy considerations.

Solar

Maine has seen robust growth in solar photovoltaic (PV) installation since 2019, with generally consistent growth in small-scale, typically behind-the-meter installations, including on rooftops; a number of several community-scale distributed projects; and growth in larger utility-scale solar installations. Solar growth is attributable to multiple factors, including:

- Continued cost decreases driven by efficiencies of scale and industry maturity;
- Effective policy supporting development of clean energy; and
- Increasing consumer awareness and demand for clean energy.

Maine's solar industry supported approximately 800 jobs in 2019, the latest year with data available as of this report's publication.[26] It is likely this number has risen given the recent increase in solar generation installed (see Fig. 24) and the strong growth projections for solar construction in the coming years (see Fig. 26). The COVID-19 pandemic and associated economic recovery may also impact employment numbers in the near term.

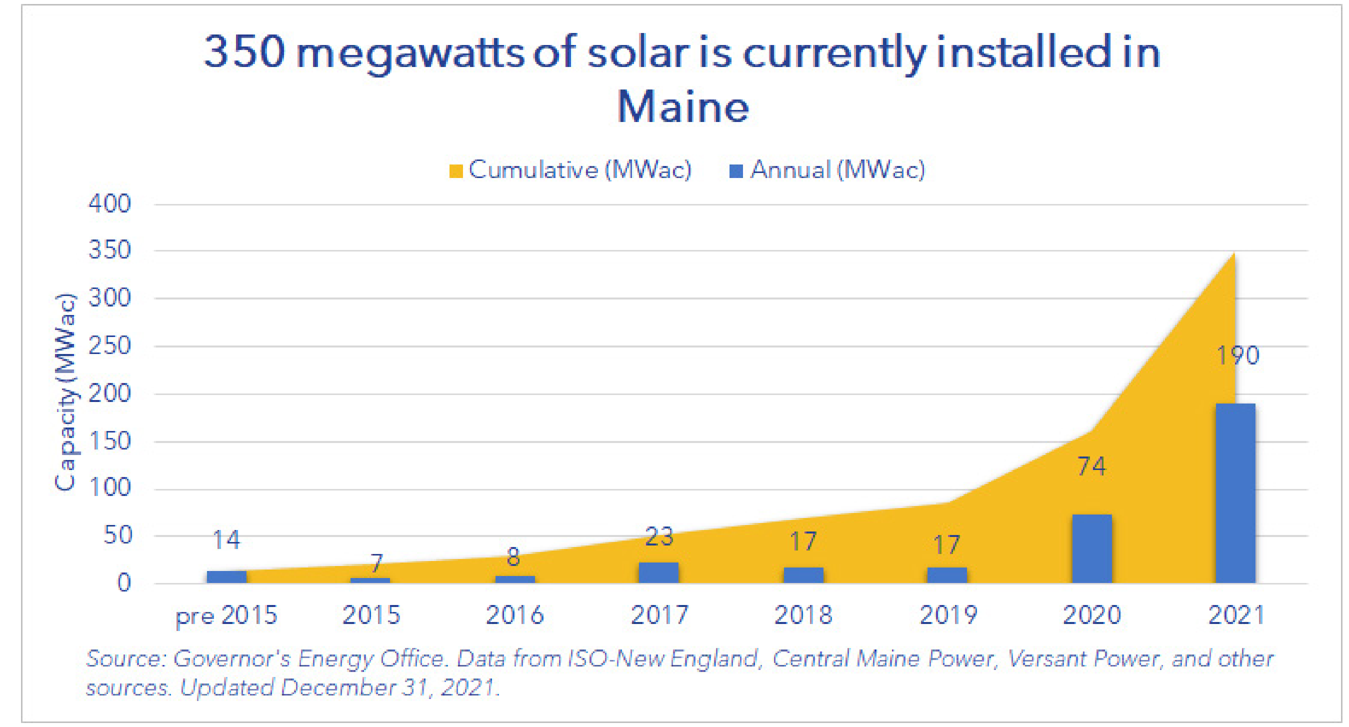
Large scale solar projects are under development across the state, driven by demand in the state and across regional markets. These projects include a total of 773 MW from 20 projects awarded contracts by the Maine PUC through procurements conducted as required by P.L. 2019 ch. 477 (LD 1494), as well as various projects developed under contract with independent power purchasers. Figure 25 shows total and per-capita operational solar capacity by county, including both distributed resources discussed in more detail below as well as larger utility-scale resources and solar resources serving Maine's consumer-owned utilities in Kennebunk and Madison.

24 Maine PUC Docket 2021-00004

25 https://www.maine.gov/energy/studies-reports-working-groups/current-studies-working-groups/renewable-energy-market-assessment

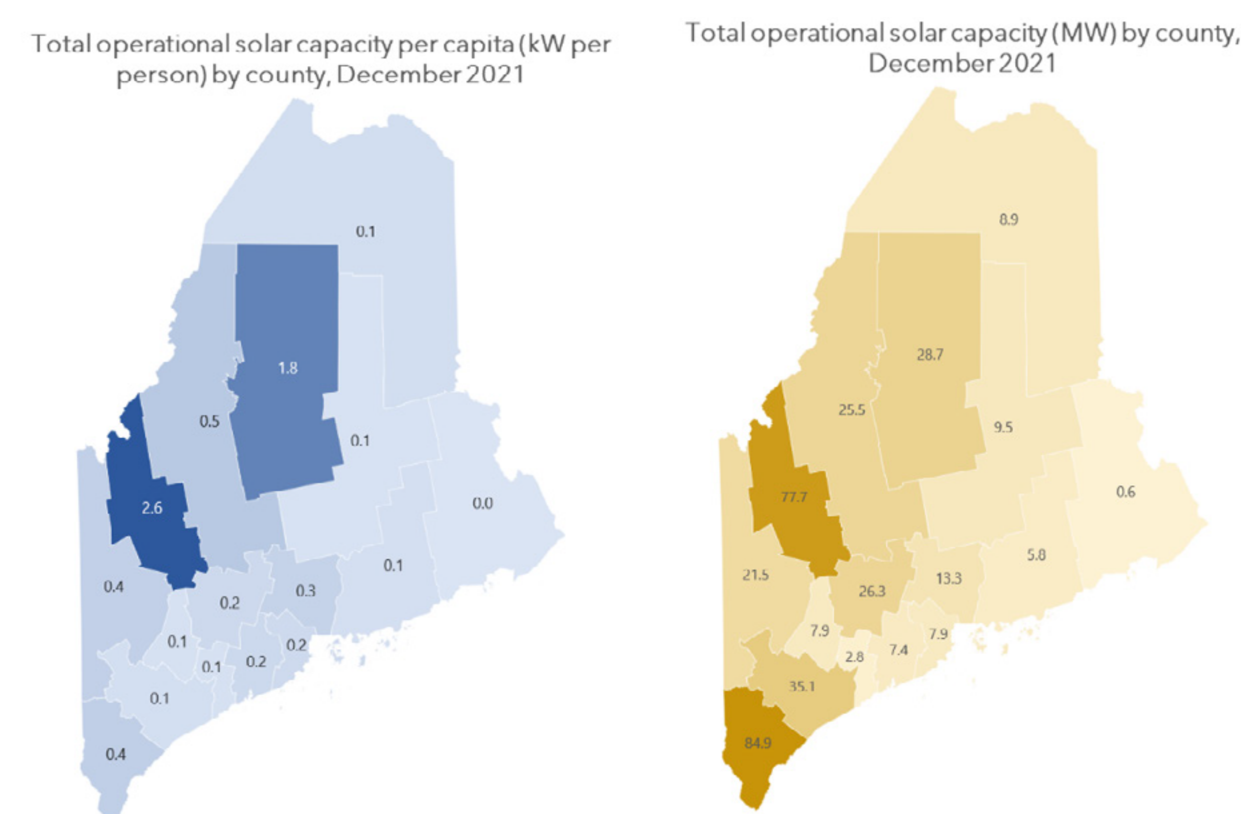
26 Strengthening Maine's Clean Energy Economy, November 2020. https://www.maine.gov/energy/sites/maine.gov.energy/files/inline-files/StrengtheningMainesCleanEnergyEconomy_Nov92020.pdf

Figure 24 - Solar generation installed in Maine



Annual and cumulative growth in installed solar capacity (MWac) in Maine by year.
Of the total 350 MW, 150 MW are distributed generation and 200 MW larger-scale projects

Figure 25 - Total and per-capita operation solar capacity by Maine county, 2021 [ISO-NE, CMP/Versant and GEO]



Distributed solar

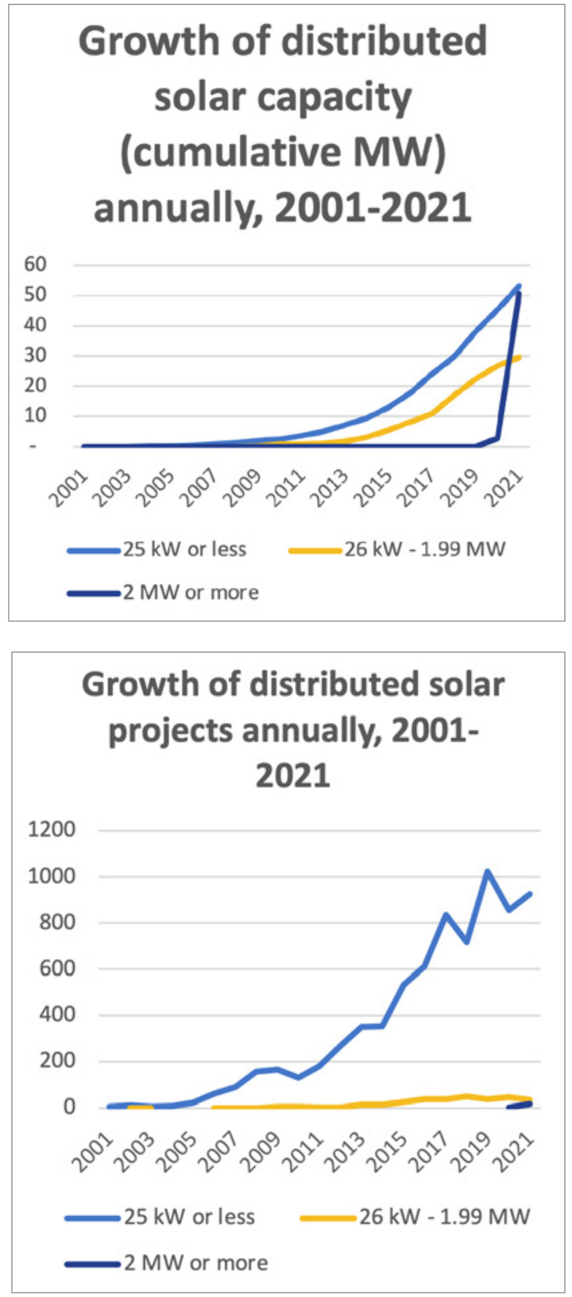
A "distributed generation resource" is defined as "an electric generating facility with a nameplate capacity of less than 5 megawatts that uses a renewable fuel or technology under [35-A MRS] section 3210, subsection 2, paragraph B-3 and is located in the service territory of a transmission and distribution utility in the state." Given the nature of this definition, it is likely that virtually all distributed generation resources are enrolled in the net energy billing programs established under 35-A MRS §3209-A and §3209-B.[27] Approximately 75% of operational capacity enrolled in the net energy billing programs is from solar resources, with the remainder largely representing small hydro (19%), wind (4%), and various biofuels and combined heat and power (2%). Solar resources also account for virtually all of the capacity in the net energy billing program queue.

State policy changes enacted in 2019 expanded the size of projects qualified for net energy billing from 660 kilowatts to less than five megawatts, and removed a cap of 10 customer accounts eligible to virtually net meter from the same facility. These changes enabled the expansion of "community solar" projects, many of which require multiple years to develop and therefore are not yet visible in Figure 24. Figure 27 shows the number of solar projects enrolled in net energy billing programs.

The number of solar projects installed annually has grown as the industry matures and costs decline. Variation in recent years may be attributed in part to factors including changes in federal tax credits, state programs, and the COVID-19 pandemic.

The net energy billing program has stimulated significant investment in distributed solar generation, with projects under development in every county. Figures 27 and 28 illustrate the status of solar projects enrolled or enrolling in net energy billing by program and by project size. Active Operational projects are currently operating; Active Not Operational projects have executed net energy billing agreements with the applicable utility, and Pending projects have not yet executed a net energy billing agreement but have initiated the process with the utility.

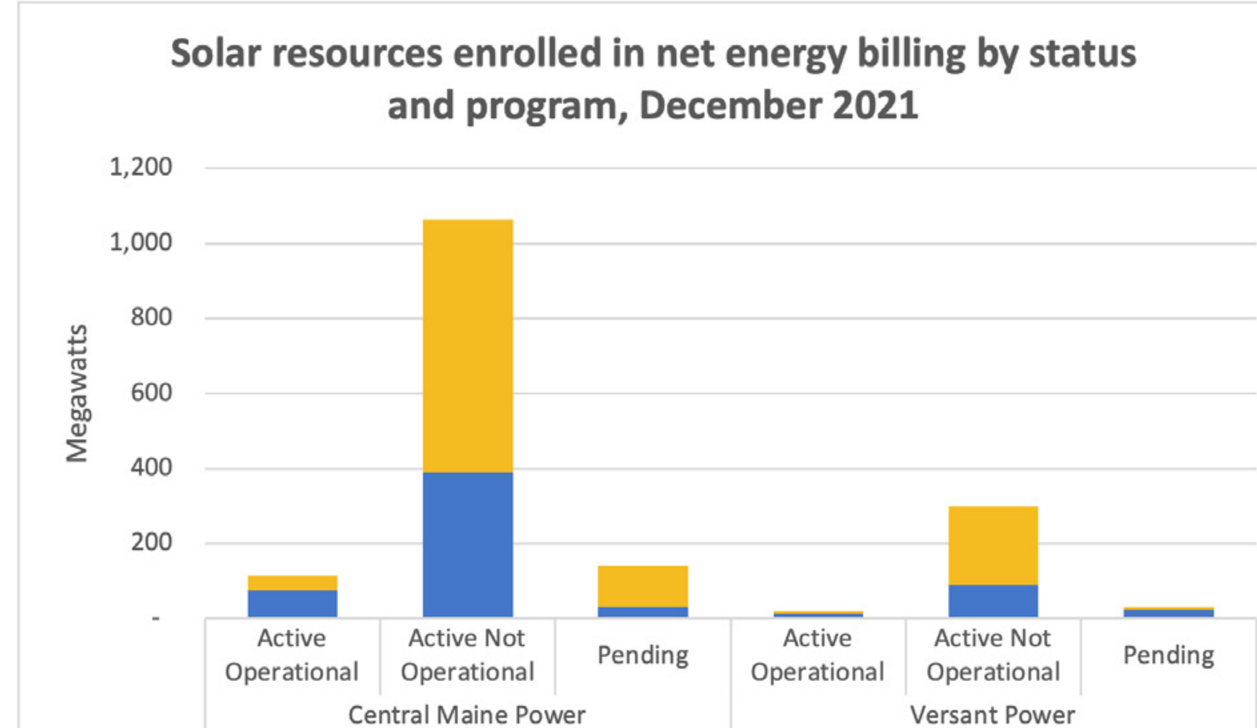
Figure 26 – Distributed Generation solar projects enrolled in net energy billing programs [CMP/Versant]



The number of solar projects installed annually has grown as the industry matures and costs decline. Variation in recent years may be attributed in part to factors including changes in federal tax credits, state programs, and the COVID-19 pandemic.

27 Unless otherwise noted, all analyses presented in this section are based on data provided monthly by Central Maine Power and Versant Power to the Maine Public Utilities Commission filed in docket 2020-00199.

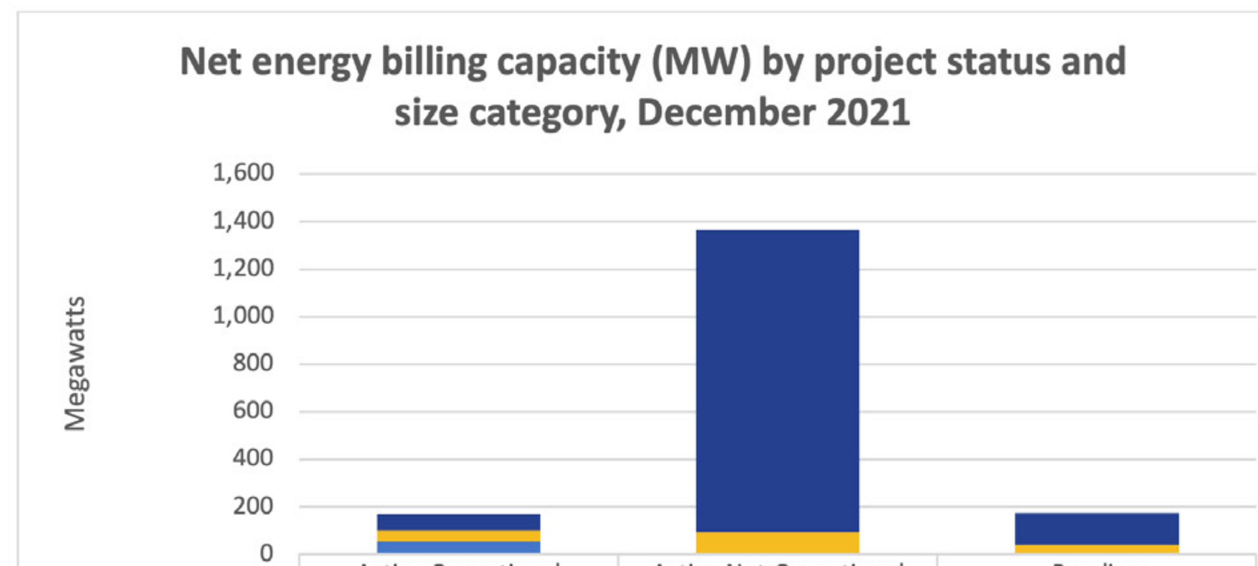
Figure 27 – Solar resources enrolled in net energy billing by status and program, October 2021 [CMP/Versant]



	Central Maine Power			Versant Power		
	Active Operational	Active Not Operational	Pending	Active Operational	Active Not Operational	Pending
tariff	38	675	111	6	211	5
kWh	76	389	31	14	89	25

A significant pipeline of distributed solar projects exists for the net energy programs, with projects enrolled in both the kWh (§3209-A) and tariff (§3209-B) programs.

Figure 28 – Solar resources enrolled in net energy billing by status and size, October 2021 [CMP/Versant]



	Active Operational	Active Not Operational	Pending
2 MW or more	71.1	1,268.1	130.3
26 kW - 1.99 MW	45.8	96.2	39.0
25 kW or less	54.3	-	3.1

Distributed Generation Stakeholder Group

P.L. 2021 Ch. 390 (LD 936) established a goal of 750 MW of distributed generation under the net energy billing programs. The bill also set a limit on distributed generation resources between 2 and 5 MW eligible for enrollment in net energy billing, and concludes the program for these resources on December 31, 2024. This legislation established a goal of 750 MW of distributed generation under the net energy billing programs. A total of 151 MW of distributed generation resources are currently operating through the net energy billing programs, 126 MW of which are distributed solar. There are more than 1,500 MW of additional distributed solar in the development queue, not all of which are likely to be constructed.[28]

The GEO has convened the Distributed Generation Stakeholder Group, pursuant to this legislation, to issue recommendations that support continued development of renewable energy, including solar, through cost-effective distributed generation. The charge of this stakeholder group is to "consider various distributed generation project programs to be implemented between 2024 and 2028 and the need for improved grid planning."

The initial report from this group was submitted on December 31, 2021, with a final report required by 2023.[29]

Agricultural Solar Stakeholder Group

To ensure responsible siting of solar energy on agricultural lands, the GEO and the Maine Department of Agriculture, Conservation and Forestry (DACF) convened an Agricultural Solar Stakeholder Group to make policy recommendations to balance the need to protect Maine's current and future farmland against the need to develop sources of renewable solar energy. The group issued a draft report in November 2021 for public comment, and considered public comments received in preparing its final report and recommendations. The final report was released on January 20, 2022. Based on its research and discussions, and additional input received from the public, the Stakeholder Group advanced seven consensus recommendations to the Department of Agriculture, Conservation and Forestry and the GEO. The Joint Standing Committee on Agriculture, Conservation and Forestry; the Joint Standing Committee on Energy, Utilities and Technology; and the Joint Standing Committee on Environment and Natural Resources received the report pursuant to Resolve 2021, Chapter 26.[30]

Next Steps

Going forward, the GEO will continue to engage stakeholders, including through the Distributed Generation Stakeholder Group, to inform future policy decisions related to distributed generation including consideration of the costs and benefits to ratepayers. Continued engagement with stakeholders to thoughtfully balance continued solar development with other land uses and interests, like the Agricultural Solar Stakeholder Group, will continue to be an important aspect of solar development. The GEO will continue to seek to continue to establish programs and policies that enable equitable access to the benefits of solar, including through community solar programs.

In terms of larger-scale solar energy development, the GEO will consider existing and future modeling and analysis to understand the role of solar in meeting the State's RPS and other clean energy and climate goals.

28 According to reports with data through November 30, 2021 filed by Central Maine Power (dated December 10, 2021) and Versant Power (dated December 15, 2021) in PUC docket 2020-00199.
29 https://www.maine.gov/energy/studies-reports-working-groups/current-studies-working-groups/dg-stakeholder-group
30 https://www.maine.gov/energy/sites/maine.gov.energy/files/inline-files/FINAL%20Report%20of%20the%20Agricultural%20Solar%20Stakeholder%20Group_Jan%202022%20with%20Appendices.pdf

Storage

Technologies that store electricity to be used to meet demand at different times can provide significant benefits to the grid and its resiliency. Energy storage can provide backup power during outages and can help customers manage their electric load. Energy storage can also help increase the availability of renewable energy from sources like wind and solar by absorbing excess energy when it is being produced, then discharging it later when the energy is needed.

Maine's Energy Storage Goals

In June 2021, Governor Mills signed P.L. 2021 ch. 298 (LD 528). The Act sets goals for energy storage in Maine and directs multiple important steps to advance its deployment to the benefit of Maine. 35-A MRSA §3481 defines an "energy storage system" as "a commercially available technology that uses mechanical, chemical or thermal processes for absorbing energy and storing it for a period of time for use at a later time."

Technologies that store electricity to be used at different times can provide significant benefits to the grid and its resiliency. Energy storage can provide backup power during outages and can help customers manage their electric load. Energy storage can also help increase the availability of renewable energy from sources like wind and solar by absorbing excess energy when it is being produced, then discharging it later when the energy is needed.

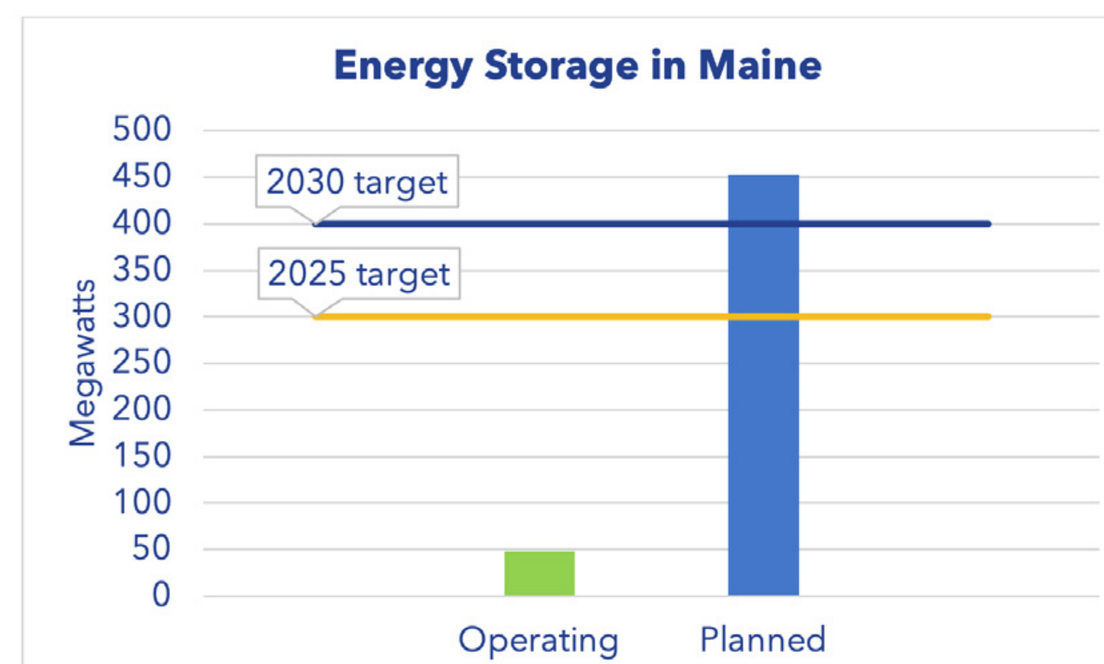
In 2021, the State of Maine established in statute the following goals for energy storage capacity installed within the state:

- By December 31, 2025 – 300 MW of installed capacity located within the State.
- By December 31, 2030 – 400 MW of installed capacity located within the State.

A goal of 400 megawatts of energy storage represents about 20% of Maine's peak electric demand in 2020, making these goals some of the most ambitious in the nation. As of 2021 there are about 50 megawatts of energy storage operating in the state and over 450 MW in the development queue.[31]

The legislation also requires the GEO to update the state's energy storage goals beginning in 2031 as needed to align with Maine's emissions reduction and renewable portfolio standard requirements.

Figure 29 - Energy Storage in Maine compared to statutory targets [ISO-NE and GEO]



31 Governor's Energy Office and ISO-New England.

Energy Storage Market Assessment

The GEO is also required to conduct a study, including opportunities for stakeholder input, to inform the achievement of the state's energy storage goals and related policy objectives. The GEO has contracted with expert consultants to support development of this study and will deliver it to the Joint Standing Committee on Energy, Utilities and Technology by March 2022. The study will include an overview of existing and potential energy storage technologies as well as modeling to inform how to cost effectively achieve the state's goals.

Next Steps

As identified by prior analysis, The GEO will pursue opportunities to deploy energy storage, particularly paired with solar, where beneficial – including in required resiliency pilots conducted by Efficiency Maine Trust. The forthcoming Energy Storage Market Assessment will produce recommendations that the GEO will consider for implementation in support of the state's energy storage goals.

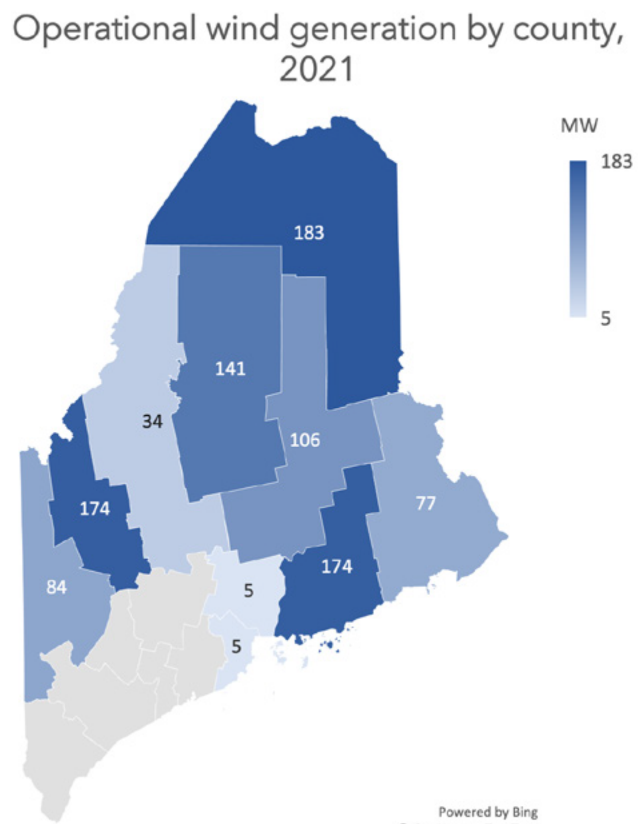
Onshore Wind

Maine has already taken advantage of and continues to have opportunity for onshore wind energy development. Maine currently leads New England states in onshore wind energy generation, helping New England power its electricity grid with affordable clean electricity generation. As outlined in a previous section, the GEO's REGMA Study found that the potential for onshore wind development in Maine continues to be significant.[32] The analysis also found, however, that Maine's high-quality onshore wind potential is largely inaccessible absent investments in transmission, as is the case with much of the generation development in Maine due to a highly constrained transmission system.

Currently 8% of Maine's in-state electricity is generated by on-shore wind resources, the most wind generation of the New England states, with 983 MW of onshore wind energy capacity operational in Maine in 2021.[33] In 2009, Maine set wind energy generation goals as part of the Maine Wind Energy Act directing the installed capacity for wind generation of: at least 2,000 MW installed by 2015; at least 3,000 MW installed by 2020, including 300 MW or more from offshore wind; and at least 8,000 MW of installed capacity by 2030, including 5,000 MW from offshore wind.

In the First Session of the 130th Maine Legislature, legislation passed (P.L. 2021, Chapter 380) to establish the Northern Maine Renewable Energy Development Program to remove obstacles to the use of and to promote the development of substantial renewable energy resources in northern Maine, defined as

Figure 30 - Operation wind generation by Maine county, 2021 [ISO-NE, CMP/Versant and GEO]



32 https://www.maine.gov/energy/studies-reports-working-groups/current-studies-working-groups/renewable-energy-market-assessment

33 Data illustrated in this map are drawn from ISO-New England's May 1, 2021 Capacity, Energy, Loads and Transmission (CELT) Forecast.

Aroostook County and other areas served by NMISA. The intent is to accomplish this through a procurement by the PUC for both a transmission line from Northern Maine connecting to the ISO-NE system, as well as a procurement for renewable energy generation for at least 18% of the retail electric load in the state. Contracts for both generation and transmission are required to be signed by November 2022 and the PUC is already taking steps towards completing this requirement. This Procurement is underway and presents the opportunity for onshore wind generation to be selected, depending on whether or not the PUC determines the bids meet the established criteria and moves forward with long-term contracts.

Next Steps

As described in the following section, offshore wind in the Gulf of Maine is also recognized as a significant resource for meeting the state's targets. The analysis of offshore wind transmission, the forthcoming regional deep decarbonization analysis, and other technical studies will be utilized by the GEO to continue to consider the onshore wind needed to meet the increasing load in Maine as the state, and region, continues to move towards beneficial electrification as a decarbonization strategy.

Offshore Wind

Offshore wind (OSW) energy offers Maine potential for long-term job creation and economic development, supply chain and port infrastructure investments, and renewable power to help meet the state's ambitious clean energy and climate change goals. Through the Maine Offshore Wind Initiative, launched in June 2019 by Governor Mills, the state will explore opportunities for thoughtful development of offshore wind energy and determine how to best position Maine to benefit from an industry expected to generate $1 trillion in global investment by 2040. The Initiative aims to balance this industry development with our state's maritime heritage and existing marine users, including Maine's commercial fishing industry, which creates more than $1.5 billion in direct economic benefit to Maine. The following are various aspects of the Initiative.

Maine Offshore Wind Roadmap

Maine's 10-year Economic Development Strategy identifies offshore wind as an opportunity to grow the state's economy, and encourages the state to set forth a balanced agenda that maximizes economic benefits for Maine people and fosters a culture of innovation that creates a foundation for future leadership in this growing industry while minimizing impacts.

The Offshore Wind Roadmap: Charting a Course for Maine is an 18-month participatory initiative led by the GEO to create an economic development plan for the offshore wind industry in Maine. The Roadmap is supported by a $2.166 million grant from the U.S. Economic Development Administration (EDA), which was received in October 2020. The GEO's objective for the Roadmap is to identify how to foster an offshore wind industry that works for Maine's people, Maine's economy, and Maine's heritage. The Roadmap is under development by an expert advisory committee and working groups with broad public input, focusing on energy markets, ports and infrastructure, socioeconomic impacts, equity, manufacturing and supply chains, workforce development, and ocean environmental compatibility. The Advisory Committee is a high-level strategic body that provides guidance to the GEO on the vision and development of the Roadmap. It is comprised of public and private sector representatives with a breadth of perspectives from across Maine, who will assist the GEO to ensure the Working Groups and stakeholder input fulfills the objectives of the Roadmap.

This work is supported by four working groups, each of which will use the substantive expertise of its members, together with support from state and technical consultants and public participation, to develop the core content and inform the Roadmap:

- **The Energy Markets and Strategies Working Group** will advise and help develop components of the Roadmap, including renewable energy targets, energy market and trend analyses, analyses of costs and benefits of offshore wind, interconnection and transmission, storage, and related research and development.

- **The Environment & Wildlife Working Group** will identify best practices, data gaps, and research needs to avoid, minimize, or mitigate impacts of offshore wind in the Gulf of Maine on wildlife (e.g., birds, bats, marine mammals, other protected species) and address broader environmental impacts to habitat.
- **The Supply Chain, Workforce Development, Ports, and Marine Transportation Working Group** will examine the economic, workforce and infrastructure opportunities and needs to support the offshore wind economy for Maine. The working group may be divided into task groups to focus on specific topics, as follows: a) supply chain; b) workforce development; and c) ports and marine infrastructure.
- **The Fisheries Working Group** will provide input into the components of the Roadmap that address the potential impacts of offshore wind on fisheries, aquaculture, and marine resources with a focus on strategies to improve existing data and avoid, minimize or mitigate potential adverse impacts.

The GEO has contracted with outside consultants to support these processes for stakeholder engagement and communications as well as a number of technical studies, outlined below.

- **Energy Markets Technical Study** – The GEO approved a contract with DNV through a public RFP process to assist with development of the technical work for the Energy Markets and Strategies Working Group, and in coordination with other working groups, as appropriate. This study will include:
  - **State of Offshore Wind Industry**: An analysis of the current state of the offshore wind market globally and nationally, including floating wind; industry-wide supply chain and R&D needs, including specific opportunities for Maine; and opportunities for existing and emerging innovations that may complement OSW.
  - **Offshore Wind Needs Assessment**: An assessment that includes Maine and the Gulf of Maine regarding future needs for offshore wind energy capacity to meet the needs of Maine and the region in meeting our clean energy and climate targets. This assessment will build on the published RPS study, *State of Maine Renewable Energy Goals Market Assessment*, the Maine Climate Council's energy sector modeling, and other assessments.
  - **Socioeconomic Analysis**: An analysis of offshore wind scenarios developed by the offshore wind needs assessment. The analysis will identify economic costs and benefits and include consideration of impacts to communities and existing ocean users.
  - **Deployment Strategies to Maximize Maine Benefits**: For each scenario, this component of the analysis will identify strategies for cost-effective deployment of offshore wind energy in Maine.
  - **Offshore Wind Transmission Strategy**: An analysis of offshore and onshore transmission options and discussion of opportunities for cost-effective, strategic approaches (including consideration of regional coordination) to develop necessary transmission assets.
- **Supply Chain & Workforce Opportunity Assessment:** Through a public state RFP process the GEO selected contractors Xodus Group, BW Research, VHB, and Karp strategies to assist with development of the Maine Supply Chain and Workforce Opportunity Assessment under the guidance and direction of the Supply Chain, Workforce, Ports and Marine Transportation Working Group, and in coordination with other working groups, as appropriate. Components of this assessment include:
  - **Assess the OSW Supply Chain Opportunity for Maine:** Establish background knowledge base and identify Maine OSW supply chain elements (including, among other elements, vessel supply to support OSW, shipbuilding, vessel operations and maintenance, supply chain specific to floating OSW, artificial intelligence and data science to enhance efficiencies and reduce impacts). This work will include the development of an action plan to improve Maine's supply chain opportunities in the offshore wind sector – including identifying specific opportunities for Minority and Women Owned Small Business Enterprises.
  - **Assess the Offshore Wind Workforce Opportunity for Maine:** This component of the report will establish background knowledge base and identify Maine offshore wind workforce elements and produce an offshore wind training inventory spreadsheet and training map as well as a gap analysis. Consultants will then review best practices to inform future improvements in Maine offshore wind workforce, conduct occupational crosswalk with complementary industries for offshore wind, and develop an action plan to improve Maine's workforce opportunity in the offshore wind sector (coordinated with the University of Maine System, Community Colleges, Maine Maritime Academy, and others, as appropriate) including identifying specific opportunities for disadvantaged or disproportionately impacted populations in Maine.
  - **Identify Strategies to Retain, Develop, and Diversify Maine Companies for the Offshore Wind Sector, as well as Attract Offshore Wind Companies to Maine:** This portion of the assessment will include the process of offshore wind supply chain companies or key groups to address gaps, challenges, and opportunities for their growth in Maine as well as a comprehensive assessment of offshore wind supply chain requirements throughout a project lifecycle and at different stages of market development, including future floating offshore wind projects, to identify areas of opportunity for Maine. Additional components include: identification of threats and challenges to development and diversification of Maine supply chain companies in offshore wind; development and launch of self-assessment capability audit with interested organizations and companies; development of a set of recommended policies to overcome key challenges identified by existing offshore wind companies in Maine; and identification of challenges and development of opportunities for attracting new offshore wind businesses to Maine.
  - **Develop Engagement Opportunities and Partnership Tools for Maine Companies, Workforce, Developers, and Larger Supply Chain Companies:** Creation of engagement opportunities for Maine companies and Maine workforce with existing partnerships and contacts in the offshore wind industry; and develop tools, including the 'playbook of partnership opportunities' to build partnerships between offshore wind developers and suppliers, with existing or new Maine offshore wind supply chain companies, and with the Maine workforce.

In addition to these technical studies as part of the Maine Offshore Wind Roadmap, outlined above, the Maine Department of Transportation contracted with Moffat and Nichol to conduct an assessment of Searsport to support offshore wind development in Maine (Phase 1) and a planning assessment of additional ports along the Maine coast to support offshore wind in complementary roles as part of a Maine network of ports (Phase 2). The Feasibility Study and Concept Design Report by the engineering firm of Moffat & Nichol was released in November 2021.[34]

34 https://www.maine.gov/mdot/ofbs/

The Phase 2 companion study on broader wind port needs in Maine is also underway and will analyze how other Maine ports, including the Ports of Portland and Eastport, can play important roles supporting the offshore wind industry. This report is anticipated to be released in 2022. The process is committed to a robust and transparent stakeholder engagement and public communication process.

To support these efforts, the GEO also joined national and regional offshore wind consortia to leverage existing resources that can be used to help support the Maine Offshore Wind Initiative. These include: 1) National Offshore Wind Research and Development Consortium; 2) Business Network for Offshore Wind; 3) Regional Wildlife Science Entity.

Offshore Wind Research Array

In November 2020, to solidify Maine's leadership in floating offshore wind energy and collaborate with Maine's fisheries on the industry's development, Governor Mills announced the State's plan to create the country's first floating offshore wind research array in the Gulf of Maine.[35] In October 2021 the GEO submitted an application to the Bureau of Ocean Energy Management (BOEM) to lease a 15.2-square-mile area nearly 30 miles offshore in the Gulf of Maine for the nation's first floating offshore wind research site in federal waters. The area of the research site is limited to 15.2 square miles, which is smaller than initial projections and which represents approximately .04 percent of the 36,000-square-mile Gulf of Maine.

The State is taking action now because there is significant interest in commercial development of offshore renewable energy in the Gulf of Maine, and because it believes the proposed research array is the right, prudent step to take before commercial scale floating offshore wind development occurs in the Gulf of Maine. Research will allow the State, the fishing industry and many others to learn about potential impacts of floating offshore wind together, in order to ensure Maine develops this industry in a manner that capitalizes on our innovative technology and abundant resources, while protecting our interests, industries, environment and values.

The GEO, in collaboration with other partners, held a series of workshops to share information and engage with a variety of audiences about floating offshore wind in the Gulf of Maine. This rapidly growing industry is a part of Maine's renewable energy portfolio and economic development strategy, but there is a great deal to learn to help better inform our dialogue as Maine moves forward. Webinars covered a variety of topics including technology to regulatory process to economic opportunities to lessons learned from the UK.[36]

In the First Regular Session of the 130th Legislature, the Governor with bipartisan support from the Legislature, passed LD 336, sponsored by Sen. Mark Lawrence, which declared the research array is in the public interest and authorized the Maine Public Utilities Commission to negotiate a power purchase agreement with the University of Maine's offshore wind development partner, New England Aqua Ventus. Governor Mills signed LD 336 in June 2021. In July 2021, in response to concerns raised by Maine fisherman and to reflect the Administration's priority of locating offshore wind in Federal waters, Governor Mills signed additional legislation, LD 1619, prohibiting offshore wind projects in State waters, which extend three miles from shore.

As an unprecedented research opportunity for offshore wind, the research site reflects the Mills Administration's commitment to advancing offshore wind responsibly in Federal waters of the Gulf of Maine, which has some of the highest sustained wind speeds in the world and abundant potential to generate clean, renewable energy for Maine people. The research site also aligns with the trajectory of the emerging offshore wind industry in the U.S., as ambitious clean energy generation

35 https://www.maine.gov/governor/mills/news/governor-mills-announces-intent-expand-research-and-development-floating-offshore-wind-maine

36 https://www.maine.gov/energy/initiatives/offshorewind/researcharray

targets by the Federal government and many states increase demand for commercial-scale projects in deep Federal waters, where floating platform technology will likely be required. By addressing fundamental questions about how offshore wind can exist in the Gulf of Maine, the intent of the research array is to advance the development of Maine's offshore wind economy while informing the responsible growth of floating offshore wind in the United States and beyond.[37] GEO continues to work with the Bureau of Ocean Energy Management on its lease application. Future steps on the application, including public input opportunities, will be led by the federal bureau.

This legislation, LD 1619, also established an offshore wind research consortium, which will include members of Maine's fishing industry, marine scientists, offshore wind industry experts, and others to oversee research priorities for the array. The GEO has begun the process of scoping and initiating the Maine Offshore Wind Research Consortium, as mandated in this legislation. In early 2022, the GEO, in coordination with other state agencies, will bring on an outside consultant to help advise on an appropriate scope, form, and governance structure for the Research Consortium, as well as develop an implementation strategy. This work will include interviewing researchers and stakeholders with expertise in the Gulf of Maine, members from the Maine Offshore Wind Roadmap Advisory Committee and Working Groups, the Research Consortium Advisory Board member representatives specifically identified in statute, the developer of the Maine Offshore Wind Research Array as applicable, and key regional and national OSW research consortia. GEO anticipates standing up the consortium and developing initial research priorities by late 2022 or early 2023.

Federal Commercial Leasing in the Gulf of Maine

In 2019, the Bureau of Ocean Energy Management (BOEM) invited Maine, New Hampshire and Massachusetts to participate in a Gulf of Maine Task Force to identify potential opportunities for renewable energy leasing and development on the Outer Continental Shelf in the Gulf of Maine; federal jurisdiction begins three miles beyond the coast. In December 2019, BOEM held its first and only task force meeting to date. In October 2022, the U.S. Department of the Interior announced plans to hold a commercial offshore wind lease sale in the Gulf of Maine by mid-2024. In response to this announcement, the Governor sent a letter to the Secretary of the Interior to request a thoughtful and transparent leasing process, particularly given the importance of the Maine fishing industry. The federal commercial leasing process is a multi-year effort that will be coordinated through the task force. GEO, along with other Maine representatives, will continue to monitor and participate in any future task force meetings. GEO anticipates coordinating with Maine stakeholders on this effort through the existing roadmap working groups.

Next Steps

In order to continue the extensive and comprehensive planning and stakeholder engagement efforts, the GEO will finalize the Maine Offshore Wind Roadmap by the end of 2022, which includes analysis and recommendations developed by approximately one hundred public and private sector experts and robust stakeholder involvement, to chart a course to pursue responsible offshore wind development while minimizing impacts to the marine ecosystem and existing ocean users.

The GEO will use the technical analysis through this Offshore Wind Roadmap process to inform next steps relating to supply chain and workforce development, transmission, and offshore wind market strategies that will allow Maine to realize the greatest benefit from offshore wind development in the Gulf of Maine.

37 https://www.maine.gov/energy/news/geo-submits-federal-lease-application-for-small-scale-floating-offshore-wind-research-site

As supported by the Maine legislature in Public Law 2021, Chapter 327 (LD 336), work to advance the proposed research array will continue. This research array is a valuable opportunity to conduct vitally important research, which is central to Maine's prudent and phased approach and phased approach to advancing and informing this innovative new industry while also protecting Maine's vital marine industries and ecosystems.

Finally, from a regional perspective, the GEO and relevant state agencies will continue to track and engage in the federal commercial leasing process, including working with the U.S. Department of the Interior's Bureau of Ocean Energy Management (BOEM) and other federal agencies to effectively coordinate with the State of Maine and Maine stakeholders to ensure the greatest benefits of offshore wind development for Maine while minimizing impacts to existing ocean users and resources.

Other advanced technologies

As outlined in *Strengthening Maine's Clean Energy Economy*, advancements in areas such as clean energy storage technologies, microgrids, demand management, and renewable energy generation technologies are continuing. Maine is already creating and implementing innovative energy solutions such as an anerobic digestor to generate power from biogas, power-to-gas pilot projects, microgrids, advancements of integrated hydrokinetics from river and tidal currents, and advanced independent home energy solutions.

As Maine continues with long-term energy planning, flexibility should be provided as technologies and associated costs will continue to be developed over the same timeframe.

Additionally, as innovative ideas develop into commercialized products and services, it is imperative to provide the necessary resources and opportunities for development. For Example pilot projects can provide cost-effective opportunities to advance new technologies as they evolve. Investing in the success of a new technology can lead to the development of advanced products and services that can be part of global clean energy solutions and reduce energy costs in the long-term as well as seed greater competitiveness for the state.

Planning & Grid Modernization

A modernization of our current grid system will be a requirement for meeting our long-term clean energy and climate goals. This includes changes to the ways in which our grid is managed, demand management strategies, grid planning, utility structures, and beneficial electrification.

The interconnected nature of a regional grid, and the related design of policies and regulations for this grid system, can have significant impacts on states' abilities to reach their clean energy goals. In recognition of this critical role, Maine Governor Janet Mills alongside the Governors of Connecticut, Massachusetts, Rhode Island, and Vermont, signed a joint statement that called for reforms at the regional grid level through ISO-NE.[38] Informed by this jointly signed statement calling for a clean, affordable, and reliable 21st century regional electric grid, the New England States Committee on Electricity (NESCOE)[39] issued a vision statement that declares the necessity for significant changes in three core segments of the shared energy system. These three segments are: Wholesale Electricity Market Design, Transmission System Planning, and ISO New England (ISO-NE) Governance.

38 https://www.maine.gov/governor/mills/news/governor-mills-new-england-governors-call-modernization-regional-electricity-system-2020-10-14

39 The New England States Committee on Electricity (or NESCOE) is a not-for-profit entity that represents the collective perspective of the six New England states in regional electricity matters. NESCOE advances the New England states' common interest in the provision of electricity to consumers at the lowest possible price over the long-term, consistent with maintaining reliable service and environmental quality.

The New England States initiated a public process, supported by NESCOE, to inform the development of any proposals related to the Vision. The dialogue around each Vision Statement element – market design, transmission, and ISO-NE governance – occurred at technical forums and through written comments. In June 2021 NESCOE released the "New England Energy Vision Statement Report to the Governors: Advancing the Vision."[40] This report offered an update on progress related to the frameworks and elements within the Vision Statement. There continues to be ongoing dialogue and efforts related to the Vision Statement.

In addition, there are several regional studies taking place through ISO-NE that are informed by stakeholders and groups like NESCOE. These include, but are not limited to:

- **ISO-NE New England's Future Grid Reliability Study:** Stakeholder led assessment of the future state of New England's power system that includes: defining scenarios; studying whether the ISO can operate the grid reliably under status-quo market mechanisms; considering what products and attributes are missing (through gap analysis); and discussing what market changes could be developed in response to any identified gaps in reliability or resource needs. The ISO is undertaking Phase 1 as its 2021 Economic Study. The first phase of this study is expected in Q1 of 2022.
- **ISO-NE Pathways to the Future Grid:** Regional identification, exploration and evaluation of potential market frameworks that may help support the evolution of the power grid. An initial report from this effort is expected in Q1 of 2022.
- **2050 Transmission Study:** New England States' vision statement seeks a transmission study that can help states determine how to expand the system to incorporate wind, hydro, and distributed energy resources.
- **ISO-NE Capacity, Energy, Loads, and Transmission (CELT):** The 10-year projections provided in the CELT Report are used in power system planning and reliability studies. The CELT provides a snapshot of the New England power system, including:
    - A long-term forecast for energy consumption and peak demand, including 10-year forecasts of energy efficiency, solar facilities, light-duty electric vehicles, and air-source heat pumps; and
    - The number of MW with capacity supply obligations, as well as the total generating capacity of resources in the region.

Maine Public Utilities Commission Planning Dockets

- Maine PUC Grid Modernization Proceeding (Docket 2021-00039): The PUC is investigating the future design and operation of the electric distribution system in Maine. The PUC will provide a comprehensive examination of the design and operation of the electric distribution system in Maine to accommodate the increasing integration and operation of Distributed Energy Resources (DER) and the potential for a substantial increase in load from policies and initiatives that seek to encourage electrification in the heating and transportation sectors. The investigation will address information transparency issues such that developers and other entities can access system needs and opportunities at a granular level. Upon the completion of consultant examination, a report will be submitted to the Commission containing their findings and recommendations. The Commission will then explore the issues and allow interested persons to examine the consultant's report and provide input and recommendations regarding the issues presented.

Power Sector Transformation

The Maine Climate Council recommended the launch of a comprehensive stakeholder process to examine the transformation of Maine's electric sector and facili-

40 https://nescoe.com/resource-center/vision-stmt-oct2020/

tate other recommendations of the Maine Climate Council. Beneficial electrification of heating and transportation, which is necessary for the state to meet its greenhouse gas reduction requirements, will necessitate changes in the electric sector and will require diligent and effective preparation. Long-term grid planning and grid modernization will be important in prioritizing grid upgrades and innovative management strategies necessary to cost-effectively meet our climate and energy goals.

