2009 Carbon Footprint Report for the Community of Braintree, Massachusetts

Prepared by

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A community advocacy group for sustainable living and environmental awareness

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"Saving the environment" has been a buzz phrase since Rachel Carson's book, *Silent Spring,* was published nearly 50 years ago. Al Gore's *An Inconvenient Truth* provided a new surge of commitment among people who want to preserve and protect the finite resources of our planet for future generations. At no time has it been so urgent to concentrate individual and collective talent and imagination within the community to create real solutions to climate change.

Sustainable Braintree started out as a small group of concerned residents, who wanted to reduce their own impact on the environment while maintaining a quality lifestyle. Although governmental inaction on all levels prevailed, we believed that climate change is a real and an urgent issue for which all citizens are responsible.

One year later, much has changed. Sustainable Braintree, Inc. has evolved into an advocacy group promoting sustainability and environmental stewardship in our community. Momentum has been building within Sustainable Braintree, town government, and other organizations to make a difference – a difference we hope will make our community a leader in energy conservation, renewable energy, recycling, and many other sustainable benefits to our community.

Sustainable Braintree conducts much of its work through three task forces: Food (which coordinates the Braintree Farmers Market), Recycling, and Energy. Within each group, committed individuals actively work to search out valuable information, educate the community, and help implement sustainable projects within our community. Through these efforts, Sustainable Braintree seeks to build a sense of community sustainability that will carry us into the future.

We invite you to join us in the advancement of environmental awareness and sustainable practices in all our community efforts. Help to make a difference and be a part of the effort to make the Town of Braintree a leader in environmental responsibility.

Mary Mitchell
2009 President
Sustainable Braintree, Inc.

A community advocacy group for sustainable living and environmental awareness

Introduction

Consumption of energy in the United States exceeds all other developed countries on a per capita basis. Typical American households generate 2-3 times as much carbon from energy use than European households. Recent studies show that the average American household wastes as much as 40-60% of the energy through lifestyle habits, inefficient heating and cooling, and poor building insulation.

As much as we tout our standard of living to the world, it comes at a significant environmental cost. We import more than half our liquid and gaseous fossil fuels from foreign countries. We lag in renewable energy resources compared to Europe. Green space is rapidly eaten up by suburban sprawl. All of our lifestyle choices and governmental inaction has left us adrift in a perfect environmental storm. This is the *Inconvenient Truth* as Al Gore puts it.

Sustainable Braintree wants to change that in our community. We believe that one can maintain a quality lifestyle and minimize environmental impact through awareness and sustainable practices. We know that even small contributions can result in long term benefits. Those benefits are not just environmental, but also financial. Replacing a single 60 watt incandescent lamp with a 13 watt compact fluorescent lamp (CFL) not only saves 100 lbs of carbon/year, but can save $7-$10 per year through lower electric bills. Not a bad deal since a CFL can be purchased today for as little as a dollar. There are other numerous lifestyle and low cost options available for energy conservation. And any burden, how little, lifted from our stressed environment is a benefit to our community and its residents.

This is our first town carbon footprint. It represents an effort to establish a baseline to compare our future efforts toward sustainability. We recognize that in years coming our goal of sustainability may change in its priorities and go through further refinements as we begin to get into a daily mind set of sustainability and environmental awareness. Sustainable Braintree will use this and future reports to gauge its progress in promoting sustainability. We also invite town residents, businesses, and government to use this report as a base metric in their endeavors as well.

Our Data Sources

As with all studies of this nature, we had to make some assumptions. The assumptions and emission factors used in this study were taken from governmental sources, whenever possible.

We gathered information from diverse sources: census data, National Grid, Braintree Electric & Light Department (BELD), town government, The US Environmental Protection Agency (USEPA), and the US Department of Energy (USDOE). Another source of information was David Gershon's 2006 *Low Carbon Diet* book and we used selected information from his book on how to calculate carbon reductions available through lifestyle, low cost, and capital energy conservation measures.

We focused on carbon dioxide (CO_2) emissions measured as carbon in short tons. We understand that there are also greenhouse gas impacts from methane, nitrogen dioxide, and other air pollutants, according to the USEPA. However, we elected to keep our first study simple and recognize that emissions calculated are conservative in nature, but allow us to establish a reasonable baseline metric to start our sustainability efforts. For future comparisons, reducing carbon dioxide emissions generally reduces emissions from the other pollutants as well.

Where important assumptions are made and caveats used, we provide the supporting resources. It is our intention to further refine this study in the future to develop a reliable tool for measuring our sustainability gains in our community.

Government Sector

The Town of Braintree owns and operates Town Hall and 28 other buildings that provide a wide variety of municipal services. The following energy usage for the municipal services in the Town of Braintree are as follows:

14,077,831 kWh provided to municipal buildings.

869,867 kWh provided for area (street) lighting.

12,975 gallons of No. 2 fuel oil used for comfort heating.

724,230 therms of natural gas used for comfort heating.

96,602 gallons of gasoline used by municipal vehicles.

13,552 gallons of diesel fuel used by municipal vehicles.

Using the Town budget and average dollars per unit cost, we looked at how energy use was segregated by Town department and energy source. We appreciate that a direct measure of energy would have provided a more accurate measure; however, we believe that 2008 expenditures and the average cost per unit energy over the entire year provides a reasonable estimate of carbon emissions at this time. The electric and natural gas cost per unit were negotiated rates for the entire Town. The following table shows the energy usage by Town department.

