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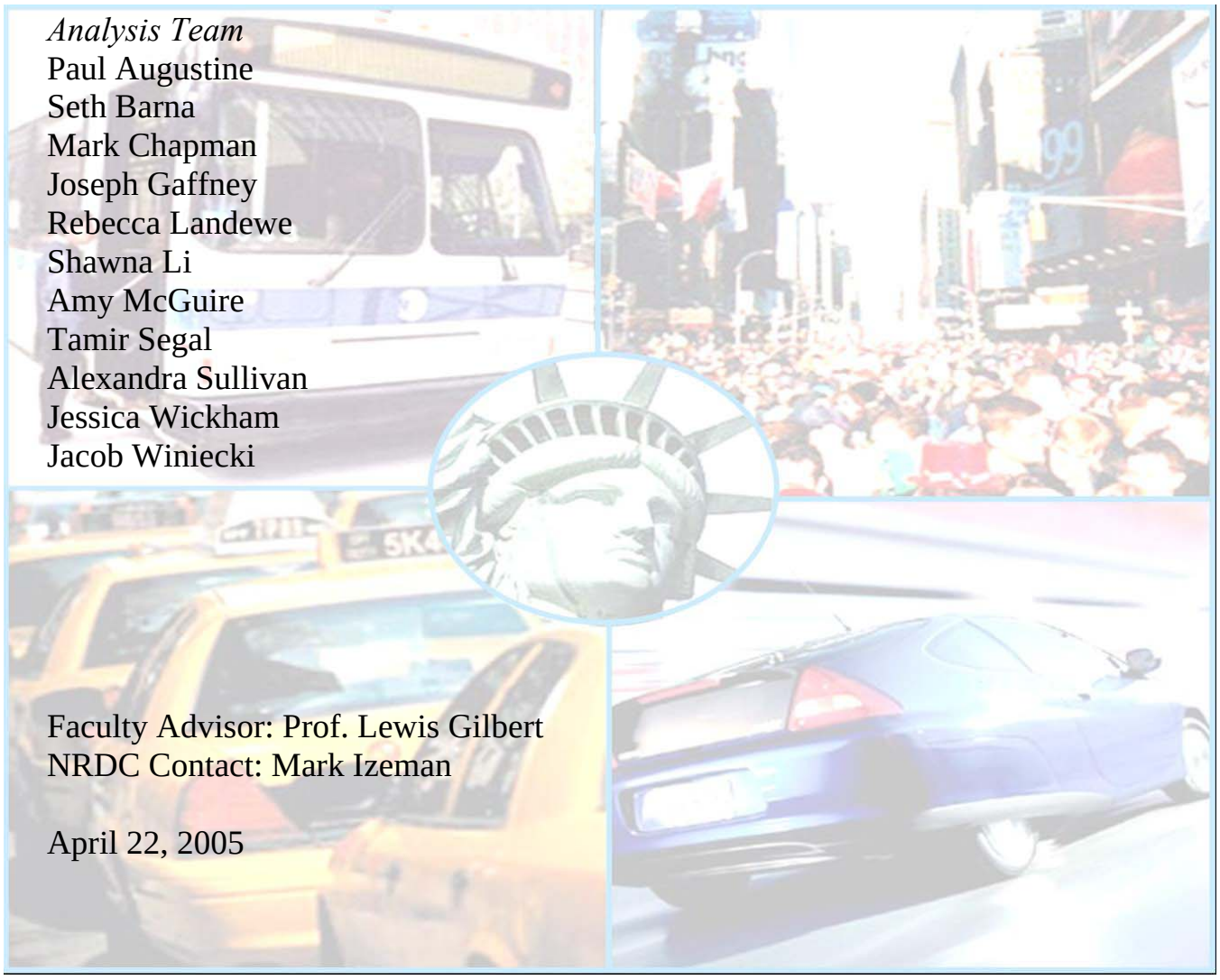
TRANSPORTING NEW YORK CITY
TO A
SUSTAINABLE FUTURE:
Clean Air Taxi Bill of 2005
&
Research Report

Prepared for Natural Resources Defense Council
By Columbia University – SIPA Spring Workshop



Analysis Team
Paul Augustine
Seth Barna
Mark Chapman
Joseph Gaffney
Rebecca Landewe
Shawna Li
Amy McGuire
Tamir Segal
Alexandra Sullivan
Jessica Wickham
Jacob Winiecki

Faculty Advisor: Prof. Lewis Gilbert
NRDC Contact: Mark Izeman

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Introduction

As the human population grows, concerns about meeting the resource demands of the future and improving the quality of life in urban centers become increasingly salient. New York City is a model city for urban transit in the United States. Population density is high, vehicle ownership is low, and the majority of residents use public transportation for travel within the city. Nonetheless, traffic continues to be a significant source of pollution, causing damage to the public health and environment. The President of the American Lung Association of the City of New York stated that the "high levels of ozone and particle pollution caused by the cars, buses and trucks that clog our streets make the mere act of breathing dangerous for the residents of New York City."[1] To remain a model for other urban centers, the city must address the pollution problem and continue to seek solutions to improve the health and quality of life for residents.

Hybrid vehicles[2] present a unique opportunity to reduce vehicle emissions and provide cost savings to taxi drivers. According to the U.S. Department of Energy, hybrids "have the potential to be two to three times more fuel-efficient than conventional vehicles", with the highest gas mileage attained under city driving conditions, such as those of the typical New York City taxi. While the higher initial cost of hybrid vehicles may deter some consumers, cost/benefit analysis indicates that a hybrid taxicab will pay for itself in one to two years of operation and provide total lifetime savings of $13,000 to $17,000.[3] Table 1 (Appendix A) compares the cost of the Crown Victoria taxicab, which constitutes approximately 94 percent of New York City yellow cabs, to the Ford Hybrid Escape that is currently on the market and being used in other U.S. cities.

This document contains four policy recommendations, presented in order of priority, for reducing air pollution from taxicabs in New York City by promoting the use of cleaner technology. The pilot program is the necessary first step: it mandates the approval of a hybrid vehicle by the Taxi and Limousine Commission (TLC), overcoming the largest barrier to introducing hybrids as alternative fuel taxis. The subsequent recommendations address the long-term impacts and have the ability to induce a substantial change in the taxi fleet composition (see Appendix B, Figure 1). These recommendations provide general guidelines for policies with negotiable dates and targets.

Recommendation # 1: Pilot Program

This policy recommends that at the latest date of January 1, 2006, the TLC Chairman present the New York City Council with a plan for a two-year pilot program for the yellow cab fleet to commence by January 1, 2007. The legislation will clearly outline minimum vehicle numbers and fuel efficiency standards. The legislation will also mandate a status report by January 1, 2008, which details the number and types of vehicles tested during the first year of the pilot

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[1] American Lung Association of the City of New York, *Lung Association Applauds City Council Leadership on Introduction of Comprehensive Emissions Control Legislation*. Aug 12, 2004. www.alany.org/news_08124.html

[2] For the purpose of this analysis, a hybrid vehicle shall be defined as a vehicle that integrates a combustion engine system together with an electric propulsion system that operates in an integrated manner.

[3] Assuming maintenance costs remain the same, the estimated lifetime cost savings of $13,000 to $17,000 are conservative. The Taxi and Limousine Commission grants a two year extension on the mandated vehicle retirement for alternative fuel and hybrid taxis, thus delaying the time at which a taxi driver replaces the vehicle and increasing the total savings of purchasing a hybrid.

program. This report must demonstrate that the TLC intends to meet designated long-term legislated standards (e.g. percent clean taxis or fuel efficiency). Furthermore, the legislation shall require that the TLC Chairman approve a fuel efficient vehicle (meeting legislative requirements) for use as a taxicab in New York City by January 1, 2009. If the TLC does not feel a suitable vehicle exists as of January 1, 2009, the Chairman may present a one-year extension plan to the City Council outlining steps to approving a vehicle by January 1, 2010. The New York City Council shall have the power to approve or reject any TLC one-year extension plan. The objective of the pilot program and mandated fuel efficient vehicle approval is to educate and thus enable the TLC Chairman to approve a more fuel efficient taxicab.

Opportunities/Challenges

The major challenge facing the pilot program is identifying and testing a fuel efficient vehicle that will satisfy customers, associated industry representatives and the TLC. The mandated vehicle approval will be politically challenging because currently there are no fuel efficient vehicles that meet all TLC specifications. Allowing the TLC to propose a one-year extension plan will give them more time to approve a vehicle while reducing pilot program opposition. Creating a pilot program may result in high upfront costs. However, the pilot program will enable the New York City Council and TLC to test vehicles on a temporary basis, which should help reduce capital investment and political opposition as compared to mandating conversion to an untested vehicle. The vehicle approval phase of the pilot program is crucial because only after a hybrid vehicle is deemed acceptable by the TLC, can the technology be used by taxicab drivers. Although these are major challenges, they are also great opportunities. San Francisco and Boston fleets using Ford Escape Hybrids have received very positive feedback from drivers and customers. See Appendix C for a detailed report of the San Francisco case study.

Recommendation # 2: Emissions Cap-and-Trade

This policy establishes an emissions cap-and-trade regime for the TLC yellow cabs by setting a baseline emissions level (see Appendix D) and mandating a schedule of percent-reduction requirements. Vehicle owners unable to invest in cleaner vehicles and make the required reductions may purchase credits from those vehicle owners that are below the baseline level. The proposed cap-and-trade program enables a smoother, more cost-effective transition to cleaner taxis than a command-and-control regulation.

Option 1: Reduction Timeline – Each vehicle must reduce emissions on a set timeline (e.g. 10% by 2010, 20% by 2014, 30% by 2016).

Option 2: Reductions at Retirement[4] – Each vehicle purchased in the year of enactment or later must meet emissions reductions at specified retirement dates (e.g. 10% by first retirement, 20% by second, 30% by third) (see Appendix D, Figure 2).

Opportunities/Challenges

The cap-and-trade system creates an innovative market-based solution, which can be used as a model in other metropolitan areas without a strict command-and-control regulation. Option 2 encourages taxi drivers to utilize alternative fuel vehicles because they are allowed a two-year

[4] TLC sets specific retirement requirements for taxicabs. Taxis that are driven two shirts per day (double shift vehicles) must be retired after three years of service. Taxis that are driven one shift per day (single shift vehicles) must be retired after 5 years. There are retirement extensions available for alternative fuel, hybrid, and handicap accessible vehicles. The process of retiring and replacing a vehicle is referred to as turnover.

extension on retirement, which delays the time by which they must meet emissions reductions. The cap-and-trade regime is challenging due to its relatively complex nature. Equity issues may arise for Option 1 because of the differing turnover rates for double shift and single shift vehicles. Those operated as single shift vehicles may turnover under the second reduction period, thereby forcing a stricter emissions reduction.

Recommendation # 3: Increase Percentage of Clean Taxis

This policy recommends mandating that the TLC increase the percentage of alternative fuel vehicles in the New York City yellow cab fleet to 40% by December 31, 2015. The 40% conversion should be proportionally distributed between fleet owners and owner-operators. Steps to reach this increase include two benchmarks: 10% by 2008 and 20% by 2010.

The percent increases will be accomplished through the traditional command-and-control structure by setting mandates that the TLC will work to achieve by specific deadlines. The first step is the implementation of the pilot program described previously. Cars in this program will be counted toward the percentage increase in clean taxis. By the final legislation deadline, all fleet and individual owners must send a report detailing the make and model of each of their taxis (alternative or non-alternative fuel) to the Chairman of the TLC and the Committee on Transportation for the New York City Council to determine the alternative fuel percent make-up of the fleet. If the overall 40% is not reached by deadline, citizen suits may be filed for failure to comply with the legislation. The following two options may be added into the legislation:

Option 1: Purchase Credits – Provide credits for owner-drivers that switch to clean taxis. These credits may be able to be acquired from the New York State Energy Research and Development Authority (NYSERDA) fund, which currently provides credits for compressed natural gas (CNG) taxis.

Option 2: Fines – Levy fines on all fleets that do not meet a mandated 40% overall composition of clean taxis by two years after the legislative deadline. Fines should be assigned at $10,000 per vehicle needed to reach the 40% composition.

Opportunities/Challenges

One benefit of this recommendation is that it can be coordinated with the taxi turnover times. However, it is difficult to mandate percent increases to individual owner-drives who only own one taxi, so fleets might bear more of the financial burden. Also, it may take significant revisions to allow credits for the use of hybrid taxis to be drawn from the NYSERDA fund. Lastly, TLC is responsible for meeting the percent increases by the deadlines, so there is an additional regulatory burden on the agency.

There are also legal impediments to regulating percentage fleet composition that are currently in litigation. Establishing fleet composition requirements may be illegal due to its indirect control of emissions, regulation of which is clearly delegated to the federal government under the Clean Air Act. Therefore, it may be difficult for New York to pursue this option.

Recommendation # 4: Improve Overall Fuel Efficiency

This policy would mandate an overall fuel efficiency average of 25 city miles per gallon for New York City TLC yellow cab vehicles by 2012. Establishing a new fuel economy standard for the fleet will result in a decrease in both emission levels and expenditures on fuel, while increasing the general health and social welfare of residents.

Opportunities and Constraints

Given the standardized turnover time for yellow cabs, the timeframe proposed in this recommendation is feasible, and there are potential funding opportunities through programs such as the Clean Cities Program. Additionally, the program follows a schedule similar to that promoted by the American Council for an Energy Efficient Economy. However, this policy may be difficult because it creates a bias towards fleet owners since it is difficult for an individual taxi cab owner to have an "average" fuel efficiency of 25 miles per gallon, when he may own only one car. These owners would be forced to purchase hybrid vehicles. This problem would make implementation difficult. There are also legal impediments to regulating fleet fuel efficiency. Mandating fleet fuel efficiency may be illegal due to federal preemption by the Federal Corporate Average Fuel Economy law. Therefore, it may be difficult for New York City to pursue this option. Finally, while there are some grant funding options, such as the Clean Cities Program, they may not be sufficient to cover the necessary incentives to bring taxi owners into compliance. Ultimately the program depends on adequate funding, available technology, the approval of a hybrid vehicle by the TLC, and a successful pilot program.

Next Steps

- Investigate funding options for the pilot program and incentive opportunities.
- Investigate potential partnerships, including the Clean Cities Coalition, NYSERDA, and local car dealerships.
- Contact automobile manufacturers (e.g. Ford Motor Company) to determine the feasibility of acquiring the quantity of new alternative fuel vehicles that will meet the needs of the pilot program and/or mandate.

Appendix A: Cost/Benefit Analysis

Average Mileage

The average annual mileage for a New York City taxicab varies depending on the number of shifts the vehicle is driven per day. Double shift vehicles are operated two shifts per day and are either part of a larger fleet or under a long-term lease from the medallion owner. Single shift vehicles operate one shift per day and are driver-owned. In 2003, New York City double shift fleet vehicles averaged 72,000 miles, double shift vehicles on a long-term lease averaged 68,000 miles, and single shift taxis averaged 42,000 miles.[5]

Vehicle Retirement

Double shift taxis must be retired after three years of service. Single shift vehicles must be retired after 5 years. The Taxi and Limousine Commission grants a two-year retirement extension for alternative fuel and hybrid vehicles.

Table 1: The table compares the initial purchase cost,[6] fuel efficiency,[7] expected gasoline expenditure, and estimated savings. Calculations are based on average fuel price in March 2005 for the New York City Metropolitan Area ($2.00 per gallon)[8] and the extended taxi lifetime, as described above.

	Crown Victoria	*Ford Hybrid Escape*	*Net Effect*	*Lifetime Savings*
Initial Cost	$24,410	$27,400	-$2,990	
City Fuel Efficiency (mpg)	18	36		
Double shift - Fleet				
(miles per year)	72000	72000		
Expected Fueling Costs	$8,000	$4,000	$4,000	
Fuel Savings			*$1,010*	$17,010
Double shift - Lease				
(miles per year)	68000	68000		
Expected Fueling Costs	$7,556	$3,778	$3,778	
Fuel Savings			*$788*	$15,899
Single shift - Owners				
(miles per year)	42000	42000		
Expected Fueling Costs	$4,667	$2,333	$2,333	
Fuel Savings			*-$657*	$13,343

[5] Schaller Consulting. *The New York City Taxicab Fact Book.* Brooklyn: Schaller Consulting. Jun. 2004. Retrieved on Feb. 2, 2005 from http://www.schallerconsult.com/taxi/taxifb.pdf

Taxi and Limousine Commission. "Frequently Asked Questions: About Vehicles." 2005. Retrieved on April 22, 2005 from http://www.nyc.gov/html/tlc/medallion/html/faq/vehicles.shtml

[6] Information is available from the Ford web site. Retrieved on March 18, 2005 from http://smartguide.fordvehicles.com/View.jsp?spaceName=cars

[7] Fuel Economy information is available online. Retrieved on March 18, 2005 from http://www.fueleconomy.gov/

[8] New York State Energy Research and Development Authority. "Monthly Average Motor Gasoline Prices." March 2005. Retrieved on April 22, 2005 from http://www.nyserda.org/Energy_Information/nyepa.asp

Appendix B: Long-term Strategy

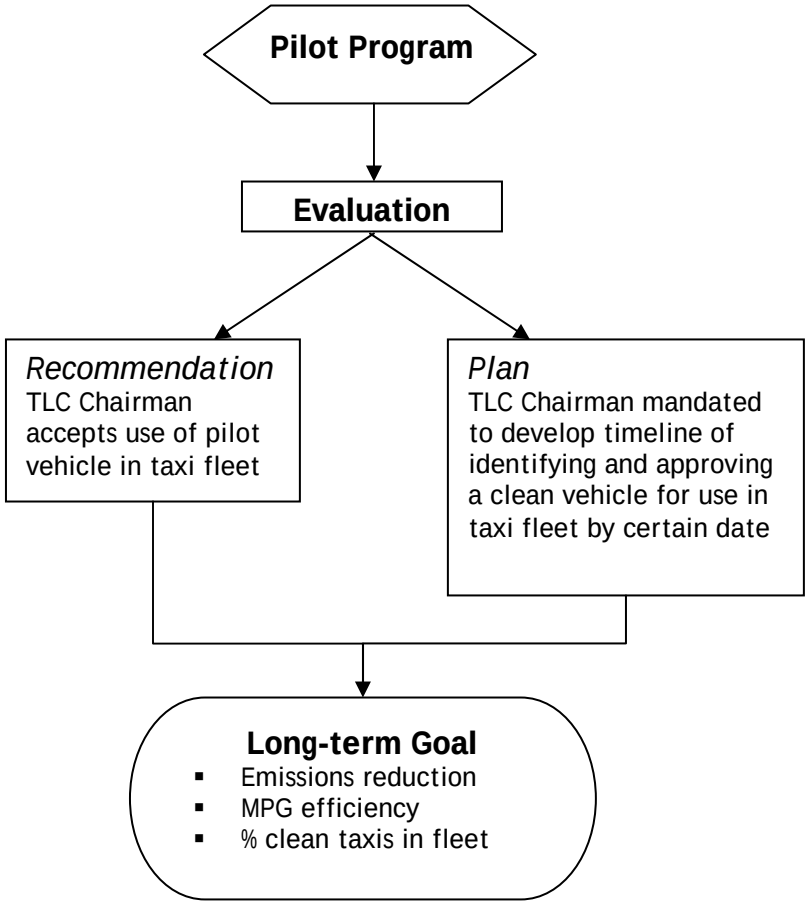

Figure 1: This diagram illustrates the intention of the recommendations to implement both a short-term plan as a critical step in achieving a long-term goal.