Areas for consideration may include: utility structure, load management, data and information access, grid modernization and expansion, non-wires alternatives, interconnection, distributed energy resources, aggregation, equitable cost allocation, and rate design, integrated grid planning, regional load electricity markets, regional collaboration, reliability and resiliency, and changes in law and regulation.

Several current efforts are underway related to the Power Sector Transformation stakeholder process including a grid modernization and distribution planning docket opened by the PUC at the request of the Governor. The PUC has retained a consultant to review the design and operation of Maine's electric distribution system needed to meet Maine's climate targets. The GEO will continue to monitor and engage in these various efforts and studies and consider next steps for an overarching process that is informed by, and not duplicative of, these existing efforts.

Next Steps

In order to address these vast and complex challenges, the GEO in coordination with the PUC will facilitate a power sector transformation process, informed by existing efforts, to help advise approaches to grid modernization challenges, as recommended by the state's climate action plan.

BOEM Intergovernmental Renewable Energy Task Force

The GEO is engaged in coordinated regional energy planning through the Bureau of Ocean Energy Management (BOEM) Gulf of Maine Intergovernmental Renewable Energy Task Force. In 2019 BOEM invited Maine, New Hampshire and Massachusetts to participate in a Gulf of Maine Task Force to identify potential opportunities for renewable energy leasing and development on the Outer Continental Shelf in the Gulf of Maine; federal jurisdiction begins three miles beyond the coast. This task force presents an additional opportunity for regional coordination in the pursuit of advancing clean energy objectives and accomplishing Maine's climate targets. As New England states each pursue their own specified targets, such as with offshore wind, there will also need to be additional coordination to ensure adequate transmission and capacity on the regional grid system for renewable energy generation to provide electricity where it is needed.

Energy Assurance Planning

The GEO, in coordination with Maine Emergency Management Agency (MEMA) and other agencies, is responsible for developing the state's Energy Assurance and Emergency Management Plan to a clear, concise and comprehensive blueprint and strategy to address a potential or actual energy emergency caused by: a supply disruption; a rapid and unsustainable increase in energy prices; or other energy emergency situation. The last plan was completed in 2012 and the GEO has partnered with the MEMA to update this plan in 2022.

Next Steps

As necessary and to inform ongoing process, the GEO will pursue additional analysis to better understand the necessary grid and generation development, demand management, and grid planning and management necessary to meet Maine's clean energy and climate goals while supporting concurrent efforts of our neighboring New England states, including through a deep decarbonization study. Additionally, the state should ensure that Maine is taking full advantage of federal incentives that can aid in the transition to a decarbonized energy future for the greatest benefit to Maine people and the economy.

Thermal Sector

Maine has long been a national outlier for reliance on oil and is currently the most heating oil dependent state for home heating in the nation with 60.1% of households using fuel oil for their primary home heating source. The number increases to 72.2% of households when including propane. This high reliance on fossil fuels for home heating results in Maine people paying money to out-of-state fossil fuel providers, significant greenhouse gas emissions that not only contribute to climate change but also cause public health concerns, and leaves Maine people and businesses susceptible to global market changes and price volatility.

Oil Dependence Reduction Targets

Maine has a goal in statute P.L. 2011, c.400 to reduce the State's consumption of oil by at least 30% from 2007 levels by 2030 and by at least 50% from 2007 by 2050. As shown in Figure 30 and Table 4, in 2007[41], Maine consumed a total of 91,859 billion Btu of distillate fuel oil[42] and 25,621 billion Btu of residual fuel oil[43] for a total of 117,480 billion Btu. In order to reach our statutory requirements, total fuel oil consumption to be at or below 82,236 billion Btu by 2030 and 58,740 billion Btu by 2050.

In 2019[44] and compared to 2007, Maine has decreased total fuel oil consumption by 44,639 billion Btu resulting in a 38% decrease compared to 2007 levels, accomplishing the stator requirement of a 30% decrease from 2007 levels by 2030. Since 2012, Maine has consistently been below the 2030 goal with the exception of 2017. Additionally, as of 2019, Maine has achieved 76% of the 2050 goal to reduce the State's consumption of oil by at least 50% from 2007 levels.

Though the magnitude of the decrease in distillate fuel oil and residual fuel oil consumption from 2007 to 2019 is comparable (decrease of 20,841 and 23,798 billion Btu respectively), residual fuel oil consumption has decreased by 93% of its 2007 levels while distillate fuel oil consumption has decreased by only 23%. The decline of residual fuel oil consumption is attributed to an overall market decrease of at least 90% by all sectors with the exception of the transportation sector which decreased consumption by 71%.

For distillate fuel oil, the 23% decrease in consumption is largely attributed to the residential and commercial sectors accounting for a decrease of 11,671 and 7,812 billion Btu, respectively, (total of 19,483) of the 20,841 billion Btu total distillate fuel oil consumption. These sectors account for 93% of the total distillate consumption or approximately 56% for the residential sector and 37% for the commercial sector.

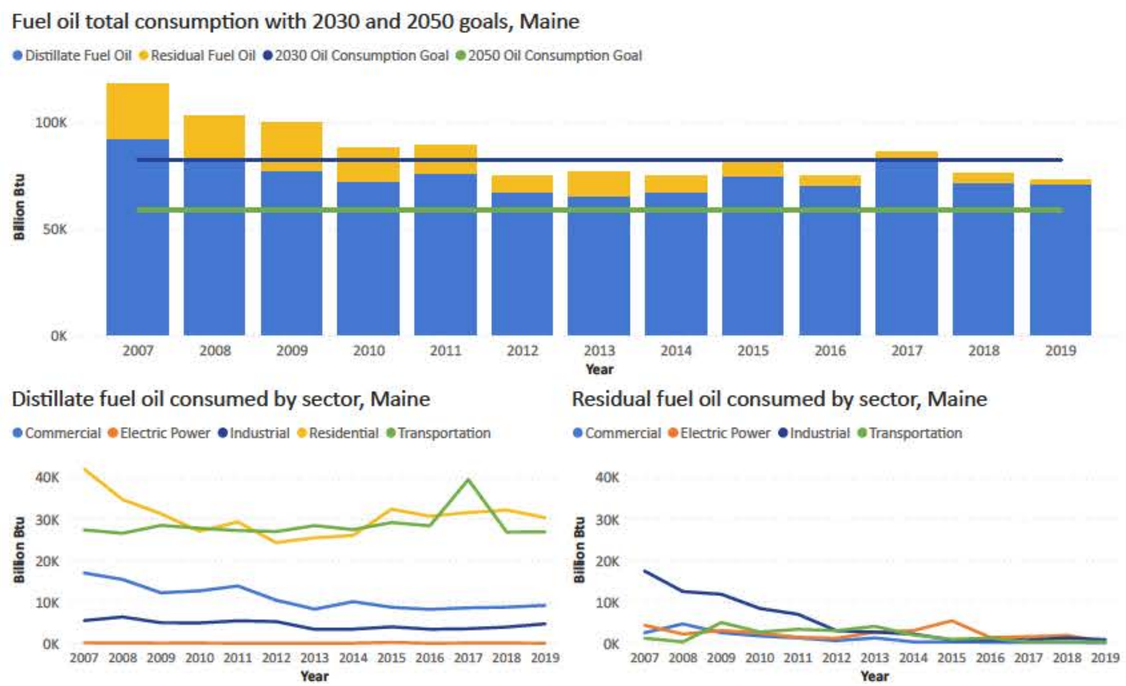
41 https://www.eia.gov/state/seds/

42 EIA defines distillate fuel oil as a general classification for one of the petroleum fractions produced in conventional distillation operations. It includes diesel fuels and fuel oils. Products known as No. 1, No. 2, and No. 4 diesel fuel are used in on-highway diesel engines, such as those in trucks and automobiles, as well as off-highway engines, such as those in railroad locomotives and agricultural machinery. Products known as No. 1, No. 2, and No. 4 fuel oils are used primarily for space heating and electric power generation. More information on distillate fuel oil can be found at https://www.eia.gov/tools/glossary/index.php?id=Distillate%20fuel%20oil.

43 EIA defines residual fuel oil as a general classification for the heavier oils, known as No. 5 and No. 6 fuel oils, that remain after the distillate fuel oils and lighter hydrocarbons are distilled away in refinery operations. It conforms to ASTM Specifications D 396 and D 975 and Federal Specification VV-F-815C. No. 5, a residual fuel oil of medium viscosity, is also known as Navy Special and is defined in Military Specification MIL-F-859E, including Amendment 2 (NATO Symbol F-770). It is used in steam-powered vessels in government service and inshore powerplants. No. 6 fuel oil includes Bunker C fuel oil and is used for the production of electric power, space heating, vessel bunkering, and various industrial purposes. More information on residual fuel oil can be found at https://www.eia.gov/tools/glossary/index.php?id=residual%20fuel%20oil.

44 EIA SEDS is updated on an annual basis for the previous year (i.e., 2020 data is released in 2021) and is subject to revisions until deemed final. At the time of writing this report, the 2020 EIA SEDS is still in its preliminary form and is likely to undergo several updated before being finalized. As such, data is only final and reported until 2019.

Figure 31 - Fuel oil total consumption with 2030 and 2050 goals, Maine;
Distillate fuel oil consumed by sector, Maine; Residual fuel oil consumed by sector, Maine



As of 2019, Maine has the highest per capita rate of distillate oil consumed in the residential and commercial sectors shown in Figure 31 and Figure 32. This is largely attributed to Maine's reliance on fuel oil for heating residential units and commercial spaces during the long winter season. The reduction in distillate oil consumption by the residential and commercial sector is attributed to a suite of contributing factors, including the adoption of clean heating technology. Maine has installed over 28,000 new high efficiency heat pumps in the last year and is on target to achieve 100,000 new high efficiency heat pumps by 2030. This beneficial electrification of heating homes with high efficiency heat pumps reduces the reliance on fuel oil consumption for heating and relies on electricity, thus reducing greenhouse gas emissions in the state.

This high reliance on fuel oil is shown further in Figure 33. Maine continues to have the highest share of households heated with fuel oil at 60% of homes with the U.S. average being only 4%. Maine's neighboring states have shares of households relying on fuel oil for heating ranging from 24% in Massachusetts to 42% in New Hampshire. These values, while still relatively high when compared to the U.S., are still 18 to 36 percentage points lower than Maine.

Though Maine's total fuel oil consumption for residential home heating has decreased from 70% in 2010 to 60% in 2019, simultaneously propane has increased from 6% to 12% and natural gas increased from 4% to almost 8% over that same timeframe (Fig. 35). This continues to demonstrate Maine's reliance on out of state fossil fuels for home heating. While electricity used for home heating has increased over this timeframe from 5% to 8%[45], significant efforts need to

45 It is worth noting that successes in heat pump adoption in Maine in recent years are only partiality reflected as the Energy Information Association State Energy Data System data is available only up until 2019. The Energy Information Association is currently, at the time of this report, in the process of reviewing and finalizing the State Energy Data System for 2020 which will reflect the roughly 13,000 installed heat pumps in 2020. Related, the 2021 iteration of the State Energy Data System will reflect the roughly 28,000 installed heat pumps in 2021.

Table 1 - Fuel oil consumed by sector and fuel oil type, Maine (2007 vs. 2019) (Billion Btu)

Fuel	Sector	2007	2019	Difference Δ	Difference Δ%
Distillate	Commercial	16,950	9,138	-7,812	-46%
	Electric Power	150	44	-106	-71%
	Industrial	5,494	4,699	-795	-14%
	Residential	41,952	30,281	-11,671	-28%
	Transportation	27,313	26,856	-457	-2%
	Total	91,859	71,018	-20,841	-23%
Residual	Commercial	2,564	169	-2,395	-93%
	Electric Power	4,384	408	-3,976	-91%
	Industrial	17,426	882	-16,544	-95%
	Transportation	1,247	364	-883	-71%
	Total	25,621	1,823	-23,798	-93%
Total		117,480	72,841	-44,639	-38%

continue in order to move Maine's heating sources away from fossil fuels to electricity – while also ensuring that Maine's electricity grid can meet the growing demand with renewable energy sources.

These values represent the predominant type of heating fuel mostly used in occupied housing units. It should be noted that Maine households typically utilize multiple heating sources, which may not be accurately reflected in the data. This is an area where improvements could be explored for greater data availability related to secondary home heating sources in Maine.

Next Steps

The state will work to maintain progress towards reaching Maine's 2050 oil dependence reduction target, pursuant to 2 MRSA § 9(5), by supporting oil reduction strategies and decarbonization efforts, particularly in Maine's thermal and transportation sectors.

Heating Fuel Price Survey

A component of data collection that is completed by the GEO as part of a federal Department of Energy program is the State Heating Oil and Propane Program (SHOPP). The GEO conducts a weekly survey of heating fuel prices, obtained from fuel retailers statewide. This survey provides the current Maine cash prices, in dollars, rounded to the nearest penny. This information, while only required by the DOE to be collected during the heating season, which runs from October to March, is collected year-round to provide more detailed information about fuel oil price trends. For the 2021-22 heating season, as a result of global energy markets, Maine is experiencing increases in this winter, especially given more recent volatility with global fossil fuel prices.

In response to these price increases, the GEO prepared a set of resources to help Maine people stay warm this winter and know where to find assistance if needed.[46] In addition, additional funding is available to Maine people through the Home Energy Assistance Program, which provides fuel assistance, weatherization, and

46 Maine Governor's Energy Office Website. Winter Heating Season Tips and Resources. https://www.maine.gov/energy/winter-heating-resources

Figure 32 - Distillate fuel oil consumed by the residential sector, 2019

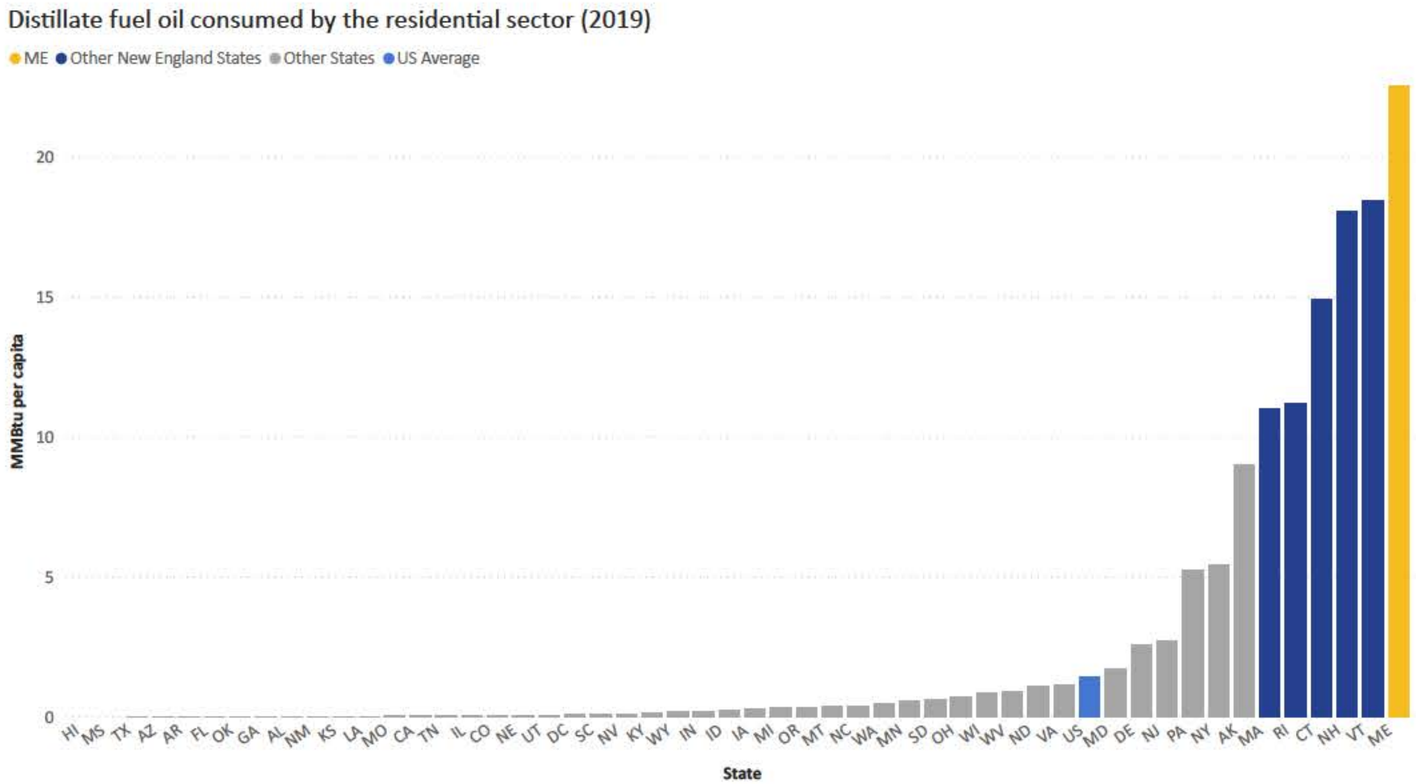


Figure 33 - Distillate fuel oil consumed by the commercial sector, 2019

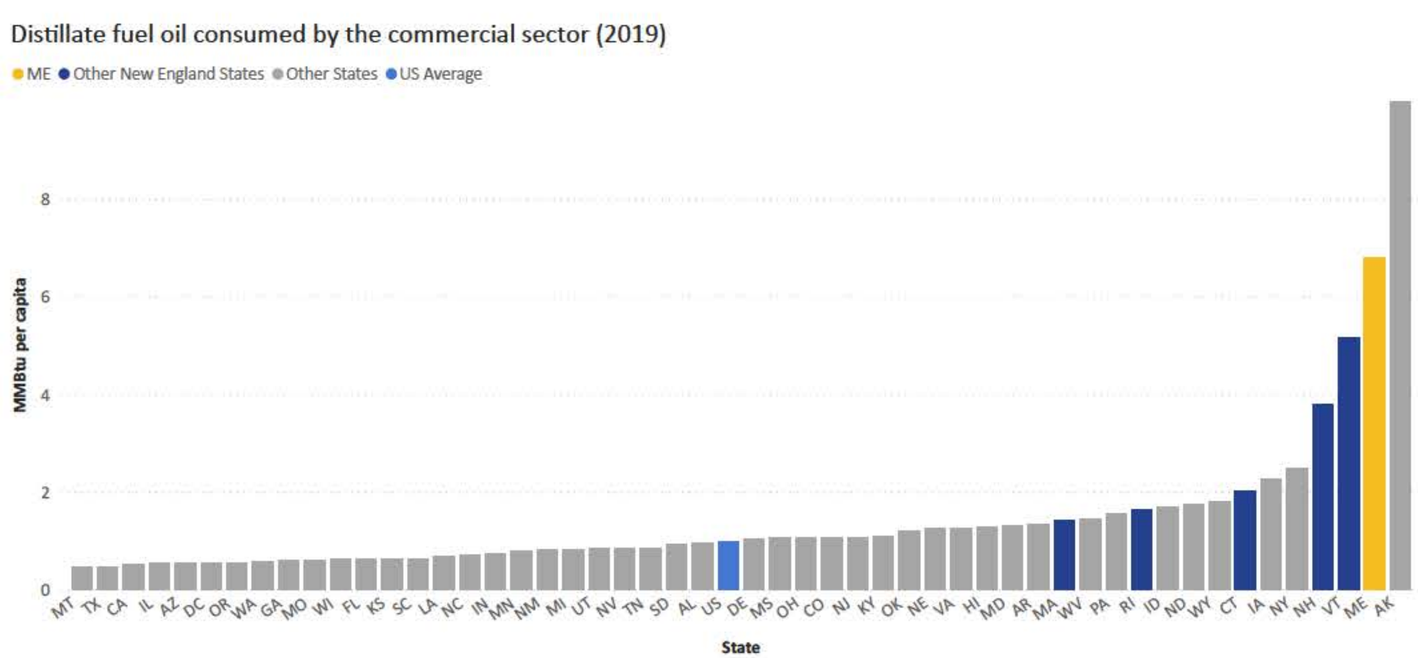


Figure 34 - Share of energy sources consumed for residential heating, 2019

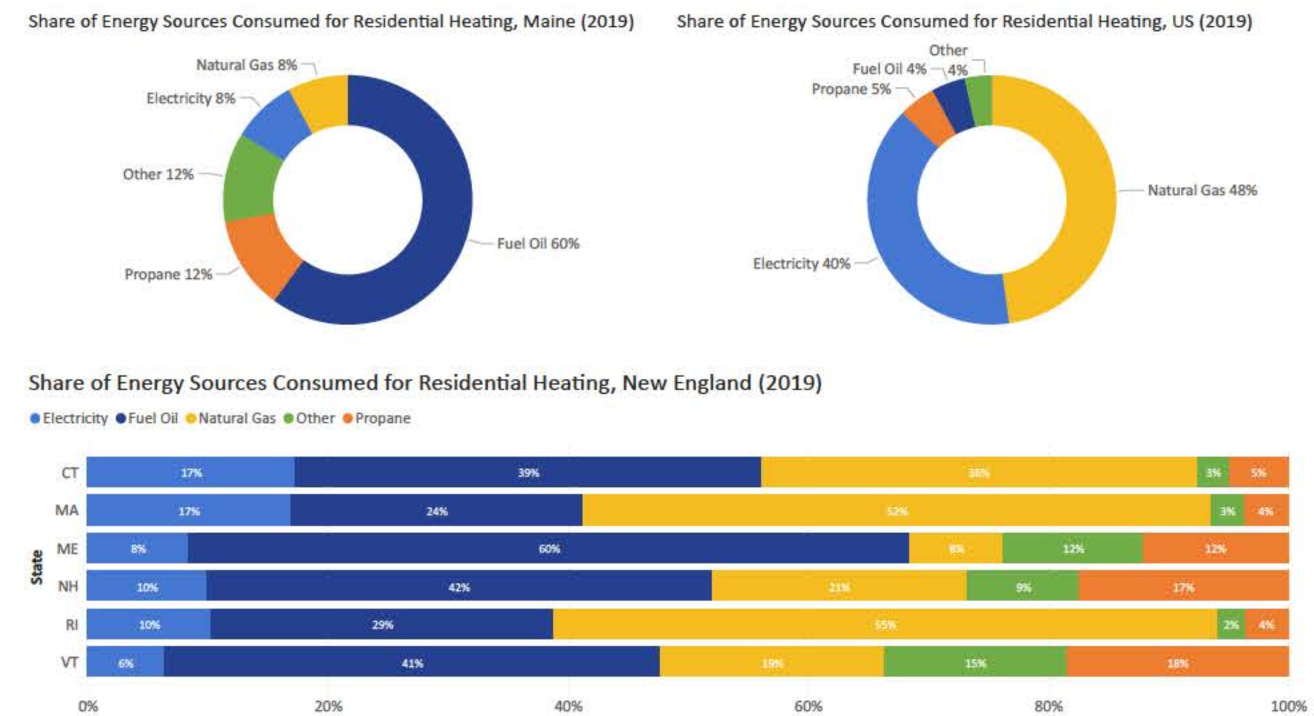
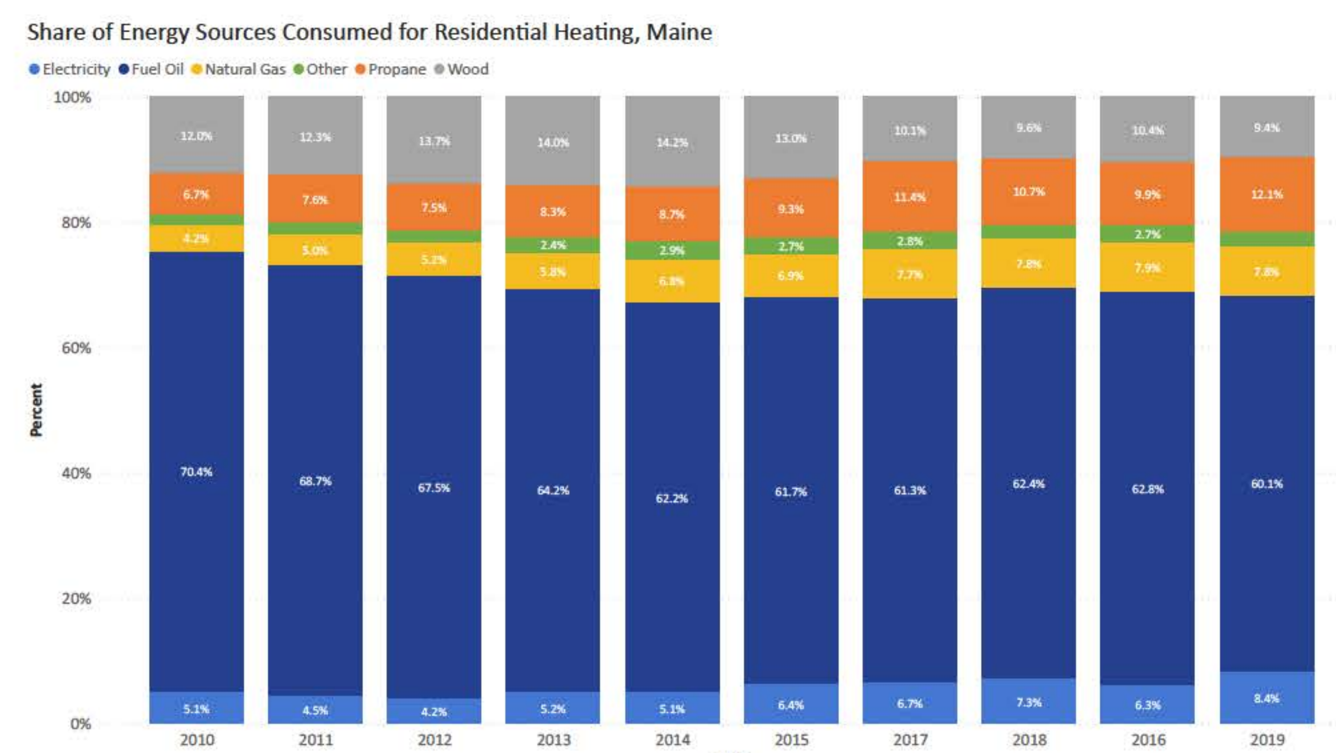


Figure 35 - Share of Energy Sources Consumed for Residential Heating, Maine



other supports through MaineHousing and local community action agencies statewide. Governor Mills also announced that $25 million from the Maine Jobs and Recovery Plan will be allocated to Efficiency Maine for home weatherization of low to moderate income Maine people, to help them stay warm this winter. The program serves both homeowners and renters.[47]

Figure 36 - Maine Retail Heating Fuel Prices, as of December 27, 2021 [GEO SHOPP Survey][48]

Heating Fuel	Statewide	Southwest/ West-Central	Southeast/ Greater Portland	Central	East/ Downeast	Northern
Heating Oil - Average	$3.13	$3.07	$3.11	$3.18	$3.14	$3.18
Heating Oil - High	$3.52	$3.41	$3.52	$3.41	$3.41	$3.40
Heating Oil - Low	$2.60	$2.60	$2.75	$2.79	$2.82	$2.91
Kerosene	$3.72	$3.66	$3.73	$3.79	$3.71	$3.71
Propane	$3.22	$3.38	$3.31	$3.16	$3.19	$3.01

These charts reflect prices through 2021 and not more recent price volatility as a result of global unrest. Latest prices can be found at www.maine.gov/energy

47 State of Maine Office of Governor Janet T. Mills. Newsroom. Press Release. Governor's Energy Office releases guide to help Maine people save money and stay warm this winter. November 5, 2021.

48 The price for the various heating fuels are statewide averages, and prices in a given geographic region of the state may be considerably higher or lower than this average. These statewide averages are spot cash prices, and not 'pre-buy', introductory, or otherwise discounted prices. Average propane prices are 30-day cash/credit prices, based on consumption of at least 900 gallons a year. Households using propane just for cooking or hot water generally pay a higher per gallon price.

Figure 37 - Maine Residential Heating Oil Prices, 2004-2021, through December 2021 [GEO SHOPP Survey]

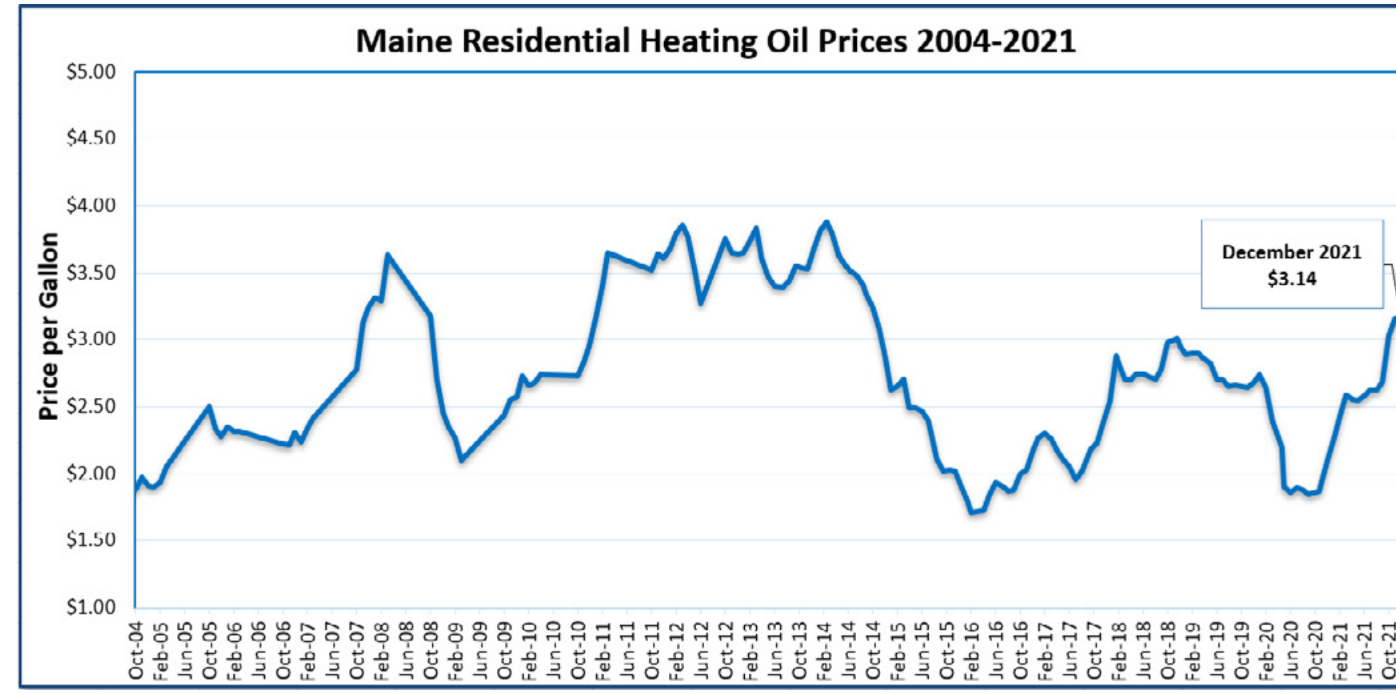


Figure 38 - Maine Residential Propane Prices, 2010-2021, through December 2021 [GEO SHOPP Survey]

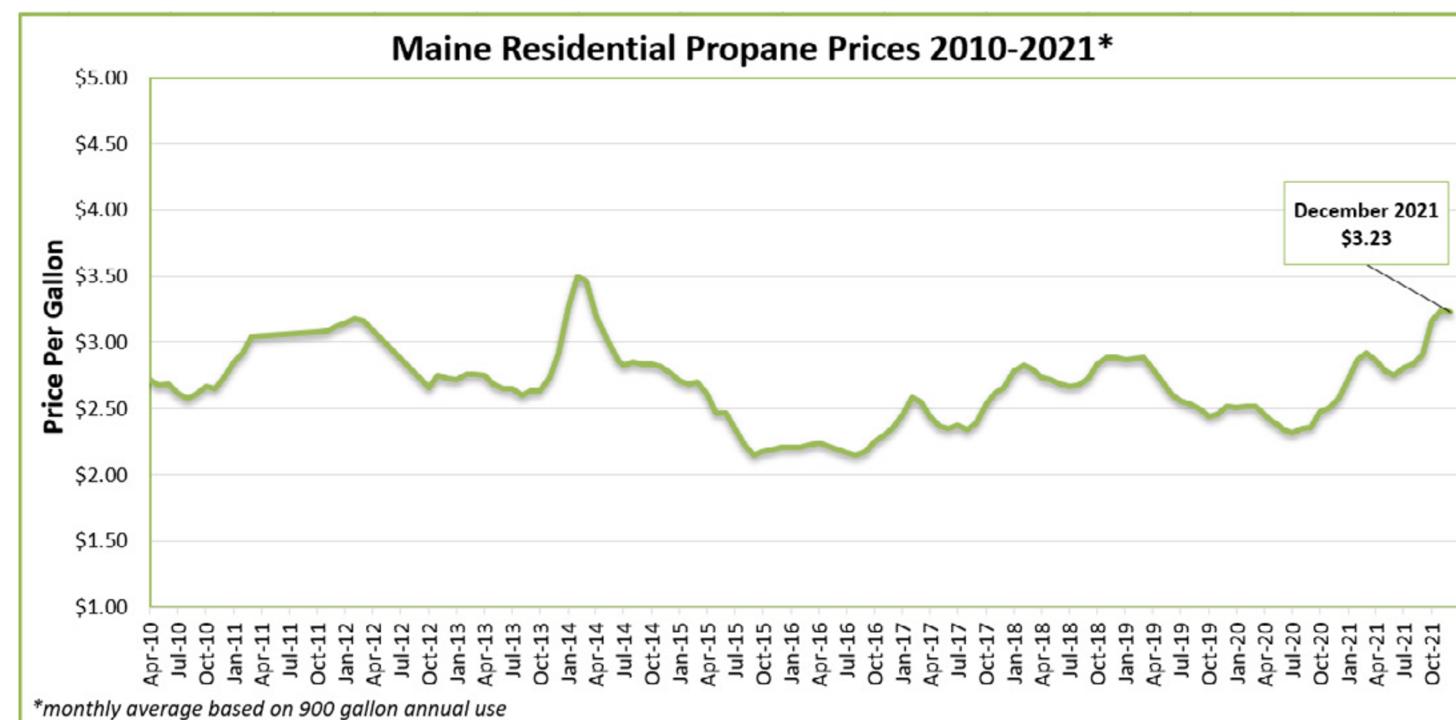
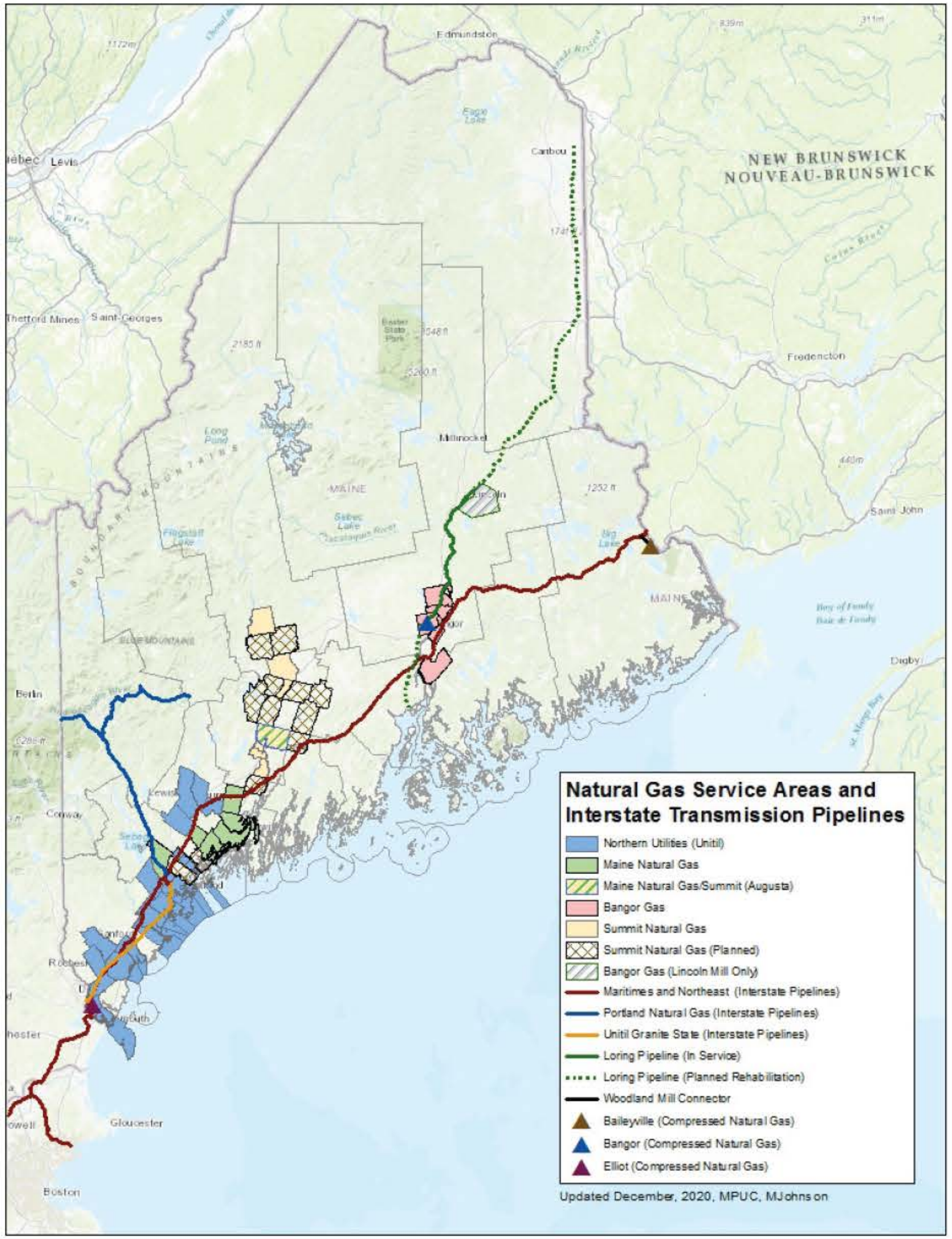


Figure 39 - Natural Gas Service Territories [Maine OPA][49]



49 https://www.maine.gov/meopa/natural-gas

Natural Gas Reporting

Natural gas utilities report their system expansion plans to the Public Utilities Commission (PUC) on a semi-annual basis. The PUC requires all gas utilities to report on their system expansion progress every six months to allow the PUC to monitor utilities' progress and to detect unforeseen problems; these plans are filed confidentially.

According to the PUC 2020 Annual report, the four natural gas utilities in Maine added a total of 33.3 miles of new mains and 1,245 new services. They provide a breakdown of these additions, by utility, in Table 2 below.

Northern Utilities, Inc. d/b/a Unitil (Northern) serves customers in the south-central Maine area, primarily in greater Portland/South Portland/Westbrook, greater Lewiston/Auburn, Biddeford/Saco and Kittery. Maine Natural Gas Corporation serves customers in the Windham, Gorham, Brunswick, Freeport, Bath, Topsham and Augusta areas. Bangor Gas Company, LLC serves customers in the greater Bangor area. Summit Natural Gas in Maine (SNG-Maine or Summit) serves customers in the Kennebec Valley area as well as in the municipalities of Yarmouth, Cumberland and Falmouth. In the table below, the PUC provides a summary of how many customers each local distribution company (LDC) has served over a period of four years. Table 3 is based on the average number of customers during each year.

Thermal RPS update

A component of the 2019 RPS legislation, P.L. 2019, Chapter 477, was the establishment of a requirement for a thermal renewable energy credit (TREC) portfolio requirement. As with the RPS, competitive electricity providers (CEP) are additionally required to purchase TRECs in an amount at least equal to specified percentages of their retail sales in the State. For 2021, the requirement begins at 0.4% and gradually increases to 4% in 2030 and for each year thereafter. In March 2020 the PUC initiated an Inquiry to seek comments and information on a variety of issues related to their rulemaking. Following stakeholder comments, in August 2020 the PUC issued a Notice of Rulemaking (NOR) and held a public hearing in August 2020.

Table 2 - 2020 Natural Gas Expansion [Maine PUC]

Utility	Mains (miles)		Number of Services	
	Added in 2020	Total Installed	Added in 2020	Total Installed
Bangor Natural Gas	9.6	328.5	344	6,628
Maine Natural Gas	6.6	224.9	153	4,910
Summit Natural Gas of Maine	11.4	223.7	340	4,668
Unitil (Northern Utilities)	5.7	603.1	408	23,289
Totals	33.3	1380.2	1,245	39,495

Table 3 - Natural Gas LDC Customers [Maine PUC]

Utility	2016	2017	2018	2019
Bangor Natural Gas	6,003	6,260	6,505	6,899
Maine Natural Gas	4,485	4,645	4,831	5,003
Summit Natural Gas of Maine	2,579	3,136	3,504	3,545
Unitil (Northern Utilities)	31,209	31,633	32,199	32,871
Totals	44,276	45,674	47,039	48,318

In November 2020 the PUC implemented the rules for the new thermal energy credit portfolio requirement. Reporting in 2022 will indicate how the 2021 0.4% TREC requirement is met.

In 2020 the legislature passed P.L. 2021, Chapter 199 (LD 597 – An Act To Establish the Wood Energy Investment Program) to establish the Thermal Energy Investment Program at the Efficiency Maine Trust and create the Thermal Energy Investment Fund (TEIF). Any alternative compliance payments (ACP) made by competitive energy providers to meet the TREC requirement will be deposited into the TEIF. Efficiency Maine is directed to utilize these funds to provide incentives and low-interest or no-interest loans for new thermal energy or cogeneration projects with the intention that they will support the industry needed to meet future TREC requirements.

Combined Heat and Power

Combined heat and power, sometimes referred to as cogeneration, is the production of both electricity and thermal energy, at the same location of the energy consumption. Where typically the heat produced by electricity generation is lost to the air, CHP facilities utilize the heat byproduct for on-site activities, resulting in increased overall efficiency.

Highly efficient CHP facilities capture heat from electricity generation to provide steam or hot water for use in space heating and cooling, water heating, and industrial processes, thereby increasing overall facility efficiency and reducing emissions. CHP avoids energy waste, reducing the need for additional energy consumption to accomplish heating and industrial processes. CHP can both reduce Maine's emissions and support existing industrial businesses and large institutions with lower operating costs.

Maine sawmills and wood manufacturers, for example, that have installed boilers to provide steam for drying lumber are increasingly investing in CHP facilities that also generate power from the same wood fuel source. Technological advances are allowing smaller facilities the ability to install efficient burner technologies. These opportunities establish greater efficiencies in wood-derived energy and provide markets for mill waste that might otherwise be landfilled.

As recommended by the Maine Climate Council, Maine should continue to support the growth of highly efficient CHP facilities. The Climate Action Plan also recognizes that achieving deep emissions reductions in the industrial sector would require significant shifts away from fossil fuels. One example of an opportunity that can be cost-effective and reduce emissions is increasing efficiencies through CHP technologies.

CHP production facilities should continue to be encouraged while considering requirements for these facilities to be highly-efficient and greenhouse-gas emissions reduction requirements for these types of facilities to keep Maine on track to simultaneously accomplish clean energy and climate targets. It is also important to ensure that these types of facilities are prioritizing the use of wood residue that helps to support Maine's forest products sector through the expansion of market opportunities for those materials.

Renewable Fuels

The Maine Climate Council's Climate Action Plan recommended the investigation of options for establishing a Renewable Fuel Standard (RFS) for heating fuels. An RFS for the heating sector would require that a certain percentage of heating fuels be lower carbon or carbon neutral in order to replace or reduce the quantity of fossil fuels in residential, commercial, and industrial sectors. As described in *Maine Won't Wait,* "This could encourage the development of renewable fuels and technologies in Maine, such as biofuels made from wood biomass, biodiesels from used vegetable oils, and fuels made from anerobic digesters on farms or in other waste environments. These projects would create jobs in Maine's rural communities and reduce both carbon and methane emissions, while reducing heating and operating costs."

As technologies such as hydrogen, renewable natural gas, and biofuels continue to advance, further analysis and consideration will be needed to best understand how they may contribute to Maine's climate and clean energy targets.

Next Steps

Given higher-than-typical energy rates for the 2021-2022 heating season, the GEO will continue to monitor and work with relevant entities to develop strategies for consumers to save money on heating costs. Additionally, the GEO will continue to pursue efforts to move Maine's home heating sources away from fossil fuels and towards high-efficiency heat pumps, including by employing incentives that make this technology available to all Maine people, in continued coordination with Efficiency Maine.

Finally, the GEO will continue to monitor markets needed to ensure compliance with Maine's Thermal Renewable Energy Certificate (TREC) program, including through the Thermal Energy Investment Program established by 2021 legislation, at Efficiency Maine Trust.

Energy Efficiency & Weatherization

Energy Efficiency

Energy efficiency is an important and economical tool to help reduce greenhouse gas emissions and reliance on fossil fuels, reduce energy costs, reduce growing energy demand, and create clean energy jobs. With close to one-third of Maine's emissions attributed to buildings, efficiency improvements in energy consumption for heating, cooling, and lighting technologies can aid in reducing energy needs, costs, and associated emissions. Maine has been recognized by the American Council for an Energy-Efficient Economy in 2020 as being in the top one-third of states in the country for energy efficiency policies and efforts as shown in Figure 40.

The two primary state agencies that provide support for energy efficiency technology adoption are Efficiency Maine Trust (EMT) and the Maine State Housing Authority (MaineHousing). EMT is Maine's quasi-state agency and independent administrator for programs to improve energy efficiency for low-income, residential, commercial, and industrial participants. MaineHousing is an independent authority created by the Maine State Legislature to address problems of unsafe, unsuitable, overcrowded, and unaffordable housing including clean heating and weatherization. The GEO works closely with both EMT and MaineHousing to ensure robust coordinated efforts between the three entities for the deployment of energy efficient technologies in an equitable, economical, and efficient manner.

Next Steps

The GEO will continue to coordinate closely with Maine State Housing Authority and Efficiency Maine Trust to continue deployment of equitable energy efficiency services, including heating resource and weatherization programs for eligible households, that support the state's energy efficiency and weatherization goals.

Heat pumps provide energy efficient heating and cooling to Maine's homes and businesses in addition to decreasing the state's high reliance on fossil fuels for heating. Pursuant to 35-A MRSA § 10119 signed in 2019, the Climate Action Plan seeks to achieve the required goal for the installation of 100,000 new heat pumps by 2025 with 15,000 new heat pumps being provided to income-eligible households. This goal will ensure that by 2030, 130,000 homes will be using 1-2 heat pumps and an additional 115,000 homes will be using whole-home heat pump systems. Since the inception of that goal and with combined efforts between EMT and MaineHousing, over 40,000 new heat pumps have been installed, with 28,000 occurring between July 2020 – June 2021, more than doubling the pace of installations from the prior year. As such, Maine is on target to achieve this ambitious goal.

