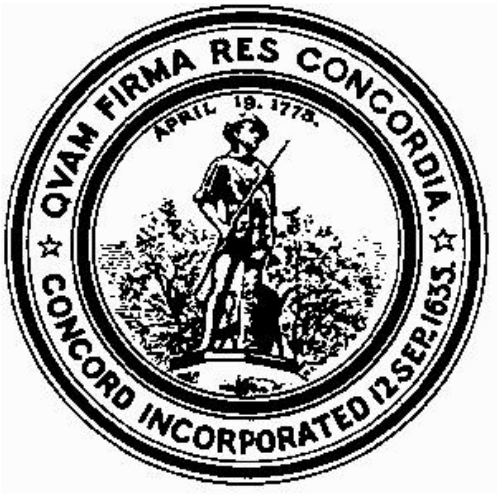

Concord Energy Master Plan

Developing a Future Based on Sustainable Approaches to Energy Resources in the Town of Concord

Comprehensive Sustainable Energy Committee
Concord, Massachusetts

Version 1

CSEC
2/25/2011

Table of Contents

Forward

This document delivers on our commitment to provide the Concord Board of Selectmen with goals and plans on energy sustainability, efficiency, and related environmental challenges.

This document will be updated from time-to-time and most likely a minimum of once per year. As this is the first time a document like this on energy & sustainability has been written in the Town of Concord, it's very likely to change substantially over time. As such, in many ways, it's a work in progress. Any input you choose to provide will be welcomed.

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Introduction

The purpose of this document is to provide information on sustainable energy and energy efficiency to enable Concord citizens to make informed policy choices over the next few years. Concord has a long history of accomplishments with conservation through its focus over the years on wetlands, forests, open space, agriculture preservation, zoning, and long-range planning. Through the Comprehensive Sustainable Energy Committee, this commitment to Concord's future is extended to include the responsible and sustainable use of energy.

The document starts by exploring activity at the Federal and Commonwealth of Massachusetts levels to provide a higher-level context for activity in Concord, as these emerging policies should influence our approach to the sustainability goals established by Concord's Board of Selectmen. The document explores Concord Municipal Government and Concord Schools' resources. Other areas include residential energy (heating and electricity), CMLP policies and strategy, renewable resources, community planning, and trash & recycling.

After adoption by the CSE Committee, this document can be viewed as an energy 'master-plan' but it will always be a work in progress. As such, we will not address all areas in the initial versions but will build-out a more complete plan as our understanding of our problems and opportunities evolve. Some sections of the report are incomplete and others need to be expanded (e.g. the review of the Commercial Segment). These areas will be pursued in Phase II and beyond as this evolves.

More importantly, that this document is intended to provide a roadmap to advance us to a point where we have:

- A mechanism for measuring energy consumption in all sectors of the community
- A set of metrics that provide visibility to the progress of the Committee and the Town in the areas of energy conservation, efficiency, and renewable energy
- A partnership with National Grid that enables us to pursue joint goals
- A partnership with the School Committee and the Concord Public Schools
- A set of recommended goals for the Selectmen and Town Manager for sustainable energy practices for all segments of the town.
- A set of tools for the education of the public about the importance of sustainable energy practices
- Close collaboration with the Concord Municipal Light Plant to develop and promote sustainable energy practices
- Plans with each of the Town's Divisions and Departments to develop and promote sustainable energy practices

Summary of Recommendations

The summary of recommendations surfacing in this report are listed below. As this effort is ongoing, you should expect these recommendations to change over time. Some of the recommendations have been implemented, others are in process, and others are still being discussed. For a more complete discussion of each recommendation and to understand the context, please read the report.

Annual Reporting

CSEC will provide annual tracking and updating of key energy and emissions statistics and metrics across all three primary Concord segments. Energy Master Plan to be updated each year, starting in 2011. (Baseline was established for 2008; same process to be followed for 2011 and beyond.)

Electricity

Sustainable Energy Committee would like consideration for the following goals and policies by the CMLP and CMLB (three-legged stool consisting of renewables, demand management, and conservation):

- Establishment of a Renewable Electricity Energy Plan for Concord. CSEC supports the establishment of a specific, quantifiable goal for renewable energy as a percent of Concord's purchased power. (In November, 2010, the CMLB has established a goal to obtain *30% of Concord's electricity portfolio from renewable energy sources by 2020*.)
- Establishment of a set of goals and plan to manage demand (capacity). This plan should focus primarily on the use of the Smart Grid and will require the following:
    - Specifications to guide development Smart Grid in upgrades to existing buildings and for new buildings.
    - New products and offerings to provide incentives to Concord residents and businesses to become Smart Grid customers. For example, we may want to offer a price concession (or 'price signal') to encourage customers to sign-up for Smart Grid control of air-conditioner thermostats during possible peak power periods. And, new Smart Grid products/pricing will be needed to support new requirements such as electric vehicles and off-peak charging.
    - Introduction of new technologies for Peak Shaving. For example, ice-based storage to augment Freon-based compressors in municipal and commercial buildings. This could be used as a pilot or demonstration project to prove-out these technologies for this area.
- Establishment of a conservation strategy and a set of goals and plans to reduce kWh consumption in the residential segment that focuses on the following capabilities:
    - Tiered-pricing: Using tiered pricing to flatten demand for heavy consumers of residential energy and to encourage users to migrate use patterns to the lower tiers.. (Tiered pricing is already in use by the CMLP.)
    - Consumption-based comparisons in billing: Installation of software at the CMLP to provide comparative feedback to users on relative energy use - comparisons to other similar users, comparisons to median & mean, etc. Normative data help people make behavioral changes, once they understand the extent to which that may compare unfavorably with their peers.
    - Efficiency: Continued focus on incentives for more efficient lighting and appliances

Natural Gas

Through CSEC, the Town of Concord will continue to develop its relationship with National Grid to ensure access to their technical expertise, programs, and rebates. More importantly, given that the carbon-to-energy ratio for is better for natural gas than for oil (40% less CO2 per BTU for natural gas), we should migrate our heating systems from gas to oil on an opportunistic basis and look for ways to make this easier and less costly for residents and business users.

Establishing a Strategy for the Municipal Segment

- CSEC will work with the TM and BOS to gain commitment to a reduction in municipal building and streetlight energy of 20% by 2015. (Note: In August, 2010, Concord's BOS and TM agreed to adopt 20% reduction goal for 2015).
- Integrated design team: While Concord has adopted the Stretch Code, we also need an integrated design team approach on all new buildings and on all enhancements to existing buildings that have any effect on energy or water consumption.
- Municipal buildings' efficiency:
    - Complete initiatives to weatherize all of the Town's 'older' municipal buildings (weatherization initiative is currently in process.)
    - Complete lighting efficiency initiative throughout all of the Town's municipal buildings (lighting efficiency initiative is currently in process).
    - Heating Plant Review: Complete technical evaluations of selected, older heating plants in our public buildings (several boilers have been updated, others are TBD).
- Renewable Energy: Support efforts to develop rooftop solar on municipal buildings.
- Smart Grid: Ensure Smart Grid compliance for all of Concord's municipal buildings.
- Municipal Energy Reporting & Control System: Complete the installation of Peregrine's Mass Energy Insight from the DOER to measure the effectiveness of our energy initiatives (Installation of Mass Energy Insight is in process.)
- Energy Plan and Energy Policy: CSEC to work with the Town Manager and Town Department Heads to roll-up all goals, plans, and initiatives into a Municipal Energy Plan and Municipal Energy Policy. The next steps should include two action planning teams: one for the Town and a second for the Schools. The plans should include the measureable goals, along with a high-level view as to actions and budget requirements for a 5 year time horizon, along with a more detailed set of action plans covering the next two years.

Residential Energy

- Home Energy: Pursue an end-to-end home energy efficiency initiative in the residential segment. This will need to include easy access to quality energy and building envelop audits as well as support for those who choose to proceed with upgrades. (A pilot Residential Energy Conservation program was completed in 2010 by the Towns's Environmental Officer.)
- Natural Gas Conversions: The second recommendation is to explore a partnership with National Grid to move customers from oil to natural gas, as new gas furnaces are more efficient than oil furnaces, the CO2 footprint is 40% smaller, and natural gas is cheaper and more plentiful. This initiative could provide information on the attractiveness of natural gas along with the process that needs to be followed if someone wants to convert. A second step could be the streamlining of the process.
- 'Normative' energy billing: As discussed under the chapter on electricity, providing CBLP billing which indicates comparisons to one's peers in the community is useful in changing behaviors and reducing energy consumption. Savings of 1-3% can be realized through this strategy.

Commercial Segment

The commercial segment is an area that requires focused attention to determine the strategy, initiatives, the resources, the incentives, and the metrics for a successful approach to the use of energy in Concord's commercial segment. This should be a focus area for CSEC in 2011.

Municipal Solid Waste

CSEC has requested a meeting with the Public Works Commission to discuss Municipal Solid Waste issues and impacts on energy.

Community Education

One area of focus in 2011 for CSEC will be support for existing Energy and Climate community education initiatives or the development of new initiatives.

Overview of Energy and Climate Crisis

There are three fundamental drivers for action on energy. The first is climate change where we will discuss the effects of Green House Gas (GHG) emissions on our climate. The second is 'Peak Oil' which is short-hand for that point in time when the world has consumed 50% of its known petroleum reserves. 'Peak Oil' is also a convenient way to discuss the move from oil that's easily obtained to 'tough oil' where the extractive process is both expensive and environmentally risky, which, in combination with declining overall reserves, makes oil a less dependable energy source as well as a more expensive one. The third driver is the 'world energy outlook'. According to the International Energy Agency[1], global demand for primary energy, especially for oil, increases by 36% between 2008 and 2035, with China and other developing countries accounting for most of the projected increase, and oil remaining as the dominant fuel in the primary energy mix through this period. This drives up prices for oil and creates volatility and instability in the market, while making renewable energy both more affordable and more critical for climate change abatement.

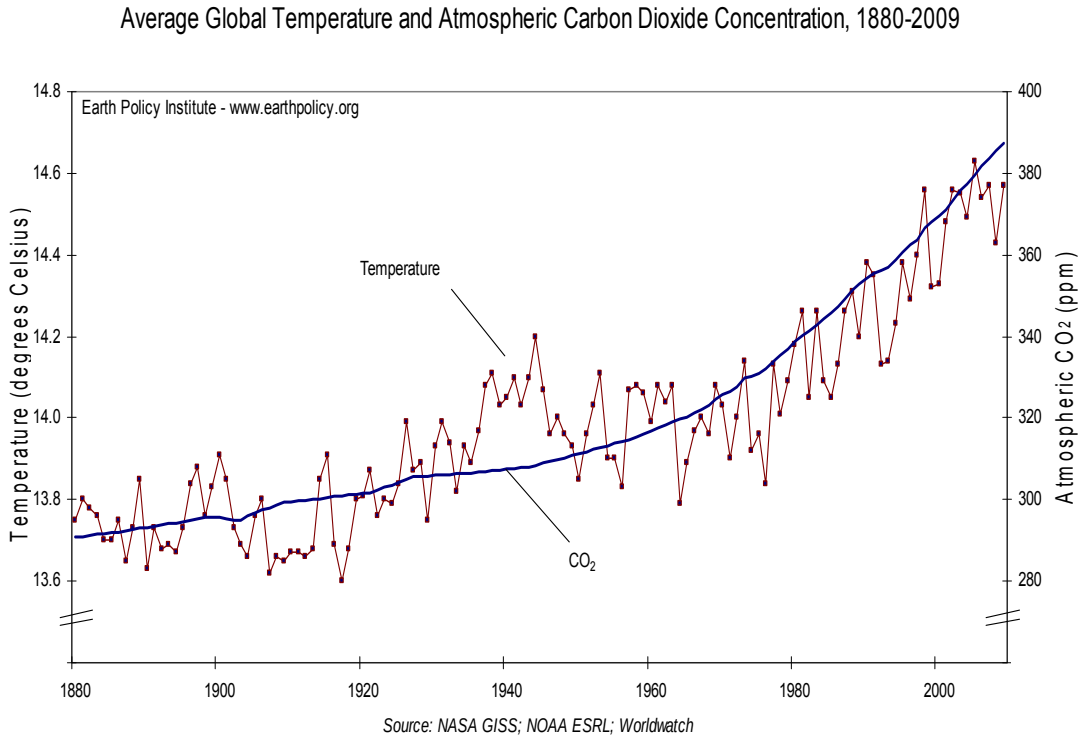
Climate Change

While an in-depth discussion of climate change and the associated climate science is beyond the scope of this document, it is important to present the case that we are confronting a disaster if we don't take aggressive action. To that end, we will present a high-level view of the key concepts, the climate science evidence that we have a serious problem, and several scenarios of likely outcomes for different paths of action.

The first important climate concept is 'Parts Per Million' (ppm) which measures of the amount of CO2 in the atmosphere. This measurement is taken daily by the Earth Systems Research Laboratory (ESRL) of the National Oceanic and Atmospheric Administration (NOAA) at the Mauna Loa Observatory in Hawaii (and at 4 other NOAA measuring stations world-wide). For example, at Mauna Loa, the measurement for Friday, November 5, 2010 was 387.18 PPM, while the first measurement was taken in 1958 at a ppm of 315.62. Mauna Loa and the other observatories also measure Methane (CH4) which is 25 times more potent than carbon dioxide and has 50% of the overall impact on warming as CO2[2]. CO2 ppm levels are important to this discussion because level of CO2 in the environment and average world temperatures appear to

[1] International Energy Agency, World Energy Outlook 2010 Factsheet (Paris, France: IEA, 2010)
[2] NOAA, Greenhouse Gases Continue to Climb Despite Economic Slump (NOAA: April 21, 2009).

correlate reasonable well[3]:



What's alarming about this data, according to climatologists, is the growth in CO2 ppm from 280 before the Industrial Revolution to its level of 387 today, or an increase of 107 ppm since 1750 and since 2000 the growth rate has been 3% per year[4]. According to this science, the increasing levels of CO2 are driving the increases in world-wide temperature and the trend-line suggests that we're in for continuing increases to levels that are unsustainable.

Some of the key concepts and data to bear in mind are listed below. While some of these points are controversial, there is a significant amount of consensus from scientists:

- Tipping points: at various level of CO2, we pass 'tipping points' which trigger positive feedback loops. Examples include the disappearance of Arctic Sea ice, the Himalayan-Tibetan glaciers, and the Greenland Ice sheet. In each case, a positive feedback loop is created which sets-off more warming. For example, a glacier is reflective while rock absorbs heat.
- CO2 accumulates: Most CO2 lasts for 1000's of years in the atmosphere. This means that the notion of a 'CO2 budget' makes sense. Any CO2 we release into the environment will have an effect on warming and we need to determine the upper limit of our emissions and stick to it or risk climate catastrophe.
- Temperature rise 'lock-in': A certain amount of temperature rise is already locked-in as a result of recent emissions which are having their effect on temperatures.
- 350 ppm threshold: James Hansen established this benchmark. His comment from 2008: "If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on earth is adapted, paleoclimate evidence and ongoing

[3] NASA GISS, Average Global Temperature and Atmospheric Carbon Dioxide Concentration, 1880-2009 (NASA GISS; NOA ESRL; WorldWatch: 2010). Included in Lester R. Brown's *World On the Edge: How to Prevent Environmental and Economic Collapse* (New York: W.W. Norton & Company, 2010)
[4] Hamilton, Clive, *Is It Too Late to Prevent Catastrophic Climate Change* (Sydney: Lecture to a Meeting of the Royal Society of the Arts, October 21, 2009), p. 2.

climate change suggest that CO2 will need to be reduced from its current level of 385 ppm to at most 350 ppm…. If the present overshoot of this target CO2 is not brief, there is a possibility of irreversible catastrophic effects.[5]"

- 2 Degrees Celsius (3.6 degrees Fahrenheit): Increase in warming beyond 2 degrees Celsius is a recipe for global disaster.
- Order of magnitude of cuts needed: A 50% reduction would stabilize atmospheric CO2 for less than a decade. After that, CO2 would be expected to rise again…. Complete elimination of CO2 emissions is estimated to lead to a slow decrease in atmospheric CO2 of about 40 ppm over the 21st century. (IPCC AR4 WG1 FAQ 10.3 (2007)
- Hell on earth: Bill McKibben at Copenhagen (2009) - "Based on emissions reductions proposals that national governments made, atmospheric CO2 would rise from 390 ppm in 2010 to about 770 ppm by 2100. These numbers add-up to hell on earth."

While it would be easy to look at this data and develop a doomsday view and become resigned to catastrophe (or to complacency), there is room for positive action. We need to consider some likely scenarios and think through what these might mean for local action by Concord residents. According to Kevin Anderson and Alice Bows in *Reframing the Climate Change Challenge*, the first task is to achieve 'peak' in GHG emissions (i.e. leveling-off of emissions) and the second is to dramatically cut emissions to levels that equate to various ppm and temperature increase outcomes[6]. Here are three scenarios from their article:

Peaking Year[7]	Annual reduction rate for all emissions	Annual reduction rate for energy and industrial emissions	Resulting concentration (ppm CO2-e)	Likely associated warming
2015	4%	6.5%	450 ppm	2 Deg C
2020	6%	9%	550 ppm	3 Deg C
2020	3%	3.5%	650 ppm	4 Deg C

Using this context, we can see that achieving peak in 2020, along with an overall reduction rate of 3%/year results in a 4 degree Celsius increase (7.2 degrees F) and 650 ppm while doubling down on the CO2 reduction rate improves our situation by 1 degree Celsius (5.4 degrees F). So, with aggressive reduction rates and 2020 as the peak, our range of temperature increase is 3-4 degrees C (5-7 degrees F) with a CO2 ppm that's 200-300 above Hansen's point of no return and well into McKibben's area of 'living hell'.

While these forecasts may not be accurate, we should consider the risks associated with doing nothing. The more we delay, the more difficult it will be to recover if the science is anywhere near close to what will play-out in the future. Simply put, a rational approach to risk management would be to take serious action now while closely monitoring the situation to determine if we're doing enough. Some of the actions that make both environmental and economic sense:

- Municipal segment: planned reductions in energy consumption and development of renewables for town buildings
- Residential and commercial segments: conservation, efficiency, renewables initiatives, and electric (and hybrid) vehicles

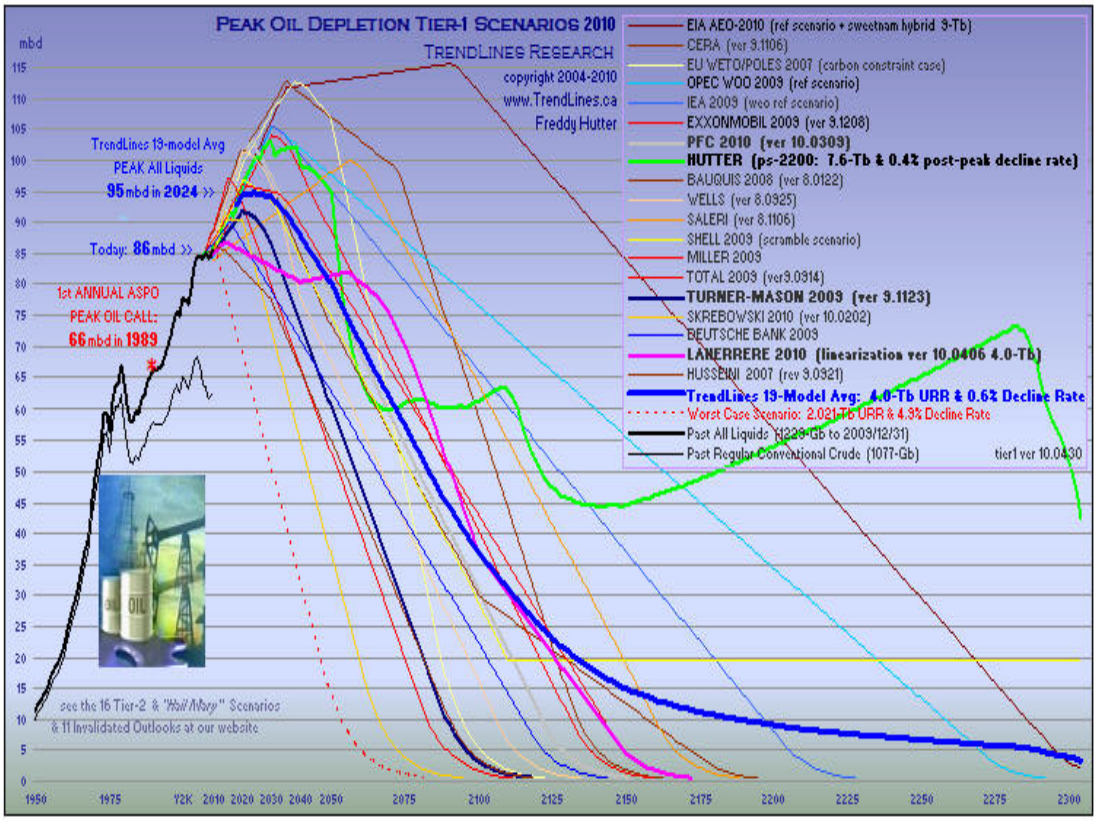
[5] Hansen, James, et. Al, *Target Atmospheric CO2: Where Should Humanity Aim*, New York, NY, Nasa/Goddard Institute for Space Studies.
[6] Anderson, Kevin and Bows, Alice in *Reframing the Climate Change Challenge*, (Manchester, UK: Tyndall Centre for Climate Change Research, Mechanical, Civil and Aerospace Engineering, University of Manchester, 2008.
[7] Hamilton, Clive, *Is It Too Late to Prevent Catastrophic Climate Change* (Sydney: Lecture to a Meeting of the Royal Society of the Arts, October 21, 2009), p. 12 (Note: table uses data from Anderson and Bows, 2008)

- Light plant: aggressive development of renewables (30% of portfolio by 2020); 80% by 2050; aggressive support for electric vehicles, conservation strategies, possible ETS heat.

