Town of Belmont

Climate Action Plan

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Sustainable Belmont
A task force of the Belmont Vision 21 Implementation Committee
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Sustainable Belmont is a task force of the Town of Belmont's Vision 21 Committee focusing on implementing one aspect of the Town's vision: "We will be an environmentally responsible community."

Toward that end, Sustainable Belmont has worked with Belmont's government, residents, and businesses in preparing the draft of Belmont's Climate Action Plan on behalf of the Town of Belmont.

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We also note that, with so many people helping at various stages, we may well have unintentionally omitted some names. If so, please accept our apologies.

On behalf of Sustainable Belmont,

Jan Kruse, Chair
John McAlpin, Vice Chair
Jack Dennis, Editor

Executive Summary

A Climate Action Plan (CAP) is a way to combat changes in the environment threatened by the continued release into the atmosphere of climate changing gases derived from the burning of fossil fuels. Scientists suggest that humanity still has the opportunity to mitigate at least the worst potential effects of climate change through aggressive reduction of carbon dioxide (CO_2) emissions. Predictions about climate change are becoming increasingly dire and the time is now for fundamental and meaningful action. The vast majority of climate scientists assert that CO_2 emissions must be reduced at least 80 percent by 2050 to make a significant difference. We believe Belmont should adopt this goal, based on the community's 2007 emissions.

Beyond the issues and challenges climate change presents, there are other important reasons for switching to a more carbon-neutral lifestyle by reducing dependence on fossil fuels. Perhaps most important: our economy and way of life is threatened by the potential disruption of oil supplies from unreliable sources in nations that are politically unstable and/or openly hostile to the United States. Other compelling reasons include financial savings, limiting waste, reducing pollution, stimulating local economies, improving health, making cities and towns more livable, and engaging citizens in a common cause to build a more cohesive community.

The Climate Action Plan (CAP)

Climate Action Plans to reduce greenhouse gas emissions have been adopted by towns and cities, large and small, around the world. The key elements of a CAP include the completion of a greenhouse gas inventory for the community and assignment of emissions-reduction targets relative to the established baseline. A plan of action is designed and policies are established to address reduction targets. As implementation of CAP recommendations proceeds, assessment of the effectiveness of actions taken is ongoing.

A Unique Challenge

The looming threat of climate change will require the Town and its residents to engage in long-range planning supporting the best interests of the community. The implementation of a CAP presents a unique challenge—one, however, that the community of Belmont appears poised to accept.The November 2008 election included the ballot question 4:

> *"Should the representative from this district be instructed to vote for legislation that reduces greenhouse gas emissions in Massachusetts by 80% by 2020, and change the tax code to favor renewable energy, conservation, and sustainable agriculture?"*

While the vote was nonbinding, 85% of the more than 13,700 people in our legislative district who chose to participate on election day voted on Question 4. Nearly 82% of those individuals voted yes in support of reducing greenhouse gas emissions (in Belmont, 70% voted yes in support, 15% voted against, and 15% did not vote on the question). The ten other legislative districts where Question 4 appeared on the ballot enjoyed similar landslides, ranging from 72% to 89% yes votes.

A 2007 Energy Conservation Study, conducted for the Belmont Municipal Light Department, included 400 interviews with BMLD customers. A full 98% of those surveyed reported conservation of electricity and energy efficiency as "very important" or "somewhat important." When asked if there are things that could be done in their own household to use energy more efficiently, 87.5% agreed "very strongly" or "somewhat strongly." Finally, 62% of those interviewed reported that they would either "strongly support" or "somewhat support" a decision by the BMLD to build wind power structures that could be as tall as 300–400 feet in height.

It is not known with certainty what the best course of action will ultimately be. However, looking forward and choosing imaginative preparedness over inaction is critical. Belmont will require unprecedented leadership and public commitment over the next four decades to meet the goal of an 80 percent reduction in carbon emissions by 2050. Belmont needs to take the first steps now to move toward the goal. Belmont must be focused and aggressive about implementing the strategies that are available today. Belmont must be open to innovation and new opportunities as they

evolve in the future. We must have faith and optimism that reaching the goal is possible.

Greenhouse Gas Inventory—Establishing a Baseline

A greenhouse gas inventory is a compilation of measures of emissions of greenhouse gases, primarily carbon dioxide, that result from activities in a city or town. Carbon dioxide emissions arise primarily from the burning of fossil fuels—natural gas, oil, and coal—to provide electrical energy, to heat buildings, and to drive transport vehicles. This report provides a comprehensive baseline for Belmont.

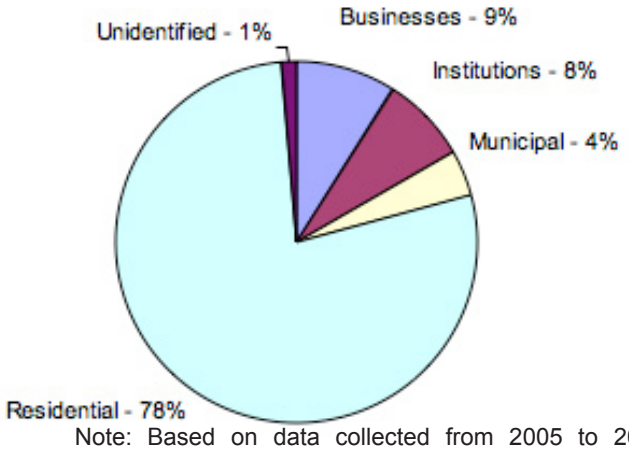
Almost all of Belmont's carbon dioxide emissions result from the combustion of fossil fuels. Use of each kind of fuel releases carbon dioxide in exact proportion to the amount of fuel used. The conversions from quantities of energy used, to quantities of carbon dioxide produced include estimates of the "upstream" carbon dioxide emissions resulting from production and delivery of the fuel to its point of use.

For the inventory of Belmont emissions, the baseline year was chosen to be 2007, the year for which the most extensive and complete data could be assembled. It proved convenient to gather data for four categories of energy users: residential households, businesses, institutions (houses of worship, private schools, clubs, and hospitals), and municipal departments, including the public schools. Some of these data were easy to obtain, especially those for electricity consumption from the Belmont Municipal Light Department.

Reliable data on gas and fuel oil use, petroleum products consumed for transportation, and quantities of waste were more difficult to gather. Methodologies utilized in the data gathering process and in calculating carbon emissions are explained in the full CAP report. To fill the gap in data from public records, Sustainable Belmont conducted two Methodologies utilized in the data gathering process and in calculating carbon emissions are explained in the full CAP report. To fill the gap in data from public records, Sustainable Belmont conducted two surveys. Town employees were surveyed to obtain data about their commuting habits. Also, a sample of managers of town businesses and institutions was interviewed for information about energy use in their operations and their employee's commuting, and quantities and means of disposal for waste materials generated.

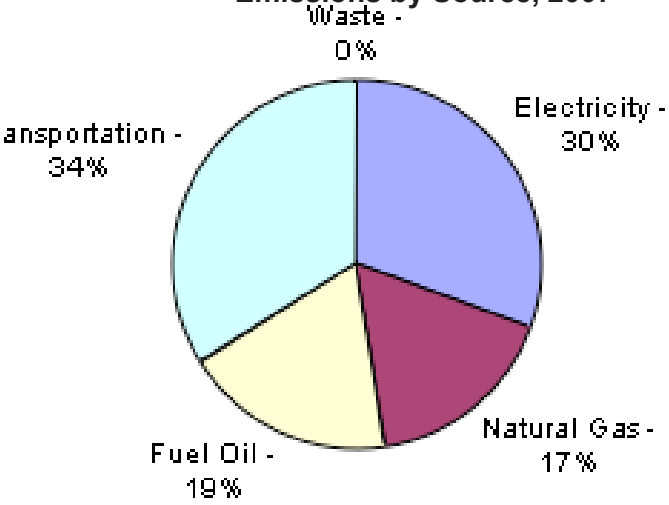
Two pie charts summarize the data collected. Figure ES-1 shows the percentage of carbon emissions contributed by each sector of use: residential, business, institutional and municipal. The values shown include emissions from vehicle use associated with each sector. Figure ES-2 shows the percentage of carbon emissions from each source: electricity, natural gas, fuel oil, transportation, and waste. All fuels used to power transport vehicles, except for trucks that transport waste, are included in "transportation." Figure ES-3 shows carbon dioxide emissions in tons by sector and source.

Figure ES-1. Belmont Carbon Dioxide Emissions by Sector, 2007



Note: Based on data collected from 2005 to 2007. Percentages have been rounded.

Figure ES-2. Belmont Carbon Dioxide Emissions by Source, 2007

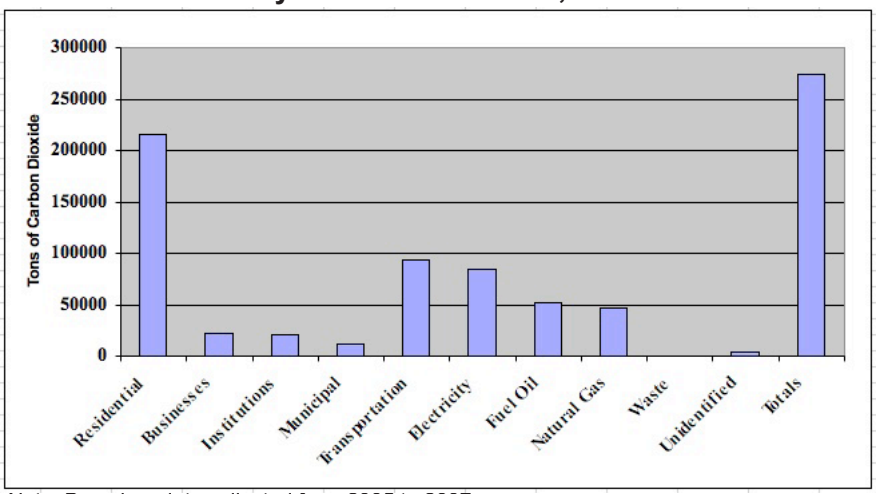


Note: Based on data collected from 2005 to 2007. Percentages have been rounded.

Key Recommendations

The Belmont greenhouse gas inventory shows where work needs to be done to reduce carbon emissions. The three principles stated below can be applied in all sectors of energy use in town, and lead to the recommen-dations summarized below for each of the four major sectors of energy use. The overarching goal is to reduce total carbon emissions by 80 percent by 2050, a goal that can be accomplished by achieving an average annual reduction of four percent in each sector. The recommen-dations give actions that will take us toward the goal.

Figure ES-3. Belmont CO_2 Emissions by Sector and Source, 2007



Note: Based on data collected from 2005 to 2007

Principles: Ways to Reduce Carbon Emissions

The first reductions of carbon dioxide will be realized across all sectors largely through energy conservation and improvements in energy efficiency.

Energy Conservation: Conservation means using less fossil fuels and by doing so producing less carbondioxide. Conservation often requires no additional costs to imple-ment and it has immediate financial benefits but it often requires a change in behavior.

Improved Energy Efficiency: Additional reductions of carbon dioxide can be made through improved efficiency. Improving efficiency has a price tag, but the costs can often be offset over time by savings in amounts of fuel used. Initial higher upfront costs may also be offset by rebates offered by the Belmont Municipal Light Department (BMLD) and other utilities for certain appliances.

Alternative Energy: In 2008, the BMLD began to offer its customers the option to purchase Renewable Energy Certificates (RECs), a program that promotes renewable energy alternatives that do not produce carbon dioxide, thus expanding carbon dioxide reduction opportunities available in town and for its residents and businesses. The BMLD is committed to bringing more electricity from renewable sources to the community as it becomes available. Over time, new technologies and growth in the renewable sector should provide additional opportunities for Belmont to reduce the carbon footprint in the areas of transportation as well as heating and cooling.

Energy conservation, improved efficiency, and the purchase of RECs are strategies available to all sectors of the community today.

Table ES-1. 2007 CO_2 Emitted by Sector and by Source in the Town of Belmont.

Belmont CO_2 By Sector, 2007				**Belmont CO_2 By Source, 2007**		
	Tons	**Percent**			**Tons**	**Percent**
Residential	215,023	78%		Transportation	93,998	34%
Business	24,561	9%		Electricity	84,443	30%
Institutions	21,412	8%		Fuel Oil	51,387	19%
Municipal	11,990	4%		Natural Gas	47,183	17%
Unidentified	4,050	1%		Waste	134	0%
Total	**277,036**	**100%**		**Total**	**277,036**	**100%**

** Unidentified is estimated to be attributed to combined natural gas usage of one industrial user and one institutional user for which National Grid did not supply numbers.*

Transportation

Transportation is responsible for 34 percent of total carbon dioxide emissions. Reduction of emissions from transportation can be accomplished in a variety of ways and across all users—municipal, residential, commercial and institutional—through both behavioral changes and purchasing commitments. Creating a community culture that favors walking and bicycling over driving, when practical, could have a positive effect and help to ease traffic congestion. Neighborhood-by-neighborhood programming to encourage children to walk to school has been effective in many other communities. Car pooling and improved ridership on public transportation are also possible and could have a significant impact on carbon emissions. As Belmont is fortunate to have both commuter rail and bus service within walking distance of many homes, businesses and government offices, individuals should make better use of this service, especially for work commuters. Expanded use of bicycles and road and bicycle path improvements that facilitate their use should also be encouraged. At a given time, many residents may not be able to afford the price of a new hybrid or fuel-efficient automobile. But as they replace their vehicles, their purchasing decisions could become powerful statements of their commitment to lower their carbon dioxide emissions.

Key Recommendations by Sector

In keeping with the format of the overall CAP draft report, this executive summary offers a list of key recommendations by sector.

Residential Sector

The residential sector produces nearly 80% of the total carbon dioxide the town emits. This sector offers both the greatest opportunities for and the greatest challenges to change. Inspiring individuals to do their part empowers a community to work collaboratively toward the common goal.

Electricity: Lowering residential electricity use and the associated carbon dioxide emissions can be accomplished in a variety of ways. Initial reductions can result from changes in behavior. While behavior changes may seem to be the easiest and least expensive approaches to employ, they are also the most difficult to commit to and sustain. Becoming more mindful of shutting off lights and appliances when not in use or reducing the loss of "phantom" energy by installing devices with standby modes are important but will not reach the necessary reduction levels.Therefore, we also recommend purchasing energy efficient appliances such as air conditioners, refrigerators, freezers, dehumidifiers, and clothes dryers and, as a first step, the installation of compact fluorescent lights. Solar panels could be utilized on many houses to produce a portion of electricity needs. Exploiting the principles of passive solar heating and shade cooling would reduce electricity required to operate heaters and air conditioners. Finally, purchase of Renewable Energy Certificates is a viable way to help grow the renewable energy sector and to offset the carbon produced from non-renewable sources.

Home Heating—Fuel Oil and Natural Gas: Residents could benefit financially by taking advantage of increased energy efficiency obtainable from programmable thermostats, improved insulation, replacement of old windows, purchase of a high-efficiency furnace, and other home improvements. These investments also reduce carbon dioxide production. Participation in the free home energy audit program offered by the BMLD can produce an analysis that predicts the payback period of actions contemplated, allowing homeowners to pursue an improvement or renovation with confidence. Educating residents about the pros and cons of installing a geothermal system or solar collectors to produce hot water may also prove useful to consumers. Finally, the community needs to be informed about the advantages of passive solar heating and cooling, and their likely impact on household energy consumption and expenses.

Waste: The waste sector is challenging to evaluate from a carbon production standpoint. What is certain is less waste means less carbon emissions. Perhaps the most effective ways to deal with this sector is to encourage purchases that involve less waste to throw away, and recycling a higher percentage of the waste that is put out for collection. Both of these actions improve energy and carbon savings. For example, reprocessing recycled aluminum uses 1/20th the energy required to produce a comparable product from ore. Yard waste should be composted on site, when feasible, thereby lessening the need to bag it and transport it elsewhere. Transfer to others of still useful materials such as clothes and household goods and materials could be encouraged through the "Freecycle" program established in the town (see www.freecycle.org). Overall, less waste left along

the curbside and increased recycling would reduce the costs to the community of trash pickup. In 2008, the Solid Waste and Recycling Advisory Committee found that if Belmont increased its recycling rate from its current 40% of recyclable material to 58% (which is the recycling rate of Lexington), it would cut the Town's disposal fee by about $190,000 per year.

Food's Role in Greenhouse Gas Emissions: Belmontians' food choices have a direct bearing on carbon footprint. The burning of fossil fuels during food production as well as transport of that food and the greenhouse gas emissions associated with livestock farming and animal waste contribute to climate change. A 2006 report from the United Nations found that worldwide the production of animal products for food consumption ultimately accounts for 18 percent of greenhouse gas emissions. The National Sustainable Agriculture Information Service (funded by the U.S. Department of Agriculture) recommends several actions that individuals can take, including eating less meat, buying locally grown foods, planting a garden, and eating foods that are minimally packaged and processed and "in season."

Businesses and Institutional Sector

Sustainable Belmont's analyses of the potential for CO_2 emissions reductions in the commercial and institutional sector are based, in part, on a survey conducted of local businesses and non-profits, such as houses of worship, private schools, and private clubs. It is recommended that the business and institutional communities collaborate to solve common challenges, such as disposal of wastes and collection of recyclable material. Cooperation may reveal opportunities to improve upon efforts directed toward energy conservation and energy efficiency. All businesses and institutions should be encouraged to commission energy audits a portion of which may be subsidized by the BMLD. Large institutions with multiple buildings could consider developing an ESCo-type project to reduce energy use. Some businesses, particularly those who rent from the same landlord, are encouraged to work collaboratively to bring energy-saving improvements to their sites.

Municipal Sector

While the municipal sector's contribution of carbon emissions is small compared to other sectors in the community, the Town has a unique role to play in the ultimate success of the Climate Action Plan. The recommendations in the CAP relating to the municipal sector reflect our view of the leadership potential of the Town Government in the effort to reduce carbon emissions and to inspire the changes required of others in the community.

The CAP recommends that an Energy Manager position be created to oversee, monitor, and report on the municipality's efforts at reducing the carbon footprint of the entire community. The Energy Manager would work with a newly created town committee toward implementation of appropriate carbon reduction actions across all sectors. An initial focus could be energy audits of town buildings and analyses of other Town practices, aimed at maximizing conservation and energy efficiency efforts in buildings not already analyzed in the ESCo project. The engagement of town employees in the effort to save energy and reduce carbon emissions will be required. The Energy Manager and the new committee will also need to promote the use of geothermal and solar options by residents and businesses, encourage smart site and growth planning near public transportation, and otherwise help to promote a variety of education, outreach, and advocacy programs to build participation and collaboration across the community.

Key Recommendations: The Belmont Municipal Light Department (BMLD)

A significant opportunity exists to provide energy conservation incentives to customers of the BMLD through electricity rate restructuring. Charging higher rates for residential customers who consume larger amounts of electric energy would send a powerful signal to consumers to use energy wisely and conserve. The BMLD is also encouraged to take strong measures to educate and inform the public about peak usage and its overall impact on the electric rates. Metering that sets higher rates during periods of peak demand would discourage inefficient use of the distribution network. Implementing net metering would encourage customers who might install alternative energy systems. Implementation of a reverse 911 system would be the most efficient means of alerting the public to a peak event.

As renewable alternatives become more available, a commitment from the BMLD to increase the amount of green energy in its portfolio should be expected. Until such time, active promotion of the purchase of Renewable Energy Certificates is strongly encouraged and expansion of the BMLD's education and outreach efforts on this issue and others is recommended. Finally, improvement and expansion of the energy

audits offered to residents and businesses should be undertaken. It is probable that more detailed cost and payback analyses of suggested efficiency options and of the sequencing of actions to be taken by consumers would increase the latter's confidence in the likely effectiveness of the recommendations. It is hoped that the BMLD will continue to work with the general government and schools to find additional ways of reducing energy use. The recent effort to lower the Town's electric bill by installing more efficient street lights is a good start.

Key Recommendations: Town Policy

The Town not only has a unique role to play in the promotion of the recommendations of the CAP but it also has built-in opportunities for town-wide change not available to other sectors. Crafting and adopting new town policies that make explicit Belmont's commitment to improved energy efficiency, energy conservation, and use of alternative technologies present significant opportunities to the Town. Such policies can be implemented through by-laws, mandates, new standards, and regulations. Town-wide planning, including development of a new Comprehensive Master Plan, can address community challenges that impact our shared emissions. New building design standards, both for municipal and private construction that are codified and adopted, are an appropriate and necessary step, following the adoption of the Sustainable Building Design Policy statement (the Select Board, March 5, 2007).

It is recommended that the Town use incentives wisely to encourage increased commercial and residential sustainable development and the development of new energy facilities in our town. Pursuing purchasing practices that favor green/sustainable options whenever possible, including the negotiation of future contracts, has significant potential for reducing carbon dioxide emissions, particularly if enhanced through strategic alliances with other communities or institutions. The Town can pursue creative approaches to conducting town business and provide services that reduce energy use and therefore carbon emissions. Following up on financing options, like those utilized to underwrite the ESCo project, and applying for grants to develop and implement sustainable policies, are also recommended. The Town should also carefully evaluate the possibility of applying to become a Green Community in order to qualify for grants under the Green Communities Act legislation passed in 2008.

The Municipal Sector Must Take the Lead!

Many of the recommendations in the CAP to reduce carbon dioxide are applicable across the municipal, commercial, institutional, and residential sectors. Nevertheless, the municipal sector must take the primary leadership position on this initiative and model the changes sought in other sectors. The Town has a great opportunity to set the tone for the community and unique roles to play in facilitating change and conducting education, outreach, and advocacy. It can also monitor carbon dioxide reduction and keep abreast of new technological innovations and other opportunities for change.

Sustainable Belmont hopes to play a continuing role in community education, outreach, and advocacy efforts in support of the CAP. It is important, as well, that the Town itself provide support and resources to maximize the effectiveness of these activities in order to reach the goal four decades in the future.

Getting Started

Should the Selectmen and Town Meeting approve a resolution supporting the goals of this Climate Action Plan, it is recommended that an Energy Committee be appointed that would include representatives of the major stakeholder groups in town, and that the initial effort be a combination of energy conservation and improved efficiency initiatives that could be implemented immediately. Initial success in the municipal sector will likely inspire others in the community to action and help reduce the Town's energy costs and provide relief to the Town budget.

Creating new social norms that support change is a major challenge that will take years to cultivate. Yet even modest changes can produce the targeted four percent average annual reduction in the near term.

Reaching the ultimate goal of an 80 percent reduction of carbon dioxide by 2050 is not a challenge that requires the community to have all the solutions today. Belmont simply needs to commit to the challenge and get started. New and additional strategies to meet the goal will present themselves over time.

Sustaining the vision, the leadership, and the will to change may be the greatest challenge of all. Success cannot be guaranteed, but let it be written in history that Belmont was a community that summoned the courage to try.

Belmont Climate Action Plan

Recommendations Summary

Below is the list of recommendations included in the Belmont Climate Action Plan (under Part III, "Recommendations"). Following each recommendation is the page number from the full report where you can find additional information.

Residents

1. Reduce residential heat loss. (43)
2. Increase heating system efficiency. (44)
3. Use heating/cooling only where and when it is needed. (45)
4. Use energy-efficient appliances and lighting. (45)
5. Employ alternative energy sources where feasible. (47)

Transportation

1. Practice conservation and energy-efficiency in choice and use of personal vehicles. (51)
2. Walk or bicycle whenever feasible. (51)
3. Reduce use of private automobiles (51)
4. Eliminate use of private automobiles. Households should consider using ZipCar. (51)
5. Use shared transporta-tion: car pools, vans and public transit. (51)
6. Consider CO_2 emissions in planning personal travel. (51)
7. Consider production and transportation CO_2 emissions in food purchases. (52)

Businesses and Institutions

1. Get an energy audit of the building(s). (55**)**
2. Take advantage of as many no-cost energy-savings practices as possible. (56)
3. Emphasizing conservation and improved efficiency, take all reasonable and appropriate steps to reduce energy use. (56)
4. Educate employees about energy-saving behaviors at work. (56)
5. Select and operate business vehicles and equipment for conservation and efficiency. (56)
6. Encourage energy-conscious commuting choices for employees. (56)
7. Offer flexible hours and encourage telecommuting. (57)
8. Comply with the state's anti-idling law and encourage others to do so as well. (57)
9. Consider adopting a policy that all bids and contracts will include language that requires or encourages vendors to adopt sustainable, energy saving practices. (57)
10. Opportunities for Collaboration (57)
11. Organize a trash-collection and recycling program for businesses and institutions in Belmont, either through the Town or as a separate organizational entity. (57)
12. Provide incentives to landlords to take energy-saving measures. (57)
13. Organize informational meetings and workshops for businesses in Belmont to share the results of the business survey, discuss options, and learn more about ways to increase energy conservation and efficiency. (57)
14. Purchase local foods; compost appropriate organic waste where feasible. (58)
15. For multi-building complexes, consider an ESCo-type program in lieu of a standard energy audit. (See description in appendix of this report.) Such a program enables the financing and implementation of multiple energy-saving steps all at once. (58)
16. Provide shuttle buses or van pools for transportation from hubs. (58)
17. Houses of worship are encouraged to investigate and join Massachusetts Interfaith Power and Light. (58)
18. Businesses and Institutions should conduct an energy audit. (58)

Town Government

1. Establish an Energy Committee. (59)
2. Investigate implementing a second ESCo project. (60)
3. Inform and engage Town employees by conducting mandatory in-service programs. (60)
4. Take aggressive steps to reduce heat loss and energy efficiency in Town-owned buildings

through conservation and improved heating and cooling systems. (60)
5. Establish a policy that new municipal buildings, additions and major renovations be built to meet eligibility criteria for LEED certification at the silver level or higher. (61)
6. Formally adopt a commitment to the "total life-cycle" concept of building construction, in new building and site design, and in major additions and renovations. (62)
7. :In demolition necessary to make way for new construction of municipal buildings, mandate disposal of waste debris in ways that are environmentally sound. (62)
8. Reduce the Town's use of electricity. (62)
9. Reduce the carbon emissions generated by the municipal fleet in the conduct of town business. (63)
10. Reduce the carbon emissions generated by town employees in commuting to work and in their conduct of Town business. (63)
11. Help residents and Town employees reduce carbon emissions from private automobile use. (63)
12. The Town should promote and publicize the availability and use of composters for residents. (64)
13. Provide information and examples to encourage environmentally aware choices and behavior. (64)
14. Teach by example, through direct instruction and by collaborative investigation, the understandings and behavioral changes that all people alike must acquire to mitigate and adapt to climate change. (64

Town Policy

1. Ensure that the new Comprehensive Master Plan for Belmont will promote low-carbon living and mobility. (66)
2. Give priority to needs of public transport, pedestrians and cyclists in road design planning and related issues. (66)
3. Evaluate the U.S. Green Building Council's LEED Guidelines for Neighborhood Development. (67)
4. Incorporate the State's zoning exemptions for renewable energy into the local zoning codes. (67)
5. Adopt a bylaw that would use the state's Stretch Code legislation allowing local building code standards to increase energy efficiency of new construction and major renovations to all buildings (municipal, commercial, and residential) in town. (67)
6. The Sustainable Building Design Policy, coupled with new building standards, should apply both to municipal and private sector development. (67)
7. Adopt a policy that all new residential construction and substantial renovation projects over 1,000 square feet and all new commercial and industrial real estate construction minimize, to the extent feasible, the life-cycle cost of the facility by utilizing energy conservation and efficiency, water conservation and alternative energy technologies. (67)
8. Adopt a policy that provides incentives for developers to build to standards that exceed conservation and energy efficiency code requirements. (68)
9. Investigate the pros and cons of being designated a "Green Community" under the Green Communities Act in a timely manner and, if appropriate, apply to become a Green Community. (68)
10. Adopt a policy for all new construction and substantial renovation projects, both municipal and private, that requires the planting of trees in close proximity to the new structures and strategically located to maximize their shade effect. (69)
11. Adopt a policy that re-quires a builder of private property (new or substantial renovation) to replace any tree whose removal is required by the construction with a newly planted tree, either on the same property or at a municipal location. (69)
12. Ensure that all Town bids and contracts include language that requires or encourages vendors to adopt sustainable, energy saving practices. (69)
13. Direct the Energy Manager to seek grant and funding opportunities to facilitate the implementation of the goals and recommendations of this Climate Action Plan. (69)

Belmont Municipal Light Department

1. Implement a rate structure that discourages electricity consumption during periods of

peak demand. (70)
2. :Extend load shedding in an emergency to residential customers by means of a "reverse 911" signaling system. (70)
3. :Work toward utilizing renewable energy sources. (70)
4. Provide incentives and rewards for BMLD staff to work toward reduced greenhouse emissions in Belmont. (72)
5. Improve the BMLD's dissemination of information to the community. (72)
6. Purchase devices, such as a Kill-a-Watt meter, that measure electric use and donate to the Belmont Public Library to make available to patrons. (74)

Waste Recommendations

1. Reduce consumption and increase reuse. (75)
2. Reduce organic material in the town waste stream by composting food and yard waste. (75)
3. Facilitate exchange of items for reuse. (75)
4. Recommendation: Provide for reuse or proper disposal of electronic junk. (75)
5. Keep toxic materials from the environment. (75)
6. Facilitate disposal of materials not presently considered recyclable. (76)
7. Regulate disposal of debris from construction and remodeling projects. (76)
8. Provide incentives for environmentally sensitive disposal of waste. (76)
9. Provide information about disposal and recycling of unwanted items. (77)
10. Encourage businesses to organize shared services for waste disposal and recycling. (77)
11. Explore opportunities for regional cooperation. (77)
12. Encourage and facilitate composting of vegetable waste at all Belmont Schools. (77)

Part I

Introduction

Welcome to the Town of Belmont Climate Action Plan, the product of several years' work by Sustainable Belmont, a group of Belmont residents organized under the Town's Vision 21 Implementation Committee and concerned with the effects of living habits on the future of Belmont.

Part I provides the setting that calls for each of us to respond to the coming changes in Earth's climate, and reviews the history of actions Belmont citizens have taken as stewards of our environment.

Part II provides data on the Belmont community's contributions of greenhouse gases, primarily carbon dioxide (CO_2), to the atmosphere from the way we live, travel and do business in Belmont. The data show that there is much we can all do to reduce Belmont's impact on global climate change.

Part III provides recommendations regarding what town residents, businesses, institutions, and town government can do to make progress toward the goal of achieving an eighty percent reduction of carbon emissions below 2007 levels by the year 2050.

> *In our every deliberation, we must consider the impact of our decisions on the next seven generations.*
>
> —from The Great Law of the Iroquois Confederacy

A Time for Action on Climate Change

The challenge of climate change has quickly become the seminal issue of our time. No other development on the world stage, human or natural, has the same potential to alter the fabric of life on the planet we know today as climate change, with perhaps the exception of an all-out nuclear war. What will be required in mounting a focused and aggressive approach to dealing with the issues of climate change is no less than a global response to a global problem. An effective response will be one that recognizes the urgency for action and a commitment to build sustainable solutions that will grow and continue to be enhanced well into the future. Change will require enlightened leadership and the involvement of a motivated and educated citizenry, business community, and government at the local, national, and international levels. A Climate Action Plan for the Town of Belmont is a significant step in shouldering the shared responsibility for the challenges that lie ahead.

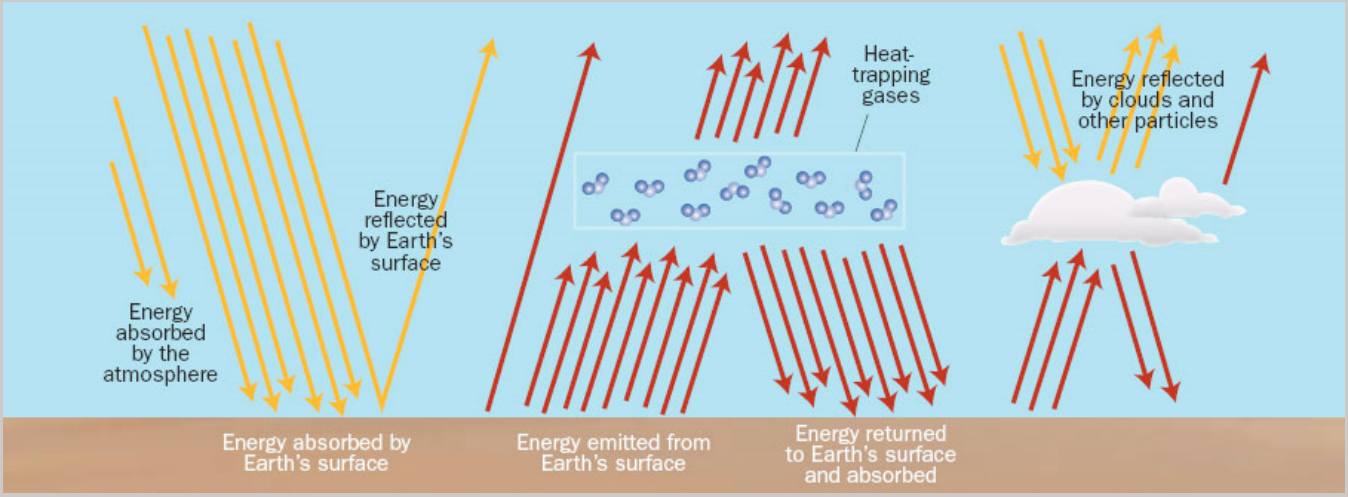
Is There a Consensus that Global Warming is a Problem?

The scientific evidence that Earth's climate is changing abnormally is overwhelming: Temperatures are rising; the polar caps are melting; severe weather events are more frequent. Scientists also have no doubt that climate change is resulting from changes in carbon balance from the burning of fossil fuels and the destruction of tropical forests. In addition to these conclusions, the International Panel on Climate Change (IPCC), in its Third Assessment Report (2001), reviewed scientific studies of climate change throughout the world and concluded:

> *"There is high confidence that recent regional changes in temperature have had discernible impacts on many physical and biological systems".*

Scientists overwhelmingly agree with these findings of the IPCC. Scientific academies around the world have endorsed the IPCC reports, including the U.S. National Academy of Sciences, Chinese Academy of Sciences, Académie des Sciences (France), Deutsche Akademie der Naturforscher Leopoldina (Germany), Science Council of Japan, and Royal Society (United Kingdom).

In addition, United States institutes specializing in the study of the climate endorse the IPCC findings, including: NASA's Goddard Institute of Space Studies, the National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA), National Center for Atmospheric Research (NCAR), and American Meteorological Society (AMS).



About half of the sun's energy (yellow arrows) is absorbed by Earth's surface. However, when this absorbed energy is emitted back to the atmosphere (red arrows), heat-trapping gases prevent most of it from escaping toward space, resulting in higher temperatures. Note: the molecules depicted in the inset box represent heat-trapping gases that are well-mixed throughout the atmosphere, and the number of yellow and red arrows is proportional to the actual balance between incoming and outgoing energy. Diagram: Union of Concerned Scientists.

A Changing Climate

The scientific communities understanding and adoption of the basic tenants of climate change has been well established for many years. Recently, the evidence for anthropogenic (human-induced) climate change, primarily driven by the release of enormous amounts of CO_2 into the atmosphere through the combustion of fossil fuels, has been described as unequivocal.

Simply put, natural variation and well-understood external forcings do not explain the observed increases in temperature or recorded warming patterns of the atmosphere and oceans. These patterns have a uniquely human signature, quite different from those predicted by an increase in solar activity.

The environmental mechanism for the measured increase in global temperatures is well understood and known as the "greenhouse effect." Since the Industrial Revolution and the wide-spread adoption of fossil fuels as an energy source, hundreds of millions of years' worth of sequestered carbon has been re-released into the atmosphere as CO_2. This increase in atmospheric CO_2 traps infrared radiation, or heat, that might otherwise be reradiated into space. As CO_2 levels in the atmosphere increase, so does the temperature of Earth's atmosphere and oceans with startling consequences.

The Global Picture

Many of the predicted changes associated with scientific climate change models are measurable today and in fact, point to a rate of change more rapid than initial models predicted. As seen from the accelerated rates of melting of the icecaps at the North and South Poles and on the massive ice sheets of Greenland, and the consequent well-documented plight of the polar bear as ice sheets disintegrate—the world is in the midst of profound change.

Scientific models point toward a change in the distribution of rainfall on land—some areas becoming wetter, others drier—and predict an increase in extreme weather events. In other words, storms that are much more dangerous because of their size, intensity, duration, and perhaps frequency, are predicted. Certainly hurricane Katrina's ferocity is evidence for the type of extreme weather events that are possible.

Natural ecosystems are changing, animals and plants are migrating to new latitudes and elevations. Invasive species are flourishing and attempts at their eradication are coming at great financial costs to governments and landowners and to the detriment of populations of native plants and animals and some species are predicted to go extinct in the face of dramatic climatic changes coming too rapidly.

Climate change is having an effect on the distribution and reemergence of infectious diseases as peak freezing temperatures are being reached in far fewer areas and warm weather fosters disease growth. Such changes are cause for concern globally as international travel has the potential to rapidly export a pandemic around the world.

In the future, additional changes are predicted. Even geologic processes may be affected by climate change. Quiet volcanoes long dormant under the overburden of a topping ice may awaken and erupt with more frequency as glaciers retreat. As sea-levels rise, the dislocation of huge numbers of people from shoreline communities seems inevitable.

The predictions of the previous paragraphs are subscribed to by the great majority of scientists, including those on the Intergovernmental Panel on Climate Change (IPCC).[1] The IPCC is considered to be the "gold standard" on the subject. The IPCC was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environmental Programme (UNEP). The IPCC was recently awarded the Nobel Peace Prize along with former Vice-President Al Gore for efforts in creating a better public understanding of climate change and its ramifications.[2]

The IPCCs formal objective is:

> *"…to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation. The IPCC does not carry out research nor does it monitor climate related data or other relevant parameters. It bases its assessment mainly on peer reviewed and published scientific/technical literature."*

One main activity of the IPCC is to provide, in regular intervals, an assessment of the state of knowledge on climate change. The *First Assessment Report* was completed in 1990. The *Second Assessment Report* was delivered in 1995 and provided key input to the negotiations that led to the adoption of the Kyoto Protocol by many nations in 1997. A *Third Assessment Report* was completed in 2001, and most recently,

1 Online at *www.ipcc.ch.*

2 Online at *http://www.ipcc.ch/pdf/press-releases/pr-121007.pdf.*

the *Fourth Assessment Report* on Climate Change, was delivered in May 2007.[3] It represents the work of more than 2,500 scientific expert reviewers, 800 contributing authors, and 450 lead authors from 130 nations and took over six years to complete.

The IPCC 2007 report assessed the probability of certain outcomes of climate change based upon a number of different climate change scenarios. Regardless of the degree of temperature change for each scenario, the planet Earth predicted for the future will be significantly different from the one we know today. The good news is that the scale of changes the climate on Earth is expected to face is still dependent upon humanity's response to the problem. In other words, by our actions today, humans still have the opportunity to shape the rate and degree of climate change significantly in the future.

Federal Action

The U.S. government is considering legislation to encourage reduction of carbon emissions. Strategies under consideration include a carbon tax and a cap-and-trade system. See Appendix A for an explanation and evaluative comparison of each strategy.

