Executive Summary

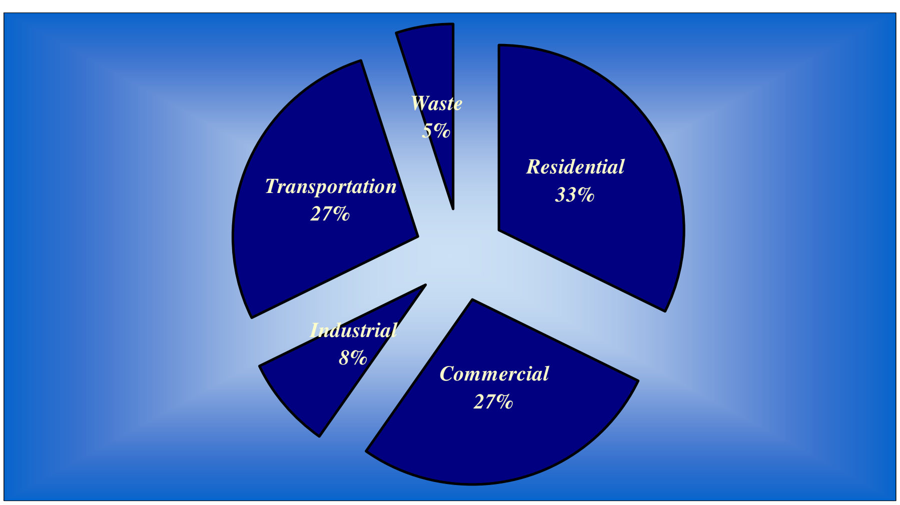
In the spring of 2003, Mayor Dannel Malloy issued a proclamation establishing the City of Stamford's participation in the International Council for Local Environmental Initiatives (ICLEI) Cities for Climate Protection (CCP) campaign. The ultimate goal of this endeavor is to reduce emissions of pollutants that contribute to global warming, known as greenhouse gases (GHGs), which primarily result from energy use The City has recognized that taking action to reduce global warming pollution can result in added benefits including: savings on utility and fuel bills, reduced local air pollution (i.e. smog) and its associated health impacts, reduced traffic congestion and overall enhancement of the City's livability.

This report represents the first step in the City's greenhouse gas reduction efforts, the development of a greenhouse gas emissions inventory and forecast. This GHG emission and energy use profile, is meant to help identify areas where reduction opportunities exist both in the community at large as well as in government operations. In addition \ the inventory highlights areas where successful GHG reductions have already been achieved through efforts that the City has already undertaken to improve the efficiency of government buildings. Advantageous employment of the initial momentum gained from the founding data in the inventory depends upon continued commitment to diminishing Stamford's contribution to global warming.

Community-wide emissions in 1998

The community inventory for the baseline year of 1998 revealed the residential sector as the chief contributor to overall GHG emissions, totaling 33% of the 1,515,865 tons of carbon dioxide equivalents (eCO_2), with the commercial and transportation sectors trailing closely behind, both at 28%.

Figure 1: Community Emissions by Sector for 1998



Emissions were calculated based on end use fuel and electricity data in the energy related sectors and waste stream data in the waste sector. These data were generously provided by a variety of sources including[1]: electricity data from Connecticut Light & Power; natural gas data from the Connecticut Office of Consumer Counsel; residential oil data from Petro[2]; and additional oil data, as well as the propane data, were derived from the US Energy Information Administration (EIA) website. The transportation data were generously supplied by the Connecticut Department of Transportation; and solid waste data were provided by the Stamford Division of Solid Waste.

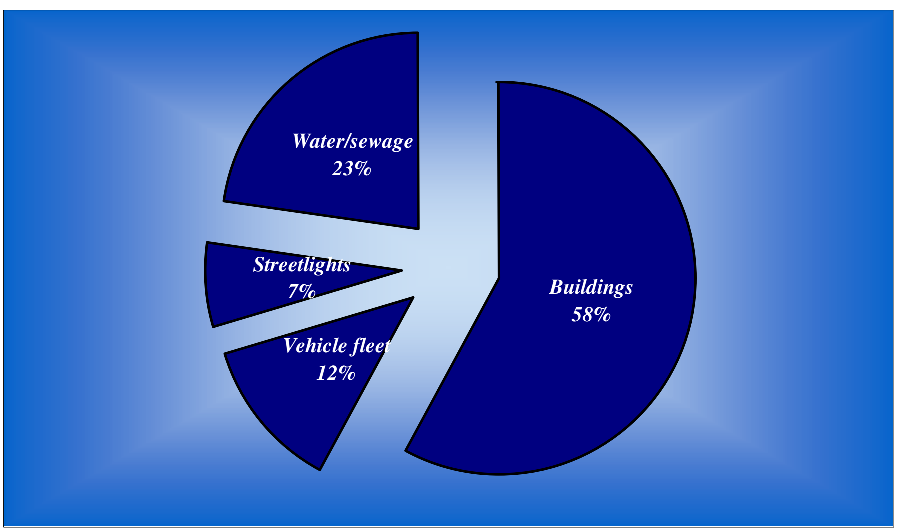
The Community-wide "Business as Usual" Forecast

Using annual projections from the US EIA, total community emissions in 2018 have been forecasted to increase 35% in a scenario where no further action is taken to reduce energy use and emissions This projection is slightly higher than the EIA's national forecast.

Emissions from Government Operations in 1998 and 2002

The government inventory for the 1998 baseline year identified the largest source of GHG emissions as the buildings sector, accounting for 58% of the 52,898 tons of carbon dioxide equivalents, with water/ sewage and the vehicle fleet both lagging far behind at 23% and 12% respectively. The largest emitters of eCO_2 from the buildings sector were Stamford High School, Westhill High School and the Government Center. Note that this is likely more a reflection of the size of these facilities rather than a measure of their efficiency. The greatest source of GHGs from the vehicle fleet was the police department, which maintains a large fleet of vehicles.

Figure 2: Government Emissions by Sector for 1998



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[1] For specific names and information from sources, see Appendix C.

[2] The data provided were average home heating oil consumption figures for 1998 and 2002; for further details on how the total residential oil data were obtained, refer to the Community data and results sections.

The majority of the data were graciously provided by Nancy Domiziano of the Stamford Engineering Bureau, including information for the buildings, streetlights and wastewater/ sewage. The vehicle fleet figures were supplied by the Stamford City Fleet Division. The water data were acquired from the Aquarion Water Company of Connecticut.

The “business as usual” forecast (assuming no reduction measures) for the government sector is expected to remain constant in terms of energy use however future emissions would fluctuate depending on the mix of fuel used to generate the electricity purchased by the City. In terms of actual emissions, the 1998 to 2002 inventory results show a decrease of more than 8% in overall GHG emissions from City operations. While weather and changes in the electricity fuel mix would play a role in this reduction it is also likely that efforts such as participation in the Rebuild America program are responsible for these impressive results. The reductions occurred primarily in natural gas usage in the building sector, electricity use in streetlights and diesel and gasoline reductions in the vehicle fleet. Based on this analysis it appears that these fuel reductions resulted in an estimated savings of over $365,000 a year.

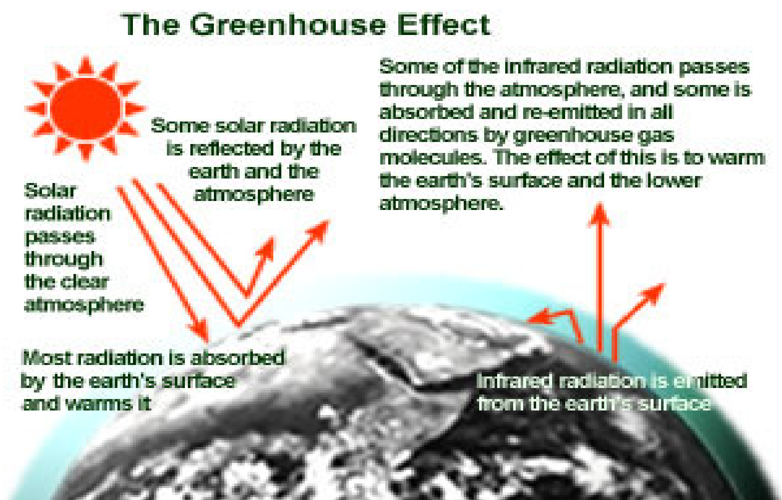
Thus far, the most substantive measures that have occurred have been implemented in several of the schools as well as through installation of LED (light emitting diode) traffic signals. The path that Stamford will choose to proceed upon henceforth will be heavily reliant upon the financial availability to fund energy and GHG-reducing projects, which will inherently tie in with the current state-level budget deficit that has drastically depleted funding for energy conservation projects. However, through creative and innovative strategies, Stamford could feasibly prevail over these obstacles to become a leader in Connecticut on the issue of smart energy policy and global warming.

A suggested next step is to assemble a task force of interested parties within Stamford to discuss possible local solutions to this global issue. This group should involve stakeholders in both the public and private sector, including representatives from the government, commercial businesses, energy/utility companies, local industries, residents and environmental groups. Ultimately, the entire community should determine what the solution is. However, the city of Stamford can take a leadership role and demonstrate that action to reduce GHG emissions with our shared environment, our future, our health and our economy.

"The Earths' climate system
has demonstrably changed on both global and regional scales since the pre-industrial era, with some of these changes attributable to human activities. Human activities have increased the atmospheric concentrations of greenhouse gases and aerosols since the pre-industrial era. The atmospheric concentrations of key anthropogenic greenhouse gases (i.e., carbon dioxide, methane, nitrous oxide and tropospheric ozone) reached their highest recorded levels in the 1990s, primarily due to the combustion of fossil fuels, agriculture, and land-use changes." (IPCC, 2001)[3]

Introduction

Yes, it's true, the greenhouse effect exists. Without the trapped gases in our atmosphere absorbing heat and re-radiating it back down towards the surface, the Earth that we know and love would cease to exist. The average global temperature would be lowered by approximately 32^0 C, making life on Earth just a bit more difficult when forced to adjust to the -18^0 C climate![4]



(United States Environmental Protection Agency, 2000)[5]

Although water vapor is the most abundant atmospheric gas playing a role in the greenhouse effect, such gases being referred to as greenhouse gases, the gas that is currently of most concern is carbon dioxide (CO_2). Anthropogenic activity, especially since the industrial age, has been accelerating the release of carbon dioxide into our atmosphere at an unprecedented rate. Through the combustion of fossil fuels that run our vehicles, heat our homes, power our businesses and enable our lives to proceed in its current fashion, the world and the United

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[3] Intergovernmental Panel on Climate Change (IPCC). *Climate Change 2001: Synthesis Report, A Summary for Policymakers.* 2001.

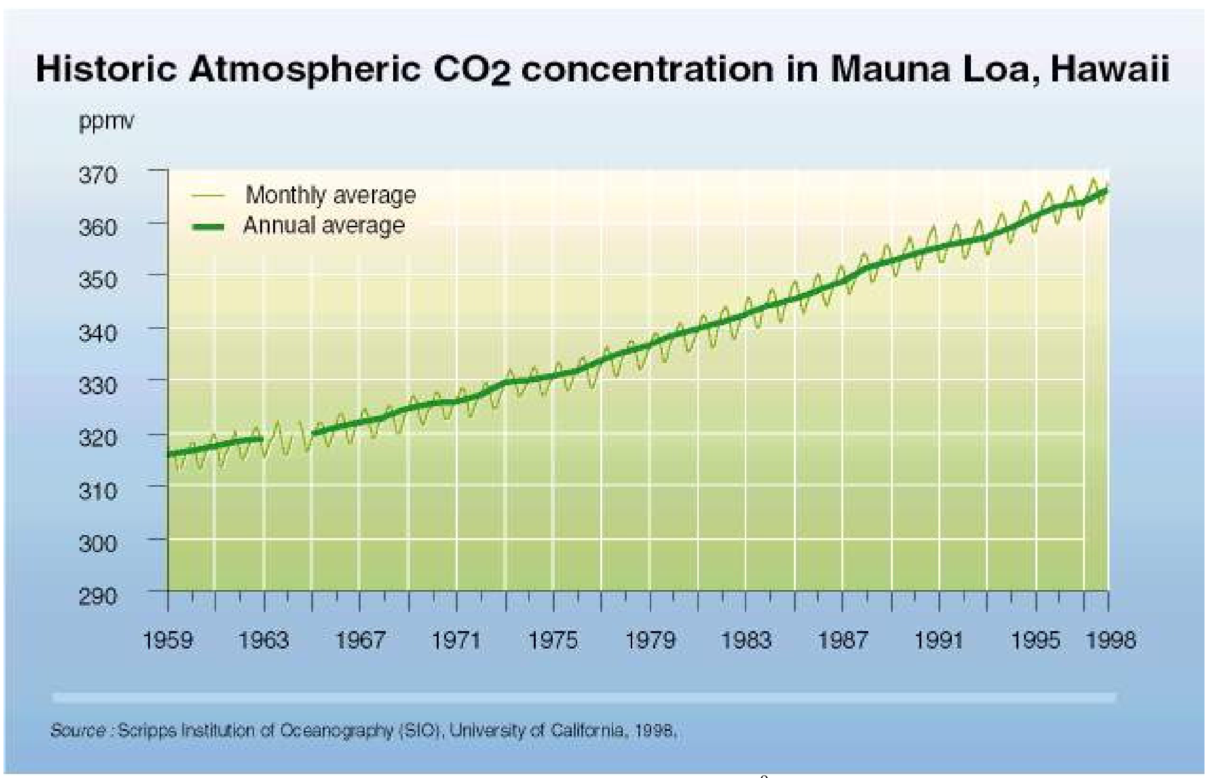
[4] National Climatic Data Center (NCDC). *National Oceanic and Atmospheric Administration (NOAA): Global Warming, Frequently Asked Questions (FAQs).* 2003. http://lwf.ncdc.noaa.gov/oa/climate/globalwarming.html

[5] United States Environmental Protection Agency (USEPA). *Global Warming- Climate.* 2000. http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html

States have increased the atmospheric concentration of carbon dioxide by 30% over pre-industrial times, from 280 parts per million by volume (ppmv) to 370 ppmv. According to the National Climatic Data Center (NCDC), this concentration of CO_2 has not been surpassed in the last 420,000 years- quite possibly, it may not have been surpassed in the last 20 million years![6] Among the other important greenhouse gases of concern, it has been estimated that methane concentrations have increased more than two-fold while those of nitrous oxide have grown by roughly 15% since the start of the industrial revolution.[7]

The Keeling Curve

One of the most celebrated graphs on carbon dioxide concentrations, and possibly on carbon in general, has been aptly referred to as the "Keeling Curve" in honor of Dr. Charles David Keeling, the scientist responsible for the data collection. At a pristine location in Mauna Loa, Hawaii, Dr. Keeling began gathering his data in 1958, which now chronologically constitutes the longest continuous data set of its kind. His research has pioneered the field of global warming science as the first to explicitly correlate increased carbon dioxide levels in the atmosphere with fossil fuel combustion.[8] The Keeling Curve, courtesy of UNEP-GRID Arendal, is depicted below.