The other step forward involves developing Concord as a model community and a standard for others in the Commonwealth to emulate. This would enable us to take a more active role in developing Massachusetts as a leader in the United States, along with the potential to influence others to join us in this effort to control GHG emissions.

Peak Oil

Peak oil is a simpler construct than climate change, however there are many different predictions as to when the peak will occur and what it will mean. At this point and for our purposes, it's reasonable to take Freddy Hutter's forecast of 2033 as a reasonable estimate of that point in time when we've used 50% of known, recoverable resources[8]. In fact, we may have reached a point where the only new reserves are 'tough oil' that require significant environmental risk to extract at



high economic costs, e.g. BP in the gulf of Mexico, Petrobras' deep water reserves, plans in the Arctic, etc. Additionally, peak oil brings growing price instability and interruptions in supply as countries compete for fewer resources. Last, as we begin to see the end of supplies as we've known them historically, we need to move to other energy sources.

However, there are contradictory voices on 'peak oil' and its meaning and the arguments carry validity. One such source is Nathan Lewis of Caltech who has said in *Powering the Planet*':

> 'Dividing our proven reserves by 1998 consumption rates shows that we have 40 years' worth of proven reserves of oil. This is what's in the ground that we can actually book with 90% confidence. People look at this and say, "We're going to run out of oil in 40

[8] Freddy Hutter's Trendlines Website

years". That's wrong. The ratio of reserves to consumption rates has been the same for 40 years since the day after oil was discovered. ….it's not a good use of a corporations' capital to prove-out more than 40 years of reserves. ….it doesn't pay to prove-out 100 years of reserves, so you *always* have about 40 years of reserves'[9].

Nathan Lewis goes on the say he believes that most of the cheapest oil has already been discovered but that there are also significant reserves remaining – between 50-150 years of oil at current consumption rates, between 200-600 years of natural gas, and possibly 2,000 years of coal. If we believe these estimates and consider the fact that our rates of consumption of fossil fuels are continuing to rise, it's easy to frame the problem in the context of climate disruption. Our rates of consumption of fossil fuels and the capacity of the environment to absorb our CO2 emissions are on a collision course. Another way of looking at this: running-out of fossil fuels will not enable us to avoid this problem. We have enough fossil fuels at our disposal to result in the near-term destruction of the climate as we know it today.

There are a few implications for Concord. First, moving from oil to natural gas for heating on an opportunistic basis makes good sense for residences and businesses with ready access to natural gas, as the carbon-to-energy ratio for natural gas is more favorable than oil, from a climate perspective. Second, we should accelerate the move from gasoline to hybrid and to electric powered vehicles. Third, we should continue our move aggressively from fossil fuel-based electricity to renewable sources of power. And, last, conservation and efficiency make imminent sense under these conditions.

World Energy Outlook

The third driver is the world-wide increase in the demand for primary energy*, coupled with oil's continuing dominance of the energy mix and the move from easier-to-extract to tougher and tougher sources during this time period. Adding complexity is the very rapid increase in demand in the developing countries (primarily China and India). According to the International Energy Agency[10]:

- 'World primary energy demand increases by 36% between 2008 and 2035'. This is a rate of 1.2%/year and depends on the implementation of 'new policies' by the countries that participated in the Copenhagen meetings. Assuming policy convergence on a more aggressive set of actions to limit concentration of CO2 to 450 ppm, the growth in consumption would need to be reduced from 1.2%/year to 0.7% per year. This latter rate would limit increase in global temperature to 2 degrees Celsius.
- 'Global demand for each fuel source increases with fossil fuels – coal, oil, and gas – accounting for over 50% of the increase in total primary energy demand'.
- 'Oil remains the dominant fuel in the primary energy mix to 2035'
- 'Natural gas is set to play a central role in meeting the world's energy needs for at least the next two-and-a-half decades'. Natural gas demand will increase at a rate that exceeds overall growth in demand – 1.4%/year.

In the light of these IEA forecasts, it makes good sense to develop an energy strategy for Concord that focuses on efficiency and conservation, on the deployment of renewable resources in our power sector, and on moving to natural gas where possible.

* Note: primary energy are those sources that are used directly in heating, transportation, and in the production of electricity.

[9] Lewis, Nathan S., *Powering the Plane,* Keynote speech at the 1st annual California Clean Innovation Conference, Caltech, May 11, 2007

[10] International Energy Agency, World Energy Outlook 2010 Factsheet (Paris, France: IEA, 2010)

Activity at the Federal & MA-Level

To provide context for our discussion of possible actions at the local level, some of the key, recent activity at the Federal and State levels are summarized below:

The White House on Energy and the Environment

"So we have a choice to make. We can remain one of the world's leading importers of foreign oil, or we can make the investments that would allow us to become the world's leading exporter of renewable energy. We can let climate change continue to go unchecked, or we can help stop it. We can let the jobs of tomorrow be created abroad, or we can create those jobs right here in America and lay the foundation for lasting prosperity.[11]"

The funded energy priorities from the American Recovery and Reinvestment Act include Smart Grid, weatherization of residences of low income people, efficiency in Federal buildings, and development of renewable energy at the state and local levels, and investment in the development of coastal wind and wave power. The White House Web Site offers a set of Guiding Principles:

"To take this country in a new direction, the President is working with Congress to pass comprehensive legislation to protect our nation from the serious economic and strategic risks associated with our reliance on foreign oil and the destabilizing effects of a changing climate. Policies to advance energy and climate security should promote economic recovery efforts, accelerate job creation, and drive clean energy manufacturing by investing in clean energy jobs, securing our energy future by reducing our dependence on oil and by producing more energy at home, and by improving our control over carbon emissions."

The White House Press Release from Office of the Press Secretary, January 29, 2010 is in the appendix.

Federal Executive Order 13514

Another activity at the Federal level that provides guidance to Concord is direct management of energy practices in the Federal Government segment itself. This is meaningful as a higher level context for what we are considering for the Town of Concord's municipal government energy management and policy. Through Executive Order 13514, the White House has established an aggressive goal to reduce energy use and to promote sustainability in the Federal sector. This goal includes reductions in energy use, migration to more sustainable practices, and conservation in conjunction with an overall goal to reduce greenhouse gas emissions by 28% by 2020. Some prominent elements of the plan:

- 30% reduction in vehicle fleet petroleum use by 2020
- 26% improvement in water efficiency by 2020;
- 50% recycling and waste diversion by 2015;
- 95% of all applicable contracts will meet sustainability requirements;
- Implementation of the 2030 net-zero-energy building requirement;

[11] The White House Website, Energy & the Environment, March 19, 2009.

Commonwealth of MA DOER Plans for Energy Efficiency (2010)

At the state level, we are now seeing goals that have implications for both the Concord Municipal Light Plant and our relationship with National Grid. The Commonwealth of Massachusetts Department of Energy Resources (DOER) has announced that energy efficiency is the Commonwealth's 'first fuel' and is developing plans that focus on both electricity and natural gas efficiency. Under this plan, investor-owned electric and gas utilities will invest $2.2B in efficiency measures over 3 years. This investment is projected to save the utilities over $6B in 3 years. The specific goals include:

- Electricity: The energy saving target is 2.4% of electricity sales in 2012 and this will reverse electricity usage trend from growing 1%/year to declining 1.4%/year, saving 2600 GW hours of electricity (350,000 homes) or enough electricity to meet 30% of electricity needs through efficiency by 2020
- Natural gas: Savings target of 1.15% of natural gas sales by 2012

For the CMLP, this raises a direct question as to whether Concord should have its own energy savings targets for electricity. In regards to natural gas usage, this is good news for Concord because it indicates that there's continuing support for incentives to improve efficiency which will be helpful as we upgrade heating systems and building envelopes in the segment of Concord that's served by National Grid.

Commonwealth of Massachusetts – Senate No. 534 (GWSA)

Another important development that will affect energy practices at the local level in Massachusetts is Global Warming Solutions Act (adopted by the Massachusetts legislature in 2008), making Massachusetts one of the first states in the nation to move forward with a comprehensive regulatory program to address Climate Change.

This legislation requires the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA), in consultation with other state agencies and the public, to set Massachusetts economy-wide greenhouse gas (GHG) emission reduction goals that will achieve:

- A reduction of 25% below statewide 1990 GHG emission levels by 2020; and
- Establishment of a baseline assessment of statewide GHG emissions that can be used to measure progress against these goals going forward.

Again, the implications from an energy perspective are fairly clear: to meet this goal in Concord, we have a set of choices:

- Reduce fossil fuel consumption between 10% and 25% vs. a Concord baseline (most directly affects electricity, heating of buildings, and vehicle use – requires efficiency and conservation measures)
- Develop renewable sources of energy inside the Concord grid such as solar and purchase renewable power outside of the Concord grid.
- Migrate from high carbon content fuels (oil) to fuels with smaller footprint (e.g. natural gas)
- Combination of the three

The Need for Local Action

While Concord has already made the decision to address sustainability from an energy perspective, it is worth revisiting the 2009 Concord Selectmen's goal for sustainability:

> "Promote energy efficiency, energy conservation, renewable energy generation to reduce short and long-term costs to Concord citizens and institutions and to reduce impacts on climate and on the environment." Adopted June 29, 2009

And here's the specific directive to the Comprehensive Sustainable Energy Committee (the statement on 'purpose' from the CSEC Committee Charge):

> 'The purpose of the Comprehensive Sustainable Energy Committee is to assist the town in identifying, designing, and implementing programs and projects for fostering energy conservation, energy efficiency, and renewable energy generation in the Town and in all segments of the community…. These [efforts] should address all forms of energy use: electricity, natural gas and heating oil, and transportation…. The benefits…may include reduced exposure to expected future energy cost trends, decreased reliance on imported energy sources, reduction of 'greenhouse gas' emissions and related pollutants, and stimulation of local sustainable energy business.'

There are other compelling reasons to take action locally.

- Policies that we establish today may enable us to reduce Town outflows for energy and to redirect those dollars for important services including education, public safety, health care, climate change resilience, etc. The same principle applies to residential living and to the commercial sector. For residents, energy efficiency enables retention of scarce dollars for other critical investments, such as education and health care. For businesses, efficiency provides a competitive edge and allows longer term survival of businesses.
- Maintaining a high quality of life in Concord requires anticipating threats and developing plans to counter them. Three possibilities should be considered if we take a 30-50 year time horizon into account: (a) serious shortages in fossil fuels along with an inability to fully replace the shortfalls with renewable sources, (b) continuing increases in CO2 levels that could precipitate serious and possible onerous government regulation, and (c) serious damage due to climate change that is already occurring. In both cases, it's prudent to plan in order to avoid the consequences of these possible shocks.
- Participation in these initiatives is 'doing the right thing' as a citizen of Concord and of the United States. We have an obligation as a wealthy and well educated community to provide leadership on these difficult energy and environmental issues, which can extend well beyond Concord and Massachusetts.

Before exploring our situation in detail, it would make good sense to define the scope or the major components of our problem, along with some of the key questions and policy options that we should address in each area. As we move through this process, we will want to establish a set of goals that are consistent with national and Commonwealth directions and we will want to define our opportunity in each of the following areas:

- *Municipal:* The municipal segment includes municipal and school buildings, municipal and school vehicles, and all of the municipal infrastructure including water treatment and pumping, wastewater and sewage treatment, and street lighting.
    - What can be done to improve the efficiency of our vehicles, our buildings, our infrastructure, and our delivery of services?
    - What are the opportunities for renewable energy in our public buildings?
    - What goals & measurements make sense and what is our approach to energy in this segment of Concord?

- *Power Generation, Management, and Control:* Concord is fortunate to have its own Municipal Light Plant which provides the Town with direct control over its policies, power purchasing, pricing, and programs for electricity.
    - How much of our energy should be from renewable sources by 2020, 2030, 2040 and beyond to 2050?
    - What policies and goals make sense in each of the following areas? (a) 'how much' power is consumed or reducing kWh's consumption, (b) 'when' power is consumed or managing & shaving peak power consumption, and (c) 'who' is consuming power or flattening the consumption profile across users…

- *Residential and Commercial and Buildings:* The Town of Concord has nearly 6000 residential properties and a significant amount of commercial square feet.
    - What goals make sense for Concord's improvement in heating efficiency in the residential sector?
    - How do we leverage National Grid's offerings and significant presence as an energy provider in Concord's residential sector? And, what steps can we take to make oil providers and oil customers partners in our efforts to reduce CO2 emissions?
    - To what extent and how do we encourage residential and commercial use of non-fossil and renewable energy?
    - What specialized programs, initiatives, and partnering makes sense for commercial heating and electricity?

- *Building Standards and Process:* The new Stretch Code, adopted at the Annual 2010 Town Meeting, has the potential to significantly improve the energy efficiency of new buildings as well as enhancing existing buildings. Over time, this is an opportunity to upgrade the overall efficiency of the building stock in Concord.
    - What else can we do to tighten-up standards for residential, commercial, and municipal buildings in Town?

- *Community Planning:* The 'way we live' has an enormous impact on consumption of energy and on the opportunity to deploy renewable energy or efficiency measures. Our sprawl creates both the need for a lot of travel to and from our residences, as well as the isolation of living units into islands that can be inefficient. One of the concepts that is being considered to change our living patterns is eco-village development where people live in a denser cluster(s) of housing and integrate their housing with services including shops and restaurants. Other considerations include different densities and rules by residential zone to allow for choice in dwelling size/scale where some zones would permit considerably smaller build-out than others.

    - What can we do through the Zoning process to offer a mix of living densities and dwelling sizes?
    - We are blessed with two centers (Concord and West Concord) that are transit hubs. Is there anything we can do to leverage this good fortune?
    - What can we do to facilitate walking and biking for trips in Town, rather than driving?
    - What can we do to discourage the development of remote properties?
    - What can we do to encourage the shared trips, shared cars, shuttles, buses, etc.

    The other side of the coin is open space which is critical both to carbon capture and to our ability to offer an attractive environment which encourages local activity.

    - What can we do to increase the amount of open space as a key source of carbon capture?
    - Can we encourage more farming to provide locally grown produce and create local jobs?
    - What can we do to develop and enhance the vitality of the business districts as places that are attractive to Concord residents for services and entertainment?

    - *Trash & Recycling:* What can be done through Municipal Solid Waste policies and practices to reduce Concord's overall carbon footprint.

- *Community Education:* Concord has an opportunity to build on the excellent work of the League of Women's Voters, Concord Conserves, and the Concord Climate Action Network in educating the community on energy and the climate.
    - How do we use our community education resources to raise awareness and effect change?
    - How do we organize an effective initiative that's focused and long-term?

Concord –2008 Energy and CO2 Baseline

Before we explore the various aspects of energy and sustainability for Concord, we need to establish a set of energy consumption, CO2, and population baseline statistics that we will use throughout this document. Second, we need to introduce the 2008 energy consumption and CO2 baseline at a high-level to show the relative contributions of CO2 from each Concord segment (Residential, Commercial, Municipal).

Population

Generally, the profile of Concord has been reasonably stable over time on the key variables that influence energy consumption rates and greenhouse gas emissions. Over the past 30 years, Concord's population has remained flat (excludes institutionalized population)[12]:

	1980	1990	2000	2008
Concord population	15468	15293	15576	15300

Some other key data from the 2000 census on our residential segment:

- Total housing units: 6153[13]
- Total occupied housing units: 5948
- Owner occupied units: 4,803
- 19% of residences are rental units
- 2.6 people per residence
- 16,260 vehicles or 2.7 vehicles/residence

The median household income in Concord for 2008 was nearly two times that of the Commonwealth of MA and more than twice the national level.

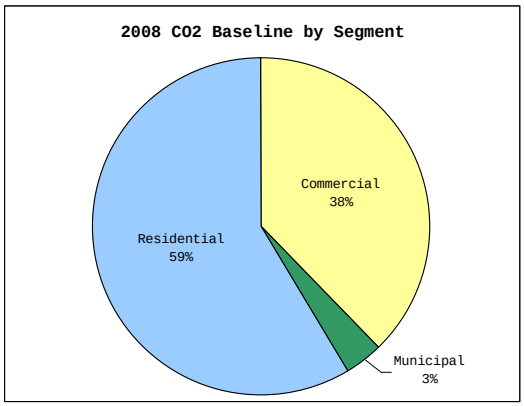
Energy and CO2 Baseline

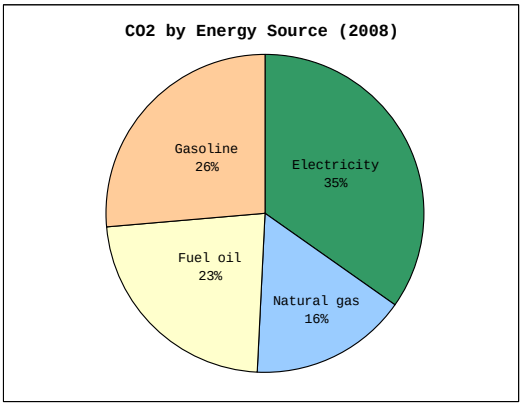
The conversion of the four energy types listed below (electricity, natural gas, diesel fuel for heat or vehicles, and gasoline) into CO2 is a simple way to normalize energy that's consumed into a single measurement. Additionally, CO2 is helpful, as it also accounts for the variability in the contribution of each source to greenhouse gases. For example, gasoline and diesel[14] are about 40% more CO2 intensive than natural gas and our electricity CO2 'factor' accounts for the higher percent of natural gas in New England's electricity power plants[15] vs. coal or oil), and so forth. As we move forward, we will track both consumption of energy (kWh, therms[16] of natural gas, etc),

[12] Data complied from Concord Annual Reports
[13] Concord Long range Plan, 2005.
[14] Gasoline and diesel factor from EPA Emission Facts – 2005.
[15] EGRID Table 4, Estimated Carbon Dioxide Rate for New England Census Division, 1999
[16] Natural gas factor from the EPA, Clean Energy, Calculations and References, August 2008.

but we'll also use CO2 to aggregate our performance and progress in each segment and for year-to-year comparison. 2008 was selected as the baseline year and will be our comparison point for our Sustainability Planning:

2008 Baseline	Electricity kWh	Nat Gas Therms	Diesel Gals.	Gasoline Gals.	Tons CO2	Tons CO2 Per Capita
Municipal units	12,188,598	555,379	38,056	61,957	10,673	0.7
Residential units	70,176,556	3,904,242	3,337,152	7,249,602	170,252	11.1
Commercial units	97,857,454	3,716,428	3,102,327		107,572	7.0
Total units	180,222,608	8,176,049	6,477,535	7,311,559		
Tons CO2	97,050	44,968	71,901	74,578	288,497	18.9
Tons Per Capita	6	3	5	5	19	
CO2/unit(factor)	1.077 lbs	0.0055 tons	22.2 lbs	19.4 lbs		

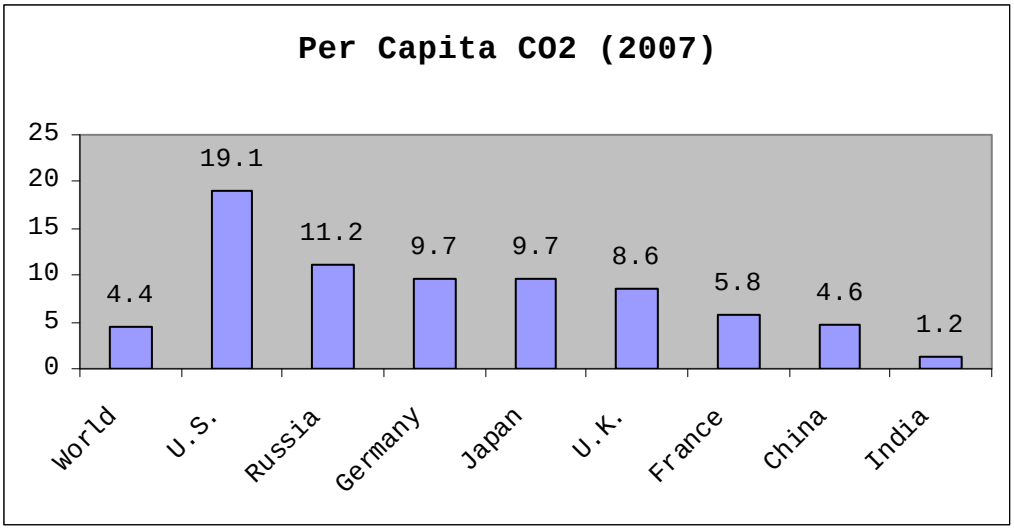




Keep one caveat in mind in looking at the relative contribution of each of these segments. We have not been able to properly allocate the ownership of vehicles to the residential and commercial segments. While we have properly accounted for 'municipal' vehicles, all remaining passenger vehicles registered in Concord (including those owned by the commercial users) are currently counted in the residential segment which undoubtedly creates a bias in the data. Hopefully we'll be able to correct this.

