# Town of Concord

## Comprehensive Sustainable Energy Plan

*A report to Develop a Comprehensive Sustainable Energy Plan for the Town of Concord, Massachusetts, submitted to the Town of Concord, Town Manager and Selectmen*


Submitted by the CSEP Committee:

**Sean Detweiler—** Patent Attorney with Lahive & Cockfield, LLP, Mechanical Engineer, & former Energy Management Consultant

**Mark Garvey—Co-Chair**
BS in Environmental Science, Owner of New England Energy Conservation Services

**Melissa Hoffer**—Environmental Attorney with Wilmer Cutler Pickering Hale and Dorr LLP

**Mike Jacobs**—Deputy Policy Director, American Wind Energy Association

**Radha Jalan**—Owner of ElectroChem Inc., a fuel cell and hydrogen energy company

**Lawrence O. Masland—Clerk**
Energy Efficiency Planner, Commonwealth of Massachusetts, Division of Energy Resources

**Vivian Myers-Marowitz—Co-Chair**
Citizen Advocate, Information Systems Consultant



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## Preface

At the end of October 2006 the Comprehensive Sustainable Energy Planning (CSEP) Committee (Committee) released its draft plan. On November 21, 2006 the CSEP Committee held a public hearing on this plan which was followed by its presentation to the Board of Selectmen (BOS) on November 27th. Also on the 27th, Daniel J. Sack, the Superintendent of Concord Municipal Light Plant (CMLP), provided a very thoughtful and thorough memorandum that pointed out errors in the report and as well as helpful commentaries. Since receiving the memorandum, members of the Committee have met with CMLP's board at regularly scheduled meetings as well as at a special meeting to discuss the Superintendent's memorandum.

In consideration of all that the Committee has learned since issuing the draft plan, we decided to incorporate summaries of public and CMLP discussions. By doing this revision, the final plan will not only better reflect what the town thinks about how to achieve a sustainable energy future but also illustrates the ongoing dialog that the Committee is having with CMLP's Board and staff. With the exception of errors, which we'll seamlessly weave into the text, we will quietly alert the reader to passages that we've added on account of the various dialogs mentioned above.

The Committee has observed two overarching reactions to the draft plan that are best addressed in this preface. First, some have concluded that the CSEP Committee wants the Concord Municipal Light Plant to take responsibility for all energy related concerns of the town. The Committee did not intend to give this impression. Secondly, others have suggested that the plan only addresses the energy use of the various town departments. Since the acronym CSEP includes the word, comprehensive, our committee's recommendations with respect to buildings include municipal, institutional, commercial, industrial and residential structures.

Before concluding this preface, the Committee wants to state its threefold strategic approach for achieving a sustainable energy future. Sustainable energy is endless, reliable and affordable. It's also wholesome for the environment. The first strategy is procuring renewable resources both inside and outside of Concord's border. Secondly, the community needs to use its energy efficiently by purchasing equipment that exceeds federal energy standards and by designing and renovating buildings beyond the requirements specified by Commonwealth's codes. The third strategy is conservation: how can each of us change our behavior so that we use less energy.

Finally, the Committee voted to submit a warrant article (Article 37 – Town Sustainable Energy Commission) for the 2007 Town Meeting. The article asks the Town to support two recommendations in this plan: a Sustainable Energy Advisory Board and a Sustainable Energy Fund. As the Committee was only charged with developing a plan, we strongly believe that by asking for a Town vote on this article, Concordians would be taking the first step to implement actions to move the community toward a sustainable energy future. Though the vote on Article 37 is non-binding, the purpose of the vote is to corroborate the results of the CSEP surveys, which showed an overwhelming endorsement of financial support for sustainable energy projects, and to demonstrate the political support for the recommendations in CSEP report.

# Contents

# I. Executive Summary

The Town of Concord Comprehensive Sustainable Energy Planning (CSEP) Committee (Committee) presents this sustainable energy use plan (Plan) to the Town, Town Manager, and Selectmen. The Committee is pleased to have the opportunity to serve the Town in connection with these important energy issues that touch every member of our community and will only become more important in the future. The Committee's effort is part of Concord's proud tradition of judicious resource management and conservation that includes the Town's long-range land use plan, and successful recycling and responsible water use programs.

The Committee was formed in January 2006. The Committee's purpose is to develop a plan, based on community input, to guide the Town's future energy choices. To effect that purpose, the Committee's charge included collecting and analyzing data from Town sources concerning private and municipal energy use patterns; holding public hearings; exploring with the Concord Municipal Light Plant (CMLP) options for diversifying energy supply and increasing incentives for conservation; identifying funding opportunities for renewable energy initiatives; and developing recommendations to promote efficiency, conservation, and cost effective options for supply diversification. This Plan sets forth the Committee's recommendations, based on the data collected and analyzed by Committee members, including the results of a Town-wide survey (Citizen Survey), developed and implemented by the Committee in the Spring of 2006.

The Citizen Survey results showed that, with respect to energy choices, environmental impacts are responding residents' primary concern (50%), followed by cost (34%). Thirty-four percent "agree" or "strongly agree" that, among all issues facing the Town, planning for conservation and efficiency measures, as well as integrating renewables into the CMLP portfolio, ranks highly. Thirty-seven percent responded that the Town should act to enhance use of sustainable energy within a year; 23% agreed the Town should act within six months, and 11% called on the Town to act within three months. Over 60% want to learn more about how household energy consumption may be reduced, and over 50% want to know how their household electricity use compares with other similarly situated households. An overwhelming 85% of respondents favor a modest surcharge on electricity bills to fund sustainable energy projects that ultimately will reduce energy costs over time; alternatively, 62% would approve a similar surcharge on annual property taxes to fund such projects.

Overall, the results reflect broad interest in and concern about the sources and security of the Town's energy supply, and support for cost-effective Town action to conserve and increase efficiency and reliance on renewable energy sources. The Committee's recommendations are tailored to respond effectively to those citizen interests and concerns.

Current energy consumption patterns reveal that oil is most frequently used to meet home heating demand, followed by gas, and that solar, wood, and coal energy is used minimally. The Committee's review revealed that private residences form the single greatest demand as a customer category (41%) for electricity in the Town. These data suggest that the Town and CMLP should focus on educating citizens on strategies for conserving and making more efficient use of energy and highlight the importance of Town choices concerning electric power sources. Moreover, additional

analysis about other customer categories (59% of consumption) will provide very useful information for educating and developing strategies for this group of customers.[1]

The Plan explains and provides examples of energy conservation, energy efficiency, renewable energy, and sustainable buildings and transportation, concluding with an overview of funding opportunities available to assist citizens, business owners, and the Town to implement sustainable energy practices.

Key Committee recommendations address issues related to diversifying Town energy supplies and measures to educate citizens and establish a permanent body to work with the Town to implement sustainability programs.

First, the Committee recommends that the Town adopt a Renewable Portfolio Standard (RPS), similar to the standard adopted by the Massachusetts Legislature in 1997 and directed to customers and suppliers served by investor-owned utilities. The State RPS requires that electric power sales by investor-owned utilities include progressively greater percentages of electricity generated from renewable energy facilities beginning in 2001, and reaching 4% in 2009. CMLP makes energy purchases valued at over $8.9 million annually; CMLP's power purchases constitute the single most important energy decision made by the Town, and therefore represent the single greatest opportunity for Concord to integrate a sustainable energy supply. The Committee recommends that the Town RPS require 4% of the electric supply to be derived from new renewable resources—solar, wind, small hydro, landfill gas, biomass, tidal, or wave.[2]

Second, the Committee recommends that the Town implement specific minimum vehicle mileage requirements (varying by type of vehicle) for Town vehicles, and transition to the use of biodiesel to fuel the Town fleet, including school busses.

Third, the Committee recommends that the Town implement a means to allow CMLP customers to compare their monthly energy use with the average use of other similarly situated CMLP customers. That information would provide a valuable benchmark to citizens seeking to assess current household energy consumption patterns in order to gauge the effectiveness of any conservation or efficiency measure they may seek to employ. Although the Committee believes that, if feasible, including this information on the CMLP bill would be most convenient for citizens, the Committee recognizes that other types of media, such as a web site or a separate mailing, would also work.

Fourth, the Committee recommends that the Town establish a permanent citizen Sustainable Energy Advisory Board (SEAB) to work with CMLP, Town departments, and the Town Manager to identify, fund, and implement sustainable energy projects within the Town, including projects to assist citizens in conserving energy and increasing energy efficiency in their homes.

Fifth, the Committee recommends that the Town establish a Sustainable Energy Fund, financed through a CMLP electric bill surcharge.

1 Polling these customers for this plan was difficult because of confidentiality concerns of CMLP.

2 CMLP is investigating a variety of renewable options for its new contract. Moreover, as one participant a CSEP's public hearing observed, CMLP may be able to procure more than 4% of its energy purchases from new renewable sources.

These, and the additional recommendations in this Plan, present opportunities for the Town to join other towns and cities in the State, and across the country, in making energy choices today that will ensure a more secure, affordable, and environmentally beneficial energy future for our citizens.

# II. Citizen Survey Results

## A. Overview

The Committee surveyed Concord residents to determine awareness of and attitudes towards sustainable energy and to provide input into the development of a sustainable energy plan for the Town of Concord.[3] These data allowed the Committee to gauge residents' priorities and concerns in connection with energy use, and to develop a plan that reflects and is responsive to those priorities.

## B. Methodology

CSEP initially distributed 923 surveys ("Survey 1") to residents by email (557); randomly (279); to Earth Day Celebration attendees (81); at Town Meeting (5); and at the Town office (1).

In response to feedback concerning potential bias resulting from the Survey 1 distribution methodology, CSEP performed a second fully randomized survey ("Survey 2") affording both online and mail response options.[4]

Each of the 900 residents receiving Survey 2 was chosen entirely by chance and every resident had an equal chance of being included in the survey distribution list. The survey distribution list was selected from data provided by the Town of Concord Assessor.[5] The Committee sought to have a large enough sample to provide a 90% confidence level that results would be within a +/-5% margin of error. In other words, if we were to conduct the same survey 100 times, 90 times out of 100, any given percentage result would be within plus or minus 5 % of the result obtained in the original survey. For example, if the survey result showed that 85% of residents surveyed preferred red M&Ms, we would be confident that between 80% and 90% (+/-5%) of residents prefer red M&Ms.[6]

The Committee used an online survey service, Survey Monkey, to collect and compile online responses. The mailed responses were compiled by a Committee member.

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3 Concord residents Susan Oman and Brian Crounse provided professional input into the development of the survey. Susan is a senior project manager with Nexus Market Research, where she is responsible for management, design, and analysis of research projects. Brian is a Principal with Carlisle & Company, Inc. and has managed data collection, validation, analysis and reporting processes.

4 Simple random sampling provides the basis for many probability sampling methods. The probability sampling method enables researchers to make probability statements about the size of a sampling error. Most governmental and professional polling surveys employ probability sampling. Statisticians prefer probability sampling methods and recommend that they be used whenever possible.

5 See MS Excel© spreadsheet titled "FY 2006 Proposed Property Values Complete", available from the Town Of Concord Tax Assessor's office or from the Town's web site.

6 The information that follows was used to determine the number of survey responses that were needed to ensure a confidence level of 90%:

| Description | Value |
|---|---|
| Concord's 2005 population age 17 and over | 12,195 |
| Tolerable sample error rate | 5% |
| Number of respondents for 90% confidence (sample size) | 266 |
| Estimated response rate | 30% |
| Number of households to send the survey to for a 30% response rate | 887 |

Copies of the survey questionnaires and a summary of the compiled survey results can be found in the Appendix.

## C. Survey Analysis

98 residents responded to Survey 1, and 179 residents responded to Survey 2,[7] for a total of 277 survey respondents. The Committee determined that, because the results of the two surveys did not differ significantly on a statistical basis, the results could be combined. The Committee's analysis is based on the combined survey results, and reveals the following trends.

- Most residents' primary concern regarding energy use is environmental.
- For the majority of residents responding, cost is the second most significant concern.
- The survey shows that 70% of Concord residents believe the Town should act on the issue of sustainable energy within 1 year or less.
- Most residents believe conserving energy in their home is important and have taken steps to reduce their energy consumption.
- Survey results show residents recognize a need for education about sustainable energy concepts, systems, and opportunities. A significant number of residents stated they would utilize information about energy conservation, energy efficiency and renewable energy if it were readily available.[8]
- A little over half of the residents are aware of CMLP's compact florescent bulb rebate program or the ENERGY STAR® appliance rebate program.
- Of the residents surveyed, 70% stated that they look for the ENERGY STAR® label when buying appliances. This indicates that there is a strong awareness of the importance of energy efficiency when making appliance purchases.
- 99% of the residents surveyed would invest in a renewable energy system for their home if the payback period was 3 years. 69% of the residents surveyed would invest in a renewable energy system for their home if the payback was 5 years.[9]

7 266 responses needed were needed to achieve a 90% confidence level and 5% error rate for Survey 2. Survey 2's actual error rate is plus or minus 6.1% with 90% confidence.

8 CMLP now has a web site that provides energy education for children. Moreover, additional information from CMLP is available up on request.

9 This finding is consistent with other research that shows significant market penetration for renewable technologies that have five year paybacks.

- There appears to be sufficient support for funding local sustainable energy projects and for the purchase of renewable energy through CMLP. In this respect, the CSEP survey results are consistent with the CMLP customer survey conducted this spring that showed that 76.8% of CMLP customers are interested in using renewable energy. Of those, 68% stated they would be willing to pay a monthly surcharge of $2 to $5 to support a renewable energy option if it was available.

- 80% of Concord's residents would support a Municipal policy requiring replacement vehicles to achieve a minimum mpg rating or operate on biofuels whenever possible.

- The responses to questions throughout the survey indicate that residents may not be making a connection between increasing energy costs and their increasing tax rate. While 70% of the residents surveyed would support a sustainable energy plan if it would reduce their energy bill and the Town's energy bill, only 53% stated they would support a policy to incorporate sustainable building principles into new municipal construction and renovation. 60% of the respondents support a requirement to perform energy audits for all municipal buildings, 10% less than the respondents stating support of an energy plan that would reduce energy bills. These results clearly show the need to educate consumers about the short term payback of energy conservation and efficiency investments.

