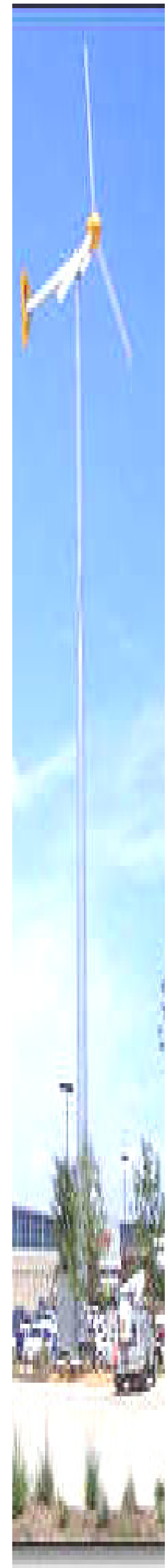
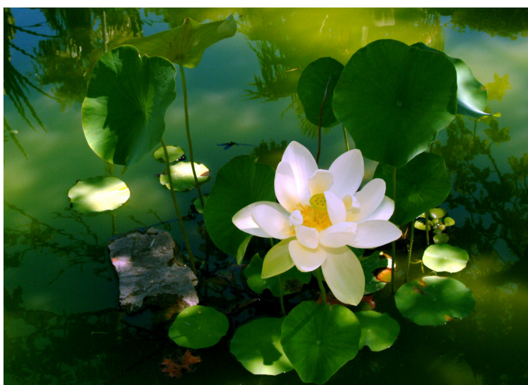
Energy and Environmental Inventory

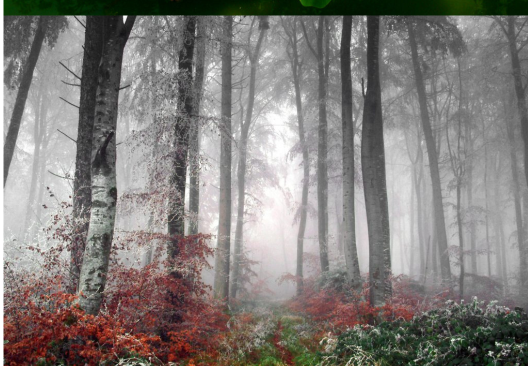
For Marlborough, Massachusetts

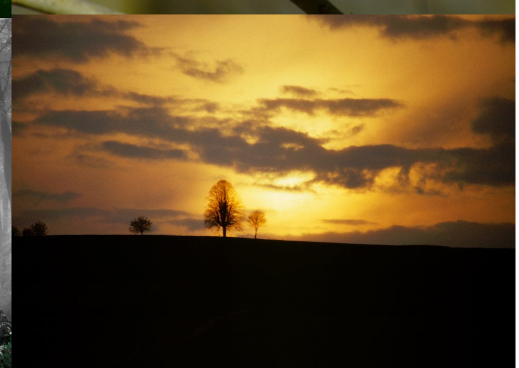
Prepared by Jennifer Boudrie, M.Ed.

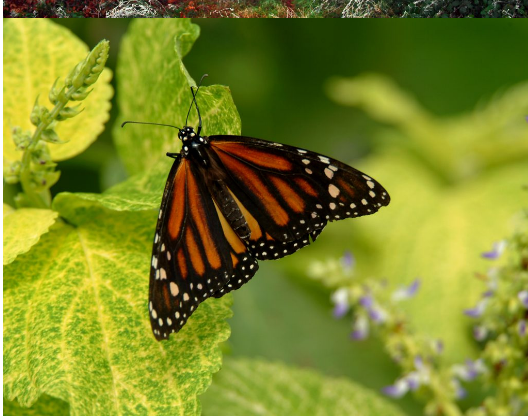
April 16, 2007











Thinking Globally and Acting Locally to Curb Greenhouse Gasses

Introduction & Acknowledgments

Over the past few years, the issue of global warming has grown a great deal in the public consciousness. It is now widely accepted that greenhouse gas emissions are contributing to extreme climate change. Emissions are also having a detrimental impact on our health, and as a nation, we are becoming increasingly aware of energy security, too. (See Appendix A).

Citizens throughout the Commonwealth are asking what can be done on the *local level* to address these important issues directly to reflect their collective values.

While this *Energy and Environmental Inventory* suggests a few answers, it doesn't provide them all. Its primary purpose is to provide a baseline for future energy and environmental measures, and greenhouse gas emissions reductions. The report also takes notice of the positive steps our city has already taken or has planned for the future, but above all else, it attempts to help further the discussion among Marlborough's leaders and members of the community with regard to this important topic.

The process of putting this report together began December 2006 when, as a private citizen, I proposed doing an *Energy and Environmental Inventory* for the city of Marlborough to Priscilla Ryder, Conservation Officer and the City's Conservation Commission. In January 2007 I put the idea before Mayor Nancy Stevens; John Ghiloni, Public Facilities Director; Ron LaFreniere, Commissioner of Public Works (DPW)-Utilities; and Doran Crouse, Assistant Commissioner, DPW-Utilities to gain their approval and assistance in collecting data. The pages that follow are a compilation of information garnered largely from utility officials.

The data represents overall municipal, residential, and commercial use of electricity, natural gas, oil and gasoline, and the associated Carbon Dioxide (CO2) emissions. Clearly buildings and transportation absorb most of our energy, but this report also presents water, wastewater, and recycling information with a particular focus on energy.

But just as importantly we uncovered something more: a keen interest in a value that I have used as the subtitle for this report, which is to say, "thinking globally but acting locally." People in Marlborough want to make a difference.

The next step for Marlborough is to create an energy task force to reduce greenhouse gas emissions produced by the entire city of Marlborough. Over the course of assembling this report, I have come to the conclusion that our city has the talent, community support and interest in getting there—and beyond.

If anyone has any comments or questions about this report, I encourage them to contact me without any hesitation. Your feedback and interest would be appreciated. Finally, I would like to thank all those who made this report not only possible, but a pleasure.

First, I wish to thank Priscilla Ryder, Conservation Officer, who supported this energy inventory and understood its global and local significance. Second, thanks to John Ghiloni, Public Facilities Director, and Doran Crouse, Assistant Utilities Commissioner, for providing access to the people and data needed to write this report. Thanks to Michael Duclos for helping me edit the final draft.

Thanks to Mayor Nancy Stevens whose support made this inventory a possibility.

Thanks to everyone who cooperated with this project and understood its importance, and who will make energy conservation, energy efficiency, and renewable energy efforts a reality and help us do our part locally to reduce the impacts of climate change.

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Methodology

Data Collection

Energy data was collected by telephone and email from city and utility officials: John Ghiloni, Public Facilities Director; Doran Crouse, Assistant Commissioner DPW-Utilities; Don Robinson, National Grid Account Manager; Paul Gedutis, NSTAR Account Manager; and many other city and energy professionals, such as plant managers, fleet managers, private fuel/transportation companies, and transportation experts at Boston Metropolitan Area Planning Council (MAPC). Other data sources included the U.S. Energy Information Agency (EIA), US Census and Marlborough Geographic Information System (GIS) data. Data was also provided by Priscilla Ryder, Conservation Officer and author of the *City of Marlborough Open Space and Recreation Plan, 2003-2008.*

Types of fuel and data sources were:

- Electricity - National Grid
- Natural Gas - NSTAR
- Heating Oil – EIA, US Census, DPW
- Gasoline - DPW
- Diesel - DPW
- Water - DPW
- Waste - DPW
- Land – DPW, Conservation Office
- Transportation - MAPC

Data was collected and analyzed for the following sectors:

- Residential
- Municipal
- Commercial

Data was collected for the entire city. Information on individual buildings was not collected except for municipal buildings (schools, fire and safety buildings, city hall, public works, elderly housing, wastewater treatment plants, Walker building). The individual building information will be published under separate cover and provided to John Ghiloni, Public Facilities Director.

Variables

When interpreting these data it is important to recognize that a number of variables can cause energy use to rise or fall each year. These variables can include population growth, business development, consumerism and weather, all of which can increase energy consumption. Other variables such as energy conservation and efficiency efforts can reduce it. Some of the changes we have seen in Marlborough in the past ten years include the following:

- Population growth has been about 1% per year
- Business electricity usage grew 2.7% per year which amounts to 27% in ten years. Business growth includes additional buildings, electric equipment, and landscaped areas.
- Residential electricity rose 1.4% per year. The increase is directly related to affluence and consumerism. A higher income may mean a larger home, a larger vehicle and larger home appliances that require more energy to operate.
- Municipal efforts to reduce energy costs have led to energy conservation efforts and new energy efficient motors and lighting in some municipal buildings.
- Weather variations affect fuel usage. Less fuel is consumed for heating in warmer winters and more fuel is consumed for air conditioning in hotter summers. (See Appendix B)

Greenhouse Gasses and Carbon Dioxide

The most significant variable in this data is the greenhouse gas calculation. Only one greenhouse gas, carbon dioxide (CO_2), was calculated to simplify the reporting process. If other greenhouse gases (methane (CH_4), nitrous oxide (NO_x), Carbon Monoxide (CO), etc.) were included the total greenhouse gas impact would be much greater than what is reported in this inventory (See Appendix A). Cities for Climate Protection (CCP) software is recommended to calculate additional greenhouse gas emissions. (See Resources, page 40.)

Energy data was used to calculate the amount of carbon dioxide (CO_2) produced using the following EPA formulas rounded to the nearest decimal:

1 kwh = 1 pound CO_2
1 therm = 11 pounds CO_2
1 gallon gas = 20 pounds CO_2
1 gallon oil/diesel = 22 pounds CO_2
2000 pounds = 1 ton

A ton of CO_2 can be represented by a 27 square-foot cube which is roughly the same volume of a two-story house.

Electricity

Where does it come from?

In Massachusetts the bulk of electricity is generated in state. Of the 3,425 thousand MWh produced, 33% of this total is generated by coal-fired plants, 39% by natural gas, 15% nuclear, 7% petroleum, 3% hydro, and 3% renewables. (See Appendix B)

What is it used for?

Electricity is used in buildings for lighting; heating, venting, air conditioning (HVAC); and electrical appliances/machines. It is also used by streetlights, traffic lights, and water pumping stations.

Electricity in Marlborough

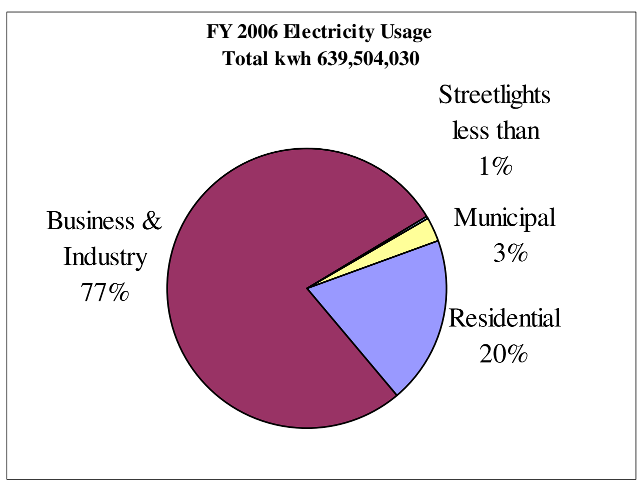
Don Robinson at the National Grid provided electricity data for the table below. This data generated information for the following tables and charts.

Electricity is measured in kilowatt hours (kwh).

	1996		**2000**		**2006***	
	Kwh	# of customers	Kwh	# of customers	Kwh	# of customers
Municipal			17,520,151		17,489,417	
Residential	99,197,175	14,393			124,830,375	15,559
Bus/Industry	360,586,667	2,323			495,253,385	2,511
Streetlights	1,420,522	20			1,930,853	14
Total					639,504,030	

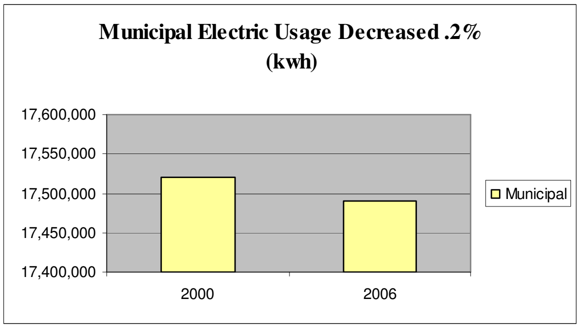
*FY2006 (April 1, 2005 to March 31, 2006)

Business and industry accounts do not include residential, municipal or streetlight accounts. They do include malls, retail stores, hotels, office parks, manufacturing, traffic lights, churches, hospitals, restaurants, and all other accounts metered as commercial accounts. As the chart to the right indicates, Marlborough's business/industry sector is the largest consumer of electricity.



Municipal electricity decreased .2% in six years.

	2000	2006	Decrease
Municipal	17,520,151kwh	17,489,417kwh	.2%



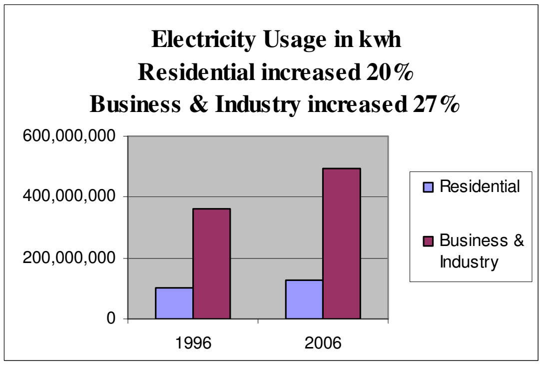
Municipal accounts include the fire, police, and public works departments; public schools; city hall; the public library; the Walker Building; wastewater treatment plants; pumping stations; municipal lighting; and elderly housing.

Marlborough's municipal electricity usage decreased .2% between 2000 and 2006. According to John Ghiloni, this is significant because in 2000 a total of 130,000 square feet were added to the Middle School and 30,000 square feet were added to Jaworek Elementary School. Schools use the largest percentage of municipal electricity. Of the approximately 1.3 million square feet in city buildings, approximately 1 million are public schools.

The reason for the decrease is in part due to the building retrofits of lighting and motors and other energy conservation measures, such as removal of personal electric appliances in schools; however, a significant reason for the decrease was the nearly 500,000 kwh decrease at the wastewater treatment plants after a manufacturing plant was required to install its own wastewater treatment unit. (See Appendix F.)

Residential electricity increased 20% in ten years.
Business and industry increased 27% in ten years.