Department	Electric (kWh)	Fuel Oil (gal)	Natural Gas (therms)	Diesel Fuel (gal)	Gasoline (gal)
Animal Control	21,775	0	2,523	0	0
Fire	445,350	0	27,649	9,315	10,229
Public Works	227,660	4,908	0	2,527	30,348
Town Hall/Offices	534,049	0	38,564	0	0
Council on Aging	64,311	1,410	428	0	1,901
Library	840.519	0	13,617	0	92
Golf Course	364,684	0	0	1,710	1,840
Water/Sewer	904,636	0	16,020	0	0
Water Treatment Plant	630,829	196	45,176	0	12,269
Schools	9,979,675	1,107	580,253	0	3,267
Police	64,343	5,354	0	0	36,656
Area Lighting	869,867	0	0	0	0
Annual Total	14,947,698	12,975	724,230	13,552	96,602

We then calculated the carbon emissions rounded to the nearest short ton for each Town department and by energy source.

Department	Electric	Fuel Oil	Natural Gas	Diesel Fuel	Gasoline	Total
Animal Control	10	0	15	0	0	25
Fire	200	0	162	104	100	566
Public Works	102	55	0	28	296	481
Town Hall/Offices	240	0	226	0	0	466
Council on Aging	29	16	2	0	19	66
Library	378	0	80	0	1	459
Golf Course	164	0	0	19	18	201
Water/Sewer Pump	259	0	94	0	0	353
Water Treatment Plant	284	2	265	0	120	671
Schools	4,491	12	3,403	0	32	7,938
Police	29	60	0	0	358	447
Area Lighting	391	0	0	0	0	391
Annual Total Carbon tons	6,578	145	4,247	151	944	12,065

Note 1: Conversion factors were taken from the Energy Information Administration, USDOE data.

2.325 lbs carbon per kWh. See Note 2 below.
22.38 lbs carbon per gallon fuel oil.
11.73 lbs carbon per therm. See Note 4 below.
19.56 lbs carbon per gallon of gasoline.
22.38 lbs carbon per gallon of diesel fuel.

Note 2: To get lbs carbon per kilowatt hour, we used the percentage of fuel sources used to provide electricity in the Town provided by BELD and New England ISO and calculated the relative emission factor by power source allotment using Energy Information Administration, USDOE emission factors. Electricity provided from:

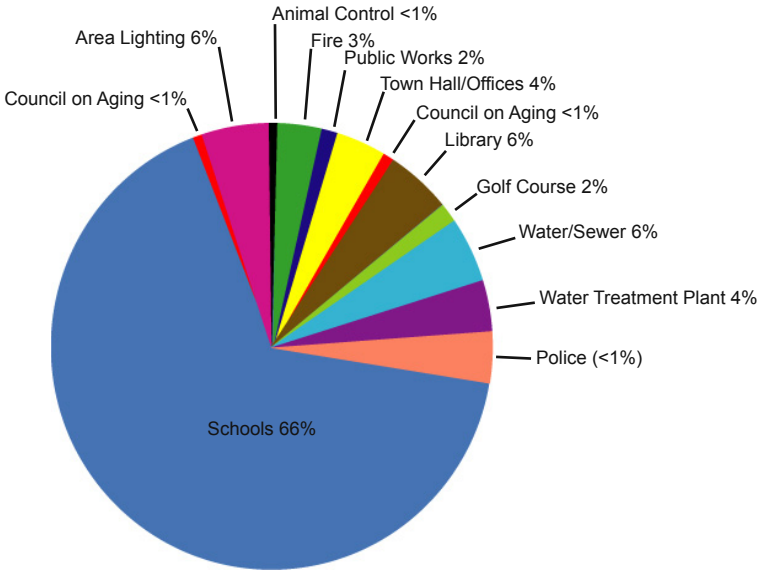
1.3 lbs carbon per kWh from natural gas plants (31%).
2.0 lbs carbon per kWh from fuel oil plants (18%).
2.1 lbs carbon per kWh from coal plants (6.5%).
0.0 lbs carbon per kWh from mix of nuclear, biomass, hydroelectric, waste, and renewables (44.5%).

This yields a relative emission factor of 0.90 lbs carbon per kWh from electricity provided to our Town.

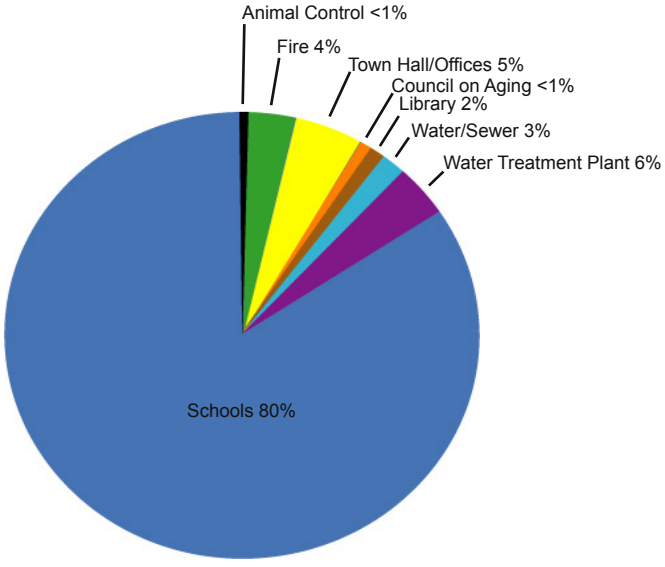
Note 3: Carbon emissions from nuclear, hydroelectric, and renewables are considered negligible and are for this analysis listed as zero emissions.