- Several respondents (including some reporting that they live on fixed incomes) noted that cost is an important concern, and indicated that they would not favor any sustainable option or approach that would increase taxes or energy costs. The CSEP Committee recognizes and has addressed that concern in the recommendations that follow this section.

- Finally, when comparing the ages of the respondents to Concord's 2006 Census data, the Committee found that the percentage of respondents in some age groups closely corresponds to the percentage of the total population and active voters, particularly the 65+ age group.[10] The CSEP Committee is confident that the views reflected in the survey closely reflect the views of the community and the voting public.

10

| Age | CSEP Surveys | % | 2006 Census Count | % | 2006 Active Voters Count | % |
|---|---|---|---|---|---|---|
| 18-25 | 6 | 2.21 | 1546 | 13.18 | 996 | 9.69 |
| 26-35 | 24 | 8.82 | 638 | 5.44 | 515 | 5.01 |
| 36-45 | 80 | 29.41 | 1871 | 15.95 | 1660 | 16.15 |
| 46-55 | 51 | 18.75 | 2533 | 21.59 | 2474 | 24.07 |
| 56-65 | 46 | 16.91 | 2411 | 20.55 | 2168 | 21.09 |
| 65+ | 65 | 23.90 | 2732 | 23.29 | 2465 | 23.98 |
| **Total** | **277** | | **11,731** | | **10,278** | |

# III. Current Energy Consumption Patterns

## A. Summary

Energy consumption among those who live and/or work in Concord falls into three main categories: electricity, which is used for a myriad of purposes, combustion of oil and natural gas for space and water heating, and consumption of oil-based fuels for transportation. Of these, the Committee was only able to obtain detailed data for electrical use. Although direct consumption of heating oil, natural gas, gasoline, and diesel fuel represents a significant portion of total energy use,[11] the Committee's analysis for these consumption modes is limited.

The goal of this section is to characterize electrical consumption in the Town, so that Town electrical use can begin to be compared with regional and national benchmarks for similar communities. Additionally, this section provides data to begin to enable citizens to benchmark household energy use against that of other Concord households with the goal of better understanding energy consumption patterns.

## B. Where Are We Now –Understanding Current Energy Usage

As described in this Plan, there are a number of different avenues for implementing sustainable energy practices. However, it is imperative for any energy plan or program to measure past and present performance prior to attempting to improve such performance. Without identifying past energy consumption patterns, it is nearly impossible to assess the impact or effectiveness of future strategies and plans to reduce energy consumption, including analyses of return on investment for such strategies.

In an effort to provide some of the historical reference points that are necessary to assess current and future performance, the Committee asked CMLP to identify the data it tracks and maintains. In addition, the Committee accessed other existing Town data sources, and included in the survey described above, questions concerning behavioral patterns, knowledge, and overall interest of Town residents relative to energy consumption and sustainable practices.

## C. Data Analysis

The Committee obtained all data available derived from existing metering in the Town for residential, commercial, and municipal electrical consumption through the cooperation of CMLP. Those data consist of bimonthly meter readings for approximately 12 months, from early 2005 to early 2006. To protect their customer's privacy, the CMLP data did not include any identifying information such as address or account number. In addition, the Committee obtained data contained in the most recent Town Assessor's Report of FY 2005 reflecting the primary type of heating system

11 According to the U.S. Energy Information Administration, electric power production accounts for 40% of U.S. energy consumption, transportation accounts for 20% of direct consumption, industry accounts for 21%, and residential and commercial consumption accounts for 11%. Of course, the electric power produced is in turn consumed by industry, residences, and commercial enterprises. Source: http://www.eia.doe.gov/emeu/aer/pecss_diagram.html

in town residences. The Committee attempted to correlate some of the data from the two sources; however, the data made available to the Committee was insufficient to enable Committee members to combine the two data sets in a meaningful way.[12]

Given the Committee's limited funding (sufficient to cover minor mailing and copying costs) additional metering and other capital intensive data collection approaches, such as in-depth investigations or individual house-by-house data collection surveys, were not feasible. The Committee's analysis is therefore based primarily on the approximately one year's worth of bimonthly meter readings obtained from CMLP.

## D. Data Description

### 1. Electrical

The dataset for electrical consumption consists of account-level kilowatt-hour (kWh) consumption time-series. This is the electrical consumption per billing separate billing account as tracked by the CMLP. It contains 7,543 records in total. The fields for each record include the fields noted in the following Table 1:

**Table 1 – Fields for Electrical Consumption Records**

| Field | Values | Valid Records | Notes |
|---|---|---|---|
| Zone | 1 to 8 | 7,543 | Zones 7 & 8 are not differentiable |
| Cat | G1, G2, G3, MU, R | 7543 | |
| Sq. Ft. | 0-439,875 | 4,931 | 4,931 non-zero records |
| Total kWh | 0-9,818,032 | 7,543 | 21 zero records |

In the above Table 1, "Zone" relates to different geographical sections of the Town, "Cat" indicates the category of electrical use (which is further defined in Table 2, below), "Sq. Ft." indicates the area (in square feet) serviced by each consumption record, and "kWh" is the unit of measurement of electrical consumption.

The following table summarizes each type of CMLP category:

**Table 2 – CMLP Category Type Descriptions**

| Field | Accounts | kWh | Pct. Total | kWh/ Acct | Description |
|---|---|---|---|---|---|
| G1 | 1059 | 24,668,830 | 13.7% | 23,294 | Small commercial (no demand charge) |
| G2 | 171 | 23,439,606 | 13.1% | 137,074 | Medium commercial (energy and demand charges: 20kW - 200kW) |
| G3 | 24 | 49,938,370 | 27.8% | 2,080,765 | Large commercial (energy and demand charges: 200kW+) |

[12] CMLP was very helpful in this analysis. However, mutual concerns about account holders' privacy limited the Committee's ability to synthesize the available data.

| Field | Accounts | kWh | Pct. Total | kWh/ Acct | Description |
|---|---|---|---|---|---|
| MU | 64 | 8,079,824 | 4.5% | 126,247 | Municipal |
| R | 6,225 | 73,285,034 | 40.8% | 11,774 | Residential |
| **Total** | **7,543** | **179,411,664** | **99.9%** | **23,785** | |

### 2. Heating Systems

The data set for heating system type consists of a listing of all residential properties with a corresponding Assessor's code indicating type of heating system. The five types of heating systems recorded in the Assessor's Report are coal or wood, electric, gas, oil, or solar.

## E. Electrical Use Metrics

This section will identify measures that can be used to assess how electrical energy is consumed in the Town of Concord. To better understand past and present use patterns, it is useful to develop a toolkit that individuals and organizations can use to assess their electrical consumption relative to their peers.

Ideally, measures that assess a site's electrical consumption should take into account relevant factors such as building size, the number and demographics (i.e., age, occupation, and other relevant characteristics) of occupants and/or building users, and the type of heating system (electrical vs. other). The CMLP data is not identified by residential address and does not, therefore, allow consideration of such factors, with the exception of square footage (for many but not all of the records).[13] CMLP data enable us to assess one measure of electrical use: the number of kWh consumed in 2005 per square foot of building area.

For buildings with comparable uses (e.g. single-family homes), those with higher electrical consumption per square foot may have greater opportunity for implementing sustainable energy practices.

Of the 6,906 clean records in the CMLP data, 4,931 (71%) had non-zero square footage. For Town residences, 83% listed square feet. The following Table 3 summarizes the extent of the area data:

**Table 3 – Square Footage (Area) Data**

| Category | % Of Accounts with Square Footage Data | Pct. Of Related kWh |
|---|---|---|
| G1 | 12% | 8% |
| G2 | 36% | 45% |
| G3 | 58% | 67% |
| MU | 24% | 76% |
| R | 83% | 87% |

13 The Committee assumes for purposes of this analysis, but cannot be certain, that the Board of Assessor's square footage data are accurate. The Committee did not attempt to validate this data.

As can be seen from Table 3, the data provide a reasonable sample for the residential segment. The coverage is mixed for other segments, especially as there are fewer records in each of the other categories.

The following graphs or "boxplots" show electrical consumption vs. area serviced. Figure 1 shows a set of boxplots that summarize electrical consumption per unit of area for each account category. A boxplot is a useful way to provide a concise description of a set of numbers. Each part of a boxplot indicates something about the data. The upper and lower bars (the "whiskers") provide a measure of the high and low limits of the data. The box itself provides another measure of the distribution of the data; specifically, the box extends from the 25th to the 75th percentile values, so that 50% of the data values lie between these limits. Finally, the dark line in the box shows the median of the data. This is simply the number which is greater than half of the data values and less than the other half. The advantage of looking at medians, as opposed to averages, is that they are not affected unduly by a small number of extreme values. Thus, the boxplots provide an efficient visual mechanism for identifying where most of the electrical consumption occurs, and how consistent or diversified the quantity of consumption is per unit of area serviced.

**Figure 1 - Summary of Electrical Use Per Square Foot by Building Category**

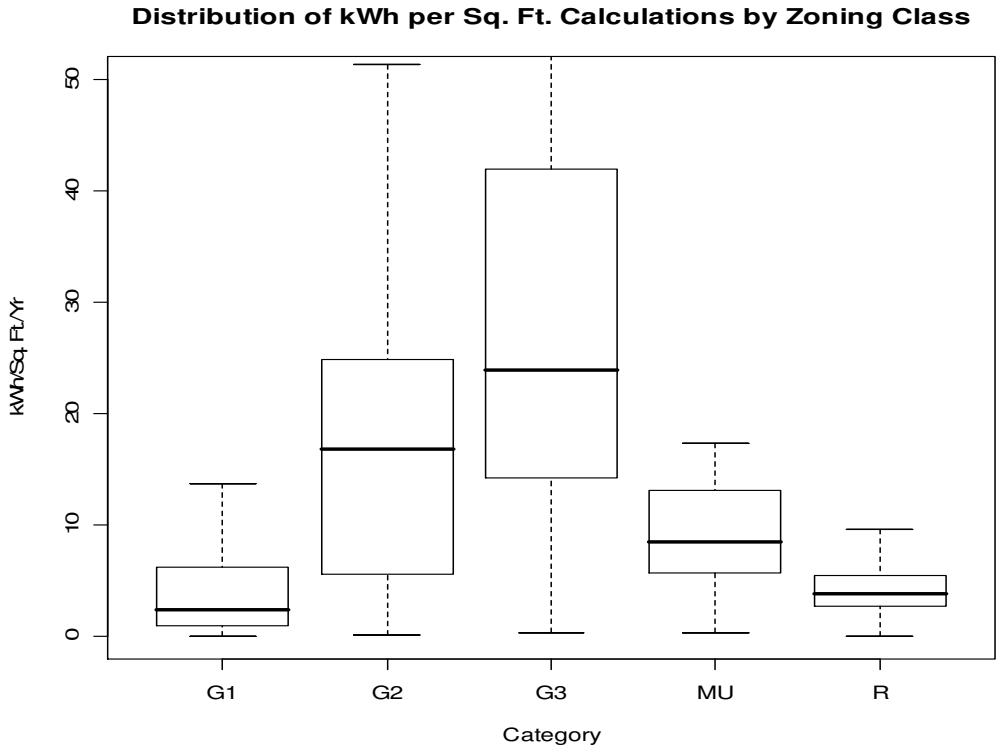



Figure 1 illustrates that electrical use per unit of area varies widely by category. G3 sites (large commercial) which by definition are intense consumers of electricity have the highest median value of 24 kWh per sq.ft. per year, and vary greatly. In contrast, residential use is much lower and more

consistent, although there is still a considerable amount of variability. As the high-consumption G1 (small commercial) and G2 (medium commercial) sites are probably quite different from one another in terms of how electricity is consumed, consumption per unit area is a less relevant metric, so the remainder of this analysis will focus on G1 (small commercial), municipal, and residential sites.

Figure 2 is an illustration of boxplots based on residential records, and segmented by zone. The boxes show that consumption per unit area is relatively similar for zones 1 and 3 through 6. The data for these zones is fairly consistent within the zone and from zone to zone. However, there is more variability in Zone 2, and overall consumption per unit area is higher in zones 7 and 8.