Appendix C: San Francisco – Hybrid Taxi Case Study

Introduction

On February 22, 2005 the City of San Francisco announced that 15 2005 Ford Escape Hybrid SUV taxis had joined the city's fleet of 1,381. These vehicles qualify for the stringent Advanced Technology Partial Zero Emissions Vehicle (AT-PZEV) classification and are certified by the U.S. Environmental Protection Agency to get 36 mpg in the city and 31 mpg on the highway.[9] Ten of the new Ford Escape Hybrid taxis are owned and operated by the Yellow Cab Cooperative and another five are now part of the Luxor Cab Company fleet. All of the vehicles were purchased from S&C Ford in San Francisco for approximately $27,000 each. "Each cab, however, will be eligible for a $2,000 clean air incentive award as part of a 'vehicle incentive program' administered by the Bay Area Air Quality Management District and funded by a $4 surcharge levied on all vehicles annually registered in the nine-county Bay Area."[10] The purpose of this case study is to evaluate the taxi system and government structure in San Francisco to better understand the emergence of this hybrid program and to consider how similar initiatives might succeed in New York City.

General Taxi Structure Information

In assessing the addition of these hybrid vehicles to the San Francisco taxi fleet it is essential to understand the structure of the city's Taxi Commission and its regulations. The San Francisco Taxi Commission Department has all permitting responsibilities, including those for drivers, permit holders, ramp taxicabs, PCN applications, color scheme changes, lost medallions, metal medallions, color scheme renewals and applications, and dispatch services.[11] This role was established in 1978 when all taxicab medallions became public property under Proposition K. The mission of the Commission is to

> *"insure the provision of prompt, safe, honest, efficient, and courteous taxi service to the residents and visitors of San Francisco; to enact and enforce just and equitable rules concerning drivers, medallion holders and companies; and to provide an open forum for debate and discussion of all issues concerning public vehicle for hire services in San Francisco."*[12]

To accomplish this mission, the Commission has outlined a set of specific regulations to govern the operation of taxicabs in the City of San Francisco. The most recently amended version of

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[9] City of San Francisco - Press Office. "First Hybrid SUV Taxis in United States Take To the Streets of San Francisco", Press Release. February 22, 2005. Retrieved on March 20, 2005 from http://www.ci.sf.ca.us/site/mayor_page.asp?id=30039

[10] Taylor, Michael. "S.F.'s fleet of 15 hybrid taxis puts cabbies on course to save gas." SFGate.com. February 23, 2005. Retrieved on March 20, 2005 from http://sfgate.com/cgi-bin/article.cgi?file=/c/a/2005/02/23/BAGFVBFL2M1.DTL

[11] San Francisco Taxicab Commission, *Taxicab Commission Annual Report 2002.* Retrieved on March 20, 2005 from http://www.sfgov.org/site/taxicommission_page.asp?id=17692

[12] City of San Francisco Taxicab Commission: Mission Statement. Retrieved on March 20, 2005 from http://www.sfgov.org/site/taxicommission_index.asp

these regulations was published in November 1999 and is available to the public on the taxi commission's website.[13]

The most important parts of the Commission's regulations cover the rules for medallion holders and color scheme holders, driver, training, dispatch and ramped taxi requirements, and the penalties for violation of commission guidelines. Medallion holders are defined as "any permittee licensed by the City & County of San Francisco to own and operate a taxicab," while Color Scheme Holders or Taxi companies are "any permittees licensed by the City and County of San Francisco to operate a taxicab company color scheme" and Taxi Drivers are "any permittees licensed by the City and County of San Francisco to drive a taxicab on behalf of any "Medallion Holder".[14] The Commission allows a maximum of three layers of leasing of medallions or permits (i.e. Medallion Holder to Color Scheme Holder to driver). This means that permits and medallions cannot be further leased among drivers or taxicab color scheme holders. There are 32 cab companies operating under this system.[15]

The Commission has also laid out a cycle of operation for vehicles serving as taxis in San Francisco under its "Vehicle Operation Standards". Vehicles in service when the regulations went into effect were allowed to continue in operation until they reached 10 model years of age or for three years from the effective date of the regulation, whichever came first. All vehicles put into service after the regulations went into effect were only permitted to operate for a maximum of three years and no vehicle older than three model years or with more than 60,000 original miles on the odometer could be put into operation (with the exception of alternative fuel vehicles, which may remain in service for an additional year). These regulations effectively mean that taxis in San Francisco are now retired every three years. Taxi companies are, however, allowed to establish their own schedule for replacing these vehicles within this three-year requirement. Because of this turnover rate, however, it would be a relatively simple process to cycle in more fuel efficient vehicles, such as hybrids, and quickly improve the overall fuel efficiency of the entire taxi fleet in San Francisco.

Kelly Castagnaro, the Acting Executive Director of the Taxicab Commission, expressed enthusiasm about the introduction of the Ford Escape hybrids. She indicated that the drivers of the cabs have not issued complaints about the vehicles and that there is an estimated cost savings to the drivers of $2,000 annually. Castagnaro also highlighted some important differences between the San Francisco taxicab structure and the system of operation in New York City. Namely, medallions in San Francisco are state property and the taxi specifications for vehicles in San Francisco do not include a passenger space requirement. The lack of a space requirement makes their system more flexible to alternative models than New York City's taxi system.[16]

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[13] The San Francisco Taxi Commission regulations can be found on their website. Specifically, it is promulgated under Appendix F of the Charter of the City and County of San Francisco and Article 16 of the San Francisco Municipal Police Code. See http://www.sfgov.org/site/taxicommission_index.asp?id=8126.

[14] City of San Francisco Taxicab Commission: Commission Regulations. Sec4c1. 9 November 1999. (The San Francisco Taxi Commission regulations can be found on their website at: http://www.sfgov.org/site/taxicommission_index.asp?id=8126.)

[15] City of San Francisco Taxicab Commission: Taxi Companies. (Directory of) http://www.sfgov.org/site/taxicommission_index.asp?id=8125. March 18, 2005.

[16] Kelly Castigator, Acting Executive Director, San Francisco Taxicab Commission. Telephone Interview. March 28, 2005.

Finally, Castagnaro indicated that the Taxicab Commission is exploring options to expand the use of hybrid vehicles in the San Francisco fleet. Specifically, she noted they have developed a special committee to examine incentives such as longer permitted vehicle life and reduced costs for vehicle emissions tests.

Government Setting

In addition to the San Francisco taxicab structure, it is instructive to understand the government framework within which this taxicab purchase has emerged. Under the mandate of the Clean Air Act, the U.S. Environmental Protections Agency established the National Ambient Air Quality Standards (NAAQS) to serve as a maximum emission level above which there are adverse effects on human health. For several years, the San Francisco Bay Area was in violation of air quality standards, and as a result, classified as a non-attainment area by the U.S. Environmental Protection Agency in 1998.[17] The City and County of San Francisco has since taken steps to improve the air quality in the Bay Area. Despite marked improvements in the last decade, the levels of some pollutants, like nitrogen oxides, still exceed the healthy standards set by the federal government.[18] This section highlights important stepping stones in San Francisco's effort to improve the air quality of the Bay Area.

A timeline of Clean Air legislation in San Francisco is as follows:

- *Late 1980s* – The Clean Air Vehicle Coalition, the precursor to the Clean Cities Coalition, was formed by Rick Ruvolo.

- *1988* – With the passage of the California Clean Air Act in 1988, areas that are in non-compliance with state air quality standards must create a Clean Air Plan for each air district.[19] The potential adverse effects on businesses and residents serve as an incentive for municipalities to be proactive in maintaining healthy air quality.

- *1994* – The Clean Air Program was established through the San Francisco Department of the Environment. One component of the program's mission is to reduce vehicle emissions by promoting the use of alternative fuel vehicles. This program has worked in cooperation with other organizations and agencies in the conversion of city fleets and development of necessary infrastructure, such as compressed natural gas fueling stations. Other projects

[17] Nonattainment and air quality in San Francisco are addressed both in the Environmental Code and in the Green Taxi Policy Resolution No. 520-00, which are referenced as follows:

San Francisco Environmental Code. "Chapter 4: Healthy Air and Smog Prevention." American Legal Publishing Corporation. 2003. http://www.amlegal.com/sfenviron_nxt/gateway.dll?f=templates&fn=default.htm&vid=alp:sf_environ

Green Taxi Policy: Resolution No. 520-00, File No. 000440. San Francisco Board of Supervisors. May 30, 2000. Retrieved on March 20, 2005 from http://www.sfgov.org/site/uploadedfiles/bdsupvrs/resolutions00/r0520-00.pdf

[18] San Francisco Department of the Environment. "Fact Sheets: Air Quality." *SF Environment.* Retrieved on March 20, 2005 from http://temp.sfgov.org/sfenvironment/facts/air.htm

[19] San Francisco Environmental Code. "Chapter 4: Healthy Air and Smog Prevention." American Legal Publishing Corporation. 2003. Retrieved on March 20, 2005 from http://www.amlegal.com/sfenviron_nxt/gateway.dll?f=templates&fn=default.htm&vid=alp:sf_environ

have included commuter rewards programs and supporting alternative modes of transportation.[20]

In this same year, San Francisco officially joined the U.S. Department of Energy's Clean Cities Program and the San Francisco Clean Cities Coalition (SFCCC) was formed. The goal of the national Clean Cities Program is to reduce the nation's petroleum consumption through the formation of local coalitions to promote the use of alternative fuel vehicles.[21] The members of the coalition include:

- San Francisco Bay Area Clean Air Vehicle Coalition (precursor organization to the Clean Cities Coalition)
- Department of Administrative Services
- Department of Public Transportation
- Bay Area Air Quality Management District (BAAQMD)
- San Francisco International Airport
- Pacific Gas and Electric Company
- NorCal Waste Management, Inc.
- Olympian Oil Company
- U.S. Department of Energy
- U.S. National Park Service
- U.S. General Services Administration

- *1997* – The Sustainability Plan for the City and County of San Francisco was approved by the Board of Supervisors. The Plan specifically states that improving air quality is important for residents and businesses in the area.[22]

- *1999* – The Healthy Air and Smog Prevention Ordinance was added to the San Francisco Municipal Code. This chapter guides the purchasing of alternative fuel vehicles for city fleets. By 2004, there were more than 600 alternative fuel vehicles in city fleets, which is a testament to the success of this ordinance in guiding the transition of city fleets to cleaner alternatives.[23]

- *2000* – According to a May 17, 2000 press release from the San Francisco Department of the Environment, 30 natural gas taxis were introduced into the city. Funded partially by the Bay Area Air Quality Management District (BAAQMD) and Trillium Corporation, Regents Cab converted 10 taxis and Yellow Cab converted 20 taxis to natural gas after participating in vehicle trials with Ford Motor Company. There are no noticeable differences in the way these vehicles drive as compared to their gasoline counterparts.

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[20] San Francisco Department of the Environment. "Clean Air Program." *SF Environment.* Retrieved on March 20, 2005 from http://temp.sfgov.org/sfenvironment/facts/clean_air.htm

[21] U.S. Department of Energy. "Clean Cities Program." *Office of Energy Efficiency and Renewable Energy.* March 8, 2005. Retrieved on March 28, 2005 from http://www.eere.energy.gov/cleancities/

[22] San Francisco Environmental Code. "Chapter 4: Healthy Air and Smog Prevention." American Legal Publishing Corporation. 2003. Retrieved on March 20, 2005 from http://www.amlegal.com/sfenviron_nxt/gateway.dll?f=templates&fn=default.htm&vid=alp:sf_environ

[23] San Francisco Department of the Environment. "Alternative Fuel Vehicles in the City Fleet." *SF Environment.* Retrieved on March 20, 2005 from http://temp.sfgov.org/sfenvironment/aboutus/air/city_vehicles.htm

Additionally, there are many benefits, including a longer life span and reduced costs associated with maintenance and fueling.[24]

In this year, Supervisor Gavin Newsom worked with the Taxi Commission and the San Francisco International Airport, a member of the Clean Cities Coalition, to develop a timeline to implement a comprehensive clean air protocol addressing taxis servicing the airport.[25] The resolution was passed after the completion of a one-year pilot project, in which the San Francisco International Airport gave clean air taxis short-line privileges.

- *2003* – On June 24, 2003, the Board of Supervisors passed a city ordinance to create the Environmental Code. The Environmental Code is comprised of select chapters of the San Francisco Administrative Code that were removed, slightly modified and compiled to form the new code. The majority of the code remained intact.

- *2004* – Ten 2005 Ford Escape Hybrids, purchased by the Yellow Cab Cooperative from S&C Ford, were first on the streets in December.[26] The introduction of these vehicles is not directly related to any initiative of the San Francisco Department of the Environment.[27]

- *2005* – In February, there was an official welcome of the hybrid SUV taxis to the San Francisco taxi fleets. Luxor Cab joined Yellow Cab by purchasing five hybrid SUVs.[28]

  In addition to the 15 Ford Escape Hybrid vehicles, the number of compressed natural gas taxis in the city has expanded from the initial 30 vehicles in 2000, to include approximately 110 compressed natural gas vehicles. Presently, the San Francisco Department of the Environment continues to work towards regulations that will require the conversion of all taxis to alternative fuel vehicles.[29] These taxis enjoy a "short-line" privilege at the airport, which means they can advance to the front of the taxi pickup line one time during each shift. Additionally, they are permitted to travel in high occupancy vehicle lanes under California State legislation. The Ford Escape Hybrid does not meet the

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[24] San Francisco Department of the Environment. "2000 Press Releases: Fleet of New Ford Clean Air Taxis Converges on City Hall." *SF Environment.* May 17, 2000. Retrieved on March 20, 2005 from http://temp.sfgov.org/sfenvironment/articles_pr/2000/pr/051700.htm

Green Taxi Policy: Resolution No. 520-00, File No. 000440. San Francisco Board of Supervisors. May 30, 2000 Retrieved on March 20, 2005 from http://www.sfgov.org/site/uploadedfiles/bdsupvrs/resolutions00/r0520-00.pdf

[25] Green Taxi Policy: Resolution No. 520-00, File No. 000440. San Francisco Board of Supervisors. May 30, 2000 Retrieved on March 20, 2005 from http://www.sfgov.org/site/uploadedfiles/bdsupvrs/resolutions00/r0520-00.pdf

[26] San Francisco Office of the Mayor. "News & Releases: First Hybrid SUV Taxis in United States take to the Streets of San Francisco." *City and County of San Francisco Office of the Mayor.* Feb. 22, 2005. Retrieved on March 20, 2005 from http://www.sfgov.org/site/mayor_page.asp?id=30039

[27] Representative of the San Francisco Department of the Environment, Clean Air Program. Telephone Interview. March 29, 2005.

[28] San Francisco Office of the Mayor. "News & Releases: First Hybrid SUV Taxis in United States take to the Streets of San Francisco." *City and County of San Francisco Office of the Mayor.* Feb. 22, 2005. Retrieved on March 20, 2005 from http://www.sfgov.org/site/mayor_page.asp?id=30039

[29] San Francisco, Department of the Environment. "Transportation and Clean Air: Private Fleets – CNG Taxis" Retrieved on March 29, 2005 from http://temp.sfgov.org/sfenvironment/aboutus/air/private.htm

requirements for high occupancy vehicle lane access.[30] Additionally, however, Ford ceased to manufacture a compressed natural gas Crown Victoria model after the 2004 model year. While BAF Technologies offer vehicle conversions, this change in manufacturing may present a difficulty for the Compressed Natural Gas Taxi Program in San Francisco.[31]

Lessons Learned

The introduction of Ford Escape Hybrids is not the result of direct legislative action or initiative the San Francisco government. Rather, the taxis were independently purchased by taxicab companies from S&C Ford in San Francisco. This type of initiative is unlikely to occur in New York City without some government intervention because the vehicle specifications are set by the Taxi and Limousine Commission.[32]

If New York City chooses to implement a pilot program or mandates the conversion of taxis to alternative fuel vehicles, funding for the program is going to be an important consideration. Because hybrid technology can be more expensive, taxi fleet owners and individual cab owners will want assistance, and are more likely to support a program if some funding options are included. U.S. Department of Energy Clean Cities Program seems to be a significant player in promoting the conversion to alternative fuels and could also be integrated into a New York City program. Clean Cities and other such programs are examples of possible grant suppliers for New York City. State or federal grants might help New York City provide assistance to taxi drivers without a substantial financial burden.

In addition to direct funding, both the San Francisco Taxicab Commission and the San Francisco Department of the Environment indicated that they were exploring incentives that could be used to increase the percentage of alternative fuel taxis. Incentives they mentioned include short-line privileges at airports, high occupancy vehicle lane access, reduced fees for emissions testing and increased vehicle turnover times for alternative fuel vehicles. If any program is to succeed in New York City, it will also require incentives, especially because in New York City has many individuals taxicab owners. These owners need to see a direct benefit in order to be motivated to purchase a more expensive vehicle. The San Francisco Department of the Environment's Compressed Natural Gas Taxi Program uses short-line privileges at the airport. In considering a similar program in New York City, one option would be short-line privileges at Penn Station, or at other pick up locations within the city.

Lastly, in San Francisco, the Healthy Air and Smog Prevention Ordinance guides the purchasing of city fleets. Adopting a similar guideline in New York City would provide a long-term vision for improving the city's air quality through fleet conversion. This would also create an expert body within the New York City government who could help determine appropriate objectives for taxi fleets.

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[30] Representative of the San Francisco Department of the Environment, Clean Air Program. Telephone Interview. March 29, 2005.

[31] BAF Technologies. "BAF Technologies to continue conversions on Ford Products." *BAF Technologies: Press Releases*. February 5, 2004. Retrieved on March 29, 2005 from http://www.baftechnologies.com/news_02-05-04.htm

[32] New York City Taxi and Limousine Commission. "Taxicab Specifications." Retrieved on Mar. 24, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/specrules.pdf. p.8.

Appendix D: Emissions Cap and Trade

Baseline Emissions

The baseline emissions level is established by selecting a year and calculating the average emissions for the entire TLC yellow cab fleet for a target pollutant (e.g. CO_2, CO, NOx, CH_4, or VOC's in pounds per year). One calculation method is to multiply a pollution index, which varies by vehicle type and technology, by miles driven annually. The total emissions level is then divided equally among the cars in the TLC yellow cab fleet.

$$Baseline = \frac{\sum Pollutant\ Index * miles\ driven\ annually}{Total\ vehicles}$$

Each yellow cab operator under TLC regulation must meet future emissions reduction requirements based on these established baseline levels and vehicle miles driven per year. That is, double shift vehicles should have greater allowable emissions than single shift vehicles due to the difference in miles driven.

Tradable Emission Credits

Original emissions credit certificates are issued to existing vehicles that are below the baseline levels. These may be traded immediately upon receipt. If a vehicle in unable to make the required reductions, they may purchase credits from vehicle owners that are below the baseline level. The TLC will need to set a feasible market price for allowances of each pollutant, and will allow the market to set future prices.

