



Local Action Plan on Climate Change

Town of Brookline, Massachusetts

February 2002



**Cities for Climate Protection
Campaign**

International Council for Local
Environmental Initiatives

Credits and Acknowledgments

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Executive Summary

The Brookline Board of Selectmen has committed the Town, its government, businesses and citizens to implement programs to reduce the emissions of greenhouse gases. With the passing of the Resolution for Participating in the Cities for Climate Protection (CCP) Campaign on April 25, 2000 (Appendix A), the Town of Brookline joined a group of more than 300 cities and counties around the world who are taking part in this campaign through the International Council for Local Environmental Initiatives (ICLEI).

The Cities for Climate Protection Campaign follows a 'Five Milestone' Process: 1) Complete a Greenhouse Gas Emissions Inventory and Report; 2) Set an Emissions Reduction Target; 3) Complete a Local Climate Action Plan to Reduce Greenhouse Gas Emissions; 4) Implement the Local Climate Action Plan; and 5) Monitor the Impact of Emissions Reductions Measures.

The Greenhouse Gas Emissions Inventory was completed in the summer of 2000. This report indicated that in 1995, 647,174 tons of eCO₂ were released from sources in Brookline. Special CCP software was used to forecast emission levels to the year 2010. If no actions are taken to address greenhouse gases in the Town, 690,325 tons of eCO₂ will be released in 2010. The second Milestone involved setting a greenhouse gas emissions reduction target. The Town has set the goal of reducing emissions in 2010 to 20% below 1995 levels. In order to reach this target, 172,586 tons of eCO₂ have to be eliminated over the next eight years.

This document demonstrates the completion of the third Milestone – the drafting of a Local Climate Action Plan. Brookline's Climate Action Plan is an outline of measures that the Town has already undertaken, and measures that the Town is encouraged to take, in order to achieve the greenhouse gas reduction target by 2010. Measures in the Plan outline actions related to transportation; energy conservation; solid waste and recycling; and land use planning and open space protection. The Plan presents information on implementation costs, financial savings and investment payback periods; co-benefits of the measure aside from the emissions reduction; and success stories from other municipalities that have undertaken similar projects.

The next step in the Campaign will involve selecting which measures to implement first. The Town's internal Climate Task Force will be charged with the task of determining which measures are most appropriate for the Town to implement in the next several years. Table 1 on the following page highlights several measures outlined in the Plan that have large CO₂ savings and/or short payback periods on investments that the Town makes on emission reduction technologies or programs. The Town should seek to prioritize these measures. Actions taken to reduce greenhouse gas emissions not only contribute to the overall regional and global mitigation of climate change, but also provide the Town with many local benefits – increased financial savings through energy efficiency, the creation of new jobs, and improved air quality and quality of life.

Table 1 Selected Emissions Reduction Measures

Measure	Status	Estimated Annual CO ₂ Reduction (Tons)	Estimated Annual Cost Savings	Estimated Implementation Cost	Payback
Police Units on Bicycle	Existing	58	\$7,229	\$600	0.1 years
Additional Police Units on Bicycle	Proposed	116	\$14,459	\$1,200	0.1 years
Walk to School Program	Proposed	58	\$4,281	\$3,000	0.4 years
Program to Increase MBTA Ridership	Proposed	3,238	\$793,115	\$75,000	0.1 years
Energy Efficient Building Code	Proposed	25,624	\$2,122,974	\$15,000	0 years
Sustainable Business Awards Program	Proposed	7,419	\$1,153,832	\$3,000	0 years
Home Composting Program	Existing	189	\$11,616	\$3,000	0.1 years
Expand Home Composting Program	Proposed	566	\$50,780	\$6,000	0.1 years
Curbside Recycling Program	Existing	21,589	\$179,265	\$587,533	3.2 years
Expand Curbside Recycling Program	Proposed	23,482	\$231,152	\$747,374	3.2 years
Bylaw Requiring Mandatory Private Recycling Services	Proposed	17,442	\$623,186	\$194,746	0.4 years
TOTAL		99,781	\$5,191,890	\$1,636,453	
Establish Energy Efficiency/ Environmental Coordinator (EEC) Position	Proposed	54,019 (Represents the emissions reduction potential of measures for which the EEC would assume responsibility).	\$3,482,814 (Represents cost savings from measures for which the EEC would assume responsibility).	\$72,000	TBD

1.1.1 Introduction

The Cities for Climate Protection (CCP) Campaign focuses on sources and quantities of greenhouse gas emissions resulting from the burning of fossil fuels and recommends actions to reduce those emissions at the municipal level. The emissions reduction efforts are aimed at two primary greenhouse gases: CO₂ and methane. CO₂ is released when fossil fuels - such as oil, coal and natural gas - are burned. Methane is emitted in urban areas when garbage and waste products decompose, primarily in landfills. There is widespread scientific agreement that the increasing quantity of these gases in the atmosphere is causing temperatures to rise and increasing the frequency and severity of extreme weather events. The accumulation of these greenhouse gases is a major threat to the climate stability of the earth. No other issue threatens our planet with such dramatic, far-reaching impacts, and no other issue is so clearly a worldwide problem. At the same time, many of the most promising solutions to climate change are local initiatives that the Town can control.

This Local Action Plan on Climate Change outlines measures that the Town of Brookline can take to reduce greenhouse gas emissions from municipal and community sources. The first part of the document presents further information on climate change and outlines potential impacts of the phenomenon in Brookline and across the globe. Next, the Plan describes the Town's involvement with the CCP campaign, and discusses the CCP Milestones that have already been completed. A brief discussion of the methodology used to select and quantify the impacts of the greenhouse gas reduction measures precedes descriptions of the actual measures in more detail.

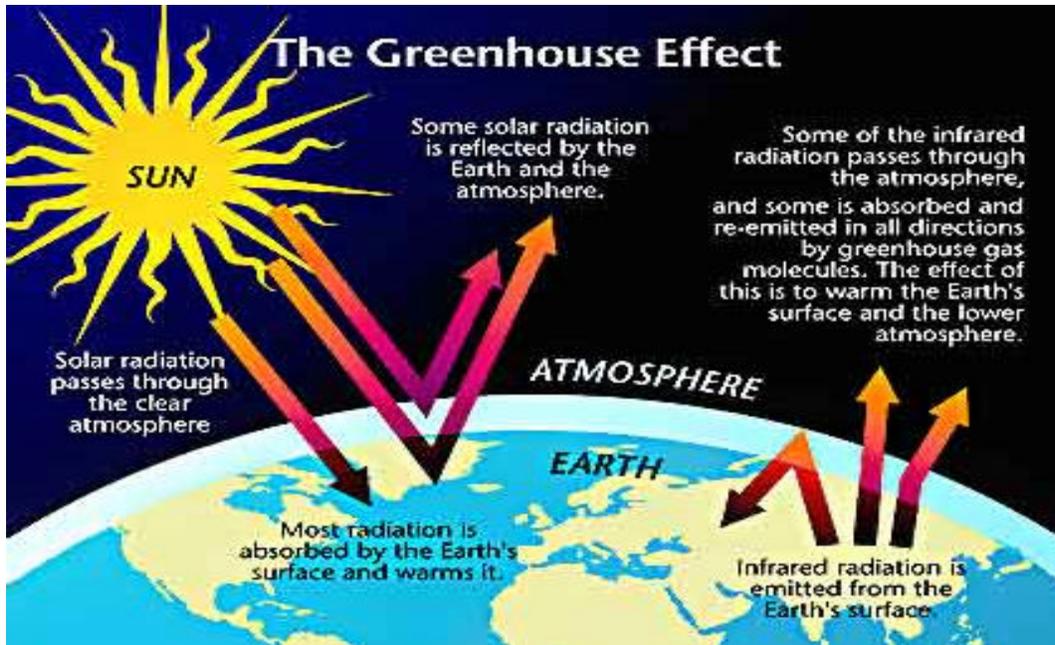
1.2.1 Global Warming and the Enhanced Greenhouse Effect

The phenomenon known as global climate change refers to the impact of a gradual rise in the earth's surface temperature caused by an increasing concentration of greenhouse gases (GHGs) in the atmosphere. Global climate change presents one of the foremost threats – economically, socially and environmentally – of the new century. Most scientists who have been studying this phenomenon for decades confirm that climate change is occurring, indicating that the global CO₂ level has increased 30% in the 200 years since 1800, primarily due to the combustion of fossil fuels for energy. Although the exact consequences are still difficult to predict, there is growing scientific consensus that greenhouse gas emissions are continuing to increase, and that dramatic changes in the Earth's climate systems (such as rising sea levels, desertification, and intensified or extreme weather patterns) will occur if no action is taken.

While greenhouse gases such as carbon dioxide (CO₂) and methane play a vital role in maintaining the necessary conditions for life on Earth, the rapidly increasing concentrations of these gases are causing a rise in global temperature. Greenhouse gases in the atmosphere behave much like the glass panes in a greenhouse. Sunlight enters the Earth's atmosphere, passing through a blanket of greenhouse gases. As it reaches the Earth's surface, land, water and the biosphere absorb the sunlight's energy. Once absorbed, this energy is sent back into the atmosphere. Some of the energy passes back into space, but much of it remains trapped in the atmosphere by the greenhouse gases, causing an increase in atmospheric temperature. The problem that we now face is that human actions, particularly the burning of fossil fuels and land

clearing are increasing the concentrations of these gases, creating the prospect of further global warming. This is the enhanced greenhouse effect.

Figure 1 *The Greenhouse Effect*

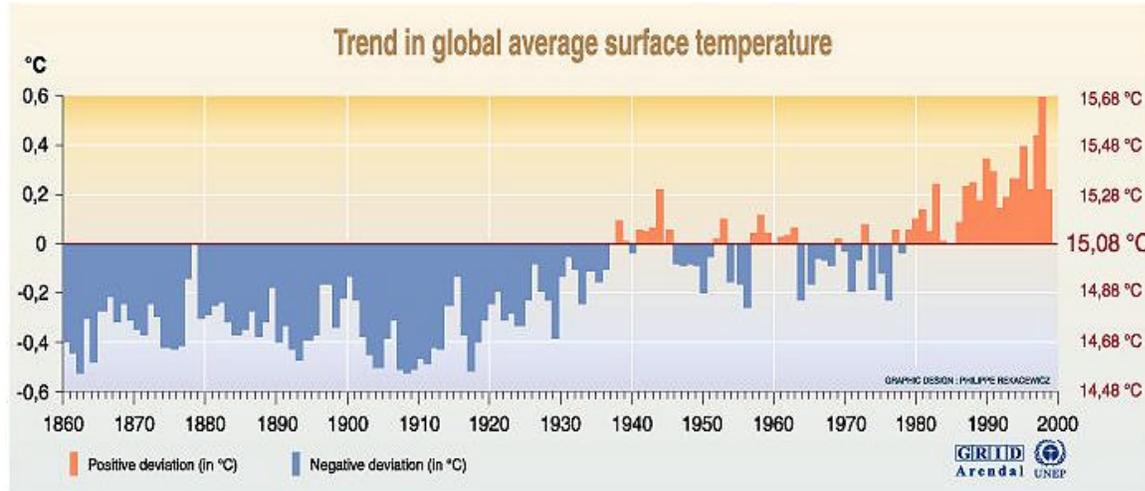


Source: NACC/USGCP graphic from Union of Concerned Scientists Website
(<http://www.ucsusa.org/globalwarming/index.html>)

Human beings increase greenhouse gas levels in the atmosphere through many daily activities. When fossil fuels are burned, the carbon dioxide that has been stored in them for thousands of years is released. Massive burning of fossil fuels in just a few recent decades has emitted a large amount of CO₂. Living, growing trees help to absorb carbon dioxide from the atmosphere, so our present trend toward deforestation of the planet means that less carbon dioxide is being absorbed. The two trends – burning more fossil fuels and cutting down more trees – taken together have increased the concentration of carbon dioxide in the atmosphere.

This anthropogenic rise in GHG emissions has caused the average temperature of the Earth to gradually increase, particularly in the last twenty years, and has contributed to what we refer to as climate change. The chart below illustrates this warming temperature trend.

Figure 2 Trends in Global Average Surface Temperature



Source: School of environmental sciences, climatic research unit, university of East Anglia, Norwich, United Kingdom, 1999.

1.2.2 Climate Change

Climate is the long-term average of a region's weather events. Climate change represents a change in these long-term weather patterns. The reason that scientist think that climate change is a more accurate term than global warming is that the increased levels of greenhouse gases in the atmosphere are causing climatic changes that vary across the planet, both from place to place and season to season.

The Intergovernmental Panel on Climate Change (IPCC), a panel of 2,000 scientists convened by the United Nation's Environment Programme and the World Meteorological Organization determined that even if steps are taken now to reduce our emissions of greenhouse gases, the globe's atmospheric temperature could rise at a rate faster than it has in the past 10,000 years. The panel concluded that the temperature rise in the last 150 years suggests a discernable human influence on global climate. If no actions are taken to reduce emissions, computer models of the earth's climate predict that global average temperatures will rise by 1.6 - 6.3°F over the next 100 years.

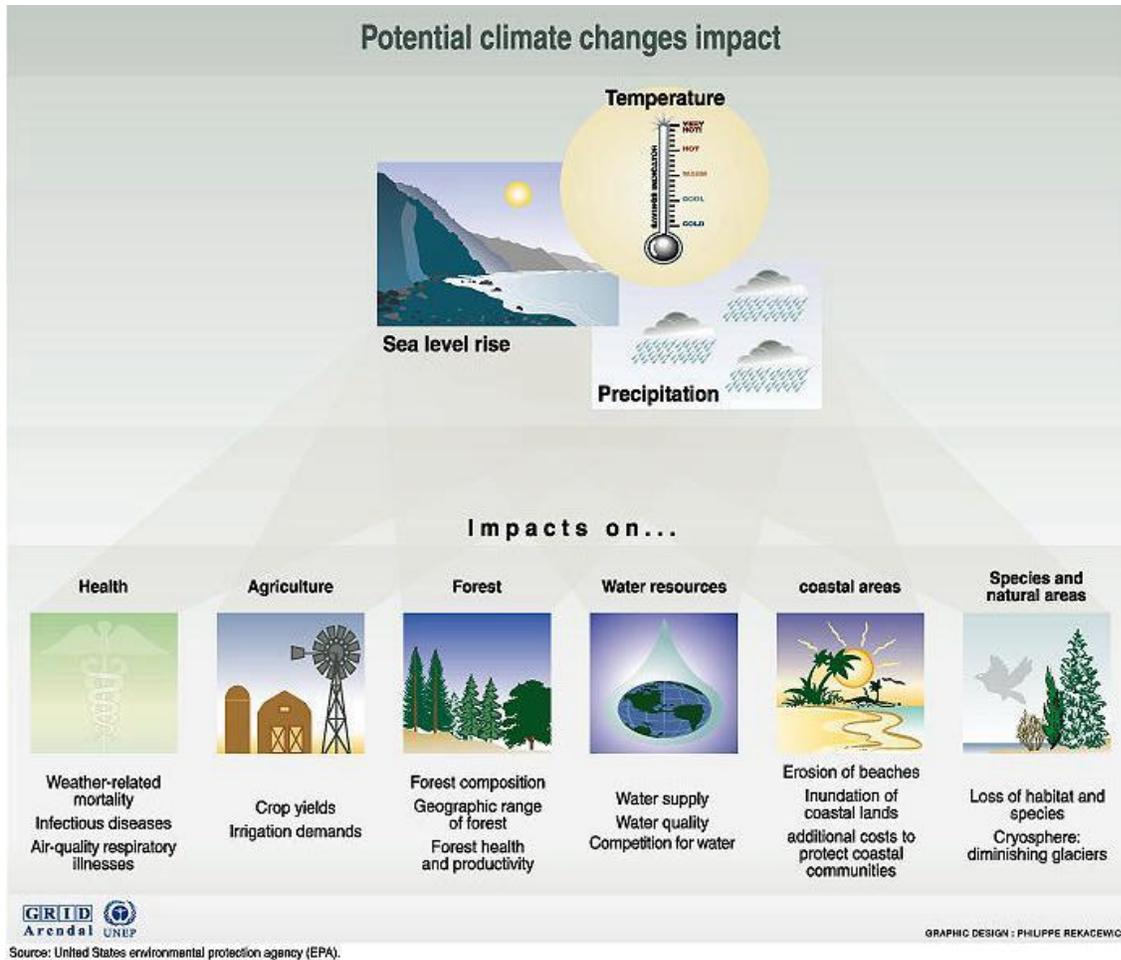
The rapid rate of climate change is cause for considerable concern. For a perspective, this projected climate change is of the same magnitude (but in the opposite direction) as the last ice age when continental ice caps penetrated well into Europe and North America. The difference is that the global warming may occur over the next few decades, whereas the ice age changes occurred over thousands of years. The rapid changes that are predicted will put great stresses on the natural resources on which cities and all human settlements depend.

1.3.1 Global Impacts of Climate Change

Global warming could produce many changes in the earth's climate, including increased incidences of extreme weather events, like hurricanes and storms; melting of the polar ice sheets, which could result in a rise in overall sea levels and can lead to coastal flooding; increased stress

on ecosystems, which could lead to desertification and/or loss of biodiversity; increases in the earth's average temperature and precipitation levels; and other dramatic climate transitions which may not easily be predicted. These environmental impacts will also affect society, particularly in agricultural and food production, fisheries stocks, air quality and ozone levels and human health. The consequences of global warming and climate change are far reaching, and can affect all countries, states and cities, regardless of socio-economic status or location.

Figure 3 *Potential Impacts of Climate Change*



1.3.2 Impacts of Climate Change in Massachusetts

In the state of Massachusetts, the effects of climate change are already apparent. The average temperature has increased by 2% over the past century, with precipitation levels rising by up to 20% in some parts of the state. This trend will more than likely continue through the next century. Projections from the IPCC show that by the year 2100, average temperatures in Massachusetts are expected to increase 4°F in the winter and spring, and 5°F in the summer and fall. This may lead to increased heat waves in the summer, which will elevate heat-related deaths especially in urban areas like Greater Boston. Studies have projected that by 2050, if no action is

taken, heat-related deaths during a typical summer could increase 50%, from close to 100 heat-related deaths per summer to over 150. Ground level ozone may also increase as a result, causing an increase in symptoms of asthma and other respiratory diseases.

In addition, the sea level in the Greater Boston area has risen 11 inches in the last century, and it is expected to rise another 22 inches by the year 2100. This sea level rise could cause excessive erosion of Massachusetts' coastal areas. General weather patterns may change, bringing an increase in precipitation, which can lead to extremes like flooding incidences, water scarcity and threats to water quality. Increased incidences of intense weather events, like heavy storms and hurricanes, may also occur, creating stresses on forests, fisheries and agricultural lands. The coastal beaches and tidal marshes of Massachusetts are especially sensitive to the effects of sea level rise and changes in river flows. Sea level rise could inundate coastal wetlands, destroying habitat for migratory birds and other wildlife. Barrier beach island refuges such as the Monomoy National Wildlife Refuge south of Cape Cod could be threatened or lost.

The brilliance of Massachusetts's fall foliage colors may be adversely affected. Warmer temperatures may eradicate some species while pests and pathogens may strike harder. Forests potentially thinned and prey to disease may lose their variety of rich color hues and brilliance. Northern hardwoods and the beautiful fall colors they produce may migrate north 100 to 300 miles. Southern trees may replace northern hardwood, spruce and fir forests.

1.4.1 What can Brookline do about Climate Change?

Local authorities representing their communities individually and collectively can play an important role in solving the world's environmental problems. They can be the first to confront the most urgent of these problems – waste disposal and the pollution of air and water. Local governments play a key role in addressing climate change because they directly influence and control many of the activities that produce these emissions.

The Town of Brookline prides itself as a Town that cares about people and the planet. The Board of Selectmen realized that local actions taken to reduce greenhouse gas emissions and increase energy efficiency provide many local benefits: decreased air pollution, creation of jobs, reduction of energy expenditures and financial savings for Town government, businesses and citizens.

Consequently, on April 25, 2000 the Board of Selectmen committed the Town to reduce the emissions of greenhouse gases. By passing the Resolution for Participating in the Cities for Climate Protection Campaign, Brookline joined a group of more than 300 cities and counties around the world in the Cities for Climate Protection Campaign. Under the guidance of the International Council for Local Environmental Initiatives (ICLEI), these cities, who are collectively responsible for an estimated 5 to 10 % of the world's total greenhouse gases, have dedicated themselves to the reduction of greenhouse gas emissions. This Local Action Plan documents Brookline's strong commitment to climate protection.

Decisions about land use and development, investments in public transit, energy efficient building codes, waste reduction and recycling programs all affect local air quality and quality of life as well as the global climate. The CCP Campaign is an opportunity for cities to take practical

steps that reduce greenhouse gas emissions and simultaneously generate multiple benefits for their communities. As the Town of Brookline moves through the process of completing the Cities for Climate Protection Campaign, the relationship between municipal priorities such as improving air quality, cutting traffic, saving money and improving quality of life will soon become apparent. This is because the sources of CO₂ and methane emissions are the same as those that make local air smoggy, streets congested and energy bills high, as well as contribute to global warming pollution and climate change.

1.5.1 The Cities for Climate Protection Campaign

The Cities for Climate Protection Campaign is a global project of the International Council for Local Environmental Initiatives (ICLEI) which is a membership association of local governments dedicated to the prevention and solution of global environmental problems through local action. ICLEI currently runs two campaigns, one of which is the Cities for Climate Protection (CCP) Campaign. This Campaign was established by ICLEI in 1993 at an international summit of municipal leaders held at the U.N. Headquarters in New York. Over the past seven years the CCP has engaged over 384 municipal governments in a worldwide effort to slow the earth's warming. Other participating cities in Massachusetts include Cambridge, Amherst, Newton, Boston, Arlington and Medford.

1.5.2 The Five Milestone Process

The Cities for Climate Protection Campaign follows a 'Five Milestone' process:

- ☞ Milestone One: Conduct a Greenhouse Gas Emissions Inventory and Report for the entire community as well as municipal operations
- ☞ Milestone Two: Set a Greenhouse Gas Emissions Reduction Target
- ☞ Milestone Three: Develop a Local Climate Action Plan
- ☞ Milestone Four: Implement the Local Climate Action Plan
- ☞ Milestone Five: Monitor Emissions Reductions

1.5.3 The Greenhouse Gas Emissions Inventory and Reduction Target

The Town has already completed Milestones One and Two. In 2000, it conducted a Greenhouse Gas Emissions Inventory for the baseline year of 1995, with an interim inventory taken for 1998 and a forecast for 2010. The main sources examined in this inventory were residential and commercial energy use, transportation and solid waste. The results of the inventory show that the Town was responsible for 647,174 tons of eCO₂ (equivalent CO₂ levels representing total quantity of methane and CO₂ emissions resulting from energy used, fuel used and landfilled waste) in 1995. By 2010, if no action is taken to reduce emissions, Brookline's emissions are predicted to increase to 690,325 tons of eCO₂.