	1996	2006	Increase
Residential	99,197,175 kwh	124,830,375 kwh	20%
Bus/Industry	360,586,667 kwh	495,253,385 kwh	27%



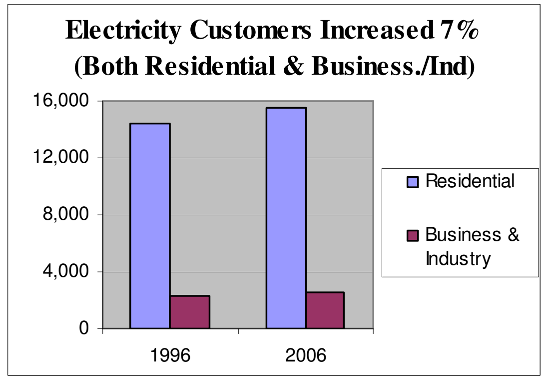
Residential accounts include houses, apartments, and condominiums.

Reasons for the increase include: population growth, business growth, and increased usage per building and per person. The latter is attributed to higher incomes used to buy more consumer goods that require more electricity. Electricity usage also increases with high summer temperatures when buildings use more electricity for air conditioning. (Appendix B)

The number of electricity customers increased 7% in ten years.

	1996 # of customers	2006 # of customers	Increase
Residential	14,393	15,559	7%
Bus/Industry	2,323	2,511	7%

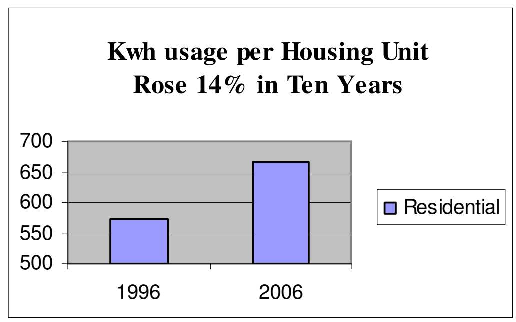
Between 1996 and 2006 the number of both residential AND business & industry customers rose 7%.



Residential electricity usage per housing unit rose 14% in ten years.

Residential	1996	2006	Increase
Average kwh per customer (housing unit) per month	574 kwh	668 kwh	14%

This means an average (not compounded) increase of about 1.4% per year. To arrive at these figures, I used the National Grid data on the previous page. The # of kwh was divided by the # of customers to find the average kwh per customer that year. That total was divided by 12 to get the monthly average. So here is the 1996 formula: 99,197,175kwh / 14,393 customers = 6892 kwh per year / 12 = 574 kwh per month.

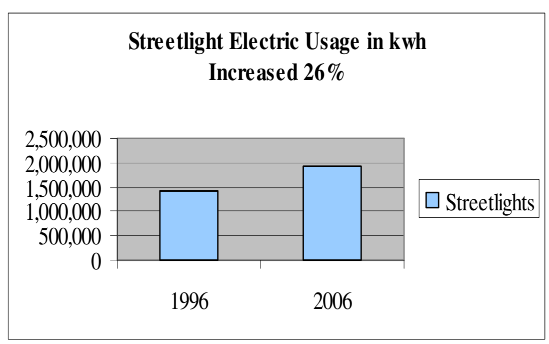


Electricity usage increased despite the price of electricity which nearly doubled in three years.

Streetlight electricity usage rose 26% in ten years.

	1996	2006	Increase
Streetlights	1,420,522 kwh	1,930,853 kwh	26%

Streetlight usage increased 26% between 1996 and 2006. According to Don Robinson at the National Grid, the earliest streetlight data available is from 2003 and it lists 2743 streetlights. He suggests that "the changes in the rental inventory for the City of Marlborough since 1996 has caused the increase in consumption." According to John Ghiloni, "additional streets were constructed."



CO2 emissions from electricity in Marlborough in 2006 according to the Environmental Protection Agency (EPA) formula are:

639,504,030 kwh = 639,504,030 pounds of CO2

See http://www.epa.gov/cleanenergy/powerprofiler.htm website for simple conversion to GHG.

NOTE: In order to be consistent, only EPA formulas were used in this inventory. The EPA suggests .98 pounds of CO2 per kwh. The formula above is rounded to the nearest decimal: 1 kwh = 1 pound of CO2. Non-EPA formulas are generally higher and up to 1.9 lbs CO2 per kwh. The wide range largely depends on the kind of fuel used to generate electricity. Fossil-fuel-burning plants have higher greenhouse gas emissions and would therefore produce higher CO2 emissions per kwh than a hydro-powered plant. (See a sample environmental disclosure for a 2006 Marlborough electricity supplier in Appendix B).

Natural Gas

What is it used for?

In Marlborough natural gas is a primarily used to heat buildings but it is also used for cooking, hot water, back up generators, and other purposes.

Natural Gas Usage in Marlborough

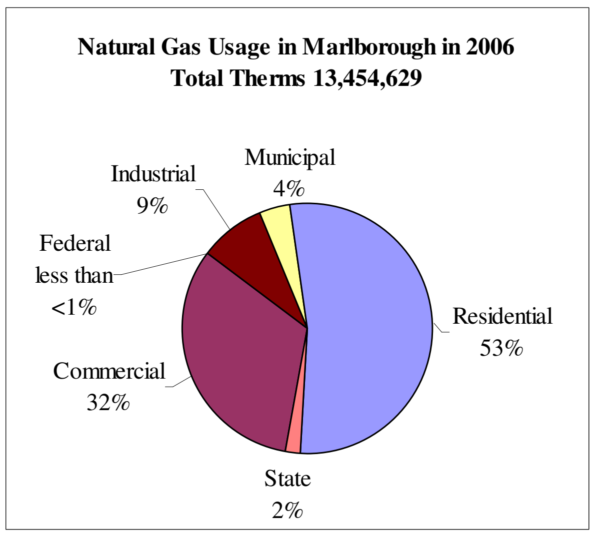
2006	Therms	
Residential	7,111,185	53%
Commercial	4,368,084	32%
Industrial	1,162,936	9%
Municipal	537,780	4%
State	273,589	2%
Federal	1,055	<1%
Total	**13,454,629**	**100%**

Natural gas data was provided by NSTAR administration for 2006 only. No other data was provided. Individual municipal building data was supplied by Paul Gedutis at NStar.

Natural gas is measured in therms. One therm is produced by burning about 100 cubic feet of natural gas.

In homes about 80% of natural gas is used for heating and 20% for cooking and hot water.

In 2006, approximately 8000 Marlborough homes used natural gas which accounted for 53% of the total natural gas usage in the city.



Marlborough homes with natural gas used an average of 900 therms per year. This figure was arrived at by dividing the total residential therms in 2006 (7,111,185) by the number of homes heated by natural gas (8000). (See Appendix C: US Census data on Home Heating Fuel) So the formula is 7,111,185 therms / 8000 homes = approximately 900 therms per home per year. The monthly usage varies a great deal because more is consumed in winter months for heating.

Business and industry buildings - including office parks, malls, and factories - also use natural gas and accounted for 41% of usage. State and federal buildings used approximately 2%. Natural gas was used primarily for building heat but was also used for back up electricity generation, cooking, hot water and other operational purposes.

The EPA formula is 1 therm = 11 pounds of CO_2. This calculation is standard.

13,454,629 therms = 148,000,919 pounds of CO_2

Fuel Oil for Building Space Heat

Where does it come from?

Fuel oil is processed petroleum which is a fossil fuel tapped from underground sources. The U.S. reached peak oil production about 30 years ago and now imports most of its oil from other countries. According to several studies, world peak oil production was realized this decade. (http://tonto.eia.doe.gov/dnav/pet/pet_pub_analysis_crd.asp)

What is it used for?

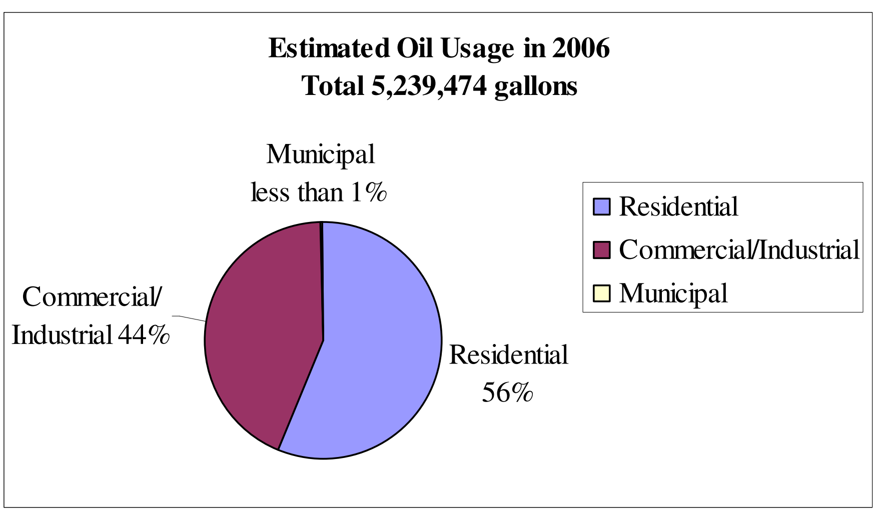
Oil can be used for building-space heat and hot water.

Oil Use in Marlborough

Exact oil data for Marlborough is not available except for municipal oil. According to John Ghiloni, the DPW building used 21,300 to heat the DPW building in 2006.

Residential and business/industry oil usage was estimated using U.S. Census and U.S. Energy Information Agency (EIA) data. (See "Oil Estimate and Sources" below.)

	Oil in gallons in 2006	**Pounds of CO_2**
Municipal	21,300	468,600
Residential	2,935,200	64,574,400
Commercial & Industrial	2,282,974	50,225,428
Total	**5,239,474**	**115,268,428**



Oil Estimates and Sources

The best source for oil data would be to contact oil supply companies directly and request data about their supply to residential and business/industry customers in Marlborough. However there are as many as 50 oil companies who supply oil to customers in Marlborough and to collect data from them all is simply not feasible at this time.

Although precise data is not available for residential usage, it is possible to estimate usage. According to the 2000 US Census, 3,669 homes in Marlborough were heated with oil or kerosene. The number in 2006 is about the same because few newly constructed homes are heated with oil if they are built near natural gas lines or if electricity was more convenient. According to the U.S. Energy Information Agency (EIA) in 2006, the average usage per home was approximately 800 gallons of oil per year. Multiplying the estimated number of homes heated with oil (3,669) by the average usage per home (800) produces an estimated 2,935,200 gallons of home heating fuel oil used in Marlborough.

There is no US Census data for the number of Marlborough business/industry buildings that use oil for heating. Nor does the EIA estimate the average usage per building. That being said, it is possible to estimate the amount of oil consumed by business and industry based on several sources. First, the US Census and EIA websites provide data to estimate the number of residential homes using oil and how much they use. Second, NSTAR provided natural gas data for residential and commercial buildings which help create a ratio to estimate building heating fuels. Third, EIA data tables summarize data for commercial and manufacturing buildings that use oil for space heating in New England. The EIA tables indicate that smaller businesses use natural gas, oil or electric heat, whereas larger companies and malls are more likely to use natural gas and some electric heat. (http://www.eia.doe.gov/emeu/cbecs/contents.html.) All this information was considered to create this formula that estimates commercial/industry oil use.

Marlborough

Residential Oil (known estimate based on US Census data for the number of homes using heating oil x the amount of oil the average home uses) **2,935,200 gallons**	Commercial/Industry Oil (unknown) **X gallons**
Residential Natural Gas (known) **7,111,185 therms**	Commercial/Industry Natural Gas (known) **5,531,020 therms**

Using this formula (**2,935,200 gallons x Xgallons = 7,111,185 therms x 5,531,020 therms)** it is possible to estimate that X is 2,282,974 gallons, the amount of commercial oil used in Marlborough.

According to the EPA 1 gallon of oil produces approximately 22 pounds of CO2. This conversion rate accounts for the following figures.

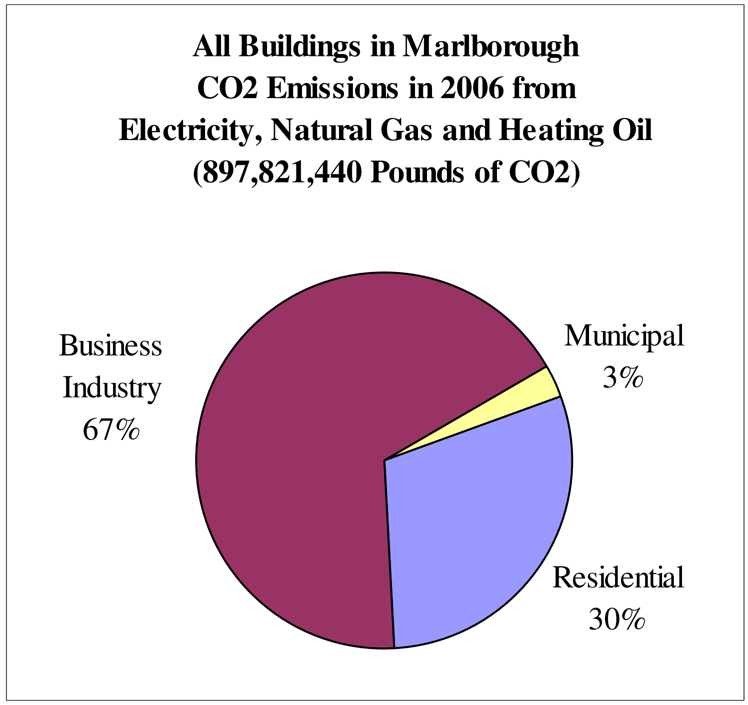
5,239,474 gallons oil = 115,268,428 pounds CO2

Results: CO_2 Emissions for Marlborough Buildings from Electricity, Natural Gas, and Oil in 2006

These CO_2 emissions for municipal, residential, and business/industry sectors were based on the electricity, natural gas, and oil usage for buildings only.