Recommendation #2: *Option 2: Reductions at Retirement*

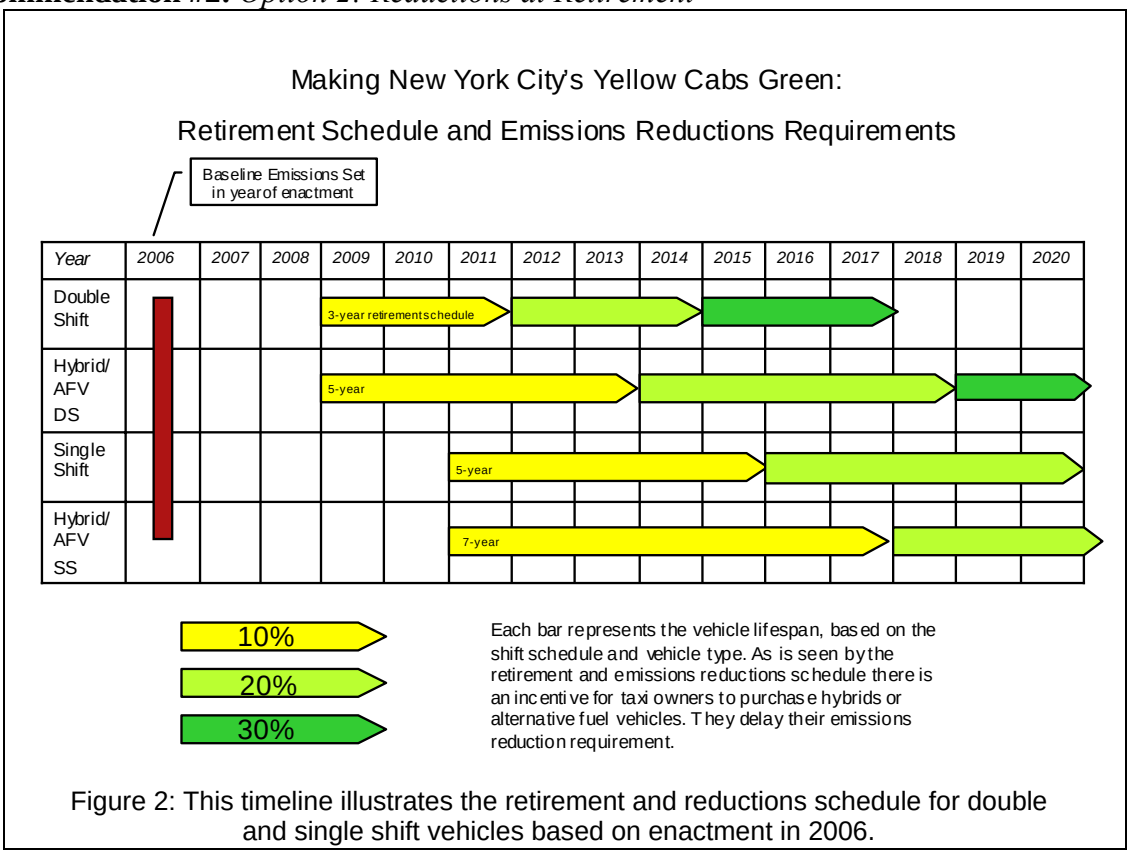
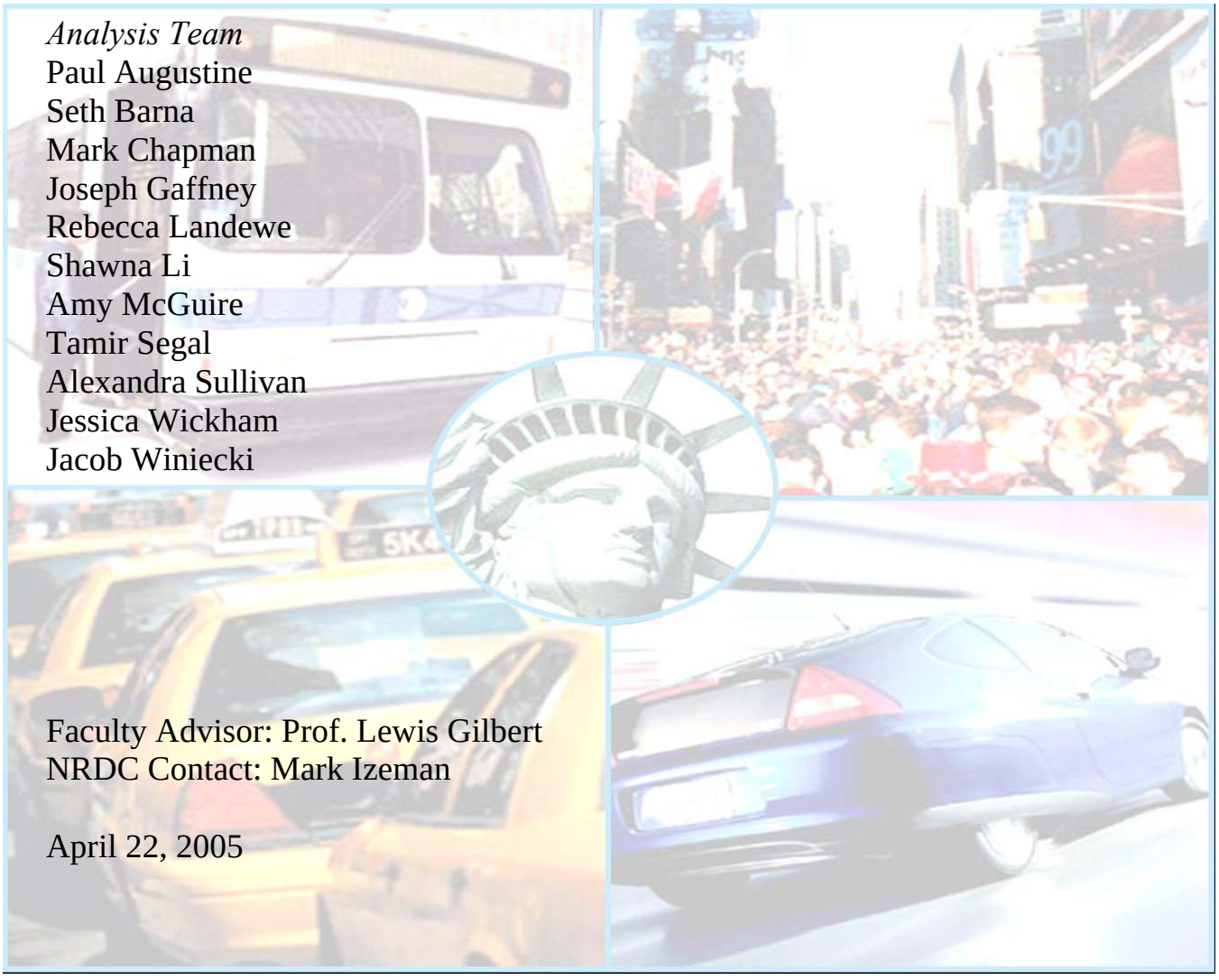


Figure 2: This timeline illustrates the retirement and reductions schedule for double and single shift vehicles based on enactment in 2006.

TRANSPORTING NEW YORK CITY
TO A
SUSTAINABLE FUTURE:
Research Report

Prepared for Natural Resources Defense Council
By Columbia University – SIPA Spring Workshop



Analysis Team
Paul Augustine
Seth Barna
Mark Chapman
Joseph Gaffney
Rebecca Landewe
Shawna Li
Amy McGuire
Tamir Segal
Alexandra Sullivan
Jessica Wickham
Jacob Winiecki

Faculty Advisor: Prof. Lewis Gilbert
NRDC Contact: Mark Izeman

April 22, 2005

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Introduction

Cities are becoming increasingly important for global sustainability as the human population continues to grow. Concerns about meeting the resource demands of the future and improving the quality of life in urban centers have become increasingly salient, pushing policymakers to look for ways to create sustainable centers of modern life.

Despite the extensive use of public transportation, vehicle emissions in New York City continue to be a significant source of pollution, causing damage to the public health and the environment. Recently the President of the American Lung Association of the City of New York stated that "high levels of ozone and particle pollution caused by the cars, buses and trucks that clog our streets make the mere act of breathing dangerous for the residents of New York City."[33] Clearly, the city must be more sensitive to concerns about pollution and its effects on human health, and continue to seek solutions to improve the health and quality of life of residents to remain a leader in addressing urban air pollution.

The Natural Resources Defense Council (NRDC) has been instrumental in moving New York City's policies toward a more sustainable model of modern urban life. Successes in improving the bus fleet and its operation had significant impacts on the air quality. In an effort to make additional strides, NRDC requested the Analysis Team to examine the passenger vehicle sector of urban transport and to develop policy recommendations that will lead to a reduction in air pollution and improve the quality of life in the city.

To develop practical policy recommendations that are feasible for New York City, the team pursued several avenues of research. This document contains summary reports in five primary research areas: New York City Environmental and Public Health, New York City Transportation, Alternative Fuel Technology, Alternative Fuel and Hybrid Market, and Legislation. Additionally, domestic and international case studies are presented as examples of policy measures taken by other cities. This report provides NRDC with the tools necessary to develop a campaign based on pragmatic vehicle policies that influence individual transport habits in the New York City metropolitan region.

The research summarized in this report served as the basis for developing a set of specific policy recommendations. At the request of NRDC the Analysis Team focused on improving the New York City yellow cab fleet by developing scalable programs[34] to reduce harmful emissions, lessen the effects of global climate change, and promote a clean and healthy future.

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[33] American Lung Association of the City of New York, *Lung Association Applauds City Council Leadership on Introduction of Comprehensive Emissions Control Legislation*. Aug 12, 2004. <www.alany.org/news_08124.html>

[34] Accompanying this research document is a set of specific policy recommendations aimed at reducing air pollution related to the taxicab industry, which were developed based on effective science and policy analysis. Please see: Augustine, P. et al. *Transporting New York York City to a Sustainable Future: Clean Air Taxi Bill of 2005.* Columbia Univeristy: New York. April 2005.

1. NEW YORK CITY ENVIRONMENT AND PUBLIC HEALTH

This section outlines the current state of the air in the New York City metropolitan area, explores the various sources of local air pollution, and investigates the strong links between motor vehicle emissions and urgent environmental and public health concerns. This section examines how restricting vehicle use in major urban centers affects public health and air quality through an extraordinary case study, the 1996 Olympics in Atlanta. Finally, these current pollution and environmental health trends are combined with climate change predictions to draw a picture of future life in the region.

1.1 Introducing Air Pollution

Government and industry efforts of the last 35 years have significantly improved overall air quality within the United States and restricted many sources of harmful air pollution. However, most major metropolitan areas are still struggling with public health concerns related to transportation and air quality. Over 100 million Americans, including 35 million children, are breathing air that fails to meet the air quality standards established by the United States Environmental Protection Agency (U.S. EPA) to protect public health.[35] In 2001, the American Lung Association found that over half of pediatric asthma cases occur in areas in nonattainment of the U.S. EPA's air quality standards and that urban populations are disproportionately impacted.[36] A report in the journal *Science* estimates that on a global level, more people are being killed by pollution from cars, trucks and other vehicles than by traffic crashes.[37] These issues are not restricted to the Western world, given the increased vehicle ownership and use in much of the developing world. In 2002, the World Health Organization estimated that air pollution will cause approximately 8 million deaths worldwide by 2020.[38]

1.1.a Vehicle Emissions

There are over 200 million motor vehicles registered in the United States. Emissions from these vehicles are the largest source of air quality and climate change concerns in the U.S. as they account for 40 percent of hydrocarbons (HC), 49 percent of nitrogen oxides (NO_x), 77 percent of carbon monoxide (CO) emissions, 60 percent of carbon dioxide (CO_2) emissions, and 24 percent of particulate matter (PM).[39] On average, motor vehicles in the U.S. produce more than 369 million pounds of carbon monoxide, 24 million pounds of nitrogen oxides, more than 1 million pounds of particulate matter, more than 47 million pounds of hydrocarbons, and 7.5 billion pounds of carbon dioxide (CO_2) per year.[40] The average

[35] U.S. Environmental Protection Agency. "AirTRENDS: The Particle Pollution Report: Current Understanding of Air Quality and Emissions." 2003.
[36] American Lung Association. "State of the Air: 2004 Report" Retrieved from www.lungusa.org.
[37] Davis, D.L. "Hidden Health Benefits of Greenhouse Gas Mitigation" *Science*. Aug 2001.
[38] World Health Organization. "The World Health Report 2002" Retrieved April 15, 2005 from http://www.who.int/whr/previous/en/.
[39] U.S. Environmental Protection Agency. *National Air Quality and Emissions Trends Report*. Dec 1998.
[40] U.S. Environmental Protection Agency. "EPA Designates Areas Not Meeting New Fine Particle Air Pollution Standard in New York State." *Region 2 News and Speeches, Press Release #04187* Retrieved on April 15, 2005 from http://www.epa.gov/region02/news/2004/04187.htm

vehicle driven within the United States produces more than a pound of CO_2 per mile.[41] In many ways, the progress made in reducing individual vehicle emissions has been offset by a near doubling of the average miles driven and number of cars on the road over the last 30 years.

Air pollution from automobiles is a result of the combustion of fuel in the vehicle's engine and additionally results from the evaporation of the fuel while idling or refueling. Vehicle emissions including HC, NO_x, CO, CO_2, PM, and other toxic contaminants, are categorized as either exhaust emissions or evaporative emissions with federally acceptable levels for each dependent on vehicle model, year, weight, mileage, and fuel type.

- **Hydrocarbons (HC):** When fuel molecules in a vehicle's engine do not burn, or only partially burn, the engine releases hydrocarbon emissions. Hydrocarbon emissions can react with sunlight and nitrogen oxides to form ground-level ozone, a major component of smog.
- **Nitrogen Oxides (NO_x):** The high temperature and pressure conditions within an engine cause nitrogen and oxygen in the air to react forming nitrogen oxides, which also contribute to ground-level ozone and acid rain.
- **Carbon Monoxide (CO):** When carbon in fuel is not fully oxidized to carbon dioxide during combustion CO is formed and emitted directly from a vehicle's tailpipe. Carbon monoxide is an odorless and colorless poisonous gas, which interferes with oxygen transport by forming carboxyhemoglobin. Vehicles produced today emit 90 percent less CO than their 1970s predecessors, steadily reducing the total CO emissions nationwide. However, with the increased number of vehicles on the roads and number of miles driven, CO levels may begin to climb again. The main source of carbon monoxide pollution in the United States is vehicle emissions. U.S. EPA studies have shown that up to 95 percent of carbon monoxide emissions in major cities come from mobile sources. [42]
- **Carbon Dioxide (CO_2)**: CO_2 is a normal byproduct of combustion and only in recent years has been seen as a pollution concern. CO_2 does not directly affect human health, but is a "greenhouse gas," one that contributes to trapping the earth's heat, and is a major source of global warming concerns. The transportation sector is responsible for approximately 60 percent of the total CO_2 emissions nationally. [43]
- **Particulate Matter (PM):** PM consists of small, discrete solid or aerosol particles, some of which are toxic or may have toxic substances adhered to their surfaces. Particulate matter ranges in size from large particles, such as visible smoke and dust, to fine particles only 2.5 microns in diameter, commonly referred to as $PM_{2.5}$. These particles have been shown to cause an estimated 12,000 premature deaths, aggravate asthma, and contribute to cardiovascular problems. In children, particulate pollution affects lung function and lung growth. Particle pollution also contributes to excess mortality and hospitalization for cardiac and respiratory tract disease.

[41] Enst, Michelle et al. "Clearing the Air, Public Health Threats from Cars and Heavy Duty Vehicles – Why We Need to Protect Federal Clean Air Laws." *Surface Transportation Policy Project* 2004.
[42] U.S. Environmental Protection Agency. *National Air Quality and Emissions Trends Report.* Dec 1998.
[43] Enst, Michelle et al. "Clearing the Air, Public Health Threats from Cars and Heavy Duty Vehicles – Why We Need to Protect Federal Clean Air Laws." *Surface Transportation Policy Project* 2004.

- **Toxic Contaminants**: Gasoline and diesel fuels also contain and release chemicals, which are listed by the U.S. EPA as toxic contaminants and carcinogens, such as benzene and butadiene. Motor vehicles are the largest source of the toxic air pollutants benzene, formaldehyde, and butadiene which are known to cause blood disorders, birth defects, immune system impairment, and lung tissue irritation.

1.1.b Ground Level Ozone

Of particular concern to major urban centers is ground-level ozone, a noxious pollutant and the major component of smog. Ozone is a molecular form of oxygen that consists of three atoms linked together. Ozone occurs naturally in the upper atmosphere, commonly referred to as the "ozone layer", and protects life by filtering ultraviolet radiation from the sun. In contrast, "ground-level" ozone can irritate the respiratory system, aggravate existing asthma, reduce lung function, and damage the lining of the lung. In healthy adults, ozone causes airway inflammation, airway hyper-reactivity, and decrements in pulmonary function. People living in major metropolitan areas have to worry about ozone exposure when ground-level concentrations are high, which happens frequently during the summer months. Existing respiratory ailments are exacerbated by increases in ambient ozone, which have been associated with respiratory hospitalizations, emergency visits for asthma, and school absences for respiratory tract infection. The U.S. EPA's Air Quality Index (AQI) now reports the concentrations of ground-level ozone and levels of other common air pollutants in an area making it easier for the public to understand the health significance of certain pollution levels.

1.2 New York Environment and Health Profile

In a 2004 press conference, the President of the American Lung Association of the City of New York stated that "high levels of ozone and particle pollution caused by the cars, buses and trucks that clog our streets make the mere act of breathing dangerous for the residents of New York City."[44] This and similar statements about New York's air quality are particularly alarming given the high proportion of residents using public transportation (over 60 percent), the relatively low rate of automobiles per household (one in every two), and the fact that New York City has the nation's highest percentage of residents living without a single vehicle (just over 50 percent).[45]

1.2.a Air Pollution in New York City

The combination of geophysical characteristics, population density, vehicle use and transportation patterns of New York City's five boroughs results in air pollution concentrations that are, at times, among the nation's most unhealthy. In 1999, motor vehicles released 1,265,905 tons of pollutants into the air of New York City. Additionally, transportation sources are responsible for approximately 54 percent of all air pollution in the

[44] American Lung Association of the City of New York. "Lung Association Applauds City Council Leadership on Introduction of Comprehensive Emissions Control Legislation." Aug 12, 2004. Retrieved April 15, 2005 from www.alany.org/news_08124.html.

[45] Bernstein, R. "Housing in Metropolitan Areas - Motor Vehicles Available." *Bureau of the Census Statistical Brief*. U.S. Department of Commerce Economics and Statistics Administration. Aug 1995.