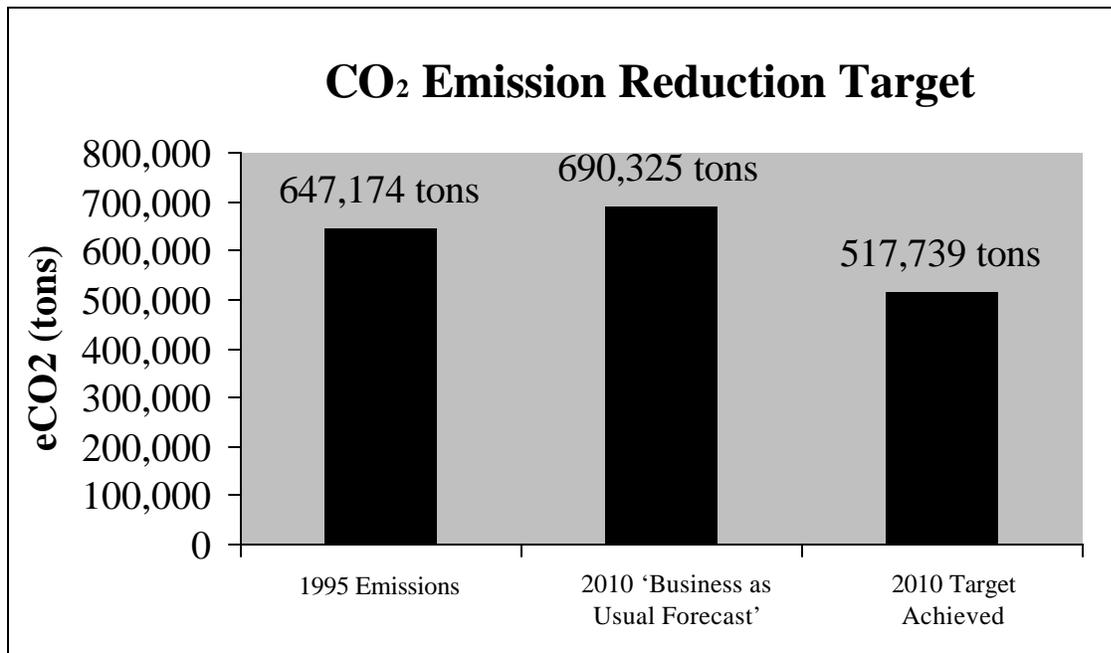
Table 2 Total Greenhouse Gas (GHG) Emissions in Brookline

Year	Total eCO ₂ (Tons)	Energy Use (BTU's)	Per Capita Emissions
1995	647,174	6,543,303	11.78 tons / person
2010 (forecast)	690,325	6,921,146	12.56 tons / person

Source: Town of Brookline Greenhouse Gas Inventory, Evans 2000

The Reduction Target is the specific GHG reduction goal that the Town aims to achieve by a designated year. Brookline has set a Reduction Target of lowering emissions in 2010 to 20% below the total amount of emissions released in 1995. In 1995, emissions from Corporate and Community sectors totaled 647,174 tons CO₂. In 2010, the emissions' forecast totals 690,325 tons of CO₂. In order to reduce emissions in 2010 to 20% below 1995 levels, a reduction of $(690,325 - 517,739.2) = 172,585.8$ tons of CO₂ is required.

Figure 4 CO₂ Emissions Reduction Target for Brookline



The following section outlines the Local Climate Action Plan, which will guide Brookline to implement measures to reach its reduction target.

Achieving the emissions reduction goal of 20% below baseline-year will be a challenge. It will take the successful implementation and continual monitoring of existing and proposed measures. It will require the ongoing commitment of Town government to provide the support needed to carry out these measures, and will also need commitment and initiative on the part of local businesses and individual citizens. The combination of these factors will enable the Town to attain the goals set forth in the Climate Action Plan.

1.6.1 The Local Action Plan

The objective of the Brookline Climate Action Plan is to identify actions that the Town can undertake to reduce greenhouse gas emissions. The combined benefits of existing, pending and newly proposed measures identified in this plan aim to reduce the Town's annual emissions to 20% below 1995 levels by the year 2010.

The Plan does not provide detailed instructions on how to carry out each of the proposed measures. Since the beginning of the Town's involvement with the CCP campaign, information and resources on greenhouse gas reduction measures has been collected. This material, while relevant and important, was not included in the Plan in the interests of keeping the document to a manageable size. Once the Plan has been adopted however, these materials will serve as excellent reference sources for the actual implementation of proposed measures.

For each of the measures outlined in the Plan, Town departments were contacted to assess the current operating status of the measure, the effectiveness and/or success of the measure to date, and whether any modifications will be applied to or considered for that measure. Each Town department was also consulted regarding the newly proposed measures. In addition, two committees formed: Town of Brookline Climate Task Force, comprised of Town Hall staff; and Climate Change Action Brookline (CCAB), a citizen's committee. In addition to providing input during the research and development of the proposed measures, the two committees reviewed and evaluated each of the proposed measures based on the following criteria:

- ~~SES~~ Cost of initial implementation and annual operation
- ~~SES~~ CO₂ reduction capability
- ~~SES~~ Environmental impacts
- ~~SES~~ Public and political support
- ~~SES~~ Feasibility of the measure

The continued involvement of the Town's internal Climate Task Force is essential to ensure the success of Brookline's emission reduction efforts. Current members of the Task Force include Erin Chute (Parks and Open Space), Jennifer Goldon (Planning), Robert Duffy (Planning), Alan Balsam (Health), Mark Sacco (Buildings) and Tom Brady (Conservation). Upon approval of the Local Action Plan by the Board of Selectmen, this group will work to prioritize the measures and to determine how the emissions reduction measures can be worked into and enhance Town policy and operations. Interdepartmental communication about emissions reduction measures will ensure that policy decisions at all levels seek to reduce climate change impacts.

1.6.2 Organization of the Plan

The measures in the Plan are grouped according to the following categories:



Corporate Transportation and Community Transportation



Corporate Energy and Community Energy



Corporate Waste and Community Waste



Other Measures

Each section of the plan outlines existing, as well as newly proposed measures:

Existing Measures: These are either current initiatives that are being implemented, or are in the developmental stage. These measures primarily consist of efforts to conserve energy or reduce waste. However, programs with goals other than energy conservation and waste reduction that have greenhouse reduction benefits are also recognized.

Proposed Measures: These are new initiatives that have not yet been considered for implementation. Many of them follow the example of other local government emission reduction efforts, but have been restructured to address the unique needs of Brookline.

Each measure listing contains the following information:

- ✍* A description of the measure
- ✍* Amount of CO₂ and financial savings to be gained
- ✍* Implementation costs and Payback period. It should be noted that the length of many payback periods will decrease as emissions reduction technology becomes less expensive and as the necessary infrastructure for many of the proposed measures becomes more widely available.
- ✍* Co-benefits that result from implementation, aside from the reduction of greenhouse gas emissions
- ✍* Success stories from other municipalities that have undertaken a similar project

In each section, existing measures are outlined first, followed by proposed measures. In some cases, a follow-up measure is proposed, in which the impact of the Town increasing its efforts in a particular area is evaluated. In cases where it was difficult to quantify the impact of the

measure in terms of emissions reductions and financial savings, these measures have been left until the end of the appropriate section.

The impact of the measures on greenhouse gas emissions and financial expenditures was calculated, using special CCP Software developed by Torrie Smith Associates. The software covers both in-house and community-wide greenhouse gas emissions from energy use and waste. Data on energy consumption is entered into the software, which then converts it to emissions of eCO₂. Data on municipal and community energy use came from Town staff, government documents and experts in the fields of transportation, waste and energy use. Where Brookline specific data was unavailable, attempts were made to base calculations on averages or estimates from similar projects or measures. The methodologies used to calculate the impact of measures are listed in Appendix B, Measure Quantification Notes. This Appendix also lists all assumptions and data sources used in the calculations.

The following tables present an overview of all the measures discussed in the Plan. Table 3 outlines those which had quantifiable emissions reduction impacts. Table 4 outlines measures whose impacts were not easily quantifiable in terms of emissions reductions and financial savings. These tables serve merely to present the data outlined in the Plan. Further information about the measures is included in the text of the Plan.

Table 3 Emissions Reduction Measures in Local Action Plan

Measure	Status	Page of LAP	Estimated Annual CO ₂ Reduction (Tons)	Estimated Annual Cost Savings	Estimated Implementation Cost	Payback
Corporate Transportation						
Police Units on Bicycle	Existing	17	58	\$7,229*	\$600*	0.1 years
Additional Police Units on Bicycle	Proposed	18	116	\$14,459*	\$1,200*	0.1 years
Hybrid Gas/Electric Vehicles in Town Fleet	Existing	18	8	\$1,019*	\$11,280*	11.1 years
Additional Hybrid Gas/Electric Vehicles in Town Fleet	Proposed	19	102	\$12,736*	\$141,000*	11.1 years
Conversion of Fleet Vehicles to CNG	Proposed	20	127	\$9,089*	\$152,750*	16.8 years
Conversion of Fleet Vehicles to Biodiesel	Proposed	21	456	\$0*	\$25,050*	0 years
Parking Cash-Out for Town Employees	Proposed	21	19	\$7,629***	\$23,520*	13.6 years
Corporate T-Pass for Town Employees	Proposed	22	35	\$7,629***	\$14,352*	1.9 years
Telecommuting for Town Employees	Proposed	23	486	\$24,451**	\$1,561,700*	63.9 years
Community Transportation						
Telecommuting for Segment of Brookline Workforce	Proposed	24	13,508	\$1,689,378**	\$29,670,515**	17.6 years
Support for Car Sharing Programs	Existing	24	26	\$3,193**	\$-161,260**	0 years
Lobby for Increased CAFÉ Standards	Proposed	25	56,431 (This figure reflects the emissions reduction at a local level that would result from lobbying for increased CAFÉ standards at a federal level).	\$7,057,403** (This figure reflects the cost savings for Brookline residents that would result from lobbying for increased CAFÉ standards at a federal level).	\$0** (This figure reflects the estimated implementation cost for Brookline residents to lobby for increased CAFÉ standards at a federal level).	0 years
Walk to School Program	Proposed	26	58	\$4,281**	\$3,000**	0.4 years
Bicycling Infrastructure Improvements and Outreach Program	Proposed	27	484	\$60,474**	\$136,000*	2.2 years
Program to Increase MBTA Ridership	Proposed	28	3,238	\$793,115**	\$75,000*	0.1 years

*Savings or costs to Town of Brookline.
 **Savings or costs community wide.
 ***Savings or costs to Town of Brookline employees.

Table 3 Emissions Reduction Measures in Local Action Plan

Measure	Status	Page of LAP	Estimated Annual CO ₂ Reduction (Tons)	Estimated Annual Cost Savings	Estimated Implementation Cost	Payback
Corporate Energy						
LED Traffic Signals	Existing	30	364	\$58,941*	\$165,000*	2.8 years
Town Building Lighting Retrofits	Proposed	31	1,300	\$189,635*	\$759,225*	4 years
Energy Efficient Windows in Town Buildings	Proposed	32	1,724	\$251,604*	\$11,854,846*	47.1 years
Energy Efficient Streetlights	Proposed	34	97	\$15,673*	\$417,600*	26.6 years
Town Owned Demonstration House	Proposed	34	10	\$839*	\$35,000*	41.7 years
LED Exit Signs and Fire Alarm Lights in Town Buildings	Proposed	35	75	\$12,221*	\$23,900*	2 years
Municipal Use of Solar Energy	Proposed	36	17	\$2,420*	\$135,000*	55.8 years
Municipal Purchase of Green Electricity	Proposed	38	2,342	\$0*	\$68,338*	n/a
Green Electricity RPS (Municipal Sources)	Proposed	39	585	\$0*	\$17,084*	n/a
Lobby for Increased RPS (Municipal Sources)	Proposed	39	1,171 (This figure reflects the emissions reduction from Town sources that would result from lobbying for an increased RPS at the State level).	\$0* (This figure reflects the cost savings for the Town sources that would result from lobbying for an increased RPS at the State level).	\$34,169* (This figure reflects the estimated implementation cost for the Town that would result from lobbying for an increased RPS at the State level).	n/a
Community Energy						
Conversion of Incandescent Bulbs to Compact Fluorescents in Brookline Residences	Proposed	37	7,181	\$655,749**	\$728,569.80**	1.1 years
Community Purchase of Green Electricity	Proposed	38	50,903	\$0**	\$1,214,301**	n/a
Green Electricity RPS (Community Sources)	Proposed	39	12,726	\$0*	\$303,575**	n/a
Lobby for Increased RPS (Community Sources)	Proposed	39	25,452 (This figure reflects the emissions reduction at a local level that would result from lobbying for an increased RPS at the State level).	\$0** (This figure reflects the cost savings at a local level that would result from lobbying for an increased RPS at the State level).	\$607,151** (This figure reflects the estimated implementation cost at a local level that would result from lobbying for an increased RPS at the State level).	n/a

*Savings or costs to Town of Brookline.
 **Savings or costs community wide.
 ***Savings or costs to Town of Brookline employees.

Table 3 Emissions Reduction Measures in Local Action Plan

Measure	Status	Page of LAP	Estimated Annual CO ₂ Reduction (Tons)	Estimated Annual Cost Savings	Estimated Implementation Cost	Payback
Energy Efficient Building Code	Proposed	40	25,624	\$2,122,974**	\$15,000**	0 years
Sustainable Business Awards Program	Proposed	41	7,419	\$1,153,832**	\$3,000**	0 years
Community Use of Solar Electricity	Proposed	42	6,280	\$524,228**	\$51,113,250**	77.4 years
Residential Use of Solar Water Heating	Proposed	43	745	\$61,203**	\$11,130,000**	181.9 years
Residential Energy Efficiency Program	Proposed	44	20,918	\$2,999,727**	\$5,000**	0 years
Community Waste						
Home Composting Program	Existing	46	189	\$11,616*	\$3,000*	0.1 years
Expand Home Composting Program	Proposed	47	566	\$50,780*	\$6,000*	0.1 years
Curbside Recycling Program	Existing	47	21,589	\$179,265*	\$587,533*	3.2 years
Expand Curbside Recycling Program	Proposed	48	23,482	\$231,152*	\$747,374*	3.2 years
Bylaw Requiring Mandatory Private Recycling Services	Proposed	49	17,442	\$623,186**	\$194,746**	0.4 years
Other Measures						
Street Tree Planting	Existing	50	4,060	n/a	\$385,000*	n/a
Establish Energy Efficiency/ Environmental Coordinator Position	Proposed	53	54,019 (These figures are not included in totals because they reflect measures already accounted for in the Table)	\$3,482,814 (These figures are not included in totals because they reflect measures already accounted for in the Table)	\$72,000*	n/a
SUBTOTAL FOR TOWN			14,196	\$1,048,678	\$17,456,521	
SUBTOTAL FOR COMMUNITY			294,261	\$17,788,452	\$94,823,848	
TOTAL			308,457	\$18,837,130	\$112,280,369	
EMISSIONS REDUCTION NEEDED TO MEET TARGET			172,586			
DIFFERENCE			135,871			

*Savings or costs to Town of Brookline.
 **Savings or costs community wide.
 ***Savings or costs to Town of Brookline employees.

Table 4 *Unquantified Measures not Accounted for in Emissions Reduction Totals*

Measure	Sector	Status	Page of LAP	Estimated Annual CO ₂ Reduction (Tons)	Estimated Annual Cost Savings	Estimated Implementation Cost	Payback
Traffic Calming	Corporate Transportation	Existing	19	n/a	n/a	\$510,000*	n/a
Purchase of Environmentally Preferable Products	Corporate Waste	Existing	45	n/a	n/a	n/a	n/a
Climate Change Outreach and Education	Other	Existing	52	n/a	n/a	\$50,000*	n/a
Promote Mixed Use and Transit Oriented Development	Other	Existing	51	n/a	n/a	n/a	n/a
Taxicab Study	Community Transportation	Proposed	29	n/a	n/a	\$3,000*	n/a
Support for Urban Ring Project	Community Transportation	Proposed	30	n/a	n/a	n/a	n/a
Town Building Heating/Cooling Efficiency	Corporate Energy	Proposed	33	n/a	n/a	n/a	n/a
Create Energy Advisory Committee	Other	Proposed	54	n/a	n/a	n/a	n/a

*Savings or costs to Town of Brookline.

Transportation Sector

Existing Corporate Transportation Measures



Police Units on Bicycle

Measure Status: Existing

Responsible Department: Police, Community Relations

CO₂ Savings in 2010: 58 tons

The Brookline Police Department currently has four bicycles which are used for patrols. These patrols usually operate from April through December, with three bicycles out during the day and two at night. The patrols fall under the Community Service Division of the Police Department and generally perform random patrols around Brookline Village, Coolidge Corner and Beacon Street. The police bicycle program has resulted in many benefits for the Town. Moving police out of cars and onto bicycles reduces municipal fuel use and provides visible evidence that bicycling is a legitimate option for transportation. Bike police also have a positive impact on crime, as bicycles are more difficult for criminals to spot than cruisers, and allow access to areas inaccessible to cars. In addition, the patrols are good for public relations, as they make the police more approachable and can be used for special events. The four mountain bikes purchased in 1999 have contributed to the elimination of 58 tons of CO₂ and savings of \$7,229 in avoided fuel costs.



- ⌘ Cost of bike \$1,800; x 4 = \$7,200
- ⌘ Average maintenance cost of bike: \$200/year; x 4 = \$800
- ⌘ Average cost of police mountain bike training course: \$150; x 4 = \$600
(Information from International Police Mountain Bike Association)
- ⌘ Average maintenance cost of automobile: \$2,000/year; x 4 = \$8,000 (AAA)
Total Implementation Cost: \$7,200 + \$800 + \$600 - \$8,000 = \$600
- ⌘ Financial savings from avoided fuel costs: \$7,229
- ⌘ Payback: 0.1 years

Co-Benefits

- ⌘ Reduce traffic congestion
- ⌘ Reduce air pollution emissions that contribute to visibility degradation and health problems
- ⌘ Promote healthy forms of transportation, police officers are more physically fit
- ⌘ Good for community relations, police officers become more approachable
- ⌘ Police able to patrol areas unreachable by car
- ⌘ Can influence helmet use and adherence to bicycle traffic and safety rules

Success Stories

- ⌘ The City of Los Angeles has 250 officers who patrol on bicycles. These bicycles have displaced 125 squad cars and resulted in an annual reduction of 1,111 tons of CO₂.

Follow-Up Measure

If six additional bikes were purchased by 2010, so that on average 8 patrol cars were displaced by bicycle patrols for nine months of the year, 116 tons of CO₂ would be eliminated and the Town could save \$14,459 in fuel costs.



Hybrid Gas/Electric Vehicles in the Town Fleet

Measure Status: Existing

Responsible Department: Transportation, Highway

CO₂ Savings in 2010: 8 tons

In November of 2000, a Warrant Article passed at Town Meeting mandated that the Town purchase two hybrid vehicles. This directive reflects a recent state mandate that all state agencies begin purchasing alternative fuel vehicles for their fleets. The DPW initially tested pure electric fleet vehicles but found that they were not appropriate for the needs of the Town as they had to be recharged too often and did not have the mileage range needed. The Town also considered CNG vehicles as a possible option but due to constraints over refueling, decided against them. Instead, the Town purchased two Toyota Prius, a hybrid gas/electric vehicle that is ideal for the needs of the fleet. The average fuel economy of a Prius is 48 mpg as compared to that of the vehicle that the Prius will replace, the Ford Focus, which has an average fuel economy of 28 mpg. This measure will eliminate 8 tons of CO₂ and save the Town \$1,019 in fuel costs. If the Prius were used to replace Ford Crown Victorias, the other common vehicle in the Town fleet, which has an average fuel economy of 17 mpg, 13 tons of CO₂ would be eliminated and \$1,579 would be saved in fuel costs.



- ⌘ In 1998, vehicles in the fleet used 990 gallons of gas to drive approximately 27,721 miles per year. In contrast, a Prius would only require 578 gallons of gas to drive the same distance, resulting in annual savings of \$1,019.
- ⌘ Implementation cost: Purchase price of two Prius (2 x \$20,450 = \$40,900) - purchase price of two Ford Focus (2 x \$14,810 = \$29,620) = \$11,280
- ⌘ Payback: 11.1 years

Co-Benefits

- ⌘ More efficient use of tax payer dollars
- ⌘ Fuel cost savings can be used for other Fleet Services projects/needs
- ⌘ Reduces consumption of non-renewable resources
- ⌘ Encourages market for alternative fuels
- ⌘ Sets example for residents and other communities - Showcase Town as innovative leader
- ⌘ Reduces air pollution emissions that contribute to visibility degradation and health problems

Success Stories

- ⌘ Denver, Colorado's 'Green Fleets Executive Order' is the first comprehensive policy in the country designed to reduce greenhouse gas emissions from municipal fleets. A key feature is the inclusion of optimum fuel efficiency in new vehicle bid specifications. The estimated effects of Denver's Green Fleets program by the year 2005 are annual fuel cost savings of \$106,000 and a reduction in CO₂ emissions of 22% relative to 1992 levels, even though the number of vehicle miles traveled will have increased by 19%. Since May of 2001, the City of Denver has purchased 39 Toyota Prius.

Follow-Up Measure

If the Town purchased an additional 25 Prius for the Town Fleet by 2010, it could result in an additional reduction of 102 tons of CO₂ and savings of \$12,736 in fuel costs.



Traffic Calming Programs

Status: Existing Measure

Responsible Department: Engineering, Transportation

CO₂ Savings in 2010: Unknown

Brookline, like other communities in the Boston area, benefits from the walkability and bike-ability of its commercial centers and neighborhoods. The Town continues to promote this with well-marked crosswalks, wide sidewalks, traffic signals prioritizing pedestrians, school crossing guards and vehicle signage. Vehicular traffic however is on the rise and other measures are being investigated to promote traffic calming, such as raised crosswalks or intersections. Traffic calming that reduces vehicular speed also reduces gasoline use and emissions. Pedestrian-friendly areas promote transit use, combined vehicular trips, bicycle travel and walking, as well as contributing to the safety of the Town's residents.

The Transportation Department has recently undertaken a number of traffic calming studies at Winchester Street, Walnut Street, Brookline High School and at the Driscoll School. The total cost of these four projects is estimated at \$510,000 (Transportation/Engineering). Future traffic calming projects are envisioned for Reservoir Road; Emerson Garden; Babcock and Pleasant Streets; and Allendale and Grove Streets. It is not possible to accurately calculate an emissions reduction that can be directly attributed to traffic calming projects. While traffic calming projects do reduce vehicular speeds and encourage walking and biking a figure for trip reductions cannot be attributed to a specific project without intensive study and research. There are, however, non-tangible benefits that result from this measure such as increased safety and community livability in the neighborhoods where traffic calming has been implemented.

Co-Benefits

- /// Improves livability of neighborhoods by reducing traffic congestion
- /// Reduces gasoline consumption
- /// Promotes alternative forms of transportation, makes streets more pedestrian friendly
- /// Makes streets and communities safer by reducing vehicular speeds
- /// Discourages use of residential streets by non-citizen cut-through vehicle traffic
- /// Influences driver behavior through education and design

Success Stories

- /// The City of Cambridge, MA has an extensive Traffic Calming Program. One project that involved curb extensions, raised crosswalks, raised intersections and zebra crosswalk markings reduced average travel speeds from 30 mph to 21 mph. Before the improvements, 41% of vehicles were going at or below the 25 mph speed limit. After the project 95% of vehicles were going at or below the speed limit. In addition surveyed residents reported that the project was visually pleasing and enhancing to the community.

New Corporate Transportation Measures



Conversion of Fleet Vehicles to CNG

Measure Status: Proposed

Responsible Department: Transportation, Highway

CO₂ Savings in 2010: 127 tons

At present, the Toyota Prius is an excellent vehicle with which to start an alternative fuel vehicle purchasing program. In the future however, the Town may decide to consider converting some fleet vehicles, such as light vans or trucks, to CNG (compressed natural gas). CNG is the cleanest burning alternative fuel vehicle, and on a gallon-equivalent basis, costs an average of 15 to 40 % less than gasoline or diesel. While natural gas vehicles do emit methane, a greenhouse gas, any slight increase in methane emissions would be more than offset by the substantial reduction in CO₂ emissions. CNG vehicles are used extensively by MassPort and the MBTA.

The main obstacle to the use of CNG vehicles is the lack of local refueling stations. The Town has investigated the construction of a CNG fast fill station at the Hammond Street DPW Yard, however the cost estimate is \$250,000. This measure evaluates the impact of converting 47 light vans or trucks in the Town fleet to CNG but does not assume the construction of a refueling station. More and more public CNG stations are being constructed in Boston, and by 2010 it is likely that refueling will be more convenient. If the Town were to convert its light vans and trucks by 2010, 127 tons of CO₂ would be eliminated, and \$9,089 saved.



- ⚡ While conventional gasoline costs \$1.235/gallon on average, the price of CNG per gasoline gallon equivalent is \$0.89. In 1998, DPW light vans and trucks used 26,647 gallons of gasoline to travel 415,058 miles at a cost of \$29,647. While CNG vehicles have a lower fuel economy, and would require 30,928 gallons of fuel to travel the same distance, it would only cost \$27,526. Savings: \$2,121.
- ⚡ The cost of converting a vehicle to CNG is \$3,250, so the implementation cost of this measure would be 47 x \$3,250 = \$152,750.
- ⚡ Payback: 16.8 years

Co-Benefits

- ⚡ Financial savings from cheaper fuel
- ⚡ Reduces ozone and air toxics emissions
- ⚡ Reduces dependence on imported fossil fuels because CNG is a domestic resource
- ⚡ Reduces smoke, noise and smell

Success Stories

- ⚡ The Johnstown, PA region of American Red Cross Blood Services opened the area's first public compressed natural gas CNG refueling station. The Red Cross will use the station to fuel 22 natural gas vehicles that will be converted during a state-funded, 2-year program. The program is expected to save approximately \$22,000 a year in fuel costs and reduce 94 tons of CO₂.