The Regional Outlook

While the IPCC report addresses global challenges, other scientific studies have focused on predictions about the effects of climate change on New England and its residents. The Northeast Climate Impacts Assessment (NECIA), a collaboration between the Cambridge-based Union of Concerned Scientists (UCS) and more than 50 scientists and economists, published a report, *Climate Change in the U.S. Northeast*, that brings the effects of climate change closer to home.[4] Their predictions are based upon models that consider lower and higher carbon emissions scenarios, again reflecting the strength of human response to the issue. The higher carbon emissions scenario reflects a modest change or a "business as usual" approach. The lower carbon emissions scenario assumes an aggressive approach to curtailing our carbon emissions. Here is an excerpt from the Executive Summary of the report:

> *By mid century and later ... most changes projected to occur depend strongly on the emissions choices we make in the near future and carry through to the rest of the century. Specifically, under the higher emissions scenario, in which the world remains on a pathway of highly fossil fuel intensive economic growth (with heat-trapping emissions from automobiles, power plants, and industries continuing to increase through the end of the century), new projections for the Northeast show that:*
>
> *By the end of this century, winters could warm by 8 to 12 degrees Fahrenheit (°F) and summers by 6 to 14°F.*
>
> *Historically, major cities in the Northeast experience 10 to 15 days per year when temperatures exceed 90°F. By mid-century, cities such as Philadelphia, New York City, and Boston could experience between 30 to 60 days of temperatures over 90°F each summer. By late in the century, most cities in the region are likely to experience more than 60 days with temperatures over 90°F, including 14 to 28 days with temperatures over 100°F (compared with one or two days per year historically).*
>
> *As winter temperatures rise, more precipitation will fall as rain and less as snow. By the end of the century, the length of winter snow season could be cut in half.*
>
> *The frequency of late summer and fall droughts is projected to increase significantly, with short-term droughts (lasting one to three months) becoming as frequent as once per year over much of the Northeast by the end of the century.*
>
> *The character of the seasons will change significantly, with spring arriving three weeks earlier by the end of the century, summer lengthening by about three weeks at both its beginning and end, fall becoming drier, winter becoming shorter and milder.*
>
> *Sea-level rise will continue, reaching anywhere from a few inches to more than one foot by mid-century. By the end of the century, global sea-level could rise from eight inches up to nearly*

3 IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22. Online at *http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf*.

4 Northeast Climate Impacts Assessment, 2006. *Climate Change in the U.S. Northeast*. Online at *http://www.climatechoices.org/assets/documents/climatechoices/NECIA_climate_report_final.pdf*.

three feet, increasing the risk of coastal flooding and damage from storm surges.

Higher global temperatures also imply a greater risk of destabilizing the Greenland and West Antarctic ice sheets. It is possible, particularly under the higher-emissions scenario, that warming could reach a level during the century beyond which it would no longer be possible to avoid rapid ice sheet melting and a sea-level rise of more than 20 feet over the next few centuries.

Increases in the likelihood and severity of heavy rainfall events, including more than a 10 percent increase in the number of annual extreme rainfall events and a 20 percent increase in the maximum amount of rain that falls in a five-day period each year.

Increases in winter precipitation on the order of 20 to 30 percent, with slightly greater increases under the higher emissions scenario.

A combination of higher temperatures, increased evaporation, expanded growing season, and other factors that will cause summer and fall to become drier, with extended periods of low stream flow. This will reduce the availability of water from northeastern rivers to natural ecosystems, agriculture, and other needs."

Simply put, the New England of the future may not resemble the New England of the past and present. The tourist attractions that attract so many to the Cape, Islands, and mountains, and help to define the New England region, will likely suffer greatly as sea-levels rise, seasonal changes limit "leaf-peeping" opportunities, ski areas experience shortened seasons and need to rely more heavily on manufactured snow, and maple sugar production moving out of the region into Canada as flora and fauna shift because of changing environmental conditions. Such changes have profound negative implications for the regional economy.

The Boston Outlook

A major study known as the CLIMB Report (Climate's Long-Term Impacts on Metropolitan Boston) was released in 2004.[5] The study culminated a four-year, one million dollar research effort, funded by the U.S. Environmental Protection Agency (EPA). Taking part in the study were 10 experts from Tufts University, Boston University, and the University of Maryland who worked in consultation with EPA officials, the State of Massachusetts, the Boston Metropolitan Area Planning Council, and local government officials throughout the metropolitan region.

"I have been spending quite a bit of time on an island off the coast of Sicily where virtually everything from water to electric power are highly valued commodities and as such are used sparingly. For the most part, wash is done by hand, and the hot water heater is only turned on when hot water is needed. We have no car, since gas is difficult to get and public transportation is more than adequate, otherwise walking works just fine resulting in no need for a planned exercise program. In spite of these limitations, it is one of the most beautiful places on earth.
Having said this, while home in Belmont, we tend to use the cars less, have converted most of our lighting to low energy bulbs, reduce the number of times we operate
the dishwasher and washer and dryer, and lower the thermostats in the winter and raise them in the summer."

—Angelo Firenze, Selectman, Belmont

Under the heading Major Impacts by 2100 of Climate Change on Metropolitan Boston are the following entries:

"During the 21st century, sea level along metropolitan Boston's coastline could rise at least 24 inches (0.61 meters)."

"Higher sea levels of just 12 inches or more could give a typical 10-year storm the intensity of the present 100-year storm; similarly, a 100-year storm would hit with the intensity of the present 500-year storm."

"Property damage from coastal flooding, plus the cost of emergency services, could total $94 billion

5 Tufts University, University of Maryland, Boston University and Metropolitan Area Planning Council. *Infrastructure Systems, Services and Climate Change: Integrated Impacts and Response Strategies for the Boston Metropolitan Area.* Online at *http://www.clf.org/uploadedFiles/CLIMB_Final_Report.pdf* (full report); *http://www.clf.org/uploadedFiles/CLIMB_media_summary.pdf* (media summary); and *http://www.clf.org/uploadedFiles/CLIMB_major_impacts.pdf* (impacts summary).

during the century."

"Homeowners in metropolitan Boston's 100- and 500-year floodplain could sustain flood damage averaging between $7,000 and $18,000 per home."

"Boston could face at least 30 days of temperatures above 90°F, more than double the current number. Mortality rates tend to rise in Boston when temperatures exceed 90°F."

"By 2030, the average number of days in July requiring air conditioning could increase by over 24% with a corresponding rise in energy use."

"Global warming will reduce water quality in rivers and streams making parts of them uninhabitable for fish and aquatic plants."

"During and after extreme weather events, motorists could spend an estimated 80% more hours on the road due to traffic delays; likewise, 82% more trips could be cancelled because of road flooding."

"River flooding related to global warming is expected to impact twice as many properties and double the overall cost of damage during this century."

"Water systems relying totally upon local supplies may need to draw on the Massachusetts Water Resources Authority system to supplement their supplies to maintain acceptable local water service affected by climate and demographic changes."

How will Boston cope? The CLIMB Report poses three possible approaches: "Ride It Out," "Build Your Way Out," or a "Green" scenario.

Of the three adaptive strategies analyzed in response to climate change, the "Ride-it-out" approach—do nothing now and simply rebuild in the aftermath of destruction—was the most costly financially and to the environment. This approach also does nothing to minimize the amount of heartbreak, suffering, and dislocation of victims.

The "Build-Your-Way-Out" approach which assumed some pre-emptive actions such as the construction of sea-walls and bulkheads to hold back the ocean was the second most costly analysis.

The "Green" scenario assumes aggressive pre-emptive actions to blunt the effects of climate change by limiting further greenhouse gas emissions through conservation measures, greater efficiency, and the use of alternative energies. The "Green" approach was the least costly of the alternatives, monetarily, to the environment, and certainly in human terms.

Beyond Climate Change

Beyond the issues and challenges climate change presents, there are other important reasons for switching to a more carbon-neutral lifestyle by using less, or finding alternatives to, fossil fuel.

Perhaps there are no reasons more important than our national security, for our economy and way of life is threatened by our dependence on, and the potential disruption of, oil supplies from unreliable sources in nations that are politically unstable and/or openly hostile to the United States.

Other compelling reasons to change course in our approach to energy include limiting waste, reducing pollution, stimulating local economies, improving health, making cities more "livable" and the simple act of galvanizing the citizenry of the United States in a common cause would provide tremendous benefits to our society and promote an improved quality of life.

The Challenge Ahead—Goals Set

The scientific evidence mandates ambitious and aggressive action now and in the future in mitigating the effects of climate change by reducing greenhouse gas emissions. Different groups and governments have set a variety of target goals, but there is a general consensus that by the year 2050 an 80% decrease in CO_2 output will be necessary to put humanity on track with the lower-emissions scenario predictions for changes in the climate.

In an effort to achieve long-term emissions reduction targets in the Northeast, in 2001, the New England Governors and Eastern Canadian Premiers (NEG/ECP) signed an agreement committing to a comprehensive regional Climate Change Action Plan.[6] This plan includes a long-term goal of reducing regional emissions of heat-trapping gases from 75 to 85 percent below 2001 levels.

Initially, these reductions may seem unrealistic and difficult to meet, however, the 80% reduction goal by 2050 is achievable with an average annual reduction in emissions of only 4%. This gives communities optimism and time to phase-in policies and procedures, innovations and actions to meet the long-term reduction goal. With an average annual 4% reduction target, a measurable and attainable framework is set that can stay on track to meet the long-term goal.

6 *Climate Change in the U.S. Northeast*, 28–29.

The Role of Towns and Cities

In many regards, cities and towns around the United States are at the vanguard of tackling the challenges of climate change.

In as much as it is the infrastructure of communities that will be tested most by the effects of climate change, municipalities have an obligation to help mitigate these effects now for the long-term health and well-being of the populace. Extreme weather events resulting in flooding, power outages, traffic snarls, accidents and injury will certainly challenge the limits of first responders, police and fire departments and emergency services, and will burden city workers in the aftermath as clean-up of clogged sewers, over-flowing effluent, damaged city streets, removal of fallen trees, and a host of other public funded services will be tested under extreme stress.

Certainly the devastation wrought by Hurricane Katrina to the Gulf Coast is a vivid reminder of how quickly a natural disaster can visit a community. This disaster also stands as a reminder of how long it can take communities to recover from such an event and the limits of the state and federal governments in helping that recovery.

Boston on Board

On April 12, 2007, Boston Mayor Thomas Menino put a 15-point plan to counter the effects of climate change into immediate effect for the City of Boston, and in doing so he put the Hub at the fore of cities taking an active approach to the problem. The plan requires the city government to cut its greenhouse gas emissions by 7 percent by 2012 and by 80 percent below 1990 levels by the year 2050.

To accomplish those goals, policies include plans to exceed federal government efficiency standards on new buildings by at least 14 % and by at least 7% for renovated municipal buildings respectively. At least 15% of the electricity bought by the city will need to come from renewable energy providers in the wind, solar, or hydro-power sectors by 2012. In the next five years, the city has set a goal of increasing the amount of material it recycles by at least 10 % and to reduce total fuel consumption by city vehicles by 5% by 2012. New city vehicles are also required to use alternative fuels, have flexible engines or use hybrid technology—except in those cases in which such options are not available.

Mayor Menino also created a new Community Climate Action Task Force that will study proposals to bring the city's private sectors on board.

"The task force is looking to take these efficiencies citywide, to see how we can engage the private sector, our utilities, businesses, residential, small companies," according to James W. Hunt, Menino's chief of environmental and energy services, who will attend task force meetings on behalf of Mayor Menino.

The new initiative also proposes to deliver low or no-interest loans to households and businesses that decide to install energy-efficient technologies. The loans would come from a fund of $500 million financed by private investors and venture capitalists interested in green financing technologies as a means of jump-starting research and development by firms in those sectors.

Cities for Climate Protection

In 1990, ICLEI (the International Council for Local Environmental Initiatives) was created. One of ICLEIs "flagship" initiatives was the creation of Cities for Climate Protection (CCP). The CCP initiative has encouraged more than 800 cities around the world to develop a Climate Action Plan (CAP) to address and reduce greenhouse gas emissions.

The CAP has five basic milestones (goals):

1. Creation of a community baseline inventory of greenhouse gas emissions;
2. Analysis of the inventory and the assignment of reduction targets;
3. Creation of a local plan of action to meet reduction targets;
4. Implementation of policies and procedures and action items to meet the reduction targets and;
5. An ongoing commitment to monitor and verify that reduction targets are being met until the final goal has been met and maintained as sustainable.

In 2005, a team of Tufts graduate students assisted Belmont in an initial greenhouse gas emissions inventory for the town and in 2006–2008, a more formal evaluation was conducted and completed. This document includes analysis of those inventories and recommends target reductions and other steps and opportunities the Belmont community can take to reduce its greenhouse gas footprint. This plan has been created for Belmont by town residents and numerous suggestions from the community are woven throughout.

Belmont Environmental Policies, Statements and Projects

The Town of Belmont has, for more than a century, played an exemplary role in the stewardship of natural resources in the Commonwealth of Massachusetts. It was in Belmont and neighboring Waltham that the appreciation of the Waverley Oaks inspired the creation of the world's first land trust, now known as The Trustees of Reservations. It was Belmont residents who underwrote the eventual protection of the Waverley Oaks with a gift to the newly formed Metropolitan District Commission in 1893. And, one hundred years later, it was the citizens and Town of Belmont that reached an historic agreement with McLean Hospital to protect a significant part of the towering forest and the beautiful highland fields that rise above Waverley Square and extend onto Belmont Hill. It is entirely appropriate that Belmont continue this proud tradition by taking a leadership role in assuring that, through decisive action on climate change, Belmont's remarkable natural resources will be sustained for centuries to come.

In the past 50 years or so, the Town of Belmont has taken a variety of steps that reflect increasing awareness of emerging environmental issues. Although most steps taken were in response to State mandates, some of the Town's responses have exceeded the minimal State requirements; and some have been initiatives driven by the twin motives of saving the Town money while intentionally taking environmentally responsible action, understood in recent years especially in the context of climate change.

Following are policy statements that the Town has approved that reflect this commitment toward environmental responsibility, that, when enforced also reduces our carbon output and saves money for the Town and its taxpayers. The Town government is also to be commended as some of the recommendations in this document are already in process of being implemented.

A Working Vision for Belmont's Future

Adopted by Town Meeting, April 23, 2001

Belmont is a desirable and welcoming community that retains a small-town atmosphere within a larger metropolitan area. Our town provides excellent educational opportunities and high quality town services. We protect the beauty and character of our natural settings and historic buildings. Thriving business centers contribute economic stability while offering places for residents to dine, shop, and socialize. The town government responds to the concerns of the residents, practices sound fiscal management, and plans for future generations. We make a commitment to preserving and enhancing our strengths as a community while respecting our differences as individuals.

Our Principles

To preserve and enhance the qualities that we value, we, the Belmont community, make a commitment to:

- foster and maintain an open and inclusive decision-making process.
- develop and use our human and financial resources wisely.
- engage in comprehensive and integrated local and regional planning.

Our Common Goals

Quality of Life

- We will ensure an excellent school system as a cornerstone of our community, providing for the learning needs of all of our children and all residents.
- We will manage traffic through and around town to ensure the tranquility of our neighborhoods and the safety of pedestrians and bicyclists.
- We will be an environmentally responsible community and conserve our natural habitats.

Character of our Town

- We will maintain our libraries, public buildings, infrastructure, and recreational facilities as investments in our future and our historic buildings as witnesses to our past.
- We will work with neighborhoods and residents to identify and support retail needs and opportunities.
- We will value cultural enrichment and encourage local talent and creativity.

Sense of Community

- We will welcome newcomers and value

diversity, while caring for our neighbors and for the needs of children, youth, and seniors.
- We will promote the involvement of all residents in the life of our community, support citizen involvement in our town affairs, and rely on an effective, representative local government.
- We will preserve our small-town community atmosphere.

Resources Savings Policy Statement

Approved unanimously by the Belmont Board of Selectmen on November 27, 2006
Approved by the Belmont School Committee in January 2007

From "A Working Vision for Belmont's Future":

"We, the Belmont community, make a commitment to . . . develop and use our human and financial resources wisely."
"We will be an environmentally responsible community and conserve our natural habitats."

Resource Savings Policy Statement:

In support of Belmont's Working Vision we will seek to promote a resource conscious and educated community, creating an effective network of consumers; staff, students, residents, business and community leaders who use energy, water and other resources wisely. To realize all potential dollar savings and promote environmental responsibility we will:

- Support conservation and efficiency in our use of electricity, gas, oil, water and other resources as Belmont's way of doing business.
- Maintain and enhance present energy and water conservation measures, support efficiency, conservation and recycling in all town and school operations, and develop initiatives to make infrastructure improvements which take advantage of new technological advances.
- Reach out to educate all town staff, students and the broader community, both residential and commercial, about the benefits of and opportunities for resource conservation and the use of alternative sources of energy to encourage behavior change and sustainable practices.

Sustainable Building Design Policy

Unanimously approved by the Belmont Board of Selectmen March 5, 2007

From "A Working Vision for Belmont's Future":

"We, the Belmont community, make a commitment to . . . develop and use our human and financial resources wisely. . . . We will be an environmentally responsible community and conserve our natural habitats."

Purpose

In support of Belmont's Working Vision, we seek to make the best possible use of all of our resources (both natural and man-made) in a way that realizes the full potential of cost savings and environmental benefits while still being fiscally responsible. Toward these goals, the Town of Belmont supports a sustainable design policy that promotes practices that protect human health and well being, and the natural environment.

The Town of Belmont, both as a matter of principle and as a cost-saving measure, supports efforts that will achieve the following benefits of sustainable design as applied to new construction and major renovation of all municipal and school district buildings, to the extent practical:

- **Economic benefits** that reduce operating costs; enhance asset value; improve employee productivity and satisfaction; and optimize life-cycle economic performance.
- **Environmental benefits** that enhance and protect ecosystems and biodiversity; improve air and water quality; reduce solid waste; and conserve natural resources.
- **Health and community benefits** that improve air, thermal, and acoustic environments; enhance occupant comfort and health; minimize strain on local infrastructure; and contribute to overall quality of life.

These benefits can be achieved by many design and construction initiatives, including but not limited to:

Site planning and design:

- Involving contractors, engineers, and other relevant parties in early planning discussions to ensure building systems (e.g., HVAC, electrical) are sited and sized properly in building design.
- Planning building design to minimize impact on natural ecosystems (e.g., wildlife habitats, wetlands, forests) or municipal resources (e.g.,

water supply, sanitary sewer system, storm water drainage, electric load).
- Designing landscaping to use native species and conserve water.
- Designing to encourage pedestrian and bicycle access, and access and amenities to encourage use of public transit where possible.

Resource-efficient elements:
- Using construction materials that are fully or partially comprised of recycled content, and/or are recyclable at the end of their useful lifetime.
- Using nontoxic materials for building envelope and interior (e.g., fiberboard, paint, adhesives, carpeting, and other materials that contain low levels of volatile organic compounds (VOCs).
- Implementing natural lighting and ventilation systems (e.g., daylighting, fresh air circulation).
- Using equipment and appliances that maximize operating efficiency (e.g., occupancy sensors, low-flow water fixtures, Energy Star-rated HVAC systems).
- Incorporating alternative energy into building systems (e.g., solar hot water, solar panels, geothermal heat pumps, wind turbines, biodiesel backup generators) .

Construction:
- Using diesel construction equipment that has been retrofitted with pollution controls to minimize exposure to harmful exhaust contaminants.
- Recycling waste materials from building construction (or demolition).

Post-construction:
- Commissioning engineering systems to ensure specifications have been met.
- Proper operation of the buildings once occupied (i.e., training employees on using and maintaining fixtures and equipment) to ensure maximum resource-saving potential.

Application

1. The Town of Belmont should incorporate sustainable building principles such as Leadership in Energy and Environmental Design (LEED), as promulgated by the U.S. Green Building Council, or other acceptable standards into the design and construction and operation of all municipal and school district buildings, to the level that is economically practical.
2. Designers selected for all capital projects should be qualified to design buildings and implement elements that are sustainable and efficient. The design team should include LEED-accredited or comparable professionals.
3. The project team should meet early in the design stage to realize optimal cost savings and best practices in energy efficiency, environmental protection, storm water management, and reduced construction waste. The team should meet regularly throughout the various design phases and periodically during construction to ensure these practices are being employed.
4. To the extent practical, building and site design should incorporate best-practices in storm water management; and should incorporate Low Impact Development site design components.
5. To the extent practical, performance objectives should be incorporated into design, construction, and contract documents, and a continual performance verification process should be used throughout the project and at completion.
6. To the extent practical, as determined by the town building committee, all building projects (whether renovation or new construction) undertaken by the town should conform to sustainable design principles.
7. School projects (i.e., K–12 public schools) will comply with Massachusetts regulations (currently CHPS (Collaborative for High-Performance Schools)).
8. The Town's Permanent Building Committee and project-specific building committees should fully consider the lifecycle costs of the building when determining the project's budget, giving consideration to operating costs, including future utility costs and environmental costs.
9. The town's building committees will include in contract documents a statement that all construction vehicles must observe state anti-idling regulations.

The Belmont Board of Selectmen embraces these policies and practices as they set a leadership example to town residents, developers, and other communities. The Board also encourages development in the private sector (e.g., residential homes and commercial/industrial buildings) to follow the strategies outlined above to ensure maximum environmental and economic benefit.

Belmont Municipal Light Department Power Supply Policy

I. Goal

To develop a managed power supply portfolio that provides Belmont ratepayers with reliable energy at competitive market-based rates and with consideration and awareness of environmental concern, conservation and alternative energy options. The Belmont Municipal Light Department ("BMLD") managed portfolio will minimize risks by entering into layered and staggered purchases at different times with credit worthy New England power suppliers, which would generally be nationally recognized and investment grade companies.

II. Vision Statement

By 2008 the BMLD will have a layered portfolio with a target of no more than 20% of its capacity needs are dedicated to any single contract. Based on current projected Forward Capacity Market ("FCM") and Locational Forward Reserves Market ("LFRM") prices, BMLD should create a capacity price hedge with the purchase of entitlements that cover no more than 50% of the BMLD's peak capacity requirements. Belmont will also strive to optimize the efficiency of energy use to both conserve energy and reduce peak demand. Where economically viable, it will seek to optimize the use of "green" resources.

III. Objectives Through 2010

1. Obtain resource and counterparty diversification by establishing Master Agreements that conform to the minimum standards set forth by the Edison Electric Institute with multiple suppliers. Such purchases shall include, but not limited to the following:
   a. energy strips;
   b. heat rate swaps;
   c. load following for energy and ancillary services;
   d. spot market purchases;
   e. unit entitlements;
   f. forward fuel hedges for unit entitlements and heat rate/fuel index contracts; and
   g. verifiable load management and/or energy conservation services.
2. Develop a staggered and layered portfolio that is designed to meet an annual and, to a lesser extent, five year energy budget. This objective will be met by procuring forward fixed-price resources and/or heat rate/fuel index resources over various market periods.
3. Active participation in regional and national issues and events; in appropriate regulatory proceedings, and with governing bodies, either independently or in collaboration with others to influence governmental and wholesale market policies for the protection and benefit of Belmont ratepayers.
4. Adhere to the following operational objectives:
   - Maintain flexible power supply and transmission options to meet an evolving market design;
   - Monitor the transmission costs and potential cost mitigation measures with NStar associated with the contractual obligations and all associated activities as stipulated within the Transmission service agreement between Cambridge Electric Light Company and the Town of Belmont, Ma. as agreed to on June 29, 1994, as well as review potential alternative opportunities to reduce the overall costs of obtaining the delivery of energy;
   - Keep abreast of market developments, availability of products, and current, as well as projected, market conditions; and
   - Periodically, but no less frequently than once each year, review this policy, including opportunities to purchase energy and capacity from renewable resources, and/or demand side equivalents with the Belmont Municipal Light Advisory Board (BMLAB), and, with the Municipal Light Board ("MLB") and make any modifications as warranted.
5. Evaluate the cost-benefits provided by demand-side management, distributed generation and energy conservation programs, implement individual programs that are deemed to be financially viable.
6. BMLD will investigate possibilities for investing in renewable energy facilities and for contracting for clean renewable energy. BMLD will attempt to contract for such power whenever the costs are comparable to the costs for conventional power sources.

IV. Procurement Review Process

1. Manager shall, on an ongoing basis, review

with BMLAB and MLB the status of the power supply market and transaction opportunities.

V. Power Supply Transaction Policy

1. The Manager/CEO, or in his/her absence, the Assistant Manager, may implement transactions that are for a term of five (5) years or less and eight (8) megawatts or less without obtaining MLB approval, provided that:
   a. the Director and/or designee, in collaboration with BMLAB, will provide the MLB with precise summaries detailing the intent and financial benefits of each transaction at the next regularly scheduled Board meeting; and
   b. all transactions will be monitored and the performance of each will be measured against the market and the portfolio.
2. Any transaction exceeding the megawatt and/or time period in V.1 above shall require the prior notice to the MLB, and BMLAB
3. Any contract or transaction involving Life-Of-Unit entitlements shall require the consent of the BMLAB and MLB

VI. Business Conduct

1. All members of the BMLD staff, BMLAB, and MLB, will be held to the highest standards of ethical business conduct and are required to fully comply with all laws, regulations and BMLD policies; these same demands apply to trading partners, consultants and/or other entities conducting business with or on behalf of the BMLD.
2. The Manager/CEO, in consultation with BMLAB, shall be responsible for implementing all necessary procedures, guidelines and controls to ensure compliance with this policy.

Belmont Municipal Light Department Electricity Conservation And Efficiency Policy Statement

Belmont Municipal Light Department is committed to providing our customers with competitively priced reliable electric service and promoting the efficient use of electricity. Accomplishing these goals requires that both supply and demand side initiatives be optimally developed, carefully weighed, and efficiently deployed. BMLD will assume a leadership role in promoting and facilitating efficient use of electric energy.

This policy recognizes that it is the customer who decides how best to meet his or her electric energy requirements. BMLD has an important role: to assist in this process by identifying, educating, providing appropriate price signals, and to advise BMLD ratepayers on conservation and efficiency strategies that will best serve their lifestyle and/or business requirements, while minimizing economic and social costs in terms of consumer bills, environmental harm, resource depletion, and overall system efficiency. Toward that end, BMLD adopts the following goals:

1. Reduce the growth rate of Belmont's total annual electric energy consumption.
   a. Provide customers, to the extent possible, with meaningful price signals reflecting actual costs for procuring power.
   b. Effective communication and education on efficiency and conservation strategies.
   c. Promote end use efficiency (e.g., lighting efficiency programs)
2. Provide the "tool kit" for BMLD customers to improve their energy efficiency.
   a. Home energy audits
   b. Target efficiency upgrades with rebates or cost sharing plans
   c. Work toward more meaningful interface for customers to use energy more efficiently
   d. Assist customers in undertaking energy efficiency measures
   e. Communicate the availability of this customer "toolkit".
3. In cooperation with municipal officials, reduce Belmont's annual municipal electricity consumption.
   a. Provide technical resource for Belmont building managers and builders to assist in site specific conservation and efficiency upgrades.
   b. Provide greater electricity usage detail for building managers.
4. Effective Management of Belmont's Peak Electricity Demand
   a. Making effective use of available demand response mechanisms.
   b. Deploy cost effective load management programs and technologies.
   c. Long-term implementation of time of use pricing and, where cost effective,

deploy technology to enable and facilitate customer response.

d. Effective, real time BMLD-customer communication on energy consumption and emergencies.
e. To collect and maintain a better database on customer usage.

BMLD will develop an annual budget to support its conservation and efficiency programs designed to optimize efficiency gains on an annual basis.

BMLD will devote appropriate human resources to assure the effectiveness of energy efficiency programs. Programs adopted to serve BMLD customers will be measured against the avoided cost. Metrics will be developed and used to evaluate and optimize program results.

Policy on Use of Municipal Vehicles

Approved by the Belmont Board of Selectmen, December 2, 2002

2. *The Town shall strive to procure the most fuel efficient and economical vehicles necessary for the purpose for which they are intended.*

Note: This is one of eight points approved; the remainder of points in the policy are not relevant to this document and therefore are not included.

The Belmont ESCo

In 2003, the Town of Belmont took initial steps to address the energy consumption of its municipal buildings. This initiative was based on a recognition that energy costs were expected to rise steeply in the near future; in 2002, the entire utility cost of the Town's municipal buildings was $933,000—a not insignificant number. With the town facing additional financial pressures, it was agreed that, if possible, the Town should take steps to reduce its municipal energy use. Additionally, there was a small but growing interest in reducing the Town's output of carbon emissions to address the challenge of climate change. Known as the ESCo Project, this program was recognized as an innovative project across the municipal spectrum.

What Is an ESCo Project?

"ESCo" stands for "Energy Services Company." At the request of a client, an ESCo develops, designs and implements energy efficiency measures to reduce the energy and water use and operations costs of existing buildings. In the course of its work with the client, an ESCo performs an extensive energy audit, designs the project, upgrades and installs energy efficiency equipment, and verifies energy savings. The ESCo assumes the risk that the project will save a guaranteed amount of energy. Projects are designed to be cash neutral—that is, the savings in operating costs for municipal utilities will pay for the infrastructure investments during the agreed-upon life of the project.

How did the ESCo project start in Belmont?

In January 2003, Chairman of the Belmont Board of Selectman, Paul Solomon, appointed an Ad Hoc Committee to work with the Belmont Municipal Light Department to explore bringing an ESCo to work with the Town. This committee set out to learn about how such projects are organized, the financing of them, and how Belmont might pursue such an endeavor. The committee determined which buildings would be included, and it developed and circulated a Request for Proposals. Two companies submitted bids.

Which buildings were included?

The Ad Hoc Committee determined that many, but not all, municipal buildings in Belmont were appropriate for inclusion. Belmont's entire physical plant comprises 915,000 square feet; the buildings in the RFP totaled 810,000 square feet, of which 700,000 square feet were associated with the schools.

The 12 buildings included were: Police Station; Library (main branch); Skating Rink; Water Department (in Town yard); Highway gar-age (in Town yard), Burbank School, Butler School, Wellington School, Winn Brook School, Chenery Middle School, Belmont High School, and the White Field house.

Buildings that were excluded for a variety of reasons:

- Not included because of being too small/ not using enough energy to be cost effective: Benton Branch, Library; Cemetery office/ garage; Pool/ Bath House; other Town Yard garages/sheds.
- Not included because they were recently constructed, under construction, planned for construction: Town Hall; Town Hall Annex (Homer); School Administration Building; two new fire stations; the Senior Center at Our Lady of Mercy.
- The Electric Light Department building (on Prince St.) was included in the original RFP, but

not in the project itself because it was determined that there was nothing that needed upgrading.

In April, 2004, The Ad Hoc Committee was dissolved and was formally recreated as a Town Meeting Building Committee, thereby giving it the authority to enter into contracts and make certain financial commitments. During the course of the year, this new, larger committee became educated on how an ESCo works, the bids were reviewed and a letter of intent signed.

Noresco was selected and commenced immediately to conduct a full energy audit of the proposed buildings. In February 2005, the Committee received the detailed energy audit, including the costs of each recommended modification and the expected "pay back" time from the cost savings. (The correct term is "cost avoidance," or the amount that would have had to be paid if the ESCo project had not been done. The actual utility bills might go up as a result of increasing rates and/or demand.)

The contract and lease agreement were signed in June 2005. Construction—the installation of the energy-saving modifications—took place between September 2005 and April 2006. Below is a table from the Annual Savings report for Year 1 from Noresco. It identifies the energy and water saved from August 1, 2006 to July 31, 2007. The dollar amounts identified are likely lower than the actual dollar costs avoided since the agreed-to annual inflation factor for utility rates in the contract was 3% and the actual inflation in rates has been higher. Analysis of the actual utility bills is currently under way.

Table 1. Verified Annual Savings for Year 1 of ESCO Project

Energy Conservation Measure	Electric energy (kWh)	Electric demand (kW)*	Natural gas (MBtu)	Water (Cubic Feet)	Oil (gallons)	Total cost savings
Energy-Efficient Lighting & Lighting Control	1,627,580	374				$131,315.77
Energy Management Systems					16,356	$14,978.01
Water Conservation			42	303,333	1,149	$34,747.13
Pool Cover at the High School	8,388			10,746	12,785	$13,303.02
Boiler Controls			1,186		11,635	$11,866.27
Vending Machine Controllers	50,360					$4,045.87
Steam Traps at the Wellington School					7,216	$6,474.54
New Rooftop HVAC Units at the High School	22,464					$1,851.05
Total	**1,708,792**	**374**	**1,228**	**314,079**	**49,140**	**$218,581.66**
						Year 1 guaranteed cost savings: $202,834
						Year 1 CO_2 savings: 1,564 tons

Source: Noresco; CO_2 savings calculated by Sustainable Belmont

Part II
Belmont Greenhouse Gas Inventory

A greenhouse gas inventory is a compilation of emissions of greenhouse gases, primarily carbon dioxide (CO_2), as a result of activities in a city or town. CO_2 emissions arise primarily from the burning of fossil fuels, natural gas, oil, and coal, to provide electrical energy, to heat our buildings, and to drive our transport vehicles. The sections that follow report data gathered for Belmont regarding electricity use, natural gas and fuel oil used for space heating and other purposes, and the energy used to power private and public modes of transportation. The report includes data on waste disposal because its handling leads to some carbon emissions, but mainly because waste disposal raises significant environmental issues. The most complete data we have been able to obtain applies to the year 2007, so that is our baseline year. Data from 2001 through 2007 are used to discuss how emissions in Belmont have changed.

As a basis for making recommendations, we consider four categories of energy users: residents, businesses including utilities, institutions (i.e. churches, private schools, clubs and hospitals), and municipal operations including the public schools. Some of these data have been easy to obtain, especially electricity consumption from information supplied by the Belmont Municipal Light Department. Reliable data on fuel oil use, energy consumed for transportation, and quantities of waste have been more difficult to obtain. To fill the gap in data from public records, Sustainable Belmont conducted two surveys. Town employees were surveyed for data about their commuting habits, and a sample of town businesses and institutions were interviewed for information about their energy use from operations and employee commuting, and the quantities and disposal means for waste materials generated.

Practically all of Belmont's CO_2 emissions result from the combustion of fossil fuels: from the gasoline and diesel fuel used in our cars, trucks, and buses; from the natural gas and fuel oil used to heat our buildings; and from the power plants fueled with coal, oil, or gas that provide most of our electricity. Use of

Energy Units

In everyday life we talk about energy in connection with heating our home, running our cars, and in our diet—the food we eat. In engineering, a fundamental unit of energy is the **joule** which is the energy delivered in one second by an electric current of one ampere supplied from a source of one volt. This is a rather small amount of energy, so other units are more commonly used in popular discourse. One **calorie** is the amount of energy required to raise the temperature of one gram of water by one degree Centigrade. One calorie is 4.184 joules. The familiar diet calorie is actually a kilocalorie, one thousand calories or 4,184 joules.

Electrical energy is calculated by multiplying the power in watts by an interval of time. If time is measured in hours, the result is **watt-hours**. A joule is one watt-second, so one watt-hour is exactly 3600 joules. One **kilowatt** is a thousand Watts, so one **kilowatt-hour** (**kWh**) is the energy of one kilowatt of power flowing for one hour, or 100 watts flowing for ten hours.

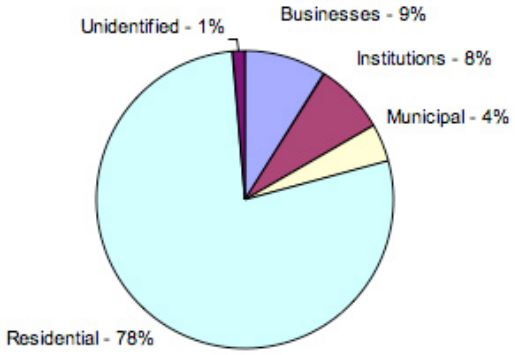
In the engineering of heating and air conditioning systems, the traditional unit of energy is the **British Thermal Unit**. One **Btu** is the energy needed to raise the temperature of one pound of water by one degree Fahrenheit and is equal to 1055 joules or about 252 calories. One kWh is 3,410 Btu. We measure natural gas consumption in therms where one therm is 100,000 Btu.

On an even grander scale, world energy consumption is discussed in terms of **quads**, where one quad is 10,000,000,000 (ten billion) therms. United States consumption was about 100 quads for 2002 versus 446 quads for the world in 2004.

each kind of fuel releases CO_2 in proportion to the amount of fuel used. The amount of CO_2 produced is the product of the amount of fuel and a coefficient that depends on the type of fuel. Total CO_2 emissions is the sum of these products over all fuel types and sources. Assembling and analyzing the Belmont greenhouse gas inventory has been aided by computer software provided by ICLEI which guides a user through the steps of data gathering and analysis. The ICLEI program uses coefficient values that include estimates of the "upstream" CO_2 emissions from production and delivery of fuel to its point of use. The software combines input data for all emission sources in town to yield a total "carbon footprint" for the town.

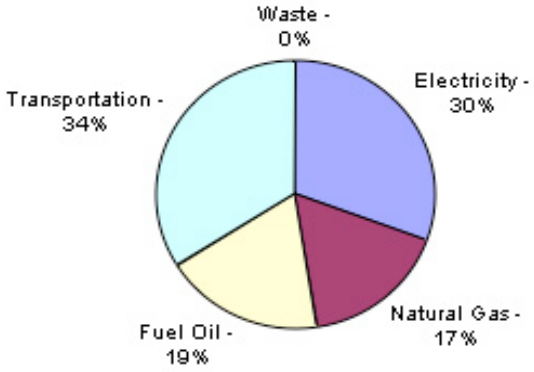
The following three charts summarize the data gathered and analyzed. Figure 1 shows the fraction of Belmont carbon emissions contributed by each sector of use: residential, business, institutional, and municipal. The values shown include the emissions from vehicle use associated with each sector. Figure 2 shows the percentage of carbon emissions from each source: electricity, natural gas, fuel oil, and transportation. In

Figure 1. Belmont Carbon Dioxide Emissions by Sector, 2007



Note: Based on data collected from 2005 to 2007. Percentages have been rounded.

Figure-2. Belmont Carbon Dioxide Emissions by Source, 2007

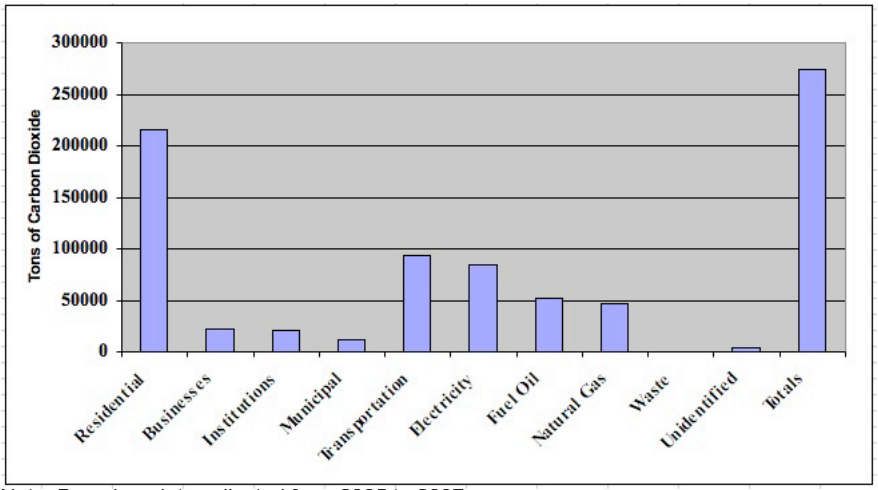


Note: Based on data collected from 2005 to 2007. Percentages have been rounded.

this chart all fuels used to power transport vehicles, except for trucks that transport waste, are included in "transportation." The fuel used to transport waste is too small to show in the chart. Figure 3 shows the amount in tons of Belmont CO_2 emissions by sector and source. Table 2 include percentages of carbon dioxide emissions by sector and source.

For a full Summary of Methodology used for the inventory of Belmont greenhouse emissions for this document, see Appendix H.

Figure 3. Belmont CO_2 Emissions by Sector and Source, 2007



Note: Based on data collected from 2005 to 2007

Table 2. 2007 CO_2 Emitted by Sector and by Source in the Town of Belmont.

Belmont CO2 By Sector, 2007				Belmont CO2 By Source, 2007		
	Tons	**Percent**			**Tons**	**Percent**
Residential	215,023	78%		Transportation	93,998	34%
Business	24,561	9%		Electricity	84,443	30%
Institutions	21,412	8%		Fuel Oil	51,387	19%
Municipal	11,990	4%		Natural Gas	47,183	17%
Unidentified	4,050	1%		Waste	134	0%
Total	**277,036**	**100%**		**Total**	**277,036**	**100%**

** Unidentified is estimated to be attributed to combined natural gas usage of one industrial user and one institutional user for which National Grid did not supply numbers.*

Emissions from Electricity

All of Belmont's electricity, whether for residential, commercial or municipal use, is procured and distributed by the Town of Belmont's municipally owned utility, the Belmont Municipal Light Department (BMLD). The BMLD operates under a manager who is responsible to the three town selectmen. The BMLD is advised by the Municipal Light Advisory Board or MLAB, which has six members appointed for staggered three-year terms by the selectmen. The MLAB provides recommendations to the selectmen who have final say in all decisions.

