Community Inventory of Greenhouse Gas Emissions, 2010

for the

City of Portland, Maine

January 2010 – December 2010

CONTENTS

SUMMARY

In the summer of 2011, Greenhouse Gas (GHG) Emissions were estimated using The Climate Registry General Reporting Protocol (GRP). This inventory was conducted to quantify emissions for the Portland community as a whole. Emissions were quantified within the geographic boundaries of the Portland city limits for the 2010 calendar year.

The city of Portland's total community GHG emissions for the 2010 calendar year were 1,142,797 metric Tons of carbon dioxide equivalent (CO2e). App. 525,403 Tons were emitted as a result of the mobile combustion of gasoline, diesel fuel, heavy fuel oil, and jet fuel. App. 310,058 Tons were emitted as a result of the stationary combustion of petroleum heating fuels, natural gas, and waste. App. 307,336 Tons were emitted indirectly to provide Portland residents with electricity. Of the overall emissions total, app. 121,252 Tons were emitted by the residential sector, 269,513 Tons by the commercial sector, and 74,409 Tons by the industrial sector. An additional 139,805 Tons were emitted from the incineration of solid waste, of which 44,745 Tons were due to the waste produced by only the Portland community.

This inventory is the third inventory conducted for the City of Portland, following emissions inventories for the 2000 and 2005 calendar years.

2010 Portland Community Greenhouse Gas Emissions						
	(metric Tons)					
	Emissions Source:	CO_2	CH_4	N_2O	CO_2e	% estimated
Solid Waste	Stationary Combustion	137566.08	14.11	6.27	139805.38	0%
Residential	Stationary Combustion	50878.44	5.93	1.59	51494.87	100%
	Indirect Emissions	69881.06	6.15	1.15	70367.74	0%
	Total	120759.50	12.08	2.74	121862.62	42%
Commercial	Stationary Combustion	75597.36	3.85	2.04	76310.37	100%
	Indirect Emissions	200315.71	17.63	3.31	201710.80	0%
	Total	275913.06	21.48	5.35	278021.16	27%
Industrial	Stationary Combustion	42297.91	1.19	0.40	42447.26	100
	Indirect Emissions	33104.41	2.91	0.55	33334.96	0%
	Total	75402.31	4.11	0.95	75782.22	56%
Mobile Combustion		517126.89	192.05	13.69	525403.19	100%
TOTAL		**1126767.85**	**243.83**	**28.99**	**1140874.57**	**61%**

Global Warming Potential	1	21	310

METHODOLOGY

The inventory quantified three of the six internationally recognized GHGs, including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The emissions of the other three internationally recognized GHGs, hydroflourocarbons (HFCs), perflourocarbons (PFCs), and sulfur hexafluoride (SF_6), were considered negligible to the emissions inventory under the assumption that all refrigerators and air conditioners were disposed of properly, since the disposal of any appliances that could emit those GHGs is regulated by the State of Maine. Fugitive emissions of SF_6 were not researched.

The emissions of the three quantifiable GHGs were recorded in metric Tons. Emissions of all GHGs were then converted from metric Tons to carbon dioxide equivalent (CO_2e) emissions using the Global Warming Potential (GWP) coefficients of each gas developed by the Intergovernmental Panel on Climate Change (IPCC).

The Operational Control Approach was used in this inventory due to the large organizational boundaries of the Portland community. This approach reports emissions from all sources that are wholly or partially owned or controlled by entities physically located within the boundaries of the City of Portland.

Emissions were calculated within the operational boundaries of all Scope I (Direct) and all Scope II (Indirect) emissions sources. Scope III emissions were not examined in this inventory; however, future year inventories may decide to include Scope III emissions.

Although every attempt was made to ensure accuracy, this document is an estimate. There is inherent error in the derived formulas, as well as sampling error from examination of data. Efforts were made to be consistent with the methodology from the reporting protocols of The Climate Registry. All assumptions and other sources of potential inaccuracy have been recorded in an effort to make each estimate as accurate as possible.