(UNEP GRID-Arendal, 2003)[9]

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[6] NCDC. *NOAA: Global Warming, FAQs.* 2003. http://lwf.ncdc.noaa.gov/oa/climate/globalwarming.html

[7] USEPA. *Global Warming- Climate.* 2000. http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html

[8] Scripps Institution of Oceanography. *Scripps Global Climate Change Pioneer to Receive The National Medal of Science.* 2002. http://scrippsnewsdev.ucsd.edu/pressreleases/keeling_natl_medal_science.cfm

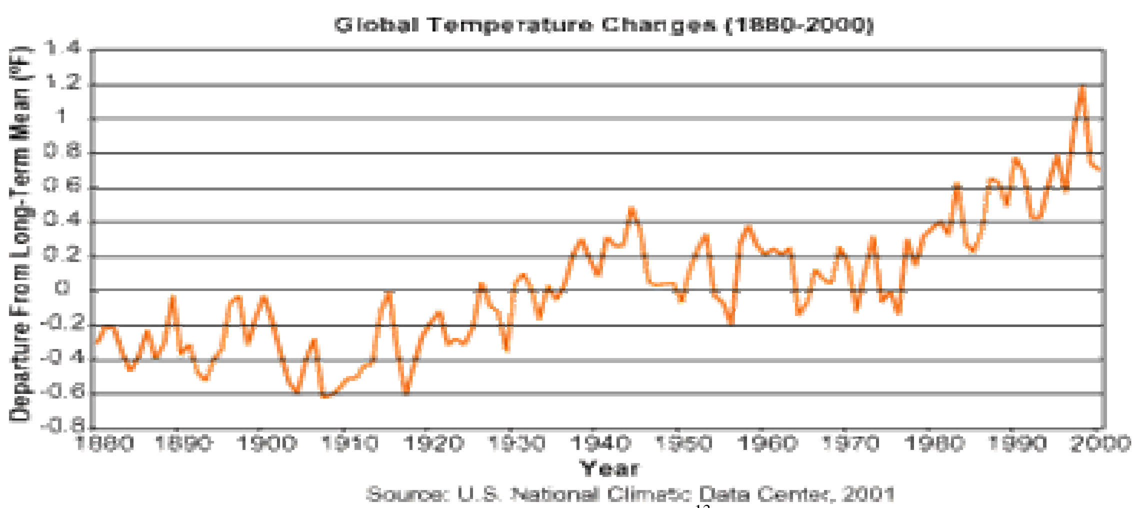
[9] United Nations Environment Programme (UNEP). *Historic Atmospheric CO_2 Concentration in Mauna Loa,*

The Problem

Now, if the greenhouse effect is necessary to our existence, why is the accumulation of CO_2 a problem? The issue arises when the concentrations of greenhouse gases (GHGs) like CO_2 increase, causing temperature changes to follow suit as a result of the additional heat that the GHGs are absorbing. When combined with the accumulating nature of carbon dioxide and other greenhouse gases, continuous release of GHGs will pose a climate threat today, tomorrow and well into the future. In the most recent synthesis report from the Intergovernmental Panel On Climate Change (IPCC), which is an organization established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), it was stated that:

> Globally it is very likely that the 1990s was the warmest decade, and 1998 the warmest year, in the instrumental record (1861-2000). The increase in surface temperature over the 20th century for the Northern Hemisphere is likely to have been greater than that of any other century in the last thousand years.[10]

Although the IPCC does not perform its own research, one of its primary roles is to assess the current state of peer-reviewed scientific data on global climate change. The IPCC comprehensively serves to "provide scientific, technical and socio-economic advice to the world community… through its periodic assessment reports and special reports".[11] However, these exact same traits, when applied with objectivity and transparency towards their goal of understanding "the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation", further strengthen the conclusions reached by the IPCC.[12] Below is a graph of the measured temperature increase that has occurred from 1880 through 2000.



(US EPA, 2001)[13]

Hawaii. http://www.grida.no/db/maps/prod/level3/id_1463.htm

[10] IPCC. *Climate Change 2001: Synthesis Report, A Summary for Policymakers.* 2001.

[11] IPCC. *About IPCC.* 2003. http://www.ipcc.ch/about/about.htm

[12] *Ibid.*

[13] US EPA. *Global Warming- Climate.* 2001.

Since the end of the 19th century, global surface temperatures have increased approximately 0.6^0 C (about 1.0^0 F), with 0.4^0 C (about 0.7^0 F) having occurred within the last 25 years.[14] According to the National Oceanic and Atmospheric Administration's (NOAA) National Geophysical Data Center (NGDC), unlike the hypothesized global warming[15] that has taken place in past centuries, the warming that is presently occurring is different in the two ways that are listed below.

1. The historical periods of hypothesized warming do not seem to have had a global extent.
2. These same warming periods can be accounted for by known natural climatic forcing conditions, which are "uniquely different" from those of the past century.[16]

In fact, analysis by the IPCC supports these distinctions, declaring not only that "new and stronger evidence" exists that attributes most of the global temperature increase of the past 50 years to human activities, but also that "detection and attribution studies consistently find evidence for an anthropogenic signal in the climate record of the last 35 to 50 years".[17] Although the IPCC refrains from stating that global warming is irrefutably caused by humans, there exists a general acceptance of this hypothesis in the international scientific community. Unfortunately, the IPCC report also forewarns of the potentially catastrophic consequences that could occur should efforts not be made to reduce emissions of GHGs anytime soon. Varying emissions scenarios (540 to 970 ppmv CO_2) for the year 2100 have been evaluated by the IPCC, resulting in the conclusion that average global temperatures will rise by 0.4 to 1.1^0 C between 1990 and 2025 and by 0.8 to 2.6^0 C between 1990 and 2050.[18]

Regrettably, the consequences of higher atmospheric GHG concentrations do not end with warmer global temperatures. Expected effects, some of which may be irreversible, include, though are not limited to: changes in sea levels and ocean circulation patterns, increased number of hot days, decreased number of cold days, more frequent and more intense weather events, heightened risk of droughts, degradation of ecosystems, retreat of glaciers and permafrost, increase/decrease in plant productivity (depending on geographic location), additional outbreaks of some vector-borne diseases, deteriorating air quality, depletion of stratospheric ozone, reduced freshwater availability, biodiversity loss and escalating desertification.[19] The potential for unalterable changes reinforces the exigency of immediate action. Notwithstanding this sense of universal urgency, it must not be overlooked that nation-states are sovereign entities, who essentially must answer only to

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http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html

[14] NCDC. *NOAA: Global Warming, FAQs.* 2003. http://lwf.ncdc.noaa.gov/oa/climate/globalwarming.html

[15] Hypothesized global warming refers to the fact that the instrumental record does not go back that far, but with the use of proxy data from ice cores, tree samples and the like, estimates of global temperatures have been hypothesized.

[16] National Geophysical Data Center (NGDC). *A Paleo Perspective on Global Warming: Paleoclimatic Data Before 1000 Years Ago.* 2003. http://www.ngdc.noaa.gov/paleo/globalwaerming/paleobefore.html

[17] IPCC. *Climate Change 2001: Synthesis Report, A Summary for Policymakers.* 2001.

[18] *Ibid.*

[19] *Ibid.*

themselves. That is why endeavors at the national level are ultimately required for international success in the campaign against global warming.

The United States

Worldwide, the United States is responsible for approximately one-fifth of the total GHG emissions, which is a fundamental factor necessitating the reduction of American CO_2 emissions to truly achieve global success. The importance of voluntary national action, along with state and municipal efforts are therefore crucial. With respect to these American emissions, the US EPA has contended that the fossil fuels consumed for transportation, home heating and industrial uses contribute to the following breakdown of anthropogenic emissions of key GHGs: 98% of CO_2, 24% of methane and 18% of nitrous oxide.[20] While landfills, deforestation, mining, industrial production and agriculture also contribute to release of GHGs, their role is comparatively insignificant. On a national scale, EPA simplifies the decision-making process with respect to raw numbers and where to target reductions. However, what about regions and individual states? Won't there be distinctive traits in one area of the country vs. another area? Assuredly, each state has their own GHG profile and will have disparate global warming consequences, which is why it is imperative to take into consideration the effects of global warming in Connecticut.

Connecticut

Between 1892 and 1995, the average temperature as measured in one local Connecticut town indicated a temperature change from 45.8^0 F (1892-1921 average) to 48.2^0 F (1966-1995 average) and as much as a 20% increase in precipitation. Using IPCC projections and results from a United Kingdom climate model, by 2100, temperatures in Connecticut are anticipated to increase by 4^0 F (2-8^0 F range), and precipitation is expected to increase between 10-20% (0-40% range). The predicted temperature increases will also occur with more frequent heat waves, with up to 20% more heat-induced deaths ensuing. Additionally, degradation of air quality can be presumed to occur via excess power-plant emissions, more hydrocarbon releases and ground-level ozone formation, all of which will serve to exacerbate respiratory conditions and illnesses such as asthma. Warmer temperatures will also contribute to the proliferation of disease-carrying organisms such as mosquitoes (malaria, Eastern equine encephalitis, West Nile virus, dengue fever) and ticks (Lyme disease).[21]

Average sea level along the Connecticut shore can be expected to rise 22 inches by the year 2100. This would transform the coastline by substantially damaging residential homes and decimating fragile freshwater marsh ecosystems. The hydrological cycle could be affected in any of several ways: increased evaporation resulting in decreased river flow rates and lower lake levels, reduced groundwater replenishment and aquifer levels more severe flooding and earlier peak spring stream flows. The reduced availability of water in

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[20] USEPA. *Global Warming- Climate.* 2001.
http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html
[21] USEPA. *Global Warming-Impacts: State Impacts- Connecticut.* 2000.
http://yosemite.epa.gov/oar/globalwarming.nsf/content/ImpactsStateImpactsCT.html

combination with warmer temperatures could affect the ability of agriculture to adapt, depending on the rate at which these changes occur. Projections run the gamut of decreased productivity between virtually no change to near 40%, while agricultural income could vary between small losses to near 50%. Along a similar line, forest ecosystems may also be greatly impacted by global warming, the magnitude of which depends on the rate of change. The species composition could be altered as well as the health and productivity of forests, which may eventually succumb to grassland invasion under elevated levels of stress from temperature, precipitation, pests, fire and diseases. This could effectively alter as much as 30-60% of the traditional Connecticut maple-dominated forests to one replete with conifers and hardwoods of inferior autumnal splendor.[22]

With all the potential damage that Connecticut may incur from global warming induced changed, it is no wonder why the Connecticut Attorney General, Richard Blumenthal, has filed suit along with Massachusetts and Maine, against the US EPA for failure to regulate CO_2 emissions under the federal Clean Air Act.

> "'EPA's inaction on carbon dioxide is intolerable- a dangerous disservice to the nation,' said Blumenthal. 'By the administration's own admission, on the public record, greenhouse gas emissions cause global warming, in turn causing disease, environmental damage and weather-related disasters such as drought and flooding.'"[23]

On another front, the Connecticut Governor, Governor Rowland, entered into a resolution, in 2000, with the New England Governors and Eastern Canadian Premiers (NEG/ECP) to address global warming and its environmental impacts. The follow-up climate change workshop of March 2001 enabled presentations of the most recent scientific data concerning the discernible human effect on global warming, along with guidance and suggestions from public and government officials, academia and industry representatives. A final climate change action plan was forged and signed in August 2001 by every member of the NEG/ECP. The major goal of the plan is to reduce emissions to a concentration that will not threaten the Earth's climate, which has been estimated at 75-85% below 1990 levels.[24] However, there are two intermittent goals for 2010 and 2020. The first is to reduce GHG emissions to 1990 levels and the second is to reduce emission by at least 10% below 1990 levels.[25] There are four principles that encompass the climate change action plan, and they are as follows:

1. Curtail GHG emissions from energy and non-energy sources by shifting to cleaner, lower carbon energy sources and by improving transportation efficiency.
2. Implement "no-regrets measures" that will engage all parts of society while improving the regional economy.

