WORCESTER'S ROLE IN REDUCTION GREENHOUSE GAS EMISSIONS

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by

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Abstract

The goal of this project was to form policy recommendations to the city of Worcester to reduce vehicular greenhouse gas emissions. Strategies that other cities in New England use were examined and then modified to fit Worcester's needs. Researching available grants and laws that may affect these recommendations was also necessary. Some of the recommendations include: downsizing municipal fleets, using alternative fuels, establishing trip reduction programs, and educating the public about the importance of reducing greenhouse gas emissions.

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Section 1 – Introduction

Over the past century, the Earth's temperature has been steadily increasing. The Intergovernmental Panel on Climate Change concluded that the average global temperature has been increasing due to accumulation of various gases that prevent heat from leaving the earth's surface. Gases such as carbon dioxide, methane, and certain other trace gases are referred to as greenhouse gases and are emitted by everyday human activities. An article published by the National Science Foundation discusses the importance of reducing greenhouse gas emissions. Lead author Jerry Meeh, who wrote *Climate Change Inevitable in 21st Century,* stated that "Even if we stabilize greenhouse gas concentrations, the climate will continue to warm, and there will be proportionately even more sea level rise. The longer we wait the more climate change we are committed to in the future (National Science Foundation, 2005)." Global warming not only poses as a serious environmental risk, but may have the potential of negatively affecting the livelihood of the world's population.

In the United States, the federal government is best equipped to combat global warming due to their powers over legislation. "In 2001, President Bush commissioned the National Research Council to examine the state of our knowledge and understanding of climate change." The United States government acknowledges that climate change is a serious issue, however, no significant reduction measures have been seen. The Environmental Protection Agency is a national organization that has been working to protect the environment and the health of the American citizens. The EPA develops and enforces environmental laws and regulations passed by Congress. Despite their efforts to reduce greenhouse gas emissions, their actions have not contributed enough to curb global warming. In addition, because the efforts of the national government have not had a significant impact on the reduction of greenhouse gases, action must be taken at the local level.

The local government has limited ability to impose new policies due to state and federal laws they must follow. However, despite these constraints, there are still ways cities can have an impact to reduce greenhouse gas emissions. Cities in Massachusetts have already shown initiative to reduce greenhouse gas emissions and Worcester is in the process of working towards the same goal. Steps that Worcester has already taken

include applying for membership to the Cities for Climate Protection campaign and proposing an Energy Task Force. Research has been conducted on greenhouse gas emissions in Worcester; Carissa Williams, working for the Regional Environmental Council, has conducted an inventory of emissions for Worcester in 2004. This inventory shows that approximately one third of all greenhouse gas emissions come from transportation, and therefore transportation is an appropriate starting point when addressing the issue of greenhouse gas reduction.

The goal of this project is to make policy recommendations to the City of Worcester to reduce greenhouse gas emissions caused by transportation. For a short-term goal, the focus is to reduce emissions caused by municipal fleets. The long-term goal is to apply reduction techniques to the community in order to reduce emissions produced by the city as a whole. In order to meet these goals, initial research must be conducted to learn more about the issue at hand.

Section 2 - Background

Greenhouse gases are emitted as a byproduct from the burning of fossil fuels (Lundgren, 2005). Depending on the type of city, the distribution of emissions may vary. Although buildings emit the most greenhouse gas emissions in Worcester, we have focused on emissions caused by transportation, which is the second greatest contributor of greenhouse gas emissions (Lundgren, 2005). When attempting to determine the responsibility of a municipal government for reducing these emissions, there must be an understanding of the effects greenhouse gases have on the city, the distribution of emissions throughout the city, and what the local government has control over. Other cities have established climate protection plans to reduce greenhouse gas emissions, and these plans were studied. By focusing on the reduction of municipal transportation emissions, the government would show initiative in solving this problem and act as a model for the private sector of the city.

Section 2.1 - Problems Associated with Greenhouse Gases

Social Issues

Greenhouse gas emissions have been on the rise for the past century and a half and their presence in the atmosphere has increased by 25% (EIA, 2001). This increase may have a major impact on global warming and climate change. Carbon dioxide is the largest contributor to global warming, and is the main emission of fossil fuel burning systems. The burning of fossil fuels for energy began during the industrial revolution over 100 years ago. According to ICLEI (2005), scientists believe that there is a link between the consumption of fossil fuels and the rise in global temperature. It has been estimated that the earth's average temperature has risen 5.9°F over this period, and at the current rate of emissions, the temperature will continue to rise 1.8°F – 6.3°F over the next century.

ICLEI (2005) stated that the elevation in global temperature affects the earth's climate in other ways as well. Some regions may experience increased or decreased levels of precipitation. There could potentially be an increase in extreme weather conditions, such as blizzards, tornadoes, hurricanes, and floods. Also, the water level of the oceans may rise due to the melting of glaciers, and the water level of inland lakes may

drop. If cities, such as Worcester, are affected by these intense weather conditions, public property and local business could be damaged. Coastal urban areas, such as Boston, will be at the greatest risk for flooding as the ocean level rises. Cities are already affected by a condition known as the "urban island heat effect." This is an increase in temperature close to the ground due to high population densities. As the temperature continues to rise and as precipitation levels increase, it becomes much easier to transmit diseases between people.

Contrary to the consensus of the scientific community, there are those who believe that the global warming issue does not exist. Martin Keeley was quoted in an article (Pearce, 2005), stating that, "global warming is a scam, perpetrated by scientists with vested interests." Keeley is an oil exploration consultant; therefore, he himself may have a heavily influenced opinion on the issue of global warming. Nonetheless, this shows global warming is a controversial issue. There are also more credible sources that support these conclusions based on scientific evidence. Some scientists claim that solar cycles can have an impact on the earth's climate. Danish scientists have found a correlation between average temperature and sunspot activity; however, in very recent years, this theory suggests that the temperature should be declining, and thus, this may not be a valid argument. Others say that satellite data starting in 1979 shows there has been no increase in the temperature of the troposphere, which is the part of the atmosphere closest to the surface of the earth. Recent analysis of this data shows that it has been misinterpreted and does not take into account the cooling in the stratosphere, which is the next layer closest to the surface of the earth (after the troposphere). Despite the controversy, mainstream opinion is that greenhouse gases are the source of global warming (Pearce, 2005).

Transportation

Approximately 25% of nationwide greenhouse gas emissions come from transportation (ICLEI, 2005). In the Worcester area, that number is closer to 33% (Williams, 2005). According to an EPA report, AirData, approximately 287,000 tons of air pollutants, excluding the CO_2 emissions, have been emitted from motor vehicles in 1999 in Worcester alone. Fifty-seven thousand tons of emissions come from off-highway

vehicles such as construction and heavy duty vehicles (EPA). Figures produced by Williams (2004) also show that approximately 652,000 tons of CO_2 have been emitted in 2004.

Conclusions

Based on scientific findings, there is an evident link between greenhouse gas emissions, global warming, and climate change. If municipalities were to downsize some of their fleets to use cars with better fuel economy, then not only would emissions be reduced, but the initial purchasing cost and money spent on fuel would be less. Since actions taken at the federal level are not having a significant impact on reducing greenhouse gases, local governments must take the initiative to educate their citizens on "green choices." The municipality of Worcester has the capability of showing such initiative due to the fact that Mayor Murray has signed on to the Cities for Climate Protection campaign (2004). However, this step must be followed by a proactive approach to reducing greenhouse gas emissions.

Section 2.2 - Greenhouse Gases in Worcester

Throughout the city of Worcester, motor vehicles are emitting a large amount of carbon dioxide on a daily basis. The City of Worcester must examine its role to mitigate emissions, and use its influence to help reduce greenhouse gases throughout the city. The municipal government, with the support of Mayor Murray, has decided to address this issue. As a result, Worcester has signed on to the Cities for Climate Protection campaign, and is committed to forming the Energy Task Force. Other cities in New England have taken similar actions and developed their own climate protection plans. The focus of this project was to create a set of policy recommendations for the transportation section of Worcester's climate protection plan.

Worcester's Role in Reducing Greenhouse Gases

The idea of Worcester joining the Cities for Climate Protection (CCP) campaign originated when Carissa Williams and Hannah Muller approached Mayor Murray with a plan to reduce greenhouse gas emissions in Worcester. The mayor has signed on to the

CCP campaign. As a participant of the campaign (because Worcester is not yet a member of the CCP), Worcester is focused on the reduction of the release of CO_2 from the burning of fossil fuels (Williams 2004).

Worcester must complete five performance indicators prior to becoming a member of the CCP. These indicators include:

- Conduct an energy and emissions inventory and forecast
- Establish an emissions reduction target
- Develop and implement policies in a Local Action Plan (LAP)
- Monitor and verify the results

In order to implement changes, the city must first understand where the major problems lie and what the government has direct control over.

When Worcester's membership in the Cities for Climate Protection has been finalized, successful reduction of greenhouse gas emissions is not guaranteed. The city must be willing to follow through with its plan and continue to support it. San Francisco, California had a very impressive and complex plan for making its city "environmentally friendly." What the city lacked, however, was commitment from the Board of Supervisors and mayor to implement the plan (Portney, 2003). However, it is evident that there is much support in the Northeast region because cities neighboring Worcester have unanimously passed and carried out similar plans.

One course of action the mayor feels will improve the air quality in Worcester is expanding on the existing commuter rail service to the west of Boston. In a document written by the mayor, he states that, "the lack of sufficient commuter rail services between Worcester and Boston has implications for the region's economic, social and environmental well being." As of now, there are only 10 daily round trip commuter trains between Worcester and Boston, and those ten trains are servicing the second largest city in Massachusetts. By adding more stops to the commuter rail service, more people may chose to ride the commuter rail, meaning more cars would be taken off the road (Murray, 2005). Not only would this reduce vehicle miles traveled, but also with fewer cars on the road, there would be less traffic, thus reducing the idling that adds to the CO_2 emissions. However, this does not promise an immediate reduction in vehicle miles traveled; for example, people who start taking the train may be replaced by those who once avoided driving to work.

Since Worcester has "the third highest average end-station boardings on the system" (Murray, 2005), the morning trains that travel from Worcester to Boston are at full capacity by the time the train arrives at the Southborough station. This means that no additional passengers can board the trains at this point and these potential "public transportation users" must resort to driving their vehicles. Another negative effect is that those who find themselves unable to board a train may lose faith in public transportation and thus decide to take their vehicles to work.

If another set of tracks were to be installed in the Boston/Worcester rail corridor, economic and environmental improvements for the entire area would very likely follow. However, depending on the funding and support that is currently available, this, and the other possible solutions mentioned, may not be feasible. Any policy recommendation will have to recognize the constraints and limitations that bear on the city.

Best Practices

East of Worcester, there are several cities that have joined Cities for Climate Protection, and each of these cities has formed their own action plan tailored to its needs and capabilities. These cities are Cambridge, Newton, Medford, Brookline, Somerville, and Burlington, VT. These cities have their own strategies to reduce greenhouse gas emissions. However, each city has specific characteristics, such as politics, demographics, financial capabilities, and origin of emissions.

Cambridge, Massachusetts is a city located east of Worcester that has an extensive, in-depth plan for reducing greenhouse gas emissions caused by transportation. Cambridge has implemented policies that focus on emissions reductions that affect the city as a whole. The Cambridge plan includes reducing the number of single-occupancy vehicles (SOV) by encouraging alternate modes of transportation, improving facilities for walking and cycling, and reducing motor vehicle emissions by purchasing alternate fuel vehicles or hybrids for municipal fleets (City of Cambridge). In this plan, the city council and the City Climate Protection task force acknowledge that in order for the plan to be successfully implemented there must be a citywide effort. There must be city leadership, such as a citywide campaign that educates the citizens as well as monitors

progress, and Worcester can take ideas established by cities that are members of the CCP as a model.

The ideas discussed are just a few in Cambridge's plan of action, but they are common action items of cities that want to implement emission reduction plans. When examining the climate protection plans of cities from other parts of the country, there are differences between their plans and climate protection plans of cities in New England. This is most likely due to the greater differences between the cities, such as geography, population density, and traffic patterns. Unlike San Francisco, Cambridge has established many programs such as a mandate for bicycle and pedestrian programs, as well as an increase in available public transportation. Cambridge created bicycle lanes on major roads and cleaned up its sidewalks to make walking more appealing. On a municipal level, the city government plans to use the Clean Cities Program, which is a program where the city can purchase alternative fuel vehicles and be reimbursed by the state for the difference in purchasing a "normal" car (Cambridge, 2005). This city is now a member of the Urban Ring Compact (City of Cambridge), which is a group of communities in the Boston area dedicated to building a transit line around Boston. Cambridge has already implemented its own strategies and joined appropriate programs for continued support of its policies.

Green fleets and public transportation are two important factors in the plans of Cambridge and other cities. Since fleet vehicles contribute a significant amount of emissions (Drumheller, 2000), it is important for Worcester, and other municipalities, to do whatever they can to reduce the pollution that their fleets emit. There are many ways to "Green your Fleets," and ICLEI has a series of steps Worcester could take to do so. The steps include "conducting a fleet analysis, setting emission goals, and determining and implementing actions to meet those goals (Drumheller, 2000)." There are two different ways to green a fleet; the first is purchasing the latest technology in alternative fuel or hybrid vehicles. The second way is downsizing vehicles so that a municipality is using vehicles that "fit the task." Alternate fuel vehicles not only reduce the national dependence on oil, but also improve air quality. Fleet cars that would benefit most from this option are taxis, which accumulate miles over centralized routes, local delivery

trucks, which travel over shorter distances more frequently, and buses/shuttles, which experience more stop-and-go traffic as well as idle time.

Emergency vehicles such as fire trucks and police cruisers were not taken into consideration because changing the style of a vehicle may hinder performance during an emergency. (Lundgren, 2006) However, bike patrols for police have expanded in cities such as Medford and Cambridge (Brookline, 2002). The city of Medford currently uses four bikes in the months of April through December. Benefits not only include an estimated reduction of 58 tons of CO_2 emissions and $7,229 in avoided fuel costs, but there are community benefits as well. Seeing local authorities on bikes may help to promote bicycling as a safe alternative mode of transportation. Not only do bikes fit into smaller areas then cruisers, but bikes are not as noticeable to a criminal and may help with crime reduction. In addition, a police officer on a bike may seem more approachable to community members.

In terms of downsizing a municipal fleet, a successful example is in Metro-Dade, Florida, where 150 large sedans were replaced with 150 Dodge Neons. By fitting the vehicle to the task, the fleet cut its CO_2 emissions by 600 tons. Also, by optimizing vehicle use so that multiple tasks can be completed on one trip, not only will the government save money fuel, but also emissions will be reduced. When Toronto, Ontario implemented this idea, it saved 140,000 gallons of fuel and reduced CO_2 emissions by 1,500 tons a year (Drumheller, 2000).

Another method cities have used for reducing greenhouse gas emissions is an idea more related to reducing vehicle miles traveled, as opposed to solely improving the vehicle itself. This newer concept, called the Trip Reduction Program (TRP), is based on the idea of reducing total vehicle miles traveled by employees who are commuting to work, especially single occupancy vehicles. Local governments are in the position to implement this plan of action because they can show private organizations ways of providing alternative transportation to their employees. Examples of alternative transportation include carpooling/vanpooling, buses, biking, and teleworking (Victoria Transport Policy Institute, 2005). Municipal governments can provide incentives to its employees and private companies that use Trip Reduction Programs, such as ticket subsidies, shuttle services, and preferential parking for carpools and vanpools

(Cambridge, 2005). Commuter Trip Reduction (CTR) is a similar idea based on providing incentives for employees (both municipal and private) to take alternative methods of transportation. For those employees who must take their own vehicles to work on a daily basis, education in the form of "improvement of trip planning and driving habits to encourage operation of vehicles at optimum efficiency and to promote traffic 'smoothing'" can be offered (ICLEI, 1993).

