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Environment and Natural Resources
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Seventh Biennial Report on Progress toward Greenhouse Gas Reduction Goals

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Executive Summary

The Department of Environmental Protection's (the Department) analysis of energy consumption, industrial processes, agriculture, and waste management data for the most recent years available, 2014 and 2015[1], found that Maine is on track to meet the medium-term goal of reducing greenhouse gas (GHG) emissions to 10% less than 1990 levels by 2020, as set forth in 38 M.R.S.A. §576. Gross statewide GHG emissions increased from the initially measured levels in 1990, reaching a peak in 2002. By 2009, emissions were below 1990 levels, reaching a low in 2012. Since 2012, emissions have increased slightly but remain at least 10% lower than 1990 levels.

The Department's analysis indicates:

- 90% of GHG emissions in Maine are the result of energy consumption, largely produced by combustion of petroleum products. Annual emissions in this source category have been reduced by nearly 30% since 2002 and 7% since 2010 (Figure 2).
- Annual carbon dioxide (CO_2) emissions from the electric power sector have decreased by 73% since they peaked in 2002 largely by replacing high carbon fuels with natural gas (Appendix B).
- Statewide CO_2 emissions remain at least 10% lower than 1990 levels in large part because of the use of lower carbon fuels such as natural gas and increased efficiencies.
- The transportation sector was responsible for 52% of Maine's GHG emissions in 2015, an increase from the historical average of 42% (Appendix B).
- Maine created 21% less GHG emissions per billion Btu (BBtu) of energy in 2015 than in 2002 (Appendix G).
- In 2015, Maine's annual GHG emissions per million dollars of state gross domestic product (GDP) were 36% less than in 1990 (Appendix G).

New federal standards for vehicle fuel efficiency, electric generating facilities, and boilers are expected to continue to reduce GHG emissions in the coming years. Additional GHG emission reductions may be achieved by encouraging energy efficiency strategies, the substitution of petroleum products with renewable energy sources or lower emitting products such as natural gas, and discontinuing the use of older, less efficient fuel combustion units (e.g., automobiles and heating devices).

[1] EPA updated its State Inventory Tool (SIT) for greenhouse gasses through 2015 in December 2017: https://www.epa.gov/statelocalenergy/download-state-inventory-and-projection-tool. Most of the inventory data in the SIT comes from the Department of Energy's Energy Information Administration (EIA), and at the time of this report, EIA data was available through 2015.

I. Introduction

In 2003, Maine's *Act to Provide Leadership in Addressing the Threat of Climate Change* (the "Act"), enacted as Public Law 2003 Chapter 237, established greenhouse gas (GHG) reduction goals for 2010, 2020, and beyond. The Act set a goal for reduction of GHG emissions within the State, in the short term, to 1990 levels by January 1, 2010; to 10% less than 1990 levels by 2020; and for reductions sufficient to eliminate any dangerous threat to climate in the long-term (38 M.R.S.A. §576). The Department is submitting this report to the Joint Standing Committee on Environment and Natural Resources pursuant to 38 M.R.S.A. §578, which requires the Department to evaluate the State's progress toward meeting these reduction goals and submit a report of its evaluation by January 1, 2006, and by that date every two years thereafter. This report summarizes the findings of the Department's seventh quantitative evaluation of Maine's progress towards meeting statutory GHG reduction goals since the development of the original Climate Action Plan in 2004.

In January 2012, the Department reported that Maine met the short-term goal of reducing GHG emissions to 1990 levels by 2009. Over this period from 1990 - 2009, Maine's real GDP increased while energy consumption and GHG emissions declined. Analysis of data for the current report shows a continuing trend of GHG emissions remaining at least 10% below 1990 levels since 2012 (Appendix A).

This report includes anthropogenic GHG emissions, i.e., emissions resulting from human activity, from within Maine using analytical methods that are consistent with the U.S. Environmental Protection Agency's (EPA) national inventory development and methods used by other New England states. The GHGs inventoried are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), and sulfur hexafluoride (SF_6).

II. Methodology

The Department utilized the State Inventory Tool (SIT)[2], a computer model developed by EPA, which was augmented with data from state programs (e.g., point source emissions data and solid waste data) to estimate GHG emissions in Maine. The SIT model was developed by EPA to provide states with a comprehensive, standardized approach to estimating GHG emissions. This tool considers the same sources that are in the national GHG inventory and is based on the recommendations of the Intergovernmental Panel on Climate Change. Since activity data is the driving force for emissions estimation, the tool contains default activity data while at the same time providing flexibility for states to input state-specific data.

The GHG emissions are expressed in units of carbon dioxide equivalents (CO_2e). Emissions values are expressed in millions of metric tons of CO_2 ($MMTCO_2$) or millions of metric tons of CO_2 equivalent ($MMTCO_2e$). Since CO_2 is the largest component of most combustion-sourced GHG emissions, and since fossil fuels are combusted in most combustion-based energy-production processes, a measure of CO_2 from the combustion of fossil fuels is presented in Appendix B. Fuel consumption values are expressed in billions of British thermal units (BBtu).

[2] https://www.epa.gov/statelocalenergy/download-state-inventory-and-projection-tool

The EPA method for estimating GHG emissions is to break down activities that create emissions into source categories. The SIT estimates GHG emissions from the following source categories:

- Energy
- Agriculture
- Industrial Processes
- Waste

The energy category is responsible for most GHG emissions and encompasses energy consuming entities, such as electric power producers, and consumption from the following sectors: industrial, commercial, transportation, and residential. The agriculture category captures emissions from livestock, manure management, plant and soil residue, and cultivation practices. The industrial processes category encompasses non-combustion activities that create emissions, such as cement production, semiconductor manufacture, and electrical power transmission and distribution. The waste category includes emissions from municipal solid waste disposal and waste water treatment activities.

Most of the inventory data in the SIT comes from the Department of Energy's Energy Information Administration (EIA). For many of the categories, this information is apportioned to the states from national and regional inventories. For this Seventh Biennial Report, the Department performed a comprehensive analysis of the data provided in the tool and updated it with information from Maine reporting programs. At the time of this report, EIA data was available through 2015.

The EIA breaks the energy source category down into five sectors — electrical generators, industrial, commercial, residential, and transportation — to align with policies and programs for GHG emission reductions that target each of these sectors separately. (See Appendix C for sector definitions.)

Renewable resources include biofuel (mainly ethanol added to motor gasoline), biomass (wood and wood waste products including black liquor and sludge), hydroelectric, wind, solar, and geothermal. GHG emissions from renewable resources were not included in this report; however, information on energy consumption from renewable sources is included in Appendix D.

Most CO_2 emissions from energy sources in Maine come from petroleum products. To better assess the consumption of various types of petroleum, this category was broken down into: motor gasoline, distillate fuel, petroleum coke, residual fuel, liquefied petroleum gas, jet fuel, kerosene, aviation gasoline, asphalt, road oil, and lubricants.[3] This analysis could allow planners to assess the relative consumption of various fuels and help in the development of future programs.

[3] Figure 4 and Appendix F

To show the relationship between economic activity and GHG emissions, the Department has included an analysis of GHG emissions as a function of state gross domestic product (GDP) in real dollars adjusted for inflation.[4] This data is shown in Appendix G.

III. Results and Discussion

A. Gross GHG Emissions

The Department's current analysis utilizing data through the end of 2015 indicates that Maine is continuing to realize a net decline in GHG emissions from a peak a decade ago, primarily due to decreased use of fossil fuels. Figure 1 shows the trend in GHG emissions from 1990 – 2015. Total estimated annual GHG emissions in Maine increased from 21.65 million metric tons of carbon dioxide equivalents ($MMTCO_2e$) in 1990 to a peak of 26.97 $MMTCO_2e$ in 2002, and then declined to 18.21 $MMTCO_2e$ in 2012. This equals a reduction in annual GHG emissions of 15% between 1990 and 2012 (a reduction of 11.7% between 1990 and 2015). There has been a slight uptick in GHG emissions since 2012 due to an increase in consumption of petroleum in the transportation, electric power, and residential sectors. A complete analysis of Maine's GHG emissions by source for each year can be found in Appendix A.