Electric energy powers all electrical appliances. Most people cannot imagine life without electric energy, as it is integral to every part of daily living. Computers, stereos and televisions, refrigerators, microwaves and air conditioners are but a few of the items used daily that require electricity to run. Electricity is even used in non-electrical heating systems; gas and oil burning appliances often use electrical ignition, and the pumps and fans that circulate heated water and air are driven by electric motors. Microprocessors, which control a vast array of products, run on a continual micro-flow of electricity. In general, anything that plugs into an electric socket or is powered by flipping a switch operates on electric energy.

In general, each town and city in the Commonwealth of Massachusetts receives its electricity either from an investor-owned utility, such as National Grid or NStar, or from a municipally- or customer-owned utility such as the BMLD. A utility company or department may either generate electricity or purchase electric power from suppliers for delivery to its customers. Under deregulation, a utility may buy electric energy from suppliers on behalf of its customers and bill the customer for the cost of buying the energy plus the cost of distribution to the customer.

The BMLD is one of just 40 municipal utilities among the 351 towns and cities in Massachusetts. The BMLD does not at present generate any electricity, but purchases energy from suppliers at market rates and operates and maintains the distribution system for electricity within the Town.

There are two main differences between an investor-owned utility and a municipal utility: First, an investor-owned utility provides dividends to its investors, pays taxes on its income and pays taxable interest on the money it borrows. These costs are passed on to its customers or rate payers in the form of higher prices. Municipal utilities, on the other hand, do not pay dividends, are exempt from taxation, and are able to borrow money at a tax-exempt interest rate. For an investor-owned utility, the customer rates and rate of return on capital infrastructure are set by the Massachusetts Public Utilities Commission. Municipal utilities charge rates established by the town government.

Second, as a result of state-wide deregulation of the electric power market, customers of investor-owned utilities may elect to purchase electricity from third-party suppliers if they wish. Under Community Choice, residents of a municipality may elect to have their electric energy supplied by third-party suppliers instead of the default supplier of their local utility company. A municipal utility is responsible for ensuring a supply of electricity and providing and maintaining the distribution network that delivers the power to its customers. It may choose the source of

Energy Generation in Massachusetts

As the most populous state in New England, Massachusetts has large energy needs and remains dependent on fossil fuels imported from domestic and foreign sources. Petroleum is generally shipped to large ports such as Boston Harbor. With nearly forty percent of Massachusetts homes requiring fuel oil for heat, the state is prone to oil shortages and price spikes during the winter months. Natural gas is piped from the Gulf Coast and Canada, while coal is brought from Appalachia and Colorado. While cleaner natural gas is now used to produce almost half of the state's electricity and petroleum electricity generation has dropped in the past 20 years, coal is still used extensively, meeting over a quarter of the state's electricity demand. Massachusetts possesses significant renewable energy potential, as wind power has great promise on both the Atlantic shore and in the western Berkshire Mountains. The building of the proposed 420-megawatt off-shore wind farm on Nantucket Sound, the first of its kind in the nation, would be a major step forward.

Wind Power

Wind power is the conversion of wind energy into a useful form, electricity nowadays, using wind turbines. Large-scale wind farms reduce greenhouse gas emissions by displacing electricity produced from fossil fuels. Wind energy is plentiful, renewable, and clean. Because wind energy is not continuously available, either other sources of power must be provided for days of calm, or energy storage is needed which is not presently economical. Wind turbines require less maintenance than conven-tional power plants. At the end of 2007, worldwide capacity for wind-powered generation was 94.1 gigawatts, about 1% of world-wide electricity production. In Denmark wind power supplies about 19% of electric energy. Globally, wind power generation increased more than fivefold from 2000 to 2007.

Wind turbines in Montana.
Photo: Obel Kraus/NREL

its electricity among suppliers able to deliver to the municipality according to the wishes of the residents. Because they are owned by the customers, municipal utilities are not profit-oriented and work to keep the price of electricity as low as possible.

Of course, there are trade-offs for participation in either structure. In the area of advancing conservation and energy efficiency, one difference is that in investor-owned utilities in Massachusetts, a percentage of the monies received for power supply and distribution is placed in a trust to fund grants for customer education about energy efficiency, rebates for renewable systems, and other measures the benefit the community at large. The Massachusetts Technology Collaborative (MTC), through its Renewable Energy Trust, administers these funds on behalf of the utilities. The MTC has provided hundreds of thousands of dollars of educational and other grants to its members. Belmont residents have not benefited from these grants due to the municipal status of the BMLD. However, the Green Communities Act passed by the state legislature in July 2008, includes a provision that allows municipal electric departments to join the MTC's Renewable Energy Trust.

Municipal utilities also have other collective organizational opportunities. The Massachusetts Municipal Wholesale Electric Company (MMWEC) is a joint action agency for the consumer-owned, municipal utilities of Massachusetts. MMWEC makes available a wide range of power supply, financial and other services to meet the common needs of its municipal members. The Town of Belmont is no longer a member of MMWEC but could consider rejoining should its activities match Belmont's goals and objectives.

The sources of electrical power consumed in Belmont are principally power plants in Massachusetts that use fossil fuels (coal, oil, or natural gas). A significant fraction comes from the Seabrook nuclear plant. As demand fluctuates, power is exchanged with other states over long distance transmission lines. In accordance with the wishes of Belmont residents, five percent of electricity for BMLD

How Electricity is Measured

The rate of use of electricity at any moment of time is called power and is measured in **watts**. For instance, a 100-watt light bulb uses 100 watts of power, a typical desktop computer uses 65 watts of power, and a central air conditioner uses about 3,500 watts. Electric energy is measured in watt-hours (Wh). The amount of energy consumed by a device is found by multiplying its power by the length of time it is used. Thus, if a 100-watt light bulb runs for one hour, it uses 100 watt-hours of energy. Energy adds up, so one 100-watt light bulb left on for five hours is 500 Wh and five 100-watt light bulbs left on for one hour is also 500 Wh. One thousand (1,000) watt-hours equals one kilowatt-hour (kWh) – a more convenient unit for measuring electric energy on a monthly or annual basis. For example, operating a 3,500 watt air conditioner five hours per day for 30 days consumes 3.5 times 5 times 30 or 525 kWh.

customers is hydro-electric power purchased from the New York Power Authority.

Electricity Use

Because the BMLD is a municipally owned utility, acquiring basic electricity data for multiple years was not only feasible but relatively easy. In fact, annual, monthly and financial data were received for each rate class for years 2001 through 2007. During this period the BMLD supplied electricity to Belmont under nine different electricity rate categories. Of the nine rate classes, Rates A and LI (Low Income) apply to residential customers, and rates B, E, F and G apply to Belmont?s commercial, industrial and institutional customers. Two rates, Town B and Town E apply to municipal buildings and rate SL applies to street lighting. Details of these rates are provided in Appendix E. [A special discount rate for McLean Hospital was introduced, apparently in 2006-2007.]

In 2006, The BMLD distributed 125,100,695 kWh of electricity to customers in Belmont corresponding to CO_2 emissions of 84,443 tons. As may be expected from a community that describes itself as "a town of homes," the residential rate class was the largest consumer of electricity, accounting for about half of total electricity consumption. The four rates classes comprising the commercial customers were responsible for slightly more than one-third, while the three municipal rates accounted for a mere six percent. Table 3 shows the breakdown of consumption and emissions among use by sectors of the town. The split of commercial rate consumption between businesses and institutions is based on survey responses (Appendix C).

The Future of Nuclear Power

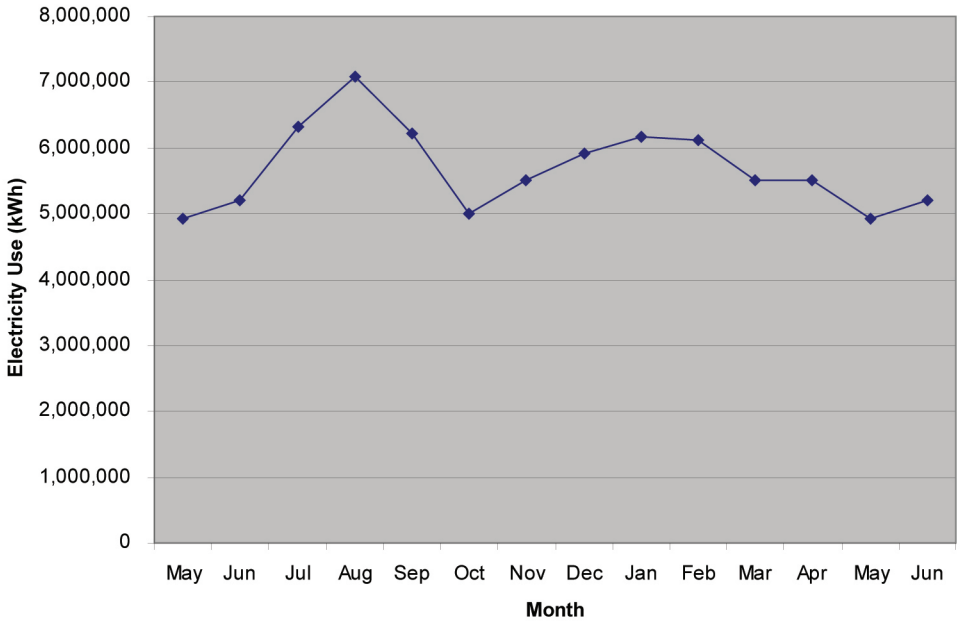
In the United States, nuclear fission reactors provide about 20% of our electricity; a much larger fraction is produced in some other countries such as France. While the carbon dioxide emissions associated with nuclear energy are very small, the safety of nuclear power is a serious concern. The fission of uranium produces highly radioactive strontium, cesium, and iodine, which would have disastrous environmental and health effects if released. Spent nuclear fuel also contains radioactive isotopes of plutonium (a potent carcinogen) and uranium that have half-lives of more than one thousand years. The choices for the waste fuel are either to store it indefinitely, or to "reprocess it" to recover plutonium for use as a fuel. Reprocessing has troublesome implications for nuclear weapons proliferation. Another source of radioactive waste arises from decommissioning of nuclear plants, which have a life expectancy of around forty years.
If these obstacles could be resolved in an environmentally acceptable and cost-effective manner, the long-sought goal of energy from nuclear fusion would likely have broad support.

Figure 4 (page 30) shows how electricity consumption varies over the months of the year, with a strong peak in the summer as air conditioners are operated on days of extreme heat and humidity-events projected to become more numerous in future years. The summer peak determines the supply capacity the Town must provide to meet customer demand, so any means of reducing peak demand will help the system operate more efficiently.

Future Electricity Usage Trends

Belmont is not growing much in population but our appetite for consuming energy is still increasing. Electricity consumption data from the BMLD show that over the years from 2001 through 2007, electricity use increased by 1.24 percent each year. Continuing this recent history would lead to electricity consumption of 135,414,000 kWh annually in 2020, which, if obtained from the same sources, would mean emissions of 13,534 additional tons of CO_2 each year. Switching some supply to renewable energy sources will help ameliorate the problem, but individuals need to make a significant difference by reducing consumption. On the other hand, electricity may play an important role in stemming CO_2 emissions and climate change. If use of electrically operated heat pumps for space heating grows substantially, or if plug-in vehicles become popular, the Town will need to fill a large increase in electricity demand, but in doing so may also achieve a large reduction in emissions from fossil fuels, especially if derived from renewable sources.

Figure 4. Average Residential Electricity Use by Month



Note: Based on BMLD data from 2001 through 2007.

Table 3. Belmont Electric Energy Consumption and Emissions, 2007

Sector	kWh	Tons of CO_2
Residential	73,177,86	49,395
Business	22,982.691	15,513
Institutional	19,234,186	12,983
Municipal	7,454,693	5,032
Unidentified *	2,251,439	1,520
Total	**125,100,695**	**84,443**

* *Attributed to Industrial use*

Natural Gas and Fuel Oil

Natural gas and fuel oil are the primary fuels for space heating in the New England states. In many cases natural gas is also used for water heating and in gas ranges and dryers. When natural gas is burned it emits less CO_2 than other fossil fuels used for heating and electricity: 29 percent less than oil and 44 percent less than coal.[7] Nonetheless, natural gas consumption is a significant contributor to global warming emissions at 11.7 pounds of CO_2 for every therm. Fuel oil used for heating is mainly no. 2 fuel oil, although kerosene and both no. 1 and no. 4 fuel oils are also used and are included in this inventory. Heating oil is an important fuel for the Northeastern United States. Of the 8.1 million households in the United States that use heating oil to heat their homes, 6.3 million households or about 78 percent are located in New England and the Central Atlantic States.[8]

Methodology

National Grid, formerly Keyspan Energy, the natural gas provider of Belmont,[9] supplied energy consumption data in therms for the years 2003 through 2007. The total natural gas consumption and number of meters for account billing was provided for two categories, residential and commercial, as shown in Table 4.

The data for commercial accounts include municipal usage and do not show how usage divides between businesses and institutions. For these missing data we used information from the ESCo project, Town offices, and from the Sustainable Belmont commercial survey (Appendix C).

For lack of better data, the municipal data pertains to the May 2003 to April 2004 period. The data is shown in Table 5 and includes fuel oil as well as natural gas. The ESCo data includes the largest schools, the library, the Town Hall and several department buildings. Natural gas and fuel oil consumption data for the few Town buildings not included in the ESCo study were provided by the Belmont Building Services Department[10] and pertain to the Town's fiscal year 2007 which is the period from July 2006 through June 2007. The sum of business and institutional natural gas consumption in Table 5 is the result of subtracting the values for municipal use from the natural gas data for commercial accounts in Table 4. The split between business and institutional use was determined from the results of the Sustainable Belmont survey of businesses and institutions (Appendix C), and the survey also provided estimates of natural gas and fuel oil consumption. These data form our best estimate of how fuel use is distributed over non-residential sectors of the town.

Table 4. Belmont Natural Gas Data

Sector	2003		2007	
	# Meters	Consumption (Therms)	# Meters	Consumption (Therms)
Residential	4,405	4,938,805	7,168	6,340,566
Commercial	242	1,465,259	339	1,724,960
Total	4,674	6,404,064	7,507	8,065,526

Many heating oil companies serve residential customers in Belmont. Given the difficulty of obtaining delivery data, we chose to estimate residential heating oil consumption using data from the Energy Information Administration (EIA) and the 2000 U.S. Census. From the year 2000 Census data, there were 9,732 occupied housing units in Belmont, of which 4,392 (45%) used fuel oil for home heating.[11] According to the EIA, the

7 Natural Gas 1998 Issues and Trends, p 49. Coal emits 20.8 pounds, and petroleum products emit 16.4 pounds of CO2 per therm. Energy Information Administration. U.S. Department of Energy. Online at *http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/natural_gas_1998_issues_trends/pdf/it98.pdf.*

8 Residential Heating Oil Prices: What Consumers Should Know. Energy Information Administration. U.S. Department of Energy. Online at *http://www.eia.doe.gov/neic/brochure/heatingoil2006/index.html*. September 8, 2007.

9 NSTAR also provides natural gas to customers in Belmont, but in a negligible service area.

10 Justin Poirier, Administrative Assistant, Belmont Building Services Department. Personal Communication, December 11, 2007.

11 *http://factfinder.census.gov*, November 6, 2007. The other heating fuels are: utility gas, 4,607 units; electricity, 593 units; bottled, tank, or LP gas, 93 units; other fuel 29; and no fuel used, 15. No units were designated as using coal or coke, wood,

Table 5. Fuel Use by Municipal Buildings, Businesses and Institutions		
Sector	**Natural Gas (Therms)**	**Fuel Oil (Therms)**
Municipal Buildings	175, 807	514, 182
Businesses	1,147, 024	368,714
Institutions	334,570	792,332
Total	**1,465,259**	1,675,228

Data collected 2007

average household in New England used 716 gallons of fuel oil in 2001.[12] Multiplying 716 gallons per household by 4,392 households and 1.4969 therms per gallon,[13] yields 4,707,260 therms which is an estimate of the total amount of energy from heating oil used by Belmont residents in 2001. There is no better estimate for 2007, for which consumption is likely to have been less due to conversions from oil to natural gas and conservation measures.

Data Analysis

Table 6 shows natural gas and fuel oil consumption and CO_2 emissions for the residential, business, institutional and municipal sectors. The data includes natural gas used both for space heating and non-heating applications.

From the survey of businesses and institutions (Appendix C), Sustainable Belmont found that fuel oil is used by somewhat less than half of the businesses contacted, and that business use is less than fuel oil consumed byinstitutions such as schools and houses of worship. The table shows how natural gas and fuel oil consumption is distributed over four activity sectors of the town. Unfortunately, lack of data precludes any conclusion regarding trends in fuel oil consumption. Natural gas use is increasing, but from 2003 to 2007 the number of gas meters increased by 63 percent, but gas consumption only increased by 30 percent, perhaps because many of the new customers have smaller residences or are practicing conservation.

Table 6. Belmont Natural Gas and Fuel Oil Consumption				
Sector	**Natural Gas**		**Fuel Oil**	
	Therms	**Tons CO_2**	**Therms**	**Tons CO_2**
Residential	6,340,566	37,092	4,707,260	38,696
Business	799,866	4,679	368,714	3,031
Institutional	316,840	1,854	792,332	6,513
Municipal	175,807	1,028	514,182	4,227
Unidentified	432,447	2,530		
Total	**8,262,250**	**47,183**	**6,382,488**	**52,467**

Note: Data collected for 2007.

Overall, the commercial and municipal customers use less energy and emit less CO_2 than residential customers. Residential customers use almost three times more natural gas than commercial customers. However, the number of therms per commercial meter is more than three times that per residential meter, which indicates commercial businesses are much more intense users of natural gas. This is not surprising, as businesses and institutions generally have much larger areas to heat than residences.

or solar energy for heating. Although the Census indicates that Belmont had 4,607 housing units using utility gas as heating fuel, National Grid data indicates there were 7,258 residential gas meters in 2001. This discrepancy is due to the facts that households that use gas only for cooking and other non-structural applications count towards the number of meters, and a two-family house, which would likely have 2 meters, is counted as one housing unit in the census.

12 *http://www.eia.doe.gov/emeu/recs/recs2001/ce_pdf/enduse/ce1-9c_ne_region2001.pdf,* February 25, 2008.
13 *http://www.uwsp.edu/CNR/wcee/keep/Mod1/Whatis/energyresourcetables.htm*, January 6, 2008.

Transportation

In Belmont, transportation is a major contributor to the Town's total CO_2 emissions. Whether measured by fuel use or vehicle miles traveled, emissions caused by transportation increased between 2001 and 2006.

Residential Sector

Belmont is known as a "town of homes." Therefore, it is not surprising that the residential sector accounts for the major share of the Town's greenhouse gas emissions. Transportation of residents, together with home heating, are the major contributors to the residential sector's total carbon emissions.

Fuel Consumption 2006 & 2001. In 2006, there were approximately 15,300 passenger vehicles registered to Belmont residents.[14] Based upon a statewide average fuel consumption of 581 gallons per year per vehicle,[15] annual fuel consumption was 8.89 million gallons. Using a conversion factor of 20 pounds of CO_2 per gallon of gasoline, we estimate that in 2006, automobile use by Belmont residents resulted in emission of about 89,000 tons of CO_2.

Five years earlier, in 2001, there were 13,766 passenger vehicles registered to Belmont residents.[16] Based on the same average fuel consumption per year per vehicle of 581 gallons, total annual fuel consumption was 8 million gallons. Applying the conversion factor of 20 pounds of CO_2 per gallon of gasoline, we estimate that in 2001, automobile use by Belmont residents resulted in emissions of approximately 80,000 tons of CO_2.

Between 2000 and 2006, Belmont's total population stayed essentially constant, decreasing by one percent (from 26,000 in 2000 to 25,641 in 2006). In contrast, between 2001 and 2006, the number of registered vehicles in Belmont increased by 11 percent. Based on the increase in the number of vehicles, Therefore, it can be estimated that annual carbon emissions increased by 9,000 tons. If that rate of increase continues, there would be 16,322 vehicles registered to Belmont residents in 2010, resulting in annual carbon emissions of approximately 95,000 tons.

> "I walk to the center from my home (one mile) whenever possible to conduct routine errands. I have installed energy saving light bulbs throughout my home. I have installed several ceiling fans to lower temperature in the summer to eliminate or reduce the use of room air conditioners.
> I think it's important to take these actions in order to begin to develop habits that will be both good for my own health and the health of my family, and also to begin to learn how to live a more sustainable life. We need to reduce demand so we can tame the beast."
>
> — Daniel C. Leclerc, Chair,
> Belmont Board of Selectmen

Modes of Transportation to Work and School. Year 2000 U.S. Census data for Belmont indicates that most employed residents travel to work in their own car. Of the 12,619 employed Belmont residents in 2000, 70% drove to work alone. Another 10% carpooled to work. The remaining 20% worked at home or traveled to work by other means, including public transportation. Another significant source of vehicle miles traveled by Belmont residents is transporting children to and from school. As of October 2007, only 19% of students enrolled in the Belmont public schools rode the school bus to and/or from school. A 2006 survey of parents at the Wellington School revealed that 41% of children enrolled at Wellington walk to school. Therefore, an estimated 40% of Belmont's students are transported to and from school by car.

Public Transportation Ridership. The MBTA provided bus and commuter rail ridership figures in terms of total boardings at specified stops.[17] Commuter rail data are available for 2001 and 2006 and indicate that ridership stayed essentially constant in those two years (with some declines in intervening years). Approximately 260 passengers board the in-bound

14 2006 excise tax data obtained from the Belmont Town Treasurer (2005 data not available).

15 Massachusetts Highway Department, Transportation Facts, 2001.

16 2001 excise tax data obtained from Boston Metropolitan Planning Organization, Central Transportation Planning staff.

17 MBTA Service Planning.

commuter train from Waverley (125 boarders) and Belmont Center (140 boarders) on a typical weekday (Table 7).

Table 7. Commuter Rail Ridership

Station	February 2001	April 2006
Waverley	127	125
Belmont Center	131	140

Source: MBTA Service Planning

Bus ridership data (for buses passing through Belmont) is collected on a rolling basis, in 2006 or earlier. Therefore, it is not possible to discern trends over our study period. The data indicate that on a typical week day 2,687 people board the bus in Belmont. That would include non-Belmont residents, as well as Belmont residents traveling within or out of town to work or other destinations. The most boardings occurred at stops as shown in Table 8. Together, these locations account for 58 percent of typical weekday boardings.

Table 8. Bus Boardings in Belmont

Location	Boardings per Day
Church St. at Lexington St.	496
Common St./Cushing Sq.	214
Trapelo Rd. at Church St.	201
Alexander Ave. at Leonard St.	176
Trapelo Rd. at Bartlett Ave.	173
Trapelo Rd. at Beech St.	156
Concord Ave. at Orchard St.	146

Municipal Sector

Like other towns, Belmont has a substantial fleet of vehicles to assist it in fulfilling its responsibilities of caring for the Town's roads and other infrastructure, fire protection and public safety, among other duties. Although the Town fleet is not as large a contributor to transportation-generated emissions as the residential and commercial sectors, it is particularly significant because by altering its practices to reduce its emissions, the Town can set an example for all Belmont residents and businesses/institutions.

Fleet Inventory. In 2006, Town departments had 122 vehicles. The largest fleets were in the following departments: Highway Department (34), Police (19), Municipal Light (18), Fire (13) and Water (12). The Parks Department had 7 vehicles, the Cemetery Department had 4, and the remaining departments had no more than 1 or 2 vehicles each. In 2006, the police department had 2 motorcycles and 4 bicycles in its fleet as well.[18]

Fuel Consumption. The fuel consumed (unleaded gas and diesel) by each department in 2006 is listed in Table 9. A total of 58,123 gallons of unleaded gas and a total of 29,729 gallons of diesel fuel were consumed by the Town fleet in 2006, resulting in emission of approximately 327 tons of CO_2. About 28 percent of the fuel is used by the Police Department, which is the largest consumer.

In addition to these vehicles, the Town contracted with Atlantic Express in Woburn to provide transportation for students on six school buses. To estimate fuel consumption, we assume each bus makes four trips of 10 miles each day for 200 days of the year. At ten miles per gallon, this results in 4,800 gallons of diesel fuel consumed and 52 tons of CO_2 emissions.

Commuting by Town Employees

Municipal employees traveling to work in Belmont are another source of emissions generated by the municipal sector. Sustainable Belmont conducted a survey of Town employees in the fall of 2007 to find out how they travel to and from work. The survey revealed that the vast majority of employees (90%) usually drive alone to and from work. Approximately half of the municipal employees live within 5 miles of their workplace and 86% of those employees usually drive alone to and from work. Although only 4% of Town employees regularly walk or bike to work, another 17% indicated that they sometimes walk or bike to work. Only 1% of municipal employees regularly commute to work by public transportation, with another 3% sometimes commuting by public transit. Based upon reported distances between home and work and automobile mileage rates, and extrapolating to the entire universe of municipal employees, it is estimated that municipal employees use their cars to travel roughly 3,305,857 miles to and from work each year. This corresponds to annual emissions of 1,322 tons of CO_2.

When asked which of a list of options would help them to switch to a more "environmentally friendly" way to commute, 56% answered "nothing" while 5%

18 Data provided by Belmont Department of Public Works and Belmont Police Department, 2006.

Table 9. Fuel Consumption by Town Vehicles

Department	# Vehicles	Gallons of Gasoline	Gallons of Diesel
Buildings	1	634	0
Cemetery	4	1,120	972
Community Development	2	673	0
Council on Aging	2	1,507	1,329
Fire	13	2,185	7,263
Parks	7	3,341	1,623
Health	2	787	0
Housing	2	1,309	0
Light	18	6,225	4,241
School	4	3,039	0
Water	12	2,677	3,048
Recreation	1	194	0
Highway	34	9,114	11,253
Library	1	304	0
Police	19	25,014	0

gave no response. Approximately 16% of respondents indicated that organized car/vanpools might be an appealing alternative. Approximately 8% answered that subsidized public transit passes would help them switch to a more environmentally friendly means of transport. A shared car that could be used by employees during the work day was chosen by 6% and bike racks by 5%. Several employees commented that better and safer bike paths and shower and locker facilities would make them more likely to bicycle to and from work. The complete survey results, including data on response rates, are in Appendix B of this report.

Business/Institutional Sector

Although it is a "Town of Homes," Belmont also has a significant number of businesses and institutions. Data about their fleets and fuel use are not as easily obtainable as for the other sectors, however. Excise tax data provides some information, although it does not appear to be complete. Sustainable Belmont conducted a survey (Appendix C) of representative businesses to get some sense of energy use patterns within this sector, including business/institutional use of vehicles.

Commercial Fleets. Excise tax data for 2006 indicate that there are 27 "Belmont businesses with fleets" and that together they have 245 vehicles.[19] The businesses included are mostly landscaping and construction businesses. The largest fleets included are those of Waverley Landscaping (54), James Flett (contractor) (35) and DS Waters (the Belmont Springs bottled water distributor) (26). The listing appears to only include vehicles which are garaged in Belmont. Responses from businesses sampled in the commercial survey showed 23 vehicles used by businesses plus 94 vehicles used by the three contractors in the sample and 21 vehicles used by the institutions. We extrapolated the number of business vehicles to 404, giving a total of 519. This total is reasonably consistent with Town data showing that there are 714 commercial vehicles registered in Belmont. Our survey responses included annual miles of operation from which we estimated that annual business and institutional vehicle use adds up to around 4,201,791 miles of operation. Using an average of 20 miles per gallon of fuel, we estimate that approximately 210,090 gallons of gas are consumed per year by Belmont?s business/institutional sectors, resulting in emissions of about 2,311 tons of CO_0.

Commuting. From the survey of businesses and institutions, an estimated 70 percent of the employees drive to work alone and 21 percent use public transport. The remaining nine percent walk or cycle, although this estimate is biased by one business in which almost all employees bike or walk to work. Employee commuting in the emissions summary for Belmont is not included because many, if not most, employees travel from residences outside Belmont.

Vehicle Miles Traveled

As an alternative means of estimating emissions generated by transportation in Belmont, we have obtained "vehicle miles traveled" (VMT) figures for Belmont for the years 2000 and 2005. These data were generated by the Central Transportation Planning Staff (CTPS) using a regional model.[20] The Belmont area consists of 14 zones. Aggregating the traffic counts in those zones, CTPS estimates that the total daily VMT in Belmont was 538,400 in 2000 and increased by 16,000 miles (a 3% increase) to 554,400 miles in 2005. That is a relatively small increase compared with the increase of 11% in the number of passenger vehicles

19 Data provided by Belmont Town Treasurer.
20 Boston Region Metropolitan Planning Organization. Online at *http://www.ctps.org/bostonmpo.*

registered in Belmont between 2001 and 2006. At 25 average miles per gallon, this traffic is responsible for emission of 80,942 tons of CO_2 annually in 2005, remarkably close to the estimate based on passenger vehicle registrations.

It should be noted that VMT includes all vehicles traveling through Belmont, regardless of where those vehicles are registered, where they originated or where their destinations are. The data suggest that Belmont traffic from out-of-town residents is roughly balanced by out-of-town miles driven by Belmont residents.

Transport of Merchandise and Food

Belmont residents bring into town purchases of household goods and food, all of which is transported from its site of manufacture or production with the consumption of energy contributing to the carbon footprint of the town. It is reasonable to suppose that food purchases, in general, account for a large portion of emissions resulting from transport of goods.

Summary

Table 10 summarizes the transportation emissions data. The emissions total for personal travel includes a small amount, less than one percent, derived from a crude estimate of emissions from public transport using the boardings data. The rest is from private autos. Emissions due to long-distance travel for business or pleasure would substantially increase the emissions total, but the data are not available. Also omitted are emissions due to transport of the merchandise and food we purchase. The municipal total is dominated by an estimate of commuting by Town employees. There is certainly some overlap with personal car use for employees residing in Belmont, but the authors judged this to be minor. The emissions amount for businesses is from survey responses, and is mostly from the three contractors in the survey who operate many vehicles. Town institutions account for a very minor portion of emissions due to transportation.

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Table 10. Summary of Transportation-Related Emissions in Belmont

Sector	CO_2 Emissions (tons)
Personal	89,877
Businesses	2,238
Institutions	73

Waste

Waste is material no longer used and consists of things thrown out in the trash, choose to recycle, or give to others or to charity. Waste may be classified as paper, cardboard, food waste, other organic material (yard waste), discarded clothing, appliances, and furniture; also building materials arising as scrap at construction sites or as demolition waste. Some materials such as cleaning chemicals, insecticides and spent lubricating oil and grease are hazardous and must be treated specially.

Waste handling leads to greenhouse gas emissions in several ways: Waste put into a landfill will lead to emission of methane from decaying organic material as well as CO_2. However, one can argue that this is a natural phenomenon for plant and animal material. Waste that is incinerated will generate combustion products, mainly water vapor, large amounts of CO_2, and significant amounts of toxic chemicals if they are not excluded from the processed waste or scrubbed out of the incineration exhaust. Again, it can be argued that the greenhouse gas produced by incineration would be produced anyway if the waste were allowed to decay naturally

Incineration can be performed in co-generation plants that produce electricity and/or heat that can be utilized in place of other energy sources. In this case, incineration has a positive effect on global warming by permitting a reduction in the use of energy produced from fossil fuels. The remaining source of emissions from waste handling lies in the transportation of waste from the site of production to the processing site, which is mostly done using trucks powered by fossil fuels.
Keep in mind that everything discarded came from somewhere. The energy consumed and CO_2 released in the manufacture and transport of goods for use far exceeds that associated with the disposal of things.
Waste includes waste water and other fluids we release in uncontrolled ways that can lead to air pollution and addition of toxic substances to our streams and rivers.

Trash Handling

Most solid household waste, including discarded furniture, is picked up weekly by a cotractor hired by the town from curbside under contract with the town of Belmont. Household appliances, such as washing machines, refrigerators, water heaters, and air conditioners, are picked up at the curb by the contractor for recycling, but each requires payment of a $20 fee and an appointment for pickup. Appliances, such as computer monitors and television sets, which contain cathode ray tubes (CRTs) are also picked up by appointment for a $15 fee. The contractor passes these items on to companies that recover components for recycling and properly dispose of hazardous materials. In 2007 the town collected $28,000 in fees, indicating that roughly 1500 discarded appliances were collected.

The Wheelabrator cogeneration facility in North Andover includes elaborate systems for removing toxic materials in waste that would otherwise end up in the atmosphere or waterways. Ferrous materials (iron and steel) are recovered from the waste stream and recycled. The processing of each ton of waste yields about 640 kWh of electric energy, which is far greater than the energy used to transport the waste. In fact, the electricity generated equals about five percent of Belmont's electricity consumption. In 2007 Belmont collected 9804 tons of trash, or about 350 pounds per resident.

Fees for trash disposal vary in that the less Belmont ships, the less it pays. In 2009, the approximate cost was $64 per ton.

Recycling

In Belmont, paper and plastic, glass and metal containers are collected bi-weekly for recycling Recycling bins are available from the town Public Works Department for a fee, although any durable container is acceptable for use. The contractor is required to market all recyclableless; its current practice is to deliver it to the FCR recycling facility in Charlestown, MA where FCR remarkets these materials around the world. Some go to uses of low value: for example, cullet (broken glass) often becomes drainage aggregate in FCR landfills but recently there was production of new glass containers. Much waste paper is shipped to Asia, filling the container ships that bring goods from China to the port of Boston. Belmont currently pays the contractor about $142 per ton to collect and recycle material.

The Public Works Department estimates that about 85 percent of Belmont households participate in the recycling program, although only about 40%

of eligible material is recycled. About 2,425 tons of material were collected in 2007, or about 87 pounds per resident. The recent expansion of the range of materials collected for recycling should lead to increased diversion of waste from trash collection.

Although Belmont's recycling program does not accept plastic bags, they are recyclable at local supermarkets, as are beverage containers for which the customer has paid a deposit. This recycling channel is probably more effective in ensuring that the material is recovered for reuse.

Yard Waste

Yard waste consisting of leaves, lawn clippings, small branches, etc. is collected by the contractor and delivered to the town's composting site at the Transfer Station on Concord Avenue. This material must be placed in 30-gallon bio-degradable paper bags, or in barrels no larger than 32 gallons, with stickers attached. Residents may also bring heavier material such as tree limbs and stumps to the composting site, which is also the destination for trees and brush cleared from town parks and other town property. Landscaping firms employed by private parties must pay to recycle leaves at the composting site. In 2007 about 2350 tons of yard waste was collected from residences and town property for composting. This amounts to about 84 pounds per resident.

Removing leaves and prunings robs mineral nutrients from the land which landowners replenish using fertilizers. Far better would be to compost the material on-site instead of shipping it away. Belmont encourages residents to compost materials themselves and sells composting bins for the purpose. They may be used for leaves and vegetable material, but not for waste meat and fat, which should be disposed of with the general trash.

Household Hazardous Wastes

Some waste materials are too toxic or hazardous to be included in the ordinary solid waste and recycling programs and great care must be exercised in disposing of them. These include materials such as cleansers, medicines, fertilizers, insecticides, herbicides, pool chemicals, paint, some batteries, mercury, many materials used in construction (paints, sealers, etc.), automotive wastes, etc.

Belmont residents may bring hazardous wastes, one Saturday each month except for the winter months, to the Minuteman Hazardous Products Facility at the Lexington Hartwell Avenue Landfill site for acceptance by waste management professionals for safe disposal. Yearly payments from each of eight towns ($12,000 from Belmont in FY 09), plus a state subsidy that has been decreasing in recent years, enable this operation to continue. For Belmont, the program is overseen by the Belmont Health Department where residents must register in advance to participate on a specific Saturday.

Fluorescent bulbs including CFLs, which contain small amounts of mercury, may be dropped off during hours of business at the Public Works Department office at Town Hall, the Belmont Municpal Light Department office on Prince Street, and Hillside Garden Supply on Brighton Street. Waste oil from various residential sources may be left at the Public Works Department Yard on C Street.

Businesses and Institutions

Belmont does not offer waste collection or recycling services to businesses and non-profit institutions. These entities must find independent means for disposal, usually through a private contractor. Our survey of businesses and institutions indicated that these two sectors of the town produced roughly 14,355 tons and 797 tons of waste, respectively, in 2007. It is not known how much is recycled. Most businesses practice recycling to some extent; there is a market for cardboard, so many businesses participate in recycling this material. An assortment of waste hauling businesses is used. Businesses and institutions are responsible for the proper disposal of any hazardous wastes they produce.

Municipal Waste

The waste contractor collects waste and materials for recycling from schools and town buildings. The Town reports that about five truckloads per week are collected. Estimating ten tons per truckload gives 2,600 tons out of the total collected.

Transport of Waste Materials

Much of the CO_2 emissions from waste handling are from the transport and processing of waste after its delivery to disposal sites. As mentioned above, incineration of trash produces CO_2, but by contributing to the electricity supply it reduces the amount of CO_2 released by fossil fuel plants. Yard waste produces emissions at the composting site, but that would also happen for other methods of disposal. For recycled materials, any CO_2 emissions from processing are probably justified by their substitution

for other materials whose manufacture would yield greater CO_2 emissions. The source of CO_2 emissions of direct concern to the town is from the transport of waste materials from the sites of origination to disposal sites. The amount of fuel use for residential waste transport may be calculated assuming that the trucks carry ten tons of waste and run at eight miles per gallon when loaded and 12 miles per gallon when empty. The results are shown in Table 11.

To complete this picture fuel use for transport of waste from businesses and institutions must be added. For this purpose, the amounts of total waste were estimated from the responses to the business survey (Appendix C), and assumed fuel for its transport is in proportion to the amount of waste. In Table 12, fuel use by the contractor was divided between residential and municipal in proportion to the quantity of waste.

Summary

In 2007, total waste collected in Belmont, by the Town or by firms under contract to the Town, amounted to 14,700 tons, or around 1,100 pounds per resident. The cost to the town for trash disposal was $170 per ton for delivering and processing at the North Andover cogeneration facility. The cost for recyclables was $142 per ton, showing the benefit of diverting waste into the recycling stream. Total residential and municipal waste generation, including trash, recycled material and yard waste has ranged between 14,000 and 15,270 tons per year since 2002. There is no obvious trend of declining or increasing waste generation over time. However, more could be done. In 2008, the Solid Waste and Recycling Advisory Committee found that if Belmont increased its recycling rate from its current 40% of eligible recyclable material to 58% (which is the recycling rate of Lexington), it would cut the Town's disposal fee by about $190,000 per year. That increase in recycling would also reduce CO_2 emissions.

In addition to the waste streams discussed above, other forms of waste deserve attention, in particular, water, releases to the atmosphere of pollutants other than CO_2, and construction debris. Also, residents should be aware that everything they purchase involves CO_2 emissions and waste generation from manufacturing and transportation that far exceed the amounts generated in Belmont.

Water. In addition to solid waste, activities in Belmont consume millions of gallons of water each day, most of which becomes waste water pumped to the MWRA processing plant at Deer Island. A sewer fee of $0.0824 per cubic foot, added to the water fee of $0.0434 per cubic foot, is charged to users for waste water disposal. Pumping waste water to Deer Island and treating it there consumes energy and yields a small amount of CO_2 emissions. Storm runoff flows into catch basins then to streams and rivers through a separate system of drain lines. There has been some cross flow between the town's sewage and storm drain systems, especially during and after heavy downpours, which the Town has been working to remedy.

Table 12 Estimated Diesel Fuel Use and Related Emissions for Waste Transport by Sector

Sector	Waste (tons)	Fuel (gallons)	CO_2 (tons)
Residential	11,979	5,366	59
Businesses	10,923	5,238	58
Institutions	733	328	4
Municipal	2,600	1,165	13
Total	**26,235**	**12,097**	**134**

Note: Data for 2007.

Table 11. Diesel Fuel Use for Waste Transport by Waste Type

Material - Destination	Waste (tons)	Distance (miles)	Fuel (gallons)
Trash - North Andover	9,804	26	5,424
Recycle - Charlestown	2,425	20	1,009
Yard Waste - Woburn.	2,350	10	98
Total	**14,579**	**48**	**6,531**

Notes: Categories include both residential and municipal waste.
Data collected for 2007.