Some jurisdictions mandate the Commuter Trip Reduction program with companies having more than 50 employees, and some people feel that this idea forces workers to give up their rights of driving into work. However, CTR and TRP only develop programs to provide incentives for employees; they do not require employees to change their current commuting patterns (ICLEI, 2005).

The whole purpose of a Trip Reduction Program is to take action that will reduce the activity that causes harmful environmental effects instead of trying to eliminate the problems of pollution after the fact (ICLEI, 2005). If municipal governments were to lead by example and use a TRP for municipal employees, private companies would soon follow. By introducing this method to densely populated areas, such as Worcester, there could be both positive and negative effects. If the TRP is successful at reducing commuter demand on roads and highways, this may free up space for other drivers who would previously avoid driving during peak hours. This could offset the reduction in vehicle miles traveled by regular commuters, and could ultimately defeat the purpose of a Trip Reduction Program. However, aside from the positive outcome of reducing CO_2 emissions, a successful local government Trip Reduction Program can also have indirect positive impacts on its people. For example, some employees may entirely change their way of traveling by relying solely on alternate modes of transportation for commuting as well as short trips; not only does this reduce total vehicle miles traveled, it also could attract others to use public transportation for non-commuting trips (ICLEI, 2005).

Publicity and education are important factors that a local government must consider when developing a Trip Reduction Program. Two steps that should be taken at the very beginning are to "engage the services of public relations and education professionals" and to "get input from employees at all levels who will be affected by the TRP" (ICLEI, 2005). In order to provide an appropriate system for Worcester, officials

must first understand what is practical for the city by taking these steps, and then design a program based upon what should be done and what the people are willing to do. This is why the people involved must know the purpose of a Trip Reduction Program, how it could be useful to Worcester, and what the positive outcomes could be. The local government can directly influence the implementation of a Trip Reduction Program by providing the initial example within its own organizations, thus educating the public firsthand and attracting citywide acceptance.

Section 2.3 - Conclusions

Cities have developed climate protection plans in order to reduce greenhouse gas emissions that they create. Each city has its own strategies to reduce greenhouse gas emissions. Some of these ideas include downsizing fleets, trip reduction programs, encouraging bicycle usage, and using alternative fuels. We have established a list of policy recommendations based off of these strategies. However, one policy may be more applicable to a city based on politics, demographics and geography. These factors were addressed before any policy recommendations were made to Worcester.

Section 3 - Methodology

Section 3.1 - Methods Overview

Several issues were addressed to determine which recommendations would be made to the City of Worcester for ways to reduce vehicular greenhouse gas emissions. Best practices of other cities were evaluated, and it was determined whether or not these ideas could be applied to Worcester. Research of existing laws, funding and support was conducted. It was important to understand the state and federal laws that Worcester must follow in terms of imposing new policies or regulations on the citizens and businesses of Worcester. In addition, it was necessary to know if these policy recommendations could be incorporated into Worcester's budget over the next few years, or if other funding was available. These steps were required when trying to determine feasible recommendations.

Officials from both Worcester and the "best practice" cities were interviewed during this process. The cities that were researched were Cambridge, Newton, Medford, Brookline, Somerville, and Burlington, VT. When evaluating each city's plan, possible recommendations were categorized by their characteristics. The results of the data collection from the current municipal fleets were used to establish appropriate policy recommendations to the City of Worcester. The municipal fleets that were considered include Worcester Police, Worcester Fire, DPW, Worcester Parks, Worcester Regional Airport, and Durham School Services (company contracted by Worcester Public Schools). Information gathered from these interviews was incorporated in our analysis.

Section 3.2 - Research Questions

What Are the Strategies of Other Cities?

ICLEI is a source that provides information on cities that are working towards greenhouse gas reduction. When researching best practices through ICLEI, a list of possible recommendations was compiled and each best practice was evaluated based on its characteristics. The following criteria were considered for the short term: initial and long-term costs, whether or not the policy could be easily implemented, if actions taken would affect the livelihood of downtown Worcester, estimate in dollar savings, and if a grant or incentive could be applied. The considered long-term criteria were if a policy

could be accepted by the community and if it would help or hinder safety, health, and Worcester's economy.

After evaluating these best practices, interviews were set up with officials who are currently working with existing policies of other cities. Speaking with these people provided insight into what obstacles might be encountered, possible solutions, and what is considered when proposing a carbon reduction policy. A meeting with Jean Clark, the PTDM of Cambridge, was a major asset when considering policy recommendations for Worcester. Ms. Clark provided valuable information that could not have been found by research. Other city officials, such as Kim Lundgren (who took part in the Medford plan) were interviewed to learn more in depth about the policies of the "best practice" cities, as well as the reasoning behind their chosen methods.

Interviews with Worcester city officials were conducted in order to understand the considerations of municipal government when passing and supporting policies and in order to understand viewpoints of politicians. Mr. Petty, the Chair of the City Council's Standing Committee on Transportation, told us that the city has no policy regarding transportation, but Worcester does support public transportation by subsidizing the Worcester Regional Transit Authority.

How Much Latitude Does Worcester Have?

When making policy recommendations to Worcester, it was important to understand state and federal laws that need to be followed. For example, the City of Worcester cannot impose a tax on sports utility vehicles because this is a power reserved by the state. The city must understand what the laws allow before taking action to implement a policy.

Existing laws do not only constrain Worcester when imposing a policy, but may in fact provide an opportunity to place more emphasis on regulations that reduce greenhouse gas emissions. For example, the Massachusetts anti-idling law (M.G.L. Chapter 90, Section 16A) and DEP regulations (310 CMR 7.11 (1)(b)) limit idling to five minutes. If the city enforces this law more aggressively to decrease idling in vehicles such as construction vehicles, police cars, and taxis, then a reduction in greenhouse gas emissions may result (School Bus Idling Reduction)

In terms of funding, the Budget Director was contacted to find out if certain aspects of the transportation policy could be incorporated into the budget over the next few years. An additional form of monetary support is non-governmental grants. After speaking with Kim Lundgren of the CCP, it was noted that third party funding is available, but is very limited. In order to relieve budgeting issues, state and federal grants were sought out.

It is difficult to locate available grants because application deadlines are generally set for a few months after the grant is publicized. Therefore, ongoing diligence must be practiced to stay informed of current grants. Also, there are restrictions with grants, such as the type of vehicle for which the funds can be used (i.e. municipal fleet versus private, diesel versus alternative fuel, etc.). These aspects must be considered when applying for grant money to support policy recommendations.

What is the Distribution of Municipal Fleet Emissions in Worcester?

Data were collected regarding municipal fleets in order to understand the distribution of vehicular greenhouse gas emissions among the municipal departments of Worcester. Municipal fleet data from each department was collected and evaluated based on total vehicle miles traveled or gallons of gasoline/diesel purchased each year. Data obtained for all Worcester fleets, besides Durham School Services, included average gallons of fuel purchased by each department (diesel and gasoline) for October 2002-October 2003. School bus fleet data included an estimated amount of vehicle miles traveled per month for buses servicing Worcester Public Schools. Fleet data was gathered through archival research and contacting the proper officials. John Rugg of the Department of Public Works provided fleet data for all departments in Worcester and Betty Brigham of Durham School Services provided all bus fleet data.

A software model (Clean Air and Climate Protection Software) provided by the Cities for Climate Protection is a convenient tool for calculating greenhouse gas emissions from these vehicles to understand which departments are contributing most to emissions. The inputs to the software require the model-type of the vehicles as well as fuel type and either gallons of fuel type used or total vehicle miles traveled. Although gallons of fuel used by each vehicle type was not specified within each department,

emissions were estimated by classifying all department vehicles as "auto full size" when using the software. This gave a general basis for comparing the fleets among the different departments. For the bus fleet, this information was known and the vehicle type was specified as "heavy truck." The output in both cases provided the amount of various emissions: carbon dioxide, nitrous oxides, sulfur oxides, carbon monoxide, volatile organic compounds, and particulate matter 10. The effectiveness of a possible solution can be estimated using this software by changing the inputs; these changes could be due to the downsizing of a fleet, a change from diesel fuel to compressed natural gas (CNG), or a reduction in vehicle miles traveled. This model not only allows one to calculate emissions, but also will help to estimate the effectiveness of a policy recommendation.

Section 3.3 - Conclusions

When determining which aspects of an existing policy can be implemented into Worcester's plan for reducing greenhouse gases, three factors were considered. It was established whether or not Worcester could feasibly adopt an existing policy from another city based on similar characteristics. It was important to understand the capabilities of Worcester in terms of funding and legislation. The distribution of emissions was identified and evaluated. Once these components were taken into account, appropriate policy recommendations were created which will serve to reduce greenhouse gas emissions in Worcester.

Section 4 - Findings

Section 4.1 - Best Practices

There are six cities in New England that have joined the Cities for Climate Protection campaign. These cities are Cambridge, Newton, Medford, Brookline, Somerville, and Burlington, VT. Each city has its own climate protection plan, which addresses ways to reduce greenhouse gas emissions caused by transportation. These best practices can be classified into four categories: municipal fleet modifications, parking regulations, modification of traveling habits, and education of the public.

Municipal Fleet Modifications

Fleet operators should consider equipping their fleets with vehicles that are more fuel-efficient. The transition to vehicles that consume less fuel will not only lower long-term fuel costs, but overall emissions from transportation will be reduced. Options that operators have are: downsizing, the use of alternative fuels, or hybrids. Sometimes it is not necessary to use an alternative fuel vehicle; replacing larger vehicles, such as SUVs, with smaller sedans with a higher fuel economy been done in other cities such as Cambridge and Medford (Appendix F). These two CCP cities not only modified the fleets, but also made plans to only contract with construction or waste management companies that meet specific requirements. These requirements include the use of catalytic converters and biodiesel for all diesel vehicles (City of Medford, 2001) (Appendix A).

Sometimes it is not possible to change the way a fleet operates. This is the case for emergency vehicles such as police cruisers and fire engines. Medford avoided modifying its emergency vehicles, because doing so would greatly impair performance during an emergency (K. Lundgren, personal communication, Feb 7, 2006) (Appendix B). There are some cases when modifications can be made to emergency vehicles. An example of this can be seen in Brookline, where it was decided to use more bicycle patrols in the police department. The use of bicycles reduces the need for traditional patrol vehicles, which helps the department save on fuel expenses (City of Brookline, 2002) (Appendix A). The transformation from high-energy consumption vehicles to

fleets that are more fuel-efficient benefits the city because of the cost savings, and benefits the community as a whole because of the reduction in emissions.

Parking Regulations

Cambridge has focused on the implementation of strict parking regulations as part of its Transportation and Demand Management Program. This has been done by installing more parking meters in the city, having more vigorous enforcement, and requiring residential permits to park along residential roads. With greater restrictions on parking, people are starting to consider alternative modes of transportation, such as biking, walking, or taking public transportation (City of Cambridge, 2005). An additional strategy that Cambridge had considered but never implemented was zoned parking permits. As of now, residents with parking permits can park their vehicles anywhere in the city that requires a permit. With zoned permits, people would be allowed to park their vehicles along the streets of only one section of the city (J. Clark, personal communication, Jan 24, 2006) (Appendix B). This would mean a Cambridge resident living in zone A could not drive a few blocks down the road to zone B and park in a space that requires a permit. However, a policy involving parking restrictions may not be beneficial to a city trying to rebuild its infrastructure. People may not want to drive into the city if there are too many parking restrictions.

Traveling Habits

It is impossible for a city to force its citizens to carpool or take alternative modes of transportation. This is why many cities have been working with local businesses to promote trip reduction programs by offering incentives. For example, Cambridge has set up a shuttle service supported financially by various companies within the city. These companies share a shuttle system that picks up employees from South Station and drops them off at their offices within the city (J. Clark, personal communication, Jan 24, 2006). Cities have also set aside a large number of preferential car/vanpool parking spaces for employers. A company in Cambridge has implemented this strategy and as a result their carpooling rate has increased by 12% (J. Clark, personal communication, Jan 24, 2006) (Appendix B). Some employees do not choose to carpool or take public transportation in

case a vehicle is needed throughout the workday. Cambridge and Brookline have been encouraging companies to purchase accounts with car sharing programs such as Zipcar, which allows members to rent a vehicle for a certain period of time (i.e. for transportation to an important meeting) (Appendix A).

Fees and rates associated with Zipcar:

- One-time account setup fee for the employer ($75) ·
- Each driver added to account must pay $25/year ·
- Rates include gas, insurance, designated parking, XM Satellite Radio

Monday-Friday member rates:

- $8.25/hour
- $51 for an entire workday (7am - 7pm)
  (Zipcar, 2006)

Additional services that businesses can offer to their employees include bicycle storage and changing facilities. The City of Cambridge offers incentives to companies that offer these facilities so that employees can bike to work. Efforts can go beyond affecting commuter choices by including programs directed toward residents. Cambridge encourages people to walk or bike around the city instead of drive. The city has modified its streets so that they are more pedestrian and biker friendly. Actions taken include beautifying the sidewalks with trees and shrubbery and setting up bike routes along the streets (City of Cambridge) (Appendix A).

The communities of Cambridge and Brookline have established plans for a walk to school program, which is provided for children who live close to school. These students have the option of walking with their parents or other adults instead of taking the bus or being driven to school. This program is expected to be an effective community builder and a way to establish strong familial bonds. Although a city cannot require its citizens to drive certain vehicles or improve traveling habits, there are ways to promote alternate modes of transportation and make people realize that they do not have to rely on their vehicles.

Educating the Public

Cities have realized that it necessary to educate citizens about the threat of global warming caused by greenhouse gas emissions. Every year Cambridge has an energy fair to educate people about the importance of conserving energy and the use of renewable energy sources. The City also has guest speakers at schools and libraries to speak about greenhouse gas emissions and global warming (J. Clark, personal communication, Jan 24, 2006). Newton has also made plans to bring awareness of the existence and cost benefits of alternative fuel vehicles (City of Newton, 2005). In order for citizens to take part in reducing emissions, sacrifices must be made and lifestyle changes must be accepted. Education gives people the opportunity to understand how their actions impact the environment and what can be done to mitigate the problem.

Section 4.2 - Laws

Constraints

It is important to understand state and federal laws before making policy recommendations to Worcester, because constraints exist that may prohibit certain actions. The only policies that Worcester could not legally implement are those that require changes in the way vehicles are taxed. For example, taxing vehicles according to the size of their engines would be a change that is controlled by the state government and thus cannot be changed by municipalities.

Federal Laws

On the Federal Level, major actions being taken against the greenhouse gas emission problem from transportation include the declaration of CAFE standards (Corporate Average Fuel Economy) (NHTSA, 2006) (Appendix E). These standards were passed in conjunction with the "Energy Policy Conservation Act" which Congress passed in 1975. This act was initially a response to the Arab oil embargo that took place in 1973-1974, which exemplified the importance of lowering dependency on imported oil. According to the CAFE standards, certain classes of vehicles sold in the United States must meet an established level of average mileage traveled per gallon of gasoline. Since 1990, the CAFE standard for passenger vehicles was amended to 27.5 miles per

gallon and 20.7 miles per gallon for light-duty trucks. These standards have remained at this level over the past sixteen years, and are set by the National Highway Traffic Safety Administration. It is the responsibility of the Environmental Protection Agency to calculate the average fuel economy for each manufacturer. When a company cannot meet the CAFE standards for that specific year, it is penalized. The manufacturer could be fined $ 5.50 per 0.1 miles per gallon under the set standard, multiplied by the total number of vehicles that are being manufactured for a given model year in the specified class. Since 1983 manufacturers have paid a total of $590 million for CAFE civil penalties. Most European manufacturers paid $1 million to $20 million in CAFE civil penalties, and Asian and most domestic manufacturers have never paid a civil penalty. If a company exceeds the CAFE standards by a certain amount then the manufacturer earns credits that can be used in the consecutive model years.