**Figure 2 - Distribution of kWh/Sq.Ft. for Residences by Zone**

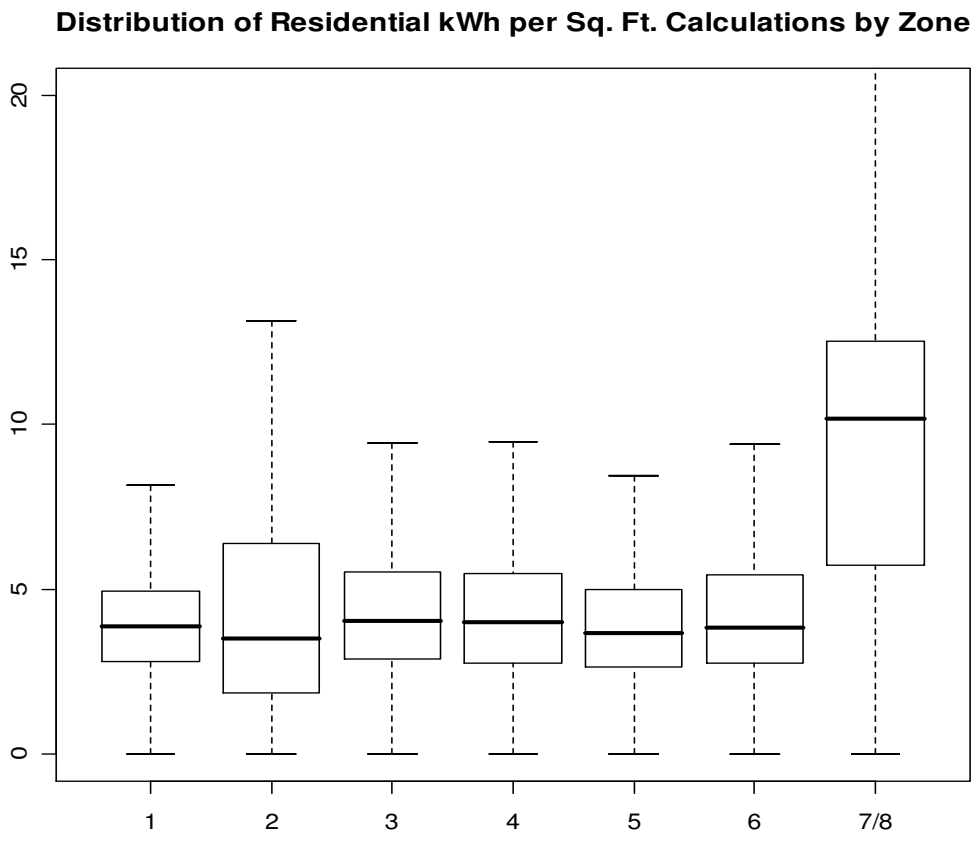
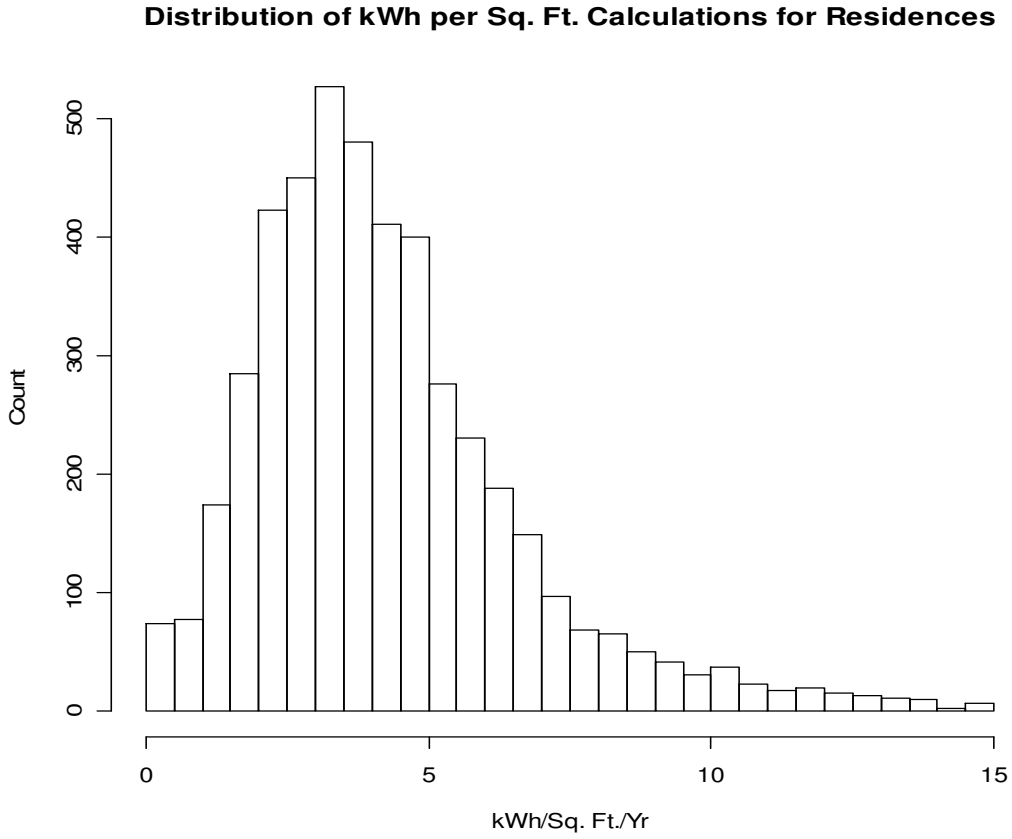



Figure 3 illustrates the distribution of the metric and indicates that the metric has a log-normal distribution. This is the expected distribution for this type of data, which suggests indirectly that the underlying data is accurate. If a reader knows their home's square-footage and they have a recent electric bill, that reader could compare their household to this distribution graph. Of course, there are several factors that make comparisons less relevant, including (but not limited to) whether a residence uses electric, oil or gas heat and/or electric, or gas hot water, as these uses are energy-

intensive.[14] Keeping such caveats in mind, a reader who finds their household well above the median value of 3.9 kWh/per square foot/per year should investigate why, as there may be significant opportunities for energy conservation and improved energy efficiency.

**Figure 3 - Distribution of kWh/Sq.Ft. for Residences**




## F. Results – Seasonal Energy Consumption Patterns

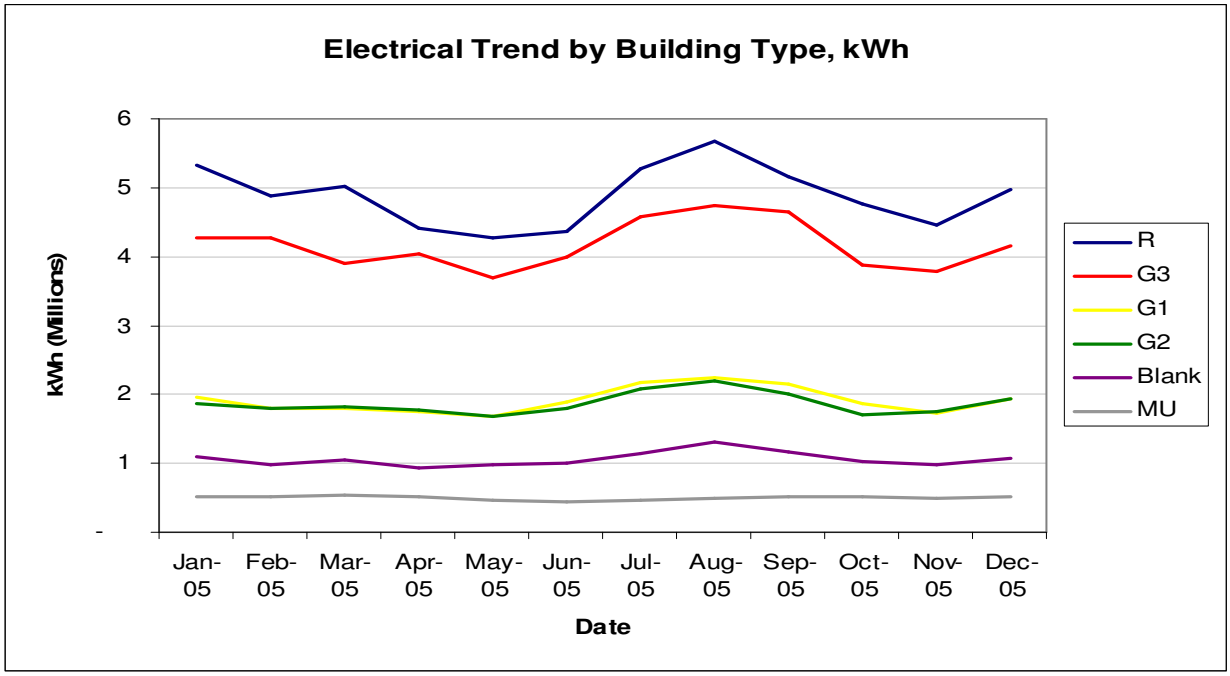
On an aggregate level, there is a moderate seasonal trend for electrical consumption. As the following tables show, the residential, commercial, industrial, and municipal all generally trend together in their electrical usage. The graphs indicate the lowest months of usage are during April, May, and June, as well as October and November. Electrical consumption rises during he later part of November, all of December, and into January. Peak electrical consumption occurs during the months of July, August, and September.[15]

Graph 1 represents the annual consumption in kWh by building type and Graph 2 represents the annual consumption normalized to the monthly mean for each building type:

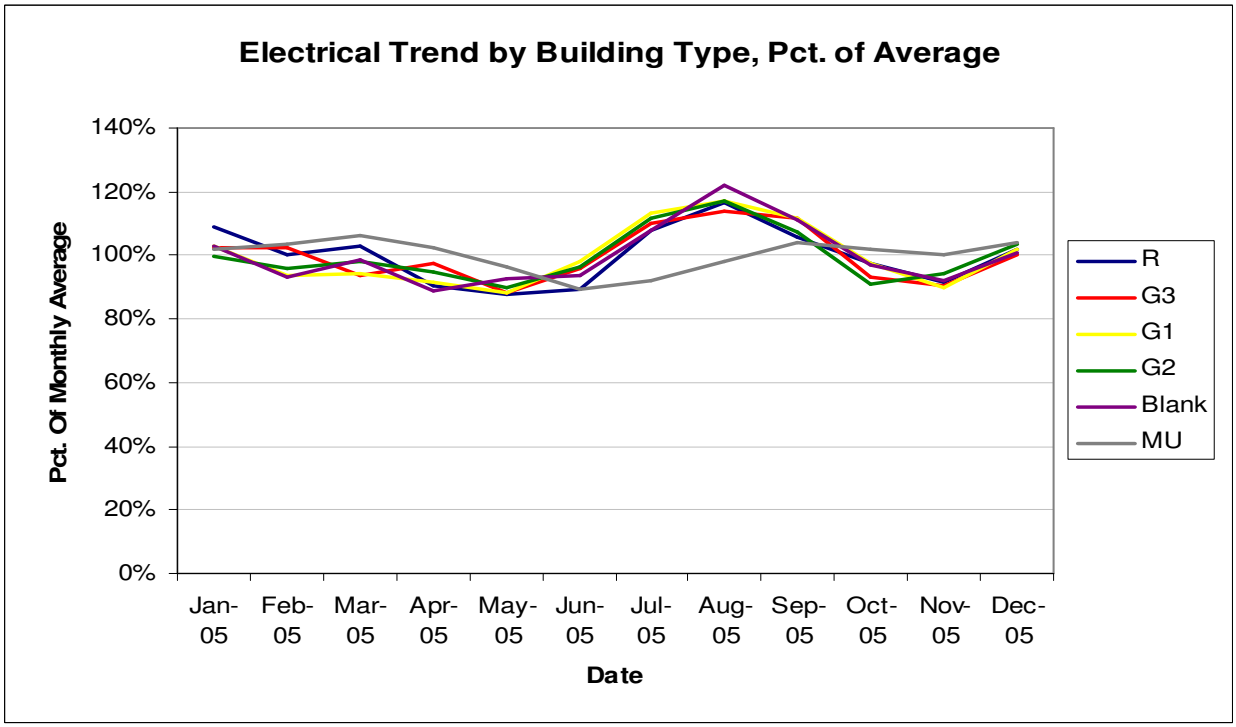
14 CMLP suggested several ideas that would make the information more comparative, including details about the residences as well as the usage data that is now more accessible on account of the newly installed automatic meter reading equipment.

15 A table containing the kWh consumed by month can be found in the Appendix. CMLP suggested that information about electrically-heated basements would help in the making winter comparisons.

## Graph 1 – Annual Energy Consumption By Building Type




## Graph 2 – Annual Energy Consumption By Building Type, Normalized



## G. Results – Residential Heating System Types

The residential heating systems are identified by code in the Town Assessor's Report. Spot checks of the accuracy of the Report indicated that the accuracy level is likely not high. However, there was no method available for verifying the accuracy of each record, nor was there capacity for verifying the percentage of accurate records. Table 4 below shows the totals for each heating type:

**Table 4 – Residential Heating System Types**

| Heating System Type | Number of Houses | % of Total |
|---|---|---|
| Oil | 2723 | 57% |
| Gas | 1991 | 41% |
| Electric | 92 | 2% |
| Coal/Wood | 5 | 0% |
| Solar | 1 | 0% |
| **Total** | **4812** | **100%** |

Table 4 shows that oil and gas are the predominant heating system types for the residential properties of the Town. A significantly smaller percentage of residences have electric heat as their primary heating system. However, it is likely that a larger percentage of residences supplement their main heating system with electrical heat, such as for a basement, garage, three season rooms, and the like. Such information is not available in the Assessor's Report. Although the accuracy of the data cannot be easily verified by this Committee, the results appear to fall within reasonably expected ranges, with oil and gas being the primary sources of heat in the Town. According to the Assessor's report, 98% of residential living space, 11.8 million square feet, is heated by either gas or oil. A typical consumption rate for single family homes is 12 BTUs per heating degree day (HDD) per square foot.[16] For 2005, the Concord area had approximately 6,700 HDD.[17] Combining these figures together yields a total heating demand of approximately 960 billion BTU. This is equivalent to 166,000 barrels of oil or 940 million cubic feet of natural gas.[18] For comparison, the 73 million kWh consumed by residences in Concord would amount to consumption of 123,000 barrels of oil, if our electricity was generated primarily by oil-burning generators (it isn't).[19] For another point of comparison, a conservative estimate indicates that Concord residents consume approximately 120,000 barrels of oil annually for transportation.[20]

For the curious reader, at CMLP's suggestion, CSEP provides the following BTU conversions:

16 Sources: http://www.kouba-cavallo.com/cgi-bin/bnchmrk.pl (heating benchmarks). Clearly, actual consumption data would be the most accurate.

17 Source: http://www.weather.gov/climate/index.php?wfo=box

18 As the purpose of this calculation is to estimate an order-of-magnitude for heating energy usage, it does not account for furnace efficiencies, etc.

19 According to the ISO-NE 2005 Annual Market Report, nearly 30% of New England electricity is generated from natural gas, 26% from nuclear, about 12% for both gas/oil and coal plants, and 5% or less for each of oil, wood/refuse, coal/oil, hydro, and other.

20 In lieu of detailed data on Concordians' vehicle ownership, this estimate is based on: 5,000 households, 1.5 vehicles per household, 15,000 miles/year/vehicle, 22 MPG per vehicle, 10% energy loss from well to gas tank. Based on summary statistics from: http://www.transtats.bts.gov/, this calculation is meant to establish the order of magnitude of energy use.

1 gallon of heating oil = 139,000 BTU
1 gallon of diesel fuel = 139,000 BTU
1 gallon of gasoline = 124,000 BTU
1 cubic foot of natural gas = 1,031 BTU
1 gallon of propane = 91,000 BTU
1 kWh of electricity = 3,412 BTU (energy delivered, not energy consumed at point of conversion)[21]

The conclusion of these calculations is that residents of Concord consume roughly equal amounts of energy for electricity, space heating, and transportation. Due to the nature of these calculations, it is not advisable to draw any more detailed conclusions (e.g. that heating uses more energy than transportation- more precise data could possibly produce the opposite conclusion).