Scope I | Direct Emissions from Stationary Combustion and Mobile Combustion

Stationary Combustion

The first subcategory of direct Scope I emissions includes all combustion to produce steam, heat, or power using equipment in fixed locations. Stationary combustion data was estimated for the residential, commercial, and industrial sectors of Portland using statewide data for Maine from

State Energy Data System from the Energy Information Administration (EIA). A supplemental data source for the residential sector was the U.S. Census Bureau records for 2010 of home heating methods by percentages of Portland residents.

Based on the available data, it was assumed that fuels used in stationary combustion in Portland included light fuel oil (#2-4 or distillate fuel oil), heavy fuel oil (#5-6, or residual fuel oil), propane, kerosene, and natural gas. It was also assumed that wood was burned in some homes.

For each of these fuel sources, statewide consumption totals were obtained from "Consumption Estimates 1960-2010" in the EIA online database, in millions of British thermal units (MMBTUs). These 2010 totals were multiplied by the ratio of Portland's population to the total population of Maine (4.98 percent). Then, totals for each type of fuel in each sector were adjusted by the square footage of that sector in Portland. Exact square footage by sector was provided by the City Assessor's property database. Because the first ratio was based on the number of Portland residents, residential square footage was used as a baseline to which commercial and industrial square footage could be compared. Thus for residential consumption totals, statewide data was multiplied by the population ratio alone, but for commercial and industrial consumption totals, statewide data was multiplied by the population ratio and the ratio of that sector's square footage to residential square footage (commercial:residiential=1.1281:1 and industrial:residential=0.3076:1).

Estimations for wood and waste were altered slightly to account for the inherent differences in the use of those sources in Portland compared to the rest of Maine. According to the 2010 U.S. Census Bureau records, only 1.1 percent of Portland residents heat their homes with wood, so the state total energy consumption for wood was multiplied by that percentage as well as the population ratio of Portland to Maine. Wood and waste is not burned in Portland in the same way as in other municipalities, so this EIA category was left out of the inventory for the commercial and industrial sectors.

It was assumed that Portland municipal solid waste was burned and converted to inert ash in the EcoMaine waste-to-energy incineration plant. Total metric Tons of municipal solid waste delivered to the plant from within Portland city limits was provided by EcoMaine. Tons of waste were then converted to MMBTUs using the default heat value of municipal solid waste provided by the California Air Resources Board.

Portland energy consumption totals in MMBTUs for each fuel source were then converted to metric Tons of emissions using fuel-specific emissions factors provided by GRP. Data for stationary combustion emissions was much lower in quality than originally planned. The attempt to sample more accurate sources failed due to the lack of cooperation by petroleum and natural gas providers. Companies either did not have the capacity to find the data or refused to report it.

Mobile Combustion

The second subcategory of direct Scope I emissions includes the combustion of fuels in all modes of transportation, including automobiles, marine vessels, and airplanes. Mobile combustion data was compiled using data from the Maine Department of Transportation (DOT), the Portland Office of the Treasury, the U.S. Bureau of Transportation Statistics, and the U.S. EPA.

Automobile emissions were estimated from the total miles driven in Portland in 2010 by the vehicles registered in Portland. The original source proposed for automobile emissions data was fuel consumption data from all Portland fuel providers. Since fuel stations either did not have the capacity to find the data or refused to report it. The inventory chose to examine the miles driven in Portland by vehicles registered in the city instead. This emissions data is of similar quality to what could have been directly reported by fuel stations, it is simply derived from vehicle mileage and fuel economy rather than gallons purchased.

The Maine DOT provided a total of vehicle miles traveled in Portland in 2010 and the Portland Office of the Treasury provided a list of all vehicles registered in the city by type (i.e. sedan, sport utility vehicle, semi truck). Fuel economy estimates for each type of vehicle from the U.S. EPA were applied to each vehicle type. Next, the total of vehicle miles traveled by all vehicles from the DOT was divided proportionally by the percentages of each vehicle type in Portland obtained from the Office of the Treasury. Then, the miles traveled by each vehicle type were multiplied by that vehicle's average combined fuel economy, which provided an estimate of the gallons of gasoline and diesel consumed by each type of vehicle registered in Portland. Gallons consumed of both fuels were then converted to metric Tons using the respective emissions factors provided by The Climate Registry.