State Laws

An existing law in Massachusetts is the Massachusetts Idling law, which states that no vehicle is allowed to idle for more than 5 minutes (Massachusetts Government, 2006). This law is applicable to all motor vehicles, however it is not strictly enforced. Various transportation companies obey this law by either the enforcement at terminals where vehicles make their stops or by equipping the vehicles with timers that stop the engine after idling for 5 minutes.

Another state action aimed toward reducing greenhouse gas emissions is the enforcement of the California Low Emission Vehicle (LEV) standards that were accepted in 1990 (Registry of Motor Vehicles, 2006). All vehicles that are sold in Massachusetts must be equipped with the modifications set by the LEV standards, which are set by the California Air Resources Board (California, 2006). These modifications focus on three main improvements. The first is to improve the air-fuel ratio in the mixture so that the combustion leaves no residues in the cylinder. The second modification is to improve the gas injection system to have a more precise timing when injecting the fuel into the cylinder, and the third is to make the catalytic converters more effective. These LEV standards have also been adopted by other surrounding states such as New York,

Vermont, and Maine. Connecticut, Rhode Island, and New Jersey are currently in the process of adopting these standards (Appendix E).

Section 4.3 - Grants and Funding

Why Funding is Necessary

Without the proper funding and support, a plan of action cannot be successfully implemented. Grants and incentives are practical alternatives to taxing citizens when determining ways to support a new policy. However, applicants must be aware of varying restrictions in each grant. Examples of restrictions include: municipal or private applicants only, modifications to specific vehicle types, educational purposes, geographical location of applicant(s), and application deadlines.

Available Grants

The Natural Gas Vehicle (NGV) and Compressed Natural Gas (CNG) Infrastructure Technical Assistance fund provides rebates and incentives to both the public and private sector (Appendix C). Customers who want to purchase natural gas vehicles or build CNG refueling stations are able to contact Mike Manning from Keyspan to submit a request.

Cons of using CNG:

- 1,300 CNG refueling stations in over 46 states (lack of refueling stations)
- Amount of energy by volume of CNG is slightly less then that of gasoline
- Initial purchase cost of a CNG vehicle is $3500-$6000 more then a gasoline vehicle

Pros of using CNG:

- Costs are fifteen to forty percent less (per gallon) than that of gasoline
- Oil does not need to be changed as often because CNG burns cleaner
- If gasoline is converted to CNG, carbon dioxide emissions decrease by 25%, carbon monoxide by 90-97% and nitrous oxides up to 60%

There are existing funds that support local governments in promoting energy efficiency. The Environmental Stewardship fund is for community-based projects that address energy efficiency and local environmental needs (2006 Environmental

Stewardship Program). A contribution of up to $250,000 is expected to be available and individual awards range from $5,000 to $25,000. The Transportation and Community and System Preservation Pilot Program is available to local governments that want to implement strategies that would reduce emissions caused by transportation, promote alternate commuter choice, and promote cleaner vehicles or green fleets. Funding from $50,000 up to $300,000 is available to each recipient, in the form of cooperative agreements.

The Diesel Emission Reduction Act of 2005 is available on the state level (Diesel Emission Reduction Act of 2005, 2005). If Massachusetts applies for funding at the federal level, then Worcester is able to apply to the state for support. These funding programs are focused on promoting the reduction of diesel emissions and non-road engines used in construction vehicles, retrofit buses, and medium- and heavy-duty trucks. Funds can also be used for creating idle-reduction programs. Since there is a Five Minute Idling law that exists in Massachusetts already, these funds may not go toward the cost of the existing law. An amount of $200 million (annually) has been authorized to fund the programs for fiscal years 2006 through 2011.

Funding is available to promote community education about environmentally friendly choices. The Bikes Belong Coalition contributes to non-profit organizations and public agencies and departments at the national, state, regional, and local level (Grant Info & Application). Funds will be given to those who show initiative towards forming programs that are focused on establishing bicycling groups or to make existing organizations more effective at promoting bicycling. Innovative pilot projects or projects that will have a significant political impact are of great interest. The Public Awareness Grant accepts applications from organizations that are involved in carrying out educational programs that increase public awareness and support for renewable energy throughout the communities of Massachusetts (Public Awareness Grants). Funds of $275,000 will be available for each round (Appendix C).

Section 4.4 - Municipal Fleet Data

Data were collected regarding either gallons of fuel purchased or vehicle miles traveled for each of Worcester's municipal fleets. The municipal departments that were considered include: Worcester Police Department, Fire Department, Department of Public Works, Durham School Services, Parks Department, and Worcester Regional Airport. Information regarding fuel purchased by each department, excluding Durham School Services, was obtained from a document produced by Carissa Williams of the Regional Environmental Council (Williams 2004) (Appendix G). Using information reported by Peterson Oil, Williams estimated the amount of gallons used by each municipal fleet based on total expenses for fuel and average fuel cost for October 2002-October 2003. This information does not include data for the school bus fleets, which are contracted from Durham School Services as of August 2005. Betty Brigham, Safety Supervisor of Durham School Services, reported an average total of vehicle miles traveled per month for the buses servicing Worcester public schools (Brigham, 2006).

In addition to gallons purchased or vehicle miles traveled, it was also important to know which fuel type is used for each fleet because there are different greenhouse gas emissions produced by different fuels. Each department purchases its own fuel for the corresponding fleets (from Peterson Oil), and the estimated amount of gasoline or diesel is recorded for a given year. For all departments in Worcester, excluding the Durham School Services bus fleet, there was an estimated 246,131 gallons of municipal diesel purchased from October 2002-October 2003 (Williams 2004). The amount of gasoline purchased during this year is estimated for each department with an estimated total of 577,000 gallon of municipal gasoline (Williams 2004). This information is provided in Table 1, which displays the amount of diesel gallons purchased by all departments (in total), as well as the amount of gasoline purchased by each department.

Information regarding the Durham School Services bus fleet does not include gallons of fuel purchased, but the estimated amount of vehicle miles traveled is known for one month (on average). The buses that service Worcester travel about 100,000 miles per month, and a typical school year is September through June. Vehicle miles traveled in an entire school year were estimated for ten months total, which does not take into consideration school vacations or field trips (see Table 1). It is also known that the bus

fleet is composed of 2006 Thomas buses, which run primarily on ultra low sulfur diesel (ULSD) fuel with use of CTR particulate filters (Appendix B).

	Average Gallons (Oct. 02-Oct. 03)
Municipal Diesel	
Total	246,131
Municipal Gasoline	
Police	248,000
DPW	284,000
Parks	11,000
Airport	11,000
Fire	24,000
Total	577,000
	Average Vehicle Miles Traveled (Sept. 05-June 06)
School Bus ULSD with CTR filter	
Total	1,000,000

**municipal diesel and all gasoline inputs are for auto full size vehicle; school bus diesel inputs are for heavy duty vehicle*

Table 1: Inputs for CACP Software Model

Section 5 - Analysis

Section 5.1 - Best Practices

There are criteria that must be met when examining the policies of other cities to determine if they can be applied to Worcester. The criteria are:

- Cost of implementing a policy
  - Availability of grants
  - Financial savings after implementing a policy
- Ease of implementation
- Negative side effects on the city
- Effects on the community
  - Public health
  - Safety

Each best practice was examined according to these criteria to determine possible strategies in making recommendations to Worcester.

Traveling Habits

The provision of preferential van or carpool parking spaces is one recommendation that should be applied to both municipal and private organizations. The cost involved would be minimal, including the purchase of signage and installation. According to Jean Clark from Cambridge, the installation of these signs would encourage employees to fill the spaces by starting to carpool. These preferential parking spaces could potentially offset the eighty percent of single occupancy vehicles that drive into Worcester each day (MASSPRIG Education Fund and Clean Water Fund, 2006). If a certain percentage of these commuters resorted to carpooling, a reduction of greenhouse gas emissions would result. For example, if a group of four single occupancy vehicles (1 SUV, 1 full size sedan and 2 mid size sedans) drive 49,400 miles a year (or 50 miles each work day per vehicle), the total greenhouse gas emissions include 32 tons of eCO_2 (carbon dioxide equivalent). If these four commuters chose to carpool to work instead (driving the SUV for a "worst case" scenario), then only 11 tons of eCO_2 would be emitted each year. Figure 1 shows how eCO2 emissions are affected if a group of 100 commuters (consisting of 50 large sedans, 30 SUVs, and 20 midsize sedans) when people carpool to work and reduce their own vehicle miles traveled per year. The graph shows

that if everyone reduced their vehicle miles traveled from 8000 miles per year to 7000 miles per year, then carbon dioxide emissions will be reduced from 533 tons to 414 tons.

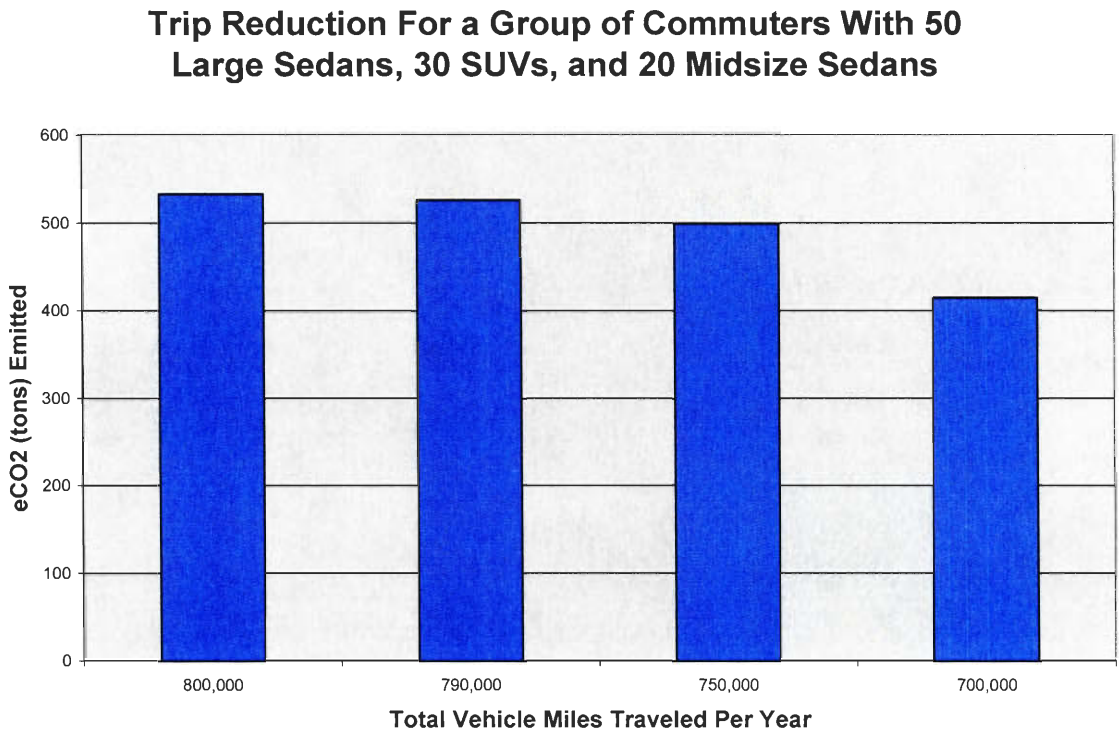


Figure 1: Trip Reduction for a Group of Commuters

A ridesharing program is an option for companies to help match employees for carpooling. It offers a simple way of joining people who are interested in carpooling so they can commute to work together, but companies may not want to spend time figuring out how to develop their own car/vanpool plan. Worcester should promote the use of MassRIDES, which is a free service that the state of Massachusetts provides to local companies who wish to improve commuting (MassRIDES). A general description of services and benefits, as well as the contact information, is given on the Massachusetts Government website. MassRIDES will help businesses develop their own commuting plans, which in the end will reduce greenhouse gas emissions and allow employees to save on fuel expenses.

In addition to the provision of reserved parking, a guaranteed emergency ride home service should be established. Many people do not consider carpooling because of the fear of getting "stuck" at work during a home emergency. Guaranteed emergency

ride services would eliminate this problem by providing a taxi or company car to an employee who must leave work in an emergency. Any costs involved would most likely be minimal and infrequent for the employer (i.e. a taxi ride home). Another reason people do not carpool is the need of a vehicle throughout the day for off-site meetings or appointments. If a business has an account with a company such as Zipcar, then vehicles could be rented out for a certain period of time at an hourly rate, or for an entire workday. Worcester should promote these options to local businesses and municipal employees to encourage transportation practices that will reduce mileage and eventually lead to greenhouse gas reduction (Appendix A).

If involvement in alternate transportation programs is lacking, the city should consider providing incentives for its employees and local companies. For municipal employees, incentives may include subsidization of parking spaces for employees who choose to carpool, or the provision of free public transportation passes for the commuter rail or the WRTA bus. For local companies, the city could offer tax breaks so that employers have the ability to provide their employees with similar services.

The use of trip reduction programs will decrease vehicle miles traveled, and thus greenhouse gas reduction will result in the city. Families may no longer need multiple cars once they learn how to live with one vehicle and/or public transportation. If this is true, then there will be a reduction of vehicle miles traveled for everyone, not only commuters. In addition to the environmental benefits of reducing vehicle miles traveled, the people of Worcester could also save money on costs associated with vehicles, such as fuel and maintenance. If the community of Worcester is aware of these advantages then there could be a major impact on the emission of greenhouse gases.

Education

Education is a powerful tool that will make the general public aware of alternative fuels, carpool services, incentives, and existing laws that are not being enforced. If this information is provided to the community, people may be more willing to consider options that could lead to the reduction of emissions. For example, there is a five minute idling law in Massachusetts regulated by the EPA but it is apparent that the public is either unaware of its existence or its purpose. If education about the idling law is

advertised, then more people may be willing to change their driving habits by reducing idling time. The community should know that idling not only emits harmful greenhouse gas emissions, but also burns more fuel, which in turn wastes money. Once the citizens recognize this law and its consequences there may be more of an effort to reduce idling. If a reduction of idling does result, this shows that education can be more effective than the law itself.

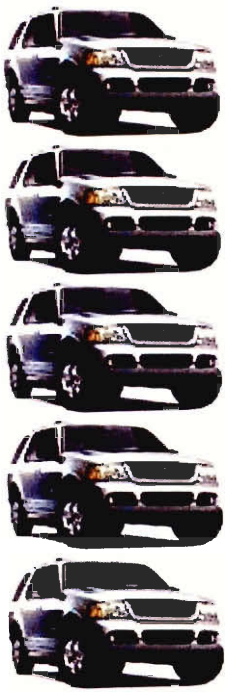
Posters and ads are examples of inexpensive forms of education. If a bus service is using an alternative fuel then the environmental benefits of converting could be advertised on the sides of buses. Also, if the City is providing incentives for citizens who change to alternative fuels, then citizens may be more inclined to consider these fuels. Without providing education to the community on the causes and effects of greenhouse gas emissions, there is little hope of voluntary change.

Fleet Modifications

The transition to more fuel-efficient vehicles serves as a role model for the community. When municipalities replace staff cars with newer models, department managers could choose to purchase mid or small size sedans rather than SUV's for the purpose of fitting the vehicle to the job. If a large vehicle is unnecessary for a specific job, then it should be replaced with a more fuel-efficient vehicle that will produce fewer emissions. For example, emissions from five SUV's each traveling 8,000 miles a year, compared to 1 mid size and 4 small sedans each traveling the same distance (8,000 miles/year), results in a reduction from thirty-three tons to nineteen tons of eCO_2.