Buildings in Marlborough

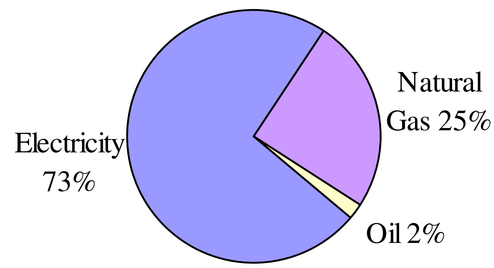
Source	*Pounds of CO2*	
Municipal	23,873,597	3%
Residential	267,627,810	30%
Business/Ind	606,320,033	67%
TOTAL	897,821,440	



Municipal

Source	*Pounds of CO2*	
Electricity	17,489,417	75%
Natural Gas	5,915,580	25%
Oil	468,000	2%
TOTAL	23,873,597	

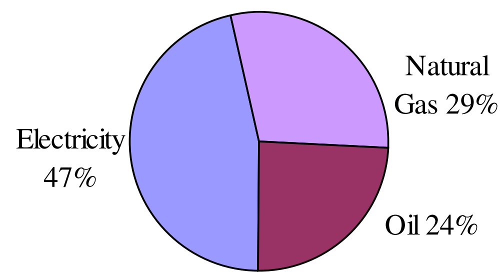
2006 Municipal Buildings CO2 Sources (23,873,597 Pounds of CO2)



Residential

Source	*Pounds of CO2*	
Electricity	124,830,375	47%
Natural Gas	78,223,035	29%
Oil	64,574,400	24%
TOTAL	267,627,810	

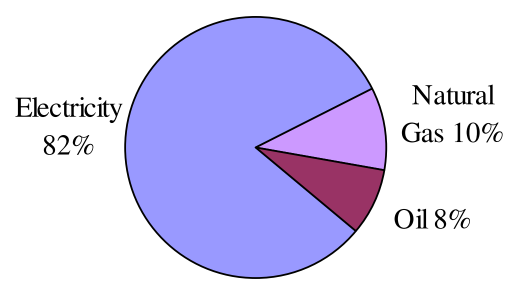
2006 Residential Buildings CO2 Sources (267,627,810 Pounds of CO2)



Business /Ind

Source	*Pounds of CO2*	
Electricity	495,253,385	82%
Natural Gas	60,841,220	10%
Oil	50,225,428	8%
TOTAL	606,320,033	

2006 Business/Industry Buildings CO2 Sources (606,320,033 Pounds of CO2)



Transportation

Transportation accounts for an estimated 33% of CO2 emissions in Marlborough.

VMT (Vehicle Miles Traveled) data was provided by Scott Peterson, Manager of Transportation Systems Analysis Group, Central Transportation Planning Staff, Boston.

	Average Weekday Vehicle Miles Traveled	Average Weekday Vehicle Hours Traveled	Average Speed
2000	1,173,500	34,300	34.2
2006	1,183,800	34,700	34.1
2025	1,503,600	48,200	31.2

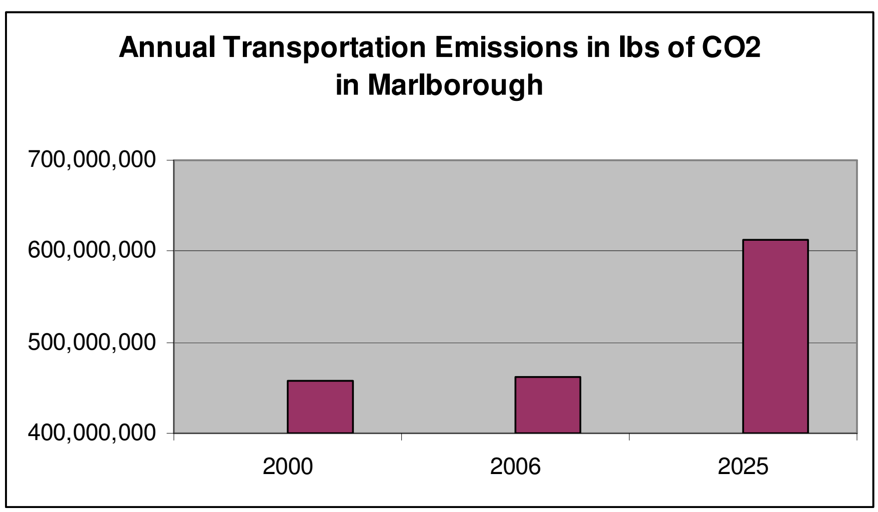
Data was provided for trips originating ending in Marlborough. VMTs are from all miles including work, school, social, recreational, shopping, and commuter traffic. The data was collected from 15-20 traffic zones in Marlborough. The data is for any driver living or working in Marlborough regardless of where they go. Such data can be used to inform traffic management or to inform mass transit decision making (for example, certain thresholds in centers per square mile would suggest a bus route.)

Calculations were based on July emissions. For every VMT mile there are 543 grams of CO2 produced in 2000 and 2006. In 2025 569 grams are produced. The higher figure takes into account a certain distribution of hybrid vehicles including compressed natural gas (CNG) vehicles which cut back on particulate emissions but generate more methane. (See Appendix E) (Not sure the CO2 data is accurate here. Logically it should be a bit lower based on Appendix E.)

The projected estimate for 2025 includes planned development and revitalization along I-495 that is projected to take off after 2010. As transportation increases so will CO2.

CO2 calculations are for transportation emissions in the city of Marlborough only.

Year	Pounds of CO2
2000	449,121,920
2006	453,063,936
2025	602,883,456



CO_2 was calculated based on the following: In July 2000 and 2006 for every vehicle mile traveled 543 grams (1.196 lbs) of CO_2 were produced. In 2025 the amount would be 569 grams (1.253 lbs).

So in 2000 the formula is (1,173,500 VMTs x 1.196 pounds CO_2 per mile x 320 (an annualized adjustment to accommodate reduced weekend travel) = 449,121,920 pounds CO_2)

In 2006 the formula is (1,183,800 VMTs x 1.196 pounds CO_2 per mile x 320 (an annualized adjustment to accommodate reduced weekend travel) = 453,063,936 pounds CO_2).

In 2025 the formula is (1,503,600 VMTs x 1.253 pounds CO_2 per mile x 320 (an annualized adjustment to accommodate reduced weekend travel) = 602,883,456 pounds CO_2).

Public Transportation

According to the Marlborough city website, "The City of Marlborough, in conjunction with other communities and entities, is constantly working to provide its citizens with various avenues for public transportation." Listed on the website are various transportation choices and companies providing service to Marlborough. Marlborough does have "Lift 7" on a bus route that goes from Marlborough to Framingham and to the Mall.
(Source: http://www.marlborough-ma.gov/gen/MarlboroughMA_WebDocmnts/S00BCC71C-00BCCDFB)

Transportation Demand Management

"Transportation Demand Management (TDM) programs provide an incentive for businesses to develop alternatives for employees who drive alone to work. The TDM policies can reduce the number of commuter trips by implementing subsidies for transit fares, shuttles, carpools, and vanpools, reducing the space required for parking, and creating facilities for bicyclists. MassRIDES, of the Massachusetts Executive Office of Transportation, provides free assistance to businesses to implement the program. MassCommute is an organization of Transportation Management Associations (TMA) using the program."
(Source: http://www.mapc.org/transportation/funding_opportunities.html#TDM)

Commuter Train

The nearest commuter train stop is in Southborough which is 4 miles south of the Marlborough city center.

Bike Routes

Transportation routes in Marlborough are designed for car and truck traffic, but not bike traffic.

Bike Path

In 2006 a three-mile Assabet River Rail Trail project was completed in Marlborough. It was designed for recreational use: biking, walking, and cross-country skiing. It presently connects neighborhoods and the town of Hudson. When completed in neighboring towns, it will extend to the commuter rail station in South Acton and will be 12 miles long.

Pedestrian Routes

Many streets have sidewalks for pedestrian traffic; however, some streets do not have sidewalks to accommodate pedestrian traffic.

Households without Vehicles

According to the 2000 U.S. Census Data for Transportation in Marlborough, MA about 7.6 % of the housing units in Marlborough have no vehicles available. It is presumed these residents either walk, bike, share rides or find other sources of transportation to work, shopping, and other activities.

Air Quality, Transportation, and Health

Although this inventory focuses on energy and the environment, both are linked to health. Scott Petersen at MAPC noted there are recent studies on air quality, traffic corridors and health at: http://www.mapc.org/transportation/Air_Quality/Air_Quality.html This is of interest to cities like Marlborough that may have public buildings such as schools, elderly housing and hospitals near heavy traffic corridors such as Routes 495 and 290. Research indicates that as air quality decreases the young, elderly, and people with poor health are increasingly at risk. Such research would be of interest to policy makers, city planners, and healthcare professionals to inform decision-making processes.

City Fleet, Diesel Oil and Gasoline

Steve Senato, Fleet Manager at the DPW, supplied the fleet fuel data. The Marlborough city fleet is comprised of cars and trucks driven by city staff to fulfill their jobs in service to the city. The vehicles also include police cars, fire trucks, snow plows, street sweepers, and city staff vehicles. School buses are not listed as they are operated by a privately-owned enterprise. All the city departments are listed below.

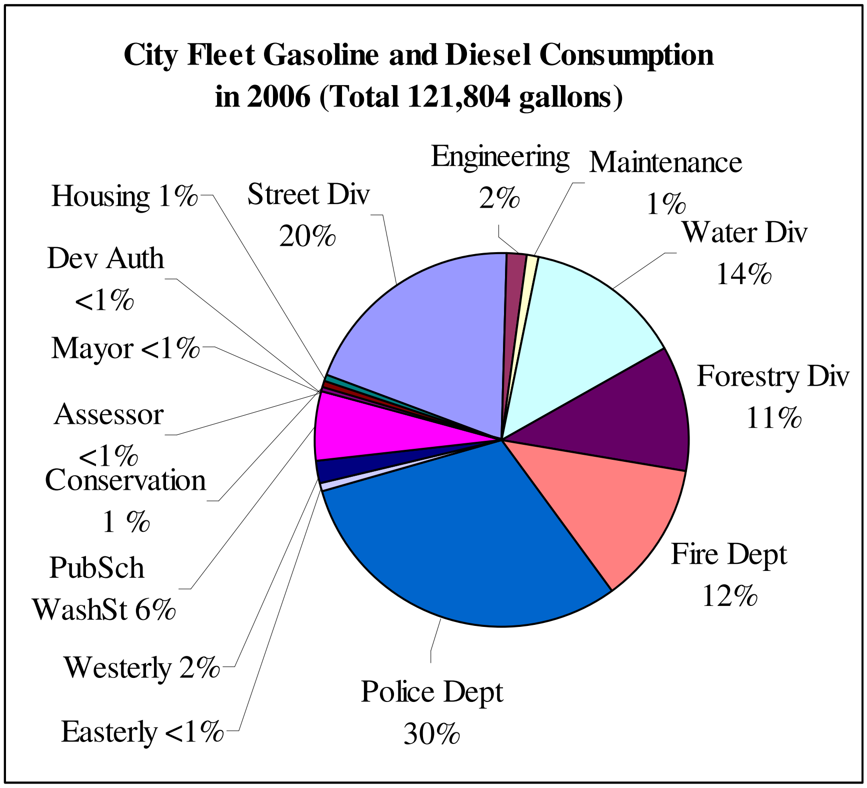
Marlborough City Fleet Fuel Usage in 2006

Department	**Diesel (gallons)**	**Gasoline (gallons)**	**Percent of Total**
Police Department	0	37,455	31%
Street Division	16,426	7,943	20%
Water Division	4,370	12,369	14%
Fire Department	12,003	2,642	12%
Forestry Division	5,751	7,479	11%
Public Facilities	1,065	6,277	6%
Engineering	0	1,884	2%
Westerly Wastewater	1,830	522	2%
Conservation Dept	0	641	1%
Marlborough Housing	0	740	1%
Fleet Maintenance	337	1,083	1%
Easterly Wastewater	74	440	<1%
Mayor's Office	0	167	<1%
Assessors Office	0	137	<1%
MarlCommDev Auth	19	149	<1%
	41,875	79,927	**121,804 Total Gallons**
Lbs of CO2 per gallon	22	20	
Lbs of CO2 emissions	921,250	1,598,540	**2,519,792 Total lbs of CO2**

One car in Marlborough's fleet is a Hybrid Prius and gets 50mpg.

Marlborough has 1 or 2 bike patrols and 1 motorcycle patrol.

Marlborough does not purchase biodiesel.



41,875 gallons of diesel + 79,927 gallons of gasoline = 2,519,790 pounds of CO2

Water

Why include water data in the inventory?

Evaporation
Global warming means higher temperatures that would increase evaporation which would have some effect on water supplies.

Electricity Usage
The Millham Water Treatment Plant used nearly 1,500,000 kwh of electricity to supply approximately 28% of Marlborough's drinking water. Another 750,000 kwh was used to deliver water via pumping stations to all the homes and businesses in Marlborough.

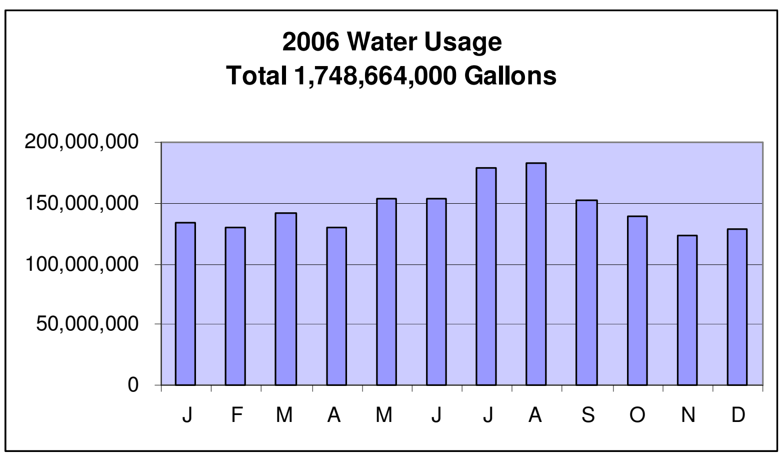
Chemical Hazards
Large quantities of chemicals, which may pose an environmental hazard, are required to treat water.

Water conservation helps protects our water supply, economy, and health.

Data

Data for Marlborough's drinking water was supplied by Doran Crouse, Assistant Commissioner DPW-Utilities, Marlborough.

In 2006 Marlborough's total water usage was 1,748,664,000 million gallons. It cannot be separated for municipal, residential, and business/industry usage.



Water use in summer months is high because of business park and residential lawn watering.

Marlborough's drinking water sources are: 70% Massachusetts Water Resource Authority's (MWRA) Carroll Water Treatment Plant (water sources are Quabbin and Wachusetts reservoirs), 28% Millham Water Treatment Plant (Marlborough water sources are Millham Reservoir and Lake Williams), and 2% private drinking water wells. The city draws on the Millham Water Treatment Plant first as it costs 25% of the MWRA water supply. These figures are from 2003. Annual percentages may vary depending on seasonal fluctuation. (Source: City of Marlborough's Open Space and Recreation Plan 2003-2008, pages 3-8)

The MWRA's Carroll Water Treatment Plant located in Marlborough was activated in July 2005. It treats drinking water for 2.3 million people in 41 Metropolitan Boston communities including Marlborough. The treatment process includes ozonation.
http://www.mwra.state.ma.us/osu/whwtpfacts.htm

The Millham Water Treatment Plant is owned by the city of Marlborough and is privately operated. It can supply a maximum of 3.6 million gallon (MG) a day. In 1998 improvements included 2 new pumps with more efficient motors. In 2001 two, new raw-water pumps were installed.