Aircraft emissions were estimated from U.S. totals provided by the Bureau of Transportation statistics. The original source proposed for aircraft emissions was the fuel provider for the entire Portland Jetport. However, this company refused to disclose any information pertaining to fuel consumption, so Portland data had to be estimated from national data. 2010 nationwide jet fuel consumption totals were multiplied by the ratio of Portland Jetport flights to all U.S. airport flights (domestic and international, incoming and outgoing) in 2010. Gallons of jet fuel consumed by the Portland Jetport were then converted to metric Tons using the appropriate emissions factor.

Marine emissions were estimated using EPA Commercial Marine Port data and Bureau of Transportation Statistics national marine fuel consumption totals. Vessels in Portland used a combination of heavy fuel oil (known as Bunker C), diesel fuel oil, and motor gasoline. Total gallons of each fuel used nationwide in 2010 in the U.S. were multiplied by the ratio of vessel

trips in Portland to vessel trips in all deep water ports in the U.S. Total gallons used of each fuel type were converted to metric Tons of emissions using the fuels' respective emissions factors.

Other Direct Emissions

Scope I emissions that were not calculated include process emissions from wastewater, process emissions from landfill solid waste, and fugitive emissions of PFCs, HFCs, and SF_6. Landfill solid waste emissions were not examined under the assumptions that most of Portland's solid waste is incinerated by the EcoMaine waste-to-energy plant and that much of what enters the landfill is inert ash. Emissions from PFCs and HFCs were considered negligible to the emissions inventory under the assumption that all refrigerators and air conditioners were disposed of properly, since the disposal of any appliances that could emit those GHGs is regulated by the State of Maine. Wastewater process emissions and SF_6 fugitive emissions were not examined.

Scope II | Indirect Emissions from Electricity

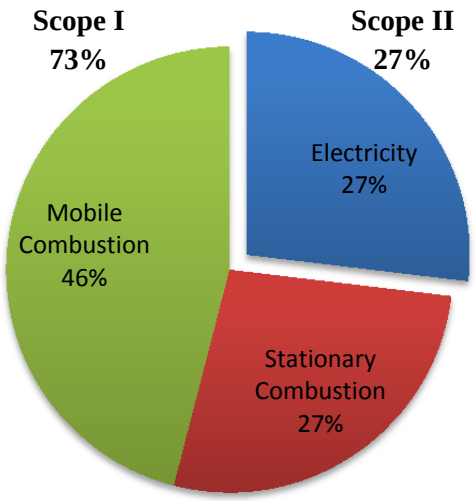
Indirect Scope II emissions result from activities within the Portland city limits, but occur at sources owned or controlled by other entities. This includes all power generation supplied as electricity. The Portland community's indirect emissions include all emissions that occur elsewhere in order to provide electricity to the residential, commercial, and industrial sectors of the city.

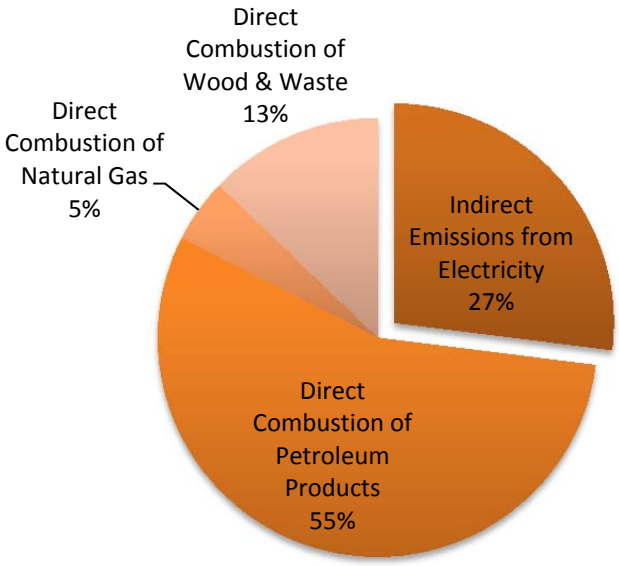
Electrical power data was obtained from Central Maine Power Company in the form of kilowatt-hours per sector (residential, commercial, and industrial) for each month of the 2010 calendar year. These kWh totals were then converted to metric Tons using the electricity emissions factor provided by The Climate Registry.