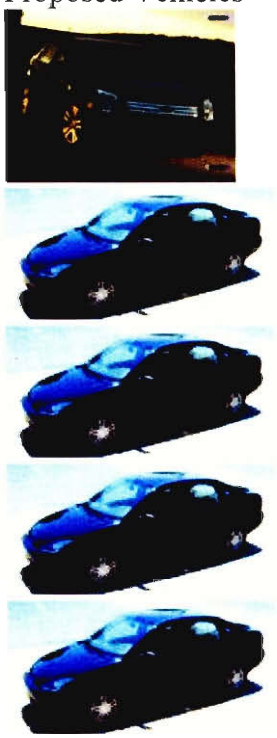
Another benefit that results from the downsizing of municipal vehicles is savings in the initial cost of the vehicle. For a new SUV, such as the 2006 Ford Explorer (4 door, 4x2, XLS), the MSRP price is around $27,000 (Ford Motor Company). A mid-size sedan with similar features, such as the 2006 Ford Fusion, is priced at approximately $18,000 MSRP (Ford Motor Company). It is evident that downsizing does not only reduce emissions, but the initial cost of a smaller vehicle is much less than that of an SUV. As long as a large vehicle is not needed to complete a specific job, companies can save money on initial costs and fuel by purchasing smaller vehicles.

Present Vehicles



5 SUV's:
Total Cost=$135,000

Proposed Vehicles



1 mid-size and 4 small sedans:
Total Cost=$73,980

eCO_2 total emissions from each vehicle driving 8,000 miles per year
33 tons eCO_2 19 tons eCO_2

If more in-depth records were kept it would be possible to determine where to focus downsizing measures. Recommendations could be specified as to which vehicles to downsize or which fuel type to convert. Also, it would be possible to determine which department vehicles may be traveling a significant amount of miles in vehicles that are not necessary for certain jobs (i.e. using an SUV for a job that does not require transportation of products). This lack of data only allows us to make hypothetical examples, and each department must make their own changes based on provided knowledge of vehicle types and fuels. Despite this, we have created a forecast if a fleet of 100 vehicles (50 SUVs, 40 full size sedans, and 10 midsize sedans) were to be downsized. This is shown in Figure 2, and Table 2 explains the types of vehicles in the fleet.

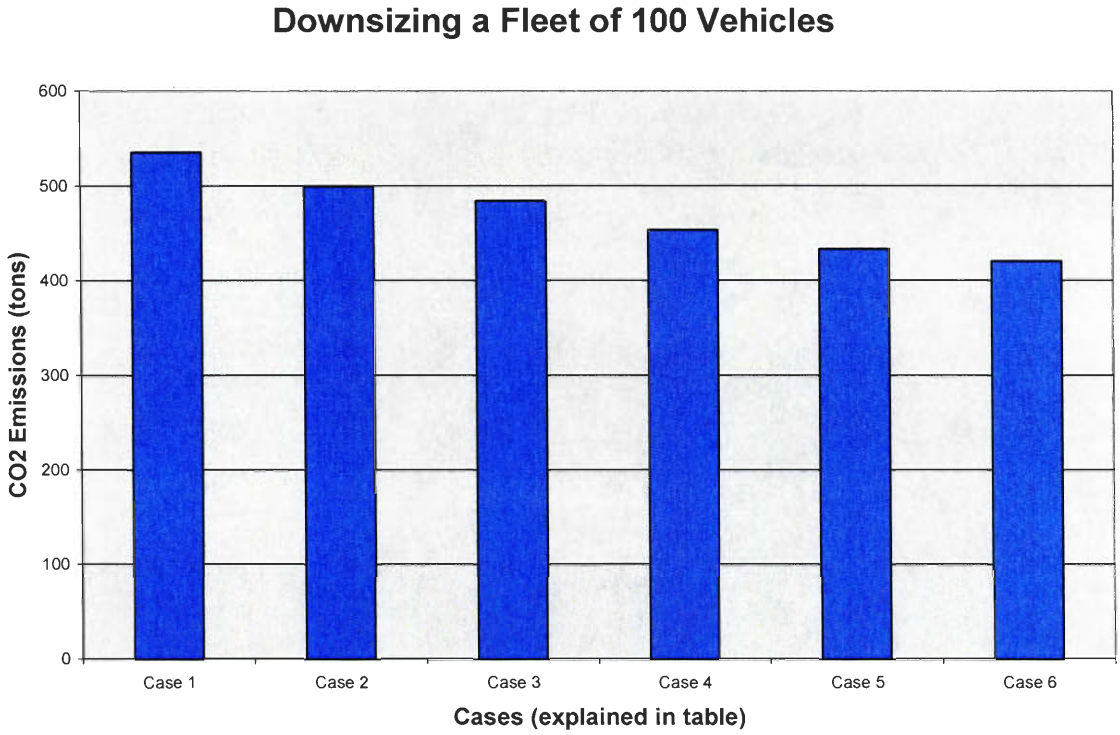


Figure 2: Downsizing a Fleet of 100 Vehicles

Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
50 SUV	30 SUV	30 SUV	20 SUV	10 SUV	10 SUV
40 Full Size	50 Full Size	30 Full Size	20 Full Size	20 Full Size	20 Full Size
10 Midsize	20 Midsize	30 Midsize	40 Midsize	50 Midsize	35 Midsize
		10 Compact	20 Compact	20 Compact	35 Compact

Table 2: Vehicles in the Fleet

Figure 2 shows that even when not converting all vehicles in a fleet to a small sedan, a reduction of emissions can be seen. When converting a fleet of 50 SUVs, 40 full size sedans, and 10 midsize sedans to 10 SUVs, 20 full size sedans, 35 midsize sedans, and 35 small sedans, eCO_2 emissions are reduced from 535 tons to 420 tons.

Alternative fuels provide an additional option when modifying fleets within the municipal departments. Compressed natural gas vehicles, along with other alternative fuel vehicles such as liquid petroleum, are more expensive than gasoline-powered vehicles (typically around $20,000 per CNG vehicle) (Appendix F). Fueling stations must be constructed in the city for these vehicles, as they are only available in certain

locations. Although alternative fuel vehicles are more expensive initially, the city can save thousands of dollars on fueling these vehicles (Appendix D). If a department downsizes to four small cars and one midsize sedan, fueling all five vehicles with CNG, there will be a four-ton decrease of eCO_2 compared to five SUV's using gasoline. In order to expand the usage of alternative fuel vehicles in the city as well as in Massachusetts, municipalities must be willing to set an example by introducing these vehicles into their own fleets. If this is accomplished, fueling stations for alternative fuel vehicles will be constructed in the area. Alternative fuels will thus be readily available for use by the citizens, which will give everyone the choice of purchasing alternative fuel vehicles. With more people following the city by driving alternative fuel vehicles, there will be fewer greenhouse gas emissions across the city. We have made estimates of eCO2 reduction based on converting gasoline or diesel municipal fleet vehicles to alternative fuel vehicles by certain percentages (see Figure 3 and Figure 4, and Table 3 on page 39 for current emission levels). Alternative fuels considered for replacing gasoline vehicles include: compressed natural gas, liquefied petroleum gas, and ethanol-85. Biodiesel was considered for replacing diesel vehicles.

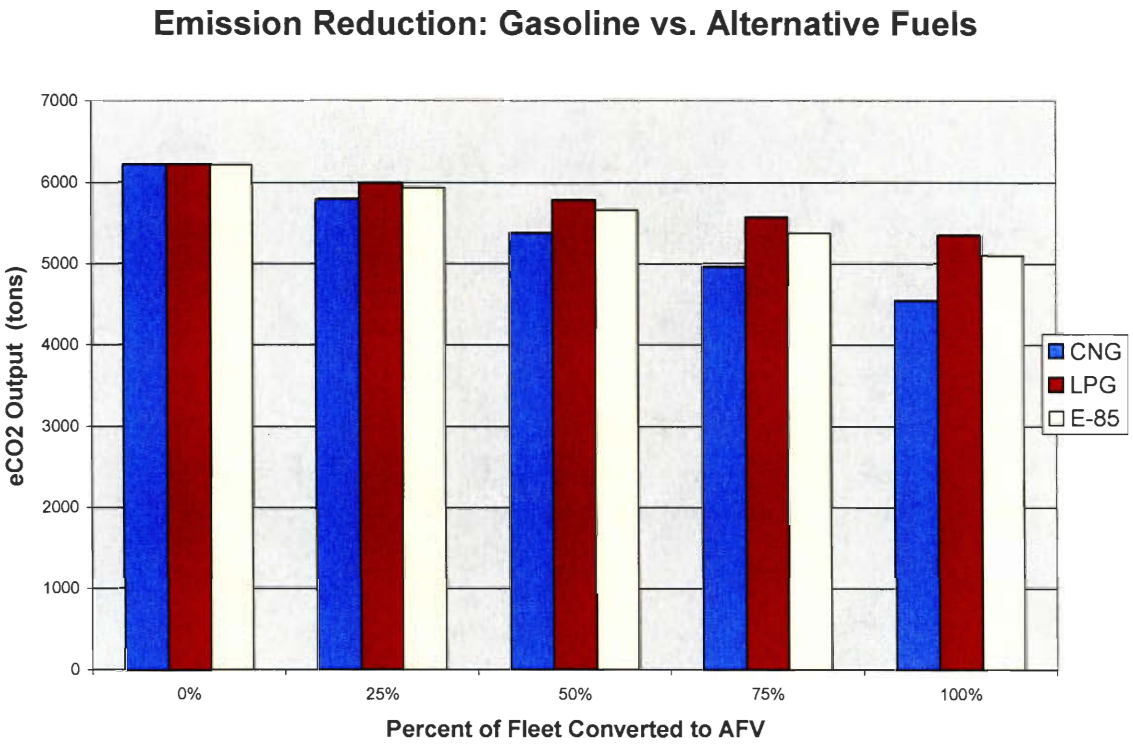


Figure 3: Emission Reduction - Gasoline vs. Alternative Fuels

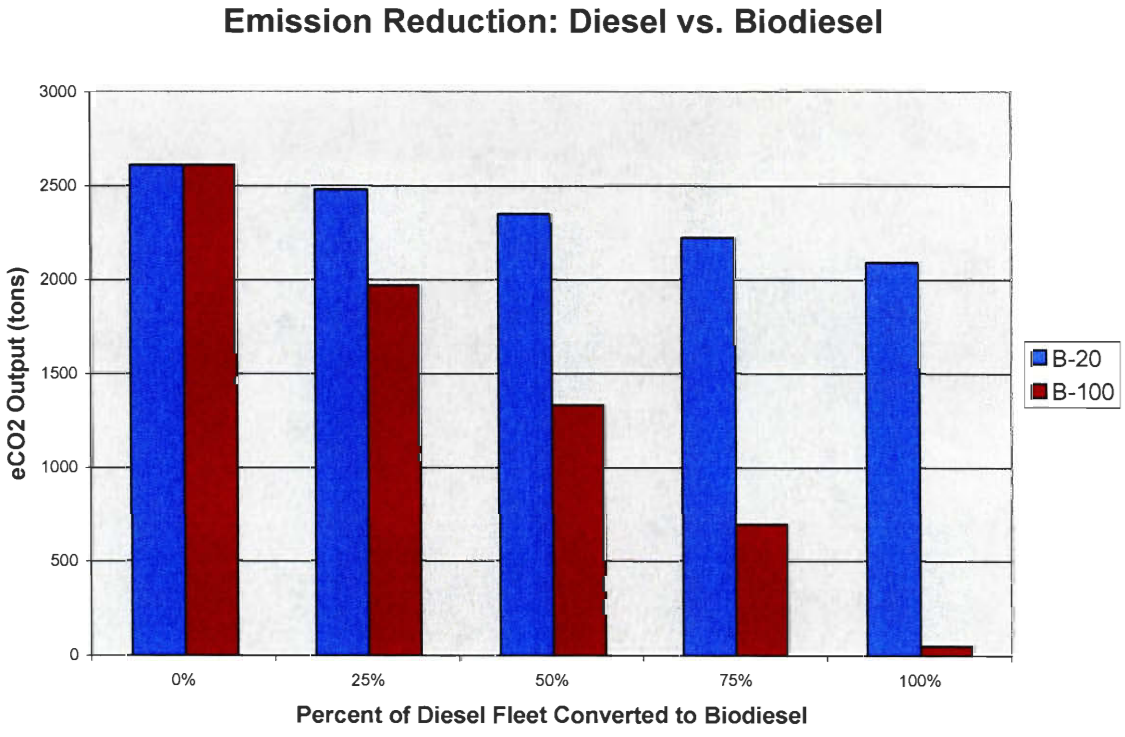


Figure 4: Emission Reduction – Diesel vs. Biodiesel

Figure 3 shows that converting to compressed natural gas would have the most effect for reducing greenhouse gas emissions when replacing vehicles that use gasoline. For example, if half of the fleet is converted to CNG, then there will be a 13.5% reduction of eCO2. Figure 4 shows the reduction of eCO2 when replacing diesel with biodiesel. These figures show the effectiveness that converting to alternative fuels has on reducing greenhouse gas emissions.

Section 5.2 - Grants and Funding

Due to the various restrictions that exist for each grant, only certain policy recommendations can be supported under each fund. Criteria used to determine which grants Worcester could possibly apply for are:

1) If the fund is for a municipal or private program
2) If the fund is for modifying vehicles to reduce greenhouse gas emissions, supporting alternate transportation or community education
3) If the city of Worcester lies within the boundaries of the grant (geography)

The Public Awareness Grant would be appropriate if Worcester decides to recommend an educational awareness group. This group should educate the public on the causes and effects of greenhouse gases, and how they can help cut down emissions. Education can come in various forms such as environmental fairs, speakers on environmental issues, billboards, advertisements on buses, etc. The amount of $275,000 will be available for each round, and two grant requests up to the amount of $50,000 will be considered within those rounds.

Both the municipality and citizens of Worcester can take advantage of The Natural Gas Vehicle (NGV) and Compressed Natural Gas (CNG) Infrastructure Technical Assistance program if vehicles are converted to CNG. If the municipal fleet operators decide that compressed natural gas is beneficial to their fleets, then incentives can be used for setting up a refueling station or the purchase of CNG vehicles.

The Transportation and Community and System Preservation Pilot Program grant funds are aimed at reducing environmental impacts of transportation by promoting commuter choice (carpools, public transportation, etc) and cleaner vehicles/green fleets. If the city recommends the downsizing of fleets, promotion of carpooling or even

improving public transportation, this grant may be helpful (Appendix A). The amount of $50,000 up to $300,000 is available to each recipient, in the form of cooperative agreements.

It is important to address grants that can be used in every aspect of a policy. For example, if Worcester were to limit its application for grants to support municipal policies, then the community would not have the necessary tools to contribute to the reduction of emissions. Therefore, the solution to reducing the greenhouse gas emissions is not the responsibility of one sector. The government and its citizens must each do their part in helping to reduce the problem, and this is not possible without the proper support.

Section 5.3 - Emissions

Comparing Greenhouse Gas Emissions Caused by Different Fuels

Although the vehicle type is has not been determined for each department within Worcester, it is possible to estimate the emissions output based on the fuel type alone. For the Durham School Services bus fleet, the vehicle type was considered a "heavy truck" when utilizing the software model, which is an appropriate classification for the 2006 Thomas school bus. The vehicle type for all other municipal departments was classified as "auto full-size." There may be other classes of vehicles included within each municipal fleet, however it is impossible to account for the emissions output for these vehicles if the fuel or vehicle miles traveled data are not available. Therefore, by inputting the data provided in Table 1 (provided in *Municipal Fleet Data*), greenhouse gas emissions outputs for all departments of Worcester were estimated for both diesel and gasoline.

When the software model processes fleet data, emissions outputs from each department are given and organized by the different types of greenhouse gases that were produced by the corresponding fleets. The greenhouse gas emissions that are calculated by the CACP Software model are:

- eCO_2 (carbon dioxide equivalent)
- Nitrous oxides
- Sulfur oxides
- Carbon monoxide
- Volatile organic compounds (VOCs)
- Particulate matter 10 (particulate matter 10 micrometers or less).