Steve Turner from the Milham Water Treatment Plant provided the following data for 2000 and 2006. Data was not available for 1996.

Millham Water Treatment Plant data only	**2000**	**2006**
Kwh	1,120,440	1,486,800
Therms (ccf Natural Gas)	8,993	12,668

Wastewater

Why include wastewater in the inventory?

Climate change could produce high rainfall and snowmelt that would lead to high runoff and stormwater which may enter the wastewater system. This may increase the amount of water needing treatment or the amount of wastewater that needs to be diverted if maximum capacity is reached. The Westerly Wastewater Treatment plant currently has a maximum capacity that is already being exceeded during winter and spring months when runoff is high. (See Westerly Wastewater Treatment graph below).

The wastewater treatment process requires machinery powered by electricity and sometimes natural gas.

Marlborough plans to increase capacity to accommodate future needs. (See below.)

Million Gallons (MG)

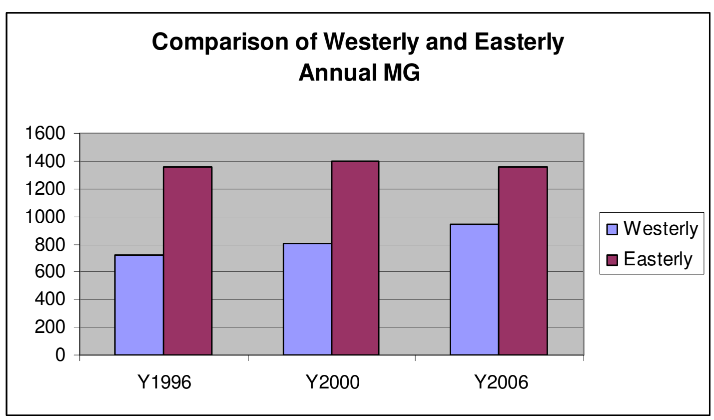
Wastewater is measured in million gallons (MG).

Marlborough's Wastewater Treatment Plants

Doran Crouse, Assistant Commissioner DPW-Utilities, provided data on Marlborough's wastewater plants.

Marlborough has two wastewater treatment plants: Westerly and Easterly Wastewater Treatment Plants. In 2006 Marlborough processed 2,290 million gallons of wastewater from homes, business/industry, and some storm drains. This table below shows a steady increase in wastewater totals in Marlborough since 1996.

	Westerly	**Easterly**	**Totals**
1996	718 MG	1,354 MG	2,072 MG
2000	804 MG	1,400 MG	2,204 MG
2006	938 MG	1,352 MG	2,290 MG



The graph at right shows little change in the Easterly plant, but a steady rise in Westerly between 1996 and 2006, a ten-year period.

Energy Usage For Wastewater Treatment

Don Robinson at National Grid provided electricity data, and Paul Gedutis' staff at NStar provided natural gas data.

Electricity			
	Westerly	**Easterly**	**Totals**
2000	1,511,760 kwh	1,967,100 kwh	3,478,860 kwh
2006	1,052,400 kwh	1,932,000 kwh	2,984,400 kwh
	-459,369 kwh	-35,100 kwh	- 494,469 kwh

Natural Gas			
	Westerly	**Easterly**	**Totals**
2004	22,394 therms	25,844 therms	48,238 therms
2005	21,398 therms	31,374 therms	52,772 therms
2006	16,930 therms	22,076 therms	39,006 therms

Electricity use decreased significantly and natural gas decreased somewhat.

Energy-efficiency retrofits are responsible in part for the decreases. Belt drives on pumps were replaced with variable frequency drives. The plant staff was trained to monitor the process and run the operation more efficiently. Lighting fixtures were replaced with energy efficient models in 2004.

The main reason for the decrease was that in 2001-2002 a large local food manufacturer installed its own wastewater treatment system to reduce the loading. Since then their wastewater has been partly processed before coming to Westerly. This reduced the load on the wastewater treatment plant. The aeration systems don't have to work as much or run on high. The system can run at a lower speed and so it uses less electricity.

These changes account for the 30% drop in energy usage at the Westerly Treatment Plant.

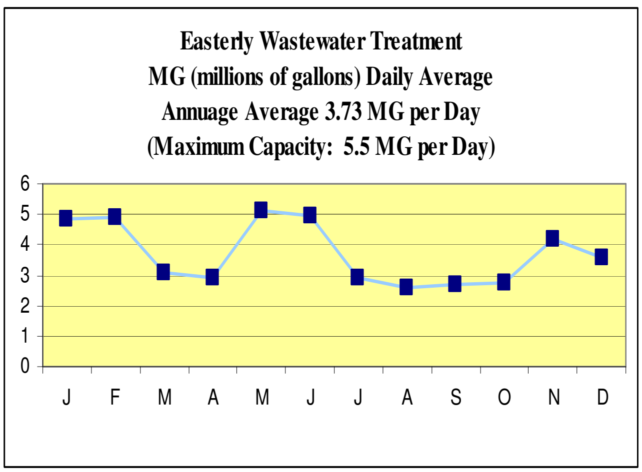
(See Appendix F for more details on the Westerly Wastewater Treatment Plant.)

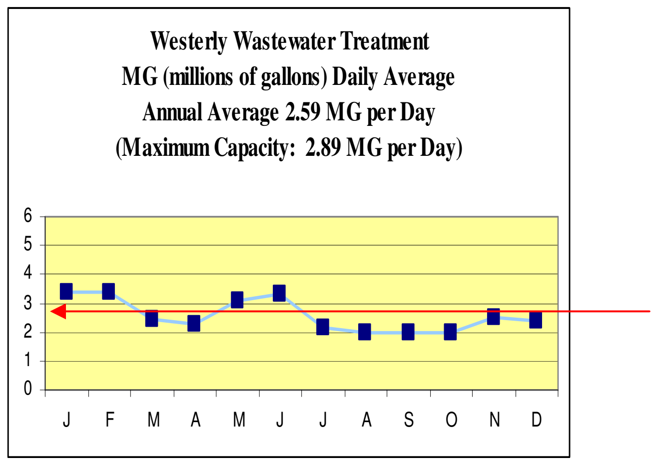
Current Status and Future Developments at Easterly and Westerly

The Easterly Wastewater Plant currently has a capacity of 5.5 million gallons (MG) per day. Proposed upgrades are under review and are scheduled for 2011.

The Westerly Wastewater plant has a capacity of 2.89 MG per day. A new upgrade beginning in 2009 requires treating phosphorus to a level of .1mg/l. This upgrade will also apply to the Easterly Wastewater Plant.

Note: 800,000 gallons per day at the Westerly plant is reserved for the town of Northborough.





Sewer service is used by all industrial and 90% of residential areas. The city plans to connect the remaining residences to the sewer system by 2023. (City of Marlborough Open Space Plan, 2003-2008, Pages 3-8).

High amounts of wastewater in January and February are due to snow melt, and in May and June are due to heavy rainfall. The runoff becomes stormwater which is treated at the plants which infiltrate. Stormwater should be addressed in the future to reduce inflow and infiltrate. (pers.com. Priscilla Ryder, 3/07)

Trash, Recycling, Composting

Trash and recycling data was provided by Doran Crouse, Assistant Commissioner, DPW-Utilities.

Marlborough is fortunate to have a residential recycling program and a recycling committee. Marlborough's curbside recycling program began in 2000. Marlborough's recycling rate is 13%.

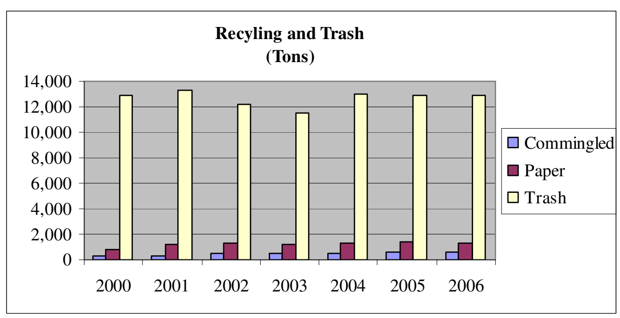
Marlborough has no business and industry recycling program; however in 2006, Abitibi, a commercial recycling company, started a paper recycling initiative at businesses and schools.

Recycling includes commingled materials (aluminum, plastic, and glass) and paper. The recycling rate was calculated by adding the tons of commingled materials and paper, and then dividing by the total. So for 2000, (349+843) / 14,124 = 8%

Browning Ferris Industries / City of Marlborough / Tonnage Report by Commodity (Amounts are in tons)

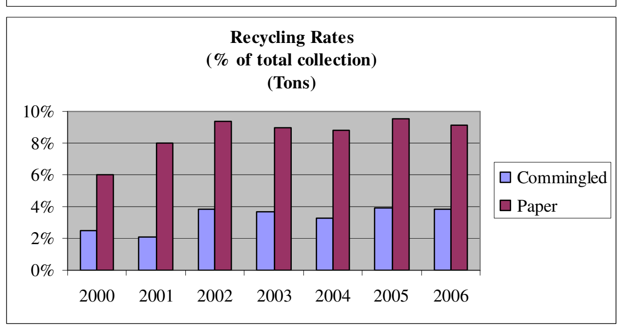
FY July-June	Commingled (aluminum, plastic, glass)	Paper	Trash	Abitibi Paper	TOTAL	Recycling Rate
2000	349	843	12,932		14,124	8%
2001	303	1,085	13,290		14,678	9%
2002	535	1,313	12,178		14,027	13%
2003*	483	1,176	11,452		13,111	13%
2004	484	1,303	12,956		14,743	12%
2005	586	1,424	12,946		14,956	13%
2006	569	1,344	12,880	31	14,824	13%

* June data is missing



What is trash?

Trash is paper, plastic, food, and other materials that are not recycled or composted. Most trash can be recycled or composted.



What is recycling?

Recycling is separating trash into paper and commingled (aluminum, plastic, glass) bins so hat it can be processed for recycled materials. Building materials can also be recycled.

How do trash and recycling affect climate change?

Trash can account for about 1% of greenhouse gasses in communities. Trash requires…

- Landfills and burning that produce greenhouse gases
- Transportation that depends on fuel
- The use of virgin materials (wood, petroleum, etc.) to produce consumer goods. This reduces carbon storage and increases energy use to process and transport goods.

Furthermore, tax dollars are needed to dispose of recyclable trash. Marlborough could save about $1 million if the recycling rate was about 75%. (Calculation based on "Marlborough Trash and Recycling" information below.)

Landfills

Although most of Marlborough's trash is composted at the WeCare Environmental Co-Composting facility, products that cannot be composted are sent to landfill. Landfill sites occupy valuable land that could be used for other purposes in the community. Local landfills are hard to find and expensive. Marlborough's landfill trash that cannot be composted is typically sent to Maine or New York.

Landfills produce greenhouse gas, particularly methane, which is more harmful per pound than CO_2.

Marlborough Trash and Recycling

"Marlborough has a solid waste collection system that includes curb-side collection, a drop-off facility, and disposal at the WECARE co-composting facility. It also provides recycling services with curb-side collection and a drop-off facility. It is estimated with every 5% increase in recycling the solid waste disposal decreases by $75,000 per year."
(Source: www.marlborough-ma.gov)

Recycling saves money and reduces greenhouse gas emissions.

WeCare Composting Facility

WeCare Environmental of Marlborough operates an industrial sized rotary-kiln digester that composts municipal solid wastes, biosolids, and food waste. Acquired in Feb 2003 from Bedminster, WeCare has a 15-year contract through 2018. WeCare accepts all municipal solid waste from the city of Marlborough as well as residuals produced at Easterly and Westerly Wastewater Treatment Plants. That material comprises about 50% of the materials composted or about 27,000 tons per year. The capacity permitted is 54,750 tons a year. The balance of the capacity is marketed to other municipalities and private generators of organic waste such as supermarkets.

Trash that cannot be composted is trucked to landfills.

The energy information below was provided by Chris Ravenscroft, President of WeCare. In 2006 the energy used by buildings and the composting process (excluding all transportation) at WeCare was as follows:

WeCare Energy Usage in 2006

		Pounds of CO2
Electricity	3,546,975 kwh	3,546,975
Natural Gas	3,992 therms	43,912
Diesel	24,163 gallons	531,586
		Total 4,122,473

(See Appendix G for energy data at the WeCare Environmental facility.)

Trees

Trees have important roles in urban communities like Marlborough. Trees improve air, water, and land quality. They absorb and filter out greenhouse gases and particulates. They filter rain water runoff and improve water quality. They decrease stormwater runoff and prevent erosion.

Trees help cool neighborhoods and buildings by providing shade. Buildings with nearby shade trees need significantly less air conditioning and electricity to cool them.

Trees also sequester carbon. A single tree sequesters about 1 ton of carbon dioxide over its natural lifetime.

Marlborough has not conducted a benefit analysis of its trees, but given case studies in other communities it is clear that Marlborough's trees play a significant role in stabilizing the air quality of the city.

According to the City of Laurel, MD, their 367 acres of trees "provide an estimated $1,080,187 per year in benefits for the air and water ecosystem services they provide. They remove 37,000 pounds of air pollutants including ozone, carbon monoxide, sulphur dioxide, nitrogen dioxide and particulate matter. They also store 15,790 tons of carbon and sequester 123 tons of carbon annually." (www.AmericanForests.org)

Land

Marlborough occupies about 22 square miles or 14,099 acres of land space. Most residential developments are on the east side of the city, while most business and industry developments are in the west. Marlborough offers a diverse landscape of lakes and woods within its city limits.

The *City of Marlborough Open Space and Recreation Plan, 2003-2008* written by Pricilla Ryder, Conservation Officer, provides a thorough account of land and water use in Marlborough.

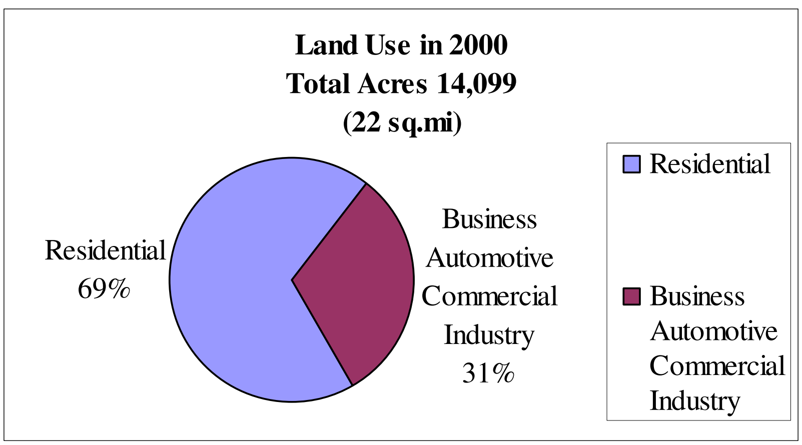
Land Use

Nat Bowen, GIS Administrator at the Department of Public Works in Marlborough, provided land use data for Marlborough.