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[22] USEPA. *Global Warming-Impacts: State Impacts- Connecticut.* 2000. http://yosemite.epa.gov/oar/globalwarming.nsf/content/ImpactsStateImpactsCT.html

[23] Risknowlogy. *EPA: Connecticut, Massachusetts and Maine Sue EPA Over Global Warming.* 2003. http://www.risknowlogy.com/modules.php?op=modload&name=News&file=article&sid=849

[24] 1990 is used as the baseline for NEG/ECP's climate change action plan in response to the Kyoto Protocol, an international treaty on climate change that also uses 1990 as the baseline year of comparison.

[25] The Governor's Steering Committee. *Leading by Example: Connecticut Collaborates to Reduce Greenhouse Gas Emissions.* 2002.

3. Institute long-term environmental and economic sustainability measures while investigating potential adaptation mechanisms.
4. Encourage federal governments to establish national solutions, such as improving vehicular energy efficiency.[26]

At the following August 2002 meeting, the ensuing four actions were endorsed by the NEG/ECP:

1. Install light-emitting diode (LED) equivalents to replace old traffic lights.
2. Work with colleges/universities to create measures to achieve NEG/ECP targets, while increasing purchases of renewable energy.
3. Procure ENERGY STAR (or higher energy efficiency) office equipment for state/provincial governments.
4. Purchase vehicles for state/provincial fleets that emit lower pollution levels and are more fuel-efficient.[27]

These efforts and decisions by the NEG/ECP have set the backdrop for Connecticut to take action, and most importantly, for the government to lead by example. As contrived by the Governor's Steering Committee, "Demonstrating energy efficiency, clean energy technologies and sustainable practices should be a fundamental task of government."[28] By doing so, there will be ancillary benefits such as reducing government expenditures, demonstrating success of available technologies, making these technologies more affordable, and lightening the burdens on future generations through engaging in environmentally responsible behavior. With respect to the public sector, the goal is to reduce GHG emissions by 25% by 2012.[29] So far, many measures have been implemented at the state level government in Connecticut. These include: energy conservation and increased energy efficiency in state government buildings; more fuel-efficient vehicles and increased use of lower carbon fuels in the transportation sector; outreach and education regarding clean energy and energy conservation; consideration of Leadership in Energy and Environmental Design (LEED), Silver Standard, and implementation of LEED wherever feasible; and acquiring environmentally friendly products and equipment whenever possible.[30]

The International Council for Local Environmental Initiatives (ICLEI)

However, there are no mandates for local governments to follow, state and national attempts to engage municipalities to reduce GHG emissions are voluntary suggestions at best. This is where municipal initiatives can have staggering impacts, potentially setting off a domino effect whereby other cities and towns will follow suit. Local officials can take the initiative to be leaders on global warming action, or they can be followers, behind other municipalities. Sooner or later, the efforts will no longer be voluntary but mandatory. Those that are first to compel changes will reap greater benefits and competitive advantages.

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[26] The Governor's Steering Committee. *Leading by Example: Connecticut Collaborates to Reduce Greenhouse Gas Emissions.* 2002.
[27] *Ibid.*
[28] *Ibid.*
[29] *Ibid.*
[30] *Ibid.*

Reducing GHG emissions creates a more livable city with cleaner air, improved health, saved money and a better economy.[31] Along with several other cities in Connecticut that have already begun a campaign to reduce greenhouse gases, Stamford has agreed to be among the leaders in the region by becoming a part of the International Council for Local Environmental Initiatives (ICLEI) Cities for Climate Protection (CCP) Campaign. Although completely voluntary, the city of Stamford and Mayor Dannel P. Malloy have committed to being part of the solution to global warming rather than simply contributing to the problem.

ICLEI is an international association of local governments that serves to affect concrete global changes through its role as an international environmental agency to local governments, which are engaging in environmental efforts that promote sustainable living.[32] The Cities for Climate Protection Campaign has over 500 local governments fighting to make a worldwide difference through their collective endeavors, with over 140 cities and counties in the United States alone.[33] By pledging to be a part of this international campaign, Stamford has committed to fulfilling the subsequent five milestones:

1. Conduct a baseline emissions inventory and forecast.
2. Establish an emissions reduction target.
3. Develop a local action plan to meet the emissions reduction target.
4. Implement the local action plan.
5. Monitor progress and report results.[34]

The CCP Campaign focuses attention on carbon dioxide and methane emissions from energy use, transportation and waste. The emissions analysis is divided into a Community Inventory, which accounts for citywide GHG emissions of CO_2 and CH_4, and a Government Inventory, which accounts for only those emissions attributable to local government operations. The purpose of this report is to discuss the results of Milestone 1 for the City of Stamford, the emissions inventory and forecast, along with potential measures that could be implemented to meet the targeted emissions reduction.

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[31] ICLEI. *Cities for Climate Protection Toolkit: Tools for Developing Local Climate Action Plans.* 2000.
[32] ICLEI. *ICLEI: The International Council for Local Environmental Initiatives (home page).* 2003. http://www.iclei.org
[33] ICLEI. *US Cities for Climate Protection Campaign (CCP).* 2003. http://www.iclei.org/us/ccp
[34] ICLEI. *Cities for Climate Protection Toolkit: Tools for Developing Local Climate Action Plans*. 2000.

General Data Collection, Methods and Procedures

The emissions inventory consists of two separate sections, the Community Inventory and the Government Inventory. The Community Inventory comprises all data for the city of Stamford while the Government Inventory is a subsection of the Community Inventory, with detailed information on municipal operations. The software that was used to analyze the data is known as the *Clean Air and Climate Protection Software (CACP Software) Version 1.0* for the State and Territorial Air Pollution Program Administrators Association of Local Air Pollution Control Officials (STAPPA/ALAPCO) and the International Council for Local Environmental Initiatives (ICLEI).

The data were obtained for the base year 1998 as well as the intermittent year 2002, as a guide to see how and in what direction Stamford was moving with respect to its greenhouse gas emissions. A twenty-year time frame was decided upon for the forecast year, whereby 2018 the targeted reduction should be achieved. It is of importance to note that the forecast data are based on the data from 1998 and represents a "business as usual" scenario, whereby no reduction measures have been incorporated. The percent growth in the different sectors of the Community Inventory were obtained from the US Energy Information Association *Annual Energy Outlook 2003 with Projections to 2025*, with the exception of waste percent growth, this was derived from the projected population change. Requests for data were made via email, telephone and letters to the relevant sources of required information. Where data could not be retrieved best estimates were made and assumptions noted. Additionally, certain data areas were estimated based on state level information due to lack of Stamford specific data. This was done based on Stamford's population as a percentage of Connecticut's population, employing this percentage as a proxy for estimating how much of the state consumption of a given energy source was attributable to Stamford.

For the Government Inventory, every entry includes figures for cost. In cases where data did not include cost, best estimates were made based on existing cost information. In addition, some of the data were adjusted in order to correct for individual differences in the time periods that energy use was tracked.[35]

The Community Inventory is broken down into six sectors for data entry: residential, commercial, industrial, transportation, waste and other (this sector would include other significant direct emission sources such as a factory plume of sulfur hexafluoride or a ranch with many methane emitting cows). Within the first three sectors, data were compiled for energy consumption via end use information about natural gas, electricity, oil and propane consumption. Natural gas data were obtained by an estimate from Yankee Gas reports, courtesy of the Connecticut Office of Consumer Counsel. Electricity data were obtained directly from a Connecticut Light & Power Company (CL&P) representative. Oil and propane data were mainly derived from state-level data off of the US Energy Information Association (EIA) website. Furthermore, residential oil data incorporated an estimate of the average amount of oil consumed per oil-heated household courtesy of Petro, a home heating oil provider for Stamford. Transportation data were collected by fuel type, vehicle type and

[35] For further and more specific information regarding data for certain sections, please see its accompanying section in this report and the attached appendices.

annual vehicle miles traveled and were received from the Connecticut Department of Transportation. Solid waste data were acquired from Stamford solid waste department, broken down by categories such as: paper products, food waste, plant debris, wood/textiles and all other waste.

The Government Inventory dictated the decision regarding which base year would be chosen for the entire GHG emissions inventory. This was a result of the buildings' data having been gathered for 1998, as well as much of 2002, as part of Nancy Domiziano's (Stamford Engineering Bureau) work for the city of Stamford on the Rebuild America program.[36]

The Government Inventory is broken into the following sectors: buildings, vehicle fleet, employee commute, streetlights, water/sewage and waste. The buildings data were broken down into subsections as such: community centers, fire department, police department, schools (Board of Education), public works, parks and recreation and the government center. The vehicle fleet data were broken down into subsections as follows: Board of Education, Dial-A-Ride, Emergency Medical Services, engineering, fire department, health department, housing authority, the office of the Mayor, operations- facilities management, operations- fleet management, operations- highways 1 and 2, operations- park maintenance, operations- solid waste collection, police department, Smith House, traffic and parking, the Water Pollution Control Authority (WPCA) and an "other" category. Like the Community Inventory, this sector required specific data relative to fuel type and vehicle type. However, instead of annual vehicle miles traveled, data were available on total annual fuel utilization, in gallons. Vehicular data were obtained from the Office of Operations, Fleet Management Division. Streetlights, water and sewage data were all based on electricity consumption. Streetlights data were courtesy of the Engineering Bureau and CL&P; water data were from Aquarion Water Company; sewage data were courtesy of the Engineering Bureau. Records on waste for the government sector were not obtained, as waste is not tracked for the government operations.

[36] Rebuild America is a US Department of Energy (DOE) program that aims to improve communities' quality of life by incorporating energy-efficiency into buildings for schools, colleges and universities, state and local governments, public and multi-family housing and commercial use. (US DOE. *Rebuild America: About Us.* 2003. http://www.rebuild.org/aboutus/aboutus.asp)

Community Inventory: Data

Community Electricity Data

In order to assess the total greenhouse gas emissions for the Community Inventory, data were obtained for the residential, commercial and industrial sectors. This was received from Carol Sherwood of Connecticut Light & Power Company (CL&P) for the years 1998 and 2002. The forecasted growth is based on annual percent growth of energy demand as predicted by the US Energy Information Association (EIA). The expected annual energy growth rates for residential, commercial and industrial sectors are 1.0%, 1.6% and 1.3% respectively.[37] Below is a chart of the data for 1998, 2002 and the 2018 projections.

Table 1: Community Electricity Consumption in kWh

	1998	**2002**	**2018**
Residential	401,175,839	455,520,917	489,510,763
Commercial	768,447,287	859,938,060	1,055,572,921
Industrial	103,596,637	96,093,477	134,132,668

Community Light Fuel Oil Data

Many attempts were made to contact different oil company vendors to determine the average amount of home heating oil consumed per household. However, only one company responded to requests for data, Petro. The estimates for 1998 and 2002 home heating oil use were 969 and 1,045 gallons respectively. From the US Census Bureau website, a figure of 45,399 households were recorded in Stamford for the 2000 Census.[38] Given that the population growth is about 0.594% per year (annual change determined based on actual population change from 1990 to 2000 for Stamford[39] and averaged with projected population change for the same period by the US Census Bureau[40]) and that approximately 52.4% of Connecticut households use oil to heat their homes, it is possible to estimate the home heating oil or residential light fuel oil data.[41, 42]

The commercial and industrial oil consumption were determined directly from figures on the US EIA website, based as a percentage population for Stamford. Since Stamford's 2000 population was 117,083 and the population of the state of Connecticut was 3,405,584,

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[37] US Energy Information Association (EIA). *Annual Energy Outlook 2003 with Projections to 2025.* 2003. http://www.eia.doe.gov/oiaf/aeo/index.html
[38] US Census Bureau. *Profile of General Demographic Characteristics: 2000.* 2000. http://censtats.census.gov/data/CT/0600900173070.pdf
[39] Connecticut Office of Planning and Management (CT OPM). *Census 2000 Population Counts: Connecticut Population Counts.* 2003. http://www.opm.state.ct.us/pdpd3/data/estimate.htm
[40] US Census Bureau. *Projections of the Total Populations of States: 1995 to 2025.* 1995. http://www.census.gov/population/projections/state/stpipop.txt
[41] Herb, Chris (Independent Connecticut Petroleum Association, IPCA). 2003.
[42] For calculations, see Appendix A.