New York City metropolitan region, compared to 57 percent in Los Angeles. As of 2003, the five boroughs of New York City are designated as areas not attaining the U.S. EPA's health-based air standards for fine particle pollution ($PM_{2.5}$), also known as soot.[46]

1.2.b Public Health Concerns

According to a 2004 report by Environmental Defense ranking the major population centers where air affects the largest number of children, New York City ranked 3rd among the "50 Worst Cities" behind Los Angeles and Riverside-San Bernadino, California.[47] New York City had 69 days of "unhealthy" air quality between 2000 and 2002 according to the U.S. EPA's Air Quality Index measurements and unhealthy air days have increased 19 percent over the past 10 years. Children, infants, and the elderly are especially susceptible to the adverse effects of air pollution in the metropolitan region. Asthma is the leading cause for emergency room evaluations, pediatric hospitalizations, and school absenteeism in New York City.[48] Exposure to outdoor air pollutants are major risk factors for developing and exacerbating respiratory diseases including asthma.

The respiratory health impacts alone are significant:

- Of the current New York City population, more than **one million residents** – including 300,000 children – have been diagnosed with asthma in their lifetime[49]
- New York City has the **highest asthma mortality rate** and some of the highest rates of asthma morbidity in the country[50]
- **17 percent of children** have experienced asthma-like symptoms in their lives[51]
- In 2000, children in New York City were almost **twice as likely** to be hospitalized for asthma as children in the United States as a whole[52]
- New York City's asthma hospitalization rate in 2000 was 3.36 per 1000 costing a total of **$242 million**[53]
- In 2000, there were **9,891 asthma hospitalizations** among children 0-14 years of age[54]

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[46] U.S. Environmental Protection Agency. "EPA Designates Areas Not Meeting New Fine Particle Air Pollution Standard in New York State." *Region 2 News and Speeches, Press Release #04187* Retrieved April 15, 2005 from http://www.epa.gov/region02/news/2004/04187.htm.

[47] Balbus J. and Y. Chee. "Dangerous Days of Summer." *Environmental Defense* 2004.

[48] While most research focuses on the influence of the indoor environment on asthma, this study examines the neighborhood effects on childhood asthma, such as housing and ambient environmental hazards.
Corburn, J., Osleeb, and M. Porter. "Urban asthma and the neighborhood environment in New York City" *Health & Place, In Press, Corrected Proof.* Jan 21, 2005.

[49] American Lung Association of the City of New York. "Lung Association Applauds City Council Leadership on Introduction of Comprehensive Emissions Control Legislation." Aug 12, 2004. Retrieved April 15, 2005 from www.alany.org/news_08124.html.

[50] New York City Department of Health and Mental Hygiene. "Asthma Facts Second Edition." New *York City Childhood Asthma Initiative*. May 2003.

[51] Corburn, J., Osleeb, and M. Porter. "Urban asthma and the neighborhood environment in New York City" *Health & Place, In Press, Corrected Proof.* Jan 21, 2005.

[52] Corburn, J., Osleeb, and M. Porter. "Urban asthma and the neighborhood environment in New York City" *Health & Place, In Press, Corrected Proof.* Jan 21, 2005.

[53] Corburn, J., Osleeb, and M. Porter. "Urban asthma and the neighborhood environment in New York City" *Health & Place, In Press, Corrected Proof.* Jan 21, 2005.

The negative health impacts of air pollution are not confined to respiratory ailments. A study on the effects of combustion-related air pollutants in New York City, funded by the National Institutes of Health and the U.S. EPA, reveals that babies in the womb are more susceptible than their mothers to DNA damage, despite the protection provided by the placenta.[55] Particulate matter pollution is strongly associated with respiratory hospitalizations, cardiovascular mortality, and lung cancer. The American Heart Association found that exposure to air pollution, specifically particulate matter, contributes to the development of cardiovascular diseases, such as heart disease, and reduces overall life expectancy by several years.[56] A California study found that children in communities with higher levels of urban air pollution, acid vapor, nitrogen dioxide, $PM_{2.5}$, and elemental carbon, had decreased lung function growth, and children who spent more time outdoors under these conditions had larger deficits in the growth rate of lung function.[57]

1.2.c Disproportionately Affected Areas

New York's poor and minority neighborhoods tend to be air pollution "hotspots" often due to their location near major bus depots, highways, and major urban roads. Of the eight major diesel bus depots in Manhattan, six are located above 96th street, with higher levels of pollution measured in these areas than in other parts of the city. This area, referred to as Northern Manhattan, has 626,968 residents who are mostly African American and Hispanic of low to mid-income. [58] Like most major urban areas of the country, New York City African-American and Hispanic communities have disproportionately high rates of asthma. According to a 1994 study, the average citywide annual hospital admission rates for Hispanics, blacks and whites were 1,003; 810; and 242 per 100,000 admissions, respectively.[59]

The National Academy of Sciences reported that students in Los Angeles living in "high-pollution areas" had twice the asthma rates as their counterparts living in neighborhoods with better air quality. Asthma hospitalization rates for children in New York City's poor, minority communities are up to 21 times higher than those in other more affluent areas.[60] Children living in poor New York City neighborhoods are also three times more likely to be

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[54] Corburn, J., Osleeb, and M. Porter. "Urban asthma and the neighborhood environment in New York City" *Health & Place, In Press, Corrected Proof.* Jan 21, 2005.

[55] Bernet et al. "Biomarkers in Maternal and Newborn Blood Indicate Heightened Fetal Susceptibility to Procarcinogenic DNA Damage." *Environmental Health Prospectives*, June 2004.

[56] Franklin et al. "Air Pollution is Serious Cardiovascular Risk." *American Heart Association Journal*, June 1, 2004.

[57] W.J. Gauderman, et al. "Association between air pollution and lung function growth in southern California children." *American Journal of Critical Respiratory Medicine*. 2000:1383 –1390.

[58] Bernstein, R. "Housing in Metropolitan Areas - Motor Vehicles Available." *Bureau of the Census Statistical Brief*. U.S. Department of Commerce Economics and Statistics Administration. Aug 1995.

[59] Restrepo, C. et al. "A comparison of ground-level air quality data with New York State Department of Environmental Conservation monitoring stations data in South Bronx, New York." *Atmospheric Environment*, Vol. 38, Issue 31. Oct 2004.

[60] Canon, J. and C. Sun. "Bus Futures: New Technologies for Cleaner Cities" *Inform Inc*. 2000. Retrieved April 15, 2005 from www.informinc.org.

hospitalized for asthma than those living in wealthy neighborhoods.[61] In these poorer areas of the city, local air pollution is a serious threat to the children's health and development.

1.3 Costs of Externalities

Traffic congestion and pollution can lead to many problems in the urban environment including noise and loss of time in traffic, estimated at $40 billion cost per year in the United States,[62] and increased levels of air pollution that affect the environment and quality of life. These externalities can lead to significant costs borne by society. As mentioned in Section 1.1.a, vehicle emissions account for significant portions of greenhouse gas emissions[63] and are a primary source of particulate matter, which can impact public health and thus productivity.[64] A World Health Organization report used the willingness-to-pay method of evaluation to estimate the costs of air pollution in Austria, France, and Switzerland. Collectively, these countries have an estimated 26 billion EUR (over $36 billion U.S.) in health costs associated with traffic pollution. There are over 30 million days of lost productivity due to poor air quality.[65]

Many experts recommend internalizing the costs associated with vehicle emissions so that they are paid for by the polluter, the motorist. However, complications arise when trying to quantify these effects. A 2000 New York City Department of Health report indicates that asthma costs totaled more that $240 million even though New York City's rate of hospitalization for asthma has decreased.[66] The ability to quantify the health impacts in monetary terms can indicate the potential savings to society if pollution levels were to be reduced.

1.4 1996 Summer Olympics – Atlanta, Georgia

Several years ago researchers took advantage of a natural experiment to observe the impact of decreased traffic levels and improved air quality on pediatric asthma. During the 1996 Summer Olympics Games, the Atlanta city government implemented alternative transportation strategies designed to severely restrict downtown traffic congestion and vehicle use during peak ozone hours. Researchers found that throughout the 17 days of the Olympic Games, peak morning traffic decreased 23 percent and peak ozone levels decreased 28 percent and emergency visits for asthma events in children decreased 42 percent. During the same period, children's emergency

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[61] Corburn, J., Osleeb, and M. Porter. "Urban asthma and the neighborhood environment in New York City" *Health & Place, In Press, Corrected Proof.* Jan 21, 2005.

[62] Transportation Research Board. "Curbing Gridlock: Peak-Period Fees to Relieve Traffic Congestion." *National Research Council.* 1994.

[63] Goldstein, B.D., B. Fischhoff, S. Marcus, and C. Coussens. "Ensuring Environmental Health in Postindustrial Cities: Workshop Summary." *Institute of Medicine, National Academy of Science.* 2003.

[64] Kunzli et al. "Public-health impact of outdoor and traffic-related air pollution: a European assessment." *The Lancet.* September 2000.

[65] Seethaler. R. "Health Costs due to Road Traffic-related Air Pollution: An Impact Assessment Project of Austria, France, and Switzerland." *Bureau of Transportation Studies, Federal Department of Environment, Transport, Energy and Communications.* 1999.

[66] Garg, R., A. Karpati, J. Leighton, M. Perrin, and M. Shah. "Asthma Facts, Second Edition." *New York City Department of Health and Mental Hygiene*. May 2003. Retrieved Feb 12, 2005 from http://www.nyc.gov/html/doh/pdf/asthma/facts.pdf

visits for causes other than asthma did not change. These results suggest how efforts to improve air quality, such as increased use of public transportation, decreased vehicle use in densely populated urban centers, and carpooling can help improve the respiratory health of a community.[67]

1.5 Global Climate Change and New York City

Of the potential effects of climate change on the New York region, the predicted temperature increase is of particular concern. In a report released by the New York Climate and Health Project, scientists state that as temperatures rise by 2.4 to 10.4 degrees Fahrenheit by 2100, New York City will be "hit even harder because it has so few trees and so much heat-retaining concrete and asphalt."[68] The three-year study also estimates that heat-related deaths, around 840 a year in the 1990's, could more than double by 2050 and increase by 258 percent by 2080 if "accompanied by unchecked development". Extreme temperatures can cause not only direct loss of life but increase air pollution and in turn harm human health due to the so-called heat-island effect. Evaporative emissions can account for a large portion of hydrocarbon pollution on hot days when ozone levels are highest. Global climate change is predicted to increase the frequency of high-ozone level days per year.

In addition, the U.S. EPA predicts both Atlantic and Gulf coastal sea level will rise by one to two feet in the next century.[69] Due to lower Manhattan's sea-level elevation, it is extremely vulnerable to such flooding. A one to two foot peak in flooding would likely occur during the spring tides and during increased river flow from snow melt, which occurs annually beginning in the month of March. Without proper reform in terms of contributions to global warming, lower Manhattan (and much of the world by association) faces a legitimate crisis. Constructing systems of dykes, levies and pumps to prevent or "bail-out" this region are a possible, yet only short-term, option.

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[67] Friedman, et al. "Impact of changes in transportation and commuting behaviors during the 1996 Summer Olympic games in Atlanta on air quality and childhood asthma." *JAMA*. 2001.

Goldstein, B.D., B. Fischhoff, S. Marcus, and C. Coussens. "Ensuring Environmental Health in Postindustrial Cities: Workshop Summary." *Institute of Medicine, National Academy of Science.* 2003.

[68] Depalma, A. "Forecast for New York This Century: Hotter and Wetter." *The New York Times*. June 27, 2004.

[69] Titus, J.G. & Richman, C. "Maps of Lands Vulnerable to Sea Level Rise". *U.S. Environmental Protection Agency* 2000.

2. NEW YORK CITY COMMUTING AND TRANSPORTATION

This section is designed to explore the existing traffic structure within New York City. A basic understanding of traffic flow is required to identify sources of congestion within the city and areas of stress on the public transportation system. Clarification of the existing problems is a prerequisite to finding a viable solution. Additionally, this section explores in great detail the structure of the New York City Taxi and Limousine Commission. Yellow cabs in New York City represent a potential opportunity for increasing hybrid vehicle use because of the large number of vehicles and the rapid turnover rate. However, the introduction of any new taxi program or legislation must be crafted to work in harmony with the structures set forth by the Taxi and Limousine Commission.

2.1 NYC Commuter and Resident Transportation

This section provides a summary of basic information regarding personal vehicle use and public transportation prevalence in New York City. Specifically, this section identifies some of the major causes of congestion. Despite incentives to reduce congestion and encourage the use of public transportation, there remain congestion problems and infrastructural limitations to public transportation.

2.1.a Personal Transportation

According to the 2002 U.S. Census, American Community Survey, New York City has the longest average commute in the country, above both Los Angeles and Chicago.[70] Lengthy commutes are faced when using both public and private transportation. In fact, most residents of New York City do not actually use personal vehicles in their daily commute. In New York City approximately 47 percent of people use public transportation to travel to work; this is ten times the national average of 4.7 percent, as reported by the 2000 U.S. Census.[71] Out of those who commute from all five boroughs to Manhattan, only approximately 360,000 people use personal automobiles as their main form of transportation to work.[72] Even in the New York City neighborhoods with high automobile use, the

[70] Information regarding travel time to work is available annually in the U.S. Census Bureau's American Community Survey. According to the state-level data, New York State has the highest commute time when compared to other states. When the data are aggregated according to county, residents of Bronx County and Nassau County, New York have the highest commute time in the country. Finally, when the data are aggregated at a place level, New York City has the highest commute time. Specifically, the following link provides access to the table form of this data at a place level. Additionally, the data can be viewed graphically and previous years are available for comparison.
U.S. Census Bureau. *2002 American Community Survey*. Retrieved Feb. 2, 2005 from http://www.census.gov/acs/www/Products/Ranking/2002/R04T160.htm

[71] U.S. Census Bureau, Census 2000 Summary File 3, Matrices P26, P30, P31, P33, P43, P45, and P46. Retrieved Feb. 2, 2005 from http://factfinder.census.gov/servlet/GCTTable?_bm=n&_lang=en&mt_name=DEC_2000_SF3_U_GCTP12_US10&format=US-10&_box_head_nbr=GCT-P12&ds_name=DEC_2000_SF3_U&geo_id=01000US

[72] This report presents an analysis of the 2000 census data. Specifically, it notes changes in traffic patterns (both commuters and non-commuters), including the types of transportation used for work and non-work related travel. The report also summarizes car ownership and commuting time patterns.

proportion of workers that drive into Manhattan is less than 15 percent. [73] Overall, the per capita energy consumption for transportation in New York State is one-third less than the national average.[74] These statistics are promising, and make New York City an example to other urban communities.

2.1.b Current Traffic Flow

Although many New Yorkers do not use automobiles to get to work, congestion aggravated by personal vehicles in New York City is a serious concern due to the high volume of traffic that enters the city limits every day. In an effort to better understand the traffic pattern in New York City, the New York City Department of Transportation publishes a "New York City Screenline Traffic Flow Report" annually. This report compiles the volume of cars recorded entering and leaving the city boundaries at 47 roadway locations. According to this survey, over 2.3 million cars crossed the city border each day in 2003; this represents a 1.5 percent increase from the previous year. During 2003, the total number of vehicle "entries and departures exceeded 100,000 vehicles per hour continuously from 6 am until 9 pm." According to the Screenline Traffic Flow Report, the greatest percentage of automobile traffic was recorded at the Queens-Nassau monitoring locations, which accounted for 41.9 percent of total traffic.[75]

In addition, New York City Department of Transportation compiles an annual report of Bridge Traffic Volumes. According to the 2003 report, in the ten years between 1993 and 2003, the average annual growth rate of total bridge traffic was 1.6 percent per year. This exceeds the average annual growth rate observed in the previous decade, which was 0.7 percent.[76] To better understand the time profile of New York City traffic patterns, the Department of Transportation reported that traffic peak hours of entering and leaving New York City are between 7 and 8 am and between 5 and 6 pm. When peak traffic volumes are analyzed by borough, the number of vehicles crossing the Queens-Nassau and Staten Island-New Jersey borders is fairly equal in both directions during morning and evening rush hours. In contrast, Manhattan sees a much greater influx from New Jersey in the morning and a

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Schaller Consulting. Commuting, Non-Work Travel and the Changing City: An Analysis of Census 2000 Commuting Results for New York City. New York, NY: Schaller Consulting, Jun. 2002.

[73] Schaller Consulting. Commuting, Non-Work Travel and the Changing City: An Analysis of Census 2000 Commuting Results for New York City. New York, NY: Schaller Consulting, Jun. 2002.

[74] Passenger Transport Division, New York State Department of Transportation. *2003 Annual Report on Public Transportation Assistance Programs in New York State.* Albany, NY: New York Department of Transportation, 2004.

[75] This report contains a summary of traffic patterns into NYC from New Jersey, Westchester, and Nassau, in addition to traffic flow among the burrows. Total traffic across the screenlines is summarized on an average hourly basis for 2003, and compared to history trends.

New York City Department of Transportation. *New York City Screenline Traffic Flow 2003*. New York City, Oct. 2004.

[76] This document summarizes volume of traffic flow across New York City bridges for 2003. It includes vehicle classification (commuter/commercial, cars, buses, etc) as well as historic trends dating back for 50 years. Trends and volumes are included for both NYC Department of Transportation and NY/NJ Port Authority Bridges.

New York City Department of Transportation. *New York City Bridge Traffic Volumes 2003*. New York City: New York DOT, Aug. 2004.

much larger number of exiting vehicles in the evening.[77] Of the over 1.8 million vehicles that cross the New York City Department of Transportation bridges between 7 am and 7 pm each day, nearly 88 percent are commuter vehicles (cars, buses, and vans). Of these commuter vehicles, 94.9 percent are automobiles.[78] The high and continually increasing volume of traffic entering New York City daily from all directions is a major source of congestion and potential concern for the public health of New York City residents.

2.1.c Commuter Incentives and Capacity Issues

There are already some incentives in place in New York City to address traffic congestion. The E-ZPass system was designed as an economic incentive to alter commuter behavior. Drivers pay lower toll rates and increased use of the E-ZPass reduces waiting at tolls and relieves congestion. An automobile with an E-ZPass has a rate reduction of $1 during peak commuting hours and a savings of $2 during off-peak hours on the Port Authority bridges and tunnels. Higher E-ZPass fare during peak hours could also reduce congestion by encouraging drivers to seek other methods of transport for their commute or join a car pool. E-ZPass has a special car pool discount, charging only $1 for cars with three or more people at all hours of the day. [79]

Transit Center, Inc. is a nonprofit corporation that offers incentive programs to encourage public transportation. When a company joins their program, employees benefit by being able to deduct a portion of their travel expenses from their before-tax income, provided that they are using public transportation. This organization was founded in 1986, when it was an alliance including the Metropolitan Transportation Authority, New Jersey Transit, and the New York-New Jersey Port Authority. It became an independent nonprofit in 2001. Currently, "its customers number over 14,000 businesses with almost one-half million employees who benefit daily from TransitCheck services."[80]

Other cities facing increased congestion have explored mechanisms called variable, congestion, and value pricing. *Variable* pricing is a general term referring to prices that fluctuate or vary; for example, prices may vary according to time of day, entrance or location point onto a road, or vehicle type. *Congestion* pricing is a special type of variable pricing in which prices fluctuate based on demand: a fee is charged to enter a highly congested area. *Value* pricing is usually used when an additional payment results in a direct benefit to the driver. An example is the 91X lanes in Los Angeles where drivers pay a special toll to travel in faster-moving lanes. Variable, congestion, and value pricing are all strategies that have the potential to influence driver behaviors.[81]

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[77] New York City Department of Transportation. *New York City Screenline Traffic Flow 2003*. New York City, Oct. 2004.