Residential	9729 acres
Business Automotive Commercial Industry	4370 acres

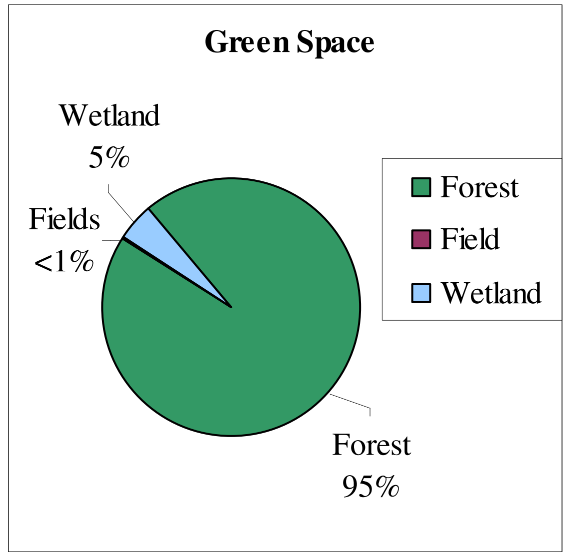
For data and maps go to:
http://www.marlborough-ma.gov/Gen/MarlboroughMA_PublicWrks/MarlboroughMA_GeoInfSrvc/Images/Conservation1

(Note: Automotive refers to automotive business and industry, not roadways.)



Green Space

Forest	6,239 acres
Field	18 acres
Wetland	312 acres



Trees and greenspace play important roles in healthy communities. They offer aesthetic, environmental, and health values.

Marlborough's parks, hills, lakes and streams make it an attractive, desirable community. It is important to protect the greenspace. Protected greenspace goes beyond air quality, aesthetics, and the view. Greenspaces safeguard our ways of life in ways we don't often consider.

Sustainability

Sustainability means taking care of human needs and the natural environment.

Local farms contribute to sustainable communities in ways we may not think about. For example, local food production reduces the need to transport food from around the world.

> "Marlborough has only one farm left. It would be great to work on its survival. Marlborough will likely lose it in several years as the farmers are getting on in age."
> - Priscilla Ryder, Conservation Officer

The energy required to transport food around the world contributes to greenhouse gas emissions. Energy used for food production and transportation accounts for as much as 20% percent of all fossil fuel use in the United States.

Landfill

Landfills have become energy sources in some communities when captured methane is used to generate electricity at power plants. Marlborough's landfill which is located at Hudson/Bolton Streets (Route 85) is not such a candidate. According to the Massachusetts' Department of Environmental Protection, Marlborough's landfill was active between 1890 and 1982, and has been inactive since. "It was a municipal solid waste landfill, not lined, with acreage unknown, and capped." (http://www.mass.gov/dep/recycle/inactlf.pdf)

According to MaryBeth Campbell at the Mass Tech Collaborative who researched Massachusetts landfills for methane capture as an energy source, it is *unlikely* this landfill has landfill-to-gas energy potential. Gas content diminishes significantly over time. If the landfill capture hasn't already occurred, then there is probably only a small amount left, if any.

According to Doran Crouse, Assistant Commissioner DPW-Utilities, the sludge landfill at the Easterly Plant has been inactive since 1990; however, it may still be producing methane and it may be worthwhile to investigate this further.

Brownfields

A good municipal strategy for preserving waterways and forested land is cleaning up Brownfields and developing them instead. Marlborough has two Brownfield sites in varying stages of development.

1) The Frye Factory site is city-owned. It has been cleaned up with EPA assistance. Construction for an assisted-living facility is scheduled to commence in Spring 2007.

2) The Seymour site on Jefferson Street is also city-owned. The cleanup contract was signed in 2007 and will be funded by a $200,000 EPA grant and $40,000 for a total cost of $240,000. It will become a parking lot and a park with picnic tables.

Trends

The public is increasingly aware of energy issues because the media is providing more information about climate change, energy security, air quality, and a greener economy. At the same time, our local, state and federal governments are promoting energy conservation, energy efficiency, and sustainable incentives. There is plenty of evidence to support these trends.

- Marlborough municipal electric usage dropped .2% in six years. Conservation and energy efficiency efforts have contributed to this somewhat. Marlborough has recently signed with NSTAR for heating controls in city hall and light sensors in Kane Middle School. Other municipal buildings are being retrofitted with new lighting to reduce energy costs. These efforts can be used as an example in the rest of the community.

- Marlborough has two LEED (Leadership in Energy and Environmental Design) certified buildings owned by Raytheon and Boston Scientific.

- The Massachusetts Department of Energy requires electric utilities to provide renewable energy for the Renewable Portfolio Standard (RPS). That means electricity must now include more local, clean, renewable energy from wind, hydro, and solar energy sources.

- Most utility programs promote demand side management (DSM) with energy conservation, energy efficiency, and renewable energy incentives for municipalities, residents and businesses.

- Energy efficient transportation is increasingly available. One vehicle in Marlborough's city fleet is a hybrid Prius with 50+mpg.

- Thirty years ago, environmentalists were a minority, but their numbers have grown significantly in recent years. According to a 2006 *New York Times* survey, "today 30% of American adults enjoy a lifestyle of health and sustainability."

- Many communities are using CCP (Cities for Climate Protection) software to conduct greenhouse gas inventories. For a list of them go to www.massclimateaction.org, www.coolcities.org, and www.iclei.org.

Although many trends are positive, many are also negative. Energy consumption and green house gas emissions are rising. Demand for electricity increases about 1.4% per year despite the rising cost of electricity. This is being curbed in communities that provide Demand Side Management and consumer education. (See Appendix B)

The average American produces 20 tons of CO_2 per year. Americans produce 25% of the world's CO_2 but account for 4% of the world's population. (Source: The Atlas of Climate Change, by Kirstin Dow and Thomas Downing, 2006)

Recent Achievements in Marlborough

This information was provided by John Ghiloni, Public Facilities Director in Marlborough.

A private company sponsored by the National Grid conducted an audit and then upgraded motors, lighting, variable frequency drives (VFD), and pumps in some city buildings.

At the Westerly Treatment Plant operational changes were made including controls to better match wastewater treatment needs.

The High School had an energy management system review with changes in motors (air/fan) and variable speed drives. The total project cost was $356,000 with a $110,000 rebate and $150,000 financing by National Grid.

New lighting was installed in the library. The total cost was $70,000 of which $35,000 will be paid by the National Grid.

Summer of 2007 plans include changes to City Hall. A $15,000 project for HVAC thermostat controls and boilers will be supported by $5000 from NSTAR and $3500 from National Grid.

Kane Elementary School, Freeman Early Childhood Center, Marlborough High School and Marlborough Middle School are all undergoing a complete energy audit by National Grid in the fall of 2007.

New Opportunities for GHG Emissions Reduction

City Buildings

Doran Crouse and John Ghiloni provided the following ideas for city buildings.

- Automatic light shut off (install motion sensors) in all city buildings
- Automatic thermostats in all city buildings
- Set standard temperature in city buildings
- Install air curtains in heated garages to keep heat in
- Solar proposal for capital improvements

- New evaluations at Easterly and Westerly Wastewater Treatment plants. The design will include energy efficiency and look at a combination of renewable resource options (wind, solar, hydro, geothermal, etc.) similar to a Lawrence wastewater treatment model.

Performance Contracting Information (Energy Savings)

http://www.cambridgeenergyalliance.org/ Energy Savings

http://www.mass.gov/Eoca/docs/doer/rbnews-3.pdf Financing Energy Efficiency Through Performance Contracting

http://www.mass.gov/doer/ **Energy Savings Performance Contracting Seminar Presentations (4/26/07)**

http://www.mass.gov/?pageID=pressreleases&agId=Agov3&prModName=gov3pressrelease&prFile=agov3_pr_070330_cambridge_energy.xml Governor Patrick's press release on performance contract initiative for 5 Massachusetts cities

Transportation

Consider alternative fuel vehicles.
See http://www.energy.ca.gov/afvs/index.html
Calilfornia is buying Ford F150 pick up trucks. CNG is less expensive than gasoline and cleaner as well.
Enforce the anti-idling laws for ALL city-owned vehicles.
Analyze traffic patterns and improve traffic flow
Purchase biodiesel instead of diesel

Recommendations to Curb Global Warming Locally

- Set an emissions reduction target (for example 5% by 2010, or 20% by 2020)
- Create an Energy Task Force to include residential, business, city, utility, and organization (EPA/DEP/MTC) members
- Strategize and implement actions to reduce emissions, such as
    - Research what other communities are doing
    - Plant to Reduce Fossil Fuel Usage in
        - Buildings
        - Transportation
    - Promote energy conservation
    - Promote energy efficiency
    - Invest in Renewable Energy
        - Promote Green Electricity
    - Promote Recycling
    - Adopt biodiesel
    - Create green schools (energy, recycling, chemicals, water)
    - Buy a green fleet
    - Enforce the anti-idling law
    - Adopt purchasing codes to buy recycled paper
    - Perform energy audits
    - Adopt energy efficiency building codes
    - Adopt smart growth practices
    - Update the energy inventory each year – and compare to monitor progress
    - Provide energy curriculum to environmental educators in the public schools
    - Protect and plant trees
    - Require environmental disclosures from utilities
    - Ask utilities for energy conservation, energy efficiency, and renewable incentives
    - Analyze traffic flow, improve traffic flow to reduce slow or stopped traffic
- Acknowledge community and business leadership with recognition awards, for example:
    - Evergreen Solar – for providing green jobs
    - Boston Scientific and Raytheon – for LEED certified buildings
    - Hewlett Packard – for being a Best Workplaces for Commuters (EPA, TDM)
    - Recycling efforts
    - Environmental Education teachers

City Government*

The city of Marlborough through its leadership and decision-making power is well-positioned to influence and control many of the activities that produce greenhouse gasses in the city. For example the city government could:

- Control municipal buildings (schools, city hall, fire and police department, library), parks, vehicle fleet, appliance and supply purchases, street lighting, and traffic signals
- Dictate building codes and permits that determine the energy efficiency of residential and commercial buildings
- Determine landfill sites that produce methane emissions which can be captured for energy generation
- Manage waste collection, recycling, and composting programs and can implement waste reduction programs
- Influence land use planning and development which determines the density and physical layout of the buildings and the community
- Control the transportation infrastructure that determines the transportation choices of residents and businesses affecting the transportation energy consumed
- Support and provide leadership for local energy conservation, energy efficiency and renewable energy efforts in the residential and business community

If there is to be success in addressing climate change, then the reduction of GHG emissions must be addressed at the local level. By having the city government involved in a GHG emission reduction plan, reduction strategies can be implemented and enforced in a much more efficient manner and can be tailored to meet the specific needs of the community. Reducing GHG emissions locally also has a number of indirect local benefits. These benefits may include reduced air pollution, cost savings, less traffic congestion, and a healthier population.

Our community can:

1. Conduct an inventory
2. Establish an emissions reduction target
3. Develop and obtain approval for the local action plan
4. Implement policies and measures in the local action plan
5. Monitor and verify results

*This page was modified for this Marlborough inventory. The original source is the 2004 Worcester Inventory by Carissa Williams which is posted on www.MassClimateAction.org. Thanks to Carissa Williams for her permission to reprint (4/9/07).

Resources

Abundant resources exist for large and small energy and environment related projects. These websites introduce possibilities with case studies and information.

www.MassClimateAction.org.
www.ICLEI.org (Provides CCP software to calculate greenhouse gasses)
www.CoolCities.org
www.MassTech.org
www.EIA.doe.gov
www.EPA.gov
www.mass.gov/doer
www.NESEA.org
www.MassEnergy.com
www.NationalGrid.com
www.NStar.com

Steven Russell, fleet services superintendent for the city of Keene, NH has been using biodiesel for 6 years and is an expert on the subject. Keene NH uses biodiesel in 78 pieces of equipment including plow trucks, ambulances, rescue trucks, wheel loader and garden tractor. For full details on his experience see:
Http://www.granitestatecleancities.org/news/russellarticle.pdf or contact him:
Steve Russell, Fleet Services Superintendent, srussell@ci.keene.nh.us

Open Questions

Municipal Electric Aggregation
Evaluate the contract and goals
Look at opportunities for Demand Side Management (DSM), conservation, efficiency, renewables for customer energy savings
Purchase green electricity and participate in MTC incentives

Water
How much electricity and natural gas does Carroll Water Treatment Plant (MWRA) use?

Trash and Recycling
How much GHG does our waste generate?
No reply yet from EPA Sara Hartwell regarding CO_2 generated by Marlborough's trash
June 2003 date for trash and recycling data should be added in.

Inventory
This energy and environmental inventory for Marlborough accounts for CO_2 which is just one greenhouse gas. Other greenhouse gasses such as methane, carbon monoxide, nitrous oxide, and fluorinated gases would increase the greenhouse gas inventory significantly. There is a method for converting the GHG effects of methane, CO and NO_x to CO_2 to "CO_2 Equivalents" so that they can be summed with CO_2 for a single number to compare. CCP software from ICLEI (kim.lundgren@iclei.org) would provide more accurate greenhouse gas emissions data.

Transportation
Marlborough school bus data was not provided.
Marlborough airport data was not requested.

Streetlights and traffic lights
Explain the 26% increase in electricity for streetlights
New lighting technology includes LEDs and solar electricity for street lights
Some traffic lights apparently still need LEDs.

Trees
Marlborough could join "Tree City USA" through the National Arbor Day Foundation or look into www.AmericanForests.org .