Figure 40 - The 2020 ACEEE State Energy Efficiency Scorecard [ACEEE]

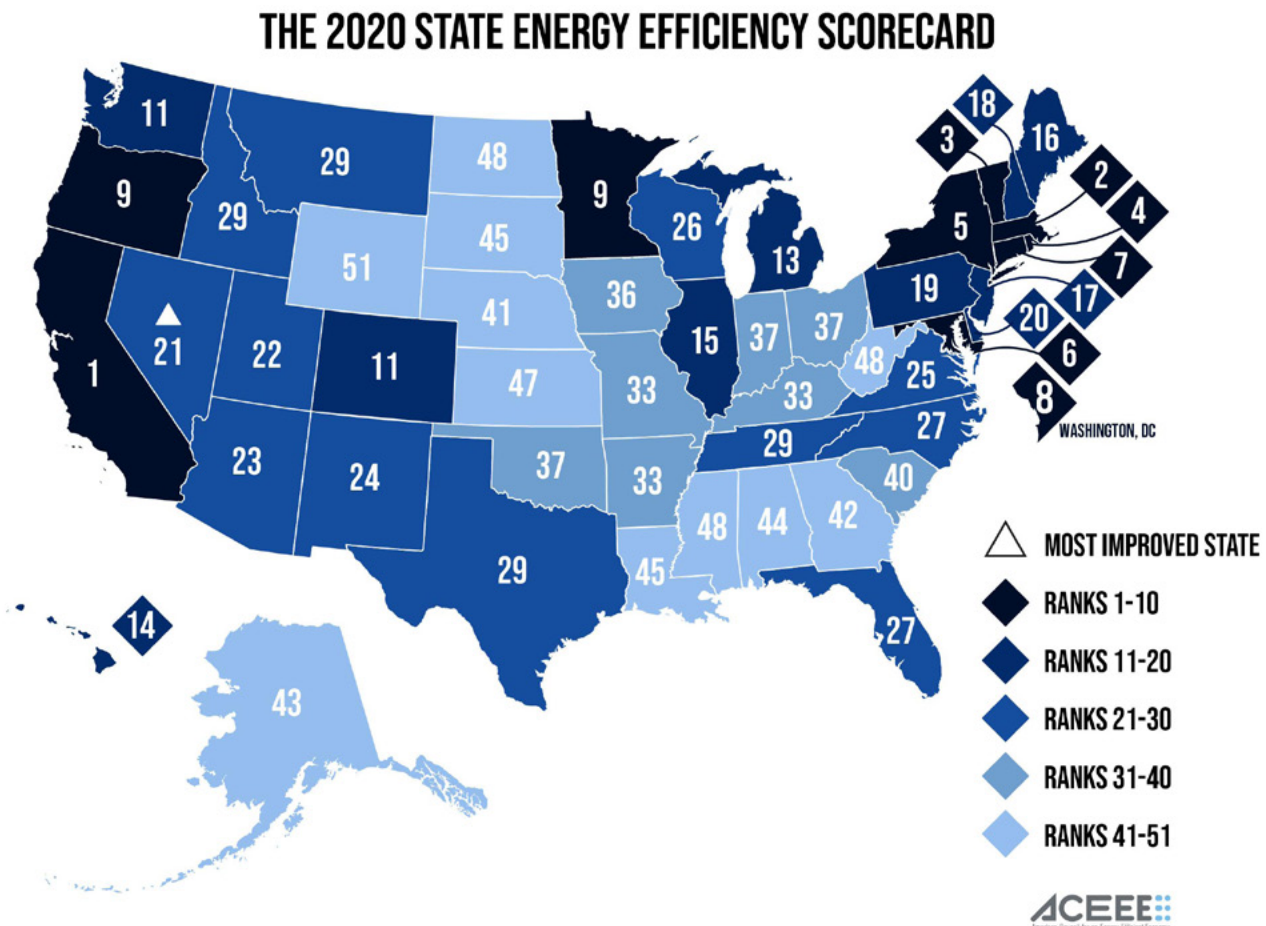
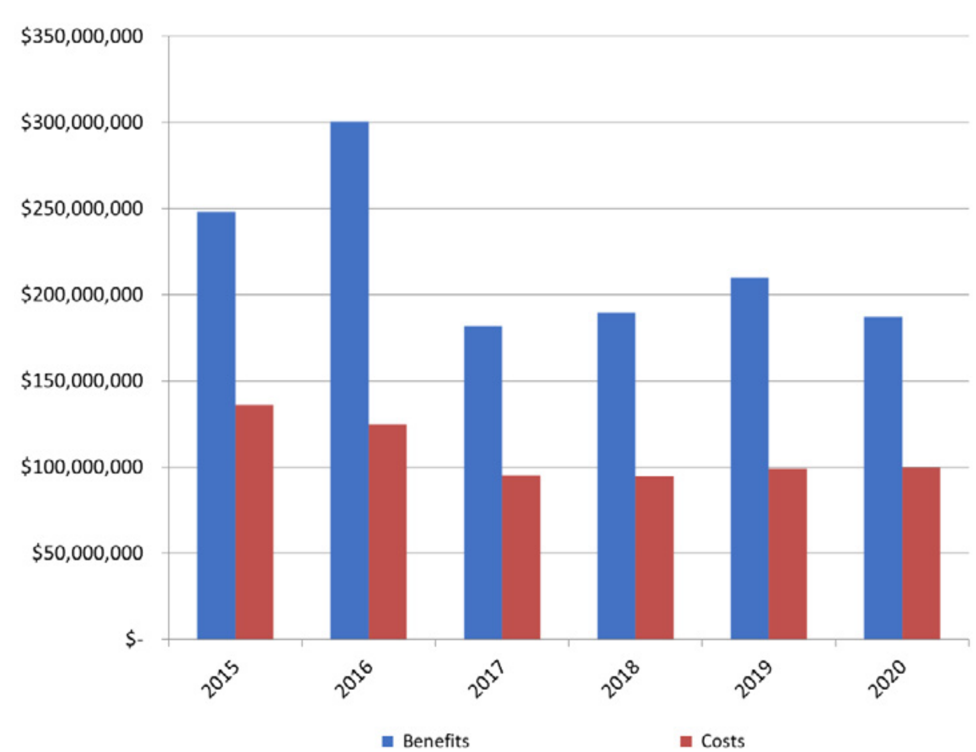


Figure 41 - Efficiency Maine Trust Benefits (lifetime) vs. costs (Efficiency Maine Trust and participant) of all Efficiency Maine Trust programs



Maine continues to make progress on LED lighting adoption. In 2021, EMT provided discounts on over 80,000 LED bulbs through their distributor initiative and over 1,400,000 LED bulbs at retailers. In a study published in July 2021 for EMT and conducted by Ridgeline Energy Analytics[50], 28% of non-residential lighting has yet to be converted to LED lighting with an energy savings potential of 156.6 GWh per year. This study additionally noted that EMT has the potential to acquire a fairly consistent 20% yearly conversion rate. This would imply that the remaining 156.6 GWh per year could be reduced to 125.3 GWh per year in 2022, 100.2 GWh per year in 2023, 80.2 GWh per year in 2024, and 64.1 GWh per year in 2025[51]. If this rate of LED market conversion potential holds, this would result in approximately 59% of the remaining electric savings potential for LEDs to be captured by 2025.

Demand Management

Energy demand management involves employing methods to reduce energy demand during peak periods and managing the existing energy load. By implementing energy demand management programs, there may be a reduced need to build new energy infrastructure to meet demand during these peak events (e.g., fossil-fuel "peaker" plants), a decreased energy usage among participants which may reduce energy bills, and improves the reliability of the energy grid. In Efficiency Maine Trust's Triennial Plan for Fiscal Years 2023-2025[52], two initiatives will be deployed under the Demand Management Program. The first is the Demand Response Initiative which will provide incentives for reducing energy use during peak periods for commercial and industrial facilities. The second is the Load Shifting Initiative which will incentivize battery storage systems, electric vehicle charging stations, and thermal storage solutions to run during off-peak hours. These two initiatives combined will help reduce peak demand on the grid, increase the grid's reliability, and help avoid peak electricity generation.

Industrial Innovation Task Force

Created by a recommendation of the state's four year climate action plan, the Industrial Innovation Task Force will help Maine's industrial sector meet the state's goal of holding industrial greenhouse gas emissions flat in Maine through 2030 and reducing them through 2050, while encouraging continued economic growth. The task force was launched in September 2021 and is led by co-chairs Commissioner Melanie Loyzim, Maine Department of Environmental Protection, and Efficiency Maine Trust Executive Director Michael Stoddard.

The Task Force will serve as a forum for members to learn about opportunities for increasing industrial efficiency and new technologies and processes for reducing greenhouse gas emissions. Through engagement between members of the Task Force and other industry experts, the Task Force will explore opportunities for innovation and pilot projects to reduce emissions, such as CHP and other fuel switching applications, as well as associated funding opportunities. The Task Force will additionally make recommendations to the Maine Climate Council for consideration for inclusion in the next state climate action plan.

Next Steps

The GEO will continue to coordinate and engage the Industrial Innovation Task Force to establish recommendations that will help Maine's industrial sector meet the state's goal of holding industrial greenhouse gas emissions flat in Maine through 2030 and reducing them through 2050 while encouraging continued economic growth, as recommended by the Maine Climate Council.

50 https://www.efficiencymaine.com/triennial-plan-v/
51 2025 is the final year of EMT's Triennial Plan for Fiscal Years 2023-2025 which was adopted by the EMT Board in November of 2021.
52 https://www.efficiencymaine.com/triennial-plan-v/

Weatherization

Weatherization benefits a building's energy efficiency through the installation of insulation to retain indoor temperature and air sealing, weather-stripping, caulking, and more to reduce air leakage through the building envelope. Maine has an aging housing stock of 550,000 homes, with over half of owned and two-thirds of rented dwellings built in 1960 or earlier suffering from energy inefficient weatherization.

Pursuant to 35-A MRSA § 10104 as amended in 2021, the Climate Action Plan seeks to double the pace of home weatherization so that by 2025, 17,500 additional homes and businesses will be weatherized, with an end goal of 35,000 homes and businesses weatherized by 2030. These goals include at least 1,000 low-income residential units per year. In 2021, 2,043 home were weatherized with combined efforts between EMT and MaineHousing. EMT estimates weatherizing an additional 14,874 additional homes by 2025 with at least 4,236 being low-income dwellings.

In addition to this progress, the Governor announced in November of 2021 that $25 million from the Maine Jobs and Recovery Plan will be allocated to EMT for home weatherization for low to moderate income Maine people, serving both homeowners and renters. With this weatherization progress, the work of EMT and MaineHousing, and additional funding support from the MJRP, Maine is on track to achieve these weatherization goals.

Maine Uniform Building and Energy Code

Building codes provide standards for building construction and maintenance throughout the state that promote safety, sustainability, public health, and more. In particular, energy codes establish standards for energy efficiency, embodied carbon, beneficial electrification, weatherization, and more. The Maine Uniform Building and Energy Code (MUBEC) is the statewide building and energy code that is comprised of codes from the International Code Council (ICC) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Pursuant to 10 MRSA §9722 6.B, MUBEC is required to ensure that both the ICC and ASHRAE codes are either the most recent edition or the edition previous to the most recent edition. ICC currently releases code revisions every three years with the most recent edition being 2021 ICC. As such, MUBEC is required to adopt either (1) 2021 ICC to ensure the most recent edition of the ICC set of codes or (2) 2018 ICC to ensure the previous to most recent edition of the ICC set of codes.

Next Steps

Pursuant to 10 MRSA §9722 6.B, the GEO will continue to monitor and support code compliance of the Maine Uniform Building and Energy Code (MUBEC) with the adoption of ICC 2018 or 2021.

Mass Timber

Mass timber is an engineered, wood-derived set of products built to meet international standards for structural integrity and used in a variety of applications for buildings and building performance. Mass timber products can be used to replace more carbon intensive building materials, such as cross laminated timber being used to replace steel joists and beams. By utilizing mass timber for buildings, the overall carbon emissions on the building materials, or embodied carbon, will be decreased. As the most heavily forested state and with ongoing innovation in wood and wood-composites products, the GEO will continue to monitor efforts pursuing and opportunities for mass timber products for buildings in the state.

Next Steps

The GEO will continue to monitor innovations and applications for cross laminated timber and mass timber in building design to capture embodied carbon of new construction facilities.

A full overview of energy efficiency and weatherization programs and impacts can be found in the Efficiency Maine Trust 2021 Annual Report.[53]

Transportation

As noted previously, Maine's transportation sector produced 54% of statewide greenhouse gas emissions in 2017, or approximately 8 million metric tons of carbon dioxide equivalent. In order to meet the state's greenhouse gas emissions reduction targets, it is pivotal to decarbonize the transportation sector. Decarbonizing this sector presents challenges, as well as opportunities – clean transportation can help to meet the State's greenhouse gas emissions reduction targets, improve public health by reducing particulate emissions, and drive the use of innovative grid and demand management strategies. *Maine Won't Wait* estimates Maine needs 219,000 light-duty electric vehicles (EVs) on the road by 2030 to meet its emissions targets.

As with the thermal sector, one major tool for the transition to a decarbonized transportation sector is electrification, which requires the continued expansion of renewable resources to power our electricity grid.

As electric vehicles become more available, charging infrastructure is a key component for adoption of this technology. As of 2021, Maine currently has 417 publicly accessible level 2 charging stations and 131 publicly accessible DCFC plugs, or level three fast chargers, as shown below in Figure 42. These values are likely underestimated due to the number of chargers in workplaces (ie office parking) or similar settings.

Figure 43 below displays emissions in the transportation sector by vehicle type in million metric tons of CO_2e in Maine. While light-duty trucks have seen a decrease in emissions since 2009, passenger cars remain more-or-less constant in emissions since 1990. The U.S. Department of Energy[54] notes that annual emissions per vehicle are 11,435 pounds of CO_2e for gasoline powered vehicles, 6,258 pounds of CO_2e for hybrid vehicles, 3,896 pounds of CO_2e for plug-in hybrid vehicles, and 947 pounds of CO_2e for all electric vehicles. These values illustrate the opportunity to reduce personal annual vehicle emissions by 45-92% by switching from a gasoline powered vehicle to a hybrid or electric vehicle.

Since 2019, Maine has experienced an increase in electric vehicle sales, increasing their total share among vehicles to 1.4% in 2019, 1.6% in 2020, and 3.7% in the first half of 2021. As shown below in Figure 44, 75% of light-duty vehicles in Maine are either sedans or crossovers/SUVs while 97% of EVs on the national market are either sedans or crossovers/SUVs. Since 2019, the number of registered electric and plug-in hybrid vehicles in Maine has increased by more than 90 percent. The number of public EV charging stations has increased by 62 percent. As of November 2021, Maine had reached a record number of electric vehicle registrations (5,677) and sales rebates (1,220), and availability of public EV charging stations (246).

The Maine Climate Council's four-year climate action plan, *Maine Won't Wait,* recommended the development of a clean transportation roadmap. The Clean Transportation Roadmap, released in December 2021, offers a variety of potential policies, programs and regulatory actions to support electrification of Maine's transportation sector.

Another important component of the transition to a decarbonized transportation sector, particularly as pertains to beneficial electrification, is the role of rate design, demand management, and grid management. As the addition of electric vehicles connected to the grid continues to grow, there are opportunities to shift demand for charging to times of lower demand, off-peak times, and to reduce the overall need for expanded capacity of the electric grid. This can be accomplished through strategies such as effective time

53 https://www.efficiencymaine.com/about/library/reports/
54 https://afdc.energy.gov/states/me

Figure 42 - Maine's Public Electric Vehicle Charging Stations [Efficiency Maine]

Figure 43 - Transportation sector emissions by vehicle type, Maine [ME Clean Transportation Roadmap]

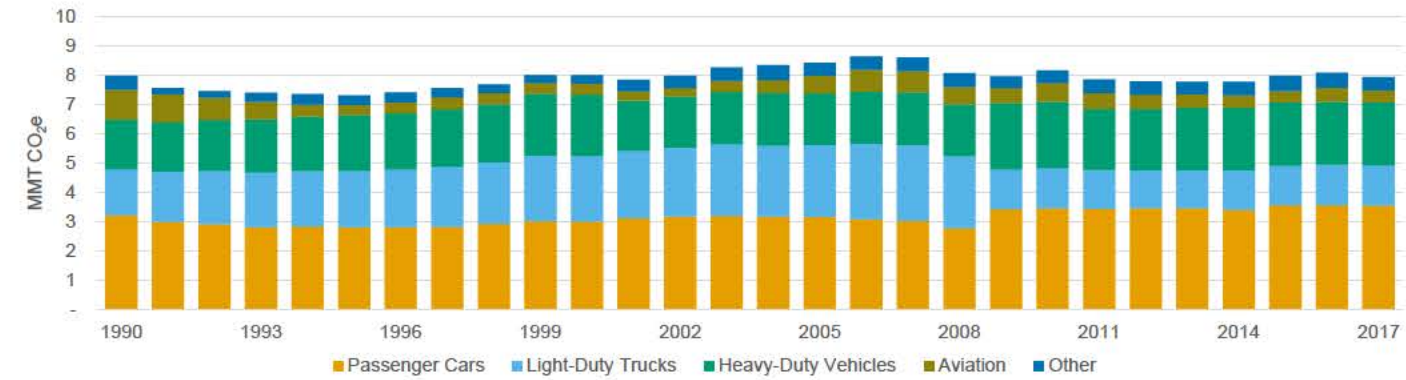
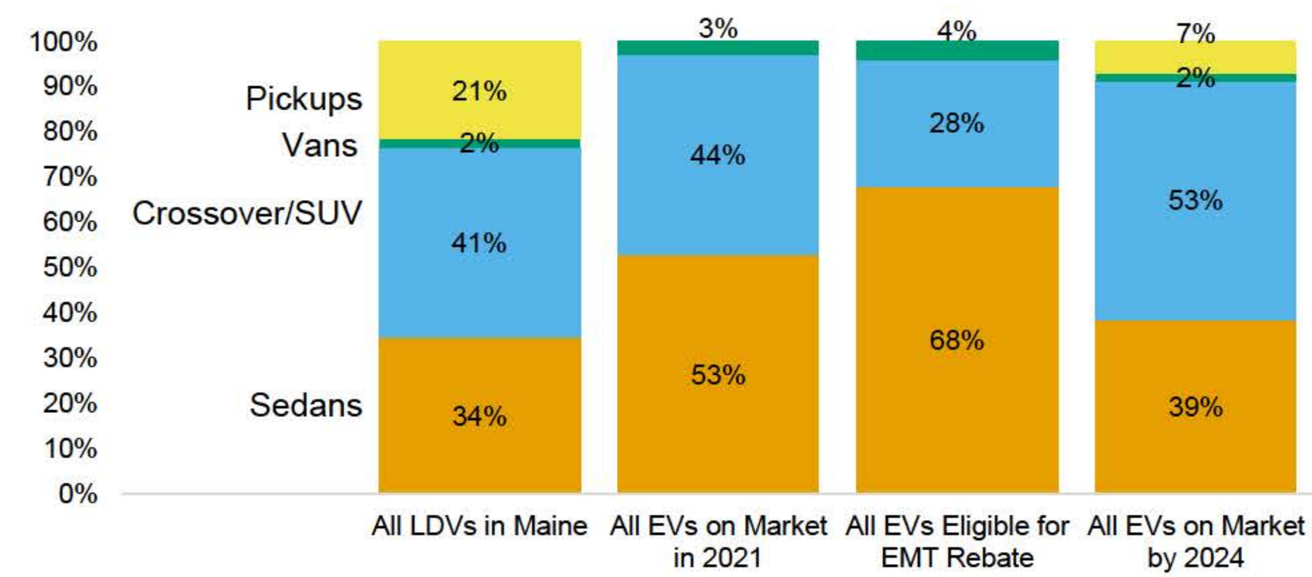


Figure 44 – Breakdown of Light Duty Vehicles in Maine [ME Clean Transportation Roadmap]



of use rate design, which provides financial incentive to shift the timing of electric vehicle charging. The addition of electric vehicle batteries connected to the grid system also provides opportunities for utilization of the storage potential of these batteries for innovative grid management strategies that could improve reliability.

Next Steps

Going forward, the GEO will continue to work on ways to incentivize electric vehicles and electric vehicle charging stations to decarbonize the transportation sector, in a way that ensures equitable access for all Maine people. The GEO will evaluate the Clean Transportation Roadmap to determine which recommendations, if any, should be considered for implementation. This work will include consideration of changes to rate design structure, demand charging challenges, and other programmatic roadblocks to transitioning Maine's transportation sector, including larger fleets, to zero-emission vehicles. A review of opportunities to utilize increased electric vehicle batteries connected to Maine's distribution grid for demand management, as well as grid management and reliability improvement opportunities, must also be considered, including as relates to larger grid planning and modernization efforts.

Clean Energy Economy & Workforce

Workforce & Business Development

Following a series of supportive clean energy and climate policies, Maine's clean energy sector has provided valuable commitments to and investments in Maine's economy. The New England region is going to experience significant growth in renewable energy generation in order to meet collective clean energy targets. Additionally, the Mills Administration's commitment to energy efficiency and weatherization is driving workforce needs and growth opportunities in those sectors. This growth is providing benefit to Maine communities and demonstrating to potential for significant economic development opportunities .

In recognition of this great potential, the GEO and the Governor's Office of Policy Innovation and the Future (GOPIF) released a report, *Strengthening Maine's Clean Energy Economy*, in November 2020. The report offered a detailed analysis of the momentum within Maine's clean energy economy, and how the sector is emerging as a source of economic growth and workforce opportunities to help the state's recovery from the economic disruptions of COVID-19. This report was received by the Maine Climate Council and recommendations from the report were incorporated into the Climate Action Plan, *Maine Won't Wait*.

Upon the release of the Climate Action Plan, Governor Mills announced the goal to more than double Maine's clean energy workforce to 30,000 clean energy workers by 2030. Pre-pandemic, 2019 clean energy jobs numbers indicated Maine employed about 14,000 clean energy workers across the state. Of those, about 9,000 worked in the energy efficiency or weatherization sector. As the report indicates, that sector of work will continue to be a key driver of clean energy workforce growth and meeting those workforce needs is instrumental in ensuring the state meets its goals.

Next Steps

The recommendations laid out in the *Strengthening Maine's Clean Energy Sector* report, prepared by GEO and GOPIF and adopted by the Maine Climate Council, will be pursued to accomplish the Governor's goal of 30,000 clean energy jobs by 2030.

One overarching recommendation that stemmed from the analysis in the report was to foster greater collaboration for workforce pathway development for key clean energy occupations. Doubling Maine's clean energy and energy efficiency jobs by 2030 will require ongoing stakeholder coordination between industry, educational, and training organizations to support current and prepare for future workforce needs. This includes ensuring that entities that contribute to those pathways – such as education, training, STEM education, business development, etc. – are communicating and coordinating efforts that focus on clean energy workforce development. In response to this need, the GEO is launching the Clean Energy Partnership (CEP), in part utilizing funding from the Maine Jobs and Recovery Plan.[55]

Through the CEP, the GEO and GOPIF will work with leading experts to sustain attention and promote collaboration to address emerging needs, build new and expand existing supply chains, and support opportunities for Maine in these fast-growing fields.

Maine's limited skilled workforce is a hurdle to accelerating clean energy and supporting cleantech innovation, as recognized in the State's 10-year Economic Plan. The Maine CEP will strengthen educational and training pathways for Maine people to find new careers, and attract a talented, diverse workforce to Maine. The clean energy industry has great potential to create new, sustained opportunities in fields such as solar, wind, bioproducts and energy efficiency that are poised for major growth in the coming decade and beyond. Nationally, median hourly wages for clean energy jobs are about 25 percent higher than the national median wage and are more likely to come with benefits such as health care and retirement.[56] Job creation in clean energy and energy efficiency can provide high-quality workforce opportunities across Maine communities, including in rural areas of the state.

Next Steps

The Clean Energy Partnership, and related analysis, should be utilized to coordinate relevant stakeholders and funding opportunities that aid in supporting clean energy workforce development needed to accomplish the state's workforce goals, support cleantech innovation, and provide resources to clean energy small businesses impacted by the pandemic.

About half of the clean energy economy workers attain no more than a high school diploma but can earn higher wages than those with similar education levels working in other industries. Clean energy jobs can offer Maine workers without a postsecondary credential, particularly those in rural areas, higher paying jobs with opportunities for training and career advancement.

To better understand Maine's clean energy workforce challenges and opportunities, the GEO is currently contracted with BW Research to assess employment demand, skill requirements, awareness, and interest of clean energy employers in Maine. The ultimate result of this work will be a strategic policy and program design roadmap that identifies key areas of focus for clean energy workforce development initiatives in the state and supplements the current offshore wind work being conducted by BW Research. This analysis will inform the Clean Energy Partnership as well as future workforce and business development initiatives.

Cleantech Innovation

Additionally, as outlined in the Strengthening Maine's Clean Energy Economy Report, there are significant opportunities for cleantech innovation.

Clean energy technologies have advanced immensely over the last few decades. Solar technologies have decreased drastically in cost from the time they first

55 https://www.maine.gov/covid19/maine-jobs-and-recovery-plan
56 Clean Jobs, Better Jobs. An Examination of clean energy jobs wages and benefits. E2, ACORE, CELI, and BW Research (2020), https://e2.org/reports/clean-jobs-better-jobs/

began to be developed. Overnight capital costs[57] required to build a new onshore wind plant have decreased 38 percent between 2010 and 2018; in comparison, overnight capital costs to build a new natural gas combined-cycle power plant has only decreased by 2 percent over the same timeframe.[58] Additionally, the costs to generate onshore wind and solar PV have fallen between 3-16% yearly since 2010, which is faster than many other consumer goods and products.[59] New energy innovations in bioproducts, tidal and river hydrokinetics, and grid management also have significant potential.

As innovative ideas develop into commercialized products and services, it is imperative to provide the necessary resources and opportunities for development. Investing in the success of a new technology can lead to the development of advanced products and services that can be part of global clean energy solutions and reduce energy costs in the long-term. There are benefits in leading clean energy innovation and having the opportunity to market that new technology outside of the state, growing the pool of customers that will contribute to the Maine economy and helping to grow new jobs. Assistance should be focused beyond just initial research and development to ensure successful growth through the commercialization phase. The transition to commercialization can be immensely challenging for new companies but is vital to reaping the full initial investment and economic benefits.

In recognition of the importance of supporting clean energy innovation, the GEO worked in collaboration with MTI to launch a Clean Energy Innovation Challenge in 2021. This $500,000 grant program was established to encourage clean energy startups and businesses to propose innovative, scalable solutions that will help meet the climate and clean energy goals of the state. The program was competitive and resulted in two Maine companies each being awarded $250,000 to advance technology to support carbon-free agriculture and renewable energy storage. Additionally, the GEO worked with MTI and E2Tech to support a record number of Maine startups participating in the Cleantech Open Northeast – the oldest and largest cleantech accelerator and mentorship program in the country.

Next Steps

The GEO will continue to support efforts to increase innovation, research and development (R&D), pilot programs, and the cleantech ecosystem overall. This includes supporting testing sites and other necessary resources for innovative technologies that will help support Maine's clean energy economy and provide innovative solutions to cost-effectively meet Maine's clean energy and climate targets. The GEO will continue to engage with the cleantech and startup ecosystem, and partners like MTI and E2Tech, on programs that promote and support cleantech innovation across the state.

Conclusion

Maine has made significant progress and is well on the path to achieving our statutory requirements. The coming year will offer opportunities to conduct additional planning to ensure the state continues advancing policies that grow Maine's economy, workforce, and clean energy sector, engage in the important fight against climate change, and ensure Maine people have equitable access to clean, affordable and dependable energy.

57 Overnight costs exclude interest expenses during plant construction and development (U.S. Energy Information Administration).

58 Xiaojing Sun. Greentech Media. Solar Technology Got Cheaper and Better in the 2010s. Now What? December 2019. https://www.greentechmedia.com/articles/read/solar-pv-has-become-cheaper-and-better-in-the-2010s-now-what

59 International Renewable Energy Agency (IRENA). Renewable Power Generation Costs in 2019. 2020. https:// www.irena.org/media/Files/IRENA/Agency/Publication/2020/Jun/IRENA_Power_Generation_Costs_2019. pdf

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Contents[1]

All Sectors........ 5
Generation and Capacity 5
Electricity........ 5
Electricity generation by energy source, Maine (2020) 5
Electricity generation by energy source, Maine (2019) 6
Electricity generation by energy source, New England (2020) 7
Electricity generation by energy source, US (2020) 8
Renewable electricity generation, New England (2020) 9
Electricity generation by energy source, Massachusetts (2020) 10
Electricity generation by energy source, Connecticut (2020) 11
Electricity generation by energy source, New Hampshire (2020) 12
Electricity generation by energy source, Maine (2020) 13
Electricity generation by energy source, Rhode Island (2020) 14
Electricity generation by energy source, Vermont (2020) 15
Electricity capacity by energy source, Maine (2020) 16
Electricity capacity by energy source, New England (2020) 17
Electricity capacity by energy source, US (2020) 18
Wind electricity total net generation, New England 19
Solar thermal and photovoltaic electricity total net generation, New England 20
Hydroelectricity net generation in the electric power sector, New England 21
Wood and waste energy consumed by the electric power sector, New England 22
Net interstate flow of electricity and associated losses, New England 23
Prices........ 24
Energy 24
Total energy average price........ 24
Natural gas average price, all sectors 25
All petroleum products average price, all sectors 26
Electricity........ 27
Electricity average price, all sectors........ 27

[1] Unless otherwise noted, all values are retrieved from U.S. Energy Information Administration: State Energy Data System (2021) with graphics, visuals, and tables developed by the Maine Governor's Energy Office.

Electricity average price, all sectors (2019) ... 28
Expenditures ... 29
Energy ... 29
Expenditures by fuel, Maine (2019) ... 29
Total energy expenditures by sector, Maine ... 30
All petroleum products total expenditures by sector, Maine ... 31
Consumption ... 32
Energy ... 32
Energy consumed by fuel, Maine (2019) (Excluding electric power sector) ... 32
Total energy consumed (i.e., sold to) by sector, Maine ... 33
Fuel oil total, distillate, and residual consumption with 2030 and 2050 goals ... 34
All petroleum products total consumption, New England ... 35
Total energy consumption (2019) ... 36
Energy consumed by fuel and renewable energy consumed, Maine and US (2019) ... 37
Energy consumed by sector by fuel, Maine (2019) ... 38
Energy consumed by sector and fuel, Maine (2019) ... 39
Electricity ... 40
Electricity consumed (i.e., sold to) by sector, Maine ... 40
Electricity consumed (i.e., sold to) by sector, Maine ... 41
Electricity total consumption (i.e., retail sales), New England (2019) ... 42
Energy Efficiency ... 43
National spending on energy efficiency programs ... 43
Annual savings from Efficiency Maine Trust programs ... 44
Benefits (lifetime) vs. costs (Efficiency Maine Trust and participant) of all Efficiency Maine Trust programs ... 45
Costs of savings for Efficiency Maine Trust electric programs (2021) ... 46
Costs and savings for Efficiency Maine Trust thermal programs (2021) ... 46
Efficiency Maine Trust payments made (2021) ... 47
Maine State Housing Authority energy efficiency and weatherization initiatives (2021) ... 48
Advanced metering infrastructure (AMI) penetration, New England (2020) ... 49
Residential Sector ... 50
Prices ... 50
Energy ... 50

Total energy average price in the residential sector 50

Natural gas price in the residential sector 51

Electricity 52

Electricity price in the residential sector 52

Expenditures 53

Energy 53

Residential expenditures by fuel, Maine 53

All petroleum products total expenditures in the residential sector (2019) 54

Consumption 55

Energy 55

Distillate fuel oil consumed by the residential sector (2019) 55

Share of Energy Sources Consumed for Residential Heating, New England Summary (2019) 56

Share of Energy Sources Consumed for Residential Heating, Maine and US (2019) 57

Share of Energy Source Consumed for Residential Heating, Maine 58

Energy Efficiency 59

Efficiency Maine Trust heat pump installations (2021), population density (2010), and income distribution (2018), Maine 59

Generation 60

Electricity 60

Solar photovoltaic electricity generation by small-scale applications in the residential sector, New England 60

Commercial and Industrial Sector 61

Prices 61

Energy 61

Total energy average price in the commercial sector 61

Total energy average price in the industrial sector 62

Consumption 63

Energy 63

Distillate fuel oil consumed by the commercial sector (2019) 63

Transportation Sector 64

Consumption 64

Energy 64

Fuels consumed in transportation sector, Maine 64

Alternative Transportation and Infrastructure 65

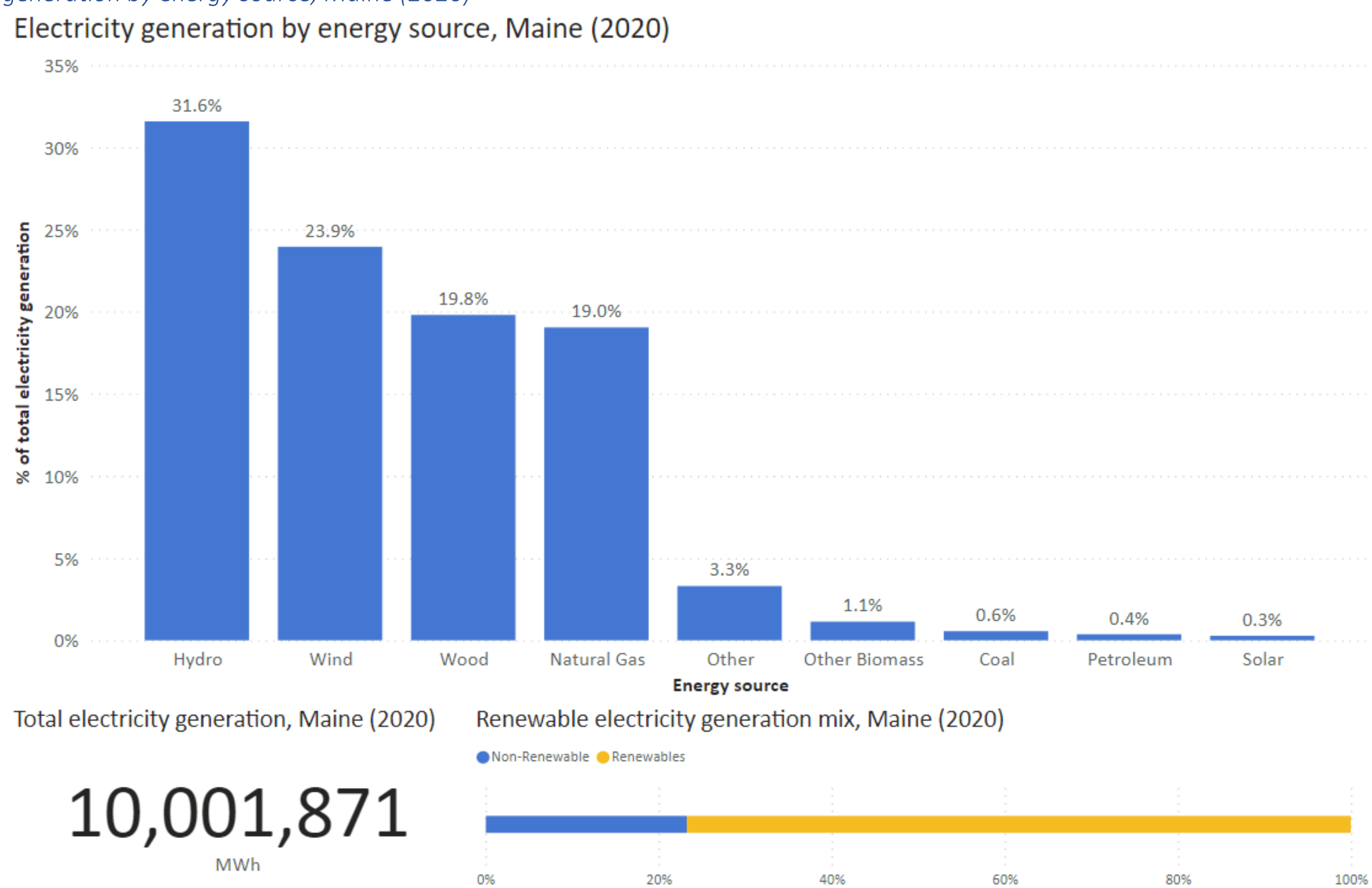
Annual emissions per vehicle in pounds of CO_2e, Maine 65
Mine-to-wheel life cycle emissions of EVs 66
Breakdown of light-duty vehicles owned and available for rebate, Maine and US (2021) 67
Average MSRP of EVs sold by vehicle category, Maine 68
Locations of 417 publicly accessible level 2 stations, 131 publicly accessible DCFC plugs, and planned chargers, Maine (2021) 69
Income distribution of new EV buyers, new car buyers, and used car buyers 70
Emissions in the transportation sector by vehicle type in million metric tons of CO_2e, Maine 71
Electric vehicle (EV) sales share of all light-duty sales, North East 72

All Sectors

Generation and Capacity

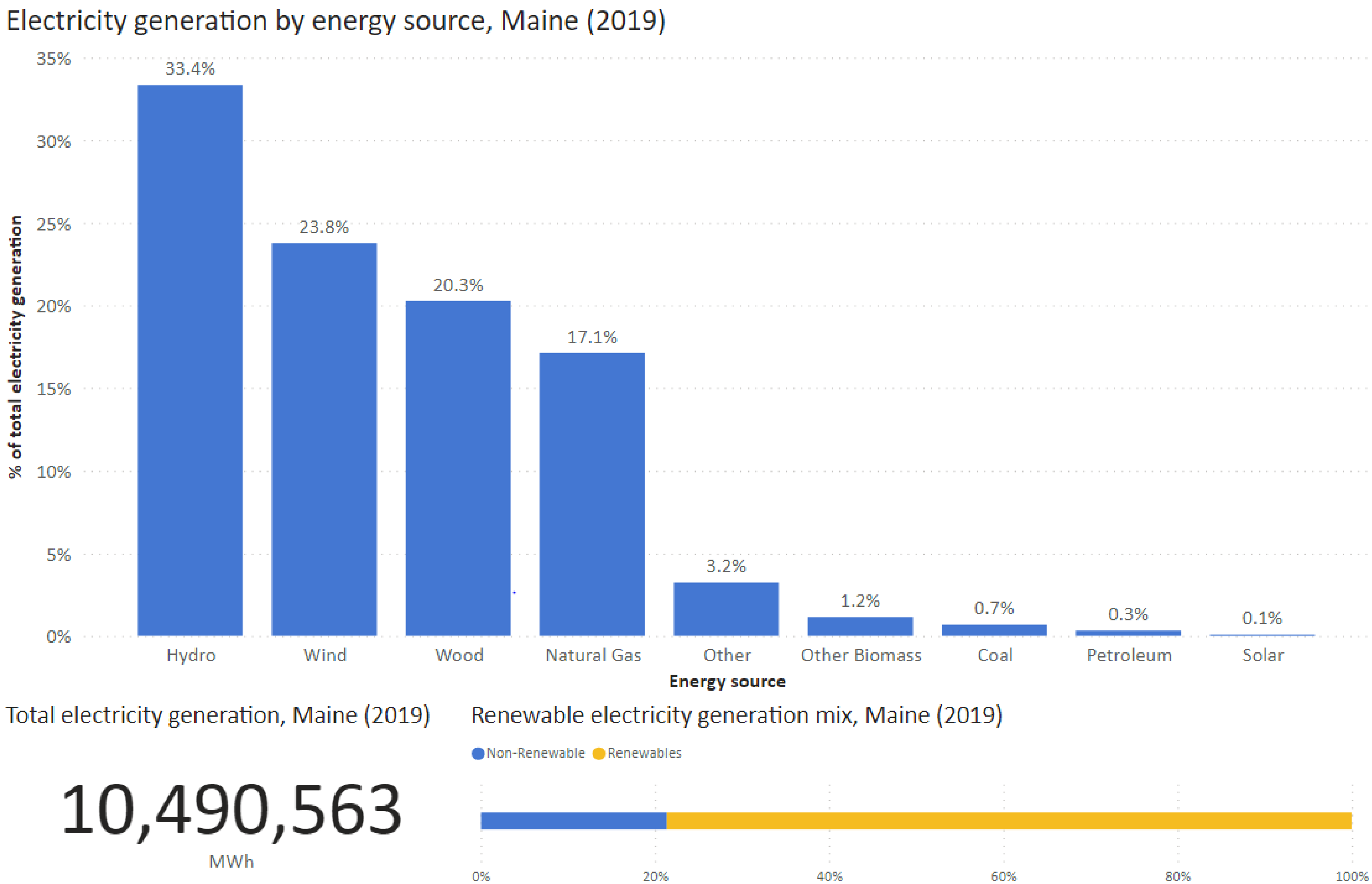
Electricity

Electricity generation by energy source, Maine (2020)[2]



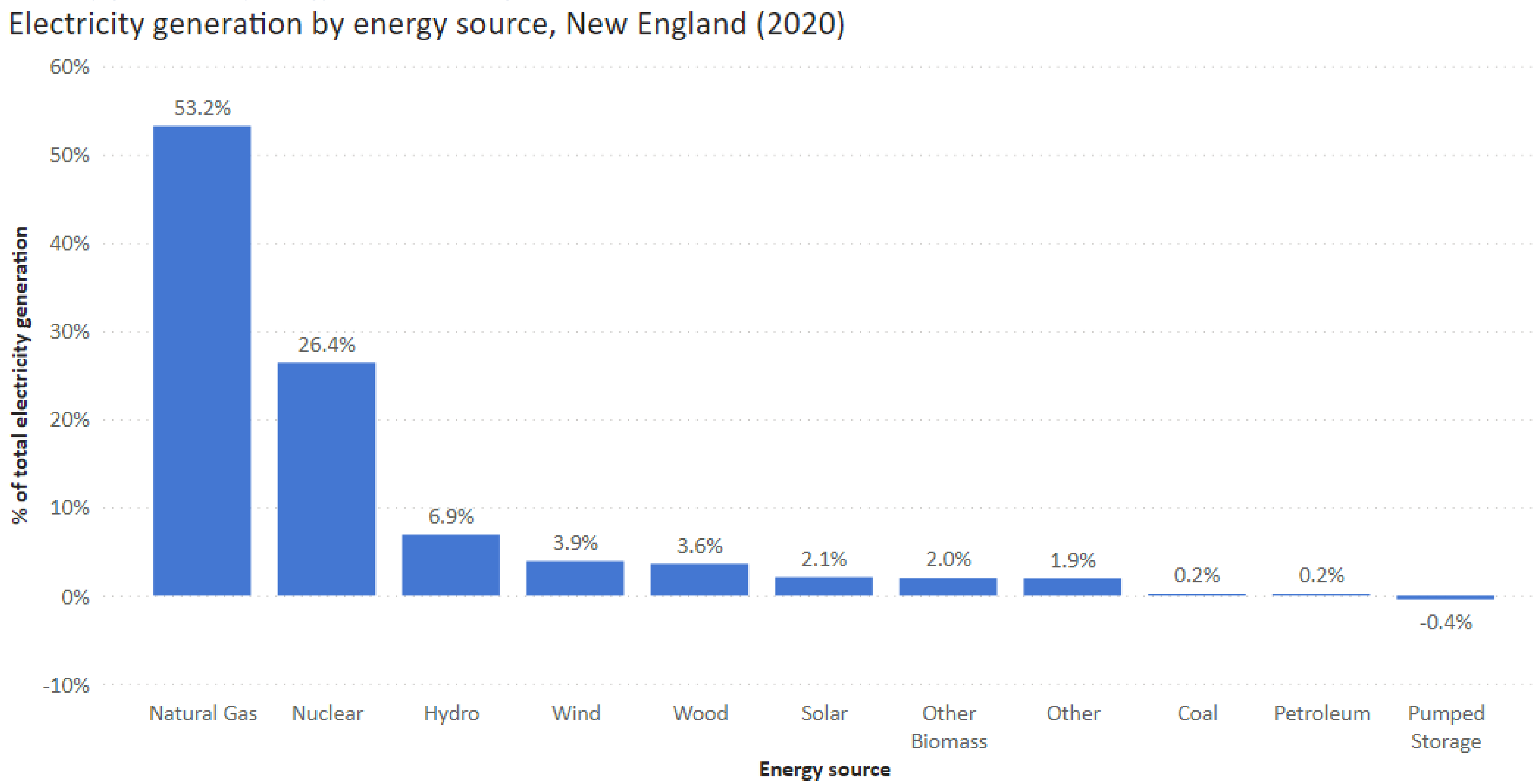
[2] Data retrieved from U.S. Energy Information Administration: Electric Power Annual (2021) with visual developed by the Maine Governor's Energy Office.

Electricity generation by energy source, Maine (2019)[3]



[3] Data retrieved from U.S. Energy Information Administration: Electric Power Annual (2021) with visual developed by the Maine Governor's Energy Office.

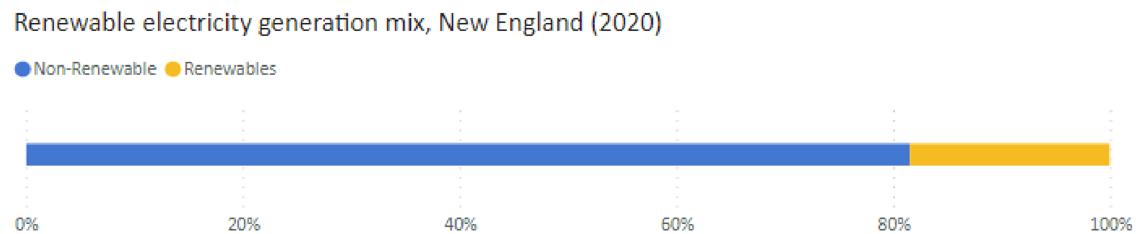
Electricity generation by energy source, New England (2020)[4]



Total electricity generation, New England (2020)

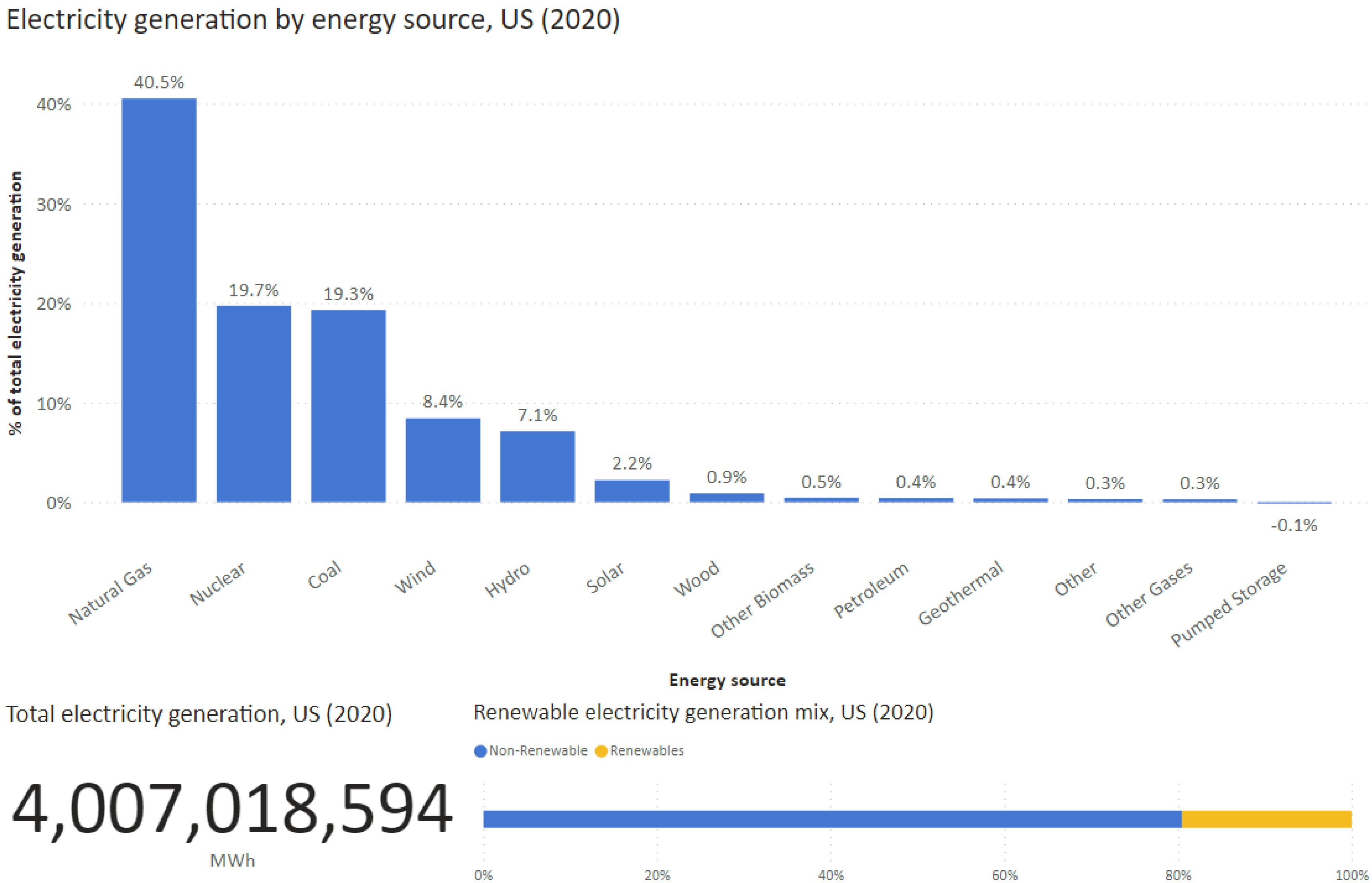
96,808,511

MWh



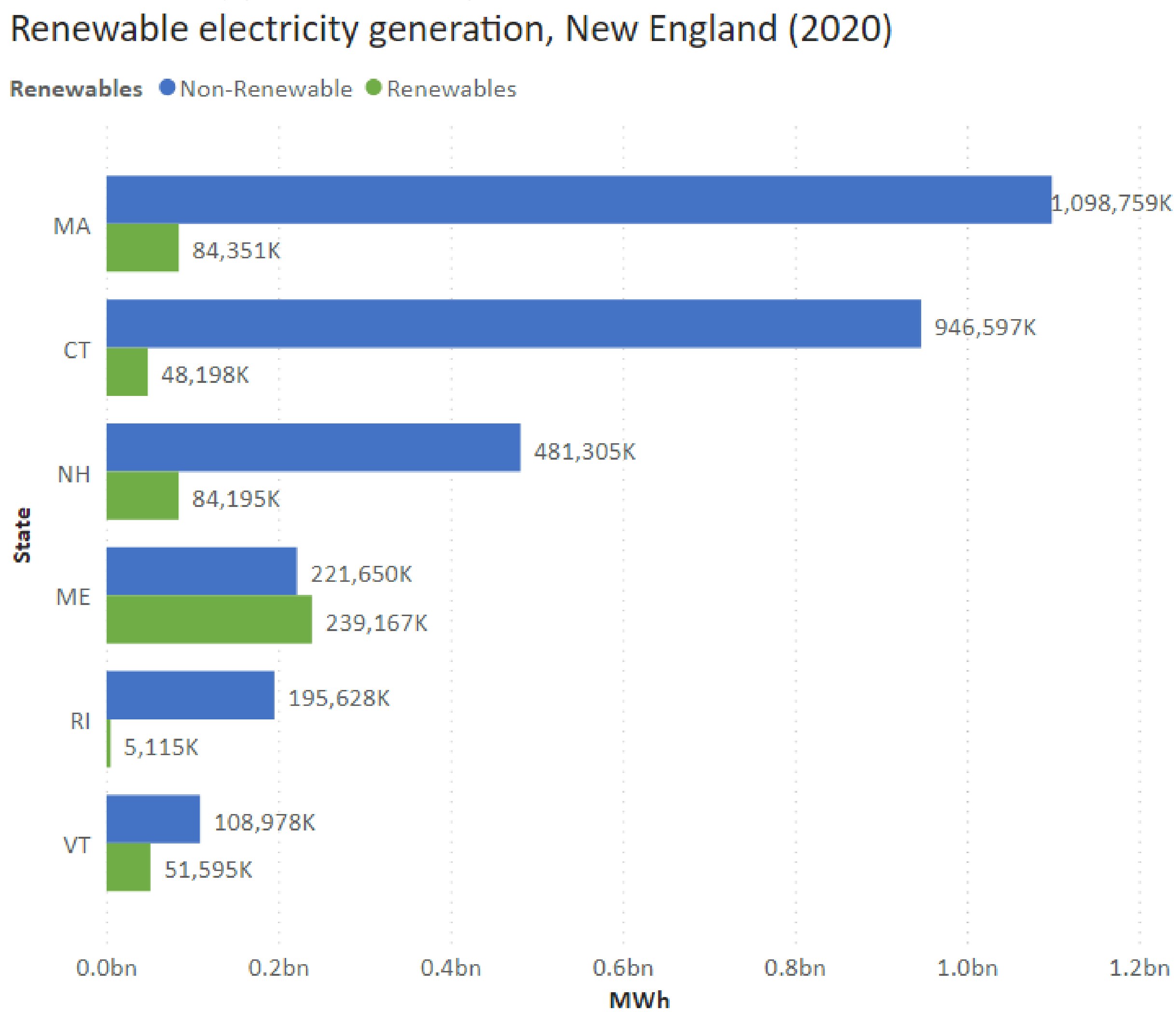
[4] Data retrieved from U.S. Energy Information Administration: Electric Power Annual (2021) with visual developed by the Maine Governor's Energy Office.

