

# MAINE STATE LEGISLATURE

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Report to the Joint Standing Committee on  
Environment and Natural Resources  
127<sup>th</sup> Legislature, Second Session

# Sixth Biennial Report on Progress toward Greenhouse Gas Reduction Goals

*January 2016*

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## Executive Summary

The Department of Environmental Protection's (the Department) analysis of energy consumption, industrial processes, agriculture, and waste management for calendar years 2012 and 2013 found that Maine is continuing in a downward trend of greenhouse gas (GHG) emissions. Maine is on track to meet the medium-term goal of reducing 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 2003, and have since steadily declined.

The Department's analysis indicates:

- Maine is creating 22% less GHG emissions per billion Btu of energy in 2013 than in 2003. (Appendix G)
- In 2013, Maine's annual GHG emissions per million dollars of state gross domestic product GDP was 34% less than in 1990. (Appendix G)
- 89% of GHG emissions in Maine are the result of energy consumption, largely produced by combustion of petroleum products. Annual emissions in this sector have been reduced by nearly 7% since 2010. (Figure 2)
- The transportation sector was responsible for 54% of Maine's greenhouse gas emissions in 2013 an increase from the historical average of 45%. (Appendix B)
- Annual carbon dioxide (CO<sub>2</sub>) emissions from the electric power sector have decreased by nearly 70 % since they peaked in 2003 largely by replacing high carbon fuels with natural gas. (Appendix B)
- State wide CO<sub>2</sub> emissions continue to decline in large part because of the use of lower carbon fuels such as natural gas and increased efficiencies.

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).

## 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 sixth quantitative evaluation of Maine's progress towards meeting statutory GHG 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 downward trend in GHG emissions (Appendix A).

This report includes anthropogenic GHG emissions, i.e. emissions as a result of 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<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), and sulfur hexafluoride (SF<sub>6</sub>).

## II. Methodology

The method used to develop this emissions inventory was the analysis of production and consumption data. Since energy consumption is a primary source of GHG emissions, the Department conducted an extensive analysis of energy consumption information from the United States Department of Energy (DOE) and additionally utilized data from Maine's own reporting programs to estimate GHG emissions. Activity data such as fuel use and industrial activity is more readily available and reliable than direct measurements from GHG emissions monitoring.

The Department utilized the State Inventory Tool (SIT), 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 takes into account 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<sub>2</sub>e). Gross carbon dioxide equivalent emissions for the GHGs are calculated from activity data through the use of emissions factors. These emissions factors convert fuel use, energy generation, consumption, and other activity data into emissions values expressed in millions of metric tons of CO<sub>2</sub> (MMT CO<sub>2</sub>) or millions of metric tons of CO<sub>2</sub> equivalent (MMT CO<sub>2</sub>e). Since CO<sub>2</sub> is the largest component of most

combustion-sourced GHG emissions, and since fossil fuels are combusted in the majority of combustion-based energy-production processes, a measure of CO<sub>2</sub> from the combustion of fossil fuels is presented in Appendix B. Fuel consumption values are expressed in billions of British Thermal Units (BBtu).

The EPA method for estimating GHG emissions is to break down activities which 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 the majority of 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.

The majority of the inventory data in the SIT tool 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 Sixth 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 2013.

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). In recognition of the fact that future efforts to reduce GHG emissions will benefit from an understanding of the relative contribution of each sector and how activities within those sectors impact their emissions, the Department evaluated energy consumption and associated GHG emissions using the same definitions.

To quantify the emissions from the Energy source category, the Department accounted for CO<sub>2</sub> emissions from fossil fuel combustion and waste incineration at Maine's waste-to-energy facilities (Appendix B) and classified nuclear power and the combustion of renewable resources as carbon neutral, meaning that emissions from these sources would not be included in the totals. 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. As a result, CO<sub>2</sub> emissions from combustion of biomass and biofuel are not captured by the tool. Information on energy consumption from renewable sources is included in Appendix D of this report.

The majority of CO<sub>2</sub> 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 and road oil and lubricants.<sup>1</sup> This analysis will allow planners to assess the relative consumption of various fuels and help in the development of future programs.

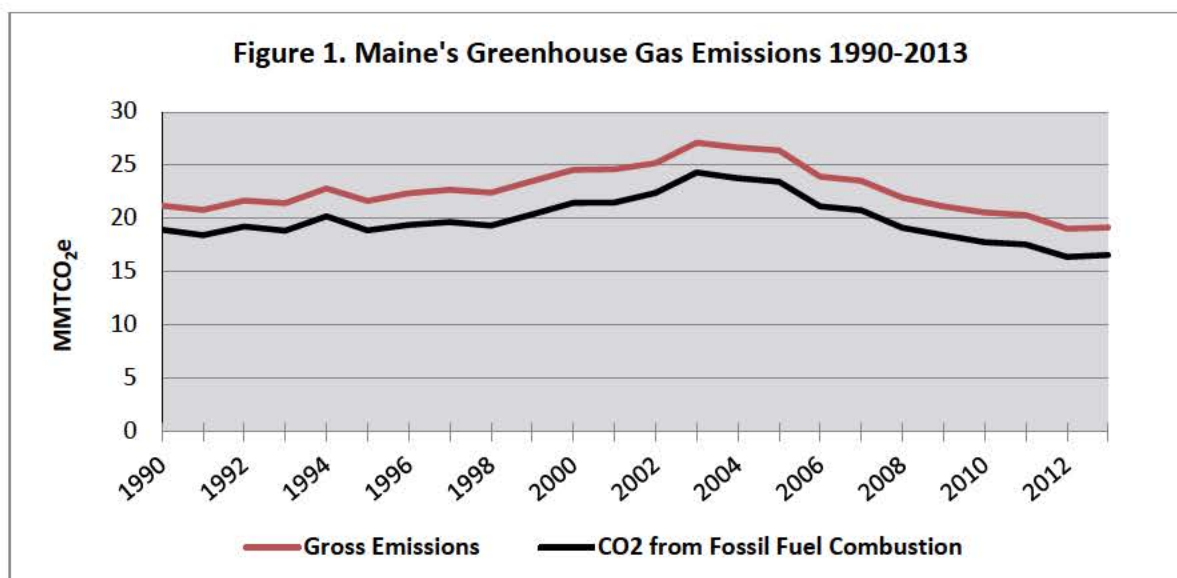
The Department did not estimate emissions or sequestration from Land Use, Land Use Change and Forestry (LULUCF) because the SIT does not provide an adequate mechanism for estimating the effects of the forest in New England. This is consistent with the approach taken by many New England states for developing GHG inventories at this time.

In order 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<sup>2</sup>. This data is shown in Appendix G.

### III. Results and Discussion

#### A. Gross GHG Emissions

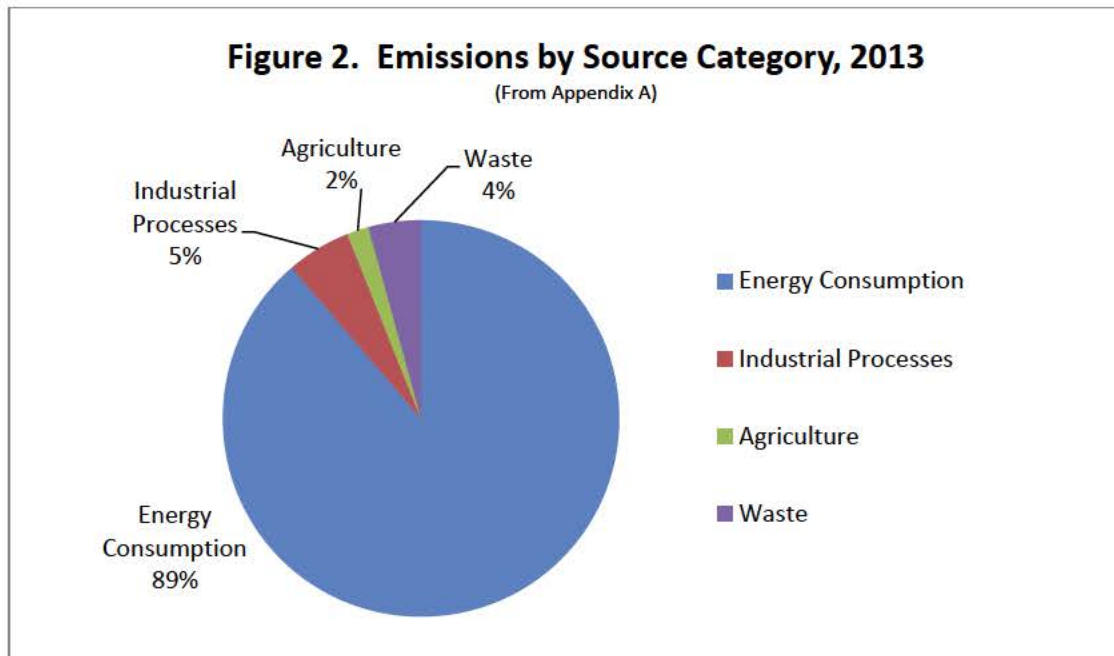
The Department's current analysis utilizing data through the end of 2013 indicates that Maine is continuing to realize a net decline in GHG emissions from a peak a decade ago, primarily due to decreased use of fossil fuels. Figure 1 shows the trend in GHG emissions from 1990 – 2013. Total estimated annual GHG emissions in Maine increased from 21.19 million metric tons of carbon dioxide equivalents (MMT $\text{CO}_2\text{e}$ ) in 1990 to a peak of 27.10 MMT $\text{CO}_2\text{e}$  in 2003, and then declined to 19.14 MMT $\text{CO}_2\text{e}$  in 2013. This equals a decrease in annual GHG emissions of nearly 10% since 1990. There was a slight uptick in GHG emissions in 2013 due to an increase in consumption of motor gasoline in the Transportation sector. A complete analysis of Maine's GHG emissions by source for each year can be found in Appendix A.