[78] New York City Department of Transportation. *New York City Bridge Traffic Volumes 2003*. New York City: New York DOT, Aug. 2004.

[79] The Port Authority of New York and New Jersey. *Toll Rates – George Washington Bridge, Goethals Bridge, Lincoln Tunnel, Outerbridge Crossing, Holland Tunnel, Bayonne Bridge*. Effective Mar. 25, 2001. Retrieved Feb. 2, 2005 from http://www.panynj.gov/tbt/TOLL_RATES.pdf

[80] TransitCenter, Inc. Retrieved Feb. 2, 2005 from http://www.transitcenter.com

[81] de Cerreno, A.L.C. *Evaluation Study of the PANYNJ's Value Pricing Initiative: Task 5- Monitoring of Media and Decision Maker's Reactions.* New York: NYU Wagner Rudin Center for Transportation Policy & Management, Jan. 8, 2004.

To combat the problem of slow traffic flow, New York City instituted a congestion/value pricing parking initiative in Midtown. Prior to this initiative, commercial vehicles were loading and parking without charge. To reduce congestion, this program began charging, with costs that increase for longer parking times. The city makes the system user-friendly by issuing cards to commercial drivers. These "smart cards" serve as debit cards so drivers are not required to have cash. In general, businesses prefer this system because parking tickets were an unwanted expense they previously incurred; now, they can write-off the smart cards as a business expense. Through this congestion pricing scheme, the city has gained substantial revenue and has reduced the average parking time of commercial vehicles in Midtown from 4-6 hours to 90 minutes. This technology is also used in many off-street municipal lots.[82]

2.1.d Public Transportation Ridership

According to the 2000 U.S. Census, the proportion of New York City residents commuting by bus or subway declined between 1990 and 2000.[83] However, Schaller Consulting found in its review of the 2000 U.S. Census data that in the last decade there has been an increase in the amount of non-commuting or work-related travel on the subway and bus, resulting in a net increase in ridership.[84] Increased population and MetroCard incentives are two factors that have caused ridership on public transportation to increase. In 2001-2002, there were 16.6 million new passengers on the public transit systems in the New York City area.[85] Commuters account for over 89 percent of the central business district workforce in Manhattan, and are expected to rise significantly in the next 20 years.[86] The most substantial increase is ridership on Metropolitan Transportation Authority transit buses, which has almost doubled since 1996, while the population of subway riders has grown by 25 percent.[87]

Unfortunately, the 44 percent increase in ridership between 1992 and 2000 has resulted in aggravated crowding and congestion on subways and buses, which was probably caused by failure to update service.[88] Thus it seems that additional infrastructural investments must be pursued to increase the quality and quantity of existing service in order to accommodate the expanding customer base.

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[82] de Cerreno, A.L.C. *The Dynamics of On-Street Parking in Large Central Cities*. New York: NYU Wagner Rudin Center for Transportation Policy & Management, Dec. 2002

[83] Schaller Consulting. Commuting, Non-Work Travel and the Changing City: An Analysis of Census 2000 Commuting Results for New York City. New York, NY: Schaller Consulting, Jun. 2002.

[84] Schaller Consulting. Commuting, Non-Work Travel and the Changing City: An Analysis of Census 2000 Commuting Results for New York City. New York, NY: Schaller Consulting, Jun. 2002.

[85] Passenger Transport Division, New York State Department of Transportation. *2003 Annual Report on Public Transportation Assistance Programs in New York State.* Albany, NY: New York Department of Transportation, 2004.

[86] Scanlon, R. and E. Seeley. *At Capacity: The Need for More Rail Access to the Manhattan CBD*. New York: NYU Wagner Rudin Center for Transportation Policy & Management, Nov. 2004.

[87] New York City Department of City Planning. *2000/2001 report on social indicator, Chapter 7 – Housing and Infrastructure.* New York: NYC DCP. <http://www.nyc.gov/html/dcp/pdf/pub/soc007.pdf>

[88] Scanlon, R. and E. Seeley. *At Capacity: The Need for More Rail Access to the Manhattan CBD*. New York: NYU Wagner Rudin Center for Transportation Policy & Management, Nov. 2004.

2.1.e Proposals for System Improvements

The New York University Wagner Rudin Center for Transportation Policy and Management published research on the feasibility of using statewide Intelligent Transportation System to direct traffic flow better on a situational basis and to enhance interagency, interregional collaboration in transportation management.[89] Intelligent Transportation Systems are "well established technologies in communications, control, electronics and computer hardware and software to improve surface transportation system performance." [90] Scanlon and Seeley, researchers affiliated with the Center, proposed four projects to alleviate the current traffic overload in Manhattan; they include "East Side Access for the Long Island Railroad," "The Second Avenue Subway," a new "Trans-Hudson Rail Tunnel," and "Improved Rail Access to Lower Manhattan," with a total budget estimate of $30 billion. They also suggested an expansion of the express bus and commuter ferry networks as temporary traffic relief, or the implementation of a Transportation Demand Management strategy to lessen the burden during peak commuting hours. [91]

A study published by Schaller Consulting explores a strategy known as "Bus Rapid Transit," which has been successfully implemented worldwide. Bus Rapid Transit was proposed to improve the efficiency and convenience of urban transportation systems. Its features include exclusive bus lanes with easy access to commuters and a pre-boarding fare collection to reduce stopping times. The systems are characterized by high capacity vehicles with greater distances between stops. Several U.S. cities also participated in the federal Bus Rapid Transit consortium.[92]

2.2 New York City Taxi and Limousine Commission (TLC)

In addition to the modes of personal transportation investigated in Section 2.1, taxicabs represent a significant method of transportation within New York City. Using U.S. Census data, Schaller Consulting reported that that 238 million people rode in taxis in 2003, and that approximately 66 percent of Manhattan residents ride in taxicabs for trips during their commute or for recreational pursuits.[93] Because taxicabs are highly regulated by the Taxi and Limousine Commission, there is a potential to investigate yellow taxicabs as an area where a policy or partnership with the city may provide an opportunity to increase alternative fuel and hybrid vehicle use in the city. Specifically, this section provides a framework for understanding the Taxi and Limousine

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[89] Peyrebruen, H. et al. *The Context for Intelligent Transportation Systems in New York State*. New York: NYU Wagner Rudin Center for Transportation Policy & Management. Jul. 2002.

[90] Peyrebruen, H. et al. *The Context for Intelligent Transportation Systems in New York State*. New York: NYU Wagner Rudin Center for Transportation Policy & Management. Jul. 2002.

[91] Scanlon, R. and E. Seeley. *At Capacity: The Need for More Rail Access to the Manhattan CBD*. New York: NYU Wagner Rudin Center for Transportation Policy & Management, Nov. 2004.

[92] Schaller Consulting. *Bus Rapid Transit for New York City.* Brooklyn: Schaller Consulting. Jun. 2002. Retrieved Feb. 2, 2005 from http://www.schallerconsult.com/pub/BRT_for_NYC.pdf

[93] The article is a comprehensive report on the $1.4 billion yellow medallion taxicab industry in New York City. It takes three main approaches, passenger, drivers, and owners, to provide an overview of the role of taxicabs in the metropolitan city. The report includes valuable data on the ridership of taxicabs and purposes of trips taken by riders, as well as other statistics on the TLC operations in NYC.

Schaller Consulting. *The New York City Taxicab Fact Book.* Brooklyn: Schaller Consulting. Jun. 2004. Retrieved Feb. 2, 2005 from http://www.schallerconsult.com/taxi/taxifb.pdf

Commission and the potential opportunities and constraints that may be associated with the given system.

2.2.a Fleet History, Medallions, and Pricing

According to the 1937 Haas Act, New York City authorities capped the number of taxicabs at 13,595 in order to regulate the growing industry.[94] The number of taxicabs is strictly regulated through the sale of medallions, where the medallion represents the right to operate a taxicab. In fact, medallion sales have only been opened during two periods in New York City's history. The second of these occasions was in 2002, when 900 additional medallions were scheduled to be auctioned. Because of these sales, the total number of yellow medallion taxicabs rose from 12,187 to 12,741 as of December 31, 2004, and this figure is expected to reach 13,087 by 2005 once all new medallions sales are awarded.[95] The average price of medallion was around $320,000 as of December 2004.[96]

Prior to auctioning the new medallions, an Environmental Impact Statement was mandated to forecast any impacts on air quality, traffic conditions, and other important socioeconomic and environmental affects. Urbitran Associates, an environmental consulting firm, issued its opinion that the introduction of new medallions would create no significant adverse impact upon air quality. It stated that additional medallions would only affect traffic in the central business district at particular intersections.[97]

In addition to the issuance of new medallions, the Taxi and Limousine Commission has recently implemented a new fare structure for yellow taxicabs. The 2004 Annual report stated that the fare hike was long overdue because the previous fare rate was at a 35-year low and below the rate in any of the 14 U.S. cities with 1,400 or more metered taxicabs.[98] For example, a 2.8-mile trip in New York City would cost $6.85, compared to $10.85 in San Francisco, $10.08 in Boston, $9.19 in Los Angeles, and $7.77 in Chicago.[99] Prior to 2004, the Taxi and Limousine Commission had not increased the fares in eight years. Not only were fares in New York City low when compared to fares in other major metropolitan areas,

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[94] The annual report of the Taxi and Limousine Commission (TLC) presents new initiatives to improve its services to riders, and information on Clean-Air taxicabs, which is TLC's response to assist with the citywide clean air initiatives. Included in the initiatives are guidelines of enabling legislation and environmental review process. New York City Taxi & Limousine Commission. *2004 Annual Report to the New York City Council.* New York: NYC TLC. 2004. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/2004_annual_report.pdf

[95] New York City Taxi & Limousine Commission. *2004 Annual Report to the New York City Council.* New York: NYC TLC. 2004. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/2004_annual_report.pdf

[96] New York City Taxi & Limousine Commission. *2004 Annual Report to the New York City Council.* New York: NYC TLC. 2004. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/2004_annual_report.pdf

[97] New York City Taxi & Limousine Commission. *2004 Annual Report to the New York City Council.* New York: NYC TLC. 2004. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/2004_annual_report.pdf

[98] New York City Taxi & Limousine Commission. *2004 Annual Report to the New York City Council.* New York: NYC TLC. 2004. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/2004_annual_report.pdf

[99] Schaller Consulting. *The New York City Taxicab Fact Book.* Brooklyn: Schaller Consulting. Jun. 2004. Retrieved Feb. 2, 2005 from http://www.schallerconsult.com/taxi/taxifb.pdf

but they were also comparatively low in relation to other forms of transportation in the city. The relative fare of taxis decreased between 1951 and 1985 and has been consistently low over the last 20 years.[100]

Revenues generated by the fare are used to pay for fuel and other operational expenses. According to 2003 statistics, taxi revenues averaged $1.76 per operating mile. This generates approximately $248 for an average shift, which covers 141 miles; or, approximately $114,600 per taxicab annually.[101] Figure 2.1 presents the breakdown of each dollar of revenue generated by fares, surcharge and an estimated 15 percent tip.[102] Given that 25 percent of every dollar earned goes to "vehicle and gas" there is an opportunity to increase a taxicab's net profit by switching to an alternative fuel vehicle or a hybrid vehicle, thus reducing fuel costs.

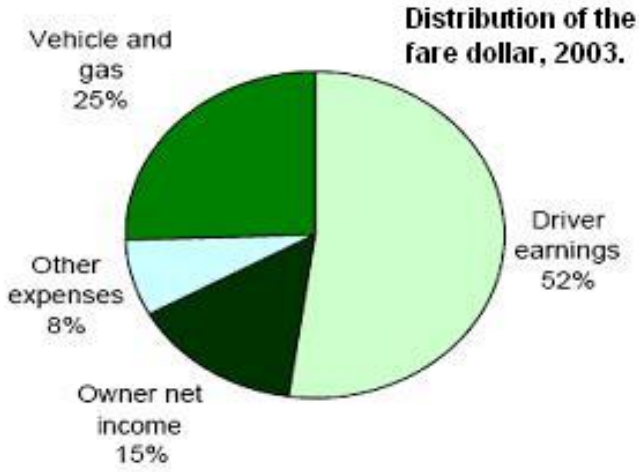

Figure 2.1: Division of taxi fare, presented by Schaller Consulting in the New York City Taxicab Fact Book as Figure 20.

2.2.b Ownership

It is important to explore the ownership structure with the Taxi and Limousine Commission in greater detail to be able to asses how new policies might be implemented. The ownership and operation of taxicab vehicles can be divided into three categories, each of which is discussed in detail in Schaller Consulting's New York City Taxicab Fact Book.[103] The first category is termed an owner-driver, a driver who owns his or her own medallion and drives his or her own taxicab. Owner-drivers account for approximately 29 percent of taxicab medallions. Frequently, these owner-drivers will lease their taxicab to another driver for a second shift, but they are required to operate the vehicle themselves for at least 210 shifts per year.

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[100] Schaller Consulting. *The New York City Taxicab Fact Book.* Brooklyn: Schaller Consulting. Jun. 2004. Retrieved Feb. 2, 2005 from http://www.schallerconsult.com/taxi/taxifb.pdf

[101] Schaller Consulting. *The New York City Taxicab Fact Book.* Brooklyn: Schaller Consulting. Jun. 2004. Retrieved Feb. 2, 2005 from http://www.schallerconsult.com/taxi/taxifb.pdf

[102] Schaller Consulting. *The New York City Taxicab Fact Book.* Brooklyn: Schaller Consulting. Jun. 2004. Retrieved Feb. 2, 2005 from http://www.schallerconsult.com/taxi/taxifb.pdf

[103] Schaller Consulting. *The New York City Taxicab Fact Book.* Brooklyn: Schaller Consulting. Jun. 2004. Retrieved Feb. 2, 2005 from http://www.schallerconsult.com/taxi/taxifb.pdf

The second category of vehicle operation is long-term leasing. In this situation a central leasing agent purchases the medallion and leases the taxicab to an operator for a period of months during which time the driver has control of the car. Some of the major leasing agents in New York City are Team Systems Corp., Ronart Leasing Corp., All Taxi Management Inc., and S&R Medallion Corp. Long-term leases account for 44 percent of all taxicab medallions. The third category of operation consists of short-term leases. In these situations, a central leasing agent owns the medallion and leases the taxicab to drivers on a per-shift basis. For this type of lease, it is not necessary to specify a "driver" as the driver will change with each shift. Typically, the agents will lease each taxicab for two shifts per day. This type of lease accounts for 27 percent of taxicabs.[104] Data shows that long-term lessees average $21,000 in annual income, versus $16,000 for shift leasers in 1993. The difference in income is a result of the long-term lessees' ability to shift administrative and oversight costs to fleet managers.[105]

2.2.c Vehicle Models and Specifications

In addition to regulations regarding leasing and ownership, the Taxi and Limousine Commission has developed an extensive list of vehicle specifications. These requirements help to ensure uniformity and reliability in the fleet; they stipulate minimum technical standards as well as minimum cargo and passenger space requirements. These specifications are detailed in the Rules of the City of New York. Due to these strict regulations, the majority of the taxicab fleet is made up of Ford Crown Victorias. Table 2.1 presents a summary of vehicles in the current New York City fleet. To meet consumers' demand for larger, roomier, and more comfortable taxicabs, the Taxi and Limousine Commission added the Ford "Stretch" Crown Victoria with additional legroom in 2001. Also, the Taxi and Limousine Commission has allowed for the purchase of the Toyota Sienna minivan, which is under evaluation because it can accommodate handicapped passengers.[106]

Table 2.1
Vehicle Classification within the New York City Taxicab Fleet

Model	Percentage of fleet
Ford Crown Victoria	54.6
Extended Ford Crown Victoria	39.7
Honda/Isuzu	5.2
Ford Explorer	0.2
Other	0.2

Figures in this table are obtained from: Schaller Consulting. *The New York City Taxicab Fact Book.* Brooklyn: Schaller Consulting. Jun. 2004. Retrieved Feb. 2, 2005 from http://www.schallerconsult.com/taxi/taxifb.pdf

[104] Schaller Consulting. *The New York City Taxicab Fact Book.* Brooklyn: Schaller Consulting. Jun. 2004. Retrieved Feb. 2, 2005 from http://www.schallerconsult.com/taxi/taxifb.pdf

[105] Schaller Consulting. *The New York City Taxicab Fact Book.* Brooklyn: Schaller Consulting. Jun. 2004. Retrieved Feb. 2, 2005 from http://www.schallerconsult.com/taxi/taxifb.pdf

[106] Chapter 3 of the Rules of the City of New York lists specifications of taxicabs to be operated in New York City. These specifications include physical dimension requirements, inspection requirements, insurance requirements, meter and meter testing requirements, marking specifications, and vehicle's age requirements.
Rules of the City of New York. *Chapter 3 – Taxicab Specifications.* New York: NYC TLC. March 2000. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/specrules.pdf & http://www.nyc.gov/html/tlc/html/news/public02_01.shtml

Due to the intensity of driving a typical taxi is used for, taxicabs have a relatively short useful life and therefore are replaced frequently. As of mid-2003, 63 percent of taxicabs were model year 2001 or later vehicles, and 18 percent were model year 1999 or earlier. According to Taxi and Limousine Commission regulation, all vehicles brought into service as taxicabs must be brand new vehicles and must be retired according to regulation. Taxis that are driven two shirts per day (double shift vehicles) must be retired after three years of service. Taxis that are driven one shift per day (single shift vehicles) must be retired after 5 years. There are retirement extensions available for alternative fuel, hybrid, and handicap accessible vehicles.[107] The process of retiring and replacing a vehicle is referred to as turnover.

According to 2003 statistics, a taxicab averaged 65,300 miles annually. Thirty-nine percent of these miles were accumulated while cruising for passengers because there has been a decline in demand for taxi service and an increase in average operating mileage.[108] The city's streets can be punishing on vehicles, so taxi fleet owners use cars with body-on-frame construction. Heavy-duty suspensions and brakes further fortify the cars for taxi duty. In contrast, the unibody construction of other vehicles has not been durable when tested by taxi fleets, although some owner-drivers have had success with minivans.[109] This durability is particularly important in the consideration of introducing alternative fuel vehicle models into the New York City taxicab fleet.

As discussed above, the specifications of the Taxi and Limousine Commission are quite strict. Vehicles must have an "EPA passenger compartment interior volume index of at least 107 cubic feet."[110] Additionally, the rear compartment must have the following dimensions as defined by the Society of Automotive Engineers:

- minimum effective leg room of 37 inches
- effective head room of at least 37.5 inches
- seat depth of at least 18 inches

The front compartment of the vehicle must meet the following dimensions:

- effective head room of at least 37.5 inches
- maximum effective leg room must be at least 40 inches
- total leg room must be at least 78 inches

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[107] Rules of the City of New York. *Chapter 3 – Taxicab Specifications.* New York: NYC TLC. March 2000. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/specrules.pdf & http://www.nyc.gov/html/tlc/html/news/public02_01.shtml

[108] The report provides a breakdown of average mileage per year based on the vehicle ownership. Fleet-owned vehicles averaged 72,000 miles per year. Long-term lease vehicles with two drivers averaged 68,000 miles. Owner-operators driving a single shift averaged 42,000 miles in 2003.
Schaller Consulting. *The New York City Taxicab Fact Book.* Brooklyn: Schaller Consulting. Jun. 2004. Retrieved Feb. 2, 2005 from http://www.schallerconsult.com/taxi/taxifb.pdf

[109] Schaller Consulting. *The New York City Taxicab Fact Book.* Brooklyn: Schaller Consulting. Jun. 2004. Retrieved Feb. 2, 2005 from http://www.schallerconsult.com/taxi/taxifb.pdf p.42

[110] Rules of the City of New York. *Chapter 3 – Taxicab Specifications.* New York: NYC TLC. March 2000. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/specrules.pdf p.8.