Stamford accounts for roughly 3.44% of the state population.[43] The assumption is then made, for ease of data estimations, that this percentage is representative of Stamford's consumption of number two oil (No. 2 oil) for the commercial and industrial sectors, and that this percentage remains constant for the time period of this emissions inventory analysis. The calculations for 1998 and 2002 vary slightly. Because complete data for 2002 were not available, the year 2000 data were used and applied for 2002 with the assumed annual growth of 1.7%.[44] The data were available in a breakdown format for residential, commercial and industrial sectors, as well as for total distillate fuel oil consumption.[45] The assumption is made that distillate fuel oil, which has many names and types, is the same as light fuel oil in the *CACP Software*. The data for 1998 were not available in a breakdown by sectors; therefore the percentages from the 2000 data (used for 2002) were applied to the total 1998 data to obtain the figures for each sector.[46] Also, 1998 data were presented on the EIA website in thousand barrels, requiring a conversion via multiplication by 42,000.[47]

Industrial Heavy Fuel Oil Data

The US EIA website lists the total amount for residual fuel (assumed to be heavy fuel oil in the *CACP Software*) consumption in 1998 to be 15,012,000 barrels.[48] For 2001, recent data were available specifically listing the amount for industrial consumption of residual fuel as 23,403,000 gallons.[49] However, as the *CACP Software* does not have a category for heavy fuel oil under the residential and commercial sectors, this figure has been omitted from these two areas. In order to determine the amount of residual fuel consumed by Stamford industry, the following calculations were necessary. First, the 2002 figure for the industrial sector was derived by using the 1.7% annual growth from the EIA website for petroleum products. Second, the 1998 figure was determined. In order to do this, the total amount of residual fuel for 2001 was estimated by using the 1998 figure and multiplying by the 1.7% annual growth. The percent of residual fuel consumed by the industrial sector in 2001 was then determined. Finally, this percent was applied to the 1998 figure, which was then multiplied by the 3.44% assumed to represent the industrial sector consumption as reflective of the population of Stamford vs. Connecticut.[50]

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[43] CT OPM. *Census 2000 Population Counts: Connecticut Population Counts.* 2003. http://www.opm.state.ct.us.pdpd3/data/estimate.htm

[44] US EIA. *Annual Energy Outlook 2003 with Projections to 2025.* 2003. http://www.eia.doe.gov/oiaf/aeo/index.html

[45] US EIA. *Table 16: Adjusted Sales of Distillate Fuel Oil by Energy Use, 2000 and 2001.* 2001. http://www.eia.doe.gov/pub/oil_gas/petroleum/data_publications/fuel_oil_and_kerosene_sales/current/pdf/table16.pdf

[46] US EIA. *Petroleum Energy Consumption Estimates by Source, 1960-2000, Connecticut.* 2003. http://www.eia.doe.gov/emeu/states/sep_use/pet/use_pet_ct.html

[47] Digital Dutch. *WWW Unit Converter.* 2003. http://www.digitaldutch.com/unitconverter

[48] US EIA. *Petroleum Energy Consumption Estimates by Source, 1960-2000, Connecticut.* 2003. http://www.eia.doe.gov/emeu/states/sep_use/pet/use_pet_ct.html

[49] US EIA. *Table 21: Adjusted Sales for Industrial Use: Distillate Fuel Oil, Residual Fuel Oil and Kerosene, 2001.* 2001. http://www.eia.doe.gov/pub/oil_gas/petroleum/data_publications/fuel_oil_and_kerosene_sales/current/pdf/table21.pdf

[50] See Appendix A for calculations.

Table 2: Community Fuel Oil Consumption in Gallons

	1998	2002	2018
Residential	22,779,965	25,155,825	27,795,886
Commercial	3,991,502	4,809,599	5,482,902
Industrial (light)	680,446	819,909	881,014
Industrial (heavy)	764,911	818,266	990,375

Community Natural Gas Data

Although attempts to contact a representative from Yankee Gas were made, the data that were being requested were not available. The alternative route to obtaining this data occurred through the Connecticut Office of Consumer Counsel (CT OCC). They were able to provide estimates for consumption of natural gas in Stamford for 1998 and 2002, via Yankee Gas annual reports. The breakdown by sector was estimated from data on the US EIA website as percentages of consumption for residential, commercial and industrial use. The projections into 2018 are achieved using the same annual growth percentages that were used above, as these percentages represent energy growth rather than simply electricity or natural gas. The assumption is that although one energy source may grow more than another, the overall growth remains the same.[51]

Table 3: Community Natural Gas Consumption in Thousand Cubic Feet

	1998	2002	2018
Residential	1,068,692	1,833,574	1,304,007
Commercial	1,269,071	2,129,311	1,743,252
Industrial	1,001,898	1,951,869	1,297,216

Community Propane Data

Propane consumption data were also available on the US EIA website. As these data are also broken down at best by state, estimation was again performed by using the assumption that data for Stamford could be determined based on the percentage population, 3.44%. Data for 1998 were available by breakdown into residential, commercial and industrial sectors, given in thousands of barrels for the state. The figures were then multiplied by 42,000 and 3.44%. Data for 2002 were not available, therefore requiring use of

[51] It should be noted that different energy sources have different emission factors for the energy output, i.e. some fuels yield more emissions per BTU than others, such as oil vs. natural gas. However, problems will arise regarding comparisons among BTUs, cost and equivalent CO_2 emissions, as some energy sources provide more energy for their cost, and more pollution, while others are more costly but less polluting.

2000 data and the 1.7% annual growth rate to get figures for total state consumption of propane by the 3 different sectors of interest.[52]

Table 4: Community Propane Consumption in Gallons

	1998	2002	2018
Residential	2,209,240	1,993,768	2,695,693
Commercial	389,866	352,456	535,537
Industrial	564,584	785,560	731,000

Community Transportation Data

Transportation data were obtained from Chester Lau of the Connecticut Department of Transportation (CT DOT). While the data were available for 1998, the data for 2002 were not yet compiled. Therefore, the figures for 2001 were adjusted by annual growth relative to 1998, continuing the recorded trend by one year. The data were given in the categories of passenger cars, motorcycles, light trucks, buses, single-unit trucks and combinations trucks as daily vehicle miles traveled (DVMT), rounded to the nearest thousand. The passenger cars were entered into the *CACP Software* as mid-size cars in an attempt to balance out the differences in vehicle sizes. Light trucks were entered under the light truck/SUV/pickup category, with the assumption that they are run on gasoline rather than diesel fuel. Single-unit trucks and combination trucks were grouped together and entered under the diesel fuel category as heavy trucks.[53] The 2002 data for city buses were supplied by Philip Fry of CTTransit for the fiscal year 2002. Unlike the data from Chester Lau, this figure was provided as annual vehicle miles traveled, along with the miles per gallon (mpg) for the Stamford fleet; therefore the figure for buses is entered as gallons of fuel to be more precise than the defaults of the software. Because the buses (2002) are all run on ultra-low-sulfur diesel fuel (ULSD), the 1998 data from Chester Lau was therefore also entered under ULSD. However, because the number is not as precise as for 2002, nor is the mpg known, the figure is in thousands of annual VMT.

Data were not provided for marine or rail transportation, which required further investigation. Because there was no government-sponsored marine transportation, the bulk of this was assumed to be minimal recreational marine boating, and therefore omitted. After attaining data from the CT DOT concerning commuter rail, the data were nonetheless

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[52] US EIA. *Tables 8-10: Residential/Commercial/Industrial Energy Consumption Estimates, 1960-2000, Connecticut.* 2000. http://www.eia.doe.gov/emeu/states/sep_use/res/use_res_ct.html http://www.eia.doe.gov/emeu/states/sep_use/com/use_com.ct.html http://www.eia.doe.gov/emeu/states/sep_use/ind/use_ind_ct.html

[53] While all light trucks may not be gasoline powered and all single-unit and combination trucks may not be heavy trucks, the assumption is that the two categories will have a slight balancing effect. However, it should be noted that these numbers may nonetheless result in calculations of more emissions than actually occur.

excluded because of its state-operated nature.[54] The forecast projections were based on a 2.0% annual growth rate from the US EIA website.[55]

Table 5: Community Transportation in Thousands of VMT (unless otherwise noted)

	1998	2002	2018
Passenger cars (Mid-Size)	529,615	551,685	786,980
Light trucks/SUVs/Pick-ups	71,905	88,638	106,847
Motorcycles	1,825	730	2,712
Buses	730	352,898 gal	1,085
Heavy trucks	27,740	32,186	41,220

Community Waste Data

The community waste data was obtained from the Solid Waste Acting Supervisor Morton Klein for the fiscal year 2002. Although the waste is shipped to other states, the data are included to reflect emissions resulting from waste produced in Stamford (under this model Stamford could thereby take "credit" for emissions avoided at these landfills as a result of waste reduction measures implemented in Stamford). The data included breakdowns of what was recycled, how much and where it was traveling. However, the data did not include actual waste stream composition, this was instead derived using national numbers provided by ICLEI. The percentages for paper products, food waste, plant debris, wood/textiles and all other wastes are 38%, 13%, 10%, 4% and 35% respectively. The figure for 1998 was approximated by using the annual population growth in reverse from the 2002 figure.

Table 6: Community Waste in Tons

Category	1998	2002	2018
Paper products	28,437	29,118	32,013
Food waste	9,728	9,962	10,952
Plant debris	7,483	7,663	8,424
Wood/textiles	2,993	3,065	3,370
Other	26,192	26,820	29,485
Total	74,834	76,628	84,244

[54] Regardless of the number of people that are removed from the roads to take the trains instead, the trains are assumed not to change their total VMT per day or per year. Also, since the CT DOT operates the trains, there are effectively no measures that the city of Stamford could implement to effectively reduce emissions from the commuter trains.

[55] US EIA. *Annual Energy Outlook 2003 with Projections to 2025.* 2003 http://www.eia.doe.gov/oiaf/aeo/index.html

Community Inventory: Results

In between the 1990 and 2000 US Census, the population of Stamford surpassed the Connecticut Office of Planning and Management projection by growing 8.4% instead of the predicted 1.0% decrease![56] According to these same projections, between 2000 and 2020, Stamford should see a 12.2% swell in numbers. However, if the actual pattern resembles the 1990-2000 period, growth may well exceed 16% or more. In light of this, residential energy demands are expected to increase an average of 1.0% per year. Coupled with other data, such as commercial and industrial energy growth of 1.6% and 1.3% respectively and transportation growth of 2.0%, the additional GHG emissions could result in an even greater per capita contribution to global warming by the city of Stamford. Data for 1998 and 2002 were entered into the *CACP Software* to determine total equivalent CO_2 (eCO_2) in tons as well as the total energy use in MMBtus. Given that the population of Stamford in 2000 was recorded as 117,083 and that the annual growth rate has been estimated as 0.594%, the approximate population of Stamford can be determined for 1998 and 2018. Consequently, the per capita eCO_2 can be calculated by dividing total eCO_2 by these population estimates.

The charts and figures, subsequently included, summarize the analysis of the Community Inventory.

Table 7: Community Inventory Analysis Summary

	1998	2002	2018
NO_x (lb)	6,566,930	6,064,212	6,391,270
SO_x (lb)	6,864,300	4,634,642	3,664,476
CO (lb)	25,061,283	25,160,164	35,134,243
VOC (lb)	2,745,774	2,712,252	3,391,146
PM_{10} (lb)	1,625,357	1,786,263	1,849,343
eCO_2 (tons)	1,515,865	1,721,858	2,039,169
Per capita eCO_2	13.1	14.5	15.5
Energy (MMBtu)	16,907,109	20,030,405	21,774,130

[56] CT OPM. *OPM Population Projections- Series 95.1*. 2002. http://www.opm.state.ct.us/pdpd3/data/project.htm

Figure 3: Community GHG Emissions Sector Breakdown for 1998

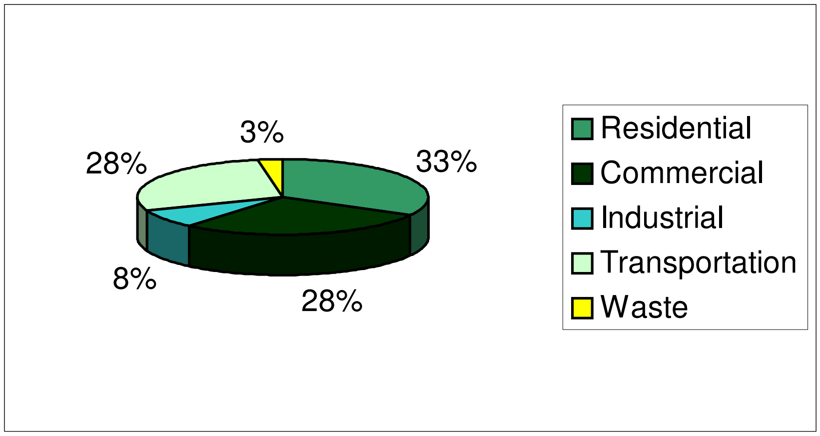


Figure 4: Community GHG Emissions Sector Breakdown for 2002

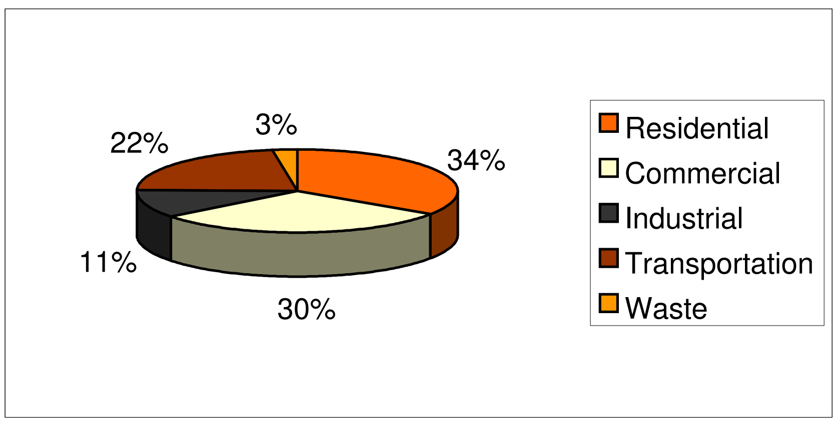


Figure 5: Community GHG Emissions Sector Breakdown for 2018

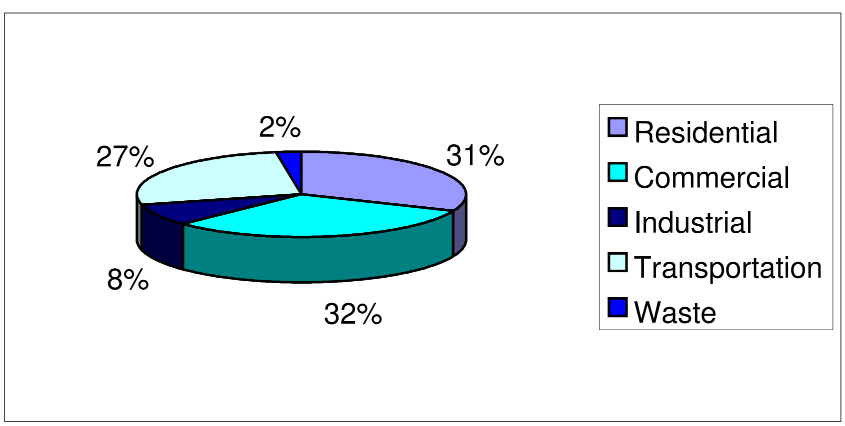


Table 8: GHG Emissions Source Profile in eCO_2 (tons)