Concord Baseline in Context (vs. U.S. and Other Countries)

Comparisons to other geographic entities help put Concord's baseline into context. The comparison below draws on per capita CO2 emissions from the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.* The first interesting point of comparison is Concord's residential numbers for home energy (electricity plus heating fuel) and vehicles (gasoline) vs. some of the listed countries. (For example, we have a higher level of greenhouse gases for this narrow set of criteria than all of the countries listed below, except for Russia.) If we were to include all sources of CO2 such as consumption of all other 'goods and services' (difficult or impossible to measure), Concord's rate would certainly be as high as the overall per capita rate for the Unites States, or possibly higher due to the suburban characteristics of our community.



On a per capita basis, the U.S. consumes nearly two times the energy of the largest European consumer (Germany) and more than four times the per capita rate for the world. Moreover, as mentioned above, Concord's rate is as high or higher as the overall U.S. rate.

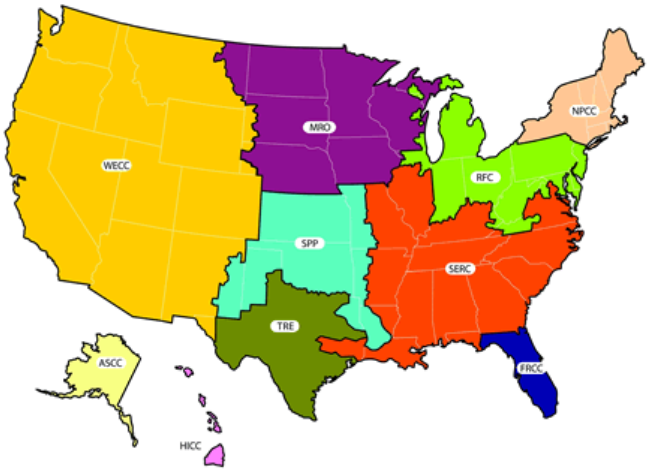
What should we make of this data? We can do endless comparisons to other similar Towns (e.g. Wellesley, Weston, Sudbury, Lexington, etc). However, it's reasonably clear where we fit into the picture for the U.S. and how we compare with other countries and that we are certainly part of the problem. As such, it is as important for us to reduce energy consumption and emissions as for any other community. The remainder of the document discusses the opportunities.

Electricity Overview

NPCC, New England ISO, and Concord Municipal Light Plant

The Concord Municipal Light Plant (CMLP) is a municipally-owned electric utility under the direction of the Concord Town Manager. The CMLP purchases its power through a set of individual suppliers outside of Concord with whom we have 'power purchase agreements'. These agreements specify the pricing per kWh for the power we use. Additionally, we are charged for transmission of power to our main substation by the Independent System Operator-New England (ISO-NE). The ISO is responsible for creating and managing a competitive wholesale market for electricity, for ensuring adequate capacity in New England, and for the operation of the power grid in New England. While we are an independent municipal power plant, we operate in the larger context of the ISO and abide by their rules (and pay them for transmission, forward capacity, etc).

Additionally, we are a part of the *Northeast Power Coordinating Council (*NPCC) region of the US power grid. The regions represent portions of the US power grid which have similar emissions and resource mix characteristics and may be partially isolated by transmission constraints. These regions are measured for greenhouse gas emissions through the EPA eGrid and a composite CO2e rate is calculated, based on the mix of fuels used in the various plants in each region and their efficiencies. This rate or CO2e factor from the eGrid Census plays an important role in our Concord CO2e baseline and is used in our measurement of progress against the baseline going forward. Here's a view of the eGrid Regions, showing NPCC:



The good news for New England is that it already has one of the lowest rates of emissions in the United States (1.077 lbs CO2e/kWh); only the 'Pacific Contiguous' is lower with its large concentration of hydropower sources, while West North Central is the highest at 1.74 lbs. While Concord's contribution is probably less than 1.077 lbs/kWh because it relies primarily on natural gas-based power plants vs. other New England utility players, the NPCC CO2e rate is used because the EPA supplies the measurements and we must make some concessions to established methodologies. (Data is for 2009 -- the actual eGrid tables can be found in the appendix).

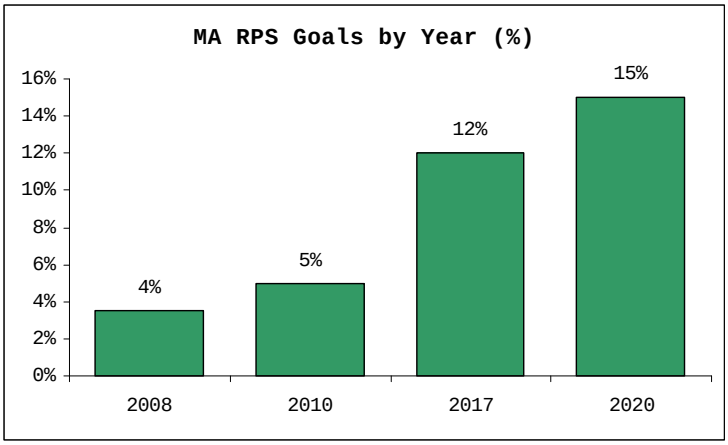
Concord's Green Power Portfolio

Commonwealth of Massachusetts Goals

The DOER has announced that Massachusetts utilities must obtain a specified percentage of the electricity they provide to customers from renewable sources to meet Massachusetts's state renewable portfolio standard (RPS). Massachusetts' renewable resources include certain types of solar, wind, ocean energy, biomass, hydro, landfill gas, geothermal, and fuel cells. The RPS increases to 5% in 2010, 12% in 2017, and 15% in 2020. (Source: ISO New England, January 2010).

While these requirements do not apply directly to Municipal Light Plants, we are the beneficiaries because the investor-owned utilities are required to participate in a mechanism called the Renewable Portfolio Standard that creates incentives for which we are eligible. This standard mandates that investor-owned utilities must generate a certain percentage of their power through renewable sources or they are subject to penalties. One way for investor-owned utilities to conform to the standard and to avoid the penalties is to purchase Renewable Energy Credits in the market that's been created by the Commonwealth. These credits are issued to any party that installs a solar array, a geothermal system, a wind farm, etc. As such, a Town like Concord that builds a renewable power source such as a solar Photo Voltaic array will receive Renewable Energy Credits from the Commonwealth which can be sold to an investor-owned utility that is attempting to avoid penalties for non-compliance. As such, the revenue from these Energy Credits can be used by the Town to offset a significant amount of the capital requirements for one of these systems. The RPS program in the Commonwealth has been modeled after the successful New Jersey program and has gotten good reviews (GreenTechMedia, Jan 6, 1010).

Administration for the Commonwealth of Massachusetts has established a goal of 400 MW of solar capacity by 2020, along with 2000 MW of wind. The overall RPS goals for the Commonwealth are ambitious, growing to 15% of overall capacity in Massachusetts by 2020:



Our power portfolio is a key leverage point for Concord for our development of a sustainable energy strategy. While there isn't much opportunity to upgrade to cleaner fossil alternatives as 100% of our current fossil-fuel based power contracts are for natural gas-generated power, we can pursue renewable sources of energy. There are two possibilities: (1) We can develop renewable sources of energy inside our CMLP grid, and (2) we can transition power contracts from gas-fired plants to renewable sources of energy outside the CMLP grid. The Concord Municipal Light Board is discussing goals for increasing the percentage of electric energy derived from renewable sources over a 40 year time horizon, starting with specific goals for 2010 and following with sub-goals for every decade thereafter. At the moment, the context for these discussions is the U.S. Administration's goal to reduce CO2e emissions by approximately 20% by 2020 and 80% by 2050 (Hugh Lauer, Toward Renewable Energy Supplies for Concord, December 2009).

Hydroelectric Power

CMLP recently signed a three-year agreement for power from a hydroelectric plant, Miller Hydro, in Lisbon Falls, Maine. This three-year contract could represent nearly 3% of Concord's current annual electrical energy requirements. Additionally, we purchase another 3% of our power from hydro sources in New York State for an overall total of 6% as hydro-sourced. While hydro is a valid renewable resource, it's both intermittent which is a drawback and it's reached the upper limits of its development potential.

Methane (Waste Recovery)

The CMLP has signed a Power Purchase Agreement with the developers of a landfill gas power plant in Granby, Massachusetts, which will produce up to 1 MW of base load power, or potentially 4% of Concord's energy needs.

Wind Power

Wind is a promising source to replace fossil fuel-based electric power in the Commonwealth. As noted above, the Commonwealth expects to develop as much as five times more power from wind than from solar. This is because Massachusetts has wind resources consistent with utility-scale production (see US DOE: www.windpoweringamerica.gov/maps). According to the maps, Massachusetts has excellent-to-outstanding resources in our coastal areas (northern part of Cape Cod and good-to-excellent areas are found in the southern part of Cape Cod and along the shore of Martha's Vineyard and Nantucket). Particular ridge crest locations of the Berkshires in western Massachusetts also have good wind resource attributes. Depending on the level of wind at a site and assuming viability, the wind turbines being installed today range from 1.65MW to 3MW/tower. Annual production is dependent on wind volumes over time. And, it should also be noted that wind is an intermittent resource.

A contract with Spruce Mountain Power of Maine has just been signed that would add 5,000,000 kWhs of wind power to CMLP's portfolio at a fixed price for 15 years. This is equivalent to slightly less than 3% of Concord's power requirement.

Solar

Concord should continue to take advantage of grants and Solar Renewable Energy Credits to finance a range of solar power systems. While there is strong interest in roof-top solar, both residential and mid-rage municipal and commercial), Concord's best opportunity to develop a strong base of renewable power from this source is through utility-scale solar. To this end, the Concord Municipal Light Board has recently approved a strategy to develop 25 megawatts of solar power in increments of 5 MW, in 5 different increments over 25 years (5 MW's every 5 years). 25 MW is about as much power as Concord's Light Plant could accommodate on normal (non-peak) days and more than 50% of the Town's total peak demand. When fully deployed, it would generate about 20% of the Town's annual electrical energy requirements at reasonable and predictable costs.

- Ground-based systems require approximately five acres per megawatt of capacity. The CMLB strategy calls for building one 5 MW capacity systems every 5 years, each delivering up 5 MWs of capacity.
- Mid-range rooftop systems are in the 40-200 kW capacity range. For example, the system that has been installed at the Willard School is a 44 kW array and will produce 54,000 kWhs of electricity in a year (at least 9% of Willard's requirement). 10-20 of these systems located on commercial and municipal buildings could produce nearly 0.5-1MW of capacity.
- Residential rooftop systems that support 50% of a moderate residential energy user (5500 kWh/yr) would require a 5 kW array (costing as much as $30,000 before rebates/credits). CMLP is considering a town-wide leasing strategy that would enable residential and small commercial users to lease a system from a solar vendor with a small upfront payment. This is highly advantageous because these systems become more attractive as we remove financial obstacles. If we could get an 8-10% penetration of Concord's residential rooftops, averaging 5 kW, we'd provide another 2MW of solar capacity.

The economics of solar benefit from three factors. First, as mentioned above in the discussion of the Commonwealth's RPS program, Concord benefits from the Renewable Energy Credits ($0.285/kWh or more depending on market conditions); second, by partnering with a third party that would own the solar generation assets we are eligible for favorable tax treatment (Investment Tax Credit and depreciation); and, third, by building solar capacity inside our grid, we avoid ISO transmission costs and we reduce our costs at 'peak', during the summer air-conditioning season. Given that the cost of is solar is currently higher than gas-fired alternatives, a phased approach makes sense because the prices for solar today are expected to decline with advances in technology, in a way similar to integrated circuits.

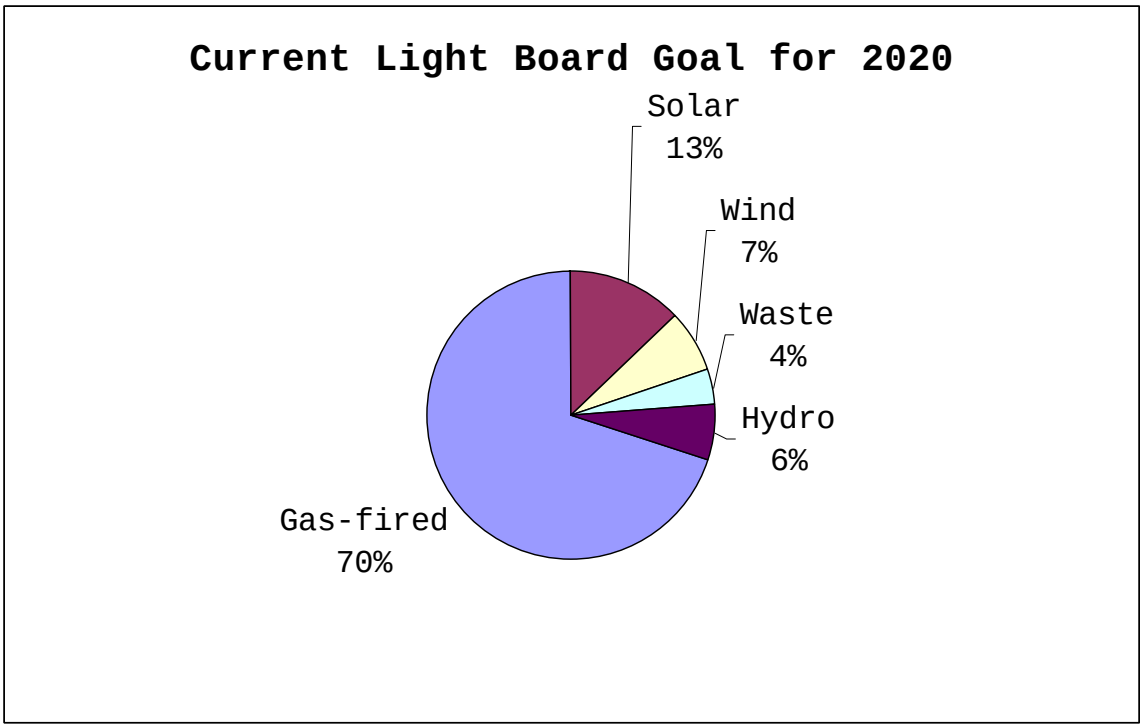
The question at this point is 'how much solar is reasonable for Concord and over what period of time?'

One Possible Scenario for Renewable Energy

In summary, we have a portfolio today where 10% is renewable (hydro and methane/waste recovery) and 90% is from natural gas-fired sources. The approved Light Board strategy calls for adding another 20% to achieve a goal of 30% renewable energy sources in the portfolio by 2020. The rationale for 30% is that we need to be bold now and push this agenda aggressively as this is one area where we can take direct policy action. In other words, the policy alternatives and the levers are reasonably clear. As important, the 'drivers' compel us to take action: peak oil and supply instability caused by 3rd world demand and instability, climate change and the possibility of various CO2 compliance challenges, not to mention the environmental issues, and the imperatives associated with transitioning to a green economy. Under this last point, we need to transition our vehicle fleet in Concord from gasoline to electricity which would put the CMLP at the center of one of the Town's most significant transitions.

The point here is that we need to get started aggressively now and get ahead of this technology and energy curve. There are daunting challenges in terms of the CMLP business model. For example, accomplishing these goals will require balancing the need for long-term contracts for base load power from gas-fired power sources with the need to maintain sufficient 'headroom' in the plan for renewable power contracts. These challenges will not get any easier if we wait and the pressure from the public to move off fossil fuels is only going to increase.

The figure below shows this scenario:



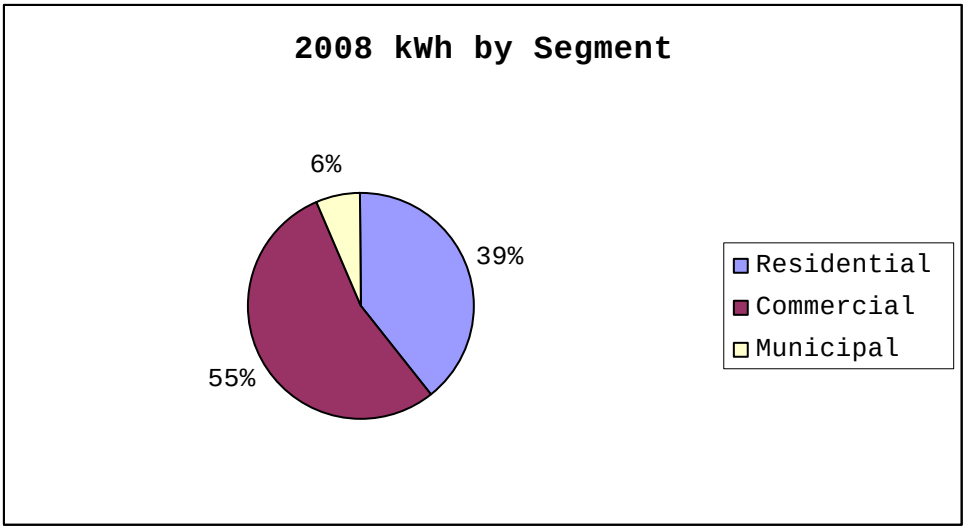
Cost Considerations for Renewable Power

Renewable sources of power are coming down in cost and the expectation is that these trends will continue. For example, the cost for solar inside the Concord grid is potentially $.012/kWh, assuming current MA Solar Re-useable Credits (SRECs) and a flat, un-shaded, 10 acre parcel of land. This is competitive with current pricing. (Recall that we avoid capacity charges for all power produced 'inside the fence' while also reducing our share of capacity charges for the New England peak.) Additionally, solar pricing will be stable over time for installed assets, while fossil fuel-based sources could be unpredictable, given supply interruptions, geopolitical issues, world-wide demand, etc. The story will be similar for wind, except that wind is likely to be an external power source.

CMLP, Smart Grid, Pricing, & Goals

Consumption by Segment

More than half of Concord's electricity consumption is in the commercial segment. We intend to focus directly on this segment in the next phase of this effort. There may be significant opportunities in this segment to improve efficiencies. As we move forward with this document, electricity consumption for each segment will be discussed further in the chapters dedicated to those segments.



Smart Grid

In 2009, Concord's Town Meeting approved a borrowing of $4.5M by the CMLP to build a Smart Grid System in the Town of Concord. This is an exciting opportunity for the Town to be a leader in the use of this technology to manage electric power resources. The Smart Grid provides two key benefits:

- A feedback mechanism to users on their power consumption which translates directly to reduced consumption as users change their behavior in response to information.
- A controlled approach to reducing peak loads, allowing the Town to better anticipate and manage demand and to avoid additional charges for peak power and for additional Light Plant infrastructure to support Concord customers in all three segments. A more individualized approach to peak load control is possible through two key 'programs': incentive-based demand response through direct load control and time-based rate programs, which are described below. Tiered pricing which affects both peak power and consumption rates is also discussed.

While we proceed with the implementation of the Smart Grid network we should also be defining our approach to these pricing and education tools.

Incentive-Based Demand Response (Direct Load Control)

The CMLP has a Direct Load Control program to cycle a customers' electrical equipment. Cycling involves a controlled shut-down of customers equipment for brief periods of time during peak demand periods in a way that isn't ordinarily noticed by the consumer. The way this works is that CMLP sends signals to electronic relays (switches) on participating customers' hot water heaters to shut-off power to the heater for relatively short periods of time. While this has little effect on the hot water supply to the individual user, when these 'power saver' activities are applied to 100's of devices at the optimal time of day, overall demand is reduced and our consumption profile is improved by cutting down the demand peaks (see seasonal variation in kWh consumption below) .. There are at least 500 CMLP customers who subscribe to the existing 'load-control program for hot water' and Electric Thermal Storage heating systems (ETS) who will be moved directly to the Smart Grid, as soon as it is implemented. Ideally, all of the remaining electric hot water heaters in Town would join this program. The possible residential applications include:

- Electric hot water heaters: Discussed above, this program should be offered to 100% of the customers in Concord with electric hot water heaters. In fact, it would make good sense to adopt a policy to ask for participation as the 'standard/default' for users with opt-out for those who have specific reasons for not wanting to participate..

- Air conditioners: Air conditioning systems can be cycled using Smart Grid wireless communications to participating residences, commercial establishments, and municipal facilities. The recommended approach is to remotely increase the settings on the thermostats to a higher temperature to cycle the air conditioning compressors when the electricity demand level in Concord exceeds a specified threshold. The decision rules to send these messages and the extent of the temperature reset are details that need to be worked through, along with the incentives to the consumer.
- Pool pumps: These are heavy electricity consumers and could be included directly in direct load control via hardwired relay devices that would be controllable using wireless communications from the Smart Grid.
- Vehicles: Charging systems should be on a Smart Grid controlled circuit and each user will need a separate meter to measure off-peak electricity used for this purpose. This supplemental meter could also support other off-peak requirements – ETS heat for example.
- Other household devices: Other heavy electricity consumers such as dishwashers and electric dryers could be included via smart devices plugged into the outlet and later by intelligence built into the appliances. For example, you may want to start your dishwasher when its loaded but allow it to run its cycle at a time that's not 'peak' from the CMLP's perspective.

It's helpful to visualize demand-based incentive programs based on the extent to which the various CMLP/Smart Grid 'interventions' are visible to the user and effect their lifestyles. This becomes important as we sort out the offerings to users and the incentives that CMLP will provide. It's safe to say that users will need to opt-in to an offering that has any serious impact. The various levels might look like:

- Level I: Interventions by the CMLP are invisible to the user. This includes both water heaters and ETS. The cycling of these devices should be fully transparent to the user and causes no inconvenience. The same can probably be said about vehicle charging systems and pool pumps. One option is to cover these applications by policy to get a very high rate of participation.
- Level II: Interventions are visible but have little impact. This might include appliances such as dryers and dishwashers.
- Level III: Interventions can have a noticeable effect. This level is most applicable to air conditioners because they are running at capacity at exactly the time when we can hit the peak. In other words, when it's hottest, we're raising the temperature settings on the thermostats.