Scope III emissions were not examined in this inventory. These could include upstream emissions from the production and transportation of any materials used by the City of Portland as well as downstream emissions from the transportation and use of sold products. Future year inventories may decide to include Scope III emissions.

RESULTS

Community Emissions by Scope and Source





Emissions by Scope: Summary

Of all 2010 GHG emissions from Portland, 73 percent were direct Scope I emissions caused by the stationary and mobile combustion of petroleum, natural gas, and waste. 27 percent of all emissions were indirect Scope II emissions caused by processes that occur outside of city limits in order to provide the city of Portland with electrical power.

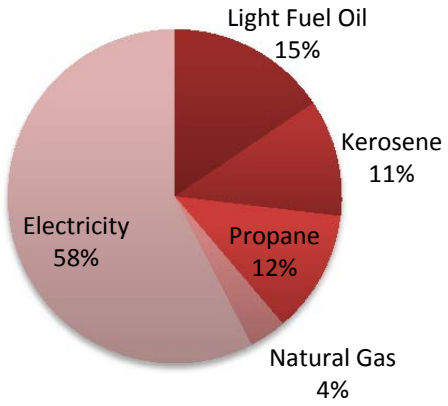
	Emissions (Tons CO_2e)
Scope I	835,461
Scope II	307,336

	Emissions (Tons CO_2e)
Mobile Combustion	525,403
Stationary Combustion	310,058
Electricity	307,336

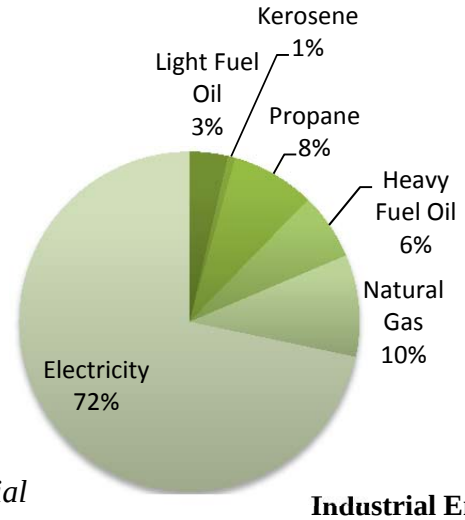
Source (Summary)	Emissions (Tons CO2e)
Petroleum Products	606,345
Natural Gas	51,381
Wood and Waste	139,988
Electricity	307,336

Community Emissions by Sector and Fuel Source

Residential Emissions by Source

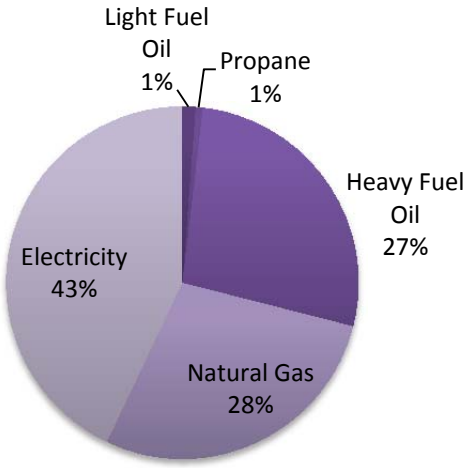


Commercial Emissions by Source



Residential, Commercial, and Industrial Emissions: Summary

Industrial Emissions by Source



The largest sources of GHG emissions in the residential, commercial, and industrial sectors were indirect emissions from electricity. The next largest sources of emissions were fuel oil and natural gas. Light fuel oil was the next largest contributor to the residential sector, while natural gas was the next largest source in the commercial and industrial sectors. Kerosene and propane resulted in a large portion of residential emissions, but did not contribute as substantially to emissions from the other two sectors. Heavy fuel oil made up a much larger portion of industrial emissions than the other two sectors' emissions.