<sup>1</sup> Figure 4 and Appendix F

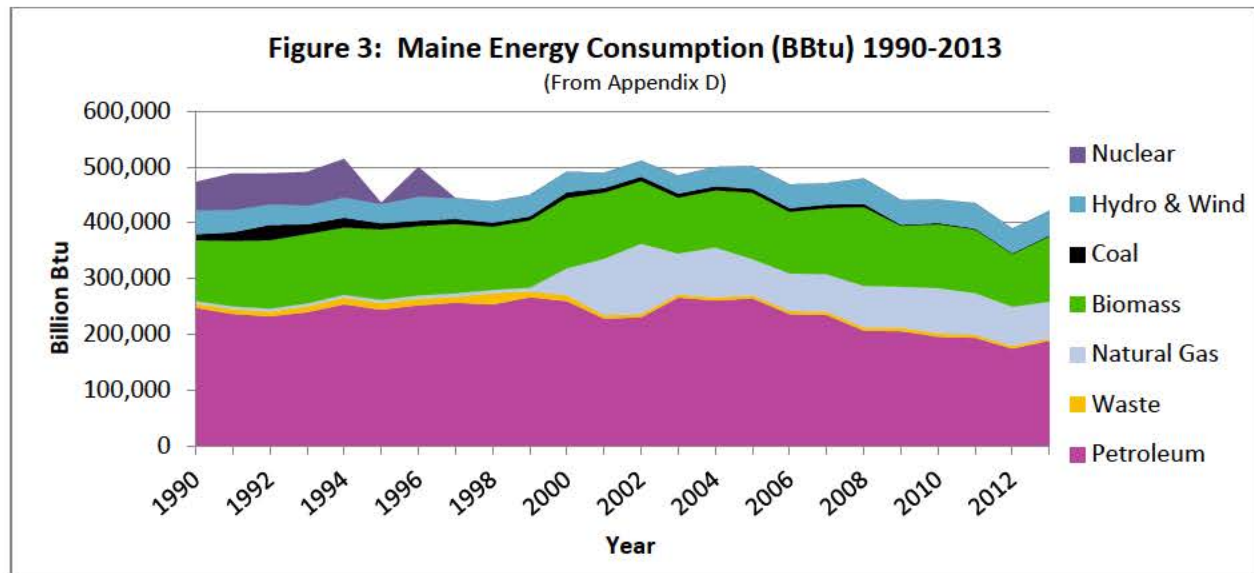
<sup>2</sup> Economic data inflation adjusted, chained 2009 dollars.

The consumption of energy is the largest source of emissions, accounting for 89% of Maine's gross GHG emissions in 2013. Agricultural activity, industrial processes, and waste disposal only contributed 11% of the 2013 GHG emissions total (Figure 2).



### ***B. Energy Consumption***

Demand for and consumption of energy drive the vast majority of Maine's GHG emissions. Figure 3 illustrates the energy sources used to meet Maine's energy demands from 1990 through 2013. In 2013, total energy consumption in Maine was 10% less than in 1990 (Appendix D).

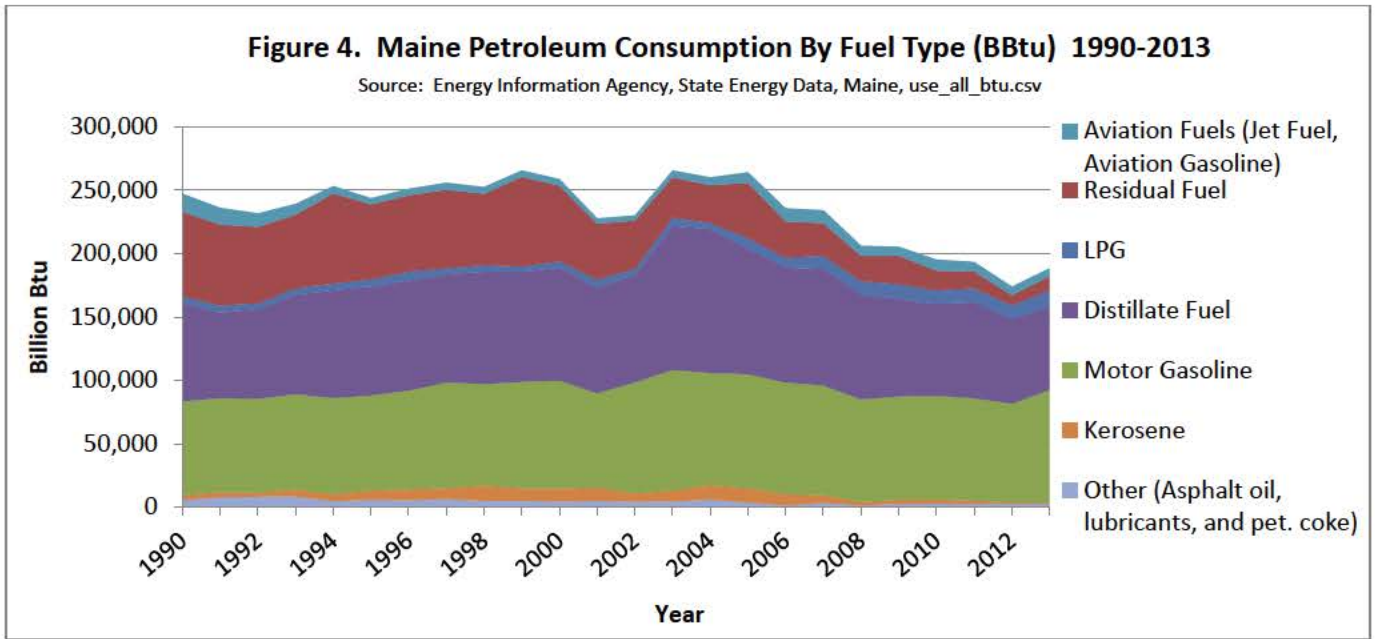


In 1990, 42% of Maine's energy was produced from carbon-neutral sources, which included nuclear power. In 2003, the percentage of Maine's energy generated from renewable sources reached the lowest point since 1990 at 26%. Since then the contribution of renewables to Maine's energy budget has climbed to 37% in 2013. Much of the decrease in the usage of carbon neutral energy seen from 1990 – 2003 was due to the decommissioning in 1996 of Maine's only nuclear power plant. Although much of the energy consumed in Maine does not come from renewable fuels, CO<sub>2</sub> emissions continue to decline in large part because of the use of lower carbon fuels and increased efficiencies.