	1998	2018	% Increase
Electricity	490,450	740,645	51%
Light fuel oil	317,587	395,189	24%
Natural gas	210,481	273,808	30%
Propane	21,366	26,759	25%
Heavy fuel oil	10,583	13,702	29%
Gasoline	366,621	458,462	25%
Diesel	53,884	79,567	48%
ULSD	1,418	2,094	48%
Solid waste	43,476	48,943	13%

Table 9: Comparative Community Per Capita eCO_2

Location	Population	GHG Emissions (tons eCO2)	Per Capita (tons/person)	Baseline Year
New York				
Buffalo, NY	309,035	3,966,716	12.8	1999
New Rochelle, NY	72,182	985,112	13.6	2000
Saratoga Springs, NY	26,186	470,135	18.0	2000
New Hampshire				
Nashua, NH	86,605	1,301,817	15.0	2000
Maine				
Portland, ME	64,249	971,849	15.9	2000
Augusta, ME	18,553	349,552	18.8	2000
Massachusetts				
Somerville, MA	77,098	751,729	9.8	1997
Amherst, MA	34,874	380,904	10.9	1997
Gloucester, MA	29,456	351,908	11.9	1998
Watertown, MA	33,284	695,675	20.9	1999
Connecticut				
Hamden, CT	56,913	613,223	10.8	2001
Stamford, CT	*155,704*	*1,515,865*	*13.1*	*1998*
State of Connecticut	3,289,090	43,015,970	13.1	1995
New Haven, CT	123,626	2,026,201	16.4	1999

(Adapted from: Adam Newcomer)

Government Inventory: Data

Government Buildings

The data from this sector of the Government Inventory were based on electricity, natural gas and oil account information, which were provided by Nancy Domiziano. Since the data were derived from actual bills, accuracy is assumed to be high, aside from missing data periods where estimations were necessary. In Stamford, the electricity provider is CL&P, the natural gas provider is Yankee Gas, and the oil provider (1998) was Standard Oil,.[57]

The first data sets received were for the electricity and natural gas consumption by schools in Stamford. Based on these figures, the most reasonable time frame appeared to be August 1998 through the end of July 1999. However, the same twelve-month data records for other facilities are not necessarily based on an August to July time frame. Calendar 1998 was employed as the next alternative option.[58] Some of the schools had natural gas data for heating and non-heating, with different rates. An average for available data for both of these rates were obtained to estimate the missing cost figures for other schools' data, separate calculations were executed for 1998 and 2002.[59]

The police department data were very courteously provided by Captain Greg Tomlin for all necessary breakdown sectors. This information was presented in dollar figures, which was then converted accordingly into energy consumption. This was achieved based on averaging all available electricity data for 1998, as well as 2002 (separately) to derive rates reflective of actual costs paid by the city. The natural gas data were provided by Nancy Domiziano and Captain Tomlin- the numbers are a medley of the two. The rate for the police department was taken from Nancy's data and applied to obtain the cubic feet of natural gas from Captain Tomlin's dollar figure.

Aside from the police department, all other government building data were provided by Nancy Domiziano. Figures were then calculated based on the process implemented for the schools. The heating oil data were provided in round estimates to Nancy via Standard Oil. The 1998 oil figures were used to derive the 2002 figures, based on the 1.7% growth rate as predicted by the US EIA. Costs were not provided and were therefore estimated from US EIA information.[60]

Although the data were received, calculated and organized on a building-by-building basis,[61] the inventory entries were grouped into categories for simplicity's sake. However, individual buildings were considered at the end of the analysis by looking at the highest

[57] Currently, the oil provider for the city is Buckley Energy.

[58] For more information, see the Appendix: Master List for City Buildings.

[59] Although most calculations for the Community Inventory are shown, the amount of numbers used for calculations in the Government Inventory outweigh any sensible attempt to illustrate them in this report. They were mostly accomplished via Microsoft Excel Spreadsheets.

[60] US EIA. *EIA's Petroleum Product Prices for Connecticut.* 2003. http://www.eia.doe.gov/emeu/states/oilprices/oilprices_ct.html

[61] To see the data building by building see the Appendix: Master List for City Buildings.

GHG emitters per grouping, overall and for the schools.[62] With suggestions from Nancy and Melissa Royael (ICLEI), the buildings were grouped into seven categories: community centers, the fire department, the government center, parks and recreation, the police department, public works (Office of Operations), and schools (Board of Education).[63] Below are tables of the energy use per grouping

Table 10(a): Government Buildings, Energy Data 1998

Department	Electricity (kWh)	Natural Gas (Ccf)	Heating Oil (gal)	Cost ($)
Board of Education	20,049,216	1,245,738	399,000	3,029,490
Community Centers	3,882,041	103,055	83,350	523,144
Fire Department	535,907	66,009	31,600	136,112
Government Center	3,198,240	88,380	200	365,220
Parks & Recreation	1,938,240	43,904	2,500	245,821
Police Department	1,081,460	56,808	0	150,554
Public Works	1,552,272	131,531	17,000	270,981

Table 10(b): Government Buildings, Energy Data 2002

Department	Electricity (kWh)	Natural Gas (Ccf)	Heating Oil (gal)	Cost ($)
Board of Education	22,670,629	921,064	394,739	3,189,365
Community Centers	4,261,397	130,799	89,164	581,185
Fire Department	587,409	66,442	33,804	152,517
Government Center	4,727,520	76,210	214	483,146
Parks & Recreation	1,540,943	60,490	2,674	196,262
Police Department	876,426	59,120	0	129,279
Public Works	1,267,466	120,450	18,186	280,879

Government Vehicle Fleet

The data for this sector were provided by Mike Ross of the City Fleet division of the Office of Operations. The data were listed by accounts, vehicles and departments. This information was used to tally up the amount of gasoline and diesel, as well as the cost, for the 2002 calendar year. The earliest system records are from 2000, thus requiring retrospective estimation from 2002 to 1998. The 2002 data compiled by Mr. Ross were week-by-week printouts, however, some of the vehicles from the master list of city fleet vehicles were not

[62] To see the top emitters, turn to the *Government Inventory: Results* section.
[63] Although the Water Pollution Control Authority is run under the Office of Operations, this category is placed entirely under the Water/sewage subsection of the Government Inventory.

included. The missing per vehicle data were estimated by Mr. Ross. Finally, it should be noted that non-transportation vehicles were not included in these calculations, such as tractors and lawn mowers. Data were entered into the *CACP Software* by the departments listed, though some of them were grouped together due to their small consumption. The table below lists the city fleet data.

Table 11(a): Government Vehicle Fleet Data, 1998

Department/Category	*Unleaded Gasoline (gal)*	*Diesel (gal)*
Board of Education	7620.7	3142.6
Dial A Ride	35836.6	8503.2
Emergency Medical Services	2698.1	8741.7
Engineering	2565.2	
Health	5174.5	
Housing Authority	17213.8	
Office of the Mayor	1369.6	
Operations:		
Facilities management	7967.5	581.5
Fleet management	2231.4	
Highways 1 & 2	40356.7	60041.3
Parks maintenance	46738.2	10140.11
Solid waste and collections	14285.3	78912.7
Other [64]	2389.7	
Smith House	4235.2	
Traffic & Parking: meter and signal	16731.7	
WPCA	3243.4	5698.08
TOTAL:	**207959.65**	**122745.9**

[64] Other category also includes Recreation, Environmental Protection, Building Department, Pool/Utility, EG Brennan, Operations' Administration, Customer Service (Traffic Enforcement and Administration)

Table 11(b): Government Vehicle Fleet Data, 2002

Department/Category	*Unleaded Gasoline (gal)*	*Diesel (gal)*
Board of Education	6948.8	2309.6
Dial A Ride	32676.9	6249.3
Emergency Medical Services	3831.4	12439.4
Engineering	2339	
Health	4718.3	
Housing Authority	15696.1	
Office of the Mayor	1248.8	
Operations:		
Facilities management	7265	427.4
Fleet management	2034.7	
Highways 1 & 2	36798.4	44126.3
Parks maintenance	42617.3	7452.3
Solid waste and collections	13025.8	57995.5
Other	2179	
Smith House	3861.8	
Traffic & Parking: meter and signal	15256.5	
WPCA	2957.4	4185.5
TOTAL:	**189623.8**	**135185.3**

Water and Wastewater

The wastewater/sewage data were provided courtesy of Nancy Domiziano and were relatively straightforward. Water Pollution Control Authority (WPCA) bills were provided and summated to establish figures reflective of the inventory time frame. Although data were provided for 1998, estimates were required for 2002. The method for this analysis was the same as that used for determining the unknown values for buildings.[65] Additionally, it should be noted that some of the WPCA accounts were shared and/or listed as being under the Solid Waste Division. All the data for the WPCA are entered under this sector, rather than under the buildings sector. This removed the need to differentiate the electricity usage for pumping and sewage treatment vs. operating/maintenance of the buildings.

[65] Electric data were perused to uncover those buildings/ accounts that had data for both 1998 and 2002. Subsequently, the rate of annual change for the conglomerate figure from 1998 to 2002 was determined. This calculation included a plethora of numbers, making visual representation in this document insensible. To see the average percent change for different energy sources, as well as rates, see Appendix E. Finally, it should be noted the rates for electricity do not include WPCA data, as the number would be too high.

The water data were far more challenging to gather. Unlike a majority of other cities, the water in Stamford is provided by a privately held company, Aquarion Water Company of Connecticut. The best figures available, courtesy of Miguel Torres, Jr., were the total daily amount of water consumed by the city in conjunction with water pump station specifics (horsepower, hours run per day, days run per year) for 2002. The final figure for electricity use for the water supply were determined by converting horsepower hours into kilowatt hours for each major pump, according to the specified usage. Subsequently, the total daily amount of water provided by these pumps was summed up and subtracted from the daily city water consumption figure. The missing percentage of electricity was then estimated based on the power and output of the major pumps. The calculation for 1998 data was based on a percent change in water demand based on a per capita gallons per day figure for Connecticut in 1995 and the current 2002 demand.[66]

Table 12: Water and Wastewater Data

	1998		**2002**	
	Electricity (kWh)	**Cost ($)**	**Electricity (kWh)**	**Cost ($)**
Water	6,304,168	610,874	5,636,475	483,610
Wastewater	10,795,277	1,660,408	11,996,364	1,833,166

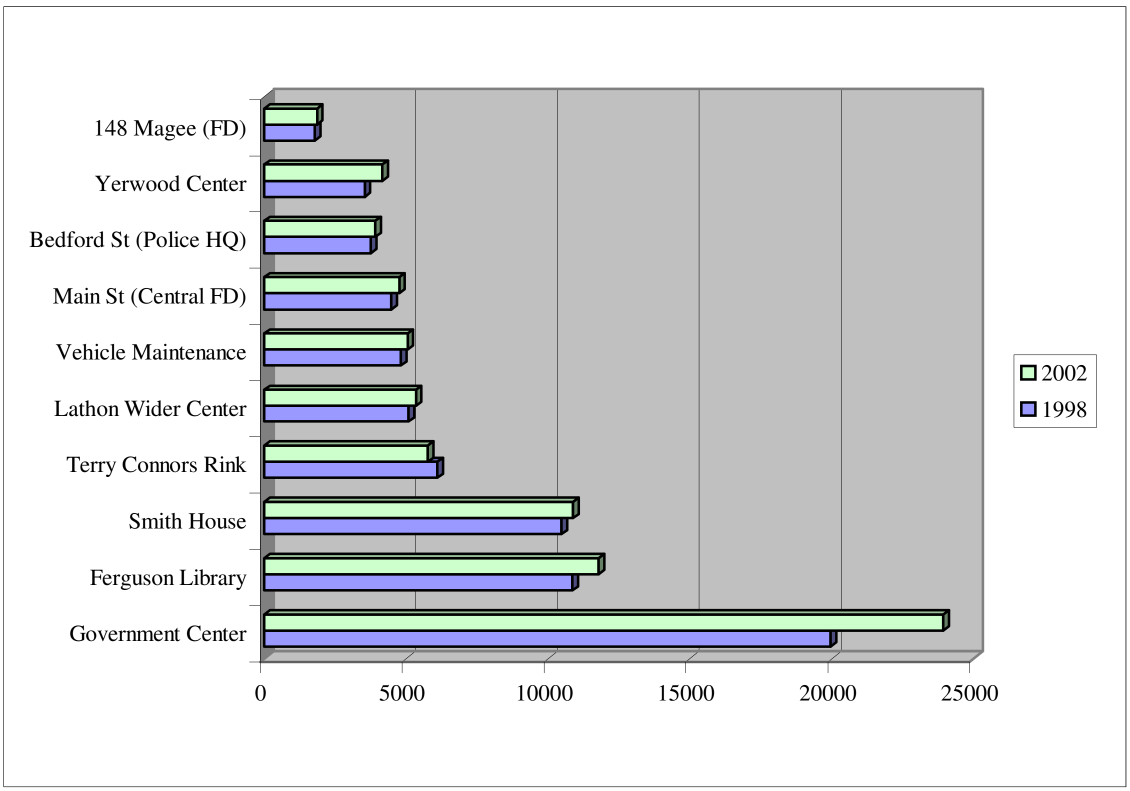
[66] US Geological Survey (USGS). *Offstream Use.* 2003. http://water.usgs.gov/watuse/pdf1995/pdf/summary.pdf