Other Pollutants. Belmont is almost entirely a residential community; commercial and industrial discharges are limited. Nonetheless, the Purecoat North plant at the corner of Hittinger and Brighton Sts. has been a cause of concern for decades, because of various odors and fumes observed emanating from it. The town also has a number of automobile repair shops, service stations, clothes cleaners, and taxi fleets, etc., each of which generates unknown amounts of CO_2.

Woodstoves, pellet stoves, and fireplaces are seeing increasing use as the prices of natural gas and heating oil rise. Their growing popularity may lead to measurable increases in air pollution and CO_2 concentration from the burning of wood.

Debris from Construction and Remodeling. Construction contractors and homeowners are responsible for arranging proper disposal of debris and scrap material resulting from construction, repair and remodeling activities. Reuse and recycling of these materials is encouraged, but the practice is only slowly developing. Scrap metal has significant value and is readily sold for recycling. Points toward LEED certification can be earned through environmentally sound disposal of construction wastes.

Conclusion

There is plenty of opportunity for misunderstanding of town policies regarding waste. Exactly what is recyclable and what materials are hazardous? It is likely that much recyclable material is thrown in the trash, along with some materials that ought to be treated as hazardous waste. It is not clear how to treat metal objects such as kitchen utensils, used car parts, and old tools, although they would best be taken to a metal scrap dealer rather than discarded as trash. Plastic items that are not containers and are not marked with a recycle code are generally trashed although they are potentially recyclable. Waste handling can be improved by educating the public and providing better and more complete information about proper and environmentally sensitive waste disposal.

Part III
Recommendations

BELMONT, we have a problem. Our spaceship Earth is in trouble, and it is trouble of our own making.

Reducing Humans' Impact on Climate Change

Climate change scientists have said an 80% reduction of carbon dioxide (CO_2) emissions will be required to have a significant impact on mitigating the effects of climate change. Numerous business groups and government initiatives have established the goal of reducing our nation's CO_2 emissions by sixty to eighty percent by the year 2050. Although this goal is daunting, it is one that can be achieved. An average reduction of CO_2 emissions by four percent each year will, in forty years, yield a reduction to twenty-one percent of the original amount.

Recommendation: Reduce CO_2 emissions to 80 percent below 2007 levels by the year 2050.

The following chapters, provide suggestions of things Belmontians can do to move toward being a community more in harmony with a sustainable future for the planet. There are many simple things that people can do immediately, saving money and energy at little or no expense. Nevertheless, in the long run, achieving the forty-year objective will require vigilance, innovative new technologies, and changes in the way we live. There are two basic ways of moving forward. One is to utilize sources of energy that do not produce CO_2 emissions: Green Energy. The second is to consume less energy through conservation and improved energy efficiency. A feasible plan for the future will have to aggressively employ both approaches.

As the emissions inventory shows, the majority of Belmont emissions come from how individuals live and move around. For example, nationally, electric power currently comes seventy percent from burning fossil fuels (coal, oil, and gas), twenty percent from nuclear plants, and ten percent from renewable energy sources such as hydroelectric plants, wind power and geothermal. By reducing our consumption by fifty percent through conservation and improved energy efficiency, and by doubling the total contribution from renewable energy sources, the goal of an eighty percent reduction in emissions from the electricity sector would be achieved. Because lighting accounts for a high percentage of residential electricity usage, simply switching from incandescent bulbs to CFLs would be a significant step toward a fifty percent reduction in residential electricity usage.

Will there be support for government policies that encourage actions consistent with moving toward a green, sustainable economy? Some facts stand out: The public is unlikely to take steps that are economically unsound (in the near term). Consequently, a sufficient global reduction in fossil fuel consumption, to avoid disastrous climate change, will not happen unless the prices of coal, gas and oil increase. Removing subsidies and other tax advantages these industries presently enjoy would help to "level the playing field," making Green Energy companies more competitive.

Two kinds of legislative proposals to control carbon emissions are being considered: "Cap and Trade" arrangements, and the "Carbon Tax". These proposals will require international cooperation to succeed. Many industries are reforming now in anticipation of a future of CO_2 regulation and are already enjoying the financial benefits of improved energy efficiency.

Mounting an effort in Belmont that is sustainable for the next four decades will require an unprecedented continuity of leadership and commitment to meet the

goal. An 80 percent CO_2 emissions reduction must become a municipal goal as fundamental as providing for schools, maintaining the roads, and delivering police and fire services or water and electricity. Of course this goal will only be met with the active and vigorous involvement of the citizenry and commercial sector.

Early reduction of CO_2 emissions will largely be met by improving energy efficiency and conservation of energy derived from fossil fuels. Later gains will be made as new technologies become available that replace energy derived from fossil fuels and as improvements in the sequestration of greenhouse gases are achieved.

In the future, those gains are likely to be substantial but will clearly have to wait until society and technology evolve such capacities. Additional technological breakthroughs are possible, and with the proper funding and incentives in place, perhaps inevitable.

"I feel strongly about reducing fossil fuel consumption for several reasons. We tend to focus on climate change, but fossil fuel dependence also weakens our economy, pollutes our air, makes us beholden to hostile nations and draws us into conflicts in which we have no other national interest. The good thing about cutting fuel dependence and saving carbon emissions is that it saves money.

With CFLs and a little attention to turning things off, we have cut our electric bill by 40%. On our gas bill, we've found that weather stripping and discipline on things like keeping the door to our enclosed porch closed can make a huge difference. On the transportation side, driving a smaller car saves gas and reduces environmental impact. We have gone down to one car—a six-year-old Honda Civic Hybrid. We cycle when we can and have reduced our driving considerably."

—Will Brownsberger, State Representative, 24th Middlesex District

There is no need to worry now about where future cuts in emissions will come from. What is needed now are the first confident steps that will move the community along a path toward the goal. Belmont must be focused and aggressive about implementing strategies available today to improve energy efficiency and conservation in the short run—and be open to innovation and new opportunities as they evolve in the future. We must have faith and optimism that reaching the goal is possible. Many scientists and others feel as though the technology required to meet our CO_2 reduction goals already exist. What the nation has lacked is the leadership and will to change.

Sustaining the vision, the leadership, and the will to change may be the greatest challenge of all. While success in meeting the goal is not guaranteed, let it be written in history that Belmont is a community that summoned the courage to try.

Calculating Carbon Footprint

In 2006, the average American emitted 20 metric tons of carbon annually, more than those in any other country in the world. For comparison, Germans emitted nearly 11 annual metric tons per capita, while those in the United Kingdom emitted about 9 annual metric tons per capita, according to the U.S. Energy Information Administration. One of the first actions that households and businesses should take is to calculate the annual metric tons of carbon emitted, creating a baseline. After calculating one's carbon footprint, then set target reductiongoals and monitor regularly to determine success in reducing carbon. There are many free online carbon calculators available. Here is one website that includes calculators for both homes and businesses: **www.carbonfootrpint.com**

The Residential Sector

Emissions generated from energy use in homes account for 48 percent of Belmont's carbon footprint, and this is where the greatest change is needed. It is primarily individual decisions that will lead to progress. These emissions result from energy use in our houses and apartments, and include emissions from electricity use, and from the burning of natural gas and heating oil. Most of the emissions come from energy used to keep warm in the winter, and secondly, to keep cool during the hot spells of summer. Appliances (washers, dryers, etc.) and lighting account for the remainder. As with other sectors, the emissions produced can be reduced by a combination of conservation, efficiency, and a shift to non-fossil fuel sources to meet our energy needs.

> "Our house abuts one of the most unique features of Belmont, Sergi Farm—owned by the Ogilby family, farmed by the Sergis and home to Community Supported Agriculture on a small portion of the farm. This gives us the opportunity to eat a lot of locally grown produce, and we don't even have to drive to get it! We are lucky to live here.
> With our old gas boiler, the service company said that it was 85% efficient. But, an energy auditor said that the boiler was like using a bulldozer to dig a small hole; it was way more than was needed. The efficiency of our new gas boiler is estimated at 96%. And we've saving money too. We also use a programmable thermostat to adjust the temperature of the house for different times of day. This keeps the amount of gas we use down as well."
>
> *— David and Miriam Weil*

The primary emphasis must be on conservation—consuming less energy. The ways to accomplish this are to cut down the heat loss in our homes, to improve the efficiency of our heating systems, and to arrange for comfort at a lower (higher in summer) ambient temperature.

Reducing Heat Loss

Recommendation: Reduce residential heat loss.

- As an initial step, residents should conduct an energy audit of the home or apartment (see Box page 44).

In most homes, cutting heat loss by 50 percent or more is feasible. If you are building a new house or doing a major remodel, then the following construction features are likely to prove well worth the investment, given that energy is destined to become ever more costly..

- Insulate walls to R19 and ceilings below attic space to R40. This includes basement walls of basement living space, and attic entryways, for example, around pull-down attic ladders.
- Install energy efficient double-pane windows mounted in non-conducting window frames, or installing storm windows over single pane windows, a less expensive and less efficient alternative.
- Add moisture sealing (a "vapor barrier") to reduce air infiltration loss. (But be sure there is adequate ventilation.)
- Use a heat-recovery ventilation system so the heat in warm ventilation exhaust is used to warm incoming air. In the summer cooler exhaust air is used to pre-cool incoming air.
- Use two or more heating/cooling zones so energy is not wasted on conditioning spaces not in use.
- Build air locks at the most used building entrances.
- Seal all openings where air could leak out from living spaces: places where plumbing, ducting, or electrical wiring pass through exterior walls; gaps around chimneys or the means of attic access.
- Supply combustion air for gas/oil/wood fuel heating units and fireplaces/wood stoves from outside heated spaces.
- Include an attic fan that can effectively cool the house on cool evenings and nights.

It may be practical to make some of these improvements without major reconstruction of the house, for example the addition of an attic fan, or implementing heating/cooling zones.

If these major steps are too costly or must be deferred, there are many things residents can do to help reduce unnecessary heat loss:

- Caulk and weather-strip doors and windows, including storms. Caulk and seal leaks where plumbing, ducting, or electrical wiring

penetrates through exterior walls, floors, and ceilings. Some common examples are mail slots in doors (use an exterior mail box instead), bathroom vents, and kitchen hoods. Look for products labeled low or no VOC (volatile organic compounds) as VOCs react with nitrous oxides to form ozone, and some are carcinogenic or neurotoxic.

- Use a flue plug in the fireplace and close the fireplace damper—except during fireplace use.[21] Consider sealing the fireplace if it's not being used.
- Place radiator reflectors between the radiator the wall to redirect heat away from the wall and into living spaces.
- Open shades/drapes/blinds by day to let the sun's heat in; at night, draw them closed to keep the heat in.
- Be certain to use storm windows.
- Rugs on floors will help insulate and prevent heat from leaking through the floor to unheated space below.
- Plant leafy (deciduous) trees on the sunny side (usually west and south sides) of the house. During the summer they provide shade, and in the winter they will shed their leaves to let the warming sunshine through. Pine or fir trees on the north side provide an energy-saving windbreak. Alternatively, use awnings to keep the house cooler during summer.
- For those with ceiling fans, change the direction of the blades in the summer and winter.
- Insulate heating pipes that pass through unheated spaces.

21 For an example of a flue plug, see *http://www.batticdoor.com/fireplacedraftstopper.html.*

Energy Audits

An energy audit is the first step to assess how much energy one's home or place of business consumes and to evaluate what measures to take to improve a building's energy efficiency. An audit reveals problems that, when corrected, should save significant amounts of energy, money, and lower one's carbon footprint. During the audit, areas where a house is losing energy are pinpointed. Audits can determine the efficiency of a home's heating and cooling systems and may also indicate ways to conserve hot water and electricity. Individuals can perform a simple energy audit, or have a professional energy auditor carry out a more thorough audit. Often payback times are included to help prioritize improvements.

A professional auditor uses a variety of techniques and equipment to determine the energy efficiency of a structure. Thorough audits often use equipment such as a blower door test, which measures the extent of leaks in the building envelope, and infrared cameras that reveal hard-to-detect areas of air infiltration and missing insulation.

Electric and natural gas utilities in Belmont conduct free residential energy audits. The Belmont Municipal Light Department (BMLD) offers free energy audits through a partnership with Energy New England. To schedule an audit, call 1-888-772-4242.

If uncertain about what changes to make that will have the greatest benefit for the cost, have an independent energy audit done. Look for services such as a heat loss scan, infrared heat loss inspection, infrared thermal scan, and blower door air infiltration test. Follow the resulting recommendations.

If living in an apartment or condominium, your options require cooperation of the landlord or condominium association, but the principles to be applied are the same. If moving to a new residence, check that the needed improvements are already in place or are feasible to implement.

Heating System Efficiency

Recommendation: Increase heating system efficiency.

Energy efficiency in space heating is the ratio of thermal energy delivered to living spaces to the thermal energy available from the fuel consumed. Improving the energy efficiency of your heating plant will reduce the amount of natural gas or heating oil homes and commercial businesses use. Not only will CO_2 emissions be lowered, but monthly bills will also decrease, and the life of equipment will be extended.

In most residences, space heating is provided either by circulating hot water from a boiler through radiators, or by circulating hot air through ducts from a furnace. The boiler or furnace is fueled by either natural gas or fuel oil. The efficiency of a boiler or furnace is measured by its annual fuel utilization efficiency (AFUE), which is the fraction of heat produced from fuel combustion that is transferred to the water or air being heated, the remainder being wasted in exhaust gases.

Energy Star certified boilers and water heaters currently have a minimum AFUE rating of 85%, while Energy Star oil and gas furnaces currently have minimum AFUEs of 83% and 90%, respectively. Furnaces and boilers over 10 years old typically have an AFUE of 60 to 70%,[22] so replacing one of these older units with a high-efficiency natural gas heating system would yield as much as a 30% reduction in fuel consumption. If an oil burning unit is replaced with one using natural gas, the reduction in CO_2 emissions could be as high as 50%. If you don't know the AFUE of your current system, a service technician should be able to determine it.

Other measures to increase heating efficiency in residences include:

- Insulate heating pipes that pass through unheated spaces.
- Remove obstructions from radiators and clean heating registers regularly. Create some space between heating elements and furniture or drapes to improve heat circulation. Use floor level deflectors for more efficient forced hot air heating and cooling.
- The temperature of the water in a boiler is regulated by a device called an aquastat. Usually set at 180°F, the aquastat can be set to a lower temperature, say 140°F, when heating demand is low.
- Have certified maintenance personnel check and service your furnace regularly—every two years for gas fired furnaces and annually for fuel oil furnaces. Replace furnace filters according to manufacturer's instructions.
- Inspect hot water radiators and bleed trapped air as necessary. This problem shows itself in radiators that are not evenly warm.

Summer Cooling

The use of air conditioning is responsible for the peak in electrical energy consumption that occurs every summer. Measures you can take to reduce energy used for summer cooling include:

- Install air conditioning units that are Energy Star certified and have the highest Energy Efficiency Rating (EER). New room air conditioners are available with an EER as high as 12 in comparison with an EER of eight for typical older units. The saving in energy use (and of emissions at the power plant) is 33 percent.
- Reduce heat gain from air infiltration through leaks, and loss of cooling through leaky ducts of central air conditioning systems.
- Install insulation and energy conserving windows to reduce heat loss in winter and reduce heat gain in the summer.
- Insolation, solar energy coming in through south-facing windows, is a major source of heat gain—very welcome in winter, but costly in the summer. Passive solar design using overhangs on south-facing walls are very effective, permitting energy gain from the sun in winter while blocking it in the summer.
- Deciduous trees that shade the south side of a house in the summer reduce the need for air conditioning. The presence of trees around a house also reduces heat transfer from the wind, both in summer and in winter.
- Add awnings to redirect sun from windows and reduce cooling costs in summer.

Recommendation: Use heating/cooling only where and when it is needed.

An important way to save energy for space heating and cooling is to refrain from heating or cooling parts of the residence not in use or when space is unoccupied. A good way to help achieve this goal is to divide the residence into several heating/cooling zones, with separate thermostats for each zone. As this might present an unaffordable expense, here are some alternate recommendations.

- Programmable thermostat(s). Buy a clock-thermostat, and during the heating season, program it to 65 to 68° F when the house is occupied. At night or when the house is unoccupied, set it back by as much as 10° F. On vacation, set it back to 50 to 55° F. Note that these recommendations may not apply for radiant heating systems.
- Close doors to unused rooms and shut off heat registers and radiators in them.
- Use local heating appliances, so the whole room does not need to be kept as warm.
- Use door "snakes" and other insulation devices in areas with troublesome drafts.

Appliance Efficiency

Recommendation: Use energy-efficient appliances and lighting.

22 *http://www.trane.com/Residential/Products/Furnaces/abc.aspx*, January 7, 2008

On Demand Water Heating

Conventional water heaters, whether gas-fired or electric, continuously lose energy from the storage tank full of hot water. Also energy is wasted heating the water that sits in pipes running from the heater to points of use. Both of these problems are solved with an "on-demand" water heater placed near points of use. The best choice for energy efficiency is a gas-fired unit as shown above, but these require a gas line and venting to the outside, which could make installation in existing buildings difficult.

Gas-fired on-demand water heater.
Photo: Oregon Department of Energy

The Water Heater. Water heating is a major use of energy in residences. In most homes a central water heater is installed using either electricity or natural gas as the energy source. Sometimes, the water heater may be integral with the heating system boiler, or may be an oil fired unit. In these installations, water is piped to points of use in the bathrooms and kitchen.

- Use of an "on demand" water heater eliminates losses from the hot water tank and long plumbing lines to fixtures.
- A water heater fueled with natural gas is much more efficient than electric units and significantly more efficient than one fueled with oil.
- Insulate pipes that convey hot water to points of use.
- Wrap the water heater with an insulating blanket, unless it is already insulated. If the tank is warm to the touch, it can use additional insulation.
- A water heater that operates "on demand" and heats water only as it is being drawn for use will eliminate heat losses from the water heater, and if placed at or close to the points of uses, will eliminate losses from piping.
- Solar water heating is an economically sound way of providing domestic hot water. Solar collectors may be installed where there is good southern exposure and the heated water is circulated to a hot water storage tank. A gas-fired heater can be used to supplement the solar energy over periods with little sunshine.
- Set water heater temperature to a lower water temperature; 120° F is recommended. Turn hot water heater off when on vacation.
- Use less hot water. Install low flow showerheads. Less hot water requires less energy to heat the water. Look for aerators that have an on/off lever.

Laundry and Dish Washing. Energy used in washing clothes and dishes is a significant source of CO_2 emissions. In clothes washers and dryers, and in dishwashers, the prime use of energy is for heating—hot water for washing, and air for drying. As with space heating, the most favorable fuel for these heating applications is natural gas. Of course, savings can result from using the minimum amount of heat feasible. Here are some suggestions:

- Front-loading clothes washers generally use less water and energy than top-loading models. Also, they can handle partial loads using less water and energy than a full load.
- Wash your clothes in cold or warm water. Rinse clothes in cold water. A whopping 85–90 percent of the energy used by washing machines is for heating the water! Use cold or warm water for the wash cycle, instead of hot water. Hot water shrinks and fades clothes and wears them out more quickly. Using warm or hot water for the rinse cycle does not get clothes any cleaner.
- Don't hand pre-rinse dishes. Just scrape off food and load. Run only when full because most dish

washers do not alter their operation for partial loads.

- Air drying clothes on an outside clothesline will avoid a lot of emissions.

Home Lighting. Lighting is a surprisingly large consumer of electrical energy, yet people are used to the idea that lighting is so cheap that it is not worth worrying about conserving its use. However, lighting is responsible for roughly one-fourth of household requirements. Today, light sources are available that provide three times as much light for the energy used than the familiar incandescent light bulb. Fluorescent lighting is currently the primary choice, and compact fluorescent bulbs are generally available that can directly replace incandescent bulbs in typical fixtures and lamps. Another choice is LED lighting devices, which are very efficient; however they remain relatively expensive and have special installation requirements. An advantage of LEDs is that they are dimmable, whereas many current CFLs are not.

- Replace all incandescent bulbs with compact fluorescent lights.
- Turn off lighting not in use.

Other Appliances. Of the remaining appliances found in the home, the biggest consumer of energy is the computer, video, or television screen. Aside from choosing the most efficient models, the most important recommendation is to turn them off when not being used.

Phantom Energy. Many electronic devices in the home, including computers, televisions, and communications equipment, draw small amounts of electrical energy, even when nominally turned off. Energy can be saved by disconnecting these equipment from the power source when they will not be needed for a long period of time.

Energy Star

Energy Star is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy helping consumers save money and protect the environment through energy efficient products and practices. Through its partnerships with more than 12,000 private and public sector organizations, Energy Star delivers the technical information and tools that organizations and consumers need to choose energy-efficient solutions and best management practices.

Energy Star has successfully delivered energy and cost savings across the country, saving businesses, organizations, and consumers about $16 billion in 2007 alone. Over the past decade, Energy Star has been a driving force behind the more widespread use of such technological innovations as efficient fluorescent lighting, power management systems for office equipment, and low standby energy use.

Energy Star also provides easy-to-use home and building assessment tools to help homeowners and building managers work toward greater efficiency and cost savings (see http://www.energystar.gov).

Alternative Heating Methods

Recommendation: Employ alternative energy sources where feasible.

Emissions from natural gas and heating oil usage can be reduced by using alternative forms of heating, some of which are complementary or supplementary to other sources.

- **Passive Solar:** Passive solar building design exploits the sun's radiation as a source of energy. This involves taking full advantage of the sun's energy during the colder seasons while sheltering the building from the sun in the warmer seasons. During the winter when the sun is lower in the sky, the sun's energy is allowed to enter unobstructed through large south-facing windows. During the summer when the sun is higher in the sky, an overhanging roof prevents the sun from directly entering the building, thereby reducing energy input and the need for cooling. Passive solar design also includes the use of massive interior structures such as masonry walls and brick fireplaces that can even out daily temperature variation by absorbing heat during the day and releasing it at night, and vice versa in the summer.
- **Active Solar Heating:** This method is most commonly used for heating hot water using roof-top solar collectors to heat water which is piped to an insulated storage tank. Installation requires space for the storage tank, pumps and controls, a suitable location for the collectors with good solar exposure, and the possibility of running pipes between them. A back-up heater is provided to cover long periods without sunshine. As the cost of energy increases,

solar water heating is increasingly practical and cost-effective. Solar collectors can also be used to heat water or air for space heating. It takes a substantial area of collectors to absorb sufficient energy, and a large storage capacity—either a water tank or a bin of rocks. The investment is substantial, but reducing heating expense and carbon emissions to near zero has a big attraction.

- **Photovoltaics:** Photovoltaic cells come in sheets that may be placed in a location with good solar exposure to produce electricity with no carbon emissions.

- **Heat Pumps:** A heat pump system is an electrically powered refrigeration system that can provide cooling during the summer, and, by operating in reverse, can provide heating in the winter. Heat pumps generally use the outside air as the sink for heat when cooling and as the source for heat when heating. Heat pumps are becoming more popular in building construction because they can provide heating and cooling in a single unit. As a cooling system a heat pump has the same efficiency characteristics as an air conditioner and is rated by its EER (energy efficiency ratio). As a heating system, a heat pump works best if the source of heat is no colder than about 50°F. Consequently, they are not very attractive in the coldest climates. However, a heat pump system that uses the earth for its heat source (which maintains a steady temperature of around 55°F year round) can be a very effective heating system, with a substantial reduction in associated CO_2 emissions (from electricity use) in comparison with direct use of fossil fuels. Such systems are known as geothermal heat pumps.

We can expect that most houses will be subject to remodeling or replacement over the next forty years, so, over time, a major reduction in carbon emissions is possible.

- Sign up for the Belmpnt Municpal Light Department's "Green Choice" program to purchase electricity that comes from renewable sources (wind, solar, and biomass.

LEED for Residential Buildings

Leadership in Energy and Environmental Design (LEED) is a voluntary set of criteria established by the Green Buildings Council to encourage building construction practices more respectful of environmental effects.[23] The LEED program defines a variety of criteria relating to conservation practices, energy efficiency, use of local and/or reusable materials, and effects on the local ecoculture, and so the goals of LEED do not relate just to the carbon footprint of the building. Satisfaction of each criterion earns the builder points toward a level of LEED certification; the levels currently provided are Certified, Silver, Gold and Platinum. The original LEED program applies to public and commercial buildings, and requires inspections by qualified examiners to verify that the claimed criteria have been met before certification can be given. LEED is now available for residential construction. However, the program is more applicable to development projects and multi-unit housing than for the individual owner/

23 LEED programs are the work of the United States Green Building Council. Further information may be found at the USGBC website at *www.usgbc.org*.

Capturing Solar Energy

Solar panels can be used to absorb heat from solar radiation and/or to generate electricity. As a source of heat, solar collectors are already economical for water heating in most parts of the United States, including Massachusetts. Solar space heating requires more panels than most people would care to have on their roofs unless their home is very well insulated. Electricity is generated using photovoltaic panels, which are becoming increasingly cost-effective with advances in technology and manufacturing techniques. Installations will have an economic benefit with the availability of net metering, as exchange of energy with the power grid avoids any need for expensive energy storage.

This residence in Missouri has five 4' X 8' solar panels installed. The panels, together with the solar green house, provide 40%-50% of the heating needs for the home during the winter and a year-round supply of domestic hot water. Photo: Ken Riead/NREL

A Model Green Home

Tufts University Professor William Moomaw and his wife, Margot, have built a retirement home in Williamstown, in Western Massachusetts, that is designed from the ground up with the environment in mind. From the original site selection and house orientation to the 63 solar panels that adorn its roof, Moomaw's home is a model of sustainability.

Their goal is to live in a home that produces more energy than it uses. In the winter, when days are short and direct sunlight is scarce, the Moomaws will draw from the power grid to supplement their energy production, but in the sunny summer, due to a net metering arrangement with the local power provider, they will sell energy back to the grid. The house is super insulated, with a very tight building envelope, and heated using a ground source heat pump. Appliances have been carefully selected that are not energy hogs, and this also makes a significant contribution toward meeting their goals.

While the house employs a lot of special technology, the first rule is that their residence must look and feel "normal." The architecture matches turn-of-the-century New England-style houses in the area. And the home will have a TV, computers, a washer/ dryer, and other typical amenities. "We're not going into a cave and using candles," says Bill. "We want to show that you can [be energy-efficient] by buying common brands," adds Margot. "You just have to do careful shopping."

builder due to the inspection requirements. Note that no defined level of carbon emissions is guaranteed by any level of LEED certification; the results depend on which of the criteria have been satisfied. However, points toward LEED certification are awarded for all of the recommendations provided above.

Greening Lawn Care

One way to reduce carbon emissions is literally in back (or front) yards. Traditional fertilizers are derived from petroleum-based products. Although fast acting, they draw nutrients from the soil. A better choice, both for the lawn, as well as reduction of carbon emissions, is to use a natural fertilizer, such as corn gluten, which can also be purchased as a pre-emergent weed killer. Corn gluten (available locally at garden supply stores) is more expensive than conventional fertilizer/ weed killer but it's also healthier for the lawn and is nontoxic for pets and humans.

Switching from gas-powered to electric lawn equipment (mowers, trimmers, leaf blowers, etc.) also makes a significant difference in carbon reduction, reduces air pollution (it's estimated that mowing, trimming, and blowing contributes up to 10 percent of the nation's air pollution every summer), is much quieter, and saves money. See below for just one example.

Gas-powered Lawn Mower Running 45 minutes	Electric Lawn Mower Running 45 minutes	Push Mower Running 45 minutes
BTUs of energy used: 50,000	BTUs of energy used (in Kwh): 2,500	BTUs of energy used: 0
Estimated cost to run for season (gas/ oil): $45	Estimated cost to run for season (electricity): $5	Estimated cost to run for season: $0
	Bonus: 90% less polluting than gas mower*	Bonus: 100 % less polluting than gas mower*
*Based on hydrocarbons, particulate matter, carbon monoxide, and greenhouse gases emitted		

Source: SafeLawns.org

Energy Savings Programs

The main natural gas provider (National Grid,) offers a number of energy saving programs for Belmont homes and small businesses.[24] These include rebates up to $1,000 for high efficiency boilers, furnaces and water heaters, and rebates for clock thermostats and Energy

24 See *http://www2.nationalgridus.com/pshome/energy/saving_ma_kedma.jsp*.

Star windows. Through the Residential Weatherization Program, National Grid will pay a portion of the cost of weatherizing homes using an approved contractor. This program includes attic, crawlspace and wall insulation, ductwork leakage testing and sealing and other energy efficient measures. The full cost (up to $4,500) is covered for low-income residents. National Grid should be encouraged to mail/e-mail out rebate forms biannually to Belmont customers with utility bills. These rebates and immediate cost savings from lower utility bills due to high efficiency appliances and behaviors should be marketed throughout the Belmont community. Note that rebate programs may change. Some information resources are provided in Appendix G.

One of the largest complaints received from those wishing to make energy efficient improvements is that they are often cost prohibitive. One must be able to look at conservation and efficiency improvements as long-term investments that will prove their worth over time in reduced energy expense.

Transportation

In Belmont, transportation is one of the two largest contributors to the Town's total CO_2 emissions. Whether measured by fuel use or vehicle miles traveled, emissions caused by transportation increased between 2001 and 2006. Transportation-related emissions generated by the residential sector far outnumber those by the municipal sector. However, reducing transportation-related emissions from Town-owned vehicles may have an influence on changing behavior in the private sector. The recommendations are aimed at reducing carbon emissions by reducing fuel consumed in all sectors. Reducing automobile use by encouraging carpooling, public transit, walking to school and other alternative means of transportation is one goal. Another is to increase fuel efficiency and reduce carbon emissions by encouraging use of hybrids and other fuel efficient vehicles and vehicles that use alternative, cleaner fuels. In the long run, transportation costs will be reduced by people living closer to where they work, and living in more compact communities close to transportation centers.

Personal Transportation

Recommendation: Practice conservation and energy-efficiency in choice and use of personal vehicles.

Most of the time people drive vehicles that are too big for the job they are doing, most commonly taking one person from home to the job or to the store for groceries. With increased cost of fuel, it may be best to use two cars, a small vehicle for single person travel and a second vehicle for family outings and vacation travel. The second vehicle could be a rented car or a shared vehicle.

- Use the model of vehicle that is the right size for the job and contributes the least pollution per mile of operation.
- Maintain and operate a vehicle so as to achieve the most economical performance. Keep the engine tuned and tires properly inflated. Refine your driving habits to conserve energy.

Recommendation: Walk or bicycle whenever feasible.

Recommendation: Reduce use of private automobiles

In choosing where to live and where to work, the emissions cost of commuting to work should be an important factor. Telecommuting when feasible and use of conference calls for meetings can make a significant difference. Make each trip count for more by chaining errands**.**

Recommendation: Eliminate use of private automobiles. Households should consider using ZipCar.

Recommendation: Use shared transportation: car pools, vans and public transit.

Using an online ride-sharing service,such as Go-Loco (www.goloco.com) would encourage carpooling. Businesses and the Town could promote van pools. As Belmont is fortunate to have both commuter rail and bus service within walking distance of many homes, businesses and government offices, individuals should make better use of these services, especially for work commutes.

Recommendation: Consider CO_2 emissions in planning personal travel.

Personal travel for business and pleasure is a significant area where choices made by Belmont residents can

Idling Reduction

Idling of vehicle engines is a significant source of unnecessary emissions. Scientific studies show that the optimum time, from an economic viewpoint and for the vast majority of automobiles on the road, is 10–30 seconds, that is, if the vehicle will be used within thirty seconds of the time it is stopped, it is better to leave the engine running. Otherwise, turning the engine off will reduce engine wear, decrease fuel use and avoid emissions. If idling time is reduced, a corresponding reduction in CO_2 emissions will be achieved. For information about idling facts and myths as well as Sustainable Belmont's Cleaning the Air Campaign (anti idling initiative), see the Healthy Homes/Healthy Community section at *http://www.sustainablebelmont.net.*

affect the amount of CO_2 emissions generated. Tables 11 shows average emissions cost for several popular travel modes.[25] Two tables are used because airline travel includes fixed costs per flight for ground operations, take-off and landing. Therefore emissions-per-mile for travel by air depends significantly on the distance traveled. Travel by car is the only mode for which the traveler can decrease emissions-per-passenger-mile by bringing along companions. When planning a personal trip, the traveler should give preference to the transportation mode that has the lowest emissions cost.

Food and Transportation

Recommendation: Consider production and transportation CO_2 emissions in food purchases.

An area that is a very significant source of carbon emissions is the transportation of food from its point of production to the point of use—a distance estimated to average 1500 miles. If informed about the transportation component in food, Belmont residents could make choices that reduce the carbon emissions cost of their food purchases.

Food and Greenhouse Gas Emissions

A 2006 report from the United Nations found that worldwide production of animal products for consumption as food accounts for 18 percent of greenhouse gas emissions. In the United States, food production, processing and distribution accounts for 17 percent of all fossil fuel use and is comparable to the energy consumed by our private cars.

Let us define diet energy efficiency as the ratio of gross diet calories to the energy used to produce the food. Energy efficiencies for several food categories are shown in the table, as reported by a 2006 study from the University of Chicago.

Food Category	Energy Efficiency Ratio (%)
Milk	20.6
Eggs	11.2
Beef	6.4
Pork	3.7
Poultry	18.1 (chicken)
Fish	0.9 (shrimp) 5.7 (farmed salmon) 110 (herring)
Plants	123 (potatoes) 500 (oats)

In the average American diet 72 percent of calories are from plant-based foods, the remainder coming from a mixture of animal sources. The University of Chicago study shows that changing to a totally vegetarian diet would yield a 78 percent reduction in energy used for food production, with a corresponding reduction in CO_2 emissions. This calculation does not include emissions from transporting food to the consumer and ignores methane and other emissions associated with livestock production.

The National Sustainable Agriculture Information Service of the U.S. Department of Agriculture recommends that individuals eat less red meat, buy locally grown foods, plant a garden, and eat foods that are minimally packaged and processed and are "in season."

Town Programs

There are several possibilities for Belmont to help residents get around with less dependence on private cars.

Town Shuttle: Public transportation available to Belmont residents serves those who wish to travel to Cambridge or Boston. There is no convenient public means for residents to travel between parts of Belmont or to adjacent communities such as Arlington or Watertown. It may be feasible to implement a town shuttle service that would connect business centers, metropolitan and regional transportation facilities, and residential areas. The goal would be to replace the use of automobiles for travel around town or to reach public transportation. At a minimum this town-wide service should connect Waverley, Cushing Square, Belmont Center, and the Alewife MBTA station. The Town could identify the appropriate vehicles, routes, and timetables for a "Town Shuttle." This would provide a basis for evaluating its feasibility and deciding what type of cost-recovery mechanism to use to fund the capital and operating needs of the service.

Safe Routes to School: Safe Routes to School (SRS) is a program implemented by Walk Boston that looks to increase the number of children walking or bicycling to school. The Town of Belmont and the Belmont School Committee should encourage children to walk, bicycle or use public transportation to

25 *Getting There Greener: The Guide to Your Lower-Carbon Vacation.* Union of Concerned Scientists, 2008. Online at *http://www.ucsusa.org/gettingtheregreener.*

travel to school and also provide education to them about how to do this safely. Using alternate forms of transportation to school teaches children that walking and bicycling are legitimate transportation alternatives to driving (see box on page 64).

Road and Intersection Improvement: In road and intersection design much can be done to make our town friendlier to pedestrians and cyclists. In addition, careful design should lead to less idling of vehicles.

Transportation Information Center: A Belmont Transportation Information Center would help residents and visitors learn about the variety and ease of travel alternatives available in Belmont. The Center would include brochures highlighting alternative modes of transportation, maps and schedules of bus routes that travel through Belmont, information regarding the best and safest walking and bicycle paths through the downtown as well as information about car sharing options. The Center should have a highly visible and readily accessible physical location as well as a presence on the internet. The information provided should help residents make informed transportation choices that favor lowering town emissions. The Center could sponsor a phone center manned by volunteers to supplement an internet-based rideshare program.

Ride Share Program: A Belmont rideshare program offered through a public internet site would encourage the use of carpools and vanpools for trips and daily commuting. A rideshare and carpooling website would increase mobility, reduce air pollution, decrease fuel consumption, decrease traffic congestion, and offer an alternative to the single occupant vehicle. The Vermont Public Transportation Association maintains a ride share and carpooling website[26] that demonstrates the workability of a rideshare system to improve transportation and reduce emissions.

Zipcar: The Town should contact the Zipcar company to find out if it would be economically viable to have Zipcar locations in Belmont for residential, business, and town employee use. Households and individuals could consider using Zipcar to replace a second car or to use as a primary vehicle. This is a good option for those who primarily rely on public transportation or walk or bike. A car or truck can be reserved minutes or months in advance in increments as little as an hour. This is a pay as you go system. The company estimates that each Zipcar takes 15–20 personal vehicles off the road. Currently there are several Zipcar locations in Cambridge. www.zipcar.com

Table 13. Carbon Emissions from Travel by Car, Train, or Bus

Mode	Pounds of CO_2 per 100 Passenger-Miles		
	Number of Passengers		
	1	2	4
Heavy SUV	208	212	221
Typical SUV	139	142	151
Typical Car	108	112	121
Efficient Car	78	81	89
Hybrid Car	54	56	60
Train–Diesel	45		
Train–Electric (Northeast Corridor)	37		
Inter-city Bus (Motor Coach)	17		

Bike racks: Installing additional bike racks at Town Hall, public schools, commercial centers, and other destination points to reduce carbon and help decrease traffic congestion. Cost could be supplemented or completely offset through grants. The Town should also assess current bike rack locations to determine if they are in appropriate places or should be relocated.

Government Programs

State and Federal Subsidies: The Transportation Equity Act for the 21st Century, known as TEA-21, is the federal authorizing legislation for surface transportation. The funds are allocated and administered through the states. Under TEA-21, funds can be spent on pedestrian and bicycle facilities and on public transportation. TEA-21 also includes some programs that fund projects to provide clean air

26 Vermont Rideshare, *http://www.vermontrideshare.org*.

benefits. The major programs are:

- The Congestion Mitigation and Air Quality Improvement (CMAQ) program, which funds projects to help meet the requirements of the Clean Air Act, e.g., transit improvements and public fleet conversion to cleaner fuels.
- The Transportation Enhancement Program, which can pay for bicycle, pedestrian and transit facilities and improvements.

Clean Cities Program: The Town of Belmont should take advantage of the Clean Cities Program. Under this federal program, Belmont can be reimbursed for the difference in cost between a conventional and an alternative fuel vehicle. The Division of Energy Resources (DOER) offers $2,000 grants to offset the incremental cost of purchasing each additional alternative fuel vehicle. The program also provides assistance for creating the infrastructure needed for alternative fuel vehicles.

Business and Institutional Sector

The business and institutional sector forms a small but important part of the town of Belmont. "Business" refers to businesses and industry; "Institutional" refers to hospitals and nursing homes, independent schools, clubs, houses of worship and meeting halls. Together, the commercial and institutional sectors generate approximately 16% of the total carbon emissions from Belmont.

Geothermal Heat Pumps

Besides being an attractive large-scale energy source, geothermal heat can be exploited for energy-efficient heating systems in buildings such as the Cambridge Savings Bank Office in Belmont Center shown above. Geothermal heat pumps exploit stable ground or water temperatures near Earth's surface to control interior building tempera-tures. While temperatures above ground change a lot from day to day and season to season, soil, rock and water a few feet below the Earth's sur-face hold a nearly constant temperature between 50 and 60°F.

In general, heat pumps transfer heat from a thermal source into buildings in winter and reverse the process in the summer. Normal heat pumps use the outside air as a source or sink for heat. Geothermal heat pumps use the Earth's mass as a source or sink for space heating and cooling. The difference is that geo-thermal heat pumps transfer the heat across a smaller temperature difference and therefore operate with greater efficiency.

According to the U.S. Environmental Protection Agency (EPA), geothermal heat pumps are the most energy-efficient, environmentally clean, and cost-effective systems for temperature control and are increasingly being used. In recent years, the U.S. Department of Energy along with the EPA have partnered with industry to promote use of geothermal heat pumps.