Separate information provided by the Town Municipal departments indicates that the Town buildings also primarily have oil and gas heating systems.

## H. What the Results Mean

Generally, it appears that the most prevalent form of residential heating systems is oil, followed closely by gas. It appears that the use of solar, wood, and coal energy in the town is minimal. It is likely that there is a greater amount of electrically based heating, especially in Town residences, than is indicated by the Assessor's report, primarily as supplemental or room specific heat. This type of heating is difficult to verify or measure with the current methodologies.

The trends of electrical consumption for residences, as well as commercial and municipal properties, appear to be similar to one another. The higher electrical consumption periods are in the summer months, while the second largest spike appears to occur around the winter holiday season. The summer electrical consumption increases can likely be attributed to the use of air conditioning units. The winter electrical spike does not occur in the colder months of January and February, but rather in December to early January. Therefore, it does not appear that electrical heating systems are the cause of the spike in consumption.

## I. Survey Results

The Citizen Survey Results are provided and discussed in many areas of this Report. There are a number of different questions that were asked in the survey that may provide some context for the energy consumption patterns to date, and the energy consumption patterns to date likewise may provide some context for interpreting the survey results. The following reflects results from a few of the survey questions that were more related to energy consumption, data, and consumption patterns.

Question #14 stated, "I would be interested to learn more about steps I can take to reduce my energy use." A total of 60% of the respondents agreed or strongly agreed with this statement. This indicates a general interest among Town residents to reduce energy consumption, and shows that almost half of Town residents want to learn about, and take steps to reduce energy consumption.

Question # 15 stated, "I would find it helpful to know how my household's energy consumption

21 Source: http://www.eia.doe.gov/kids/energyfacts/science/energy_calculator.html

ranks in comparison to other residents in Town." A total of 51% of the respondents agreed or strongly agreed with this statement. At the time of this analysis there was no data set that would have allowed precise electrical consumption comparisons between similarly situated residences. However, an individual household can certainly determine how many kWhs they consume per square foot if they know their home's square-footage and they have a recent electric bill. They could then compare their consumption to the distribution in Figure 3. But doing so does not provide a clear view of relative energy usage owing to many variables (such as heating type) for which this metric is not adjusted.

Question # 16 asked, "If you were more aware of your energy use would you be more inclined to conserve?" The highest percentage answer was "Yes" (85%). This is a strong statement that if Town residents were provided with more and easily accessible information concerning their own level of energy consumption, they may be more likely to conserve.

## J. Recommendations

- The Committee urges the Town of Concord to recognize the interest in over half of the Town residents to learn about, and act upon, energy consumption reduction measures.

- Town residences, in the aggregate, form the single greatest demand for electricity in the Town—nearly 41% of all CMLP electricity is used by Town households. The Committee therefore recommends that the Town and CMLP provide a mechanism to allow each Concord household to compare how much electricity it uses in comparison to similarly situated Town households. One vehicle for this may be through a website that provides comparative data of average residential consumption for individual residents to consult and compare to their own usage. Another vehicle may be through the provision of a graph or chart on each resident's monthly electric bill indicating consumption amounts by the resident with a comparison to an equivalent average residential consumer in Town.

- The Committee further urges the CMLP to update its data collection with respect to electrical consumption as it relates to individual building structures to enable better tracking and consumption measurements and comparisons.

# IV. Renewable Energy

## A. Summary

This section defines renewable energy, discusses the different technologies and considers the practical applications of these technologies at the Municipal, residential, and commercial levels.

## B. What is Renewable Energy?

Energy from water, wind, sun and plants grown through agriculture or sustainable forestry is renewable. Using vegetable oil ("biodiesel") or ethanol for engines, adding solar panels to buildings and woodstoves to homes or producing electricity in wind farms, hydro-electric plants or wood-burning power plants are typical ways to use renewable energy instead of non-renewable fossil fuels.

To make more renewable energy[22] part of the Town's energy supply requires making energy purchase decisions and possibly, energy equipment investments. Concord makes electric energy choices through CMLP; those decisions determine the types of energy we use, *e.g.*, electricity from coal-fired power plants, nuclear reactors, or wind farms. Our survey, and CMLP's own survey, show support for greater use of renewable energy in the supplies purchased for all users in Concord.

The Committee recommends that the Town act through CMLP to acquire a portfolio of energy resources that includes 4% of renewable energy from new generators. This is the same portfolio requirement standard that applies to most of the state under the Massachusetts Renewable Portfolio Standards ("RPS") law. The Committee defines new generators as those that could not operate prior to 2005 and expands the eligibility for supplies to a wider region than that which is allowed under the Massachusetts Renewable Portfolio Standards law. Suppliers in Canada and New York, for example, may be suitable for Concord's needs but not meet state RPS requirements.

## C. Renewable Energy Today

Renewable energy is used today to replace fossil fuel at the power plant and at the home or business of the user. Rooftop solar collectors for solar hot water heating or electricity production from photovoltaic panels are common ways that renewable energy is used on-site. Renewable energy power plants that supply electric companies can be found in New England on rivers, at landfills where buried garbage creates methane gas, at plants built or converted to burn wood, and where wind is powering wind turbines.

In Massachusetts, there are two significant mechanisms supporting increased use of renewable energy, the Massachusetts Renewable Energy Trust (MRET) and the state RPS. These both were created by legislation in 1997 and are directed to customers and suppliers served by investor-owned utilities. Concord, as one of 52 communities served by 40 municipal light plants, is not governed by this legislation, and does not have the obligations or opportunities created by it. The Massachusetts RPS requires electric power sales by investor-owned utilities to include a progressively greater

22 As described in Renewable Energy Today (below), Concord buys a small amount of renewable electricity from New York and from Acton.

percentage of electricity generated from new renewable energy facilities beginning in 2001, and reaching 4% by 2009. [23]

MRET provides a number of grants and loans for businesses, homeowners, and schools for the development and use of renewable energy. The state collects funds from every customer of investor-owned utilities in Massachusetts through an additional charge per kWh, totaling around fifty cents per month per household.

CMLP has the obligation to purchase electricity supplies for all the electric users in Concord. Those purchases totaled over $8.9 million in 2005. The scale of CMLP's electricity purchase decisions dwarfs the energy choices made by any other Town department or collection of engaged citizenry, and therefore must be part of the Town discussion of future energy planning. This is particularly true given that CMLP currently is not bound by the State RPS.

Today, CMLP has two hydro-electric suppliers in addition to the current short-term power purchase contract with power marketing company Constellation Energy Commodities Group. The hydro facilities at Niagara Falls are part of a public power supply that has been dedicated to municipal light departments such as CMLP. [24] This long-term, renewable energy supply benefits every household[25] in Concord by making a portion of our electricity supply stable in price and immune from fossil fuel price increases or air pollution costs. However, the majority of CMLP's supply comes from the Constellation contract, which will end in 2009 and must be replaced.

When Concord, acting through CMLP, obtains new electricity supplies, a range of power generation sources will be considered. The Committee recommends that 4% of the electric supply come from new renewable energy sources (solar, wind, small hydro, landfill gas, biomass, tidal or wave). This is the same requirement applied by state law to investor-owned utilities. Renewable energy options offer both sustainability as a general benefit, and immunity from escalating fossil fuel costs. The risk of rising fuel costs plus the risk of additional limits on air pollution from fossil-fuel plants is a risk that CMLP should take steps to avoid, by obtaining some power supplies with stable prices. To secure the benefit of stable prices, CMLP should contract for energy purchases, or ownership rights, from renewable energy sources. In its search for renewable power, CMLP should include purchase opportunities that provide a financial hedge, (*i.e.*, protection from price increases)[26],contract to buy energy for a long term at a fixed price from a renewable generator-located in the Northeast where energy prices will change at the same time that CMLP costs for energy will change. Purchasing some energy at a fixed price will help stabilize CMLP energy costs and rates. If the renewable generator is not in New England, CMLP may get the rate stability from reselling the fixed price energy at the prevailing market prices.[27]

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23 Mass General Law Ch. 25A Section 11F.

24 The Massachusetts Municipal Wholesale Electric Company and the New York Power Authority renewed the supply from New York hydro facilities in 2006, now set to expire in 2025. (MMWEC Public Power News, January 2006).

25 The savings from the New York public power are limited to the residential customers.

26 New York State has examples and analyses of the benefits and approaches to stabilizing energy costs by using a purchase from wind. See http://www.powernaturally.org/About/documents/WindHedgeExSumm.pdf and http://www.powernaturally.org/About/documents/WindHedgecomplete.pdf.

27 Another, more complicated approach is to contract for the difference in price between the agreed purchase price for the renewable energy, and an index price that reflects the changing market price of energy. The effect of either approach is to lock in some energy at a price that will not be affected by air pollution regulations or fuel costs.

Recently, CMLP developed a Green Power program and contracted with a local renewable energy facility to provide additional hydro power for Concord customers. The Green Power program enabled Concord customers to make voluntary purchases from Acton Hydro, located at Powdermill Dam just west of Concord, at an additional cost of 3 cents per kWh. Eighty households and businesses enrolled in the Green Power program. However, before Acton Hydro was able to restart electricity production and make sales to Concord, heavy rains damaged the Powdermill Dam in the spring of 2004. Efforts to complete permitting for repairs were lengthy, and work has now begun. The Committee recommends that CMLP contract with Acton Hydro for additional energy supplies, as available, at a stable-price.

The future financial impact of these two purchase recommendations is not known and cannot be determined with certainty. As with long-term bonds in a financial portfolio, a renewable energy portion of an electric supply provides stability and predictability. The market prices for electricity have risen sharply in the past few years, and Concord has benefited from the stability of the NY hydro purchases. We do not know what the cost will be for conventional power supplies that must buy fossil fuel over the next 5-20 years. New wind power supplies available in neighboring areas offer energy at long-term stable prices that can either be delivered to New England, including Concord, or could be re-sold and serve as a hedge against price increases for supplies purchased within New England.

## D. Renewable Energy Supply Examples

Municipal utilities have seen the benefits of renewable energy through a long experience with the stable costs of hydro power. Some municipal utilities' original electric supplies came from locally owned hydro facilities at waterfalls within town boundaries. Examples in Massachusetts include Holyoke and Chicopee.

Currently, the Massachusetts Municipal Wholesale Electric Company ("MMWEC"), a consortium of municipal utilities that includes Concord, has contracted to buy the output from a new wind farm, Berkshire Wind, located on Brodie Mountain in Hancock, MA. This 10 turbine, 15 MW wind project will be paid for by, and its power generated for, participating municipal light departments.[28]

## E. On-site Generation and Energy Use

Many forms of renewable energy can be built on the site of a home or commercial property, providing electric supply "on-site." These small generation additions, (*e.g*. wind, solar or fuel cells) can be owned by the property owner or by the local utility. The smaller scale makes installations and siting feasible, but can mean higher cost of the energy produced. Despite the challenges for Concord-based generation, there are opportunities for homeowners to install solar panels today and fuel cells in the near future. The use of biofuels in residential home heating currently relying on oil can begin immediately.

### 1. Wind Turbines

28 At the time that MMWEC initially contracted for this project, CMLP, on account of its Boston Edison contract, was unable to participate. Due to construction delays, this project became dormant. CMLP has recently joined other municipal utilities to see whether or not they can restart this project. CMLP indicated that CSEP's work help to draw attention to this renewable opportunity.

Wind turbines are the most visible form of renewable energy generation for on-site use. Using windmills for water pumping is part of Concord's agricultural heritage, as can be seen in the Nine Acre Corner area. However, based on available wind data, Concord does not have the wind resource to make electric generation in a cost-effective manner.

One Massachusetts community with a municipal electric department that has brought wind turbines into view inside the town is Hull. Hull's location in Boston Harbor means that much of the town has a valuable wind resource. In 2001, and again in 2006, Hull Municipal Light Plant installed a utility-scale wind turbine. These two wind turbines, totaling almost 2.5 MW produce over 12% of the total electricity consumption in Hull.

Each of Hull's turbines provides an economical alternative to the purchase of electricity by Hull from outside sources. The position of the turbines in the Town allows Hull to avoid paying additional fees for energy delivery to Hull. This combined with the power of the wind resource and the scale of the turbines has made on-site generation a very good deal for Hull Municipal Light Plant.

### 2. Solar Photovoltaics

The simplest and most easily adopted renewable energy generation is solar, using photovoltaic panels ("PV"). Numerous efforts by Massachusetts communities to use PV on schools, homes, and brownfields offer lessons for Concord. As an on-site generator, a solar panel is able to replace purchases of power by the consumer at the high retail price. This helps the economics, but even with other financial support, the return on investment is still low.

Still, Concord will see continued and growing interest in solar panels, and both the building inspector and CMLP should be familiar with the latest technology for installation and connection of solar panels, as well as fuel cells, described below, so that the adoption of these generators will be smooth when the market is ready.

### 3. Fuel Cells

Fuel cells provide a very attractive alternative as a completely renewable energy source. A fuel cell is an electro-chemical device that combines hydrogen and oxygen to produce electricity, heat, and water without any combustion of gases. Fuel cells are a promising technology since hydrogen is available from many sources. Concord may be able to obtain a renewable source of hydrogen fuel for fuel cells from methane from the sewage treatment plant[29].

There are many companies that are developing fuel cells for power generation, automobiles, homes, back-up power, and other applications. A few companies have been installing small fuel cell plants in customer locations to provide energy and on-site back-up power for emergency needs. These units extract hydrogen from water using natural gas. Though not completely renewable, these installations have helped communities to understand more about potential benefits of the technology. Since fuel cells are still manufactured in very small quantities, their purchases and installation are government subsidized.

29 Although closed landfills are also a source of methane, CMLP learned from a consultant, hired to study landfill gas, that Concord's landfill had insufficient quantities of methane to make electrical generation economically feasible at the time.

Even though fuel cells are not commercial yet, their benefits, as a reliable clean power source is undisputed. It is important to explore the opportunity to install units in the Town for emergency back–up power, as well as for educational purposes.

#### 4. Biofuel for Home Heating

Biodiesel is an environmentally friendly fuel that supports American farmers and potentially could reduce pollution and reliance on foreign oil imports. Biofuel, biodiesel, bio-heat, and bio-oil are terms used to describe a blend of biodiesel and the conventional No. 2 heating oil. The Energy Consumption Patterns section of this report estimates that 57% [30] of the homes in Concord use oil for heating their homes. 20% of the fuel oil used for heating could be replaced with a B-20 biofuel blend.