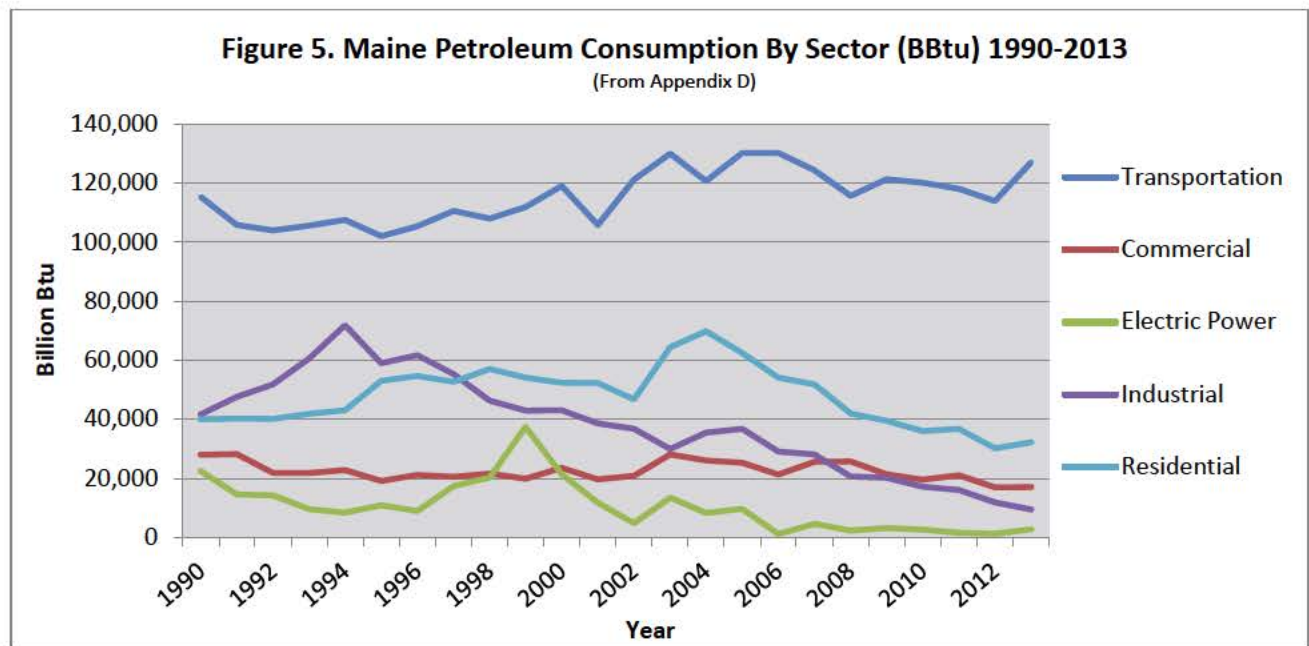
#### i. Petroleum Consumption

The petroleum products being consumed in Maine consist primarily of: aviation fuels, residual fuel, liquefied petroleum gas (LPG), distillate fuel, motor gasoline, and kerosene. In 2013, petroleum products accounted for 44% of all energy consumed and for 78% of CO<sub>2</sub> emissions. Information in Appendix F shows that in 2013, motor gasoline, distillate fuel, and residual fuel account for 88% of all petroleum products consumed. Only two petroleum fuels, LPG and motor gasoline, have shown an increase in consumption since 1990, while the other six petroleum fuels have all shown marked decreases. The reduction in residual fuel oil consumption, 83% since 1990, is a large driver of overall decline in GHG emissions.





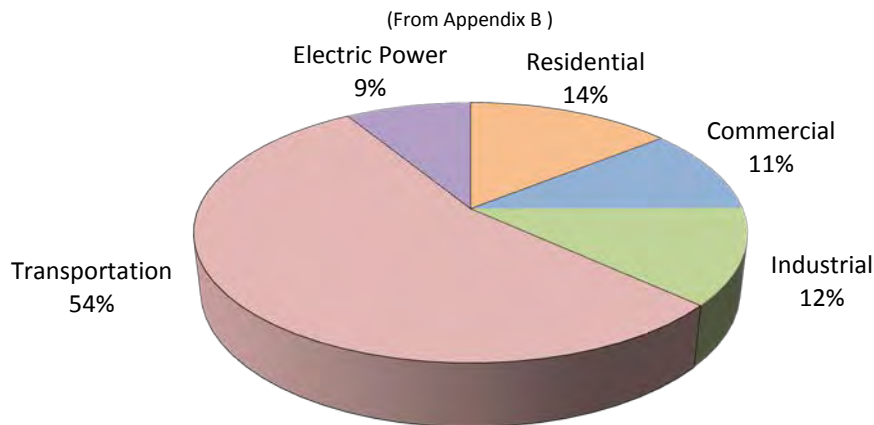
Over the ten year period from 2003-2013, the aggregate carbon dioxide emissions from petroleum combustion (in all sectors) has declined 30%. (Appendix B). While the transportation sector has consistently maintained the highest petroleum consumption rate, Figure 5 shows that the decline in the industrial sector’s consumption has allowed the residential sector to be ranked 2<sup>nd</sup> in consumption after transportation since 1998. This can 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<sub>2</sub> Emissions by Sector

Figure 6 illustrates the relative CO<sub>2</sub> emissions from the combustion of fossil fuels and waste incineration from each sector in 2013. This graph shows that the transportation sector produced over half of all CO<sub>2</sub> emissions in Maine in 2013. The residential sector accounted for the next highest amount of emissions at only 14%.

**Figure 6. Emissions from Fossil Fuel and Waste Combustion by Sector 2013**



### *Electric Generators*

In 2013, Maine's electric utility generators emitted 1.48 MMTCO<sub>2</sub> from the combustion of fossil fuels and waste, nearly a 70% drop from the 2003 peak (Appendix B). The consumption of petroleum products and consequent emissions of CO<sub>2</sub> from electric generating facilities has declined by 93% since 1990. Nuclear-, petroleum-, and coal-powered generation have been largely replaced with generation using natural gas, biomass, and waste products as fuel (Appendix E, Figure E-1). In 2013, natural gas combustion accounted for 76% of the CO<sub>2</sub> emissions from this sector. Renewable resources (biomass, hydropower, and wind) provided 70% of the energy consumed by these facilities in 2013.

### *Industrial*

Maine's industrial sector emitted 2.01 MMTCO<sub>2</sub> from the combustion of fossil fuels in 2013. In 2013, natural gas provided over three times more energy to the industrial sector than petroleum did. In this sector, 58% of the energy consumed was from renewable resources, slightly less than in 1990. (Appendix E, Figure E-2)

### *Commercial*

The commercial sector emitted 1.79 MMTCO<sub>2</sub> from fossil fuels and waste management in 2013, an overall 23% reduction in CO<sub>2</sub> emissions from this sector from 1990 – 2013. During this same time period there was a five-fold increase in the use of natural gas and a significant decrease in the use of petroleum. Petroleum continues to account for 65% of CO<sub>2</sub> emissions in the sector. In 2013, Maine's waste-to-energy facilities provided nearly 6% of the energy used by this sector (Appendix E, Figure E-3).

### ***Residential***

In 2013, the residential sector emitted 2.41 MMTCO<sub>2</sub> from fossil fuel consumption. This sector is highly dependent upon petroleum products and is significantly impacted by fuel price fluctuations. In 2013, petroleum accounted for 96% of all the CO<sub>2</sub> emissions from this sector. Emissions from residential petroleum use peaked in 2004 at 5.20 MMTCO<sub>2</sub> and declined 54% by 2013. Between 2004 – 2013, the cost of home heating oil increased by 92%<sup>3</sup>, 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.<sup>4</sup> This sector exceeds the commercial sector in consumption of distillate fuel and has been the least served by natural gas, although this may change as the infrastructure for natural gas distribution expands.

### ***Transportation***

In 2013, the transportation sector emitted 9.21 MMTCO<sub>2</sub> from fossil fuel combustion, 54% of the state's total CO<sub>2</sub> emissions (Appendix B). Petroleum accounts for 99% of the CO<sub>2</sub> emissions from and the energy consumed by the transportation sector (Appendix E, Figure E-5). The transportation sector consumed 11% more energy in 2013 than in 1990, but total CO<sub>2</sub> emissions declined 11%. This reduction 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 flat from 2006 to 2013, as shown in Figure 7. It is also evident that emissions of CO<sub>2</sub>e had increased overall from 1990 – 2003 at which point they began a marked decrease through 2012. Since 1990, Maine's real GDP grew from \$37.1 billion to \$50.9 billion in 2013<sup>5</sup>. During the same period, energy consumption declined from 446,468 billion Btu to 400,990 billion Btu. From 1990 through 2003 greenhouse gas emissions increased and tracked very closely with real GDP. However, in 2004, GHG emissions began to decrease significantly. (Figure 7 and Appendix G).

<sup>3</sup> [http://www.maine.gov/energy/fuel\\_prices/archives.shtml](http://www.maine.gov/energy/fuel_prices/archives.shtml), December 2004 to December 2013.

<sup>4</sup> Northeast Pellets, Corinth Wood Pellets, Geneva Wood Fuels, and Maine Woods Pellets.