Nonetheless, the Taxi and Limousine Commission does have the authority to approve vehicles that do not meet all of the above specifications. Such an exemption will only be granted in cases where the taxicab is above the minimum requirements in other areas, and where the vehicle offers special qualities that warrant testing on the street to determine suitability as a taxicab. The Chairman of the Taxi and Limousine Commission has the right to make these exceptions for vehicles as long as they meet the following requirements: [111]

- the vehicle is either a full size or larger four-door sedan or a minivan equipped with at least four doors.
- all doors shall open outward on hinges (not sliding doors)
- the vehicle must be capable of carrying three passengers seated behind the driver
- any space which would otherwise be available to seat more than three passengers shall be used instead to provide luggage space
- the vehicle shall have U.S. Environmental Protection Agency passenger compartment interior volume index of at least 107 cubic feet
- if the vehicle is equipped with shock absorbers, the rear shock absorbers must be of the heavy-duty variety
- the vehicle shall be equipped with a factory installed air conditioning system
- the vehicle may not be equipped with an engine in which the maximum horsepower exceeds 220

At present, the Taxi and Limousine Commission has made exceptions for the Honda Odyssey, the Isuzu Oasis, the Ford Explorer, and Toyota Sienna on experimental bases.[112] The experimentation with these vehicles is an important step in introducing alternative fuel vehicles into the New York City taxicab fleet. There is, however, a major limitation because none of the available hybrid models (see Appendix A) meet the specifications outright. This lack of permanent approval is likely one of the reasons why alternative fuel vehicles are not more prevalent in the New York City taxicab fleet.

Table 2.2 compares interior dimensions of the Ford Crown Victoria, the Ford Escape Hybrid, and the Toyota Sienna. As shown, the Ford Escape Hybrid does not meet two of the TLC space requirements for taxicabs. Rear legroom is 0.7 inches below the requirement and total passenger cargo space is 7 cubic feet below the requirement. Additionally, the Ford Escape has unibody construction and is higher off of the ground, making it less accessible to handicap users. The Toyota Sienna Hybrid would meet the passenger space requirements, but the unibody construction is still of concern for durability in the city. Current use of conventional gasoline-powered Toyota Sienna minivans in New York City's taxi fleet will provide a good basis of judgment for the durability of this model. Toyota has not yet announced when and if it will introduce a hybrid version of the Toyota Sienna to the U.S. automobile market, but some predict this to occur by 2007.[113]

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[111] Rules of the City of New York. *Chapter 3 – Taxicab Specifications.* New York: NYC TLC. March 2000. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/specrules.pdf pp.9-10.

[112] Rules of the City of New York. *Chapter 3 – Taxicab Specifications.* New York: NYC TLC. March 2000. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/specrules.pdf pp.9

[113] HybridCars.com. "Cars." Retrieved on March 18, 2005 from http://www.hybridcars.com/cars.html

Table 2.2 Comparison of Alternative Fuel Vehicles to the Ford Crown Victoria			
	Ford Crown Victoria	**Ford Escape Hybrid**	**Toyota Sienna**
Rear Headroom (in.)	37.7	39.2	40.2
Rear Legroom (in.)	39.6	***36.3***	39.6
Front Headroom (in.)	39.2	40.4	42.0
Front Legroom (in.)	42.0	41.6	42.9
Passenger Compartment Volume (cubic feet)	111	***100***	177
Cargo Volume (cubic feet)	20.6	27.6	43.6

Note:
1. ***Italicized text*** indicates non-compliance with a required specification
2. Ford Crown Victoria and Escape Hybrid information is obtained from the manufacturer website: http://smartguide.fordvehicles.com/View.jsp?spaceName=cars (Accessed on March 18, 2005)
3. Toyota Sienna information is obtained from the manufacturer website: http://www.hybridcars.com/toyota-sienna-minivan-hybrid.html (Accessed on March 18, 2005)

2.2.d New Taxi Initiatives

In July 2003, the New York City Council responded to the concern of disable citizens by by designating 9 percent of all future medallion issuances for wheelchair-accessible vehicles. The same piece of legislation recognized the growing importance of alternative fuels, and specified that at least 9 percent of all future medallion issuances be set aside for alternative fuel vehicles.[114] To provide an incentive for the purchases of these special restricted medallions, the Taxi and Limousine Commission has set the price well below the average medallion sale price. However, the 2004 Annual Report stated that "the sales of these medallions have not yet been consummated due to the unavailability of appropriate alternative fuel vehicles" and only 19 alternative fuel medallions were sold during the new round of medallion sales.[115] To ensure future compliance with the regulation, the Taxi and Limousine Commission entered a joint venture with the New York State Energy Research and Development Authority to develop both wheelchair accessible and alternative fuel vehicles.[116] Unfortunately, hybrid vehicle options can only be used on an experimental basis because of the Taxi and Limousine Commission's vehicles specifications. If a vehicle is formally approved, it will be easier for medallion owners to convert their vehicles to hybrid options.

[114] New York City Taxi & Limousine Commission. *2004 Annual Report to the New York City Council.* New York: NYC TLC. 2004. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/2004_annual_report.pdf

[115] New York City Taxi & Limousine Commission. *2004 Annual Report to the New York City Council.* New York: NYC TLC. 2004. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/2004_annual_report.pdf

[116] New York City Taxi & Limousine Commission. *2004 Annual Report to the New York City Council.* New York: NYC TLC. 2004. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/2004_annual_report.pdf

The Taxi and Limousine Commission is active in adopting new practices to respond to emerging consumer demand. In 2004, it adopted several new initiatives to enhance the riding experience of taxicabs. These initiatives include:[117]

- Installation of scratch-free partitions which would allow clear display of the driver's name and license
- Implementation of credit card machines in taxicabs
- Utilization of digital mapping systems to maximize travel efficiency and provide riders with visualization of driving routes

These requirements must be met by November 1, 2005 for any new taxicabs coming into service, or by the first inspection subsequent to that date for every existing taxicab.[118] The Taxi and Limousine Commission has selected CTGi, a Virginia based firm with experience in contracting with government agencies, as its technological consultant in project management. The Taxi and Limousine Commission also augmented four new inspection lanes at its Safety and Emission facility in Woodside, Queens to conduct "On-Board Diagnostics" II (OBD II) emission testing protocols, which fully commenced on January 3, 2005. All taxicab vehicles are mandated to undergo inspection three times annually.[119] This coordinated effort demonstrates technical and organizational capacity on the part of the Taxi and Limousine Commission. Such capacity is an important prerequisite for the implementation of new policies or programs.

[117] New York City Taxi & Limousine Commission. *2004 Annual Report to the New York City Council.* New York: NYC TLC. 2004. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/2004_annual_report.pdf

[118] New York City Taxi & Limousine Commission. *2004 Annual Report to the New York City Council.* New York: NYC TLC. 2004. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/2004_annual_report.pdf

[119] New York City Taxi & Limousine Commission. *2004 Annual Report to the New York City Council.* New York: NYC TLC. 2004. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/2004_annual_report.pdf

3. ALTERNATIVE VEHICULAR TRANSPORT TECHNOLOGY

There are a variety of alternative fuel technologies currently available on the market. They have been incorporated into urban transit in an effort to reduce traffic-related pollution and subsequently improve air quality. There are five commonly known alternative fuels; including compressed natural gas (CNG), liquefied petroleum gas (LPG), ethanol, methanol, and biodiesel. In addition, there are several vehicle technologies that serve as alternatives to the traditional internal combustion engine, which include electric, hybrid electric, and fuel cell vehicles. Having a basic knowledge of the many alternative fuels and technologies is important for understanding the research, development, and incentive programs being undertaken by federal, state, and local governments.

3.1 Alternative Fuels for Internal Combustion Engines

3.1.a Compressed Natural Gas (CNG)

GENERAL BACKGROUND

Compressed natural gas (CNG) consists primarily of methane and is retrieved from gas wells or in conjunction with crude oil production.[120] It is widely produced in the United States and is fairly accessible given the current utility infrastructure.[121] Current estimates indicate that it is available at approximately 1,300 fueling stations in 46 U.S. states and there are already over 85,000 compressed natural gas vehicles. [122] Vehicles utilizing compressed natural gas generally come in two varieties: those with fuel systems that run solely on compressed natural gas, and those with fuel systems that can run on natural gas or gasoline. Compressed natural gas is approximately 15 to 40 percent more expensive than gasoline, and requires frequent refueling because it contains only about a quarter of the energy content of gasoline.[123]

SAFETY

Natural gas has a very limited range of flammability; it will not burn in concentrations below roughly 5 percent or above roughly 15 percent when mixed with air. Gasoline and diesel burn at much lower concentrations and ignite at lower temperatures.[124]

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[120] This website contains articles on nearly all potential alternative fuels for internal combustion engines. Each fuel has its own 2-3 page article covering important factors such as the fuel's availability and affordability. Additionally, the fuel's performance and emissions are characterized. Where applicable, safety is discussed. Finally, success stories are detailed.
U.S. Environmental Protection Agency. *Fact Sheets on Alternative Fuels*. March 2002. Retrieved Jan. 31, 2005 from http://www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm

[121] U.S. Department of Energy, Energy Efficiency and Renewable Energy. *Alternative Fuels Data Center*. Jan. 25, 2005. Retrieved Feb. 1, 2005 from http://www.eere.energy.gov/afdc/altfuel/altfuels.html

[122] U.S. Environmental Protection Agency. *Fact Sheets on Alternative Fuels*. March 2002. Retrieved Jan. 31, 2005 from http://www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm

[123] U.S. Environmental Protection Agency. *Fact Sheets on Alternative Fuels*. March 2002. Retrieved Jan. 31, 2005 from http://www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm

[124] Natural Gas Vehicle Coalition. *How Safe are Natural Gas Vehicles?* Retrieved Feb. 13, 2005 from http://www.ngvc.org/ngv/ngvc.nsf/bytitle/techbull2.html

ENVIRONMENTAL

Natural gas is one of the cleanest burning available alternative fuels and offers a number of advantages over gasoline. It is non-toxic and it poses no threat for ground or water contamination in the event of a fuel release.[125] In light-duty applications, air exhaust emissions from natural gas vehicles are much lower than those from gasoline-powered vehicles. In addition, smog-producing gases such as carbon monoxide and nitrogen oxides are reduced by more than 90 percent and 60 percent, respectively, and carbon dioxide, a greenhouse gas, is reduced by 30 to 40 percent. [126]

3.1.b Liquefied Petroleum Gas (LPG)

GENERAL BACKGROUND

Liquefied petroleum gas (LPG), also known as propane, is a byproduct of natural gas processing and petroleum refining. It is generally comprised of approximately 90 percent propane, with the balance of the gas consisting of butane, ethane, and propylene. Under moderate pressure, propane gas turns into a liquid mixture that is easily transportable and storable in vehicle storage tanks. [127] Current estimates indicate that there are approximately 350,000 liquefied petroleum gas vehicles on U.S. roads today, including taxicabs, school buses, and police cars. In fact, there are over 5,000 liquefied petroleum gas refueling stations across the country; with at least one in every state, thus making liquefied petroleum gas the most widely used alternative fuel. [128] Additionally, approximately 85 percent of all propane used in this country comes from domestic sources, therefore liquefied petroleum gas vehicles can help reduce U.S. dependence on imported oil and strengthen national energy security.

SAFETY

Liquefied petroleum gas has the lowest flammability range of any alternative vehicle fuel, reducing the chances of a vehicle fire. However, because it tends to become a gas when leaked, it is more likely to ignite than gasoline and other liquid fuels. [129]

ENVIRONMENTAL

Propane vehicles, when properly designed, can produce fewer ozone-forming emissions than vehicles powered by reformulated gasoline. In comparison to gasoline, propane can lower vehicle carbon dioxide, carbon monoxide, and other toxic emissions. [130] Tests on light-duty, bi-fuel vehicles have demonstrated a 98 percent reduction in the emissions of toxics, including benzene, 1,3 butadiene, formaldehyde, and acetaldehyde, when the vehicles were

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[125] U.S. Environmental Protection Agency. *Fact Sheets on Alternative Fuels*. March 2002. Retrieved Jan. 31, 2005 from http://www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm

[126] U.S. Department of Energy, Energy Efficiency and Renewable Energy. *Alternative Fuels Data Center*. Jan. 25, 2005. Retrieved Feb. 1, 2005 from http://www.eere.energy.gov/afdc/altfuel/altfuels.html

[127] U.S. Environmental Protection Agency. *Fact Sheets on Alternative Fuels*. March 2002. Retrieved Jan. 31, 2005 from http://www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm

[128] U.S. Environmental Protection Agency. *Fact Sheets on Alternative Fuels*. March 2002. Retrieved Jan. 31, 2005 from http://www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm

[129] U.S. Environmental Protection Agency. *Fact Sheets on Alternative Fuels*. March 2002. Retrieved Jan. 31, 2005 from http://www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm

[130] U.S. Environmental Protection Agency. *Fact Sheets on Alternative Fuels*. March 2002. Retrieved Jan. 31, 2005 from http://www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm

running on propane rather than gasoline. In the event of a propane spill, propane is non-toxic, slightly soluble, and quickly biodegrades in air, soil and water.

3.1.c Ethanol

GENERAL BACKGROUND

Ethanol is a colorless liquid more commonly known as ethyl alcohol or grain alcohol. It is produced by fermenting plant sugars and can be made from corn, potatoes, wood, waste paper, wheat, brewery waste, and other agricultural products and food wastes. Pure ethanol is rarely used for vehicle fuel. Fuel blends consisting of at least 85 percent ethanol are considered alternative fuels under the Energy Policy Act of 1992. E85, a blend of 85 percent ethanol and 15 percent gasoline, is used in flexible fuel vehicles (FFVs) that are currently offered by most major auto manufacturers. Flexible fuel vehicles can run on gasoline, E85, or any combination of the two. Ethanol is primarily used in the Midwest, where excess corn is distilled into the fuel. There are nearly 60 fueling station in 16 states that offer E85. While most drivers do not know it, almost all internal combustion engines can run on E10 fuel (10 percent ethanol/90 percent gasoline), also know as gasohol. [131] Additionally, many vehicles currently on the market are able to run on E85.

SAFETY

Pure ethanol is not considered toxic at levels likely to be inhaled when used as a vehicle fuel. It is less flammable than gasoline, resulting in less frequent and less severe fires when spills or vapor releases occur. It is considered safer than gasoline when storing, transporting, and refueling. It is also a safe replacement for toxic octane enhancers in gasoline such as benzene, toluene, and xylene. [132]

ENVIRONMENTAL

Since ethanol is water soluble and biodegradable, land and water spills of pure ethanol are considered harmless. Unfortunately, since ethanol fuel is generally accompanied by gasoline, the gasoline portion of the spill would still be problematic. Ethanol reduces our dependence on foreign oil because it can be produced domestically. Today, ethanol reduces the demand for gasoline and methyl tertiary-butyl ether (MTBE)[133] imports by 98,000 barrels per day. A 98,000 barrel per day replacement of imported MTBE would represent a $1.1 billion reduction to our annual trade deficit. In addition, because the petroleum refining industry is running near capacity, the ethanol industry helps extend our petroleum supply, thereby helping moderate fuel costs to consumers. Air pollution can also be reduced by using ethanol. Ethanol is low in reactivity and high in oxygen content, making it an effective tool in reducing ozone pollution. Additionally, compared to gasoline, E85 emissions are 40 percent lower in carbon monoxide, 20 percent lower in particulate matter, and 10 percent lower in nitrogen oxides.

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[131] U.S. Department of Energy, Energy Efficiency and Renewable Energy. *Alternative Fuels Data Center*. Jan. 25, 2005. Retrieved Feb. 1, 2005 from http://www.eere.energy.gov/afdc/altfuel/altfuels.html

[132] U.S. Department of Energy, Energy Efficiency and Renewable Energy. *Alternative Fuels Data Center*. Jan. 25, 2005. Retrieved Feb. 1, 2005 from http://www.eere.energy.gov/afdc/altfuel/altfuels.html

[133] Initially MTBE was used during the phase out of leaded gasoline as an additive to raise the octane and reduce air pollution. It does not easily degrade in the environment and is now considered a serious threat to water quality.

3.1.d Methanol

GENERAL BACKGROUND

Methanol, commonly known as wood alcohol, is considered the simplest alcohol chemically, as it contains only one carbon atom per molecule. Methanol is predominantly produced by steam reforming of natural gas to create a synthesis gas, which is then fed into a reactor vessel in the presence of a catalyst to produce methanol and water vapor. A variety of feedstocks other than natural gas can be used but natural gas is generally the most cost efficient. The synthesis gas is generally a combination of carbon monoxide and hydrogen. Although a large amount of synthesis gas is used to make methanol, most synthesis gas is actually used to make ammonia. As a result, most methanol plants are adjacent to or are part of ammonia plants. The synthesis gas is fed into another reactor vessel under high temperatures and pressures, and carbon monoxide and hydrogen are combined in the presence of a catalyst to produce methanol. In the final stages, the reactor product is distilled in order to purify and separate the methanol from the reactor effluent.

Methanol has physical and chemical characteristics that give it several inherent advantages over gasoline as an automotive fuel. Some benefits of methanol include lower emissions, higher performance, and lower risk of flammability than gasoline. In addition, methanol has the flexibility of being manufactured from a variety of widely available, domestic, carbon-based feedstocks such as natural gas, coal, and biomass (e.g., wood); the use of methanol would help reduce U.S. dependence on imported petroleum." Methanol as a vehicle fuel seems to be most commonly used in a mixture of 85 percent methanol and 15 percent gasoline, known as M85. Currently, there are already over 15,000 M85 vehicles in operation in the United States, primarily in the states of California and New York.[120]

SAFETY

There are some safety concerns with methanol since it burns with a nearly invisible flame, making fire detection for drivers quite challenging. However, compared to gasoline, methanol is less flammable and fires are less severe when ignited. If ingested, a few teaspoons of methanol can result in blindness, and several tablespoons could be fatal if not treated.[120]

ENVIRONMENTAL

One negative characteristic of methanol is it produces a high amount of formaldehyde in emissions. Conversely, methanol can easily be reacted to form hydrogen, and many researchers are working to overcome the barriers to using methanol as a hydrogen fuel source. Methanol has a strong potential to create hydrogen for fuel cell vehicles in the future.[121]

Methanol offers important emissions benefits as compared to gasoline when used in today's engines. It can reduce hydrocarbon emission by 30 to 40 percent with M85 fuel and up to 80 percent with M100 (100 percent methanol fuel). These emissions figures decrease even more when methanol is used in a fuel cell vehicle.[120]

3.1.e Biodiesel

GENERAL BACKGROUND

The diesel engine was demonstrated for the first time at the World Exhibition in Paris in 1900 using peanut oil as fuel. Since then, petroleum-based diesel has become the diesel fuel of choice due to its low cost. However, today's diesel engines are still capable of running on renewable biodiesel fuels such as soybean, sunflower, canola, or cottonseed oil, to name a few. These can be obtained from agricultural feedstocks or from used oil such as cooking grease.[120] Pure biodiesel is known as B100; however, it is more commonly mixed with petrodiesel in a blend of 20 percent biodiesel and 80 percent petrodiesel, known as B20. Most major diesel engine manufacturers have affirmed that using B20 in their equipment will not void their warranties. Although B100 is also usable in any diesel engine, its use might void warranties.[120]

SAFETY

The use of B100 fuel should pose no risk or hazards to drivers, as these fuels are non-toxic and commonly ingested or utilized in a variety of other applications. There have been instances of school districts fueling their fleets with biodiesel from used cooking grease from the school cafeteria, which has resulted in the aroma of hot dogs.[120] Biodiesel blended with petrodiesel should pose a safety risk only to the extent of the flammability and toxicity of the petrodiesel.