Chemistry
Look into air quality issues: traffic corridors, air quality in schools and the hospital, ozone
Look into using chemistry/technology in business and manufacturing; and the local manufacture, use, and disposal of solvents and other chemical products

Conclusion

This inventory provides a 'scoping' of the energy use and GHG problem in Marlborough. The next step is to take a 'closer look' at what is going on and what can be done. The section titled "Recommendations to Curb Global Warming Locally" above suggests the kinds of things that can be done. To that end these four steps are posited:

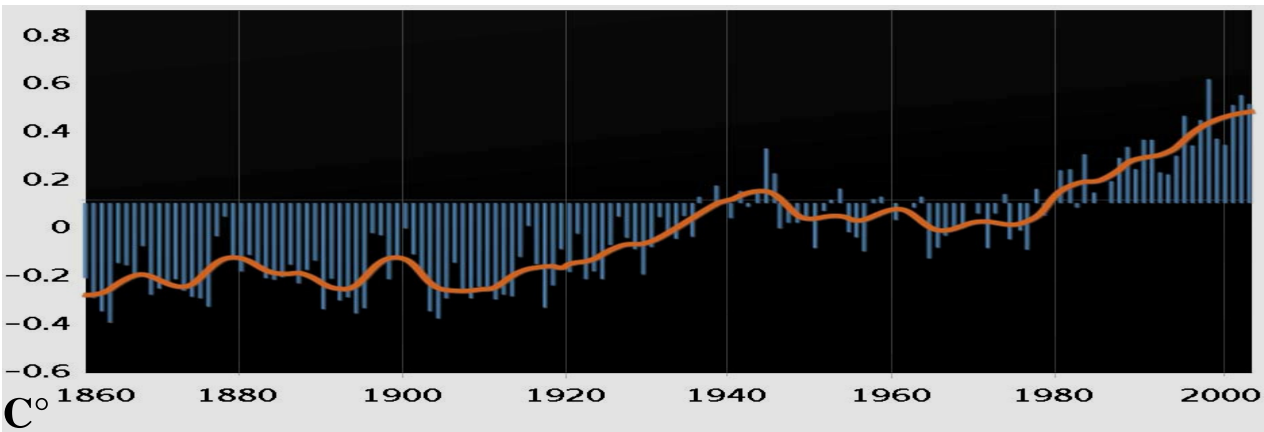
Establish an emissions reduction target
Worcester and Boston have set their GHG emissions reduction target to 20% by 2020. Given that Marlborough has a 2010 initiative, we could consider a 5% reduction by 2010.

Develop a local action plan
The numbers in this report serve to demonstrate the need for action on this issue. An energy task force composed of city officials, energy professionals, business, and residents could outline a local action plan to meet the emissions reduction goal. Efforts can focus on energy conservation, efficiency, and renewables for buildings and transportation. (See Appendix I)

Implement policies from the local action plan
A local action plan would provide solutions to city, business, and residential sectors for building and transportation emissions reduction. Several models already exist, such as www.cambridgeenergyalliance.org
.

Monitor and verify results.
Conduct a routine comparison quality energy use audit to measure and verify results. Review and revise the plan as needed to achieve intended results.

Appendix A: An Introduction to Global Warming, Climate Change, and Greenhouse Gas (GHG) Emissions



(Temperature in Celsius) **Global Temperature is Rising**

Common Sense on Climate Change: Practical Solutions to Global Warming
Source: The Union of Concerned Scientists

The scientific consensus is in. Our planet is warming, and we are helping make it happen by adding more heat trapping gases, primarily carbon dioxide (CO_2), to the atmosphere. The burning of fossil fuel (oil, coal, and natural gas) alone accounts for about 75 percent of the increase in CO_2. Deforestation – the cutting and burning of forests that trap carbon – accounts for another 20 percent.

Procrastination is not an option. Scientists agree that if we wait 10, 20, or 50 years the problem will be more difficulty to address and the consequences for us will be that much more serious.

We're treating our atmosphere like we once did our rivers. We used to dump waste thoughtlessly into our waterways, believing that they were infinite in their capacity to hold rubbish. But when entire fisheries were poisoned and rivers began to catch fire, we realized what a horrible mistake that was.

Our atmosphere has limits, too. CO_2 remains in the atmosphere for about 100 years. The longer we keep polluting, the longer it will take to recover and the more irreversible damage will be done.

The solutions to climate change are here and it's time we put them to use. If we get started today we can tackle this problem and decrease the unpleasant outcomes that await us if we do nothing. The steps we need to take are common sense. And, more often than not, they will save consumers money. The cost of inaction, however, is unacceptably high.

Greenhouse Gas Overview

Source: http://www.epa.gov/climatechange/emissions/index.html#ggo)

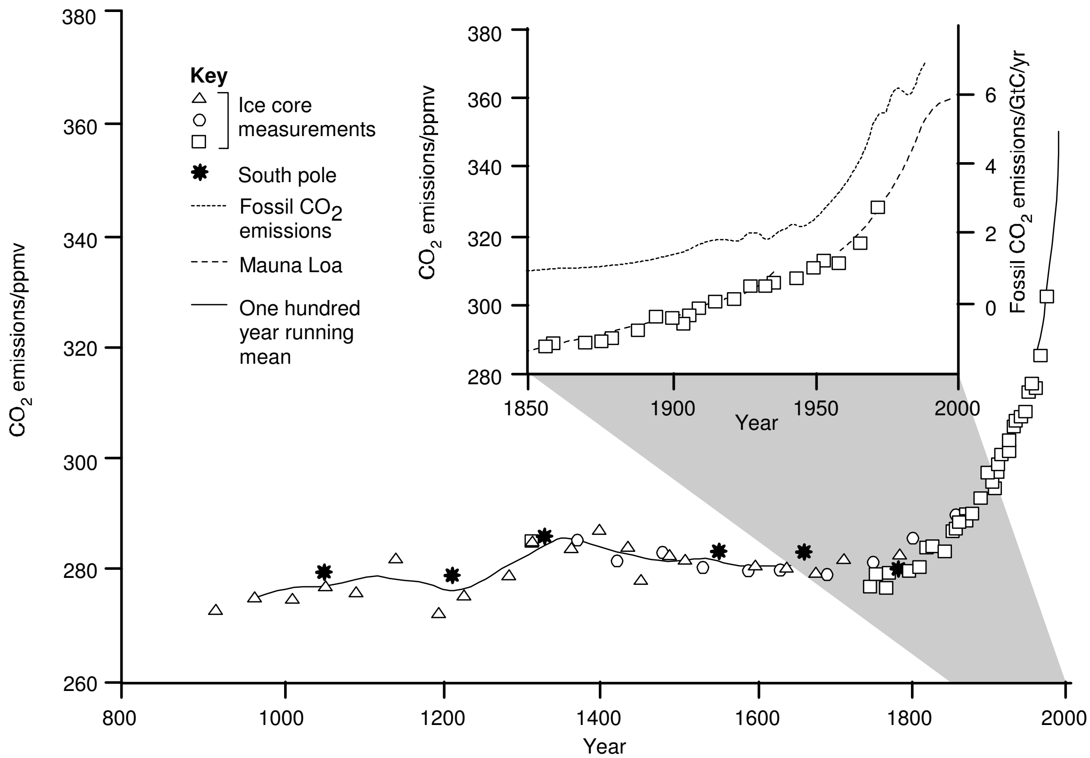
Some greenhouse gases such as carbon dioxide occur naturally and are emitted to the atmosphere through natural processes and human activities. Other greenhouse gases (e.g., fluorinated gases) are created and emitted solely through human activities. The principal greenhouse gases that enter the atmosphere because of human activities are:

- **Carbon Dioxide (CO2)**: Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement). Carbon dioxide is also removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.
-
- **Methane (CH4)**: Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.
-
- **Nitrous Oxide (N2O)**: Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.
-
- **Fluorinated Gases**: Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for ozone-depleting substances (i.e., CFCs, HCFCs, and halons). These gases are typically emitted in smaller quantities, but because they are potent greenhouse gases, they are sometimes referred to as High Global Warming Potential gases ("High GWP gases").

Greenhouse Gas Levels and Sources

Source: Intergovernmental Panel on Climate Change.

The amounts of greenhouse gases in the atmosphere have increased dramatically over the last fifty years. This is mainly because of increased human population and activities, such as man-made chemicals and combustion.



The graphs above show carbon dioxide levels. Some greenhouse gasses occur naturally. The table below lists the main man-made sources of these gasses.

Greenhouse gas	**Sources Due to Human Activities**	
Carbon dioxide	Burning of fossil fuels	Deforestation
Methane	Bacteria in rice paddy fields Landfill – (getting rid of waste) Coal mining	Released from natural gas and oil well Domestic animals – mostly cattle Biomass burning
Chlorofluorocarbons (CFCs)	Refrigerants	Aerosols
Nitrous oxides	Fertilizers Combustion of fuels in cars and power stations	Biomass burning

One of the big problems with greenhouse gases is that once they enter the atmosphere, it is a long time before they leave. The table below shows how long each molecule of gas will stay in the atmosphere.

Atmospheric Lifetime of Greenhouse Gases

	Carbon dioxide	**Methane**	**CFC-11**	**Nitrous oxide**
Atmospheric lifetime (years)	50–200	10	65	150

Human Health

"Increased frequency and severity of heat waves may lead to an increase in illness and death, particularly among young, elderly, and frail people, especially in large urban centers. The net effect of reduced severity of extreme cold is likely to have a beneficial effect. Acclimatization may be slower than the rate of ambient temperature change.

Increased frequency of convective storms could lead to more cases of thunderstorm-associated asthma. More frequent flood events and other extreme events may result in an increase in deaths, injuries, infectious diseases, and stress-related disorders, as well as other adverse health effects associated with social disruption, environmentally forced migration, and settlement in urban slums.

Vector-borne diseases, including malaria and dengue fever, may expand their ranges in the United States and may develop in Canada. Tick-borne Lyme disease also may also expand its range in Canada. However, socioeconomic factors such as public health measures will play a large role in determining the existence or extent of such infections. Diseases associated with water may increase with warming of air and water temperatures, combined with heavy runoff events from agricultural and urban surfaces.

Respiratory disorders may be exacerbated by warming-induced increases in the frequency of smog (ground-level ozone) events, acidic deposition, and particulate air pollution."

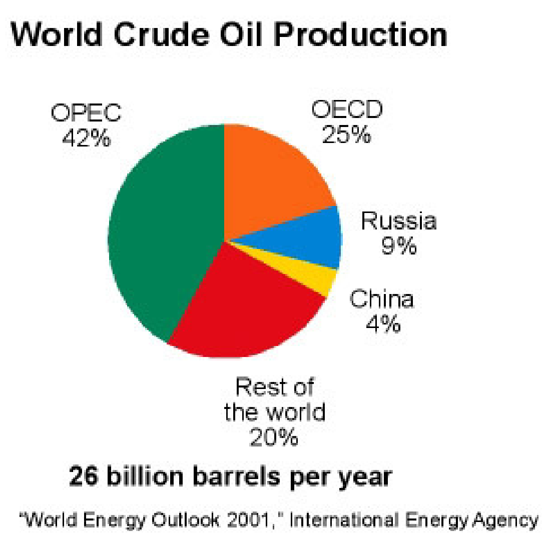
Source: http://www.epa.gov/climatechange/effects/health.html
See link to Intergovernmental Panel on Climate Change (IPCC) at
http://www.grida.no/climate/ipcc_tar/wg2/548.htm

Energy Security

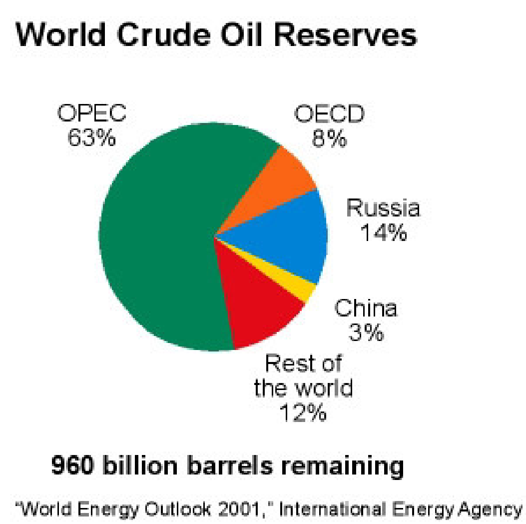
The Price of Dependency

“Petroleum is our number one fuel, and our consumption of it continues to grow at a rate faster than all other primary energy sources. Today the U.S. consumes more than a quarter of the world's oil—more than the next five oil-consuming countries combined. In 2000, our imports cost U.S. consumers $109 billion, an amount equal to 25% of our country's balance-of-trade deficit for the year.

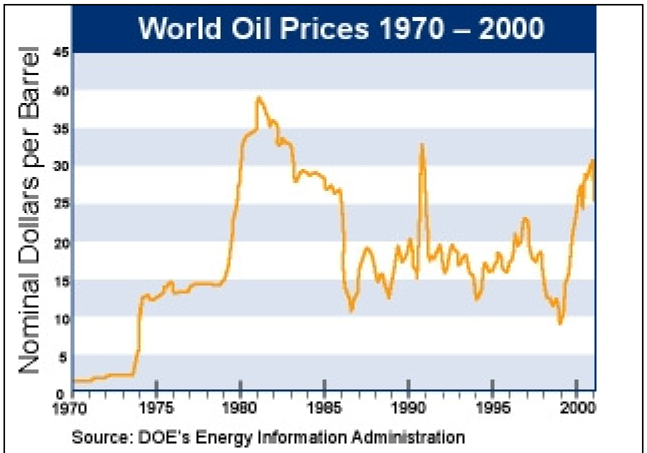
In part because oil producing countries in the Organization of Economic Development and Cooperation (OECD) are pumping their reserves faster than the OPEC countries, OPEC is expected to control an even greater portion of the world's oil in 20 years than it does today. In addition, the demand for petroleum will continue to increase in the late-developing countries as their domestic economies grow. The combined forces of increased demand and finite supply can be expected to maintain upward pressure on price. (Continued on next page)



OECD countries in Europe and North America are producing their reserves faster than OPEC.



As a result, an increasing percentage of what's left lies in OPEC's hands.



Over the last three decades, the world has experienced seesaw swings in the price of oil. *Source:* World Oil Market and Price Chronologies DOE Energy Information Administration; originally published by the Department of Energy's Office of the Strategic Petroleum Reserve, Analysis Division

(Continued)

Strategic geo-political alliances will continue to be made, based on the need for the resource of the "oil have-nots" and on the need for foreign currency in the "oil haves." Countries on the "wrong" side of these alliances might experience reduced oil supplies or dramatically increased prices. In the last 30 years, each of three oil price shocks in the U.S. was precipitated by a political crisis in the Middle East. Moreover, after each shock, the U.S. suffered an economic recession.

While no credible experts argue that it is possible to go "off" imported oil in the near- or mid-term, energy efficiency, RETs, and domestically produced renewable fuels can reduce the extent of our dependence on foreign countries for the energy lifeline of our economy."

(Source:
http://www.eere.energy.gov/state_energy_program/feature_detail_info.cfm/fid=8)

Appendix B: Electricity

Where does our electricity come from?

Electricity is generated at power plants. It is sent via the physical infrastructure to end users homes and businesses. Retail suppliers and municipal power departments govern the purchasing and selling process. In this appendix all of the information is from reliable sources (EIA, National Grid). It provides some basic information about the electricity generation and consumption in Massachusetts.