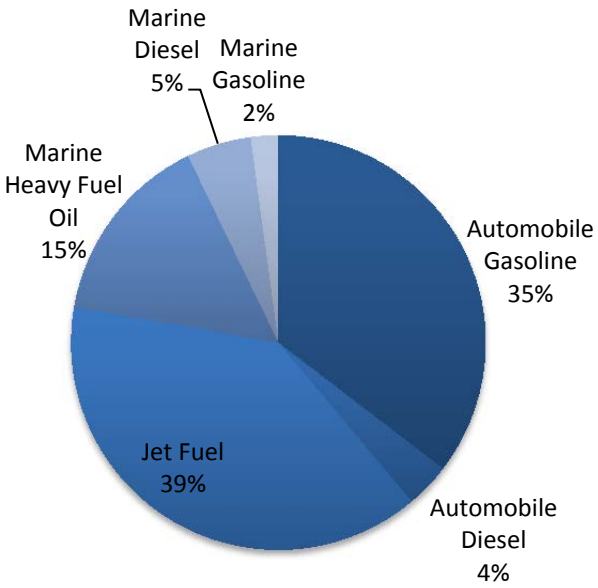
Source	Residential (Tons CO_2e)	Commercial (Tons CO_2e)	Industrial (Tons CO_2e)
Electricity	70,368	201,710	33,334
Light Fuel Oil	18,836	9,862	900
Heavy Fuel Oil	-	17,188	20,165
Propane	14,416	21,340	492
Kerosene	13,710	1,849	-
Natural Gas	4,349	26,142	20,890
Wood	183	-	-
Total Emissions	121,252	269,513	74,409

Mobile Combustion Emissions: Summary

The two modes of transportation that produced the most emissions in the transportation sector were airplanes and automobiles, which each accounted for 39 percent or the total. Thus the fuels that produced the most emissions were jet fuel and gasoline. Heavy fuel oil used by marine vessels was the next largest contributor to all transportation emissions, and diesel fuel used by automobiles and marine vessels resulted in the smallest portion of emissions.

Mobile Combustion Source	Emissions (Tons CO_2e)
Automobile Gasoline	185,907
Automobile Diesel	18,382
Jet Fuel	204,047
Marine Heavy Fuel Oil	79,321
Marine Diesel	26,441
Marine Gasoline	11,305

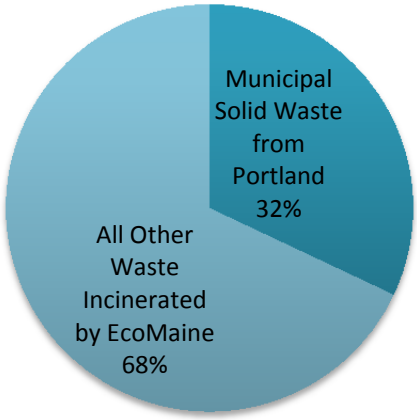
Mobile Combustion Emissions by Mode and Fuel Source