Government Inventory: Results

Government Buildings: Individual

After compiling all the buildings data, each building's total energy use (schools not included) in MMBtu (electric, natural gas and oil) was analyzed to determine the ten greatest sources of GHG emissions for 1998 and 2002.[67] This was also done for the schools in a separate analysis. The buildings sector analysis also constituted looking at the percent change from 1998 to 2002. Like the Community Inventory, the eCO_2 percent breakdown for all the sectors in the Government Inventory was computed from the *CACP Software*. Furthermore, the sources of the GHG emissions were examined to better understand how the emissions were divided. Data were also calculated for energy use per square foot. These data were provided courtesy of Nancy Domiziano, except for the Ferguson Library[68] and the Smith House[69].

Figure 6 (a): MMBtu for Top 10 Energy-Using Government Buildings, 1998 and 2002



[67] The assumption is made that the highest energy users will also be the highest eCO_2 producers. It should also be noted that the WPCA and Public Works Incinerator are large sources, but were not included in the top 10 as the energy use are assumed not to be mainly for building operations.

[68] Architects something or other. *Ferguson Library.* 2003. http://www.chsnperch.com/newmanFrameX.html

[69] The figure for the total square footage was not provided by the Smith House. Attempts to contact them were unfruitful; therefore an estimate based on the number of beds and the fact that the facility is an SNF (skilled nursing facility), a reasonable figure was 60,000 when compared to other SNFs on-line.

Figure 6 (b): eCO_2 (tons) for Top 10 Energy-Using Government Buildings

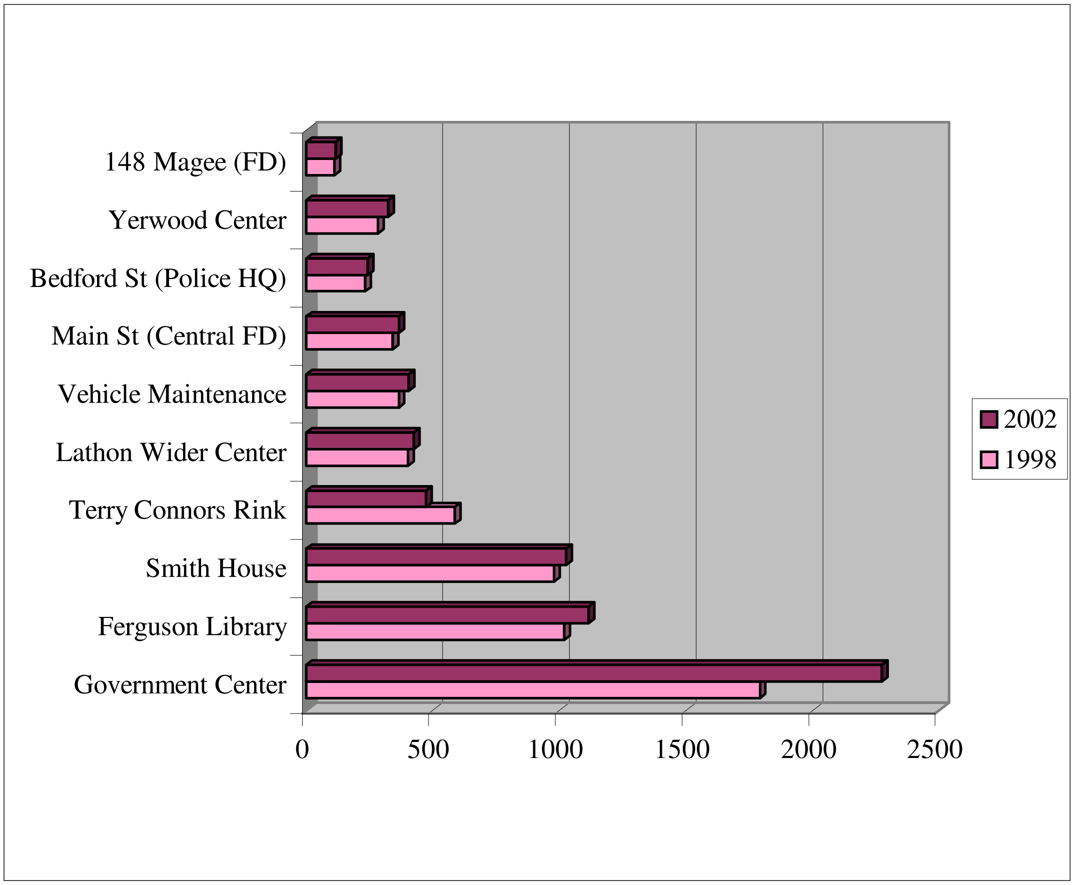


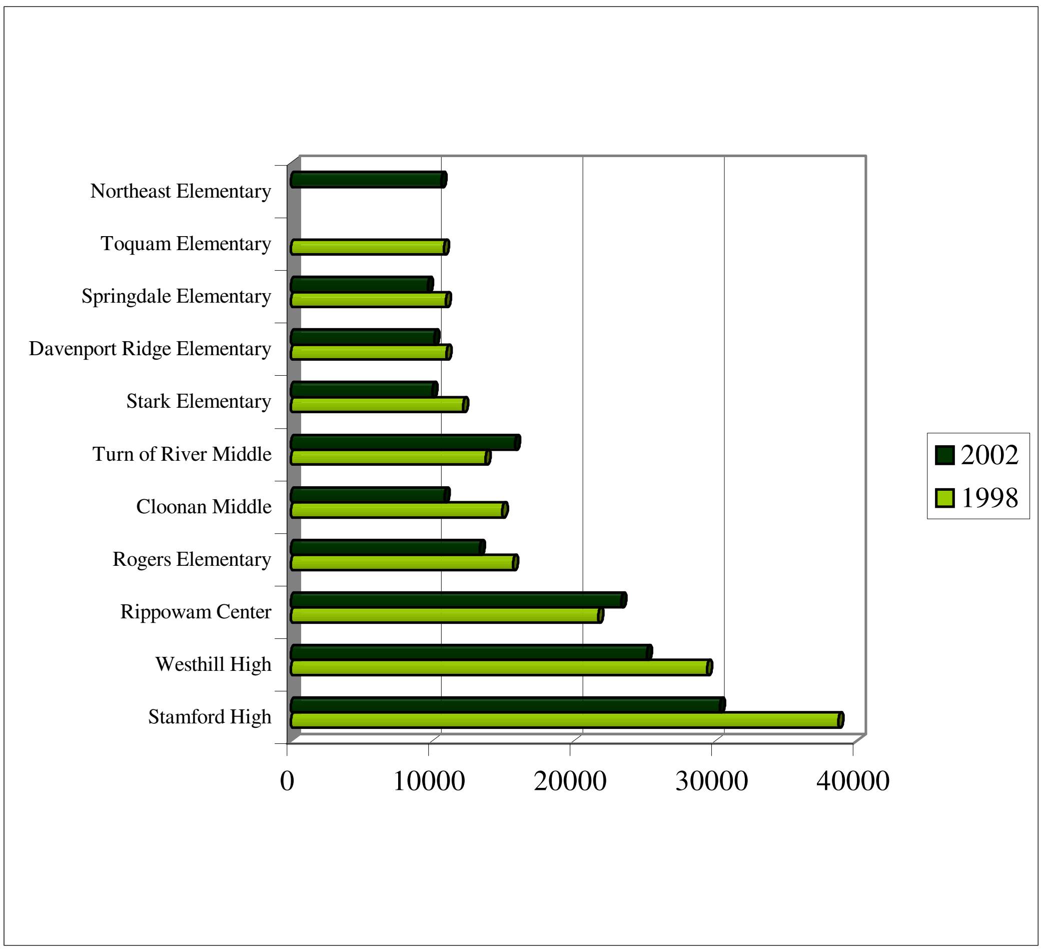
Table 13: Percent Change for Top 10 Municipal Energy Users, from 1998 to 2002

	MMBtu		% Change	eCO_2 (tons)		% Change
Government Center	19,959	23,939	**19**	1,791	2,292	**28**
Ferguson	10,860	11,792	**9**	1,018	1,114	**9**
Smith House	10,474	10,892	**4**	979	1,026	**5**
Terry Connors	6,094	5,765	**-5**	586	472	**-19**
Lathon Wider	5,088	5,343	**5**	402	425	**6**
Vehicle Maintenance	4,815	5,047	**5**	365	404	**11**
Central FD	4,481	4,761	**6**	341	365	**7**
Police HQ	3,749	3,912	**4**	232	242	**4**
Yerwood	3,536	4,155	**18**	282	323	**15**
Magee (FD)	1,793	1,871	**4**	111	116	**5**

The charts visually support the results of Table 13, that the government buildings have displayed an increase in both energy consumption and eCO_2 emissions. The only building that did not increase energy use or subsequent eCO_2 emissions was the Terry Connors Rink. The increased emissions of GHGs are to be expected with higher energy usage, unless Stamford were to invest time and money into buying and/or developing clean, renewable sources of energy. That will be the only way that increased energy needs do not exacerbate the current global warming catastrophe.

Unlike the top ten buildings for the government sector (schools not included), the schools do not have the same ten buildings for 1998 and 2002. In the following charts (Figures 6a and 6b), there are eleven entries, but two of them have data for only one year because of this fact.[70] Also, unlike the other municipal buildings, the schools are generally reducing energy use and thereby reducing GHG emissions.[71]

Figure 7 (a): MMBtu for Top 10 Energy-Using Schools, 1998 and 2002



[70] However, it is not that the data do not exist, simply they are not included to keep with the "Top 10" theme for each year. See Table 14 for percent change.

[71] These efforts have largely been implemented by Nancy Domiziano as a part of the Rebuild America program.