The ISO also offers a Demand Response Program for its large users. The process involves reducing consumption by a predetermined amount when the ISO calls. This is ideal for larger users like Valley Sports, Middlesex School, and the Water and Sewer Division of the town. Effective marketing and measurement of the results are keys to success in this segment.

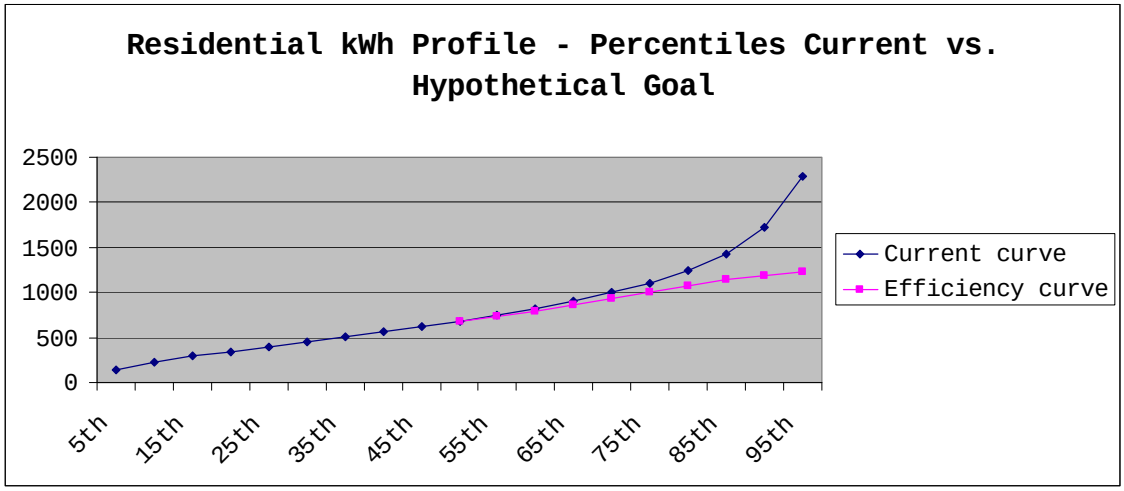
Time-based Rate Programs

Time-of-use rates and Real-time prices: These strategies are interesting but have had mixed results. A more promising approach would be to leverage day-ahead information and to leverage this information to obtain better rates and more use at specific times. This information is being used manually by the CMLP today to optimize pricing for ETS heating systems. In the future, as our capability improves to optimize on an automated basis (using decision rules embedded in Smart Grid application software), we will be in a position to take advantage of this day-ahead information without manual intervention.

Tiered Pricing

While incentive-based demand-response pricing should impact peak demand, tiered pricing should reduce overall kWh use, while also providing a vehicle to increase revenues to further reduce rates at the low end or to enable other investments including infrastructure improvements and renewable energy sources.

One possibility for Concord is a more aggressive three-tiered approach to further discourage high-volume consumption of kWh's as shown in the graph below where the ramp-up in the 'current curve' (2008)[17] is fairly dramatic as we move from the 75th percentile to the largest residential user (95th percentile is 2x the 75th percentile), while the second curve shows a possible effect of a more aggressive tiered pricing approach -- a flatter profile across the percentiles. One key caveat that we need to keep in mind: we will need to make a provision for those devices that we want to encourage, such as heat pumps for geothermal.



A good example of an aggressive tier structure is Palo Alto's program which provides a base rate for Tier I at 10kWh per day (30 day bill is 300 kWh for a month with 30 days). Tier 2 is at a higher rate for 100-200% of the initial 300 kWh (i.e. for kWh between 300-600) and Tier 3 is for usage over 200% of Tier 2[18].

Per kWh	$ Power	$ Distrib. *	$ 'Cares'	$ Total
Tier I	0.055	0.038	0.003	0.096
Tier II (100-200% of Tier I)	0.077	0.051	0.003	0.131
Tier III (over 200% of Tier 1)	0.104	0.067	0.003	0.174

Discussions are underway at the CMLP to modify the existing tiered pricing.

* Distribution is the cost of the services to distribute electricity to users. In the case of CMLP, distribution is the cost of the fixed infrastructure and its maintenance while power is the cost of the kWhs and capacity that is purchased from external sources such as Morgan Stanley, Braintree, Granby, etc.

Financial Implications – Peak Demand

The demand profile for New England for 2009 is shown below. As you can see from the graph, the peak for 2009 was on August 18th at 3:00PM. The New England 'peak' can occur at any time in the summer months (during air conditioning season) and the highest point is used as the basis for measurement of all power consuming entities in New England. The peak is important for several reasons. First, the peak for the grid reflects the maximum power consumption level for the year. In order to avoid partial shutdowns or blackouts, New England must have sufficient capacity to support the peak, regardless of the demand levels throughout the rest of the year. To support this demand, power production is distributed between two fundamentally different kinds of power plants: (a) 'baseload' plants which run continuously throughout the year to supply power

[17] Data for 'current curve' provided by Concord Municipal Light Plant, PLM Electric Power Engineering, Sept 9, 2009.
[18] From Palo Alto website. Rates are for 2009.

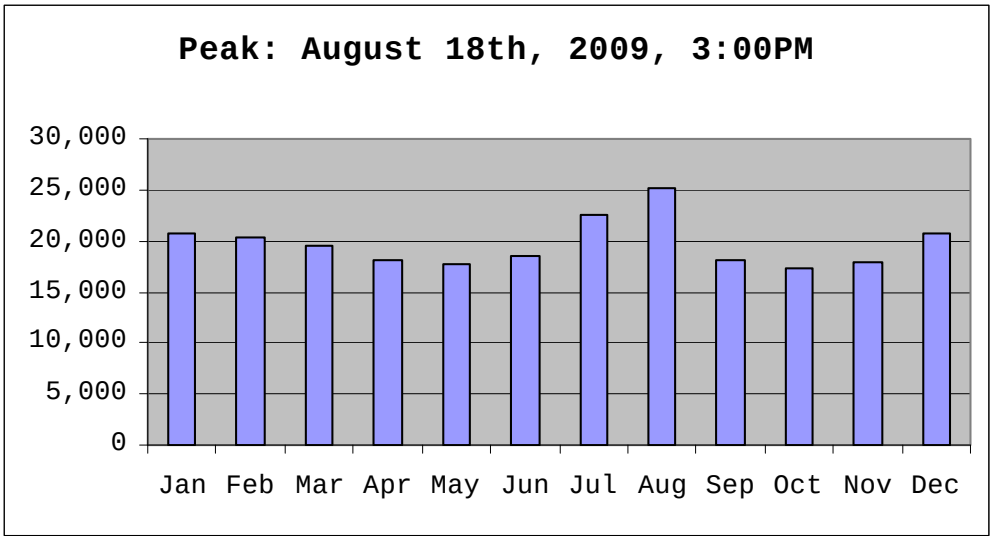
that's demanded on average all year long, and (b) 'peaker' plants which can be fired-up quickly to support a demand spike but which can easily be shut down subsequently. These peakers support the demand in the summer months which corresponds with the hottest days.

The implications of the peak are twofold:

- Forward capacity charge: Concord (CMLP) is required to pay a 'forward capacity charge' which is reflected in the CMLP charges for power. CMLP is required to "purchase sufficient capacity [from the ISO] for reliable system operation for a future year at competitive prices where all resources, both new and existing, can participate (ISO FAQ)." The forward capacity charge for the year is determined by the demand from Concord's users on the New England power generation resources at the time of the New England peak hour. Effectively, this means that the Concord consumption rate for one hour, on the hottest week day of the year, determines the forward capacity charge to Concord for a full year. These charges are large, currently at $250,000/month. If power consumption was perfectly flat with no spikes whatsoever, we would pay only for power delivered and consumed. But, because we need to support our power spikes, there's this additional peak charge which is incremental to the actual kWh's consumed, to cover the cost of the additional capacity to meet these demand spikes. Given that the charges represent 15% of overall CMLP costs, effective demand management and the resulting 'peak shaving' should be a key priority. The best case is a perfectly flat demand profile where every hour of every day throughout the year is perfectly balanced as a 'flat line'. We'll never achieve that level of predictability and consistent consumption, but it's a good way to think about one aspect of our goals.

  In addition to Smart Grid which has been discussed, other key strategies include the use of alternatives to Concord's purchased power (power from outside the Concord grid). For example, for office facilities of 5,000 sq ft or larger, it can be cost effective to install ice-based chillers to augment Freon-compressor-based air conditioning. Freezing water into ice in the middle of the night using low cost, off-peak power and using the ice-based chiller during the peak from 1:00PM – 4:00PM would be useful. Additionally, as discussed, installing solar capacity inside Concord enables us to directly serve our users without external 'peak power' purchases.

- CMLP infrastructure: A second important financial implication of demand or capacity is on the CMLP-owned infrastructure. The CMLP maintains a grid that consists of a Town-owned distribution system with power/light poles, transformers for each user, and substations. The system includes three substations: 'Forest Ridge' which is the primary Concord substation which functions as a gateway for all power coming into Concord and two other substations that are branches off this main: Main Street substation and Williams Road substation. Today, the Forest Ridge substation is operating at a level that is 10% below maximum capacity. Upgrading the substation will be an expensive project (~$5M) depending on specific approach) and could be deferred for several years, if we are successful in our demand and consumption management efforts.



Summary on peak implications: reducing peak demand ('shaving the peak') or flattening the demand profile saves the CMLP money by reducing forward capacity charges and by delaying the need to upgrade infrastructure (namely, the Forest Ridge Substation).

Financial Implications – Overall Consumption Level

The second financial impact is the reduction of costs to the user by consuming less. There is no savings to the CMLP as it simply reduce payments for purchased power but the consumer benefits through a reduced bill. In the case of the residential consumer, this is reflected in a reduced 'residential sales' line (reflects kWh consumption). Of course, if we both reduce our peak and cut our consumption, we win both ways: through a reduced charge for power (kWh volume) and through a lower rate (the forward capacity charge is baked into the charge of power that you pay) The same logic applies to the commercial and municipal segments.

Another policy question for Concord is related to our level of consumption and the extent to which we should set an overall kWh goal and sub-goals for each of our segments (residential, commercial, municipal). Two comments here:

- While Concord's electricity consumption appears to have been reasonably flat over the past 5-10 years, we consume at levels above the average for the State and the Region. Concord average consumption per residence of 900 kWh/month is nearly 46% higher than the average for all Massachusetts residences (618 kWh/month overall for Massachusetts as reported by U.S. EIA – latest data = 2009; average for New England is 630 kWh/month; reported on November 2010). And, note that median consumption for Concord is 680 kWh/month.
- Estimates of 'achievable' electricity savings are at 20% (median studies of 6 different markets from ACEEE, 2004).

This points to an opportunity to improve in ways that both save money and reduce CO2 emissions, while building a defensive posture against shocks from future scarcities or pricing volatility. One option is to choose a course that's similar to DOER direction, by setting a specific energy saving target for each of its three segments. This is challenging as it will require changes in the CMLP business model and pricing strategies as the CMLP's operation is based on a kWh sales volume of 180 million kWh's per year. While we can reduce consumption levels below 180 million kWh, the CMLP still needs to provide service coverage to the entire Town and needs to fully cover its costs.

Proposed Goals

CMLP is a municipally-owned electric utility under the direction of the Concord Town Manager; while the goals for the Light Plant are set by the Town Manager, in consultation with the CMLB

and the Light Plant staff, the Sustainable Energy Committee would like consideration for the following goals and policies:

- Establishment of a Renewable Electricity Energy Plan for Concord. CSEC supports the establishment of a specific, quantifiable goal for renewable energy as a percent of Concord's purchased power. Under discussion is a goal to obtain *30% of Concord's electricity portfolio from renewable energy sources by 2020*. And, we'd assume the CMLB would want a 1, 3, and 5 year set of goals as well. The commitment to this goal includes several caveats:
    - First, Concord has little control over the availability of renewable power outside of Concord and the future of solar incentives is subject to change which could effect feasibility. Nevertheless, establishing a goal for renewable energy prepares the Town for the challenges that lie ahead and indicates that we believe pursuit of additional renewable sources of energy is the right thing to do.
    - Second, Concord will need to develop a power purchase strategy which balances the need for long-term contracts with the need to retain sufficient 'headroom' in the plan to allow for the growth to 30% of purchased power by 2020 and an even larger percentage in the 30 years to 2050.
- Development of 'in-town' renewable energy to support 30% goal:
    - Residential solar: The CMLP is already pursuing a residential rooftop solar initiative which CSEC fully supports. Current goal of 20 rooftops per year (100 rooftops over 5 years for a total capacity of 500 kW's) is a prudent way to kick-off this effort. The goal can be adjusted upwards if we get good uptake. In support of this initiative, the CMLP should consider a project to assess roof-top potential, using GIS.
    - Municipal and Schools solar: The CMLP should support the development of additional capacity on rooftops of Town buildings, but this will need to be budgeted through the Town and Schools.
    - Ground-based solar: With the passage of Article 64, planning is now underway for a utility scale solar installation on town-owned land.
- Establishment of a set of goals and a plan to manage demand. This plan will include the use of the Smart Grid and will require the following:
    - Specifications to guide development Smart Grid in upgrades to existing buildings and for new buildings.
    - New products and offerings to provide incentives to Concord residents and businesses to become Smart Grid customers. For example, we will need to offer a price concession to encourage customers to sign-up for Smart Grid control of air-conditioner thermostats during possible peak power periods. And, new products are needed to support new requirements such as electric vehicles and off-peak charging.
    - Partnering with CSEC to introduce new technologies for Peak Shaving. For example, CSEC is interested in partnering with the Light Plant on a pilot project to install ice-based chillers to augment Freon-based compressors in a municipal building in 2010.
- Establishment of a strategy and a set of goals and plans to reduce kWh consumption in the residential and commercial segments.
    - Strategy and Goals: As the discussion on 'overall consumption' in the section above indicates, there are opportunities for Concord to reduce consumption of electricity. While the benefits from the consumer's perspective are clear (reduced utility bills) the strategic benefits need to be articulated as an element in the plan. While we are transitioning to a plan with more renewable sources, we will still be dependent on fossil-fuel base-load plants and the associated contracts. These sources are going to become more expensive over time and there will be continued pressure to reduce greenhouse gas emissions. For these reasons, it makes sense to cut kWh's consumption, however, this strategy should be articulated by the CMLP as there are significant implications to the existing business model.
    - The plan should address the use of the following capabilities for reducing consumption:
        - Tiered-pricing: Using tiered pricing to flatten demand for heavy consumers of residential energy. (Tiered pricing is already in use by the CMLP. This goal encourages examination of a more aggressive use of this tool…)
        - Consumption-based comparisons in billing. This was proposed previously and needs to be reconsidered, as it could lower residential consumption by 2-3%.

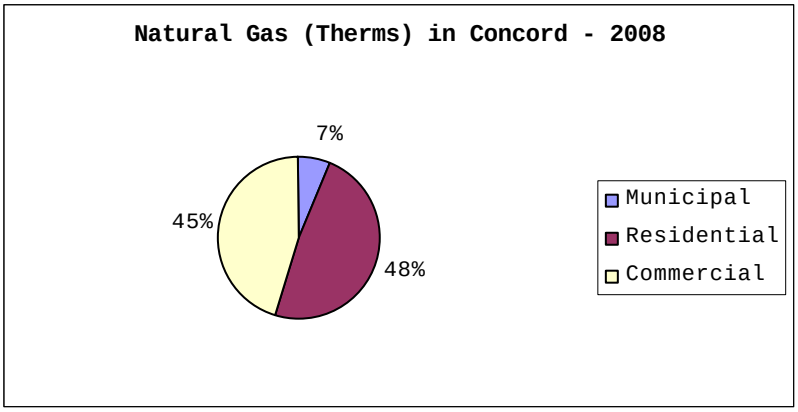
There have been a variety of reports in the news over the past 2 years, from behavioral scientists focusing on utilities. And, one behavioral science-oriented company, Opower, claims significant gains from providing comparative feedback to users on relative energy use - comparisons to other similar users, comparisons to median & mean, etc. It's becoming clearer that normative data help people make behavioral changes, once they understand the extent to which that may compare unfavorably with their peers.

- Efficiency: Continued focus on incentives for more efficient lighting and appliances

Natural Gas

The data in the charts below were provided by National Grid, Concord's Natural Gas supplier. The unit of measurement for natural gas is therms (in table below) which convert to CO2 at the rate of 0.0055 tons per therm (approximately 180 therms = 1 ton of CO2).
The data indicate that:

- Natural gas consumption has been reasonably stable in Concord over the 2007-2009 period and we will use an average of those three years for our discussion of natural gas. (The same is true of electricity in Concord as the discussion on CMLP will show).
- Commercial and residential segments are roughly equivalent consumers of natural gas.
- Commercial and residential segments are roughly 50/50 oil vs. gas in heating consumption.
- While municipal is only 6% of overall natural gas consumption, this segment is nearly 100% heated with this fuel source.



There are several interesting policy questions and opportunities for us:

- The Town of Concord could gain through a well-managed relationship with National Grid, because they are a significant provider of energy to Concord and because a close partnership with National Grid could be beneficial through improved access to their programs, rebates, and expertise.
- Moving more of our heating to natural gas would reduce our carbon footprint, as natural gas has a better carbon-to-energy ratio than fuel oil (natural gas is 40% less carbon intensive).
- What Town-level goals should be established with National Grid? Should we get in line with Commonwealth goals for natural gas or should we exceed them? Some possibilities include:
    - 5, 10, 20 year reduction in natural gas consumption through improved heating efficiencies
    - Extending the reach of National Grid to more homes and businesses in Concord
    - Strategic approach to key commercial facilities
    - Tighter integration and partnership between CMLP and National Grid. One interesting example is a consolidated bill showing both Natural Gas and Electricity

consumption (nearly 50% of Concord residences are heated with natural gas and the vast majority of commercial CMLP customers are also National Grid customers.

Municipal Segment

Town (Municipal) Goals

The DOER through the Green Communities Act (Commonwealth of Massachusetts – 2008) establishes five key criteria for participating communities which involve zoning ('as-of-right zoning for renewable energy), municipal energy use, vehicle efficiency, and building codes ('stretch code'). While we are not a direct participant in the Green Communities Program because we do not pay the added assessment, we are considering complying with the standards established by the Legislature. This makes sense because the Legislature has established Green Communities criteria as leadership guidelines for communities throughout the United States, a lot of thought was put into establishing these criteria, and it is a convenient baseline or launch point for our community. Certainly, in the future, we may choose to deviate from these guidelines or to exceed them, but this is as good a place to get started as any. As we move forward as a CSE Committee, we will consider ways to evolve our goals to fit Concord's requirements and interests.

One of the key criteria in the program is to establish an energy baseline for the town and to develop a 20% energy reduction plan. We have established 2008 as the baseline and we have developed an energy database of all Town resources – buildings, infrastructure, and vehicles (all 2008 and 2009 data). This data will be loaded onto the DOER's new Mass Energy Insight tool and we'll have a user-friendly way to view, manipulate, and update the data for each of the key resources in Town. The second important aspect of this criterion is the Town energy plan to address energy use across buildings, infrastructure, and vehicles. The DOER requires commitment to a goal to reduce energy use by a minimum of 20% over 5 years from 2008. Adopting a goal like this will require further discussion with the Town Manager and most likely approval by the Selectmen.

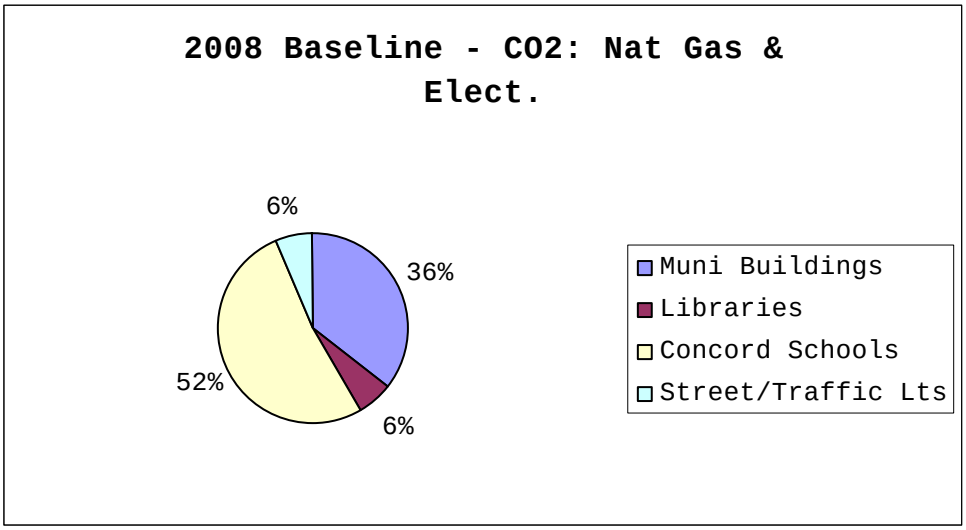
A 20% reduction by 2015 is most likely a reasonable and achievable target. It is consistent with goals that are emerging for some of the buildings that the Sawyer Trust Fund has invested in recently (e.g. West Concord Fire and Public Safety) and is less aggressive than the target established through the recent A.D.I. audit of Concord's municipal facilities where they indicated an opportunity to reduce energy consumption in municipal buildings by 26%. Another way of looking at this is programmatically. We have established initiatives to weatherize and to upgrade lighting systems and we're focusing on the replacement of high-energy impact heating systems (51 Walden and WC Fire have been replaced; Public Safety is in the queue).