Note 4: The Energy Information Administration emission factor for natural gas is 120.59 lbs per 1,000 ft^3. We converted this to 11.73 lbs carbon/therm. A therm is equal to 100,000 Btu or 97.27 ft^3 of natural gas at 1,028 Btu per cubic foot.

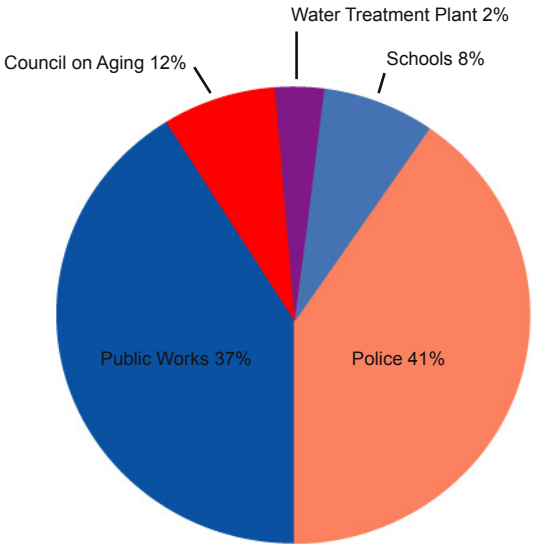
To provide a comparative sense of carbon emissions by town department, we prepared the following pie charts.



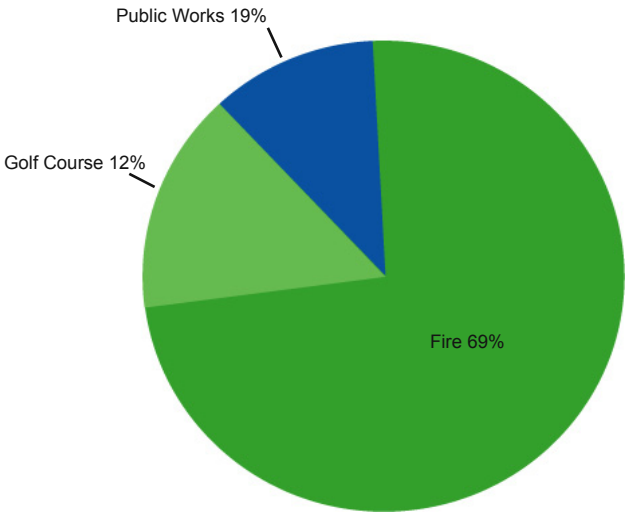
Percent Carbon Emissions from Electric Usage



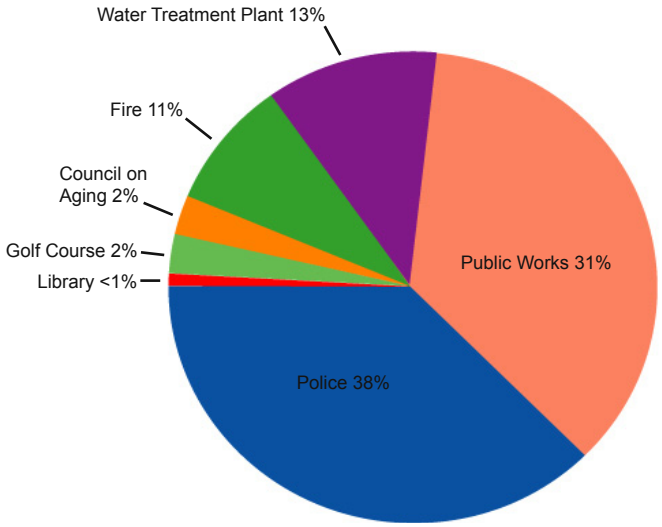
Percent Carbon Emissions from Natural Gas for Comfort Heat & Domestic Hot Water



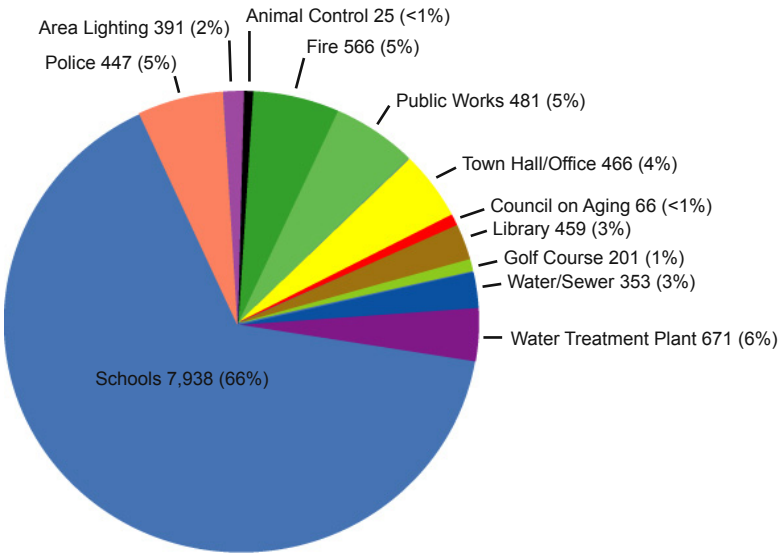
Percent Carbon Emissions from Fuel Oil for Comfort Heat



Percent Carbon Emissions from Vehicle Diesel Fuel



Percent Carbon Emissions from Vehicle Gasoline



Total Tons (%) of Carbon Emissions from All Energy Use in Municipal Sector

Government Sector Summary

6,578 tons of carbon from electric usage.