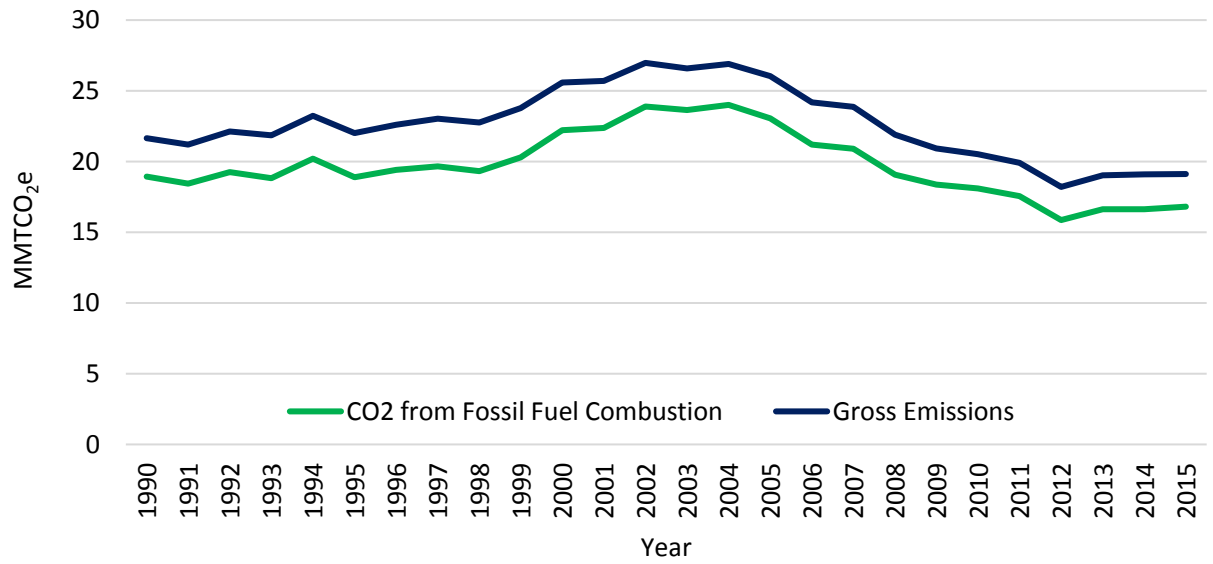

Figure 1. Maine's greenhouse gas emissions 1990-2015

The consumption of energy is the largest source of emissions, accounting for 90% of Maine's gross GHG emissions in 2015. Agricultural activity, industrial processes, and waste disposal combined only contributed 10% of the 2015 GHG emissions total (Figure 2).

[4] Economic data inflation adjusted, chained 2009 dollars.

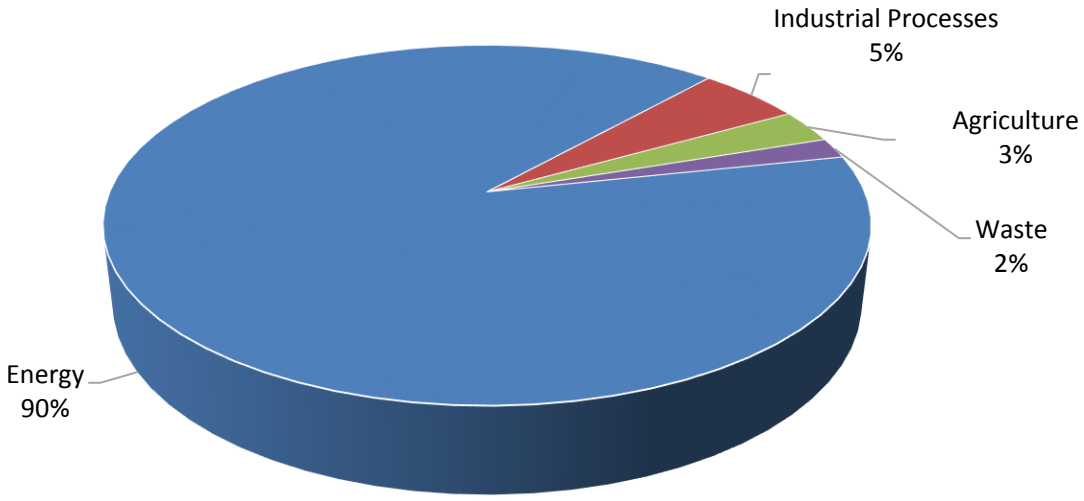

Figure 2. Emissions by source category for 2015 (data in Appendix A)

B. Energy Consumption

Demand for and consumption of energy drive the clear majority of Maine's GHG emissions. Figure 3 illustrates the energy sources used to meet Maine's energy demands from 1990 through 2015. In 2015, total energy consumption in Maine was 13% less than in 1990 (Appendix D).

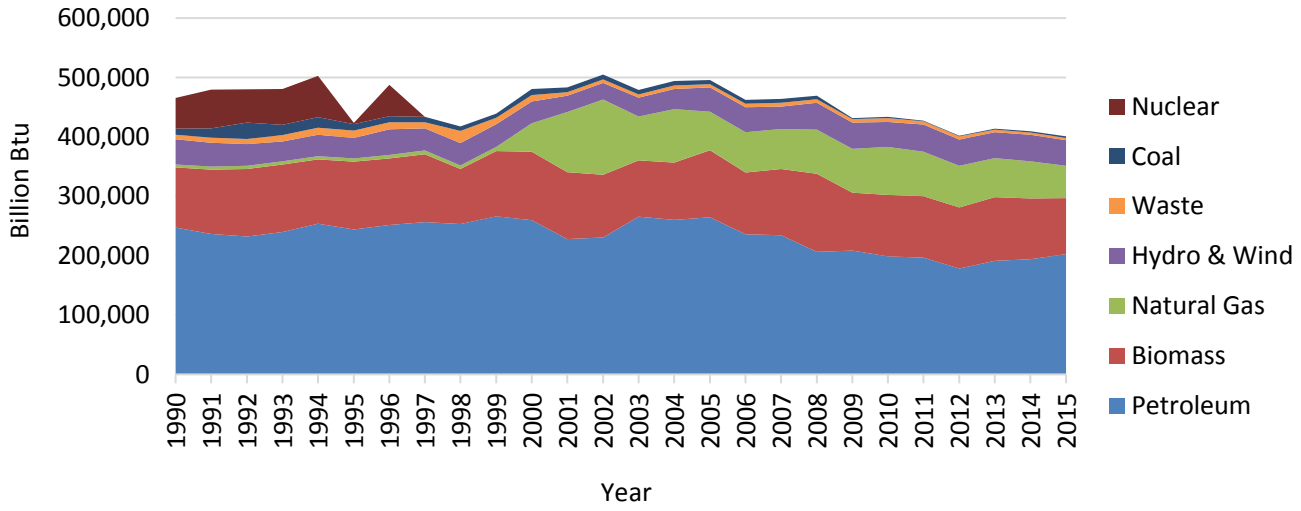

Figure 3. Maine energy consumption (BBtu) 1990-2015[5]

Although much of the energy consumed in Maine does not come from renewable fuels, CO_2 emissions continue to decline in large part because of the use of lower carbon fuels and increased efficiencies.

[5] Data Source: EIA State Energy Data System (https://www.eia.gov/state/seds/seds-data-complete.php, file name: use_all_btu.csv)

i. Petroleum Consumption

The petroleum products being consumed in Maine consist primarily of motor gasoline, distillate fuel, liquefied petroleum gas (LPG), residual fuel, aviation fuels, and kerosene. In 2015, petroleum products accounted for 50% of all energy consumed (Appendix D) and for 82% of CO_2 emissions (Appendix B). The reduction in residual fuel oil consumption, 89% since 1990, is a large driver of the overall decline in GHG emissions.