Conversion of Fleet Vehicles to Biodiesel

Measure Status: Proposed

Responsible Department: Transportation, Highway

CO₂ Savings in 2010: 456 tons

Another emissions reduction measure that the Town could implement would be to convert heavy trucks used by the DPW to biodiesel fuel. Biodiesel is a clean, renewable diesel fuel substitute produced from agricultural resources such as soybeans or rapeseed. It can be burned in any standard, unmodified diesel engine. Current biodiesel fleets have reported operational consistency over extended periods of use - engine performance, payload power and range are completely unaltered. Biodiesel does not function well in cold weather, but, as no tank conversion is required, vehicles can simply be fueled with conventional diesel during winter months. If the Town's 48 heavy trucks and equipment vehicles currently running on diesel were fueled with biodiesel for eight months of the year by 2010, 456 tons of CO₂ could be eliminated. The Town could also investigate low sulphur diesel, which, although not widely available in the United States at present, reduces the particulate emissions that are associated with conventional diesel.



- /// There is no cost to convert engines to run on biodiesel fuel.
- /// Biodiesel costs an average of \$0.30/gallon more than petroleum diesel. Therefore, it would cost the Town \$25,050 more to fuel the 48 heavy trucks and equipment vehicles with biodiesel. However, when the cost of meeting tougher emissions standards is considered, an emissions management system based on biodiesel may be the best option. Meanwhile, there is a great deal of research underway that is exploring ways to reduce the cost of biodiesel.

Co-Benefits

- /// Lowers particulate emissions
- /// Does not require special storage
- /// No engine modifications necessary
- /// Non-toxic to plants, animals and humans
- /// Biodegradable fuel
- /// Renewable source of energy

Success Stories

- /// The Green Team, a San Jose recycling and garbage company runs 95 trucks on 100% biodiesel. A spokesperson for the company says that the conversion cuts 50,000 pounds of air pollution each year.



Parking Cash-Out for Town Employees

Status: Proposed Measure

Responsible Department: Personnel, Transportation

CO₂ Savings in 2010: 19 tons

Parking Cash-Out is a measure that would give municipal employees who have reserved parking in the Town to give up their parking space in exchange for its cash value. This measure could be implemented in conjunction with the subsidized MBTA pass program, to further encourage Town employees to seek out alternative forms of transportation. The calculations used to quantify the impact of this measure on greenhouse gas emissions focus only on the 104 parking pass holders who park in the Town Hall lot. If

this measure were applied to all Town Employees who currently drive to work, its impact would be far greater. Calculations suggest that this measure would eliminate 18 tons of CO₂ per year and avoid \$7,629 in fuel costs.



- /// 26 parking spaces valued at \$65/month (Source:Engineering) would cost \$23,520.00
- /// The Town could regain the cost of 'buying-back' the parking passes by renting the spaces after business hours to non-municipal employees.
- /// Fuel costs avoided: $123,552 \text{ (potential mileage reduction from measure)} / 20 \text{ (mpg - average fuel economy of passenger car)} = 6,177.6$ gallons of fuel. 6,177.6 gallons of fuel at (\$1.235/gallon) cost \$7,629.34
- /// Payback: 13.6 years

Co-Benefits

- /// Reduces traffic congestion
- /// Reduces air pollution emissions that contribute to visibility degradation and health problems
- /// Reduces municipal parking congestion
- /// Increase employee morale
- /// Financial savings for employees

Success Stories

- /// The City of Santa Monica, CA implemented a parking cash out program as an element of their Transportation Management Plan Ordinance. 26 of Santa Monica's 105 employers with 50 or more employees had implemented cash-out programs by February 1999 resulting in a VMT reduction of 544,000 miles per year. This measure has also resulted in a CO₂ reduction of 196 tons per year.



Corporate T-Pass for Town Employees

Status: Proposed Measure

Responsible Department: Personnel

CO₂ Savings in 2010: 35 tons

The MBTA operates a Corporate T Pass Program in which businesses and municipalities can purchase subway and bus passes in groups for employees. The MBTA sends the passes to the business at the end of each month for the convenience of employees. Many employers choose to subsidize the pass program as an incentive for employees to take public transportation to work and to increase workplace morale. Even if the Town decides against subsidizing the program, employees can still enroll (minimum participation is 5 people), as the benefits of public transportation and group purchase are numerous. The calculations used to quantify the impact of this measure on greenhouse gas emissions focus only on the 104 parking pass holders who park in the Town Hall lot. If this measure were applied to all Town employees who currently drive to work, its impact would be far greater. Calculations suggest that this measure would eliminate 35 tons of CO₂ per year and avoid \$7,629.34 in fuel costs.



- /// Average monthly cost of pass: \$46
- /// Passes for 26 employees: \$14,352/year
- /// Town could rent out 26 newly available parking spaces for \$23,520/year (\$65 x 26 x 12)
- /// Fuel costs avoided: 123,552 (potential mileage reduction from measure)/20 (mpg - average fuel economy of passenger car) = 6,177.6 gallons of fuel. 6,177.6 gallons of fuel at (\$1.235/gallon) = \$7,629.34
- /// Payback: 1.9 years

Co-Benefits

- /// Reduces traffic congestion
- /// Reduces air pollution emissions that contribute to visibility degradation and health problems
- /// Group purchase of pass easier for employees
- /// Reduces municipal parking congestion
- /// Financial savings for employees

Success Stories

- /// NASA recently passed a policy directive titled 'Fare Subsidies for NASA Headquarters Employees Utilizing Public Mass Transportation'. The objective of this initiative is to reduce petroleum-product consumption and traffic congestion, and improve local air quality through encouraging the use of public mass transportation within Washington, DC and its environs.



Telecommuting for Town Employees

Measure Status: Proposed
 Responsible Department: Personnel, Information Technology
 CO₂ Savings in 2010: 486 tons

Telecommuting, the act of working from home rather than traveling back and forth to a workplace, is thought to produce benefits for the companies and individuals involved, as well as present intangible benefits for the rest of society. The Town could provide the technology and flexibility for certain employees to take advantage of telecommunication advances and reduce their number of trips by working from home. Each department would need to evaluate where this is possible and how such a program could be established fairly. Calculations demonstrate that creating a program whereby 350 Town employees worked from home twice a month could result in an annual savings of \$24,541 and the reduction of 486 tons of CO₂.



- /// Average cost of telecommuting: One-time fee of \$4,462 per employee (this cost includes computer, phone equipment and network installation), annual cost of \$2,158 per employee (includes support, network costs and home equipment maintenance). For 350 employees: one time fee of \$1,561,700 and average annual costs of \$755,300. Only the one-time costs are entered into the software as it is assumed that average annual costs are similar to support costs for employees working in Town facilities.
- /// Annual savings from avoided fuel costs \$24,451
- /// Payback: 63.9 years

Co-Benefits

- /// Creates staffing flexibility, expanded labor pool
- /// Can serve as a recruitment tool
- /// Reduces traffic congestion
- /// Reduces air pollution emissions that contribute to visibility degradation and health problems
- /// Improves quality of life and productivity for employees
- /// Reduces office space and parking requirements
- /// Reduces worker absenteeism

Success Stories

The following findings are taken from the 1994 Massachusetts Telecommuting Initiative Survey

- /// 87% of telecommuters reported improved productivity and overall work performance
- /// 100% of those who supervised telecommuters reported improved or sustained productivity
- /// 86.8% of telecommuters reported that their work arrangement had a positive impact on their home life
- /// Telecommuters averaged 24.5 fewer daily miles than non-telecommuters
- /// Telecommuters participating in the study saved roughly 18,600 gallons of fuel per year

Follow-Up Measure

If all Brookline employers were encouraged to allow employees to telecommute the impact on greenhouse gas emissions could be quite substantial. Calculations used to quantify the impact of this measure assume that 40% of the total workforce in Brookline (30,668 people) work in positions that are suitable for telecommuting. If 9,952 employees telecommuted twice a month, it could result in financial savings of \$5,739,715 and in the reduction of 105,776 tons of CO₂.

Existing Community Transportation Measures



Support for Car Sharing Programs

Measure Status: Existing

Responsible Department: Transportation

CO₂ Savings in 2010: 26 tons

The Town is currently assisting with the Zipcar car sharing program by providing three free parking spaces for Zipcars in Brookline. There are 81 members in Brookline with five Zipcars located in the Town. The benefits of the program are numerous. According to recent statistics compiled by Zipcar, the member/car ratio in Brookline is approximately 16 to 1, which has taken an estimated 38 cars off the road. The cost of being a Zipcar member is far less than the cost of renting or owning a vehicle. Additionally, members do not have to worry about the responsibilities associated with owning a car - Zipcar takes care of those logistics. The Zipcar program in Brookline is responsible for the elimination of 26 tons of CO₂.



- ⌘ The 40.5 Zipcar members in Brookline who were previous car owners have reduced passenger miles traveled (PMT) by 53,806 miles. This has resulted in a reduction of 2585.2 gallons of gas, or a savings of \$3192.72.
- ⌘ The basic Zipcar membership includes a \$25 application fee, a \$300 refundable insurance security deposit, a \$75 annual fee, and a \$0.40/mile fee. Hourly rental fees are \$4.50 to \$7.00/hour. The average total amount paid by Zipcar members is \$1,300/year. In contrast, AAA calculates that the average annual cost of a new car is \$5,300/year, not including purchase price.
- ⌘ Implementation cost $[(40.5 \times 1,300) - (40.5 \times 5,300) = -\$162,000] + 783.60$ (Town loss from three free parking spaces) = \$-161,260

Co-Benefits

- ⌘ Reduces traffic congestion, decreased traffic leads to increased social interaction, more livable communities
- ⌘ Reduces air pollution emissions that contribute to visibility degradation and health problems
- ⌘ Reduces parking congestion
- ⌘ Reduces costs of driving for members

Success Stories

- ⌘ Zipcar is a success story. According to Zipcar statistics, the program has taken 38 cars off the road in Brookline, and 437 off the road system wide in metro Boston. The estimated number of parking spaces freed up in Boston is 1,311.

New Community Transportation Measures



Lobby for Increased CAFE Standards

Measure Status: Proposed

Responsible Organization: CCAB

CO₂ Savings in 2010: 56,431 tons

This measure evaluates the impact of lobbying for increased CAFE (Corporate Average Fuel Economy) standards. The fuel economy of the average new passenger vehicle peaked in 1988 and is now less than it was 10 years ago. The stagnation of CAFE standards since 1985, doubling of the annual vehicle miles driven in the last 25 years and the recent explosion of SUV and light truck sales have eaten away at the nation's fuel efficiency. To reverse these trends and provide benefits to consumers and the environment, fuel economy standards need to be increased to over 40 mpg by 2010 and 55 mpg by 2020.

A fleet of cars and light trucks that reach 40 mpg will cost consumers only about \$1,000 to \$2,000 extra per vehicle. However, the \$2,500 to \$5,300 saved on fuel over the life of the vehicle will more than compensate consumers. In Brookline, this measure could eliminate 56,431 tons of CO₂ and save \$7,057,403 in avoided fuel costs.



- ⌘ In 1995, passenger cars and light trucks in Brookline drove 207.31 million miles. Those vehicles with current average fuel economies of 20 mpg for cars and 14 mpg for light trucks would use 10,897,247 gallons of gas at a cost of \$13,458,100 to travel the same distance.
- ⌘ If those vehicles had increased fuel efficiency levels of 40 mpg, only 5,182,750 gallons of gas would be needed at a cost of \$6,400,696.
- ⌘ Savings: \$7,057,404

Co-Benefits

- ⌘ Cost savings to citizens
- ⌘ Reduces air pollution emissions that contribute to visibility degradation and health problems
- ⌘ Decreases dependency on diminishing fossil fuel resources
- ⌘ Encourages innovation and energy efficient technology from automakers, creates new jobs in automotive industry

Success Stories

- ⌘ Raising national fuel efficiency standards to 45 mpg for cars and 34 mpg for light trucks would save the United States over \$200 billion in petroleum costs over the next ten years, and would save American families about \$590 annually, for a net savings of \$60 billion per year, according to a 1998 Surface Transportation Policy Project report.



Walk to School Program

Measure Status: Proposed

Responsible Department: Transportation, School Department, Energy Efficiency/Environmental Coordinator

CO₂ Savings in 2010: 58 tons

Many parents in Brookline drive their children to school even though many schools are well within walking distance. The increased vehicular traffic going into and out of the schoolyards each morning and afternoon pose safety hazards for students as well as drivers. A Walk to School program would lessen concerns about traffic safety near schools. A Walk to School program would involve parents walking their children to school, or putting them on a 'walking bus', which would consist of parent volunteers and a group of children that attend the same school. Such a program has many other benefits aside from decreasing emissions and increasing safety. It can create a sense of community between families and schools in a particular area and promote healthy forms of transportation such as walking or bicycling. If Walk to School programs achieved a 25% participation rate in Brookline's 8 elementary schools, 58 tons of CO₂ could be eliminated and residents could save \$ 7,281 in avoided fuel costs.



- ⌘ Implementation cost of Walk to School Program in Brookline's 8 elementary schools estimated at \$3,000 to survey current transportation patterns to and from school, paint walking routes and create promotional materials about the program. Cost for salary for Energy Efficiency/Environmental Coordinator is accounted for in separate measure.
- ⌘ Financial savings from avoided fuel costs \$7,281
- ⌘ Savings from program \$7,281 - \$3,000 = \$4,281
- ⌘ Payback: 0.4 years

Co-Benefits

- ☞ Reduces traffic congestion
- ☞ Reduces air pollution emissions that contribute to visibility degradation and health problems
- ☞ Increases safety for school children as result of fewer vehicles around schools
- ☞ Fosters social capital among children and parent volunteers, creates sense of community between families and schools
- ☞ Program promotes exercise and healthy forms of transportation

Success Stories

- ☞ The Safe Routes to Schools Program in Arlington, MA, implemented by WalkBoston, aims to increase the number of children walking and bicycling to schools, and help communities improve safety along their routes. Additional goals include reducing the demand for single occupancy vehicles and the resulting high levels of air pollution. The Program includes parent participation in planning walking routes; creating safer streets and sidewalks; a 'Walking School Bus'; and special events such as seasonal 'Walk to School Days'. An interim progress report of the program showed that walking to school in Arlington has increased by 12% and walking home from school has increased by 13%.



Bicycling Infrastructure Improvements and Outreach Program

Measure Status: Proposed

Responsible Department: Transportation, Highway

CO₂ Savings in 2010: 484 tons

The four greatest impediments for commuters choosing to bicycle to work and for errands are safety, weather, distance and inadequate facilities for storage or changing at destinations. While the Town cannot control weather or people's commuting distance, better infrastructure in the form of bike lanes and storage facilities can encourage more bicycling. This measure would involve the construction of a one-mile bike lane, the installation of 100 bike racks in Town and a supporting education/outreach program to stress the value of biking. The outreach program could be developed with input from the Brookline Bike Coalition. If this measure encouraged 300 people to switch to bicycling as their primary method of transportation for eight months of the year, it could result in a reduction of 484 tons of CO₂ and financial savings of \$60,474.49 in avoided fuel costs.



- ☞ Cost of constructing one-mile bike path: \$123,000
- ☞ Cost of installing 100 bike racks: \$11,000
- ☞ Cost of bicycling outreach program: \$2,000
- TOTAL: \$136,000
- ☞ Financial savings from avoided fuel costs: \$60,474
- ☞ Payback: 2.2 years

Co-Benefits

- Reduce traffic congestion, increased social interaction and community building from decreased traffic
- Reduce air pollution emissions that contribute to visibility degradation and health problems.
- Promote healthy forms of transportation
- Increase safety for cyclists
- Showcase Town as bicycle-friendly and livable

Success Stories

- The City of Seattle, WA has included the promotion of bicycling as a critical component of the City's transportation system. The City wrote a Comprehensive Bike Plan to ensure that safe access and parking facilities would be provided for cyclists throughout the City, as well as to encourage more people to cycle. The City has approximately 28 miles of bike trails, 14 miles of striped bike lanes and about 90 miles of signed routes. A study conducted before and after a project that added bicycle lanes to both sides of a street that linked to Seattle's downtown showed that 14,500 single occupancy vehicle miles traveled were avoided and that 7 tons of CO₂ were eliminated as a result of the improvements.



Program to Increase MBTA Ridership

Measure Status: Proposed

Responsible Department: Transportation, Engineering, Energy Efficiency/Environmental Coordinator

CO₂ Savings in 2010: 3,238 tons

With this measure, the Town could implement an outreach program or social marketing campaign with the goal of decreasing personal automobile trips and increasing MBTA ridership among Brookline residents. While many people in Brookline have excellent access to public transportation, the personal automobile remains the most frequently used form of travel. There are many reasons why this is so: people feel that they have more control with regard to time when they drive; it is difficult for those with small children or multiple destinations to take public transportation; many feel that public transportation is unsafe or inconvenient. However despite negative perceptions about alternative forms of transportation, great potential exists for more Brookline residents to make the switch to the 'T' or the bus. An outreach program or social marketing campaign could be developed that enabled Brookline residents to overcome these perceived barriers to public transportation, and to see the numerous individual and community benefits that would arise from an increased MBTA ridership in the Town. If such a campaign was successful, and enabled 10% of the Town's population to switch to public transportation for 60% of their trips, 3,238 tons of CO₂ could be eliminated and \$793,115 could be saved through avoided fuel costs.



- Implementation cost: \$75,000 for administration of the program (based on estimates from budgets of similar programs), \$72,000 (\$45,000 salary x 1.6 for administrative costs etc.) for salary of full-time Energy Efficiency/Environmental Coordinator (cost accounted for in separate measure).
- Financial savings from avoided fuel costs: \$793,115
- Payback: 0.1 year

Co-Benefits

- ☞ Saves money for residents
- ☞ Reduces traffic congestion, decreased traffic leads to increased social interaction, more livable communities
- ☞ Reduces air pollution emissions that contribute to visibility degradation and health problems
- ☞ Reduces parking congestion

Success Stories

- ☞ ‘Walking the Talk’ was a social marketing campaign in Ottawa, Ontario that featured home visits similar to energy efficiency visits made by utility companies. Residents were given a free one-day bus pass, an action sheet that listed 10 Simple Steps to Improve Air Quality and were asked to commit to considering alternative modes of transportation. The same residents were later surveyed and 30% reported walking, biking and taking public transportation more often than before.



Taxicab Study

Measure Status: Proposed

Responsible Department: Transportation, Highway

CO₂ Savings in 2010: Unknown

The Town is currently considering undertaking a study to determine how to make Brookline taxicabs more sustainable through improved regulations. Currently, Bay State owns the two local cab companies - Bay State Cab and Red Cab. Bay State is licensed to run approximately 175 cabs between the two companies. The possibility of cab companies acquiring new and more efficient vehicles is unlikely, as the up front costs are too high. In addition, there are only 24 taxi stands (with a capacity of 39 cabs), which are not sufficient to support the number of cabs running in a day. This results in taxis idling or roaming about the Town, which, combined with a fleet of aging cars makes a significant contribution to Brookline’s greenhouse gas emissions.

The Transportation Department is planning to open up the taxi market to two outside companies in the next year. The proposed cab study will look at the effects of ‘opening up’ the taxi market in the Town, with the aim of ascertaining the sustainable number of taxicabs in Brookline. The results of the study will then determine the number of taxis that each company will be allowed to operate. The Department hopes that increased competition will allow enforcement of stricter regulations on the taxi companies, particularly in terms of more stringent inspections, the age of cars and compliance with idling and roaming rules. The taxi study would also determine average VMT for taxis in Brookline, which would enable the calculation of greenhouse gas emissions from this sector. Daniel Flores of the Department of Economics at Boston University, who studies the taxi industry, has offered to undertake the study for approximately \$3,000. The Highway Department is investigating approval for the funding.



Support for Urban Ring Project

Measure Status: Existing

Responsible Organization: Board of Selectmen, CCAB

CO₂ Savings in 2010: Unknown

The Urban Ring project of the MBTA plans to add a ‘rim’ to the current hub and spoke transit system in greater Boston that connects with all the existing and planned transit lines (Commuter Rail, Green, Blue, Orange, Red, Silver and numerous MBTA bus lines). This transit route will provide vital transportation and economic links between Boston area communities, by providing more direct access to destinations around the downtown core area. In addition, travel time and quality of service on the MBTA will be improved. The Urban Ring will most likely connect with the Green line at the Longwood T Station and will coincide with planned improvements to the Green C and D lines. While Brookline will only host a small portion of the transit line, it will increase the efficiency for other transit line riders in the Town. The construction of the Urban Ring will provide an incentive for Brookline residents to use public transportation more often and help to reduce greenhouse gas emissions from single-occupancy vehicle use.

In January of 1999, the Joint Committee on Transportation of the Board of Selectman sent a letter to the Town’s state representatives endorsing the Urban Ring transit route, and signed the Urban Ring compact with Boston, Cambridge, Everett, Chelsea and Somerville. The Town should continue to support the measure in the future. Since there will inevitably be some time before the actual construction of the Urban Ring begins, the project may provide opportunity for the Town and CCAB to lobby for the use of alternative fuel vehicles to be used on the new lines once construction is complete.

Energy Sector

Existing Corporate Energy Measures



LED Traffic Signals

Measure Status: Existing

Responsible Department: Highway/DPW

CO₂ Savings in 2010: 364 tons

The DPW recently installed LED (light emitting diode) lights for the green and red signals at most of the traffic signals in Brookline. The project was funded with a grant from Boston Edison. LED lights use 80 to 90% less energy than conventional incandescent bulbs. In addition, LED lights require 1/6 the maintenance of conventional bulbs, only needing replacement every eight to ten years. The street light conversion will result in the elimination of 364 tons of CO₂ in 2010 and annual financial savings of \$58,941. The Town could also perform conversions in pedestrian signals and yellow traffic lights.



- /// Cost of converting traffic signals to LED: \$165,000
- /// Financial savings from reduced energy use: \$58,941
- /// Payback: 2.8 years

Co-Benefits

- /// Saves tax payer dollars
- /// Reduces preventative maintenance costs (each relamping of a conventional traffic signal costs approximately \$20 in staff and truck time)
- /// Reduces costs of emergency relamping
- /// Reduces liability for accidents due to burned-out signals
- /// Saves in the disposal of many used light bulbs per year
- /// Reduces air pollution emissions that contribute to visibility degradation and health problems
- /// Excellent opportunity to lead by example, investing in a highly cost-effective energy savings measure

Success Stories

- /// After a successful pilot project, the City of Philadelphia decided to install red LEDs in all 2,900 intersections. The new signals used 83% less energy and required six times less maintenance than incandescent lights. These savings amounted to \$800,000 annually and have a simple payback of about 4 years. This measure resulted in a 41,490-ton decrease in CO₂ emissions.



Town Building Lighting Retrofits

Measure Status: Existing/Proposed
 Responsible Department: Buildings
 CO₂ Savings in 2010: 1,300 tons

In many Town buildings, lighting fixtures account for a large proportion of energy consumption. Many buildings, including most of the schools, have received upgraded lighting in the form of compact fluorescents that have reduced electricity costs for the Town. In addition, occupancy sensors in buildings such as Town Hall and the High School prevent the unnecessary lighting of vacant space. Lighting retrofits are planned for all municipal buildings, and the Building Department is committed to installing the most energy efficient technology throughout the Town. With lighting efficiency measures that have already been undertaken, and those that are planned over the next eight years, this measure could result in the elimination of 1,300 tons of CO₂ in 2010, and annual financial savings of \$189,635.