4,392 tons of carbon from comfort heat.

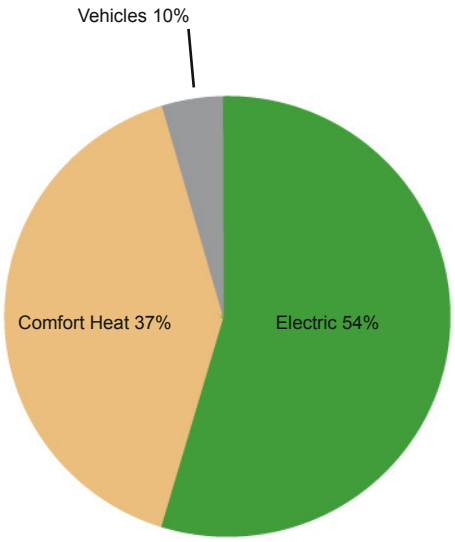
1,095 tons of carbon from vehicle fuel usage.

0 tons of carbon from waste disposal (included in residential sector tally).

12,065 total tons of carbon for this sector.

or

24,130,000 lbs of carbon



Percent Carbon Emissions from All Energy Sources in the Municipal Sector

Residential Sector

Residential energy use represents about 21% of the carbon emissions as a national average according to the Office of Energy Administration (USDOE).

Looking from 2007 back 10 years, residential energy use for heating and cooling has remained essentially flat overall per household and actually has declined in some areas. Significant gains in permanent and lifestyle energy conservation measures appears to be offsetting, what might otherwise would be, significant increases in fossil fuel consumption. This energy conservation movement in all sectors (not just residential) is based on the incremental, but significant, rise in fossil fuel costs over the last two decades and our growing need for foreign fuels. Comfort heat and cooling energy costs have begun to take a bite out of our disposable income, rising as much as 10-20% per annum even though fuel use is relatively flat per household. The recent decline in prices from an extraordinary spike in fossil fuel cost in the summer of 2008 is a welcome relief, however, government agencies tracking long term energy costs predict a continual cost rise for the next decade.

Residential electricity use, on the other hand, is steadily increasing at 1-5% per year depending on the area. Renovations and new construction generally have more lighting for larger square footage and larger appliances. Refrigerators, freezers, stoves/ovens, dryers, and electric hot water heaters represent the biggest percentage of a residential electric bill.

Lighting can represent up to 20% or more of a typical electric bill. To offset lighting increases, we see improvements in lighting options, from compact fluorescent lamps (CFLs) to the next generation lighting, LED bulbs. CFLs save us money and they only use 25% of the electricity compared to equivalent wattage incandescent lamps, but they need mercury to produce the light. They represent a environmental hazard if they are disposed and not recycled. The next generation LED bulbs are touted as the next holy grail. They use 90% less energy, last 10 times longer than CFLs (which last 5-7 times longer than incandescents). LED bulbs are 5-10 times more expensive than CFLs now. But the general prediction among industry leaders is that LEDs will drop in price within five years to make them a viable option for residential use.

Computers and digital televisions consume 10-15% of our electric bill depending on daily use. Improvements in their efficiencies through the USEPA's Energy Star Program has helped to reduce their overall power consumption. But, again as consumers, we crave for bigger in-home entertainment systems, computer monitors, and other gadgetry. So it is not clear what the real savings may be, if any, on a household basis. Then there is *phantom energy* – the fact a computer or television is not really off when you turn it off. Some components are kept on low power to allow "instant-on". The growth of residential phantom energy consumption is a direct reflection of our instant-on culture. It can now represent as much as 8-11% of a typical electric bill today.

To power our homes, 50% of our electricity comes from coal-fire plants, another 25% from natural gas, 5% from fuel oil, 19% from nuclear, and the remaining a mix of hydro-

electric, biomass, municipal waste, and renewables (wind and solar). Coal power plants emit 81% of the carbon emissions from the power industry in this country, followed by 15% from natural gas, 3% from fuel oil, and 1% from municipal waste. Nuclear, biomass, hydroelectric, and renewables are considered negligible sources of emissions.

For our carbon analysis, we obtained the number of residential buildings from the Town Tax Collector for 2008 as follows:

8,985 single households.

1,426 condominiums.

31 unclassified residences

409 2-family houses.

82 3-family houses.

75 apartment buildings with at least four units.

We combined them to yield a town-wide number of households of 11,806. For this analysis, we assumed the minimum four units per apartment (defined by the Tax Collector) because we do have not accurate data on the actual number of apartments in the Town at this time.

In some instances, we also used 2000 census data as a starting point to look at different fuel usage for comfort heat.

Residential Electric

BELD provided us with the 2008 electric usage by sector. Total kilowatt hours for residential service was 112,195,924 kwh.

We then divided this total according to the percentage of fuel sources used to provide electricity in the Town as follows:

7,292,737 kWh came from coal plants (6.5%).

34,780,736 kWh came from natural gas plants (31%).

28,609,960 kWh came from nuclear plants (25.5%).

20,195,266 kWh from fuel oil plants (18%).

21,317,225 kWh from a mix of biomass, hydroelectric, waste, and renewables (19%).