ENVIRONMENTAL

Biodiesel has wide domestic availability, a vital characteristic as the U.S. tries to become less dependent on foreign source of energy. Additionally, it has numerous environmental benefits from an emissions perspective. Compared to conventional petrodiesel, B20 offers a potential reduction in carbon monoxide emissions of 10 percent, while B100 offers a 50 percent reduction. B20 offers a 15 percent reduction in particulate matter and B100 offers a 70 percent reduction. B20 offers a 20 percent decrease in sulfate emissions, while B100 offers a 100 percent reduction. However, B20 use would result in a 2 percent increase in nitrogen oxides, while B100 would result in a 9 percent increase.[120]

3.2 Electric Vehicle Technology

GENERAL BACKGROUND

Electric vehicles derive power from a battery, which is recharged by plugging into an electrical socket.[120]

RELIABILITY, SAFETY, AND MAINTENANCE

Electric vehicles have lower fuel and maintenance costs than gasoline-powered vehicles. The cost of an equivalent amount of fuel for electric vehicles costs less than the price of gasoline. Also, maintenance for electric vehicles is less since electric vehicles have fewer moving parts to service and replace. However, the batteries must be replaced at great cost every three to six years. The only extra safety concerns for electric vehicles that do not exist for conventional cars relate to the handling of vehicle batteries, as there is a potential for electric shock, as well as contamination and chemical burns.

ENVIRONMENTAL FRIENDLINESS

Vehicles that run on electricity have no tailpipe emissions. This is the primary benefit of owning an electric vehicle. Emissions that can be attributed to electric vehicles are generated in the electricity production process at the power plant. According to one study, "generating the electricity needed to power an electric vehicle one kilometer results in…much more NO_x, more CO_2, much more SO_2, and slightly less CO and non-methane organic gases" than running a conventional Toyota Corolla on gasoline for the same distance.[134] Manufacturers have made some improvements in fuel economy and emissions of conventional cars, making it difficult for electric vehicles to compete. [135] Battery-powered cars have the following additional problems: 1) short driving ranges between charges. 2) lack of recharge infrastructure, 3) high vehicle costs due to the high battery costs, and 4) environmental discharges associated with the mining and smelting of battery metals, manufacturing processes, and disposal of batteries.

3.3 Hybrid Vehicles

GENERAL BACKGROUND

Hybrid-electric vehicles, more commonly known as hybrid vehicles, are powered by two energy sources: 1) an energy conversion unit, such as a combustion engine or fuel cell and 2) an energy storage device, such as batteries or ultracapacitors.[136] The energy conversion unit may be powered by gasoline, methanol, compressed natural gas, hydrogen, or other alternative fuels. Typically hybrids combine the power of an internal combustion engine from a conventional gasoline or diesel-powered vehicle with the battery and electric motor of an electric vehicle. This combination results in low emissions with the power, range, and convenient fueling of conventional vehicles and unlike pure electric vehicles, hybrids never need to be plugged in. [137] "The inherent flexibility of [hybrid vehicles] makes them well suited for fleet and personal transportation." Additionally, hybrids "have the potential to be two to three times more fuel-efficient than conventional vehicles." [138]

There are three primary hybrid vehicle designs; parallel, series design, and a combination of the two. In a parallel design, the energy conversion unit and electric propulsion system are connected directly to the vehicle's wheels. The primary engine is used for highway driving; the electric motor provides added power during hill climbs, acceleration, and other periods of high demand. In a series design, the primary engine is connected to a generator that produces electricity. The electricity charges the batteries, which drive an electric motor that powers the wheels. Hybrid vehicles can also be built to use the series configuration at low speeds and the parallel configuration for highway driving and acceleration. [139] Figure 3.1 presents a basic diagram of the hybrid electric engine.

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[134] Lave, L.B. and H. MacLean. "Are Hybrid Vehicles Worth It?" *IEEE Spectrum*. March 2001: 48.
[135] Lave, L.B. and H. MacLean. "Are Hybrid Vehicles Worth It?" *IEEE Spectrum*. March 2001: 48.
[136] U.S. Department of Energy. "Funding Alternative Fuel Activities." *Clean Cities: Fact Sheet.* Apr. 2003. Retrieved Feb. 17, 2005 from http://www.ccities.doe.gov
[137] U.S. Department of Energy. "Funding Alternative Fuel Activities." *Clean Cities: Fact Sheet.* Apr. 2003. Retrieved Feb. 17, 2005 from http://www.ccities.doe.gov
[138] U.S. Department of Energy. "Funding Alternative Fuel Activities." *Clean Cities: Fact Sheet.* Apr. 2003. Retrieved Feb. 17, 2005 from http://www.ccities.doe.gov
[139] U.S. Department of Energy. "Funding Alternative Fuel Activities." *Clean Cities: Fact Sheet.* Apr. 2003. Retrieved Feb. 17, 2005 from http://www.ccities.doe.gov

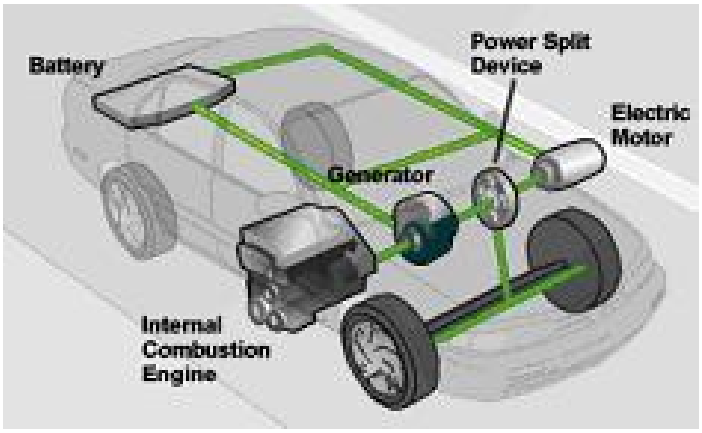

Figure 3.1: This diagram illustrates the basic design hybrid electric engine, comprised of an internal combustion engine, electric motor, and battery.[140]

RELIABILITY, MAINTENANCE, AND SAFETY

Reliability, maintenance, and safety issues for both electric vehicles and hybrid vehicles are speculative, since they are relatively new to the commercial market. Manufacturers of hybrid vehicles expect hybrid vehicle batteries to last the lifetime of the vehicle, approximately 250,000 km. But the warranty for the batteries on the Toyota Prius, for example, runs out after 160,000 km.[134] The only extra safety concerns for hybrid vehicles that do not exist for conventional cars relate to the handling of vehicle batteries, as there is a potential for electric shock, as well as contamination and chemical burns.

ENVIRONMENTAL

The use of the electric motor allows hybrid electric vehicles to significantly reduce emissions compared to traditional gasoline vehicles. Exhaust emissions of hydrocarbons, nitrogen oxides and carbon monoxide are typically reduced by over 50 percent and have been shown to be reduced by as much as 90 percent.[136] Emissions reductions are dependent on the fuel efficiency and cleanliness of the gasoline engine and the amount of power provided by the electric components. The disposal of batteries can pose contamination concerns; however, the batteries in hybrid vehicles are expected to have longer lives than purely electric vehicle batteries.

According to Demirdöven and Deutch of Massachusetts Institute of Technology, "fuel cell vehicles using hydrogen from fossil fuels offer no significant energy efficiency advantage over hybrid vehicles operating in an urban drive cycle." They conclude that "priority should be placed on hybrid vehicles by industry and government."[141]

3.4 Fuel Cell Vehicles

GENERAL BACKGROUND

[140] Fueleconomy.gov. "How Do Hybrid Electric Vehicles Work?" *U.S. Department of Energy.* Retrieved on April 13, 2005 from http://www.fueleconomy.gov/feg/hybridtech.shtml

[141] Demirdöven, N. and J. Deutch. "Hybrid Cars Now, Fuel Cell Cars Later." *Science*. Aug. 13, 2004: 974. Retrieved Feb. 13, 2005 from http://www.sciencemag.org/cgi/content/full/305/5686/974?ck=nck

A fuel cell is an electrochemical device that uses hydrogen (or a hydrogen-rich fuel) and oxygen to produce electricity. It is physically and chemically similar to a battery, but unlike batteries that run down and need recharging, fuel cells make use of an input fuel, which enables them to be refueled at any time. Fuel cells utilize chemical processes that are inherently more efficient than combustion.[142] For example, a typical combustion-based fossil fuel power plant operates at about 35 percent efficiency, while a fuel cell can operate at 40 percent to 60 percent efficiency.[143] Therefore, it is possible to conclude that fuel cells could potentially provide energy in a cleaner and more efficient process than combustion engines.

There are many varieties of fuel cells, but they all generally have three basic components: (1) an anode, (2) a cathode, and (3) an electrolyte that separates them. The hydrogen fuel flows to the anode, where the electrons are removed and shuttled to the cathode through an external circuit to produce electricity. Oxygen, or another oxidant, is used at the cathode. When the oxygen, the positively charged hydrogen, and the electrons combine, water and heat are generated as waste, and the process is complete. Figure 3.2 below provides a visual representation of this electrochemical process. One type of fuel cell, the polymer electrolyte membrane (PEM) cell, has become the focus of fuel cell technology research for transport purposes, primarily due to its power density and low operating temperature.[144] The power output from a single cell is relatively low. However, fuel cells are usually arranged in "stacks" to provide the necessary voltage to power a building or a car. Because of this, fuel cells can be sized to power any application - from a small cell phone to a large power plant. [145]

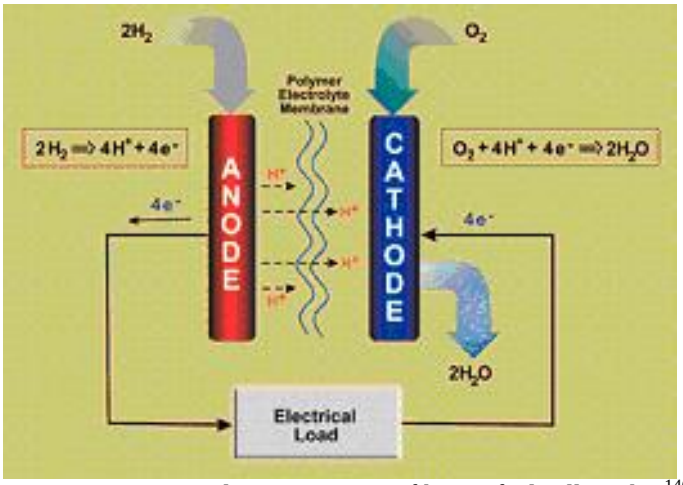

Figure 3.2: Visual representation of how a fuel cell works. [146]

[142] U.S. Environmental Protection Agency. "Fuel Cells and Vehicles Basic Information." Retrieved Feb. 13, 2005 from http://www.epa.gov/otaq/fuelcell/basicinfo.htm#background
[143] Yacobucci, B. "A Hydrogen Economy and Fuel Cells: An Overview." CRS Report for Congress RL32196. Jan. 14, 2004.
[144] U.S. Environmental Protection Agency. "Fuel Cells and Vehicles Basic Information." Retrieved Feb. 13, 2005 from http://www.epa.gov/otaq/fuelcell/basicinfo.htm#background
[145] U.S. Environmental Protection Agency. "Fuel Cells and Vehicles Basic Information." Retrieved Feb. 13, 2005 from http://www.epa.gov/otaq/fuelcell/basicinfo.htm#background
[146] U.S. Environmental Protection Agency. "Fuel Cells and Vehicles Basic Information." Retrieved Feb. 13, 2005 from http://www.epa.gov/otaq/fuelcell/basicinfo.htm#background

RELIABILITY, MAINTENANCE, AND SAFETY

There are safety concerns associated with fuel cells. Most of these concerns revolve around the question of the safety of hydrogen. However, hydrogen has been used safely for decades by industry in a wide variety of applications and conditions. Hydrogen has properties that make it safer than other fuels used today. For example, unlike gasoline, it is non-toxic, and it dissipates quickly when released.[147] However, some of its other properties present technical challenges. For example, to efficiently use hydrogen as a vehicular fuel, it likely will need to be in a liquefied or in a compressed form. This compression creates additional safety concerns (i.e. explosion) and creates design difficulties since strong, and potentially heavy, fuel tanks would be required to store the compressed hydrogen. There are currently few guidelines governing the use of hydrogen as a transport fuel. Such codes and standards are now in the process of being developed by national and international organizations around the world.

ENVIRONMENTAL

Fuel cell vehicles provide the hope of an emissions-free form of future vehicle transportation. With potential tailpipe emissions of only water vapor and heat, this seems to be the ideal solution from an environmental perspective. However, it is important to note that creating the hydrogen to fuel these vehicles is likely to be an energy-intensive process. Countless plants would likely have to be dedicated to creating hydrogen. The most likely and abundant source of hydrogen is from water; however, a process known as electrolysis is needed to extract hydrogen from water. If the electrolysis process is not powered by clean energy sources, such as wind power, then creating hydrogen will lead to significant emissions, even if the actual hydrogen-powered fuel cell vehicles create no emissions. Extracting hydrogen from current petrol-based fuels with an on board reforming device is also an option, but the process does not appear to be as efficient and environmentally friendly as a fuel cell running on pure hydrogen.

3.5 Life-cycle Cost Comparison

Princeton researchers calculated the total lifecycle costs of different vehicle models in order to compare the impacts of various alternative fuels. They included estimates of the air pollution damage for the "upstream" processes, such as production and fuel extraction, as well as the greenhouse gas emissions from operating the car. They calculated three sets of estimates based on low, medium, or high damage scenarios. Their study found that all advanced fueling options had lower lifecycle costs than current combustion engines. "The goal of reducing externalities should be the main driver for technological innovation in car engines and fuels." However, they note that if there is an extensive shift to compressed natural gas technologies, reliance on imports could increase the price in the long-run and thus be more costly than other alternatives. If the externalities are low as modeled by the low damage scenario, then the best option is the conventional combustion engine with improvements in gas mileage (45.6 mpg, assuming a continued trend of technological improvements in gas mileage). Hydrogen-fueled vehicles have estimated lifecycle costs that are greater than a conventional, fuel-efficient (45.6 mpg) vehicle, under one modeling scenario. Given different parameters, however, the hydrogen-fueled vehicle

[147] U.S. Department of Energy, Energy Efficiency and Renewable Energy. *Hydrogen, Fuel Cells, and Infrastructure Technologies Programs.* Retrieved Feb 23, 2005 from http://www.eere.energy.gov/hydrogenandfuelcells/education/safety.html

is the best option and "a strong candidate for becoming the Car of the Future." The researchers note that there are considerable fueling infrastructure obstacles that prevent widespread use in the near term. These results emphasize the need for government policies that drive car manufacturers to produce more efficient vehicle models.[148]

[148] Ogden, J.M., R.H. Williams, and E.D. Larson. "Societal Lifecycle Costs of Cars with Alternative Fuels/Engines." *Energy Policy.* Vol. 32. 2004: 7-27.

4. ALTERNATIVE FUEL AND HYBRID MARKET

Despite apparent price differences, the market for alternative fuel and hybrid vehicles is growing. Initiatives on the local, state, regional, and national level have provided incentives for research, development, and use of alternative fuels. Many urban initiatives to reduce vehicle emissions have increased their use of compressed natural gas and liquefied petroleum gas in fleet vehicles. The market demand for hybrid vehicles has increased with the rise of gasoline prices. The savings inherent in the fuel efficiency of hybrid vehicles often offset the higher initial cost than traditional gasoline vehicles. A clear understanding of the trends in the alternative fuel and hybrid markets is important for understanding the future feasibility of implementing programs that incorporate these technologies.

4.1 Automotive Fuel Alternatives

The Energy Policy Act of 1992 classifies biodiesel, electricity, ethanol, hydrogen, methanol, natural gas, p-series and propane as alternative automotive fuels. Hybrid electric vehicles (HEVs) have become the most popular alternative to conventionally gasoline- or diesel-powered personal vehicles as hybrid technology has proved nearly as reliable as a conventionally-powered vehicle and maintains a significantly lower price than vehicles powered by either compressed natural gas (CNG) or hydrogen. Few personal vehicle prototypes currently use compressed natural gas or hydrogen for fuel. There is a potential $500,000 price tag for a natural gas-powered vehicle and the American Motors General's Hummer 2 Hydrogen (H2H) is still an unlisted novelty vehicle. Compressed and liquefied petroleum gas vehicles are widely used in America;[149] however, nearly all are fleet and public transportation vehicles.