For each fuel type (gasoline, diesel, or ultra low sulfur diesel), the greenhouse gas emissions outputs vary because each fuel type contributes more or less of certain emissions. The specific department outputs, from both diesel and gasoline fleets, were compared for the different greenhouse gases (see Table 3). By examining the emissions outputs of diesel and gasoline, for example, it is possible to know which municipal fleets are contributing the most to each type of greenhouse gas. In Figure 5, it is evident which departments are contributing the most to eCO_2 emissions.

	eCO_2 (tons) *carbon dioxide equivalent*	**NOx (lbs)** *nitrous oxides*	**SOx (lbs)** *sulfur oxides*	**CO (lbs)** *carbon monoxide*	**VOC (lbs)** *volatile organic compounds*	**PM10 (lbs)** *particulate matter (10)*	**VMT** *vehicle miles traveled*
Municipal Diesel	2,608	13,387	1,078	13,742	5,088	1,607	4,633,342
Municipal Gasoline							
Police	2,667	15,754	764	153,284	16,226	330	4,394,899
DPW	3,054	18,041	875	175,535	18,581	378	5,032,868
Parks	118	699	34	6,799	720	15	194,935
Airport	118	699	34	6,799	720	15	194,935
Fire	258	1,525	74	14,834	1,570	32	425,313
Total (from Gasoline)	6,215	36,718	1781	357,251	37,817	770	10,242,950
School Bus ULSD (Ultra Low Sulfur Diesel w/ CTR filter))	1,939	33,067	34	21,084	2,705	1,559	1,000,000

Table 3: Greenhouse Gas Emission Outputs (using CACP Software Model)

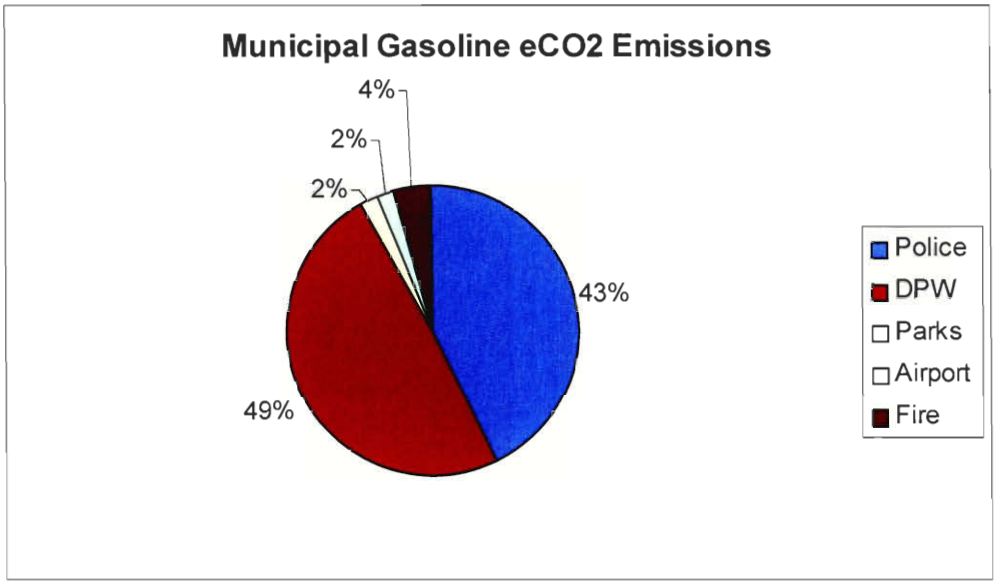


Figure 5: Municipal Gasoline eCO_2 Emissions

Table 3 shows greenhouse gas emissions of five municipal departments that use gasoline, and total diesel emissions for all departments. Outputs were based on total gasoline or diesel consumed from October 2002 to October 2003. Due to the limited information, all vehicles were classified as large sedans, except for buses, which were classified as heavy trucks. These five departments output a total of 6215 tons of eCO_2 for gasoline vehicles, and diesel emissions contributed to 2667 tons of eCO_2. Figure 5 shows that the Department of Public Works is responsible for half of those emissions, but this is because they drive more than any other department.

It is also possible to use the CACP Software model to calculate greenhouse gas emissions caused by alternative fuels that are not currently used by Worcester municipal fleets. These emissions can be calculated by inputting the same information into the software, and only changing the fuel type. For example, changing the fuel type from ultra low sulfur diesel to Compressed Natural Gas (CNG) for the bus fleet (using the same amount of vehicle miles traveled) shows the difference in eCO_2 emissions (see Figure 4). Different fuel types can be compared with the CACP Software model to determine how emissions may vary if a fleet changes its fuel type. Figure 6 shows that if school buses are converted from ultra low sulfur diesel to CNG, eCO_2 emissions should decrease by about 750 tons.

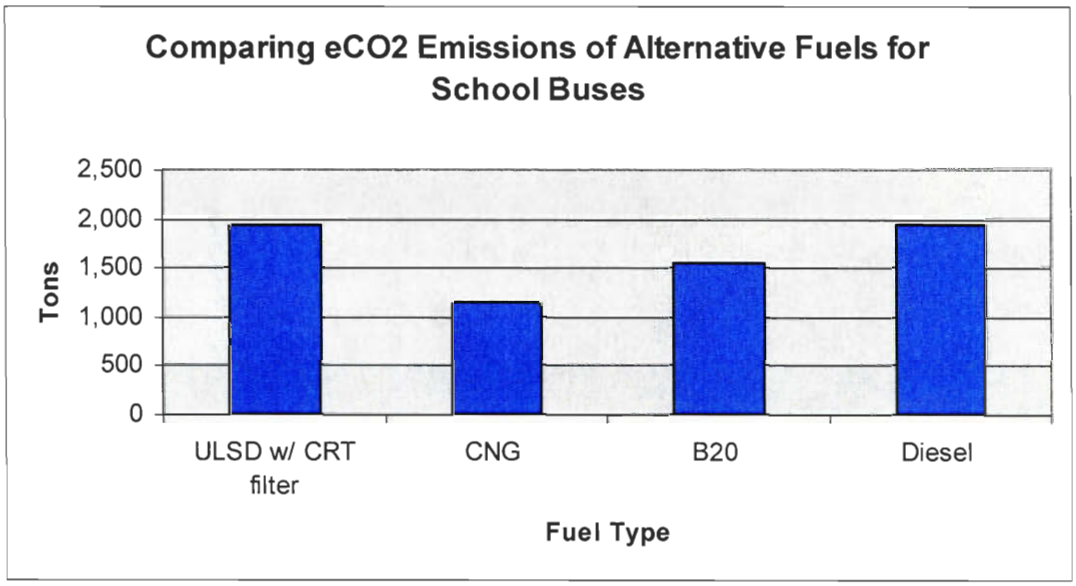


Figure 6: Comparing eCO_2 Emissions of Alternative Fuels for School Buses

Section 6 - Recommendations

From gathered data, interviews with city officials and studying best practices of other cities, a list of appropriate criteria for Worcester was developed. This list was prepared in order to provide the best strategies to reduce greenhouse gas emissions. These recommendations involve action from both the municipality and citizens, for this should be an "all-hands" effort. The three classifications include:

- Traveling Habits
- Education
- Fleet Modification

Successful implementation of these strategies will reduce greenhouse gases throughout the city.

Section 6.1 - Traveling Habits

We recommend that the City of Worcester take the following actions for municipal employees, and encourage businesses within Worcester to take the same actions:

- Provide preferential van or carpool parking spaces
    - Guaranteed emergency ride home
    - Encourage the use of the MassRIDES services
    - Get an account with car rental services such as Zipcar
    - Provide rideshare matching for carpooling
    - Provide incentives if participation is lacking

The provision of preferential van or carpool parking spaces, in conjunction with supporting measures, should be applied to both municipal and private organizations. Carpooling not only cuts fuel costs for those involved, but also reduces greenhouse gas emissions. In order to implement this idea, additional services, such as Zipcar and guaranteed emergency rides home, must be provided by the employers. These services are necessary because many people avoid carpooling for the fear of not having transportation available for meetings, errands, or emergencies during the workday (Appendix A). One way to promote carpooling is the use of incentives. Employers could offer gift certificates to employees that carpooled to work. Carpooling will result in lower vehicle miles traveled, which will ultimately lead to a reduction of greenhouse gas emissions.

Section 6.2 - Education

Educating the community of Worcester about the causes and effects of greenhouse gas emissions is necessary to make people aware of how they should take action against this problem. We recommend that these methods should be used to educate the public:

- Environmental fairs at schools
- Minor changes in the school's curriculum
  - Falls under the city's jurisdiction
  - Does not require cost to implement
- Guest speakers addressing the greenhouse gas issue
- Posters on the sides of buses about emissions reduction
- Television advertisements about alternative fuels
- Advertisement of actions taken by the municipal government to reduce emissions (sets example for the community)

Educational resources such as the examples listed above will provide the community with information needed to modify their lifestyle to become more environmentally friendly.

In order to promote greenhouse gas emission reduction measures, application to the Public Awareness Grant would be appropriate. Eligible organizations are those involved with carrying out educational activities that increase community awareness of and support for renewable energy among Massachusetts residents. The amount of $275,000 will be available for each round (Appendix C).

The Diesel Emission Reduction Act of 2005 is a fund Worcester could apply for to reduce idling of diesel vehicles. This fund cannot be used to help enforce the current Massachusetts idling law, but could be used towards idle-reduction programs of these large diesel vehicles. The amount available is $200 million annually for the fiscal years 2006 through 2011 for all states (Appendix C).

Section 6.3 - Fleet Modifications

We recommend that the City of Worcester take the following actions to modify the municipal fleet:

- Downsize vehicles
  - Fit the vehicle to the job
- Convert diesel and gasoline vehicles to alternative fuel vehicles

The downsizing of municipal fleets would not only have the potential of reducing greenhouse gas emissions but also would set an example for the community. The city can purchase smaller vehicles that have better fuel economy and save money on the initial costs and fuel expenses over the course of the vehicle's life (Appendix F). If these actions are taken and advertised to the community, people in Worcester will be aware of a change in the city's fleets and therefore may take similar actions.

If each municipal department kept more in-depth records (per year) with information such as vehicle miles traveled per vehicle, fuel type and purpose of the vehicle, then more specific recommendations could be made. It would be appropriate for municipal departments to start recording all vehicle data on a yearly basis so that problems can be recognized and appropriate modifications can be made to each fleet.

In addition to downsizing, operators of municipal fleets could replace current vehicles with alternative fuel vehicles. Depending on which alternative fuel is chosen, the emission reduction levels vary when compared to either conventional gasoline or diesel (Appendix D). Compressed natural gas (CNG) is one of the most readily available fuel alternatives. However, the initial costs of a CNG vehicle and fueling stations for private and public use are significantly higher than vehicles using gasoline. If incentives are available, the difference in cost may not be much of an issue when converting to CNG.

Both the municipality and citizens of Worcester could apply to The Natural Gas Vehicle (NGV) and Compressed Natural Gas (CNG) Infrastructure Technical Assistance program if vehicles are converted to CNG. Rebates or incentives are available on a case-by-case basis, and can go towards natural gas refueling stations or the initial purchase of a CNG vehicle.

The City of Worcester, and any city planning organizations, is eligible for the Transportation and Community and System Preservation Pilot Program grant. The purpose of this grant is to fund plans aimed at reducing environmental impacts of transportation by promoting commuter choice (carpools, public transportation, etc) and cleaner vehicles/green fleets. Therefore, the municipality could put this funding towards downsizing fleets and using alternative fuels, or setting up parking meters to promote

alternative modes of transportation throughout the city. In addition, businesses could use this money to provide incentives for carpooling or stipends for using public transportation (Appendix A). The amount of $50,000 up to $300,000 is available to each recipient, in the form of cooperative agreements.

Section 6.4 - Suggestion for Exploration

Further Research and Zoned parking permits for residential parking is a concept we encountered while researching. These permits would only be implemented in residential areas, and zoning would be necessary in order to discourage a resident with a permit to drive a few blocks away and have the ability to park. In places such as the areas around college campuses where many students unnecessarily bring their cars, parking would not be as readily available. As a result, alternative transportation such as buses may be used. Due to the insufficient time available for carrying out the necessary research and analysis, zoned parking should be explored by the city in the near future.

Section 6.5 - Conclusions

Each of these recommendations may be focused on a specific sector (municipal or community), but if these policies prove to be successful, the entire community will benefit. These strategies may be the most effective for reducing greenhouse gas emissions caused by transportation. In addition, these strategies are only the first step to reduce greenhouse gas emissions from all sources, and it is our hope that in the future, additional measures will be taken to address this issue.

Section 7 - Conclusions

Global warming is a known issue that has a major impact on the environment and the livelihood of the world's population. Global warming is caused by greenhouse gases that are emitted as a byproduct from the burning of fossil fuels. A large portion (about 33%) of the greenhouse gas emissions comes from motor vehicles. The national government is doing little to address this issue, and many cities have been creating their own climate protection plans with strategies to reduce greenhouse gases emissions. Several cities in New England have done this as well, and these cities include Cambridge, Newton, Medford, Brookline, Somerville, and Burlington, VT. By studying their climate protection plans, we have been able to adopt many of their strategies in suggesting ways to reduce greenhouse gas emissions from transportation in Worcester.

These strategies include:

- Modifying the municipal fleets to make them more efficient
- Promoting the use of carpooling or other methods of commuting to work
- Establishing more parking restrictions
- Educating the citizens of Worcester about the problems associated with global warming and how they can take action

By successfully implementing these strategies, there will be a reduction of greenhouse gas emissions caused by transportation.

Appendix A – Best Practices

Subsidize employees who use commute free parking:
Applies to: municipal government and the community
Used by: Cambridge, Brookline, Medford, and Newton
Cost: $65 per month for each parking space (according to Brookline)
Savings: 18 tons of eCO_2 if done for 104 parking spaces (according to Brookline)
The city as well, as local companies, buys back parking spaces from employees who take public transportation to work.

Bike-friendly facilities (showers, lockers, bike storage):
Applies to: municipal government and the community
Used by: Cambridge, Brookline, and Newton
Cost: Construction of facilities in municipal buildings
Savings: 484 tons of eCO_2 if 300 people switch to biking as their primary mode of transportation for 8 months (according to Brookline)
The city constructs shower and locker facilities in their buildings so employees can bike to work and get changed for their day. The city also encourages local businesses to do this as well, or provide incentives for companies that do this.

Emergency guaranteed ride home:
Applies to: municipal government and the community
Used by: Cambridge
There are people who do not carpool to work because they are afraid if there is an emergency at home, they will not be able to respond to it. This will provide employees who carpool to work with a way to go home in the event of a home emergency.

Preferential carpool or vanpool parking spaces:
Applies to: municipal government and the community
Used by: Cambridge
Savings: 21 tons of eCO2 if four people who commute a 50-mile round trip to work each day take one vehicle instead of four.
A certain number of parking spaces are set aside for carpool or vanpool only. The city encourages companies to do this or provides incentives for companies who implement this.

Rideshare matching for carpool:
Applies to: municipal government and the community
Used by: Cambridge
Rideshare matching helps employees set up carpooling amongst each other by matching people together who would be best for carpooling.

Telecommuting:
Applies to: municipal government and the community
Used by: Cambridge and Brookline
Costs: $4500 per employee to set up, plus $2000 each year per employee for maintenance (according to Brookline)
Savings: 486 tons of eCO_2 if done by 350 employees twice per month (according to Brookline)
Telecommuting allows employees to work at home and also make video conference calls so they do not have to drive to their meetings.

Publicize information about commuting:
Applies to: municipal government and the community
Used by: Cambridge
People may be more apt to take public transportation is they knew more about the system in there area.

Pedestrian/bike plan:
Applies to: municipal government and the community
Used by: Cambridge, Newton, and Brookline
Making the city more pedestrian and biker friendly may get more people to consider walking or biking around town. This requires the installation of bike racks, and updating the streets to provide bike lanes and increasing safety measures for pedestrians.

Parking permits for residents:
Applies to: the community
Used by: Cambridge
You must get a permit to park along streets of the city that have residential buildings. However, these permits are only available to residents of the city, forcing people who wish to come into the city to take other modes of transportation.