<sup>5</sup> U.S. Bureau of Economic Analysis. Regional Data ([http://www.bea.gov/iTable/index\\_regional.cfm](http://www.bea.gov/iTable/index_regional.cfm))

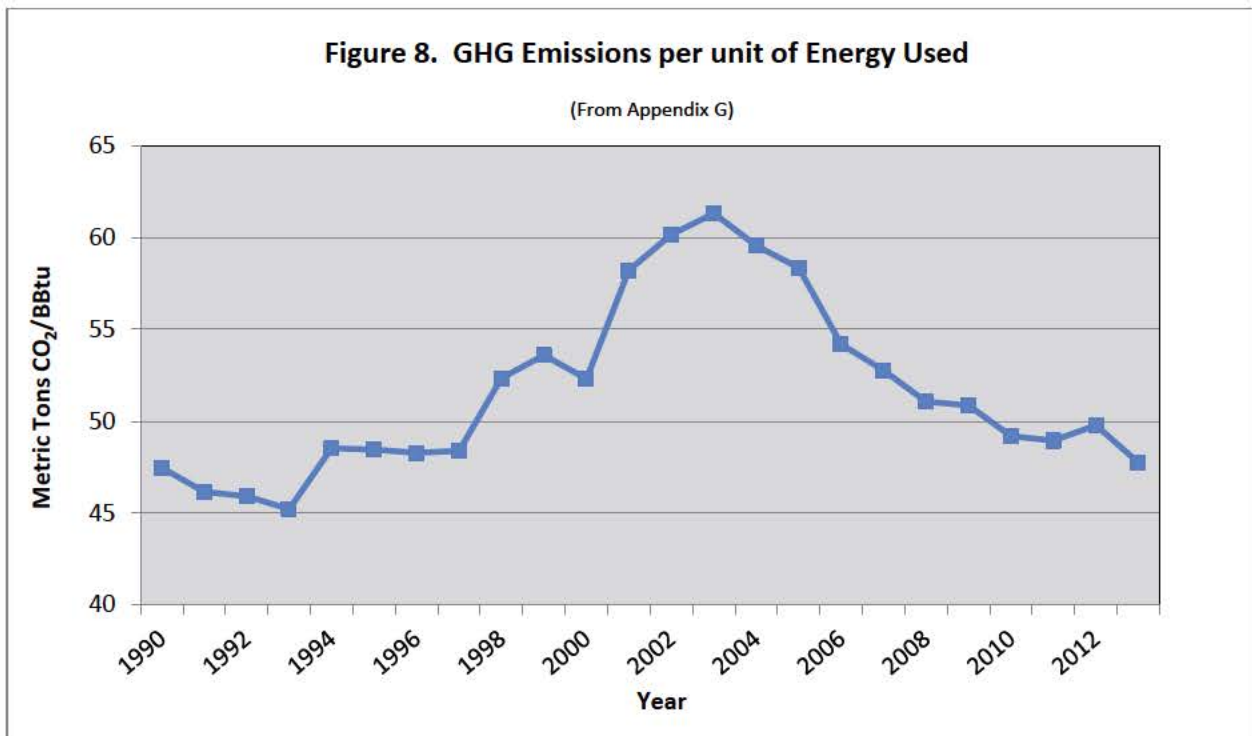
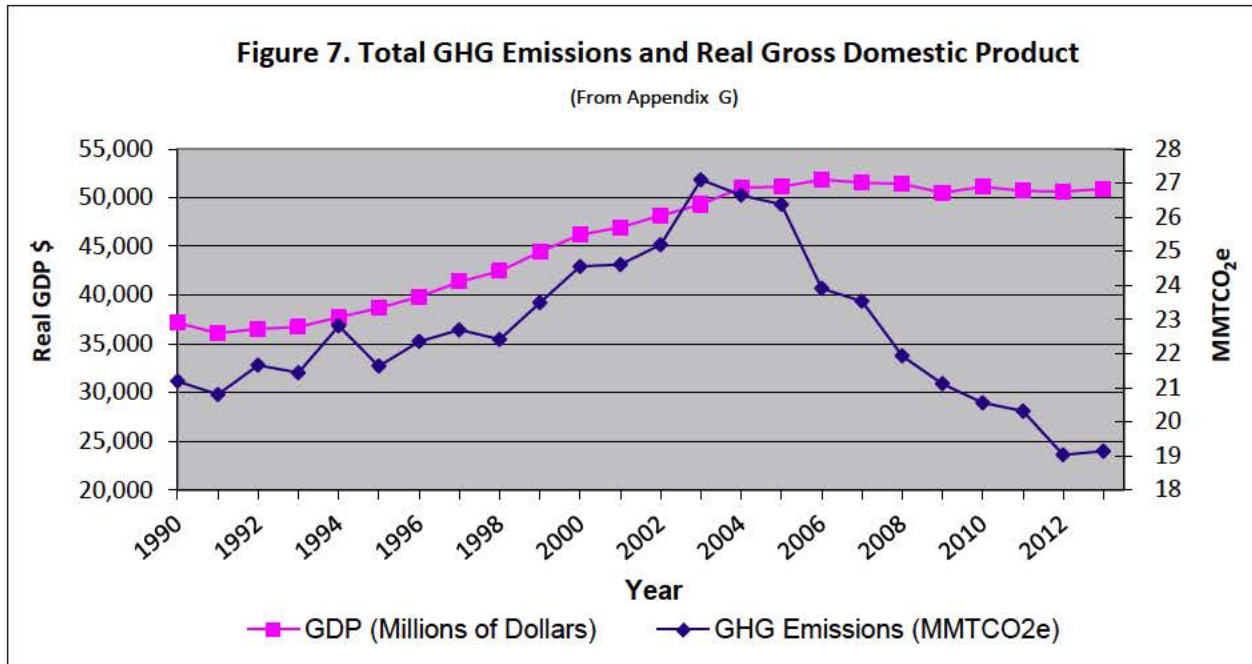


Figure 8 shows that because of a transition to lower carbon fuels, like natural gas, and a more efficient use of all fuels that the GHG emissions per unit of energy input has declined since 2004.

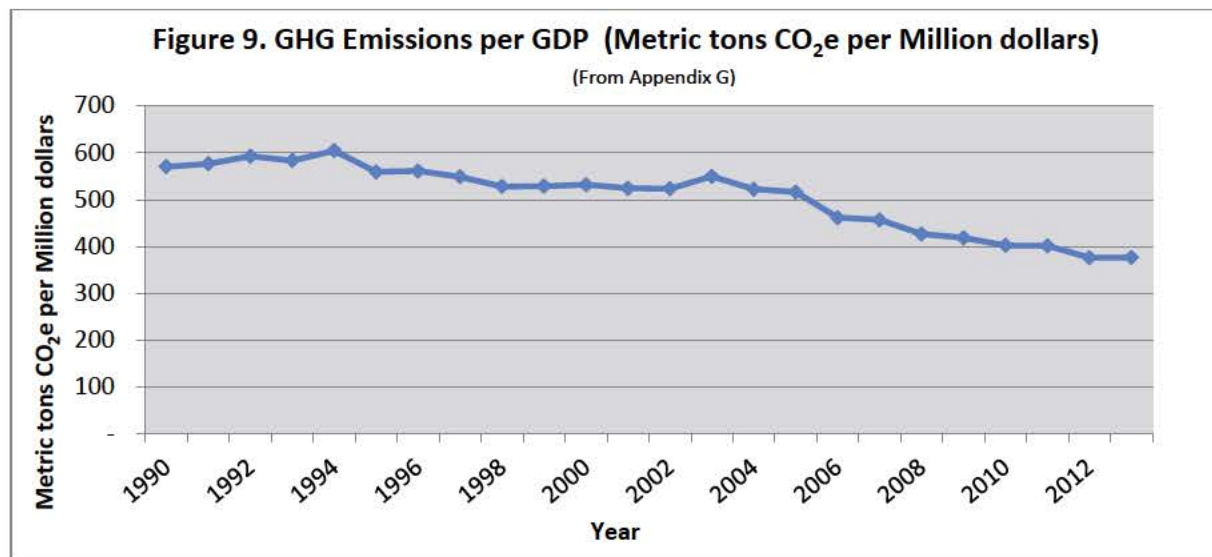


Figure 9 shows that emissions per million dollars of GDP are declining, indicating that the Maine economy is transitioning to lower carbon emitting fuels, more efficient equipment, and industries which require less energy per dollar of GDP.

#### IV. Conclusion

This *Sixth Biennial Report* on Maine's progress toward statutory GHG reduction targets provides an updated analysis of gross GHG emissions for the period of 1990-2013. The Department's analysis continues to indicate that Maine met the first statutory reduction target of reducing GHG emissions to 1990 levels by 2010. Gross GHG emissions by the end of year 2009 were 0.09 MMTCO<sub>2</sub>e below the target. The data in Appendix A show that in 2013, Maine's GHG emissions were 9.7% 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 met considering the following:

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

The Department recognizes that estimating emissions using historic data trends can have limited value, and is working to develop methods to improve these estimates. For certain categories and sectors, recent year input data has been difficult to find and compile in time to include in this report.

Each year the Department revises these numbers with more recent data that has been quality assured and quality checked to a high level of accuracy.