Biodiesel is most commonly made of refined soybean oils, though it can also be made from recycled cooking grease, or animal fats. Heating oil and biodiesel must meet specifications before blending.[31] The blend is often called by a name that indicates the percentage of biologically derived oil contained in the blend. For example, a blend of 10% bio-oil and 90% No. 2 heating oil is referred to as "B-10." Home heating oil distributors market blends between 2% and 20% biofuel. The most important reason for using these blends is because 100% biodiesel will cloud or gel at very cold temperatures. A blend of B-20 or less will prevent this problem. Biodiesel can be used in existing commercial or home heating systems, and can be mixed with heating oil present in an oil tank. It has been shown to slowly break down the sludge and reduce acid buildup in heating oil tanks and oil lines. Because biodiesel reduces soot buildup, less energy is used to generate heat, saving the consumer between 3-5% on heating bills. Biodiesel blends for use as a home heating fuel are being used in many homes and businesses throughout Eastern Massachusetts.[32]

## F. Survey Results

Several questions in the CSEP survey found significant citizen support for Town action to purchase renewable energy supplies for all electricity users. 76% of Concord residents surveyed support the idea that CMLP should adopt a standard for renewable energy supply.[33] 84% of residents indicated a willingness to pay more on their electric bill for renewable energy,[34] and 85% supported a surcharge to fund sustainable energy projects like the 2% electric bill surcharge for underground wires CMLP customers are currently paying. [35]

## G. Recommendations

- The Committee recommends that CMLP purchase 4% of the electric supply from new renewable energy sources.

30 Committee used most recent data from Town Assessor's Report of FY 20005 to gather primary type of heating systems in town residences. 2723 houses report heating type is oil, 1991 report gas, 92 electric, 5 wood, 1 solar.
31 American Society for Testing and Materials website: http://www.astm.org
32 National Biodiesel Board – www.biodiesel.org, www.nbb.org
33 See survey question 26 in the Appendix.
34 See survey question 27 in the Appendix.
35 See survey question 8 in the Appendix.

- The Committee recommends that residents, commercial property owners and the Town (where applicable) consider the use of the biodiesel for heating purposes. See the Appendix for a list of biodiesel/ bioheat retailers.

# V. Energy Conservation

## A. Summary

Once we have a better understanding of how we use energy, we can begin to create a lifestyle that strives for energy independence. Concord has a strong tradition of environmental stewardship with respect to preserving open space, recycling solid wastes and conserving water. Examining the policies that created these successful outcomes and reviewing other States' successful conservation programs should guide Town policymaking with respect to promoting energy conservation.

## B. What is Energy Conservation?

Energy is conserved when we use less of it. There are many ways to use less energy, and most involve common sense. Turning off the lights when leaving a room, putting on a sweater at home in the winter instead of turning the thermostat up, and bicycling or walking, instead of driving, for short trips are all simple ways to use less energy. In the aggregate, these simple steps can result in substantial decrease in the overall amount of energy consumed.

The Town's solid waste recycling program, responsible water use practices, and abundant open space demonstrate our community's commitment to environmental conservation. The Town has nurtured that commitment by providing incentives and information to citizens to increase conservation practices. Concord's "A" performance in the Commonwealth for recycling, for example, results from a strong educational campaign, a program design that facilitates citizen participation and provides clear performance measures, and monetary incentives—citizens who recycle pay reduced trash collection fees. To promote water conservation, the Town used an increasing block rate price mechanism: for each unit[36] above 25 consumed by a residence, the next units cost more; the third block is more than twice as much as the first. The Town's long range land use plan, adopted in the 1980s, emphasized open space preservation; subsequently, citizens approved funds to purchase or to put in trust significant parcels of land. Open space preservation has ensured that Concord remains one of the most beautiful and desirable towns in the greater Boston area.

To make energy conservation a part of everyday life requires being energy mindful—that is, become aware of the energy we use each day. That awareness, coupled with a commitment to conserve, results in a change in personal energy use patterns, and reduced energy use.

These conservation success stories share a key common element: an educated and engaged citizenry. However, policy choices that combined education, performance measurements, and monetary incentives guaranteed the success of these programs. CSEP's energy conservation policy relies on that same combination of motivational elements.

## C. Energy Conservation Programs

Since at least the early 1970s, much research has been performed to identify the challenges posed by and opportunities for developing educational campaigns and performance measures to promote

36 One unit equals 748 gallons of water.

energy conservation. While programs may differ in detail, a key feature of any conservation strategy is the financial incentive, which can be structured around a reward for conserving energy, or a loss for opting not to conserve. Two programs, one in Maine and an evolving one in California, illustrate the two approaches.

**Financial Reward**—Maine's Save A Watt 10% Challenge

During the winter of 2005-06, Maine responded to a potential disruption of the energy supply from Hurricane Katrina by running a conservation sweepstakes. Electric customers who reduced consumption by ten percent or more when compared to a similar period for the previous year were eligible to win $1,000 dollars toward the purchase of energy efficient appliances. Maine linked the educational (marketing) campaign for this sweepstakes with its on-going energy efficiency programs, relied heavily on radio and television to promote participation in the program, and appealed not only to participants' desire to win the lottery, but also to the community spirit of its citizenry.

To measure performance, the state's Department of Public Utilities (DPU) required electric companies to provide it with customer usage data. The DPU analyzed these data automatically to identify qualifying homes. During the three winter months that the program operated, 28 percent of residences reduced electric usage by 10 percent or more. Not only did these customers lower their electric bills, but the electric supplier agreed to pay for each documented kilowatt-hour saved. The estimated amount paid by the supplier for these conserved kilowatt hours was in the hundreds of thousand dollars--enough to cover a large amount of program costs.[37]

**Financial Loss—**California's Critical Peak Pricing Tariff

The driver for California's conservation program is the perennial potential for summer shortages during periods of peak electric demand[38] caused by air conditioning. The California Energy Commission through its Critical Peak Pricing Tariff requires electric companies to provide time-of-use meters[39] to all residential customers. Since electricity costs more to produce when the demand for it is greatest,[40] the time-of-use meters will allow the electric utilities to charge customers a rate proportional to their hourly purchase price. For example, customers who opt to use major electric appliances, such as hot water heaters, air conditioners, and washers at off-peak hours will pay less overall for electricity.

Participation in the program is optional. In return for a lower price per kilowatt-hour for most the year, participants pay over ten times more for a kilowatt-hour during approximately twelve peak periods each year. However, these customers will receive notices a day-ahead about peak-period

37 This program addressed a unique event. Whether or not these savings are permanent was not addressed. However, an ongoing conservation effort might make these savings permanent.

38 Peak electric demand is a daily and annual occurrence. Peak demand is only a problem when supplies are insufficient to service the load. Another problem is that very inefficient generators provide electricity during periods of peak demand.

39 Time-of-use meters measure when energy load occurs.

40 The load-descriptive categories define three types of electric plants: base, intermediate and peak. Of these, peak-load electric plants cost the most to run because they are mostly idle. Operators of these plants will turn them on only when the price is high enough to cover their fixed and fuel costs. The consumer's cost of energy during these periods is usually spread out over all the energy purchased for the billing period. Without a time-of-use meter, users will never see a price signal that reflects the real cost of electricity.

rates and can thereby plan to reduce their electricity use. Non-participating customers will pay a higher rate that will exceed the amount paid under the current rate structure.

## D. Survey Results

The questions relating to conservation in CSEP's survey found that not only is conserving energy important to Concord residents (Question 12 - 60% agree or strongly agree), but also that residents have taken action (Question 13 - 63% agree or strongly agree) by turning off lights in a room when no one is using it, adjusting thermostats to 68 degrees or lower in the winter and turning on computer's sleep setting to save energy when not in use, etc.

With respect to what might motivate residents to conserve more energy, almost 56% replied yes, that they would use less electricity if they had to pay a higher rate for usage above a certain level (much the same as the water rates in town (Question 17). The CSEP survey did not poll whether or not residents would support such a rate.

## E. Recommendations

- The CSEP Committee recommends the creation of a Sustainable Energy Advisory Board (SEAB) that would have the task to design and coordinate energy conservation, energy efficiency and renewable energy programs. The SEAB would work with the Light Board in the development of a system that would track electrical consumption. The advisory board would also work with the Concord Conserves[41] program to create a public outreach campaign. The SEAB would be able apply for funding from a Sustainable Energy Fund.[42]
- Of the two energy efficiency programs described earlier, the CSEP Committee recommends that the Town explore a conservation program modeled on financial reward. Its successful implementation depends on attributes of this plan that receive a fuller discussion in other sections, such as on-going monitoring of energy consumption, education, and financial support.

41 The Concord Conserves program is coordinated by the CMLP and Concord's DPW.
42 See the Financial Incentives section for more information about a Sustainable Energy Fund.

# VI. Energy Efficiency

## A. Summary

Energy efficiency relies on people purchasing buildings and products that use less energy. For example, the United States Department of Energy and the Environmental Protection Agency helps citizens identify more efficient products with their ENERGY STAR® program. To be successful, programs to promote energy efficiency must educate customers about what makes a building or products energy efficient; assure customers about the reliability of efficient goods; bridge any financial gap between what is standard and what is efficient; and overcome landlord-tenant situations where a landlord purchases an appliance or equipment but does not pay for the energy a tenant uses. Key policy components for energy efficiency are educating and assuring customers about the benefits of energy efficiency as well as overcoming the financial obstacles posed by the higher cost of efficient design.

The section will examine these common energy efficient opportunities: lighting, heating, air conditioning, water heating, motors, compressed air, process improvements and facility management training. A subsection will include examples of components for energy efficiency programs in Concord.

## B. Overview

Since 1988 Massachusetts, in response to a forecasted shortage of electric power plants, has required investor-owned electric companies, which serve 90% of the state, to provide energy efficiency programs for its residential, commercial and industrial customers. The Commonwealth now boasts the greatest gross domestic product per unit of energy in the country as one of the results of this policy. A key component of these programs is the provision of technical assistance and financial incentives to customers. This strategy educates and assures customers about the benefits of energy efficiency as well as overcomes the financial obstacles posed by the higher cost of efficient design.

With improved facility manager training, there are opportunities for increased efficiency in lighting, heating, air conditioning, water heating, motors, compressed air, and industrial processes.

### 1. Lighting

Historically, lighting improvements have provided almost half the electric savings in traditional energy efficiency programs. For residential customers, the primary technology is the compact fluorescent bulb that fits into most standard residential lighting fixtures. A very small percentage of residential lighting becomes more efficient with the installation of fixtures that can only use a pin-based fluorescent bulb. Thanks in large part to its ratepayer-funded programs, by 2005 Massachusetts had installed more compact fluorescent bulbs per fixture (11%) than any other state.[43] Massachusetts has a multifaceted campaign to establish compact fluorescent lighting in homes: manufacturers get incentives to lower their wholesale costs; retailers receive discount coupons and marketing assistance; customers may request mail order catalogs; energy auditors install up to eight

43 Market Progress Report (MPER) For 2005 ENERGY STAR® Lighting Program

bulbs per household; and new homes certified as ENERGY STAR® have a compact fluorescent bulb in every appropriate socket. Town residents who purchase these bulbs more than likely pay less on account of these programs.

Commercial and industrial lighting offers considerably more options with respect to efficient lighting equipment. The fastest evolving technology is fluorescent lighting, those ubiquitous four and eight foot tubes. Both the bulbs and the ballasts that power them have produced major gains in the number of lumens (light output) per watt (energy input). Less energy also means less heat, thereby reducing the amount of energy used to cool a building. Lighting controls, such as occupancy sensors that turn off lights in empty rooms or daylight sensors that dim lights on sunny days, provide additional efficiency gains from lighting. In larger buildings, energy management systems can identify unusual light-use patterns and signal the need for appropriate intervention. Other lighting fixtures that can deliver more lumens per watt use high intensity discharge lamps and light emitting diodes. Applications for the former are rooms with high ceilings or outdoor lighting and for the latter are exit signs, traffic lights, and other specialty applications.

The Massachusetts commercial building code may soon advance to the point where lighting power density (watts per square foot) approaches that of state-of-the art equipment. This code applies to new construction and major renovations. Additional efficiency gains will be those that integrate day lighting into the building's design.

### 2. Heating Ventilation & Air Conditioning (HVAC)

Opportunities to upgrade buildings with energy efficient HVAC are numerous. First are structural or weatherization improvements to the building, including reducing drafts, improving wall, attic and basement insulation, and using better windows and doors. Second is higher efficiency heating and cooling equipment accompanied by properly designed and sized apparatus for distributing either the heated or cooled steam, water or air. Third is equipment that controls relative humidity. The fourth category of efficient HVAC are those controls that maintain small variability in temperature in occupied spaces, suspend conditioning to unoccupied zones, and compensate for outside temperatures.

### 3. Refrigeration

Residential customers in the market for energy efficient refrigeration should look for the ENERGY STAR® label on refrigerators and freezers.

For commercial customers, refrigeration improvements typically treat walk-in refrigerators and freezers with the testing of and fixing door seals and insuring the correct pressure of refrigerant in the compressor.

Industrial processes with refrigeration and freezing components, such as those found in the food processing business, may improve efficiency with better-packaged equipment, design, or components, such as compressors or insulation.

### 4. Hot Water

Efficient hot water equipment uses less heated water to accomplish the same outcome. The deployment of horizontal axis clothes washing machines has realized the biggest reductions in hot

water use. Low-flow showerheads and faucet aerators also lower the use of hot water. Other devices make more hot water with less energy (such as indirect hot water heaters and tankless water heaters[44]) or make hot water using the sun's energy. Finally, buildings achieve more efficient utilization of energy by insulating hot water pipes and water tanks.

#### 5. Motors

Energy efficient motors that run blowers, pumps and industrial processes have higher quality materials than standard motors. Additional efficiency gains arise from using variable speed drives that more closely match the motors' outputs to their loads.

#### 6. Compressed Air

Efficiency improvements to compressed air systems include new compressors, proper sizing and the elimination of leaks.