Increase permit price for vehicles that exceed a certain length:
Applies to: the community
Used by: Cambridge
It is not possible to tax larger vehicles, such as SUVs. However, it is possible to charge them higher rates for parking permits when they exceed a certain length.

Raise prices in parking lots:
Applies to: municipal government and the community
Used by: Cambridge
This is focused on making people reconsider driving into the city and think about taking public transportation to avoid higher parking expenses.

Get business account with ZipCars:
Applies to: municipal government and the community
Used by: Brookline
Some people don't carpool to work because they require a vehicle to get to certain meetings. However, there are companies such as ZipCars that provide hourly based car rentals for businesses.

Make bikes available to rent for employees:
Applies to: municipal government and the community
Used by: Cambridge
There are some people who may want to bike to work or bike to do their errands while at work, but do not own a bike to do so. The city provides municipal employees with the option of renting a bike, and encourages local companies to do the same.

Add parking meters:
Applies to: municipal government and the community
Used by: Cambridge
By adding more parking meters, people may be less likely to drive to their destination in the city. However, for this to be effective, the meters must be monitored more carefully than they are now.

Enforce idling law:
Applies to: municipal government and the community
There is a five-minute idling law in effect in Massachusetts, but it is not enforced. Enforcing this law will reduce emissions from idling vehicles.

Mandate the use of catalytic converters on diesel vehicles:
Applies to: municipal government
Used by: Medford
Although this does not reduce greenhouse gas emissions, it will reduce other emissions, such as toxic particulate matter. Vehicles, such as buses and construction vehicles, should be required to have catalytic converters on their vehicles.

Encourage the use of MassRIDES:
Applies to: municipal government and the community
MassRIDES is a free service of the state that helps companies establish trip reduction programs.

Contracted waste management trucks must use alternative fuels:
Applies to: municipal government
Used by: Medford and Newton
Waste management trucks are used frequently in cities and create a large volume of emissions. Using alternative fuels for these vehicles, such as biodiesel or liquid petroleum, will reduce these emissions.

Downsize the municipal fleet:
Applies to: municipal government
Used by: Medford
In order to get the best fuel efficiency from the fleet, it is best to use vehicles that fit the task that are required to be performed. Smaller vehicles with a greater fuel economy should be used in replacement of larger vehicles.

Adding alternative fuel vehicles to the municipal fleet:
Applies to: municipal government
Used by: Cambridge, Brookline, Medford, and Newton
Costs: $20,000 for a new AFV
Savings: Most alternative fuels are less expensive, and the greenhouse gases they emit are also less, but vary depending on fuel type.
Biodiesel is the easiest to implement, because it requires no modifications to the vehicle. However, it's approximately 30 cents more expensive per gallon. Other alternative fuels, such as compressed natural gas, are much cheaper than gasoline, but expensive fueling stations must be constructed first.

Provide incentives for those who use trip reduction programs:
Applies to: municipal government and the community
Sometimes encouraging people to carpool or take alternative modes of transportation to work is not effective. Providing incentives to municipal employees or companies with similar programs may help encourage more people to use trip reduction programs.

Bike patrols for police:
Applies to: municipal government
Used by: Medford and Brookline
Costs: $2000 for each bike and training an officer (according to Brookline)
Savings: Fuel expenses, and 58 tons of eCO_2 for four officers biking 8 months of the year (according to Brookline)
Emergency vehicles typically aren't adjusted because it may affect performance during an emergency. However, it is possible to replace some police cruisers with bicycles.

Walk to school program:
Applies to: the community
Used by: Cambridge and Brookline
Many parents drive their children to school, even though they are within walking distance of the school. A walk to school program would involve parents walking their children to school, or putting them on a "walking bus" that consist of parent volunteers and children going to the same school. Aside from reducing emissions, a walk to school program is a great community builder and promotes healthy alternative forms of transportation, such as walking or biking.

Inform the public about alternative fuel vehicles and their benefits:
Applies to: the community
Used by: Newton
Many people are unaware of incentives available for people who purchase alternative fuel vehicles. Others don't know where to get fuel for alternative fuel vehicles. People need to be given this information, and doing so may increase the sales of alternative fuel vehicles.

Appendix B – Interviews

Harriet Chandler
Massachusetts Senator
January 20, 2006

1. How are senate bills 2176 and 2209 related?

They both concern about fossil fuel consumption and they are a part of a bigger bill to change all state vehicles to alternative fuel vehicles

2. Are you aware of any state laws that may prevent a municipality such as Worcester to implement a tax on people with larger vehicles, or tax-breaks for environmentally friendly cars?

Look at www.mass.gov, transportation for state laws. Also check out other bills with similar issues. There might be a recent federal law.

3. Where is most of your funding coming from?

If the bill that passes doesn't talk about money then there is not going to be any support from the budget of the government initially. Grants need to be researched and small groups and organizations that would be interested in the subject should to be found.

4. Are there projections on how effective bill 2209 (and the other bills related to it) will be, and if so, how did you arrive at those projections?

There are no projections on how effective this bill will be.

5. What are the other bills that go along with bill 2209?

There are no bill as comprehensive as S. 2209. However, there are a few bills that have similar goals as S. 2209 Rep. Finegold has a bill (H. 2357 http://www.mass.gov/legis/bills/house/ht02/ht02357.htm) that has one part of S. 2209 which is the tax credit for purchasing a hybrid car. Rep. Marzilli (H. 2430 http://www.mass.gov/legis/bills/house/ht02/ht02430.htm) which exempts cars with zero emissions from sales tax, and Rep. Wolf (H.1314 http://www.mass.gov/legis/bills/house/ht01/ht01314.htm) reducing diesel emissions.

6. Are you aware if any bills exist that specifically target the reduction of carbon emissions?

As far as I can tell there are no bills that exist that specifically target reducing carbon emissions.

Jean Clark-PTDM Planning Officer
Stephanie Anderberg- TDM Planner
January 24, 2006

- Municipal construction projects
  - Contractors must have emissions controls on vehicles
  - Catalytic filters- this does not interfere with any laws (current laws do not constrain off-road vehicles)
    - Requirement for the Big Dig
    - Put in contracts for companies signed on with Cambridge
- Switched all municipal fleets from diesel to biodiesel
  - Fuel station at the DPW
  - Currently have been using regular diesel because pricing is at a better premium for diesel
- Parking
  - Resident parking program
    - Politically difficult, unless there is a perceived problem
    - Makes people living outside of the city think about coming in
  - Meters
  - Zoned parking permits (not currently done in Cambridge)
    - Should be considered to restrict people from being able to park anywhere in the city with one pass
  - *The High Cost of Free Parking* – book by Donald Shoup
    - Free parking ends up costing a city more in the end
  - Free spaces up front for carpools/vanpools
    - Even if spaces are empty, eventually people will notice and start to fill them up
- State and local transit agencies
  - Expanding services to more areas
  - Park and Ride shuttle services for public transportation
  - Transit benefits for employees
    - 65% of T passes paid by city (up to $100/month)
    - Pretax deductions- lowers amount of general taxes taken from paycheck
    - New federal tax law pre-taxing transit pass cost for businesses ($105 cap), but can take double transit pretax for parking ($210); vanpools are included under $105 cap (commutercheck.com)
- Making roads safer for all users
  - Traffic calming, road design, bike lanes, etc.
  - Informational stickers, pamphlets, etc.
- Cambridge Vehicle Trip Reduction Ordinance (1017)
  - Hired TDM Planner
  - Supported by city planners and councilors
  - Emphasis on walking (focus on health)
    - Pedestrian awareness, new lighting, wider sidewalks

        - Pedometer program for employees to promote going to lunch or doing errands on foot (might influence habits at home)
    - Bicycling for police force
        - Safer communities
        - Police become more familiar with people of the area
    - "The Easy Ride" – businesses pay dues to belong and all employees/members ride free (frequent service from S. Station)
    - Rideshare matching
    - Emergency ride home program for employees who take public transportation and may need a car for the day
        - Zip Car account
        - Company cars
    - Promote bicycling
        - City-owned bicycles for company use
        - Bike rooms, showers, locker rooms in buildings
        - Biking spaces in well-lit, weather-free places
    - Zoning (Chapter 19)
        - Traffic analysis
        - Encourage dense development so that many things are in one place (banks, restaurants, etc.)
    - Vehicle Trip Reduction
        - Census telling how many/which vehicles usually come to area
            - Develop plan to reduce that by certain percentage
        - Constraining parking supply
        - Charge for parking
        - Mode split commitment (surveyed every year)
- PTDM (Parking and Transportation Demand Management)
    - Politically touchy issue
    - Massive development of city in the 90's helped this
    - Cambridge joined Cities for Climate Protection in 1999
        - Goal to reduce greenhouse gas emissions by 20% by 2010
        - Now they have more ghg emissions than when they started, most likely due to new development (biotech labs, etc.)
        - Transportation has gotten slightly better, as far as they can tell
        - Residential areas a slightly better due to renovation
    - City has to make own buildings green to set example
    - Subsidies and recognition
        - Climate Leaders program
        - Working with biggest employers (MIT, Harvard)
    - Community education
        - Energy Fair to talk to residents
    - Funding
        - Mass Highway design standards for highway/road design to receive state money for plans
        - City money is used if not following design standards

        - Money from parking permits goes to support programs that are set up to reduce vehicle miles traveled
        - Most of funding for traffic design (traffic calming, etc.) from Mass general law Chapter 90 (where applicable)
        - Most things are not high in price (remarking roads, etc.)
    - Success of plan
        - New emissions inventory
        - Look at city's own buildings to measure changes

Betty Brigham
Durham School Services:
January 27, 2006

1. Percent Diesel
   100%, 2006 Thomas Buses, they also all use ultra low sulfur diesel with CTRF filters
2. How many?
3. Idling at bus depot?
   Follow state law for idling, 5 min then automatic turn-off by preset timer
4. Route miles traveled?
   88 routes, 100,000 miles per month
5. Emission Standards
   Follow State laws
6. Catalytic converters?
   Unsure but doubts it
7. Gallons of fuel purchased a year?
   Unknown because now company as of Aug
8. Emissions statistics
   Unknown

Kim Lundgren
ICLEI USA, Northeast Regional Director
February 7, 2006

1. Were there any state laws that you had to follow when creating your own policies in terms of restrictions on transportation policies?

Very few restrictions are in effect. Most of the restrictions just prevent cities from creating certain taxes

2. Why weren't police cars considered when creating this plan?

Emergency vehicles are not appropriate to change. Changing the type of vehicle they use may affect their performance during an emergency

3. Buses account for 81.3% of the diesel emissions in Medford and the highway department accounts for 37.15% of gasoline emissions. How did you address this?

Medford was given an EPA grant to retrofit all of their buses, which was done last year. The highway department has requested for a similar grant.

4. What specific goals did you have in mind when presenting these policies?

The city aimed for a 20% reduction from the 1998 emissions for the municipal government, and 10% reduction for the entire city.

5. How have you been monitoring your progress towards these goal?

Updating the inventory; the last update was done in 2003. However, according to that update the emissions have been increasing.

6. How much support was there for this policy.

There was much support for the plan. It passed unanimously.

7. Did any of your policies need to be put into the budget, and were you able to receive enough money from the budget?

There were a lot of things that were both paid for by the city or given to the city. A new Department of Energy and Environment was created, the city also paid for its biodiesel and new solar panels. At the same time, Medford was given new electric cars and free natural gas retrofitting.

8. Did you educate your citizens about the issues?

Community groups were formed to help explain the plan to the citizens, there were also guest speakers at the library, newspaper articles, speakers at schools, an "Energy Fair" is hosted every year, and a website was created.

John Carney G.M.
Nicole Rohan Asst. G.M.
WRTA
February 10, 2006

1. Since a portion of Worcester's budget goes toward supporting the WRTA, does Worcester have any influence for recommendations?
    a. I.e.: lower emission levels for buses, the use of catalytic converters, a transition to biodiesel

Not really, Worcester's payment is based on a state assessment on what Worcester should pay based on ridership from community. Contribution because of WRTA's service through Worcester (more people=more service). Does not exceed 2% of budget

2. Is the city contracted for fuel?
    a. If so, do you get the fuel at a discounted rate?

Yes they are contracted through Peterson oil Do not get any discount for higher volume purchases

3. Have catalytic converters or alternative fuels (biodiesel, CNG, CLG) been considered?

All buses have catalytic converters. 2007 will have particulate traps because converting to ultra-low sulfur diesel which isn't beneficial without traps. Worcester has to buy new buses in 2007 because as of October 15th, 2006, the EPA set a goal of 15 parts per million sulfur for all retail diesel (< 500 ppm for on-road now)

$8000 per particulate trap

All buses meet EPA standards for year they were built

Biodiesel:

$.25 more then diesel
Raises nitrous oxides but reduces particulate matter
Freezes, can cause massive shutdowns of service

Emissions of ultra-low sulfur diesel close to that of natural gas

May have to switch to natural gas by 2010 because of EPA goal for wants better
- $2 million for NG filling station for buses

4. How is public transportation set up?
   a. How do you decide the routes/where to stop?
   b. Do you use vans for routes that aren't as busy?

Based on recommendations from Urbitran (international consulting firm for public transportation efficiency)

- looks at demographics
- ridership per route
- avg num of vehicles per household along routes
- 5 year plan= get buses near college areas

Year 1 of 5 year plan: more frequent services
Year 2 of 5 year plan: extend service to 10pm (stops at 7pm now)

Yes, use vans for low-ridership routes and for routes that cannot accommodate large buses

5. How are your idling policies set up and how are they enforced?

Automatic shutoff after 10 minutes (law set for max of 5 min)
Excessive fines imposed
Signs reminding employees

Additional Information:

"Take people out of cars"

- Very interested in improving traffic light synchronization
  - Help increase ridership because buses more reliable
  - Save on fuel
- Possible implementation by school system of mandating that all contracted bus companies use ultra low sulfur diesel along with particulate filters
  - Instead of the popular 1-2 year contracts, extend to 3-5 year
- Not feasible to turn off engines in police fleets because of the amount of electrical devices in cruisers (would drain the battery)

Appendix C – Available Grants

Name of Grant: Natural Gas Vehicle (NGV) and Compressed Natural Gas (CNG) Infrastructure Technical Assistance
Eligible Applicants: customers wishing to purchase natural gas vehicles (NGVs) or to build CNG refueling stations
Description of Grant: Rebates or incentives are available on a case-by-case basis Mike Manning at (781) 466-5373, or via email at mmanning@keyspanenergy.com.
http://www.eere.energy.gov/afdc/progs/view_ind.cgi?afdc/5343/0

Name of Grant: Environmental Stewardship
Eligible Applicants: For community-based projects that address energy efficiency and local environmental needs
Description of Grants: Energy service areas
Restrictions: Projects in AR, LA, MS, MA, NH, NY, TX and VT
Monetary Amount: Up to $250K expected to be available, award range generally $5K to $25K.
Responses due 3/10/06
http://www.entergy.com/our_community/environmental_grants.aspx

Name of Grant: Diesel Emission Reduction Act of 2005
Eligible Applicants: National and state-level
Description of Grant: Loan programs to promote the reduction of diesel emissions and non-road engines used in construction, retrofit buses, medium- and heavy-duty trucks, idle-reduction programs.
Restrictions: May not be used to fund the cost of any emission reduction mandated under federal, state, or local law,
Monetary Amount: Authorize $200 million annually for fiscal years 2006 through 2011 to fund the programs.
http://www.catf.us/projects/diesel/take_action/DERA2005-SectionBySection.pdf

Name of Grant: Bikes Belong Coalition
Eligible Applicants: Non-profit organizations; and from public agencies and departments at the national, state, regional, and local level.
Description of Grant: Initiatives that (a) will make a newer group sustainable, and (b) have tangible long-term goals. Programs that make existing organizations more effective at generating ridership. Innovative pilot projects or projects that will have a significant political impact.
Restrictions:
Monetary Amount:
http://bikesbelong.org/site/page.cfm?PageID=21