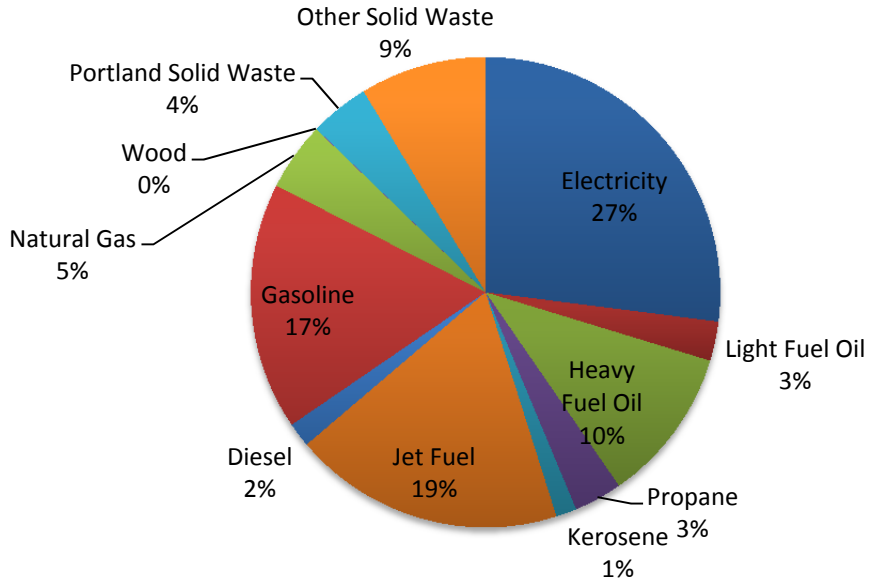
Solid Waste Emissions: Summary

Solid waste from the greater Portland area was incinerated at the EcoMaine plant, which operates within city limits. In 2010, the municipal solid waste from the Portland community was burned to emit a total of 44,745 Tons CO2e, which was app. 32 percent of the total emissions produced by the EcoMaine incineration plant in 2010.

Solid Waste Emissions by Source



2010 Community Emissions by Fuel Source



Emissions by Source: Summary

Although electrical power was the largest single source of emissions, the fuels that accounted for the most emissions were jet fuel, gasoline, and heavy fuel oil. The next largest source of emissions was solid waste, followed by natural gas. Other petroleum products and wood were the smallest sources of total Portland GHG emissions in 2010.

Fuel Source	Emissions (Tons CO_2e)
Electricity	307,336
Jet Fuel	204,047
Gasoline	185,907
Diesel	18,382
Natural Gas	51,381
Light Fuel Oil	29,598
Heavy Fuel Oil	166,604
Propane	36,249
Kerosene	15,560
Wood	183
Portland Solid Waste	44,745
Other Solid Waste	95,060

DISCUSSION

While it is beyond the scope of this community emissions inventory to make detailed recommendations based on the data presented above, a few general trends may be highlighted for consideration in further study.

Mobile combustion alone produced a larger portion of the total Portland GHG emissions in 2010. The majority of these emissions came from the combustion of jet fuel by airplanes and the combustion of gasoline by automobiles. Although airplanes are a very specific target for emissions reductions, low data quality should be taken into account, because jet fuel consumption had to be estimated from national totals. Since the nature of air and sea travel is inter-city, reductions in emissions from jet fuel and marine fuels need to be examined on a much larger scale than fuels used by automobiles. Automobile emissions could be lowered by increasing vehicle fuel efficiency and use of public transportation. According to the 2005 GHG Inventory and Energy Audit conducted for Portland, emissions from automotive transportation have decreased from 323,805 in Tons CO_2e in 2005 to 204,289 Tons in 2010. This is nearly a 37 percent decrease in five years. However, the calculation of emissions is inconsistent between the 2005 inventory and the 2010 inventory, which makes changes difficult to ascertain. Even though all data is not consistent, there are ample opportunities for emissions reductions in the modes of transportation involved in mobile combustion.

Electricity accounted for the largest portion of residential, commercial, and industrial emissions in 2010. The electrical power total for kWh consumption and GHG emissions is the most accurate data available, thus reductions in this energy source could be easily monitored and reported by future inventories. There are opportunities to reduce the use of electricity in the residential, commercial, and industrial sectors.

Although stationary combustion data for petroleum fuels and natural gas should have been as accurate as electricity data, there was a lack of cooperation from the natural gas utility and the fuel providers. There are many opportunities for reductions in the emissions caused by the stationary combustion of these sources, but low data quality will make comparing these emissions to those in future years more difficult.

Solid waste incineration accounted for 12 percent of total emissions in Portland in 2010. Solid waste totals, are also some of the most accurate data used in the inventory. The incineration plant is more efficient than land filling in some ways, such as its production of electricity and its transformation of methane-producing waste into inert ash. However, the opportunities for emissions reductions in waste incineration rely on the amount of waste produced. Waste

reduction in the future could result from decreasing the consumption of some products and materials, increasing the reuse of some products and materials, and increasing recycling rates.

Although the results of this inventory show the composition of the community's greenhouse gas emissions, they cannot accurately forecast opportunities to reduce emissions. Mobile combustion emissions, although they are more difficult to monitor and quantify, are the largest single area in which energy consumption could be reduced. Since the most accurate data are the emissions caused by electricity and solid waste, these may be areas where reductions can be most easily monitored and compared to inventories for past and future years.