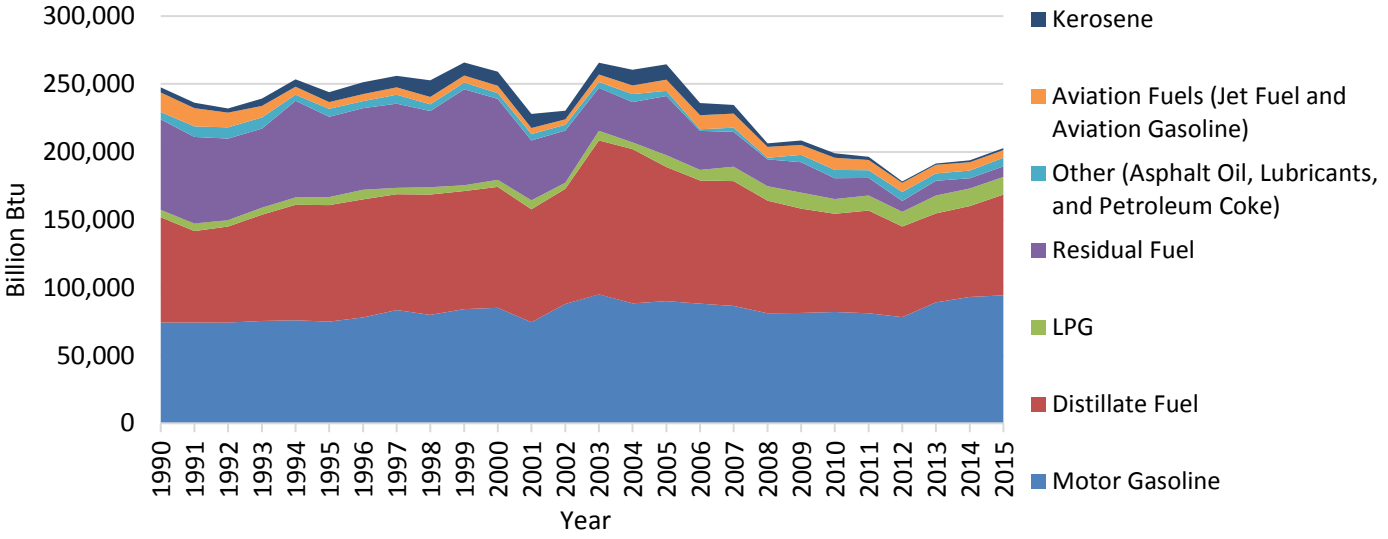

Figure 4. Maine petroleum consumption by fuel type (BBtu) 1990-2015[6]

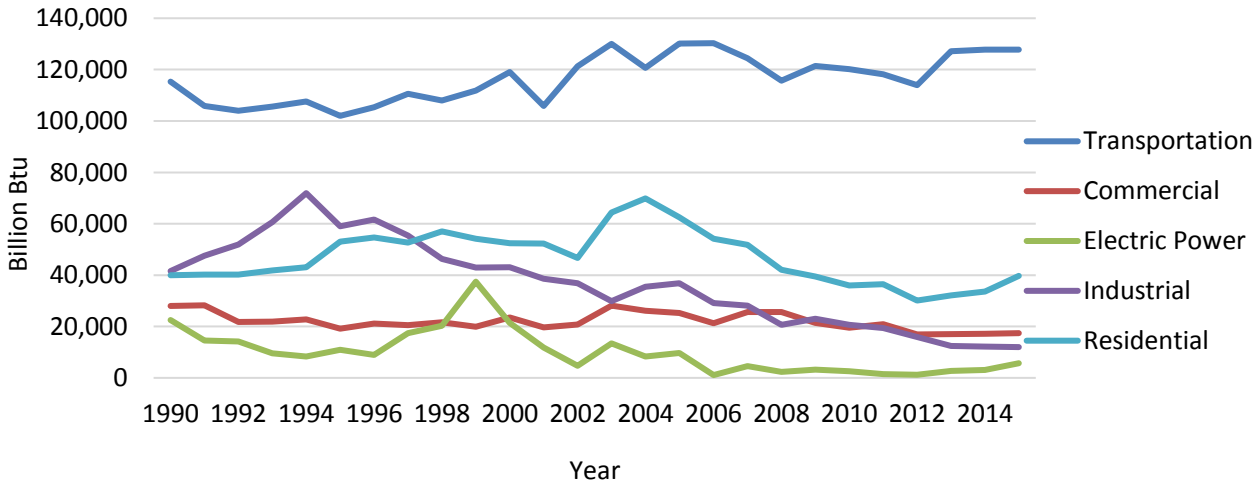

Figure 5. Maine petroleum consumption by sector (BBtu) 1990-2015

[6] Data Source: EIA State Energy Data System (https://www.eia.gov/state/seds/seds-data-complete.php, file name: use_all_btu.csv)

Over the ten-year period from 2005-2015, the aggregate carbon dioxide emissions from petroleum combustion (in all sectors) has declined 28%. (Appendix B). This may be explained in part by an increase in natural gas use in the industrial sector and a decrease in industrial activity within the State.

ii. Combustion CO_2 Emissions by Sector

Figure 6 illustrates the relative CO_2 emissions from the combustion of fossil fuels from each sector in 2015. This figure shows that the transportation sector produced over half of all CO_2 emissions in Maine in 2015. The residential sector accounted for the next highest amount of emissions at 18%.

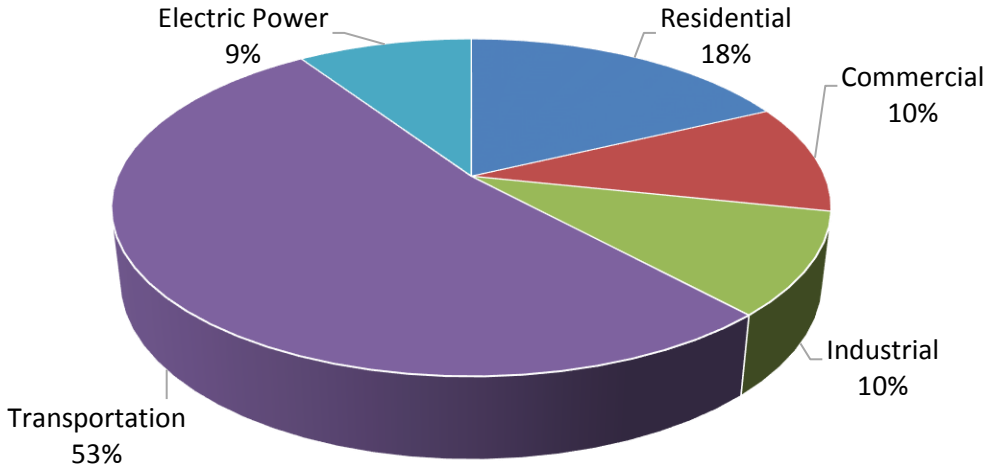

Figure 6. Emissions from fossil fuel combustion by sector for 2015 (data in Appendix B)

a. Electric Generators

In 2015, Maine's electric utility generators emitted 1.57 $MMTCO_2$ from the combustion of fossil fuels, 9% of the state's total CO_2 emissions, which is a 73% drop from the 2002 peak (Appendix B). Nuclear-, petroleum-, and coal-powered generation have been largely replaced with generation using natural gas and biomass as fuel (Appendix E, Figure E1). In 2015, natural gas combustion accounted for 62% of the CO_2 emissions from this sector. Renewable resources (biomass, hydropower, and wind) provided 62% of the energy consumed by these facilities in 2015.

b. Industrial

Maine's industrial sector emitted 1.66 $MMTCO_2$ from the combustion of fossil fuels in 2015, 10% of the state's total CO_2 emissions (Appendix B). In 2015, natural gas provided more than twice as much energy to the industrial sector than petroleum did. In this sector, 46% of the energy consumed was from renewable resources, slightly less than in 1990 (Appendix E, Figure E2).

c. Commercial

The commercial sector emitted 1.75 $MMTCO_2$ from fossil fuels in 2015, 10% of the state's total CO_2 emissions (Appendix B), which is an overall 21% reduction in CO_2 emissions from this sector from 1990 – 2015. During this same period, there was a six-fold increase in the use of natural gas and a significant decrease in the use of petroleum. Petroleum continues to account for 69% of CO_2

emissions in the sector. In 2015, Maine's waste-to-energy facilities provided 3% of the energy used by this sector (Appendix E, Figure E3).

d. Residential

In 2015, the residential sector emitted 3.01 $MMTCO_2$ from fossil fuel consumption, 18% of the state's total CO_2 emissions (Appendix B).. This sector is highly dependent upon petroleum products and is significantly impacted by fuel price fluctuations. In 2015, petroleum accounted for 95% of all the CO_2 emissions from this sector. Emissions from residential petroleum use peaked in 2004 at 5.20 $MMTCO_2$ and declined 42% by 2015. Between 2005 – 2014, the cost of home heating oil increased from to $1.93 per gallon (February 2005) to $3.88 per gallon (February 2014)[7], which incentivized residents to find more economical heating fuels, to make homes more energy efficient, and invest in higher efficiency heating equipment. The use of wood pellets as a fuel replaced a portion of this heating load, as Maine saw four pellet mills begin operations from 2006 – 2008.[8] This sector exceeds the commercial sector in consumption of distillate fuel and, along with the transportation sector, has been the least served by natural gas, although this may change as the infrastructure for natural gas distribution expands.

e. Transportation

In 2015, the transportation sector emitted 8.82 $MMTCO_2$ from fossil fuel combustion, 53% of the state's total CO_2 emissions (Appendix B). Petroleum accounts for 99% of the CO_2 emissions from and the energy consumed by the transportation sector (Appendix E, Figure E5). Primarily due to an increase in vehicle miles traveled, the transportation sector consumed 10% more energy in 2015 than in 1990, with total CO_2 emissions increasing by 6%. The lower increase in CO_2 emissions relative to the energy consumed is attributed in part to the increased use of ethanol in this sector. Since biofuel is considered a renewable resource in this inventory, emissions from ethanol are omitted from emissions totals.