Electricity generation by energy source, US (2020)[5]



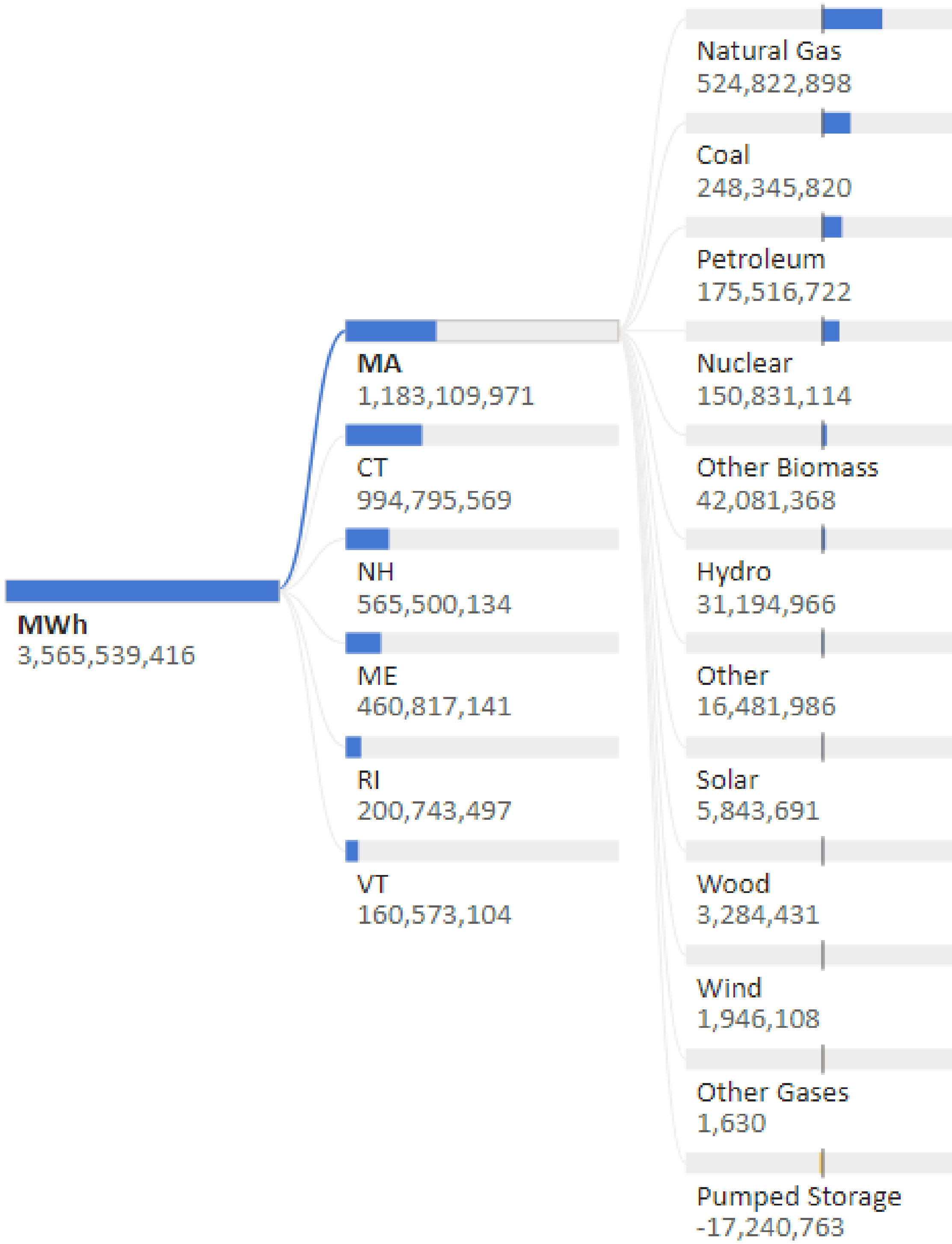
[5] Data retrieved from U.S. Energy Information Administration: Electric Power Annual (2021) with visual developed by the Maine Governor's Energy Office.

Renewable electricity generation, New England (2020)[6]



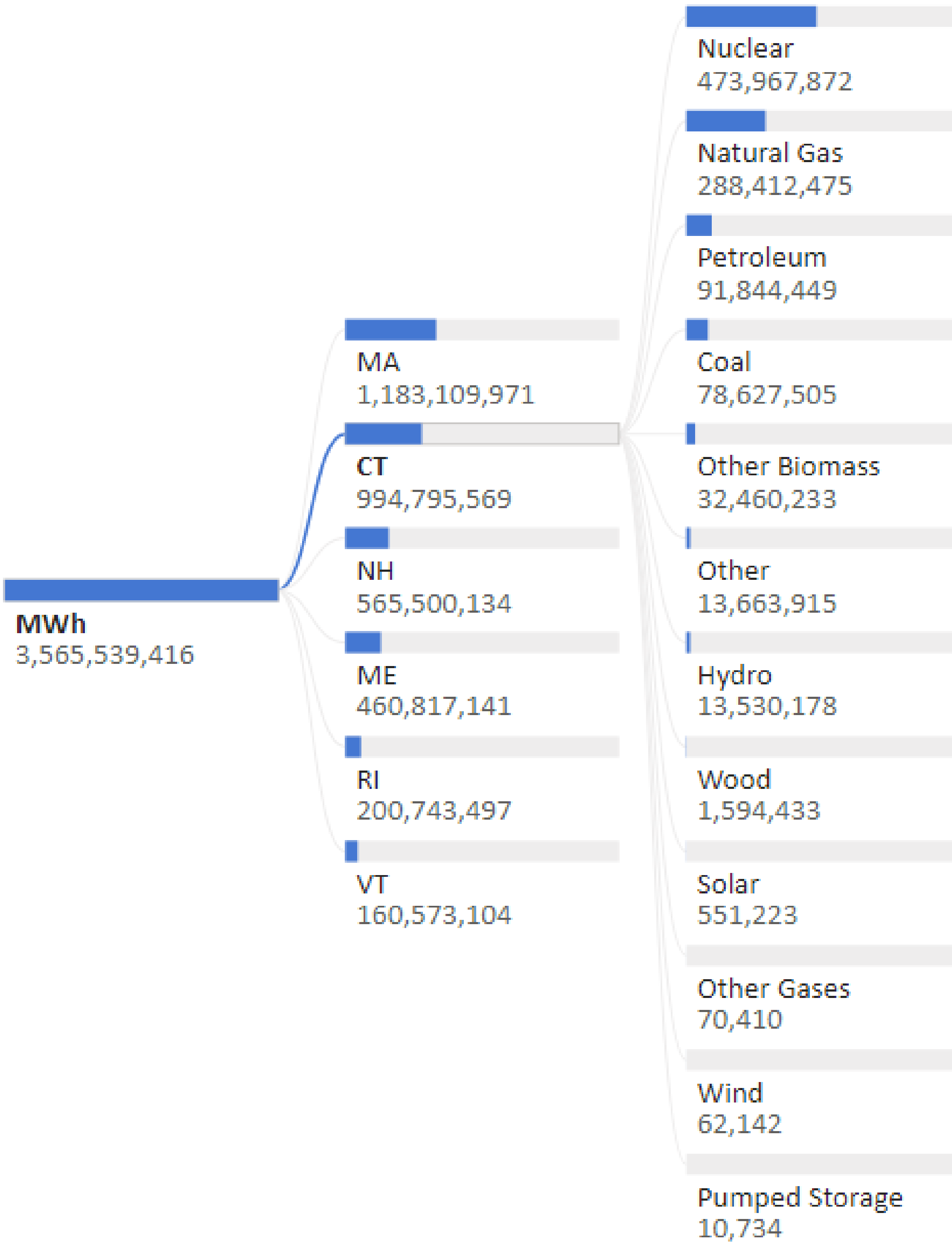
[6] Data retrieved from U.S. Energy Information Administration: Electric Power Annual (2021) with visual developed by the Maine Governor's Energy Office.

Electricity generation by energy source, Massachusetts (2020)[7]



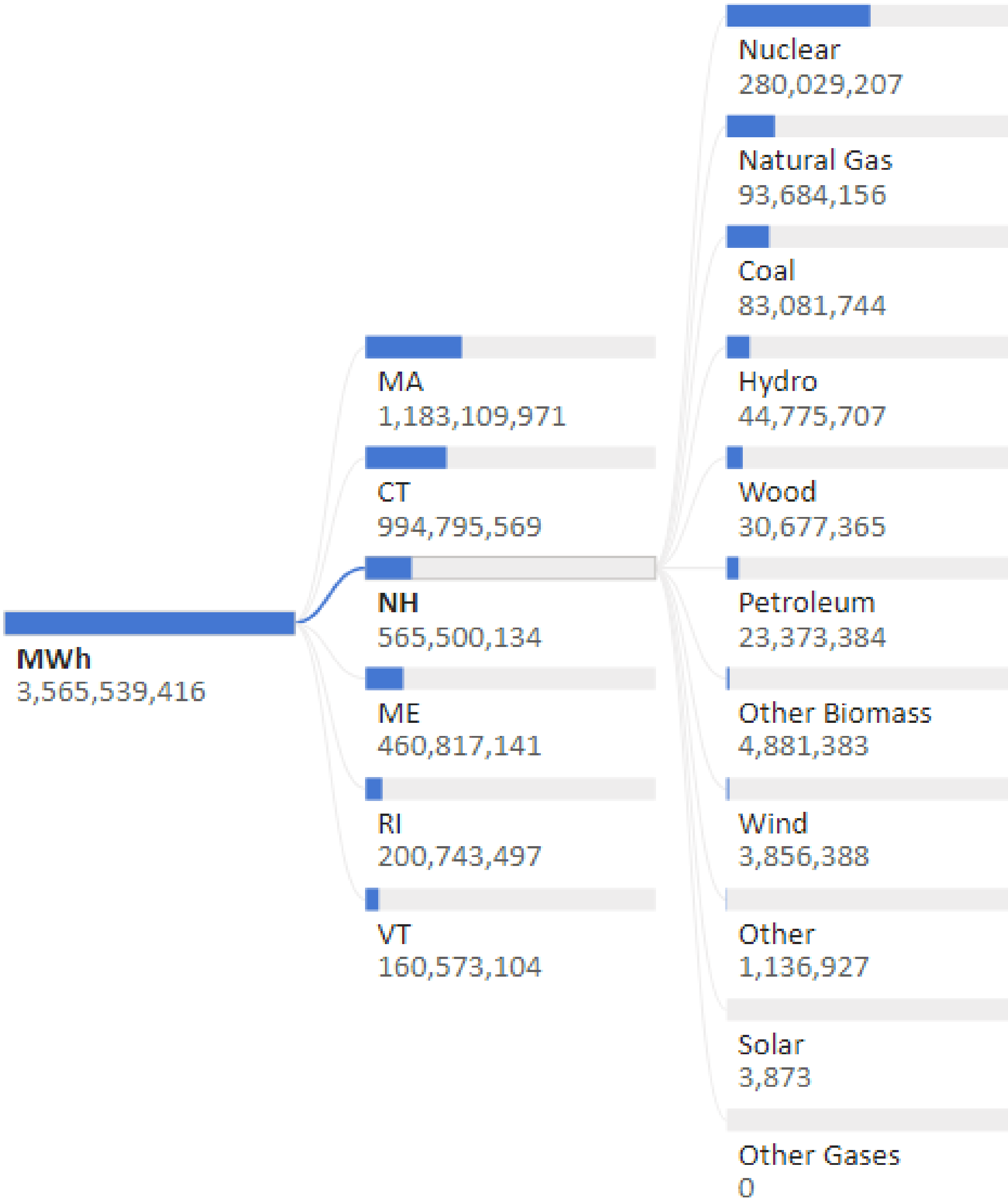
[7] Data retrieved from U.S. Energy Information Administration: Electric Power Annual (2021) with visual developed by the Maine Governor's Energy Office.

Electricity generation by energy source, Connecticut (2020)[8]



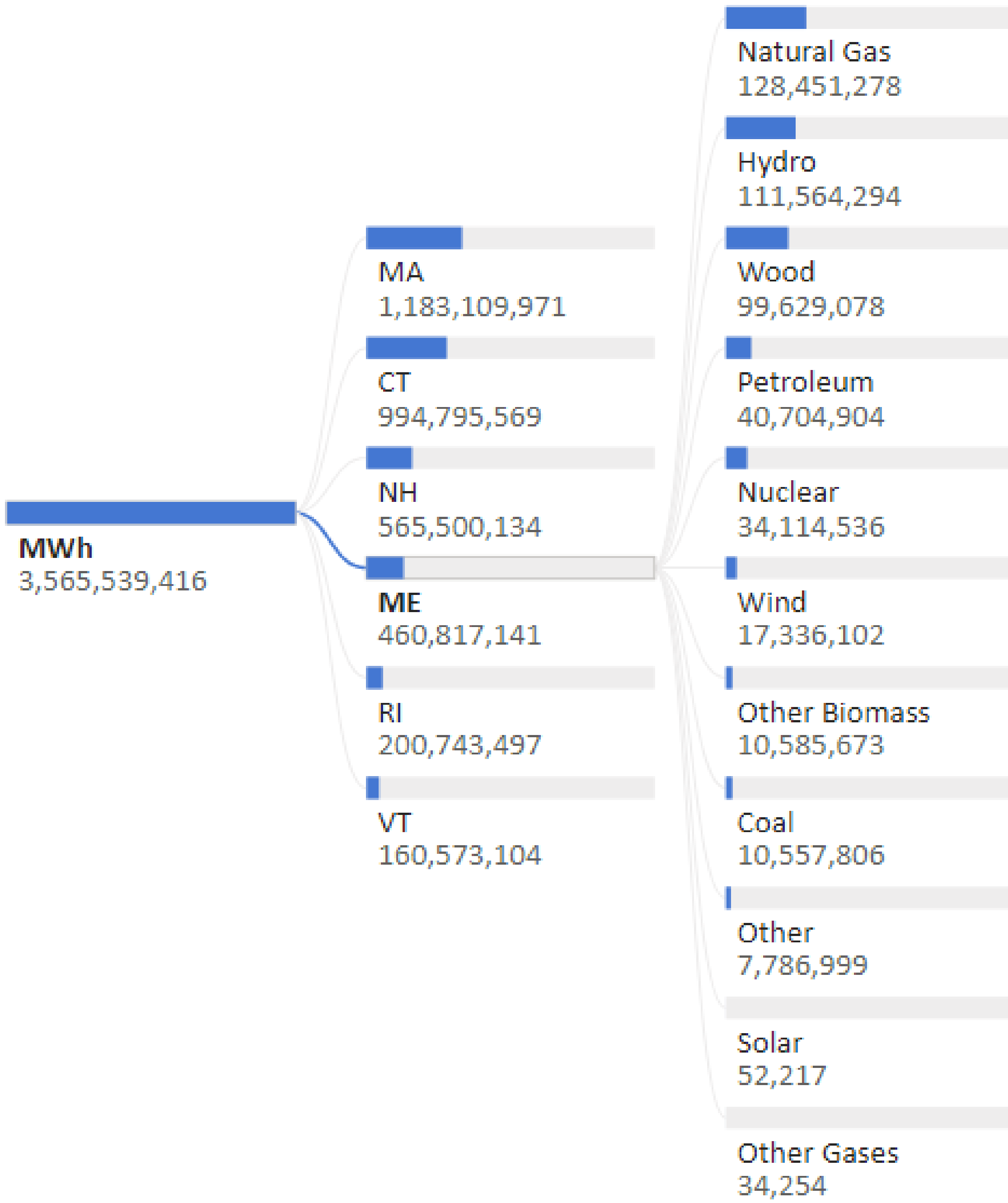
[8] Data retrieved from U.S. Energy Information Administration: Electric Power Annual (2021) with visual developed by the Maine Governor's Energy Office.

Electricity generation by energy source, New Hampshire (2020)[9]



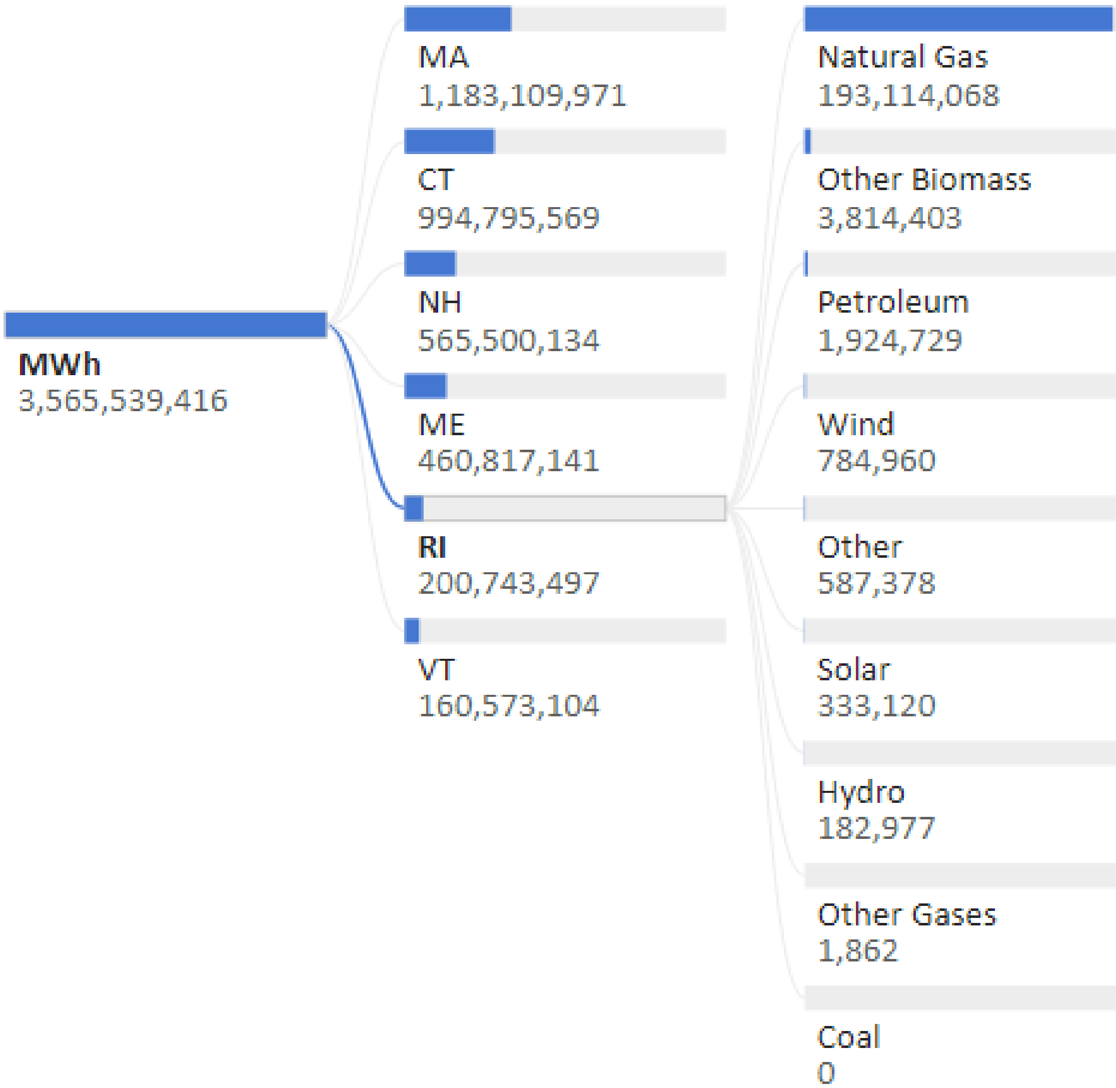
[9] Data retrieved from U.S. Energy Information Administration: Electric Power Annual (2021) with visual developed by the Maine Governor's Energy Office.

Electricity generation by energy source, Maine (2020)[10]



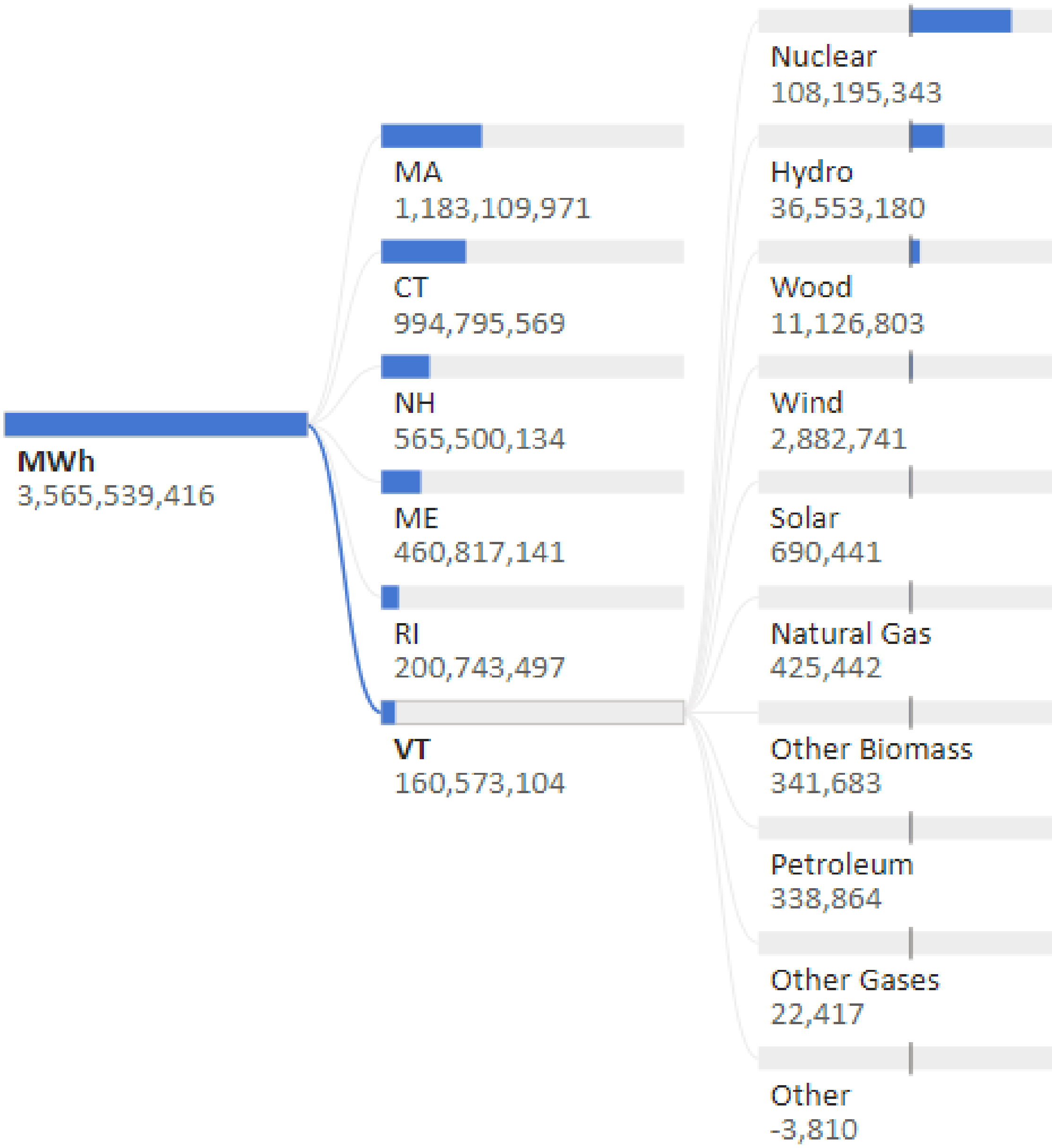
[10] Data retrieved from U.S. Energy Information Administration: Electric Power Annual (2021) with visual developed by the Maine Governor's Energy Office.

Electricity generation by energy source, Rhode Island (2020)[11]



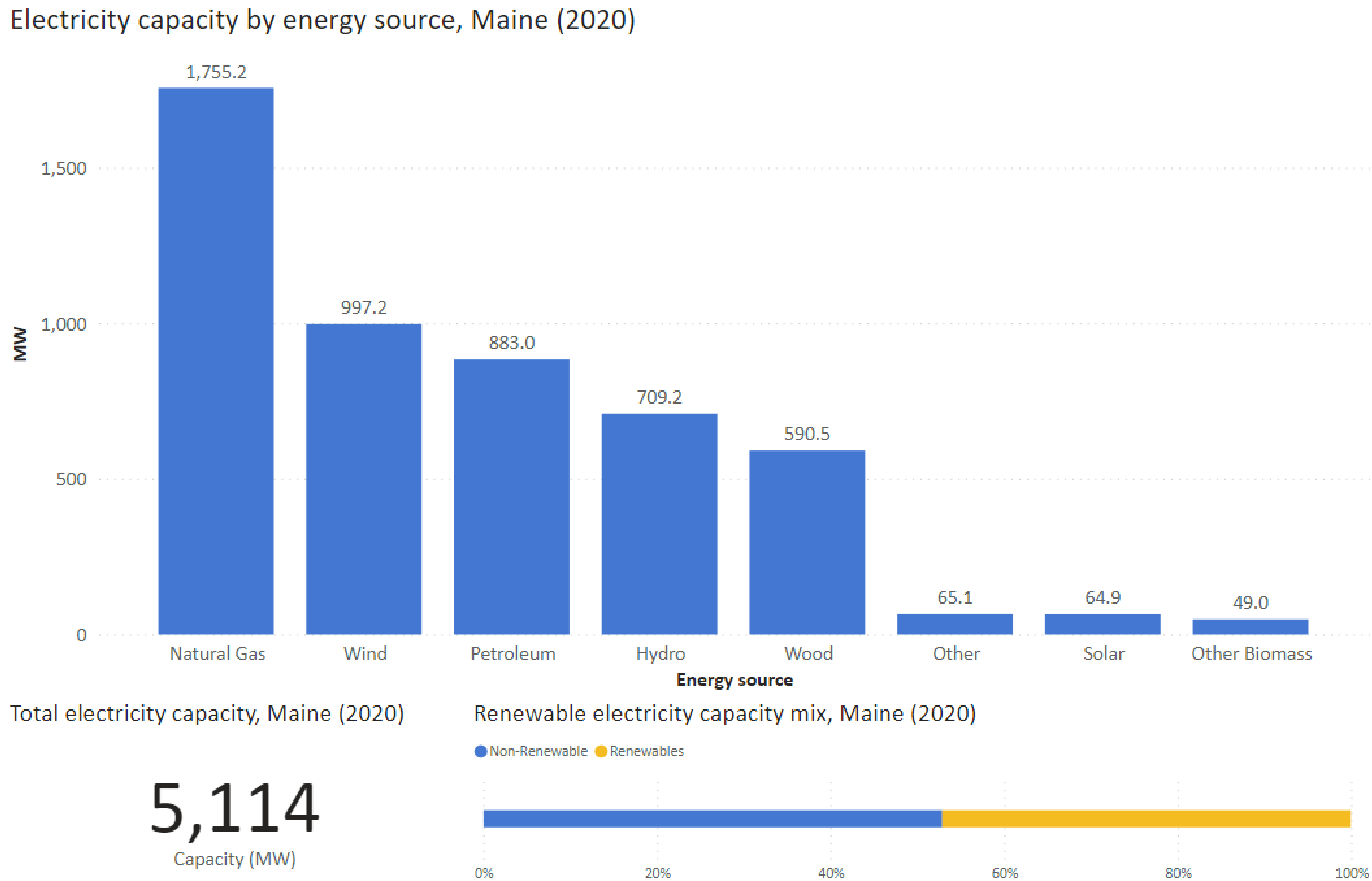
[11] Data retrieved from U.S. Energy Information Administration: Electric Power Annual (2021) with visual developed by the Maine Governor's Energy Office.

Electricity generation by energy source, Vermont (2020)[12]



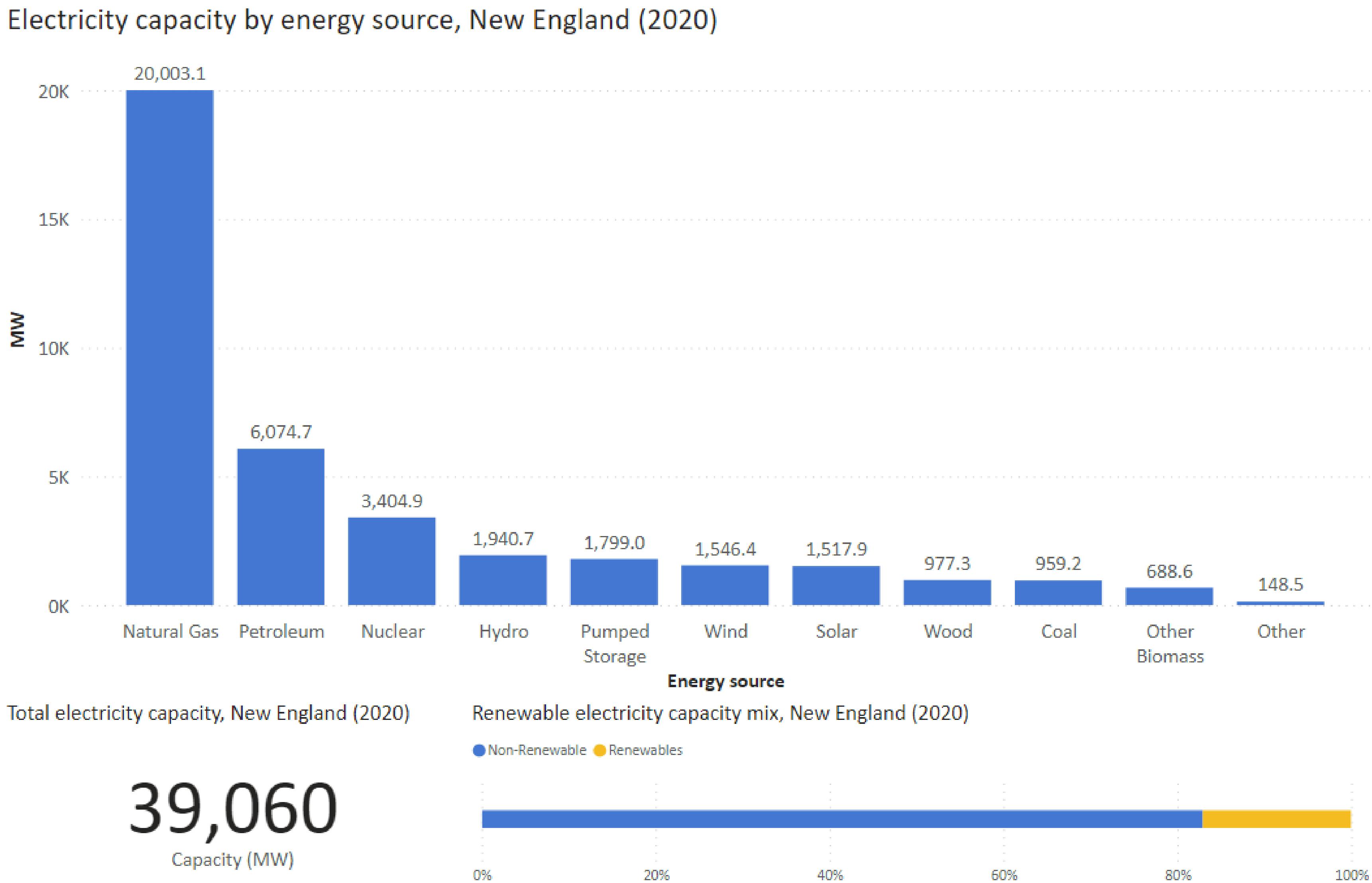
[12] Data retrieved from U.S. Energy Information Administration: Electric Power Annual (2021) with visual developed by the Maine Governor's Energy Office.

Electricity capacity by energy source, Maine (2020)[13]



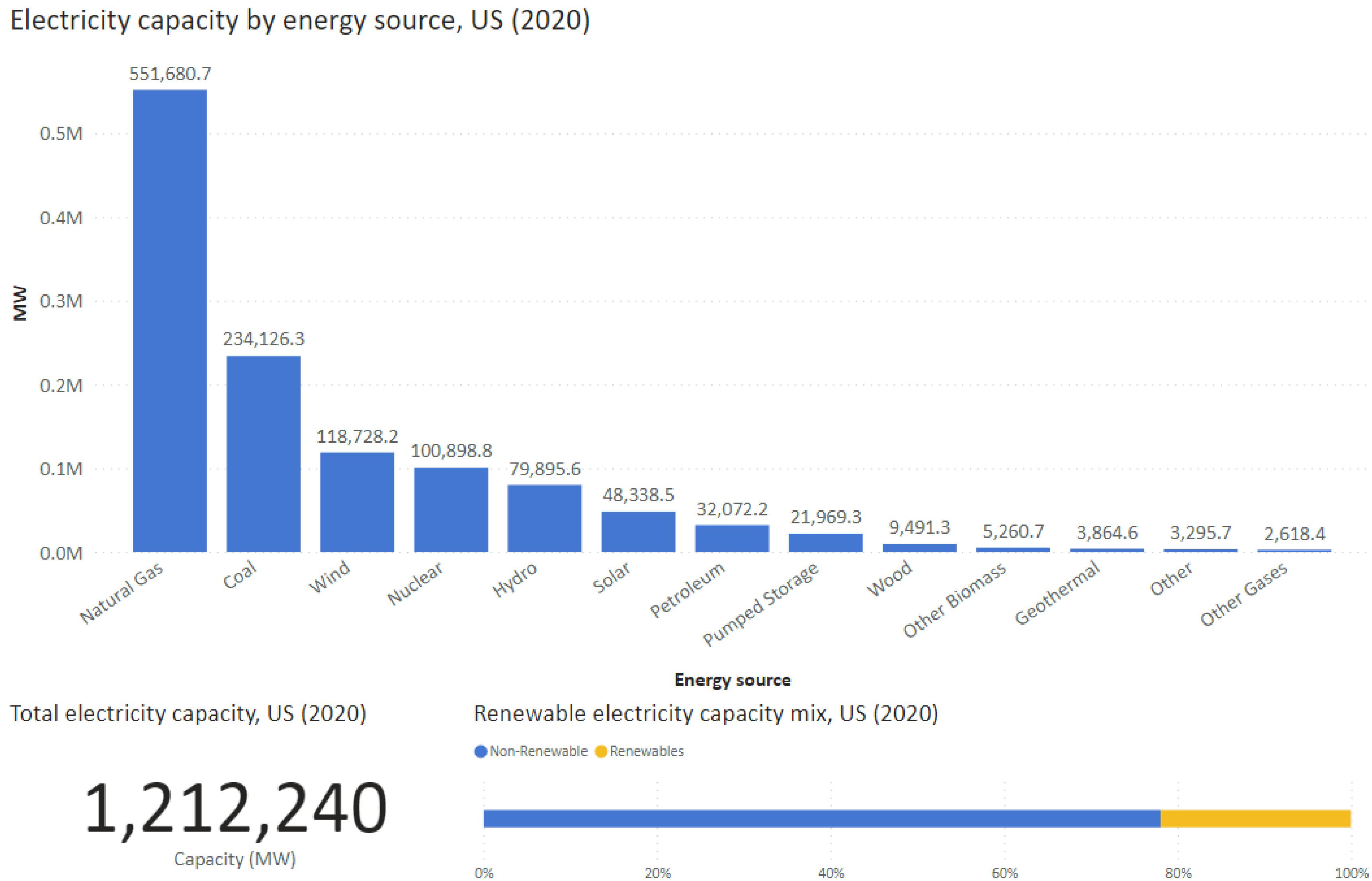
[13] Data retrieved from U.S. Energy Information Administration: Electric Power Annual (2021) with visual developed by the Maine Governor's Energy Office.

Electricity capacity by energy source, New England (2020)[14]



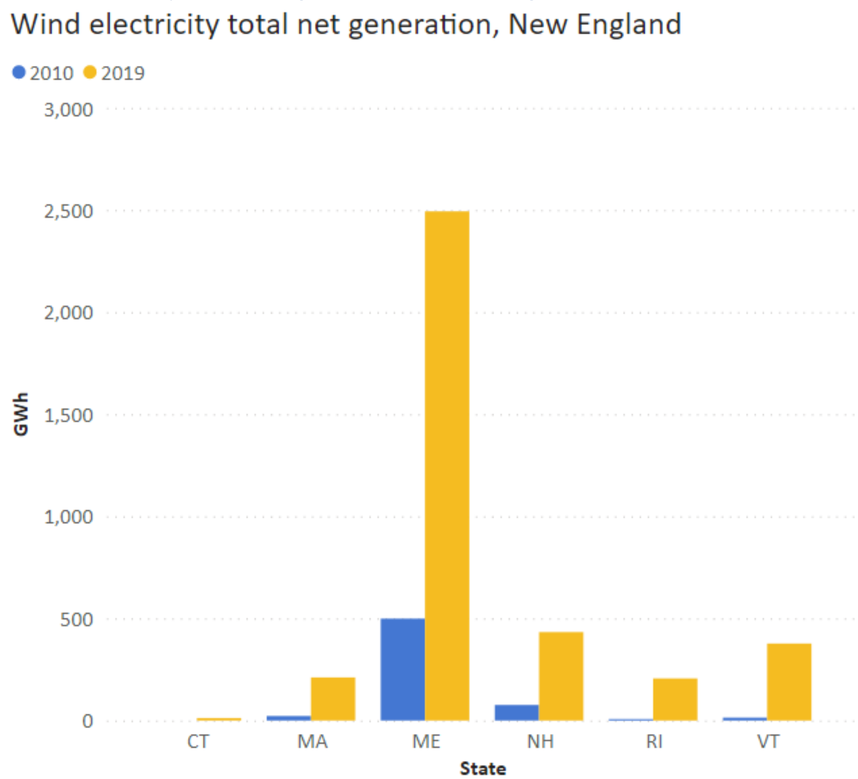
[14] Data retrieved from U.S. Energy Information Administration: Electric Power Annual (2021) with visual developed by the Maine Governor's Energy Office.

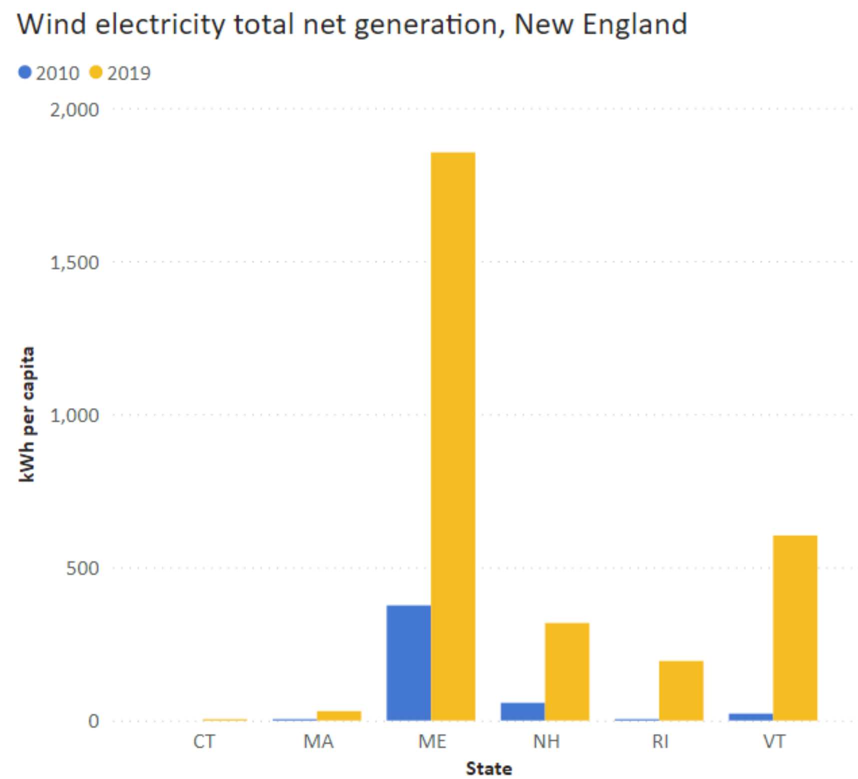
Electricity capacity by energy source, US (2020)[15]



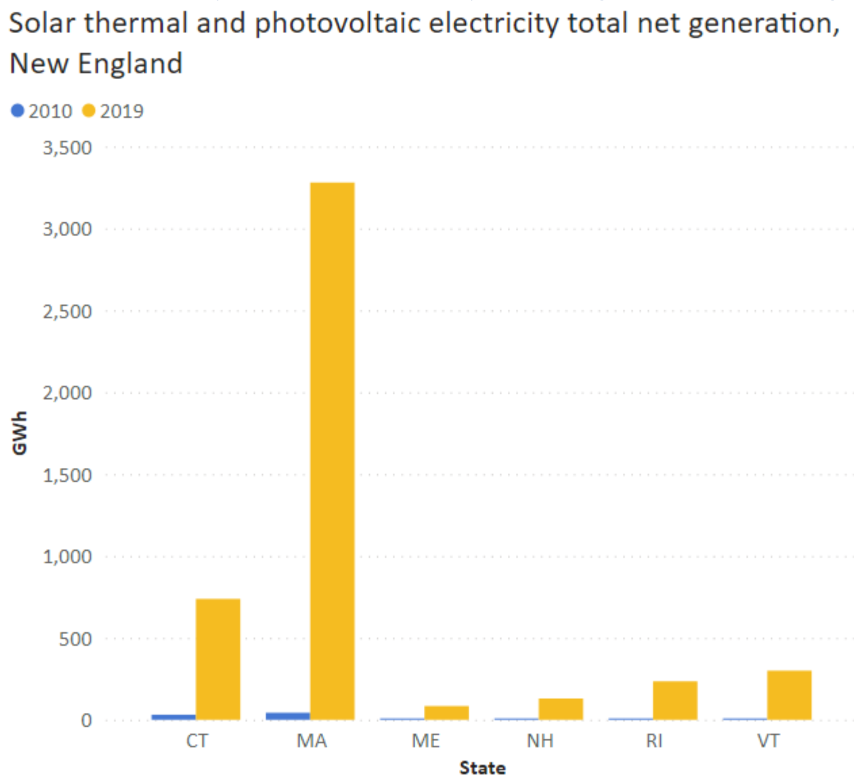
[15] Data retrieved from U.S. Energy Information Administration: Electric Power Annual (2021) with visual developed by the Maine Governor's Energy Office.