Based on these power allotments, we calculated the carbon emissions according to the Energy Information Administration (USDOE) emission factors and tallied them up.

50,488 total tons of carbon emissions from residential electric usage.

Note 1: To get lbs carbon per kilowatt hour, we used the percentage of fuel sources used to provide electricity in the Town provided by BELD and New England ISO and calculated the relative emission factor by power source allotment using Energy Information Administration, USDOE emission factors. This yields a relative emission factor of 0.90 lbs carbon per kWh from electricity provided to our Town. See Note 1 on page 4 for more details.

Note 2: According to 2000 census data, 8.3% of the households also use electricity for comfort heat.

Residential Comfort Heat

Natural Gas Usage

National Grid provided us with the gas usage for comfort heat for the period of 2002 through 2008. We also used the 2000 Census data for estimating the percentage of different fuels used for residential comfort heat and hot water. We assumed for this analysis that for households using, let's say, natural gas for comfort heat, also used it for domestic hot water and cooking. In general, cooking represents 1-2% of the monthly natural gas bill and hot water up to 10% – the rest being allotted to comfort heat.

4,708,912 therms of natural gas for residential usage in 2008.

34.9% households that use natural gas for comfort heat (may include domestic hot water and cooking).

Fuel Oil Usage

We were unable to find relatively accurate fuel oil usage for comfort heat data for our Town. There are numerous suppliers, both located in town and outside town, that deliver to residents here. So we took data from Energy Information Administration (USDOE) and the 2000 Census to give us an estimate of fuel oil usage.

730 gallons of fuel oil per residence national average.

55.1% households that use fuel oil for comfort heat (may include domestic hot water) in New England.

8,618,380 gallons of fuel oil for residential usage in 2008.

Electric Usage

Our previous estimated residential electric usage also included that used for comfort heat and/or domestic hot water. It is not counted towards emissions under this analysis for comfort heat because there is no way to accurately determine how many kilowatt hours were used only for comfort heat from our available data. However, according to the 2000 Census data, 8.3% of the households in the Town have electric heat.

Propane Usage

We were unable to find relatively accurate propane usage for comfort heat data for our Town. Approximately 1% of the households use propane for comfort heat according to the 2000 Census data. As a substitute analysis, we prorated the natural gas usage above

which is assumed to be similar on a per household basis, and applied it to propane usage. That yielded:

134,925 therms of propane for residential usage.

1% households that use propane for comfort heat (may include domestic hot water and cooking).

Other Fuel Usage

According to 2000 Census data, less than 1% of the households used other fuels – wood, solar, wind, coal, and other unidentified fuels. The USEPA considers solar and wind sources as having zero carbon emissions potential. Six residences used wood for comfort heat according to 2000 Census data. At this time, the USEPA considers emissions from wood burning as having zero potential impact. Only 26 residences used coal in 2000 and we suspect that number has likely decreased since then. Because of this small statistical significance compared to total emissions in this sector, we chose not to analyze the emissions impact from these sources at this time.

Summary

Based on our analysis of each comfort heat fuel source, we determined the following:

27,617 tons from natural gas.

96,440 tons from fuel oil.

0 tons from electric usage (previously counted as part of overall residential electric usage)

939 tons from liquid propane.

124,996 total tons of carbon emissions from residential comfort heat.

Note 1: Conversion factors were taken from the Energy Information Administration, USDOE data.

0.374 lbs carbon per kWh
22.38 lbs carbon per gallon fuel oil
11.73 lbs carbon per therm (120.59 lbs per 1,000 ft^3 natural gas)
12.67 lbs carbon per gallon of propane

Note 2: The Energy Information Administration emission factor for natural gas is 120.59 lbs per 1,000 ft^3. We converted this to 11.73 lbs carbon/therm. A therm is equal to 100,000 Btu or 97.27 ft^3 of natural gas at 1,028 Btu per cubic foot.

Residential Household Waste

Nowhere is our standard of living so prominently displayed as in the amount of solid waste generated weekly by American households. We live in a disposable economy touted for its convenience. We have junk food, junk cars, junk electronics, and last year's fashions and toys. All of this convenience and the question of need versus luxury puts a strain on our environmental resources. Our economy has the world's largest trade deficit because we can't produce enough of what we want. Not only are we depleting our own resources, Americans are depleting the resources of foreign countries to justify their standard of living, highest in any industrialized country in the world.

The USEPA states that in 2006 (last year data was available), an average 4.6 lbs of trash and garbage was generated per person daily in this country. This is 25-50% more than European residents. The good news is that the USEPA says that approximately 60% of household trash is recyclable. Another 15-20% is compostable, leaving only 20-25% unrecoverable as waste. Nationally, 31% of household wastes are recycled. More good news, although there is room for significant improvement.

The Town provided us with the quantity of household waste collected for disposal and recycling in 2008.

17,300 total tons of household waste generated in 2008.

15,000 tons of household waste disposed.

2,300 tons of household waste recycled.

That equates to only a 13% recycling rate in our Town. To reach the national average rate we would have to recycle an additional 3,100 tons of household waste. In late 2008, our Town embarked on single stream curbside recycling on trash day. Recyclables are placed in a can or bin separate from trash and picked up by a truck dedicated to recyclables. We are encouraged that our recycling rate has significantly improved to approximately 21% by making recycling convenient and through community outreach. The Town receives $22 per ton recycled versus $55 per ton disposed, a net to the Town of $77 per ton – a savings of $121,000 if we could reach the national recycling rate of 31%.