#### 7. Process

For manufacturers, three features define improvements in process energy efficiency: comprehensive improvements to manufacturing (such that these improvements reduce energy per unit output); systematic improvements to pump systems; and specialty equipment that consume less energy and produce the same output as industry-standard equipment.

#### 8. Facility Manager Training

Sponsored by investor-owned ratepayer-funded programs, a course is available for facility managers. This course assists managers to manage facility energy use more efficiently.

### C. Examples of Energy Efficiency Programs in Concord

CMLP offers four programs that help improve the efficiency of buildings. Two offer rebates—one for compact fluorescent bulbs and the other for ENERGY STAR® appliances. The other two provide energy audits for residential (Residential Conservation Service Program) and municipal buildings.

### D. Survey Results

The CSEP survey findings relating to energy efficiency informs the recommendations in three ways.

First, over 60 percent of respondents agreed or strongly agreed that Concord should perform energy audits for all municipal buildings. One recommendation that follows proposes that the town improve the efficiency of municipal buildings first, if funds for such improvements become available.

Secondly, a slight majority of residents are aware of CMLP's programs that offer rebates for compact fluorescent light bulbs (58%) and ENERGY STAR® appliances (57%). Moreover, 71

44 Indirect water heaters have efficiencies equivalent to that of the boilers. In the winter, they store residual heat after the boiler has warmed the building. Tankless water heaters are either electric, which require a very large electrical service, or gas. The tankless heater is located close to the tap. A home that only used tankless heater would need one for each tap. www.tanklesswater.com

percent look for the ENERGY STAR® label when purchasing appliances. Inasmuch as many compact fluorescents now sell for under $5 on account of manufacturing incentives provided by investor-owned ratepayer-funded energy efficiency programs and that almost three-quarters of the town are probably buying ENERGY STAR® appliances anyway, CSEP recommends in the next section that the Sustainable Energy Advisory Board propose other types of incentives programs for CMLP customers.

Third, a little less than half (47%) agreed or strongly agreed that they had "made energy efficiency changes to my home such as insulating, installing energy efficient appliances and windows, and using fluorescent light bulbs." This may indicate that with some financial encouragement, more residents will improve the efficiency of their homes.

## E. Recommendations

After discussing these programs with the staff of CMLP and taking into account the survey results, CSEP recommends that a Sustainable Energy Advisory Board (SEAB)[45] propose to CMLP how to improve energy efficiency programs that increase installation of energy efficient products. Specifically, the Committee recommends that, through the establishment of a Sustainable Energy Advisory Board, the Town should:

- Undertake a technical potential study to determine the cost-effective energy efficiency and renewable energy opportunities in the town.[46]
- Increase participation and implementation in the comprehensive audit programs that CMLP provides to all its customers.[47]
- Keep records of audit recommendations[48] and of what the customer implemented. These records should also include the reductions in customers' energy consumption as a result of improvements in a building's energy efficiency.
- Establish a program for new construction and major renovation projects that will educate and motivate developers to construct buildings that are more efficient than those built to code.
- Determine financial incentives to help narrow the financial gap between standard and efficient equipment.[49]
- Recommend a budget to the CMLP light board to fund these programs.[50]
- Funding should reflect the demand and success of these programs and may grow over time.
- If demand exceeds funds, CSEP recommends the program services be offered first to municipal buildings, then to low income residents and finally to residential,

45 A recommendation to create a Sustainable Energy Advisory Board is found in the Energy Conservation Section.
46 This study will provide a foundation for designing energy efficient and renewable energy programs for the town.
47 At the public hearing, CSEP heard a strong willingness to make homes more energy efficient, but needed assistance in finding experienced and reliable contractors to do the work.
48 CMLP is in the process of tracking recommendations, but has not had the time to see if and when the customers implemented the recommendations.
49 CMLP currently has about $64,000 devoted to financial incentives. CSEP has suggested that CMLP review these incentives.
50 See the Financial Incentives Section for more information about a Sustainable Energy Fund

commercial, institutional and industrial buildings.

In the design of these programs, the SEAB should consider whether a study should be undertaken to determine how much the Town's overall energy efficiency could be increased, including return on investment for implementing measures to achieve maximum efficiency. Moreover, when considering the level of financial incentives, the SEAB may want to have larger incentives for projects that are replacing equipment that is still operable and lower incentives for equipment that needs replacement.

# VII. Sustainable Buildings

## A. Summary

Sustainable building principles will be discussed in this section along with benefits of applying these principles to new construction and renovating existing structures.

## B. What is a Sustainable Building?

The aim of a sustainable building is to employ energy conservation and energy efficiency strategies to lower the energy demand to the point that renewable energy provides all the building's energy requirements. Accomplishing this goal requires an integrated design process and energy simulation modeling.[51]

The most important consideration is the building's orientation. The long axis of the building should have an east-west orientation in order to maximize the building's exposure to the sun. The building's southern exposure should harvest solar energy for lighting, heating, and electricity. Sustainable buildings use significantly more insulation along with more efficient windows so that outdoor temperatures have a minimum impact on the building's interior. Finally, fresh air coming into the building is either warmed or cooled by the air being exhausted from the building. The energy simulation model measures how the building performs through out the year and informs the designer how to optimize the design for energy management.

Leading design teams can design and construct sustainable buildings for no more money than it costs for those built to code.[52] In fact, a new term for design is the "living building." These living buildings will produce energy and other environmental benefits.

## C. Overview

A sustainable building program has three features: (1) measuring a building's energy consumption and production; (2) making existing buildings sustainable; and (3) ensuring that major renovations and new construction projects have sustainable energy goals.

### 1. Benchmarking

Pursuing a sustainable building campaign requires measuring energy consumption and the production of renewable energy.

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51 Energy Simulation Modeling is computer software. It takes into account all energy related building features such as insulation levels, heating and cooling equipment, window orientation and inside temperature and calculates the energy consumption based on weather conditions that include sunshine, cloud cover and temperature. The more sophisticated program inputs temperature and other weather data at intervals of 15 minutes.

52 Since the early 1990's the Passive House Institute in Germany has built housing that uses one-twentieth the conditioning energy requirements for a house built to code. The total energy consumption is about 10% of normal values. The additional money spent on better windows and insulation comes from savings of lower cost heating and cooling systems. These homes are built in a climate similar to Massachusetts'.

### 2. Existing Buildings

The greatest potential for sustainability is in existing residential, commercial, institutional and municipal buildings. These buildings will become more sustainable in two ways:

- *Incrementally*, through practicing conservation, replacing existing equipment at the end of its useful life[53] with more efficient equipment, installing insulation where practicable and investing in renewable energy technology; and

- *Comprehensibly*, through a one-time retrofit of the entire building with state-of-the-art energy efficiency applications and renewable energy technology.

### 3. New Construction and Major Renovations

The greatest opportunity for sustainability is in new construction and major renovations. The Green Building Council, which developed the Leadership in Energy and Environmental Design (LEED), has been instrumental in motivating developers, architects, engineers, and trades in striving to create more sustainable buildings. LEED provides a system to rate a buildings performance according to energy and environmental criteria.

## D. Survey Results

Fifty-three percent of the respondents agreed or strongly agreed that: "If the Town made a decision to incorporate sustainable building principles into new municipal construction and renovation, such as measures to conserve energy use and reduce energy consumption, (the respondent) would support that decision, even if it cost more at the outset, so long as the savings paid for the increased investment over a reasonable timeframe."

## E. Recommendations

This plan does not make a formal recommendation for a Sustainable Building program. However, the Committee encourages all Town building committees to engage in an integrated design process and examine whether properly orienting a building, increasing levels of insulation, and making thoughtful window selection to determine to what extent the reduction in capital and operating costs for heating and cooling the building would justify these sustainable features.

Moreover, the CSEP Committee supports the Green Team's recommendation that Town building committees should consider using the LEED rating system. Incorporating its rating system into the design process will achieve sustainability goals that go beyond those that focus on energy. These goals include sustainable water use, building materials, land use, and indoor air quality.
The details of the Green Team's LEED recommendation are included in the Appendix.

53 CMLP commented that if considerable energy savings can be realized, equipment should be replaced before the end of its useful life.

# VIII. Sustainable Transportation

## A. Summary

The objective of this section is to examine the Municipal and School District transportation fleets' fuel cost, fuel usage, infrastructure and vehicles to determine how sustainable transportation principals can be applied and the costs thereof.

## B. Municipal and School Districts Fuel Use

### 1. Fuel Contract Information

Both the Town and School Districts have fuel contracts with C.W. Lorden Fuel Corporation (63 Groton St Pepperell, MA 01463-1522). The current fuel contract period for both entities is July 1, 2006 through June 30, 2007. The contract cost for diesel and gasoline is $.0290 added to the posted tankwagon price; thus price varies daily. The Town and school districts have a good opportunity to consider the purchase and use of biodiesel before the current fuel contract expires. See the biodiesel program analysis in this section for more information.

### 2. Fueling Station Information

The Light Plant has one split gasoline and diesel tank that will store 1000 gallons of each. The Public Works Department has one split gasoline and diesel tank that will store 5,000 gallons of each. The Concord Public School District Transportation Department has a 5,000 gallon diesel tank. This information is important to know when considering implementing a biodiesel program. If the Town were to implement a pilot program, a smaller tank such as the one at the Light Plant might be used for this purpose.

### 3. Fuel Cost and Use Analysis

In FY 2006 diesel purchases from both the Town and School districts totaled 91,563 gallons at a cost of $216,601.[54] During that same period the Town purchased 65,472 gallons of gasoline at a cost of $164,401.[55] The average cost per gallon of gasoline was $2.51; the average cost per gallon of diesel was $2.57 for the Town, $2.26 for CPS, and $2.28 for CCRHS.[56] Vehicle fuel costs are considerable and continue to fluctuate; finding ways to get a measurable reduction and control of this operating cost would certainly be meaningful.

The following Town departments had the highest diesel usage; Highway (24%), Snow (21%), CMLP (18%), and Fire (22%). The school districts purchased 61,815 gallons of diesel, 68% of the diesel purchased. The Police department (39%) and CMLP (11%) had the highest gasoline usage of all Town departments. Use of alternative fuels, alternative vehicles such as electric, and higher mileage vehicles could yield a significant savings for many of these departments.

Currently the average miles per gallon achieved by Town owned passenger vehicles is 20 city, 26 highway; SUV - 16 city, 22 highway; truck - 16 city, 21 highway; and van - 17 city, 24 highway.

54 Detailed fuel use data can be found in the Appendix.
55 CCRSD and CPS district's gasoline purchases are included here.
56 Detailed fuel cost information can be found in the Appendix.

With a minimal increase in fuel economy (4 miles per gallon for example) significant savings would be realized.

Because vehicle fuel costs are expected to continue to increase due to the volatility of the petroleum market, it would be advisable for the Town and School Districts to take steps to control cost by reducing consumption, increasing fuel efficiency, to consider fuel alternatives to insure a secure supply, and to consider using alternative vehicles.

#### 4. School Bus Idling Policy

The CPS and the CCRSD currently have a policy limiting the number of minutes school buses are permitted to idle as do most school districts in the U.S. per the recommendations of the Department of Energy. A sample School Bus Idling policy can be found in the Appendix. Significant fuel savings are achieved through the policy, though the Committee did not calculate the exact savings amount. An example of the savings the school districts achieve through this policy follows; if each of twenty buses in a fleet avoids 60 minutes of idling in a year, 1800 gallons of fuel would be conserved. Assuming a $2.50 per gallon fuel cost, $4,500 dollars could be saved annually.

Considering the cost savings the school districts are achieving from their policy, it would be prudent for the Town of Concord to consider implementing a similar policy.

## C. Vehicle Replacement Analysis

A list of Concord's municipal and school district vehicles can be found in the Appendix. The Public Works, Fire, and Police Departments did not provide vehicle information in response to the Committee's request. The Committee obtained data related to vehicles operated by those departments from the Town's list of insured vehicles, and the vehicle analysis is therefore limited.

As the Town's current fleet ages and vehicles begin to reach the end of their useful lives, the Town should consider replacing those vehicles with more fuel efficient models. Each can be replaced with an alternative vehicle, with the possible exception of the COA Aerolite Van. The next known alternative replacement vehicle opportunity is expected to be in 2007.

## D. Fuel Economy Analysis

The average mpg rating for Town, CPS, CCRSD vehicles appears in the following table (based on available data, this does not include all vehicles presently operating).[57]

**Table 5 – Average MPG rating by type of vehicle**

| Type of Vehicle | City | Hwy |
|---|---|---|
| Passenger | 20 | 26 |
| SUV | 16 | 22 |
| Truck | 16 | 21 |
| Van | 17 | 24 |

A 20% improvement in fuel economy would result in an estimated reduction of gasoline fuel usage of 9,900 gallons or $23,562, and an estimated reduction in diesel fuel usage of 15,260 gallons or

57 See the Appendix for a list of the Municipal and School district vehicles with the estimated fuel economy.

$36,167 (based on the average cost for gasoline and diesel for FY 2006). The mpg increase necessary to achieve an overall 20% improvement in fuel economy is only 4 mpg. The Committee understands that an improvement in fuel economy is not possible for all vehicles.

## E. Alternative Fuels

As fleet owners, the Town, CPS, and CCRSD have an opportunity to help drive the biofuels market. The use of biofuels fuels in our vehicles reduces our use of petroleum fuels, and there is a significant particulate matter emission reduction from diesel engines when using biodiesel. Using biodiesel makes budgeting for fuel expenditures easier because it protects the user from price spikes in the international oil markets. The price of biodiesel fluctuates far less than regular diesel. One biodiesel supplier stated their price fluctuated only 18 cents over a 12 month period. Most of that fluctuation was the result of higher feedstock prices during the winter months and can be accounted for in contracts in advance.[58]

With the introduction of the 2005 Federal Biofuel Production tax incentives, the supply of biofuels is expected to increase to meet the market demands. The new tax incentives are expected to be passed on from the producers to the consumer, thereby increasing the supply and reducing the cost of the fuels.