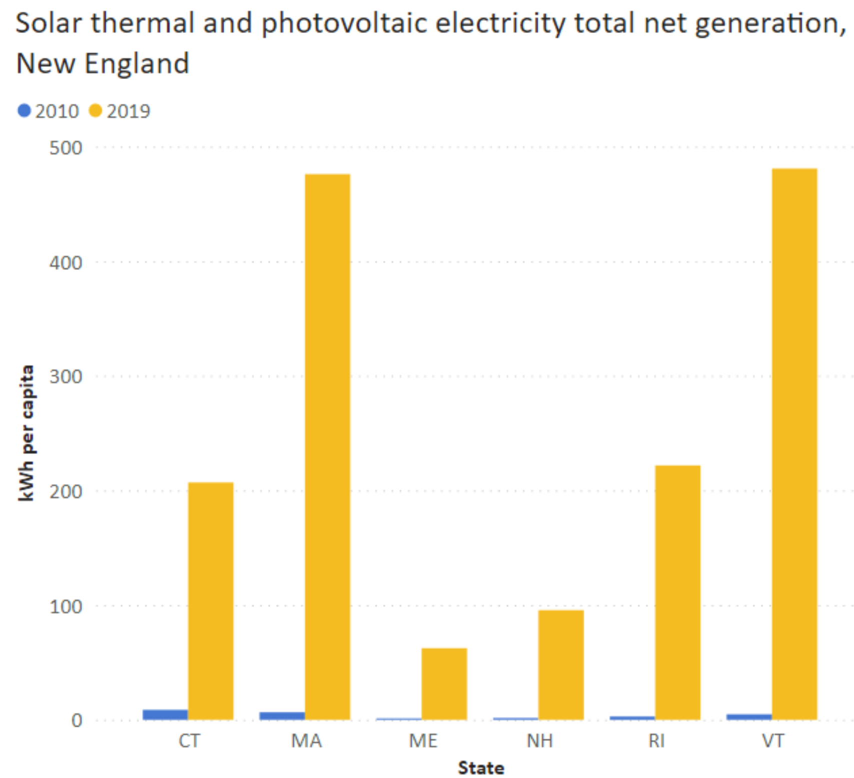
Wind electricity total net generation, New England



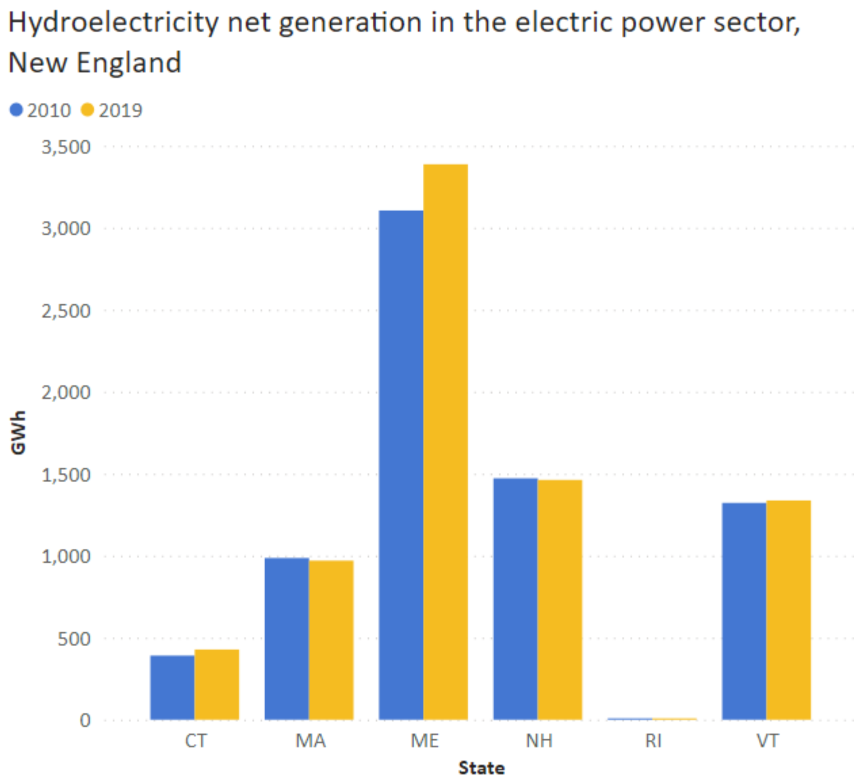


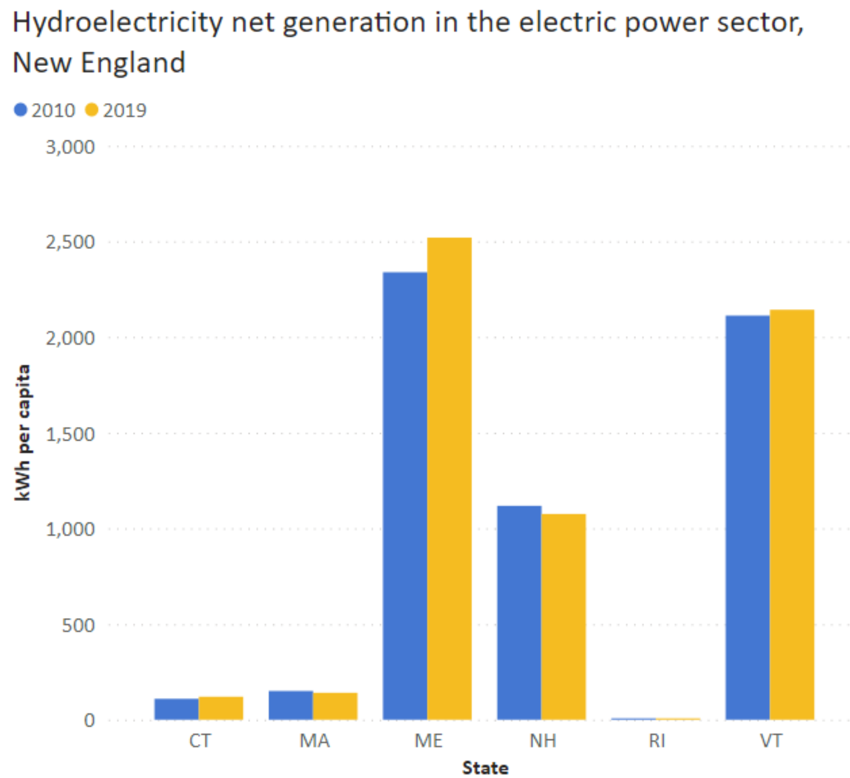
Solar thermal and photovoltaic electricity total net generation, New England



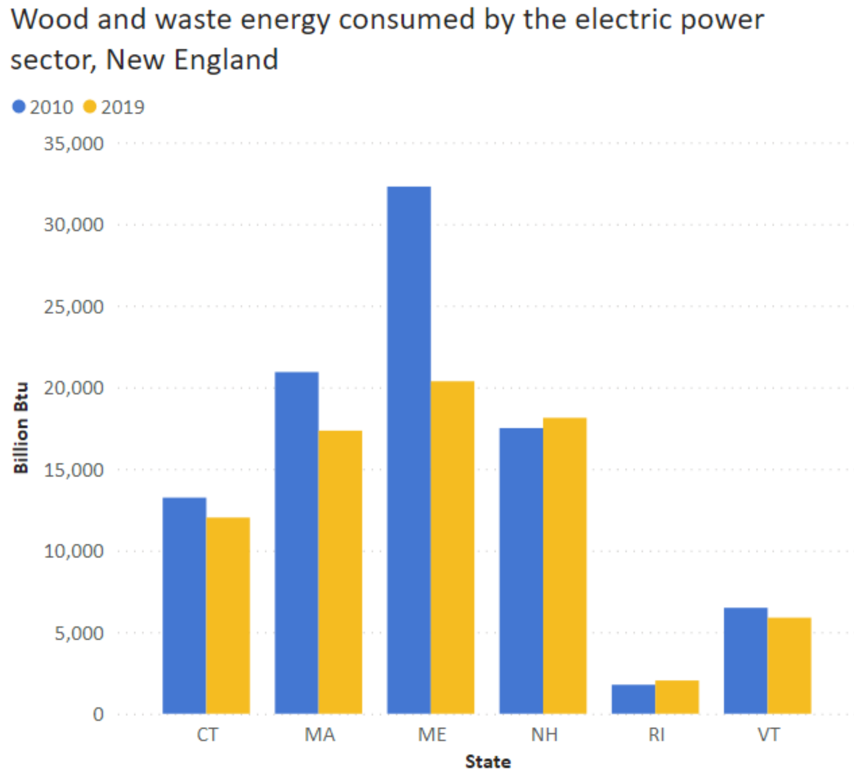


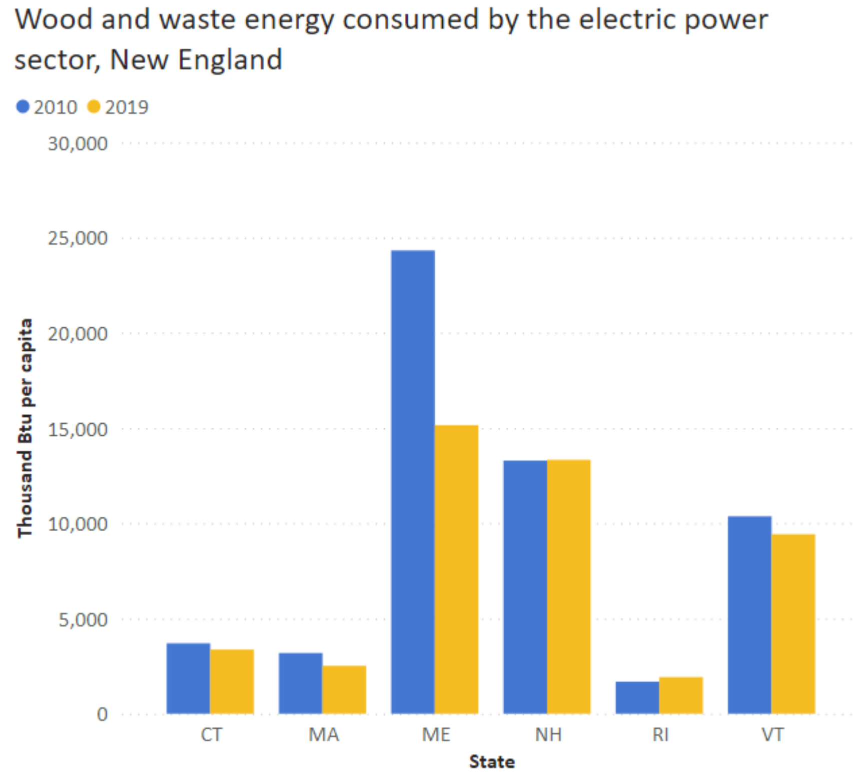
Hydroelectricity net generation in the electric power sector, New England



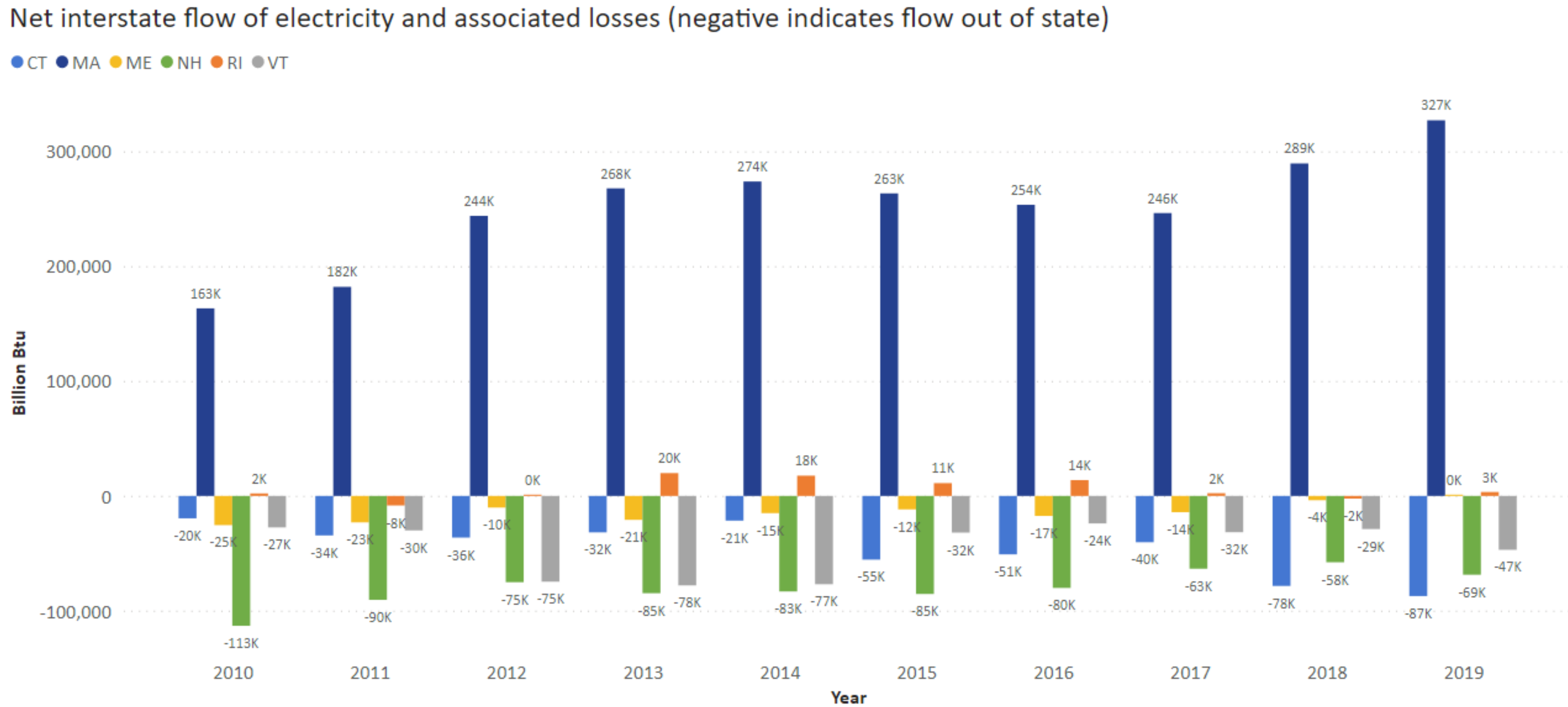


Wood and waste energy consumed by the electric power sector, New England





Net interstate flow of electricity and associated losses, New England

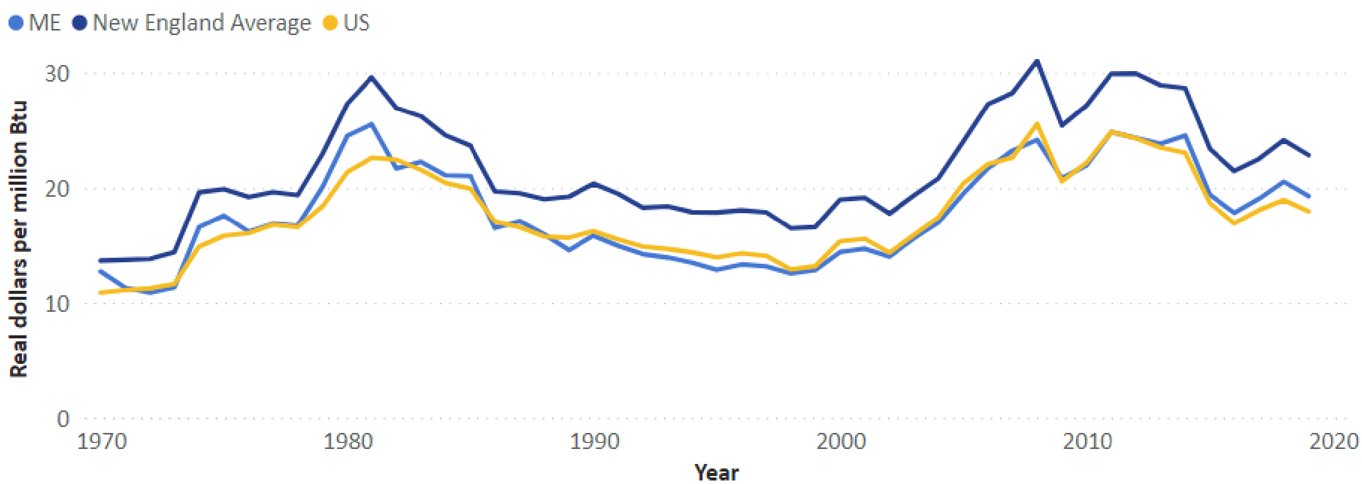


Prices

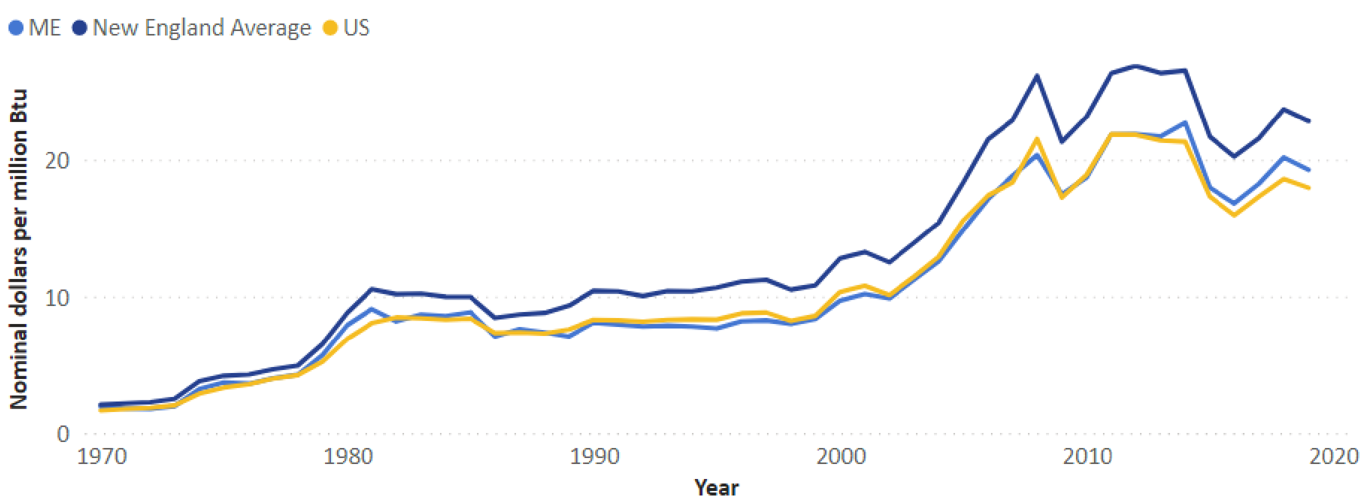
Energy

Total energy average price

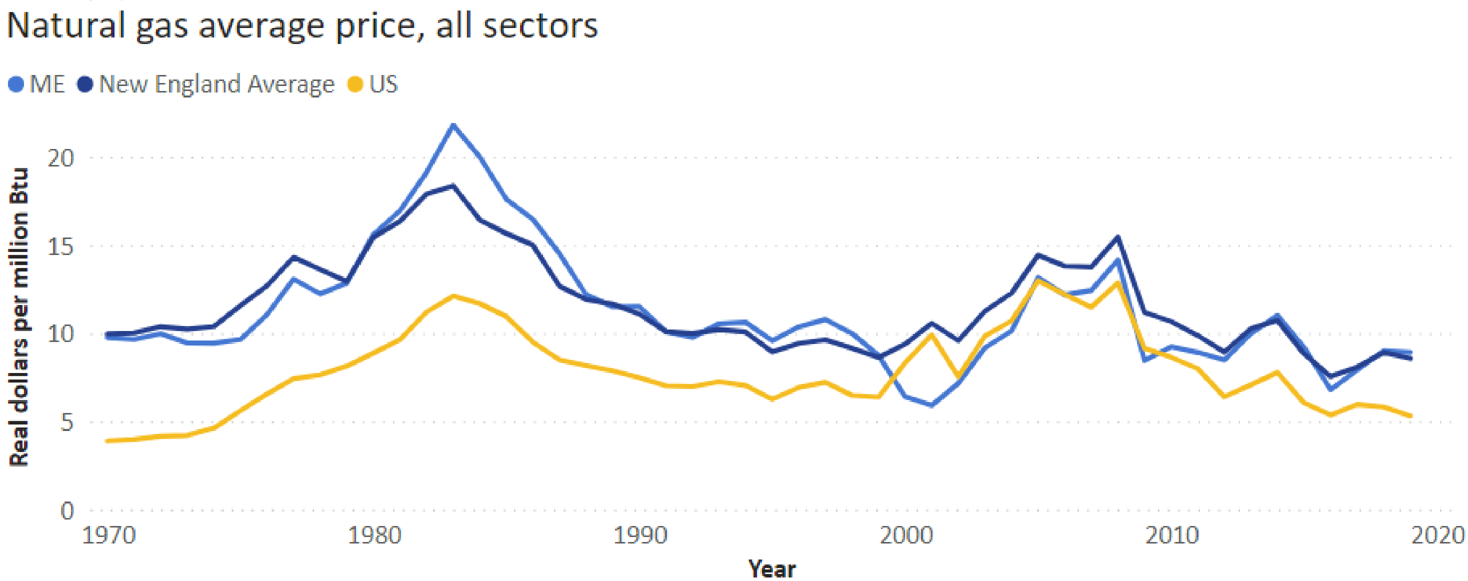
Total energy average price

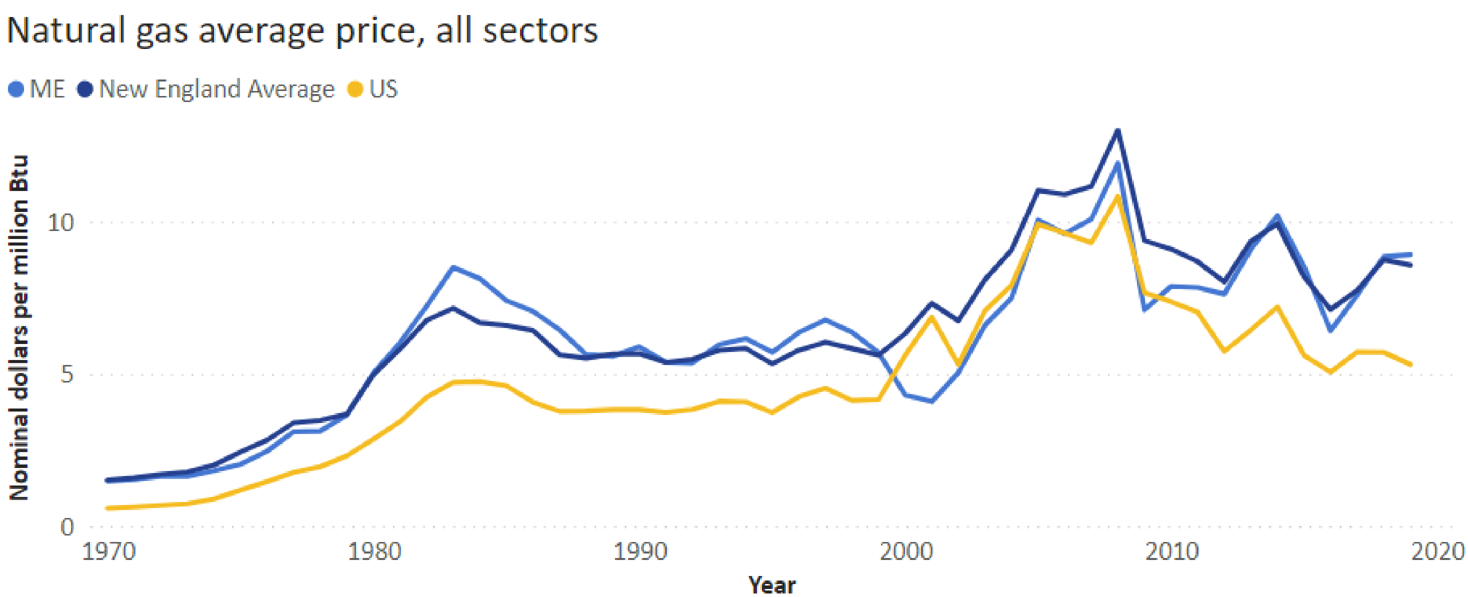


Total energy average price

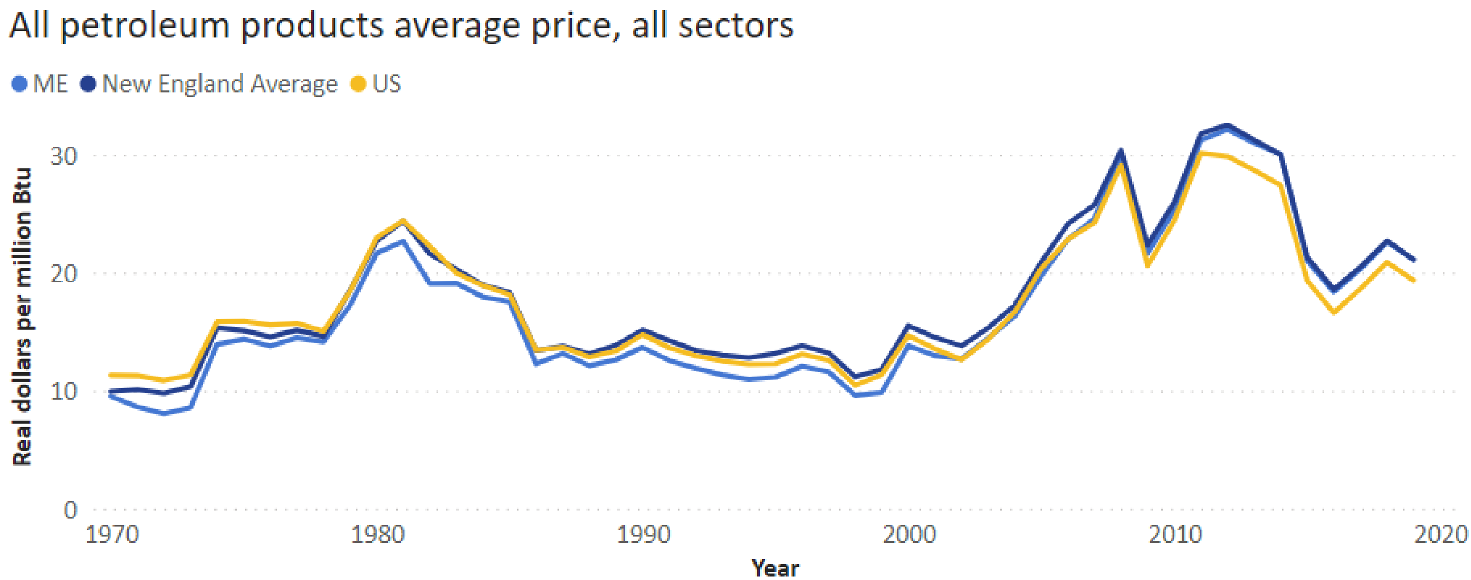


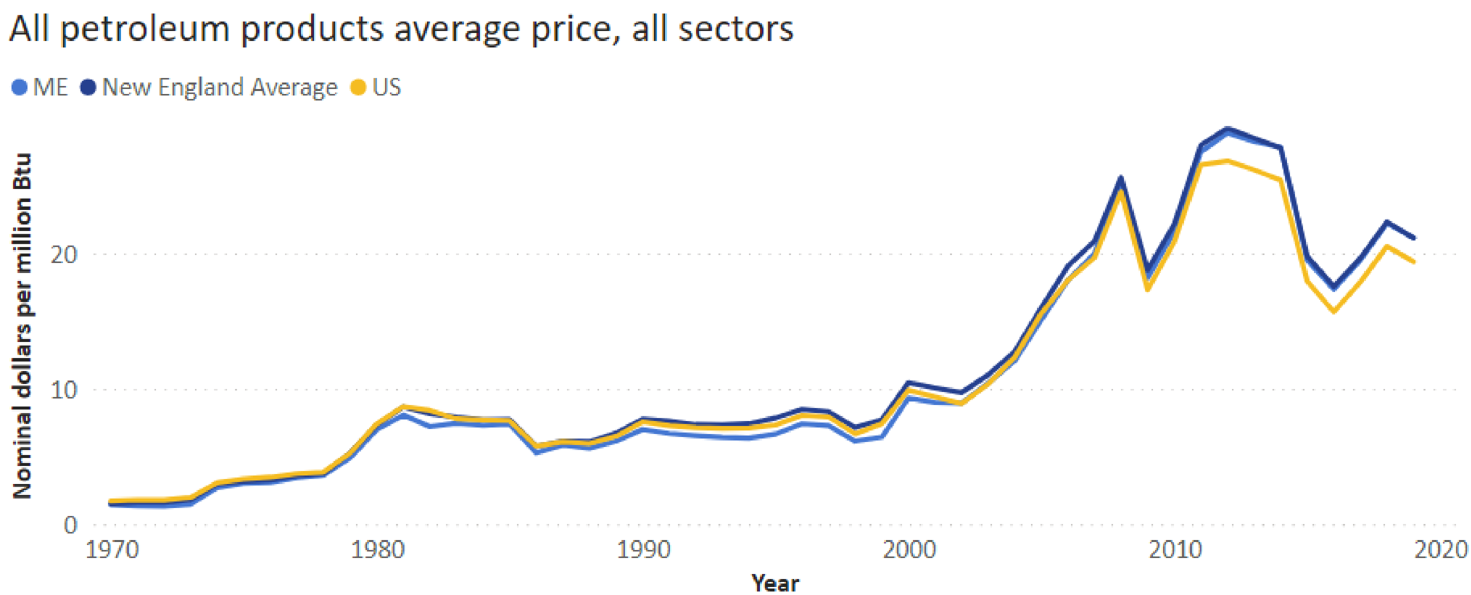
Natural gas average price, all sectors





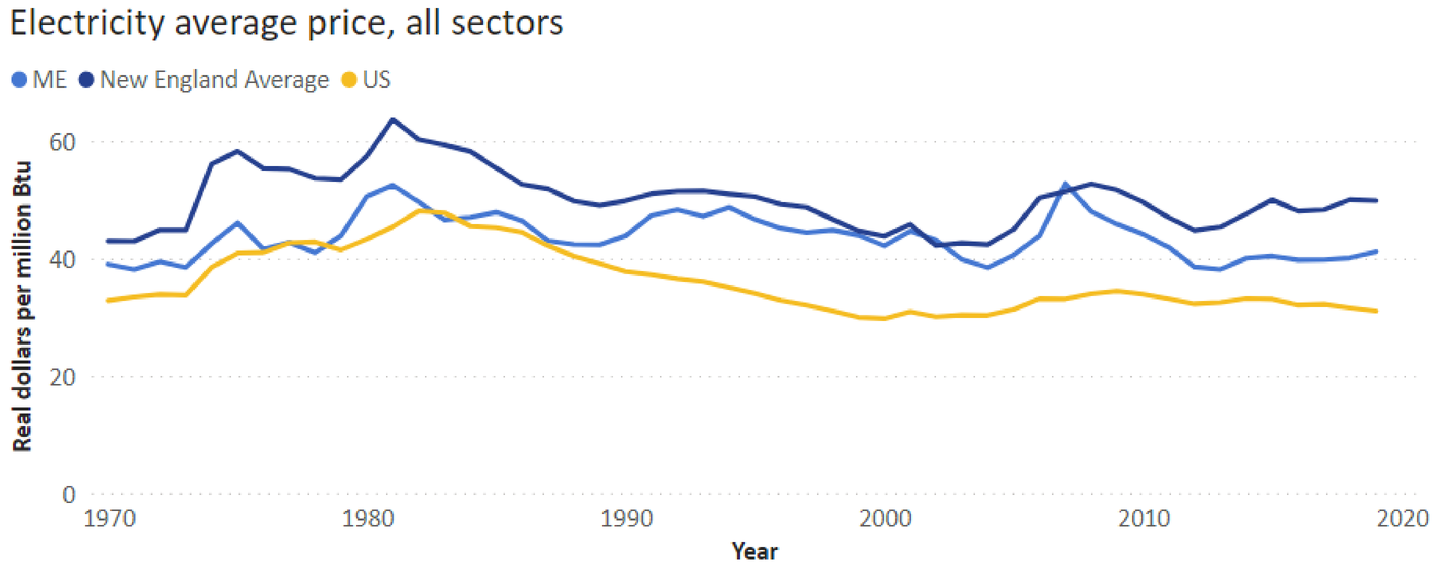
All petroleum products average price, all sectors

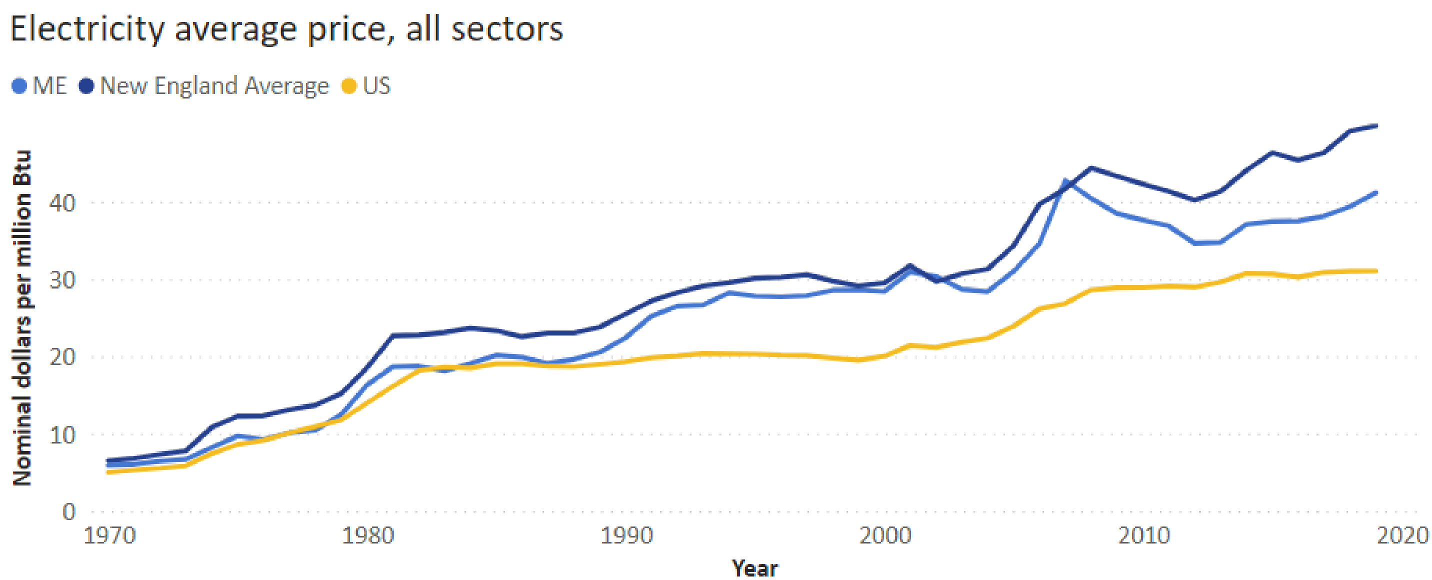




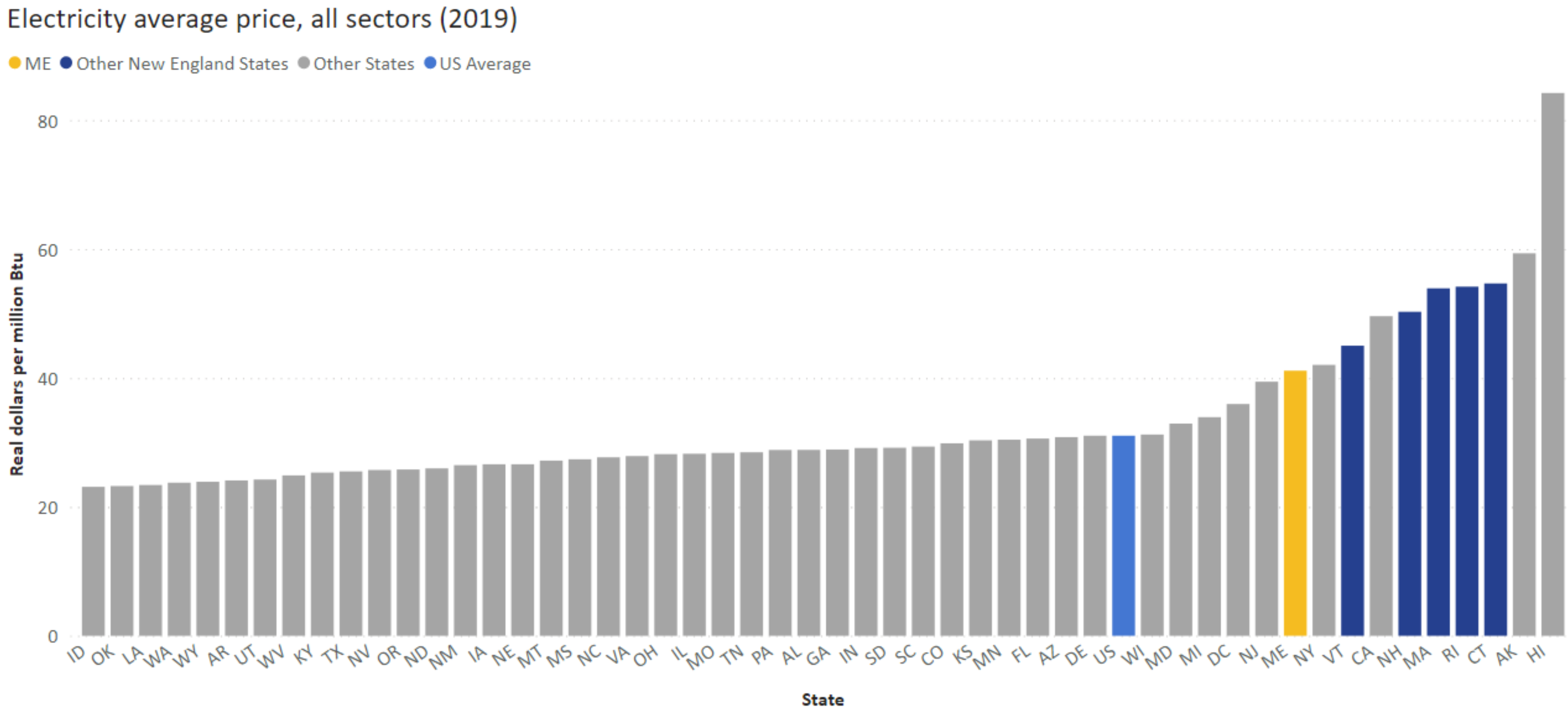
Electricity

Electricity average price, all sectors





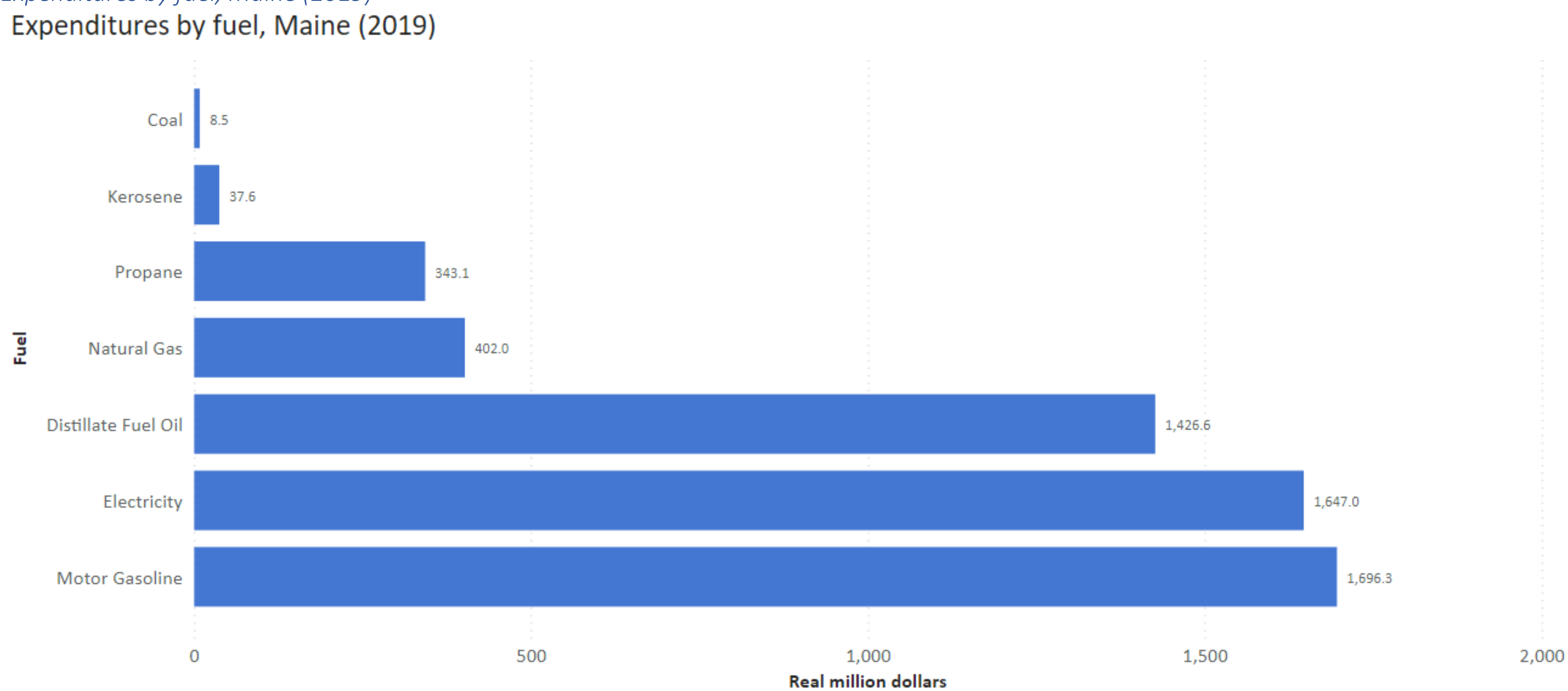
Electricity average price, all sectors (2019)



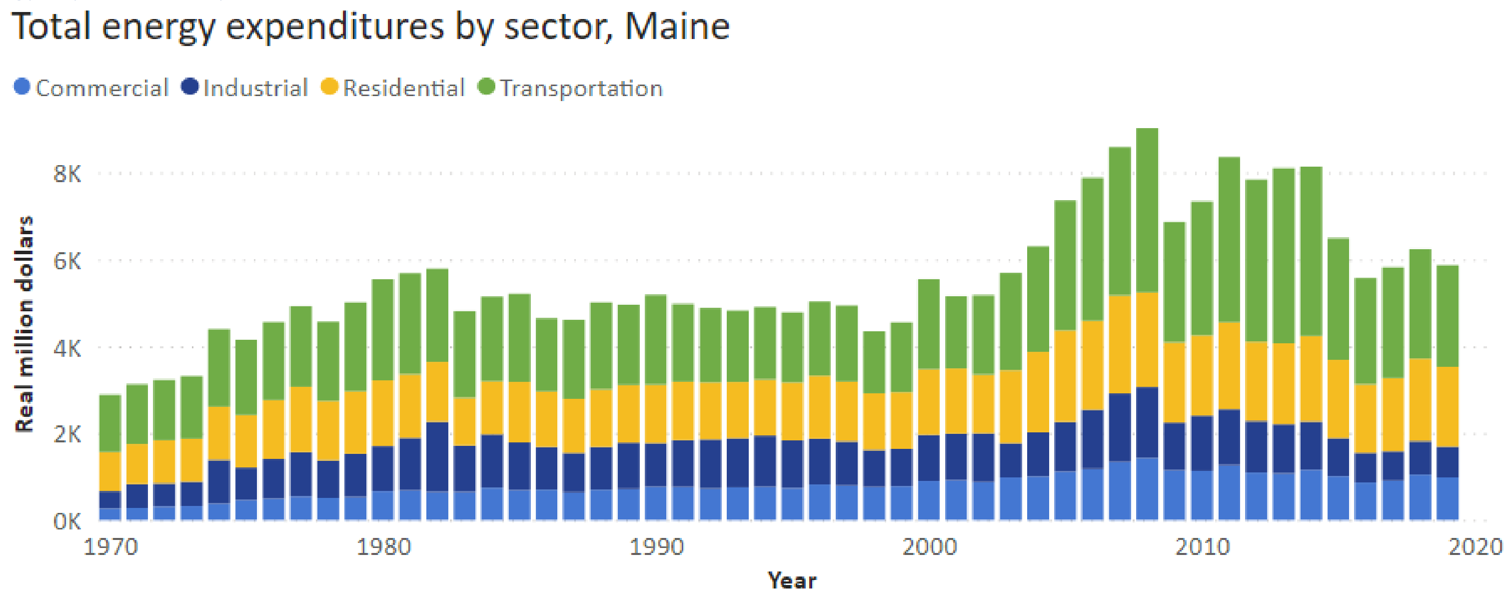
Expenditures

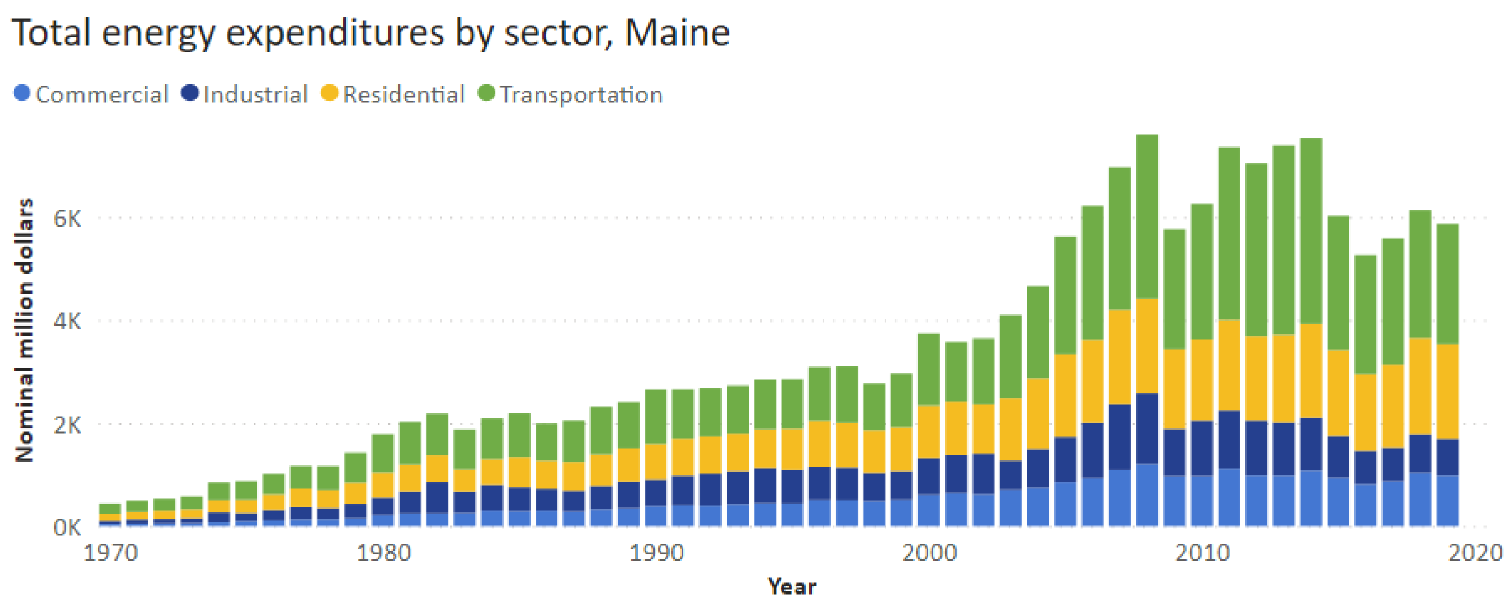
Energy

Expenditures by fuel, Maine (2019)

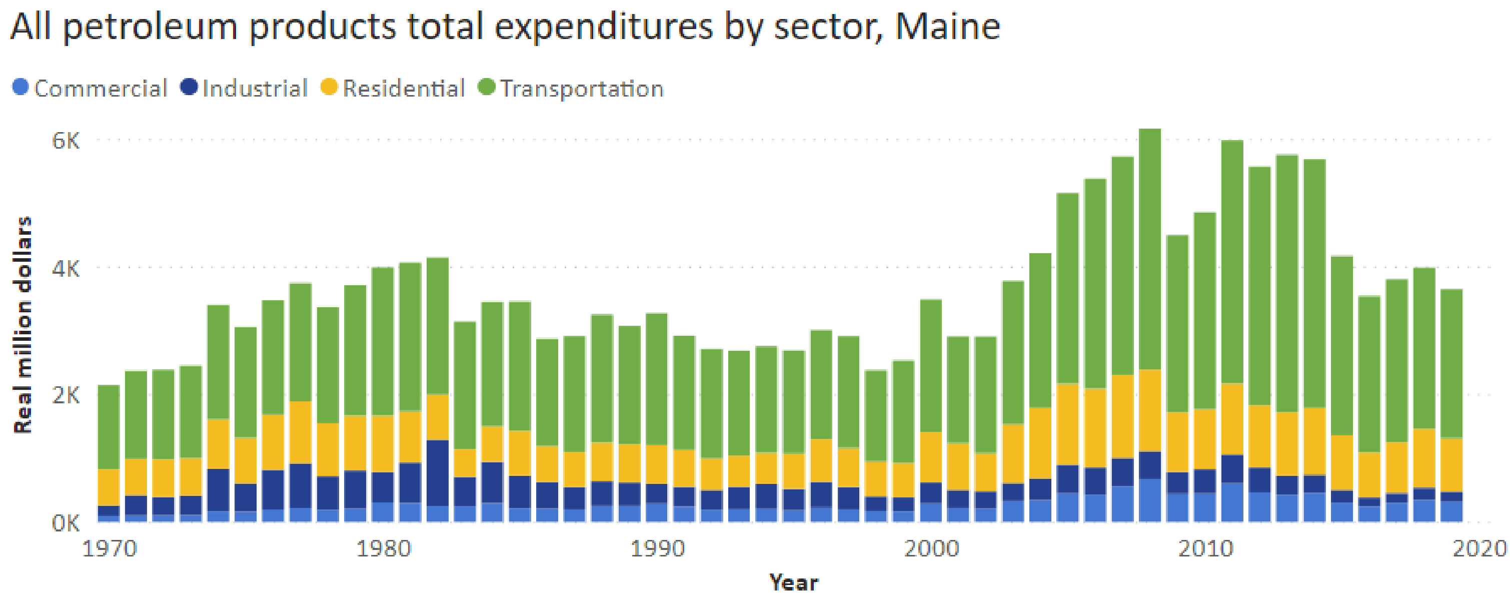


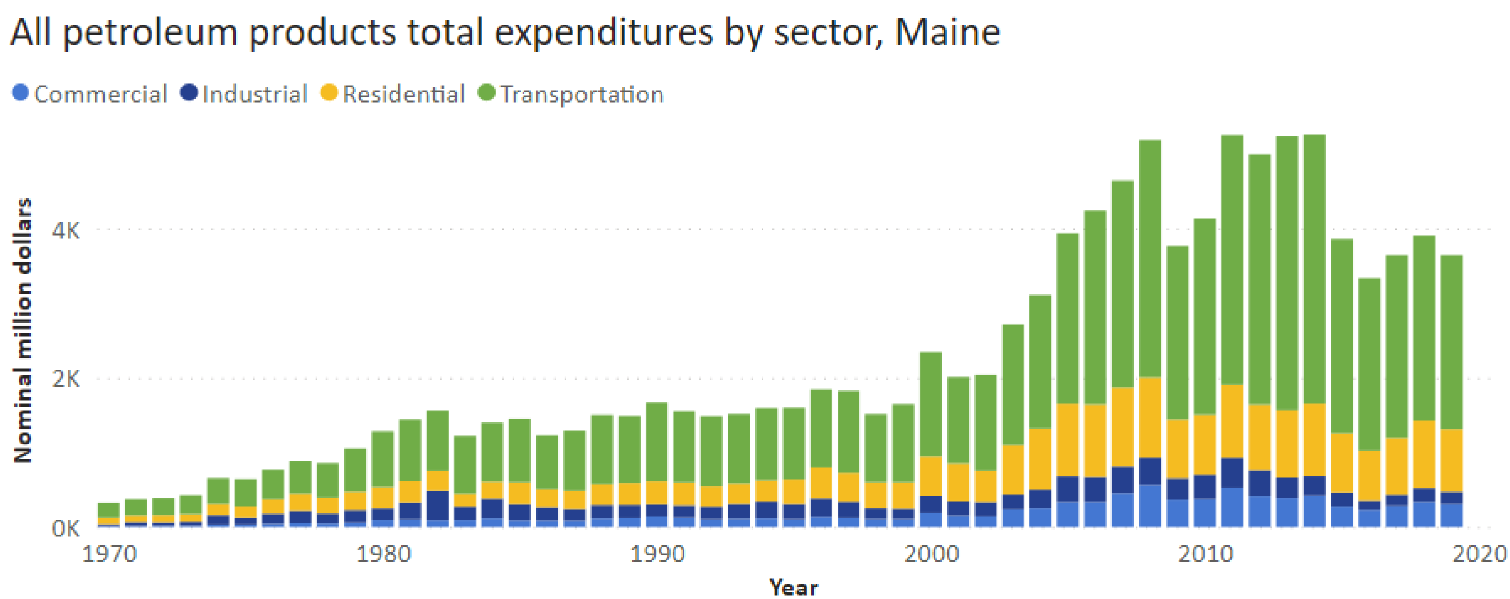
Total energy expenditures by sector, Maine