Our household wastes are incinerated at a regional solid waste incinerator. There is a benefit to this; the USEPA says that incinerating wastes and then generating energy from that incineration results in less emissions than if the waste was only landfilled. This reduction is primarily from electricity generated by incineration, which would otherwise be generated in power plants. However, the USEPA also says that recycling wastes reduces emissions 10-15 times more than either incineration or landfilling. For example, recycling an aluminum soda can and making it into a new one saves 96% of the energy needed to make a soda can out of virgin ore. Or consider that a ton of waste newspaper, when

recycled, saves 20-70% of the energy to make virgin paper and also saves approximately 17 trees. This fact alone makes recycling as much household waste as possible a mandate for sustainable living in our community.

To estimate the carbon emissions, we first assumed that all of the household wastes were incinerated to provide a baseline metric.

17,300 total tons of household waste.

2,076 tons from incineration.

Note 1: Conversion factors were taken from USEPA 2006 data.
0.12 tons of carbon emissions per ton of waste (includes transportation).

We then took a credit for emissions saved from recycling a portion of our household wastes.

2,300 tons of household waste recycled.

276 tons saved from incineration.

Leaving:

1,800 total tons of carbon emissions from incineration.

According to the USEPA, approximately 550 kW are generated per ton of household waste incinerated. That yields:

200,242 kWh generated from incinerating 15,000 tons of household waste.

Note 1: The SEMASS incinerator in Rochester, MA has a maximum process feed rate of 41.2 tons per hour. We used this rate for our estimate.

Since the electricity saved by converting our household waste to energy means an equivalent of kilowatt hours were not generated by power plants, we took another credit. (Note, however, the waste-to-energy electricity may not have been used in our Town. Since it was still used by someone else in place of native power, we are taking the credit anyway for our waste.)

90 tons saved from electricity generated from our household waste.

Note 1: To get lbs carbon per kilowatt hour, we used the percentage of fuel sources used to provide electricity in the Town as provided by BELD and New England ISO and calculated the relative emission factor by power allotment using Energy Information Administration, USDOE data. This yields a relative emission factor of 0.90 lbs carbon per kWh from electricity provided to our Town. See Note 1 on page 4 for more details.

Our carbon emissions from disposal of household wastes, taking our credits for recycling and waste-to-energy electricity came to:

1,710 total tons of carbon emissions from our household waste.

At this time, there are also carbon emissions and credits for white goods (refrigerators, washers, dryers, etc.) recycled curbside and yard waste taken to our Town Compost Center. We did not investigate the emissions generated or saved because we do not have reliable data at this time. When this data becomes available in the future, we will incorporate it into this analysis.

Residential Transportation

The automobile is the classic American icon. Henry Ford turned the automobile from a luxury into the common man's need. Today, the United States has 5% of the world's population and 30% of the world's passenger automobiles, but we contribute 45% of the world's automotive carbon emissions (2006 Environmental Defense Fund data). SUVs, pickup trucks, and large cars contribute 55% of the emissions in this country. Small and mid-size cars contribute the rest.

The Town of Braintree is located on the South Shore where two major highways converge north to Boston. The Town is impacted by its own residential driving habits as well as 200,000 commuters that drive those highways and our local streets daily. For this exercise, we decided only to look at the direct emissions contribution by Town residents. We recognize that as a Town we have no control over daily highway commuter traffic and, therefore, want to use only direct contribution as a future sustainability metric.

35,550 automobiles in the Town of Braintree (2008 Town data).

12,500 miles driven annually on average.

122,674 tons from direct emissions from the light truck category.

103,852 tons from direct emissions from the passenger vehicle category.

226,526 tons of total carbon emissions for resident transportation.

Note 1: Conversion factors were all taken from USEPA 2006 data.
21.5 mpg national average across all vehicle makes and types
0.916 lbs of carbon per mile directly emitted by passenger vehicles
1.15 lbs of carbon per mile directly emitted by light trucks (includes SUVs, large cars, and pickup trucks)

Note 2: The light truck category includes SUVs, pickup trucks, and other large cars. This represents 48% of the national fleet of passenger vehicles. So we calculated the carbon emissions at 48% light truck and 52% passenger vehicle emissions, respectively.

Note 3: We saw estimates in the range of 10,000-15,000 miles driven/year from federal government sources. So we used 12,500 miles/year.

Please note that these emissions are not restricted to driving within Town limits and represent direct contribution by town residents in all of their driving miles.

Residential Sector Summary

50,488 tons of carbon from electric usage.

124,996 tons of carbon from comfort heat.

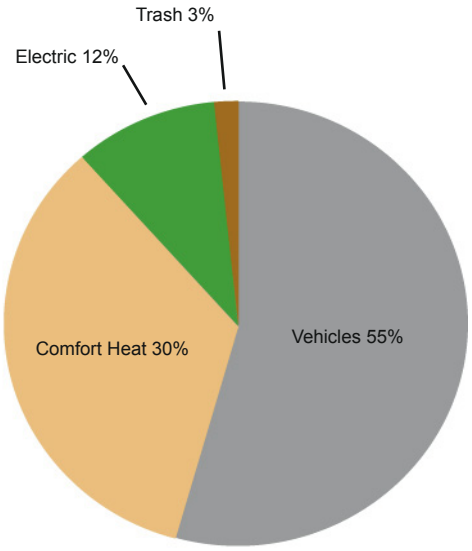
1,710 tons of carbon from household waste disposal.