According to the US Energy Information Agency (EIA), the ten largest electricity plants by generation capability in Massachusetts are:

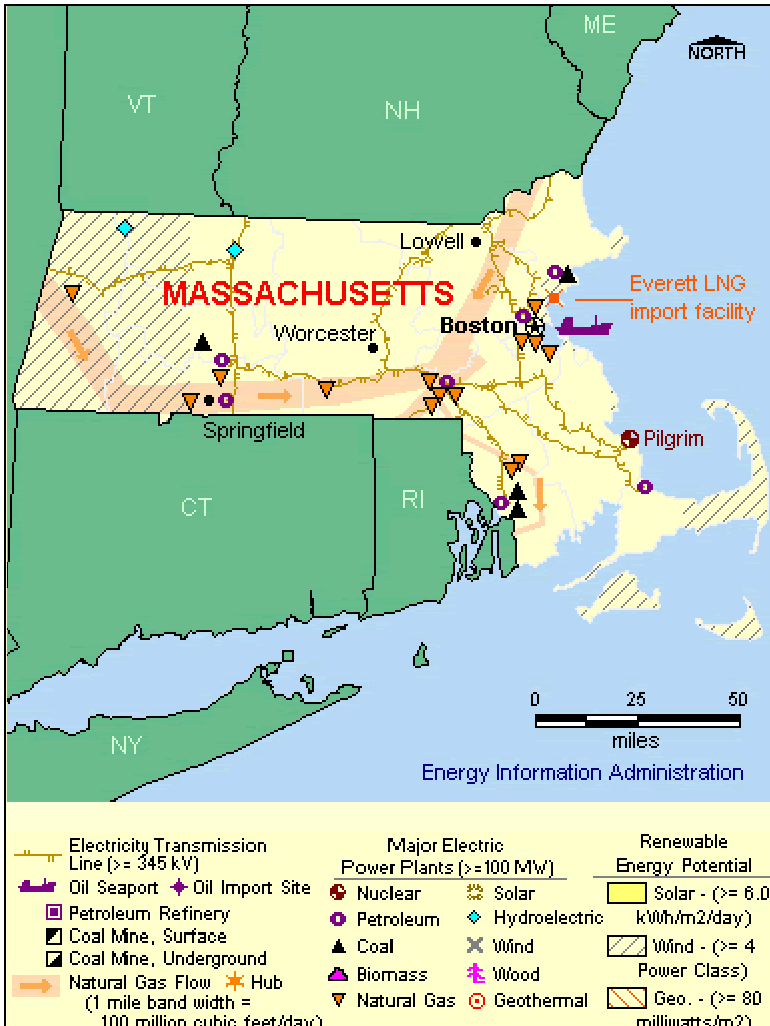
Table 2. Ten Largest Plants by Generation Capability, 2005

Plant	Primary Energy Source or Technology	Operating Company	Net Summer Capacity (MW)
Massachusetts			
1. Mystic Generating Station	Gas	Boston Generating LLC	1,932
2. Brayton Point	Coal	Dominion Energy New England, LLC	1,545
3. Canal	Petroleum	Mirant Canal LLC	1,112
4. Northfield Mountain	Pumped Storage	Northeast Generation Services Company	1,080
5. Salem Harbor	Coal	Dominion Energy New England, LLC	743
6. Pilgrim Nuclear Power Station	Nuclear	Entergy Nuclear Generation Co	685
7. Fore River Generating Station	Gas	Boston Generating LLC	668
8. Bear Swamp	Pumped Storage	Brookfield Power New England	563
9. ANP Bellingham Energy Project	Gas	ANP Bellingham Energy Co	493
10. ANP Blackstone Energy Project	Gas	ANP Blackstone Energy Co	441

NOTE: Northfield Mountain and Bear Swamp both generate electricity by using electricity to pump water to a reservoir at the top of a mountain when the price of electricity is low. When the price is high the water is sent through generators to generate power. These electricity storage mechanisms mean they aren't really non-polluting hydropower sources of power, since the source of the energy used to pump the water is not specified.

NOTE: Dominion Energy New England, LLC owns two of the five largest power plants in Massachusetts. Both plants burn coal, the most polluting of all power sources.

Net Electricity Generation	In Massachusetts	Period	
Total Net Electricity Generation	3,425 thousand MWh	Dec-06	100%
Petroleum-Fired	228 thousand MWh	Dec-06	7%
Natural Gas-Fired	1,347 thousand MWh	Dec-06	39%
Coal-Fired	1,117 thousand MWh	Dec-06	33%
Nuclear	508 thousand MWh	Dec-06	15%
Hydroelectric	104 thousand MWh	Dec-06	3%
Other Renewables	112 thousand MWh	Dec-06	3%

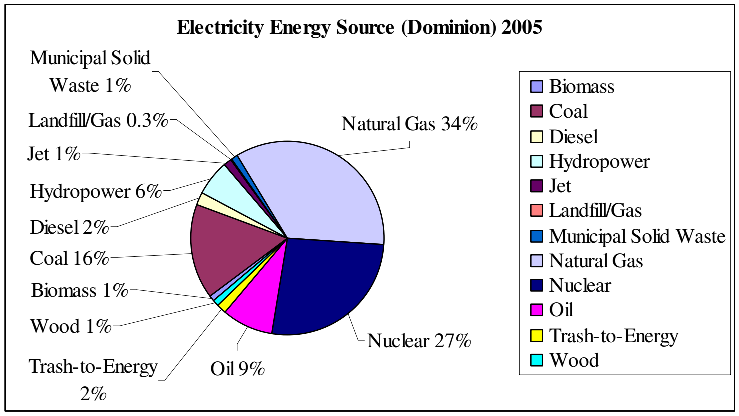


Massachusetts Quick Facts

- The Everett liquefied natural gas (LNG) import facility is the only existing LNG terminal in the Northeast.
- Massachusetts is one of the few States that require the statewide use of reformulated motor gasoline blended with ethanol.
- Massachusetts is a leading source of electricity generated from landfill gas and municipal solid waste.
- Massachusetts is the only New England State that relies significantly on coal-fired power plants, with coal accounting for one-fourth of electricity generation.
- A proposed 420-megawatt wind power project in Nantucket Sound could become the Nation's first offshore wind farm.

http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=MA

The pie chart to the right indicates the fuel source of the electricity supplier, Dominion Retail, for Marlborough residential and small business customers in 2005 according to their environmental disclosure website at: http://retail.dom.com/offers/pdf/mass_jan_june06_disclosure.pdf



It is not clear from the website whether this is the actual mix or the estimated mix of fuels used to generate electricity to residents in Marlborough.

For more information go to these two websites:
http://www.eia.doe.gov/cneaf/electricity/st_profiles/massachusetts.html
http://www.nationalgridus.com/masselectric/

New England Temperature

"In New England there has been a 0.7F increase between 1895-2000 years. The New England coastal zone was warmed by 1.7F." (Source: http://www.necci.sr.unh.edu/necci-report/NERAch2.pdf)

Peak Demand for Electricity

Electricity peak demand growth was 4.6% during 2004 - 2006. The all time peak demand in New England was set on August 2, 2006 at 28,127 MW. In summer of 2006, demand reached record levels on several occasions due to extremely hot weather.

	2004	2005	2006
Summer Peak Demand (MW)	24,116	26,885	28,127

"Very little new generation has been brought on line in New England. The ISO states that if this trend continues the region could begin to experience reliability issues as early as 2007-2008." (Source: http://ferc.gov/market-oversight/mkt-electric/new-england/2007/archives/01-2007-elec-ne-archive.pdf)

(Source: Derived from ISO-NE data)

Top 10 Demand Days for Electricity (Source: www.iso-ne.com)

Date	Demand (MW)
Aug 2, 2006	28,127
Aug 1, 2006	27,467
Jul 18, 2006	27,332
Aug 3, 2006	27,122
Jul 27, 2005	26,885
Jul 19, 2005	26,736
Jul 17, 2006	26,727
Aug 05, 2005	25,983
Jul 26, 2005	25,555
Aug 14, 2002	25,348

Appendix C: Home Heating Fuel

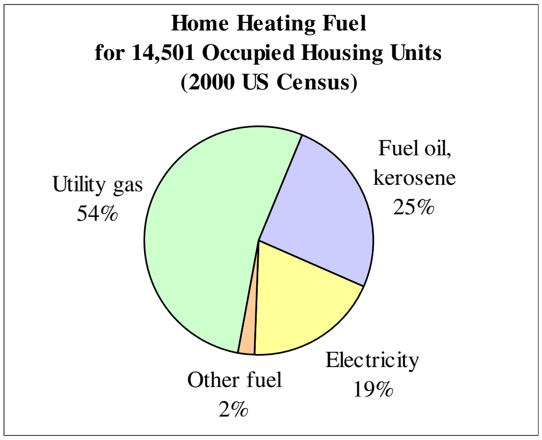
2000 U.S. Census Data Home Heating Fuel in Marlborough, MA		
HOME HEATING FUEL		%
Occupied housing units	**14,501**	**100.0**
Utility gas	7,757	53.5
Fuel oil, kerosene, etc	3,669	25.3
Electricity	2,743	18.9
Bottled, tank, or LP gas	163	1.1
Wood	45	0.3
Coal or coke	29	0.2
Solar energy	0	0.0
Other fuel	49	0.3
No fuel used	46	0.3

Census Source:
http://factfinder.census.gov/servlet/SAFFHousing?_event=&geo_id=16000US2538715&_geoContext=01000US%7C04000US25%7C16000US2538715&_street=&_county=marlborough&_cityTown=marlborough&_state=04000US25&_zip=&_lang=en&_sse=on&ActiveGeoDiv=&_useEV=&pctxt=fph&pgsl=160&_submenuId=housing_1&ds_name=DEC_2000_SAFF&_ci_nbr=null&qr_name=null&reg=null%3Anull&_keyword=&_industry=

http://www.eia.doe.gov/emeu/cbecs/contents.html

Renter occupied housing units is 39%	5,659 housing units
Owner occupied housing units is 61%	8,842 units
Subtotal	**14,501 Total occupied Units**
Vacant housing	402 units
	14,903 units TOTAL

The National Grid lists 15,559 residential electricity accounts for Marlborough in 2006.



In preparing this report someone asked, “Which of the home heating fuels is more efficient?” According to www.EnergyStar.com “Electricity is not itself a fuel, but rather a “secondary” source of energy which must be produced through the combustion of “primary” fuels, such as coal [oil, natural gas]. The typical process of converting primary fuels into electricity is about 30% efficient.” (Source: http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_benchmark_comm_bldgs)

Mike Duclos, an electrical engineer, suggests that the three main reasons he is aware of for the use of electric heat are: “it is easy to install, there is no maintenance, and each room can have a thermostat at very little expense.” In addition to these conveniences, it is also possible that natural gas lines are not available and insurance for oil may be more difficult to obtain.

Oil and natural gas are less expensive and more energy efficient than electricity for building heat.

Appendix D: Notes from EIA Tables and Phone Call to Determine Business/Industry Building Oil Usage Estimates

Sales of Distillate Fuel Oil by Energy Use in Massachusetts in 2004, 2005
(Thousand gallons) (Source: EIA)

Residential		Commercial		Industrial	
2004	2005	2004	2005	2004	2005
810,208	773,294	180,658	197,748	16,832	16,807

According to this table Commercial/Industrial fuel oil use is about 20 % of the total usage for buildings.

Total Energy Usage by Major Fuel for all Buildings in 2003 in New England

(Trillion BTU) (Source: EIA) Comparison of Natural Gas and Oil only

Natural Gas	Fuel Oil
87 BTU	74 BTU

54% 46%

(Source: EIA) 2003

	New England Commercial buildings, non mall BTUs trillion		NorthEast Mfg. Buildings BTUs trillion	
Electric	108	43%	334	34%
Gas	75	30%	538	56%
Oil	69	27%	98	10%

According to Joelle Richards at EIA CBECS, space heating in commercial NorthEast buildings is 49% oil, 22% natural gas and 21% Electric. But she acknowledged that cities are more likely to use gas than oil.

NOTE: According to the US Census 25% of Marlborough homes use oil and kerosene while the 80% of the town of Harvard homes use oil because they do not have gas lines.

Appendix E: Transportation

Alternatives to Traditional Transportation Fuels 1994, Volume 2
Greenhouse Gas Emissions
(Source: http://www.eia.doe.gov/cneaf/alternate/page/environment/exec2.html)

Executive Summary

This report provides information on greenhouse gases (GHGs) as required by Section 503 a(4) and b(3) of the Energy Policy Act of 1992 (EPACT). Although EPACT is principally concerned with improving energy efficiency and curbing U.S. dependence on foreign oil, the requirement to estimate greenhouse gases reflects a desire that energy security not be promoted at the expense of the environment. EPACT was developed around the time (1992) that President Bush and other world leaders met in Rio de Janeiro to sign the "Framework Convention for Climate Change." This document committed developed nations to stabilizing emissions of greenhouse gases at 1990 levels.

Section 503 requires the Secretary of Energy, in consultation with the Administrator of the Energy Information Administration (EIA), to estimate GHG emissions resulting from the use of the subset of replacement fuels [1] known as "alternative transportation fuels" [2]. Further, EPACT requires an examination of GHG emissions over the entire fuel cycle rather than only those produced from combustion. EIA has decided to use the "Delucchi" fuel cycle [3] approach because it offers the best framework for adhering to the EPACT requirements for estimating GHG emissions from alternative transportation fuels, using gasoline as a comparison [4]. For a discussion of the Delucchi approach and EIA's prior work in the area, consult *Alternatives to Traditional Transportation Fuels: An Overview* [5], *Alternatives to Traditional Transportation Fuels 1993* [6], and *Alternatives to Traditional Transportation Fuels 1994: Volume I* [7].

The Earth's average temperature has been increasing for the past few centuries, leading to concern about a variety of related issues (e.g., average ocean levels). One possible cause of the temperature rise is the amount of "greenhouse gases" that mankind is emitting into the atmosphere. Basically, greenhouse gases are those that trap heat emanating from the Earth's surface. Without these gases, this heat would otherwise escape from the atmosphere. Some level of greenhouse gases is necessary; without them the Earth's average temperature would be nearly 0oF [8]. A major human activity responsible for increased greenhouse gases in the atmosphere is fuel combustion. Water vapor and carbon dioxide, both greenhouse gases, are the principal products produced from burning hydrocarbon fuel.

Concern about possible effects of greenhouse gases heightens when future trends in transportation fuel consumption are examined. Motor vehicle greenhouse gas emissions are projected to grow in the United States and throughout the world as a result of the increasing number of vehicles and vehicle miles traveled (VMT). VMT is expected to grow in the United States at double the rate of population growth and even faster in Africa and Asia. The transportation sector contributes about one-third of total carbon dioxide emissions in the United States and other countries that belong to the Organization for Economic Cooperation and Development.