All petroleum products total expenditures by sector, Maine

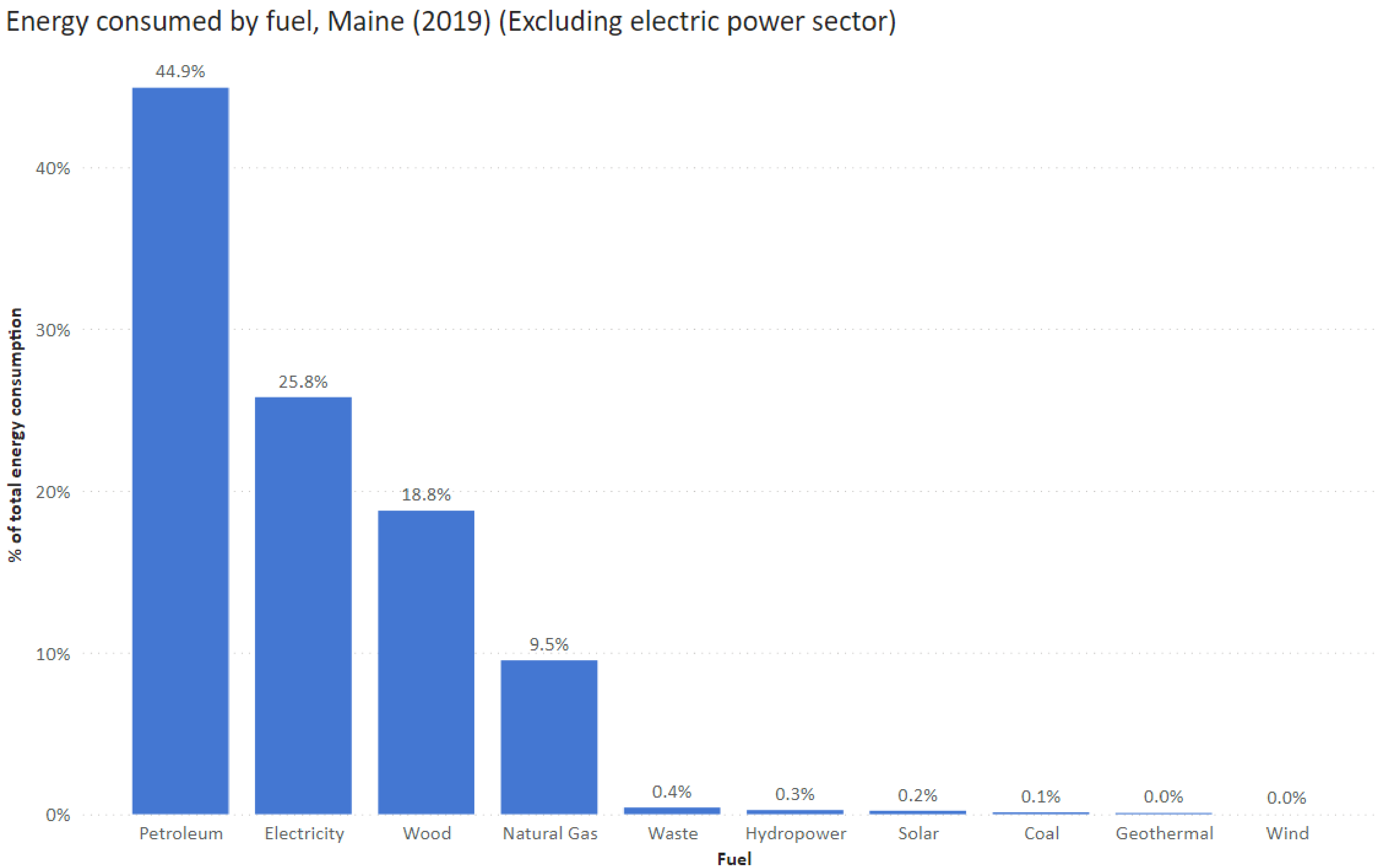




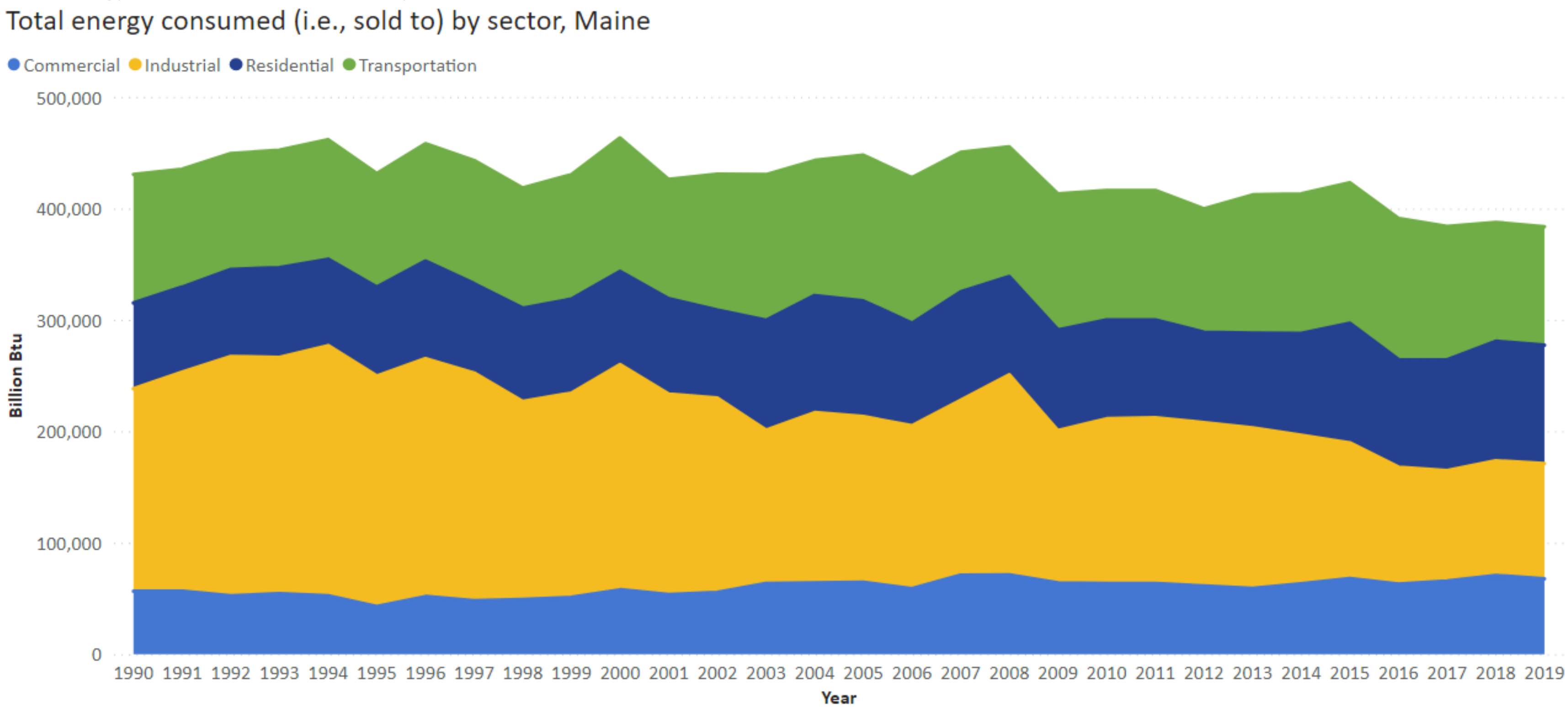
Consumption

Energy

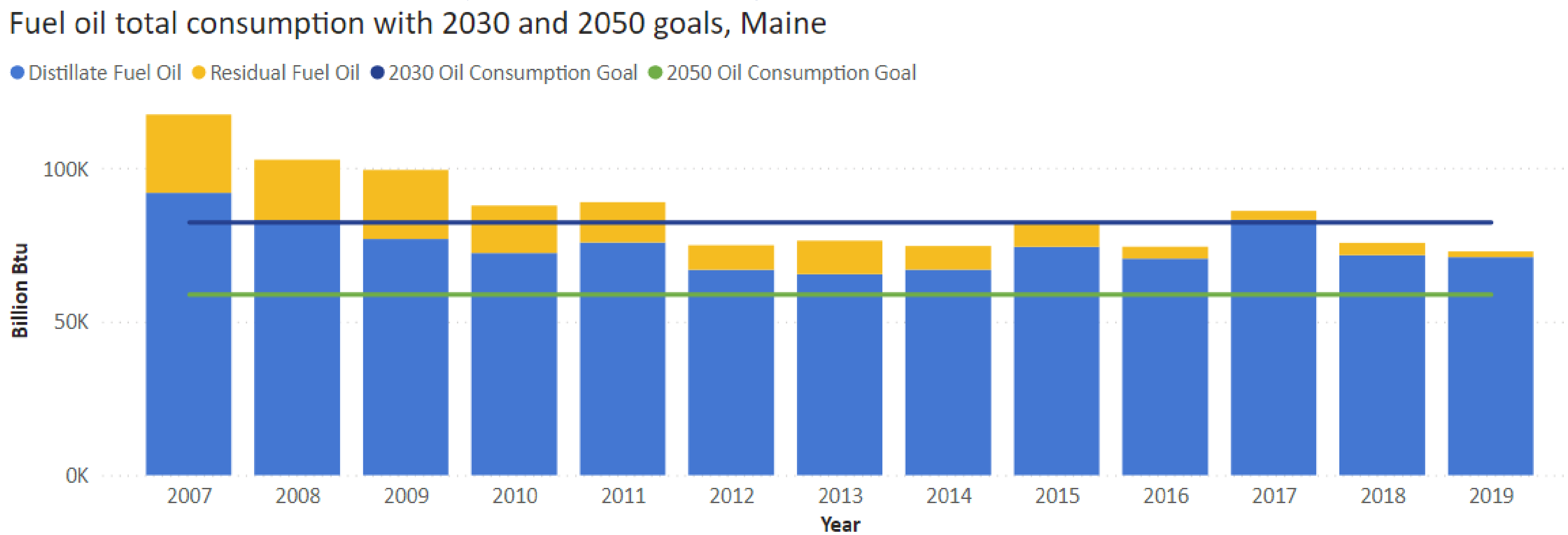
Energy consumed by fuel, Maine (2019) (Excluding electric power sector)

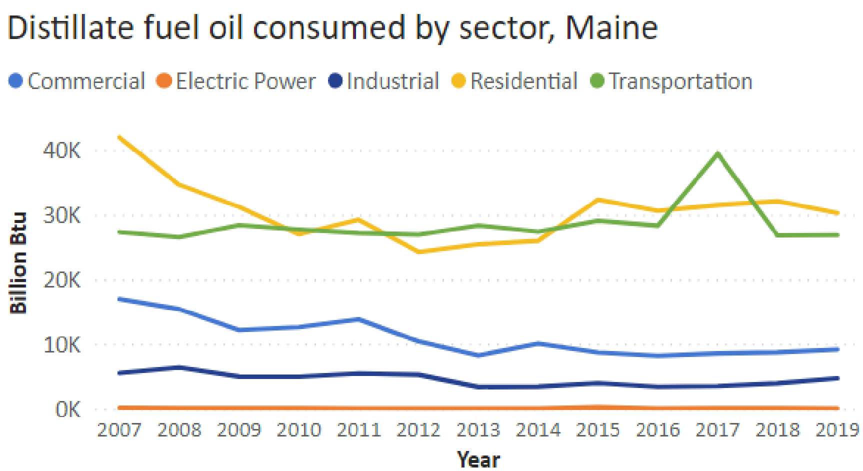


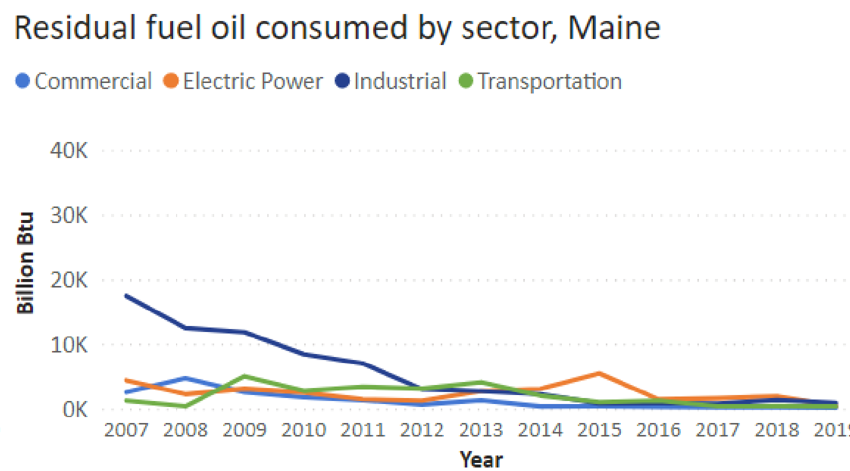
Total energy consumed (i.e., sold to) by sector, Maine



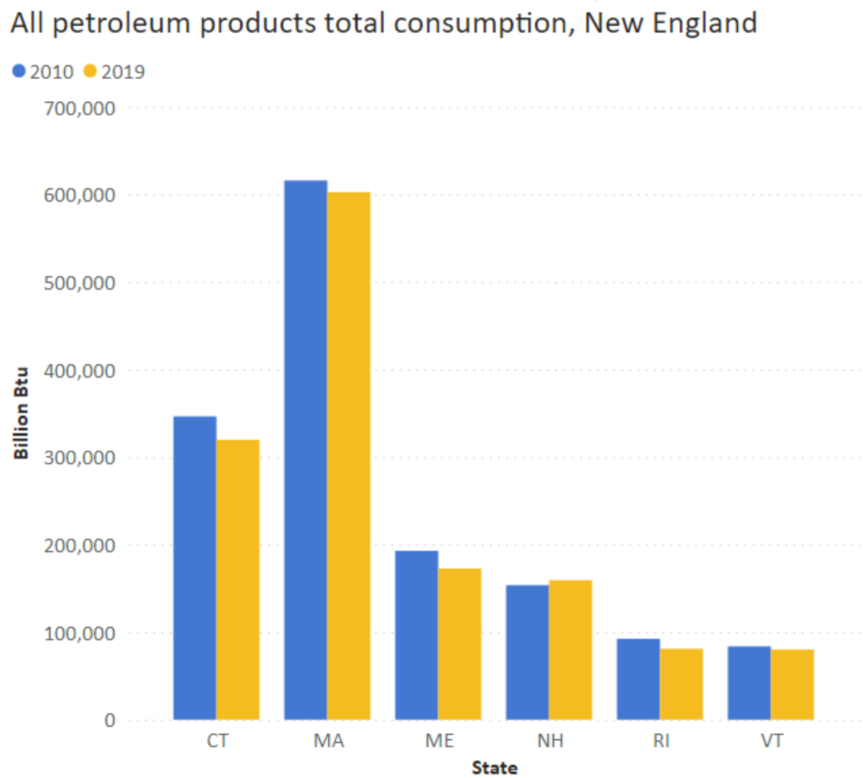
Fuel oil total, distillate, and residual consumption with 2030 and 2050 goals

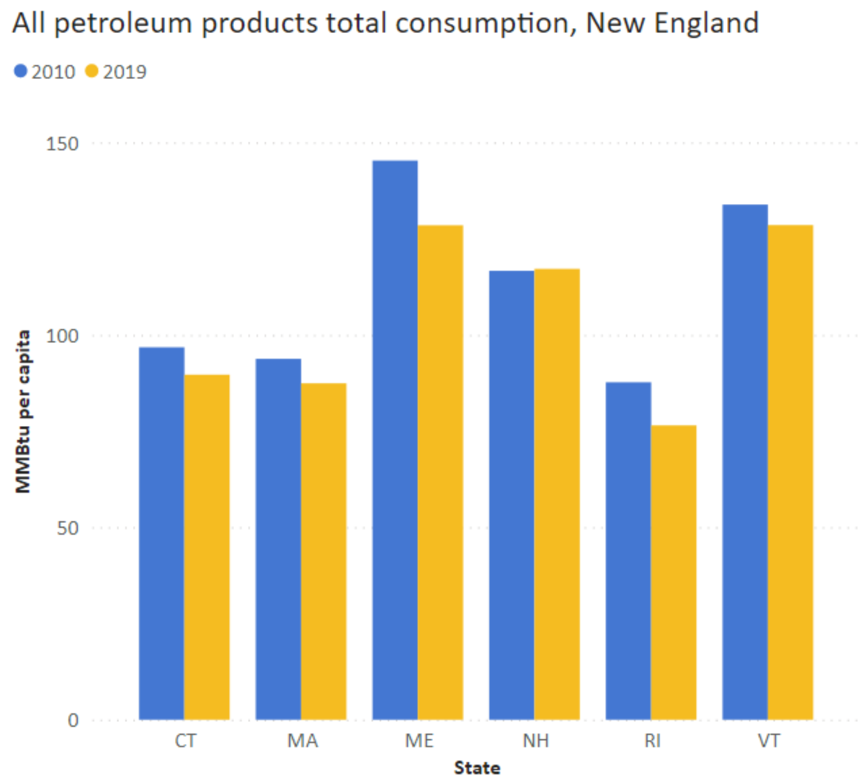




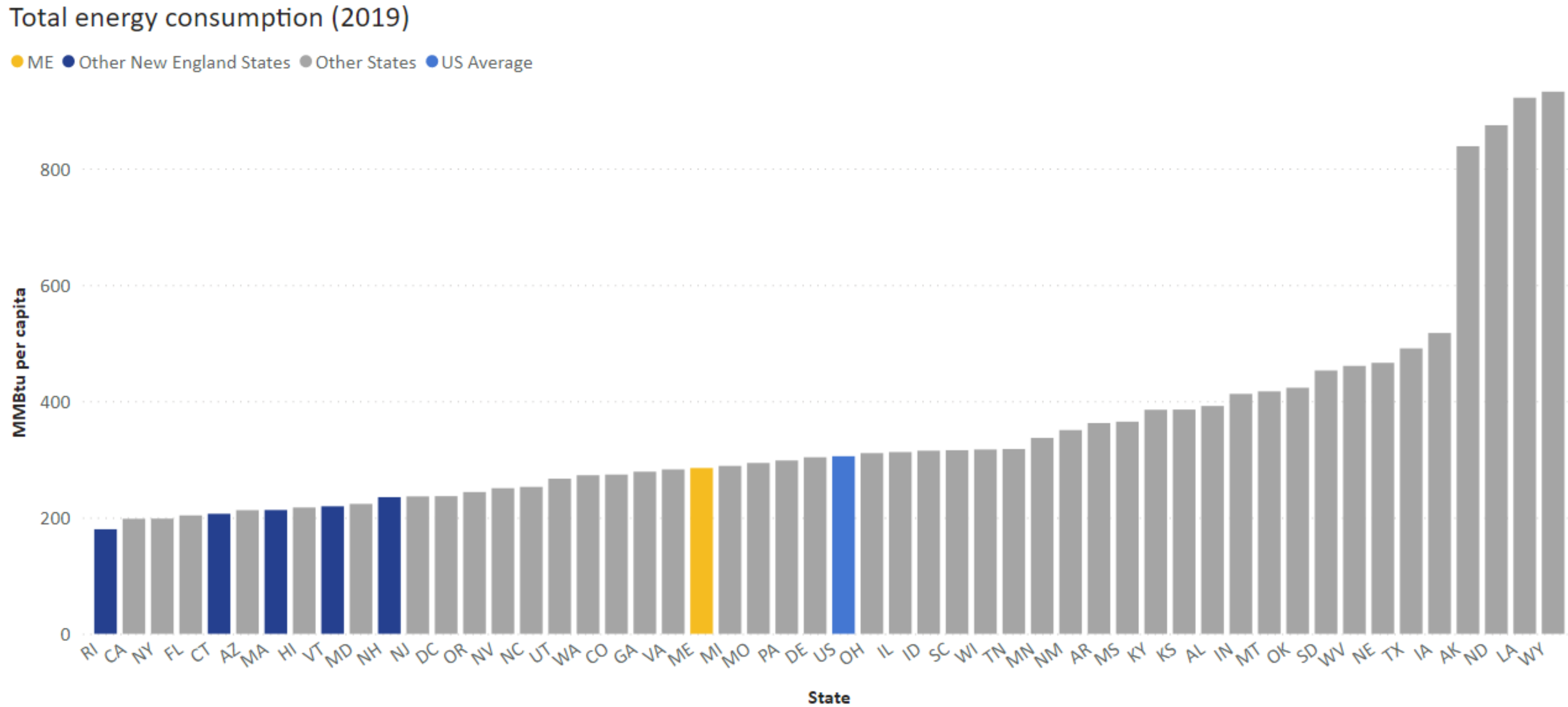


All petroleum products total consumption, New England

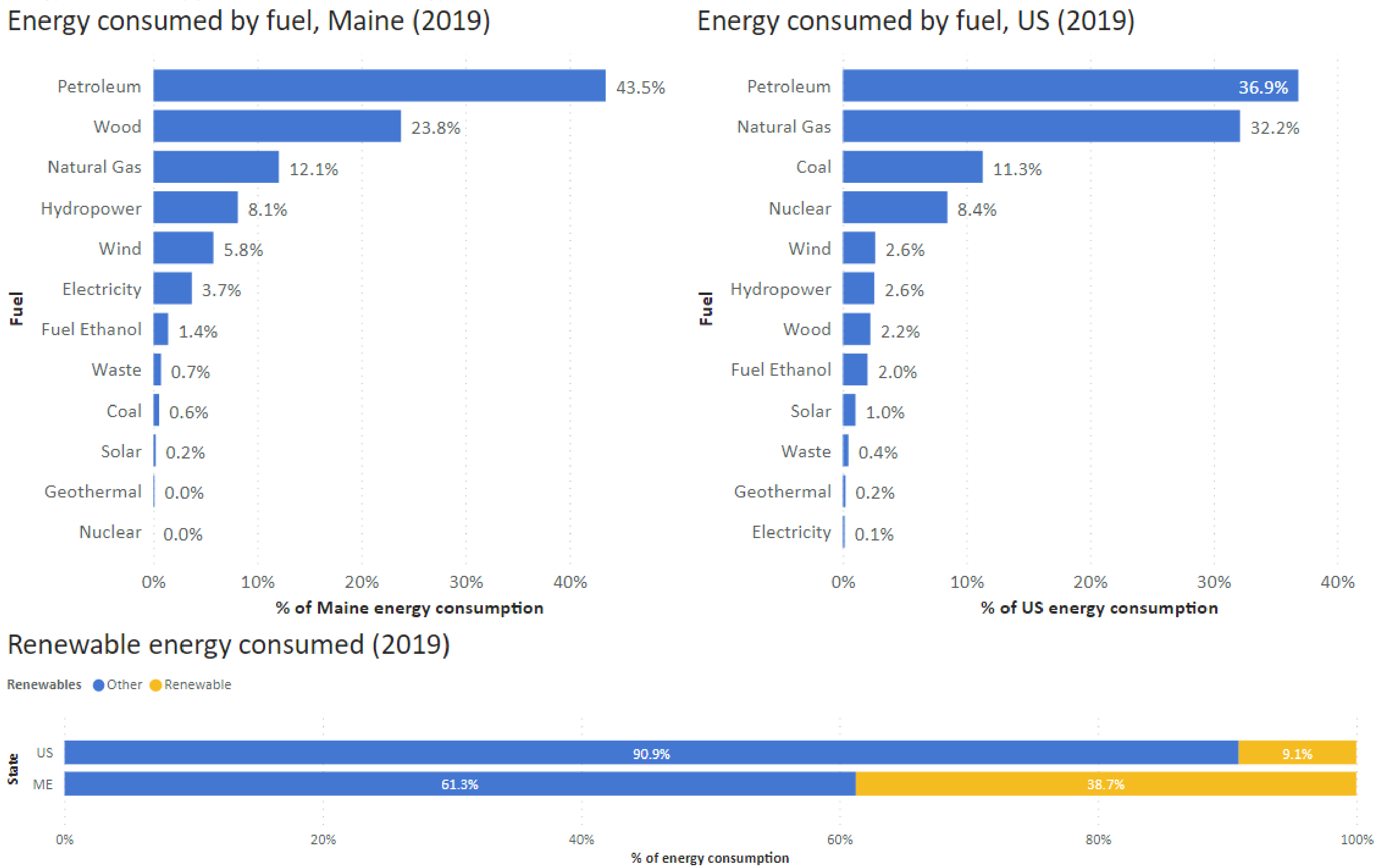




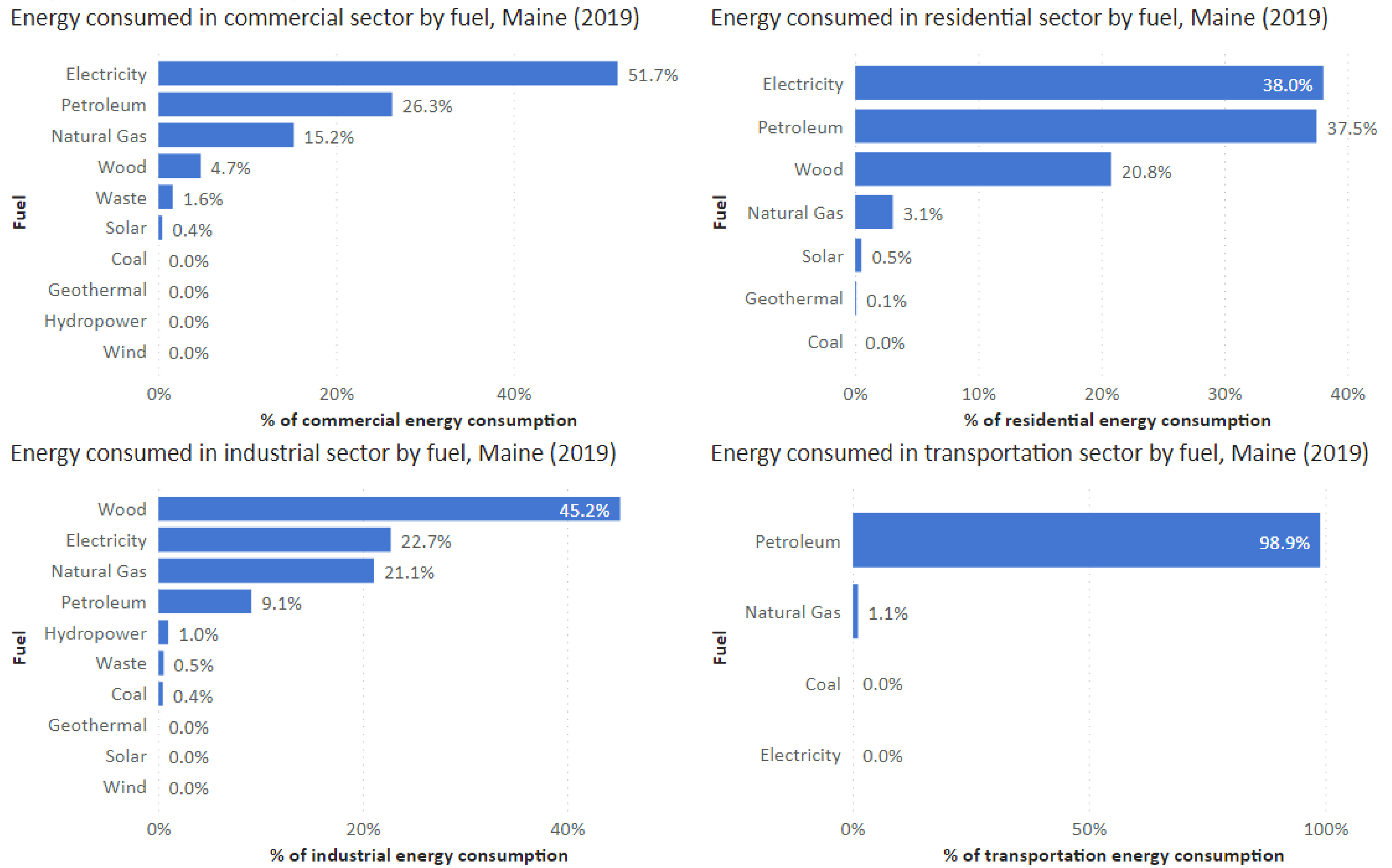
Total energy consumption (2019)



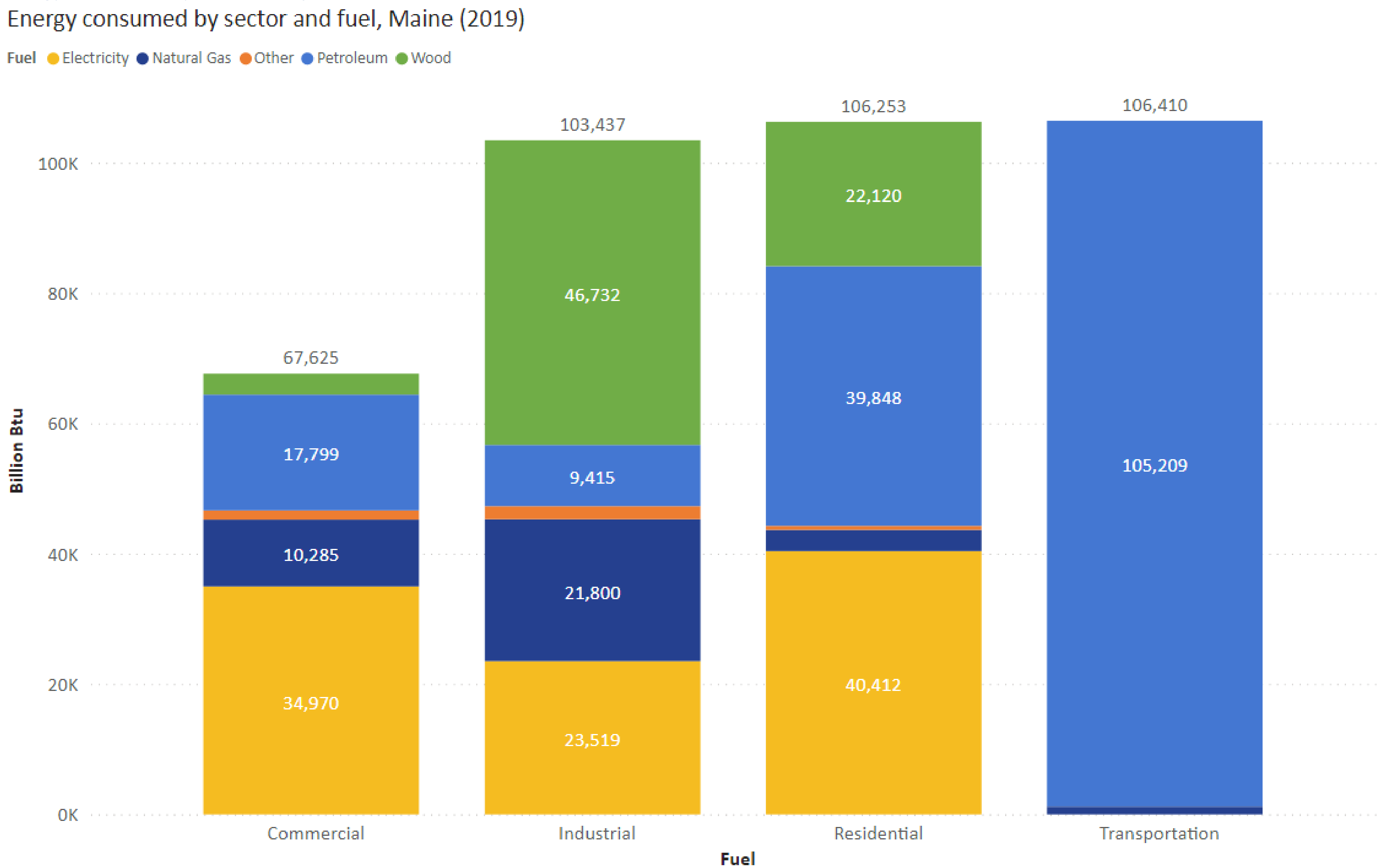
Energy consumed by fuel and renewable energy consumed, Maine and US (2019)



Energy consumed by sector by fuel, Maine (2019)

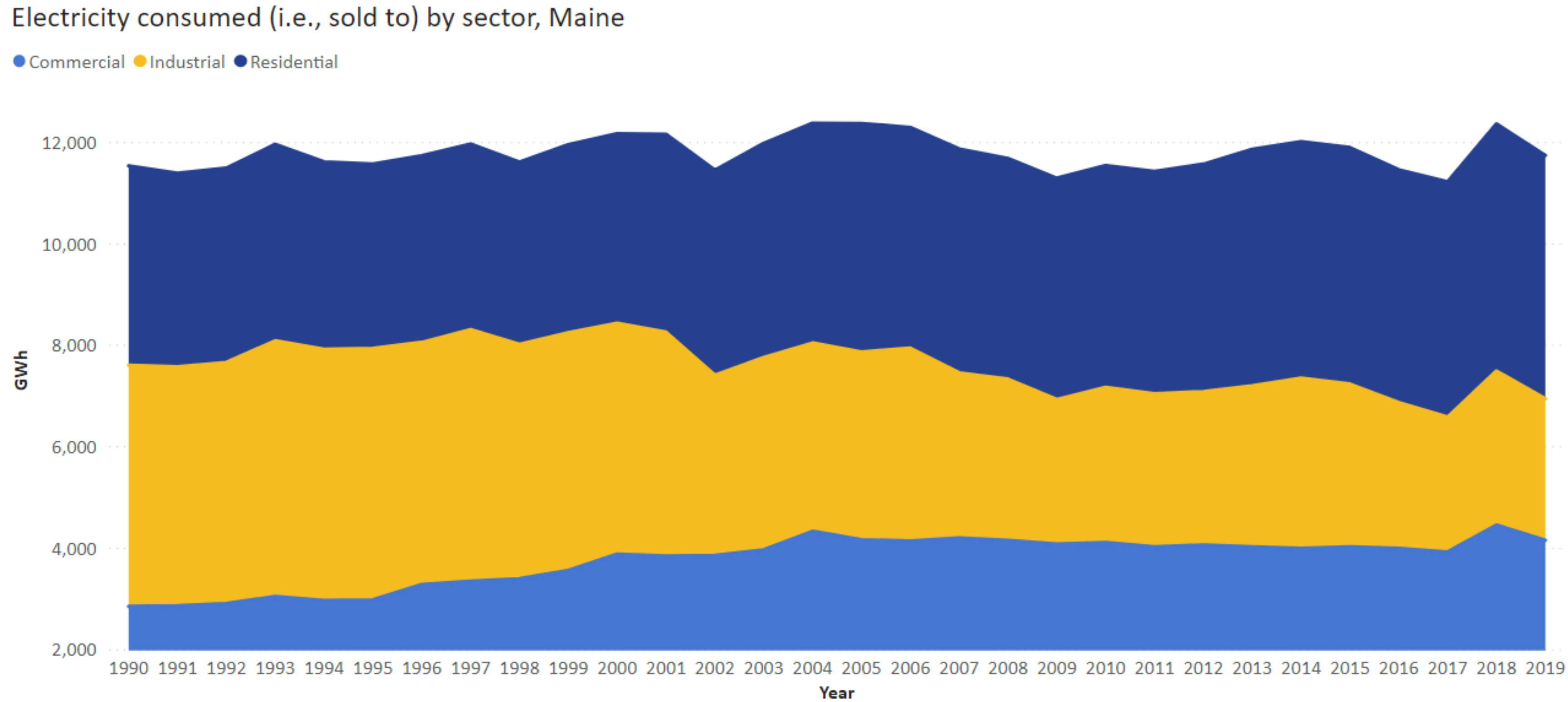


Energy consumed by sector and fuel, Maine (2019)

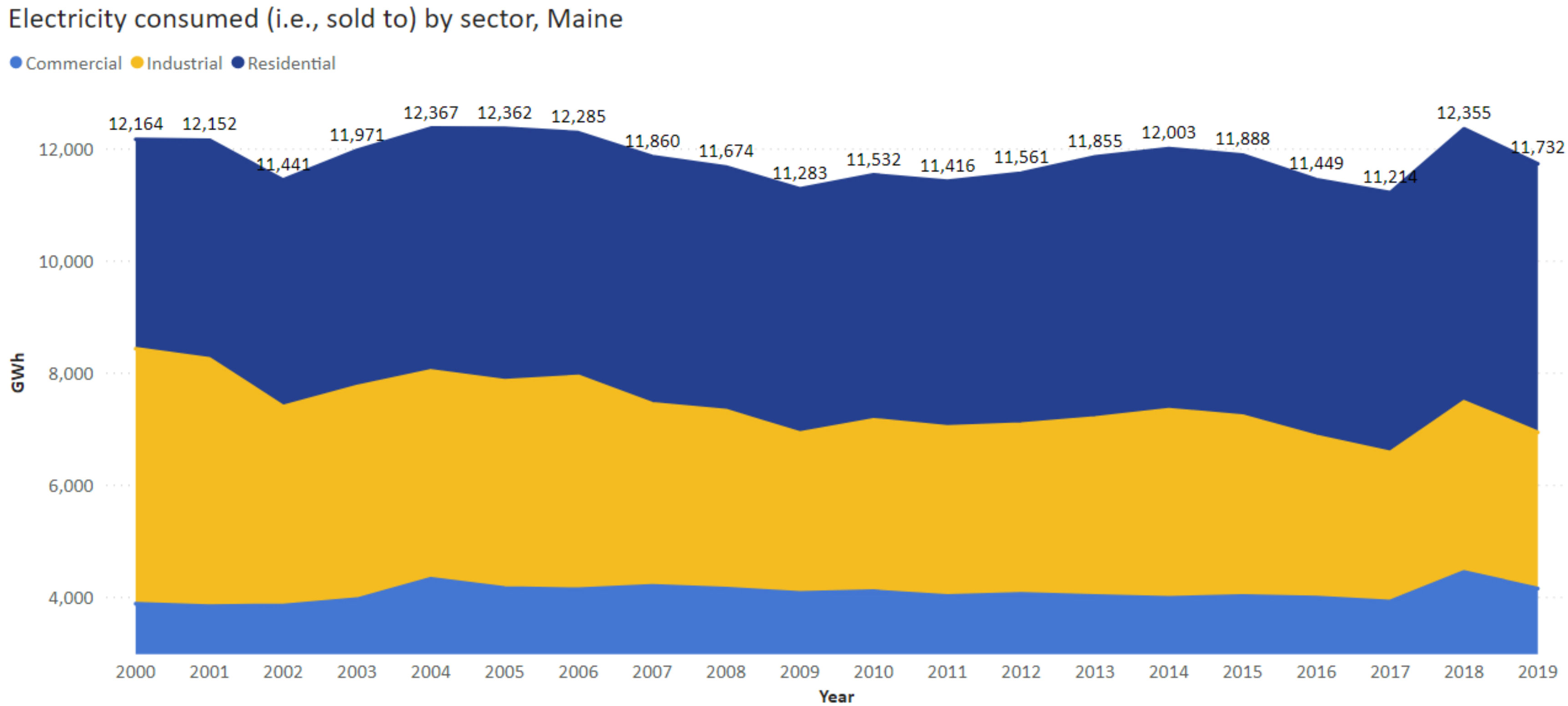


Electricity

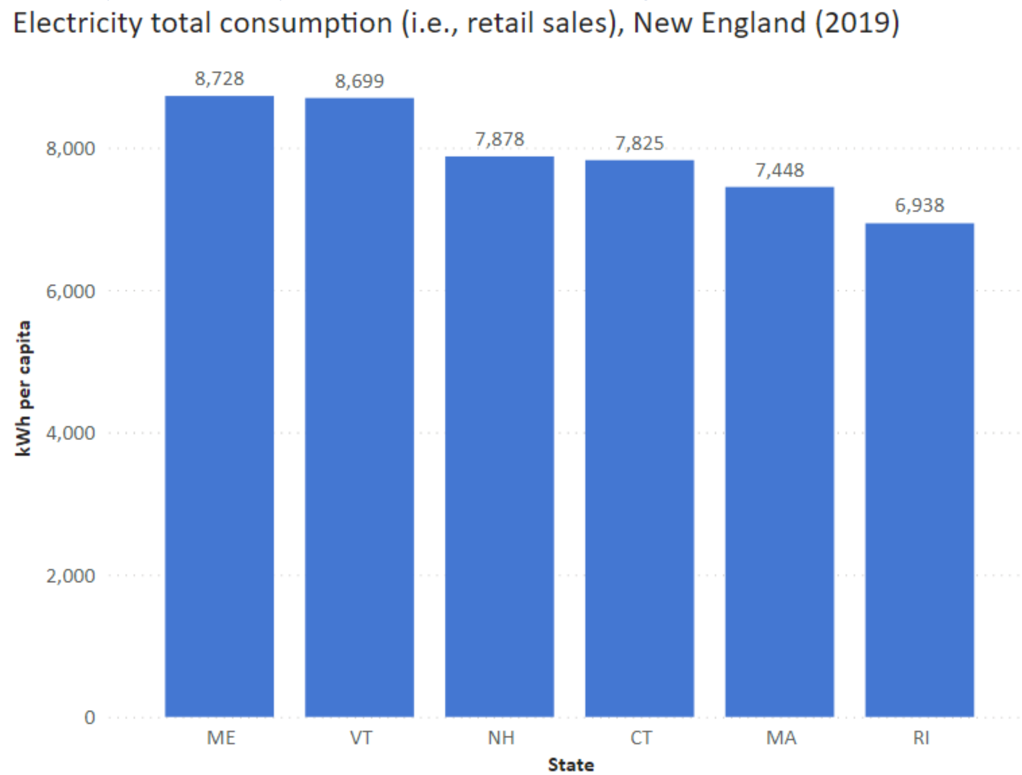
Electricity consumed (i.e., sold to) by sector, Maine

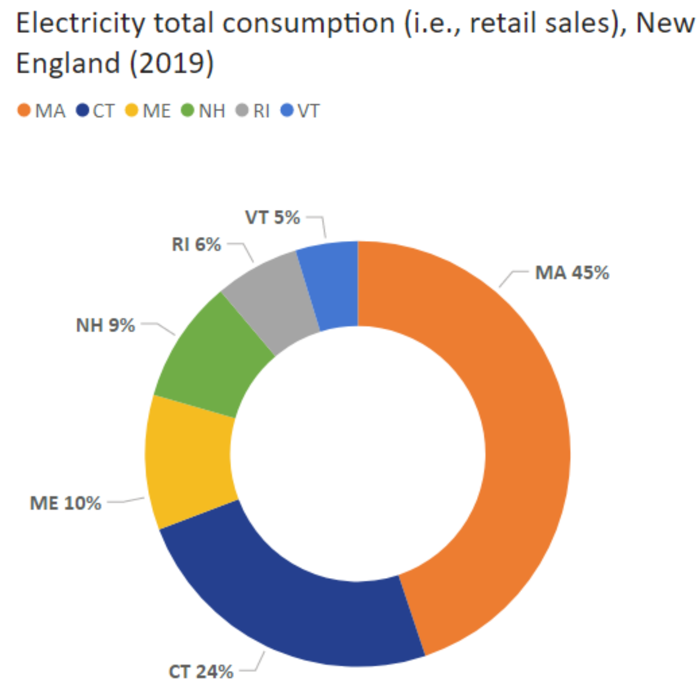


Electricity consumed (i.e., sold to) by sector, Maine



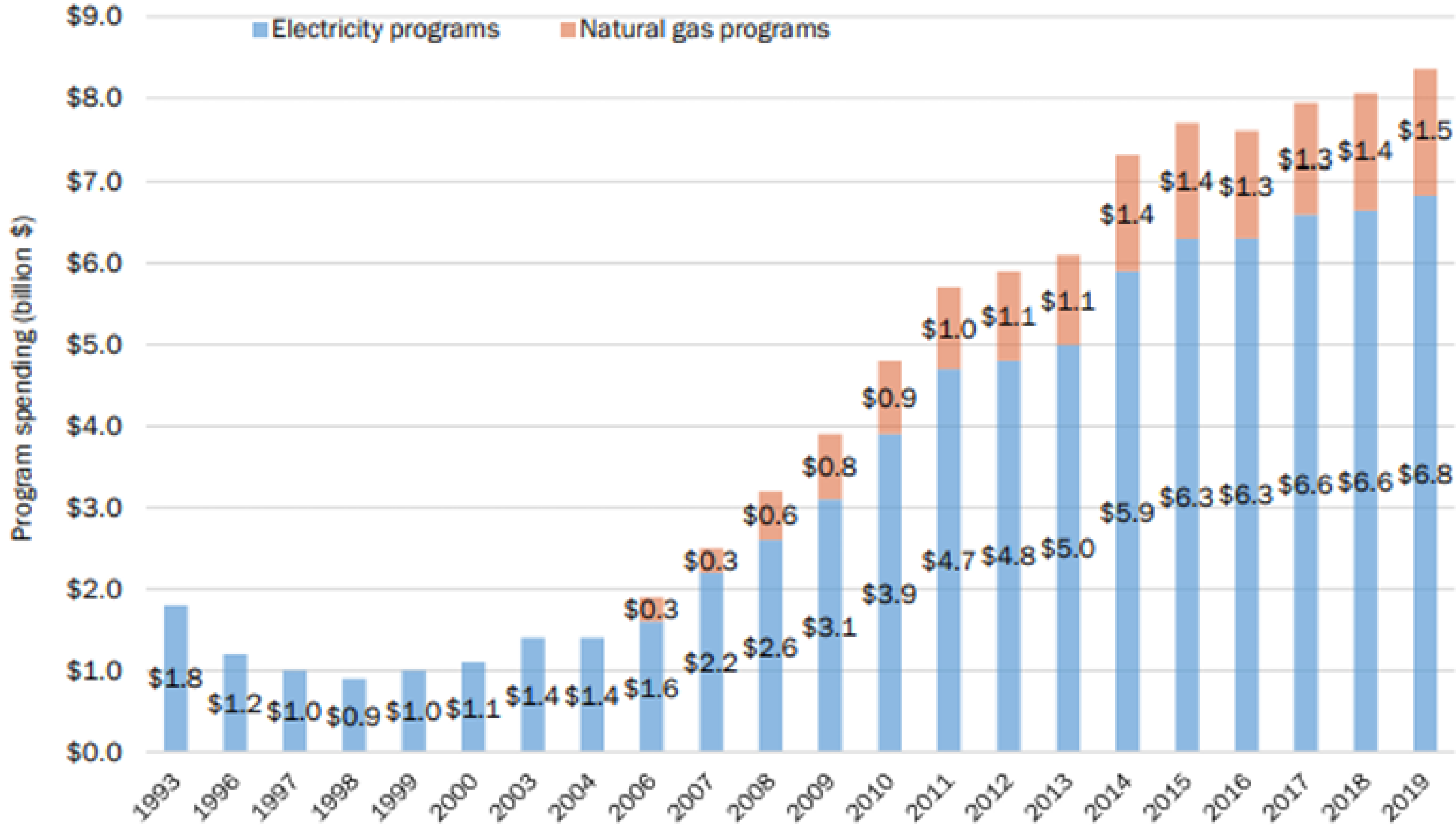
Electricity total consumption (i.e., retail sales), New England (2019)





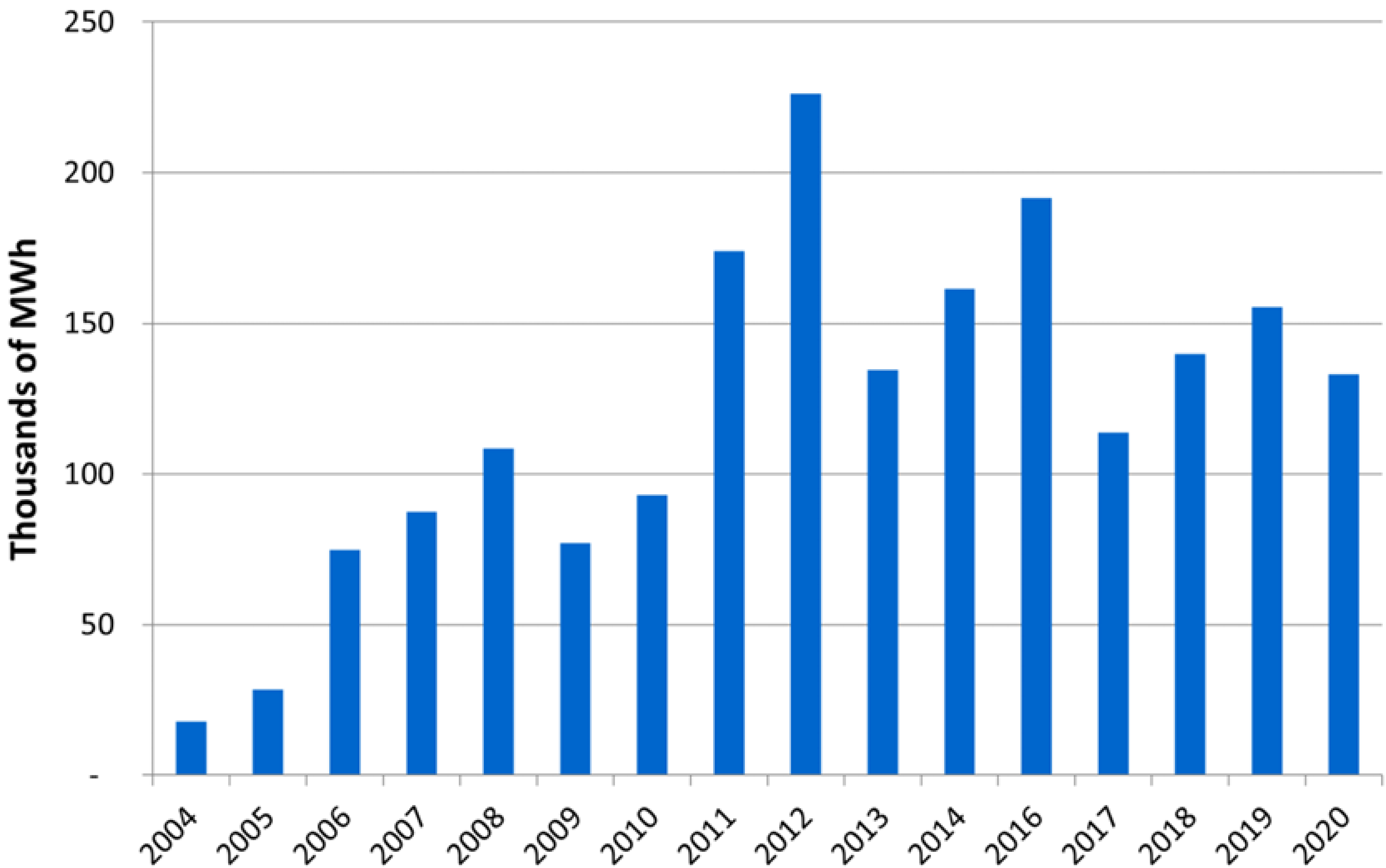
Energy Efficiency

National spending on energy efficiency programs[16]



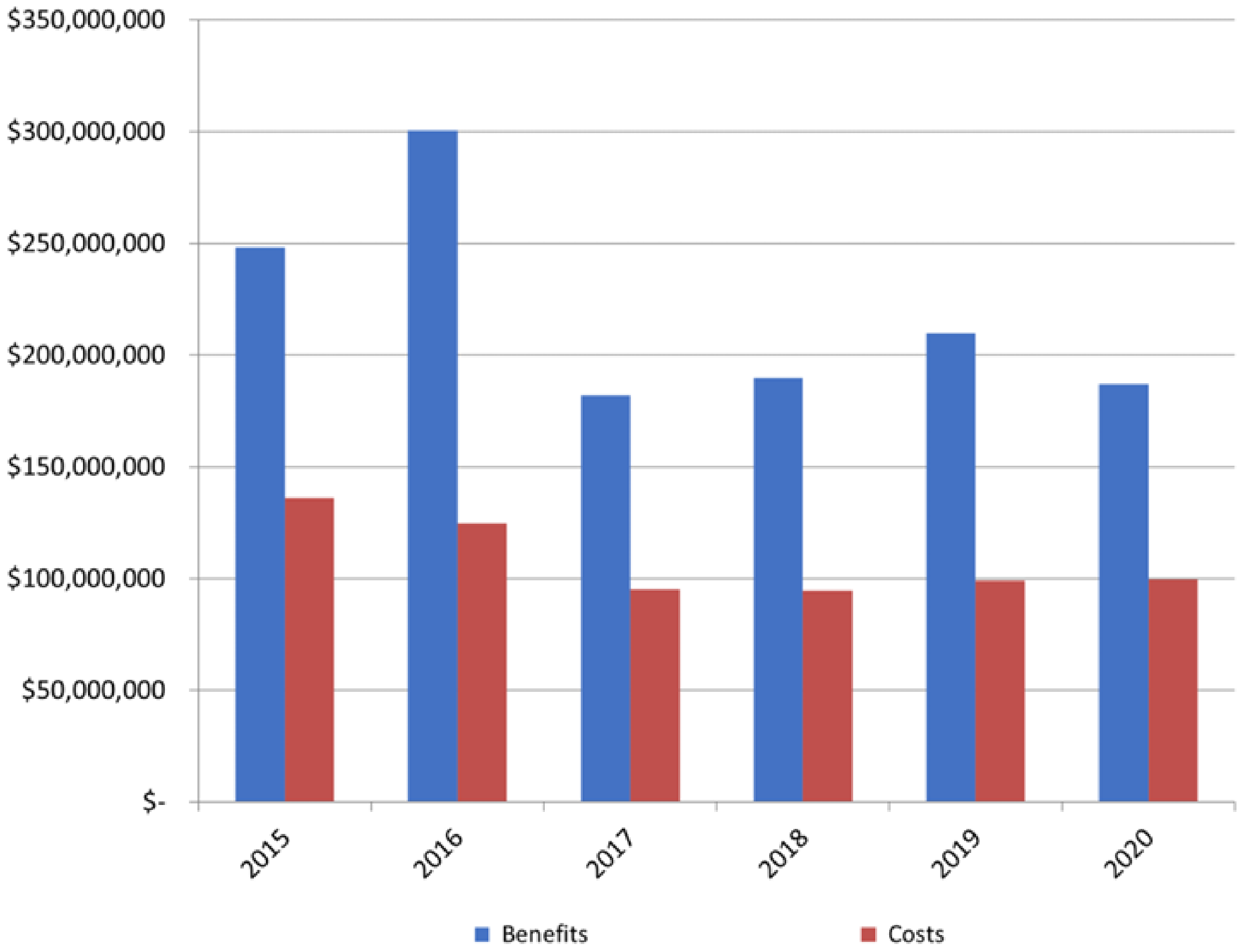
[16] Efficiency Maine Trust: Triennial Plan V 2023-2025 (2022)