And, we have a strategy for the Municipal segment (see below). It hasn't evolved into a specific plan as yet, but it will. One, three, and five year goals should be established for each of our municipal and school buildings. These goals should address electricity and natural gas consumption, as well as overall financial savings. There's a fairly significant opportunity for us in our municipal, school, and library buildings, as our annual expenses for natural gas and electricity exceed $1.25MM. We could start the discussion with consideration of a DOER Green Communities guideline - 20% overall energy consumption reduction target for 2015 for all municipal buildings and street/traffic lights (the guideline allows credit for the effects of renewable energy installed on municipal/school buildings). The following table shows the 2008 'Municipal Baseline' and the proposed goals (a complete spreadsheet can be found in the Appendix). This baseline was developed using data from the Town of Concord (energy bills for each relevant area of the Town), from the CMLP, and from National Grid. Each of the data sources were cross checked and a table by building or consumption source was developed which ties to Green Communities definitions and to the list of buildings that are eligible for Sawyer Trust funds for energy efficiency upgrades (see the Appendix for the 2008 Energy and CO2 Baseline – Concord Municipal Segment and for a listing of buildings eligible for Sawyer Trust funding). The following is an overview of the Town's current consumption levels and the goal to which the BOS and Town Manager committed in August, 2010:

2015 Town of Concord Energy Baseline & Proposed Goals

2008 Consumption Level	Therms	Oil/Gals.	kWh's	1 yr	20 yrs	Tons/CO2/yr
Municipal Buildings	117,077	2,538	2,701,905	$ 473,233	$ 9,464,667	2,129
Libraries	15,333		513,760	$ 79,475	$ 1,589,506	361
Concord Schools	265,656		3,109,924	$ 710,964	$ 14,219,275	3,118
Street/Traffic Lights			714,318	$ 82,147	$ 1,642,931	385
Total 2008	**398,066**	**2,538**	**7,039,907**	**$ 1,345,819**	**$ 26,916,379**	**5,993**
2015 Goal @ 80%	**318,453**	**2,030**	**5,631,926**	**$ 1,076,655**	**$ 21,533,103**	**4,795**
Savings @ 20%	**79,613**	**508**	**1,407,981**	**$ 269,164**	**$ 5,383,276**	**1,199**
	$1.33	**$2.68**	**$0.12**			

CO2 is a good proxy for energy consumption as it normalizes electricity and natural gas usage to a single composite measure. If we view energy this way, we see that Concord Schools (excluding CCHS) are roughly half of the Town's overall energy consumption and municipal buildings and libraries are 42%. The remainder is in street and traffic lights. We did not include 'infrastructure' (water pumps, wastewater treatment, etc) in these numbers or in the goals, as it would not be consistent with the approach recommended by Green Communities, although we could include these items if we wish (detail for all elements of municipal energy is in the Appendix).



Additionally, we need to establish goals for Town and School vehicle emissions. Statistics for Town vehicles are as follows:

2008 Municipal Vehicle Population	
Light Trucks	77
Heavy Trucks	77
Passenger Vehicles	22
Total	176
2008 Fuel Consumption	
Diesel Fuel	35,655 gal. CO2 = 395 tons
Gasoline	61,957 gal. CO2 = 601 tons
Total	Total CO2 = 996 tons

Combining the energy consumed in buildings and in vehicles and converting it to CO2, we have a composite baseline for Concord in 2008 of 6988 tons of CO2 for the municipal segment.

Sawyer Trust

A fund of $1.7 million was established in 2007 by the Alfred H. Sawyer Trust to enable the Town of Concord to improve of its public facilities with respect to energy conservation, water conservation, and materials recycling. The funds, in conjunction with the CSEC strategy, provide Concord with a significant opportunity for leadership in municipal energy efficiency and conservation.

With a primary objective to improve Town buildings' energy efficiency or and to reduce 'carbon footprint', CSEC is investing STF funds in state-of-the-art in both Town's facilities and school buildings:

- Weatherization & lighting efficiency in public facilities
- Development of renewable energy sources such as solar and geothermal
- Water conservation
- Materials recycling and zero trash initiatives
- Conservation and building 'transformation' demonstration projects to influence public opinion

Recent STF projects

For the past year or so, the Town has been responding opportunistically to requests for funding and has been providing consultation to improve energy efficiency in municipal buildings in Concord. Before we discuss the strategy for sustainability for the municipal sector going forward, here's a quick review of some of the recent projects funded through the Sawyer Trust:

- Friends of the Performing Arts in Concord: New high efficiency boilers, insulation, weather-sealing, and lighting & ventilation improvements
- West Concord Fire Station: New high efficiency boilers and AC
- Concord Fire and Police: Augmentation of Town's upgrade of that facility by adding high efficiency boilers, high efficiency windows, building envelope enhancements (insulation), LED lighting, and state-of-the art water conserving devices
- Sleepy Holly Administration Building: High efficiency heating and LED lighting, high efficiency windows, insulation, and water conserving devices
- Beede Center: Re-plumbing the HVAC for pool heating, atomic clock & photo-sensor lights in the pool area, and enhancements to the lobby, etc
- Willard School Renewable Energy Project: In collaboration with the CMLP, CSEC has recommended Sawyer Trust funding for solar on the Willard School. This project is contributing an annual reduction of 9% in electricity consumption at Willard from purchased power.

Establishing a Strategy for the Municipal Segment

While the Committee will continue to respond to various requests that are consistent with the priorities and intent of the Sawyer Trust Fund, we are moving toward a strategy that will enable us to address all of the public facilities in a comprehensive and consistent way. As mentioned above, we completed an overall audit of the Town's facilities through ADI and are moving ahead with several initiatives to implement that work.

Initiatives currently underway are as follows:

- Weatherization: The Town has contracted with a third party, Chapman Construction & Design, for a pilot project on two facilities: Town House and West Concord Fire Station. The purpose of the pilot is to analyze the building envelope deficiencies and to evaluate strategies for improving the performance of the building envelope at these two addresses. The outcome of this work will be a set of plans that can be put to out bid for the construction that's required. If the pilot is successful, the Town will enlarge the scope to include other public buildings in Concord.

- Lighting: The Town has established a similar process for the same two buildings to upgrade the lighting to improve efficiency. The process involves identifying the opportunities for upgrades (lighting fixtures, lights, controls) and obtaining quotes from manufacturers for the material and from contractors for the labor. Again, this is being handled as a pilot which can be replicated for other public facilities in Concord.
- Reporting & Control System: The Town has selected Peregrine's Mass Energy Insight from the DOER as the preferred software for energy reporting and control. Our requirement is for a capability to upload data on natural gas and electricity consumption each month and for that data to be available via an intuitive, user friendly interface. The Reporting & Control System will include the 2008 baseline data that will be used for measurement of progress going forward. Software should be fully operational in the first quarter of Calendar Year 2011.
- Smart Grid: The Town is proceeding with wireless, programmable thermostats as new heating systems are installed in public facilities. The intent is to be compliant with the emerging Concord Smart Grid and to use those capabilities in public facilities as they become available. Smart Grid will provide visibility to historical data in each of our municipal buildings on heating/cooling levels in each zone in each municipal building. (The integration of Smart Grid and Peregrine functions & data is under discussion. Access through a single user interface would be helpful.)

Other initiatives that need to be considered:

- Organizing roles & responsibilities: At present, roles and responsibilities in the Town and in and in the Schools need to be structured to include a proper level of focus on energy efficiency and conservation.
- Smart Grid: The Town and the Schools should sign-on to 100% support of the Town's Smart Grid policies and offerings. This includes both technical compliance in existing and new buildings, as well as participation in the 'leadership-level' offerings which possibly involve some sacrifice in comfort to enable peak shaving and management under Smart Grid control.
- Heating Plant Review: The Town is considering pursuing a technical evaluation of selected, older heating plants in our public buildings. Moving from outdated 80% inefficient boilers to new, 95% efficient systems could reduce natural gas consumption by 20% and the investments are eligible for reimbursement by National Grid.
- Air conditioning: As discussed above, reducing the Town's peak energy demand by augmenting traditional air conditioning compressors with chillers is promising. The ice-based refrigerant would be produced at night (ice) and the air handlers would use this cooling source between 1:00PM and 4:00PM in the summer when overall demand is highest.
- Integrated design team: While Concord has adopted the Stretch Code, we also need an integrated design team approach on all new building and on all enhancements to existing buildings that have any effect on energy or water consumption. Additionally, the Sawyer Trust initiatives need to be oriented more to 'design/build' where we can spend some of the STF resources on design expertise for specific projects.
- Renewable Energy:
    - Solar in Concord: Solar should be extended to other municipal rooftops. As discussed in the section on Renewable Energy, we should consider a goal of 5% of Concord's electricity to come from inside-the-grid solar with 2% from larger municipal and commercial rooftops. (The rooftops at the Light Plant and at 135-141 Keyes Road have already been estimated at 0.3MW.)

Vehicles:

Vehicles represents approximately 10% of the Town's overall energy consumption (Town plus Schools). With CSEC support, the Town should review our policies for the purchase of Town vehicles and consider making changes, if necessary, to ensure that we are purchasing fuel-efficient light trucks and passenger vehicles whenever such vehicles are commercially available and practicable.

Areas for consideration as we work though our policies for vehicles:

- Establishment of vehicle pools to allow vehicle sharing across Divisions. This would enable more optimization on purchases of light trucks and fewer of these vehicles while allowing us to transition more of our vehicle miles to hybrid passenger vehicles.
- Review purchasing practices for police vehicles to determine if part of the fleet can be transitioned to higher mileage vehicles.
- Review with Schools to determine if we can move any of the new bus purchase to bio-diesel.

Residential

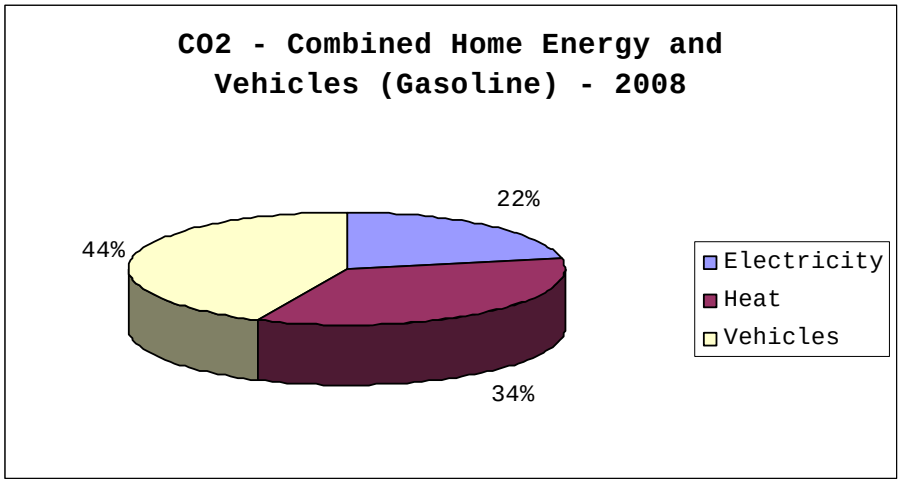
Overall Residential Baseline

The total tons of CO2 per residence in Concord is approximately 31 tons/year (12 tons/capita) for those factors that we can measure with some certainty,. This is based on Concord data for home energy, vehicle fuel, and curbside trash and on national data for diet. Other factors that are potentially significant have not been included because we lack sufficient data. For example, airplanes on a per passenger mile-basis are more CO2 intensive than auto travel but we currently have no way to estimate air travel for Concord because we have no data from which to estimate average trips/year. The major components of residential energy that we can measure include:

Residential	Total	Residence/Yr	CO2 Tons	CO2 Tons/ Residence*	CO2/ Capita
Electricity	70,176,556 kWh	11,798 kWh	37,790	6.4	2.5
Natural Gas	3,904,242 therms	1,575 therms	21,473	8.7	3.3
Fuel Oil	3,337,152 gals	1,092 gals	37,042	12.1	4.7
Gasoline	7,249,602 gals	1,219 gals	73,946	12.4	4.8
Total			170,252		

* Note: Residences by type of heat: 2479 natural gas; 3056 fuel oil.

Home energy at 56% (combined total for heat and electricity) is the largest contributor to directly measureable residential energy consumption and CO2. And, of the two, home heating is the most significant contributor.



Residential Heating

Given the importance of home heating as an energy consumer and CO2 contributor, we will discuss the variables affecting home heating energy and greenhouse gases and we will review several different home heating scenarios. Key variables influencing home heating fuel

consumption are the age of the residence, heating efficiency (furnace), and size (net square feet). The three scenarios include:

- Average Concord residence – 2500 square feet of living space and 64 years old. Our strategy for improving efficiency should target this profile.
- New build of 2500 square feet for comparison purposes to better understand our opportunity for gains in heating efficiencies in the majority of Concord's residences
- Average new home of 4500 square feet of living space. House sizes are increasing. Between 1980 and 1993, the average size of a new home grew from 3123 sq. ft. to 4376 sq. ft., while new homes in 2008 are averaging 4477 sq. ft. Consistent with population trends, the number of new, single family homes added between 2004 and 2009 (2009 Annual Report: Concord Building Inspections Division) has been relatively stable at 25/year.

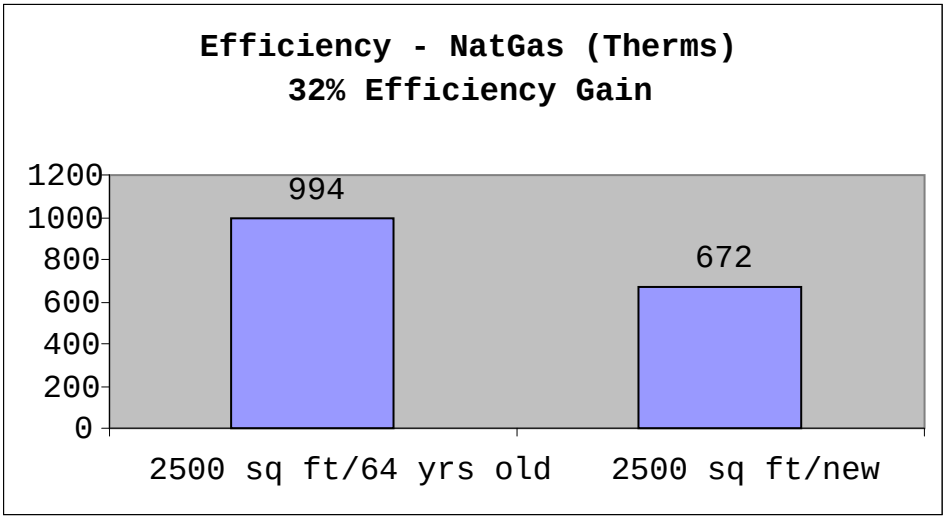
Model Used In Comparisons

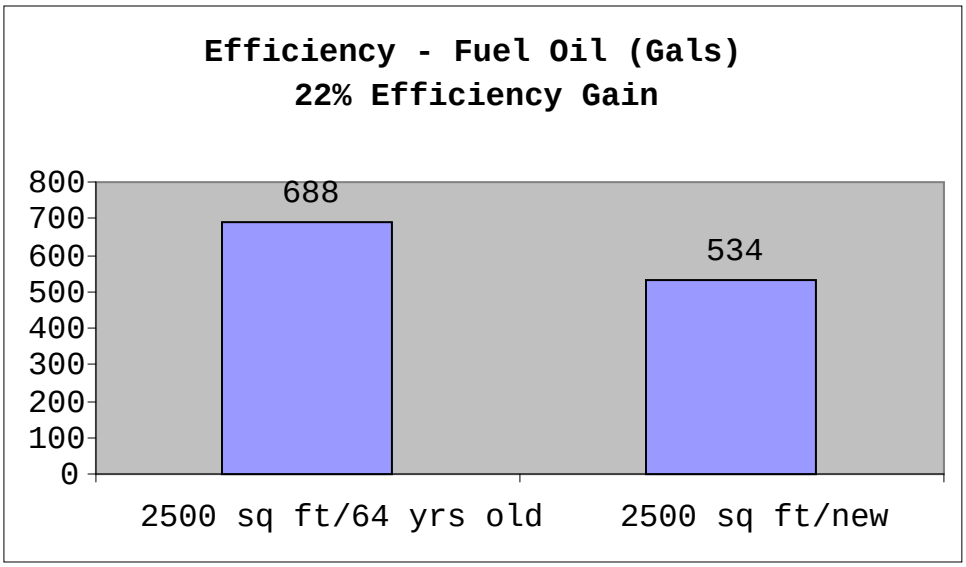
A model from National Grid is used to make the comparisons. This model uses data from the EPA to properly account for the impact of key housing variables on heating fuel consumption and CO2. These include:

- Age of building envelope: The EPA provides 'historical heat loads' by region and age of home which reflect BTU's per square foot. This enables the model to account for the efficiency of the building envelop or insulation, relative building quality, and overall heat loss.
- Furnace efficiency: for 'vintage' furnaces, we used the EPA ratings for furnaces installed between 1988 and 1991. For new home furnaces, we used high efficiency ratings, between 86% (oil) and 95% (natural gas).
- Type of fuel: The third variable is fuel type. Natural gas is more efficient than oil as mentioned above and produces 40% less CO2 per BTU than oil. Also, at present, natural gas is less expensive.

Average Concord Home vs. 'Same Size' New Build

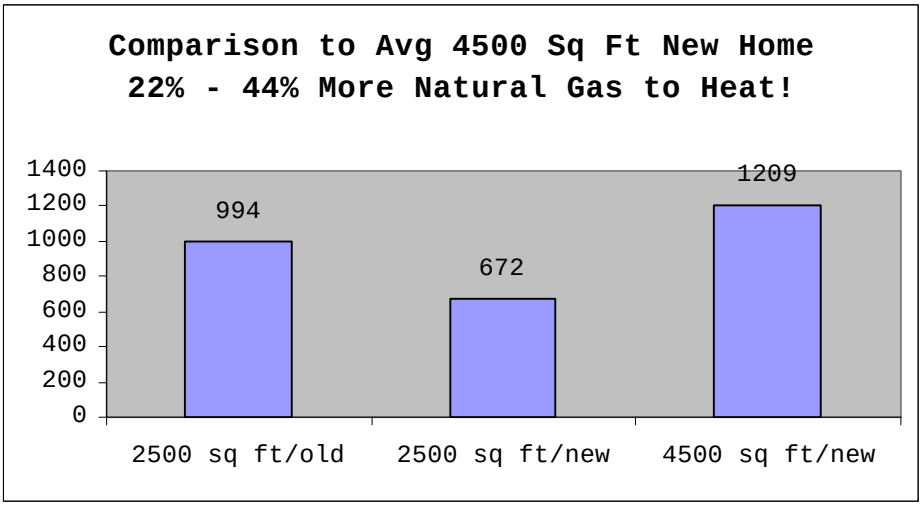
The first comparison is between an average Concord home of 2500 net square feet and 64 years old versus a new build of the same size. The assumed heating system efficiency (from EPA charts) for the older homes are 77% for gas-fired and 80% for oil. For new construction, we assumed high efficiency boilers with ratings of 95% for gas and 86% for oil. The results are shown below. Note that the efficiency gains for natural gas are higher (32% savings) than for oil (22% savings) as we move from the 64 year old home to new construction. This shows that there's a significant opportunity for gains through improvement in weatherization and boiler systems, especially if the fuel is natural gas.