**Appendix A****Maine's Greenhouse Gas Emissions in MMTCO<sub>2</sub>e**

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy	19.61	19.14	19.99	19.58	20.94	19.63	20.14	20.39	20.02	21.09	22.18	22.18
Industrial Processes	0.36	0.35	0.35	0.42	0.45	0.57	0.66	0.69	0.75	0.77	0.70	0.69
Agriculture	0.44	0.44	0.42	0.45	0.43	0.42	0.46	0.49	0.54	0.51	0.44	0.46
Waste	0.79	0.88	0.89	0.99	0.99	1.01	1.09	1.12	1.10	1.13	1.24	1.27
<b>Gross Emissions</b>	<b>21.19</b>	<b>20.80</b>	<b>21.66</b>	<b>21.44</b>	<b>22.81</b>	<b>21.63</b>	<b>22.35</b>	<b>22.70</b>	<b>22.41</b>	<b>23.49</b>	<b>24.55</b>	<b>24.61</b>

Sector	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Energy	23.02	24.90	24.34	24.03	21.67	21.28	19.65	18.92	18.23	18.01	16.76	16.99
Industrial Processes	0.72	0.73	0.75	0.82	0.82	0.85	0.81	0.76	0.96	0.97	0.97	1.00
Agriculture	0.47	0.45	0.48	0.52	0.56	0.62	0.58	0.54	0.51	0.49	0.35	0.34
Waste	0.99	1.01	1.07	1.00	0.86	0.79	0.89	0.90	0.86	0.86	0.95	0.82
<b>Gross Emissions</b>	<b>25.19</b>	<b>27.10</b>	<b>26.64</b>	<b>26.38</b>	<b>23.91</b>	<b>23.54</b>	<b>21.93</b>	<b>21.11</b>	<b>20.56</b>	<b>20.32</b>	<b>19.03</b>	<b>19.14</b>

**Appendix B****Carbon Dioxide Emissions from Fossil Fuels and Waste Incineration**

MMTCO <sub>2</sub>	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
<b>Residential Total</b>	<b>2.99</b>	<b>2.99</b>	<b>3.01</b>	<b>3.13</b>	<b>3.20</b>	<b>3.94</b>	<b>4.05</b>	<b>3.92</b>	<b>4.23</b>	<b>4.03</b>	<b>3.90</b>	<b>3.88</b>
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
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
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
Waste	-	-	-	-	-	-	-	-	-	-	-	-
<b>Commercial Total</b>	<b>2.32</b>	<b>2.28</b>	<b>1.87</b>	<b>1.88</b>	<b>1.90</b>	<b>1.61</b>	<b>1.78</b>	<b>1.76</b>	<b>1.82</b>	<b>1.71</b>	<b>2.01</b>	<b>1.71</b>
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
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
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
Waste	0.09	0.08	0.09	0.11	0.09	0.08	0.10	0.11	0.11	0.12	0.12	0.12
<b>Industrial Total</b>	<b>3.37</b>	<b>3.97</b>	<b>5.32</b>	<b>5.03</b>	<b>6.26</b>	<b>4.88</b>	<b>5.02</b>	<b>4.41</b>	<b>3.72</b>	<b>3.52</b>	<b>3.85</b>	<b>3.80</b>
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
Petroleum	2.74	3.01	3.30	3.95	5.10	4.13	4.38	3.84	3.28	3.04	3.04	2.57
Natural Gas	0.11	0.12	0.11	0.09	0.09	0.11	0.12	0.13	0.12	0.22	0.29	0.85
Waste	-	-	-	-	-	-	-	-	-	-	-	0.08
<b>Transportation Total</b>	<b>8.29</b>	<b>7.59</b>	<b>7.48</b>	<b>7.61</b>	<b>7.72</b>	<b>7.31</b>	<b>7.55</b>	<b>7.93</b>	<b>7.74</b>	<b>8.00</b>	<b>8.58</b>	<b>7.66</b>
Coal	-	-	-	-	-	-	-	-	-	-	-	0.00
Petroleum	8.29	7.59	7.48	7.61	7.71	7.30	7.55	7.92	7.74	8.00	8.53	7.59
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	-	-	0.05	0.07
Waste	-	-	-	-	-	-	-	-	-	-	-	-
<b>Electric Power Total</b>	<b>2.16</b>	<b>1.83</b>	<b>1.77</b>	<b>1.46</b>	<b>1.35</b>	<b>1.39</b>	<b>1.29</b>	<b>1.94</b>	<b>2.14</b>	<b>3.43</b>	<b>3.47</b>	<b>4.80</b>
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
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
Natural Gas	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	1.21	3.33
Waste	0.10	0.16	0.13	0.15	0.14	0.16	0.20	0.20	0.21	0.21	0.23	0.17
<b>GROSS CO<sub>2</sub> Emissions</b>	<b>19.12</b>	<b>18.67</b>	<b>19.46</b>	<b>19.10</b>	<b>20.42</b>	<b>19.12</b>	<b>19.69</b>	<b>19.96</b>	<b>19.64</b>	<b>20.69</b>	<b>21.81</b>	<b>21.85</b>
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
Petroleum	17.71	16.72	16.39	16.94	18.26	17.57	18.17	18.46	18.34	19.31	18.75	16.28
Natural Gas	0.24	0.26	0.28	0.27	0.28	0.30	0.31	0.34	0.31	0.42	1.78	4.47
Waste	0.19	0.24	0.21	0.26	0.23	0.24	0.30	0.31	0.32	0.33	0.35	0.36



**Appendix B (continued)**

MMTCO <sub>2</sub>	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>Residential Total</b>	<b>3.49</b>	<b>4.78</b>	<b>5.20</b>	<b>4.63</b>	<b>4.01</b>	<b>3.84</b>	<b>3.10</b>	<b>2.93</b>	<b>2.65</b>	<b>2.73</b>	<b>2.25</b>	<b>2.41</b>
Coal	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-	-	-
Petroleum	3.43	4.71	5.13	4.57	3.96	3.77	3.04	2.85	2.58	2.65	2.16	2.31
Natural Gas	0.06	0.07	0.07	0.06	0.06	0.07	0.06	0.07	0.07	0.08	0.08	0.10
Waste												
<b>Commercial Total</b>	<b>1.95</b>	<b>2.49</b>	<b>2.32</b>	<b>2.26</b>	<b>1.97</b>	<b>2.33</b>	<b>2.35</b>	<b>2.01</b>	<b>1.92</b>	<b>2.07</b>	<b>1.77</b>	<b>1.79</b>
Coal	0.00	0.00	0.00	0.01	0.01	0.01	-	-	-	-	-	-
Petroleum	1.52	2.04	1.90	1.82	1.54	1.84	1.85	1.51	1.39	1.50	1.19	1.17
Natural Gas	0.29	0.27	0.27	0.27	0.26	0.33	0.33	0.31	0.32	0.36	0.40	0.45
Waste	0.14	0.17	0.15	0.16	0.16	0.15	0.17	0.19	0.21	0.21	0.19	0.17
<b>Industrial Total</b>	<b>3.75</b>	<b>3.19</b>	<b>3.46</b>	<b>3.67</b>	<b>3.34</b>	<b>2.98</b>	<b>2.66</b>	<b>2.36</b>	<b>2.12</b>	<b>2.29</b>	<b>2.60</b>	<b>2.01</b>
Coal	0.21	0.29	0.28	0.30	0.26	0.27	0.24	0.07	0.08	0.05	0.05	0.06
Petroleum	2.47	1.96	2.27	2.51	2.09	1.88	1.51	1.35	1.13	1.06	0.74	0.48
Natural Gas	1.00	0.93	0.86	0.82	0.95	0.78	0.87	0.89	0.86	1.14	1.77	1.43
Waste	0.07	0.01	0.05	0.04	0.04	0.05	0.04	0.04	0.04	0.04	0.04	0.04
<b>Transportation Total</b>	<b>8.75</b>	<b>9.37</b>	<b>8.71</b>	<b>9.38</b>	<b>9.41</b>	<b>9.03</b>	<b>8.37</b>	<b>8.80</b>	<b>8.75</b>	<b>8.64</b>	<b>8.26</b>	<b>9.21</b>
Coal	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum	8.70	9.32	8.67	9.35	9.39	8.98	8.32	8.75	8.66	8.51	8.22	9.16
Natural Gas	0.05	0.05	0.04	0.03	0.03	0.04	0.05	0.05	0.10	0.13	0.04	0.05
Waste	-	-	-	-	-	-	-	-	-	-	-	-
<b>Electric Power Total</b>	<b>4.82</b>	<b>4.86</b>	<b>4.48</b>	<b>3.92</b>	<b>2.83</b>	<b>3.00</b>	<b>3.09</b>	<b>2.81</b>	<b>2.81</b>	<b>2.33</b>	<b>2.00</b>	<b>1.48</b>
Coal	0.53	0.40	0.40	0.35	0.35	0.33	0.30	0.08	0.13	0.09	0.08	0.09
Petroleum	0.36	1.01	0.62	0.73	0.08	0.34	0.17	0.24	0.19	0.11	0.09	0.12
Natural Gas	3.77	3.25	3.26	2.62	2.17	2.12	2.36	2.26	2.25	1.87	1.56	1.13
Waste	0.17	0.20	0.20	0.22	0.23	0.21	0.24	0.24	0.24	0.25	0.27	0.14
<b>GROSS CO<sub>2</sub> Emissions</b>	<b>22.75</b>	<b>24.68</b>	<b>24.16</b>	<b>23.87</b>	<b>21.57</b>	<b>21.18</b>	<b>19.58</b>	<b>18.90</b>	<b>18.25</b>	<b>18.06</b>	<b>16.88</b>	<b>16.90</b>
Coal	0.74	0.70	0.68	0.66	0.62	0.61	0.55	0.15	0.21	0.14	0.12	0.15
Petroleum	16.47	19.05	18.60	18.97	17.06	16.82	14.89	14.71	13.96	13.83	12.41	13.24
Natural Gas	5.16	4.56	4.48	3.81	3.47	3.33	3.68	3.57	3.59	3.59	3.85	3.15
Waste	0.38	0.38	0.39	0.43	0.43	0.42	0.46	0.46	0.48	0.50	0.50	0.35

## Appendix C

### Sector Definitions<sup>6</sup>

- **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.