Name of Grant: Transportation and Community and System Preservation Pilot Program, Trnasportation Equity Act for the 21st Century
Eligible Applicants: The States, local governments, and metropolitan planning organizations (MPOs), are eligible for discretionary grants to plan and implement strategies which improve the efficiency of the transportation system, reduce environmental impacts of transportation, reduce the need for costly future public infrastructure investments
Description of Grant: Funding for planning grants, implementation grants, and research to investigate and address the relationship between transportation and community and system preservation. Smart growth efforts that reduce transportation-related emissions, commuter choice, and cleaner vehicles/green fleets
Restrictions:
Monetary Amount: $50,000 up to $300,000 to each recipient, in the form of cooperative agreements
http://www.fhwa.dot.gov/tea21/fedreg3.htm

Name of Grant: "Clean Air Transportation Communities: Innovative Projects to Improve Air Quality and Reduce Greenhouse Gases: Solicitation Notice"
Eligible Applicants: State, local, and multi-state agencies
Description of Grant: Done in 2001…may have continued since
Restrictions:
Monetary Amount: $50,000 up to $300,000 to each recipient, in the form of cooperative agreements
http://www.epa.gov/fedrgstr/EPA-AIR/2001/February/Day-21/a4268.htm

Name of Grant: Public Awareness Grants
Eligible Applicants/ Description: Applications from organizations interested in carrying out educational activities that increase public awareness of and support for renewable energy among Massachusetts residents
Monetary Amount: $275,000 will be available for each round. Applicants are invited to submit grant
http://www.mtpc.org/renewableenergy/ed_grants.htm

Name of Grant: Clean Diesel Grants
Eligible Applicants: Massachusetts (EPA Region 1), Massachusetts Executive Office of Environmental Affairs ($120,000)
Restrictions: May not fund our policy ideas
Monetary Amount: $275,000 will be available for each round. Applicants are invited to submit grant requests for up to $50,000, with funding likely for at least one or two proposals at this maximum amount
http://www.epa.gov/otaq/diesel/grantfund.htm#ncdc-grant-2005

Appendix D – Alternative Fuels

Alternative Fuel Type	**Biodiesel**	
	B20 (20% biodiesel, 80% petrodiesel)	***B100 (pure biodiesel)***
Availability	Suppliers can deliver fuel anywhere in the country	
Affordability	$.30-.40 more than diesel per gal. (2002)	$1.95-3.00/gallon (2002)
	Usable in diesel engine with little or no modification to engine/fuel system	
	Can order bulk quantities at a reduced price	
Emissions	*(% compared to petroleum diesel)*	
Carbon Dioxide	15% decrease	75% decrease
Carbon Monoxide	10% decrease	50% decrease
Particulate Matter	15% decrease	70% decrease
Hydrocarbon	10% decrease	40% decrease
Sulfate	20% decrease	100% decrease
Nitrogen oxide	2% increase	9% increase
Methane	no change	no change
Safety	Biodegradable, less combustible than petrodiesel, non-toxic	
Maintenance	Same as petrodiesel vehicles	Change fuel filter after first tank of fuel
	Can impact fuel system components, unless parts are biodiesel-compatible	
Performance	***Increases engine's performance, can enhance life of heavy-duty engines***	
	Cold start problems, relative to petrodiesel (more of an issue for B100 fuels)	
Uses	Tractors, combines, semi trucks, delivery trucks, light trucks/commercial vehicles	
	Generators, automobiles, buses, snow plows, road pavers, ambulances	
Example	Deer Valley School District (Phoenix, Arizona)-state mandate to use afv's	
	the program receives state grant money	

Alternative Fuel Type	**Compressed Natural Gas (CNG)**
	2 types engines: dedicated (natural gas), dual-fuel (nat. gas or gasoline)
Availability	Available at appx. 1300 refueling stations (46 states); refuel at home by connecting small compressor to the natural gas supply
Affordability	Generally costs 15-40% less than gasoline or diesel, but requires more frequent refueling, less energy by volume; CNG vehicles cost between $3500-6000 more than their gasoline counterparts
Emissions	*(% relative to conventional gasoline)*
Carbon Dioxide	25% decrease
Carbon Monoxide	90-97% decrease
Particulate Matter	little to none produced
Hydrocarbon	potential 50-75% decrease
Sulfate	n/a
Nitrogen oxide	35-60% decrease
Methane	n/a
Safety	Narrow flammability range, non-toxic, safety standards applied to CNG buses
Maintenance	Oil does not need to be changed as frequently, CNG burns more cleanly
Performance	In a dedicated engine power, acceleration can be greater than gas engine CNG engines can run more efficiently than gas engines (extends life)
Uses	Vans, shuttle buses, taxis
Example	US Dept. of Energy study of CNG taxis vs. gasoline powered taxis (1999): CNG taxis more cost effective and produced less emissions

Alternative Fuel Type	**Liquefied Natural Gas (LNG)** *LNG vehicles have been primarily used by fleet managers*
Availability	Most refueling stations at heavy-duty vehicle fleet operations Public LNG stations are limited
Affordability	Cost per mile generally less than or equal to diesel LNG trucks/buses can cost an additional $30,000-50,000 Fuel dispensing/storage typically $15,000-22,000 per vehicle
Emissions	*(% relative to diesel)*
Carbon Dioxide	potential 25% decrease
Carbon Monoxide	can significantly reduce CO emissions
Particulate Matter	production of half particulate matter of avg. diesel vehicles
Hydrocarbon	50% or more decrease
Sulfate	n/a…drastic reduction in toxic/carcinogenic pollutants
Nitrogen oxide	50% or more decrease
Methane	Increase in methane emissions
Safety	Restricted to frequently driven vehicles or those stored indoors
Maintenance	Refueling and servicing LNG vehicles requires training Cleaner burning characteristics, less noise than diesel engines
Performance	No differences when compared to diesel
Uses	Heavy-duty trucks and buses, new gas-fueled locomotives Not viable for light-duty vehicles
Example	Waste Management Inc. purchasing new LNG vehicles and converting existing vehicle engines to LNG (waste haulers)

Alternative Fuel Type	**Liquefied Petroleum Gas (LPG)**
Availability	***Most widely available alt fuel, 5000+ fueling stations nationwide*** Over 90% of LPG used within the US originates within the country
Affordability	Propane and gasoline are comparable in price per gallon It takes 1.4 gal of propane to provide same energy as 1 gal of gas LPG vehicles $3000-5000 more than gasoline counterparts
Emissions	*(% relative to ultra-low sulfur (ULS) petroleum)*
Carbon Dioxide	11-13% less
Carbon Monoxide	30-35% less
Particulate Matter	80-95% less particulates *(compared to ULS diesel)*
Hydrocarbon	20-40% less
Sulfate	n/a
Nitrogen oxide	15-80% less, 90-99% less *(compared to ULS diesel)*
Methane	n/a
Safety	Least flammable fuel in liquid form, but ignitable in gas form Nontoxic, slightly soluble, biodegrades rapidly
Maintenance	Reduces engine wear and maintenance requirements
Performance	Possible increase in engine power-output and better thermal efficiency, reducing fuel consumption and emissions
Uses	Fleets including school buses, taxis, police cars, forklifts
Example	Texas Dept. of Transportation: 4400 propane vehicles in its on-road fleet

Overall Average Fuel Prices, September 2005

Nationwide Average Price for Fuel	
Gasoline	$2.77 per gallon
Diesel	$2.81 per gallon
CNG	$2.12 per GGE (gasoline gallon equivalent)
Propane	$2.56 per gallon
Biodiesel (B20)	$2.91 per gallon
Biodiesel (B99-B100)	$3.40 per gallon

Appendix E – Laws

1) In Massachusettes Chapter 90 E section 2A of the General Laws requires the commissioner of the Massachusetts Highway Department to "make all reasonable provisions for the accommodation of bicycle and pedestrian traffic in the planning design and construction reconstruction or maintanence of any project undertaken by the department.

http://www.massbike.org/bikelaw/mass.htm#C90ES2A

2) The Massachusetts Anti-Idling Law

Massachusetts General Law (MGL), Chapter 90, Section 16A,
310 Code of Massachusetts Regulation (CMR), Section 7.11 and
MGL, Chapter 111, Sections 142A – 142M

MGL, Chapter 90, 16A and 310 CMR, 7.11:

"No person shall cause, suffer, allow, or permit the unnecessary operation of the engine of a motor vehicle while said vehicle is stopped for a foreseeable period of time in excess of five minutes. 310 CMR 7.11 shall not apply to:

Vehicles being serviced, provided that operation of the engine is essential to the proper repair thereof, or

Vehicles engaged in the delivery or acceptance of goods, wares, or merchandise for which engine assisted power is necessary and substitute alternate means cannot be made available or,

Vehicles engaged in an operation for which the engine power is necessary for an associated power need other than movement and substitute alternate power means cannot be made available provided that such operation does not cause or contribute to a condition of air pollution."

Note: the regulation applies to all motor vehicles.

Penalties

Penalties can range from $100(MGL Chapter 90, Section 16A) to as much as $25,000 (MGL Chapter 111, Section 142A);

Drivers and/or companies can be held responsible for paying the fine;

Local police have the authority to enforce the law, as do health officials or other officials who hold enforcement authority.

3) CAFE (Corporate Average Fuel Economy):
An average mpg of a manufacturers fleet which consists of light trucks and passenger vehicles that weigh less than 8500 lbs
The "Energy Policy Conservation Act," enacted into law by Congress in 1975, added Title V, "Improving Automotive Efficiency," to the Motor Vehicle Information and Cost Savings Act and established CAFE standards for passenger cars and light trucks. The Act was passed in response to the 1973-74 Arab oil embargo. The near-term goal was to double new car fuel economy by model year 1985. The CAFE Standards have remained the same since 1985.

49 U.S.C. 32911 requires manufacturers to comply with the applicable average fuel economy standard. Each passenger automobile or light truck manufacturer must achieve a minimum corporate average fuel economy (CAFE) or be subject to penalties for violations.

http://www.nhtsa.dot.gov/cars/rules/cafe/overview.htm

4) The Massachusetts Low Emission Vehicle (LEV) law, enacted in 1990, requires that all new passenger vehicles sold and registered in Massachusetts meet cleaner California motor vehicle emission standards.

Simply put, the LEV program requires that new vehicles - any vehicle with 7,500 miles or less on the odometer - must be equipped with factory-installed California-certified advanced emission control systems. This applies to all 1995 and newer passenger cars and light-duty trucks up to 6,000 pounds sold and registered in Massachusetts.

Beginning with model year 2003, medium-duty gasoline and diesel fueled vehicles must be certified as meeting California motor vehicle emission standards prior to being sold or registered in Massachusetts. This applies to all vehicles with 7500 miles or less on the odometer. Medium-duty vehicles are vehicles weighing **6,001 - 14,000 lbs**.

http://www.arb.ca.gov/msprog/levprog/test_proc.htm

5) Medford's Climate Protection Plan stated that:

The Commonwealth of Massachusetts mandates that 75% of new light-duty vehicles purchased for the State are alternative fuel vehicles (AFVs).

http://www.massclimateaction.org/pdf/MedfordPlan2001.pdf

Appendix F – Car Model Comparison

	Model	Engine Size	Engine Options: Hybrid (H) Flex-Fuel (FFV) Nat. Gas (CNG)	Miles per Gallon (city/highway)		GHG emissions (tons per year)***		Price ($)
				Normal	Hybrid / Flex-Fuel	Normal	Hybrid / Flex-Fuel	
	'06 Ford Escape 4WD	4 cylinders, 2.3 Liters Automatic	H	21 / 24	33 / 29	8.6	6.2	19,995 27,515*
	'06 Ford Explorer 4WD	6 cylinders, 4.0 Liters Automatic	FFV	15 / 20	11 / 15	11.3	8.5	27,175
	2006 Ford Fusion	4 cylinders, 2.3 Liters Automatic	N/A	24 / 32	-	7.1	-	17,795
	'06 Ford Taurus	6 cylinders, 3.0 Liters Automatic	FFV	19 / 27	15 / 20	8.5	6.2	21,595
	'06 Ford Crown Victoria	8 cylinders, 4.6 Liters Automatic	FFV	17 / 25	12 / 18	9.6	7.2	25,285
	'06 Chevrolet Impala	6 cylinders, 3.5 Liters Automatic	FFV	21 / 31	16 / 23	7.8	5.6	20,990
	'06 Chevrolet Cobalt	4 cylinders 2.2 Liters Automatic	N/A	24 / 32	-	6.9	-	13,490
	'06 Chevrolet Aveo	4 cylinders 1.6 Liters Automatic	N/A	24 / 34	-	6.8	-	9,890
	'06 Toyota Corolla	4 cylinders, 1.8 Liters Automatic	N/A	30 / 38	-	5.7	-	14,105
	'06 Toyota Prius	4 cylinders, 1.5 Liters Automatic	H	-	60 / 51	-	3.5	21,725
	'06 Honda Civic	4 cylinders, 1.8 Liters Automatic	H	30 / 38	49 / 51	5.8	3.9	14,560 21,850*
	'05 Honda Civic	4 cylinders 1.7 Liters Automatic	CNG	-	30/34	-	5.1	21,760

* Price for the hybrid version of the specified model

** Flex-Fuel Vehicles prices are same as the baseline prices

*** Greenhouse gas emissions have been calculated based on 45% highway driving, 55% city driving and 15,000 miles annually

Appendix G – Fleet Data

Municipal Fuel Consumption (Oct. 2002 – Oct. 2003)

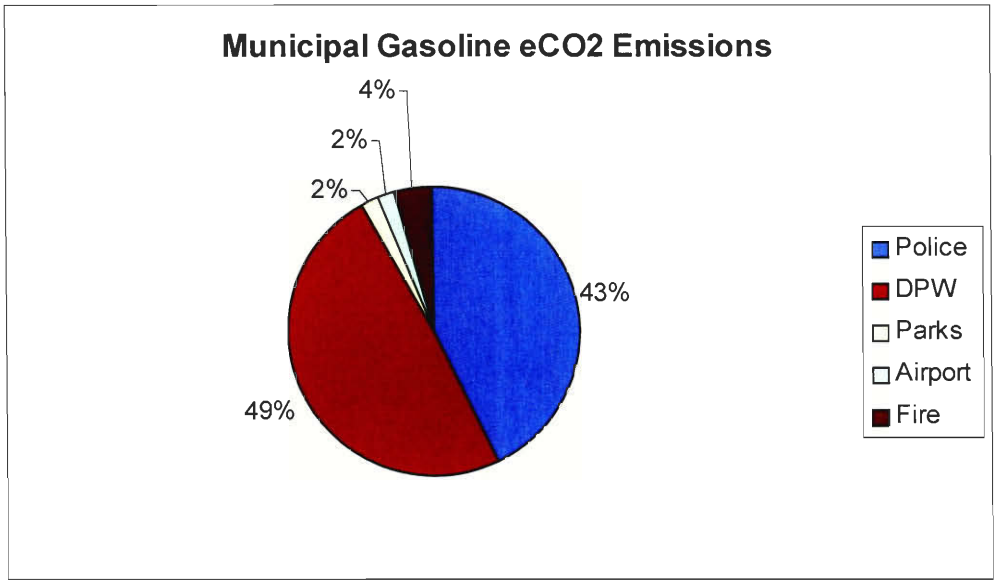
	Gallons of Fuel Used
Municipal Diesel	
Total	246,131
Municipal Gasoline	
Police	248,000
DPW	284,000
Parks	11,000
Airport	11,000
Fire	24,000
Total	577,000