226,526 tons of carbon from resident driving.

403,720 total tons of carbon for this sector.

or

807,440,000 lbs of carbon



Percent Carbon Emissions from All Energy Sources in the Residential Sector

Commercial/Industrial Sector

Our Town is a diverse community. Only 11 miles from Boston via highway and with a commuter rail station, our Town is well situated as a suburban hub of residences and local employment.

Industry and commercial businesses are also a diverse mix. Based on business data from city-data.com, an online data source for cities nationwide, our Town has about:

41 manufacturing companies.

84 wholesalers (business-to-business).

286 retail trade companies (business-to-consumer).

44 information companies (broadcast, print, telecommunications, etc.).

53 real estate & leasing companies.

91 professional, scientific & technical service firms.

420 administrative and support firms.

9 education service firms.

110 health care establishments and their support vendors.

15 arts, entertainment, & recreation businesses.

92 hotels & restaurants.

108 other miscellaneous services and businesses.

1,363 total business establishments in our community.

We only looked at electric usage and comfort heat for this sector, because we did not have any reliable data on waste disposal/recycling or fleet vehicles. When that data becomes available, we will include it in the future.

Commercial/Industrial Electric Usage

BELD provided us with the 2008 electric usage for this sector. Total kilowatt hours for commercial service was 220,135,339 kWh and 29,968,950 kWh for the industrial sector.

We then divided these totals according to the percentage of fuel sources used to provide electricity in the Town.

Commercial Sector

14,308,797 kWh came from coal plants (6.5%).

68,241,955 kWh came from natural gas plants (31%).

56,134,511 kWh came from nuclear plants (25.5%).

39,624,361 kWh from fuel oil plants (18%).

41,825,714 kWh from a mix of biomass, hydroelectric, waste, and renewables (19%).

Based on these power allotments, we calculated the carbon emissions using 0.9 lbs carbon per kWh as our relative emission factor for electricity provided to the Town.

99,060 total tons of carbon emissions from commercial electric usage.

Note 1: To get lbs carbon per kilowatt hour, we used the percentage of fuel sources used to provide electricity in the Town as provided by BELD and New England ISO and calculated the relative emission factor by power source allotment using Energy Information Administration, USDOE emission factors. This yields a relative emission factor of 0.90 lbs carbon per kWh from electricity provided to our Town. See Note 1 on page 4 for more details.

Industrial Sector

1,948,046 kWh came from coal plants (6.5%).

9,290,685 kWh came from natural gas plants (31%).

7,642,337 kWh came from nuclear plants (25.5%).

5,394,591 kWh from fuel oil plants (18%).

5,694,290 kWh from a mix of biomass, hydroelectric, waste, and renewables (19%).

Based on these power allotments, we calculated the carbon emissions using 0.9 lbs carbon per kWh as our relative emission factor for electricity provided to the Town.

13,486 total tons of carbon emissions from industrial electric usage.

Note 1: To get lbs carbon per kilowatt hour, we used the percentage of fuel sources used to provide electricity in the Town provided by BELD and New England ISO and calculated the relative emission factor by power source allotment using Energy Information Administration, USDOE emission factors. This yields a relative emission factor of 0.90 lbs carbon per kWh from electricity provided to our Town. See Note 1 on page 4 for more details.

Commercial/Industrial Sector Tally

112,546 total tons of carbon emissions from commercial/industrial electric usage.

Commercial/Industrial Comfort Heat

Natural Gas Usage

National Grid provided us with the gas usage for comfort heat used by this sector for the period of 2002 through 2008.

10,542,764 therms of natural gas for commercial/industrial usage in 2008.

653,516 tons of carbon emissions for the commercial/industrial sector.

Note 1: The Energy Information Administration emission factor for natural gas is 120.59 lbs per 1,000 ft^3. We converted this to 11.73 lbs carbon/therm. A therm is equal to 100,000 Btu or 97.27 ft^3 of natural gas at 1,028 Btu per cubic foot.

Fuel Oil Usage

We were unable to find relatively accurate fuel oil usage by the commercial/industrial sector for comfort heat or manufacturing processes. So we took data from Energy Information Administration (USDOE) regarding fuel usage in the manufacturing sector nationwide to give us an estimate of fuel oil usage compared to natural gas usage above. The Energy Information Administration also says the fuel oil usage in the manufacturing sector has been declining for the past two decades and that less than 3% still use it as a fuel. We assumed that most industrial & wholesale companies, particularly the largest fuel users in Town, were using natural gas because of its common use in comfort heat HVAC units in this area and manufacturing processes. We also assumed that since the industrial sector used only 14% of electricity used by the combined commercial/industrial sector, then an equivalent percentage of total therms was also used by this sector.

1,370,559 therms of fuel oil for industrial average.

978,970 gallons of fuel oil for industrial usage in 2008.

10,954 tons of carbon for the commercial/industrial sector.

Note 1: Conversion factors were taken from the Energy Information Administration, USDOE data.

22.38 lbs carbon per gallon fuel oil

Note 2: There are approximately 140,000 Btu in a gallon of fuel oil. One therm is equal to 100,000 Btu.

Electric Usage

Our earlier estimated commercial/industrial electric usage also included that used for comfort heat and/or domestic hot water. It is not counted towards emissions under this analysis for comfort heat because there is no way to accurately determine how many kilowatt hours were used only for comfort heat from our available data.