C. Economic Analysis

Maine's real GDP generally increased through the period from 1990 to 2006 and has remained relatively flat from 2006 to 2015, as shown in Figure 7. It is also evident that emissions of CO_2e had increased overall from 1990 – 2002, at which point they began a marked decrease through 2012. Since 1990, Maine's real GDP grew from $37 billion in 1990 to $51 billion in 2015.[9] During the same period, energy consumption declined from 449,599 billion Btu to 395,387 billion Btu. From 1990 through 2002 greenhouse gas emissions increased and tracked very closely with real GDP; however, in 2005, GHG emissions began to decrease significantly (Figure 7 and Appendix G).

[7] http://www.maine.gov/energy/fuel_prices/archives.shtml, December 2004 to December 2013.
[8] Northeast Pellets, Corinth Wood Pellets, Geneva Wood Fuels, and Maine Woods Pellets.
[9] U.S. Bureau of Economic Analysis. Regional Data (http://www.bea.gov/iTable/index_regional.cfm)

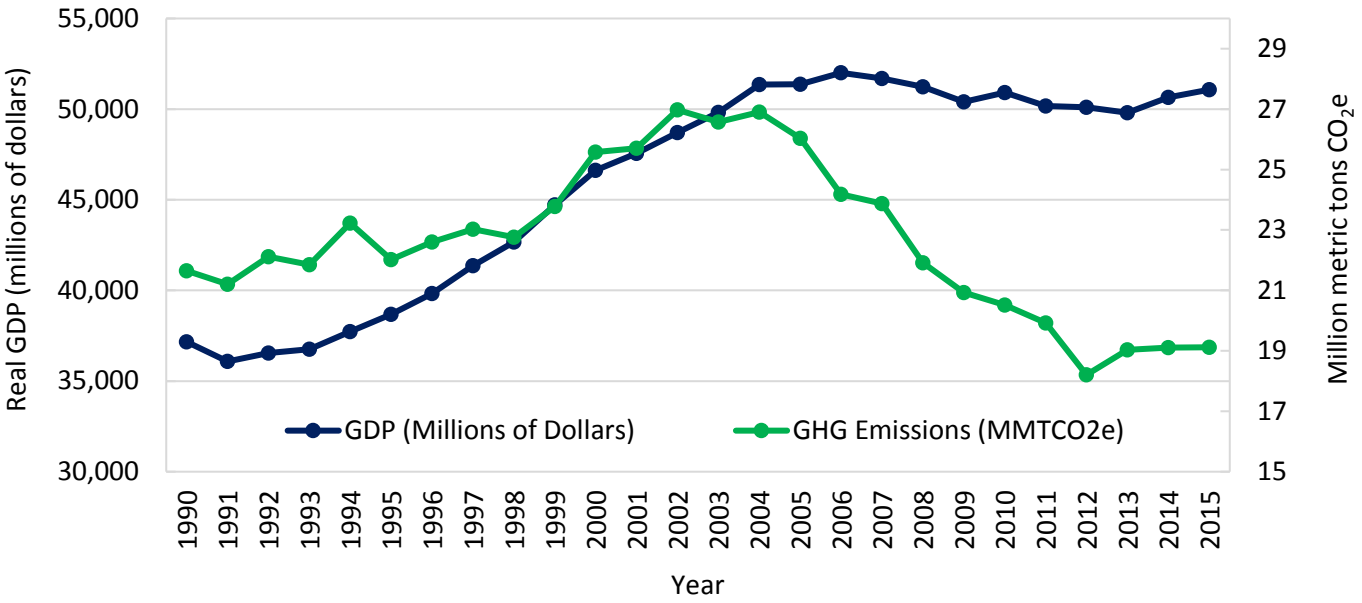

Figure 7. Total GHG emissions and real gross domestic product (GDP)

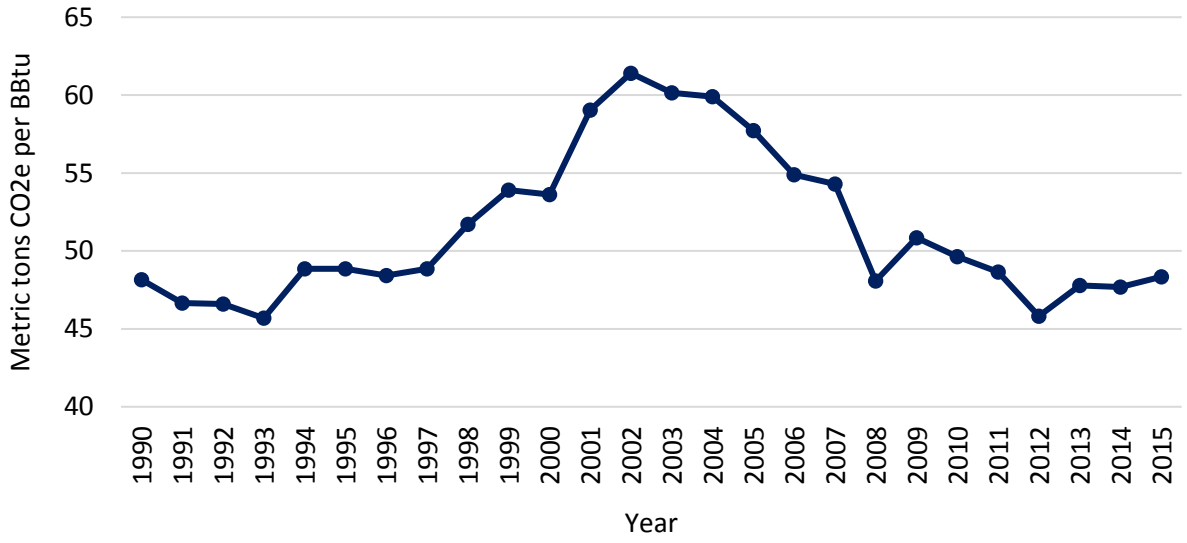

Figure 8. GHG emissions per unit of energy used

Figure 8 shows the GHG emissions per unit of energy input has declined since 2002 because of a transition to lower carbon fuels, like natural gas, and a more efficient use of all fuels.

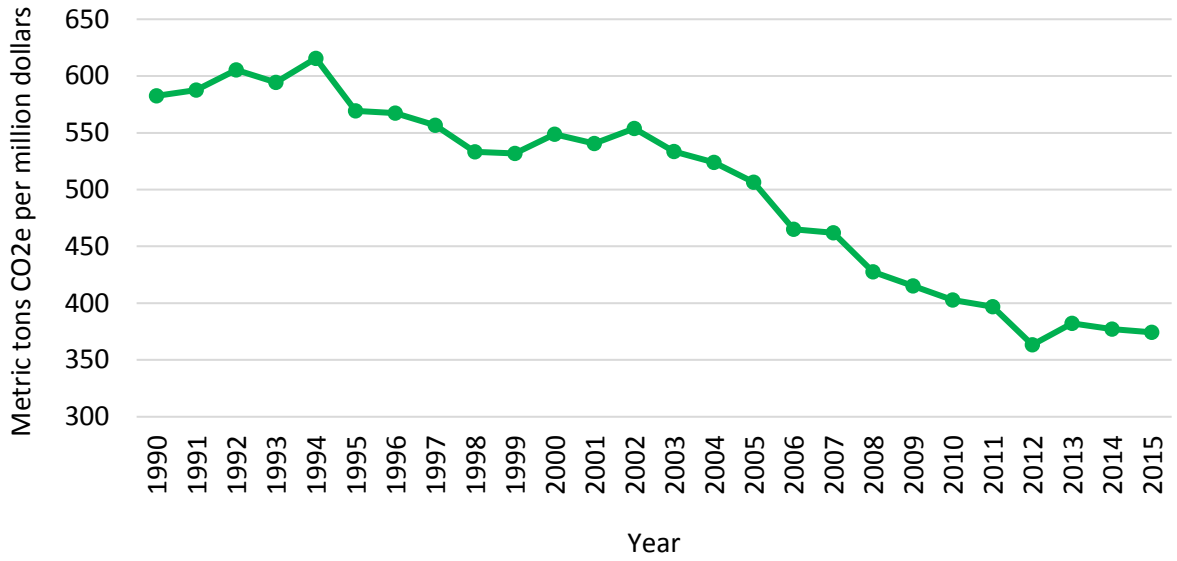

Figure 9. GHG emissions per GDP (metric tons CO_2e per million dollars)