- /// Total cost of lighting retrofit and installation of occupancy sensors in 21 Town buildings: \$759,225 (Cost based on estimated average cost/square foot calculated from Comptroller data for Old Lincoln).
- /// Financial savings from avoided energy costs: \$189,635
- /// Payback: 4 years

Co-Benefits

- ☞ Reduces municipal energy use
- ☞ Saves money on Town electricity bills
- ☞ Improves occupant comfort and building value
- ☞ Reduces air pollution emissions that contribute to visibility degradation and health problems
- ☞ Sets example for citizens and other communities, showcase Town as innovative leader

Success Stories

- ☞ The City of Toledo, OH undertook comprehensive retrofits of 20 City buildings and facilities. Energy saving measures in Toledo's program included installing energy efficient lighting and motion sensors and replacing window air conditioners with digitally controlled boilers and chillers. In the first year, electricity use was cut by 5,823,000 kwh and the upgrades resulted in financial savings of \$710,208



Energy Efficient Window Installation in Town Buildings

Measure Status: Existing/Proposed
Responsible Department: Buildings
CO₂ Savings in 2010: 1,724 tons

The energy lost through residential and commercial windows costs U.S. consumers about \$25 billion a year. In a typical building, 40% of the annual energy budget is consumed by heating and cooling. New glass technology can drastically cut energy loss from windows, significantly affecting how much money is spent on energy use in Town buildings. The EPA estimates that the installation of energy efficient windows can result in energy savings of 15%. This measure calculates the impact of installing energy efficient windows in the following buildings by 2010 (buildings marked an asterisk refer to projects that have already been completed): Main Library, Coolidge Library, Putterham Library, Town Hall, Main Police, Health, Lynch Recreation, Soule Recreation, Baker*, Baldwin, Devotion*, Driscoll*, Heath*, Phys.Ed/UA Arts*, High School*, Lawrence, New Lincoln, Old Lincoln, Runkle* and Pierce). There are obviously other municipal buildings in which window replacements could be undertaken, however only the above are used in calculations as these buildings had the most consistent and available data on energy usage. If new windows were installed on these Town buildings, 1,724 tons of CO₂ could be saved in 2010, and annual financial savings of \$251,604 could result.



- ☞ Total cost of window replacements in 21 Town buildings: \$11,854,846 (Cost of window replacement based on estimated average cost/square foot calculated from Comptroller data for Runkle project).
- ☞ Financial savings from avoided energy costs: \$251,604
- ☞ Payback: 47.1 years. There are many opportunities for funding and tax rebates for energy efficiency improvements available from federal sources and utility companies that would make the window retrofit projects more economically feasible.

Co-Benefits

- ☞ Improves occupancy comfort in buildings
- ☞ Energy and cost savings in heating and cooling seasons
- ☞ Increases light and view
- ☞ Reduces fading
- ☞ Reduces condensation

Success Stories

- ☞ A 20,000 square foot book store in Boulder, CO installed low-emissivity (Low-E), super-insulated, double-paned windows that not only limit the amount of solar heat entering the store, but also limit heat loss in the winter. The windows also cut down on the admission of ultraviolet rays, which fade the books. The project has resulted in cash savings of \$4,800 and annual energy savings of 1,429 kwh (Source: http://www.epa.gov/smallbiz/successstories/ss_boulder.html).



Town Building Heating/Cooling Efficiency Measures

Measure Status: Existing/Proposed
Responsible Department: Buildings
CO₂ Savings in 2010: Unknown

The Town has undertaken many measures to make the heating and cooling systems in its buildings more efficient. These measures include the installation of new HVAC systems and the replacement of old heating systems with dual gas-oil boilers. In addition, revised energy management systems that are able to sense energy needs in specific rooms across Town buildings based on occupancy schedules and indoor versus outdoor temperatures have been installed.

It has been difficult to calculate the impact of heating and cooling efficiency measures on energy usage. Utility records for Town properties list monthly consumption by building. However, in many buildings where retrofits were undertaken, there were simultaneous changes that actually served to increase energy consumption. These include for example, substantial additions to buildings, or purchase of new ventilation equipment that, although meeting the stringent requirements of the Clean Air Act, contain more mechanical parts and actually consume more electricity. These issues have arisen even in spite of the Town's commitment to energy efficiency in buildings and operations. While these issues are also of consequence for calculations involving lighting retrofits and window replacements, more data was available from industry sources as to the energy savings resulting from energy efficient lights and windows.

The Town should continue with energy efficiency improvements on heating and cooling systems in municipal buildings. One further measure that should be investigated would be a requirement that an 'energy impact report' be completed after any building or renovation project, or after the installation of new equipment. A standardized system of energy impact reporting would allow the Town to track energy and financial savings from specific changes, which would be enormously helpful for monitoring greenhouse gas emissions. The Building Department would then be able to prioritize projects based on the impact that they would have on energy consumption and financial expenditure on utility bills.

New Corporate Energy Measures



Energy Efficient Streetlights

Measure Status: Proposed
Responsible Department: Highway, DPW
CO₂ Savings in 2010: 97 tons

In October of 2001, the Town purchased 3,800 street lights from Boston Edison both in order to improve the level of service to the community and to achieve the benefits that will accompany Town ownership. Of the 4,130 lights now owned by the Town, 348 are mercury vapor. This measure would encourage the Town to convert the remaining 348 to more efficient high pressure sodium technology. High-pressure sodium streetlights use on average 54.91% less electricity than do mercury vapor lights. Implementation of this measure could result in annual savings of \$15,673 and in the elimination of 97 tons of CO₂.



- /// Cost of converting mercury vapor lights to high pressure sodium: \$1,200/light
- /// 348 lights = \$417,600
- /// Energy savings from streetlight conversion: 125,885.1 kwh
- /// 125,885.1 kwh at \$0.1245/kwh = \$15,673.00
- /// Payback: 26.6 years

Co-Benefits

- /// Saves taxpayers and Town money
- /// Reduces air pollution emissions that contribute to visibility degradation and health problems
- /// Excellent opportunity to lead by example, investing in a highly cost-effective energy savings measure - chance to showcase Town as innovative leader
- /// Better lighting makes community more safe

Success Stories

- /// Chittenden County, Vermont has created model outdoor lighting regulations that emphasize energy efficiency and aesthetics. Through the program, the City of Burlington, VT estimates that the conversion of 10,000 streetlights to high pressure sodium fixtures will save 4 million kwh of electricity per year and result in annual financial savings of \$675,000.



Town Owned Demonstration House

Measure Status: Proposed
Responsible Department: Buildings
CO₂ Savings in 2010: 10 tons

The City of Cambridge, MIT and Tufts University have all created project houses that demonstrate alternative energy technology and energy efficiency retrofit projects. The Town could sponsor a renovation of a Town owned property to serve as an outreach center for conservation and renewable

energy education for residents and businesses. One potential property that could be converted into a demonstration house is the Town owned residential property at 27 Acres Ave. If retrofits such as a solar hot water heating system, a solar electricity system and energy efficient appliances and lighting were installed at the property, it could result in the elimination of 10 tons of CO₂ and financial savings of \$839.



- ✂ Estimated cost of energy efficient renovations: \$5,000 solar hot water; \$20,000 solar electricity; \$10,000 for weatherization, energy efficient lighting and appliances. Total: \$35,000.
- ✂ Annual financial savings from energy conservation: \$839
- ✂ Payback: 41.7 years

Co-Benefits

- ✂ Good opportunity to lead by example for residents and other communities
- ✂ Educational opportunities for citizens
- ✂ Reduces air pollution emissions that contribute to visibility degradation and health problems
- ✂ Saves money for Town

Success Stories

- ✂ The Tufts Climate Initiative at Tufts University in Medford, MA has a green demonstration house that was renovated in 1999. TCI will monitor the energy and cost savings associated with the climate change reduction related improvements at the Schmalz house over time and plans to share its experience with other universities. Some of the improvements made at the house include the installation of a solar hot water system, high efficiency lights, and Energy Star appliances.



Retrofit Fire Alarm Lights and Exit Signs in Town Buildings

Measure Status: Proposed
 Responsible Department: Buildings
 CO₂ Savings in 2010: 75 tons

Lit exit signs and fire alarm lights are required in all public buildings. Today over 100 million exit signs are in use throughout the U.S. consuming more than 30 to 35 million kwh of energy and costing \$1 billion to operate annually. The Town does not keep specific records on the energy consumption of exit signs. However, there are records for the 239 incandescent red lights marking the location of fire alarms in the Town. In 1998 the fire alarms accounted for 130,880 kwh of energy use. Converting the fire alarm lights to LED technology would eliminate 75 tons of CO₂ and result in annual savings of \$12,221.



- ✂ Average cost to convert fire alarm light to LED: \$100
- ✂ Cost for 239 lights: \$23,900
- ✂ Financial savings from reduced energy use: \$12,221
- ✂ Payback: 2 years

Co-Benefits

- Financial savings for Town and taxpayers
- Reduces liability for accidents due to burned-out signs
- Saves in the disposal of used light bulbs
- Reduces air pollution emissions that contribute to visibility degradation and health problems
- Excellent opportunity to lead by example, investing in a highly cost-effective energy savings measure

Success Stories

- The City of Overland Park, KS changed from incandescent lights to LED exit signs in all public buildings. The project saves the City 41,000 kwh of electricity and \$2,750 annually. This measure resulted in a CO₂ reduction of 35 tons.



Municipal Use of Solar Electricity

Measure Status: Proposed
Responsible Department: Buildings
CO₂ Savings in 2010: 17 tons

The installation of solar photovoltaic panels on municipal buildings could provide many environmental and economic benefits to the Town. Photovoltaics produce electricity from the sun's rays using semiconductor technology. PV systems can be used to power lights, appliances and business equipment. A PV system is a way to guarantee reliable and uninterrupted power at a time when energy shortages are becoming more commonplace. While the technology for municipal solar use exists today, there are many barriers, due mostly to the high cost of installation, that stand in the way of this measure. However programs like the federal Million Solar Roofs initiative and organizations like Solar Boston are working to overcome barriers like lack of consumer and professional knowledge about solar technologies, limited number of qualified solar installers, high system cost, limited financing options and infrastructure barriers to grid-tied systems. The Building Department has indicated that the following buildings present possible opportunities to incorporate solar electricity production into renovation projects: Driscoll, Runkle, Devotion and Pierce schools and the Main Library and Police Department. If a 2kw PV system was installed on each of these six buildings, it could result in the elimination of 17 tons of CO₂ in 2010.



- Average implementation cost of PV system \$11.25/watt. Six 2 kw PV systems would cost $\$11.25 \times 2,000 \times 6 = \$135,000$ to install.
- Financial savings from reduced electricity use: \$2,420 per year
- Payback: 55.8 years. There are many funding opportunities and tax incentives available to municipalities that make the installation of solar technology more economically feasible.

Co-Benefits

- ☞ Creates market for renewable energy
- ☞ Sets example for residents and other municipalities
- ☞ Reduces air pollution emissions that contribute to visibility degradation and health problems
- ☞ Promotes local and independent sources of electricity
- ☞ Decreases dependency on diminishing fossil fuel resources
- ☞ Reduces adverse environmental impacts associated with conventional forms of electricity generation (coal mining, drilling for natural gas, damming rivers, nuclear storage etc.)
- ☞ Saves on utility bills, reduce vulnerability to fuel price spikes

Success Stories

- ☞ Massachusetts Electric Company teamed up with the city of Medford, Massachusetts to encourage businesses and residents to install solar energy panels on their roofs. Photovoltaic systems have already been installed at Medford City Hall and Medford High School. Students learn about solar electric systems through solar demonstrations at the high school, while officials at the city hall are using their systems to learn how the sun can help them save money on their electric bills.

New Community Energy Measures



Use of Compact Fluorescent Light bulbs in Residences

Measure Status: Proposed

Responsible Organization: CCAB

CO₂ Savings in 2010: 7,181 tons

This measure evaluates the impact of Brookline residents converting conventional incandescent light bulbs to compact fluorescents for their home lighting needs. Incandescent light bulbs waste a lot of electricity through the heat that the bulbs produce. A fluorescent bulb produces much less heat and as a result can be four to six times as efficient as incandescent bulbs. A 15-watt compact fluorescent provides the same amount of light as a 60-watt incandescent. In addition, compact fluorescents last at least nine to ten times longer than an incandescent. Approximately 9% of a home's energy budget is used for lighting. Collectively, Americans could save \$750 million if everyone switched to compact fluorescents. If Brookline residents converted their light bulbs to compact fluorescents, it could result in the elimination of 7,181 tons of CO₂ in 2010 and result in \$655,749 in financial savings.



- ☞ Life-cycle cost comparison of incandescent vs. compact fluorescent: For a 10,000-hour life, ten 60-watt incandescent bulbs cost \$5 to purchase and have an estimated energy cost of \$36 for a total cost of \$41. For a 10,000-hour life, one 15-watt compact fluorescent costs \$14 to purchase and has an energy cost of \$9 for a total cost of \$23. (Source <http://www.mge.com/business/saving/lighting.htm>).
- ☞ Payback: 1.1 year for purchase of compact fluorescent bulb.

Co-Benefits

- Financial savings for residents
- Light bulbs last longer than conventional bulbs, saves time and money spent replacing burnt-out bulbs
- Compact fluorescents operate at a lower temperature than incandescent bulbs, can help to lower cooling costs

Success Stories

- Harmony Library in Fort Collins, CO installed 26-watt Energy Star compact fluorescents in place of 75-watt incandescent bulbs. The project saves \$12,000 in annual operating costs.



Purchase of Green Electricity

Measure Status: Proposed
Responsible Organization: CCAB, Moderator's Committee
CO₂ Savings in 2010: 53,245 tons

With the deregulation of electricity in Massachusetts consumers are free to change their electricity provider. However, there are currently no competitive electric suppliers from which residential consumers can choose. This is due to a number of factors, including the fact that rates dropped after electric industry restructuring went into effect, making it undesirable for competitive suppliers to try to compete in the marketplace. MassEnergy predicts that by 2010 electricity providers will be able to sell green energy options that draw electricity from renewable energy sources such as wind power, small hydro or biomass, and that approximately 20% of the state's population will opt to purchase the cleaner energy. This measure evaluates the impact of 20% of the Town's residential, commercial and municipal customers purchasing green energy in 2010. The cumulative impact of a 20% demand for green electricity from all three sectors could result in the reduction of 53,245 tons of CO₂.



Implementation cost calculated as amount kwh at green energy rates - amount kwh at conventional energy rates.

- Residential: [27,705,134 kwh at green electricity rates (\$0.07574/kwh) = \$2,098,387] - [27,705,134 kwh at projected NStar electricity rates for 2010 (\$0.063117) = \$1,748,665] = \$349,721.90
- Commercial/Industrial: [38,580,064 kwh at green electricity rates (\$0.13446/kwh) = \$5,187,475] - [38,580,064 kwh at projected NStar electricity rates for 2010 (\$0.11205) = \$4,322,896] = \$864,579.20
- Implementation costs: [3,049,438 kwh at green electricity rates (\$0.13446/kwh) = \$410,027.40] - [3,049,438 kwh at projected NStar electricity rates for 2010 (\$0.11205) = \$341,689.50] = \$68,337.91
- While green electricity will cost consumers more, the additional burden will be relatively insignificant. For example, in 2010 the typical Brookline household is forecasted to use an average of 6223.1 kwh of electricity per year. If the household purchased conventional electricity, their annual bill would be \$392.78, while the bill for green electricity would be \$471.34.

Co-Benefits

- ⚡ Continued diversification of services provided by utility provider stimulates the market for renewable energy in Massachusetts
- ⚡ Decreases dependency on diminishing fossil fuel resources, increased sustainability
- ⚡ Reduces air pollution emissions that contribute to visibility degradation and health problems
- ⚡ Reduces adverse environmental impacts associated with conventional forms of electricity generation (coal mining, drilling for natural gas, damming rivers, nuclear storage etc.)
- ⚡ Development of domestic renewable energy will keep energy dollars in the United States and create jobs.

Success Stories

- ⚡ In 1999, Santa Monica CA became the first major city in the world to have all of its municipal power needs served by clean, renewable energy. The City Council voted unanimously to enter into agreements with Commonwealth Energy of Orange County to purchase 5 megawatts/year of renewable power from geothermal sources for its municipal needs. This measure eliminates 13,672 tons of CO₂ per year.



Lobby for Increased Renewable Portfolio Standard (RPS)

Measure Status: Proposed

Responsible Organization: CCAB, Moderator's Committee

CO₂ Savings in 2010: 13,111 tons

Another option that Massachusetts consumers have is to lobby for an increased RPS (Renewable Portfolio Standard). An RPS is a regulation that requires states to mandate that a percentage of any utility's total electricity production come from renewable sources. An RPS is desirable because it means that all citizens will start receiving some of their electricity from clean energy sources, not just those who are willing or able to pay more for renewable energy. An RPS has been established in Massachusetts, starting at 1% in 2003, rising to 4% by 2009. After 2009 the RPS will increase annually by 1%. In 2010 therefore, the RPS will be 5%. A 5% RPS has the potential to eliminate 13,111 tons of CO₂ in 2010. If citizens were to lobby for an increased RPS of 10%, 23,236 tons of CO₂ could be eliminated in 2010.



Implementation cost calculated as amount kwh at green energy rates minus amount kwh at conventional energy rates.

- ⚡ 10% of projected residential energy use: 13,852,567 kwh. Implementation cost: \$174,861
- ⚡ 10% of projected commercial/industrial energy use: 19,290,032 kwh. Implementation cost: \$432,289.60
- ⚡ 10% of projected municipal energy use: 1,524,719.20 kwh. Implementation cost: \$34,168.96
- ⚡ While green electricity will cost consumers more, the additional burden will be quite insignificant. 10% of the electricity bill for a typical Brookline household in 2010 will be 622 kwh. 622 kwh of conventional electricity would cost \$39.26 while 622 kwh of green electricity would cost \$47.11. On a monthly basis, this means an additional cost of \$0.65 to pay for renewable energy sources for 10% of the electricity.

Co-Benefits

- ⚡ Continued diversification of services provided by utility provider stimulates market for renewable energy in Massachusetts
- ⚡ Reduces air pollution emissions that contribute to visibility degradation and health problems
- ⚡ Decreases dependency on diminishing fossil fuel resources, increases sustainability
- ⚡ Reduces adverse environmental impacts associated with conventional forms of electricity generation (coal mining, drilling for natural gas, damming rivers, nuclear storage etc.)
- ⚡ The development of domestic renewable energy will keep energy dollars in the United States and create jobs.

Success Stories

- ⚡ The State of Maine became the first state to adopt a renewable portfolio standard when the state enacted restructuring legislation in 1997. The 30% RPS, the highest in the nation, reflects the state's plentiful renewable resource base and state policies to utilize that resource base.



Energy Efficient Building Code

Measure Status: Proposed

Responsible Department: Buildings, Energy Efficiency/Environmental Coordinator

CO₂ Savings in 2010: 25,624 tons

Recent changes in the Massachusetts State Building Code require that all new construction be within 5% to 10% of the minimum energy efficiency thresholds set by the U.S. Department of Energy. The code for the Town of Brookline is the same as the state, and applies to new commercial and residential developments, in addition to substantial additions. The Town could consider developing its own green building code with incentives that would enhance the State requirements. Based on estimated savings from other municipal green building codes, this measure could result in the elimination of 25,624 tons of CO₂ and financial savings of \$2,137,974 for citizens who choose to make energy efficiency upgrades in their buildings.



- ⚡ An energy efficient building code in residential and commercial development and additions could result in a savings of 33,366,852 kwh or \$2,137,974.
- ⚡ Implementation costs: \$15,000 staff time to evaluate measure and draft ordinance. Salary for administration of program accounted for in Energy Efficiency/Environmental Coordinator Measure.
- ⚡ Savings to Town: \$2,137,974 - \$15,000 = \$2,122,974
- ⚡ Payback: 0 years

Co-Benefits

- Stimulates a local market for 'green' building materials so that they become more readily available
- Saves money on utility bills
- Reduces use of water and toxic materials
- Indoor air quality improvements
- Improves occupant comfort and building value
- Increases worker productivity in commercial buildings

Success Stories

- The Residential and Commercial Energy Conservation Ordinance in Berkeley, CA requires energy efficiency upgrades in existing residences and commercial properties and energy efficiency standards in new construction. Since 1981 over 20,000 residences (50% of housing stock) have been improved. Residential natural gas use has declined by 18%. Over 130 commercial buildings (10% of City's total) have been upgraded.



Sustainable Business Program

Measure Status: Proposed

Responsible Department: Economic Development, Energy Efficiency/Environmental Coordinator

CO₂ Savings in 2010: 7,419 tons

With this measure, the Town could issue a certification or award to businesses that initiate emissions reduction activities with regard to energy conservation or waste prevention. The award would serve as public recognition of the efforts of local businesses to lessen the impact of their activities on the environment. This program will not only help local businesses save money through reduced energy consumption, but the awards will serve as advertising that will help attract new customers. If 40% of businesses in the Town committed to a 10% reduction in energy consumption through the program, it could result in the elimination of 7,419 tons of CO₂ and financial savings of \$1,206,832.



- Cost to implement Sustainable Business Awards: \$72,000 (\$45,000 salary x 1.6 for benefits, administration etc.) for full-time Energy Efficiency/Environmental Coordinator to administer program (cost accounted for in separate measure), \$3,000 for recognition awards/materials.
- Financial savings from energy conservation: \$1,206,832
- Savings to Businesses: \$1,153,832
- Payback: 0 years

Co-Benefits

- ☞ Reduces air pollution emissions that contribute to visibility degradation and health problems
- ☞ Serves as form of advertising for businesses
- ☞ Improves comfort in buildings
- ☞ Financial savings for businesses
- ☞ Businesses gain competitive advantage, attract new customers, enhance customer loyalty

Success Stories

- ☞ The EcoStar Business Awards Program administered by the Montana Pollution Prevention Program recognizes businesses that are taking environmentally friendly steps to reduce waste, maximize efficiency and create a safer work environment. EcoStar Awards winners are featured in press releases, receive a certificate of recognition and other materials for company advertising and are automatically eligible for the prestigious Outstanding Achievement in Pollution Prevention Award sponsored by the U.S. Small Business Administration.



Residential and Commercial Use of Solar Electricity

Measure Status: Proposed
Responsible Department: Buildings, CCAB
CO₂ Savings in 2010: 6,280 tons

Individual homeowners and commercial establishments can use solar photovoltaic systems to power their lights and appliances. Photovoltaics produce electricity from the sun's rays using semiconductor technology. While the technology for residential solar use exists today, there are many barriers that stand in the way of the widespread adoption of this measure. However programs like the federal Million Solar Roofs initiative and organizations like Solar Boston are working to overcome barriers such as the lack of consumer and professional knowledge about solar technologies, limited number of qualified solar installers, high system cost, limited financing options and infrastructure barriers to grid-tied systems. If 10% of Brookline residences and commercial establishments installed a 2 kw PV system by 2010, it could result in the elimination of 6,280 tons of CO₂ and annual financial savings of \$524,228.



- ☞ Average installation cost of PV system \$11.25/watt. To install 2 kw PV systems on 10% of Brookline residences and commercial buildings (2,226 households and 45.7 commercial buildings) by 2010: $11.25 \times 2,000 \times 2,271.7 = \$ 51,113,250$.
- ☞ Financial savings from reduced electricity use: \$524,228
- ☞ Payback: Average of 77.4 years. There are many funding opportunities and tax incentives available to citizens that make the installation of solar technology more economically feasible.

Co-Benefits

- ☞ Creates market for renewable energy
- ☞ Reduces air pollution emissions that contribute to visibility degradation and health problems
- ☞ Promotes local and independent sources of electricity
- ☞ Decreases dependency on diminishing fossil fuel resources
- ☞ Reduces adverse environmental impacts associated with conventional forms of electricity generation (coal mining, drilling for natural gas, damming rivers, nuclear storage etc.)
- ☞ Saves on utility bills, reduces vulnerability to fuel price spikes

Success Stories

- ☞ A 1.8 kw PV system installed on a residence in Carbondale, CO produces 2,785 kwh per year, providing about 75% of the home's electricity. The installation has resulted in the annual elimination of about 5,750 pounds of CO₂.
(<http://www.nrel.gov/ncpv/pdfs/25724.pdf>)



Residential Use of Solar Hot Water Heating

Measure Status: Proposed
Responsible Department: Buildings
CO₂ Savings in 2010: 745 tons

In Massachusetts, water heating accounts for approximately 14% of the average family's home energy consumption. Solar hot water heating systems can cut water heating electricity use by 40 to 60%. A solar hot water heating system collects thermal energy from the sun to heat the water used to take showers, wash dishes and clean laundry. After a heat transfer fluid runs through pipes in rooftop panels and is heated by the sun's rays, the fluid is pumped down to a heat exchanger where it warms household water. If 10% of residences in Brookline installed solar hot water heating systems by 2010, 745 tons of CO₂ could be eliminated and \$61,203 could be saved due to reduced electricity consumption.