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<sup>6</sup> Source: EIA State Energy Data System ([www.eia.doe.gov/emeu/states/\\_seds.html](http://www.eia.doe.gov/emeu/states/_seds.html))

**Appendix D****Maine Energy Consumption<sup>5</sup> in Billion Btu**

<b>Coal</b>	<b>1990</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Transportation	0	0	0	0	0	0	0	0	0	0
Commercial	858	70	65	57	0	0	0	0	0	0
Electric Power	3,808	3,764	3,767	3,583	3,275	856	1,418	969	810	967
Industrial	5,533	3,219	2,780	2,937	2,633	797	862	573	489	690
Residential	214	6	6	6	0	0	0	0	0	0
<b>Coal Total</b>	<b>10,413</b>	<b>7,059</b>	<b>6,618</b>	<b>6,583</b>	<b>5,908</b>	<b>1,653</b>	<b>2,280</b>	<b>1,542</b>	<b>1,299</b>	<b>1,657</b>

<b>Petroleum</b>	<b>1990</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Transportation	115,381	130,194	130,294	124,438	115,694	121,406	120,215	118,149	114,030	127,110
Commercial	27,986	25,239	21,332	25,652	25,689	21,360	19,511	21,106	16,917	17,037
Electric Power	22,502	9,708	1,093	4,534	2,329	3,155	2,591	1,516	1,243	1,561
Industrial	41,614	36,804	29,073	28,068	20,659	20,162	17,180	16,100	11,806	9,490
Residential	40,001	62,502	54,164	51,801	42,021	39,517	35,978	36,755	30,121	32,180
<b>Petroleum Total</b>	<b>247,484</b>	<b>264,447</b>	<b>235,956</b>	<b>234,493</b>	<b>206,392</b>	<b>205,600</b>	<b>195,475</b>	<b>193,626</b>	<b>174,117</b>	<b>187,378</b>

<b>Natural Gas</b>	<b>1990</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Transportation	5	612	520	806	1,007	873	1,821	2,500	785	876
Commercial	1,686	5,019	4,954	6,157	6,270	5,778	6,055	6,867	7,525	8,398
Electric Power	196	49,514	40,944	39,982	44,611	42,618	48,137	40,122	33,387	25,497
Industrial	2,034	6,807	18,457	23,176	27,338	27,033	29,460	28,885	31,123	33,308
Residential	651	1,204	1,038	1,253	1,174	1,341	1,282	1,467	1,530	1,947
<b>Natural Gas Total</b>	<b>4,572</b>	<b>63,156</b>	<b>65,913</b>	<b>71,374</b>	<b>80,400</b>	<b>77,643</b>	<b>86,755</b>	<b>79,841</b>	<b>74,350</b>	<b>70,026</b>

<b>Biofuels</b>	<b>1990</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Transportation	0	375	551	789	4,054	5,154	4,758	4,888	5,005	5,751
Commercial	0	0	1	2	5	11	11	6	6	10
Electric Power	0	0	0	0	0	0	0	0	0	0
Industrial	0	6	10	12	52	63	93	97	94	97
Residential	0	0	0	0	0	0	0	0	0	0
<b>Biofuels Total</b>	<b>0</b>	<b>381</b>	<b>562</b>	<b>803</b>	<b>4,111</b>	<b>5,229</b>	<b>4,862</b>	<b>4,991</b>	<b>5,105</b>	<b>5,858</b>

<sup>5</sup> Data Source: EIA State Energy Data System ([www.eia.doc.gov/emeu/states/\\_seds.html](http://www.eia.doc.gov/emeu/states/_seds.html))

**Appendix D (continued)**  
**Maine Energy Consumption<sup>5</sup> in Billion Btu**

<b>Waste</b>	<b>1990</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Transportation	-	-	-	-	-	-	-	-	-	-
Commercial	2,177	3,168	3,075	3,087	3,452	3,501	3,679	3,661	3,246	3,354
Electric Power	2,459	4,244	4,326	4,241	4,873	4,401	4,212	4,367	4,659	2,655
Industrial	0	828	746	984	845	701	710	730	775	704
Residential	0	0	0	0	0	0	0	0	0	0
<b>Waste Total</b>	<b>4,636</b>	<b>8,240</b>	<b>8,147</b>	<b>8,312</b>	<b>9,170</b>	<b>8,603</b>	<b>8,601</b>	<b>8,758</b>	<b>8,680</b>	<b>6,713</b>
<b>Biomass</b>	<b>1990</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Transportation	0	0	0	0	0	0	0	0	0	0
Commercial	933	969	899	980	1,015	2,038	1,993	1,942	1,685	1,958
Electric Power	19,040	39,682	38,333	38,345	31,666	27,548	29,623	25,574	24,108	25,906
Industrial	76,963	66,375	59,496	66,270	56,503	53,863	59,168	63,529	46,798	62,607
Residential	4,292	6,037	5,354	5,918	6,622	14,290	12,476	12,760	11,909	16,446
<b>Biomass Total</b>	<b>101,228</b>	<b>113,063</b>	<b>104,082</b>	<b>111,513</b>	<b>95,806</b>	<b>97,739</b>	<b>103,260</b>	<b>103,805</b>	<b>84,500</b>	<b>106,917</b>
<b>Hydro and Wind</b>	<b>1990</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Transportation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Electric Power	28,568	34,655	34,710	31,064	37,711	36,630	35,161	38,257	40,036	39,798
Industrial	13,982	6,250	7,725	6,863	7,509	7,391	6,883	7,269	3,923	4,169
Residential	0	0	0	0	0	0	0	0	0	0
<b>Hydro &amp; Wind, Total</b>	<b>42,550</b>	<b>40,905</b>	<b>42,435</b>	<b>37,927</b>	<b>45,220</b>	<b>44,021</b>	<b>42,044</b>	<b>45,526</b>	<b>43,959</b>	<b>43,967</b>
<b>ALL SECTORS</b>	<b>1990</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Coal	10,413	7,059	6,618	6,583	5,908	1,653	2,280	1,542	1,299	1,657
Petroleum	247,484	264,447	235,956	234,493	206,392	205,600	195,475	193,626	174,117	187,378
Natural Gas	4,572	63,156	65,913	71,374	80,400	77,643	86,755	79,841	74,350	70,026
Biofuels	0	381	562	803	4,111	5,229	4,862	4,991	5,105	5,858
Waste	4,636	8,240	8,147	8,312	9,170	8,603	8,601	8,758	8,680	6,713
Biomass	101,228	113,063	104,082	111,513	95,806	97,739	103,260	103,805	84,500	106,917
Nuclear*	51,436	0	0	0	0	0	0	0	0	0
Hydro & Wind	42,550	40,905	42,435	37,927	45,220	44,021	42,044	45,526	43,959	43,967
<b>Total</b>	<b>462,319</b>	<b>497,251</b>	<b>463,713</b>	<b>471,005</b>	<b>447,007</b>	<b>440,488</b>	<b>443,277</b>	<b>438,089</b>	<b>392,010</b>	<b>422,516</b>
Electricity Exports (zero imports)	-15,851	-45,285	-22,465	-24,902	-17,580	-25,309	-25,394	-23,032	-9,639	-21,526
<b>Total Net Electricity</b>	<b>446,468</b>	<b>451,966</b>	<b>441,248</b>	<b>446,103</b>	<b>429,427</b>	<b>415,179</b>	<b>417,883</b>	<b>415,057</b>	<b>382,371</b>	<b>400,990</b>