### 1. Biodiesel

Blended biodiesel up to 20 percent can be used in diesel engines with little or no modification. Biodiesel is widely available, simple to use, biodegradable, and nontoxic. Because it is and effectively free of sulfur and aromatics it is better for the environment when compared to petroleum diesel. Biodiesel has been shown to prolong the life of engines and decrease maintenance costs because it burns cleaner and its lubricating properties are better than petroleum diesel. No change to the existing diesel refueling infrastructure is required to store biodiesel. Biodiesel that meets ASTM D6751 standard is registered with the EPA and is a legal motor vehicle fuel for sale and distribution.[59]

The market price of biodiesel fluctuates and can cost 10-20 cents more per gallon (for a 20% blend with regular diesel). Biodiesel prices for low-level blends (B-2 to B-5) are about the same as regular diesel. Pure biodiesel (B-100) can cost 59 cents more per gallon at than regular diesel.[60] Jeff Bursaw, a local biodiesel retailer reported that in early August 2006, his cost for biodiesel was .07 cents less than regular diesel. At that time, he was selling B-10 at a retail cost of $2.619, B-20 for $3.049, B-100 for $3.149, and regular diesel for $3.11.[61]

School buses fueled with biodiesel give schools the opportunity to be renewable energy leaders. The buses also offer public relations rewards and can be tied to a school district's environmental and renewable energy curriculum.[62]

Biodiesel retail suppliers are listed in the Appendix.

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58 National Biodiesel Board, www.biodiesel.org, www.nbb.org.
59 National Biodiesel Board, www.biodiesel.org, www.nbb.org
60 September (2005) Department of Energy, "Clean Cities Alternative Fuel Price Report," available at www.eere.energy.gov/afdc.
61 For more information on setting up and on site biodiesel fueling station see: http://www.eere.energy.gov/afdc/infrastructure/bio_resources.html.
62 EPA Clean School Bus USA program.

### 2. Ethanol

In the U.S., most ethanol is made from corn. The use of ethanol as an alternative fuel can help reduce the demand for gasoline, however, ethanol yields fewer miles per gallon than gasoline. For example, a vehicle that averages 20 miles per gallon using conventional gasoline would average only 14.2 miles per gallon using E85, a gasoline ethanol blend.[63]

At the time of this writing there are no E85 retailers in Massachusetts.[64] One other drawback of ethanol as a motor fuel is that it has a delivery problem because it attracts water, which prohibits it from being transported through pipelines. If water is introduced to fuel it can cause mechanical problems. These two issues preclude ethanol from being a viable alternative fuel alternative here in Concord at this time, therefore the Committee cannot recommend its use.

### 3. Biobutanol

Biobutanol can be derived from sugar-beets, corn, other organics or waste biomass and is made much the same way as ethanol. Biobutanol has several advantages over ethanol as a fuel component; it generates more miles per gallon and can be shipped though a pipeline as it does not attract water. [65] Though not confirmed, this fuel can reportedly be used gallon for gallon in place of gasoline.

Scientists are working to develop a new process to produce biobutanol economically even if oil prices fall into the $30 per barrel range. DuPont and BP have stated that this new biofuel will be available in the U.S. by 2010.[66] This is a fuel to watch for in the near future.

## F. Hybrid, Flex Fuel, Diesel, Electric, and High Mileage Vehicles[67]

### 1. Hybrid Vehicles

Most hybrids marry a gasoline engine with electric motors. They recapture braking energy as battery power, shut down the engine at stops and can operate at low vehicle speeds on battery power alone. Operating costs for hybrid vehicles have been shown to be lower than standard internal combustion engines, both in fuel savings and in maintenance costs.[68] A more fuel efficient two-mode hybrid technology is expected to be utilized in vehicles available in late 2007. The two-mode technology not only offers enhanced fuel efficiency in stop-and-go city traffic but also on the highway and is expected to produce a 25 percent improvement in combined mileage of standard models.[69]

There are a few vehicles that are equipped with automatic fuel-saving modes. These vehicles automatically shift to fuel conserving modes which turn off the air conditioner when the temperature is stable and can shut down cylinders to save fuel. Some of these vehicles have an "ECO" indicator that lights up when the vehicle is meeting or exceeding EPA fuel ratings.[70]

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63 For more information about fuel economy go to the US DOE website; www.doe.gov.
64 For more information about E85 retailers and suppliers go to the U.S. DOE Alternative Fuel locator: http://afdcmap2.nrel.gov/locator/findpane.asp or go to http://www.e85fuel.com.
65 http://www.dupont.com/ag/news/releases/BP_DuPont_fact_sheet_Biobutanol.pdf.
66 http://www.dupont.com/ag/news/releases/BP_DuPont_fact_sheet_Biobutanol.pdf.
67 A list of Hybrid, E85, Diesel, Electric , Fuel Cell and High Mileage Vehicles can be found in the Appendix.
68 www.fueleconomy.gov
69 Scientific American Magazine, August 2006
70 Scientific American Magazine, August 2006

A subsidiary of Navistar International Corporation ("IC") has partnered with Enova Systems, Inc. to develop a school bus that can attain an approximate 40 percent increase in fuel economy. Widespread production on the model is expected in 2008. IC and Enova have determined that the hybrid will save up to 40 percent of the costs of diesel fuel over the 12-year life cycle of the bus. The tradeoff is that the current up-front cost is approximately two-and-a-half times that of the average $80,000 price tag on regular, full-size diesel school buses, coming in at $200,000 a piece. However, there are federal funding sources that can help offset the higher cost of the vehicle.[71]

Hybrid vehicles are a viable option for improving mileage, but their higher cost may make this type of vehicle less attractive. See the Appendix for a list of hybrid vehicles and the tax credits available for these vehicles.

### 2. Flex-Fuel Vehicles

Flex-fuel vehicles (FFV) have a single fuel tank, fuel system, and engine. The vehicles are designed to run on regular unleaded gasoline and an alcohol fuel (either ethanol or methanol) in any mixture, for example, 100% gasoline, E85 (85% ethanol, 15% gasoline), or M85 (85% methanol, 15% gasoline) or any combination of these fuels.[72] As E85 is currently not available for sale in Massachusetts, this type of vehicle is not a viable choice at this time. See the Appendix for a list of flex-fuel vehicles.

### 3. Diesel Vehicles

The benefit of diesel fueled vehicles is that they are more fuel efficient (more miles per gallon) and they can utilize biodiesel as an alternative fuel. All diesel vehicles can use biodiesel as an alternative fuel with little or no modifications.[73] Diesel engine vehicles can be considered a viable option, however, most diesel vehicles cost some what more than gasoline motor vehicles. However, a diesel vehicle not utilizing biodiesel can have higher NOX and particulate emissions than a gasoline powered vehicle. See the Appendix for a list of diesel vehicles.

### 4. Electric Vehicles

Electric drive systems are virtually non-polluting and extremely energy efficient. Compared to gasoline powered vehicles, electric vehicles are far more energy efficient. Approximately 20% of the energy in gasoline translates to power that reaches the wheels of an internal combustion vehicle, 75% or more of the energy from a battery powered vehicle reaches the wheels. Battery energy storage capacity and the availability of recharging stations limit the opportunities for electric vehicle use at this time.[74]

There may be a real opportunity to utilize electric cars in the Town and school district's fleets for those passenger vehicles used in and around the Town of Concord. The purchase price for most of these vehicles is under $10,000 and the operating costs are very low. Minimal additional research would be required to determine the feasibility of this type of vehicle. See the Appendix for a list of electric vehicles.

CMLP alerted CSEP to plug-in hybrid vehicles. This is a new type of vehicle being promoted by the American Public Power Association. It has a larger energy storage battery capacity, but still

71 www.enovasystems.com
72 U.S. Department of Energy, Energy Efficiency and Renewable Energy web site: http://www.eere.energy.gov
73 U.S. Department of Energy, Energy Efficiency and Renewable Energy web site: http://www.eere.energy.gov
74 www.fueleconomy.gov

contains a gasoline engine. This larger storage capacity results because the battery can be charged at home at night using off peak energy. Since there is a gasoline engine in the vehicle, recharging stations are not necessary. More information can be found at the American Public Power Association's website www.appanet.org <http://www.appanet.org>. CMLP has signed on to be a Plug-in Partner.

#### 5. Higher Mileage Vehicles

There is an opportunity for the Town to replace some existing vehicles with vehicles that offer higher fuel efficiency ratings. These vehicles are reasonably priced and offer excellent fuel economy. Prices for these vehicles start at $10,950 and offer city mpg ratings of 27-34 and highway mpg ratings of 33-40. See the Appendix for a list of higher mileage vehicles.

#### 6. Fuel Cell Vehicles

Although they are not expected to reach the mass market before 2010, fuel cell vehicles (FCVs) may someday revolutionize on-road transportation. This emerging technology has the potential to significantly reduce energy use and harmful emissions, as well as our dependence on foreign oil. Concord should stay apprised of this developing technology. See the Appendix for a list of fuel cell vehicles.

## G. Biodiesel Fuel Program

The following is an analysis of the cost for implementing a B-20 biodiesel fuel program in Concord. The estimated program costs have been broken down by Town and by the two school districts. A pilot program might be a viable option to help determine if this fuel option makes sense. A pilot program could be implemented at a department level or at the school district level. There are some funding opportunities available which may make this a more viable option. These funding opportunities include infrastructure reimbursements as well as fuel producer tax incentives that are intended to be passed on to the biodiesel consumer.

**Table 6 – Biodiesel Program Cost Comparison**

| Model | Town | CPSD | CCRSD | Total | Cost Difference Diesel/ Biodiesel | % Differen |
|---|---|---|---|---|---|---|
| **Diesel $2.37 per gallon[75]** | | | | | | |
| **Gallons[76]** | 29,748 | 37,327 | 24,488 | 91,563 | | |
| **Cost** | $76,584 | $84,285 | $55,732 | $216,601 | | |
| **Model # 1 $2.47 per gallon[77]** | | | | | | |
| **Cost** | $73,478 | $92,198 | $60,485 | $226,161 | $9,560 | 4.41% |
| **Model # 2 $2.57 per gallon[78]** | | | | | | |
| **Cost** | $76,452 | $95,930 | $62,934 | $235,317 | $18,716 | 8.64% |
| **Model # 3 $2.437 per gallon[79]** | | | | | | |
| **Cost** | $72,496 | $90,966 | $59,677 | $223,139 | $6,538 | 3.02% |

The biodiesel program cost variance for these three models demonstrate a cost increase over regular diesel ranging between 3.02% and 8.64%. At the time this report was drafted, price fluctuations in diesel and biodiesel fuel made it very difficult to estimate the actual cost of a biodiesel program. The purpose of these three models was to show the difference between a diesel program's actual costs versus estimated costs based on U.S. government department guidelines and to get a better idea of what the actual cost of implementing a biodiesel fuel program would be.

The Keene N.H. biodiesel program was included in this analysis as they have successfully implemented a biodiesel program.[80] Also note that Keene, N.H. purchases 7,000 gallons of B-20 per week versus approximately 3,000 gallons of diesel fuel purchased per week in Concord. Their cost will be lower due to higher volume purchases. Concord may want to consider soliciting a joint B-20 bid with an adjacent town(s) to get a better price per gallon or biodiesel can be purchases through the State contract which might offer a lower price. The reality is that the true costs for a biodiesel program will not be known until the contract bidding process occurs. It is important when soliciting bids for a biodiesel program that the wholesaler be required to pass on the biofuel production federal tax credit of $1.00 per gallon of biodiesel through to the Town (the consumer).

75 Average cost per gallon FY 2006 for Municipal, CPS and CCRHS diesel purchases.
76 Gallons of diesel fuel purchased FY 2006.
77 Department of Energy's 2005 "Clean Cities Alternative Fuel Price Report," guide of .10 cents more per gallon for biodiesel.
78 The National Biodiesel Board's guide to add one cent per gallon for each percent of biodiesel blended with regular diesel.
79 Keene, NH B-20 cost per gallon (8/9/2006) $2.22 plus $.0235 Mass. State Fuel Tax. Municipalities in New Hampshire are excluded from paying the state fuel tax. The fuel tax is included in the other cost models.
80 For more information about Keene's biodiesel experience see the H. Other Communities Experiences with Biodiesel Fuel section.

## H. Other Communities Experiences with Biodiesel Fuel

**Cambridge, MA**

John Nardone is the Assistant Commissioner of Public Works in Cambridge, his experience with a pilot biodiesel program follows. Cambridge had a biodiesel pilot program but suspended its use of B20 in the fall of 2005 due to price increases. At the time they were facing about a $1 per gallon premium for biodiesel and given the general increase in energy costs, the cost became too high. Part of the problem was timing. They had a contract in place for conventional diesel which had a quite favorable price and then they sent out a bid for a new B-20 contract just as prices were peaking.

The Spring of 2006 Cambridge sought bids for diesel and biodiesel again. They were working with other towns on a joint bid coordinated by the Town of Brookline. The bid came in with conventional diesel price of $2.6542 per gallon. Their bids show a .30 cent premium for B-20. Cambridge hasn't resumed using B-20 as they are looking at about a .61 cent per gallon increase in diesel compared to their last contract.

**Keene, NH**

Steve Russell is the Fleet Superintendent for the City of Keene, New Hampshire; his experience with biodiesel follows. Keene's biodiesel program started July 1, 2002. The fuel is used in 68 vehicles and equipment including fire trucks. In the four years of using biodiesel, no fuel related problems have been reported. Their experience has been a very positive one.

At the time of this writing he stated that their cost for biodiesel is currently 5 cents per gallon more than regular diesel at a cost of $2.22 per gallon for B-20. Note, in New Hampshire, municipalities are exempt from state fuel tax, thereby lowering their biodiesel program cost.

Mr. Russell has generously offered to come and speak to us in Concord about his experiences with their biodiesel program.

## I. Survey Results

The results of question number 35 in the Citizen Survey show that 80% of the citizens would support a policy that requires replacement vehicles to achieve a minimum mpg rating or the use of biofuels.

## J. Recommendations

- State Senator Susan Fargo has been asked to consider introducing legislation to eliminate the tax on biofuels as an incentive to increase their use in the Commonwealth. This legislation would reduce the cost of biodiesel by 23.5 cents per gallon. The Town should support any such legislation.

- Implement a Town vehicle idling policy similar to the policy already in operation at CPS.