In 2007 Sustainable Belmont conducted a "limited sample" survey of commercial and institutional entities in Belmont to obtain data relating to carbon emissions that were not available from public sources. Sustainable Belmont had received comprehensive data from the Belmont Municipal Light Department, but also sought data relating to natural gas and fuel oil consumption, amount of waste generated and its disposal, vehicle use for business purposes and employee commuting practices. Businesses and institutions that reflected diversity of size and missionwere selected. Forty-one businesses and institutions participated, of which three were houses of worship and six were other kinds of institutions.

The survey showed that most businesses and institutions are very aware of the challenge to reduce energy consumption and lower carbon emissions. An impressive example is the new Belmont offices of the Cambridge Savings Bank, where the use of a geothermal source/sink for heating and air conditioning has been installed. Noted, too, was the commitment of McLean Hospital to provide a shuttle bus for its employees traveling between the hospital and Waverley Square, as well as its recent decision to establish a "green committee."

Belmont's business and institutional community mirrors that of the residential sector: the preponderance of energy is used in heating, cooling and lighting the buildings. Most recommendations for residential buildings, stated earlier in this report (page 43), also apply to commercial and institutional buildings—with some differences. For example, large retail operations tend to use a lot of electricity for lighting and refrigeration, and less energy per square foot for heating due to the size of buildings. Electricity use supplies a significant portion of the heating needed in winter, but increases the air conditioning load in summer.

Efficiency and Conservation to Save Energy

Recommendation: Get an energy audit of the building(s).

An energy audit is a very good place to begin. Whether the audit concerns one or many buildings, the cost-payback analysis of and recommendations from the

audit will guide the development of a plan for energy savings.

Energy audits can be arranged through the National Grid gas company, the Belmont Municipal Light Department and private energy companies. At least a portion of the BMLD program may be subsidized. Large institutions, with several buildings, may wish to consider undertaking an ESCo-type project to reduce energy use.

One caveat to keep in mind when committing to an energy audit by a utility company: most energy audits focus on short-term solutions—that is, most recommend immediate and affordable steps to take, suggesting that the second level of actions is more expensive. However, particularly if the business owner also owns the building, it may be prudent to consider long-term, more expensive solutions as well, with the intention of addressing them sooner. Though more expensive, their payback is possibly more substantial and their impact greater. Additionally, some energy audits tend not to suggest alternative technologies, even though some of them may be well worth considering. To help its commercial customers save energy, Belmont Municipal Light Department (BMLD) currently (2009) offers a $2,000 discount on commercial energy audits. Audits are conducted through a BMLD partnership with Energy New England. Call 1-888-772-4242.

Recommendation: Take advantage of as many no-cost energy-savings practices as possible.

These might include: use window shades as passive-solar devices; avoid "phantom" energy use by turning computers and other equipment completely off at night—rather than putting them in "sleep" mode; lower the temperature of hot water heaters at night and on weekends; consume less electricity overall. Not all energy-savings steps need to cost money. Many personal behaviors and practices result in wasted energy and could be changed.

Recommendation: Emphasizing conservation and improved efficiency, take all reasonable and appropriate steps to reduce energy use.

These might include: immediately install energy-efficient lighting (e.g. replace incandescent light bulbs with compact fluorescent lights), improve insulation, increase the efficiency of the heating and air conditioning systems, and—when replacing appliances and computers—purchase Energy Star models or their equivalent. These steps will make a significant difference in energy bills while also reducing the CO_2 emissions of a business or institution. The energy audit will inform about what specific steps are appropriate and payback period a building's needs.

Recommendation: Educate employees about energy-saving behaviors at work.

Employees can help reduce energy use in a variety of ways. They might ensure: that heat vents and radiators are not blocked; that computers and other electronic devices are both turned off and unplugged at night; that fresh air is used as an appropriate alternative to air conditioning for much of the year. Employees themselves may have sound suggestions to offer; consider an incentive or reward for good ideas that are implemented. Establishing target reduction goals—and celebrating or rewarding employees' achievement—encourages shared responsibility and team effort.

Transportation

Recommendation: Select and operate business vehicles and equipment for conservation and efficiency.

Businesses and institutions in Belmont operate a total of approximately 302 vehicles in their activities, the greatest number being used by landscape contractors and construction companies. Efforts should be made to select, maintain and operate vehicles for highest fuel efficiency, and to minimize the miles traveled to perform jobs. Retrofitting heavy equipment to use biofuel cuts emissions and fuel costs significantly; business owners should investigate this option. Additionally, new technologies are being developed to help reduce idling on heavy trucks. As these technologies become available, significant savings in energy and emissions will be possible.

Recommendation: Encourage energy-conscious commuting choices for employees.

The survey showed that the great majority of employees of town businesses travel to work in single-occupant personal vehicles. A significant emissions reduction could be achieved through carpooling, more walking and biking, and increased use of public transportation. Larger businesses may wish to investigate reduced T-cards for employees. The installation of bicycle racks and showers, where feasible, also encourages biking to work.

Recommendation: Offer flexible hours and encourage telecommuting.

Some businesses and institutions may be able to offer their employees the opportunity to work a full work-week but on a four-days-a-week schedule. Some employees may have jobs that are essentially sitting at workstations, and could telecommute for a given number of days. Such arrangements, where feasible and appropriate, cut down on the number of automobile trips the employee makes, resulting in energy conservation.

Recommendation: Comply with the state's anti-idling law[27] and encourage others to do so as well.

This state-wide law, on the books for more than 30 years, prohibits the unnecessary operation of the engine of a motor vehicle, while stopped, for a period of time in excess of five minutes. The law helps to protect the health of our citizens, particularly the children, and reduces CO_2 emissions. It applies to all vehicles with a few exceptions (e.g., refrigeration trucks). It is gaining increasing public attention and should be of particular interest to vehicle owners because idling is wasteful of gas, reduces the life of the vehicle, has significant health impacts on the population, and contributes to global warming. But implementing it is a challenge. Businesses with fleets should make clear that their drivers understand the benefits of not idling and are expected to obey the law. Additionally, all business owners should expect delivery trucks to adhere to it.

Purchasing Practices and Negotiated Contracts: Using Your Greenbacks

Utilizing purchasing practices that favor green sustainable options, including the negotiation of future contracts, offers significant potential to influence CO_2 emissions by commercial enterprises.

Recommendation: Consider adopting a policy that all bids and contracts will include language that requires or encourages vendors to adopt sustainable, energy saving practices.

Choosing where and how we spend our dollars is one of the most effective means to change the behavior of others. For example, consider giving a priority to doing business with companies that use or sell recycled paper products; companies that reject excess packaging and/or that use carbon-neutral packaging materials; companies that use carbon-neutral shipping; companies that specialize in using or selling products made with local resources or from recycled materials.

Opportunities for Collaboration

Recommendation: Organize a trash-collection and recycling program for businesses and institutions in Belmont, either through the Town or as a separate organizational entity.

A major opportunity exists in the handling of commercial waste. Much recyclable waste is currently disposed of as trash. The business survey revealed that many businesses would welcome (and pay for) a town service that would collect recyclable materials from businesses and institutions. Of note is the fact that much commercial waste is cardboard boxes which, if segregated, have a significant value in the recyclables trade, suggesting the possibility that other recycling and trash-collection costs might be partially offset.

Recommendation: Provide incentives to landlords to take energy-saving measures.

Businesses "sharing" a landlord (especially renting space in the same block from the same landlord) may wish to arrange an energy audit together, perhaps saving on the cost of the audit and putting the businesses in a stronger position to negotiate with the landlord regarding energy-saving steps. They may also wish to collaborate on more than an energy audit: for example, they may make a proposal to share the cost of energy-saving alterations with the landlord, with agreements on both sides regarding such question as tax deductions (if applicable) and extended contracts without increase in rent; discussions with realtors about the enhancement of property values may help owners to see the financial advantage in in-vesting in energy upgrades. In other words, work for a "win-win" agreement—solutions that bring savings and benefits to both owner and renter.

Recommendation: Organize informational meetings and workshops for businesses in Belmont to share the results of the business survey, discuss options, and learn more about ways to increase energy conservation and efficiency.

Opportunities to learn collaboratively may be

27 MGL, Chapter 90, 16A and 310 CMR, 7.11.

especially useful to busy business owners for whom it is inefficient and discouraging to research energy matters and take action in isolation. Such collaborative efforts may produce additional benefits for the Belmont business community as a whole. Business owners may wish to consider joining the Greater Boston Sustainable Business Leader program (*http://www.sustainablebusinessleader.org*). The Belmont/Watertown Chamber of Commerce may be another good source of information.

Food and Energy

Recommendation: Purchase local foods; compost appropriate organic waste where feasible.

The survey informs us that several restaurants in town purchase local produce; and a couple of food stores engage in a limited form of composting off-site to dispose of appropriate organic waste. These practices, when feasible, should be encouraged.

Recommendations to Institutions

Larger institutions will all benefit from considering the recommendations made above. Additionally, here are a few recommendations particularly appropriate for them.

Recommendation: For multi-building complexes, consider an ESCo-type program in lieu of a standard energy audit. (See description on page 22 of this report.) Such a program enables the financing and implementation of multiple energy-saving steps all at once, thereby ensuring that the loan is paid back from cost savings in a systematic manner.

The challenge with such a program is to remember that much of the work will address the "low-hanging fruit "through which payback begins as soon as the renovations are complete. The model is an effective way to address multiple energy problems and to finance the changes required. However, implementing this model leaves still to be addressed some of the larger, more expensive and long-lasting renovations—including alternative energy technologies—necessary for a sustainable future, yet whose payback may exceed the length of the traditional contract.

Recommendation: Provide shuttle buses or van pools for transportation from hubs.

This is an option for institutions that are not located near transportation centers and that have a large work force, particularly groups of employees who work on regular "shifts." It greatly reduces carbon emissions, air pollution, and traffic congestion.

Recommendation: Houses of worship are encouraged to investigate and join Massachusetts Interfaith Power and Light.[28]

This is an organization that specializes in and is designed specifically to assist houses of worship in addressing their energy needs. The organization's web site gives this description: "A non-profit initiative offering Massachusetts congregations of every religious tradition a comprehensive means of reducing energy consumption, lowering operating costs, and promoting clean, renewable energy in houses of worship and related buildings. In short, we are a mutual ministry working with the community of faith toward environmental justice and care of creation."

Rcommendation: Businesses and Institutions should conduct an energy audit.

28 Online at *http://www.mipandl.org*.

Town Government

This section includes recommendations for the municipal sector including both general government and the schools. **Note:** In some case the Town (including the Belmont Municipal Light Department) is in process of implementing some of the recommendations.

Municipal Sector

The single most important step that the leadership of the Town can take is to make clear to both residents and employees—by word and by deed—that it is committed to the goal of reducing greenhouse gas emissions to 80 percent below 2007 levels by 2050. Commitment to this goal should be made clear by its explicit adoption, by taking visible steps to launch its implementation and by giving maximum visibility to steps taken toward the achievement of the goal. Belmont's government—both on the "town" side and on the "school" side—must be an exemplar of conservation and energy efficiency and must help us all anticipate a fossil-free future by using alter-native fuels whenever possible. Through policy initiatives and actions, it can facilitate progress by the other sectors of the community in meeting the Town's goal.

Implementation and Oversight

Recommendation: Hire an Energy Manager.

The Energy Manager will have responsibility for guiding implementation of this climate action plan and monitoring progress.

Funding: It is acknowledged that this recommendation is a "tough sell," given the perilous financial times in which we live. The decision to recommend this position is not lightly taken; creating such a position ensures accountability in the quest to reduce energy use and carbon emissions throughout the Town.

Town leadership is encouraged to explore a variety of financing possibilities for this position, for example:

- Time sharing the job with another community;
- Initial staffing by a qualified volunteer working for the first year for a stipend, on a basis similar to that of the Selectmen, with an understanding that after savings are achieved and documented, it would become a salaried position;
- Contributed funding by the BMLD;
- Securing grant money to assist in funding this position initially;
- Incentivizing the compensation by tying it to the results sought (saving money and CO_2.

Responsibilities: The Energy Manager could:

- Oversee, monitor, and report on the Town's progress in reducing the carbon footprint of the entire community;
- Work with town departments, committees, and resident groups to provide general and technical information and conduct public education programs and workshops for residents, employees, institutions and businesses regarding reduction of carbon emissions and conservation of such resources as water;
- Learn about and assess the suitability to Belmont of new technology for energy reduction and water conservation;
- Provide information to businesses, institutions, and residents regarding rebate pro-grams and subsidies for various kinds of energy-related and water-conservation initiatives;
- Reach out to other communities to share resources and information;
- Work with state officials and foundations to secure funding for energy-reduction projects;
- Review the Town's bids and proposed contracts to ensure the inclusion of language and conditions that reflect the Town's commitment to work with vendors who support the reduction of carbon emissions and promote a sustainable future;
- Create future updates of the Climate Action Plan.
- Oversee a new Energy Committee (see below).

Recommendation: Establish an Energy Committee.

The Energy Committee will work with the Energy Manager toward implementation and monitoring of appropriate carbon reduction actions across all sectors of the community, as outlined in the Climate Action Plan. The committee will represent a cross-section of the major "stake holders"—including Town employees, public schools, residents, houses

of worship, the business community, and private institutions—and also will include individuals with significant knowledge about energy issues.

Recommendation: Investigate implementing a second ESCo project

The first ESCo project was initiated in 2003 and was completed in April 2006. Measurement of a full year of the dollar savings was carried out between August 2006 and July 2007. The measured savings of $218,581 exceeded the projected savings of $202,834. This first ESCo project focused on electric lighting efficiency, water conservation, and some improvements to the heating and cooling plant. The resource and dollar savings are shown below.

Table 14a. First ESCo Project Savings Summary

Resource	Dollars	
Type	Saved	Percent
Electric	$137,732	63%
Oil	$49,140	22%
Water	$35,044	16%
Nat Gas	$1,228	1%
Total	$218,582	102%

These savings were calculated using average commodity prices in the period of Jan 2004 to Dec 2004, which were:

Table 14b. ESCo Baseline Costs

Resource	Jan/2004 to Dec 2004
Type	Ave Cost
Electric $/kwhr	$0.079
Oil #4 $/gal	$0.930
Oil #2 $/gal	$0.930
Nat Gas $/therm	$1.140

This initial ESCo project did not include insulation or weatherization (window and door stripping) to reduce building energy loss in cold weather, nor time-of-day temperature controls to allow for the more optimum heating of buildings to match periods of occupation. Research for this document shows that in the 2006 – 2007 heating year, the town consumed 689,989 therms of heating oil and natural gas to heat 915,000 sq feet of floor space. This results in an average across all town floor space of 0.75 therms per sq foot for heating energy use. This ratio of 0.75 compares favorably with some entities in the town that have large heating loads, and not with others. If the town were to improve building heating efficiency to 0.6 therms per sq foot, then, under the assumption of $2.30 per gal cost of oil, the town could save over $200,000 per year in heating costs. For these reasons it is recommended that the town form a second ESCo committee to investigate whether a second ESCo project is viable. Additionally, several town buildings were not included in the first project (Town Hall, Town Hall Annex (Homer Building), School Administration Building, and two fire stations) and should be assessed for potential retrofits.

Employee Education and Engagement

Recommendation: Inform and engage Town employees by conducting mandatory in-service programs.

The purposes of such programs include:

- To inform the employees of the Town's emissions-reduction goal and to enlist their support, participation, and cooperation;
- To ensure that all employees understand and implement best energy-reduction practices at work;
- To elicit suggestions from employees about other steps that could be taken by them and by the Town to reduce or conserve energy use, which will also save money.

The program should include workers in outsourced custodial services. In addition, contracts for outsourced custodial services should include encouragement for compliance with established energy-saving and recycling procedures.

Heating and Cooling of Buildings

Although the total emissions of Town buildings is not large compared to that of the residential sector, the buildings provide an opportunity for the leadership of the Town to articulate and demonstrate its commitment to energy reduction. The following recommendations are aimed at conserving energy, increasing the efficiency of its use, and increasing the use of new, renewable sources of energy.

Recommendation:Take aggressive steps to reduce heat loss and energy efficiency in Town-owned buildings through conservation

and improved heating and cooling systems.

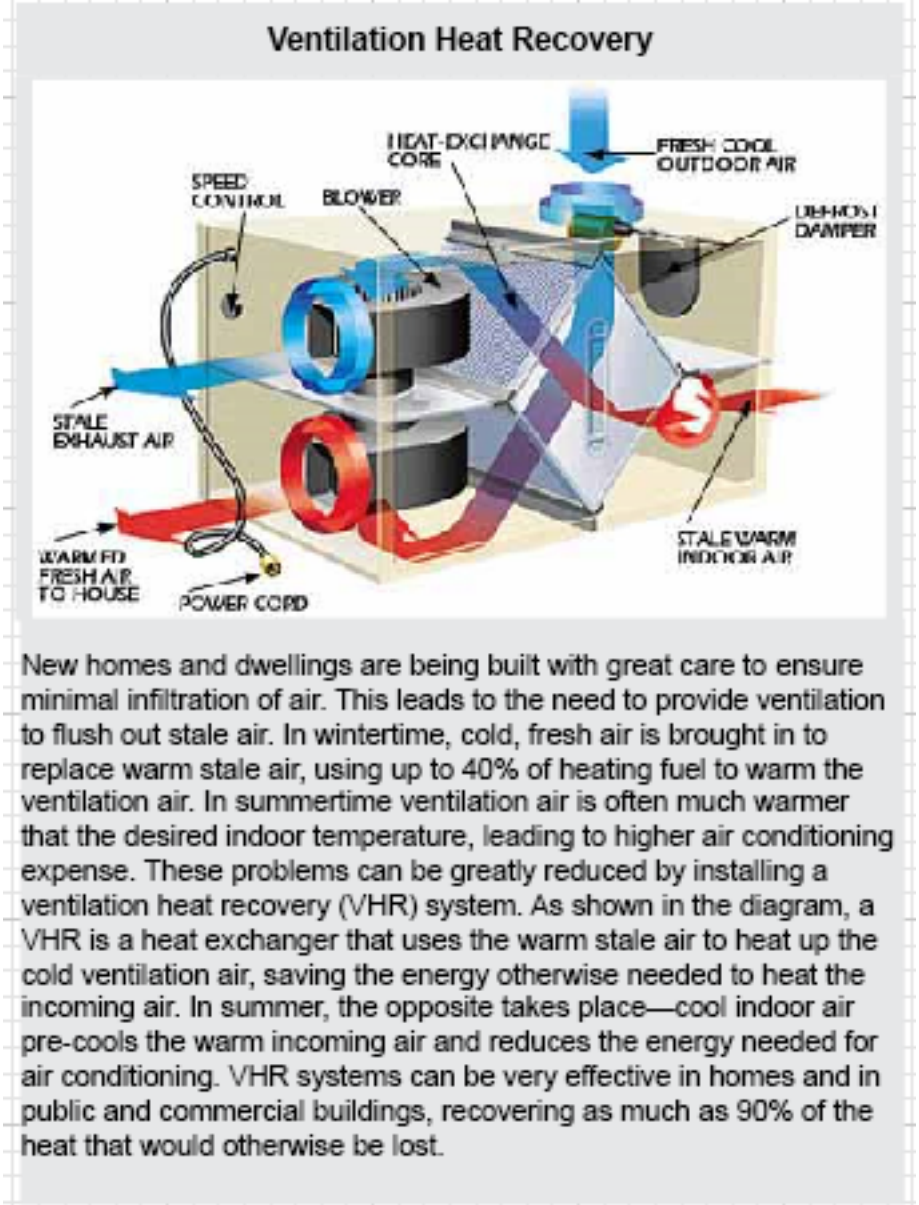
The first steps should be to ensure that all buildings are brought to highest feasible level of heat conservation. These steps include:

- Install energy-efficient double pane windows mounted in non-conducting window frames.
- Ensure that the highest practical level of wall and ceiling insulation is installed and that air infiltration is limited.
- Install heat-recovery ventilation systems. (This allows the heat in warm ventilation exhaust to be used to warm incoming air; in the summer months, cooler exhaust air is used to pre-cool incoming air.)
- Provide air locks at the most-used building entrances.

Then retrofit or replace building HVAC equipment to match heating and cooling capacity to the reduced load and to operate with highest efficiency. Consider installing building control systems.

A project similar to the recent ESCo project, but chartered to consider longer-term changes to buildings could be useful in selecting the most economical sequence for undertaking recommended changes. Some of the larger-item modifications in the original ESCo buildings whose payback did not fit into the 10-year ESCo framework could be reconsidered. It would be appropriate to give special attention to buildings not included in the original ESCo project, in particular, the Town Hall, the Homer Building, the School Administration Building and the two fire stations.

While waiting for major conservation and efficiency improvements to be made, many of the suggestions listed in "The Residential Sector" are also appropriate for municipal buildings.



New homes and dwellings are being built with great care to ensure minimal infiltration of air. This leads to the need to provide ventilation to flush out stale air. In wintertime, cold, fresh air is brought in to replace warm stale air, using up to 40% of heating fuel to warm the ventilation air. In summertime ventilation air is often much warmer that the desired indoor temperature, leading to higher air conditioning expense. These problems can be greatly reduced by installing a ventilation heat recovery (VHR) system. As shown in the diagram, a VHR is a heat exchanger that uses the warm stale air to heat up the cold ventilation air, saving the energy otherwise needed to heat the incoming air. In summer, the opposite takes place—cool indoor air pre-cools the warm incoming air and reduces the energy needed for air conditioning. VHR systems can be very effective in homes and in public and commercial buildings, recovering as much as 90% of the heat that would otherwise be lost.

New Building Construction

In new building construction, additions and major renovations in the municipal sector, maximize energy efficiency and introduce renewable sources of energy.

Recommendation: Establish a policy that new municipal buildings, additions and major renovations be built to meet eligibility criteria for LEED certification at the silver level or higher.

Massachusetts regulations require public schools to be built to the CHPS standards,[29] so many of the criteria for LEED certification already must be met in the case of schools.

30 Collaborative for High-Performance Schools. Online at *http://www.chps.net*.

Buildings constructed according to green building design principles can be more expensive to build, yet their life-cycle costs should show net savings in the form of reduced operating and maintenance expenses.

Building Construction and the Environment

"Buildings account for 38 percent of U.S. carbon emissions, 40 percent of raw-materials use, and 30 percent of waste output. Any comprehensive attempt to curb climate change needs to acknowledge these facts and transform our approach to construction, old and new."

Recommendation: Formally adopt a commitment to the "total life-cycle" concept of building construction, in new building and site design, and in major additions and renovations.

The Town's Building Committees should consider fully the life-cycle costs of a building when determining the project's budget and design, giving special consideration to long-term operating costs, including future utility costs, and to the environmental costs. For example, use of geothermal and solar options for all or part of the energy requirements should be seriously considered.

Recommendation:
In demolition necessary to make way for new construction of municipal buildings, mandate disposal of waste debris in ways that are environmentally sound.

Such disposal strategies are often found to be financially advantageous to the contractor.

Reduction of Electricity Use

Recommendation: Reduce the Town's use of electricity.

This will be achieved through conservation, increased efficiency, and the use of alternative sources. Today, fluorescent lighting provides three times as much light for the energy used as the familiar incandescent light bulb. LED lighting is even more efficient and, although expensive, has a life-cycle cost that is favorable for municipal buildings. Other actions include:

- Continue work with the BMLD to reduce electricity used in streetlights.
- Ensure that municipal and school computers do not draw power when not in use.
- Install motion sensors in all hallways and rooms in Town buildings to shut off lighting when it is not needed.
- Reduce outdoor lighting.
- Exploit the benefits of photovoltaic cells to produce free electricity with no carbon emissions on Town buildings where feasible. Apply for grant funds as appropriate.

Trees

Recommendation: Restore funding for the Town's shade tree planting program.

By sequestering carbon and providing shade, trees give value in two ways. But trees take time to grow. The Town should restore and expand its municipal tree-planting program. It is recommended that the Town plant a variety of deciduous tree species, particularly those that are drought-resistant. They should be planted along roadways, paths and playing fields, in parks and around and in parking lots (to reduce the heat-island effect).

Land Conservation

Green space is valuable to our quality of life in Belmont. Many citizens enjoy the benefits of the green space provided by protected areas such as Mass Audubon's Habitat Wildlife Sanctuary and the Beaver Brook Reservation. Land conservation provides recreational, aesthetic, artistic, educational, spiritual, and scientific value and further offers critical habitat for a variety of resident and migratory species. Healthy ecosystems also provide a variety of other services and functions, including temperature and precipitation regulation, storm protection, flood control, and drought recovery. Healthy ecosystems help regulate hydrological flows, store and retain water resources, aid retention of soil and soil formation processes, aid in the treatment of wastes, contribute to the recycling of nutrients and nutrient storage¬--including carbon sequestration--and help to provision pollinators for the reproduction of natural and agricultural plant populations.

Transportation

Transportation produces a higher percentage of CO_2 emissions than any other single source. The Town

can take many steps to reduce its own emissions from transportation, thereby setting an example through leadership. The Town also has many opportunities to enable and facilitate emissions reductions by residents and employees.

Recommendation: Reduce the carbon emissions generated by the municipal fleet in the conduct of town business.

- Ensure ongoing commitment to Belmont's Fuel Efficient Procurement Policy for Town Vehicles,which was approved by the Belmont Board of Selectmen, within the Policy on Use of Municipal Vehicles (Dec. 2, 2002). This policy establishes the principle that the Town shall strive to procure the most fuel efficient and economical vehicles necessary for the purpose for which they are intended.
- Investigate converting Town diesel trucks to biodiesel fuel. Biodiesel is a clean, renewable diesel fuel produced from agricultural resources, and can be burned in any standard, unmodified diesel engine. Changing the fueling of the Town's heavy trucks and equipment to biodiesel would eliminate 327 tons of CO_2 emissions annually.
- The Commonwealth of Massachusetts has mandated a five-minute maximum idling time for vehicles.[30] Belmont should consider an educational program and incentives for town employees to minimize idling of town vehicles. It has been estimated that reducing the amount of time that Town vehicles idle could eliminate an annual 25 tons of CO_2 emissions.
- In developing bids for vehicle contracts such as school bus and waste-collection companies, the Town can include the requirement that the buses be retrofitted for reduced emissions or that the buses reflect the highest standards for fuel efficiency in their class.
- Promote the use of bicycles and encourage walking beats by Belmont police.

Recommendation: Reduce the carbon emissions generated by town employees in commuting to work and in their conduct of Town business.

Data from the employee transportation survey (Appendix B) reveal that ninety percent of our Town employees drive to work alone. Approximately half commute more than five miles, and approximately one quarter commute more than 10 miles. Reducing the number of vehicle trips is a reasonable goal. The Town can assist in reducing employee use of private vehicles in the following ways:

- Offer transit passes pretax to municipal employees; consider also partially subsidizing the passes.
- Promote flexible hours: enable 25 percent of Town employees to telecommute or work compressed schedules at least one day every two weeks.
- Institute a four-day workweek schedule for employees during one or two months each summer. (The employees would work longer hours each day to compensate.)
- Promote car-pooling and ride-sharing. (The employee transportation survey indicated that 16.2% of Town employees suggested that an organized car or vanpool would be helpful.)
- Encourage employee use of bicycles.

Recommendation: Help residents and Town employees reduce carbon emissions from private automobile use.

Encourage use of public transportation.

- Investigate economics of providing a town shuttle that would connect business centers, metropolitan and regional transportation facilities, and residential areas.
- Encourage use of public transportation into Boston by providing resident-only parking facilities for cars and bicycles near transportation centers.
- Work with the MBTA to provide safe and attractive shelters at all T stops.
- Reserve some parking spaces for commuter in town public lots to encourage use of public transportation

Encourage the use of bicycles and walking throughout Town.

- Assess current bike rack locations in public areas throughout the Town and assess if any should be relocated; invite review of plans by Town's bicycle and pedestrian committees and

30 *Massachusetts General Law*, Chapter 90, Section 16A. Online at *http://www.mass.gov/ legis/laws/ mgl/90-16a.htm*.

groups.
- Add additional bike racks where appropriate.
- Work toward creating a pedestrian and bicycle connection crossing the railroad tracks near the High School.
- Ensure that appropriate accommodation for bicycles and pedestrians are part of any road-improvement plan.
- Promote the benefits of bicycle paths that connect to a larger network of paths or to transportation hubs.
- In winter weather conditions, ensure pedestrian access to safe walkways throughout the town.

Food and Energy

Recommendation: The Town should promote and publicize the availability and use of composters for residents.

Pavement

Recommendation: Investigate adopting a policy requiring that all paved driveways, sidewalks, alleys, and parking lots be made of pervious material.

With storms of increasing frequency and intensity, Belmont's flooding problems will become worse. Pervious material allows more water to seep into the ground and replenish the water table, rather than contribute to over-burdened storm water drains.

Increasing Public Awareness of Success and Opportunities

Recommendation: Provide information and examples to encourage environmentally aware choices and behavior.

Encourage homeowners, businesses, and institutions to follow the lead of others who have already taken action toward sustainable living. Publicize successful actions by the Town and in the private sector.

Schools

The Town's public school system implicitly sets an example to the public and to its pupils by the actions and attitudes it exhibits regarding environmentally responsible behavior. Therefore it is especially important that the recommendations for Town buildings and employees also be adopted by the schools. The Schools also teach environmentalism explicitly through the curriculum, the behavioral standards to which they hold the children and communications with parents. For children, mitigating climate change and taking adaptive measures are essential to their future.

Safe Routes to School

Safe Routes to School (SRTS) is a national program designed to help schools make walking and bicycling to school safer for children and to increase the number of children who choose to walk and bicycle. SRTS programs can enhance children's health and well-being, ease traffic congestion near the school and improve air quality. Safe Routes to School promotes a variety of support programs to help communities raise the fraction of children walking and biking to school, including the following:

A "Walking School Bus" organizes children, parents, and neighbors to walk or bicycle to school together from a designated location. The "driver" of the school bus is a volunteer who leads the group. Currently, there are about 15 walking buses organized in Belmont neighborhoods.

Through the Traveler Ticket program, students earn check marks each time they walk to school and may be eligible for a reward or entered into a raffle. Both the Wellington and the Winn Brook elementary schools have participated in a version of this program.

Massachusetts Walk to School Days are led by a local "celebrity" walker. Currently, all of the Belmont public elementary schools and Chenery Middle School participate in this program one day each fall and one day each spring.

On the Web: *http://www.saferoutesinfo.org*

Recommendation: Teach by example, through direct instruction and by collaborative investigation, the understandings and behavioral changes that all people alike must acquire to mitigate and adapt to climate change.

Steps the Belmont Schools can take:
- Engage staff and students in developing ways to help the school become more environmentally responsible.
- Emphasize waste reduction and reuse in the

schools; promote and expand recycling.
- Find ways to diminish the paper flow.
- Encourage purchasing practices that use reduced packaging and/or that consider the miles traveled.
- Introduce climate change curriculum at all levels (causes; evidence; mitigation—including energy conservation and efficiency, adaptation). Grasping the global impact of climate change will help students to appreciate the consequences of their own actions.
- Plant trees around schools—Engage children in activity and educate on reasons.
- Develop a food-composting program for vegetable matter.
- Review and revise menus of school lunch programs to become healthier and to include more local foods, and to reduce packaging.
- Ensure compliance with the state's anti-idling law by school buses and vans to reduce CO_2 emissions and promote good health in children.
- Work with PTOs to encourage environmental actions and behavioral change at home.
- Encourage walking to school and bicycling by older children.
- Encourage the driving school that offers driver education to high school students to cover driving strategies that lower fuel consumption in their teaching.
- Discourage students from driving automobiles to school.
- Encourage the Minuteman High School to adopt recommendations similar to those of the Belmont Climate Action Plan.
- Promote ridership of school buses and work to reduce cost to individuals to encourage use of school buses as an alternative to private cars

Town Policy

Cushing Square Redevelopment

At a special town meeting in 2006, planning guidelines were adopted for a Cushing Square Overlay District that apply to building rehabilitation and new construction in the neighborhood surrounding the intersection of Trapelo Road and Common Street. The guidelines offer incentives to business owners and developers to contribute to "smart growth" by creating mixed use projects with greater housing density and shared green space.

The goal is to "promote the redevelopment of under utilized properties in a coordinated and well-planned manner" so as to provide a more pedestrian-oriented environment while "remaining sensitive to abutting residential districts, environmental impacts, and historic preservation." Uses envisioned for new projects include retail sales and services, restaurants, office space, and residences. Building designs are to be "pedestrian oriented and shall reflect community preference for moderate-scale structures that reflect the residential character of the Town." Designs also "... shall incorporate best-practices in energy efficiency, environmental protection, and storm water management; [and] shall address current Leadership in Energy and Environmental Design (LEED) standards (or other comparable standards), as promulgated by the U.S. Green Building Council ... ."

This step by the Town is a positive move toward a future of mixed use development around transportation centers and is in the direction of creating a society with a smaller carbon footprint.

Through actions of the Town Meeting and policy-making committees and boards, Belmont can influence the course of development in the town and provide leadership through enlightened management to bring municipal operations in line with a sustainable future.

Town Planning

Town-wide planning, including the recently launched development of a new Comprehensive Master Plan, must address community challenges that impact our shared carbon emissions.

Recommendation: Ensure that the new Comprehensive Master Plan for Belmont will promote low-carbon living and mobility.

In the spirit of this Climate Action Plan, a new master plan for Belmont should include such elements as the redesign of commercial centers, transportation systems, new approaches to housing arrangements and reconfiguration of roads, intersections, housing and open spaces. New zoning and other regulations will be needed to facilitate the implementation of this intention.

Locating new commercial and large-scale residential projects near transportation centers reduces the need for and use of automobiles. Mixed-use projects should be encouraged and also be clustered near commercial and transportation centers because engaging and productive street life, both day and night, creates a positive and pedestrian-friendly atmosphere, possibly mitigating energy use for transportation. Open spaces located near densely inhabited areas also contribute to satisfaction with urban living.

Recommendation: Give priority to needs of public transport, pedestrians and cyclists in road design planning and related issues.

Belmont and the nation must shed our dependence on private automobiles powered with fossil fuels. The town can facilitate use of public transportation by increasing public parking near transport centers, by revising our on-street parking regulations (perhaps introducing resident parking stickers); and by providing convenient and safe protective shelters at transport stops and nearby covered bicycle racks.

Bicycling and walking can be encouraged and supported through careful planning, including pedestrian-friendly intersections, frequent pedestrian crossings, well-marked bicycle lanes, efficient off-road bicycle paths, the establishment of additional one-way streets, and systematic planting of healthy, drought-resistant shade trees along the roadways, paths, parks and parking lots.

Recommendation: Evaluate the U.S. Green Building Council's LEED Guidelines for Neighborhood Development.

The U.S. Green Building Council's LEED Guidelines for Neighborhood Development is expected to launch in 2009. These guidelines include such topics as facilitating mixed-use development; protecting threatened species by reducing habitat fragmentation through compact development patterns; ensuring proximity to water and wastewater infrastructure; ensuring wetland conservation and restoration; and other elements such as school proximity, brown field development, reduced auto dependence, bicycle path networks, and more.[31] The Town should determine which of these are applicable for Belmont, and integrate them into Town policies and procedures.

Energy Zoning

Recommendation: Incorporate the State's zoning exemptions for renewable energy into the local zoning codes.

The state has enacted changes to the Commonwealth's zoning regulations that exempt some types of renewable energy sourcing systems from some local zoning regulations.[32] Eliminating zoning-related barriers to introducing new residential renewable energy sourcing systems will encourage introduction of these systems leading to a reduction in CO_2 emissions.

Recommendation: Adopt a bylaw that would use the state's Stretch Code legislation allowing local building code standards to increase energy efficiency of new construction and major renovations to all buildings (municipal, commercial, and residential) in town.

The Stretch Code is state legislation passed in 2009 that allows cities and towns to adopt more stringent building codes promoting greater energy efficiency for new construction and major renovations beyond that required at the state level. Once adopted, the stretch code would be the new mandatory base code for the city or town on building projects within its jurisdiction.

31 For more information, see *http://www.usgbc.org/DisplayPage.aspx?CMSPageID=148*.
32 M.G.L. Chapter 40A, Section 9B.

New Building Construction and Major Renovations

Old buildings reflect the accepted standards of the period when they were designed and built, including whatever standards for energy use were considered relevant at that time. Buildings have a long life and, if left unchanged, will continue to consume energy as though those standards still prevail; therefore retrofitting them—in this "new age" of energy reduction—should be a first priority for any owner.

New building construction in both the municipal and private sectors presents new opportunities that will serve us well as the climate changes, will have environmental benefits, will have positive health effects in the community by improving air, thermal, and acoustic environments, will enhance the health and comfort levels of the occupants, and will have a positive economic effect for the owner/developer.

The Sustainable Building Design Policy statement (approved, Select Board, March 2007;) applied only to municipal buildings. We assume, but have not verified, its implementation by the Town's building committees.

Recommendation: The Sustainable Building Design Policy, coupled with new building standards, should apply both to municipal and private sector development.

If, the community is committed to reducing our energy CO_2 emissions by 80% by 2050, then new building construction must not add to the Town's total emissions levels. There will always be new construction in Belmont, both municipal and private. There are still buildable sites in the town, others may materialize, and old buildings—municipal, commercial, residential—will be gradually replaced. The need for establishing new and rigorous building standards is urgent.

In view of the development of LEED certification and the Energy Star designation of the EPA, it is time for Belmont to consider stronger requirements for new construction and renovation projects in town.

Recommendation: Adopt a policy that all new residential construction and substantial renovation projects over 1,000 square feet and all new commercial and industrial real estate construction minimize, to the extent feasible, the life-cycle cost of the facility by utilizing energy conservation and efficiency, water conservation and alternative energy technologies.

The requirements for energy and water conservation and efficiency would be based on the criteria for LEED certification of the US Green Building Council, and standards established by the EPA.

This recommendation is offered on its own merits, regardless of whether the Town decides to pursue Green Community designation. If the Town does decide to qualify for such designation, then adopting the recommendation above is an essential step.[33] Although the language of the Act addresses projects over 3,000 square feet, our recommendation applies to those over 1000 square feet, and will cover the construction of large residences and many conversions to condominiums.

Recommendation: Adopt a policy that provides incentives for developers to build to standards that exceed conservation and energy efficiency code requirements.

33 Green Communities Act, Chapter 25A, Section 10.

Incentives such as reduced permit fees or tax benefits might be appealing to developers. For example, building to LEED gold or platinum standards—and having the building certified as such—might be a viable option if the incentives were appealing.

Green Communities Act

In 2008, Massachusetts enacted the Green Communities Act (Chapter 169), a comprehensive energy reform law intended to lead to a reduction in electric bills, increase the use of renewable energy and stimulate the clean energy industry currently being cultivated in Massachusetts. Part of this law establishes the "Green Communities Program", which will provide funding and technical assistance for energy efficiency and renewable energy efforts to qualifying communities that make a commitment to efficiency and renewable energy. The program will be funded from a variety of sources including emissions allowance trading programs, utility efficiency charges and alternative compliance payments generated by the renewable Portfolio Standard and the Renewable Energy Trust Fund.

Recommendation: Investigate the pros and cons of being designated a "Green Community" under the Green Communities Act in a timely manner and, if appropriate, apply to become a Green Community.

Does Belmont wish to apply for designation as a Green Community? The town should give serious consideration to this opportunity, to the benefits that would accrue to the Town under the Act and to the steps and actions that would be required should we wish to qualify for such a designation. The municipalities that

Small Wind

Small wind-powered electric systems sized for homes, farms, and small businesses have experienced major growth in popularity during the past decade. These turbines, of 100 kilowatts or less in capacity, are the product of a new industry that expects to grow by 18 to 20 percent through 2010.

The turbine shown was installed at the McGlynn Middle School in Medford, MA, in February 2009. The turbine's hub is 131 feet high and its three blades are 34 feet long; it was made by Northern Power of Vermont and is expected to generate 170,000 kilowatt hours of electricity per year which is about 10 percent of the school's consumption. The U.S. is the leading producer of small wind turbines. Individuals can use these machines to lower their electric bills and reduce their contribution to climate change.