## Appendix E

### Energy Consumption by Sector Graphs

Figure E-1 Electric Power Generation

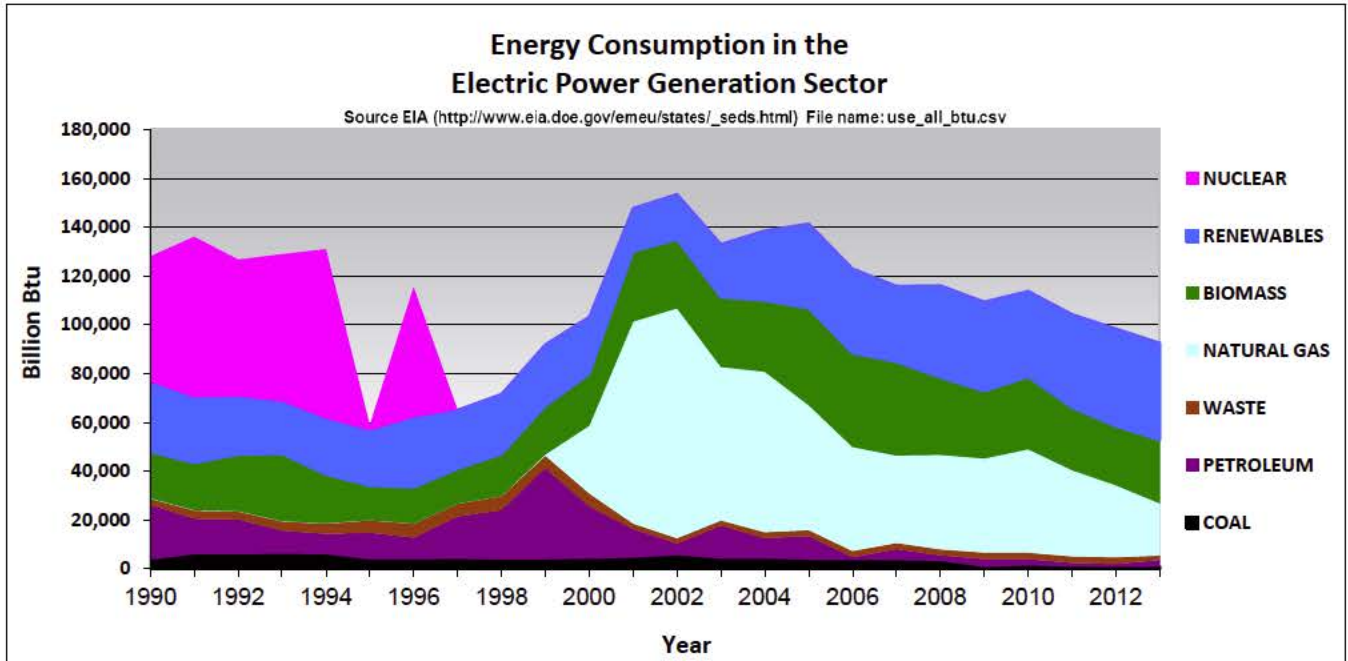
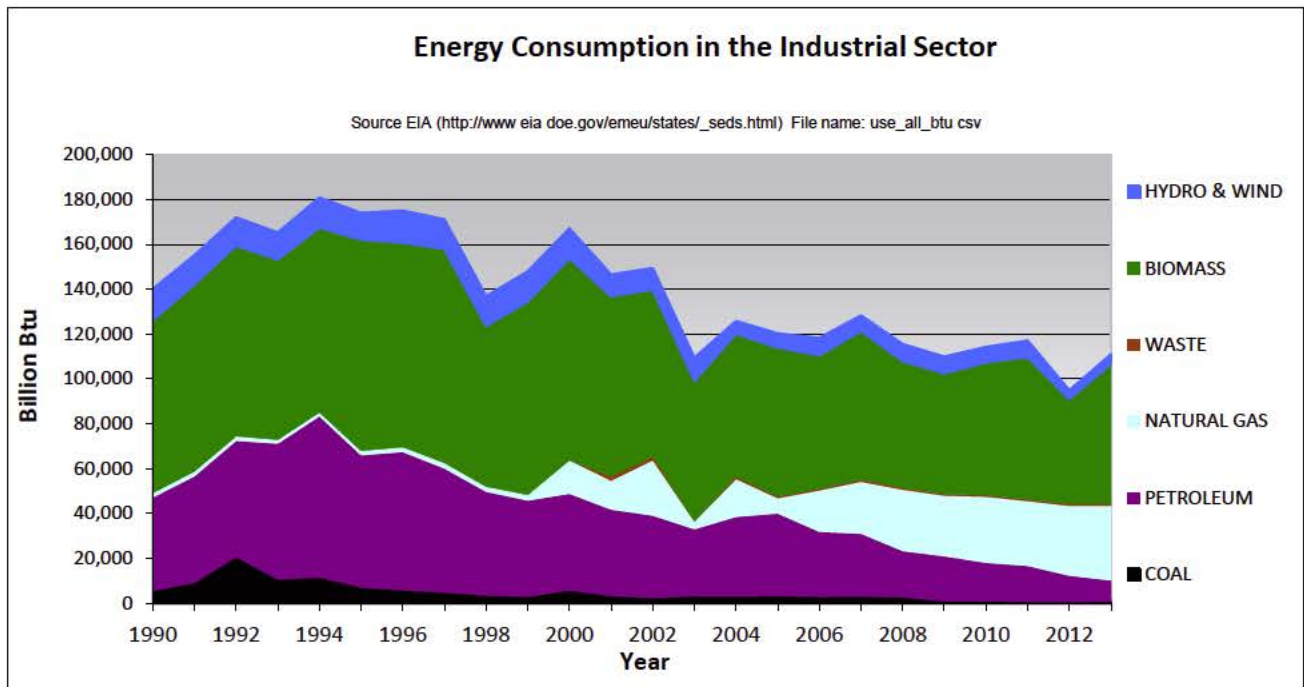