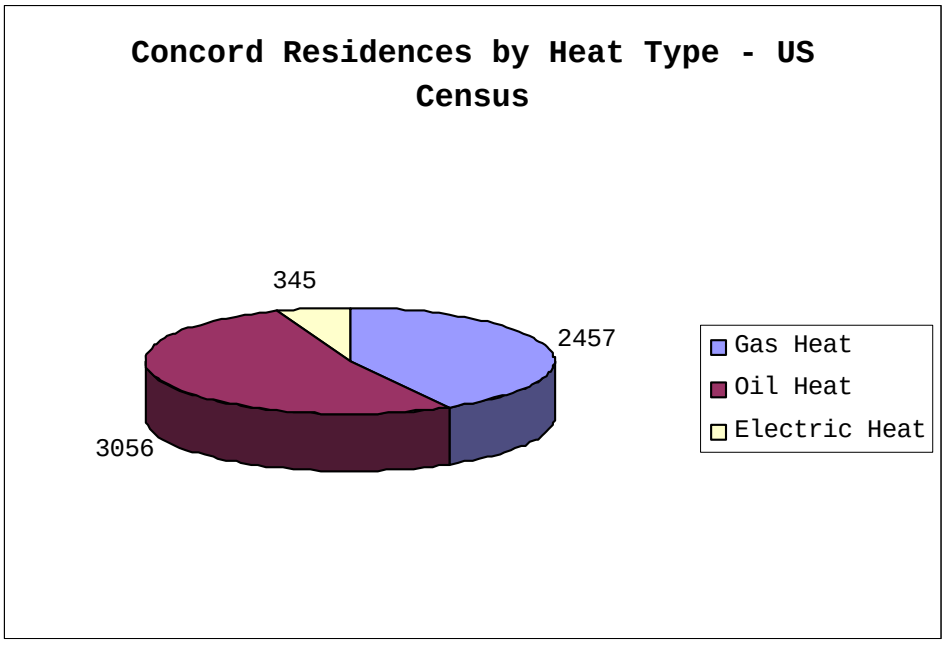
Average 4500 Sq. Ft. Concord Home (Age = New)

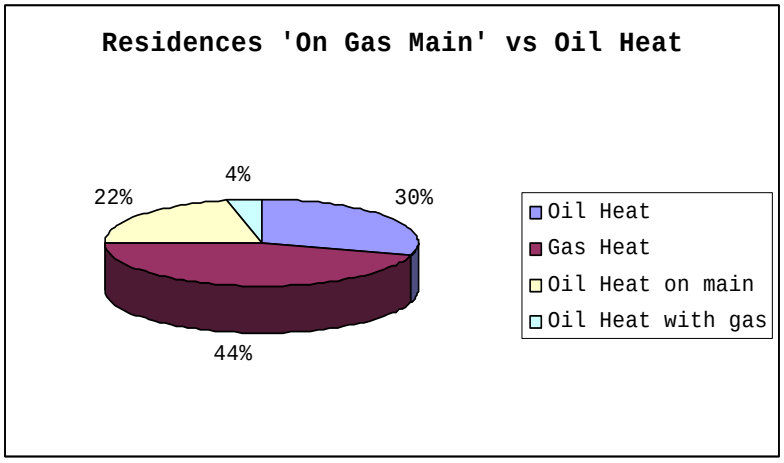
With the average new home in Concord averaging 4500 sq. feet, we lose many of the efficiency gains due to the need to heat larger volumes of space: the larger but more efficient new homes are requiring between 22%-44% more resources to heat than the average Concord home.



Oil vs. Gas Heat

From a CO2 emissions perspective, it's an unfortunate aspect of Concord's demographics that a large proportion of our residences are heated with oil (there's substantial difference between oil-heat and gas heat from a CO2 perspective - oil-heat contributes 40% more CO2 than natural gas). However, there may be a silver lining in the cloud. The large number of potential gas heat customers' currently using oil may present us with an opportunity that both improves the economics of heating in Concord and reduces our carbon footprint.





National Grid estimates there are approximately 1200 residences that are in close proximity to the gas line but who are not customers of National Grid in any way at present. Another 200 are gas customers but only for appliances (dryers, water heaters, etc). This means we have total of 1400 residences are that are candidates for conversion ** (or nearly 50% of existing oil heat customers). It might make strategic sense for Concord to work with National Grid to convert as many of these customers to natural gas on an opportunistic basis. At the very least, we should be sure that home owners understand the various trade-offs:

- Carbon footprint: natural gas is clearly superior to oil on a CO2 basis -- gas contributes approximately 40% less CO2.
- Efficiency: we'd get the added benefit of moving these customers to high efficiency gas boilers which will reduce overall consumption in Concord.
- Supply: We have a larger domestic supply of natural gas than oil and this adds security and stability to the equation.

Conversion from oil to natural gas: Given the 40% CO2 spread between gas and oil heat, significant reductions in our carbon footprint could be achieved by moving oil heat customers over to gas. The 1400 oil customers with access to gas service could benefit by moving to cleaner fuel and boilers with higher efficiency ratings.

**Note: A new service installation costs $1,300 for up to 100 feet of service line length; beyond 100 feet costs an additional $10 per foot.

Heating Efficiency

While experts indicate that a substantial reduction in housing energy use is possible, converting home heating efficiency audits (intentions) to investments (action) has been problematic in most communities. The following are some of the possible strategies that should be considered:

- Building codes: While Concord's population is relatively stable and we're only seeing slight increases in our total housing stock on an annual basis, the new Stretch Code, passed at the 2010 Annual Town Meeting addresses energy efficiency issues and will help us to upgrade the overall efficiency over time by ensuring that the new residences and additions are built to a higher standard.
- National Grid initiative: Given the availability of incentives from National Grid, it would make good sense to partner with National Grid to implement a residential energy efficiency initiative in Concord. We need to understand the results they think they can attain and we should partner with them to improve upon those results. Upon completion of a residential program, it could be extended to the commercial segment.
- Gas-heat and oil-heat customers and energy efficiency in general: we need an end-to-end solution that completes the loop from audit to corrective action. It's well understood that the completion rates (follow-through) for audit programs is quite poor, suggesting that the voluntary approach has its flaws. Some possible ideas:
    - Research on persuasion indicates that the major influence upon our attitudes and behavior is our contact with other people. Communicating with people over the phone or face-to-face about improving the energy performance of their home will enhance the likelihood they will take action.
    - Communicate through a variety of media to encourage Concord residents to participate in a home energy efficiency program to foster an understanding of what others are doing with conservation and efficiency. People consider others' behavior when deciding what is appropriate behavior for themselves. In fact, the knowledge that others have taken steps to conserve energy has been shown to have more influence over people's energy conservation decisions than motivations associated with saving money or protecting the environment.
    - We need to ensure that customers who request audits are properly qualified for potential to follow-through. This is accomplished through screening against a set of criteria that are reasonable predictors of success.
    - Establish a standard that has value. Can we establish a 'green seal of efficiency' and work with the real estate community to market this as something that creates new value for the homeowner?
    - Lost cost loans will help. We need to make corrective action appealing. The problem we are confronting is the unappealing nature of an investment which has long term payback and which deals with an intangible (CO2 emissions). Can the Town establish a low cost loan mechanism and use the real estate tax as the method to eliminate financial obstacles by enabling loan payback over longer periods of time (say, 20 years)?
    - Town-driven marketing. The Town will need to push this initiative through its goal statements and policies to the extent it can do so without becoming onerous. We need a bully pulpit….

Vehicles in Residential Segment

The vehicle population in Concord has been reasonably stable over the 2000 – 2008 timeframe with growth in 'automobiles & luxury cars' of just 2%; however, growth in 'SUVs' was 32% over that period, from approximately 3500 to 4500. (MA DOR, Socioeconomic, last updated 02/01/2010). Included in the "automobile and SUV' category are hybrids.

Data below exclude Municipal vehicles but residential and commercial are combined (we have no way to break-out commercial vehicles).

Light vehicles	11,764
SUVs	4,496
Total vehicles	16,260
Light vehicle fuel efficiency	27.5
SUV fuel efficiency	21.6
Average miles traveled	11,400
Average vehicles/residence	2.7
Gals of gas - light vehicles	4,876,713
Gals of gas – SUVs	2,372,889
Total	7,249,602
Gallons/year/residence	1,219

While home heating & home electricity are the biggest sources of residential energy consumption, vehicles are the second largest consumers of energy. Suburbs and ex-urbs are problematic, from both commuting and services perspectives. However, a focus on policies that reduce vehicle miles over time can brighten the picture. There are three areas that need focus:

- Migration to smaller vehicles – both hybrids and electric cars. In addition, the Smart Grid, with its associated pricing policies is a very promising level for change. Concord could encourage more rapid adoption of electric vehicles by offering incentives such as separately metered and lower cost off-hours electricity.
- Localization: This area holds promise for reducing the need to travel to jobs and for services (see discussion under this topic). A more vibrant community with attractive services should reduce the need for driving outside of the Concord area.
- Community Planning: We can encourage development over time that is more conducive to walking, biking, and mass transit. (see discussion under Community Planning.)

Other Contributors to Residential CO2

To develop a more complete picture of the residential segment, we've added food/diet and air travel:

- Food/diet: We are using the numbers from David Pimental, Cornell University, which indicate 4.2 total tons per person/year for food production and distribution[19]. A vegan diet is estimated at 2.2 tons/year while a typical diet with animal products is 4.2 tons/year. At 10.9 tons for a Concord family, this accounts for the same overall percentage as vehicles. It's important to account for food/diet because we have choices that affect greenhouse gases. For example, beef is a significant contributor while other meat is less CO2 intense and locally produced dairy and vegetables have less transportation content.

- Airplane travel: Airplanes are more CO2 intensive than vehicles and are a potentially very significant greenhouse gas contributor, but, as mentioned, we do not have data to assess the CO2 impact. Nevertheless, we will provide an example. If we assume a family of 2.6 people taking a roundtrip fight (1500 miles in one direction), the CO2 impact from that single trip is 1.7 tons of CO2. A round trip flight from Boston to San Francisco is going to contribute 3 tons. As such, the CO2 effect of a single round trip for the family to the West Coast or to Europe is approaching 1/3 of the CO2 from annual use of household vehicles.

[19] Pimental, David, *Food, Energy and Society*, University Press of Colorado, 2008, p. 147

- Trash: This is discussed below. CO2 contribution from trash on a per residence basis is less than 1 ton of CO2 annually. However, improvements in this area have a salutary effect on one's overall approach to the environment and it's simply the right thing to do. And, effects from removing wet garbage from the waste stream could be significant because at least half of our garbage is sent to landfills and wet garbage produces methane which is 20x more harmful than CO2.

Summary of Residential Energy Consumption/CO2

The summary of the 'safe' data on energy consumption in Concord in the residential segment shows the following:

	Tons CO2 per Residence	Tons CO2 per Person	Notes
Vehicles	12.4	4.8	Based on Concord vehicle census (source – Commonwealth of MA)
Food/Diet	10.9	4.2	David Pimental, Cornell
Heat	9.8	3.8	Nat Grid for gas, extrapolated to oil
Electricity	6.4	2.5	Actual CMLP data
Trash	1	0.4	Concord Waste Mgt data
Total	**40.5**	**15.7**	

This means that a Concord resident on average is using energy equivalent to nearly 16 tons of CO2 annually, before we account for the effects of other consumption (manufacturing of the autos and PCs we purchase, all goods purchased other than foods, telecommunications & internet, medical services, and infrastructure (use of cities, buildings, roads). The point here is that we are most likely on the high end of energy consumption and well above the average for Americans (20 tons of CO2/person). However, these comparisons are difficult to make and we'll need to do a bit more research.

Proposed Recommendations

Home Energy: The first recommendation is for Concord to pursue an end-to-end home energy efficiency initiative. Initially, this could focus on weatherization and boiler efficiency to reduce natural gas use and the associated CO2. And, this initiative could be broadened to include electricity used in natural gas-heated homes. Phase II would extend this initiative to include oil heated residences, although this is more problematic because there are no incentives for oil-heat customers. Additionally, it is recommended that Concord develop a strategy for low cost loans to support efficiency objectives. In at least one noteworthy East Coast community (Babylon NY), home improvements for efficiency are averaging $8,500 with $1,000 average savings per year, supported with 3% loans.

Natural Gas Conversions: The second recommendation is to explore a partnership with National Grid to move customers from oil to natural gas, as new gas furnaces are more efficient than oil furnaces, the CO2 footprint is 40% smaller, and natural gas is cheaper (at least at the present time). This initiative could provide information on the attractive use of natural gas along with the process that needs to be followed if someone wants to convert. A second step could be the streamlining of the process.

'Normative' energy billing: As discussed under the chapter on electricity, providing billing which indicates comparisons to one's peers in the community is useful in changing behaviors and reducing energy consumption. Savings of 1-3% can be realized through this strategy. O-power is providing these services to National Grid customers and we could do the same here in Concord, focusing on a consolidated view for both natural gas and electricity. Oil-heat customers would be limited to an electricity view. As discussed, these bills provide comparisons of one's consumption to 'efficient neighbors' and to 'all neighbors'.

Vehicle Fleet: This is a significant consumer of energy and a serious problem from a CO2 perspective. As discussed, there are some underlying reasons for heavy vehicle use in a town like Concord which need to be addressed through nuanced strategies that encourage walk-able & bike-able development, smaller/less remote homes, more attractive, local services, as well as local sources of fresh food. More obvious solutions include education on the effects of driving and direct encouragement of the alternatives through marketing efforts. As important, we need to make biking a more attractive way to get around Concord by implementing well understood strategies for biker friendliness – bike paths, rules on rights-of-way for bikers, bike racks, etc.

Trash: While this is discussed under the trash and recycling section, there's no good reason to provide the residential segment with so much choice over garbage haulers. A single hauler strategy would be a big gain for us in reduced disruption and improved efficiencies. Second, we should consider a separate stream for wet garbage to enable its recycling. (A companion recommendation is to increase the incentives for people to establish their own compost piles.)

Commercial Segment

Concord's commercial real estate base consists of approximately 3.5M square feet of floor space and on an annual basis this segment consumes 55% of Concord's kWh's and 41% of its natural gas. And, more than half of the commercial segment is heated by oil.

	Annual Consumption	Annual Cost	Annual CO2
Electricity	97857454 kWh	$10,488,391	51,286
Natural Gas	3716428 Therms	$6,503,749	18,582
Fuel Oil	3102327 gals.	$8,531,398	31,023
		$25,523,538	100,891

Areas of focus should include:

- Continued focus by CMLP on power factor and demand management for larger users. Improving the power factor improves the efficiency in our use of electric distribution capacity and reduces cost. This is already a priority for the CMLP.
- Providing incentives and support to add ice chillers to off-load high consuming standard air conditioning compressors would help with peak load management. This is discussed above.
- Transitioning larger commercial users from oil to gas or from standard electric baseboard to ETS has obvious advantages. Again, this requires a focused outreach program and we can leverage information from the assessors data.
- Insulation/weatherization: Participation in the National Grid program would make sense as incentives are available for insulation. Importantly, incentives are also available in the commercial segment for boiler upgrades to the high efficiency standard.

The Municipal sector will receive more focus in Phase II of this effort which will kick-off later in 2010….

Community Planning

Community planning is by nature an inclusive process that integrates all aspects of real property and the zoning laws that govern it, the public health, safety and welfare, vested economic interests, transportation networks, housing diversity, land use, environmental considerations, natural resource conservation and the existing social make-up of a place. Community planning, though often legally grounded in local bylaws and influenced or bound by regional, state-wide or federal initiatives, is necessarily evolving to reflect the shifting paradigms of the times and the focus of the citizenry.

One of the big paradigm shifts over the past few decades that is related to community planning has been the trend toward sustainable development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 3/20/87), as evidenced by the spread of ideas such as new urbanism, eco-villages, renewable energy sources and the proliferation of the green building industry. Other such shifts in focus include smart growth versus sprawl, transit-oriented mixed-use projects versus auto-dependent strip-mall development, complete streets that provide travel choice versus single-mode roadway systems and provisions for renewable energy resources versus status quo grid dependency. These principles all promote a pattern of higher density, walk-able developments that are proximate to existing infrastructure and utility networks, that provide easier access to essential services for all ages and abilities and that reduce reliance on fossil fuels.

Strategic Position

Concord has many of the right characteristics to capitalize on the trend toward a more sustainable future and more sustainable planning techniques – it is located just 20 miles west of downtown Boston with two stops on the Fitchburg Line of the MBTA Commuter Rail; it has a healthy tax base given its relatively modest population of about 15,300 people; it has a robust tourist industry due to its rich literary and Revolutionary War history, much of which lies within six different historic districts in the downtown areas; it has about 1,350 acres of active farmland[20] and 1,380 acres of permanent conservation land[21]; and it has two lively downtown areas – Concord Center and West Concord – that encourage the development and patronization of local businesses.

In order to take the Town's strategic position to the next level, Concord needs to create policies that promote sustainable planning practices, such as those mentioned above, which may be most effectively implemented and enacted through "codification in" or "amendment of" the Town of Concord Zoning Bylaw.

The Town of Concord has a 7-member Planning Board that is appointed by the Board of Selectmen, supported by Planning Division staff and authorized under the General Laws of Massachusetts to propose local Zoning Bylaws and adopt the Subdivision Rules and Regulations as they pertain to proposed developments and subdivision of land within Town. The Planning Board is also responsible for proposing Zoning Bylaw amendments as determined to be necessary at the Annual Town Meeting; this may include such things as adopting specific chapters of the Massachusetts General Laws, revising existing bylaws for increased densities and making modifications to dimensional requirements in zoning districts.

Current Codes & Practices

The current Town Zoning Bylaw that is implemented by the Zoning Board of Appeals and the Planning Board includes a few sections that speak to sustainable planning practices, albeit somewhat indirectly. While these bylaws have been implemented with some success, there may be ways in which they can be revised to more directly meet the goals of this plan.

Flood Plain Conservancy, Groundwater Conservancy & Wetlands Conservancy Districts
These bylaws are in place primarily to protect natural floodwater storage areas and Zone II aquifer recharge areas from the negative impacts of development and provide information relative to wetlands for planning purposes. Protecting these areas in turn protects residents and property owners from the hazards of flooding and from the adverse impacts created when wetlands are filled and potable water quality and supply are compromised.

When developments are proposed on sites within these jurisdictions, the Planning Board and Natural Resources Commission work to align their recommendations and requirements, and often ask for connected public access trails, reductions in impervious area, and stormwater management and design that follows best management practices and takes advantage of site-specific opportunities for low impact development techniques.

Residential Compound, Residential Cluster and Planned Residential Development
These bylaws are in place primarily to promote the concentration or cluster of development on one area of a site to enable the preservation of large open space areas and the rural character of the Town; they are frequently-used alternatives to the land consumptive standard subdivision. These bylaws also encourage a mixture and diversity of housing types and have allowances for somewhat greater density if affordable housing units are provided.

[20] Comprehensive Long Range Plan, March 2005, page xvii
[21] Open Space and Recreation Plan, 2004, page 49

The Planning Board is proposing minor modifications to the Planned Residential Development Bylaw at the 2010 Town Meeting and has been exploring the possibility of replacing or supplementing the PRD with a Flexible Residential Development Bylaw that will allow for a greater variety of density and development options based on the underlying land features and what is proposed.

Subdivision Rules & Regulations
The Planning Board purview of standard subdivisions under the Subdivision Rules and Regulations extends to the layout, pedestrian and vehicular access, provision of utilities, drainage design, trees and plantings, street signage and lighting, and preservation of historical and rural character.

Town staff from many divisions will be working together on a revised set of Subdivision Rules & Regulations that specifically target the provision of low impact development (LID) techniques for storm water system design in 2010 and 2011. At such time, other areas will be revised as needed and other opportunities may be discovered. The Planning Board will have the option to adopt the new regulations without a Town Meeting vote, but after a public hearing.

Suggestions/Recommendations
The Planning Board, whenever possible, recommends that applicants incorporate porous pavement, grass pavers, centralized recycling/composting bins and mailboxes, bike racks, sidewalks, pedestrian paths, reduced lighting, organic fertilizers, preservation of trees, and low impact development techniques into their plans.

Opportunities

The Patrick Administration's Smart Growth / Smart Energy Program
In 2007, Governor Patrick established the Development Committee to focus state policies and practices around a series of sustainable development principles: (1) concentrate development and mix uses, (2) advance equity, (3) make efficient decisions, (4) protect land and ecosystems, (5) use natural resources wisely, (6) expand housing opportunities, (7) provide transportation choice, (8) increase job and business opportunities, (9) promote clean energy, and (10) plan regionally.[22] The Smart Growth / Smart Energy Program seeks to disseminate these principles throughout the 351 municipalities in the Commonwealth through an annual educational conference, state funded grants and awards (i.e., Commonwealth Capital Policy, Smart Growth/Smart Energy Awards), technical assistance, and a toolkit with model bylaws – some of which are noted below (*) as potential opportunities for the Town of Concord.

State Level Initiatives

1. *Adopt MGL Chapter 40R: Smart Growth Zoning Districts**
   The Town of Concord may be eligible to adopt Smart Growth Zoning Districts that would promote the integration of land uses, housing diversity, compact design, open space preservation, transportation choice and informed decision making. Eligible locations for Smart Growth Zoning Districts include areas near transit stations, areas of concentrated development and areas that are currently underutilized but have adequate existing infrastructure. The major benefit to the Town of adopting Chapter 40R is the entitlement to zoning incentive payments and one-time density bonuses for affordable housing allocated on a sliding scale based on the number of units constructed.

[22] http://www.mass.gov/envir/smart_growth_toolkit/pages/state-policy.html

In addition, municipalities that adopt Chapter 40R and implement a Smart Growth Zoning District will be eligible for Chapter 40S funding to educate the increased number of school children that result from the 40R development.

2. *Adopt the Stretch Code (MA Building Code Appendix 120.AA, "Stretch" Energy Code)*
The Massachusetts Board of Building Regulations and Standards (BBRS) adopted the Stretch Code in 2009 in order to provide an alternative for improved energy efficiency in the Commonwealth. At this year's Town Meeting, the Town of Concord may choose to adopt the Stretch Code in place of the "base" building code, which would result in approximately 20% greater efficiency in new construction and renovation and would require third party testing and rating of building energy performance sooner than 2012.

Local Bylaw Amendments & Potential Local Initiatives

1. *Right To Farm Bylaw*
In order to increase awareness about the history and ongoing importance of farming in Concord, the Town has the opportunity to adopt a Right to Farm Bylaw. This Bylaw was not moved at Town Meeting this year but the plan is to return with this at the 2011 Town Meeting. The purpose of the bylaw is to reinforce within the community that farming is a valued and accepted activity in Town, to promote a better understanding between farmers and their neighbors, and to alert potential newcomers that farming activities that may cause dust, noise and odors are a normal and necessary aspect of living in Town. Such a bylaw is important to the localization of food production and the conservation, maintenance and improvement of agricultural land for its natural and ecological value.