Figure 7 (b): eCO_2 (tons) for Top 10 Energy-Using Schools, 1998 and 2002

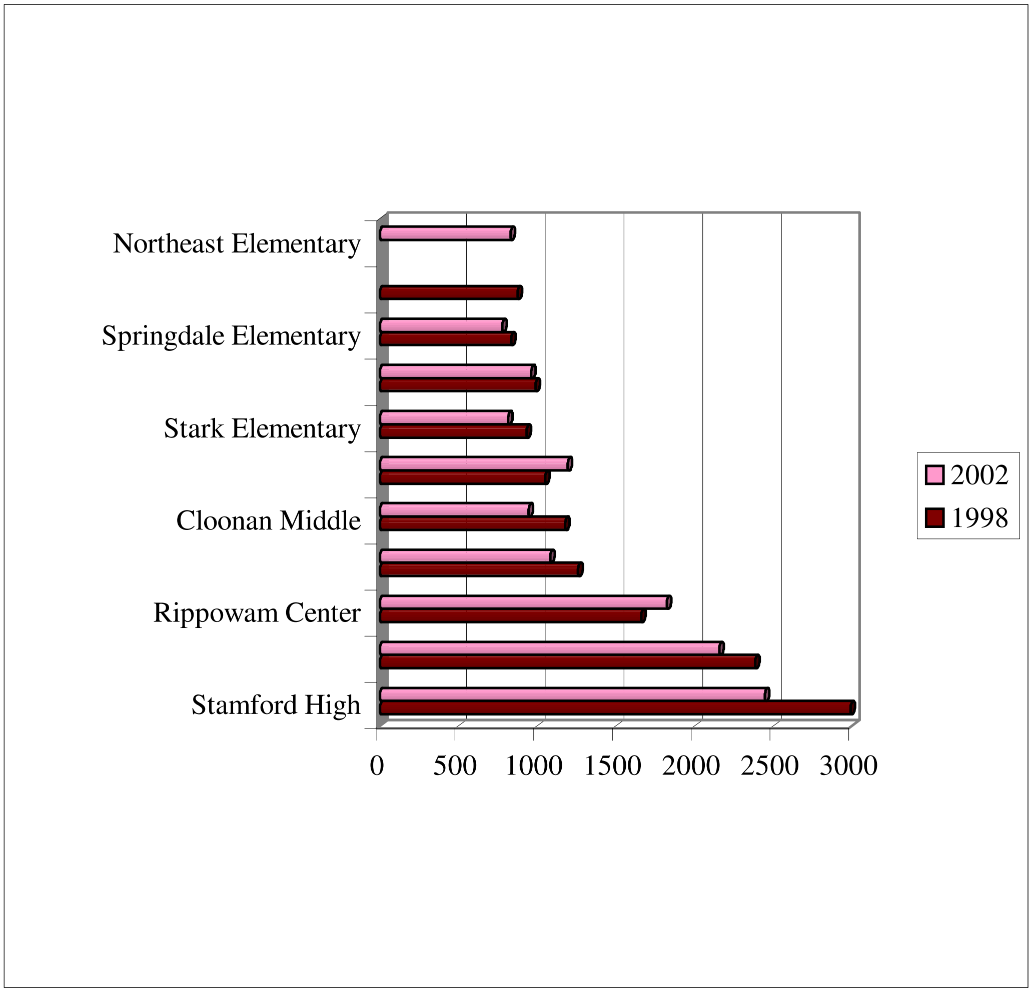


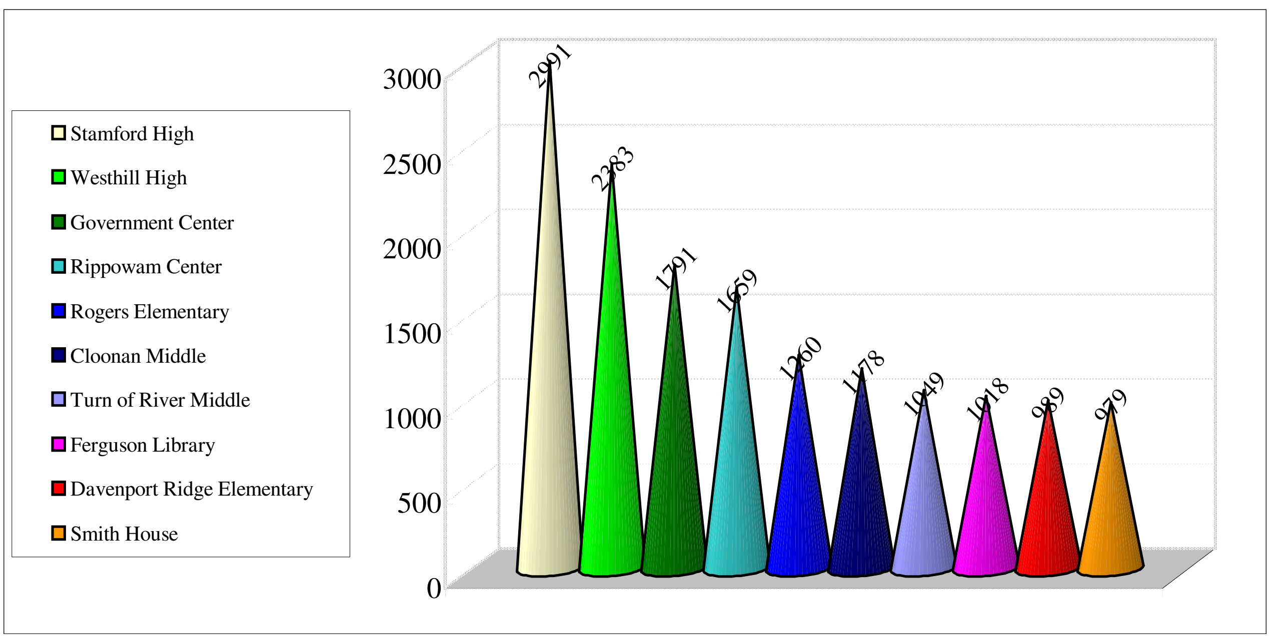
Table 14: Percent Change for Top 10 Energy-Using Schools, from 1998 to 2002

	MMBtu		% Change	eCO_2 (tons)		% Change
Stamford High	38,667	30,287	**-22**	2,991	2,446	**-18**
Westhill High	29,399	25,151	**-14**	2,383	2,157	**-9**
Rippowam	21,737	23,327	**7**	1,659	1,823	**10**
Rogers Elementary	15,723	13,371	**-15**	1,260	1,082	**-14**
Cloonan Middle	14,960	10,888	**-27**	1,178	946	**-20**
Turn of River Middle	13,767	15,841	**15**	1,049	1,194	**14**
Stark	12,195	10,026	**-18**	932	816	**-12**
Davenport Ridge	11,026	10,160	**-8**	989	961	**-3**
Springdale	10,965	9,709	**-11**	833	776	**-7**
Toquam	10,826			874		
Northeast		10,629			829	

In marked contrast to the government buildings, the school buildings have generally demonstrated a reduced energy demand with the expected ensuing decrease in GHG emissions. The exceptions here are the Rippowam Center and the Turn of River Middle School, which both showed escalated energy consumption comparable to the other government buildings. Aside from these two, the examples set by the other schools are promising models of simple changes that can achieve targeted reductions.

The overall top 10 GHG-emitting government buildings, derived from both cases as depicted above, are shown in the following figures, along with the percent change from 1998 to 2002 and the energy cost per square foot in Table 15. While the eCO_2 changes are quite reflective of energy conservation measures, the cost savings does not appear to occur hand in hand. This can be accounted for by the rate increases for several energy sources, as well as for switching from one energy source to another. [72] Table 16 displays the top three buildings in several categories on a per square foot basis: MMBtu per square foot, eCO_2 per square foot and energy cost per square foot.[73]

Figure 8(a): Top 10 GHG-Emitting Government Buildings for 1998 (tons of eCO_2)



[72] As mentioned earlier, the tradeoff dilemma arises when deciding whether or not to save extra dollars by switching to cheaper fuels, while increasing GHG emissions or to switch to cleaner fuels and spend more. However, the problem is avoided when energy conservation is implemented rather than switching fuels.

[73] For more similar numbers, see Appendix F.

Figure 8(b): Top 10 GHG-Emitting Government Buildings for 2002 (tons of CO_2)

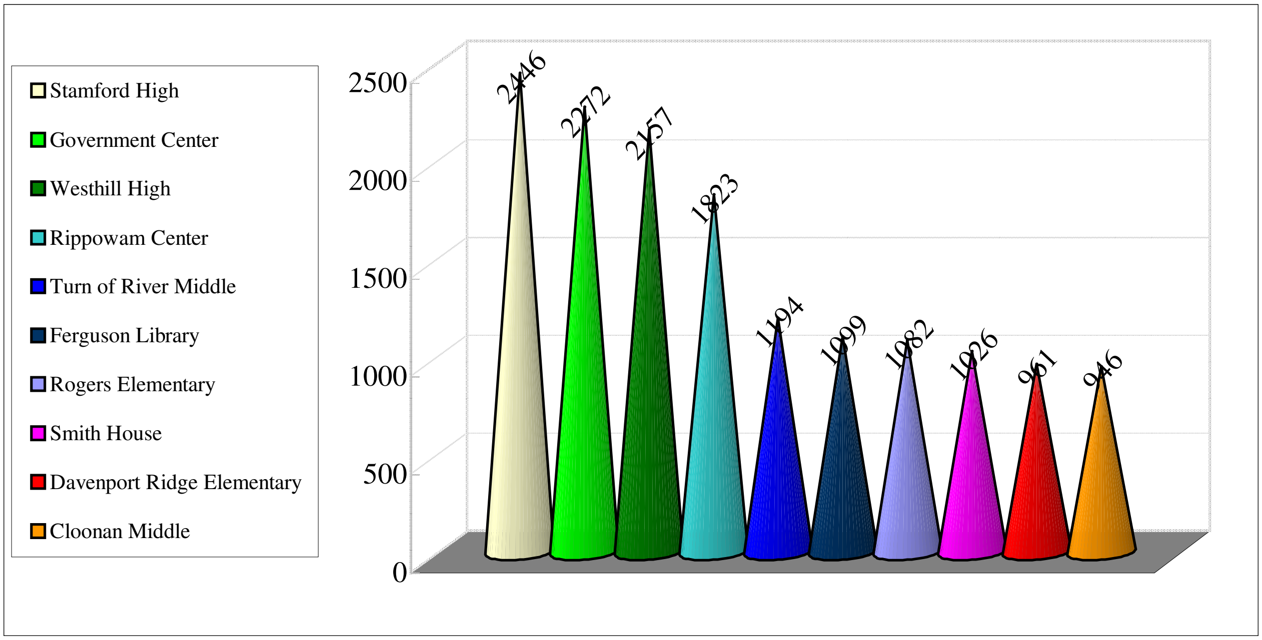


Table 15: Government Data, Percent Change in Emissions for Top 10 Buildings

	eCO_2 (tons)		% Change	Cost (energy) / square foot		% Change
	1998	**2002**		**1998**	**2002**	
Stamford High	2991	2446	-18	1.133	1.379	22
Government Center	1791	2272	27	1.318	1.744	32
Westhill High	2383	2157	-9	1.113	1.215	9
Rippowam Center	1659	1823	10	1.005	1.087	8
Rogers	1260	1082	-14	1.525	1.407	-7
Cloonan	1178	946	-20	0.964	0.941	-2
Turn of River	1049	1194	14	1.059	1.343	27
Ferguson Library	1018	1099	8	5.084	5.298	4
Davenport Ridge	989	961	-3	2.348	2.462	5
Smith House	979	1026	5	2.442	2.600	6

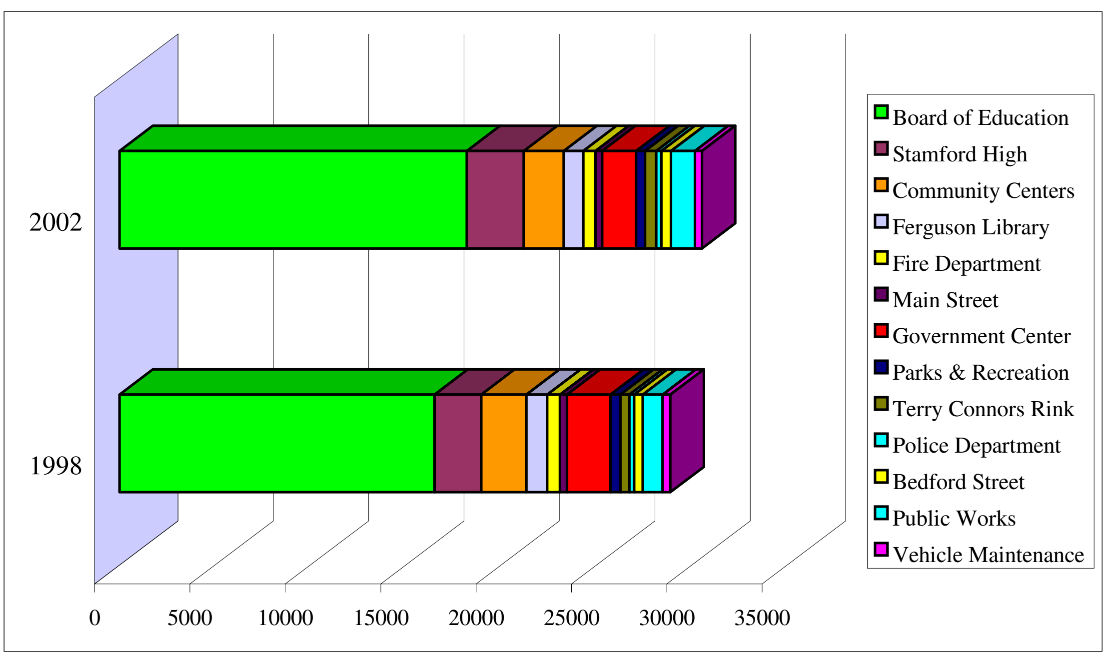
Table 16: Top 3 Government Buildings for 3 Listed Categories (per square foot)[74]

1998 TOP ECO2/SF	TONS/ SF	2002 TOP ECO2/SF	TONS/SF
Ferguson Library	0.0237	Ferguson Library	0.0256
Terry Connors Rink	0.0175	Smith House	0.0171
Smith House	0.0163	Terry Connors Rink	0.0141
1998 TOP MMBTU/SF	**MMBTU/SF**	**2002 TOP MMBTU/SF**	**MMBTU/SF**
Ferguson Library	0.253	Ferguson Library	0.274
148 Magee	0.217	148 Magee	0.227
Terry Connors Rink	0.182	Smith House	0.182
1998 TOP ENERGY COSTS/SF	**$/SF**	**2002 TOP ENERGY COSTS/ SF**	**$/SF**
Ferguson Library	5.084	Ferguson Library	5.298
Terry Connors Rink	3.59	Terry Connors Rink	2.786
Smith House	2.442	Smith House	2.6

Government Buildings: Department

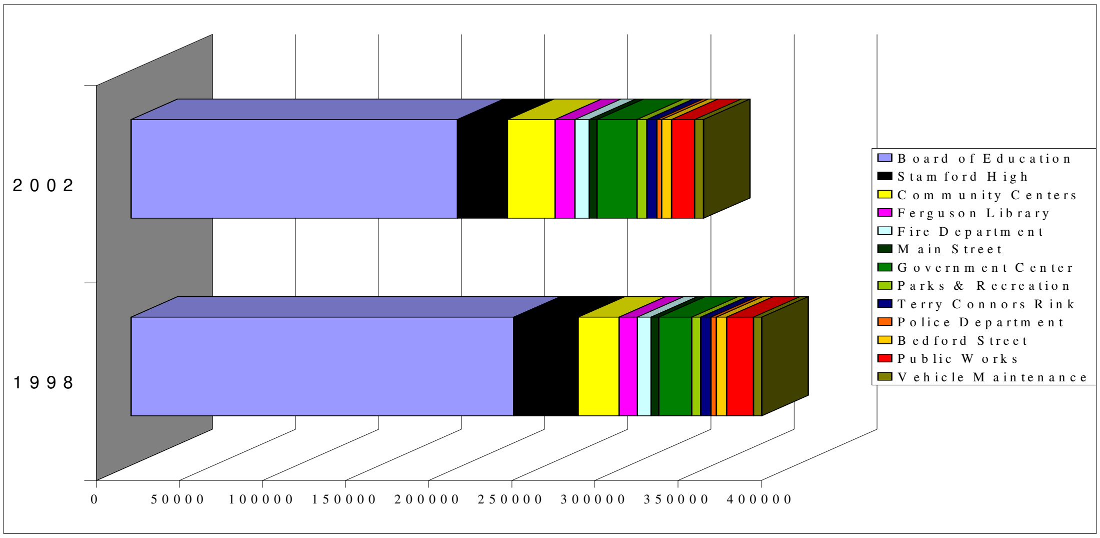
Along with looking at emissions and energy use on an individual building-by-building basis, it is also helpful to view the situation from a departmental perspective.