- ☞ Average installation cost of solar hot water heating system \$5,000 x 2,226 households = \$11,130,000.
- ☞ Financial savings from reduced electricity consumption: \$61,203.
- ☞ Payback: 181.9 years. There are many funding opportunities and tax incentives available to citizens that make the installation of solar technology more economically feasible.

Co-Benefits

- ☞ Creates market for renewable energy
- ☞ Reduces air pollution emissions that contribute to visibility degradation and health problems
- ☞ Promotes local and independent sources of electricity
- ☞ Decreases dependency on diminishing fossil fuel resources, increases sustainability
- ☞ Reduces adverse environmental impacts associated with conventional forms of electricity generation (coal mining, drilling for natural gas, damming rivers, nuclear storage etc.)
- ☞ Saves on utility bills, reduce vulnerability to fuel price spikes

Success Stories

- ☞ The installation of a 150-gallon solar hot water heating system installed on a house in Natick, MA resulted in an annual emissions offset of 1.5 tons of CO₂.
(<http://www.solarboston.org/natickhome.htm>)



Residential Energy Efficiency Program

Measure Status: Proposed

Responsible Department: Buildings, Energy Efficiency/Environmental Coordinator

CO₂ Savings in 2010: 20,918 tons

The Town could develop a residential energy efficiency program that supported programs already set in place by local utilities such as NStar. NStar has a variety of programs to promote energy efficiency that offer free energy audits and rebates for energy efficient retrofits and appliances. Brookline could develop an energy education and outreach program for citizens and schoolchildren that advocates energy conservation and involvement with NStar's residential programs. The program could involve the creation of informational material and workshops that outline available resources and contacts and strategies for energy conservation. If a residential energy efficiency program resulted in a 5% decrease in energy consumption in Brookline residences, 20,918 tons of CO₂ could be eliminated and annual financial savings of \$2,999,727 could result.



- ☞ Implementation cost of program: \$5,000 for educational materials and coordination of workshops. \$72,000 (\$45,000 salary x 1.6 for benefits, administration etc.) for one full-time employee to administer the program (cost accounted for in Energy Efficiency/Environmental Coordinator measure).
- ☞ Financial savings from avoided energy costs: \$2,999,727.
- ☞ Payback: 0 years

Co-Benefits

- ☞ Reduces air pollution emissions that contribute to visibility degradation and health problems
- ☞ Saves money for residents
- ☞ Improves occupant comfort
- ☞ Increases value of buildings

Success Stories

- ☞ The City of Ashland, OR has a wide variety of residential conservation programs that include: Free home energy analysis, zero-interest loan program for energy retrofits and rebate programs for water heaters, solar water heaters and energy efficient appliances.

Waste Measures

Existing Corporate Waste Measures



Purchase of Environmentally Preferable Products

Measure Status: Existing
Responsible Department: Purchasing
CO₂ Savings in 2010: Unknown

Purchasing policies can greatly affect the environmental impact of operations from government entities. State and local governments purchase more than \$1 trillion in goods and services each year, according to Governing Magazine. The EPA has developed an Energy Star labeling program for energy efficient equipment and appliances. Each Energy Star computer and monitor eliminates nearly 1 ton of CO₂ per year and saves \$15 to \$25 per year in energy costs. The Operations Service Division at MASS DEP has established an Environmental Preferred Products (EPP) program to assist local governments and state agencies buy energy saving and pollution preventing materials. The Town is committed to increasing efforts to purchase more environmentally preferred products such as recycled paper, toner cartridges and energy efficient office appliances. Approximately 5 to 7% of overall office products purchased in 2000 were bought according to EPP guidelines. In 2000, the Town's office paper supply was 30% post-consumer recycled content. Recycled paper results in 74% less air pollution and 64% less energy use to manufacture than paper from wood.

There does not exist sufficient data to calculate the impact of the Town's environmentally preferable purchasing measures in terms of reduced emissions. However several amendments to Town purchasing policies as listed below would significantly lessen the environmental impact of its operations. These recommendations could be developed into a formal EPP Policy.

- ☞ Products made from recycled materials should be preferred over those made from virgin materials when considerations of quality and cost are similar.
- ☞ The Town should expand EPP purchases to include janitorial and cleaning products, environmentally friendly vehicle products (oil, traffic cones, recycled antifreeze) and building products (recycled plastic lumber).
- ☞ Municipal departments should practice bulk purchasing of energy efficient and recycled content products.

Co-Benefits

- ☞ Saves tax payer dollars
- ☞ Good opportunity to lead by example, showcases Town's commitment to energy efficiency and solid waste reduction
- ☞ Encourages market for green products
- ☞ Educates Town staff about energy efficiency

Success Stories

- ☞ Santa Monica CA developed an Environmentally Preferable Purchasing Program in 1991. Benefits of the program include: 5% reduction in spending on custodial supplies by replacing 15 products with less toxic or non-toxic alternatives, switching to an integrated pest management program that cost up to 30% less than traditional pest application used before, using re-refined motor oil that cost the City 25% less than virgin motor oil.

Existing Community Waste Measures



Home Composting Program

Status: Existing Measure

Responsible Department: Conservation

CO₂ Savings in 2010: 189 tons

Since 1997, the Conservation Department has been selling compost bins to residents at a reduced rate with the assistance of a DEP grant. To date, residents have bought approximately 600 of the 3 x 3 ft bins. A single-family unit that composts in Massachusetts diverts approximately 47% of their yard waste and 54.7% of their food waste from the municipal solid waste stream. Calculations based on data from the State of Massachusetts Residential Organic Waste Management Study suggest that 203 tons of solid waste have been diverted as a result of the Home Composting Program.



The Town purchases the compost bins at the rate of \$25/bin with the assistance of a DEP grant (bins normally priced at \$80). The bins are sold to residents for \$20/bin, therefore the cost to the Town is \$5/bin. The cost of hauling solid waste in 2001 was \$68.74/ton (Municipal Recycling Data Sheet for the Town of Brookline 2001).

- ☞ 600 bins cost (600 x 5) = \$3,000
- ☞ 203 tons diverted from waste stream saves (203 x 72.00) = \$14,616
- ☞ Savings to Town (14,616 - 3,000) = \$11,616
- ☞ Payback: 0.1 year

Co-Benefits

- ☞ Diverts waste from landfill
- ☞ Keeps costs down as waste hauling fees increase as volume increases
- ☞ Neighborhood beautification through the use of compost in residential landscapes
- ☞ Participation in home composting programs will broaden support for other public environmental problems as residents become aware of need to take responsibility for the waste they produce

Success Stories

- ☞ Seattle, WA has an aggressive how-to-compost educational program accompanied by compost bin giveaways. It has been estimated that eventually, 70% of the targeted population will compost 70% of its yard waste. This means that approximately 49% of the City's yard waste will eventually be composted at home.

Follow-Up Measure

Selling an additional 150 bins per year for eight years would result in an additional 1,200 bins in circulation by the year 2010, for a total of 1,800 compost bins in Brookline residences. These compost bins would result in the diversion of 608 tons of waste. Assuming the Town continues to receive the DEP grant, the cost of the additional 1,200 bins would be \$6,000 (1,200 x 5). This cost would be sufficiently offset, however, from the \$50,780.16 that would be saved in waste hauling fees. The sale of additional bins would also result in a further elimination of 566 tons of CO₂ in 2010.



Curbside Recycling Program

Status: Existing Measure

Responsible Department: Conservation

CO₂ Savings in 2010: 21,589 tons

The Town's municipal weekly curbside recycling program serves both residential and municipal areas. The materials recycled include newspapers, magazines, phone books, mixed paper, corrugated cardboard, glass bottles and jars, aluminum, steel, tin and plastic containers marked '1' or '2'. In addition, bulk metal items, cathode ray tubes from computer monitors and Christmas trees can also be collected at curbside. This is material that would otherwise become part of the Town's waste stream.

The municipal recycling program is very successful, and resulted in 10,649.97 tons of waste being diverted from the municipal waste stream in 2000. If current recycling rates continue, this measure will result in an emissions reduction of 21,589 tons of CO₂ in 2010. Emissions reductions from the recycling program not only include savings from disposal methods that contribute to greenhouse gas emissions but also account for the energy savings of resource recovery.

Accomplishments of the recycling program include a recycling hotline, a 24-hour recycling drop-off location at Coolidge Corner, education and outreach about recycling and a Household Hazardous Products (HHP) Collection Day, which is held annually in the first weekend of May. Additional projects being considered to help increase diversion rates even further include: translation of recycling and informational materials into other languages; increasing educational outreach at schools; establishing of a reuse and repair center, or 'Freebie Barn'; and creating more drop-off sites.

In 2000, the following materials were diverted from the municipal waste stream through the curbside recycling program:

Yard Waste:	5,227.07 tons
Mixed Paper (includes Town Hall and Schools):	3,866.25 tons
Comingled Containers:	885.78 tons
Scrap Metal:	670.87 tons
TOTAL:	10,649.97 tons



Cost of recycling \$94.50/ton. Cost of yard waste recycling \$14/ton. Solid waste hauling fee \$72.00/ton. (Source: 2001 Municipal Recycling Data Sheet for Town of Brookline/Schofield, Inc.).

- /// Implementation cost: Tonnage x recycling fee for yard waste (\$73,178.90) + mixed paper (\$367,250.60) + comingled containers (\$83,706.21) + scrap metal (\$63,397.22) = \$587,533.01
- /// Cost savings calculated as (tonnage x recycling fee) - (tonnage x waste hauling fee) = \$179,264.77
- /// Payback: 3.2 years

Co-Benefits

- /// Diverts waste from landfill
- /// Raises community pride and awareness
- /// Conserves finite and limited supplies of natural resources (oil, mineral, timber etc.)
- /// Reduce taxes as haulers charge a higher hauling fee for increased volumes of solid waste
- /// Provides educational opportunities

Success Stories

- /// In Claremont, CA a program to raise participation rates in curbside recycling involved oral presentations by boy scouts and commitment cards signed by residents in support of the recycling program. After these measures were implemented, recycling rates increased by 42%.

Follow-Up Measure

Increasing the recycling rate 10% by 2010 would result in the annual diversion of an additional 523 tons of yard waste, 387 tons of mixed paper, 89 tons of comingled containers and 67 tons of scrap metal, for a total of 1,066 additional tons of recycled material. Implementation cost: \$747,374.02. Cost savings: \$231,152.41. Potential emissions reduction: 23,482 tons CO₂.

New Community Waste Measures



Bylaw Requiring Mandatory Private Recycling Service

Measure Status: Proposed

Responsible Department/Organization: Conservation (Kristin Pelak)

CO₂ Savings in 2010: 17,442 tons

Municipal curbside recycling only reaches residential and commercial buildings on Town trash accounts. Apartment buildings and homeowners can choose to use private haulers for their solid waste, and these haulers may or may not provide recycling. The Town could pass a bylaw or permitting process that would require private haulers with scheduled pick-ups of residential or commercial solid waste to offer recycling services. This legislation could be based on MA DEP requirements that mandate all landlords of multi-unit apartments to offer recycling services to their residents. Calculations suggest that this measure could result in the diversion of 8,665 tons of waste and the reduction of 17,442 tons of CO₂.



Implementation cost is the [tonnage x recycling fee] - [tonnage x the solid waste hauling fee]. The recycling collection cost is \$94.50/ton. The solid waste hauling fee is \$72.00/ton. (Source: 2001 Municipal Recycling Data Sheet/Schofield, Inc.)

4,248.11 tons yard waste: \$95,582.36

3,142.15 tons general mixed paper: \$70,698.40

719.88 tons comingled containers: \$16,197.36

545.23 tons scrap metal: \$12,267.62

TOTAL: \$194,745.70

Financial savings from avoided solid waste hauling and tipping fees: \$623,186.40

Payback: 0.4 year

Co-Benefits

- Diverts waste diverted from landfill
- Conserves finite and limited supplies of natural resources (oil, mineral, timber etc.)
- More opportunities to recycle could reduce taxes as haulers charge a higher hauling fee for increased volumes of solid waste

Success Stories

- St. Tammany Parish in Louisiana requires all licensed haulers to provide a residential curb-side recycling program. The program mandates weekly collection and requires that haulers maintain records of the recycling program to document the effectiveness of the program's volume reduction, and to guarantee that the material is being taken to a recycling facility or direct market.

Other Measures



Street Tree Planting

Measure Status: Existing

Responsible Department/Organization: Conservation

CO₂ Savings in 2010: 4,060 tons

Trees play an important role in reducing pollution levels in the atmosphere by absorbing carbon dioxide and giving off oxygen. When urban forests are healthy, they provide communities with many other valuable services that can be measured in dollar benefits. Trees have value for stormwater management by slowing runoff and reducing peak flows. Additional ecological values provided by urban forests include energy conservation and wildlife habitat enhancement. The Town of Brookline currently has 11,794 street trees. Each year, the Department of Parks and Open Space plants approximately 150 new trees along streets and in parks. This number is slightly less than the actual number of trees planted to account for tree death. In 2010, the Town should have approximately 12,994 street trees. In addition, the Town has received funding for restoration work at the Muddy River, Hall's Pond and Amory Woods Sanctuaries and the Emerald Necklace Conservancy. All of these projects will ensure the continued health of the Town's urban forest. Based on estimates of carbon sequestration rates from the American Forest's Global Releaf program, Town owned trees in Brookline could eliminate 4,060 tons of CO₂ by 2010.



Annual implementation and administration costs of street tree program: \$385,000

Cost to Town of reducing CO₂ through street tree program: $\$385,000 / 3,858.97 \text{ tons} = \$99.77/\text{ton}$.

Co-Benefits

- ☞ Shade trees reduce energy and money spent on air conditioning
- ☞ Trees can be used to block cold winds during winter, reducing heating bills
- ☞ Aid in stormwater management
- ☞ Provide habitat for urban wildlife
- ☞ Increase community livability and property values

Success Stories

- ☞ Sacramento County uses about 1,300 GWh (1 GWh = 1,000,000kwh) of electrical energy for air conditioning at a cost of \$105 million. The six million trees that comprise Sacramento's urban forest are responsible for approximately 157 GWh of electricity due to shading and cooling effects. The 6 million trees also absorb 238,000 million tons of CO₂ each year. These environmental benefits total approximately \$8/tree/year and increase to \$90 once benefits such as increased property values, scenic value and recreation are added. Sacramento spends about \$5 to \$20 per tree each year for maintenance. Hence initial research indicates that benefits are several times greater than costs.

Source:

http://www.wcefre.ucdavis.edu/urban_forest_benefits_from.htm



Promote Mixed-Use and Transit Oriented Development

Measure Status: Existing

Responsible Department/Organization: Planning

CO₂ Savings in 2010: Unknown

Brookline is characteristic of the network of compact, walkable, mixed-use centers and neighborhoods in older cities and towns scattered throughout New England and the Boston region. Many of these centers were historically connected by rail transit and still reflect land use patterns that were enabled by these strong connections. Brookline's overall land use pattern contributes to the goals of a sustainable community and region by supporting a variety of transportation choices; creating walkable, close-knit mixed use neighborhoods that provide diverse housing types; and intertwining the built environment with open space, farmland and natural beauty.

There are many connections that can be made between land use patterns and climate change. Mixed-use development and zoning is designed to permit a variety of community activities, locales and services to co-exist in close proximity, thereby reducing the need for extensive automobile travel. Transit oriented development brings potential riders closer to transit facilities rather than building away from population centers and making people more dependent on roads and automobiles. Put simply, if people live in close proximity to employment, retail, services, and entertainment, they won't need to drive as much. Fewer miles traveled means less greenhouse gas emissions.

Another beneficial impact of mixed use and transit oriented development is to reduce the need for excess parking. Excess parking has costs for us all. For an individual housing development, excess parking requirements drives up costs and reduces the potential for other amenities such as open space. Open space in Brookline provides a variety of environmental and aesthetic benefits. Paved land tends to reduce adjacent property values, increases water pollution and stormwater flooding, reduces visual and acoustic privacy and causes urban heat island (increased local temperatures).

On a larger scale, excess parking contributes to traffic congestion and ironically even encourages more car ownership. Numerous studies have shown that higher land use densities are essential to reduce rates of car ownership and miles driven. Generous parking requirements encourage automobile dependency and urban sprawl by increasing the amount of land needed per unit, thus making lower priced urban periphery land relatively more attractive than higher priced but more accessible urban locations.

In November of 2000, Town Meeting approved an increase in the minimum residential off-street parking requirement as stipulated in the Town's zoning bylaw. The requirements were increased from 1.6 spaces per unit to 2 spaces per unit for medium density residential dwellings with two bedrooms or less, and from 1.8 spaces per unit to 2.3 spaces per unit for medium density residential dwellings with more than two bedrooms. These requirements are higher than requirements in surrounding communities and, paradoxically, affect Brookline's mixed use, transit-oriented neighborhoods more intensely than they effect the low-density suburban neighborhoods. A further benefit of mixed-use development is to reduce the need for excessive parking. The development of walkable communities that combine retail, services and residential buildings reduce the need and use of cars.

The Town and the Planning Department should continue to promote mixed use and transit oriented development in Brookline. The Planning Department is currently working to incorporate the principles of sustainability into the Town's new Comprehensive Plan, which will take shape over calendar years 2002

and 2003. A further commitment should be made to incorporate climate change concerns into the Comprehensive Planning process, and to continue to promote mixed use and transit oriented development, so that future policy does not contradict the goals of sustainability and emissions reduction.

Co-Benefits

- /// Creates enhanced sense of community
- /// Preserves open space in Town
- /// Contributes to vitality of commercial areas
- /// Encourages healthy modes of transportation such as walking and biking
- /// Decreases traffic congestion
- /// Financial savings to residents from avoided driving costs
- /// Results in improved air quality and a better quality of life for all in Brookline

Success Stories

- /// A study of 3,000 travel analysis zones in the Chicago, Los Angeles and San Francisco metropolitan areas found that residential density is the strongest determinant of household auto ownership and VMT. Using odometer readings taken from vehicle emissions testing of private vehicles, they found that density explained nearly 90 % of the cause for decreased driving in Chicago, and 63 % in both L.A. and San Francisco.



Climate Change Outreach and Education

Measure Status: Existing/Proposed

Responsible Department/Organization: CCAB, Parks and Open Space, Energy Efficiency/Environmental Coordinator

CO₂ Savings in 2010: Unknown

The Town should develop an education program on climate change to be incorporated into the public school curriculum and to be used for general outreach about the CCP program. Programs in schools could incorporate hands-on learning projects such as monitoring lighting usage in schools or having students monitor automobile usage at home. A climate change curriculum guide is currently being developed for fifth graders in Brookline schools that provides an introduction to climate change as well as learning exercises and assignments to help students apply and retain the information. In addition to the curriculum guide, educational resources could be compiled for teachers to share with students, such as internet sites, books and journals and helpful contact organizations.

Building outreach and awareness of climate change can also extend beyond the classroom. In this respect, resources that discuss specific climate change issues with a focus on positive solutions could be compiled for all Brookline residents. This may include public displays, tabling at local events, continuous public forums, press coverage and citizen participation in the CCP process. Such outreach activities are instrumental for generating interest in the Town's involvement with climate change efforts. The formation of Citizens Climate Action Brookline (CCAB) in 2000 reflects the interest of residents in reducing greenhouse gas emissions in the Town.

While greenhouse gas emission reductions that might result from this measure are not easily quantified at this time, continued efforts to expand a climate change education and outreach program will have a

significant impact on emissions in the Town. The administration of such a program could become the responsibility of the Energy Efficiency/Environmental Coordinator should the Town create this position.



- Implementation costs estimated as \$50,000 for administration of the program, \$72,000 (\$45,000 salary x 1.6 to account for administrative, hiring costs etc.) for full-time Energy Efficiency/Environmental Coordinator (cost accounted for in separate measure).

Co-Benefits

- Develop understanding of importance of environmental issues among school children
- Children can pass lessons on to families, resulting in an increase in sustainable behavior throughout the community
- Outreach events to general public can highlight local efforts, show residents what Town is doing to save energy and money

Success Stories

- The Cool Schools Initiative in Toronto is a program managed by the Clean Air Partnership that provides curriculum and funding to Toronto area schools which agree to make education on climate change a fundamental part of the learning experience. Over 80 schools are involved in the program. Some measures the Cool Schools have implemented include the creation of a green outdoor classroom, a walk to school award program and a no-idling campaign.



Establish Energy Efficiency/Environmental Coordinator Position

Measure Status: Proposed

Responsible Department/Organization: Human Resources, Board of Selectmen

CO₂ Savings in 2010: 54,019 tons

The Town should implement measures to ensure that the emissions reduction measures outlined in this Plan actually become reality. Too many plans of this nature end up collecting dust on bookshelves. The Town has already invested nearly \$10,000 in staff time in the preparation of the Plan. One way to ensure completion of the five Milestones of the CCP Campaign, incorporate energy efficiency throughout all municipal operations would be to hire a full-time Energy Efficiency/Environmental Coordinator (EEC). This person could be charged with maintaining the emissions inventory on CCP software so that the Town can measure its progress towards the emissions reduction target. This individual could also assume responsibilities not directly related to the CCP Campaign, such as incorporating information from the recent Brookline Sustainability Inventory into the Town's Comprehensive Plan. In general, the role of the Energy Efficiency/Environmental Coordinator would be to protect and improve environmental quality in Brookline through programs and projects that prevent pollution, encourage environmentally friendly alternatives and promote energy conservation.

Some of the measures outlined in this Plan for which the EEC could assume direct responsibility include: the Residential Energy Efficiency Program, the Sustainable Business Awards Program, the Walk to

School Program and the Energy Efficient Building Code. When combined, these measures result in the elimination of 54,019 tons of CO₂.



- /// Implementation cost: \$45,000 salary for EEC x 1.6 (to account for hiring, administrative and support costs) = \$72,000
- /// Implementation cost of four measures mentioned above for which EEC could assume responsibility: \$26,000
- /// Financial savings to Town from four measures for which EEC could assume responsibility: \$3,580,814
- /// Amount that Town would save by hiring an EEC: \$3,580,814 - \$98,000 [\$72,000 + \$26,000] = \$3,482,814

Co-Benefits

- /// Financial savings for Town
- /// Ensures completion of CCP Campaign and achievement of emissions reduction target
- /// Showcases Town as an environmental steward in the community and State

Success Stories

- /// The City of Cambridge, MA has an Environmental Planning division within its Community Development Department and employs a full-time Environmental Planner
- /// The City of Somerville, MA employs a full-time Environmental Coordinator
- /// The City of Medford, MA, which recently completed its LAP, employs a part-time Energy Efficiency Coordinator



Create Energy Advisory Committee

Measure Status: Proposed
Responsible Department/Organization:
CO₂ Savings in 2010: Unknown

This measure would establish an Energy Advisory Committee composed of interested Town residents and local experts on issues related to climate change. Members of this Advisory Committee could meet regularly to discuss priorities and progress related to the implementation of emissions reduction measures outlined in the Local Action Plan. Since the development of the Plan relied heavily on collaboration and input from members of the community, the same individuals should also be involved in overseeing and monitoring the implementation of measures they helped create. This group could also take the lead on continuing to compile and distribute information on greenhouse gas reduction technologies, programs and policies that will improve Brookline's economy and environment.

Co-Benefits

- ☞ Increases chance that the Town successfully reaches emission reduction target and completes all Milestones of the CCP Campaign
- ☞ Showcases climate change efforts within the Town to residents
- ☞ Helps to incorporate climate change issues into other Town policy

Success Stories

- ☞ The establishment of an Energy Advisory Board in the City of Boston has helped to increase accountability for the development and implementation of policies and measures for the City's Climate Change Plan.

RESOLUTION

The Board considered the question of adopting a resolution joining the Cities for Climate Protection (CCP) Campaign.

- a. Question of executing a Memorandum of Understanding with the International Council for Local Environmental Initiatives (ICLEI) in connection with the Cities for Climate Protection Campaign.
- b. Question of designating a staff person as the point of contact between the Town and ICLEI and to supervise the intern assigned to assist with CCP Campaign.