2. *Floor Area Ratio, Yard Setbacks, Height Restrictions, Massing & Scale*
The Town of Concord has been experiencing a steady rate of development that has included an average of 19 tear-downs per year since 2004.[23] Many of the homes that have been torn down have been replaced with much larger homes, though the lots that they are built on may be fairly small. The current Zoning Bylaw limits house sizes in each zone through front, side and rear yard setbacks and height limitations; some homeowners in Zones B and C in particular, would like to see the Town revisit these dimensional requirements and bylaws to incorporate a combination of the following: (1) a provision for Floor Area Ratio, (2) an increase in the existing setbacks, (3) a decrease in the maximum height permitted, (4) provisions for controlling the massing and scale of homes to maintain the character and open space of the neighborhood, and (5) the implementation of a Large House Review process. These are just a few of the options that the Planning Board and town residents will explore in determining how best to balance the property rights of existing homeowners with those of their neighbors. As housing is one of the largest contributors to the Town's carbon footprint, any limitation on house size by zone, with or without behavioral change, would help reduce a homeowner's electric use and heating demand (and construction debris for new development), while ensuring the privacy, views and adequate access to sunlight for solar thermal and daylighting of the neighboring properties.

3. *As-Of-Right Siting Bylaw for Renewable and Alternative Energy*
The current Town of Concord Zoning Bylaw neither designates specific sites for large scale renewable and alternative energy projects nor expressly permits development of commercial renewable energy projects; however, such uses may be allowed under the current bylaw if they are deemed accessory to the principal use or if the company works out a public/private partnership with the Concord Municipal Light Plant so that it could reasonably be legally determined to be a municipal use, for which the Town may need to vote to allow the Town Manager to enter into a long-term lease of municipal land for a renewable energy installation.

   The Town of Concord may want to explore the option of amending its Zoning Bylaw to allow large scale renewable installations by-right in certain Zoning Districts and to establish an As-Of-Right Siting Bylaw or Overlay District for Renewable and Alternative Energy to regulate

[23] 2009 Annual Report: Concord Building Inspections Division

the placement, design, construction, operation, maintenance and removal of such facilities in order to protect neighboring developments, scenic vistas and natural resources from unintended consequences.

4. *Transfer of Development Rights (TDR) Bylaw**
   As approximately 40% of Concord's land area is developed and 30% is protected open space, approximately 30% remains undeveloped and unprotected, of which slightly more than 600 acres are unprotected farmland.[24] The Transfer of Development Rights concept is one in which development potential and development rights in certain areas (called sending areas) are more restricted to encourage people to transfer their development rights to other areas (called receiving areas), where development incentives are encouraged through the use of density bonuses and affordable housing bonuses. The basic intent of such a bylaw is to protect large tracts of agricultural land, which are often in more remote locations in town, by allowing people to transfer their development rights to a more appropriate location, in town or in the region, where development is more desirable due to existing infrastructure, potential reuse of brownfield sites, greater density and housing demand and the realization of an equal or greater economic gain. This is a more challenging option because it is difficult for residents to understand and accept increased density of development.

5. *Transit Oriented Development (TOD) Overlay District Bylaw**
   The basic principle behind Transit Oriented Development is to concentrate higher density mixed-use developments within ¼ to ½ mile of transit nodes to encourage ridership, decrease auto-dependency, and meet local needs for housing choice, transportation, employment and services.

6. *Form Based Codes**
   Form Based Codes emphasize physical building form and scale over segregation of uses and are sometimes viewed as a response to traditional single-use zoning and urban sprawl. Form Based Codes could be implemented to help areas of Concord achieve more walk-able, compact development with an integrated built form and a strong relationship between building facades.

7. *Low Impact Development (LID) Bylaw**
   Due to its significant water resources and sandy, glacial till soils, large areas of the Town of Concord are prone to flooding during intense rain events. In order to reduce nonpoint source pollution from runoff and maintain the ecological integrity of the Town's water bodies, watersheds and drinking water supply, the Town may consider adopting a Low Impact Development Bylaw that would mandate certain Best Management Practices for storm water design and management.

Proposed Areas for Focus & Goaling Discussion

Possible areas of focus using planning tools include the following items, many of which need more discussion and definition and are an abstraction from the discussion of Community Planning above:

Town character & localization: One area where the Town has some leverage to direct commercial development is 'Formula Businesses'. Laws are fairly restrictive (interstate commerce, etc), however Towns like Concord are allowed some control over aesthetics and 'Town character' and this can be used to influence 'localization' where the objectives include maintaining a vibrant and useful set of Town services with a positive economic impact (local ownership). It makes sense to continue to consider these objectives, using available planning tools.

Smart development that focuses on minimizing negative transportation effects: This includes many of the initiatives and opportunities discussed in this section – residential

[24] Comprehensive Long Range Plan, March 2005, page xvii

compounds, denser development patterns, and smart growth emphasizing transportation centers, and development that is more friendly from a walking and biking perspective.

Providing more conservative residential scaling and more choice in housing density by creating new rules for existing zones: This includes current efforts to restructure the rules for Zone C in Concord which could have the effect of making more mid-sized and more energy efficient housing available in town.

Open Space: Another key area is the protection of existing open space and the setting-aside of additional, new space that can be protected from development. 'U.S plants and soils store almost 90 billion metric tons of carbon —the equivalent of around 50 years of U.S. carbon dioxide emissions at current levels. All together, terrestrial ecosystems in the US are soaking up carbon equivalent to about 30% of U.S. fossil fuel CO2 emissions." (Interior Secretary Salazar at COP-15, 12/10/09) The same is true in Concord. We have a wealth of undeveloped, open space that is an invaluable asset in our effort to offset the use of fossil fuels.

Agriculture: The last area that needs focus is the protection and extension of existing agricultural resources. Give the potential effects of 'peak oil' on agriculture, one of the most important areas of focus must be the development of additional local food capacity. It's estimated that agriculture currently uses ten calories of oil for every one calorie of food that's produced. This is clearly unsustainable and planning for the future will require development of more Concord-based farming assets.

Municipal Solid Waste

Residential Curbside Program

"Most people don't realize that the trash they throw away leads to emissions of greenhouse gases. Each pound of trash you throw away will emit approximately 0.94 pounds of carbon dioxide equivalent in the form of methane, and the average person in the U.S. throws away over 1,130 pounds of waste per year. For every person in the U.S., about 1,060 pounds of CO2 equivalent comes from the garbage we throw out every year. ….The average recycling rate for the United States is 31%. If the recycling rate increased to 35%, greenhouse gas emissions from waste could be reduced by 67 pounds of CO2 equivalent per person." (US EPA)….

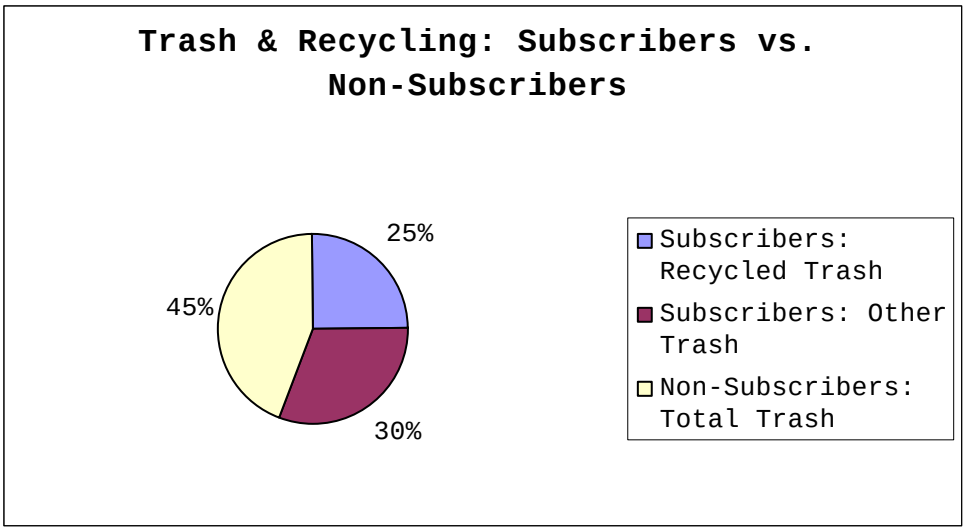
If you look at Concord's curbside collection, we can gain some insight into our performance as a town. First, this is a sample and includes those in Concord who participate in curbside collection – approximately 55% of single family residences[25]. Other residents use competing haulers and we do not have any data on the results; however, for CO2 analysis purposes, it should be acceptable to extrapolate these results to the town as a whole.

Number of Concord Household Subscribers **	3305
Total Trash (tons) for Subscribers**	4492
Total Recycled Trash for Subscribers**	2025
Percent Recycled for Subscribers **	45%
Total Trash per Subscriber Household (tons)	1.4
Total Number of Concord Households (Census)	5948
Total Trash in Concord – extrapolated (tons)	8084

A few points are interesting. First, Concord's participants in the municipal curbside collection program ('Subscribers') are leaving less trash at the curbside (after factoring for recycling) than the average U.S. residence – approximately 50% of the U.S. rate. Second, we are recycling more: a stable rate of 45% vs. the U.S average of 30%. But, given the lack of data on the 45% of Concordians who contract with a trash hauler other than the Town's contracted hauler (Waste

[25] Concord Solid Waste Fund – FY10 Proposed Enterprise Budget.

Management), it's unclear as to overall Concord performance on recycling and overall trash volumes.



Multiple Haulers (Residential) and the Waste Management Contract

There are at least 10 trash haulers active in Concord. The result is that we have multiple services in Concord on the same streets each week – multiple trucks, additional miles of driving, and the added nuisance of the additional pick-ups. A single hauler strategy would be more efficient in terms of the trucking and related CO2 emissions. Currently, Waste Management is using 22,800 gallons of diesel fuel/year (1900 gals/month) to pick-up garbage from 55% of Concord's residences, using routes that cover most of the Town. The other haulers follow many of the same routes and could consume another 20,000 gallons/year, given that they service the remaining 45% of Concord's residences.

If we were to adopt a single hauler strategy, there would be several benefits. First, the route would become more efficient and we would get a better overall social return on our investment in Waste Management's 22,800 gallons of diesel fuel. Second, we would eliminate the congestion and additional CO2 from the other 10 haulers operating in Concord. Additionally, a single hauler approach gives us better control over the process, policies, and reporting. And, this would enable us to add other value added services that could benefit the Town as a whole.

While there are potentially significant benefits from a single hauler strategy, there are also drawbacks and challenges. One problem is that the Town needs to accommodate residents who are unable to participate in the Town's Waste Management program due to the problems associated with moving their trash from their homes to the curbside pick-up. Long driveways and health issues can make this difficult for some residents. Others have developed a long-term relationship with their private hauler and don't want to make a change. For these reasons, the Town has not mandated a single hauler strategy. However, it's certainly worth a follow-up discussion between CSEC and the Public Works Commission to discuss ways to market the Town's program to increase the subscription rate and to derive some of the benefits discussed above.

Residential Construction and Demolition Waste

A second area in residential trash that needs to be evaluated is construction and demolition (C&D) waste. While it's unclear how many of the 600-700 building permits/year require a dumpster, it's safe to say that a large amount of trash is being hauled away each year from these additions/renovation sites and from the 25 new houses built each year (not to mention the 15-20 residential tear-downs each year). The question is whether the Town should institute a set of controls on this trash to encourage better practices. While the Town has primarily focused on

education, there is interest in further discussion on the use of enforcement controls for C&D materials, and this is something that may be evaluated in the future.

Organics

A third area for investigation is the elimination of organics from the waste stream with diversion to a high solids anaerobic digestion plant that would consume soiled paper, food waste, yard and tree waste as feed stocks to produce utility quality gas that could be used to produce both heat and electric power (CHP). Anaerobic digestion is a relatively new technology for this specific application but has been widely deployed in Europe. Harvest Power from Waltham has over 30 installations in Europe and a few in the U.S.

The challenge is finding sufficient land (3 acres) and the necessary volume of feed stocks (20,000 tons/year) to enable us to build-out a small scale plant (2 MW). The other challenge is obtaining community support for a combined waste collection point and power plant. However, we should look at this technology as an opportunity that could be deployed on a regional basis.

Harvest Power can be viewed at www.harvestpower.com.

Localization

Localization is a complex and nuanced topic that is as important as any in this document. While a detailed discussion of localization at this point is beyond the scope of this document, we would like to position Localization as 'phase II' for this master-planning effort. At the same time, it's helpful to provide a high level view of localization and it's impacts on a community like Concord.

First and foremost, localization focuses on the vitality of the local community, its economy, and its friendliness to low carbon living. A community which is highly self-sufficient where most of the requirements for life can be obtained locally meets the requirements we are discussing here. That is, residents can shop, work, and recreate in the same community in which they live. With no need to travel, vehicle and air miles decline to zero. Of course we don't achieve that utopia but that's the general idea. And, the point here is that communities that implements strategies and policies that improve the level of localization will have a lower carbon footprint than communities that don't. Second, there are other more nuanced aspects of this discussion that relate to the goods we purchase. Purchasing locally produced goods improves the vitality of the local economy and the related enjoyment of the community, as well as improving both choice and quality of services. Third, we should think about localization as something that needs to occur on a regional basis, rather than specific to your community; however, we need to focus on both.[26]

Community Education

If we are going to change Concord's approach to the use of energy resources, we will need to gain consensus around a new vision and our values will need to evolve to include better efficiency, additional focus on conservation, and a more local approach to life. Organizations like the League of Women's Voters and Concord Climate Action Network already play a vital role in the design and implementation of comprehensive and focused community education and can be counted on to further build-out our capability. Additionally, the CSEC could do more to publicize its activities.

[26] For a more complete discussion of Localization and its benefits, read Bill McKibben, *Deep Economy*, (New York, NY: Henry Holt, 2007)

There are at least three major themes or organizational concepts around which we could organize a community education initiative:

- Energy use and greenhouse gases: This area is focused on the relationship between consumption on the one hand and scarcity and greenhouse gases on the other. We all can be better educated on the sciences of energy and climate change. Prominent authors include Lester Brown, *Plan B*, and George Monbiot, *Heat,* as well as many others including James Hansen (NASA). Well-known films in this space include *The Big Squeeze* and *The Crude Awakening.*
- Life style choices: These are the less obvious, life-style-oriented, underlying drivers of energy consumption, such as diet (eating meat), use of local resources (services, food, shopping, vacations), and community planning (our interest in remote, suburban living). This area could focus on best practices and success stories from other communities or countries.
- How-to's: This would focus on the nut-and-bolts information that will help people make good choices. Examples include composting, weatherizing your home, evaluating your boiler, etc.

CCTV has been an effective vehicle for educating residents on energy and greenhouse gas issues and could be used more extensively, both for showing films, hosting live interviews of expert town residents, and delivering how-to demonstrations. Other delivery vehicles for community education include Life-In-The-Balance Series hosted by the League of Women's Voters and CCAN, as well as meetings in our churches in Town. Additionally, we need a focused effort to publicize activities and opportunities in the Concord Journal. Last, we should consider ways to exploit 'the teaching moment'. This includes our permitting process; when people apply for a permit, is that a good time to work through an energy agenda?

Appendix

The White House, Office of the Press Secretary, January 29, 2010

WASHINGTON, DC – [The U.S. Administration] announced today announced that the Federal Government will reduce its greenhouse gas (GHG) pollution by 28 percent by 2020. Reducing and reporting GHG pollution, as called for in Executive Order 13514 on Federal Sustainability, will ensure that the Federal Government leads by example in building the clean energy economy. Actions taken under this Executive Order will spur clean energy investments that create new private-sector jobs, drive long-term savings, build local market capacity, and foster innovation and entrepreneurship in clean energy industries.

As the single largest energy consumer in the U.S. economy, the Federal Government spent more than $24.5 billion on electricity and fuel in 2008 alone. Achieving the Federal GHG pollution reduction target will reduce Federal energy use by the equivalent of 646 trillion BTUs, equal to 205 million barrels of oil, and taking 17 million cars off the road for one year. This is also equivalent to a cumulative total of $8 to $11 billion in avoided energy costs through 2020.

“As the largest energy consumer in the United States, we have a responsibility to American citizens to reduce our energy use and become more efficient,” said President Obama. “Our goal is to lower costs, reduce pollution, and shift Federal energy expenses away from oil and towards local, clean energy.”

Federal Departments and Agencies will achieve greenhouse gas pollution reductions by measuring their current energy and fuel use, becoming more energy efficient and shifting to clean energy sources like solar, wind and geothermal….”

On October 5, 2009, President Obama signed Executive Order 13514 on Federal Sustainability, setting measureable environmental performance goals for Federal Agencies. Each Federal Agency was required to submit a 2020 GHG pollution reduction target from its estimated 2008 baseline to the White House Council on Environmental Quality and to the Director of the Office of Management and Budget by January 4, 2010. The Federal target announced today is the aggregate of 35 Federal Agency self-reported targets.

Greenhouse gas emissions serve as a useful metric to measure the effectiveness of agency energy and fuel efficiency efforts as well as renewable energy investments. Agencies are already taking actions that will contribute towards achieving their targets, such as installing solar arrays at military installations, tapping landfills for renewable energy, putting energy management systems in Federal buildings, and replacing older vehicles with more fuel efficient hybrid models.

As a next step, the Office of Management and Budget will validate and score each agency’s sustainability plan, assuring a long-term return on investment to the American taxpayer. To ensure accountability, annual progress will be measured and reported online to the public….

eGrid Tables

Table 4. Estimated Carbon Dioxide Emissions Rate From Generating Units at U.S. Electric Plants by Census Division, 1998 and 1999 (Pounds per Kilowatthour)

Census Division	1998					1999				
	Total	Coal	Petroleum	Gas	Other[a]	Total	Coal	Petroleum	Gas	Other[a]
New England	1.059	1.934	1.984	1.213	1.339	1.077	1.827	2.156	1.250	1.328
Middle Atlantic	1.071	2.062	1.884	1.188	1.502	1.058	2.089	1.872	1.178	1.502
East North Central	1.680	2.113	2.244	1.239	1.124	1.579	2.061	2.759	1.630	1.131
West North Central	1.767	2.262	1.759	1.659	2.422	1.746	2.250	2.207	1.958	2.596
South Atlantic	1.334	2.026	1.821	1.113	1.377	1.342	2.019	1.822	1.115	1.372
East South Central	1.457	2.060	1.515	1.857	3.244	1.470	2.031	1.530	1.734	3.244
West South Central	1.469	2.214	3.955	1.376	0.151	1.529	2.215	3.170	1.382	0.151
Mountain	1.572	2.179	2.802	1.257	0.005	1.542	2.128	3.036	1.214	0.005
Pacific Contiguous	0.417	2.158	2.396	1.287	2.140	0.435	2.152	2.419	1.238	2.108
Pacific Noncontiguous	1.453	2.229	1.641	1.375	1.661	1.393	2.209	1.488	1.319	1.661
U.S. Average	**1.350**	**2.117**	**1.915**	**1.314**	**1.378**	**1.341**	**2.095**	**1.969**	**1.321**	**1.378**

[a]Other fuels include municipal solid waste, tires, and other fuels that emit anthropogenic CO_2 when burned to generate electricity. Nonutility data for 1999 for these fuels are unavailable; 1998 data are used.

Note: Data for 1999 are preliminary. Data for 1998 are final.

Sources: •Energy Information Administration, Form EIA-759, "Monthly Power Plant Report"; Form EIA-767, "Steam-Electric Plant Operation and Design Report"; Form EIA-860B, "Annual Electric Generator Report - Nonutility"; Form EIA-900, "Monthly Nonutility Power Report." •Federal Energy Regulatory Commission, FERC Form 423, "Monthly Report of Cost and Quality of Fuels for Electric Plants."

Table 3. Percent of Electricity Generated at U.S. Electric Plants by Fuel Type and Census Division, 1998 and 1999
(Percent)

Census Division	1998					1999				
	Coal	Petroleum	Gas	Other[a]	Nonfossil	Coal	Petroleum	Gas	Other[a]	Nonfossil
New England	17.9	24.4	13.8	4.6	39.3	16.3	22.9	18.0	4.6	38.3
Middle Atlantic	38.4	5.2	13.6	1.3	41.5	35.8	4.5	17.5	1.3	40.9
East North Central	76.3	0.8	3.8	0.4	18.8	72.0	0.7	4.4	0.4	22.5
West North Central	75.5	0.7	2.3	0.3	21.1	73.9	0.7	3.0	0.3	22.0
South Atlantic	55.3	7.2	6.6	0.7	30.2	55.5	6.7	7.8	0.7	29.2
East South Central	66.2	2.1	3.2	*	28.4	68.0	1.4	3.9	*	26.7
West South Central	39.1	0.6	42.2	0.3	17.8	40.1	0.7	44.6	0.3	14.3
Mountain	67.9	0.2	6.8	0.1	25.0	67.5	0.3	8.1	0.1	24.1
Pacific Contiguous	4.3	0.7	23.1	0.4	71.4	4.2	0.5	26.2	0.4	68.7
Pacific Noncontiguous	12.2	52.3	21.3	1.9	12.4	11.7	52.2	24.8	1.9	9.4
U.S. Total	**51.8**	**3.5**	**13.5**	**0.6**	**30.6**	**51.0**	**3.2**	**15.2**	**0.6**	**30.0**

[a]Other fuels include municipal solid waste, tires, and other fuels that emit anthropogenic CO_2 when burned to generate electricity. Nonutility data for 1999 for these fuels are unavailable; 1998 data are used.