Annual savings from Efficiency Maine Trust programs[17]



[17] Efficiency Maine Trust: Triennial Plan V 2023-2025 (2022)

Benefits (lifetime) vs. costs (Efficiency Maine Trust and participant) of all Efficiency Maine Trust programs[18]



[18] Efficiency Maine Trust: Triennial Plan V 2023-2025 (2022)

Costs of savings for Efficiency Maine Trust electric programs (2021)[19]

Program	Annual kWh Savings	Lifetime kWh Savings	Efficiency Maine Costs	Participant Cost	Lifetime Energy Benefit	Cost/kWh (Lifetime)	Benefit-to-Cost Ratio
Commercial and Industrial Custom Program – Electric	7,043,743	102,547,310	$2,207,603	$2,415,261	$10,575,335	$0.045	2.29
Commercial and Industrial Prescriptive Program – Electric	39,961,358	514,756,912	$9,263,812	$11,762,204	$55,627,462	$0.041	2.65
Small Business Initiative - Electric	2,263,944	29,431,165	$1,777,859	$998,939	$5,145,108	$0.094	1.85
Distributor Initiatives – Electric	22,474,617	286,191,294	$7,445,951	$2,188,923	$28,383,858	$0.034	2.95
Retail Initiatives – Electric	39,109,578	226,218,840	$7,344,323	$4,157,977	$37,282,824	$0.051	3.24
Home Energy Savings Program – Electric	53,489,129	962,804,321	$15,481,618	$34,926,865	$93,453,680	$0.052	1.85
Low-Income Initiatives – Electric[11]	10,509,982	119,996,942	$3,269,356	$454,789	$14,850,406	$0.031	3.99
Strategic Initiatives – Electric	-	-	$1,753,703	-	-	-	-
Administration – Electric	-	-	$1,987,837	-	-	-	-
Total	**174,852,350**	**2,241,946,785**	**$50,532,061**	**$56,904,958**	**$245,318,673**	**$0.048**	**2.28**

Costs and savings for Efficiency Maine Trust thermal programs (2021)[20]

Program	Annual MMBtu Savings	Lifetime MMBtu Savings	Efficiency Maine Costs	Participant Cost	Lifetime Energy Benefit	Cost/ MMBtu (Lifetime)	Benefit-to-Cost Ratio
Commercial and Industrial Custom Program – Natural Gas	9,456	144,658	$292,421	$341,284	$1,004,938	$4.38	1.59
Commercial and Industrial Custom Program – Unregulated Fuels	6,044	88,131	$384,137	$405,980	$1,502,670	$8.97	1.90
Commercial and Industrial Prescriptive Program – Natural Gas	13,565	320,780	$179,975	$47,882	$2,030,495	$0.71	8.91
Commercial and Industrial Prescriptive Program – Unregulated Fuels	20,105	404,202	$443,131	$722,784	$6,332,393	$2.88	5.43
Small Business Initiative – Unregulated Fuels	11,264	168,954	$1,011,850	$2,549,471	$4,415,923	$21.08	1.24
Distributor Initiatives – Natural Gas	5,468	71,869	$124,999	$127,590	$554,333	$3.51	2.19
Distributor Initiatives – Unregulated Fuels	11,586	289,661	$896,699	$299,150	$5,241,724	$4.13	4.38
Home Energy Savings Program – Unregulated Fuels	35,006	814,879	$3,202,948	$10,388,773	$18,576,716	$16.68	1.37
Low-Income Initiatives – Unregulated Fuels	30,630	551,242	$3,355,459	$7,660,046	$15,134,197	$19.98	1.37
Renewable Energy Demonstration Grants Program	-	-	$0	-	-	-	-
Electric Vehicle Initiatives[12]	52,182	510,484	$2,701,687	$13,044,262	$15,736,324	$30.85	1.01
Strategic Initiatives – Thermal	-	-	$490,140	-	-	-	-
Administration – Thermal	-	-	$1,372,153	-	-	-	-
Total	**195,307**	**3,364,858**	**$14,455,600**	**$35,587,221**	**$70,529,713**	**$14.87**	**1.41**

[19] Efficiency Maine Trust: FY2021 Annual Report (2022)

[20] Efficiency Maine Trust: FY2021 Annual Report (2022)

Efficiency Maine Trust payments made (2021)[21]

Use of Funds	Amount
Programs	**$ 59,989,151**
Commercial and Industrial Custom Program	$ 2,863,770
Commercial and Industrial Prescriptive Program	$ 9,886,919
Small Business Initiative	$ 2,794,708
Distributor Initiatives	$ 8,467,516
Retail Initiatives	$ 7,344,746
Home Energy Savings Program[14]	$ 19,305,282
Low-Income Initiatives	$ 6,624,524
Renewable Energy Demonstration Grants Program	$0
Electric Vehicle Initiatives	$ 2,695,311
Other Initiatives[15]	**$6,375**
Agricultural Fair Assistance Program	$0
Lead by Example Initiative	$6,375
Strategic Initiatives, Public Information, and Administration	**$3,988,572**
Strategic Initiatives	$ 2,243,846
Administration	$ 3,359,992
Other Payments[16]	**$ 72,256**
Total Use of Funds – Efficiency Maine Trust	**$ 65,665,245**

[21] Efficiency Maine Trust: FY2021 Annual Report (2022)

Maine State Housing Authority energy efficiency and weatherization initiatives (2021)[22]

MaineHousing
MAINE STATE HOUSING AUTHORITY

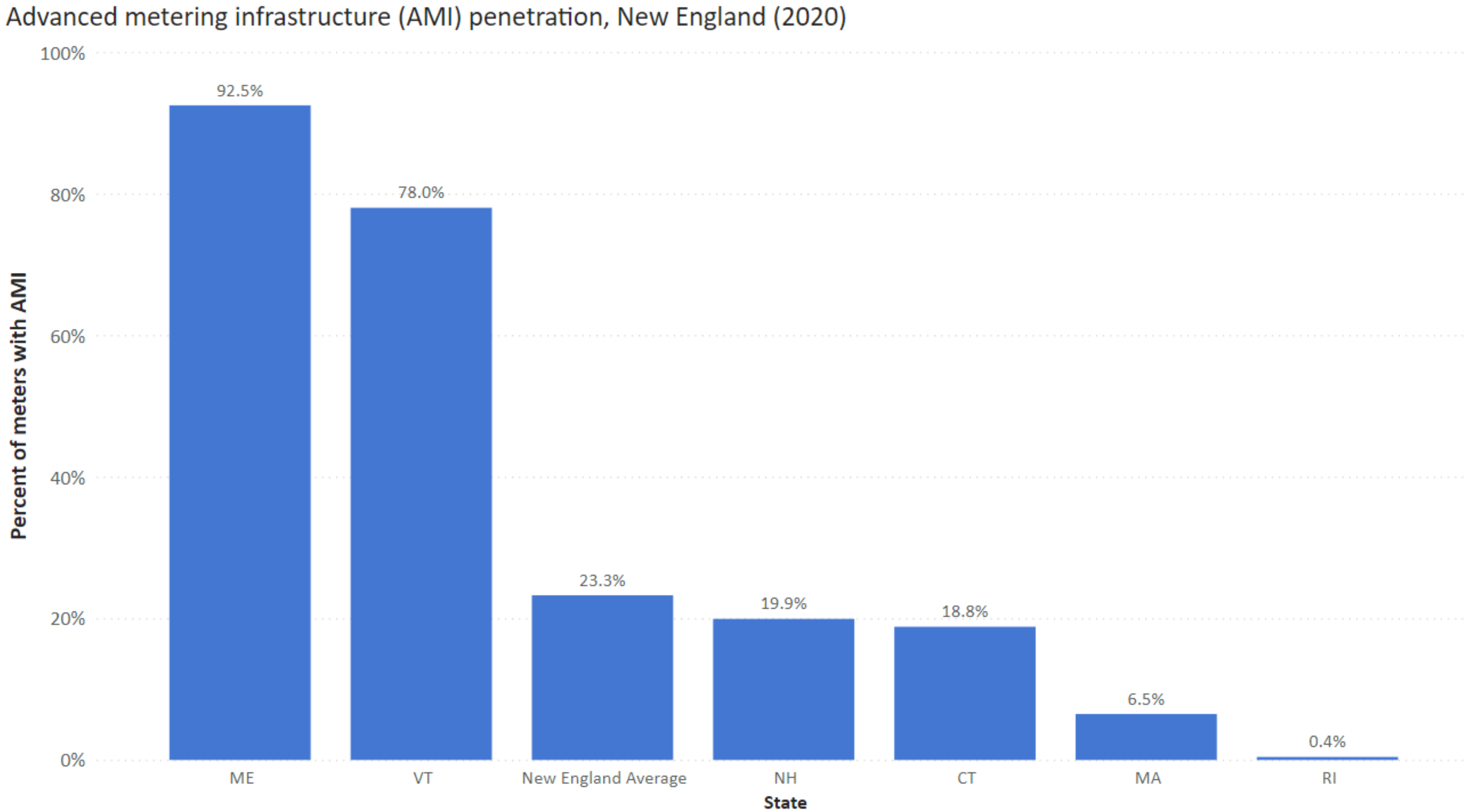
	GRANT YEAR/PERIOD		PRODUCTION BUDGET	PRODUCTION EXPENSES	UNITS		COMMENTS
HEAP WEATHERIZATION							
Weatherization efforts to maximize energy savings and reduce fuel burden; maximum health/safety per unit of $1,200 and minimal incidental repairs (20% of weatherization costs) to make installation of weatheriization materials effective; funds allocated to Community Action Agencies (CAAs), then paid directly to contractor for services; per unit average of $7,669	**2017**	**10-01-16/03-31-21**	$ 4,029,557	$ 4,025,808	462	Completed	Production Closed
	2018	**10-01-17/03-31-22**	$ 3,421,317	$ 3,416,365	399 403	Completed Projected	Production in Process Contract extended to 03/31/2022
	2019	**10-01-18/03-31-22**	$ 1,935,513	$ 1,897,380	216 234	Completed Projected	Production in Process Contract extended to 03/31/2022
	2020	**10-01-19/09-30-22**	$ 2,351,154	$ 1,187,746	147 265	Completed Projected	Production in Process
	***2021**	**10-01-20/09-30-23**	$ 2,495,800	$ 157,832	18 321	Completed Projected	Production in Process
DEPARTMENT OF ENERGY WEATHERIZATION (DOE/Wx)							
Funding used in conjunction with HEAP Weatherization funding to maximize energy savings and reduce fuel burden.	**2020**	**04-01-20/03-31-21**	$ 4,718,456	$ 2,184,072	242	Completed	Production Closed remaining funding rolled into 2021
	2021	**04-01-21/3-31-22**	$ 5,217,004	$ 1,338,201	87 482	Completed Projected	Production in Process
HEAP CENTRAL HEATING IMPROVEMENT							
Central Heating Improvement Program is designed to repair or replace non-working or ineffective permantly installed home heating systems to increase efficiency and reduce household fuel burden. *Per unit average of $5,000.* *HEAT PUMPS installed using CHIP funding are accounted for below*	**2017**	**10-01-16/03-31-21**	$ 5,864,422	$ 5,858,450	2505	Completed	Production Closed
	2018	**10-01-17/03-31-22**	$ 5,459,679	$ 5,403,368	2078 2088	Completed Projected	Production in Process Contract extended to 03/31/2022
	2019	**10-01-18/03-31-22**	$ 3,684,946	$ 3,465,340	1099 1143	Completed Projected	Production in Process Contract extended to 03/31/2022
	2020	**10-01-19/09-30-22**	$ 3,757,116	$ 3,211,435	1050 1159	Completed Projected	Production in Process
	***2021**	**10-01-20/09-30-23**	$ 4,809,432	$ 492,120	145 994	Completed Projected	Production in Process
HEAP HEAT PUMPS							
Pays for the purchase and installation of heat pump as a secondary heating system to help reduce households' overall energy burden. Eligible households must reside in an owner-occupied dwelling that is a good candidate for effective usage of heat pumps.	**2020**	**10-01-19/09-30-22**	$ 135,700	$ 585,658	27 1714	Completed Projected	Funding available is contingent on availability and grant amounts from LIHEAP.
	***2021**	**10-01-20/9-30-23**	$ 7,283,574	$ 1,783,649	389 1638	Completed Projected	Production in Process

prepared by gls/MH 09-09-2021

*** Numbers are inclusive of Standard HEAP funding as well as a Supplemental Funding Award from the American Rescue Plan**

[22] Efficiency Maine Trust: FY2021 Annual Report (2022)

Advanced metering infrastructure (AMI) penetration, New England (2020)[23]



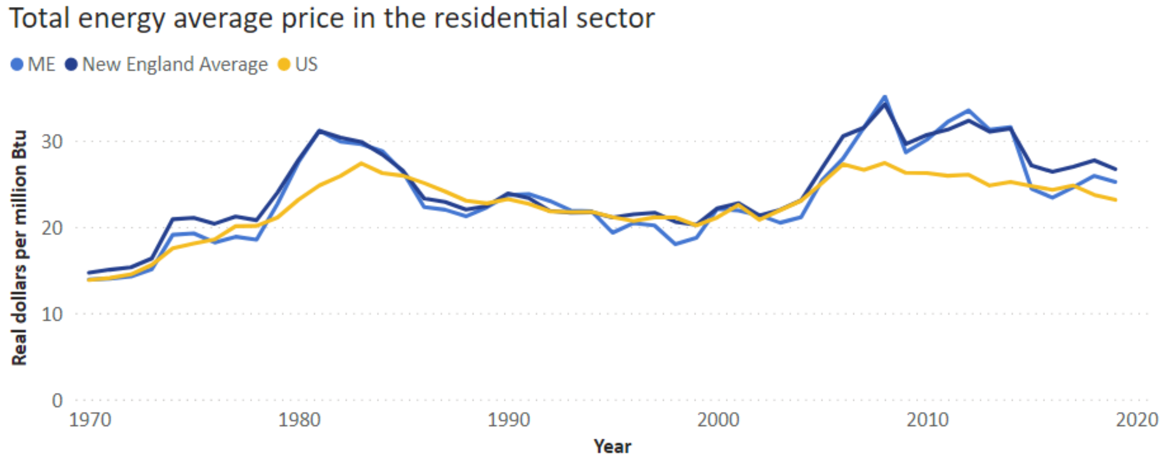
[23] Data retrieved from U.S. Energy Information Administration: Annual Electric Power Industry Report, Form EIA-861 (2021) with visual developed by the Maine Governor's Energy Office.

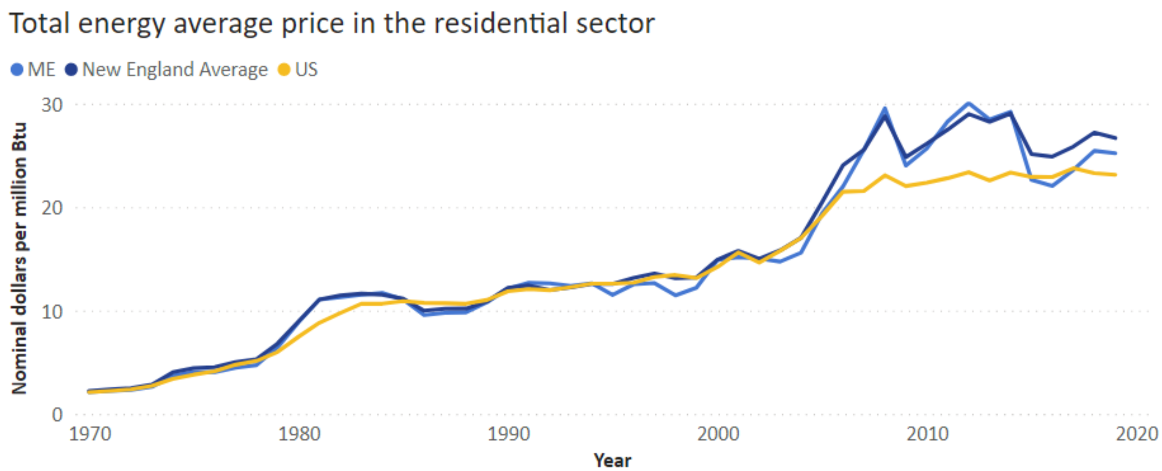
Residential Sector[24]

Prices

Energy

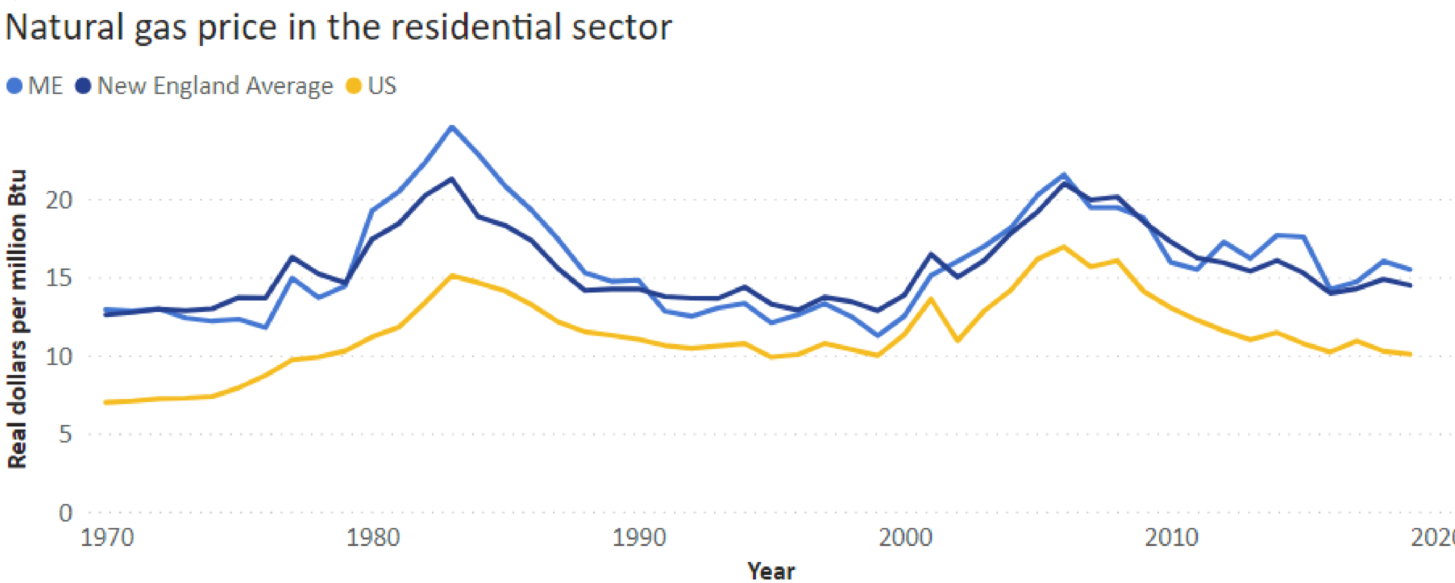
Total energy average price in the residential sector

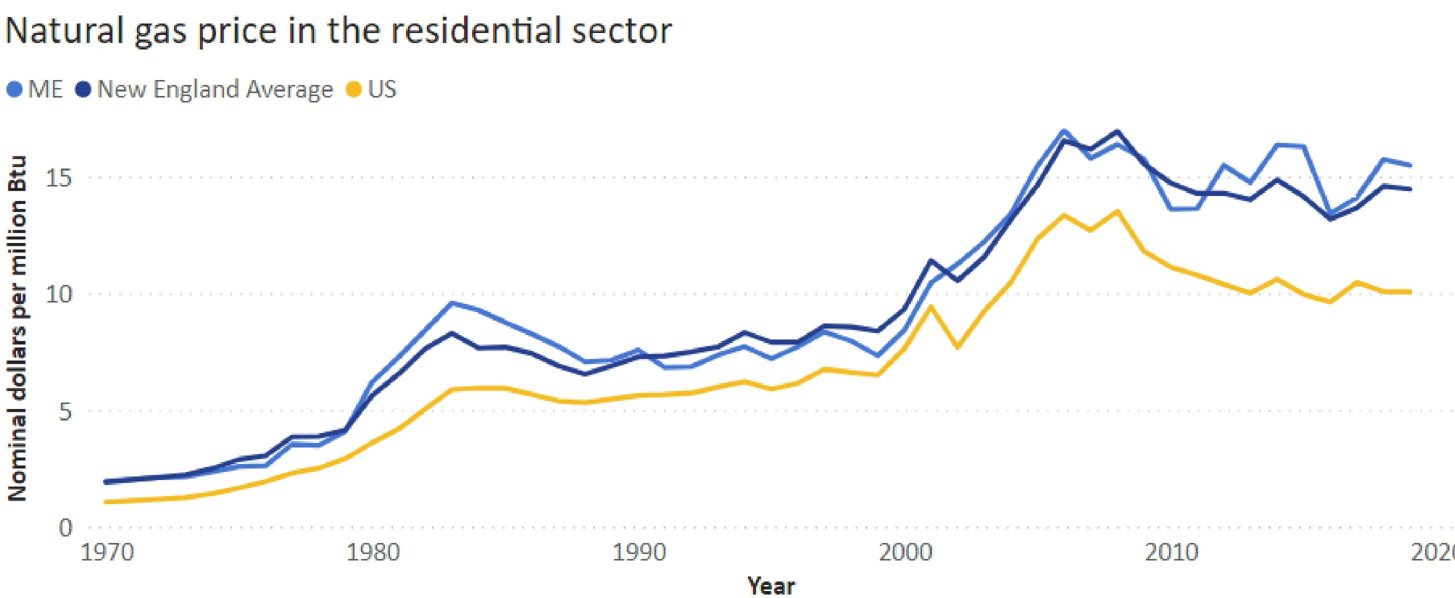




[24] Additional data on the residential sector is included under All Sectors.

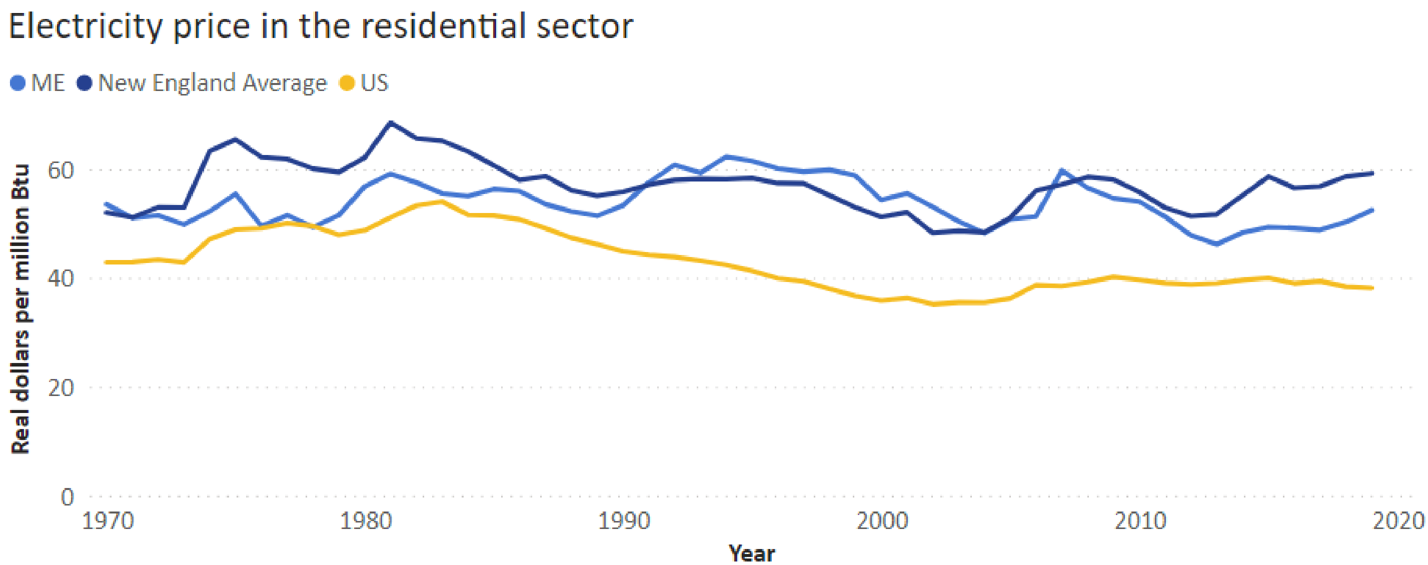
Natural gas price in the residential sector

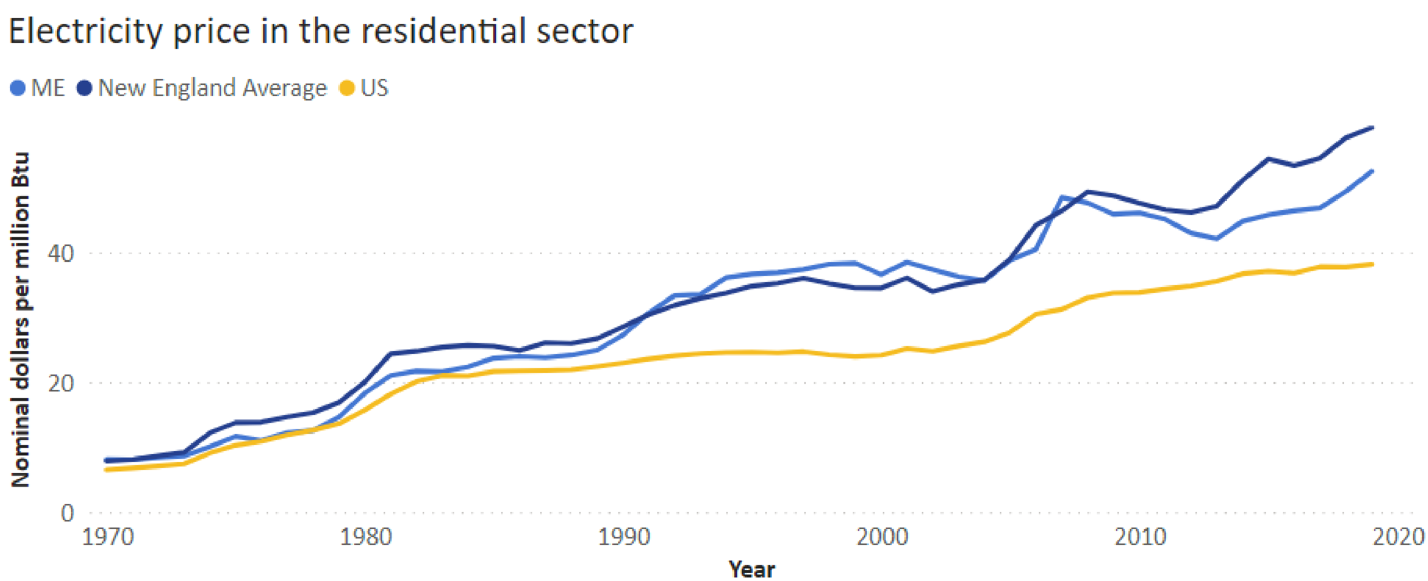




Electricity

Electricity price in the residential sector

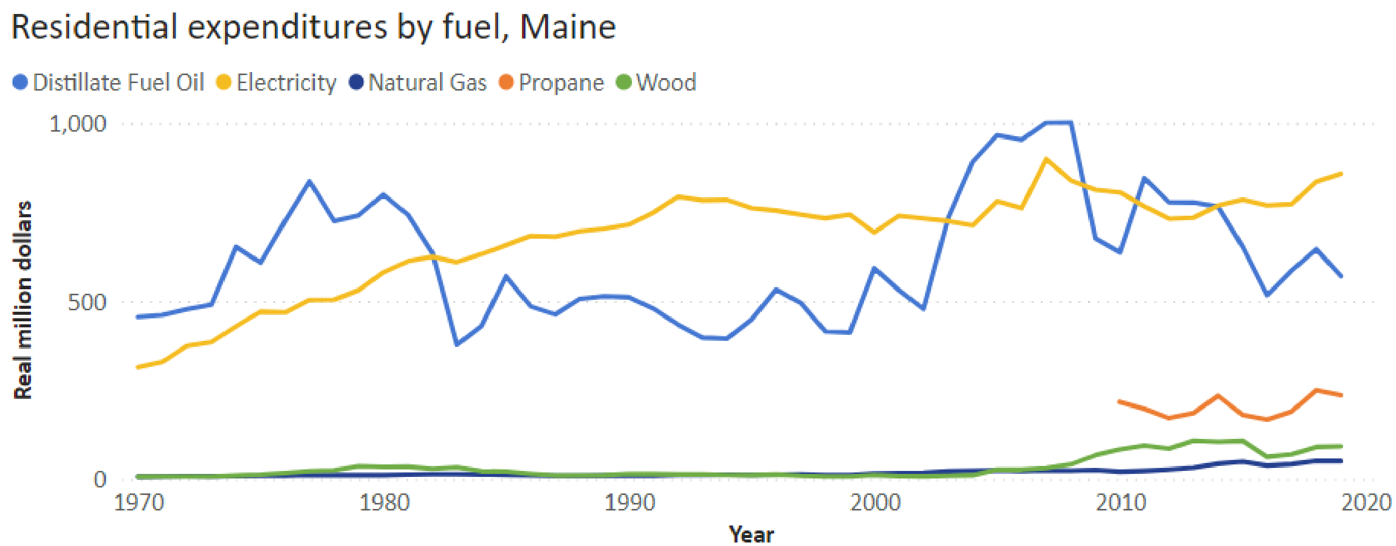


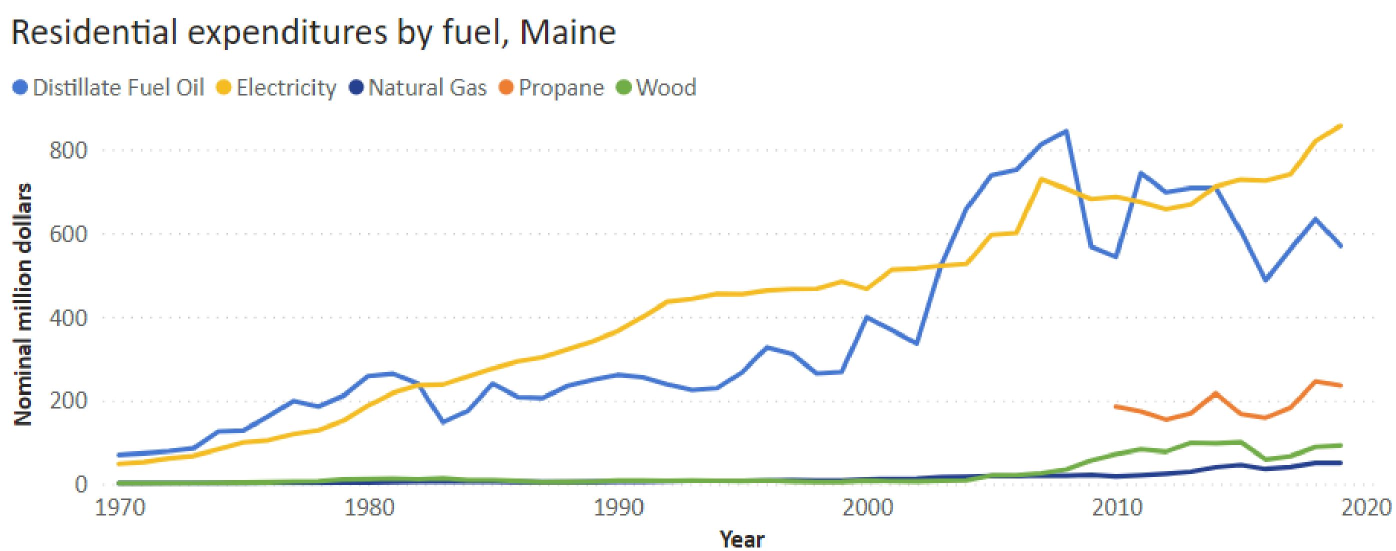


Expenditures

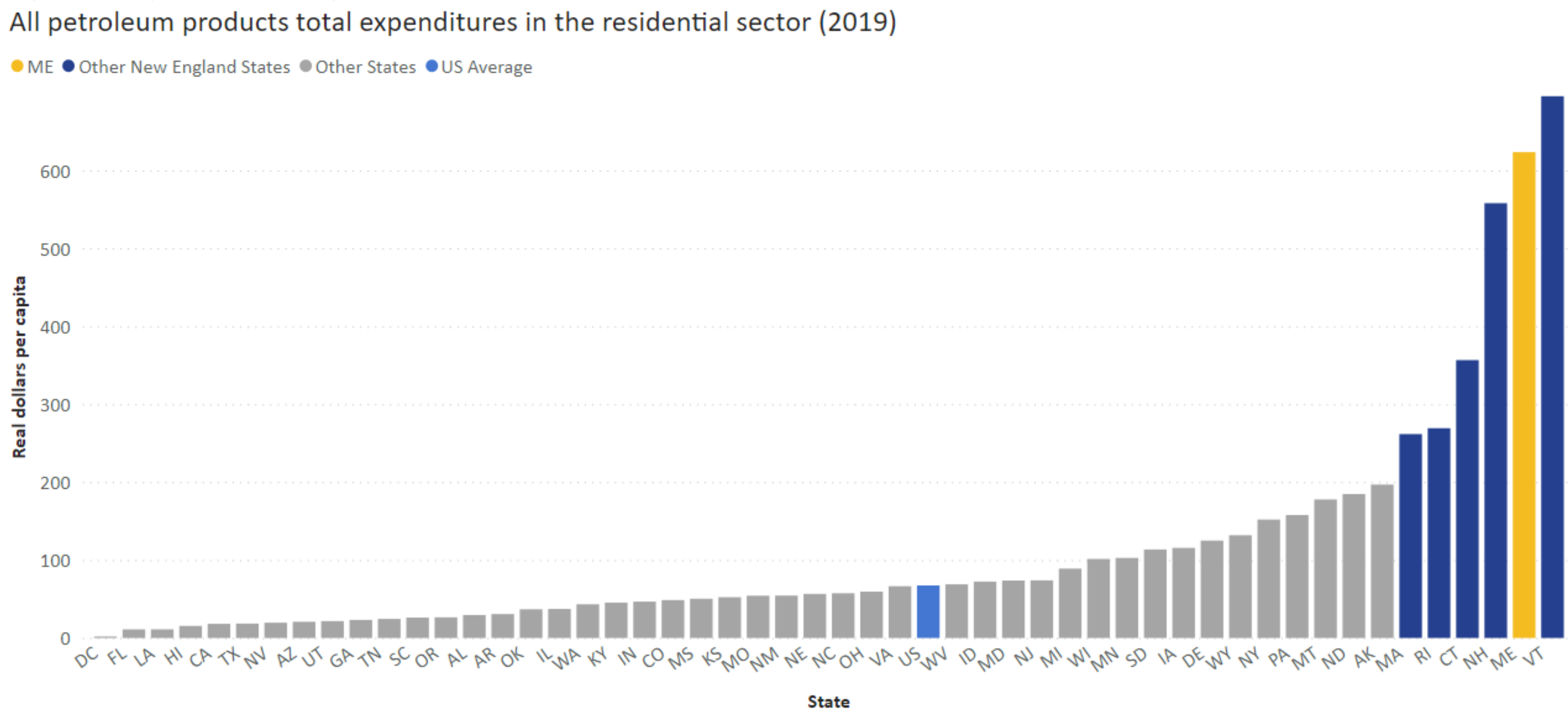
Energy

Residential expenditures by fuel, Maine





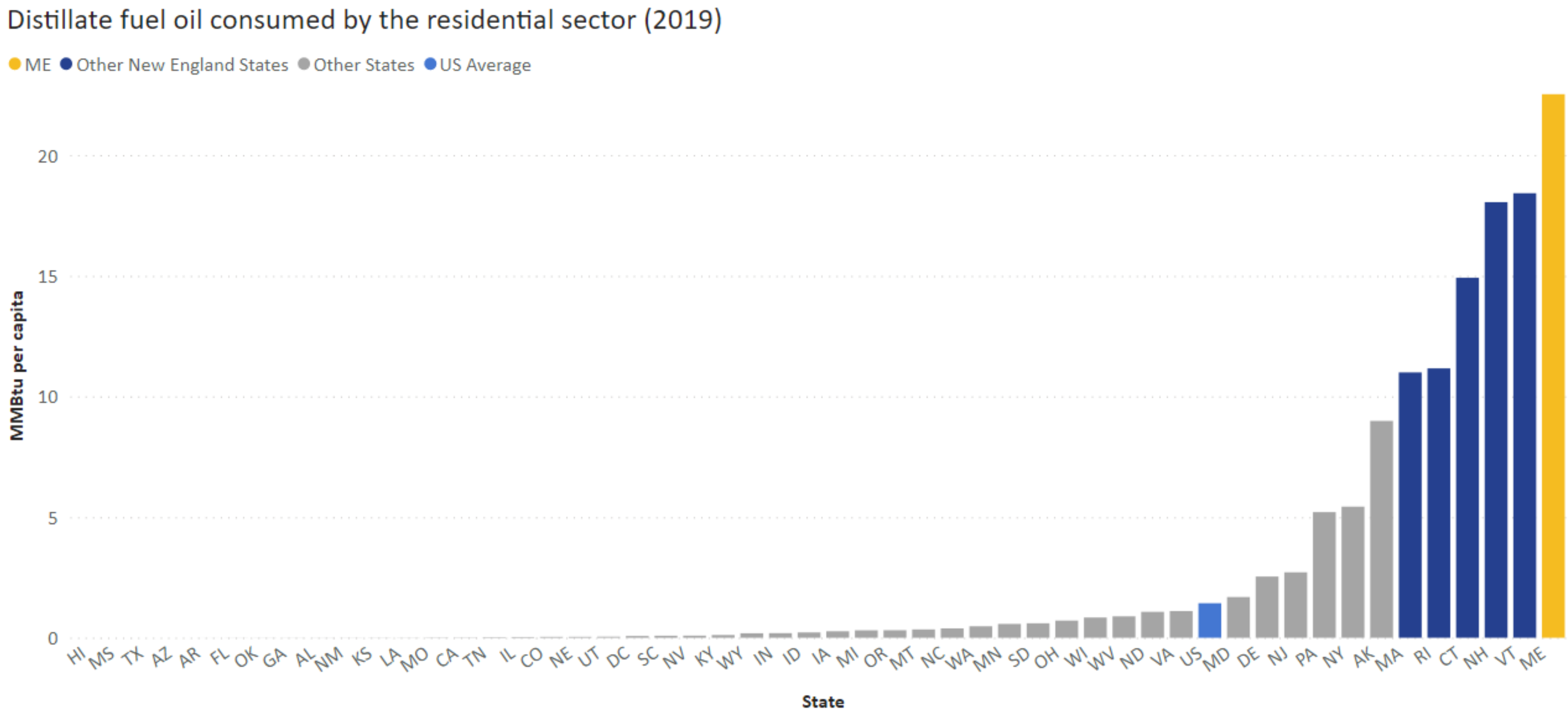
All petroleum products total expenditures in the residential sector (2019)



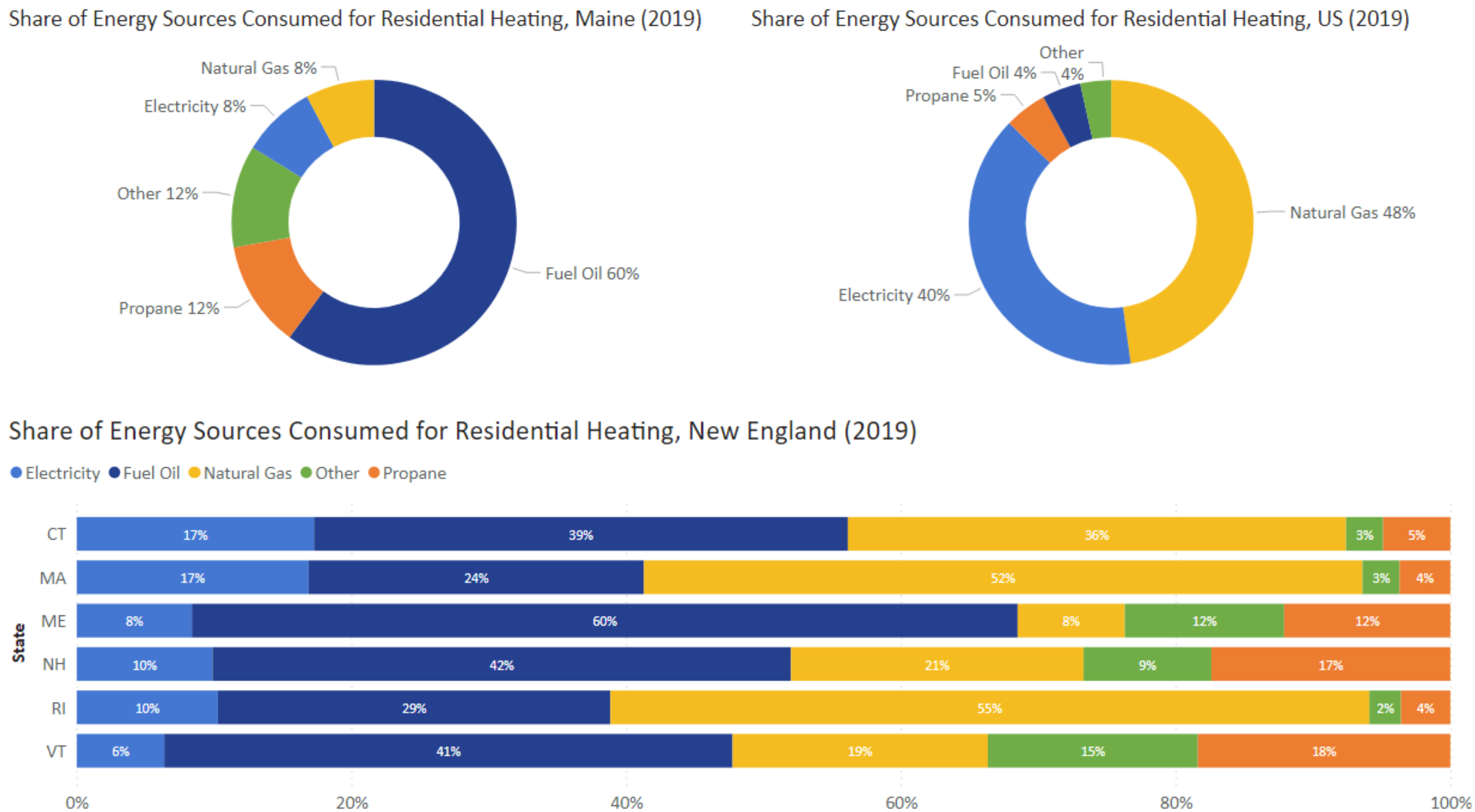
Consumption

Energy

Distillate fuel oil consumed by the residential sector (2019)

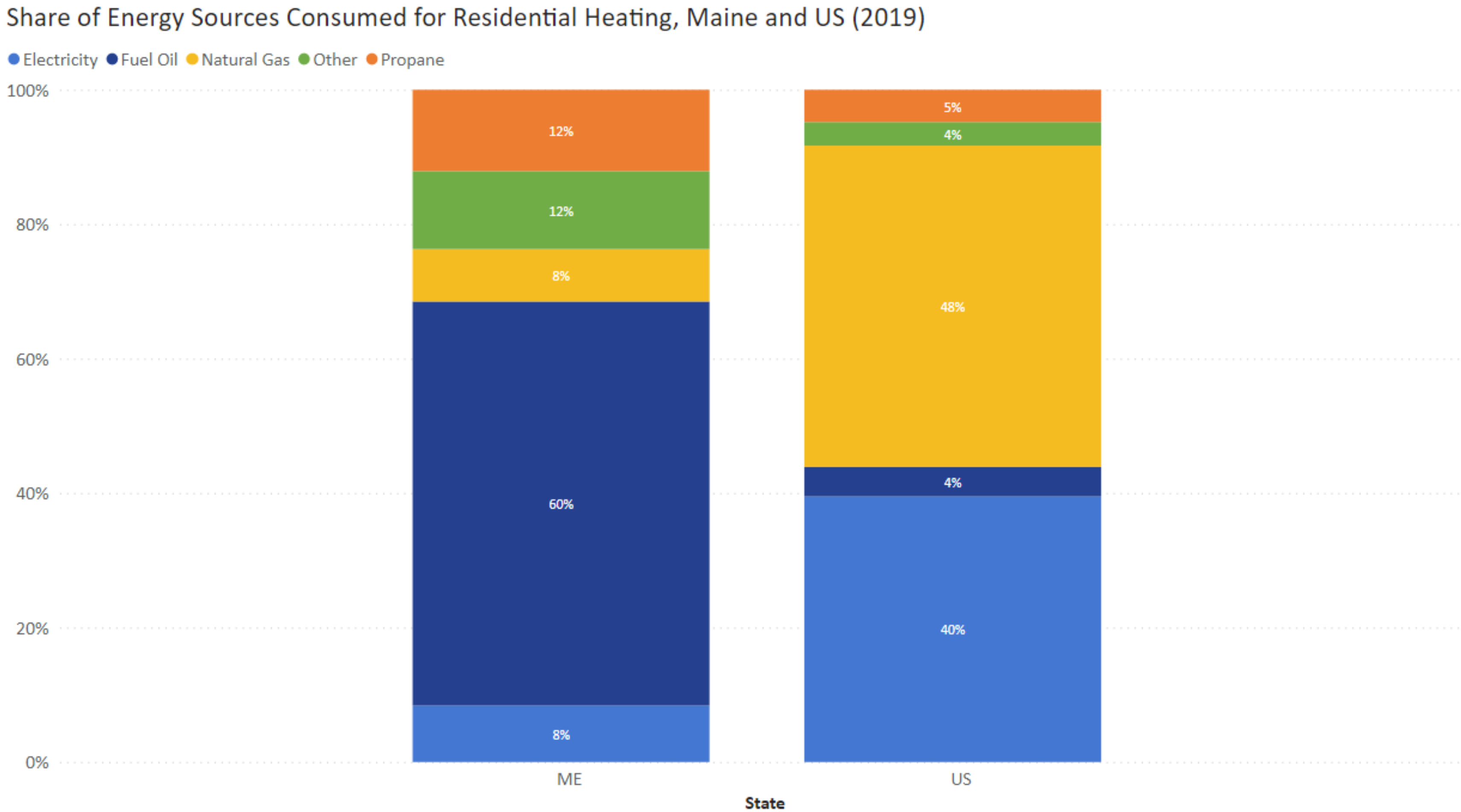


Share of Energy Sources Consumed for Residential Heating, New England Summary (2019)[25]



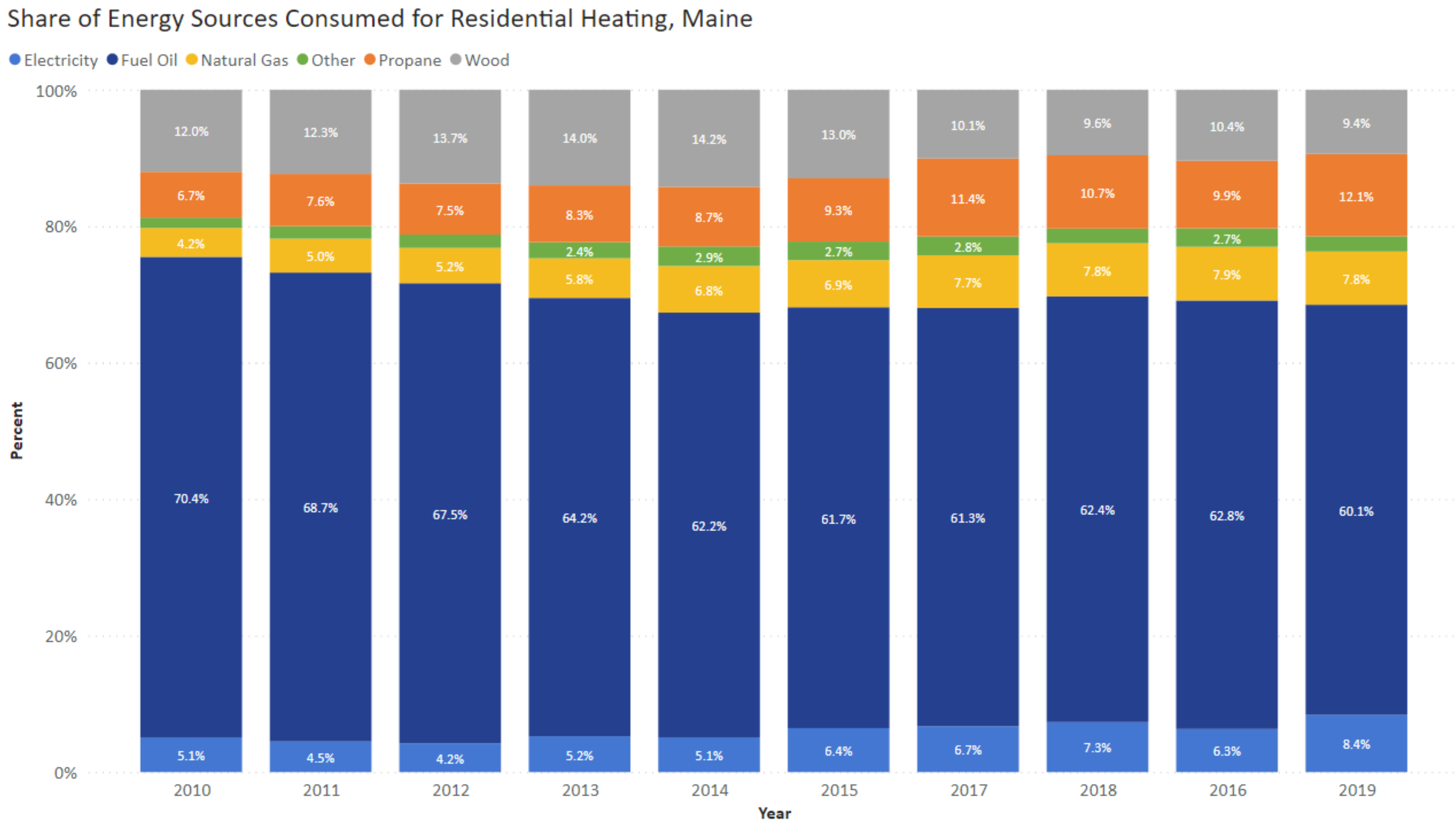
[25] Data retrieved from U.S. Energy Information Administration: State Profile and Energy Estimates (2022) with visual developed by the Maine Governor's Energy Office.