Figure E-2. Industrial



**Appendix E (continued)**

Figure E-3. Commercial

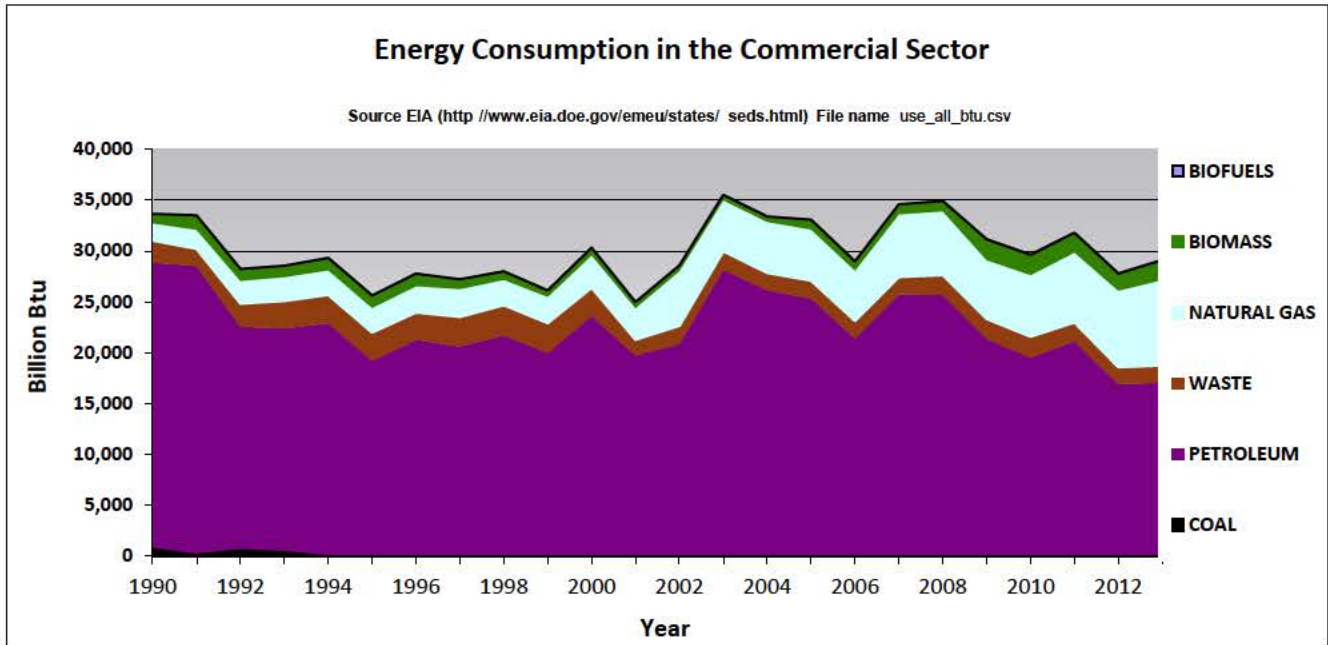
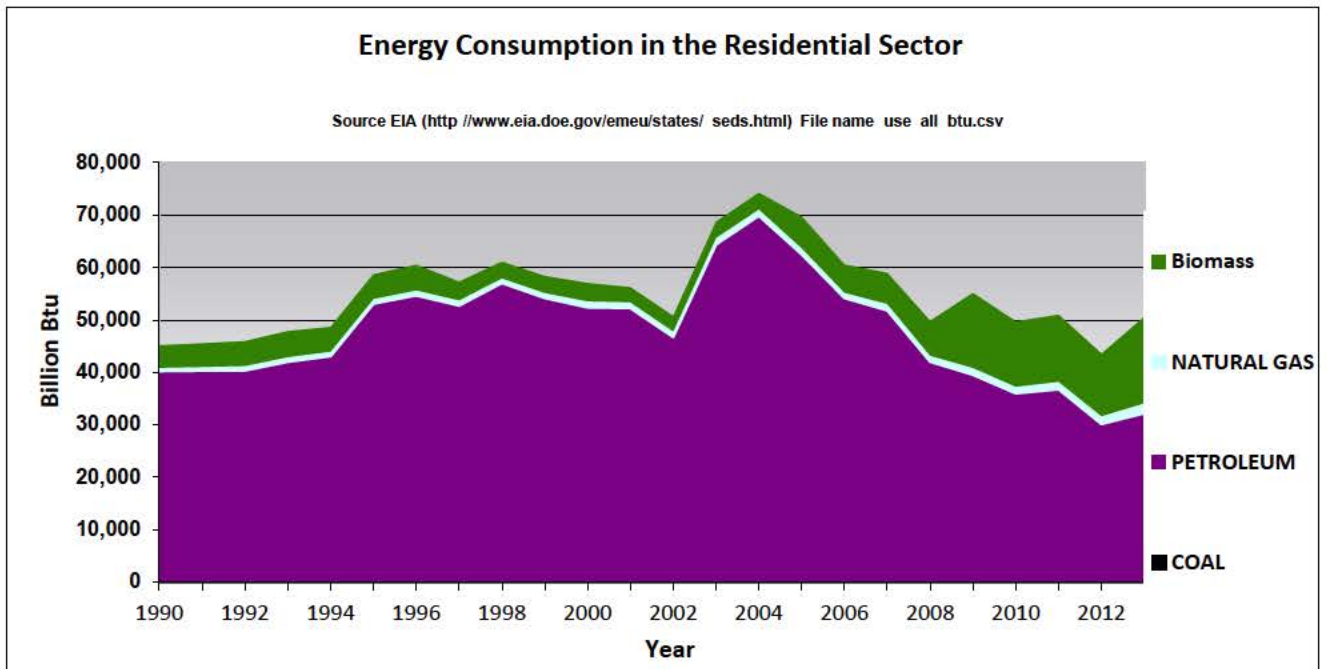
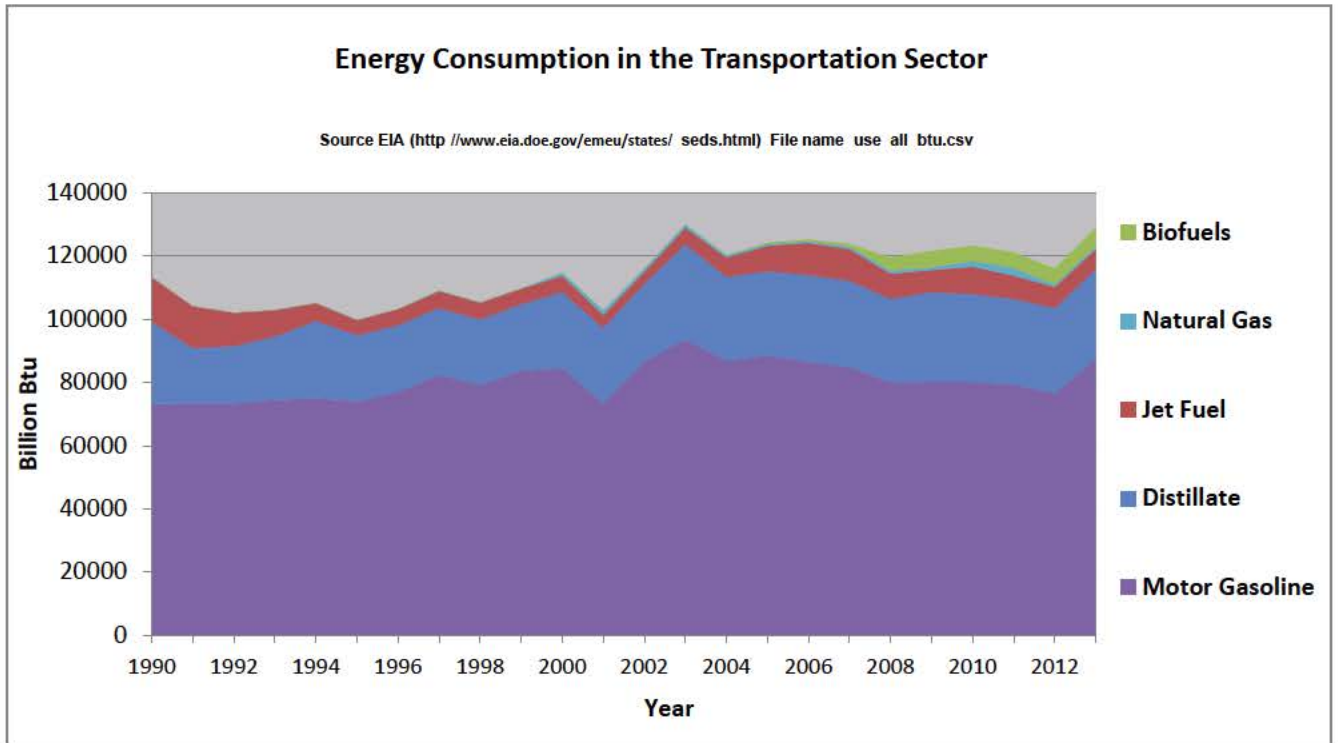


Figure E-4. Residential



**Appendix E (continued)**

Figure E-5. Transportation



**Appendix F****Petroleum Consumption by Fuel Type<sup>7</sup> in Billion Btu**

<b>Fuel Type</b>	<b>1990</b>	<b>2000</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
<b>Aviation Gasoline</b>	312	128	203	262	260	169	179	113	268	90	78
<b>Distillate Fuel Oil</b>	77,654	89,129	98,752	90,585	91,875	82,961	76,877	72,377	75,791	66,915	65,557
<b>Jet Fuel</b>	14,015	5,148	8,081	10,149	10,008	7,946	6,976	8,719	7,325	6,663	6,313
<b>Kerosene</b>	3,726	10,429	11,295	8,954	6,268	2,690	3,396	3,278	2,348	998	1,032
<b>LPG</b>	5,238	5,040	8,855	7,978	10,677	10,512	11,739	10,859	11,155	10,825	13,201
<b>Lubricants</b>	1,219	1,242	1,048	1,021	1,054	979	880	978	928	854	903
<b>Motor Gasoline</b>	74,206	85,133	90,028	88,228	86,464	81,122	81,342	81,963	80,947	78,151	89,131
<b>Residual Fuel Oil</b>	66,833	59,723	43,593	28,559	25,621	19,776	22,496	15,457	13,171	7,991	10,843
<b>Other: Asphalt, Road Oil, and Pet Coke</b>	4,282	2,222	2,526	167	2,224	199	1,688	1,698	1,662	1,599	1,515
<b>Sum</b>	<b>247,485</b>	<b>258,194</b>	<b>264,381</b>	<b>235,903</b>	<b>234,451</b>	<b>206,354</b>	<b>205,573</b>	<b>195,442</b>	<b>193,595</b>	<b>174,086</b>	<b>188,573</b>

<sup>7</sup> Source: EIA State Energy Data System ([www.eia.doe.gov/emeu/states/\\_seds.html](http://www.eia.doe.gov/emeu/states/_seds.html))



## Appendix G

### Economic Analysis Input Data

YEAR	GDP (Millions of Dollars) <sup>8</sup>	GHG Emissions (MMTCO <sub>2</sub> e) <sup>9</sup>	Total Energy per GDP (BBtu per Million Dollars) <sup>10</sup>	GHG Emissions per GDP (Tons CO <sub>2</sub> e per Million Dollars)	GHG Emissions per Energy Input (Tons CO <sub>2</sub> e per BBtu) <sup>11</sup>
1990	37,168	21.19	12.01	570	47.47
1991	36,082	20.80	12.49	577	46.16
1992	36,539	21.66	12.91	593	45.92
1993	36,755	21.44	12.90	583	45.22
1994	37,725	22.81	12.46	605	48.52
1995	38,681	21.63	11.54	559	48.46
1996	39,834	22.35	11.62	561	48.28
1997	41,378	22.70	11.34	549	48.39
1998	42,457	22.41	10.09	528	52.34
1999	44,443	23.49	9.86	529	53.59
2000	46,184	24.55	10.16	532	52.31
2001	46,958	24.61	9.00	524	58.21
2002	48,153	25.19	8.69	523	60.17
2003	49,312	27.10	8.96	550	61.31
2004	51,029	26.64	8.77	522	59.56
2005	51,110	26.38	8.84	516	58.36
2006	51,828	23.91	8.51	461	54.19
2007	51,543	23.54	8.65	457	52.76
2008	51,427	21.93	8.35	426	51.08
2009	50,487	21.11	8.22	418	50.86
2010	51,136	20.56	8.17	402	49.19
2011	50,677	20.32	8.19	401	48.95
2012	50,634	19.03	7.55	376	49.78
2013	50,889	19.14	7.88	376	47.74

<sup>8</sup> Bureau of Economic Activity ([www.bea.gov](http://www.bea.gov))

<sup>9</sup> Appendix A

<sup>10</sup> Appendix D, "Total Net Electricity"/ GDP

<sup>11</sup> Appendix D