* = the absolute value is less than 0.05.

Note: Data for 1999 are preliminary. Data for 1998 are final.

Sources: •Energy Information Administration, Form EIA-759, "Monthly Power Plant Report"; Form EIA-767, "Steam-Electric Plant Operation and Design Report"; Form EIA-860B, "Annual Electric Generator Report - Nonutility"; Form EIA-900, "Monthly Nonutility Power Report." •Federal Energy Regulatory Commission, FERC Form 423, "Monthly Report of Cost and Quality of Fuels for Electric Plants."

2008 Energy and CO2 Baseline – Concord's Municipal Segment

CY 2008 Town of Concord 'Municipal' Baseline -- Energy, CO2 Emissions

	Therms	Oil-Gals	kWh's	Heat-CO2	kWh-CO2	Total CO2
141 Keyes Rd/DPLM)	4,003		97,680	22	53	75
133 Keyes/Engin.	14,965		159,341	82	86	168
135 Keyes (WS/HG)	1,873		101,088	10	54	65
HWCC	13,152		114,080	72	61	134
Town House	6,580		90,000	36	48	85
Town House chillers			11,545	0	6	6
Gun House			619		0	
Admin/Deeds			1,067	0	1	1
Maint/Cemetary		1,068	2,151	13	1	14
Info Ctr	709		8,371	4	5	8
Police and Fire	14,196		300,358	78	162	240
WC Fire	8,110		38,920	45	21	66
Hunt	7,704		93,360	42	50	93
105 Everett	151	1,470	5,005	19	3	21
Beede	45,634		1,247,760	251	672	923
CMLP	0		430,560	0	232	232
Municipal bldgs total	**117,077**	**2,538**	**2,701,905**	**675**	**1,455**	**2,129**
Main Library	13,015		469,560	72	253	324
Fowler	2,318		44,200	13	24	37
Concord libraries total	**15,333**		**513,760**	**84**	**277**	**361**
Alcott	38,681		695,160	213	374	587
Thoreau	44,603		806,760	245	434	680
Willard	45,926		338,417	253	182	435
Ripley Admin	44,869		414,640	247	223	470
Sanborne - note	43,609		498,000	240	268	508
Peabody	47,968		324,640	264	175	439
Athletic fields	0		32,307	0	17	17
Concord schools total	**265,656**		**3,109,924**	**1,461**	**1,657**	**3,118**
CCHS total	**150,482**		**2,570,785**	**828**	**1,384**	**2,212**
Radio Tower			3,787		2	
Pumping stat/wells	3,464		1,303,553	19	702	721
Street/Traf Lights			714,318	0	385	385
CMPL Infrastructure			220,886	0	119	119
Deaconess Water Plant	3,367		402,000	19	216	235
W. W. Treat. Pl.		8,311	647,680	101	349	449
Infrastructure total	**6,831**	**0**	**3,292,224**	**19**	**1,773**	**1,792**
Municipal buildings	117,077	2,538	2,701,905	675	1,455	2,129
Concord libraries	15,333		513,760	84	277	361
Concord schools	265,656		3,109,924	1,461	1,657	3,118
CCHS	150,482		2,570,785	828	1,384	2,212
Infrastructure	6,831		3,292,224	19	1,773	1,792
Totals	**555,379**	**2,538**	**12,188,598**	**3,067**	**6,546**	**9,613**

WORLD ENERGY OUTLOOK 2010 FACTSHEET

What does the global energy outlook to 2035 look like?

The pace of the global economic recovery holds the key to energy prospects for the next several years, but it will be governments' responses to the twin challenges of climate change and energy security that will shape the future of energy in the longer term. The level and pattern of energy use worldwide varies markedly across the three scenarios in this year's *Outlook*, which differ according to assumptions about energy and environmental policies.

In the New Policies Scenario – the central scenario this year – world primary energy demand increases by 36% between 2008 and 2035, or 1.2% per year on average. This compares with 2% per year over the previous 27-year period. The scenario assumes cautious implementation of the policy commitments and plans announced by countries around the world, including the national pledges to reduce greenhouse-gas emissions and plans to phase out fossil-fuel subsidies. Projected demand growth is slower than in the Current Policies Scenario, in which no change in policies beyond those already adopted is assumed; demand grows by 1.4% per year over 2008-2035. In the 450 Scenario, which sets out an energy pathway to limit the concentration of greenhouse gases in the atmosphere to around 450 parts per million of CO2 equivalent consistent with an increase in global temperature of 2°C, demand still increases, but by only 0.7% per year.

In the New Policies Scenario, non-OECD countries account for 93% of the projected increase in global energy demand, reflecting mainly faster rates of growth of economic activity. China, where demand has surged over the past decade, contributes 36% to the projected growth in global energy use, its demand rising by 75% between 2008 and 2035 (our preliminary data suggest that, although Americans consume more on a per-capita basis, China overtook the United States in 2009 to become the world's largest energy user). Aggregate energy demand in OECD countries rises very slowly. Nonetheless, by 2035, the United States remains the world's second largest energy consumer behind China.

Global demand for each fuel source increases, with fossil fuels – coal, oil and gas – accounting for over 50% of the increase in total primary energy demand. Rising fossil-fuel prices for end uses, resulting from upward price pressures in international markets and increasingly onerous carbon penalties in many countries, together with policies to encourage energy savings and switching to low carbon energy sources, help to restrain demand growth for all three fuels.

Oil remains the dominant fuel in the primary energy mix to 2035. Nonetheless, its share of the primary fuel mix diminishes as higher oil prices and government measures to promote fuel efficiency lead to further switching away from oil in all sectors. Demand for coal rises through to around 2020 and starts to decline towards the end of the *Outlook* period. The share of nuclear power increases from 6% in 2008 to 8% in 2035. The use of modern renewable energy — including hydro, wind, solar, geothermal, modern biomass and marine energy — triples between 2008 and 2035, its share in total energy demand increasing from 7% to 14%.

Natural gas is set to play a central role in meeting the world's energy needs for at least the next two-and-a-half decades. Global natural gas demand, which fell in 2009 with the economic downturn, is set to resume its long-term upward trajectory from 2010. Demand increases by 44% between 2008 and 2035 – an average rate of increase of 1.4% per year. Growth in demand for gas far surpasses that for the other fossil fuels due to its more favourable environmental and practical attributes, and constraints on how quickly low-carbon energy technologies can be deployed. China's gas demand grows fastest, accounting for more than one-fifth of the increase in global demand to 2035. The Middle East leads the expansion of gas production, its output doubling by 2035. Over a third of the global increase in gas output comes from unconventional sources — shale gas, coalbed methane and tight gas — in the United States and, increasingly, from other regions. A glut in global gas-supply capacity, which could peak in 2011, will keep the pressure on gas exporters to move away from oilprice indexation, notably in Europe.

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WORLD ENERGY OUTLOOK 2010 FACTSHEET

What will shape the future of oil?

The global outlook for oil remains highly sensitive to policy action to curb rising demand and emissions. In the Current Policies and New Policies Scenarios, global primary oil use increases in absolute terms between 2009 and 2035, driven by population and economic growth, but demand falls in the 450 Scenario in response to radical policy action to curb fossil-fuel use.

The oil price needed to balance oil markets is set to rise, reflecting the growing insensitivity of both demand and supply to price. The growing concentration of oil use in transport and a shift of demand towards markets where subsidies are most prevalent are limiting the scope for higher prices to choke off demand and discouraging fuel switching. At the same time constraints on investment mean that higher prices lead to only modest increases in production. In the New Policies Scenario, the average IEA crude oil price reaches $113 per barrel (in year-2009 dollars) in 2035 – up from just over $60 in 2009.

Oil demand (excluding biofuels) continues to grow steadily in the New Policies Scenario, reaching about 99 million barrels per day by 2035 – 15 mb/d up on 2009. All of the net growth comes from non-OECD countries, almost half from China alone; demand in the OECD falls by over 6 mb/d. Global oil production reaches 96 mb/d, the balance of 3 mb/d coming from processing gains. Crude oil output reaches an undulating plateau of around 68-69 mb/d by 2020, but never regains its all time peak of 70 mb/d reached in 2006, while production of natural gas liquids (NGLs) and unconventional oil grows strongly. Total OPEC production rises continually through to 2035 in this Scenario, its share of global output increasing from 41% to 52%. Iraq accounts for a large share of the increase in OPEC output. By contrast, total non-OPEC oil production is broadly constant to around 2025, as rising production of NGLs and unconventional production offsets a fall in that of crude oil; thereafter, production starts to drop.

The eventual peak in oil will be determined by factors affecting both demand and supply. In the New Policies Scenario, production in total does not peak before 2035, though it comes close to doing so. By contrast, in the 450 Scenario, production does peak, at 86 mb/d, just before 2020, as a result of weaker demand, falling briskly thereafter. Oil prices are much lower as a result. The message is clear: if governments act more vigorously than currently planned to encourage more efficient use of oil and the development of alternatives, then demand for oil might begin to ease soon. As a result, we might see a fairly early peak in oil production, which would help prolong the world's oil reserves.

Unconventional oil is set to play an increasingly important role in world oil supply through to 2035, regardless of what governments do to curb demand. It meets about 10% of world oil demand in all three scenarios by 2035 compared with less than 3% today. In the New Policies Scenario, output of unconventional oil in aggregate rises from 2.3 mb/d in 2009 to 9.5 mb/d in 2035. Canadian oil sands and Venezuelan extra-heavy oil dominate the mix, but coal-to-liquids, gas-to-liquids and, to a lesser extent, oil shales also make a growing contribution in the second half of the *Outlook* period. In the New Policies Scenario, oil-sands production alone climbs from about 1.3 mb/d in 2009 to 4.2 mb/d in 2035, making an important contribution to the world's energy security.

The rate at which unconventional resources are exploited will be determined by economic considerations and the cost of mitigating their environmental impact. Unconventional sources of oil are thought to be huge – several times larger than conventional oil resources – but are among the most expensive available. Consequently, they will play a key role in setting future oil prices. The production of unconventional oil generally emits more greenhouse gas per barrel than that of most types of conventional oil, but, on a well-to-wheels basis, the difference is much less, as most emissions occur at the point of use. In the case of Canadian oil sands, well-to-wheels CO2 emissions are typically between 5% and 15% higher than for conventional crude oils. Mitigation measures will be needed to reduce emissions from unconventional oil production.

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WORLD ENERGY OUTLOOK 2010 FACTSHEET
How green will the energy future be?

Renewable energy sources will have to play a central role in moving the world onto a more secure, reliable and sustainable energy path. The potential is unquestionably large, but how quickly their contribution to meeting the world's energy needs grows hinges critically on the strength of government support to stimulate technological advances and make renewables cost competitive with other energy sources. Government support for renewables can, in principle, be justified by the long-term economic, energy security and environmental benefits they can bring, though it is essential that support mechanisms are cost-effective.

The greatest scope for increasing the use of renewables in absolute terms lies in the power sector. In the New Policies Scenario, renewables-based generation triples between 2008 and 2035 and the share of renewables in global electricity generation increases from 19% in 2008 to almost one-third (catching up with coal). The increase comes primarily from wind and hydropower, though hydropower remains dominant over the *Outlook* period. Electricity produced from solar photovoltaics increases very rapidly, though its share of global generation reaches only around 2% in 2035. The share of modern renewables in heat production in industry and buildings increases from 10% to 16%. The use of biofuels grows more than four-fold over the *Outlook* period, meeting 8% of road transport fuel demand by the end (up from 3% now).

Renewables are generally more capital intensive than fossil fuels, so the investment needed to provide the extra renewables capacity is very large. Investment in renewables to produce electricity is estimated at $5.7 trillion (in year-2009 dollars) over the period 2010-2035. Investment needs are greatest in China, which has now emerged as a leader in wind power and photovoltaic production, as well as a major supplier of the equipment. The Middle East and North Africa region holds enormous potential for large-scale development of solar power, but there are many market, technical and political challenges that need to be overcome.

Although renewables are expected to become increasingly competitive as fossil fuel prices rise and renewable technologies mature, the total value of government support is set to rise as their contribution to the global energy mix increases. We estimate that government support worldwide in 2009 amounted to $37 billion for electricity from renewables and $20 billion for biofuels. In the New Policies Scenario, total support grows to $205 billion (in year-2009 dollars), or 0.17% of global GDP, by 2035. Over the *Outlook* period, 63% of the support goes to renewables-based electricity. Support per unit of generation on average worldwide drops over time, from $55 per megawatt-hour (MWh) in 2009 to $23/MWh by 2035, as wholesale electricity prices increase and their production costs fall due to technological learning. This does not take account of the additional costs of integrating them into the network, which can be significant in some cases, for example, because of the variability of some types of renewables, such as wind and solar energy.

The use of biofuels – transport fuels derived from biomass feedstock – is expected to continue to increase rapidly over the projection period, thanks to rising oil prices and government support. In the New Policies Scenario, global biofuels use increases from about 1 mb/d today to 4.4 mb/d in 2035. The United States, Brazil and the European Union are expected to remain the world's largest producers and consumers of biofuels. Advanced biofuels, including those from ligno-cellulosic feedstocks, are assumed to enter the market by around 2020. The cost of producing biofuels today is often higher than the current cost of imported oil, so strong government incentives are usually needed to make them competitive with oil-based fuels. Globally, government support to biofuels is projected to rise to about $45 billion per year between 2010 and 2020, and $65 billion per year between 2021 and 2035. Government support typically raises costs to the economy as a whole. But the benefits can be significant too, including reduced imports of oil and reduced CO2 emissions – if sustainable biomass is used and the fossil energy used in processing the biomass is not excessive.

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WORLD ENERGY OUTLOOK 2010 FACTSHEET
What will tackling climate change mean for the energy sector?

The outcome of the landmark UN conference on climate change held in December 2009 in Copenhagen was a step forward, but still fell a very long way short of what is required to set the

world on the path to a sustainable energy system. The Copenhagen Accord established a non-binding objective of limiting the increase in average global temperature to two degrees Celsius (2°C) above pre-industrial levels. It also set a goal of mobilising funds for climate mitigation and adaptation in developing countries and requires the industrialised countries to set emissions targets for 2020.

Were those commitments to be implemented in a *cautious* manner, as assumed in the New Policies Scenario, rising demand for fossil fuels would continue to drive up energy-related CO2 emissions, making it all but impossible to achieve the 2°C goal. This is because the reductions in emissions needed after 2020 would become prohibitively expensive or even impossible with today's technologies. In that scenario, global emissions continue to rise through the projection period, though the rate of growth falls progressively. Emissions jump to over 35 Gigatonne (Gt) in 2035 — 21% up on the 2008 level of 29 Gt. Non-OECD countries account for all of the increase; OECD emissions peak before 2015 and then begin to fall. These trends are in line with stabilising the concentration of greenhouse gases (GHG) at over 650 parts per million (ppm) of CO2-equivalent, resulting in a likely temperature rise of more than 3.5°C in the long term.

The 2°C goal can only be achieved with vigorous implementation of current commitments in the period to 2020 and much stronger action thereafter. According to climate experts, in order to have a reasonable chance of achieving the goal, the concentration of GHGs would need to be stabilised at a level no higher than 450 ppm CO2-equivalent. Accordingly, the 450 Scenario describes how the energy sector could evolve in order to achieve this objective. It assumes implementation of the measures to realise the more ambitious end of target ranges announced under the Accord as well as more rapid implementation of the removal of fossil-fuel subsidies agreed by the G-20 than assumed in the New Policies Scenario. Emissions reach a peak of 32 Gt just before 2020 and then slide to 22 Gt by 2035 in the 450 Scenario.

Cutting emissions sufficiently to meet the 2°C goal would require a far-reaching transformation of the global energy system. In the 450 Scenario, oil demand peaks just before 2020 at 88 mb/d, only 4 mb/d above current levels, and declines to 81 mb/d in 2035. Coal demand peaks before 2020, returning to 2003 levels by 2035. Among the fossil fuels, demand for natural gas is least affected, though it too reaches a peak before the end of the 2020s. Renewables and nuclear double their current combined share to 38% in 2035. Global energy security is enhanced by the greater diversity of the energy mix.

The cost of getting on track to meet the climate goal for 2030 has risen by about $1 trillion compared with the estimated cost in last year's *Outlook*. This is because much stronger efforts, costing considerably more, will be needed after 2020. In the 450 Scenario in this year's *Outlook,* the additional spending on low-carbon energy technologies (business investment and consumer spending) amounts to nearly $18 trillion (in year- 2009 dollars) more than in the Current Policies Scenario, in which no new policies are assumed, in the period 2010-2035. It is around $13.5 trillion more than in the New Policies Scenario.

The timidity of current commitments has undoubtedly made it less likely that the 2°C goal will be achieved. Reaching that goal would require a phenomenal policy push by governments worldwide: carbon intensity — the amount of CO2 emitted per dollar of GDP — would have to fall at twice the rate of 1990-2008 in 2008-2020 and four times faster in 2020-2035. The technology exists today to enable such a change, but such a rate of technological transformation would be unprecedented. These commitments must be interpreted in the strongest way possible with much stronger commitments adopted and acted upon after 2020, if not before.

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Policies, Procedures and Priorities of Sawyer Trust Funds (STF)

Comprehensive Sustainable Energy Committee (CSEC)

Overview

A fund of $1.7 million was established in 2007 by the Alfred H. Sawyer Trust to enable the Town of Concord to improve of its public facilities with respect to energy conservation, water conservation, and materials recycling. Expenditures of the Fund are under the direction of the Town Manager, in consultation with Concord's Sustainable Energy Committee.

Priorities

The primary objective of the CSEC is to pursue improvements in town facilities intended to reduce a building's energy consumption or 'carbon footprint'. As such, the Committee will focus on state-of-the-art technologies to conserve energy in the Town's facilities and school buildings). Key priorities include:

- Weatherization & lighting efficiency in public facilities
- Development of renewable energy sources such as solar and geothermal
- Water conservation
- Materials recycling and zero trash initiatives
- Conservation and building 'transformation' demonstration projects to influence public opinion

It's understood that the applications for Sawyer Trust Funds will need to be considered on a case-by-case basis and that the approach to evaluating proposals cannot be codified. For example, while our objective is to pursue value-added investment that are incremental to run-rate maintenance of public facilities (e.g. the additional or incremental investment needed to upgrade a set of plans/procurements from a traditional approach to a higher, state-of-the-art standard), our specific approach will need to be determined through committee evaluation of proposals and in consultation with the Town Manager.

Procedure

The CSEC will establish a working subcommittee to review applications for Sawyer Trust funds. This subcommittee will consist of the Chairman of CSEC and two members of the CSEC. The specific procedure includes:

- Submission of a CSEC request form by the relevant Town Building Manager, Town employee, or citizen to the Town Planner.
- Complete requests need to be received at least three weeks prior to a scheduled meeting of CSEC. Town Planner will forward the request to the subcommittee and will assign one member of the subcommittee as the lead for each request. (Lead responsibility shall rotate on the subcommittee with each submission.)
- The Lead on the subcommittee for an application shall act as the focal point for questions from other members of the subcommittee prior to the regular CSEC meeting and will lead the discussion of the proposal at the CSEC meeting. This includes providing leadership in asking final questions of the applicant.
- The CSEC will close discussion with the applicant prior to deliberating and voting on the proposal.

Eligible facilities in Town of Concord

Town of Concord

- Engineering 133 Keyes Road
- Water/Sewer 135 Keyes Road
- DPLM 141 Keyes Road
- Hunt Recreation 90 Stow Street
- Beede Center 500 Walden Street
- Harvey Wheeler Center 1276 Main Street
- West Concord Fire Station 1201 Main Street
- Concord Police and Fire 209 Walden Street
- Town House 22 Monument Square
- Sleepy Hollow Admin Building 150 Lexington Road
- Waste Water Treatment Plant
- Deaconness Water Treatment Plant
- Concord Municipal Light Plant 1175 Elm Street
- CMLP Substation Building(s)

Concord Schools

- Alcott Elementary School 93 Lauren Street
- Thoreau Elementary School 29 Prairie Street
- Willard Elementary School 185 Powder Mill Road
- Sanborn Middle School 835 Old Marlboro Road
- Peabody Middle School 1231 Old Marlboro Road
- Ripley/School Administration 120 Meriam Road

Concord-owned but Leased Facilities

- Performing Arts Center 51 Walden Street
- Emerson Umbrella 40 Stow Street

Application Form

Applicants should use the attached format in making requests for funding.

STF Subcommittee Review

Name of Facility: _____

Background: (request context, and history of project & funding)

Overall project description: Describe overall request

STF Project Scope: What's included in the request, what not included…

Engineering Firm:

If applicable

Subcommittee Review: Results of review by STF subcommittee. Who was involved, observations, recommendations, etc

Items under evaluation:

Item 1 or group of items: (e.g. ceiling insulation)

- Base Case: Plan without the improvement
- Proposed Case: Description of the enhancement
- Incremental Investment Cost for enhancement: $xx.xx
- Annual Savings (in natural gas or electricity): $xx.xx

Item 2

- Base Case:
- Proposed Case: Incremental investment cost:
- Incremental Investment Cost for enhancement: $xx.xx
- Annual Savings (in natural gas): $xx.xx

Item 3

etc

Financial Summary

Roll-up of incremental investments: $xx.xx
Roll-up of annual savings: $xx.xx
Simple payback in years: total cost divided by the annual savings: x.x years