DPW Commissioner DeMaio told the Board that Brookline has been invited to participate in the International Council for Local Environmental Initiatives (ICLEI) Cities for Climate Protection (CCP) Campaign. If Brookline joins, ICLEI will train and pay for a full-time intern for the summer to begin the work. This is a great way to continue the leadership exhibited by the Town in proactively addressing open space and environmental issues. There are 360 local governments participating worldwide, and 68 in this country.

The network created by Cities for Climate Protection allows local governments to learn from the best environmental practices of their colleagues worldwide. ICLEI provides participating communities with technical assistance, software tools, training workshops, case studies, and climate change updates and grant funding.

Ms. Chute, Conservation Administrator, told the Board that the intern will begin the end of May, and will be a highly qualified candidate. The intern will do an inventory of the entire Town, including residential, commercial and municipal. The Town will then use this information to draft an action plan that would help improve air quality and save money. The plan will set realistic goals for the Town at a certain time out.

Selectman Weitzman asked what role Mr. Simmons of the Building Department will play in this initiative? Ms. Chute replied that he will be used to provide data that the intern will need, also they will need access to records for town and school buildings. He then asked if this initiative will play a role in the comprehensive plan? Mr. Duffy replied it will, and added in the zoning bylaw amendment as well.

Commissioner DeMaio noted that at some point, they would ask that the Selectmen appoint a Board member to be assigned as the lead political figure in the project. This has been the case for all communities involved.

On motion, it was unanimously

RESOLUTION (cont'd)

VOTED: To adopt the following resolution, joining the Cities for Climate Protection (CCP) Campaign:

**Resolution for Participating
IN THE
CITIES FOR CLIMATE PROTECTION CAMPAIGN**

WHEREAS, a scientific consensus has arisen that Carbon Dioxide (CO₂) and other greenhouse gases (ghg) released into the atmosphere will have a profound effect on the Earth's climate; and

WHEREAS, scientific evidence indicates that global warming is already beginning, with the 1990's the hottest decade in recorded history; and

WHEREAS, based on scientific evidence, the United States has pledged along with 160 countries under the United Nations Framework Convention on Climate Change to reduce its greenhouse gas emissions; and

WHEREAS, energy consumption, specifically the burning of fossil fuels, e.g. coal, oil and gas, accounts for more than 80% of U.S. greenhouse gas emissions; and

WHEREAS, local governments greatly influence their community's energy usage by exercising key powers over land use, transportation, building construction, waste management, and, in many cases, energy supply and management; and

WHEREAS, local government actions taken to reduce greenhouse gas emission and increase energy efficiency provide multiple local benefits by decreasing air pollution, creating jobs, reducing energy expenditures, and saving money for the City government, its businesses and its citizens; and

WHEREAS, the Cities for Climate Protection Campaign, sponsored by the International Council for Local Environmental Initiatives, has invited the Town of Brookline to become a partner in the Campaign;

NOW, THEREFORE, BE IT RESOLVED that the Town of Brookline pledges to join with jurisdictions from all over the world in the Cities for Climate Protection Campaign and, as a participant in the Cities for Climate Protection Campaign, Brookline pledges to:

- 1.) Take a leadership role in increasing energy efficiency and reducing greenhouse gas emissions from municipal operations;
- 2.) Develop and implement a local action plan which describes the steps Brookline will take to reduce both greenhouse gas and air pollution emissions; the plan will include:
 - a greenhouse gas emissions analysis and forecast to determine the source and quantity of ghg emissions within the jurisdiction;

RESOLUTION (cont'd)

- a CO2 or greenhouse gas emissions reduction target;
- the strategy for meeting Brookline's greenhouse gas reduction target (e.g. an outline of the programs and measures that will be implemented to achieve the target)

ATTEST:

Richard J. Kelliher
Town Administrator
April 25, 2000
BOARD OF SELECTMEN

On motion, it was unanimously

VOTED: To execute a Memorandum of Understanding with the International Council for Local Environmental Initiatives (ICLEI), in connection with the Cities for Climate Protection Campaign.

MOU between ICLEI and Brookline relating to placement of Intern for work in Summer 2000

The purpose of this Memorandum of Understanding is to reiterate Brookline's intention of participating in the Cities for Climate Protection (CCP) Campaign and to indicate Brookline's willingness to accept and supervise an intern to assist it with CCP Campaign tasks.

As a participant in the CCP Campaign, Brookline is agreeing to undertake a community- and municipal-wide greenhouse gas emissions (ghg) inventory and to develop a ghg reduction plan. In signing this MOU, Brookline enables ICLEI to provide an intern to assist it with these tasks during the summer of 2000.

This MOU commits Brookline to supervising and engaging the intern in helping Brookline conduct its emissions inventory and in performing other tasks related to developing its ghg reduction plan. Commitment for participation in the CCP Campaign is indicated by Brookline having passed the Campaign participation resolution on April 25, 2000.

Brookline's commitment

In order to initiate and facilitate tasks necessary for accomplishing the CCP Campaign milestones, Brookline is glad to accept an intern to assist with ghg emissions inventory and other tasks related to developing its action plan for reducing community ghg emissions. Brookline will undertake these milestones with the assistance of the intern and provide day-to-day supervision of the intern. Brookline will engage the intern in helping complete its baseline emissions inventory and developing its global warming prevention plan. Brookline commits to overseeing and involving its intern for the duration of 400 hours (10 weeks at full-time work) over the course of this summer.

RESOLUTION (cont'd)

Brookline agrees to assign a staff person, who will be directly involved in performing the city's emissions analysis, to supervise and work directly with the intern. (This staff person is ideally, but not limited to being, the primary staff liaison, who will be designated as the point of contact between the city and ICLEI.)

Brookline agrees to provide the intern with a workspace, desk, computer and other materials or equipment necessary for the successful completion of the tasks assigned. The intern will work in close proximity with his/her city staff supervisor and have access to information and other city staff/departments necessary to perform his/her task.

Brookline also commits to communicating Campaign progress and coordinating intern-supervision efforts with ICLEI staff through regular conference calls and three face-to-face meetings involving the city staff, intern and ICLEI staff.

ICLEI's responsibilities

ICLEI will recruit, screen and interview applicants to provide a pool of qualified interns for Brookline to choose from. ICLEI will be the employer of the intern and will be responsible for payment to the intern at \$15/hr.

Once placement is finalized, ICLEI staff will conduct training for the interns and city staff, focusing on the process of performing the emissions inventory and other tasks related to the development of the ghg reduction plan. ICLEI will coordinate and pay for costs of conference calls and costs associated with organizing the three face-to-face meetings.

In order to ensure placement of intern, MOU should be submitted to ICLEI no later than May 1st, 2000.

The Board of Selectmen Adopts this Memorandum of Understanding to accept and supervise an intern to assist it with CCP Campaign tasks.

Approved by the Board of Selectmen on April 25, 2000

BOARD OF SELECTMEN

On motion, it was unanimously

VOTED: To designate Erin Chute, Conservation Administrator, as the staff person to be the point of contact between the Town and ICLEI and to supervise the intern assigned to assist with the CCP Campaign.

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Appendix B: Measures Quantification Notes

Transportation Sector

Existing Corporate Transportation Measures

Police Units on Bicycles

Page Number in Local Action Plan: 17

This measure evaluates the impact of the current police bicycle patrol. The methodology used to calculate the impact of this measure is based on the following data and assumptions.

Ordinarily, the police have approximately 15 cars on patrol at any given time. In 1995 the police fleet used 83,239 gallons of gasoline (\$1.40/gallon for total of \$116,557). The fleet comprises 41 cruisers, 4 trucks, 2 motorcycles, 1 bus and 1 VW beetle. For the sake of these calculations it is assumed that the 41 cruisers accounted for 80,000 gallons of gas. The average fuel economy for the Ford Crown Victoria cruisers is 17 mpg. Therefore, the cruisers travel approximately $(80,000 \times 17) = 1,360,000$ miles on an annual basis, or $(1,360,000/41) = 33,170.73$ yearly miles/car, or $(33,170.73/12) = 2,764.228$ miles/month/car.

The Brookline Police Department operates three bicycle patrols during the day and two at night from April to December (9 months). For the purpose of these calculations, it is assumed that on average, the bicycle patrols displace 4 patrol cars per day for nine months per year.

$4 \times (9 \times 2,764.228) = 99,512.2$ miles. At 17 mpg, it would take $(99,512.2/17) = 5,853.659$ gallons of gas for the 4 cars to travel 99,512.2 miles.

This measure does not assume that the bicycle patrols cover the same distance as the automobile patrols, but that there are other benefits associated with having police on bicycles such as improved crime fighting potential and improved community relations. These benefits are further outlined in the text of the Plan.

The cost of the bicycles is \$1,800. Average cost of training course for officers \$150 (International Police Mountain Bicycle Association). Average maintenance cost for bicycle: \$200/year; \$2,000/year for car (AAA).

4 training courses x \$150 = 600

4 bicycles x \$1,800 = \$7,200

4 bicycles x \$200 = \$800 in bicycle maintenance fees

4 cars x \$2,000 = \$8,000 in car maintenance fees

Total implementation cost: $\$7,200 + \$800 + \$600 - \$8,000 = \$600$

Follow-Up Measure - Additional Police Units on Bicycle

The impact of the Police Department buying 6 additional bicycles, for a total fleet of 10 bicycles, would be:

Assume that on average, bicycle patrols displace 8 patrol cars per day for nine months per year.

$8 \times (9 \times 2,764.228) = 199,024.4$ miles. At 17 mpg, it would take $(199,024.4/17) = 11,707.32$ gallons of gas for the 8 cars to travel 199,024.4 miles.

The cost of the bicycles is \$1,800. Average cost of training course for officers \$150 (International Police Mountain Bicycle Association). Average maintenance cost for bicycle: \$200/year; \$2,000/year for car (AAA).

8 training courses x \$150 = \$1,200

6 bicycles x \$1,800 = \$10,800

6 bicycles x \$200 = \$1,200 in bicycle maintenance fees

6 cars x \$2,000 = \$12,000 in car maintenance fees

Total implementation cost: $\$10,800 + \$1,200 + \$1,200 - \$12,000 = \$1,200$

Hybrid Gas/Electric Vehicles in the Town Fleet

Page Number in Local Action Plan: 18

Town currently owns 2 Prius out of 200 fleet vehicles. These 200 vehicles use approximately 100,000 gallons of gas per year. Approximately 95 vehicles from the following departments (Assessors, Building, Council on Aging, Fire, Health, Police, Recreation, School, Water and Sewer) are classified as passenger vehicles/light trucks that could easily be replaced by hybrid vehicles similar to a Prius.

In 1998, these 95 vehicles used 94,054 gallons of gasoline (\$84,648) or approximately 990.0421 gallons per vehicle (\$891.03). For the purpose of these calculations it is assumed that these vehicles match the specifications of a Ford Focus or Escort, which is the vehicle that the Prius will displace in the fleet. A Ford Focus sedan has an average fuel economy of 28 mpg. Thus in 1998, this vehicle fleet of approximately 95 passenger cars drove $28 \times 94,054 = 2,633,512$ VMT or 27,721.18 VMT/car.

The average fuel economy for a Prius is 48 mpg. A Prius driving 27,721.18 miles would use 577.5246 gallons of gas. The Town bought two Prius in 2001. Thus per year, the purchase of the two Prius has resulted in a gasoline savings of $(990.0421 - 577.5246) \times 2 = 825.035$ gallons.

Cost of new Toyota Prius: \$20,450, cost of new Ford Focus: \$14,810. Implementation cost: Cost of two Prius (\$40,900) - cost of two Focus (\$29,620) = \$11,280.

Follow-Up Measure - Additional Hybrid Gas/Electric Vehicles in the Town Fleet

The Town now has approximately 93 vehicles that are suited to transition to hybrids. This measure assumes that by the target year of 2010, the Town will have purchased an additional 25 Prius. In 1998 the 95 passenger vehicles in the Town fleet used 94,505 gallons of gas for a total

VMT of 159,918 or 27,721.18 VMT/car. The average mpg for a Prius is 48. A Prius driving 27,721.18 miles would use 577.5246 gallons of gas. The purchase of 25 Prius would result in a gasoline savings of $(990.0421 - 577.5246) \times 25 = 10,312.94$ gallons.

Implementation cost: cost of 25 Prius (\$511,250) - 25 Ford Focus (\$370,250) = \$141,000.

New Corporate Transportation Measures

Conversion of Fleet Vehicles to CNG

Page Number in Local Action Plan: 20

This measure evaluates the impact of converting DPW light vans or trucks to CNG. CNG conversion is not ideal in heavy trucks - they are much better suited to LNG conversion. This is not a measure that the Town is currently considering.

In 1998, the DPW light vans or trucks (47 vehicles) used 29,647 gallons of gasoline (information from Brookline GHG Inventory). According to the CCP software, light trucks/vans have an average fuel economy of 14 mpg (gasoline).

In 1998, DPW light vans or trucks had a VMT of $(29,647 \times 14) = 415,058$ miles or an average VMT/vehicle of 8,831.021 miles.

According to <http://www.fueleconomy.gov>, CNG light trucks have an average fuel economy of 13 mpg. To go 415,058 miles at 13 mpg would require 30,927.54 gallons of CNG.

Cost of CNG conversion kit estimated at \$3,250/vehicle (Alternative Fuels Data Center). $47 \times \$3,250 = \$152,750$ (implementation cost).

Cost of CNG per gasoline gallon equivalent: \$0.89/gallon (Alternative Fuels Data Center). $30,927.54 \text{ gallons} \times \$0.89 = \$27,525.51$. Cost of conventional gasoline \$1.235/gallon (Source). $29,647 \text{ gallons} \times 1.235 = \$36,614$. Avoided fuel cost savings from CNG conversion: $\$36,614 - \$27,525.51 = \$9,088.49$.

Conversion of Fleet Vehicles to Biodiesel

Page Number in Local Action Plan: 21

This measure would convert the Town's fleet of heavy trucks and equipment vehicles to 100% biodiesel for 8 months of the year. Biodiesel is not ideal for cold weather use but there is no conversion required, biodiesel can simply be mixed with regular diesel in conventional fuel tanks. In 1998, 48 heavy trucks and equipment vehicles from the Council on Aging, DPW, the Rec Dept and the Water and Sewer division used 73,836 gallons of diesel at a cost of \$57,884 (\$0.784/gallon). According to the CCP software, heavy trucks run on diesel have an average fuel economy of 8 mpg. Therefore, in 1998 this section of the fleet generated a VMT of $(73,836 \times 8) = 590,688$ miles or an average of 12,306 miles per vehicle. The 48 vehicles had an average monthly VMT of $(590,688/12) = 49,224$ miles or 1,025.5 miles per vehicle per month.

Thus the potential affected VMT is 48 (vehicles) x 1,025.5 (monthly VMT/vehicle) x 8 (months warm enough to use biodiesel) = 393,792 miles. To travel 393,792 miles would require $(393,792/8) = 49,224$ gallons of diesel.

Pure 100% biodiesel reduces fuel economy by 10% (US DOE), thus the average fuel economy of heavy trucks running on biodiesel would be $8 - (10\% \text{ of } 8) = 7.2$ mpg. To travel 393,792 miles would require $(393,792/7.2) = 54,693.33$ gallons of biodiesel.

According to the US DOE, biodiesel produces 2,661 grams of carbon dioxide per gallon compared to 12,360 grams per gallon for conventional diesel fuel. Therefore, 54,693.33 gallons of biodiesel produces $(54,693.33 \times 2,661) = 145,538,951$ grams of carbon dioxide. 49,224 gallons of diesel produces $(49,224 \times 12,360) = 608,408,640$ grams of carbon dioxide.

For the 48 vehicles, biodiesel produces 143.24 tons of carbon dioxide compared to the 598.80 tons produced by conventional diesel. As there no biodiesel option in the CCP software, this measure has been calculated as 'other' under corporate measures.

Price of petroleum diesel per gallon (\$1.58) from:

http://www.eia.doe.gov/oil_gas/petroleum/special/gasoline_update/market_summary.html as of 10/30/01. $49,224 \text{ gallons} \times 1.58 = \$77,773.92$. Price of biodiesel on average \$0.3 more than conventional diesel (<http://www.biodiesel.org>). $54,693.33 \text{ gallons} \times 1.88 = \$102,823.46$. Difference: \$ 25,049.54.

Parking Cash-Out Program for Town Employees

Page Number in Local Action Plan: 22

This measure is similar to the T Pass Program for Town Employees in that the target group is Town employees who currently drive to work. The methodology is again based on the number of employees who have parking passes for the Town Hall lot (104). A 25% participation goal is assumed (26 participants). It is also difficult to characterize the transportation choices of people who give up their parking passes - they could switch to the T, walk, bicycle, or car pool. For the purpose of quantifying the measure however, and for the sake of calculating an impact different to that of the T Pass Program, it is assumed that participants take the bus after cashing in their parking passes.

Number of parking permits issued: 104 (Engineering Department data)

$104 \text{ permits} \times 2 \text{ trips per day} = 208 \text{ trips per day}$

Approximately 264 working days per year (22 days per month x 12). $264 \times 208 = 54,912$ annual number of trips.

Estimate average commute length for Brookline: 9 miles (based on methodology from Vijay Mahal CTPS - assumes 24 minute commute based on 1990 Census data, at an average speed of 24 miles per hour).

Therefore $54,912 \text{ trips} \times 9 \text{ miles} = 494,208$ passenger miles traveled (PMT)

Goal of measure: Get 25% of Town employees who currently drive to work to switch to the T. 25% of 104 people = approximately 26 people or 52 trips per day. 52 trips x 264 = 13,728 # of trips reduction = 13,728 trips or $(13,728 \times 9) = 123,552$ reduced PMT.

Implementation cost: Value of parking spaces estimated at \$65/month by Engineering Department. 26 parking spaces: $26 \times 65 = \$1,690$ per month, or \$23,520. Town could easily regain this cost by renting municipal parking spaces to non-Town employees after business hours.

Corporate T-Pass for Town Employees **Page Number in Local Action Plan: 22**

This measure would implement a group purchase of MBTA subway and/or bus passes among municipal employees. The methodology used to calculate the impact of this measure on GHG emissions focuses only on those municipal employees who have parking passes for the Town Hall lot (104). Calculations are based on the following assumptions:

The parking pass methodology is used because no data was available on how people who don't get parking passes commute to work. Therefore, double counting of those who might already be taking alternative forms of transportation is avoided.

Number of parking permits issued: 104 (Engineering Department data)

104 permits x 2 trips per day = 208 trips per day

Approximately 264 working days per year (22 days per month x 12). $264 \times 208 = 54,912$ annual number of trips.

Estimate average commute length for Brookline: 9 miles (based on methodology from Vijay Mahal CTPS - assumes 24 minute commute based on 1990 Census data, at an average speed of 24 miles per hour).

Therefore $52,416 \text{ trips} \times 9 \text{ miles} = 494,208 \text{ PMT}$

Goal of measure, get 25% of Town employees who currently drive to work to switch to the T. 25% of 104 people = approximately 26 people or 52 trips per day. 52 trips x 264 = 13,728 # of trips reduction = 13,728 trips or $(13,728 \times 9) = 123,552$ reduced PMT. For ease of entering data into software, it is assumed that those who switch to public transportation take the subway.

Implementation costs: Passes are purchased by Town Employees, or are subsidized by the Town. Monthly subway passes cost \$35, monthly bus passes cost \$25 and combo passes cost \$57. Assume that most people buy subway or combo passes, for an average cost of \$46.00. Average monthly cost for 26 employees: \$1,196.00, for year: \$14,352.00.

Value of parking spaces estimated at \$65/month by Engineering Department. 26 parking spaces: $26 \times 65 = \$1,690$ per month, or \$23,520.

Telecommuting for Town Employees
Page Number in Local Action Plan: 23

The methodology used to calculate the impact of this measure is based on the following assumptions:

A breakdown of municipal employees by department was used to estimate that approximately 350 positions in the Town would be suited for telecommuting.

From 1990 Census: 8,256 of 30,668 employees in Brookline took public transit to work: 26.92% while 16,624 of 30,668 employees drove to work: 54.21%
26.92% of 350 = 94.22 employees
54.21% of 350 = 189.74 employees

For 190 Town employees who drive to work:
Average commute length: 9 miles, x twice a day, x 22 days per month x 12 months = 4,752 miles per employee, x 190 = 902,880 miles

If each employee telecommutes twice a month: 9 x twice a day x 2 days per month x 12 months: 432 miles, x 190 = 82,080 miles

For remaining 160 Town employees who take public transportation (for the sake of calculations assume the 'T'):
Average commute length: 9 x 2 x 22 x 12 = 4752, x 160 = 760,320 miles
If each employee telecommutes twice a month: 9 x 2 x 2 x 12: 432 miles, x 160 = 69,120 miles

So that the measure could be entered onto one page in the Corporate Measures section, the energy savings from Town employees who take the 'T' was calculated using the Community Measures Transportation Calculator in the CCP Software which converts the amount of electricity used by the subway system into equivalent gallons of gasoline. The calculator computed that before the measure, 174,786.2 equivalent gallons of electricity were used by the 160 employees to commute to work. After the measure, 158,896.6 equivalent gallons were used, for a difference of 15,889.6 equivalent gallons.

The same methodology was used to calculate energy savings with regard to the people that drive to work. Before the measure, 42,994.39 gallons of gasoline were used, after the measure: 39,085.7 gallons were used for a difference of 3,908.69 gallons.

Cost of telecommuting estimated as: One-time fee of \$4,462 per employee (this cost includes computer, phone equipment and network installation), annual cost of \$2,158 per employee (includes support, network costs and home equipment maintenance). For 350 employees, one time fee of \$1,561,700 and average annual costs of \$755,300. Only the one-time costs are entered into the software as it is assumed that average annual costs are similar to support costs for employees working in Town facilities.

Follow-Up Measure: Telecommuting for Broader Segment of Brookline Workforce

This measure would encourage Town businesses to allow employees to telecommute to work twice a month. The calculations used to estimate the impact of this measure on greenhouse gas emissions are based on the following methodology and assumptions:

Average commute length in Brookline: 9 miles

Calculations assume that measure enables 40% of Brookline workforce (30,668) with positions suitable for telecommuting to work from home twice a month. Based on 1990 Census data, 8256 (40% = 3,302.4) of 30,668 employees took public transportation to work. 16,624 (40% = 6,649.6) drove their car. For the sake of calculations, we assume that public transportation refers to the subway.

Drivers: 9 miles x 2 (twice a day) x 22 (days per month) x 12 (months) = 4,752 miles, x 6,649.6 = 31,598,899 miles.

9 miles x 2 (twice a day) x 2 (twice a month) x 12 = 432 miles, x 6,649.6 = 2,872,627 miles.

Difference: 31,598,899 - 2,872,627 = 28,726,272 miles.

Public transportation: 9 miles x 2 (twice a day) x 22 (days per month) x 12 (months) = 4,752 miles, x 3,302.4 = 15,693,005 miles

9 miles x 2 (twice a day) x 2 (twice a month) x 22 (days per month) x 12 (months) = 432 miles, x 3,302.4 = 1,426,637 miles

Difference: 15,693,005 - 1,426,637 = 14,266,368

One time cost: 9,952 employees x average cost \$4,462 = \$44,405,824. Only the one-time costs are entered into the software as it is assumed that average annual costs are similar to support costs for employees working in Town facilities.

Existing Community Transportation Measures

Support for Car Sharing Programs

Page Number in Local Action Plan: 24

The Town is currently cooperating with the Zipcar carsharing program. There are 81 members in Brookline and five vehicle locations. Zipcar states that approximately half of their members took public transportation before joining the program while the other half were car owners.

To determine the impact of this measure on VMT among Zipcar members who were previously car owners the following methodology was used. The total annual VMT for Brookline (average between 1990 and 2000) is 213.65 million miles (GHG Inventory). This figure was divided by the population of Brookline (53,605) to get an approximate figure for per capita VMT: 3,985.64 miles. This figure was multiplied by 40.5 (half of Zipcar members who were previous car owners) to get: 161,418.42 VMT. Based on the assumption that carsharing members drive 1/3 less than regular drivers (assumption from Ryan Bell, ICLEI), this figure was divided by 3 to get the affected PMT: 53,806.14 miles.