Figure 9 shows that emissions per million dollars of GDP are declining, indicating that the Maine economy is transitioning to lower carbon emitting fuels, more efficient equipment, and industries that require less energy per dollar of GDP.

IV. Conclusion

This Seventh Biennial Report on Maine's progress toward statutory GHG reduction targets provides an updated analysis of gross GHG emissions for the period of 1990 – 2015. The Department's analysis continues to indicate that Maine has met the first statutory reduction target of reducing GHG emissions to 1990 levels by 2010. Gross GHG emissions by the end of year 2013 were 0.45 $MMTCO_2e$ below the target. The data in Appendix A show that in 2015, Maine's GHG emissions were 11.7% below 1990 levels, and that Maine is on track to meet the second statutory reduction target of 10% below 1990 levels by 2020.

Our current goal of decreasing emissions statewide to 10% less than 1990 levels by 2020 could be more easily maintained considering the following:

- Maine could continue to encourage replacement of petroleum products with low carbon emitting energy sources.
- Maine could support electrical grid efficiency practices.
- Maine could consider enhancing policies and best practices to advance energy efficiency in the industrial, commercial, residential, and transportation sectors.
- Opportunities could be considered through life-cycle analysis of efficient handling of materials, manufacturing, and distribution, which could result in lower GHG emissions.

V. Appendices

Appendix A

Table A1. Maine's greenhouse gas emissions in $MMTCO_2e$ (1990 - 2002)

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Energy	19.62	19.15	20.00	19.57	20.94	19.64	20.15	20.40	20.03	21.03	22.94	23.06	24.53
Industrial Processes	0.85	0.84	0.90	1.01	0.99	1.13	1.14	1.25	1.31	1.32	1.27	1.25	1.24
Agriculture	0.67	0.67	0.66	0.68	0.67	0.65	0.69	0.73	0.75	0.74	0.65	0.65	0.68
Waste	0.51	0.54	0.56	0.59	0.62	0.60	0.62	0.65	0.67	0.69	0.71	0.74	0.53
Gross Emissions	**21.65**	**21.20**	**22.12**	**21.85**	**23.22**	**22.02**	**22.60**	**23.03**	**22.76**	**23.78**	**25.58**	**25.71**	**26.97**

Table A2. Maine's greenhouse gas emissions in $MMTCO_2e$ (2003 - 2015)

Sector	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Energy	24.24	24.58	23.64	21.74	21.43	19.60	18.85	18.55	18.00	16.28	17.06	17.06	17.20
Industrial Processes	1.20	1.25	1.27	1.30	1.35	1.27	1.08	0.99	1.00	0.99	1.04	1.13	1.00
Agriculture	0.67	0.67	0.70	0.71	0.72	0.72	0.67	0.62	0.57	0.58	0.58	0.57	0.57
Waste	0.46	0.40	0.42	0.43	0.37	0.32	0.32	0.35	0.35	0.36	0.36	0.36	0.35
Gross Emissions	**26.58**	**26.90**	**26.03**	**24.18**	**23.87**	**21.91**	**20.93**	**20.51**	**19.92**	**18.21**	**19.04**	**19.10**	**19.12**

Appendix B

Table B1. Carbon Dioxide Emissions from Fossil Fuel Combustion in Maine (1990 – 2002)

$MMTCO_2$	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Residential Total	2.99	2.99	3.01	3.13	3.20	3.94	4.05	3.92	4.23	4.03	3.90	3.88	3.49
Coal	0.02	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Petroleum	2.93	2.95	2.95	3.07	3.15	3.89	4.00	3.87	4.18	3.97	3.84	3.82	3.43
Natural Gas	0.03	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06
Commercial Total	2.23	2.21	1.79	1.77	1.80	1.52	1.68	1.65	1.71	1.59	1.89	1.59	1.81
Coal	0.08	0.03	0.07	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Petroleum	2.06	2.08	1.60	1.59	1.66	1.39	1.53	1.49	1.57	1.45	1.71	1.42	1.52
Natural Gas	0.09	0.10	0.12	0.12	0.13	0.13	0.14	0.15	0.13	0.14	0.17	0.16	0.29
Industrial Total	3.37	3.97	5.32	5.03	6.26	4.88	5.02	4.41	3.72	3.44	4.34	3.53	3.95
Coal	0.52	0.84	1.91	0.98	1.06	0.64	0.53	0.44	0.31	0.26	0.53	0.30	0.21
Petroleum	2.74	3.02	3.31	3.96	5.11	4.14	4.38	3.84	3.29	3.04	3.04	2.57	2.47
Natural Gas	0.11	0.12	0.11	0.09	0.09	0.11	0.12	0.13	0.12	0.13	0.77	0.66	1.27
Transportation Total	8.29	7.59	7.48	7.59	7.72	7.31	7.55	7.93	7.74	8.00	8.59	7.67	8.75
Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Petroleum	8.29	7.59	7.48	7.59	7.72	7.31	7.55	7.92	7.74	8.00	8.54	7.59	8.71
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.05	0.07	0.05
Electric Power Total	2.06	1.68	1.65	1.31	1.21	1.23	1.09	1.74	1.92	3.25	3.49	5.70	5.88
Coal	0.36	0.57	0.57	0.58	0.57	0.37	0.38	0.39	0.35	0.36	0.39	0.43	0.53
Petroleum	1.69	1.09	1.07	0.72	0.63	0.86	0.71	1.34	1.57	2.85	1.63	0.88	0.36
Natural Gas	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.03	1.47	4.39	5.00
Gross CO_2 Emissions	**18.94**	**18.44**	**19.25**	**18.83**	**20.20**	**18.89**	**19.40**	**19.65**	**19.33**	**20.30**	**22.21**	**22.37**	**23.89**
Coal	0.98	1.44	2.57	1.63	1.65	1.02	0.92	0.84	0.68	0.63	0.93	0.73	0.74
Petroleum	17.72	16.73	16.40	16.93	18.27	17.57	18.18	18.47	18.35	19.31	18.76	16.29	16.48
Natural Gas	0.24	0.26	0.28	0.27	0.28	0.30	0.31	0.34	0.31	0.35	2.53	5.35	6.67

Table B2. Carbon Dioxide Emissions from Fossil Fuel Combustion in Maine (2003 – 2015)