Figure 9 (a): Government Buildings eCO_2 (tons) Emissions by Department (with highest emitter per sector)



[74] These buildings are not out of all of the municipal buildings in Stamford, they are derived solely from the top 10 buildings, separately considered both for municipal and Board of Education, for total energy use in MMBtu.

Figure 9(b): Government Buildings Energy (MMBtu) Use by Department (with highest emitter per sector)



Comparison between the two years shows an overall decrease in energy use, led by efforts through modifications and upgrades achieved in the schools. As the largest consumer of energy in the government sector, the logic to affect changes in this department speaks clearly through these figures. However, the dilemma mentioned earlier also becomes visually apparent. Even though overall energy use decreased, emissions increased. Changing to fuels that are cleaner, such as natural gas and renewables, would highlight the energy saving efforts thus far accomplished with beneficiary GHG reductions as well.

Table 17: Government Buildings, Percent Change in Energy and Emissions by Department, From 1998 to 2002

	MMBtu		% Change	eCO_2 (tons)		% Change
	1998	2002		1998	2002	
Board of Education	269057	226580	**-16**	21196	18954	**-11**
Community Centers	35428	40366	**14**	3109	3469	**11**
Fire Department	12985	13514	**4**	988	1032	**4**
Police Department	9486	9022	**-5**	774	704	**-9**
Public Works	21095	19159	**-9**	1623	1449	**-11**
Parks & Recreation	11443	11804	**3**	1052	996	**-5**
Government Center	19959	23939	**20**	1791	2272	**27**

Government Sectors

Another useful policy application of this inventory is to analyze the government data by the sectors of water/sewage, streetlights, buildings and vehicle fleet. The figures illustrate the reduced energy use from the baseline in 3 of the 4 categories. Unlike other government-attributed functions, water and wastewater treatment tend to increase more readily with population.[75] Table 18 displays the percent changes for each sector with respect to energy use and eCO_2 emissions.

Figure 10(a): Government Energy Consumption (MMBtu) by Sector

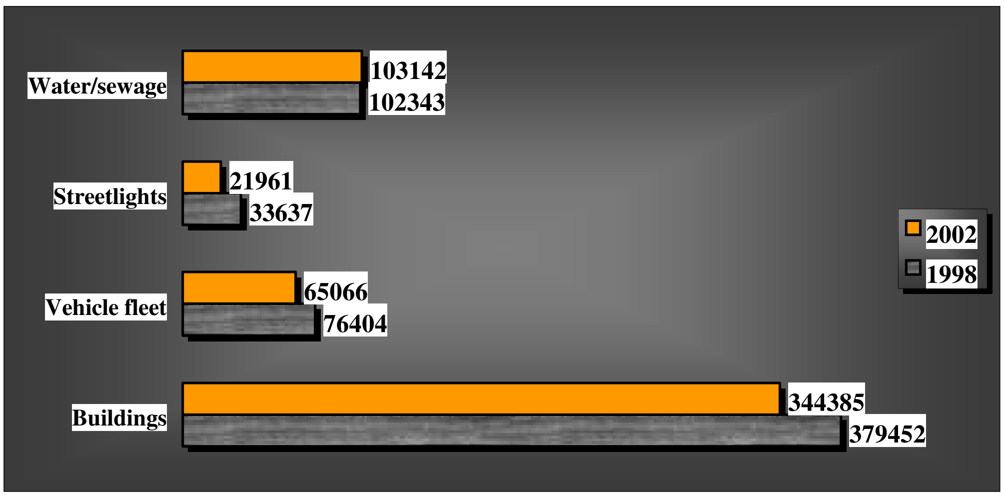
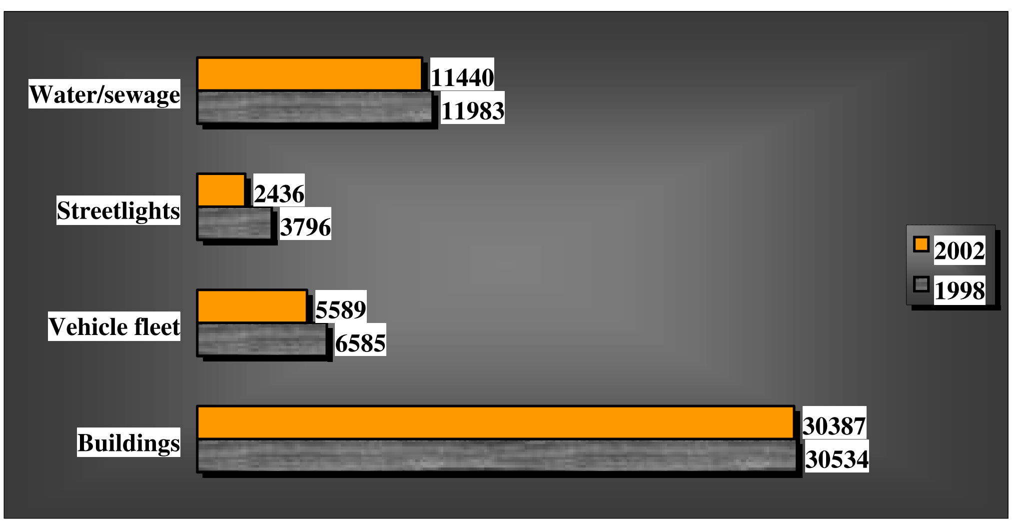


Figure 10(b): Government eCO_2 Emissions (tons) by Sector



[75] Not to say that governments do not also increase with population increase; it often does not occur on a gradual basis, but rather on a discrete path with government intervention at a given point in time enabling increased fleet size, a new building, a dozen new employee computers, etc.

Table 18: Government Sectors, Percent Change in Energy and Emissions by Department, From 1998 to 2002

	MMBtu		% Change	eCO_2 (tons)		% Change
	1998	2002		1998	2002	
Water/sewage	102343	103142		11983	11440	
Streetlights	33637	21961		3796	2436	
Vehicle fleet	76404	65066		6585	5589	
Buildings	379452	344385		30534	30387	

Government Sources

Finally, this inventory analysis can be applied by looking at individual energy sources to consider where measures could be implemented most effectively. With the buildings as the highest energy consumer, it is no surprise that electricity is the highest source of emissions, followed by natural gas and oil.

Figure 11 (a): Government eCO_2 (tons) Emissions by Source

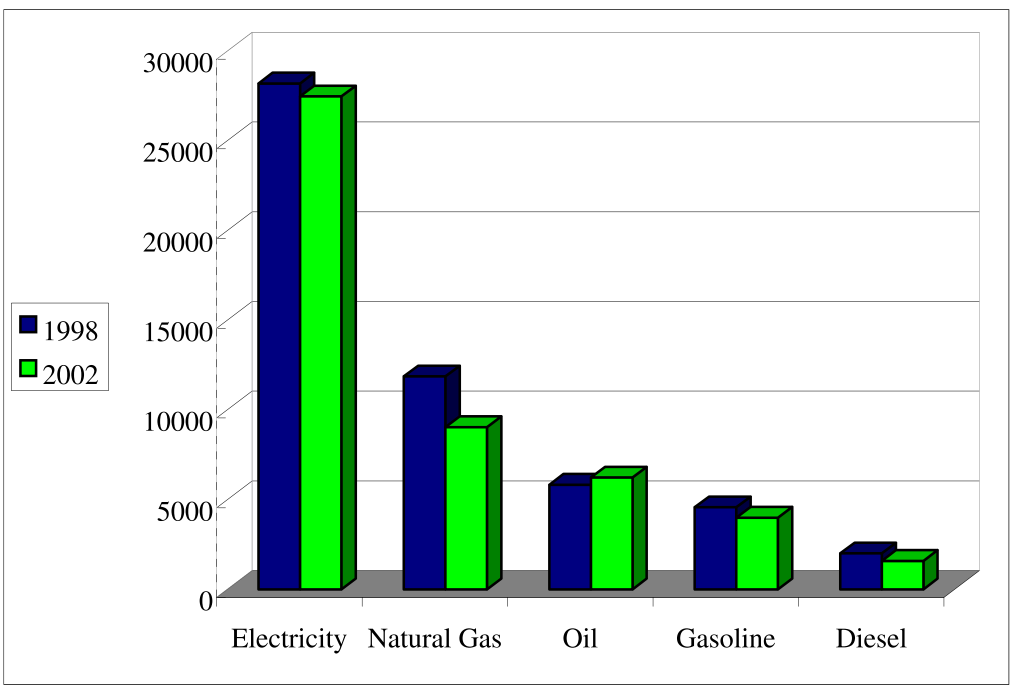


Figure 11(b): Government Energy Consumption (MMBtu) by Source

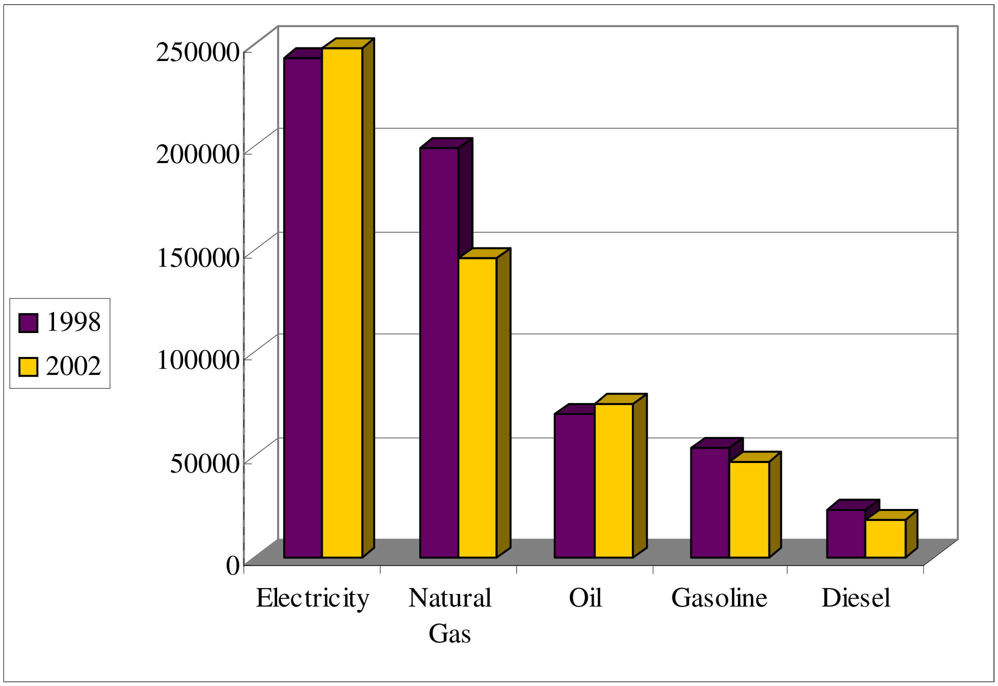


Table 18: Government Data, Percent Change in Energy Use and Emissions by Source

	MMBtu		% Change	eCO_2 (tons)		% Change
	1998	**2002**		**1998**	**2002**	
Electricity	242706	247736	**2**	28198	27479	**-3**
Natural Gas	198940	146343	**-26**	11868	9041	**-24**
Oil	70509	75406	**7**	5827	6233	**7**
Gasoline	53309	46769	**-12**	4575	3997	**-13**
Diesel	23095	18296	**-21**	2006	1593	**-21**

Future Measures

With the completion of this GHG emissions inventory analysis, it is clearly intended to act as a guide for policy measures aimed at reducing the pollution responsible for global warming. The inventory could have an especially effective use when applied to government operations because of the comparatively more detailed nature of these data. Although Stamford has already successfully achieved energy conservation measures in the schools through the Rebuild America program and state-level funding, the uncertain nature of future funding leaves the status of GHG reduction goals ambiguous and tentative hopes at best. However, with the determination and resolve that the city has demonstrated thus far, in reducing emission 7% in 4 years, the future prospects continue to shine brightly.[76]

[76] For future potential measures, see Appendix J.