- Implement a minimum mileage guideline for new vehicle purchases. The guideline should be based upon different types of vehicles and their use. A performance measure requiring an overall decrease in vehicle fuel consumption by 20% within 5 years would be used to insure the implementation and compliance of the measure. The Committee understands that it may not be technically or economically viable to reduce the fuel consumption for all vehicles. The following table shows examples of mileage guidelines and the average MPG rates for existing Town and School District vehicles: [81]

**Table 7 – Vehicle Mileage Guideline**

| Type of Vehicle | Current Avg MPG City | Current Avg MPG Hwy | Suggested MPG City | Suggested MPG Hwy |
|---|---|---|---|---|
| Passenger Car | 20 | 26 | 24 | 30 |
| SUV | 16 | 22 | 20 | 26 |
| Truck | 16 | 21 | 20 | 25 |
| Van | 17 | 24 | 21 | 28 |

- Implement a biodiesel program for Town and school district diesel vehicles.

- Promote the Biodiesel Program by placing bumper stickers on vehicles using biofuels, "Fueled by Biodiesel."

81 A list of the Municipal and school districts vehicles with their estimated mpg rating can be found in the appendix.

# IX. Funding Opportunities and Financial Incentives

## A. Summary

This section summarizes the energy efficiency and renewable energy funding opportunities and financial incentives available to residents, businesses, the Town and the School Districts.

> See the Appendix for detailed information about all the financial and funding opportunities discussed in this section.

There are many financial incentives currently available to the residential and commercial sector for energy efficiency and renewable energy projects and purchases. Making these incentives known to the public appears to be the most challenging aspect of increased utilization.[82] The majority of these incentives and funding opportunities are easy for consumers to take advantage of.

### 1. Residential

- At the local government level, property owners with solar, wind and hydropower systems used for the purpose of heating or supplying the energy needs of taxable property, qualify for a limited property tax exemption.

- The Massachusetts Energy Consumers Alliance (Mass Energy), a non-profit organization in Boston purchases renewable energy certificates (also known as green tags) from renewable energy systems in Massachusetts and Connecticut. These certificates are used to promote renewable energy; the cost of these certificates is tax deductible.

- The Commonwealth of Massachusetts offers personal income tax deductions, tax credits and sales tax exemptions to promote energy efficiency and renewable energy.

- The federal government offers tax deductions, tax credits, and funding opportunities for such things as energy improvements to the building envelope, renewable energy projects, alternative vehicles, and energy efficiency mortgages.

- Concord Municipal Light Plant offers rebates for compact florescent bulbs and energy efficient appliances.

- Keyspan Energy Delivery (natural gas supplier) offers rebates for energy efficient windows, programmable thermostats, and weatherization.

82 See the Community Education Section of this report for information about improving resident's knowledge of these incentives.

### 2. Commercial

- At the local government level, property owners with solar, wind and hydropower systems used for the purpose of heating or supplying the energy needs of taxable property, qualify for a limited property tax exemption.

- The Massachusetts Energy Consumers Alliance (Mass Energy) and Peoples Power and Light (PP&L) are offering to purchase renewable energy certificates at a rate of $60 per Megawatt-hour (or $.06 per kWh) for a period of three years for PV systems installed after 1998.

- The Commonwealth of Massachusetts offers income tax deductions, tax credits, excise tax credits, and sales tax exemptions to promote energy efficiency and renewable energy. Additionally, the Massachusetts Green Power Partnership (MGPP) provides financial assistance to stimulate private investment in the construction of new clean electric-generating facilities in Massachusetts.

- The federal government offers depreciation deductions, tax deductions, tax credits, and funding opportunities for such things as energy efficient buildings, renewable energy projects, manufacturing of energy efficient appliances, renewable energy production, alternative fuel infrastructure, and producing biofuels.

- Concord Municipal Light Plant offers rebates for compact florescent bulbs and energy efficient appliances.

- Keyspan Energy Delivery (natural gas supplier) offers rebates for the installation of solar thermal technologies, natural gas efficiency projects, and installation of high efficiency gas and water heating equipment.

### 3. Municipal

There are various financial incentives currently available to the Town of Concord and the Public School Districts for energy efficiency and renewable energy projects and purchases. The funding is available from the State of Massachusetts, the Federal Government, and from organizations that promote renewable energy. The majority of these incentives and funding sources require some investment in resources (grant writing) to reap the benefits.

- The Massachusetts Energy Consumers Alliance (Mass Energy) and Peoples Power and Light (PP&L) are offering to purchase renewable energy certificates at a rate of $60 per Megawatt-hour (or $.06 per kWh) for a period of three years for PV systems installed after 1998.

- Massachusetts Green Power Partnership (MGPP) provides financial assistance to stimulate private investment in the construction of new clean electric-generating facilities in Massachusetts.

- The federal government offers renewable energy production incentives, funding opportunities for school buses, funding to help address energy priorities, and support to adopt practices that contribute to the reduction of petroleum consumption.

- Concord's Community Chest may have funds available for environmental educational opportunities.

## B. Survey Results

The results of the Citizen Survey show that 85% of those surveyed supported a surcharge on their CMLP bill to fund sustainable energy projects. Of those in favor of the surcharge, 80% would support a surcharge of 2.5%. The results of the survey also showed that 62% of residents would support a property tax to fund sustainable energy projects. Of those respondents that supported a property tax surcharge, 64% would support a surcharge of 2%.

## C. Recommendations

- There are two options to finance a Sustainable Energy Fund based upon the results of the Citizen Surveys, a real estate surcharge or an electric bill surcharge. The following is an analysis of the two options. The survey results show stronger support for Option 2, a surcharge on CMLP electric bills. The analysis indicates Option 2 has a lower cost to residents and a higher yield when compared to Option 1. Therefore, the Committee is recommending Option 2, a surcharge on CMLP electric bills, to generate revenue for a Sustainable Energy Fund.

  **Option 1: Taxable Real Estate Surcharge**

  There are several options to choose from for this surcharge. The following is the estimated yield of a surcharge based on the FY 2006 Budgeted Property Tax of $53,273,087.

  - A .5 % surcharge would amount to $266,365 per year (A lower surcharge could be used to finance the debt on a project.)
  - A 1% surcharge would amount to $532,731 per year
  - A 1.5% surcharge would amount to $799,096 per year
  - A 2% surcharge would amount to $1,065,462 per year

  A resident with a home valued at $500,000 could expect to pay an additional $250 per year if the surcharge was set at .5 percent.[83]

83 Based on the FY 2006 property tax rate of $10.23 per thousand dollars of assessed valuation.

This surcharge would be used to fund municipal sustainable energy projects including energy efficiency, energy conservation, and renewable energy projects within the Municipal town limits. Projects for consideration would be proposed by the Sustainable Energy Advisory Board based upon the Town Manager's instruction for projects that offer the best return on investment.

Projects would be voted upon and approved at the Town meeting similar to the process the Community Preservation funds are approved for expenditure. The surcharge would be in place for five years at which time a vote would take place at the Town meeting to determine if the surcharge should continue. Continuation of the surcharge would be voted upon every five years until such time as it is voted down. The surcharge could be set up to increase from .5 % to 1.5% over a 3 year period. The funds would be held in an escrow account.

**Option 2: CMLP Electric Bill Surcharge**

There are several options for this surcharge, which would be used to fund sustainable energy projects. The following estimated yield of surcharges is based on CMLP FY 2006 total amount billed of $16,298,994.

- A .5 % surcharge would amount to $81,494
- A 1% surcharge would amount to $162,990
- A 1.5% surcharge would amount to $244,485
- A 2% surcharge would amount to $325,980
- A 2.5% surcharge would amount to $407,475

A residential rate payer with an average of 750 kWh used per month would see an increase of $2.36 per month if a 2.5% surcharge were approved.[84]

To assure the equitable distribution of funds amongst CMLP customers, funding could be distributed in the following manner.

- A percentage of the funds would be used for Municipal energy conservation, energy efficiency and renewable energy projects.
- A percentage of the funds made available to low income residential customers with required income verification.
- A percentage of the funds made available to all residential customers no income verification would be required.
- A percentage of the funds would be made available to commercial customers.

All surcharge funds would be held in an escrow account. The CMLP Board and a Sustainable Energy Advisory Board would jointly recommend and approve the CMLP renewable energy projects to be funded through this surcharge.

84 Based on a cost of 12.61 cents per kWh, the average cost per kWh for a residential bill dated October 10, 2006.

**Building Permit Fee Waiver**

- Eliminate the residential and commercials building permit fees for sustainable energy projects (eliminate the fee, not the requirement for a permit or inspection). This includes but is not limited to solar heating, solar water heating, solar electricity generation, geothermal heat pumps, wind electricity generation, fuel cells, and energy efficiency updates to a building's envelope such as installing energy efficient windows.

# X. Community Education

## A. Summary

This section discusses the Sustainable Energy Advisory Board's (SEAB), a committee recommended in the Energy Conservation Section, role in providing educational information to residents regarding energy conservation, efficiency and renewable energy. Promoting energy conservation and efficiency through the Concord Conserves program is also discussed.

## B. Energy Conservation

Although numerous energy providers deliver heating fuels via truck and pipeline within the Town of Concord, most residential and commercial properties obtain electricity from the Concord Municipal Light Plant (CMLP). One of the key methods to convey information to Concord residents is to include usage information on the bill from the CMLP. Just as energy efficiency rating graphs help consumers make educated purchases when shopping for appliances, residents can view their energy consumption in comparison to minimum and maximum usage of similar users in town (residential, commercial). See the Current Energy Consumption Patterns Section for more information regarding this topic.

Additional information that might be included on the bill, such as heating degree days[85] and cooling degree days[86], will assist residents in viewing their electricity usage patterns. The Committee recognizes, however, that the types of data that can be added to the CMLP billing statement may be limited due to the capacity of the legacy billing system and the proprietary nature of the software.

## C. Energy Efficiency

The SEAB educational outreach mission should include a regular column in the Concord Journal (monthly or quarterly) highlighting energy conservation methods, energy conservation rebates, energy alternatives (walking instead of driving, air drying dishwasher loads, use of seasonally appropriate attire including thermal underwear in cooler weather), new technology developments (biofuels, fuel cells, nanotechnology, etc.) and drawing attention to the fact that as people reduce energy use, they also reduce emissions.

Taking advantage of the multiple media outlets in town, the SEAB can leverage resources to advocate for sustainable energy programming on the local public access television station, Concord Carlisle Television channel 8. Volunteer time is required to research available programming that can be shown with minimal or no licensing fees on the station, but once identified, these programs can continue in regular rotation on the broadcast programming schedule. In addition, SEAB committee members may have an interest in producing their own documentaries to highlight the CSEP message.

85 The cumulative number of degrees in a month or year by which the mean temperature falls below 18.3°C/65°F.
86 The cumulative number of degrees in a month or year by which the mean temperature is above 18.3°C/65°F.

## D. Renewable Energy

Recognizing the global effort underway to promote energy conservation, encourage emerging technologies and support fledging sustainable energy production, it is advisable for the SEAB to partner with field leaders to increase the educational and economic opportunities available. Mass Energy, for example, is a leading non-profit consumer alliance involved in conservation and sustainable energy development. Through their activities, such as trips to Hull's wind turbine installation, residents can gain first-hand knowledge of sustainable energy technology in order to expand the knowledge base supporting these technologies. Demand for sustainable energy sources, and support for CMLP to seek sustainable source energy production might grow as a result.

Working with the Concord-Carlisle Regional School District (CCRSD), SEAB members can develop grade-appropriate education workshops to inform and motivate teachers and students on methods to conserve at school and at home. The forum for SEAB's engagement might be speaking to an entire school group in an assembly setting, or meeting with teachers on a professional day to discuss how to incorporate sustainable energy/ energy conservation in a curriculum, or working with the schools' science teachers/specialists to affect the curriculum. The U.S. Environmental Protection Agency might be a source of funding for development of curricula under their Environmental Education Grants Program (http://www.epa.gov/ne/ra/ed/edgrant.html).

CCRSD approved posters can be posted at all school buildings to foster energy conservation messages and behaviors both at school and at home.

Through a myriad of educational outreach opportunities, SEAB can engage residents and relay pertinent information that might otherwise be unreported. For instance, the average American household generates the equivalent of 4 ½ Olympic sized swimming pools of carbon dioxide per year, whereas the average British household generates less than half that amount[87]. With the USA containing 4% of the world population but using 25% of the earth's natural resources and contributing close to 30% of total greenhouse gas emissions[88], SEAB's educational outreach can play a significant role in matching educated residents with the opportunities to bring their usage patterns into a more sustainable balance.

## E. Survey Results

The survey results show that 60% of residents are interested in learning how to reduce their energy use and 85% stated they would be more inclined to conserve energy if they were more aware of their use. A significant number of residents stated they would utilize information about energy conservation, energy efficiency and renewable energy if it were readily available.

87 BP Global, http://www.bp.com/iframe.do?categoryId=9008641&contentId=7016686
88 Boston Globe, June 28, 2006. p 18

## F. Recommendations

The CSEP Committee is making the following recommendations to educate our community regarding the benefits and costs associated with energy conservation, energy efficiency and renewable energy.

- The Committee recommends that the Town provide funding in the amount of $3,000 per year to the Concord Conserves program which is operated by the Public Works and Light Plant. These funds would be used to promote energy conservation and energy efficiency and for community education purposes.
- The Committee recommends that CMLP provide comparative data on customer bills to give customers the ability to gauge their electrical usage.
- There is a community based initiative in Concord to increase awareness of global warming; the Committee recommends that the Town support this effort. Specifically, the Committee asks the Town to provide any and all information requested to establish a baseline of Concord's carbon footprint. This baseline information will be used as part of an International Council for Local Environmental Initiatives (ICLEI) effort.
- The Committee recommends that regular articles be published in the Concord Journal to highlight energy conservation tips, conservation rebates, energy alternatives, and new technology as it develops.
- When defining the charge for the SEAB, include the responsibility for coordinating community education efforts such as those described above.
- The Committee recommends that programs with a sustainable energy/energy conservation theme be broadcast on the local public access station, CCTV Channel 8.
- An onsite fuel cell would offer a significant educational opportunity to students at the high school. There may be funding opportunities through Concord's Community Chest for such a program.