$MMTCO_2$	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Residential Total	4.78	5.20	4.63	4.02	3.84	3.11	2.93	2.65	2.71	2.25	2.41	2.54	3.01
Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Petroleum	4.71	5.13	4.57	3.96	3.77	3.04	2.86	2.58	2.64	2.17	2.31	2.41	2.87
Natural Gas	0.07	0.07	0.06	0.06	0.07	0.06	0.07	0.07	0.08	0.08	0.10	0.13	0.15
Commercial Total	2.31	2.17	2.09	1.81	2.17	2.17	1.81	1.71	1.84	1.58	1.62	1.68	1.75
Coal	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Petroleum	2.04	1.90	1.82	1.54	1.83	1.84	1.51	1.39	1.48	1.18	1.17	1.19	1.20
Natural Gas	0.27	0.27	0.27	0.26	0.33	0.33	0.31	0.32	0.36	0.40	0.45	0.49	0.55
Industrial Total	2.43	3.43	3.16	3.31	3.36	3.17	2.83	2.74	2.62	2.40	2.37	1.91	1.66
Coal	0.29	0.28	0.30	0.26	0.27	0.24	0.07	0.08	0.05	0.05	0.06	0.08	0.07
Petroleum	1.97	2.27	2.51	2.09	1.88	1.50	1.35	1.13	1.07	0.74	0.58	0.54	0.46
Natural Gas	0.18	0.88	0.35	0.96	1.21	1.42	1.41	1.53	1.50	1.62	1.73	1.29	1.12
Transportation Total	9.37	8.69	9.36	9.38	8.97	8.09	8.43	8.42	8.30	7.90	8.79	8.85	8.82
Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Petroleum	9.32	8.66	9.33	9.35	8.93	8.03	8.39	8.32	8.16	7.86	8.75	8.78	8.77
Natural Gas	0.05	0.04	0.03	0.03	0.04	0.05	0.05	0.10	0.13	0.04	0.05	0.07	0.05
Electric Power Total	4.75	4.51	3.79	2.69	2.57	2.53	2.36	2.57	2.08	1.73	1.43	1.65	1.57
Coal	0.40	0.40	0.35	0.35	0.33	0.30	0.08	0.13	0.09	0.08	0.09	0.12	0.17
Petroleum	1.01	0.62	0.73	0.08	0.34	0.17	0.24	0.19	0.11	0.09	0.21	0.23	0.43
Natural Gas	3.34	3.49	2.72	2.26	1.90	2.05	2.04	2.25	1.88	1.56	1.13	1.29	0.98
Gross CO_2 Emissions	**23.64**	**24.00**	**23.04**	**21.20**	**20.91**	**19.07**	**18.37**	**18.09**	**17.55**	**15.86**	**16.62**	**16.63**	**16.81**
Coal	0.70	0.68	0.66	0.62	0.61	0.55	0.15	0.21	0.14	0.12	0.15	0.20	0.24
Petroleum	19.05	18.59	18.95	17.02	16.76	14.60	14.34	13.62	13.46	12.04	13.01	13.14	13.72
Natural Gas	3.90	4.73	3.43	3.57	3.54	3.93	3.88	4.26	3.95	3.70	3.46	3.28	2.85

Appendix C

Sector Definitions[10]

- **Electric Power Sector:** An energy-consuming sector that consists of electricity-only and combined-heat-and-power plants within the North American Industry Classification System (NAICS) 22 category whose primary business is to sell electricity, or electricity and heat, to the public. *Note: This sector includes electric utilities and independent power producers.*

- **Industrial Sector:** An energy-consuming sector that consists of all facilities and equipment used for producing, processing, or assembling goods. The industrial sector encompasses the following types of activity: manufacturing (NAICS codes 31–33); agriculture, forestry, fishing and hunting (NAICS code 11); mining, including oil and gas extraction (NAICS code 21); and construction (NAICS code 23). Overall energy use in this sector is largely for process heat and cooling and powering machinery, with lesser amounts used for facility heating, air conditioning, and lighting. Fossil fuels are also used as raw material inputs to manufactured products. *Note: This sector includes generators that produce electricity and/or useful thermal output primarily to support the above-mentioned industrial activities.*

- **Commercial Sector:** An energy-consuming sector that consists of service-providing facilities and equipment of: businesses; Federal, State, and local governments; and other private and public organizations, such as religious, social, or fraternal groups. The commercial sector includes institutional living quarters. It also includes sewage treatment facilities. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a wide variety of other equipment. *Note: This sector includes generators that produce electricity and/or useful thermal output primarily to support the activities of the above-mentioned commercial establishments.*

- **Residential Sector:** An energy-consuming sector that consists of living quarters for private households. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a variety of other appliances. The residential sector excludes institutional living quarters.

- **Transportation Sector:** An energy-consuming sector that consists of all vehicles whose primary purpose is transporting people and/or goods from one physical location to another. Included are automobiles; trucks; buses; motorcycles; trains, subways, and other rail vehicles; aircraft; and ships, barges, and other waterborne vehicles. Vehicles whose primary purpose is not transportation (e.g., construction cranes and bulldozers, farming vehicles, and warehouse tractors and forklifts) are classified in the sector of their primary use. In this report, natural gas used in the operation of natural gas pipelines is included in the transportation sector.

[10] Source: EIA State Energy Data System (https://www.eia.gov/state/seds/seds-data-complete.php)

Appendix D

Table D1. Maine energy consumption in billion Btu[11]

Coal	**1990**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Residential	214	9	6	0	0	0	0	0	0
Commercial	858	69	70	0	0	0	0	0	0
Industrial	5,533	5,687	3,219	862	573	489	690	815	742
Electric Power	3,808	4,216	3,764	1,418	969	810	967	1,328	1,846
Transportation	0	0	0	0	0	0	0	0	0
Total Coal	10,413	9,981	7,059	2,280	1,542	1,299	1,657	2,143	2,588

Petroleum	**1990**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Residential	40,001	52,365	62,502	35,974	36,526	30,109	32,158	33,606	39,771
Commercial	27,986	23,551	25,239	19,509	20,871	16,911	17,029	17,121	17,431
Industrial	41,614	43,121	36,804	20,653	19,427	15,937	12,446	12,202	11,986
Electric Power	22,502	21,414	9,708	2,591	1,516	1,243	2,758	3,116	5,691
Transportation	115,381	119,116	130,194	120,210	118,140	114,016	127,113	127,820	127,847
Total Petroleum	247,484	259,567	264,447	198,937	196,480	178,216	191,504	193,865	202,726

Natural Gas	**1990**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Residential	651	1,195	1,204	1,282	1,467	1,530	1,947	2,434	2,782
Commercial	1,686	3,194	5,019	6,055	6,867	7,525	8,398	9,327	10,380
Industrial	2,034	14,969	6,807	29,460	28,885	31,123	33,308	24,914	21,613
Electric Power	196	27,758	51,177	42,371	35,342	29,488	21,362	24,397	18,398
Transportation	5	932	612	1,821	2,500	785	871	1,350	1,030
Total Natural Gas	4,572	48,048	64,819	80,989	75,061	70,451	65,886	62,422	54,203

Biofuels	**1990**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Residential	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	11	6	6	10	8	105
Industrial	0	0	6	93	97	94	97	86	75
Electric Power	0	0	0	0	0	0	0	0	0
Transportation	0	0	375	4,758	4,888	5,005	5,753	5,913	6,044
Total Biofuels	0	0	381	4,862	4,991	5,105	5,860	6,007	6,224

[11] Data Source: EIA State Energy Data System (https://www.eia.gov/state/seds/seds-data-complete.php)

Appendix D (continued)

Waste	**1990**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Residential	0	0	0	0	0	0	0	0	0
Commercial	2,177	2,757	1,774	2,061	1,867	1,655	1,710	1,627	1,780
Industrial	3,131	2,758	1,382	1,625	758	801	733	805	664
Electric Power	2,459	5,321	2,442	2,670	2,654	2,738	1,772	1,471	1,335
Transportation	0	0	0	0	0	0	0	0	0
Total Waste	7,767	10,836	5,598	6,356	5,279	5,194	4,215	3,903	3,779

Biomass	**1990**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Residential	4,292	3,474	6,037	12,476	12,760	11,909	16,446	16,742	12,473
Commercial	933	751	969	1,993	1,942	1,685	1,958	2,045	2,210
Industrial	76,963	90,083	66,375	59,168	63,354	65,100	62,466	57,012	49,872
Electric Power	19,040	21,136	39,682	29,623	25,574	24,108	25,906	26,591	29,626
Transportation	0	0	0	0	0	0	0	0	0
Total Biomass	101,228	115,444	113,063	103,260	103,630	102,802	106,776	102,390	94,181

Hydro & Wind	**1990**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Residential	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0
Industrial	13,982	13,221	6,250	6,883	7,269	3,923	4,169	3,727	3,632
Electric Power	28,568	23,409	34,655	35,161	38,257	40,036	39,798	41,166	39,759
Transportation	0	0	0	0	0	0	0	0	0
Total Hydro & Wind	42,550	36,630	40,905	42,044	45,526	43,959	43,967	44,893	43,391