The basic Zipcar membership includes a \$25 application fee, a \$300 refundable insurance security deposit, a \$75 annual fee, and a \$0.40/mile fee. Hourly rental fees are \$4.50 to \$7.00/hour. The average total amount paid by Zipcar members is \$1,300/year. In contrast, AAA calculates that the average annual cost of a new car is \$5,300/year, not including purchase price. Implementation cost $(40.5 \times 1,300) - (40.5 \times 5,300) = -\$162,000$. Implementation cost also includes money that the Town loses from providing three free parking spaces for Zipcars. Engineering estimates that a parking space in the Town is worth approximately \$65/month. Therefore the three spots represent a loss of 12 months \times \$65 \times 3 parking spots: \$783.60. Total implementation cost: $-\$162,000 + 783.60 = -\$161,260$

New Community Transportation Measures

Lobby for Increased CAFE Standards Page Number in Local Action Plan: 25

With this measure, the Town and community groups could lobby the Federal Government to increase CAFE (Corporate Average Fuel Economy) Standards. The methodology used to calculate the impact of this measure is as follows:

Number of passenger cars registered in Brookline: 27,573 (83.29%)
Number of light trucks registered in Brookline: 5,533 (16.71%)
(Source: Planning Department)

Current average MPG figures:

Passenger cars: 21.4 mpg
Light trucks: 19.6 mpg
(Source: CTPS)

Total VMT from 1995: 207.31 million miles (gasoline powered personal vehicle from GHG Inventory)

83.29% (Passenger cars): 172.6685 million miles
16.71% (Light trucks): 34.6415 million miles

So, passenger cars going 172.6685 million miles at 20 mpg use 8,422,853.7 gallons of gas. Light trucks going 34.6415 million miles use 2,474,392.9 gallons of gas.

If fuel efficiency levels were increased to over 40 mpg (assumed minimum for passenger cars and light trucks), then both types of vehicles going 207.31 million miles would use 5,182,750 gallons of gas. Thus, the potential fuel savings would be $(8,422,853.7 + 2,474,392.9) - 5,182,750 = 5,714,497$ gallons.

Walk to School Program Page Number in Local Action Plan: 26

This measure would implement a 'Walk to School' program that encouraged a reduction of vehicle trips to school. The impact of this measure is calculated with a goal of 20% participation in each elementary school. The population of the High School is not included in the calculations.

The schools included in the calculations are (2001 Information from <http://profiles.doe.mass.edu>):

Baker	772 students
Devotion	715 students
Driscoll	450 students
Heath	385 students
Lawrence	550 students
Lincoln	470 students
Pierce	625 students
Runkle	400 students
Total	= 4367 students

Average walk to school 0.375 miles (Source: Transportation)

If program gets 20% of students walking, 20% of 4367 is 873.4 students.

Total distance walked = 0.375 miles x 873.4 students = 327.525 miles x 2 trips per day = 655.05 miles x 180 school days = 117,909 miles potential reduction in PMT

Fuel economy of average passenger car according to GHG Software is 20 mpg. 117,909 miles at 20 mpg requires $117,909/20 = 5,895.45$ gallons of gas. Price of fuel per gallon (\$1.235) from http://www.eia.doe.gov/oil_gas/petroleum/special/gasoline_update/market_summary.html as of 10/30/01. $5,895.45 \text{ gallons} \times 1.235 = \$7,280.90$ savings in avoided fuel costs.

Implementation cost: \$3,000 for staff time to conduct survey about current modes of transportation to school, to paint walking routes, to create promotional materials about the program.

Bicycling Infrastructure Improvements and Outreach Program

Page Number in Local Action Plan: 27

Methodology based on the following assumptions: Daily Personal Vehicle VMT 2000: 744,276 (Data from CTPS and Brookline GHG Emissions Inventory)

Population Brookline 2000: 54,718

Therefore estimate daily VMT per capita at 13.602 miles

Goal of 1-mile bicycle lane, 100 bicycle racks and outreach program that attracts 300 riders for 8 months per year.

$13.602 \text{ miles} \times 30 \text{ days in a month} \times 8 \text{ months} \times 300 \text{ new riders} = 979,344$ potential mileage reduction.

Fuel economy of average passenger car according to GHG Software is 20 mpg. 979,344 miles at 20 mpg requires $979,344/20 = 48,967.2$ gallons of gas. Price of fuel per gallon (\$1.235) from http://www.eia.doe.gov/oil_gas/petroleum/special/gasoline_update/market_summary.html as of 10/30/01. $48,967.2 \text{ gallons} \times 1.235 = \$60,474.49$ savings in avoided fuel costs.

Implementation figures based on following costs of bicycle lanes:

1-mile bicycle lane in Gurnee, IL: \$200,000

0.9 mile bicycle lane in Dublin, CA: \$107,000

1-mile bicycle lane in Treasure Island, CA: \$120,000

1-mile bicycle lane in Taveres, FL: \$65,000

Average cost for 1-mile bicycle lane: \$123,000

Average cost of bicycle rack installation:

150 racks in Oakland, CA: \$16,450; \$110/rack

1000 racks in San Francisco, CA: \$85,000; \$85/rack

700 racks in San Francisco, CA: \$97,600; \$139/rack

Average cost per rack: \$111.00. Cost for 100 racks: \$11,100

Cost of staff time and educational materials for outreach program: \$2,000

Total implementation cost of Bicycling Infrastructure Improvements and Outreach measure: \$136,000

Program to Increase MBTA Ridership

Page Number in Local Action Plan: 28

With this measure, the Town would implement an outreach program or social marketing campaign with the goal of increasing MBTA ridership through decreasing personal automobile trips by 10% in Brookline. The calculations used to determine the impact of this measure on greenhouse gas emissions are based on the following assumptions.

Total population Brookline: 53,605 (1999)

Total VMT (from GHG Inventory): 213.65 million miles

Average VMT/capita: 3,985.64 miles

Goal of measure: 10% of Town population switch to public transportation 60% of the time.

10% of Brookline population: 5,360.50

60% of per capita VMT: 2,391.38

60% of VMT for 10% of population = $5,360.5 \times 2,391.38$ = potential VMT reduction of 12,818,992 miles

Measure assumes that 75% of target population switch to riding the 'T' while the other 25% ride the bus.

75% on 'T' = 9,614,224 miles

25% on bus = 3,229,748 miles

Implementation cost: \$75,000 for administration of the program (based on estimates from budgets of similar programs), \$72,000 (\$45,000 salary x 1.6 for administrative costs etc.) for salary of full-time Energy Efficiency/Environmental Coordinator (cost accounted for in separate measure).

Energy Sector

Existing Corporate Energy Measures

LED Traffic Signals

Page Number in Local Action Plan: 30

This is an existing measure through which the DPW has installed LED lights for the Green and Red signals at most of the traffic signals in Brookline. The energy savings from these installations is estimated at 75% (Jamie Pianka Highway). The total energy use in 1998 from streetlights was 631,233 kwh at a cost of \$65,819. The lights were installed in 2000. The resulting energy savings are calculated as 75% of 631,233: 473,424.8 kwh. Therefore it is estimated that after the LED installations, the total electricity used for traffic lights: 157,808.2 kwh

According to the Town of Brookline 2000 Annual Report, conversions were made to 1,100 units in 1999. Calculations assume that 550 were to red lights and 550 to green lights. The conversion cost for LED traffic signals is estimated as \$100/red light and \$200/green light (Lighting Research Center, Rensselaer Polytechnic Institute). Conversion cost: $(\$100 \times 550) + (\$200 \times 550) = \$165,000$

Town Buildings Lighting Retrofits

Page Number in Local Action Plan: 31

The methodology used to calculate the impact of this measure is based on data from lighting retrofits at the Old Lincoln School in 1999 undertaken by Coastal Lighting. Installation of energy efficient lighting and occupancy sensors resulted in annual savings of 36,481 kwh. In 1998, the Old Lincoln School used 212,400 kwh of electricity. Energy savings were thus 17% of total electricity use. This figure has been applied to other Town buildings in order to estimate energy savings from past and future lighting retrofits, although that is an approximate calculation. The figure of 17% is used because no other data exists that specifically calculates savings from lighting retrofits. Calculations assume that lighting retrofits and occupancy sensors will have been undertaken on the following buildings by 2010, resulting in a 17% reduction in kwh used from forecast amounts.

Forecasted Electricity Use in Municipal Buildings 2010

Main Library: 653,400 kwh	17% = 111,078 kwh
Coolidge Library: 241,680 kwh	17% = 41,085.6 kwh
Putterham Library: 100,410 kwh	17% = 17,069.7 kwh
Town Hall: 1,235,292 kwh	17% = 209,999.6 kwh
Main Police (Washington Street): 481,910 kwh	17% = 81,924.7 kwh
Health Center: 79,199 kwh	17% = 13,463.83 kwh
Lynch Rec. Center: 34,408 kwh	17% = 5,849.36 kwh
Soule Rec. Center: 45,821 kwh	17% = 7,789.57 kwh
Baker School: 231,303 kwh	17% = 39,321.51 kwh

Baldwin School: 26,845 kwh	17% = 4,563.65 kwh
Devotion School: 656,652 kwh	17% = 111,630.8 kwh
Driscoll School: 267,257 kwh	17% = 45,433.69 kwh
Heath School: 239,228 kwh	17% = 40,688.76 kwh
Phys Ed./UA Arts: 1,290,719 kwh	17% = 219,422.2 kwh
High School: 1,793,971 kwh	17% = 304,975.1 kwh
Lawrence School: 430,755 kwh	17% = 73,228.35 kwh
New Lincoln: 984,194 kwh	17% = 167,313 kwh
Old Lincoln: 212,400 kwh	17% = 111,508.7 kwh
Runkle: 252,282 kwh	17% = 42,887.94 kwh

Total Usage: 9,977,189 kwh

Total Savings: 1,689,322 kwh

Implementation costs based on average costs of various window replacement projects in Town (from Comptroller records):

Old Lincoln School, 1999 lighting retrofit and installation of occupancy sensor \$31,903. Methodology used to calculate average estimated cost of lighting retrofit projects: Generate a cost/square foot for Old Lincoln project and apply to other buildings. Note that this is an estimate cost, and that project costs will vary substantially from project to project.

Cost of lighting retrofit and installation of occupancy sensors/square foot for Old Lincoln:
 $\$31,903/67,557 \text{ feet} = \$0.472/\text{square foot}$

Building	Square Footage (feet)	Cost per Square Foot
Main Library	55,000	\$25,960
Coolidge Library	15,710	\$7,415.12
Putterham Library	9,425	\$4,448.60
Town Hall	76,208	\$35,970.18
Main Police	8,828	\$4,166.82
Health	5,088	\$2,401.54
Lynch Rec.	3,600	\$1,699.20
Soule Rec.	4,075	\$1,923.40
Baker	93,642	\$44,199.02
Baldwin	9,976	\$4,708.672
Devotion	148,633	\$70,154.78
Driscoll	97,397	\$45,971.38
Heath	61,815	\$29,176.68
Phys.Ed/ UA Arts	142,915	\$67,455.88
High School	350,850	\$165,601.20
Lawrence	85,513	\$40,362.14
New Lincoln	87,500	\$41,300
Old Lincoln	67,557	\$31,886.90
Runkle	70,300	\$33,181.60
Pierce	197,796	\$93,359.71
		Total: \$751,342.80

Energy Efficient Window Installation in Town Buildings
Page Number in Local Action Plan: 32

According to the EPA Energy Star program, approximately 40% of an annual energy budget covers heating and cooling costs. The installation of energy efficient windows can result in 15% savings in energy used for heating and cooling purposes. The methodology used to calculate the impact of this measure is based on energy use forecasts for various Town buildings (Main Library, Coolidge Library, Putterham Library, Town Hall, Main Police, Health Center, Lynch Rec, Soule Rec, Baker, Baldwin, Devotion, Driscoll, Heath, Phys.Ed/UA Arts, High School, Lawrence, New Lincoln, Old Lincoln, Runkle) in 2010. Potential energy savings estimated as 15% of 40% of total energy consumption.

Energy Savings Calculations from Window Retrofits

Building	2010 Elec. (kwh)	40% (kwh)	15% of 40% (kwh)	2010 Gas (ekwh)	40% (ekwh)	15% of 40% (ekwh)	2010 Oil (ekwh)	40% (ekwh)	15% of 40% (ekwh)
Main Library	865,800	346,320	51,948	1,481,917	592,766.7	88,915	0	0	0
Coolidge Library	241,680	96,672	14,501	0	0	0	451,668.52	180,667.4	27,100.1
Putterham Library	100,410	40,164	6,024.6	263,657.7	105,463.1	15,819.47	0	0	0
Town Hall	1,235,292	494,117	74,117.6	48,505.3	19,402.12	2,910.3	1,354,924	541,969.6	81,295.4
Main Police	481,910	192,764	28,914.6	55,861.7	22,344.68	3,351.7	0	0	0
Health	79,199	31,679.6	4,751.94	338,481.8	135,392.7	20,308.91	0	0	0
Lynch Rec.	34,408	13,763.2	2,064.48	248,769.1	99,507.64	14,926.15	0	0	0
Soule Rec.	45,821	18,328.4	2,749.26	123,915.6	49,566.24	7,434.9	463,319.75	185,327.9	27,799.19
Baker	231,303	92,521.2	13,878.2	47,889.8	19,155.92	2,873.4	1,984,620.16	793,848.1	119,077.2
Baldwin	26,845	10,738	1,610.7	234.47	93.788	14.07	362,206.62	144,882.6	21,732.39
Devotion	656,652	262,661	39,399.1	62,250.9	24,900.36	3,735.05	2,022,058.91	808,823.6	121,323.5
Driscoll	267,257	106,903	16,035.4	37,221.6	14,888.64	2,233.3	1,761,820.93	704,728.4	105,709.3
Heath	239,228	95,691.2	14,353.7	2,696.4	1,078.56	161.78	917,473.33	366,989.3	55,048.4
Phys.Ed/ UA Arts	1,290,713	516,285	77,442.8	146,277.8	58,511.12	8,776.7	7,847,307.74	3,138,923	470,838.5
High School	1,793,971	717,588	107,638	138,569.8	55,427.92	8,314.2	7,847,307.74	3,138,923	470,838.5
Lawrence	430,755	172,302	15,845.3	120,808.9	48,323.56	7,248.5	1,464,144.19	585,657.7	87,848.66
New Lincoln	984,194	393,678	59,051.6	1,272,479.5	508,991.8	76,348.8	0	0	0
Old Lincoln	212,400	84,960	12,744	73,651.8	29,460.72	4,419.1	1,107,355.8	442,942.3	66,441.35
Runkle	252,282	100,913	15,136.9	2,488,628.4	995,451.3	149,317.7	0	0	0
Pierce	679,463	271,785	40,767.8	2,635,169.9	154,068	23,110.2	0	0	0
TOTAL	10,149,583	4,059,834	598,975	9,586,947	2,934,795	440,219.2	19,736,900	11,033,683	1,184,214

Total potential energy savings in ekwh: 598,974.7 (electricity) + 440,219.2 (gas) + 1,184,241 (oil) = 2,223,408 ekwh

Implementation costs based on average costs of various window replacement projects in Town (from Comptroller records):

Runkle School 1999 window replacement \$518,363. Methodology used to calculate average estimated cost of window retrofit projects: Generate a cost/square foot for Runkle project and apply to other buildings. Note that this is an estimate cost, and that project costs will vary substantially from project to project.

Cost of window replacement/square foot for Runkle: \$518,363/70,300 feet = \$7.37/square foot

Building	Square Footage	Cost per Square Foot
Main Library	55,000	\$405,350
Coolidge Library	15,710	\$115,782.7
Putterham Library	9,425	\$69,462.25
Town Hall	76,208	\$561,653
Main Police	8,828	\$65,062.36
Health	5,088	\$37,498.56
Lynch Rec.	3,600	\$26,532
Soule Rec.	4,075	\$30,032.75
Baker	93,642	\$690 141.5
Baldwin	9,976	\$73,523.12
Devotion	148,633	\$1,095,425
Driscoll	97,397	\$717,815.9
Heath	61,815	\$455,576.6
Phys.Ed/ UA Arts	142,915	\$1,053,284
High School	350,850	\$2,585,765
Lawrence	85,513	\$630,230.8
New Lincoln	87,500	\$644,875
Old Lincoln	67,557	\$497,895.1
Runkle	70,300	\$518,111
Pierce	197,796	\$1,457,757
		Total: \$11,731,774

New Corporate Energy Measures

Energy Efficient Streetlights

Page Number in Local Action Plan: 34

According to the GHG Inventory (Evans) there are over 4,000 streetlights and other outdoor lights in Brookline. In the Inventory, the lights are broken down into the following categories: Boston Edison Lots and Spots, Boston Edison Street, DPW Traffic Controls, Fire Alarm Lights, Park lights and Town owned. The Boston Edison purchase in October 2001 gave the Town ownership over the lots and spots, streetlights, park lights and fire alarm lights. The Town currently owns 4,130 lights of which 348 are mercury vapor. This measure would encourage the Town to convert the 348 mercury lights to high pressure sodium.

The methodology used to calculate the impact of this measure is based on the following assumptions:

4,130 lights - 212 mercury vapor lights owned by the Town before Boston Edison purchase (1995 used 182,884 kwh) - 239 Fire alarm lights (1995 used 130,880 kwh) = 3,679 lights (lots and spots, street, parks all previously owned by Boston Edison, in 1995 used 2,484,167 kwh)

136 of the 3,679 are mercury vapor (Source: Greenhouse Gas Inventory): 3,679-136 = 3,543 lights

136 = 3.7% of the lights, 3.7% of 2,484,167 = 91,914.18 kwh

3,543 = 96.3% of the lights 96.3% of 2,484,167 = 2,392,253 kwh

Therefore, in 1995 the mercury vapor lights used 182,884 (212 previously Town owned) + 91,914.18 (136 previously Boston Edison) = 274,798.2 kwh

High pressure sodium lights are on average 7 times more efficient than mercury vapor (Source: Defense Supply Center Philadelphia Light Efficiency Comparison Chart <http://dscp.dla.mil/gi/general/lightcat/genifno.pdf>).

Mercury vapor LPW (lumens/watt) = 30 - 63, average 46.5
High pressure sodium LPW = 63 - 140, average 101.5

46.5 is 45.81% of 101.5, therefore HPS lights are $(100-45.81) = 54.19\%$ more efficient than mercury vapor.

Previous energy use from mercury vapor lights in 1995: 274,798.2 kwh
 54.19% of 274,798.2 = 148,913.1 kwh = energy use after conversion
Potential energy reduction: $274,798.2 - 148,913.1 = 125,885.1$ kwh

According to DPW, the cost of converting the mercury vapor lights is \$1,200 per lamp. $348 \text{ lamps} \times 1,200 = \$417,600$.

Town Owned Demonstration House **Page Number in Local Action Plan: 34**

This measure would convert a Town owned property into an energy efficient demonstration house. One potential property for such a project is the residential property at 27 Acres Avenue. Utility records however combine this building with Town Hall. The methodology used to calculate the impact of turning 27 Acres Ave into a green demonstration house is based on the average energy usage for a residential home in Brookline in 1998.

In 1998, 21,000 households used 141,268,948 kwh electricity, 12,267,540 therms and 10,539,350 gallons heating oil. Therefore, per household energy usage: 6,727.093 kwh electricity, 584.1686 therms natural gas and 501.8738 gallons heating oil. For the sake of the calculations natural gas and heating oil data has been converted to ekwh with the CCP Software Units Converter:

584.1686 therms = 17,121 ekwh natural gas
501.8738 gallons = 20,445.62 ekwh heating oil
Total ekwh/household: $6,727.093 + 17,121 + 20,445.62 = 44,293.71$ ekwh/household.

Assume following energy efficiency renovations in the demonstration house: solar hot water heating system, solar electricity 2 kw PV system, energy efficient appliances, energy efficient weatherization, energy efficient lighting. It is assumed that these retrofits result in energy savings of 30% of ekwh in the building, or 30% of $44,293.71 = 13,288.11$ ekwh..

Cost of renovations estimated at: solar hot water \$5,000; solar electricity \$20,000; weatherization, lighting retrofit and energy efficient appliances \$10,000. Total \$35,000.

Retrofit Fire Alarm Lights and Exit Signs in Town Buildings
Page Number in Local Action Plan: 35

There is no specific record of the electricity consumption of exit signs in Town buildings and facilities. This measure calculates only the impact of converting fire alarm lights. Currently there are 239 incandescent red lights marking the location of fire alarms in Brookline. In 1998, fire alarm lights accounted for 130,880 kwh (\$21,214) of energy use according to the GHG Inventory (Evans). Retrofitting the lights would consist of a transition either to LED or compact fluorescent bulbs. LED conversions can result in estimated energy savings 75%. Thus, a potential energy saving of 75% of 130,880 kwh = 98,160 kwh could result.

Cannot find information anywhere on cost of LED fire alarm lights. City of Overland Park, KS paid \$107.76 for each exit sign they converted. Calculations based on assumption that LED fire alarm lights cost approximately \$100 each. 239 lights x \$100 = \$23,900.

Municipal Use of Solar Electricity
Page Number in Local Action Plan: 36

New construction and renovations in Town buildings present opportunities to incorporate solar electricity production into design. Future possibilities that have been identified include Driscoll, Runkle, Devotion and Pierce Schools, as well as the Main Library and Police Department (Sacco).

Total energy consumption forecasted for these buildings in 2010: 3,203,364 kwh
Calculations assume that each building installs a 2 kw PV system that generates 3,600 kwh/year.
6 buildings = 6 x 3,600 = 21,600 kwh

Cost of installation on average \$10 to \$12.50 per watt. Therefore, installation cost for 2kw photovoltaic system: \$11.25 x 2,000 = \$22,500. Total installation costs for 6 buildings: \$22,500 x 6 = \$135,000

New Community Energy Measures

Replace Incandescent Bulbs with Compact Fluorescents in Residential Sector
Page in Local Action Plan: 37

Residential electricity usage in 2010: 138,525,670 kwh
Number of households in 2010: 22,260. Therefore electricity usage/household:
 $138,525,670/22,260 = 6,223.076$ kwh
Lighting accounts for approximately 9% of a household's energy budget (http://www.iclei.org/efacts/home_eff.htm).
 $9\% \text{ of } 6,223.076 = 560.0768$ kwh.
Compact fluorescents produce about 4 times more illumination/watt than traditional incandescent bulbs, therefore replacing conventional bulbs with CFs can reduce electricity usage attributed to lighting by 75%.

560.0768 kwh x 22,260 households = 12,467,310 kwh
75% of 12,467,310 kwh = 9,350,482 kwh
Difference = 3,116,827 kwh

Implementation cost:

Assume that typical Brookline residence has 20 light fixtures, which are in use for an average of 5 hours per day, or 1,865 hours per year.

For a 10,000-hour life, ten 60-watt incandescent bulbs cost \$5 to purchase and have an estimated energy cost of \$36 for a total cost of \$41. For a 10,000-hour life, one 15-watt compact fluorescent costs \$14 to purchase and has an energy cost of \$9 for a total cost of \$23. (Source <http://www.mge.com/business/saving/lighting.htm>).

10,000 hours = 5.5 years of use

Retail bulb costs for ten 60-watt: \$5 x 20 fixtures/5.5 years = \$18.18/year x 22,260 households = \$404,686.80

Retail bulb costs for one CF: \$14 x 20 fixtures/5.5 years = \$50.91/year x 22,260 households = \$1,133,256.60

Implementation cost is difference between two: \$728,569.80

Purchase of Green Electricity

Page Number in Local Action Plan: 38

Residential and Commercial

The calculations for this measure assume a 20% demand for green electricity with a 100% renewable content in residential and commercial/industrial sectors by 2010. According to MassEnergy, the power content of green energy produced in Massachusetts in 2010 will most likely be: 40% wind, 40% biomass, and 20% small hydro.

According to Brookline's GHG Inventory, in 2010 the residential energy sector will use 138,525,670 kwh of electricity and the commercial/industrial sector will use 192,900,320 kwh. MassEnergy and national surveys show approximately a 20% demand for renewables.

20% of 138,525,670 (residential) = 27,705,134 kwh

20% of 192,900,320 (commercial/industrial) = 38,580,064 kwh

Electricity rates estimated at 10% less than 2001 rates due to increased competition. Residential average: \$0.063117/kwh, Commercial/Industrial: \$0.11205/kwh. Green electricity rates estimated to be 2/10 of a cent higher than conventional rates. Residential average: \$0.07574/kwh, Commercial/Industrial: \$0.13446/kwh (Source: MassEnergy).