Propane & Other Fuel Usage

Based on limited data available to us, we did not have any reliable information on propane and renewables used in the commercial/industrial sector at this time. As with the residential sector, we felt that it was insignificant compared to other fuel sources. When this data becomes available in the future, we will incorporate it into this analysis.

Summary

Based on our analysis of each comfort heat fuel source, we determined the following:

.

653,516 tons from natural gas usage.

10,954 tons from fuel oil usage.

0 tons from electric usage (previously counted as part of electric usage for this sector)

0 tons from liquid propane usage (not available).

0 tons from other fuel usage.

664,470 total tons of carbon emissions from the commercial/industrial sector.

Commercial/Industrial Sector Summary

112,546 tons of carbon from electric usage.

664,470 tons of carbon from comfort heat.

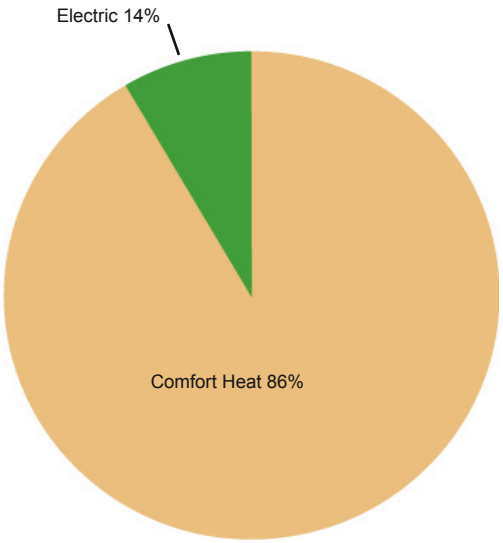
No Data available from waste disposal.

No Data available from fleet vehicles.

777,016 total tons of carbon for this sector.

or

1,554,032,000 lbs of carbon



Percent Carbon Emissions from All Energy Sources in the Commerical/Industrial Sector

Community Summary

Although we were unable to account for some sources of carbon emissions in Town because of lack of reliable data, we feel that the emission values represent a conservative baseline of significant direct sources.

Sector	Electric	Comfort Heat	Vehicles	Wastes	Totals
Government	6,578 (55%)	4,392 (36%)	1,095 (9%)	NA	12,065 (2%)
Residential	50,488 (13%)	124,996 (31%)	226,526 (56%)	1,710 (<1%)	403,720 (33%)
Commerical/Industrial	112,546 (15%)	664,470 (85%)	NA	NA	777,016 (65%)
Total	169,612 (21%)	793,858 (61%)	227,621 (18%)	1,710 (<1%)	1,192,801

Note 1: Values are in short tons of carbon emissions. Values in parentheses are percentage of total emissions. Because of rounding, percentages may not equal 100%.

Note 2: NA means Not Available.

These emission values tell us some interesting things about our Town.

- The commercial/industrial sector, as we suspected, represents the largest carbon emitter (66% of total emissions) in our community. Comfort heat from this sector alone represents 85% of the total emissions. More efficient heating and cooling within this sector would create sizable emission reductions. Since the long term trend in fossil fuel prices is expected to continue upward, investments should look more attractive.
- The residential sector is the second largest emitter (33% of total emissions) in our Town. Residential driving (85%) represents the single dominating emission source followed by comfort heat (31%) and electric use (13%). Unless we change our driving habits and purchase more efficient vehicles, significant emission reductions in this sector will only be from improvements in comfort heat and electric savings.
- Because our household trash is incinerated in a waste-to-energy plant, carbon emissions are very low (0.1% of the community's total emissions) because the electricity generated offsets that from power plants as opposed to landfilling. However, significantly increasing our recycling rate provides a huge environmental benefit by reducing energy that would otherwise be used to turn virgin resources into products even if we do not see a direct community benefit. Plus, it represents a significant financial gain for the Town in reduced disposal costs.

- The government sector represents only 1% of the total carbon emissions in our community. It is analogous to being a large business. Its largest carbon source was electric usage (55%) followed by comfort heat (36%). The largest municipal emitter is the school department (64% of the total) simply because of the number and size of buildings it maintains. Carbon from town-wide municipal vehicle fuel usage represented only 9% of its emissions.

Community Summary

12,065 tons of carbon from the government sector.

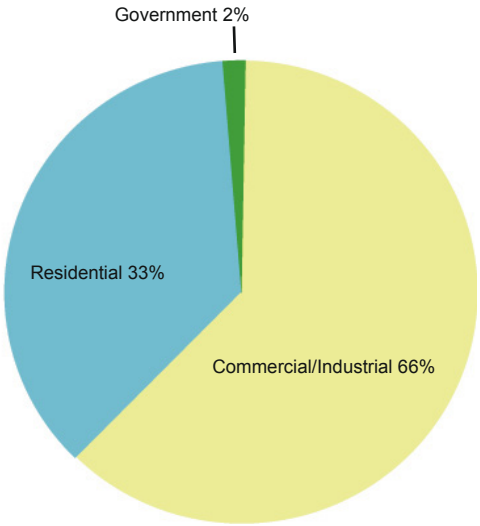
403,720 tons of carbon from the residential sector.

777,016 tons of carbon from the commercial/industrial sector.

1,192,800 total tons of carbon for our community.

or

2,385,600,000 lbs of carbon for our community.



Percent Carbon Emissions from All Energy Sources in the All Sectors

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A community advocacy group for sustainable living and environmental awareness