ALL SECTORS	**1990**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Coal	10,413	9,981	7,059	2,280	1,542	1,299	1,657	2,143	2,588
Petroleum	247,484	259,567	264,447	198,937	196,480	178,216	191,504	193,865	202,726
Natural Gas	4,572	48,048	64,819	80,989	75,061	70,451	65,886	62,422	54,203
Biofuels	0	0	381	4,862	4,991	5,105	5,860	6,007	6,224
Waste	7,767	10,836	5,598	6,356	5,279	5,194	4,215	3,903	3,779
Biomass	101,228	115,444	113,063	103,260	103,630	102,802	106,776	102,390	94,181
Nuclear	51,436	0	0	0	0	0	0	0	0
Hydro & Wind	42,550	36,630	40,905	42,044	45,526	43,959	43,967	44,893	43,391
Total	**465,450**	**480,506**	**496,272**	**438,728**	**432,509**	**407,026**	**419,865**	**415,623**	**407,092**
Electricity Exports (Zero Imports)	-15,851	-3,509	-45,285	-25,394	-23,032	-9,639	-21,452	-14,988	-11,705
Total Net Electricity	**449,599**	**476,997**	**450,987**	**413,334**	**409,477**	**397,387**	**398,413**	**400,635**	**395,387**

Appendix E

Maine Energy Consumption by Sector (Figures)[12]

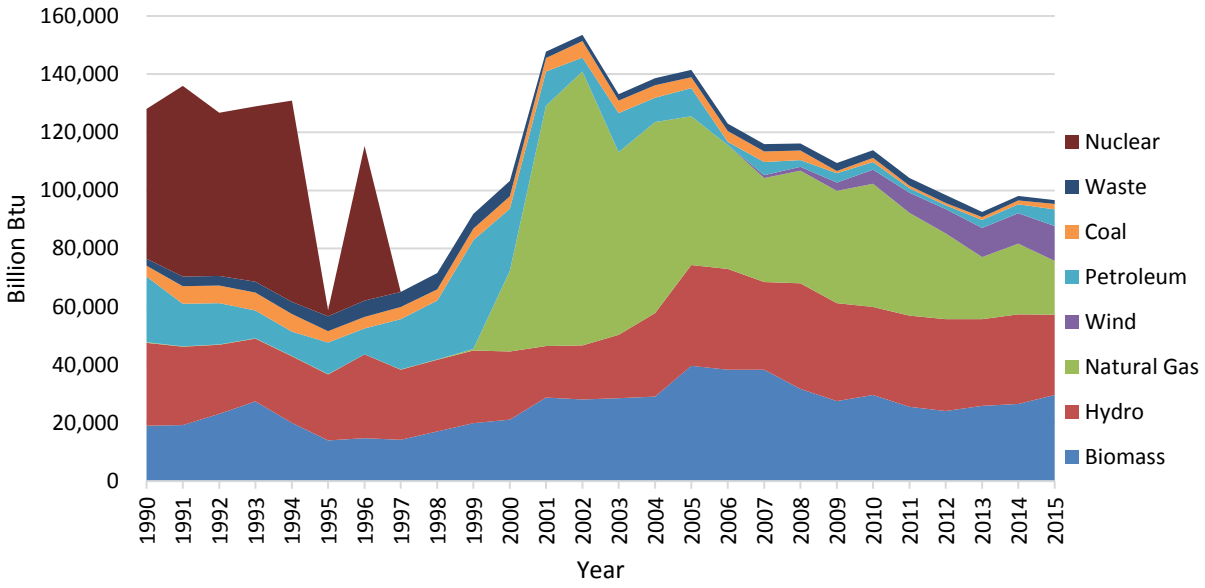

Figure E1. Energy consumption in the electric power generator sector

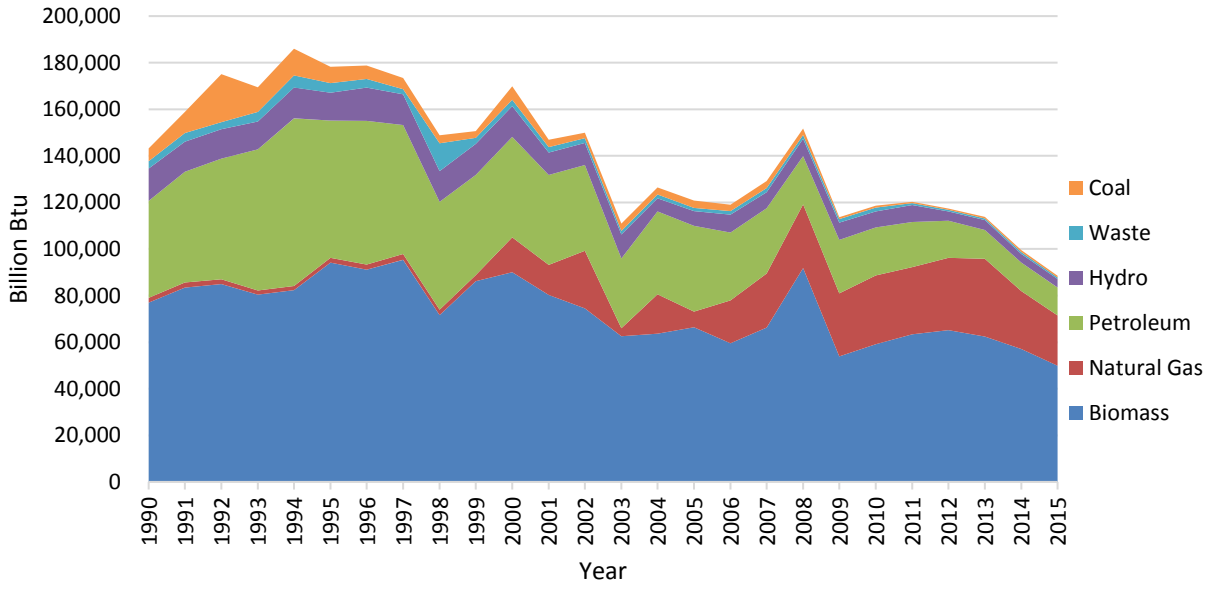

Figure E2. Energy consumption in the industrial sector

[12] Data Source: EIA State Energy Data System (https://www.eia.gov/state/seds/seds-data-complete.php, file name: use_all_btu.csv)

Appendix E (continued)