With net metering the user may benefit from wind energy and still be assured of power from the electric grid whenever needed. Independence from the grid is possible but requires the additional expense of a storage system to cover days of calm weather. Small wind turbines can be cost-effective today in locations with favorable wind conditions.

On the Web: *http://insidemedford.com*

are early adopters of this program are likely to have a larger pot of grant monies available to them.

Trees

Recommendation: Adopt a policy for all new construction and substantial renovation projects, both municipal and private, that requires the planting of trees in close proximity to the new structures and strategically located to maximize their shade effect.

The crucial role of trees in efforts both to mitigate and to adapt to climate change cannot be overstated. By sequestering carbon, they reduce the amount of CO_2 sent into the atmosphere, and therefore contribute immediately to carbon reduction. As the planet heats up, trees will be increasingly essential, helping make human life tolerable both indoors and out by providing cooling shade. Deciduous trees planted on the south and east sides of buildings will protect the building from the sun, thereby cooling it and reducing the need for air conditioning in hot weather. The leaves drop as winter approaches, thereby allowing the warming effect of sunlight to contribute to passive solar heating.

Recommendation: Adopt a policy that requires a builder of private property (new or substantial renovation) to replace any tree whose removal is required by the construction with a newly planted tree, either on the same property or at a municipal location.

This recommendation extends to trees on private land an existing policy regarding Town-owned trees.

Purchasing Practices and Negotiated Contracts: Using our Greenbacks

Pursuing purchasing practices that favor green sustainable options, including the negotiation of future contracts, offers significant potential for the Town to reduce CO_2 emissions, particularly if such practices are enhanced through strategic alliances with other communities or institutions.

Recommendation: Ensure that all Town bids and contracts include language that requires or encourages vendors to adopt sustainable, energy saving practices.

Choosing where and how to spend dollars is one of the most effective means to change the behavior of others. The Energy Manager will review bids and proposed contracts to ensure the inclusion of language and conditions that make clear the Town's intention to work with vendors who support the reduction of carbon emissions and promote a sustainable future. Examples might include school buses retrofitted for reduced carbon emissions; companies that employ "carbon-neutral" shipping; companies that reject excess packaging and use carbon-neutral packaging materials; companies that specialize in using or selling products made with local resources or from recycled materials.

New Sources of Funding

The Town can pursue creative approaches to conducting town business and providing services that reduce energy use and therefore carbon emissions. A clear example is the opportunity to qualify as a Green Community under the new state law.

Seeking creative energy-saving financing options—for example those utilized on the ESCo project—and applying for grants to develop and implement sustainable approaches and improvements should also be pursued. Belmont might seek grants and funding for opportunities to conduct outreach and education programs, install large-scale energy-efficient equipment, pilot new low-carbon or energy-efficient technologies in Belmont and facilitate the development of renewable and alternative energy resources.

Recommendation: Direct the Energy Manager to seek grant and funding opportunities to facilitate the implementation of the goals and recommendations of this Climate Action Plan.

Belmont Municipal Light Department

The Belmont Municipal Light Department, through its responsibility for electricity supply and distribution to town residences, businesses and institutions, can provide leadership in promoting conservation and efficiency, and a shift toward renewable energy sources.

Rate Structure

Electricity use in Belmont varies with the seasons and time of day. The peak load on the BMLD distribution system occurs in summer afternoons, when the air conditioning load is the greatest. Two problems arise in attempting to supply this load:

(1) Belmont's feeders from its electricity suppliers have limited capacity. To increase feeder capacity requires capital investment that is only utilized a few days of the year. Reducing the peak amount of power the system must supply will permit the system to operate more efficiently at less expense.

(2) At times of high demand for electricity, Belmont's suppliers of electrical energy turn to their least efficient power plants to meet the load. This leads to significantly greater expense per unit of energy and higher emissions because the least efficient plants are those that generate greater amounts of CO_2.

The way Belmont's suppliers pass the extra cost to the town is to set their rate for electricity according to the peak demand from the town's consumers over the past several months. To get a better rate the town can lower its peak demand. The way to accomplish this is by shifting as much electricity use as possible from periods of high demand to periods of lower demand. Consumers can be encouraged to participate in making this shift by a rate scheme that charges more for consumption during peak use periods and less for consumption in periods of average or low demand.

Recommendation: Implement a rate structure that discourages electricity consumption during periods of peak demand.

When the load on Belmont's electricity distribution system is excessive, the BMLD must respond to the emergency by cutting load, which means black-out for some customers. To avoid this possibility, the BMLD has made arrangements with some commercial and institutional customers whereby these customers can shed a portion of their electrical load upon request from the BMLD in an emergency.

Recommendation: Extend load shedding in an emergency to residential customers by means of a "reverse 911" signaling system.

Renewable Energy Sources for Electricity

Currently, residential customers of BMLD receive five percent of their electrical energy from New York Hydro and a varying amount of electricity from the Seabrook nuclear plant. Otherwise, all of Belmont's electricity is generated at fossil-fueled power plants, with a corresponding contribution to the town's emissions of CO_2.

Recommendation: Work toward utilizing renewable energy sources.

Several potential sources of renewable energy are or may become available to the Town. Two in-state wind power generation projects are at different stages of planning, Berkshire Wind and Cape Wind. Also, biomass power plants might be tapped for renewable energy supply. In the future, more of these may become available as economies and technologies evolve and government policy turns more toward favoring alternative energy sources.

- The BMLD should track progress in renewable energy sources and tap into them as progress permits.

Locally, photovoltaic installations turn solar energy into electricity and are becoming practical to install on public and commercial buildings.

- Investigate the possibilities for photovoltaic installations on Belmont public buildings, especially schools.

Photovoltaic arrays may also be installed on homes' roofs and some residents may wish to pursue this possibility.

Local wind turbine installations are another possibility. These are most effective when installed at higher elevations where the best wind exposure is found. There are few sites in Belmont where a wind turbine installation would be practical due to the built-up nature of most of the town. However, individual residents located in favorable areas might choose to invest in wind energy. With wind and photovoltaic energy sources, the supply is dependent on the weather and presence of sunshine. It is possible to install net metering so energy can be supplied to the electric grid by the consumer when there is more available than needed, and drawn from the grid when the amount of wind or solar energy is insufficient.

- Provide net metering to customers wishing to install private sources of electricity.

One step toward greater use of renewable energy is the BMLD's offer to customers of Renewable Energy Certificates (RECs) which are discussed below.

Clean Power with RECs The Belmont Municipal Light Department currently offers residential customers the BMLD "Green Choice" option. This allows consumers in Belmont to purchase renewable energy and contribute to the growth of renewable energy sources in New England through the purchase of Renewable Energy Certificates (RECs). Renewable Energy Certificates (RECs) is a way for BMLD customers to immediately and significantly

Net Metering

Net metering programs provide an important incentive for consumer investment in renewable energy generation. Net metering enables customers to use their own electricity generation to offset their consumption over a billing period by allowing their electric meters to run backwards when they generate electricity in excess of their demand. With this arrangement customers receive retail prices for the excess electricity they generate.

Net metering is low-cost and easily administered. It increases the value of the electricity produced by renewable generation and allows customers to "bank" their energy and use it at a different time than it is produced, giving customers the flexibility to maximize the value of their production. Providers may also benefit from net metering because when customers are producing electricity during peak periods, the system load factor is improved. Currently, net metering is offered in more than 35 states. Present Massachusetts state law provides for net metering of farm-renewable-energy systems and combined heat and power systems, and applies only to investor-owned utilities.

Further information may be found at *http://apps3.eere.energy.gov/greenpower/markets/netmetering.shtml.*

Compact Fluorescent Lights

Compact florescent light bulbs, known as CFLs, are a version of the fluorescent lamp that is interchangeable with common light bulbs. CFLs use almost 75% less energy than regular incandescent bulbs and last 10 times longer. The installation of one CFL can save over $30 dollars in energy costs over its lifetime compared to incandescent bulbs, as well as saving 2,000 times its weight in greenhouse gases.

Lighting is estimated to account for nearly 20% of all household energy consumption, so if every home in the United States replaced one incandescent light bulb with a compact fluorescent, the energy saved could light over three million homes and avoid the emission of greenhouse gases equal to that of 800,000 cars.

Like all fluorescent lamps, CFLs use an electrical discharge through mercury vapor to produce ultraviolet radiation that excites phosphorescent material coating the glass tube to produce visible light. The filament of the incandescent lamp is absent. The amount of mercury in a fluorescent lamp is tiny, far less than the mercury released by burning coal to power an incandescent bulb. Nevertheless, in consideration of the environment, CFLs and other fluorescent tubes should be disposed of properly.

Photo: *www.energystar.gov*

decrease the CO2 emissions that come from electric power generation with fossil fuels. Under this program, renewable electric power is generated and put onto the national electricity grid displacing fossil fuel-based electric power on a one-to-one basis and so eliminating those CO2 emissions. RECs are purchased in units of 100 Kwhr per month and cost $6.00 per month. With the purchase of one REC, a customer who consumes 100 Kwhrs per month and pays about $18 per month will now pay about $24 per month ($18 +$6= $24), equivalent to about a 30% premium to have green electricity generated. Customers may purchase several RECs.

For example, a customer using 450 Kwhrs per month might purchase 4 RECs, thus covering 400 Kwhrs of the total 450 Kwhrs with green electricity. In this example, the customer has decreased his/her household's electric power CO2 footprint by 88% and has avoided putting, annually, 6,480 pounds of CO2 into the atmosphere. (This is equivalent to eliminating a compact car getting 30 mph and doing 10,000 miles per year). The relation between the number of RECs purchased and the CO2 emissions avoidance is shown in the Table below

Table 15. CO_2 Emissions Avoidance for Different RECs Purchase Choices

Number of RECs Purchased	REC Kwhr per month	RECs Kwhr per Year	Pounds of CO_2 Emissions Avoided per Year
1	100	1,200	1,620
2	200	2,400	3,240
3	300	3,600	4,860
4	400	4,800	6,480
5	500	6,000	8,100
6	600	7,200	9,720
7	700	8,400	11,340
8	800	9,600	12,960
9	900	10,800	14,580
10	1000	12,000	16,200

Besides the opportunity to avoid CO_2 emissions, purchasing RECs helps increase the demand for renewable energy and thus encourages further investment in green electricity generation. Download a brochure to purchase RECs through the Belmont Municipal Light Department's Green Choice program. Visit: **www.belmont-ma.gov/electric.** From the menu on the left, select **Programs** and click on **Green Choice** in the rollover menu.

BMLD Staff Incentives

The mission of the BMLD has been to provide reliable electricity at the least practical cost. Given the urgency of responding to the specter of disastrous climate change, it is necessary that the BMLD take on an expanded mission of stewardship for the environment. To fulfill this new mission, it is necessary that the staff of BMLD assume explicit responsibility for evolving operations and policies that will aid in lowering greenhouse gas emissions in Belmont.

Recommendation: Provide incentives and rewards for BMLD staff to work toward reduced greenhouse emissions in Belmont.

Outreach and Education

A major role of the BMLD is in providing information to Belmont residents and businesses to help work toward conservation and efficiency of electricity use. The means of communication available to BMLD include the monthly bills sent to consumers, which frequently include newsletters, the BMLD pages at the town website, and the presence of BMLD at town events such as the annual "Meet Belmont."

Recommendation: Improve the BMLD's dissemination of information to the community.

Information is needed by the community that makes consumers aware of how their behavior compares with that of others. Also, the community needs to be informed of energy conservation or efficiency initiatives adopted by the BMLD. Some questions and issues that might be addressed through BMLD information dissemination are:

- Reasons for conservation and energy efficiency measures
- Electrical appliances and phantom energy
- Reducing demand during peak times
- Energy Star and "Appliance Exchange Days"

Cutting Phantom Energy Loss

The average U.S. home contains many products that waste electricity by continually drawing power, even when the product is turned off. Cell phone chargers, cordless phones, computers, audio and TV equipment, microwaves and clock radios with digital displays are just some of the culprits. Cutting phantom power might save as much as 10% of an electricity bill and reduce the carbon footprint.

The biggest vampires are devices that are continuously ready to receive a signal calling them into action: communications equipment such as fax machines and telephone answering machines; entertainment equipment with a remote control. Also guilty are appliances with a display that is constantly on such as the clock on a microwave, and devices powered by an external power supply.

Many of these devices use so little standby power that they likely won't be noticed in an electric bill. However, some devices and equipment are notorious offenders. Here is a list of some of the worst:

Product	Average Standby Power
Digital Video Receiver	37 watts
Set-top Box for Digital Video	37 watts
Set-top Box for Digital Cable or Satellite	18 watts
Cordless Power Tool– plugged in and fully charged	8 watts
Combination TV/VCR	6 watts
Inkjet Fax Machine	5 watts
Garage Door Operator	5 watts
Multifunction Office Device	5 watts
Cordless Phone with Answering Machine	3 watts

Also remember that most computers left on but unused still consume a lot of power. Turning them off when not in active use will save a lot of energy. If suspicious that a particular device might be a standby power hog, check it out with a power-measuring meter such as a Kill-a-Watt. Keep these figures in mind when purchasing new products, and be sure to disconnect the power when services they provide are not needed.

- Promotion of town building policies (LEED)
- Energy audits for residential and commercial users
- Energy audits for municipal users
- Explain the meaning and benefit of appliances that bear the "Energy Star" label.

Means for dissemination include:

- Comprehensive print material and interactive online resources/tools.
- A user-friendly and interactive website that will both educate and touch a broad audience.
- A sticker that people can post on their cars or windows noting they're reducing energy use and come up with a catchy slogan for the campaign.
- Structures in which homeowners, commercial, municipal buildings, etc. can "compete" publicly with each other to reduce electricity consumption and CO_2 production; announce "winners" on the BMLD website, the monthly bill, and the *Belmont Citizen-Herald*; provide expert BMLD "coaches" to owners who request them to help them compete better.
- Partner with the library in organizing and sponsoring climate-related events; explore similar collaborations with the schools, houses of worship, service clubs, etc.
- Launch an "ROI" reimbursement program: Replace Old Incandescents, or Replace Outside Incandescents, or Return on Investment, to encourage use of efficient light bulbs.

Here are some suggestions of information that would be useful to have available from the BMLD web pages:

- A robust CO_2 calculator that compares various appliance models.
- Information on energy consumption by appliances based on appliance year and model and amount of savings if replaced with the newer/newest Energy Star model.
- Average kWh usage figures and current costs for "typical" homes and businesses of varying square footage to provide consumers with a frame of reference for comparing their property to others of similar size.

The monthly electricity bill received in virtually all Belmont households should be the primary means of communicating with consumers about the town's efforts to reduce electricity consumption and CO_2 production:

- Suspend community messaging on the BMLD light bill and focus on delivering conservation-related information; or reserve a limited area of the BMLD monthly bill statement for "Community Messages" and dedicate the rest of the bill to BMLD conservation-specific messages.
- Use graphs only when they are very clear (i.e., when the data are graphically quantifiable); otherwise, provide comparative information in tables of numbers.
- Let consumers know the cost implications (in both dollars and CO_2) of peak and non-peak usage days and provide specific strategies to reduce use during peak load periods

Recommendation: Purchase devices, such as a Kill-a-Watt meter, that measure electric use and donate to the Belmont Public Library to make available to patrons.

There are several devices on the market today to help homeowners monitor their electric usage real-time. Some devices measure consumption for the whole house and others measure consumption of one appliance at a time. Currently, prices range from $25 to $150. Some require plugging in to an outlet and others require an hour of an electrician's time. The devices could cut the homeowner's electric bill by up to 15% if their use prompts the homeowner to use a particular appliance less or use it at a less costly time of the day. Some of these devices are: Kill-A-Watt, Watts Up, Black & Decker Power Monitor, and The Energy Detective 5000. The Town of Lexington has such devices available for patrons through its public library.

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Waste Recommendations

The disposal of waste materials accounts for less that one percent of Belmont's CO_2 emissions. However, one should understand that everything we throw away was produced, manufactured and transported to satisfy our appetite for goods. Most of the energy used in industry, agriculture and transport, is related to the desire for comfortable, healthy, and fun experiences in life. Waste disposal can also release toxic materials into our environment, and a sustainable society must avoid these negative consequences.

The recommendations fall into two categories: The first group consists of ways of sending less to the waste streams; the second group consists of ways to reduce the environmental impact of the waste we must dispose of. Most of these recommendations apply equally to residents, businesses, institutions, the schools and government operations.

Recommendation: Reduce consumption and increase reuse.

Live prudently: "Recycle, redeem, and sell", rather than throw away unwanted objects. Buy items that have a longer useful life. Buy goods without unnecessary packaging. Use cloth and/or recyclable plastic bags for shopping. Give or sell useful items no longer needed to others who can use or resell them. For example, give unwanted books to the Belmont Library, GotBooks.com, 1-800-GOT-JUNK, etc.; donate unwanted clothes to charitable collection agencies like Big Brother-Big Sister, the Epilepsy Foundation, and others who will pick them up from the front door, or consign them to a thrift shop. Drink tap water instead of bottled water. Invest in effective house and/or tap filters if you wish to use filtered water.

Not only do these actions reduce emissions associated with waste handling, but they yield a far greater reduction in emissions from the non-production, non-manufacture and non-transport of goods we avoid acquiring.

To reduce the flow of unwanted catalogs and junk mail, contact mail order firms directly, as well as websites such as catalogchoice.org, dmachoice.org, and ProQuo.com.

Recommendation: Reduce organic material in the town waste stream by composting food and yard waste.

Start and maintain a compost heap for yard and vegetable waste and use the finished material on lawn and garden. The Public Works Department sells composting bins and provides instructions for effective composting.

Recommendation: Facilitate exchange of items for reuse.

Operate a durable goods exchange (see sidebar "Got Stuff?"), perhaps at the Concord Avenue site, where residents may leave items of possibly continued usefulness, for others to take away. This could be staffed, in part, by volunteers from the community. Belmontians are encouraged to use the Freecycle Network online swap.

Recommendation: Provide for reuse or proper disposal of electronic junk.

Electronic junk of all kinds must be kept out of the town's trash stream, primarily because of the toxic materials used in their manufacture. Some devices such as unwanted cell phones may be donated to agencies for reuse. There are active sites devoted to reuse of unwanted electronic hobby and entertainment equipment. Equipment unsuited for reuse must be processed to recover recyclable components and dispose of toxic materials, and the Town should provide means for its disposal or provide residents with information for proper disposal.

Recommendation: Keep toxic materials from the environment.

Belmont must continue to provide means for safe disposal of hazardous materials. Currently the only in-town provisions are for used motor oil, which may be taken to the Town Yard, and fluorescent tubes and CFLs that may be taken to the BMLD, Public Works Department at the Homer Building, Health Department, or Hillside Garde Supply on Brighton Street.. The town should ensure that the Minuteman Hazardous Products Facility continues to be available and should encourage the state to make similar facilities available throughout Massachusetts.

Residents, businesses and institutions must be meticulous about not disposing of hazardous materials through the town's sewer or storm drain systems. Also, reduce use of chemicals to melt snow and ice on sidewalks, driveways and streets. Businesses are responsible for ensuring that any waste water released to town drains is free of contaminants.

Recommendation: Facilitate disposal of materials not presently considered recyclable.

Currently, many items discarded as unusable go into the trash stream and are fed to the incinerator. Much of this, such as large plastic objects, metal scrap, rags and rugs, can be usefully recycled, but are not accepted in the town's recycling program. Other towns sponsor recycle days and "drop/ swap" events where these materials can be left for exchange, reuse or recycle. Belmont should have a similar program, perhaps at the Concord Avenue site.

Recommendation: Regulate disposal of debris from construction and remodeling projects.

Typically, all waste material from construction and remodeling projects is put in dumpsters and hauled away by a disposal contractor. Often, masonry, metal scrap, used and scrap wood, even asphalt shingles are commingled and go to the same disposal site. The Town, in cooperation with state authorities, should investigate means for ensuring that construction waste is separated and recycled to the maximum extent feasible.

Homeowners and contractors should be aware that organizations such as the Boston Building Materials Resource Center will accept donations of reusable building materials.

Recommendation: Provide incentives for environmentally sensitive disposal of waste.

Consider schemes for encouraging people to recycle and reduce waste:

- Investigate joining "RecycleBank," a national effort to increase recycling in which participants earn a share of profits from recycling. In this system, each bin is weighed by a device on the truck, for which the recycler receives "points" based on the weight, redeemable at participating local and national stores.[34]

34 More details about RecycleBank may be found at *www.*

Got Stuff? Reuse and Recycle!

Here are some ways of seeing your unwanted items reused instead of going out with the trash.

Freecycle Network. Since its origin in Tucson, Arizona, in 2003, The Freecycle Network™ has grown to more than 4,500 groups with over five million members in more than 75 countries. It's a grassroots and entirely nonprofit movement of people who give (and get) stuff for free and thus keep good stuff out of landfills. Nearby there are local groups in Cambridge, Lexington, Medford, Newton and Watertown with a total of nearly ten thousand members. Members of Freecycle collectively keep more than 300 tons a day out of landfills. Sign up for the Belmont chapter or joining a nearby chapter. Online at *www.freecycle.org.*

Got Used Books, CDs, and DVDs? Here are two suggestions for reuse:

Donate to the Belmont Memorial Library. The Friends of Belmont Public Library will resell donated books during book sales. The money raised has funded passes to museums, young adult programs, children's programs, the Belmont lecture series, a new PC for public use, and other important gifts to the library. Books can be brought to the back of the library next to the staff parking lot (see white door; inside is a room for donations).

Donate to Got Books. This for-profit used bookseller gives books free to libraries, schools, children's causes and other groups in need, teachers for their classrooms, and to troops overseas. Books, CDs, Videos, DVDs, and audio books are accepted at drop-off sites in Massachusetts. To schedule a pick-up, call 978-664-6555 or go online to schedule a pick-up at your home or business. The donation may be tax-deductible. For more information, visit *www.gotbooks.com.*

Of course there are many charitable organizations and rummage sales that will happily accept many kinds of reusable stuff. For items of greater value, Craigslist (*www.craigslist.com*) is a great way to find them a new home.

- Sponsor a competition among town groups to achieve the highest score for recycling and waste reduction.
- Revisit the possibility of instituting a "pay as-you-throw" program for solid waste collection. Such a plan would charge nothing for disposing of recyclables, but require purchase and use of bags from the Town for solid waste.
- For municipal operations, record the amount of waste and recyclables generated each week by each Town building and/or department and charge the costs of disposal to departments, providing a financial incentive to conserve and recycle.

Recommendation: Provide information about disposal and recycling of unwanted items.

Publish a "How to Get Rid of It in Belmont" online guide to provide residents and organizations information about disposal options for unwanted items and material. This would include lists of agencies that accept donations of unwanted goods, instructions about what is recyclable and how to get it to where it can be processed, information on composting organic material, and the disposal of hazardous waste.

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recyclebank.net.

Recommendation: Encourage businesses to organize shared services for waste disposal and recycling.

Businesses generate roughly half of Belmont's waste and would benefit from participation in cooperative waste disposal and recycling services. The Town should encourage businesses and institutions to organize collective arrangements for these services.

Recommendation: Explore opportunities for regional cooperation.

Work with nearby towns to establish a cooperative waste disposal district aimed at: increased recycling and lower costs. This should be an ongoing effort.

Recommendation: Encourage and facilitate composting of vegetable waste at all Belmont Schools.

Summary

Waste contributes far less CO_2 to the environment than heating and cooling, transportation, or electricity generation, but direct citizen involvement in environmentally sound disposal practices can lead to deeper commitment to the Town's overall sustainability program.

Education and Outreach

Public sentiment is everything. With public sentiment, nothing can fail; without it nothing can succeed. Consequently he who moulds public sentiment, goes deeper than he who enacts statutes or pronounces decisions. He makes statutes and decisions possible or impossible to be executed.

—Abraham Lincoln
(August 21, 1858)

For the town of Belmont to achieve its reduction goals, members of the community must under-stand the need for the Climate Action Plan and participate in making the necessary changes to reduce CO_2 emissions. Deliberate action, rethinking accustomed practices, and adopting new behaviors will be required. Reductions made in CO_2 emissions will directly benefit Belmont and its community members by providing savings in energy costs, improving air quality, reducing the impact of climate change, and improving the overall quality of life.

Persuading people to change their habits is a most challenging endeavor. Community members will need not only be educated about the reasons to reduce their CO_2 emissions, the benefits of adopting the CAP recommendations, and the various options for making those reductions, but they will also need to have demonstrations of how they as individuals and we as a community can make changes to reduce emissions.

Despite the difficulty of the challenge, other communities around the world are addressing this issue and making progress. For example, Portland, Oregon, which in 1993 became the first U.S. city to adopt a plan to reduce carbon emissions, has reduced its emissions, on a per capita basis, by 12.5% since 1993.[35] Salt Lake City, Utah has succeeded in reducing the carbon emissions from its municipal operations by 31% since 2001.[36] Much can be learned from other communities about how to address the challenge of changing behaviors.

The reduction of CO_2 emissions will need to be a community-wide effort and will require the involvement of all sectors of the community, including residents, businesses, municipal departments, and institutions. Therefore, a coalition of representatives from all of the sectors would be best suited to develop plans and to lead the effort to implement the recommendations. As part of this effort the coalition could oversee the development of an outreach program or programs to promote the CAP and its recommendations to the public.

35 Online at *http://www.portlandonline.com/ osd/index.cfm?c=41896.*
36 Online at *http://www.slcgreen.com/CAP/default.htm.*

Oversight, Vision, Implementation, and Outreach

One mechanism for pulling together representatives of the various sectors in the town would be for the Selectmen to form an ad hoc or a standing committee whose mission would be to oversee the implementation of the Climate Action Plan. Such a group could include representatives of town government (such as the Office of Community Development, the Health Department, and the Department of Public Works), the Municipal Light Department, the schools (including a representative of administration, faculty, and at least one high school student), the Vision Implementation Committee, Sustainable Belmont, business owners, representatives of institutions (e.g., private schools, churches, and health care facilities) and interested residents, ideally including some with experience in social marketing and technical experience in climate change and/or environmental protection.

Such a committee could develop guidelines for reductions in CO_2 emissions for each sector; prepare educational materials such as brochures, posters, hangtags, postcards and signs for the various constituencies; and oversee a monitoring system to track reductions and improvements. See box for an example of an educational hangtag related to Sustainable Belmont's Cleaning the Air (anti-idling) campaign. As part of this overall effort, the group could develop a plan or plans for education and outreach programs using the tools of social marketing to effectively introduce the CAP to the Belmont community.

Principles of Community Based Social Marketing

The most effective way to achieve voluntary behavior change is to change what is socially acceptable. Social science research has shown that campaigns to change people's behavior that have employed methods such as providing education and information, promoting attitude change, or even appealing to economic self-interest have not proven effective in persuading

people to adopt new behaviors. In short, research and experience have shown that simply providing people with information is not enough to convince them to adopt new behaviors or give up old ones. Social marketing is a programmatic approach to influence the voluntary behavior of a target group to achieve social goals. One methodology that has been developed and used successfully to do this is known as Community Based Social Marketing (CBSM).

Doug McKenzie-Mohr, Ph.D., an environmental psychologist in Canada, has studied and written extensively on the uses of CBSM in promoting the adoption of sustainable behaviors. Dr. McKenzie-Mohr's research has shown that there are usually three key reasons why people do not readily adopt a desired behavior. His research has found that people fall into one of three categories:

1) they are not aware of a desired behavior and its benefits; or

2) they know about the behavior and the benefits but see difficulties or barriers to adopting it; or

3) although they see no barriers to the behavior, they fail to see the possible benefits from it.

The CBSM approach to change behaviors and attitudes involves first doing an analysis of the population or target audience involved and their attitudes toward the desired behavior changes. The recommended analysis would include:

1. Identifying the barriers to sustainable behavior,
2. Developing a strategy or program to use tools that have proven effective in persuading people to change their behavior,
3. Running a pilot test of the program with a targeted group that will then serve as a role model to the larger community, and
4. Evaluating the strategy following its use in the community.

While it may be tempting to employ shortcuts to this system and skip the research phase, Dr. McKenzie-Mohr cautions against making assumptions about what barriers may prevent the target audience from making changes. The three tools for identifying barriers recommended are a review of relevant literature, focus groups, and telephone surveys.

After choosing a target audience and identifying barriers for that audience, McKenzie-Mohr advocates using six tools for designing effective social marketing campaigns. These tools are:

1. seeking a commitment from individuals to the new behavior,
2. providing sufficient, clear prompts to help remind them of the desired behavior,
3. creating social norms in support of the behavior,
4. developing effective communication about the behavior,
5. providing incentives to reward the behavior,
6. making certain that the new behavior can be done with convenience.

While it is not necessary to utilize all six in a given campaign, using them in combination is likely to increase effectiveness.

Perhaps the most important message that McKenzie-Mohr has to share is about the power of modeling and social diffusion. He writes:

"We believe deeply that we must do all we can to protect and preserve our limited natural resources. We also want to do whatever we can to assure that our grandchildren, and all children will raise their families in a livable environment. Toward that end:

We own a Hybrid car (Prius). We no longer use all three heating or A/C zones in our house simultaneously, closing doors to seal off areas not being used. We are careful to shut off lights when leaving a room, even for only minutes at a time. We are replacing light bulbs with CFLs.

We buy EnergyStar appliances. We participate in the Belmont Municipal Light Dept's "Green Choice" program. We compost all possible kitchen waste. We buy "local" and use organic food when possible. We use only organic fertilizer in our garden. We recycle practically everything. We carpool to meetings when possible."

—Paul and Phyl Solomon

> *Commitment, modeling, norms and social diffusion all have at their core the interaction of individuals in a community. Commitment occurs when one individual pledges to another to carry out some form of activity. Modeling results when we observe the actions of others. Norms develop as people interact and develop guidelines for their behavior, and social diffusion occurs as people pass information to one another regarding their experiences with new activities. Recent research has documented that it is possible to harness these processes in order to have a significant impact upon the adoption of sustainable behaviors.*[37]

The good news about this message is that the readers of this report have it within their power to initiate and to affect real change in Belmont by reaching out to friends, neighbors, and colleagues and sharing with them an action or actions that they are taking to reduce carbon emissions.

What Works

In *Communicating Sustainability*, a 2005 publication prepared for the United Nations Environment Programme by Futerra, a U.K. communications firm specializing in sustainability, authors Lucy Shea and Solitaire Townsend pro-vide an overview of environmental public relations efforts around the world. Shea and Townsend's recommendations for effective CBSM programs include the following:

a. Targeting community leaders who are not the "usual suspects" who are already convinced and already employing sustainable patterns and making sustainable choices;

b. Seeking to inspire—stirring empathy by portraying threatened people and animals. People are more likely to take action to prevent losses rather than to realize gains. However, too much fear causes paralysis and a sense of hopelessness;

c. Providing information to raise awareness, change attitudes, and engage the public in adopting new behaviors;

d. Making it personal and practical—providing help to people who are attempting to change their behavior;

e. Using language carefully, making solutions sound heroic; while portraying desired actions as normal and bad actions as rare;

f. Providing feedback to acknowledge progress and express gratitude;

g. Using visuals to make points and act as triggers or prompts to remind people of the purpose of the desired behavior;

h. Providing multiple reminders in varying media and locations; and

i. If asking for pledges, making certain that the pledges are meaningful and personal.

Some Examples

Groups around the country and the world are addressing climate change and finding different ways to work to change habits and decision making within the different sectors of their community.

Commercial Sector: An example of an outreach campaign directed at the commercial sector comes from Fort Collins, Colorado. That city's Climate Wise Program, an award-winning voluntary program, provides businesses with technical assistance (including environmental assessments and creative solutions), public recognition, and networking opportunities to help them reduce both costs and

37 McKenzie-Mohr, Doug, *Fostering Sustainable Behavior*. Online at *http://www.cbsm.com/ pages/guide/ communication.*

climate changing emissions. Begun in 2000, this growing program promotes energy efficiency, green power, solid waste management, water conservation, alternative transportation, and transportation demand management through public-private partnership. The Climate Wise Program estimates that participating businesses (now totaling over 90) have accounted for the reduction of over 70,000 tons of CO_2 emissions per year, which represents more than 40% of overall reductions realized in Fort Collins.

General Public Focus: Sweden developed its Climate Campaign in 2002–2003, and the planners named the target audience "dozing community activists"—people whom they de-scribed as being those who were open to new ideas and experiences, believed that social and environmental issues were important, and who did not mind doing their part to help as long as it was not too difficult to do so and as long as they themselves would benefit in some way. The campaign's three main objectives were to: 1) increase knowledge of the causes of the accelerating greenhouse effect;

2) increase knowledge of the effects the accelerating greenhouse effect can have; and

3) change attitudes about individuals' ability to reduce greenhouse gases. The campaign consisted of a series of public relations activities, including advertising and direct mailing, along with local events aimed at increasing knowledge about the greenhouse effect and climate change.

Six months of careful planning preceded the campaign. The realization that climate change causes great uncertainty and that that uncertainty causes the reluctance of individuals to commit to personal activities to mitigate climate change shaped the focus of the campaign. The slogan for the campaign was, "The greenhouse effect affects you; how do you affect it?" The campaign identified two key principles to keep in mind: 1) the importance of relating the information presented to people's everyday lives, and 2) the need to associate threatening scenarios with positive actions or solutions. At the close of the campaign, an independent survey group found that 74% of the Swedish population believed that individual actions could reduce the greenhouse gas effect.

Comprehensive Approach: Salt Lake City, Utah, has taken a comprehensive approach to environmental protection. Under its Salt Lake City Green umbrella, the city has developed an education plan, its **e2 program** (e2 for environmentally and economically sustainable) that includes components designed for businesses, citizens, and students. The **e2 Business** program provides support and recognition for Salt Lake City's business community and economy. Businesses that sign onto the program must track their energy usage and work to reduce it, submitting an annual report and setting three measurable goals per year. In return, they get assistance and advice, free advertising, certification and branding as a participant. The **e2 Citizen** program asks residents to sign up to take five actions (including at least three new goals) from the seven categories they call: transportation; energy conservation; reduce, reuse, recycle; water conservation; food; health; and community education. The **e2 Student** program asks children to calculate their carbon footprints using the online calculator, set three goals for themselves, and spread the word to friends and family members.

Meanwhile closer to home, in neighboring Medford, MA, the local cable television station aired a reality show competition in 2007. The show was titled the *Energy Smackdown*,[38] and involved three family teams competing to see which household could decrease their carbon footprint by the greatest percentage. A member of the winning team observed, "We learned it's not that hard to decrease your footprint but still live comfortably."[39] In 2008, the *Energy Smackdown* expanded to include teams from Medford, Arlington, and Cambridge, each with ten families participating.

Outreach and Education in Belmont

After studying the principles of CBSM and considering examples from other communities, an outreach and education group or CAP implementation group can develop a plan for educating the community about the CAP and programs to encourage behavior change. They might elect to employ several different campaigns to reach different segments of the community and thereby reinforce the messages to all. For example, by partnering with businesses to support their efforts to reduce energy use and recycle materials, not only would strides be made in reducing the carbon emissions from the commercial sector, but valuable messages about the importance of taking action would be reinforced to the general public. Similarly, a program in the school

38 Online at *http://www.energysmackdown.com.*
39 Online at *http://www.csmonitor.com/2008/0109/p14s04-sten.html?page=2.*

that aimed at educating students about the importance of reducing transportation-related carbon emissions would also help adults in the community to reconsider transportation options. Additionally, a well-publicized competitive reality show like the *Energy Smackdown* or Massachusetts Climate Action Network's Low Carbon Diet contest could generate interest and promote greater awareness of actions to reduce climate change among residents, town employees, and businesses.

In Belmont, there could be an overall community campaign that will aim to reduce all climate change emissions on an individual basis. An example of such a campaign is Burlington, Vermont's 10% Challenge, which is a voluntary program to help residents and businesses reduce emissions by at least 10%. The 10% Challenge provides the tools and the information necessary to implement such a reduction. The online emissions calculator can be used to determine current annual emissions and to track the progress of emissions-reduction techniques.

> "In our household, we have focused on two types of conservation. First, we look for the EnergyStar label for all appliances and light bulbs. Second, since the transportation sector is a major driver of the demand for oil, we have invested in a hybrid car, and we look forward to the next generation of hybrids (plug-ins). Electric cars can contribute to a reduction in GHG emissions, depending on the fuel source in the generation of electricity. A more immediate potential benefit is an opportunity to address the political and economic crisis created by our dependence on foreign oil."
>
> *—Ralph T. Jones, Ph.D., Belmont Selectman*

The Board of Selectmen and the Chamber of Commerce could assist with the implementation of such a "challenge" campaign, providing literature and other tools to community members and businesses that wish to reduce emissions. In doing so, it is possible to educate residents on the large contribution of transportation towards their overall emissions.

On Earth Day in April, the town of Belmont could begin having a "Sustainable Commute" day where commuters in Belmont seek to use alternative, sustainable methods of transportation to go to work. Someday this could potentially turn into friendly competition with Arlington, Watertown, Newton, and other surrounding towns. Using a different method of commuting would hopefully inspire some individuals in Belmont to change the way they commute for the rest of the year and thus reduce their CO_2 emissions at the same time. "Sustainable Commute" day could be advertised throughout town with posters being displayed in public buildings, businesses, and on Sustainable Belmont's website.

Targeted Outreach: Residential Sector

According to the 2000 United States census, Belmont had a population of 24,194 with 9,732 households.[40] A marketing campaign targeted to Belmont households should be designed to increase awareness about the relationship between climate change and CO_2 emissions. Educational outreach should be developed to communicate suggestions for household energy efficiency, purchase of RECs, alternative transportation choices, and the potential cost savings and positive health impacts possible with town-wide emissions reductions. (See Appendix F for suggested tips.) Small neighborhood gatherings could be held to share information and techniques, using a "sustainability kit," (which provides simple tools and suggestions for reducing one's carbon footprint) for which a prototype has been developed by Sustainable Belmont. Similarly, presentations regarding the CAP and carbon emissions reductions could be made at local organizations, committees, the Council on Aging, and houses of worship.

Sustainability indicators could be developed and maintained by Sustainable Belmont and posted on the Sustainable Belmont website and displayed at Town Hall and the Library in the form of a regularly updated display that illustrates Belmont's progress toward its CO_2 emissions reduction goal.

Targeted Outreach: Commercial Sector

CBSM efforts could be used to educate businesses on how they can benefit financially and improve environmental conditions in the Town by participating in Belmont's sustainability initiative. An awards program such as the *GoGreen Awards* in Cambridge would both reward responsible businesses that take action to reduce CO_2 emissions by giving them public recognition and provide further modeling of environmentally responsible action, increasing the awareness of the general public and reinforcing the message of steps to reduce emissions. A proposed "sustainability toolkit" containing information on implementation strategies and potential cost savings could act as a communication tool to convey

40 Data Set: 2000 U.S. Census. Online at *http://www.census.gov.*

sustainability ideas to businesses and immediate assistance in employing energy-saving techniques.

Targeted Outreach: Municipal Sector

Several measures reducing CO_2 emissions and energy costs have already taken effect including the ESCo project and, in 2007, the adoption of the Sustainable Building Resolution affirming a commitment to use sustainable design principles and energy conservation considerations in new construction and renovation of municipal buildings. One possible future CBSM strategy would involve holding a visioning workshop for town employees to brainstorm low-cost and other measures the town can take to reduce CO_2 emissions.

Ideas from Belmont Stakeholders

Additional ideas for educating the public were suggested at a forum hosted by Sustainable Belmont to discuss the CAP and its presentation to the community. A group of representatives from a number of committees, boards, and leadership groups in town suggested a numerous ideas for promoting the CAP and the adoption of sustainable behaviors throughout the town. These suggestions should be studied closely and utilized in fashioning outreach, education, and implementation programming. (For examples of some of the suggestions, see Guides to Action, Appendix F)

Conclusion

The CAP sets an ambitious but necessary goal of 80 percent reduction of 2007 carbon emissions by 2050. To achieve that goal, the Belmont community must eliminate annual emissions of 222,000 tons of CO_2. Implementing the commercial, municipal, residential, and transportation CO_2 emissions reduction measures set forth in this plan will put us on the path to meeting this goal but to do so will require the combined efforts of the entire Belmont community and its stakeholders. Therefore the key to the Climate Action Plan's success is to engage the community in the effort.