Share of Energy Sources Consumed for Residential Heating, Maine and US (2019)[26]



[26] Data retrieved from U.S. Energy Information Administration: State Profile and Energy Estimates (2022) with visual developed by the Maine Governor's Energy Office.

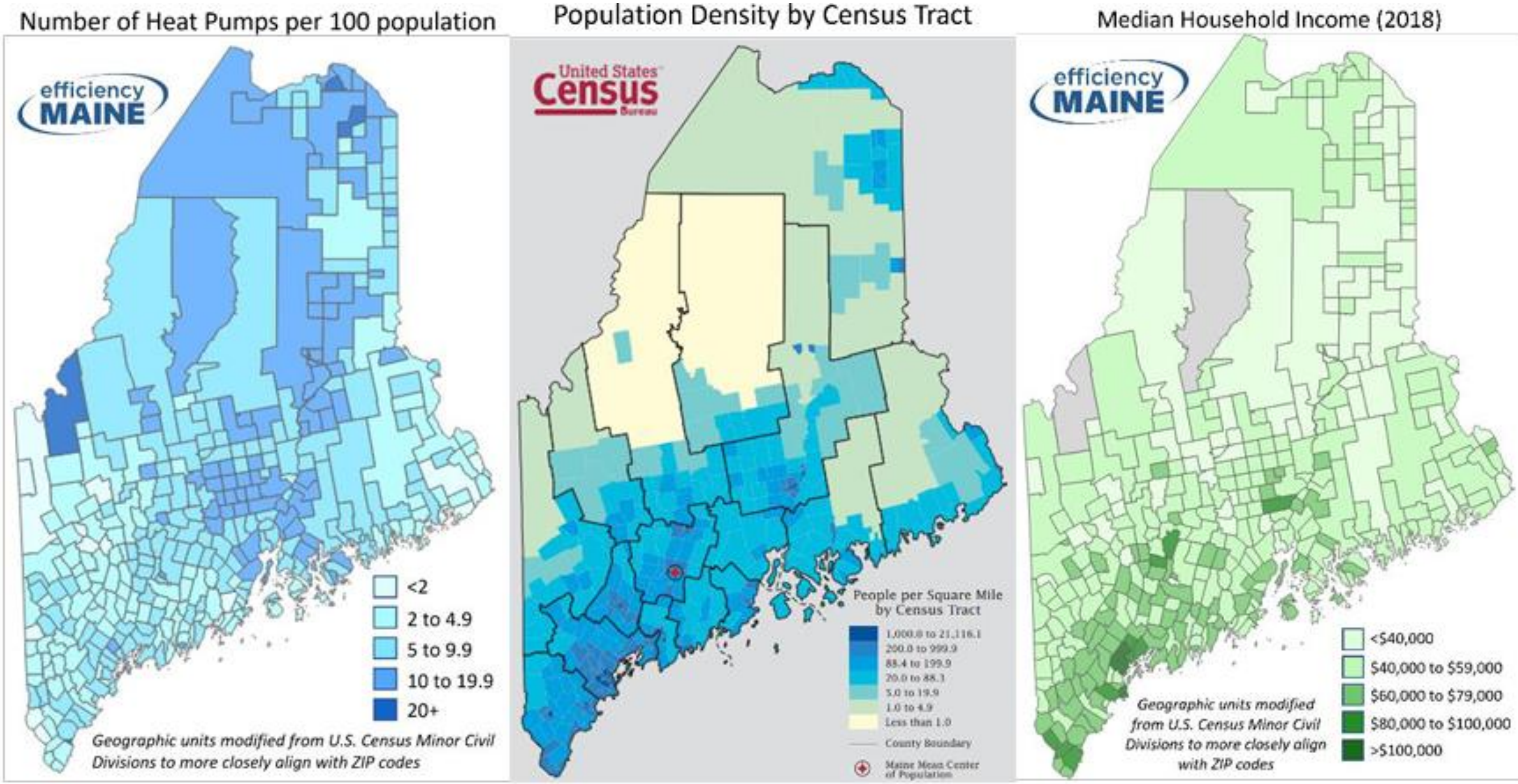
Share of Energy Source Consumed for Residential Heating, Maine[27]



27 Data retrieved from U.S. Energy Information Administration: State Profile and Energy Estimates (2022) with visual developed by the Maine Governor's Energy Office.

Energy Efficiency

Efficiency Maine Trust heat pump installations (2021), population density (2010), and income distribution (2018), Maine[28]

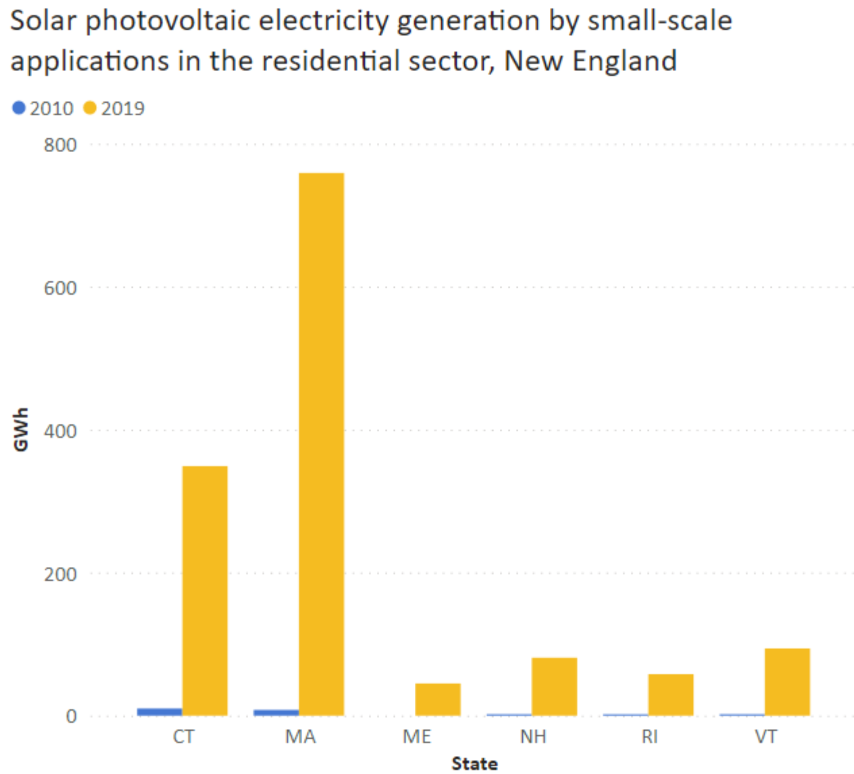


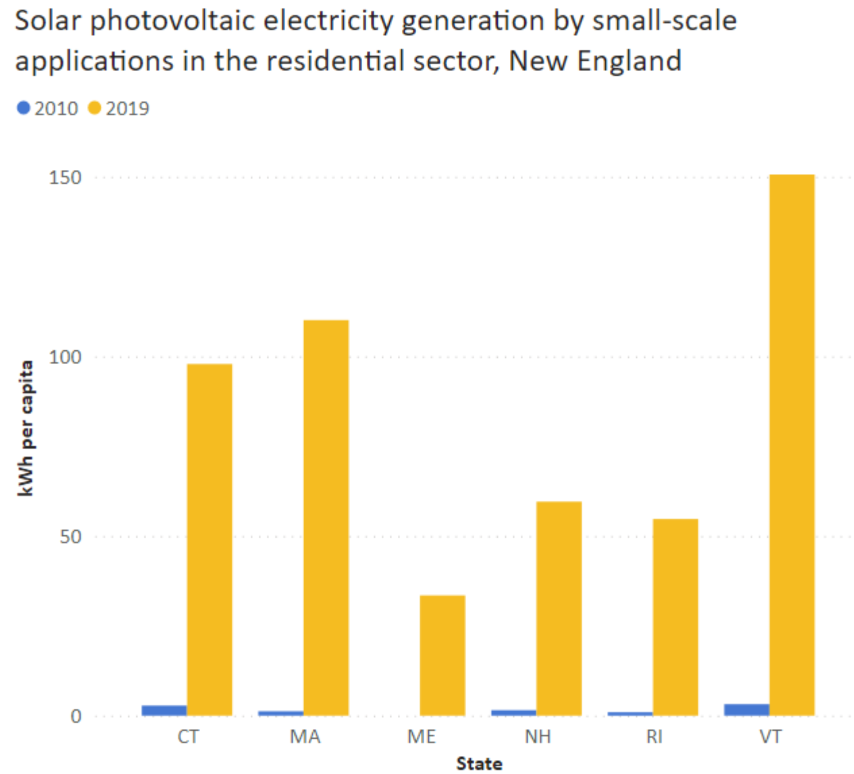
[28] Efficiency Maine Trust: Triennial Plan V 2023-2025 (2022)

Generation

Electricity

Solar photovoltaic electricity generation by small-scale applications in the residential sector, New England



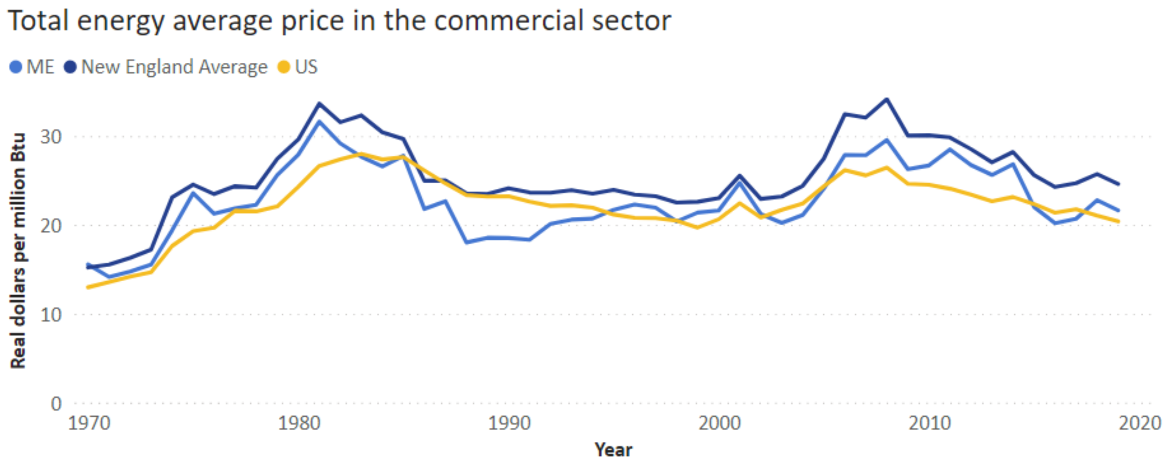


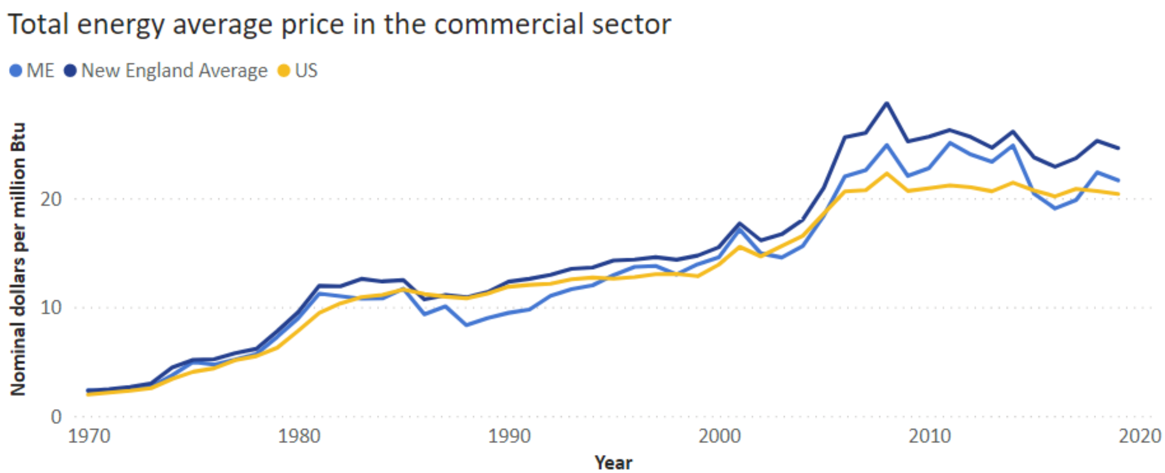
Commercial and Industrial Sector[29]

Prices

Energy

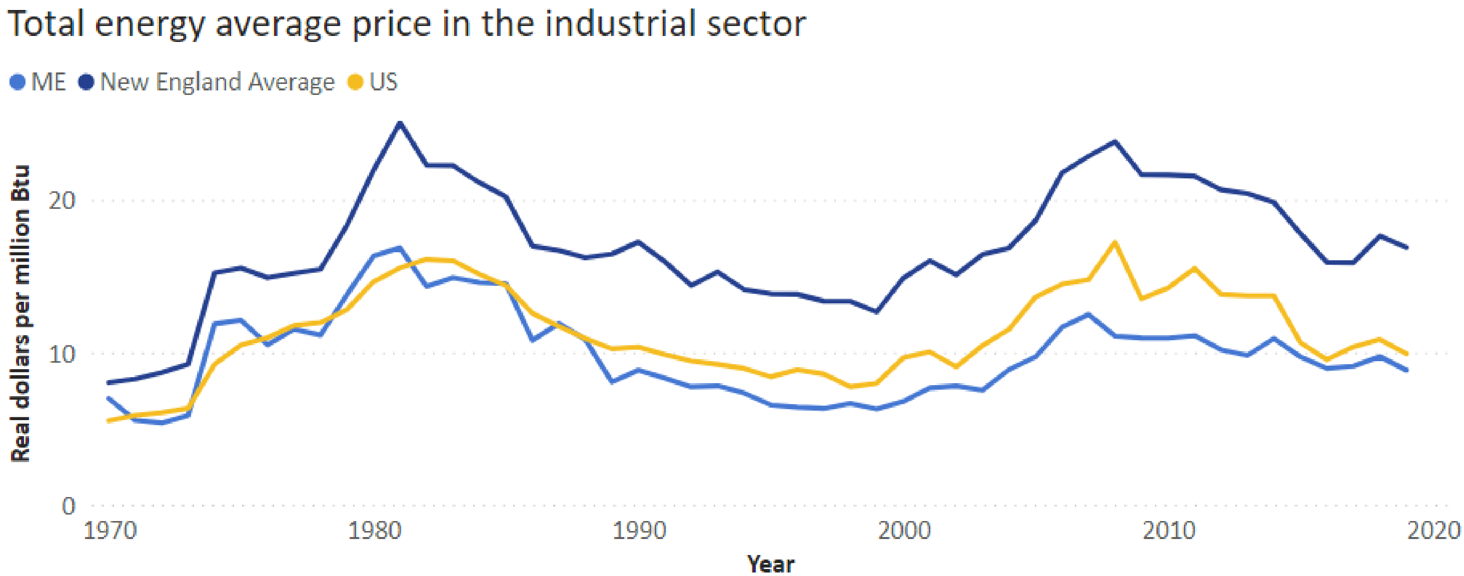
Total energy average price in the commercial sector

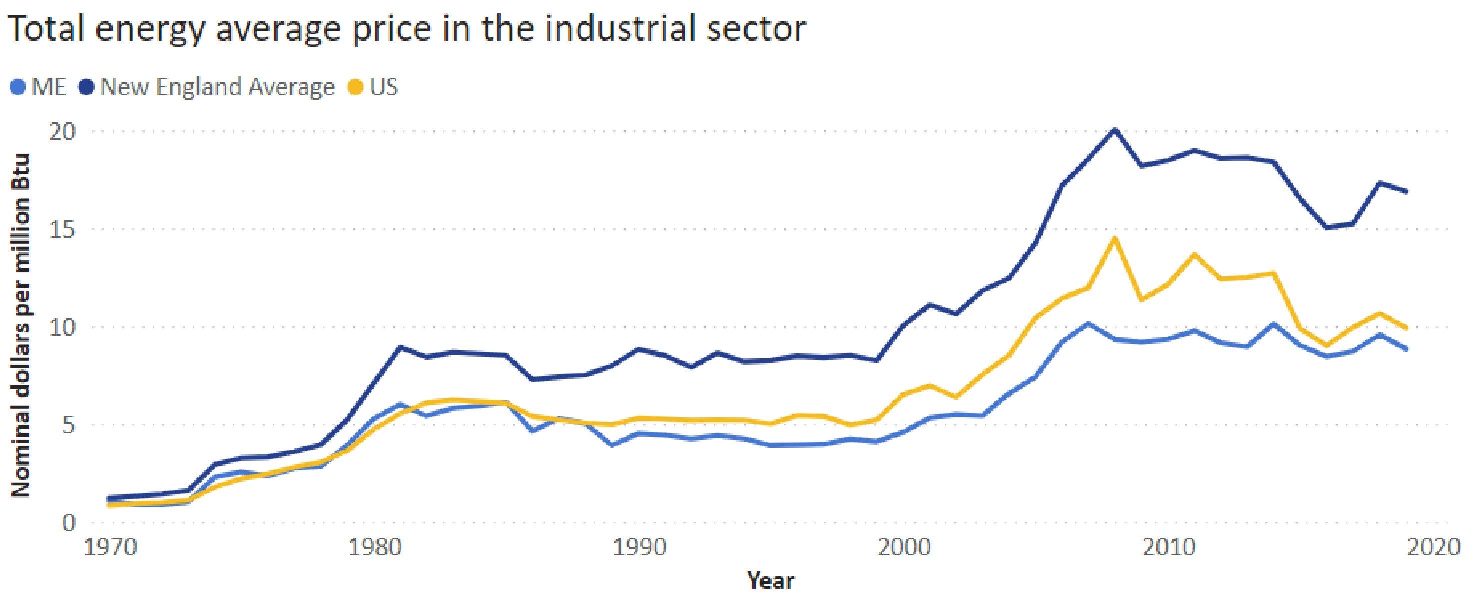




[29] Additional data on the commercial and industrial sector is included under All Sectors.

Total energy average price in the industrial sector

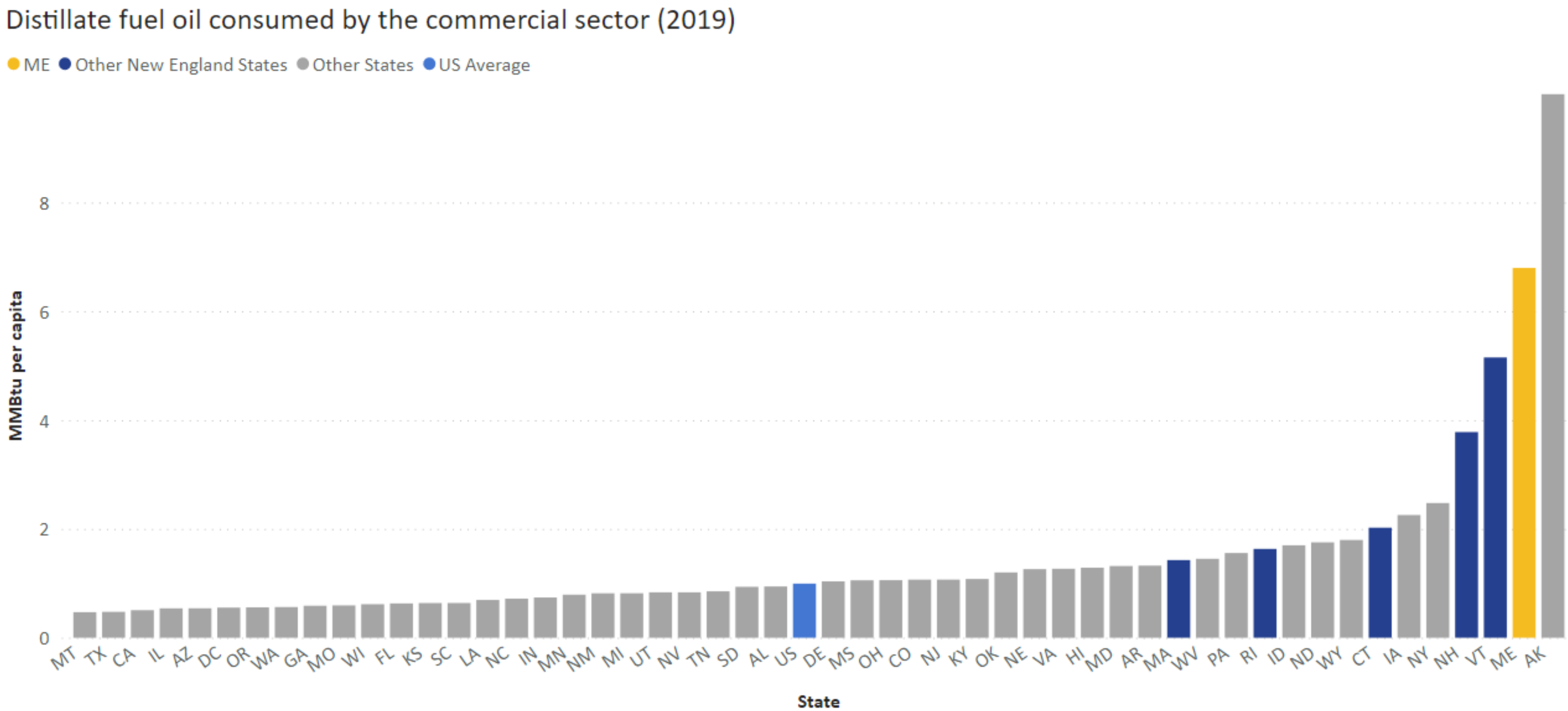




Consumption

Energy

Distillate fuel oil consumed by the commercial sector (2019)

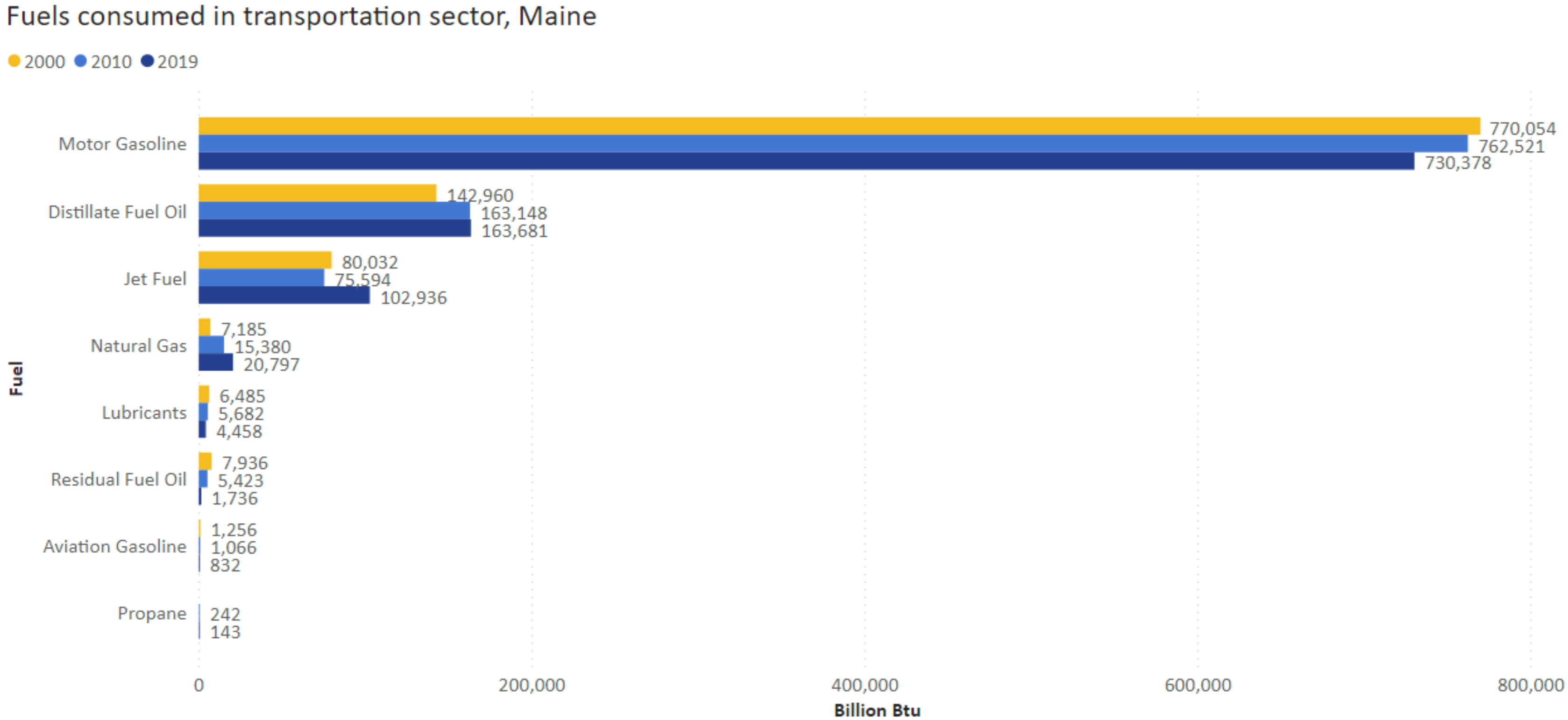


Transportation Sector[30]

Consumption

Energy

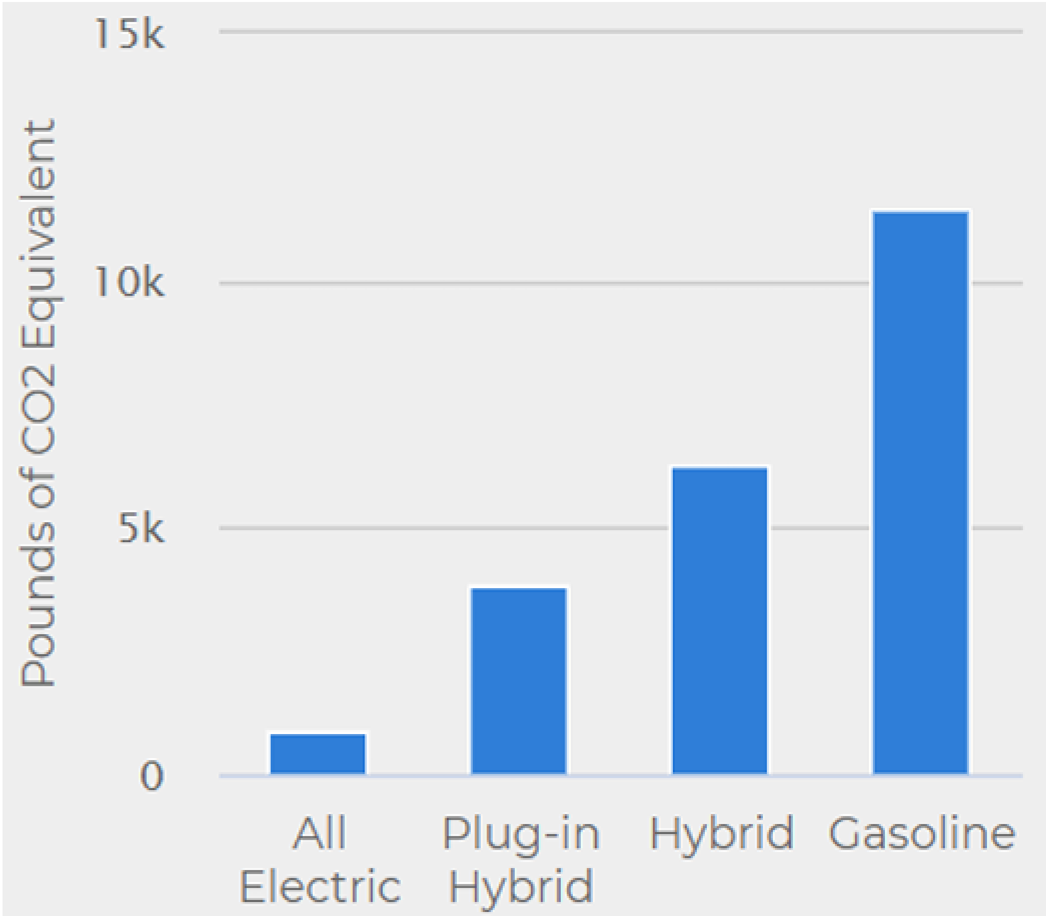
Fuels consumed in transportation sector, Maine



[30] Additional data on the transportation sector is included under All Sectors.

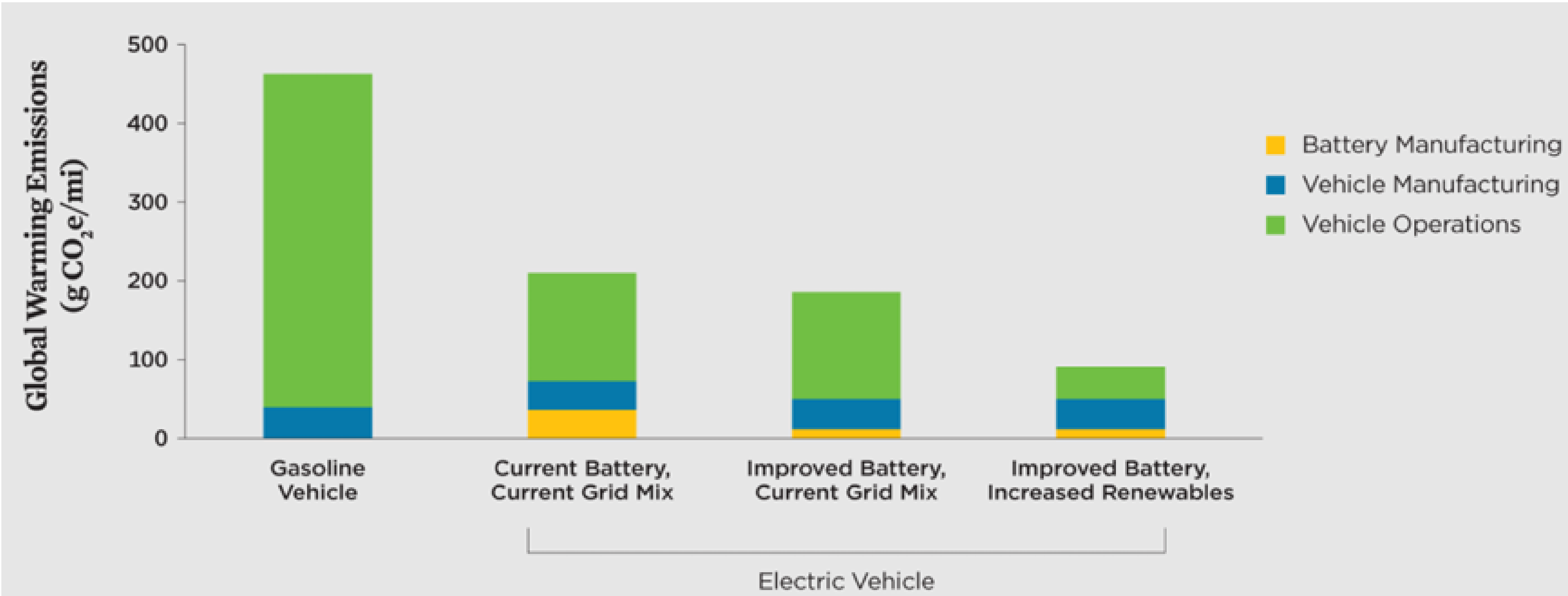
Alternative Transportation and Infrastructure

Annual emissions per vehicle in pounds of CO_2e, Maine[31]



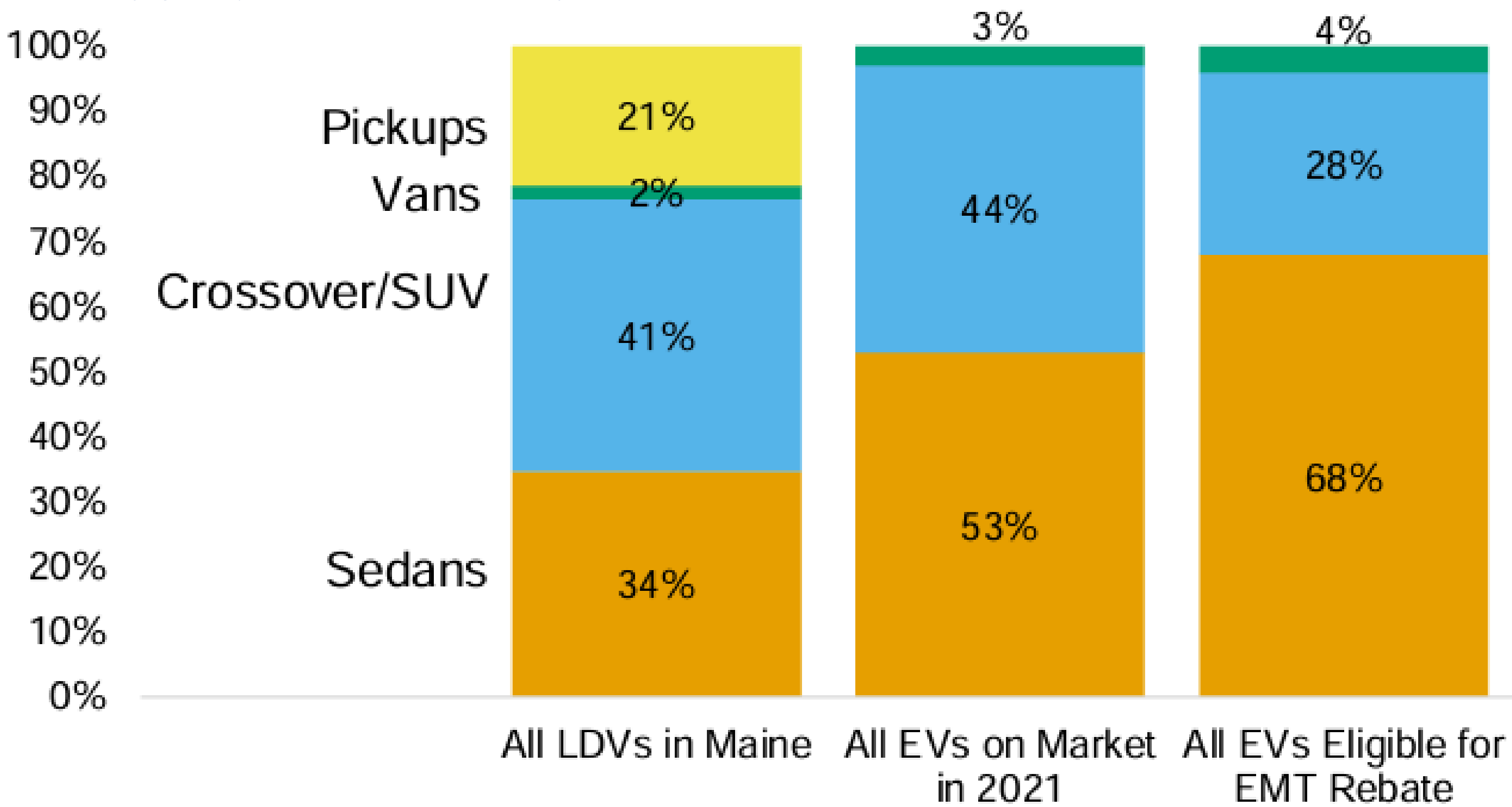
[31] Governor's Office of Policy Innovation and the Future: Maine Clean Transportation Roadmap (2021)

Mine-to-wheel life cycle emissions of EVs[32]



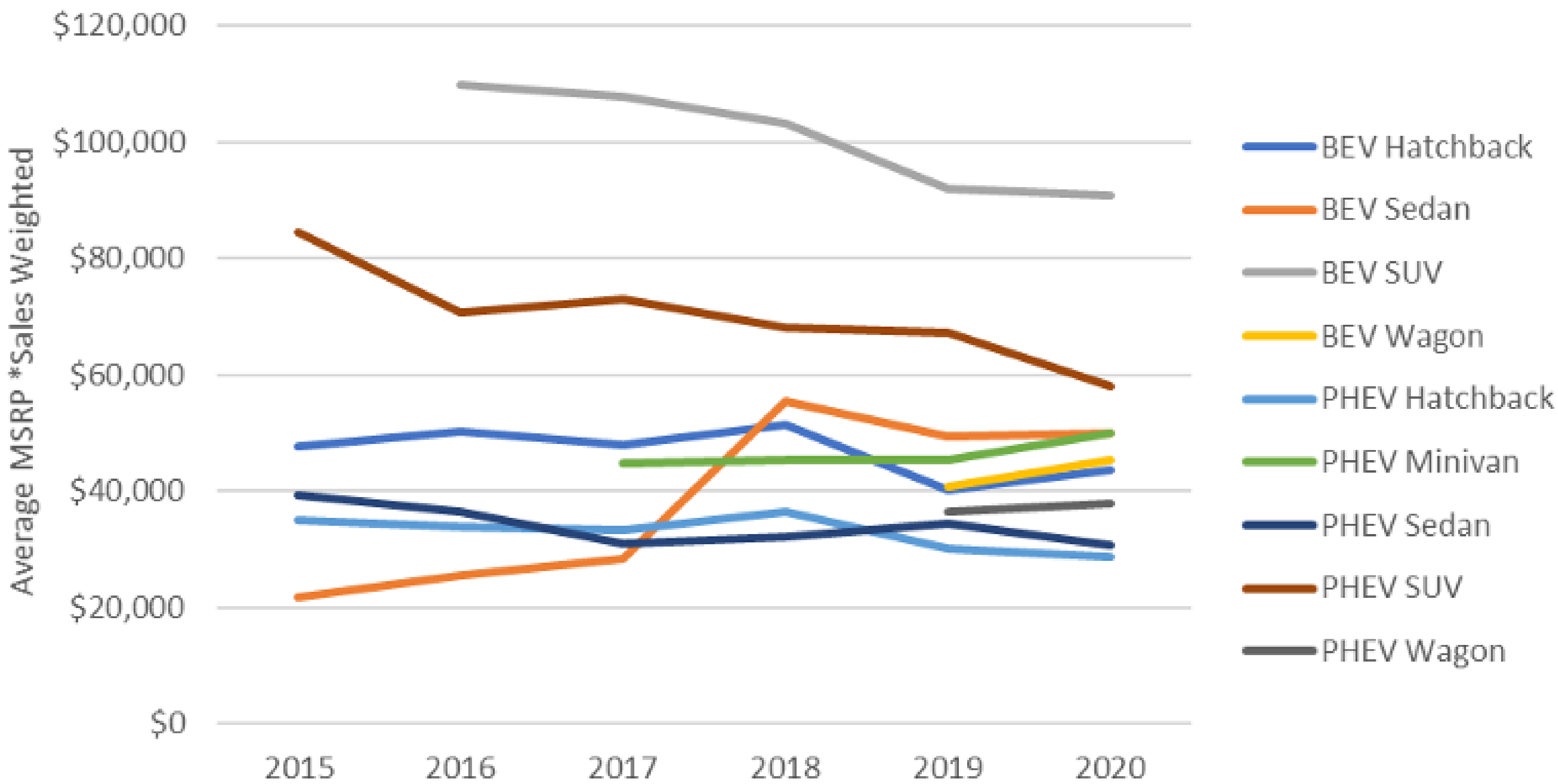
[32] Governor's Office of Policy Innovation and the Future: Maine Clean Transportation Roadmap (2021)

Breakdown of light-duty vehicles owned and available for rebate, Maine and US (2021)[33]



[33] Governor's Office of Policy Innovation and the Future: Maine Clean Transportation Roadmap (2021)

Average MSRP of EVs sold by vehicle category, Maine[34]

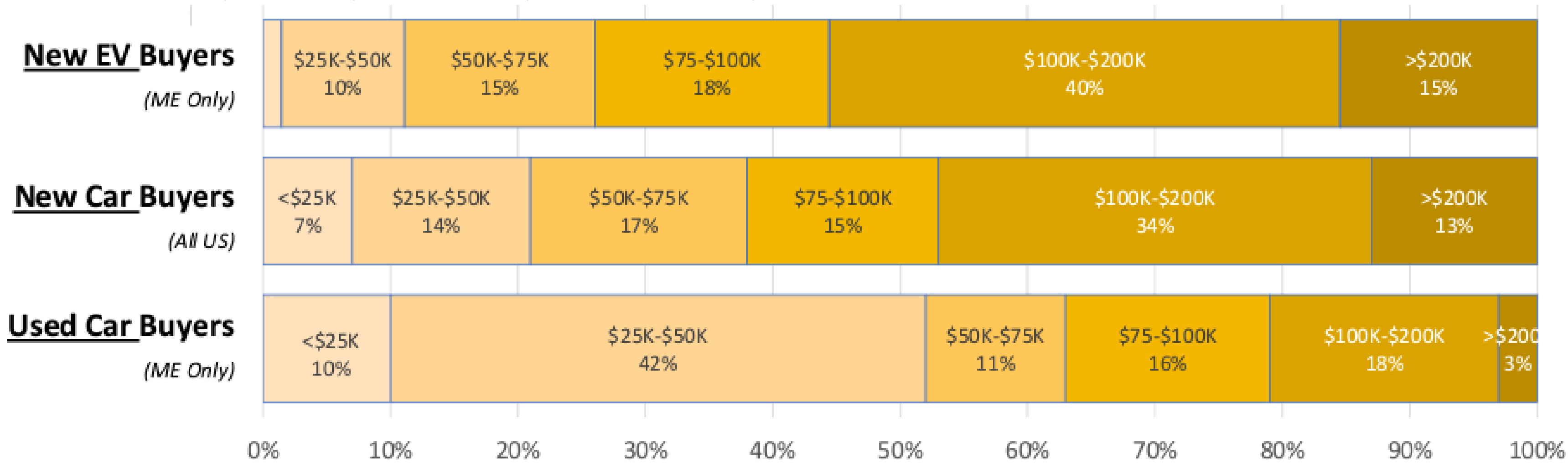


[34] Governor's Office of Policy Innovation and the Future: Maine Clean Transportation Roadmap (2021)

Locations of 417 publicly accessible level 2 stations, 131 publicly accessible DCFC plugs, and planned chargers, Maine (2021)[35]

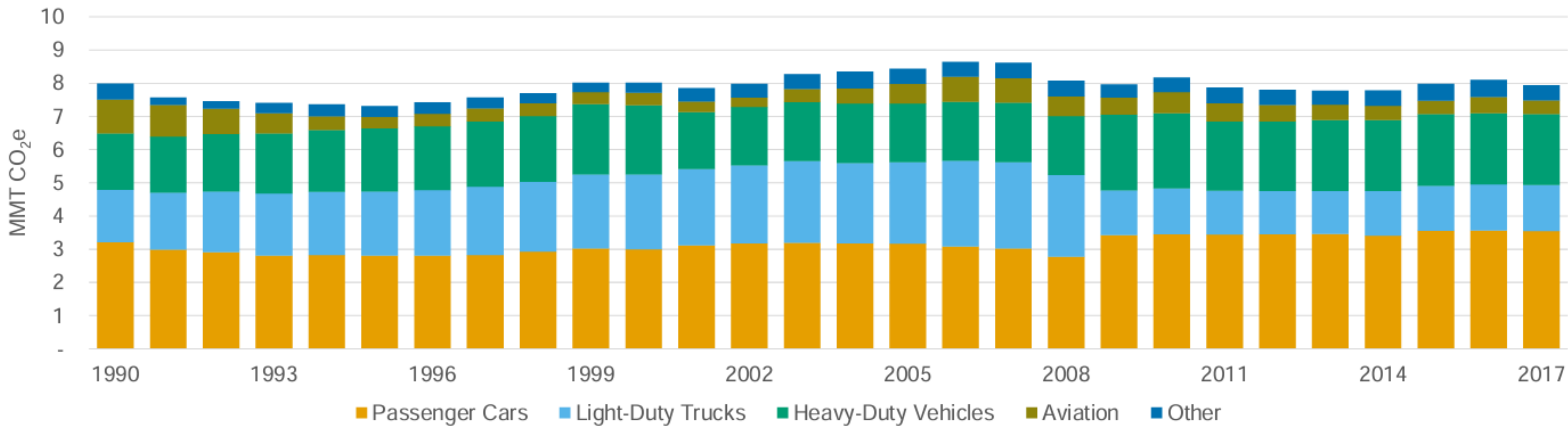
[35] Governor's Office of Policy Innovation and the Future: Maine Clean Transportation Roadmap (2021)

Income distribution of new EV buyers, new car buyers, and used car buyers[36]



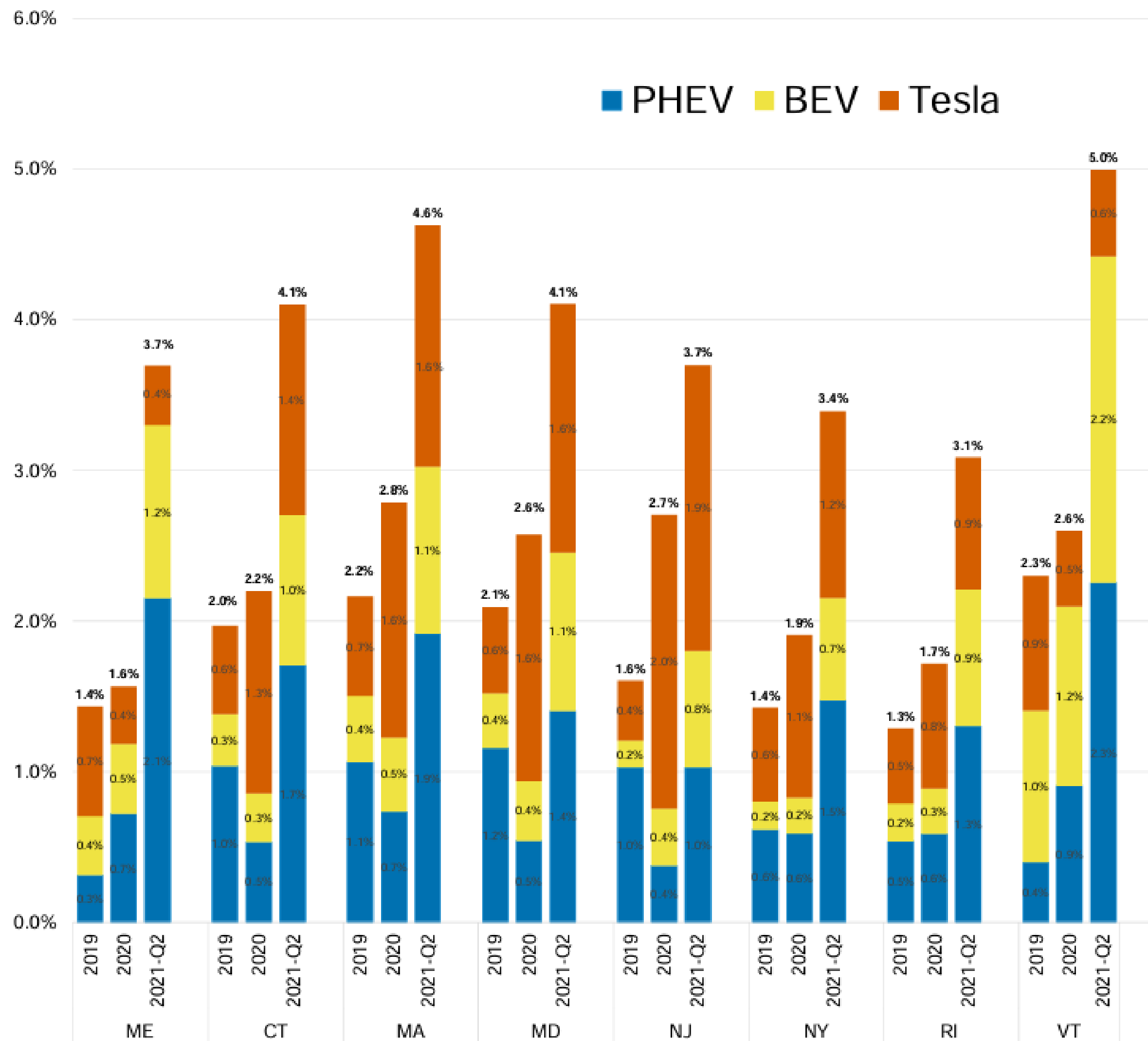
[36] Governor's Office of Policy Innovation and the Future: Maine Clean Transportation Roadmap (2021)

Emissions in the transportation sector by vehicle type in million metric tons of CO_2e, Maine[37]



[37] Governor's Office of Policy Innovation and the Future: Maine Clean Transportation Roadmap (2021)

Electric vehicle (EV) sales share of all light-duty sales, North East[38]



[38] Governor's Office of Policy Innovation and the Future: Maine Clean Transportation Roadmap (2021)