Implementation costs:

Residential: [27,705,134 kwh at green electricity rates (\$0.07574/kwh) = \$2,098,387] - [27,705,134 kwh at projected NStar electricity rates for 2010 (\$0.063117) = \$1,748,665] = \$349,721.90

Commercial/Industrial: [38,580,064 kwh at green electricity rates (\$0.13446/kwh) = \$5,187,475] - [38,580,064 kwh at projected NStar electricity rates for 2010 (\$0.11205) = \$4,322,896] = \$864,579.20

Municipal

Cities such as Santa Monica have passed ordinances that mandate the purchase of 100% renewable energy to power all city facilities. The Town is not currently considering a 100% purchase of renewable energy. Calculations therefore assume that the Town will opt to purchase 20% of its total electricity needs from green sources in 2010. According to the GHG Inventory, electricity use in Municipal buildings, facilities, operations and streetlights is forecasted to be 15,247,192 kwh at a cost of \$2,184,690. 20% of 15,247,192 = 3,049,438 kwh. The replacement energy source is entered into the CCP software as solar, as there is no entry function for green energy in this version of the software.

Electricity rates in 2010 estimated to be 10% less than 2001 rates due to increased competition. Residential average: \$0.063117/kwh, Commercial/Industrial: \$0.11205/kwh. Green electricity rates estimated to be 2/10 of a cent higher than conventional rates. Residential average: \$0.07574/kwh, Commercial/Industrial: \$0.13446/kwh (Source: MassEnergy).

Implementation costs: [3,049,438 kwh at green electricity rates (\$0.13446/kwh) = \$410,027.40] - [3,049,438 kwh at projected NStar electricity rates for 2010 (\$0.11205) = \$341,689.50] = \$68,337.91

Lobby for Increased Renewable Portfolio Standard Page Number in Local Action Plan: 39

An RPS regulation requires states to derive a percentage of any utilities' total electricity production from renewable sources. An RPS has been established in Massachusetts starting at 1% in 2003 and rising to 4% by 2009; after 2009 the RPS will increase annually by 1%. Therefore, in 2010 the RPS will be 5%. The calculations used to determine the impact of this measure take 5% of the amount of electricity forecast to be used in each sector in 2010 and replace it with solar.

Residential: 138,525,670 kwh, 5% = 6,926,284
Commercial/Industrial: 192,900,320 kwh, 5% = 9,645,016
Total municipal: 15,247,192 kwh, 5% = 762,359.6

Electricity rates in 2010 estimated to be 10% less than 2001 rates due to increased competition. Residential average: \$0.063117/kwh, Commercial/Industrial: \$0.11205/kwh. Green electricity

rates estimated to be \$0.02 higher than conventional rates. Residential average: \$0.07574/kwh, Commercial/Industrial: \$0.13446/kwh (Source: MassEnergy).

Implementation costs:

Residential: [6,926,284 kwh at green electricity rates (\$0.07574) = \$524,596.8] - [6,926,284 kwh at projected NStar electricity rates for 2010 (\$0.063117) = \$437,166.3] = \$87,430.48

Commercial/Industrial: [9,645,016 kwh at green electricity rates (\$0.13446) = \$1,296,869] - [9,645,016 kwh at projected NStar electricity rates for 2010 (\$0.11205) = \$1,080,724] = \$216,144.8

Municipal: [762,359.6 kwh at green electricity rates (\$0.13446) = \$102,506.9] - [762,359.6 kwh at projected NStar electricity rates for 2010 (\$0.11205) = \$85,422.39] = \$17,084.51

A proposed measure would involve lobbying on the part of the Town and community groups for increased RPS standard. The impact of a 10% RPS standard is based on the following calculations.

Residential: 138,525,670 kwh, 10% = 13,852,567
Commercial/Industrial: 192,900,320 kwh, 10% = 19,290,032
Total municipal: 15,247,192 kwh, 10% = 1,524,719.2

Implementation costs:

Residential: [13,852,567 kwh at green electricity rates (\$0.07574) = \$ 1049193] - [13,852,567 kwh at projected NStar electricity rates for 2010 (\$0.063117) = \$ 874,332.5] = \$ 174,861

Commercial/Industrial: [19,290,032 kwh at green electricity rates (\$0.13446) = \$ 2,593,738] - [19,290,032 kwh at projected NStar electricity rates for 2010 (\$0.11205) = \$ 2,161,448] = \$ 432,289.6

Municipal: [1,524,719.2 kwh at green electricity rates (\$0.13446) = \$ 205,013.7] - [1,524,719.2 kwh at projected NStar electricity rates for 2010 (\$0.11205) = \$ 170,844.8] = \$ 34,168.96

Energy Efficient Building Code **Page Number in Local Action Plan: 40**

With this measure the Town could adopt an energy efficient building code, similar to the Berkeley Residential Energy Conservation Ordinance for example. The Green Building Code would apply to new commercial and residential developments in the Town, in addition to substantial additions. The Ordinance would describe the minimum energy efficiency requirement for each component of the home. The City of Fort Collins assumes that their Model Energy Code (1997) reduces 2 ekWh per square foot per year of energy use. The City of Toronto estimated that their ASHRAE 90.1 Code reduces 8 ekwh per square foot per year. For the purpose of these

calculations, it will be assumed that a Green Building Code implemented in Brookline would reduce 3 ekwh/sq.ft./year.

Data from the Metropolitan Area Planning Commission, assisted by the Brookline Planning Department projects the following growth in commercial and residential sectors by 2010:

Additional residential units: 1030

Additional developable land area: 10,904,581 square feet, x 3 ekwh = 32,713,743 ekwh

Additional commercial buildable floor area: 217,703 square feet, x 3 ekwh = 653,109 ekwh

For the purpose of the calculations, it is assumed that the energy savings refer to electricity. Projected electric rates for 2010 from NStar:

Residential: \$0.063117/kwh; 32,713,743 x \$0.063117 = \$2,064,793.

Commercial: \$0.11205/kwh; 653,109 x \$0.11205 = \$73,181.

Implementation cost: \$15,000 staff time to evaluate the measures and draft the ordinances; \$72,000 (\$45,000 salary x 1.6 to account for benefits, administration etc.) for one full time Environmental Coordinator to administer the program (cost accounted for in separate measure).

Sustainable Business Awards Program **Page Number in Local Action Plan: 41**

With this measure, the Town could issue a certification or award to businesses that initiate emissions reduction activities with regard to energy conservation and waste prevention. The following methodology is used to calculate the potential impact of this measure on emissions. The target population is the commercial and industrial sector of the community. Obviously, the implementation of this measure would be quite different for a small business as opposed to a large industrial customer. Perhaps, if the program were successful upon implementation, categories for awards could be created according to the size and scale of operations. The base level of energy usage is taken from the 1995 Inventory on Commercial and Industrial energy use. It is assumed that the project would be started in 2003, but that the goal of 40% of the Town's businesses committing to a 10% reduction in energy usage would not be achieved until 2008. According to information provided by the Assessor's Department, in 1995 there were 487 Commercial properties in the Town and 8 Industrial properties - a total of 495 properties. The energy usage in 1995 for Commercial and Industrial properties was:

171,829,678 kwh electricity

7,771,000 therms natural gas

675,479 gallons oil

Thus, on a average per property basis,

347,130.7 average kwh/property

15,698.99 average therms/property

1,364.604 average gallons/property

Therefore, a 10% reduction in energy use per property would mean a reduction of:

34,713.07 kwh reduction in electricity

1,569.90 therm reduction in natural gas
136.46 gallons reduction in oil
40% of 495 properties = 198 properties

Therefore, the potential energy reductions for 198 Commercial/Industrial properties:

6,873,188 kwh electricity
310,840 therms natural gas
27,019.16 gallons heating oil

Implementation cost: \$72,000 (\$45,000 salary x 1.6 to account for benefits, administration etc.) for Environmental Coordinator to administer the program (cost accounted for in separate measure); \$3,000 for recognition awards/materials.

Residential Use of Solar Electricity

Page Number in Local Action Plan: 42

Greenhouse gas emissions inventory forecast for 2010: 22,260 households will use 138,525,670 kwh electricity/year or 6,223.076/household/year. Measure assumes that by 2010, 10% of households (2,226) will have installed a 2kw photovoltaic system with production capability of approximately 3,600 kwh/year. Follows general rule of 1 kw PV system generates approximately 1,800 kwh (<http://www.solarexpert.com>).

Energy produced by solar: $2,226 \times 3,600 = 8,013,600$ kwh
8,013,600 kwh of electricity that were once produced using fossil fuels are now produced with solar.

Cost of installation on average \$10 to \$12.50 per watt. Therefore installation cost for 2kw photovoltaic system: $\$11.25 \times 2,000 = \$22,500$. Total installation costs for 2,226 households: $\$22,500 \times 2,226 = \$50,085,000$

Commercial Use of Solar Electricity

Page Number in Local Action Plan: 36

Aim for 10% of businesses to install 2 kw PV systems by 2010.

2010 projected electricity use: 192,900,320 kwh for 457 commercial establishments, or 422,101.4 kwh/establishment.

10% of 457 establishments is 45.7 establishments, using $45.7 \times 422,101.4 = 19,290,034$ kwh. Assume that a 2 kw PV system generates 3,600 kwh of electricity/year (follows general rule of 1 kw PV system generates approximately 1,800 kwh (<http://www.solarexpert.com>), $45.7 \times 3,600 = 164,520$ kwh.

Cost of installation on average \$10 to \$12.50 per watt. Therefore installation cost for 2kw photovoltaic system: $\$11.25 \times 2,000 = \$22,500$. Total installation costs for 45.7 households: $\$22,500 \times 45.7 = \$1,028,250$

Residential Use of Solar Hot Water Heating
Page Number in Local Action Plan: 43

In Massachusetts, solar water heating systems can cut the average family's water heating electricity use by 40-60%. Water heating accounts for about 14% of the average family's home energy consumption. Methodology used to calculate this measure assumes electric hot water heating system.

2010 residential energy use forecasted at 138,525,670 kwh for 22,260 households or 6,223.076/household/year. 14% of 6,223.076 kwh = 871.2306 kwh used to heat hot water. Measure assumes that by 2010, 10% of residences replace electric hot water heating system with solar. 10% of residences = 2,226

Before solar, using $2,226 \times 871.2306 = 1,939,359$ kwh to heat water.

After solar, 50% of this generated by solar: $2,226 \times 435.6153 = 969,679.7$ kwh

Solar hot water systems generally cost from \$4,000 to \$6,000 but vary depending on size and difficulty of installation. Installation cost for 2,226 solar hot water heating systems: $\$5,000 \times 2,226 = \$11,130,000$

Residential Energy Efficiency Program
Page Number in Local Action Plan: 44

This measure seeks to achieve a 5% reduction in home energy consumption with the implementation of a residential energy conservation program. To calculate the impact of this measure on emissions, the following methodology was used.

From 2010 GHG Inventory residential energy forecast:

Electricity: 138,525,670 kwh

Gas: 12,655,000 therms

Oil: 10,539,350 gallons

5% reduction in energy use would be:

Electricity: 6,926,284 kwh

Gas: 632,750 therms

Oil: 526,967.5 gallons

These figures were entered into the CCP Software as Potential Energy Reductions.

Implementation cost estimated as \$5,000 for educational materials and coordination of workshops. \$72,000 (\$45,000 salary x 1.6 to account for benefits, administration etc.) for one full-time Environmental Coordinator to administer program (cost accounted for in Environmental Coordinator Measure).

Waste Measures

Existing Community Waste Measures

Home Composting Program

Page Number in Local Action Plan: 46

Since 1997 the Department of Parks and Open Space has been selling compost bins to residents at a reduced rate with the assistance of a DEP grant. Since 1997, residents have purchased approximately 600 of the 3 x 3 ft bins.

Unless referenced otherwise, statistics used in the following calculations come from the State of Massachusetts Residential Organic Waste Management Study:

(<http://www.state.ma.us/dep/recycle/files/repfinal.doc>).

~~///~~ Compost rate of multi-family homes in Massachusetts is 50% less than that of single family homes.

~~///~~ Diversion of leaves: single family 46.73% diverted, multi-family 23.37% diverted

~~///~~ Diversion of grass: single family 62.05% diverted, multi-family 31.03% diverted

~~///~~ Diversion of brush/trimmings: single family 31.96% diverted, multi-family 15.98% diverted.

~~///~~ 25% of MA residents compost 54.7% of their food waste

Therefore,

Average diversion of yard waste for Mass residents who compost:

Single-family: $(46.73\% \text{ leaves} + 62.05\% \text{ grass} + 31.96\% \text{ brush/trimmings})/3 = 46.91\%$

Multi-family: $(23.37\% \text{ leaves} + 31.03\% \text{ grass} + 15.98\% \text{ brush/trimmings})/3 = 23.46\%$

Average diversion of food waste for Mass residents who compost:

Single family: 54.7%

Multi-family: 27.35%

Calculations assume that residents who purchased compost bins are composting yard and food waste according to estimates outlined above.

Brookline has 26,413 housing units (Census 2000). The Recycling Coordinator, Kristin Pelak estimates that the majority of sales have been to single family homes. Calculations are therefore based on the assumption that 75% of the bins (450) have been purchased by single-family homes and 25% (150) by multi-family homes.

Typical MA dwelling produces 0.55 tons of yard waste/year.

Typical MA resident produces 0.63 pounds of food waste per day, 229.95 pounds per year, or 0.104 tons. Each Brookline dwelling has average of 2.16 residents (2000 population 57,107/26,413 households), each producing approximately $(2.16 \times 0.63) = 0.22464$ tons of food waste/year.

Therefore,

Single-family homes:

57.4% (single family compost rate for food waste) of 0.22464 tons (food waste per housing unit) = 0.128943 tons x 450 (bins purchased) = 58.02435 tons of diverted food waste.

46.91% (single family compost rate for yard waste) of 0.55 tons (yard waste per housing unit) = 0.258005 x 450 bins = 116.1023 tons of diverted yard waste

Multi-family homes:

27.35% (multi-family compost rate for food waste) of 0.22464 tons (food waste per housing unit) = 0.061439 tons x 150 (bins purchased) = 9.21585 tons of diverted food waste.

23.46% (multi-family compost rate for yard waste) of 0.55 tons (yard waste per housing unit) = 0.12903 x 150 = 19.3545 tons of diverted yard waste

Total waste composted in Brookline:

Yard waste: 116.1023 + 19.3545 = 135.4568 tons

Food waste: 58.02435 + 9.21585 = 67.2402 tons

TOTAL: 202.697 tons

Estimated implementation cost to Town: Town sells compost bins to residents at rate of \$20/bin. Town purchases bins at the rate of \$25/bin with the assistance of a DEP grant (bins usually \$80). Therefore, cost to Town is \$5/bin, for 600 bins = \$3,000. Fee/ton for waste hauling \$72.00. Money saved: 203 x 72.00 = \$14,616.

Follow-Up Measure: Continue to Sell 150 bins/year until 2010

Selling additional 150 bins per year (112.5 to single family, 37.5 to multi family) for eight years would result in an additional 900 bins at the single family level (for a total of 1,350 single-family bins) and an additional 300 at the multi-family level (for a total of 450 multi-family bins).

Therefore, single-family homes:

57.4% (single family compost rate for food waste) of 0.22464 tons (food waste per housing unit) = 0.128943 tons x 1,350 (bins purchased) = 174.0731 tons of diverted food waste.

46.91% (single family compost rate for yard waste) of 0.55 tons (yard waste per housing unit) = 0.258005 x 1350 bins = 348.3068 tons of diverted yard waste

Multi-family homes:

27.35% (multi-family compost rate for food waste) of 0.22464 tons (food waste per housing unit) = 0.061439 tons x 450 (bins purchased) = 27.64755 tons of diverted food waste.

23.46% (multi-family compost rate for yard waste) of 0.55 tons (yard waste per housing unit) = 0.12903 x 450 = 58.0635 tons of yard waste

Total waste composted in Brookline:

Yard waste: 174.0731 + 348.3068 = 522.3799 tons

Food waste: 27.64755 + 58.0635 = 85.71105 tons

TOTAL: 608.091 tons

Estimated implementation cost to Town: Town sells compost bins to residents at rate of \$20/bin and purchases bins at the rate of \$25/bin with the assistance of a DEP grant (bins usually \$80). Therefore, cost to Town is \$5/bin, for additional 1,200 bins = \$6,000. Fee/ton for waste hauling \$68.74 in 2001 (Municipal Recycling Data Sheet for Brookline 2001). Estimated fee/ton for waste hauling in 2010 \$83.52/ton (reflects 2% increase/year as stipulated in contract). Money saved: $608 \times \$83.52 = \$50,780.16$.

Curbside Recycling Program

Methodology used to calculate implementation cost of recycling program: (tonnage x recycling fee).

Methodology used to calculate cost savings of recycling program - The difference between what it costs the Town to recycle and what it costs the Town to dispose of recyclables as solid waste: (Tonnage x recycling fee) - (Tonnage x waste hauling fee).

Yard Waste

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In 2000 approximately 5,227.07 tons of yard waste was collected by the curbside recycling program (Source: Conservation). Recycling costs: \$14.00/ton. Solid waste hauling \$72.00/ton (Source: Peter Ditto).

Implementation cost: [Tonnage (5,227.07) x recycling collection cost (\$14.00/ton) = \$73,178.90]

Cost savings: [Tonnage (5,227.07) x recycling collection cost (\$14.00/ton) = \$73,178.90]

- [Tonnage (5,227.07) x waste hauling fee (\$72.00/ton) = \$376,349] = \$-303,170.

Follow-Up Measure

Recycling costs in 2010: \$16.24/ton. Solid waste hauling \$83.52/ton. (Costs reflect 2% increase/year as stipulated in contract). Increasing the recycling rate for yard waste by 10% by 2010 would result in an additional diversion of 523 tons.

Implementation cost: Tonnage (5,750.07) x recycling collection cost (\$16.24/ton) = \$93,381.14

Cost savings from yard waste measure: [Tonnage (5,750.07) x recycling collection cost (\$16.24/ton) = \$93,381.14] - [Tonnage (5,750.07) x waste hauling fee (\$83.52/ton) = \$450,245.80] = \$-386,865

Mixed Paper

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In 2001, 3,866.25 tons of mixed paper was diverted from the waste stream (Source: Conservation). This figure includes paper that was collected from Town Hall and the Schools. Recycling costs: \$94.50/ton. Solid waste hauling \$72.00/ton (Source: Peter Ditto).

Implementation cost: Tonnage (3,886.25) x recycling collection cost (\$94.50/ton) = \$367,250.60

Cost savings: [Tonnage (3,886.25) x recycling collection cost (\$94.50/ton) = \$367,250.60] - [Tonnage (3,866.25) x waste hauling fee (72.00) = \$278,370] = \$88,880.60

Follow-Up Measure

Recycling costs in 2010: \$109.62/ton. Solid waste hauling \$83.52/ton. (Costs reflect 2% increase/year as stipulated in contract). Increasing the recycling rate for mixed paper by 10% by 2010 would result in an additional diversion of 387 tons.

Implementation cost: Tonnage (4,253.25) x recycling collection cost (\$109.62/ton) = \$466,241.30

Cost savings: [Tonnage (4,253.25) x recycling collection cost (\$109.62/ton) = \$466,241.30] - [Tonnage (4,253.25) x waste hauling fee (83.52) = \$355,231.40] = \$111,009.80

Comingled Containers

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In 2000, 885.78 tons of comingled containers were diverted from the waste stream (Source: Conservation). Recycling costs: \$94.50/ton. Solid waste hauling \$72.00/ton (Source: Peter Ditto).

Implementation cost: Tonnage (885.78) x recycling collection cost (\$94.50/ton) = \$83,706.21

Cost savings: [Tonnage (885.78) x recycling collection cost (\$94.50/ton) = \$83,706.21] - [Tonnage (885.78) x waste hauling fee (72.00) = \$63,776.16] = \$19,930.05

Follow-Up Measure

Recycling costs in 2010: \$109.62/ton. Solid waste hauling \$83.52/ton. (Costs reflect 2% increase/year as stipulated in contract). Increasing the recycling rate for comingled containers by 10% by 2010 would result in an additional diversion of 89 tons.

Implementation cost: Tonnage (974.78) x recycling collection cost (\$109.62/ton) = \$106,855.40

Cost savings: [Tonnage (974.78) x recycling collection cost (\$109.62/ton) = \$106,855.40] - [Tonnage (974.78) x waste hauling fee (83.52) = \$81,413.63] = \$25,441.77

Scrap Metal

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In 2000, 670.87 tons of scrap metal was diverted from the waste stream (Source: Conservation). As there is no category for scrap metal in the software, the data was entered as 'steel cans'. Recycling costs: \$94.50/ton. Solid waste hauling \$72.00/ton (Source: Peter Ditto).

Implementation cost: Tonnage (670.87) x recycling collection cost (\$94.50/ton) = \$63,397.22

Cost savings: [Tonnage (670.87) x recycling collection cost (\$94.50/ton) = \$63,397.22] - [Tonnage (670.87) x waste hauling fee (72.00) = \$48,302.64] = \$15,094.58

Follow-Up Measure

Recycling costs in 2010: \$109.62/ton. Solid waste hauling \$83.52/ton. (Costs reflect 2% increase/year as stipulated in contract). Increasing the recycling rate for scrap metal by 10% by 2010 would result in an additional diversion of 67.10 tons.

Implementation cost: Tonnage (737.97) x recycling collection cost (\$109.62/ton) = \$80,896.27

Cost savings: [Tonnage (737.97) x recycling collection cost (\$109.62/ton) = \$80,896.27] - [Tonnage (737.97) x waste hauling fee (83.52) = \$61,635.25] = \$19,261.02

Total implementation cost for existing recycling: \$587,533.01

Total cost savings for existing recycling: \$179,264.77

Total implementation cost for follow-up recycling: \$747,374.02

Total cost savings for follow-up recycling: \$231,152.41

New Community Waste Measures

Bylaw Requiring Mandatory Private Recycling Service

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According to 2002 Municipal Recycling Data Sheet, the number of households served by municipal refuse and recycling program is 12,964, and the number of households served by private haulers is 10,536.

The following amounts were collected from the 12,964 households on the Town collection route (2000):

Yard waste: 5,227.07 tons, = (5,227.07/12,964) 0.403199 tons/household

General mixed paper: 3,866.25 tons, = (3,866.25/12,964) 0.29823 tons/household

Comingled containers: 885.78 tons, = (885.78/12,964) 0.068326 tons/household

Scrap metal: 670.87 tons, = (670.87/12,964) 0.051749 tons/household

Thus, there is the potential for 10,536 households to recycle the following amounts:

Yard waste: (0.403199 x 10,536) = 4,248.105 tons. Implementation cost: [94.50 x 4,248.105 = \$401,445.90] - [72.00 x 4,248.105 = \$305,863.60] = \$95,582.36

General mixed paper: (0.29823 x 10,536) = 3,142.151 tons. Implementation cost: [94.50 x 3,142.151 = \$296,933.30] - [72.00 x 3,142.151 = \$226,234.90] = \$70,698.40

Comingled containers: (0.068326 x 10,536) = 719.8827 tons. Implementation cost: [94.50 x 719.8827 = \$68,028.92] - [72.00 x 719.8827 = \$51,831.55] = \$16,197.36

Scrap metal: (0.051749 x 10,536) = 545.2275 tons. Implementation cost: [94.50 x 545.2275 = \$51,524] - [72.00 x 545.2275 = \$39,256.38] = \$12,267.62

Implementation cost entered into the software is the [tonnage x recycling fee] - [tonnage x the solid waste hauling fee]. The recycling collection cost is \$94.50/ton. Solid waste hauling fee is \$72.00/ton. (Source: 2001 Municipal Recycling Data Sheet/Schofield, Inc.)

Other Measures

Street Tree Planting

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The Town of Brookline currently has 11,794 street trees. Tom Brady, Conservation Administrator, estimates that 40 new trees are planted each year. In 2010, the Town should have approximately 12,154 street trees. According to the Global Releaf program of American Forests (http://www.americanforests.org/clmt_chg/trees/html), a street tree is responsible for the annual sequestration of approximately 699.97 pounds of CO₂. Therefore, in 2010, 12,154 trees will eliminate $12,154 \times 699.97 = 8,507,435$ pounds or 3,858.97 tons of CO₂.

The Conservation Administrator estimates that the Town spends approximately \$385,000 on the street tree program annually (includes new trees and tree maintenance). This means a cost of approximately \$31.67/tree.