Appendix A : Comparison of Carbon Tax and Cap and Trade

The federal government is considering legislation that would encourage reduction of carbon. The following are two strategies under consideration

Carbon Tax

A carbon tax is a tax on the carbon content of fuels derived from sequestered carbon—fossil fuels. Currently, the prices of gasoline, electricity and fuels in general include none of the costs associated with devastating climate change. This omission suppresses incentives to develop and deploy carbon-reducing measures such as greater energy efficiency, renewable energy, conservation-based behavior such as bicycling and recycling, and overall mindfulness toward energy consumption. Conversely, taxing fuels according to their carbon content will invigorate these incentives at every chain of decision and action—from individuals' choices and uses of vehicles, appliances, and housing, to businesses' choices of new product design, capital investment and facilities location, and governments' choices in regulatory policy, land use and taxation. A carbon tax could be revenue-neutral, meaning that revenues would be returned to the public in the form of research and subsidies for development of renewable energy sources, and funds to mitigate the impact of carbon taxes on low-income energy users.

Cap and Trade Systems

A commonly discussed climate strategy for industry is a "cap-and-trade" system for reducing emissions. These systems draw on the power of the marketplace to reduce emissions in a cost-effective and flexible manner. A cap-and-trade system creates a financial incentive for emission reductions by assigning a cost to polluting. First, an environmental regulator establishes a "cap" that limits emissions from a designated group of polluters, such as power plants, to a level lower than their current average emissions. The emissions allowed under the new cap are then divided up into individual permits—usually equal to one ton of pollution—that represent the right to emit that amount. Because the emissions cap restricts the amount of pollution allowed, permits that give a company the right to pollute take on financial value. Companies are free to buy and sell permits in order to continue operating in the most profitable manner available to them. Those that are able to reduce emissions can sell permits to companies not ready to invest in replacement or improvement of high-emission plants.

Cap-and-Trade Versus the Carbon Tax

Both cap-and-trade and the carbon tax have the benefit of changing the economic balance to favor reduced use of fossil fuels. Each scheme may have an important role in the fight against climate change. Both approaches will increase the cost to the consumer of using energy derived from fossil fuels.

The carbon tax has the advantage that it naturally applies uniformly over all uses of energy. Its disadvantage is that it appears to the public as a tax whereas cap and trade proposals operate through regulation of industry and have an indirect effect on consumer prices. It is not clear how to apply the cap and trade concept to private gasoline-powered cars which are a major source of emissions. Applying cap and trade to car manufacturers to promote low-emission cars seems fraught with bureaucratic pitfalls. Cap and trade appears to require separate regulations and bureaucracies for each sector of industry that has carbon dioxide or other polluting emissions.

A feature of many carbon tax proposals is their revenue-neutral quality. The revenue would be used to fund development of renewable energy sources and to subsidize energy expense where the cost is a social burden. Thus the carbon tax is a progressive cost recovery method, whereas cap and trade schemes pass the cost equally to all consumers. Of course there is no harm in implementing both schemes. An argument given for cap and trade is that it gives industry more "flexibility" in contrast to regulations that require adherence to a uniform limit on emissions. However, the carbon tax offers the same flexibility.

Appendix B: Commuting Survey of Town Employees

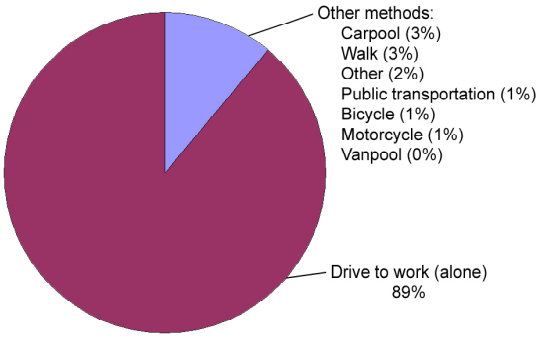
As an employer, how can the Town of Belmont encourage and enable its employees to use low-carbon means of transport? In October 2007 a survey polled the Town of Belmont's employees regarding their means of commuting to work. There are approximately 803 full- and part-time Town employees, including employees of the schools (400), Town government (375), and Belmont Municipal Light Department or BMLD (28).

The known number of employees who received the survey was 615 (schools: 400; Town government: 187; BMLD: 28; not all employees have access to a computer and the survey was conducted online; hard copies were also available and 18 hard copies were returned). Five hundred twenty-seven surveys were returned. The response rate was the following: Schools: 95%; Town government: 29%; BMLD: 80%.

Results

The questions in the survey and the corresponding results are shown in Figure B-1. The overwhelming majority (89%) of respondents usually drive alone to work. (The "other" category comprised various kinds of ride-sharing, such as being picked up/dropped off or driving children to school before work.) About half (52%) of respondents live within 5 miles of the workplace. A majority (58%) of respondents said that "nothing" would help them choose a more "environmentally friendly" method of transportation, but 17% said organized car/vanpools would help, and other measures were chosen by others.

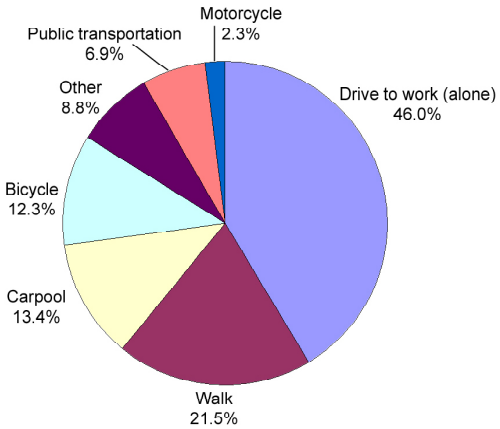
Figure B-1. Question 1.
What is your primary method of commuting to work?



Note: 520 out of 527 survey respondents answered this question. Respondents were instructed to select only one answer.

Estimate of Gasoline Consumption and Emissions

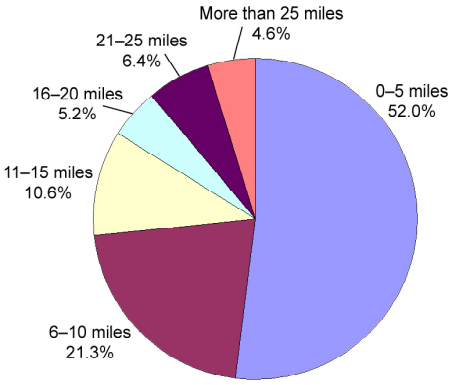
Figure B-2. Question 2.
What other methods do you use to commute to work?



Note: 266 out of 527 survey respondents answered this question. Results exceed 100% because respondents were instructed to select all applicable answers. Vanpools were used 0% of the time and are excluded from this chart.

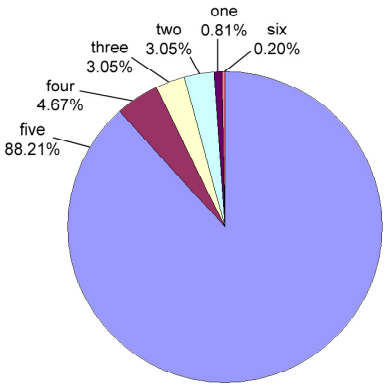
An estimate of the range of gallons of gasoline per week consumed by Belmont employees can be calculated as follows. Each respondent checked off a range of distance from the workplace and a range of mileage for the vehicle. The minimum distance divided by the minimum mileage provides an estimate of the minimum gallons of gasoline consumed per trip for the respondent. A similar quotient provides a maximum estimate.

Figure B-3. Question 3.
How many miles (approximately) is your commute from home to work (one-way)?



Note: 517 out of 527 survey respondents answered this question. Respondents were instructed to select only one answer.

Figure B-4. Question 4.
How many days per week do you typically commute to work via a car, truck, van, or motorcycle?



Note: 492 out of 527 survey respondents answered this question. Respondents were instructed to skip this question if not applicable to their commuting situation.

Summing these values multiplied by the number of trips each week gives a range for the gallons per week used by the 489 respondents. The resulting range is 520–1385 gallons per week. (Because some of the questions didn't require respondents to state a minimum or maximum, certain reasonable assumptions were made: a minimum distance from work of 0.1 mile, a minimum gas mileage of 10 miles/gallon and a maximum gas mileage of 40 miles/gallon.)

Then, since not every Belmont employee responded, the numbers are extrapolated to the whole population of Belmont employees, assuming the proportion of non-drivers and other relevant characteristics (e.g., car mileage, distance to work, number of days worked) are the same in the whole population and in the population of those who responded). For example, if 91% of the 803 employees or 731 employees drive a car or motorcycle, the scaled up range of gallons per week will be 777–2070 gallons per week. The numbers are multiplied by two (to account for the round-trip) to obtain the final range, 1554–4140 gallons per week. The geometric mean value of gallons per week is 2,536. Using 25 miles per gallon, this yields 3,305,857 miles and 1,322 tons of CO_2 per year.

Comments from Respondents

A large number of respondents (34) commented that they cannot use public transportation because it is inadequate. Public transportation often isn't available close to their homes or to their work-places in Belmont (e.g., some schools). If it does exist, it often takes too long, e.g., necessitating a trip from a suburb into Boston (perhaps traveling between North Station and South Station) and back out to Belmont. Frequency and earliest arrival time (7:45 AM for the commuter rail to Belmont Center) were also cited as inadequate. About a dozen respondents cited having to drive among locations (e.g., different schools) during the day as the reason to have a car. Several said that a town-provided car available during the work day would enable them to take public transportation to work, but it seems that these employees need to move among locations every day and so would need a dedicated car.

Some respondents (4) mentioned the need for the Rail Trail and other safe bike paths. Several employees (6) cited the need for shower and locker facilities for bicycling. They further cited the inconvenience of changing into formal clothes (suit and briefcase) after bicycling to work. Other barriers to giving up the car are the need to give others a ride (e.g., children), the need to run errands before and after work, carrying heavy loads, winter weather, and hilly terrain. One respondent mentioned that a vanpool worked at a previous job, but others pointed out that varied schedules (which are typical for teachers), both among individuals and on different days for the same individual, make scheduling carpools and vanpools difficult.

Individual respondents also had other ideas such as on-site childcare, telecommuting, side-walks (especially on busy streets such as upper Concord Ave.), planting shade trees, and a later start time to the school day. It was also suggested to address student transportation.

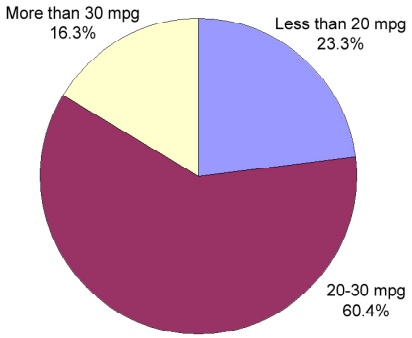
What Can Be Done?

Since employees may have different needs and opportunities depending on the distance from their workplaces, it may be instructive to break down the method of transportation by distance from work (Figure B-2). A large majority of respondents drive alone no matter how close they live to the workplace (86% of respondents living within 5 miles as compared to about 90% overall).

Since a majority of employees surveyed (52%) live within 5 miles of their workplace and 86% of these employees usually drive alone to work, perhaps it would be fruitful to pay special attention to this group. Some low-cost measures would make walking or bicycling easier for these employees (e.g., more casual dress days). Other measures, though costly, would have collateral benefits (e.g., Rail Trail, bike paths, sidewalks, planting trees). Since it is feasible to bicycle up to five miles but only feasible to walk up to perhaps 1.5 miles, it may be useful to conduct an additional survey asking employees who live nearby for the exact distance to their workplace.

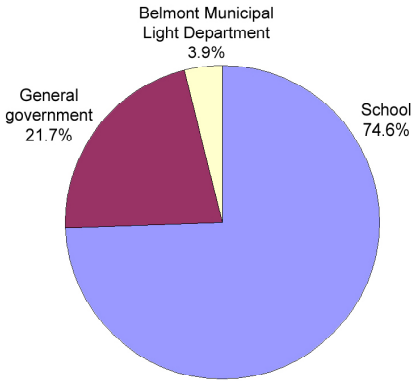
Respondents who usually drive alone to work but who already walk or bicycle sometimes may be most likely to be encouraged to drive less. Forty-seven respondents who usually drive alone to work said they sometimes walk, and an additional twenty-four said they sometimes bicycle; together they constitute 13% of the respondents.

Figure B-5. Question 5.
If you commute in a car, truck, van, or motorcycle, what is approximately the average miles per gallon of the vehicle?



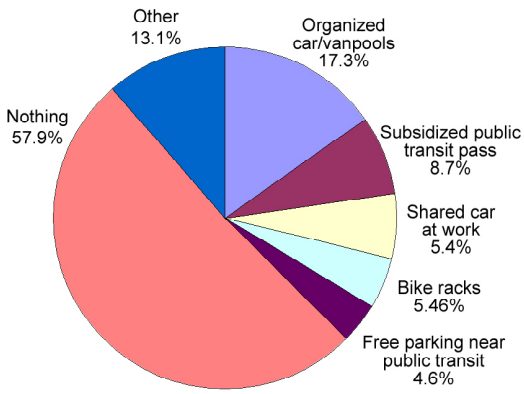
Note: 492 out of 527 survey respondents answered this question. Respondents were instructed to skip this question if not applicable to their commuting situation.

Figure B-6. Question 6.
What is your primary town affiliation?



Note: 508 out of 527 survey respondents answered this question. Respondents were instructed to select only one answer.

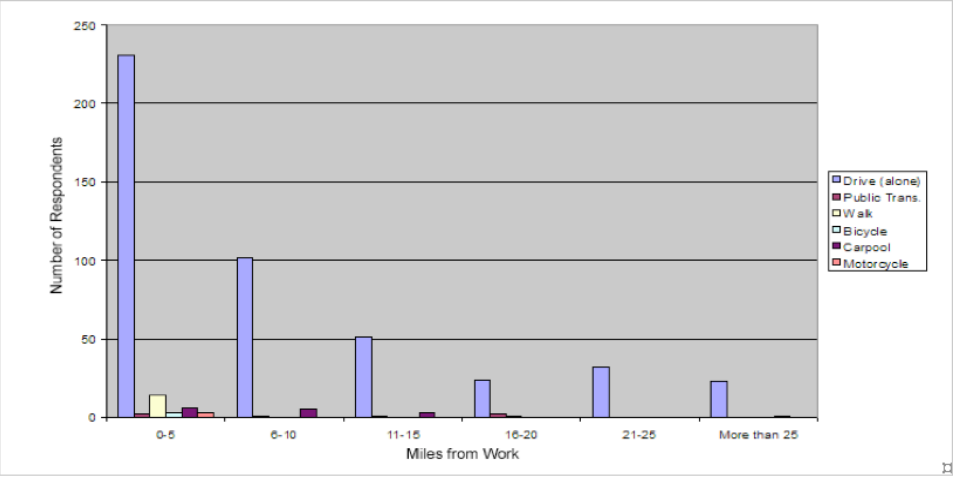
Figure B-7. Question 7.
Which of the following would help you to choose a more "environmentally friendly" way to commute to work?



Note: 496 out of 527 survey respondents answered this question. Results exceed 100% because respondents were instructed to select all applicable answers.

The estimated gasoline consumption of this group (round-trip) is 14–208 gallons/week (1%-5% of the total). (This figure may be compared with the estimated gasoline consumption of the twenty-three respondents who provided the relevant data who live more than 25 miles away, which is 132–194 gallons per week.)

Figure B-8: Method of Transportation and Distance from Work



The survey and the estimated weekly gasoline usage among respondents citing different measures which would help them suggest that Belmont should investigate the feasibility of organized car/vanpools. There would be difficulties with scheduling and cost, but if the car/vanpools served a large number of employees who live further away, the per-employee savings in fuel consumption would be large.

The recommendations below include ideas inspired by the comments of only one or two respondents but which are worth considering because they cost little (e.g., increase telecommuting) or because they carry other benefits (e.g., plant shade trees).

Recommendations:

1. Permit and accept casual dress more often (even if one still has to change clothes after bicycling, running, or walking, it's easier to carry a set of casual clothes than a suit and briefcase).
2. Build or designate shower and locker facilities for employees (the facilities already exist in BHS).
3. Investigate feasibility of organizing car/vanpools.
4. Conduct a more detailed study of feasibility of walking and bicycling among employees who live within 5 miles from the workplace (including request to report distance from work more precisely).
5. Increase telecommuting.
6. Complete Rail Trail and build other bike paths and bike lanes.
7. Build sidewalks to make more streets walkable (e.g., upper Concord Ave.)
8. Plant shade-trees to cool down streets in the summer.
9. Consider reserving childcare slots at daycare facilities close to Belmont town workplaces. (The ideal would be on-site childcare, but this seems unlikely to be feasible.)
10. Investigate student transportation methods.
11. Consider later start times for school (if there are other benefits, e.g., being more compatible with teenagers' circadian rhythms).

Table B-1. Current Gasoline Consumption Avoidable by Alternative Transportation Type

Measure that would help respondent choose more "environmentally friendly" transportation	Percentage of respondents	Current gasoline consumption (gallons/ week)
Nothing	57.90%	586-1522
Organized car/vanpools	17.30%	194-504
Other	13.10%	180-435
Subsidized public transit pass	8.70%	112-268
Shared car at work	6.70%	44-136
Bike racks	5.40%	12-104
Free parking near public transportation	4.60%	50-126

Town of Belmont Employee Commute Survey

Q1. What is your primary method of commuting to work? [Please select one.]
Walk
Bicycle
Motorcycle
Public transportation
Drive to work
Carpool
Vanpool
Other

Q2. What other methods do you use to commute to work? [Check all that apply]
Walk
Bicycle
Motorcycle
Public transportation
Drive to work
Carpool
Vanpool
Other

Q3. How many miles (approximately) is your commute from home to work (one-way)? [Please select one.]
0 - 5 miles
6 - 10 miles
11 - 15 miles
16 - 20 miles
More than 25 miles (please specify

Q5. If you commute in a car, truck, van, or motorcycle, what is approximately the average miles per gallon of the vehicle? (Skip if not applicable)
Less than 20 MPG
20 – 30 MPG
More than 30 MPG

Q6. Which is your primary town affiliation? [Please select one.]
General government
School
BMLD

Q7. Which of the following would help you to choose a more "environmentally friendly" way to commute to work> [Check all that apply.]
Subsidized/pretax public transit pass
Organized car/van pools
Bike racks
Availability of a shared car for personal errands for use during lunch or break time (e.g., Zipcar).
Free or reduced parkig for town employees near public transportation depots
Nothing
Other (please specify)

Q8. Please add any additional comments her:

Appendix C: Business and Institutional Survey

In 2007 Sustainable Belmont conducted a survey of businesses and institutions in Belmont to obtain data relating to carbon emissions that was not available from public sources. The data sought concerned fuel oil consumption, how much waste is generated, how it is disposed, and vehicle use for business purposes and in employee travel to places of work.

The survey covered 41 businesses and institutions which were contacted in person by interviewers from Sustainable Belmont. The inter-viewers presented each business owner or representative with a form (included at the end of this appendix), explained the purpose of the survey, and usually left the form with the business owner or representative to fill in after having time to obtain data. We attempted to choose businesses representative of those in Belmont, but favored businesses that were known to the interviewers. Almost all of the businesses we contacted responded with useful data. Our survey also included the private schools, hospital, nursing home, and clubs, so we have nearly complete information from six Belmont institutions which use a significant fraction of the energy consumed in Belmont.

Through the much appreciated assistance of the Belmont Municipal Light Department (BMLD), we obtained electricity usage data for all commercial rate electricity accounts for the calendar year 2007. We found that, after consolidating accounts that pertained to the same business address, and excluding some industrial accounts, communications operators and government accounts, there were 566 distinct customers, which we took to be a reasonable estimate of the number of separate businesses operating in Belmont. Omitting the three religious associations in our survey and the six institutions mentioned above, our 32 sample businesses represent 5.1 percent of Belmont's businesses that deal with the general public. For the purposes of our analysis, we attempted to assign a category of business to each customer account on the theory that the desired data would have some consistency within each business category. For 79 businesses of the 566 we were unable to determine a category, but these 79 accounted for less than four percent of the electricity consumption, sufficiently small to have little impact on our conclusions.

We adopted the hypothesis that electricity consumption is an indicator of the level of economic activity of a business, and that it is therefore reasonable to extrapolate the value of a factor such as fuel use to the set of all businesses from our sample by multiplying the factor value for our sample by the ratio of electricity use for all businesses to electricity use for the businesses in our sample. To the factor value thus obtained, we added a similar extrapolation calculated for the religious associations and the factor values for each of the six surveyed institutions. The results and special considerations for each factor evaluated are discussed in the following paragraphs.

As a check, we applied our method to use of natural gas, for which the total consumption by Belmont commercial accounts was supplied by National Grid. The results are shown in the Table C-1. To obtain the survey sample data in therms it was necessary to convert some data from dollars for which we used the rates listed on the National Grid web site for natural gas in 2007.

Table C-1. Natural Gas Use by Businesses and Institutions

Sector	Survey Sample (Therms)	Extrapolated (Therms)
Businesses	49,741	1,147,024
Religious	41,031	105,655
Institutions	227,915	227,915
Total		**1,480,594**

National Grid reports that all Belmont commercial-rate natural gas customers consumed 1,724,960 therms of natural gas energy in 2007. Subtracting the 175,807 therms of estimated municipal consumption leaves 1,549,153 therms as the natural gas energy consumed by businesses and institutions. The excess of this number over our survey-based total of 1,480,594 therms may be explained by our lack of data on natural gas use by industrial and utility operations in Belmont. For the summary

report of this Climate Action Plan, the commercial value derived from the National Grid data is split between business and institutional in the proportion established by the survey. This gives 1,200,138 therms for businesses and 349,015 therms for institutions.

There are clearly weaknesses in our methodology. For example, the distribution of business sizes is not the same for the town and the surveyed subset. Further, some users of energy did not fall into a category for which we have survey data; for example, automotive service facilities are not represented in our survey. Also, some electricity accounts represent businesses that operate in Belmont, such as the communications companies Verizon, Comcast, and T-Mobile, but do not to our knowledge consume other resources. Nevertheless, we hope the results will prove useful for town planning.

Fuel Oil

To estimate fuel oil use for the town, we computed estimates separately for businesses, religious associations, and institutions. For businesses and churches/ synagogues we assumed that fuel use is proportional to the amount of electricity used. We found that the contracting businesses in town (such as a mover or landscape services company) had a significantly different pattern of fuel use from others. In fact, two of them employ used motor oil from their vehicle fleets for their space heating needs. It is not clear how this should be accounted in our emissions inventory because we do not know what happens to used motor oil from other vehicles and power equipment operated in town. For this reason these businesses were not used in estimating fuel consumption.

These results are summarized in therms in Table C-2 below. A gallon of oil was taken to yield 1.497 therms of energy. The survey responses sometimes provided fuel use in dollars instead of gallons of oil. These were converted using three dollars per gallon as the price of oil.

Waste

The amount of waste generated by Belmont businesses and institutions was found to be as shown in Table C-3. These data are subject to considerable error from sloppy reporting and uncertainty as to the volume of a "bag" or dumpster, and the density of the waste, as well as how full a dumpster is when emptied. We assumed that a bag is 50 pounds, a dumpster holds four to ten yards, and that the waste has an average density about one fourth that of water.

A large portion of the businesses in our sample reported that they practiced recycling. However the fraction of waste recycled was not reported. A few businesses and institutions use a second dumpster for cardboard or paper recycling.

Vehicles Used in Operations

The three Belmont contracting businesses included in our survey operate a large number of vehicles, so we left them out of our sample for purposes of extrapolating business vehicle use and include their data separately to obtain the totals shown in Table C-4. These data do not include any rental vehicle use by businesses.

Table C-2. Fuel Oil Use by Businesses and Institutions

Sector	Survey Sample (Therms)	Extrapolated (Therms)
Businesses	14,395	368,740
Religious	0	0
Institutions	792,438	792,438
Total		**1,161,178**

Employee Commuting

Most employees of businesses in Belmont drive to work, but some, especially those whose jobs are near transit lines, use public transport (Table C-5). We separated the three contractors in our sample because we felt that they are not representative of typical Belmont businesses.

The responses show that people are more likely to use public transit if their place of work is near a transit line, also that people in more professional work are

Table C-3. Waste Generated by Businesses and Institutions

Sector	Survey Sample (Tons)	Extrapolated (Tons)
Businesses	623	14,355
Religious	11	46
Institutions	751	751
Total		**15,152**

Table C-4. Vehicle Use by Businesses and Institutions

Sector	Survey Sample		Extrapolated	
	# Vehicles	Total Miles Driven	# Vehicles	Total Miles Driven
Businesses	23	117,900	530	2,718,774
Contractors			94	2,000,000
Religious	0	0	0	0
Institutions	21	133,000	21	133,000
Total			**645**	**4,851,774**

less likely to use public transport. McLean hospital is unique in providing shuttle service for the many of its employees who use public transport.

Other Questions

In addition to the quantitative data summarized above, the survey asked two general questions:

- What have you done to ameliorate climate change?
- What could the town do to help you move toward greener operation?

The responses revealed that businesses and institutions are generally aware of the need to improve energy efficiency and to practice conservation, making changes such as improving lighting, replacing windows, and installing more efficient heating systems. Suggestions for the town centered on making waste handling easier and providing information relating to energy conservation and waste recycling, for example:

- Provide information: Recycling rules. What light bulbs save energy? Keep AC on at night? Waste disposal contractors?
- Provide incentives to landlords.
- Bus: Between Belmont Center and Waverley.
- Require use of solar power by commercial operations.
- Accept shredded paper for recycling.
- Biodiesel fueling station.

Conclusion

The data show that Belmont businesses produce about 8.3 percent of the town's CO_2 emissions and institutions produce about 7.7 percent. On the other hand our survey suggests that businesses generate about 48 percent of the town's waste whereas institutions generate less than three percent.

Included in the survey data are the heated areas of buildings used by businesses. This permitted us to compute values for energy consumed per square foot of heated space. The results show that several businesses and institutions have work to do to bring their energy efficiency up to the levels of other town businesses and institutions, let alone respond to the demands of future conservation and efficiency standards.

Notable actions by Belmont businesses and institutions include the shuttle bus to public transport provided by McLean Hospital and the ground-source heat-pump installation of the Cambridge Savings Bank.

Table C-5. Commuting by Businesses and Institution Employees

Sector	Survey Sample			Extrapolated			Total
	# who drive	# who take public transit	# who walk or cycle	# who drive	# who take public transit	# who walk, cycle, or carpool	
Businesses	196	45	41	6,554	1,843	1,075	9,472
Contractors				60	27	1	88
Religious	21	1	1	88	4	4	96
Institutions				1,019	430	61	1,510
Total				**7,721**	**2,304**	**1,141**	**11,166**

Sustainable Belmont – Climate Action Plan

Interview Data Sheet

Company name_____

Interviewer _____

Date of interview _____

Type of business _____

Contact name _____ ___

Address _____

Email address _____

Phone _____

Hours of operation _____

Approximate floor area of buildings (heated) _____(sq. ft.)

Please answer the following questions for calendar year 2006.

1. Energy source for Heating (please check):
   - ___Natural gas
   - ___Oil
   - ___Electricity
   - ___Other_____
2. Energy source for Hot Water (please check):
   - ___Natural gas
   - ___Oil
   - ___Electricity
   - ___Other_____
3. What is your total energy use in 2006 for each of the following categories?

   a. Electricity (KWh) _____

   b. Natural Gas (therms)_____

   c. Fuel oil (gallons) _____

   d. Other: (e.g. Propane, renewable energy sources, solar) _____
4. Waste
   a. Do you contract with a Waste Disposal Contractor? Yes/No
      If yes, at your discretion, please share your Waste Disposal Contractor's name: _____
   b. How often is your waste picked up? _____
   c. Estimated quantity of waste per pick up: _____ bags
      _____ dumpsters
   d. Content of waste (approximate percentage):
      - paper_____
      - cardboard_____
      - plastic (#1-7), glass, metals_____
      - food waste_____
      - miscellaneous/other_____
   e. Does your Waste Disposal Contractor offer recycling? Yes/No
   f. Do you recycle in your business? Yes/No

Sustainable Belmont – Climate Action Plan

5. Business Fleet
  a. How many vehicles does your company use in the course of doing business?
  _____
  b. If possible, please estimate the total miles (for all vehicles) traveled
  in 2006? _____
6. Commuting
  a. How many employees do you have? _____

  b. If possible, please estimate what percentage:
Drive to work _____
Take public transportation_____
Other_____
7. Are there any steps that you have taken or are considering to reduce your energy consumption and costs that you'd like to share with us? (I.e. installed CFLs, added insulation, etc.)
_____
_____
8. What could the town do to help you reduce your energy consumption and costs? _____
_____
_____
9. How long did it take you to complete this survey?_____

Appendix D: History of Conservation and Environmental Initiatives in Belmont

Land Conservation, Wetlands Protection, and the Conservation Commission

During the first half of the twentieth century much had been done to conserve our state's vanishing natural resources. Gradually it became clear that municipalities needed both a municipal conservation agency and specific authorization of conservation as a valid municipal purpose before they could acquire areas for passive use rather than active recreational development. And so the Commonwealth of Massachusetts invented the Conservation Commission. In 1957, the Massachusetts Legislature passed the Conservation Commission Act, enabling municipalities to establish Conservation Commissions through a vote of the local legislative body. These Commissions were initially established as the official municipal agencies charged with protection of a community's natural resources.

In 1967, Belmont's Town Meeting voted to establish a Conservation Commission. The following year (1968) a Special Town Meeting voted to purchase Rock Meadow from McLean Hospital for $550,000.00 (50% federal funds, 25% state funds, and 25% Town funds.) Henceforth Belmont's Commission was responsible for preserving the interests of the Rock Meadow Conservation Land and Victory Gardens, and for advising other town boards and officials on various aspects of conservation and other environmental issues.

Over time, the responsibilities of the Conservation Commission were expanded as the State took steps to further protect its natural resources. In 1972, the Massachusetts Legislature passed the Wetlands Protection Act to protect wetlands, flood plains and waterways, assigning to Conservation Commissions the additional regulatory responsibility for administering the provisions and standards of the Act. Thus Conservation Commissions (including Belmont's) were now responsible for the protection both of open space and of wetlands.

Later, their responsibilities were further expanded to include the protection of wildlife habitat (1987) and river buffers (Rivers Protection Act, 1996).

To further protect and preserve open space in Belmont, a group of residents established in 1999 the Belmont Land Trust, which works with residents to preserve open space through such vehicles as conservation restrictions on privately owned property.

Waste

As in all towns and cities, waste handling in Belmont has evolved over the years. It used to be that residents disposed of yard waste, particularly leaves in the fall, by burning them in the gutter or in the back yard. The resulting particulates in the air, and occasional fires, led the town to ban this practice. In the 1960s, Belmont collected food waste (garbage) separately from trash. This was discontinued around the time Belmont closed its town incinerator in 1973. Since the town closed its landfill in 1980, solid waste from houses, apartments, and municipal buildings has been collected by private companies working under contract with the Belmont Public Works Department. Waste is taken to the Wheelabrator facility in North Andover for incineration in a cogeneration plant.

Recycling

In 1956, the Town acquired from Metropolitan State Hospital 15.6 acres of land on Concord Ave., near the Lexington line, for use as an incinerator site. Built by the town, the incinerator opened in 1959 to incinerate Town refuse. In 1966 an additional, adjacent 9.6 acres was acquired from Massachusetts General Hospital for leaf disposal and composting. In 1973 incineration activity was halted and the incinerator closed; seven years later the ash landfill portion of the site was capped and sealed with clay to minimize the possibility of groundwater contamination. At about this time the Conservation Commission issued an Order of Conditions to protect the brooks.

The site was converted to a recycling center, permitting residents to drop off glass, newspapers, tin and aluminum. The Town contracted with private companies for recycling these materials. The Highway Department and the Conservation Commission jointly coordinated this first recycling effort.

In 1989, the Board of Selectmen established the Belmont Recycling Advisory Committee (BARC) to negotiate a contract with a waste collection company and to study and oversee the possibility of instituting

curbside recycling. In 1991 the Town Meeting passed a bylaw mandating recycling and instituted the alternate-week curbside collection of recyclables. With help from a state grant, a part-time staffer was hired to help promote recycling and educate the community about the newly expanded program. In 2000, the Selectmen established the Solid Waste and Recycling Advisory Committee (SWARAC) to assist in developing a new contract for the procurement of solid waste and recycling collection and marketing services.

Initially only basic recyclables were collected curbside. Gradually other recyclables were added to the collection, significantly improving and expanding Belmont's program over the years. Notable changes were as follows:

1991—Curbside recycling begins: Collection of newspapers, glass containers, aluminum and tin containers, # 1 and 2 plastic containers.

1992—Added: Leaves and yard waste; white goods (appliances).

1994—Added: All recyclable newspaper, including colored inserts; all white paper.

2000—Added CRTs (television and computer monitors)

2002—Added: Plastics # 3–7; all mixed recyclable paper.

2004—Added fees: $15.00 for CRTs; $20.00 for appliances.

2007—Added corrugated cardboard, milk and juice cartons (coated paper), aseptic containers (e.g. juice boxes).

Belmont's recycling program was and is managed by the Department of Public Works (formerly the Highway Department). SWARAC was disbanded in 2004, but in 2006 the Selectmen reactivated the dormant committee as interest in and concern for the environment increased, and new volunteers were appointed. The newly reconstituted SWARAC undertook as its first projects to institute recycling of cardboard and to work with the public schools to institute a comprehensive program of recycling and education. In 2007 they commenced with the Chenery Middle School, and have expanded into each of the other public schools in subsequent years.

Town government buildings participate in the recycling program, though with varying degrees of success; successful recycling appears to depend on the training and commitment of personnel (including personnel from contracted cleaning services) as well as on the availability of various appropriate recycling containers and appropriate disposal systems.

Energy Conservation: Belmont Municipal Light Department

During the 1990s and in the first few years of the twenty-first century, the Belmont Municipal Light Department (BMLD) initiated a variety of programs to help the Town and its residents conserve electricity:

1. Street Lights Conversion: In the early 1990s, the BMLD began to convert the Town's streetlights from mercury vapor to high-pressure sodium. Over several years, all two thousand streetlights in Belmont were converted, cutting the overall load by approximately 50%. At the same time, new cut-off fixtures were installed, directing the light downward, to lessen light pollution.

2. Traffic Signal Conversion: In 2003/2004, the BMLD started a program of converting traffic signal lights to LED bulbs. Belmont has 28 intersections with traffic signals controlling them. The conversion to LED is an expensive one, each light costing $200–$400, depending on the color. Over the next several years, all "red" and "green" lights were converted, though not many "yellow" lights were included, as they are not lit for long and hence consume less energy. The "walk/don't walk" lights are converted only when new installations are brought in, though bulb size has been reduced in the pedestrian signals.

3. Hybrid Cars: In 2004 the BMLD became the first town agency or department to purchase a hybrid car. BMLD now owns three hybrids—the original Civic hybrid and two Ford Escapes. To date, these are the only hybrid vehicles owned by the Town.

4. Residential Home Energy Conservation Programs: In recent years, the BMLD has developed three programs designed to motivate and assist homeowners to reduce their electricity consumption: the home audit program, introduced around 1995, the Energy Star Appliance Rebate program since about 2002, and the CFL "give-away" program (since 2006). The BMLD anticipates reviewing each of these programs to assess their effectiveness in motivating homeowners to make further changes in their homes. In 2007, BMLD spent approximately $62,000 on these efforts, the most expensive being the rebate program ($39,000). The CFL program appears to be increasingly popular: in 2006, the BMLD gave away approximately 1000 CFL light bulbs; in the following year, 4000 CFL bulbs.

Additionally, conservation and energy tips are marketed on the BMLD's website, calendar, and newsletter. In 2007, the BMLD provided space on its newsletter regularly to Sustainable Belmont for further public education on conservation. The newsletter is provided to every electric customer in Belmont.

5. New programs for residents: In February, 2008, the BMLD announced a program that enables individual residents to purchase renewable energy certificates (RECs) to support alternative, sustainable energy projects in New England. Additionally, the Department is exploring such possibilities as offering rebate programs for the purchase and installation of solar panels on private homes.

6. Holiday lights replacement program: In December, 2007, the BMLD replaced approximately 6000 feet of light strings and bulbs—half the Town's "holiday lights"—converting them to LEDs; each new bulb, formerly at seven watts, now consumes one watt, resulting in considerable savings. In 2008 the remaining 6000 feet of strings and bulbs were replaced.

7. Transformer evaluations: Since 1997, the BMLD has completed a loss evaluation in purchasing new transformers. This evaluation provides a method for selecting transformers that minimizes electrical losses, thus reducing energy costs.

8. Renewable energy in BMLD's portfolio: As of 2008, contracts of the BMLD do not include Renewable Energy Certificates (RECs) or contracts with alternative/renewable energy sources. The Department will continue to investigate contracts with renewable energy generators whenever market considerations prove feasible. Hydropower is included in the Town's portfolio—1000-megawatt hours/year —although hydropower is not recognized as a renewable source. The BMLD is working with municipal departments from other towns to develop collaborative projects, such as solar ventures, common bid and source programs, smart metering, and other technological changes.

Other Environmental Initiatives

In recent years, other Town and School Departments have initiated a wide variety of programs aimed to reduce energy use and/or to increase public health and safety. These programs include, from the Health Department, a hazardous waste program, changes in the practice of pesticide spraying, the identification of recycling sites for compact fluorescent lights, and a mercury collection program; from the Public Works Department, the use of natural fertilizer on open spaces, the use of a chemical mix—safer than salt—for icy roads in winter, and use of reclaimed materials in laying road foundations; and from the School Department, stricter surveillance of use of chemicals in school laboratories.

An "Energy/Resource Savings Work Group" was established in June 2006, during a combined meeting of the Selectmen and the Warrant, School, and Capital Budget Committees as one of 10 areas of investigation of ways the Town could save money. The task of the work group was to investigate how the Town could save money through the conservation of electricity, oil, gas, water and other resources. It developed a "Resource Savings Policy Statement" (Appendix D), which was passed by both the Belmont Board of Selectmen and the Belmont School Committee. The policy signified the Town's commitment to using natural resources wisely to save money and promote environmental responsibility. The group also drafted a job description for a potential Town employee whose responsibility would be to oversee this area; examined issues of implementing such a position; and drafted a set of procedures for all staff and those using town buildings to implement the adopted policy. The group last met in May 2007.

In March 2007 the Town's Board of Selectmen adopted a "Sustainable Building Resolution," committing the town to a policy requiring sustainable design principles and energy conservation considerations in the design of municipal and school district buildings, both in new construction and in renovation projects.

The decade between 1995 and 2005 saw significant changes in the curriculum of the schools at all grade levels, reflecting increased interest and concern in environmental and conservation issues and especially in climate change. Courses in Environmental Science were offered at the High School; and modules pertaining to environmental science were included in the lower grades. A variety of co-curricular projects such as the Courtyard Project at Chenery and the establishment of an Environmental Club at the High school also were initiated.

Belmont's Vision 21 Implementation Committee

"We will be an environmentally responsible community."

In 2000, the Board of Selectmen appointed a committee to develop a "vision" for Belmont. Soliciting public participation through focus groups, forums, feedback sessions and a town-wide survey, the committee developed a "Working Vision for Belmont's Future" (Appendix D) which was adopted unanimously by the Town Meeting in April 2001. The "Vision" is a broad, aspirational statement, covering many facets of town life. One of its "common goals" states, "We will be an environmentally responsible community."