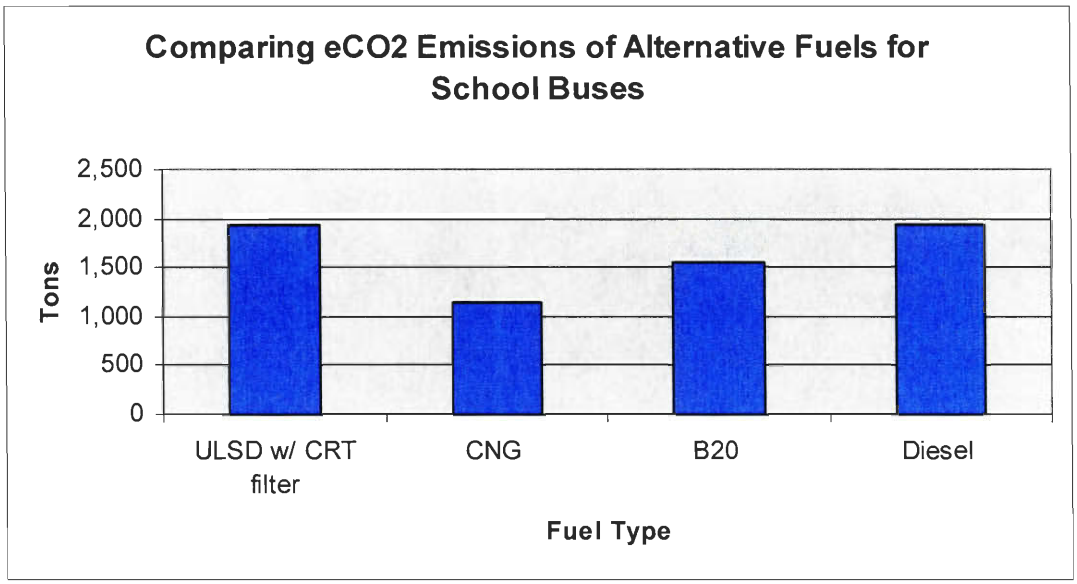
Durham School Bus Data

	Avg. VMT (Sept. 05-June 06)
School Bus ULSD	1,000,000
Total	1,000,000

Municipal Fleet Emissions Output

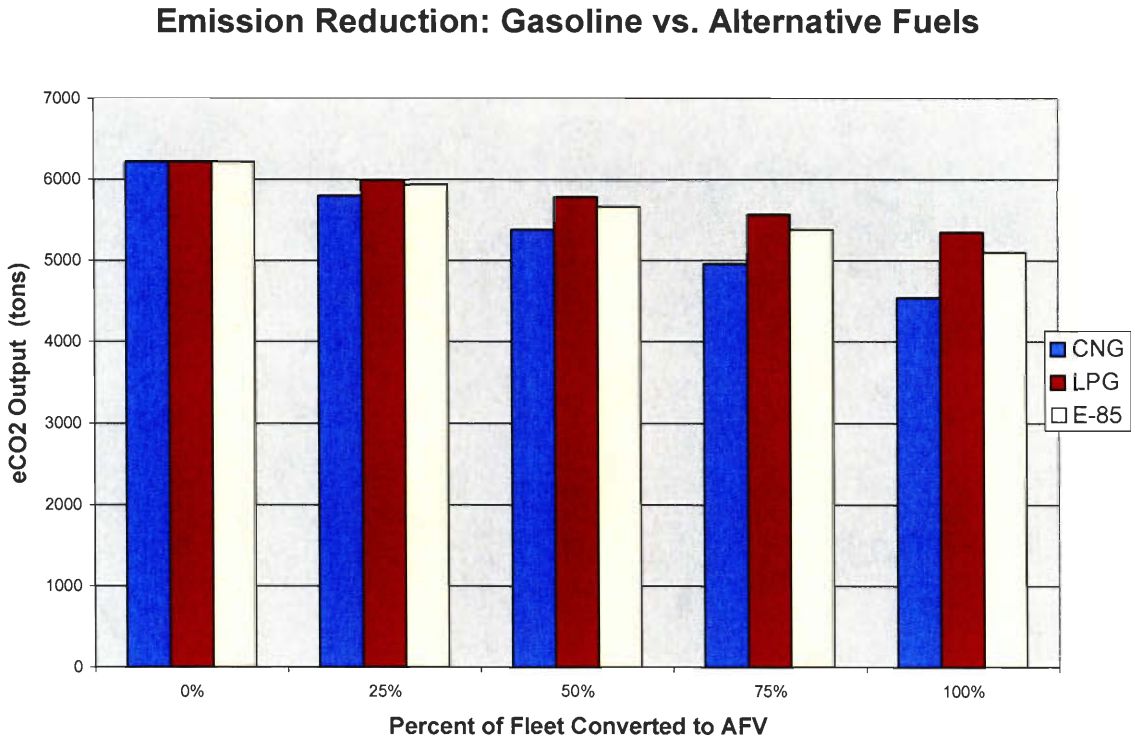
	eCO_2 (tons) *carbon dioxide equivalent*	**NOx (lbs)** *nitrous oxides*	**SOx (lbs)** *sulfur oxides*	**CO (lbs)** *carbon monoxide*	**VOC (lbs)** *volatile organic compounds*	**PM10 (lbs)** *particulate matter (10)*	**VMT** *vehicle miles traveled*
Municipal Diesel	2,608	13,387	1,078	13,742	5,088	1,607	4,633,342
Municipal Gasoline							
Police	2,667	15,754	764	153,284	16,226	330	4,394,899
DPW	3,054	18,041	875	175,535	18,581	378	5,032,868
Parks	118	699	34	6,799	720	15	194,935
Airport	118	699	34	6,799	720	15	194,935
Fire	258	1,525	74	14,834	1,570	32	425,313
Total (from Gasoline)	6,215	36,718	1781	357,251	37,817	770	10,242,950
School Bus ULSD (Ultra Low Sulfur Diesel w/ CTR filter))	1,939	33,067	34	21,084	2,705	1,559	1,000,000


Municipal Gasoline eCO2 Emissions
4%
2%
2%
43%
49%
Police
DPW
Parks
Airport
Fire


Comparing eCO2 Emissions of Alternative Fuels for School Buses
2,500
2,000
1,500
1,000
500
0
Tons
ULSD w/ CRT filter
CNG
B20
Diesel
Fuel Type

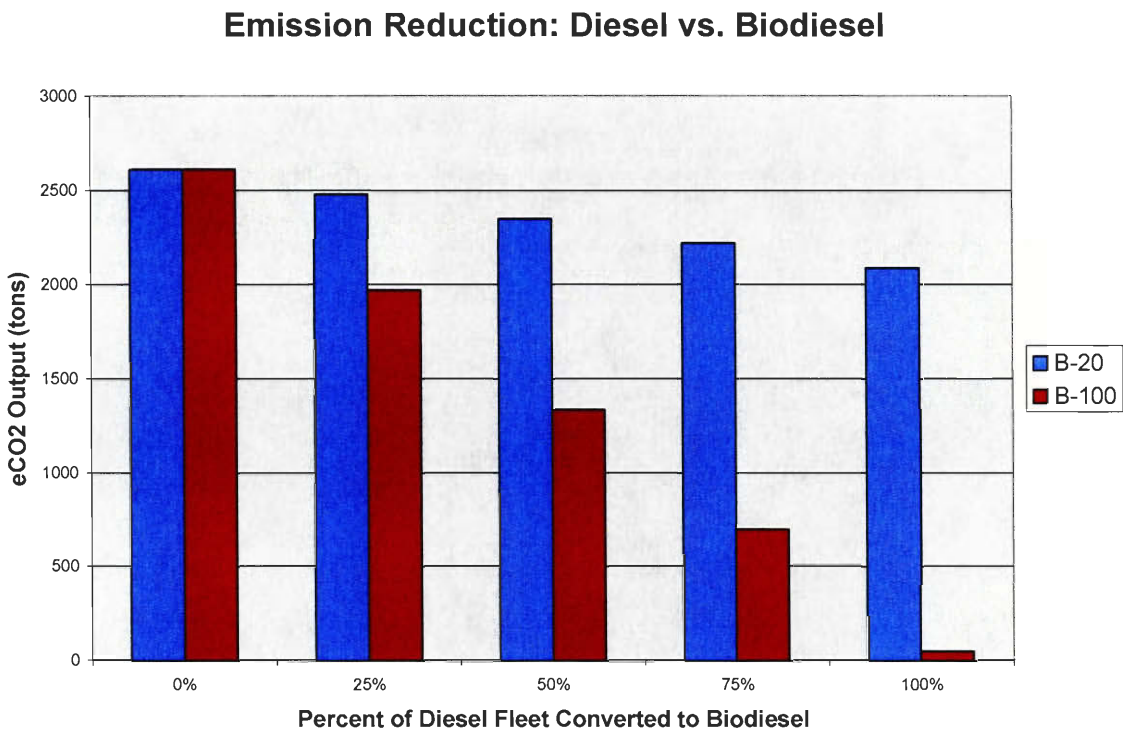
Projected Emissions Output (tons of eCO_2) When Changing Municipal Fleet Fuels (Gasoline)

Percent Replacement	**0%**	**25%**	**50%**	**75%**	**100%**
Fuel					
CNG	6215	5795.5	5376	4956.5	4537
LPG	6215	5997.5	5780	5562.4	5345
E-85	6215	5935.3	5655.7	5376	5096.3



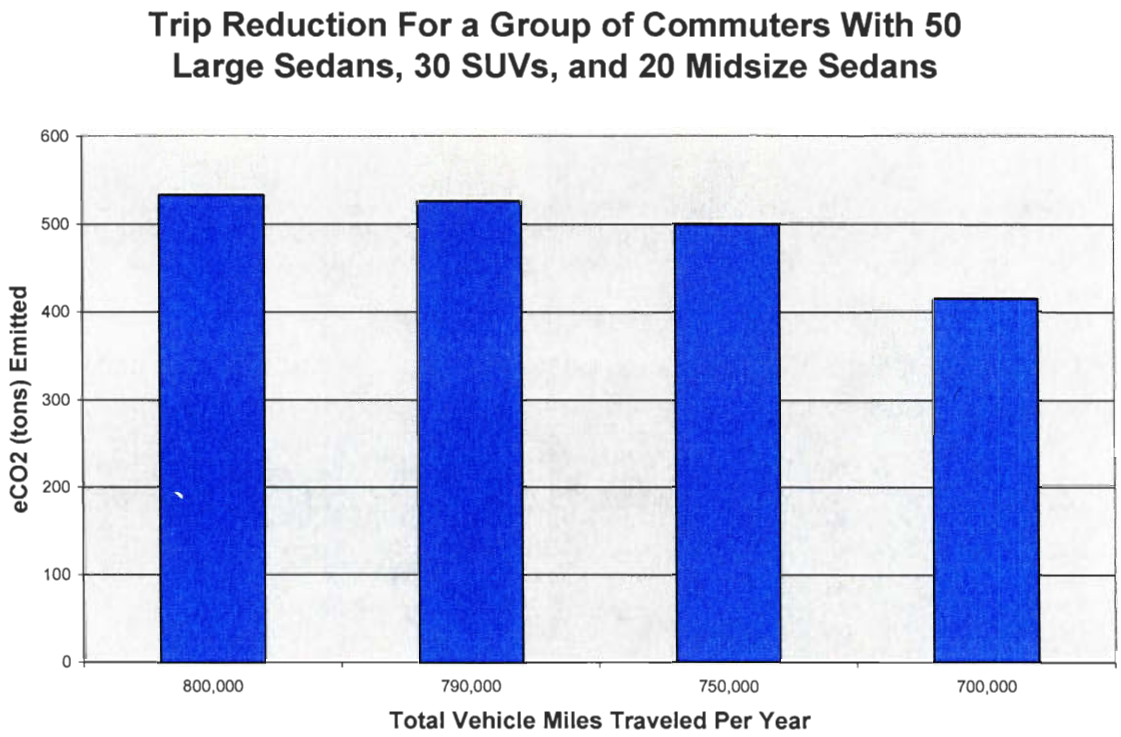
Projected Emissions Output (tons of eCO_2) When Changing Municipal Fleet Fuels (Diesel)

Percent Replacement	**0%**	**25%**	**50%**	**75%**	**100%**
Fuel					
B-20	2608	2477.6	2347.2	2216.8	2086.4
B-100	2608	1969	1330	691.1	52.2



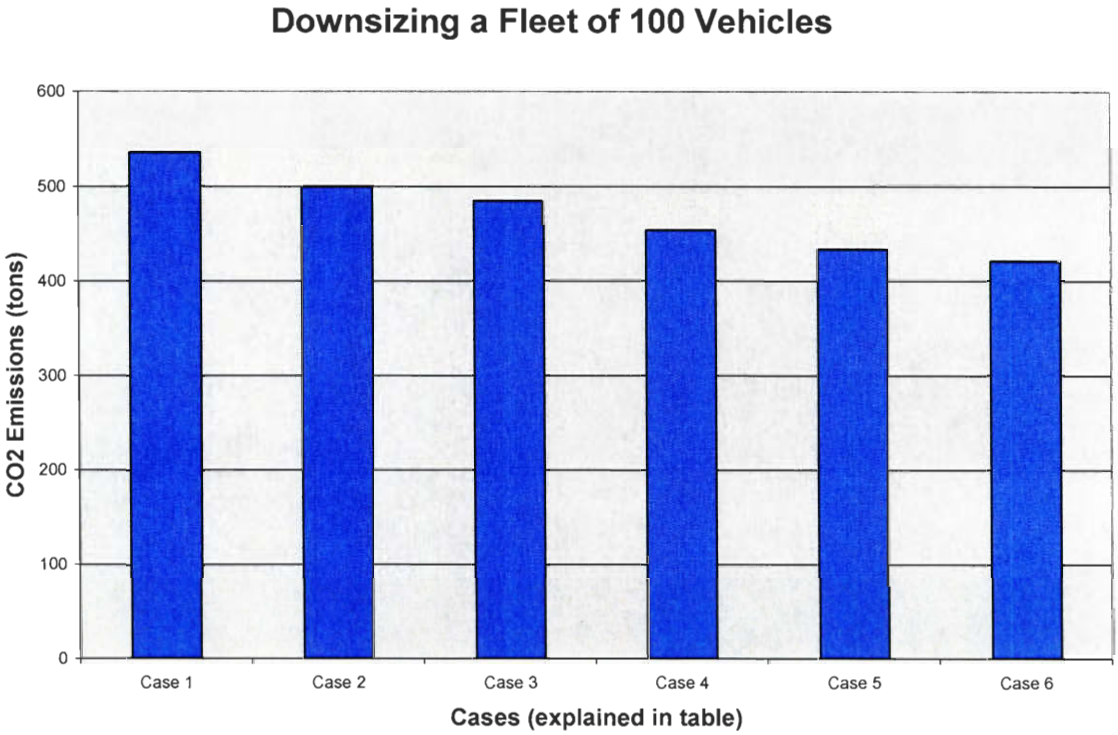
Vehicle Miles Traveled Reduction for 100 Commuters

Total VMT	800,000	790,000	750,000	700,000
eCO_2 (tons)	533	526	499	414



Fleet of 100 Vehicles and Their Emissions When Downsizing

	Vehicles in Fleet	CO2 (tons)	Nox (lbs)	Sox (lbs)	CO (lbs)	VOC (lbs)	PM 10 (lbs)
Case 1	50 SUV 40 Full Size 10 Midsize	535	2479	159	29014	2968	54
Case 2	30 SUV 50 Full Size 20 Midsize	499	2503	150	28569	2915	56
Case 3	30 SUV 30 Full Size 30 Midsize 10 Compact	484	2503	150	28569	2915	56
Case 4	20 SUV 20 Full Size 40 Midsize 20 Compact	453	2515	146	28347	2888	58
Case 5	10 SUV 20 Full Size 50 Midsize 20 Compact	433	2527	141	28125	2862	59
Case 6	10 SUV 20 Full Size 35 Midsize 35 Compact	420	2527	141	28125	2862	59


Downsizing a Fleet of 100 Vehicles
600
500
400
300
200
100
0
CO2 Emissions (tons)
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6
Cases (explained in table)

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