Greenhouse gases considered by EIA are water vapor, carbon dioxide, methane, nonmethane hydrocarbons (NMHC), carbon monoxide, nitrous oxide, nitrogen oxides [9], and ozone. Water vapor is the most abundant greenhouse gas, varying from roughly 0 to 4 percent of the Earth's atmosphere. Currently, however, water vapor from fuel combustion is not believed to have a significant impact on atmospheric water vapor concentrations. Next is carbon dioxide, followed by ozone, nitrous oxide, carbon monoxide, and nitrogen dioxide. The amount of each gas, except NMHC and ozone [10], is reported for conventional gasoline, methanol, ethanol, compressed natural gas (CNG), and liquefied petroleum gas (LPG, i.e., propane) (Table ES1) [11]. GHG emissions are generally reported as moles per VMT throughout this report instead of the traditional grams per VMT [12]. The raw quantity of each greenhouse gas ("unweighted") is reported, in terms of the amount emitted into the atmosphere per VMT. In addition, a "weighted" quantity is shown for each gas except water vapor. This represents the equivalent amount of carbon dioxide that would have to be emitted in order to have the same heat-absorbing capability as the unweighted amount of each gas.

Table ES1. Total Fuel Cycle Greenhouse Gas Emissions From Gasoline and Alternative Transportation Fuels

Greenhouse Gas	Gasoline	Methanol From Natural Gas	Ethanol From Corn	Compressed Natural Gas	Liquefied Petroleum Gas
Unweighted Quantities (millimoles per VMT)					
Carbon Dioxide(CO_2)	7,900	8,700	7,400	5,640	6,000
Water Vapor (H_2O)	7,750	16,230	17,280	10,930	8,180
Methane (CH_4)	22	34.6	39.3	91.3	17.2
Nitrous Oxide (N_2O)	1.7	1.7	9.3	1.6	1.6
Nitrogen Oxides(NO_x)	26.5	36.2	58.3	24.2	22.9
Carbon Monoxide (CO)	330.4	327.1	258.25	324.2	325
Weighted Quantities (moles CO_2 equivalent per VMT)					
Carbon Dioxide(CO_2)	7.9	8.7	7.4	5.64	6
Water Vapor (H_2O)[a]	NA	NA	NA	NA	NA
Methane (CH_4)	0.22	0.35	0.39	0.91	0.17
Nitrous Oxide (N_2O)	0.54	0.54	2.98	0.54	0.54
Nitrogen Oxides(NO_x)	1.06	1.45	2.33	0.97	0.92
Carbon Monoxide(CO)	0.99	0.98	0.78	0.97	0.98
Total[b]	**10.71**	**12.02**	**13.88**	**9.03**	**8.61**

[a]Global warming potential value for water vapor has not been determined by the Intergovernmental Panel on Climate Change.
[b]Total weighted greenhouse gas (GHG) emissions do not include contributions from water vapor.
CO_2 = Carbon dioxide.
NA = Not applicable because the Intergovernmental Panel on Climate Change has not issued a global warming potential for water vapor.
VMT = Vehicle mile traveled.
For notes and sources, see Table 1.

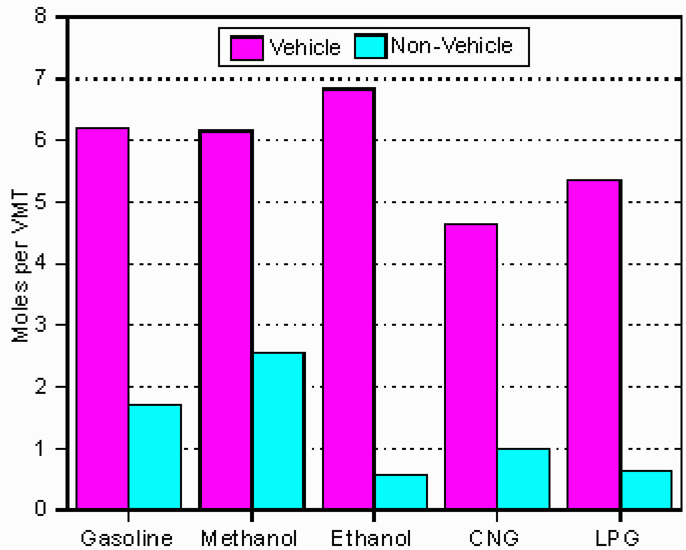
Total "weighted" emissions of alternative transportation fuels do not vary by more than 20 percent from those of gasoline. Because of the uncertainties in estimating the "weighting factors" (i.e., the global warming potential (GWP) **[13]** of each gas, compared with carbon dioxide), the fuel-specific variations shown in weighted emissions may not be significant. Alcohol fuels show greater weighted emissions than conventional gasoline, while the gaseous fuels show less. Weighted estimates for water vapor are not presented because the Intergovernmental Panel on Climate Change has not established a definitive GWP factor for water vapor.

These results represent emissions from the total fuel cycle--from resource recovery through energy transformation (e.g., refining) through end-use consumption. Emission estimates for each portion of the fuel cycle are shown in the report. Notable facts involving total fuel cycle emissions include the following:

- CNG produces the lowest level of carbon dioxide emission across the total fuel cycle, followed by LPG and ethanol from corn.
- CNG produces the largest methane emissions.
- Ethanol from corn produces the largest nitrous oxide emissions across the total fuel cycle.

Except for methanol, the "vehicle" (end-use) portion of the fuel cycle accounts for at least 80 percent of total fuel cycle carbon dioxide emissions (Figure ES1). This suggests that examining actions to reduce greenhouse gases as a direct result of vehicle use is justified.

Figure ES1. Carbon Dioxide Emissions per Vehicle Mile Traveled in Vehicle and Non-Vehicle Stages of the Fuel Cycle for Various Fuels



CNG = Compressed natural gas.
LPG = Liquefied petroleum gas.
VMT = Vehicle mile traveled.
For notes and sources, see Figure 1

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Transportation Demand Management

All new businesses must financially support Transportation Demand Management (TDM). In support of TDM, the EPA posted the following on its website:

"Coalition Announces 2nd Annual List of New England's Best Workplaces for Commuters^{SM} - More than 110 employers recognized for offering outstanding commuter benefits."

(Source: http://www.epa.gov/region01/pr/2004/aug/040809.html)

To qualify as one of the Best Workplaces for Commuters^{SM}, employers must provide:

- At least one primary commuter benefit, such as a monthly transit/vanpool pass subsidy, cash in lieu of free parking, or a significant telework program.
- At least three supporting commuter benefits, such as carpool incentives, lockers/showers for bikers or walkers, incentives for living near work, or onsite amenities such as day care or dry cleaning.
- A central point of contact for commuter information who actively promotes commuter benefits.
- Access to an Emergency/Guaranteed Ride Home program.

About the Best Workplaces for Commuters^{SM}
Best Workplaces for Commuters^{SM} is an innovative partnership that distinguishes and provides national recognition to employers who offer their employees superior commuter benefits. These benefits help reduce air pollution, alleviate traffic congestion, and save fuel. They can also help employers save on taxes, reduce the need for parking facilities, and meet government trip reduction goals. For more details and to see if an organization qualifies, visit www.bwc.gov.

About the New England Region Best Workplaces for Commuters^{SM} Coalition
The New England Region Best Workplaces for Commuters^{SM} Coalition is composed of leading government, transportation demand management, and health organizations in the New England Region working to reduce traffic congestion, improve air quality, and make commuting less stressful and costly. Members include the Association for Commuter Transportation Patriot Chapter, Massachusetts Bay Transportation Authority, MassCommute, New England Employee Benefits Council, Upper Valley Rideshare, and U.S. Environmental Protection Agency.

New England's Best Workplaces for Commuters^{SM} includes Hewlett-Packard, Marlborough, Massachusetts

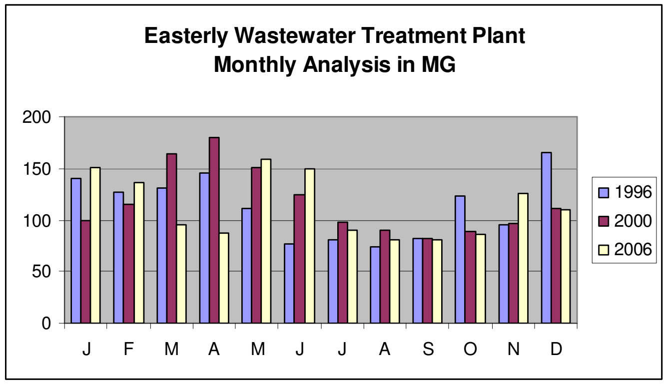
Appendix F: Wastewater Treatment Plants

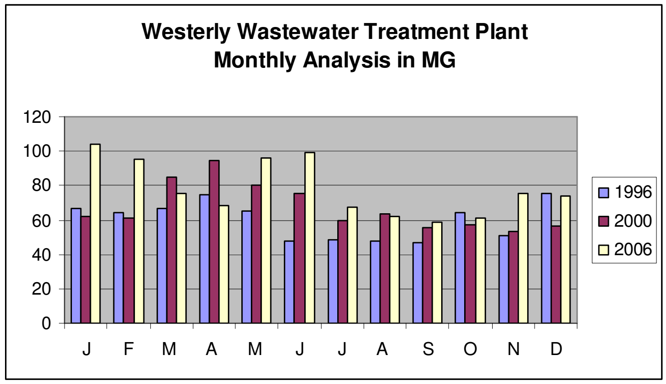
This data showing monthly wastewater flows may be of interest to managers and planners.

	Easterly
1996	1354 MG
2000	1400 MG
2006	1352 MG

	Westerly
1996	718 MG
2000	804 MG
2006	938 MG

Comments below are from Doran Crouse, DPW; Don Robinson, National Grid; and Harry Butland, Westerly Plant Manager.





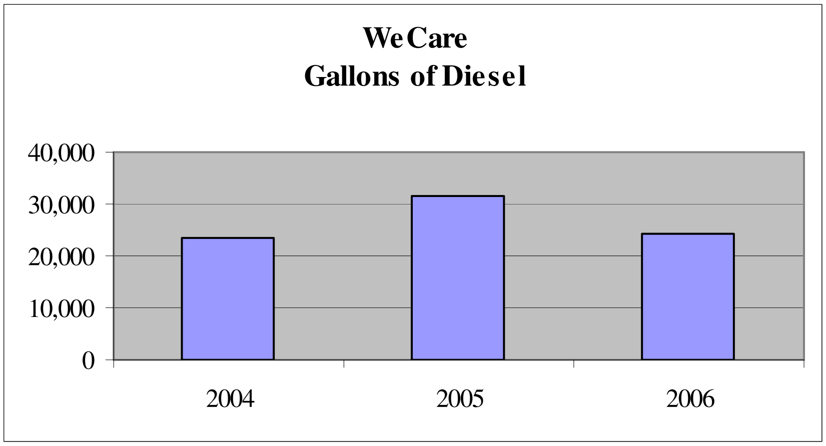
Natural Gas		COMMENTS
2004	22,394 therms	
2005	21,396 therms	
2006	16,930 therms	Reduction may be due to auxiliary (backup) power is more efficient or used less.

Electricity		COMMENTS In recent years, employees were trained to monitor energy efficiency
2000	1,511,760 kwh	Variable Frequency Drives (VFDs) replaced belt drives around 1999 or 2000
2001-2002	Not available	Large food manufacturer began pretreating wastewater in 2000 or 2001
2003	1,104,600 kwh	
2004	1,114,240 kwh	Energy efficient lighting was installed December 2004 with a National Grid grant
2005	1,089,840 kwh	
2006	1,052,400 kwh	
2007		Looking into redesign for alternative energy such as solar, wind, geothermal, biomass, hydro, thermal capture, etc.

Appendix G:

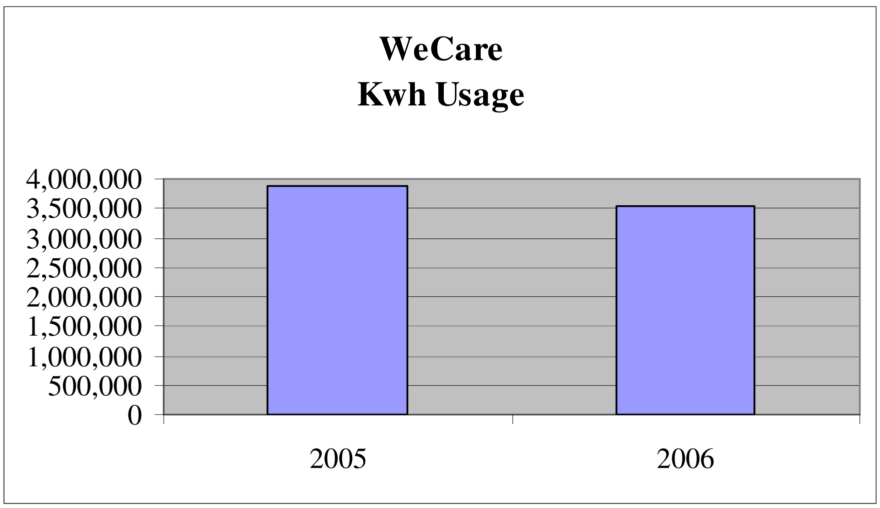
Diesel used for composting equipment

WeCare	Gallons of Diesel
2004	23,360
2005	31,603
2006	24,163



Electricity for buildings and composting equipment

2005	3,875,275
2006	3,546,975



Appendix H

Abbreviations

B20	20% Biodiesel + 80% conventional diesel
B100	100% Biodiesel
CCP	Cities for Climate Protection
CO	Carbon Monoxide
CO2	Carbon Dioxide
DPW	Department of Public Work
E85	85% Ethanol + 15% conventional gasoline
EIA	Energy Information Agency
EPA	Environmental Protection Agency
GHG	Greenhouse Gasses
GIS	Geographical Information System
Kwh	Kilowatt hour
MAPC	Boston Metropolitan Area Planning Council
MG	Million Gallons
MWRA	Massachusetts Water Resource Authority
NESEA	NorthEast Sustainable Energy Association
TDM	Transportation Demand Management
VMT	Vehicle Miles Traveled
VFD	Variable Frequency Drive
VOC	Volatile Organic Compounds

Appendix I

Case Studies to help launch Energy Task Force and Action Plan

www.MassClimateAction.org

Cutting Global Warming Pollution: Case Studies of Municipalities, School Districts, and Communities (draft)

Global Warming Policy Priorities for Mass., Dec. 2006

Sample municipal climate action plans - in Massachusetts and other states

City Websites

http://www.ci.worcester.ma.us/ocm/energy/actionplan.htm

http://www.massclimateaction.org/pdf/Newton%20EAP021005.pdf

http://www.cambridgeenergyalliance.org/

Organizations

www.ICLEI.org

www.CoolCities.org

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