In 2001, the Board of Selectmen appointed a "Vision Implementation Committee" charged with helping the Town implement the Vision. To help actualize the environmental component of the Vision, the Committee initiated three projects:

"Environmental Conversations" Project: In the summer of 2003 the Vision Implementation Committee invited representatives from town departments, committees and commissions, pubic advocacy groups and interested individuals to engage in a series of group conversations about what the town was already doing that might be considered "environmentally responsible." It was felt that this positive approach would lay the groundwork for subsequent efforts. The information that emerged, along with recommendations that were proposed, constitutes the report, "Environmental Conversations."[1]

Environmental Fair: In October 2004 the Vision Implementation Committee, together with a volunteer Steering Committee, and in collaboration with the Belmont Public Schools, hosted a day long "Environmental Fair" to spark interest in and educate the community about environmental issues. The Fair was held in the Field House of the High School. Approximately 80 exhibitors participated; over 1100 people attended the fair. The exhibiting tables were organized into four categories: air, water, earth and heat/energy. About 200 residents volunteered to assist during the fair.

Establishment of Sustainable Belmont: Following the Environmental Fair, the Vision Implementation Committee determined that there was sufficient interest in the Town and a growing need to establish a group dedicated to helping the Town become more environmentally responsible. They determined that such a group would be a Task Force of the Vision Implementation Committee, enabling the group to serve as a part of Town government.

Sustainable Belmont (2005–present)

In February 2005 the Vision Implementation Committee established a task force, charged with helping the town implement that part of the Vision that said, "We will be an environmentally responsible community." Two individuals were appointed by the Vision Committee to serve as co-chairs and were encouraged to recruit volunteers to work with them. In the following three years, the group has worked diligently in a variety of areas. Most significant among these are the following:

Public Education and Outreach: This is an on-going effort. Sustainable Belmont has organized informational programs on topics such as "phantom energy," green building practices, organic yard care, and climate change; and sponsored two showings of the movie, *An Inconvenient Truth*.

Town Policies for Belmont: Sustainable Belmont members participated in the Energy Resource Savings Work Group that developed the Resource Savings Policy (adopted by the Selectmen in 2006 and by the School Committee in 2007); and also encouraged the establishment of and participated in the Green Building Study Group that developed the Sustainable Building Design Policy, adopted by the Selectmen in 2007 (see Appendix D to read these policy statements).

Anti-Idling / Cleaning-the-Air Campaign: This on-going Sustainable Belmont campaign seeks to educate citizens about the State's Anti-Idling law and to reduce automobile idling in Belmont, thereby enhancing residents' health and reducing carbon emissions.

Collaboration with Town Departments: Sustainable Belmont has collaborated with the Belmont Heath Department regarding disposal of CFLs; with the Permanent Building Committee to develop a Sustainable Building Design Policy; with the Municipal Light Department regarding a green power/ RECs program and in developing written materials on energy conservation and efficiency; with the BMLD Advisory Board regarding an Energy Efficiency and Conservation Policy; and with the Belmont Public Schools regarding environmental programs.

1 Online at *http://www.town.belmont.ma.us/ Public_Documents/BelmontMA_BComm/vision21.*

Affiliation with Other Environmental Groups: Sustainable Belmont is a member of MCAN (the Massachusetts Climate Action Network) and Greater Boston Breathes Better. Sustainable Belmont encouraged the Town to join ICLEI (a worldwide network of cities and towns committed to addressing sustainability and climate change). The BMLD has paid for the Town's membership in ICLEI, thus enabling the Town to receive computer software critical for the development of the Town's greenhouse gas inventory. Membership in these three organizations offers our residents opportunities to learn from others in the larger environmental community beyond Belmont.

Climate Action Plan: As a task force of the Vision Implementation Committee, Sustainable Belmont has, since its inception, been committed to helping the town become an environmentally responsible community. As part of that goal, and with the support of the Board of Selectmen, it has undertaken to develop a plan by which Belmont can respond to the challenge of climate change. To initiate the project, Sustainable Belmont arranged with Tufts University for five interns who would start the development of a greenhouse gas inventory. Their efforts provide a benchmark from which progress in reducing our carbon emissions can be measured. Members of Sustainable Belmont have refined and extended the work of the interns, solicited additional public input, and conducted surveys of businesses and town employees as they continue the ongoing effort to draft a plan for Belmont. The draft of the CAP will be further vetted by the public (spring 2009) before being brought to the Board of Selectmen for review and consideration of next steps.

Appendix E: BMLD Rate Classes

The Belmont Municipal Light Department sells electricity to customers using several different rate classes. The commercial rates have a higher monthly customer charge and a slightly lower charge per kWh of energy to reflect the higher cost to the town of providing the connections and the greater efficiency of delivering larger amounts of power. Additional commercial rates are avail-able that provide a benefit if the maximum power demand is kept within limits.

Table E-1. BMLD Rate Classes

BMLD Rate Class	Description
Rate A – Residential	All single-phase,120/140 volt, domestic purposes in an individual private dwelling or an individual apartment.
Rate B – Commercial	For commercial purposes including stores, banks, offices, churches, private schools, halls, and similar places that are used for purposes other than as private residences.
1Rate E – Commercial Large*	For customers whose demand exceeds 75 kilowatts and is applicable to all purposes except resale. Service will be supplied, if requested, at 2,300 or 4,160 volts or higher, where lines for such delivery are available and the customer furnishes any necessary transformers.
Rate F – Commercial Heating	For commercial and industrial customers where permanently installed, department approved, electric space heating is used exclusively for comfort heating and is metered separately. Air conditioning and non-process water heating may also be included, if electricity is used exclusively for these purposes. All other electrical energy shall be metered separately under the appropriate rate.
Rate G – Private Area Lighting	Exclusive of the Town of Belmont for purposes of lighting outdoor areas or exterior of building surfaces by means of equipment furnished and maintained by the Department.
Rate SL – Street Area Lighting	For all municipal street lighting purposes.
Town Rate B – Small	For all municipal buildings – small.
Town Rate E – Large	For all municipal buildings – large.

* Although Rate E is predominately commercial users, a few residential customers fall within its “greater than 75 kilowatts” description. Examples of a residential use that may benefit from this rate class is heating an indoor swimming pool or a driveway or cooling an indoor hockey rink.

Appendix F: Guides to Action

Here are two lists of steps Belmont residents can take to help ameliorate climate change. These are suggestions that residents can post on their refrigerators to remind them that their choices every day can make a difference.

Ten Steps You Can Take Now

1. Improve your home's energy efficiency by sealing cracks; adding insulation to attics, walls, ducts, and water heaters; and using a programmable thermostat. Set your thermostat at 68˚ in the winter (adjusting it to go down by 10˚ at night or when you are away) and if you have air conditioning to 78˚ in the summer (turning it off when you are away).
2. Drive less when you can by taking public transportation, walking, bicycling, carpooling, and grouping your errands. Consider alternatives to flying when possible. When you use your car, drive more slowly (60 m.p.h. or less), accelerate moderately, and don't idle.
3. When buying your next vehicle, choose one that is more fuel efficient.
4. When buying appliances, look for the Energy Star label; the Belmont Municipal Light Department offers rebates for many Energy Star purchases.
5. Turn off unused lights and appliances. Set back your hot water heater's thermostat to 120˚ (or on Low). Wash your clothes in cold or warm water; rinse in cold water.
6. Replace incandescent and halogen light bulbs with energy-saving CFL or LED bulbs.
7. Invest in renewable energy such as Belmont Municipal Light Department's Renewable Energy Certificates Green Choice option.
8. Reduce waste by reusing, recycling, and choosing durable items with minimal packaging. Remember to bring reusable bags to the store; try keeping them by your back door or in your car. Compost your kitchen and garden waste and send yard waste to the town for composting.
9. Shop wisely for local foods and products and support local agriculture. Reduce consumption of meat. Support climate-friendly products and services, such as wood harvested from forests managed sustainably.
10. Talk about what you are doing to address climate change. Share your new actions and in-formation with your family and friends and others in the community.

A Quick Guide to Steps You Can Take Now

Tackling climate change will be one of the most important things that we do in this century, and to succeed, everyone needs to get involved. Each day around the country and around the world, more people are taking action and making decisions to reduce carbon dioxide (CO_2) emissions and address other environmental problems. Belmont's Climate Action Plan is loaded with recommendations for practical solutions and actions that members of the Belmont community can take to reduce carbon emissions and protect our environment. Here is a short list of some ideas to help you get started.

1. Saving Energy at Home

Your home energy use is likely your biggest contribution to climate change. Heating, cooling, and hot water account for 80 percent of the energy used in homes in New England, so this is a good place to start when looking for savings.

Turn down your thermostats. Turning your thermostat down by one degree in the winter or up by one degree in the summer could reduce carbon emissions and cut your fuel bills by up to 10%. Try setting your thermostat at 68˚ in the winter (adjusting it to go down by 10˚ at night or when you are away) and if you have air conditioning to 78˚ in the summer (turning it off when you are away). Installing a programmable thermostat that automatically lowers your heating/cooling load when the house is not occupied can reduce a typical family's total CO_2 emissions by 5% and save at least $150 per year. Setting your hot water heater's thermostat to 120˚ (or Low) and washing clothes in cold or warm water reduces energy use too.

Look for the labels. When buying products that use energy—refrigerators, freezers, furnaces, air conditioners, and water heaters use the most energy—look for the Energy Star label. While energy efficient models may cost a bit more to purchase, they save money in reduced energy costs over time. Belmont's Municipal Light Department (BMLD) often offers rebates on purchases of Energy Star products.

Improve your insulation. More than half the heat lost in your home escapes through the walls and roof. Sealing cracks and adding insulation to the attic, walls, heating and cooling ducts, and water heater can reduce a typical family's total CO_2 emissions by about 5% and reduce the costs of heating and cooling by up to 20%. Use shades, blinds, and windows strategically to lower your energy bills: put them up in winter during daytime to take advantage of the sun's rays for warmth and close them at night to keep in heat; in summer, close them in daytime to keep out sun's heat, and open windows at night to cool down your house.

See the light. Replace incandescent and halogen light bulbs with CFL or LED bulbs wherever possible. If every household in the United States replaced one regular light bulb with an energy saving model, we could reduce global warming pollution by more than 90 billion pounds over the life of the bulbs—equivalent to taking 6.3 million cars off the road. To save the most energy and money, replace your highest-use fixtures or the light bulbs in them with energy-efficient models. The highest-use fixtures in a home are typically the kitchen ceiling lights, the living or family room table and floor lamps, and the outdoor porch or post lamp. The BMLD offers free CFLs.

2. Getting Around

Transportation accounts for around 35% of the carbon emissions in the northeast region. In Belmont, we are fortunate to have many transportation options.

Think before you drive and try to reduce your car use. Reduce the number of short trips you make in the car. Walking, cycling, or taking the subway, bus, or commuter rail will help reduce local air pollution and the climate change effects of getting around. Belmont is a compact town with several commercial areas, which means many of us can walk to do errands such as shopping, banking, and going to the library. Developing the habit of walking will be good for you and good for the environment. The annual CO_2 savings from avoiding just 10 miles of driving per week is 500 pounds. Not only will you help the environment, but you will save money as well. Carpooling and combining errands are other ways to reduce miles driven.

When driving your car, don't idle and don't speed. Learn to break the idling habit. Idling causes carbon emissions, wastes fuel, pollutes the air, and is bad for your engine. If you will be in one place for longer than 10 seconds, it pays to turn off your engine. Driving at speeds above 60 m.p.h. drastically lowers your engine's efficiency. Slowing down, driving at a steadier pace, and accelerating gradually will save you money and reduce carbon emissions.

Choose an efficient car. The vehicle you drive has the single largest impact on climate change of any action you take. When buying a new car, choose a more efficient model. This will cut your carbon emissions and save you money on fuel. For each gallon of gas you burn, between 20 and 25 pounds of CO_2 is released into the atmosphere. If your new car gets only 3 miles per gallon more than your old one, your annual CO_2 reduction could be 3,000 pounds, depending on how much you drive.

Tackling the environmental impact of flying. Consider the need for a flight and the alternatives when deciding whether or not to fly. Air travel is a major contributor to climate change. By eliminating one round-trip flight of 1,600 miles, you can save 720 pounds of CO_2 emissions. Consider options for reducing your travel, such as taking fewer, longer breaks instead of several short ones. Or, consider taking a vacation closer to home. When going longer distances, consider traveling by rail or sea.

3. Cutting Waste and Recycling

Reducing, reusing and recycling waste saves on the raw materials and energy that are needed to make new paper, metal, glass and other items.

Reuse and repair. Avoiding waste in the first place, by reusing and repairing items, is the most efficient way to reduce waste. For example, buy durable items that can be reused rather than disposables, and pass things on when you've finished with them.

Recycle more. Nearly two-thirds of all household

rubbish can be recycled, and the annual CO_2 savings of recycling half of a typical household's waste is 2,400 pounds.

Make the most of compost. Composting food and yard waste reduces climate change effects. Belmont's Department of Public Works (DPW) offers low-cost compost bins which you can use to compost kitchen scraps, and the DPW picks up yard waste at the curb that it then composts. If you don't have a use for your own compost, give it to a friend or neighbor who gardens.

4. Eating and Drinking

Food production is responsible for approximately a fifth of our climate change effects. Some foods, such as red meat, pork and lamb, have a much bigger impact on the environment than others. Reduce consumption of those foods that have a larger carbon footprint.

Buy fresh and in season. Buying food and drink when locally in season, and unprocessed or lightly processed food, is likely to mean that less energy has been used in its production. Providing it has been produced and stored under similar conditions, choosing food that has traveled a shorter distance will help to reduce congestion and trans-port emissions. Belmont Farmers' Market offers fresh local produce and products from mid-June through October.

Look for the labels. Look for the labels to help you choose food that has been produced with the aim of reducing the negative impact on wildlife and the environment.

5. Exercise your Own Green Power

There are lots of choices you can make when shopping that help take care of the environment. By shopping wisely, you can use your power as a consumer to help reduce climate change. Talk to you neighbors and friends. By sharing your new actions and information with others in the community, you can help reduce far more emissions than you could by just acting alone.

Take a bag. Remember to bring reusable bags to the store; try keeping them by your back door or in your car.

Use your power as a consumer. Use labels to choose products that have a lower impact on the environment. You can exercise your power by selecting energy efficient appliances and cars, and selecting food that is grown or caught following sustainable methods. Using labels to buy sustain-able wood and peat free compost will protect important natural habitats that help balance climate change effects. Choose durable goods with minimal packaging.

Buy recycled. Look for recycled products. Many paper, plastic, and steel products are now made from recycled materials. Using recycled materials keeps the materials out of the waste stream, reduces the energy costs of production by 50% and reduces industrial air pollution by 85%!

Increase your own impact by sharing what you do. Talk about what you are doing to address climate change. Share your new actions and information with your family and friends and others in the community. Get involved in the community. Share your concerns about climate change with local, state, and federal leaders.

Appendix G: Information Resources

The sources listed below are major organizations concerned with scientific, economic and policy aspects of caring for our environment and showing the path to a sustainable future for planet Earth.

Information Sources and Advocacy Organizations

The Intergovernmental Panel on Climate Change (IPCC)
http://www.ipcc.ch

The IPCC is a scientific intergovernmental body set up by the World Meteorological Organization and the United Nations Environment Programme. The IPCC was established to provide decision makers and others interested in climate change with an objective source of information about climate change. The IPCC does not conduct any research nor does it monitor climate related data or parameters. Its role is to assess on a comprehensive, objective, open and transparent basis the latest scientific, technical and socioeconomic literature produced worldwide relevant to the understanding of the risk of human-induced climate change, its observed and projected impacts and options for adaptation and mitigation. The IPCC reports strive to be neutral with respect to policy, although they need to deal objectively with policy-relevant scientific, technical and socioeconomic factors. They achieve high scientific and technical standards, and aim to reflect a range of views, expertise and wide geographical coverage.

Worldwatch Institute
http://www.worldwatch.org
The Worldwatch Institute is an independent re-search organization that works for an environmentally sustainable and socially just society, in which the needs of all people are met without threatening the health of the natural environment or the well-being of future generations. By providing compelling, accessible, and fact-based analysis of critical global issues, Worldwatch informs people around the world about the complex inter-actions between people, nature, and economies. Worldwatch focuses on the underlying causes of and practical solutions to the world's problems, in order to inspire people to demand new policies, investment patterns, and lifestyle choices.

Union of Concerned Scientists
http://www.ucsusa.org
The Union of Concerned Scientists (UCS) is a leading science-based nonprofit working for a healthy environment and a safer world. UCS combines independent scientific research and citizen action to develop innovative, practical solutions and to secure responsible changes in government policy, corporate practices, and consumer choices. UCS staff scientists and policy experts are highly respected in both Washington, DC, and state capitals, and are frequently called to testify before government committees. UCS researches and develops practical solutions to a range of issues, from global warming and the dangers of nuclear weapons to vehicle pollution and the risks of genetically engineered food crops.

Conservation Law Foundation
http://www.clf.org
Conservation Law Foundation (CLF) is the oldest regional environmental advocacy organization in the nation. Since 1966, CLF's advocacy staff has worked to solve the most significant environmental problems that threaten New England. CLF's advocates use law, economics and science to create innovative strategies to conserve natural resources, protect public health and promote vital communities in our region. Protecting Georges Bank from oil drilling and overfishing, ending decades of thoughtless sewage dumping into Boston Harbor, preserving bear habitat in Vermont, saving New Hampshire's Franconia Notch from a 4-lane highway, and writing monumental lead protection laws in Rhode Island are just a few of CLF's landmark achievements. The CLIMB report (Full Report, Media Summary List of Major Impacts) may be accessed at *http://www.clf.org/ general/internal.asp?id=597*.

Environment Massachusetts
http://www.environmentmassachusetts.org

Environment Massachusetts, a statewide, citizen-based environmental advocacy organization, is the new home of MASSPIRG's environmental work. Its professional staff combines independent research, practical ideas and tough-minded advocacy to overcome the opposition of powerful special interests and win real results for Massachusetts' environment. Environment Massachusetts draws on 30 years of success in tackling the state's top environmental problems.

DSIRE: Database of State Incentives for Renewables & Efficiency (DSIRE)
http://www.dsireusa.org
Established in 1995, DSIRE is an ongoing project of the North Carolina Solar Center and the Interstate Renewable Energy Council (IREC) funded by the U.S. Department of Energy. IREC's mission is to accelerate the use of renewable energy sources and technologies in and through state and local government and community activities. Formed in 1980, IREC supports market-oriented services targeted at education, coordination, procurement, the adoption and implementation of uniform guidelines and standards, and consumer protection. IREC's members include state and local government agencies, national laboratories, solar and renewable organizations and companies, and individuals.

Information about federal, state, and utility incentives (including tax credits, deductions, exemptions, loans, grants, and rebates) for Massachusetts residents and businesses is online at *http://www.dsireusa.org/library/includes/map2. cfm?CurrentPageID=1&State=MA&RE=1&EE=1.*

City of Boston Environment Department
http://www.cityofboston.gov/environment
Boston's Environment Department aims to protect built and natural environments and provide information on environmental issues affecting Boston. Sound management and environmental practices will help ensure the future of our livable city. The Environment Department protects Boston's wealth of historic sites, buildings, landscapes, and waterways through protective designation and review.

On April 13, 2007 Mayor Menino issued an Executive Order to set clear and challenging goals for the City's efforts. These include reducing annual greenhouse gas emissions seven percent below 1990 levels by 2012 and 80 percent below 1990 levels by 2050. The Boston community—its residents, businesses, and institutions—is taking action as well, and the city is supporting their essential activities with a variety of resources.

EPA Green Power Partnership
http://www.epa.gov/grnpower
The Green Power Partnership is a voluntary program that encourages organizations to buy green power as a way to reduce the environmental impacts associated with purchased electricity use. The Partnership currently has hundreds of partner organizations voluntarily purchasing billions of kilowatt-hours of green power annually. Partners include a wide variety of leading organizations such as Fortune 500 companies, small and medium sized businesses, local, state, and federal governments (including the City of Boston), and colleges and universities.

ICLEI—Local Governments for Sustainability
http://www.iclei.org
ICLEI was founded in 1990 as the International Council for Local Environmental Initiatives. ICLEI—Local Governments for Sustainability is an international association of local governments and national and regional local government organizations that have made a commitment to sustainable development. More than 700 cities, towns, counties, and their associations worldwide comprise ICLEI's growing membership. ICLEI works with these and hundreds of other local governments through international performance-based, results-oriented campaigns and programs.

ICLEI provides technical consulting, training, and information services to build capacity, share knowledge, and support local government in the implementation of sustainable development at the local level. Its basic premise is that locally designed initiatives can provide an effective and cost-efficient way to achieve local, national, and global sustainability objectives. Information about its Cities for Climate Protection program is online at *http://www.iclei.org/index.php?id=800.*

Regional Greenhouse Gas Initiative
http://www.rggi.org
The Regional Greenhouse Gas Initiative, or RGGI, is a cooperative effort by 10 Northeastern and Mid-Atlantic states to reduce CO_2 emissions from power plants. The RGGI states will be developing a regional strategy for controlling these emissions; central to this initiative is the implementation of a multi-state cap-

and-trade program with a market-based emissions trading system.

United States Climate Action Partnership
http://www.us-cap.org
USCAP is an expanding alliance of major businesses and leading climate and environmental groups that have come together to call on the federal government to enact legislation requiring significant reductions of greenhouse gas emissions. After a year of dialogue and collaboration, the group produced a set of principles and recommendations to guide the formulation of a regulated economy-wide, market-driven approach to climate protection. The group believes that swift legislative action on the USCAP solutions-based proposal, titled *A Call for Action*, would encourage innovation, enhance America's energy security, foster economic growth, improve our balance of trade and provide critically needed U.S. leadership on this vital global challenge. From its *Call for Action:*

> *"We, the members of the U.S. Climate Action Partnership, pledge to work with the President, the Congress, and all other stakeholders to enact an environmentally effective, economically sustainable, and fair climate change program consistent with our principles at the earliest practicable date."*

The members include several major corporations:

Alcan Inc.	Alcoa
American International Group, Inc.	Boston Scientific Corporation
BP America Inc.	Caterpillar Inc.
Chrysler LLC	ConocoPhillips
Deere & Company	Dow Chemical
Duke Energy	Company
Exelon Corporation	DuPont
FPL Group, Inc.	Ford Motor Company
General Motors Corp.	General Electric
Marsh, Inc.	Johnson & Johnson
PepsiCo	NRG Energy, Inc.
PNM Resources	PG&E Corporation
Shell	Rio Tinto
Xerox Corporation	Siemens Corporation

Some non-industrial members are:

Environmental Defense	National Wildlife Federation
Natural Resources Defense Council	The Nature Conservancy
Pew Center on Global Climate Change	World Resources Institute

Green Roundtable
http://www.greenroundtable.org/about
The Green Roundtable, Inc. (GRT) is an independent non-profit organization whose mission is to mainstream green building and sustainable design. The GRT works toward this goal by promoting and supporting healthy and environmentally integrated building projects through strategic out-reach, education, policy advocacy and technical assistance. It envisions a world in which green building is business as usual.

Unhealthy, inefficient, and unsustainable development is caused by a lack of systems thinking and coordination among building professionals and stakeholders. The GRT uses systems-based holistic strategies to proactively create effective programs that reach out across industries, professions, and other boundaries. It engages major building stakeholders, and provides services to help them integrate sustainable design and construction strategies and standards. Its strategy is to educate people who inhabit, commission, and operate buildings to define their own green criteria and expectations while simultaneously training and supporting design professionals to provide the services that meet these changing needs.

Concurrently, the GRT work with policy and regulatory bodies to encourage the integration of sustainable design principles into regulatory requirements. To effect market transformation, it develops initiatives specific to particular market sectors (schools, housing, etc.) with an understanding of the forces and constraints acting on each sector (legal, financial, etc.) and their impacts on public health, natural resources and the environment (air, water, solid waste management, energy, etc.).

U.S. Department of Energy (DOE)
http://www.energy.gov
The DOE's overarching mission is to advance the national, economic, and energy security of the United States; to promote scientific and technological innovation in support of that mission; and to ensure the environmental cleanup of the national nuclear weapons complex. The DOE's strategic goals to achieve the mission are designed to deliver results along five

strategic themes: Energy Security, Nuclear Security, Scientific Discovery and Innovation, Environmental Responsibility, and Management Excellence.

Two DOE websites provide energy efficiency and other energy-related statistics:
http://www.energy.gov/energyefficiency/index.htm
http://www.eia.doe.gov

Alliance to Save Energy
http://www.ase.org
The Alliance to Save Energy promotes energy efficiency worldwide to achieve a healthier economy, a cleaner environment, and greater energy security. Energy efficiency is the quickest, cheapest, cleanest way to extend our world's energy supplies.

Woods Hole Resource Center (WHRC)
http://www.whrc.org
The Woods Hole Research Center is an independent, nonprofit institute focused on environmental science, education, and public policy. The Center seeks to conserve and sustain the planet's vegetation, soils, water, and climate by clarifying and communicating their interacting functions in support of human well-being and by promoting practical approaches to their management in the human interest. The Center has projects in the Amazon, the Arctic, Africa, Russia, Alaska, Canada, New England, and the Mid-Atlantic—as well as integrative efforts at continental to global scale — working in collaboration with partners ranging from local NGOs, research centers, and enterprises to national governments and the United Nations.

Sources of Information on Legislation

The following are websites with information on laws, regulations, and pending legislation concerning climate change mitigation.

Massachusetts

Massachusetts Legislature
http://www.mass.gov/legis
This website includes links to Massachusetts General Law and searchable text of House and Senate bills (i.e., pending legislation) and their status, contact information for legislators, and current news; a section called "Legislative History" at the bottom of the page lists more records of legislation.

State Representative William N. Brownsberger
http://www.willbrownsberger.com
Representative Brownsberger (representative of Belmont and parts of Arlington and Cambridge) maintains a website that includes information on ongoing legislation that he is working on, plus his research results relating to climate change. To see topics related to climate change go to the "Sub-scribe to News from Will Brownsberger" line and click "Visit this group," go to the "Pages" section.

Massachusetts Climate Action Network (MCAN)
http://www.massclimateaction.org
MCAN is a coalition of locally organized groups (including Sustainable Belmont) fighting the climate crisis. MCAN promotes carbon-reducing practices in our homes and communities; encourages MCAN chapters and allied organizations to grow a focused statewide movement; and communicates policy to members and leverages our collective voice at the state level. The MCAN website includes information on climate policy, positions on legislative priorities, and information on pending legislation.

Federal

United States Senate
http://www.senate.gov

United States House of Representatives
http://www.house.gov
These two websites include information on each member of Congress as well as links to individual legislator and committee websites. They also provide a legislative calendar, links to bills currently under debate in each floor of Congress, and roll call votes.

THOMAS—Library of Congress
http://thomas.loc.gov
This website contains detailed information on legislation from current and previous sessions of Congress. It includes a searchable database where you can find detailed and summary text of bills (including sponsors and cosponsors), the status of the bill in Congress, and roll call votes. It also provides information on legislative schedules, committee reports, treaties, presidential nominations, and other government-related items.

Appendix H: The Belmont Greenhouse Gas Inventory

Summary of Methodology

Jack Dennis, August 2009

This note is a report on the methodology used to obtain the inventory of Belmont greenhouse gas emissions for the Belmont Climate Action Plan (CAP). The focus is on carbon dioxide emissions which are of concern with respect to global warming and arise primarily from energy use for heating, cooling, transportation and running the multiplicity of mechanical devices used in business and in our everyday lives. The sections below describe how we chose sectors of Town operations, the sources of emissions, and how we obtained data to quantify emissions for the CAP.

Sectors

Given the nature of the Town of Belmont, we chose to quantify CO_2 emissions for the following sectors of Town operations:

1. Residential
2. Institutional (Hospitals, Private Schools, Social Clubs)
3. Religious Institutions
4. Businesses
5. Municipal

The transportation sector includes emissions from all modes and uses of transportation means including private automobiles. The other sectors cover emissions from energy use for space heating and cooling and to operate various powered appliances. Sources of emissions not covered by our inventory include construction and remodeling work in Belmont and emissions associated with the production, manufacture and distribution of food and merchandise consumed in the Town.

Sources of Emissions

Carbon dioxide emissions result primarily from the burning of the fossil fuels coal, fuel oil, natural gas, and the gasoline and diesel fuel used to run motor vehicles and power equipment. Carbon dioxide emissions also result from the use of these fuels in power plants to generate electricity. We include all of these emissions in our inventory even though power plant emissions are not released within the Town of Belmont.

For each kind of fuel, the carbon dioxide released in use is determined by multiplying the quantity of fuel by a coefficient. The coefficients used to calculate our inventory are the following:

Electricity: 0.675 tons CO_2 per 1000 kWh

This coefficient was provided by the ICLEI Software Package, and includes an estimate of emissions from generation and distribution for the Northeast Region of the U.S.

Fuel Oil: 16.4 lbs. CO_2 per therm; 1.4969 therms per gallon

Natural Gas: 11.7 lbs. CO_2 per therm

These coefficients were obtained from the U.S. Department of Energy publication *Natural Gas 1998 Issues and Trends,* Table 2, page 58. Online at http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/natural_gas_1998_issues_trends/pdf/it98.pdf. It appears these coefficients do not include emissions from production and distribution, so using coefficients from the ICLEI software may be more accurate.

Gasoline: 20 pounds CO_2 per gallon

Diesel Fuel: 22 pounds CO_2 per gallon

These coefficients were supplied by the Union of Concerned Scientists and include emissions from production and distribution for the Northeast.

Electricity

For calculating emissions from electricity use, we used data provided by the Belmont Municipal Light Department (BMLD). Initially, data was obtained for the years 1999 through 2007, although the data was incomplete for 2007. Later (January 2008), in attempting to analyze year 2007 data on individual commercial accounts in connection with our business/institution survey, we learned that the initial data did not cover all of the rates used by BMLD in 2007, and that adjustments of the data were needed to compensate for usage included in the data but not occurring during the year of billing. In particular, a discounted rate offered to McLean Hospital was not included.

Annual consumption data were provided by the BMLD for each rate class for years 2001 through 2007. During this period the BMLD supplied electricity to Belmont under several different electricity rate categories. Of the rate classes, Rate A and Rate LI (Low Income) apply to residential customers and rates B, E, F and G apply to Belmont's commercial, industrial and institutional customers. Two rates, Town B and Town E apply to municipal buildings and rate SL applies to street lighting. Details of these rates are provided in Appendix E.

The year 2006 remained the most recent year for which we had complete data for all Town rate classes. The quantities of kWh shown in Table 1 were calculated as follows: The residential amount is the sum of billings for Rate A (Residential) and Rate LI (Low Income residential rate) for 2006. The municipal amount is the sum of adjusted amounts for accounts under Rates Town B and Town E for 2007 and the total for rate SL for 2006. The institutional amount is the sum of adjusted amounts for accounts under Rate B and Rate E that we identified as institutional accounts, and a discounted rate provided for McLean Hospital. The business amount is the sum of adjusted amounts for accounts under Rate B and Rate E that we identified as business accounts, omitting in particular institutions and churches. We were not able to identify the customers for accounts under Rate F (space heating) and rate G, and some accounts under Rates B and E were industrial and did not fit into our categories. These amounts are collected as "unidentified". This entry also includes any adjustment due to differences between 2006 and 2007 data.

The values for CO2 emissions were obtained using the coefficient of 0.675 tons of CO_2 per 1000 kWh.

Table 1. Belmont Electric Energy Consumption and Emissions, 2007

Sector	kWh	Tons of CO_2
Residential	73,177,686	49,395
Business	22,982,691	15,513
Institutional	19,234,186	12,983
Municipal	7,454,693	5,032
Unidentified	2,251,439	1,520
Total	**125,100,695**	**84,443**

Natural Gas and Fuel Oil

Data on Natural Gas consumption were obtained for the years 2003 and 2007 from Keyspan/National Grid. Totals in therms were provided for the categories of commercial customers and residential customers. Given the time frame for producing the CAP we did not pursue National Grid for more detailed data on commercial accounts. Hence the totals for commercial accounts include all of Belmont's business, institutional, and municipal accounts.

In the Natural Gas and Fuel Oil Chapter of the CAP we wrote:

> The data for commercial accounts include municipal usage and do not show how usage divides between businesses and institutions. For these missing data we used information from the ESCo project (Appendix A), Town offices, and from the Sustainable Belmont commercial survey (Appendix C). For lack of better data, the municipal data pertains to the May 2003 to April 2004 period. The data is shown in Table 3 and includes fuel oil as well as natural gas. The ESCo data includes the largest schools, the library, the Town Hall and several department buildings. Natural gas and fuel oil consumption data for the few Town buildings not included in the ESCo study were provided by the Belmont Building Services Department and pertain to the Town's fiscal year 2007 which is the period from July 2006 through June 2007. The sum of business and institutional natural gas consumption in Table 3 is the result of subtracting the values for municipal use from the natural gas data for commercial accounts in Table 2. The split between business and institutional use was determined from the results of the Sustainable Belmont survey of businesses and institutions (Appendix C), and the survey also provided estimates of natural gas and fuel oil consumption. These data form our best estimate of how fuel use is distributed over non-residential sectors of the town.

Determining quantities of fuel oil consumed is more problematic. We wrote:

> Many heating oil companies serve residential customers in Belmont. Given the difficulty of obtaining delivery data, we chose to extrapolate residential heating oil consumption using data from the Energy Information Administration (EIA) and the 2000 U.S. Census. From the year 2000 Census data, there were 9,732 occupied housing units in Belmont, of which 4,392 (45%) used fuel oil for home heating. According to the EIA, the average household in New England used 716 gallons of fuel oil in 2001. Multiplying 716 gallons per household by 4,392 households and 1.4969 therms per gallon yields 4,707,260 therms which is an estimate of the total amount of energy from heating oil used by Belmont residents in 2001. We have no better estimate for 2007, for which consumption is likely to have been less from conversions to natural gas and conservation measures.

Again, Fuel Oil consumption for the municipal sector was estimated using the ESCo study data for 2003 - 2004, supplemented with data provided by Town departments. For the institutional sector, we used the survey responses from the major institutions; because no church in our survey used fuel oil, we assumed no consumption by religious institutions. The results are presented in Table 4 of the CAP.

Table 4. Belmont Natural Gas and Fuel Oil Consumption

Sector	Natural Gas		Fuel Oil	
	Therms	Tons CO_2	Therms	Tons CO_2
Residential	6,340,566	37,092	4,707,260	38,696
Business	799,866	4,679	368,714	3,031
Institutional	316,840	1,854	792,332	6,513
Municipal	175,807	1,028	514,182	4,227
Unidentified	432,447	2,530		
Total	**8,065,526**	**47,183**	**6,382,488**	**52,467**

Transportation

For the transportation sector we chose three areas for gathering fuel use data:

- Personal Automobiles (Passenger Vehicles)
- Commercial Fleets
- Municipal Operations

For emissions from operation of personal cars, the best approach we could devise used vehicle registrations and average fuel consumption per vehicle. Registration data for 2006 was supplied by the Belmont Town Treasurer, and average fuel consumption was taken from
Transportation Facts, 2001. Massachusetts Highway Department. We wrote:

> In 2006, there were approximately 15,300 passenger vehicles registered to Belmont residents. Based upon a statewide average fuel consumption of 581 gallons per year per vehicle, annual fuel consumption was 8.89 million gallons. Using a conversion factor of 20 pounds of CO_2 per gallon of gasoline, we estimate that in 2006, automobile use by Belmont residents resulted in emission of about 89,000 tons of CO_2.

For use of vehicles by businesses and institutions, we used information gathered in our survey:

> Reponses from businesses sampled in the commercial survey showed 23 vehicles used by businesses plus 94 vehicles used by the three contractors in the sample and 21 vehicles used by the institutions. We extrapolated the number of business vehicles to 404, giving a total of 519. This total falls short of Town data showing there are 714 "Commercial" vehicles registered in Belmont. Our survey responses included annual miles of operation from which we estimated that annual business vehicle use adds up to around 4,068,791 miles of operation. Using an average of 20 miles per gallon of fuel, we estimate that approximately 203,440 gallons of gas are consumed per year by Belmont's businesses, resulting in emissions of about 2,034 tons of CO_2. Total vehicle miles from institutional use amounted to only 133,000 miles corresponding to CO_2 emissions of 665 tons.

Emissions from municipal vehicle operation were calculated using information from Town departments:

> In 2006, Town departments had 122 vehicles. The largest fleets were in the following departments: Highway Department (34), Police (19), Municipal Light (18), Fire (13) and Water (12). The Parks Department had 7 vehicles, the Cemetery Department had 4, and the remaining departments had no more than 1 or 2 vehicles each. In 2006, the police department had 2 motorcycles and 4 bicycles in its fleet as well.

A total of 58,123 gallons of unleaded gas and a total of 29,729 gallons of diesel fuel were consumed by the Town fleet in 2006, resulting in emission of approximately 327 tons of CO_2. In addition, we estimated that contracted operation of school buses uses 4,800 gallons of diesel fuel yielding 52 tons of CO_2 emissions.

We also considered energy use for commuting by Town employees but decided that there would be overlap with data for private vehicle use, and many employees reside out of town. We considered public transport services and reported on ridership. However, deriving energy use data attributable to the Town of Belmont appeared too problematic and would have amounted to a very minor portion of the inventory.

As an alternative to estimating vehicle use based on registrations and average miles per year, we reviewed data on "vehicle miles traveled" for Belmont, available from the Boston Region Metropolitan Planning Organization, Online at http://www.ctps.org/bostonmpo.]. The Belmont area consists of 14 zones. Aggregating the traffic counts in those zones, the Metropolitan Planning Organization estimates that the total daily vehicle miles traveled in Belmont was 554,400 in 2005. At 25 average miles per gallon, the 554,400 daily miles estimate yields annual emissions of 80,942 tons of

CO_2, remarkably close to our estimate based on passenger vehicle registrations. Perhaps vacation and other out-of-town personal travel are balanced by the inclusion of commercial and public vehicles in the vehicle miles traveled data.

The table below is a summary of emissions data relating to transportation (25 miles per gallon for private cars; 20 miles per gallon for business and institution vehicles; 20 pounds of CO_2 emissions per gallon of fuel). A simplified version of this table appears in the CAP as Table 10.

Table 8. Summary of Transportation-Related Emissions in Belmont

Sector	Annual Miles	Fuel (gallons)	CO_2 Emissions (tons)
Personal: Private Car		8,900,000	89,000
Personal: Commuter Rail	1,144,000		226
Personal: Public Bus	11,823,000		651
Personal: Total			**89,877**
Businesses: Total	**4,068,791**	**203440**	**2,238**
Institutions: Total	**133,000**	**6650**	**73**
Municipal: Commuting	3,305,857		1,322
Municipal: Operations		87,852	327
Municipal: School Buses		4,800	52
Municipal: Total			**1,701**
Total Emissions			**93,889**

Waste

In Belmont, three waste streams can be identified:

- Trash sent to the cogeneration facility in North Andover
- Recyclables sent for processing to Charlestown.
- Yard Waste trucked to a composting site on Concord Avenue.

We did not attempt to quantify emissions from processing recyclable material once delivered to Charlestown, assuming that such emissions are more than offset by emissions avoided from the production of new materials replaced by recycled materials. Electrical energy is obtained from burning trash at North Andover, so we assumed that the resulting CO_2 emissions replace emissions from the avoided electricity generation.

The remaining source of emissions in waste handling is from trucking of waste. To estimate this we guessed (without justification) that the trucks used carry a load of ten tons, that they operate at 8 miles per gallon of diesel fuel loaded and 12 miles per gallon empty, and the distances traveled were obtained using www.mapquest.com. We extended this calculation to municipal, institutional and business waste assuming that the disposal transportation cost per ton of waste is the same as for the residential sector. Municipal waste is handled by the Russell company along with residential waste; the Belmont Highway Department provided an estimate of how much of the waste has a municipal origin.

Summary

The table below provides a summary of Belmont emissions by sector and by source.

Belmont Emissions Summary by Sector and Source (Tons of CO_2)						
Sector	**Electricity**	**Natural Gas**	**Fuel Oil**	**Transport**	**Waste**	**Total**
Residential	49,395	37,092	38,600	89,877	59	215,023
Businesses	15,513	4,679	2,073	2,238	58	24,561
Institutions	12,983	1,854	6,498	73	4	21,412
Municipal	5,032	1,028	4,216	1,701	13	11,990
Unidentified	1,520	2,530				4,050
Total	**84,443**	**47,183**	**51,387**	**93,889**	**134**	**277,036**