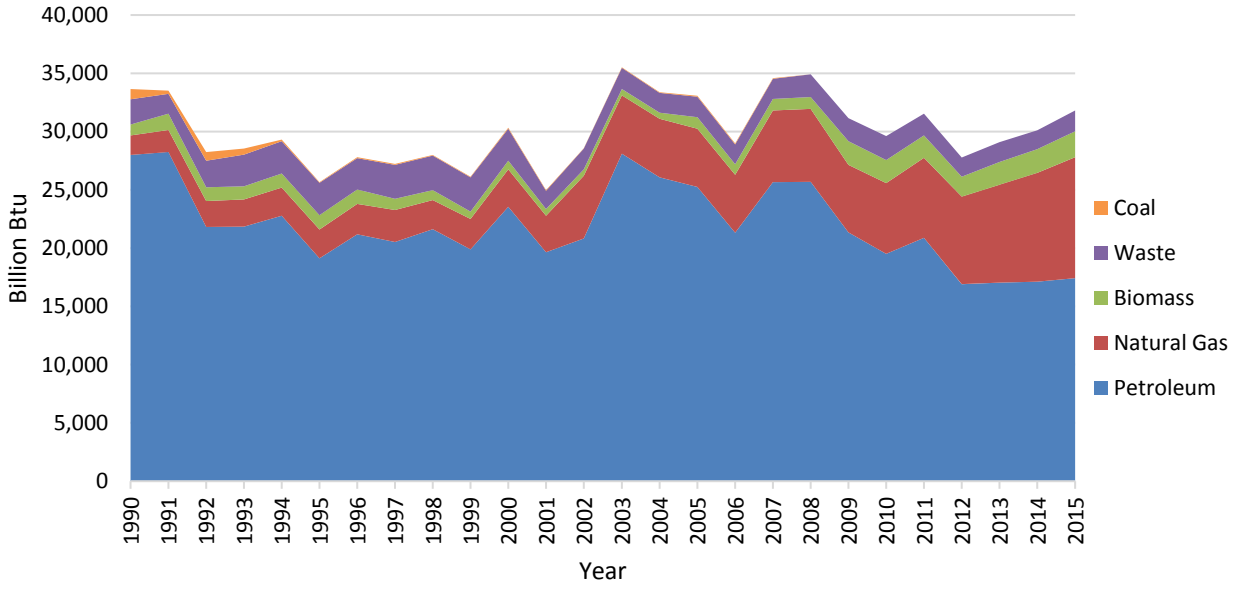

Figure E3. Energy consumption in the commercial sector

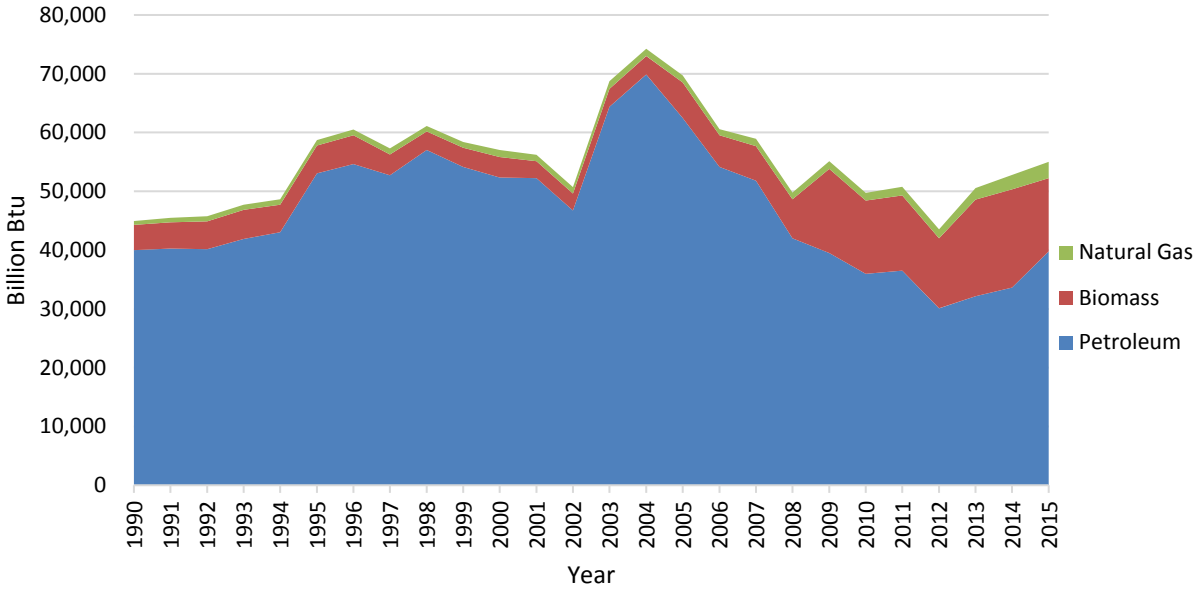

Figure E4. Energy consumption in the residential sector

Appendix E (continued)

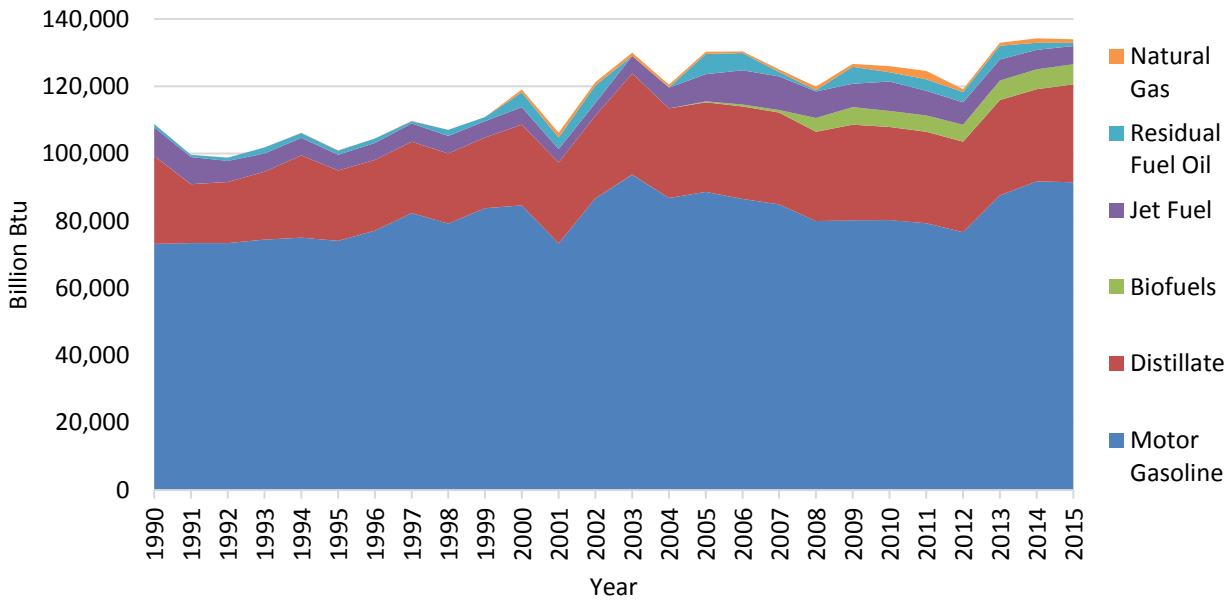

Figure E5. Energy consumption in the transportation sector

Appendix F

Table F1. Petroleum consumption by fuel type in billion Btu[13]

Fuel Type	1990	2000	2005	2010	2011	2012	2013	2014	2015
Motor Gasoline	74,206	85,133	90,028	81,963	80,947	78,151	89,153	93,177	94,152
Distillate Fuel Oil	77,654	89,129	98,752	72,365	75,765	66,880	65,501	66,937	74,394
LPG	5,238	5,040	8,855	10,859	10,996	10,825	13,201	12,801	13,043
Residual Fuel Oil	66,833	59,723	43,593	15,457	13,171	7,991	10,843	7,704	7,632
Asphalt & Road Oil	4,282	2,222	2,526	5,171	4,702	5,733	4,479	4,746	5,417
Jet Fuel	14,015	5,148	8,081	8,719	7,325	6,663	6,313	5,839	5,372
Kerosene	3,726	10,429	11,295	3,278	2,348	998	1,032	1,638	1,533
Lubricants	1,219	1,242	1,048	978	928	854	903	942	1,026
Aviation Gasoline	312	128	203	113	268	90	78	80	156
Petroleum Coke	0	837	0	0	0	0	0	0	0
Total	247,485	259,031	264,381	198,903	196,450	178,185	191,503	193,864	202,725

[13] Data Source: EIA State Energy Data System (https://www.eia.gov/state/seds/seds-data-complete.php)

Appendix G

Table G1. Economic analysis input data

Year	GDP (millions of dollars) [14]	GHG Emissions ($MMTCO_2e$) [15]	Total energy per GDP (BBtu per million dollars) [16]	GHG emissions per GDP (tons CO_2e per million dollars)	GHG emissions per energy input (tons CO_2e per BBtu) [17]
1990	37,168	21.65	12.10	582	48.15
1991	36,082	21.20	12.59	588	46.65
1992	36,539	22.12	12.99	605	46.59
1993	36,755	21.85	13.01	594	45.68
1994	37,725	23.22	12.60	616	48.86
1995	38,681	22.02	11.65	569	48.86
1996	39,834	22.60	11.72	567	48.42
1997	41,367	23.03	11.39	557	48.85
1998	42,674	22.76	10.31	533	51.71
1999	44,718	23.78	9.86	532	53.90
2000	46,618	25.58	10.23	549	53.62
2001	47,564	25.71	9.15	540	59.03
2002	48,708	26.97	9.02	554	61.41
2003	49,825	26.58	8.87	533	60.16
2004	51,351	26.90	8.74	524	59.91
2005	51,381	26.03	8.78	507	57.72
2006	52,002	24.18	8.47	465	54.90
2007	51,683	23.87	8.51	462	54.29
2008	51,236	21.91	8.89	428	48.08
2009	50,405	20.93	8.17	415	50.84
2010	50,921	20.51	8.12	403	49.63
2011	50,180	19.92	8.16	397	48.64
2012	50,106	18.21	7.93	363	45.81
2013	49,810	19.04	8.00	382	47.78
2014	50,641	19.10	7.91	377	47.69
2015	51,070	19.12	7.74	374	48.35

[14] Bureau of Economic Activity, U.S. Department of Commerce (https://www.bea.gov/)
[15] Appendix A
[16] Appendix D, "Total Net Electricity"/ GDP
[17] Appendix D