4.2 Hybrid Vehicle Market

Hybrid passenger vehicles were introduced in the United States in model year 2000, a few years after introduction in Japan. The Honda Insight was the first hybrid available in the United States, followed by the Toyota Prius in model year 2001. Honda then introduced a hybrid version of its Civic sedan, and Toyota offered a second-generation Prius. Several other major automakers now offer hybrids or plan to do so in the near future. Ford Motor Company started selling the Escape Hybrid in late Summer 2004 and says it will begin selling two more hybrid models by 2007. Ford's embrace of hybrid technologies has split the automobile industry into two camps: Ford, Honda, and Toyota are actively pursuing hybrid technologies as a means to save gas, reduce emissions, and meet government regulations while General Motors, DaimlerChrysler, and Nissan are putting their money into other technologies, such as hydrogen- or diesel-powered cars. The investments of both camps are carefully calculated. For example, Toyota feels that hybrid vehicles will sell briskly enough to turn a profit and in turn smooth the learning curve to develop hydrogen-powered cars. On the other hand, companies such as General Motors feel that hybrid vehicles are a pricey interim solution and take money away from the development of hydrogen

[149] U.S. Department of Energy, Energy Efficiency and Renewable Energy. "Natural Gas Vehicles." Oct 18, 2004. Retrieved Feb. 16, 2005 from http://www.eere.energy.gov/afdc/afv/gas_vehicles.html

fuel cells. In addition, DaimlerChrysler, Volkswagen, and BMW see clean diesel cars as better alternatives to hybrid vehicles.[150]

4.2.a Hybrid Sales

Average cost comparison between a manufacturer's hybrid and their conventional models reveals that hybrid vehicles, or conversions, cost nearly $6,000 – 7,000 more than their traditional gasoline counterparts.[151] Despite this, hybrid sales have risen consistently in the U.S., from 9,350 cars in 2000 to over 85,000 in 2004. Future prices are expected to decrease $3,000 by 2012, which will further increase demand. Although Market predictions for future sales of hybrid vehicles are varied, all show increasing sales. Automotive analyst J.D. Power and Associates foresees annual sales totaling 350,000 by 2008, accounting for two percent of all car sales.[152] Oak Ridge National Laboratories predict hybrid car sales to total 800,000 to 1 million by 2010 and accounting for 14.9 percent of the market share in 2012 (Figure 4.1).[153] More optimistic predictions contain figures of 1.2 million hybrids sold by 2008.[154]

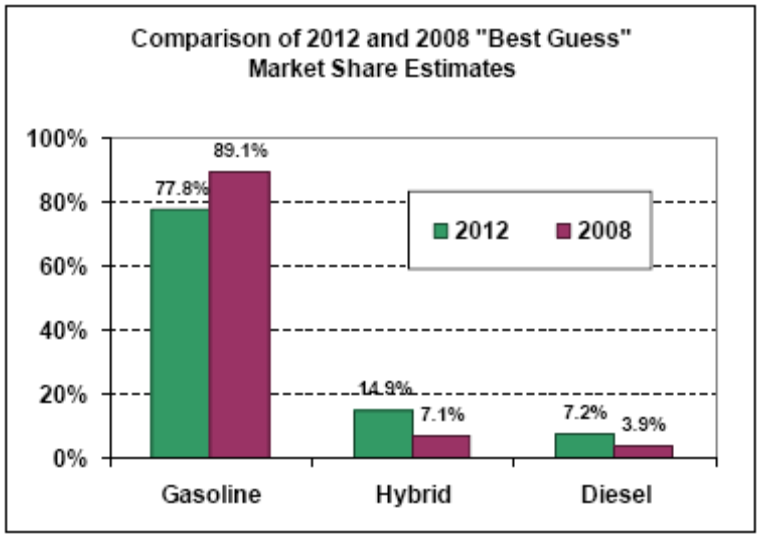

Figure 4.1: This graph illustrates the market share estimates for hybrid and diesel vehicles in 2008 and 2012. Note that hybrid vehicles are predicted to comprise 14.9% of the market in 2012, which is based on 0.1% market share in 2002. [155]

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[150] Welch, D., K. Kerwin, and J. Carey. "Gentlemen, Start your Hybrids: Ford, Toyota, and Honda Are Betting on a Payoff. GM and Others Aren't So Sure." *Business Week*. New York: Apr 26, 2004. Issue 3880: 45.

[151] A Honda Civic Hybrid costs approximately $20,800, whereas the conventional Civic costs about $14,500. The time required for fuel savings to compensate for the initial price difference varies depending on city/highway use, miles driven per year, and the price of fuel.

[152] Motavalli, J. "Getting There: A Guide to Planet-Friendly Cars." *E: The Environmental Magazine*. Vol. 15, No. 4. Jul/Aug 2004: 54-55.

[153] Greene, D.L., K.G. Duleep, and W. McManus. "Future Potential of Hybrid and Diesel Powertrains in the U.S. Light-Duty Vehicle Market." *Oak Ridge National Laboratories*. August 20, 2004. Retrieved on April 8, 2005 from http://www.dieselforum.org/resources/downloads/DOE_HybridDiesel0804.pdf

[154] HybridCars.com. "Sales Numbers and Forecasts for Hybrid Vehicles." Retrieved Feb. 6, 2005 from http://www.hybridcars.com/sales-numbers.html

[155] Greene, D.L., K.G. Duleep, and W. McManus. "Future Potential of Hybrid and Diesel Powertrains in the U.S. Light-Duty Vehicle Market." *Oak Ridge National Laboratories*. August 20, 2004. Retrieved on April 8, 2005 from http://www.dieselforum.org/resources/downloads/DOE_HybridDiesel0804.pdf

4.2.b Vehicle Fuel Economy

According to the U.S. Department of Transportation, Bureau of Transportation Statistics, the average U.S. passenger car fuel efficiency in 2001 was 9.4 kilometers per liter (kmpl), while the average passenger car fuel efficiency was 9 kmpl in 1991 and 6.8 kmpl in 1980. Thus, the increases in average fuel efficiency between 1980 and 1991 were greater than the increases between 1991 and 2001.[156] Despite improvements made in the last three decades, more recently there has been a decline in fuel economy. Since 1981 automotive purchasers have sought a 24 percent increase in vehicle weight and a 93 percent increase in vehicle horsepower. Vans, trucks, and sport utility vehicles now account for about 50 percent of private vehicles sold in the United States, resulting in the lowest average fuel economy in 20 years for new light-duty vehicles on the market today.[157] It is important to see if consumer desires in the coming years for larger vehicles can be met by hybrid models whose manufacturers' also purport combined savings of 35 to 40 percent in U.S. oil demand (2 – 3.5 billion barrels/day) by 2015. [158]

A 2004 study by J.D. Power & Associates revealed that 60 percent of Americans are willing to pay more for a hybrid vehicle. The importance of gas mileage rose from thirteenth to fifth in a ranking of the most important factors behind automotive consumer purchases.[159] In another 2004 survey, hybrid vehicle purchasers reported desires to decrease dependency on foreign oil, reduce emissions, and decrease fuel costs as the major reasons for their selection of a hybrid electric vehicle.[160] Due to increasing gas prices, hybrid vehicles have been integrated into commercial and government fleets. In Martin and Marion counties, Florida, hybrid vehicles are being used in police fleets parking patrol and detective work. Each new hybrid cruiser saves approximately $103 per month in gasoline. Although such fleets have traditionally relied on American automobiles, the major U.S. auto manufacturers are trailing Japanese automakers, leaving them out of consideration for the Florida Sheriff Association's fleet.[161]

Appendix A contains a comprehensive summary of the specifications of eight hybrid vehicle models: Toyota Prius, Ford Escape, Toyota Sienna, Honda Accord, Honda Civic, Chevrolet Malibu, Toyota Highlander, and Mercury Mariner. Each of these models is either currently available or is expected to be available by 2007. Additionally, the specifications of the current

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[156] U.S. Department of Transportation. *Bureau of Transportation Statistics: Table 4-23M: Average Fuel Efficiency of U.S. Passenger Cars and Light Trucks*. Retrieved Feb. 2, 2005 from http://www.bts.gov/publications/national_transportation_statistics/2003/html/table_04_23_m.html

[157] Transportation Research Board. "Surface Transportation Environmental Research: A Long-Term Strategy." *National Academy of Science*. 2002. Retrieved Feb. 16, 2005 from http://www.TRB.org

[158] Cole, C. "Strategy for Cutting U.S. Oil Demand Focuses on CAFE". *Octane News.* Jan 17, 2005, Vol. 20, Issue 2: 1. Retrieved Feb. 1, 2005 from http://proquest.umi.com/pqdweb?index=0&did=783936811&SrchMode=1&sid=3&Fmt=3&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1107229426&clientId=15403

[159] HybridCars.com. "Hybrid Driver Survey." Feb. 6, 2004. Retrieved Feb. 17, 2005 from http://www.hybridcars.com/survey.html

[160] HybridCars.com. "Hybrid Driver Survey." Feb. 6, 2004. Retrieved Feb. 17, 2005 from http://www.hybridcars.com/survey.html

[161] Fialka, J.J. "Police Vehicles Go Green and Help Save Green" *Wall Street Journal* (Eastern edition). New York: NY, Feb. 6, 2003: B1.

Crown Victoria taxicab are included for comparison, as they affect the feasibility of introducing hybrid vehicles into the taxi fleet.

4.3 Public Transportation: Hybrid Vehicles and Compressed Natural Gas

One of the most popular mediums for hybrid vehicles and compressed natural gas transportation are city buses. In 2000, 20 percent of buses being manufactured were powered by compressed natural gas, despite an additional $25,000 – $50,000 cost more than conventional bus. It is estimated that these buses make-up the price differential in 3 years with $0.25 per gallon saved by using neither gasoline nor diesel fuels. Although compressed natural gas fuel tanks are more costly than low-sulfur diesel tanks, buses require fewer tanks to operate and are slightly less costly to maintain.[162] The operating cost is actually in favor of natural gas and is expected to become more so as emission standards are intensified in the future. According to a U.S. General Accounting Office report, the result of using alternative fuel buses on air quality improvement is inconclusive. It is anticipated that alternative fuel buses do have positive impacts on urban air quality, but this needs to be quantified and systematically studied.[163]

The trend of using alternative fuel in mass public transportation is upward sloping.[164] As of 2001, New York City public transit system consisted of 4,489 buses, 221 of which were powered by compressed natural gas and 10 were diesel-electric hybrids. These alternative-fuel buses represented five percent of New York City's bus fleet, with that percentage expected to rise to 24 percent by 2006 (649 compressed natural gas and 390 diesel-electric hybrid).[165]

4.4 Government Incentives

While savings in fuel costs are reported as the number one reason for purchasing a hybrid electric vehicle, consumers are deterred by the relatively higher purchase prices. To increase consumer demand for cleaner technologies governments have offered incentives to encourage the purchasing of hybrid vehicles. Federal, state, and local governments have taken strides in recent years to promote the use of alternative fuels and hybrid vehicles. Below is an overview of some of the federal and state programs available for alternative fuel and hybrid vehicles, as well as initiatives that affect New York City and the taxi fleet directly.

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[162] U.S. Department of Energy, Energy Efficiency and Renewable Energy Office of Transportation Technologies. *Natural Gas Buses: Separating Myth from Fact*. May 2000. http://www.eere.energy.gov/afdc/pdfs/MythvsFact.pdf

[163] U.S. General Accounting Office. *Use of Alternative Fuels in Transit Buses.* Washington D.C.: U.S. GAO. December 1999. Retrieved Feb. 2, 2005 from http://www.gao.gov/new.items/rc00018.pdf

[164] U.S. General Accounting Office. *Use of Alternative Fuels in Transit Buses.* Washington D.C.: U.S. GAO. December 1999. Retrieved Feb. 2, 2005 from http://www.gao.gov/new.items/rc00018.pdf

[165] National Renewable Energy Laboratory. "Advanced Technology Vehicles in Service: Diesel Hybrid Electric Buses." *U.S. Department of Energy, Energy Efficiency, and Renewable Energy.* Sept 2001. Retrieved on April 8, 2005 from http://www.eere.energy.gov/afdc/pdfs/diesel_hybrid.pdf

4.4.a Federal Programs and Incentives

The United States government has played a significant role in alternative fuel and technologies sector by funding research and development. The U.S. Department of Energy contributed funding to Cummins Westport to develop natural gas engines for buses and trucks. The U.S. Army is a customer of Electric Fuel, a company developing zinc-air fuel cells.[166] The Clean Cities program within the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy promotes alternative fuel initiatives. It provides resources for companies and organizations participating in a Clean Cities coalition. There are a variety of funding sources to support fleet purchasing and conversion, including the following:[167]

- U.S. DOE State Energy Program Grants
- Congestion Mitigation and Air Quality (CMAQ), funded by the Federal Highway Administration and Federal Transit Administration
- U.S. Environmental Protection Agency
- FedBizOpps.gov
- National Biodiesel Board
- Natural Gas Vehicle Coalition

Corporate Average Fuel Economy (CAFE) standards and the National Commission on Energy Policy (NCEP) have established vehicle fuel consumption limits and introduced incentives to spur sales of hybrid and clean fuel vehicles in an effort to reduce both emission levels and national reliance on foreign oil supplies. The incentives to bolster production and consumption have included subsidies to manufacturers per vehicle sold and a $2,000 – $4,000 tax deduction for consumers. The "Working Families Tax Relief Act" of 2004 extended the $4,000 electric vehicle tax deduction and the $2,000 clean fuel vehicle tax deduction through 2005 with the possibility of new legislation after that time.[168]

4.4.b State Programs and Incentives

At the state level, there are a variety of programs and policies to support alternative fuels. California sets stringent air quality standards that are generally adopted by New York, Vermont, and Massachusetts. Together, these four states make up approximately 20 percent of the market for light-duty vehicles in the United States, [169] and as such, they have the potential to influence the direction of the market toward alternative technology. Other programs to increase hybrid car ownership include free local parking, sales tax exemption, access to high-occupancy vehicle lanes, rebates, emissions control inspection exemption, and tax credits.[170]

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[166] Chediak, M. "Transportation Sector Analysis." *Red Herring*. Feb. 2002: 82.

[167] U.S. Department of Energy. "Funding Alternative Fuel Activities." *Clean Cities: Fact Sheet.* Apr. 2003. Retrieved Feb. 17, 2005 from http://www.ccities.doe.gov

[168] Fueleconomy.gov. "Advanced Technology: Hybrid Vehicles - Tax Incentives." *U.S. Department of Energy*. 2004. Retrieved on January 20, 2005 from http://www.fueleconomy.gov/feg/tax_hybrid.shtml

[169] Ogden, J.M., R.H. Williams, and E.D. Larson. "Societal Lifecycle Costs of Cars with Alternative Fuels/Engines." *Energy Policy.* Vol. 32. 2004: 7-27.

[170] HybridCars.com. **"**Local and Regional Hybrid Car Incentives." Retrieved Feb. 2, 2005 from www.hybridcards.com/incentives.html

Some programs partner universities with private industry.[171] For example, as part of a state-led initiative to fund technological research, North Carolina started the NC Alliance for Competitive Technologies. In New York, the New York State Clean Sharing Network, through the New York State Energy Research and Development Authority (NYSERDA), promotes the purchase of alternative fuel fleets, provides incentives to reduce the cost of fueling infrastructure, and offers training programs for vehicle mechanics.[172] For example, the Clean Sharing Network supported the United Parcel Service purchase of compressed natural gas vehicles. Additional incentives were provided by the New York State Alternative-Fuel Tax Incentive and the New York State Electric and Gas (NYSEG) to cover the increased fueling costs of the fleet.[173] New York State provides a sales tax exemption for alternative fuel vehicle consumers on vehicles placed in service prior to December 31, 2006. For qualified hybrid vehicles, the sales tax exemption is generally equal to $3,000 unless the vehicle manufacturer certifies a higher incremental cost.[174]

Providing incentives to use alternative transportation, such as walking and biking, is another approach to addressing pollution and congestion problems. In 1998, New York and Connecticut partnered with over 200 businesses to launch a commuter rewards program. Members were offered incentives, such as discounts at hotels and health clubs, for committing to alternative modes of transportation, including public transportation, walking, biking, and carpooling.[175] In Georgia a legislator recently introduced a bill to promote automobile insurance that rewards motorists for driving less, creating an incentive to use public transit. The legislation would allow Georgia insurance companies to offer "mile-based" policies with premiums determined by the number of miles driven.[176]

4.4.c New York City Programs and Incentives

A combination of state and local programs is responsible for the use of alternative fuel vehicles in New York City. In 1998, Governor Pataki announced an initiative in partnership with Ford to put 600 compressed natural gas vehicles in the New York City taxi fleet. This was thought to be an important environmental initiative since nearly one-third of all vehicle

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[171] North Carolina State University. "Research and Graduate Studies: Environmental Scan." *North Carolina State University.* Jan 2000. <http://www2.ncsu.edu/research/mission/escan.html>

[172] This site is run by the State of New York and has information on alternative vehicles and their current use in the state. It also has case studies regarding alternative vehicles and descriptions of each vehicle type currently in use in the city. In addition, it contains some state funding numbers for alternative vehicles and information on New York State's Clean Water/Clean Air Bond Act of 1996.
New York State Energy Research and Development Authority. "Alternative-Fuel Vehicle Program." 2004. Retrieved Feb. 17, 2005 from http://www.nyserda.org/programs/Transportation/afv.asp

[173] New York State Energy Research and Development Authority. "UPS – On the Ground and In the Air." *New York State Clean Cities Sharing Network: Case Study.* April 1999. Retrieved on April 8, 2005 from http://www.nyserda.org/programs/Transportation/ccups.pdf

[174] NYC Taxi & Limousine Commission. "Frequently Asked Questions: Alternative Fuel/Accessible Medallions." *TLC Medallion Sale Information*. Retrieved on March 22, 2005 from http://www.nyc.gov/html/tlc/medallion/html/faq/altfuel_accessible.shtml#4

[175] "NY-Conn. program rewards commuters." *Railway Age*. Sept 1998: 1.

[176] "Proposed Mile-Based Auto Insurance Creates Incentive to Use Mass Transit." *Urban Transport News.* Mar 20, 2002. Retrieved Feb. 2, 2005 from http://goliath.ecnext.com/coms2/summary_0199-1564437_ITM&referid=2090

miles driven south of 96th street are by taxis.[177] The New York State Energy Research and Development Authority (NYSERDA) has an alternative vehicles programs including funding to encourage organizations to convert fleets to alternative fuel vehicles.[178] The New York City Clean Fuel Taxi Program aims to introduce natural gas taxis into the fleet of 13,000 yellow cabs in New York. The partnership among New York City agencies, Consolidated Edison, Ford Motor Company, and the New York State Energy Research and Development Authority, provided $3.5 million in grant funds to cover 80 percent of the $5000 cost of converting taxis to compressed natural gas or provided up to $6000 toward the purchase of compressed natural gas taxicabs.[179] Ford funded the remaining amount for new compressed natural gas Crown Victorias to match the price of regular Crown Victoria, as well as offered a $5000 free fuel incentive. Approximately 300 natural gas taxis have been operated by taxi drivers throughout the city as a result of this program.[180] There are currently only 91 compressed natural gas taxis in operation.[181]

[177] New York State Press Release. *Governor Pataki Announces Clean-Fuel Taxis For New York City.* April 3, 1998. Retrieved on March 22, 2005 from http://www.state.ny.us/governor/press/april9_3_98.html

[178] New York State Energy Research and Development Authority. "Alternative-Fuel Vehicle Program." 2004. Retrieved Feb. 17, 2005 from http://www.nyserda.org/programs/Transportation/afv.asp

[179] NYC Taxi & Limousine Commission. "Frequently Asked Questions: Alternative Fuel/Accessible Medallions." *TLC Medallion Sale Information*. Retrieved on March 22, 2005 from http://www.nyc.gov/html/tlc/medallion/html/faq/altfuel_accessible.shtml#4

[180] New York State Energy Research and Development Authority. "Alternative-Fuel Vehicle Program." 2004. Retrieved Feb. 17, 2005 from http://www.nyserda.org/programs/Transportation/afv.asp

[181] NYC Taxi & Limousine Commission. *TLC News*. November 20, 2003. Retrieved on March 22, 2005 from http://www.nyc.gov/html/tlc/html/news/testimony112003.shtml

5. LEGISLATION

Legislation is an important component for reducing the levels of urban traffic-related pollution. Several approaches have been taken to address the air pollution problem, including mandated pollution emission limits for vehicles and incentives for purchasing hybrid cars. Conflict has arisen over whether states have the ability to pass their own legislation regulating vehicle emissions at levels that are more stringent than the national standards; this topic has recently come to the forefront of discussion in California. The following section provides an overview and discusses the implications of the existing legislation that has been enacted at the federal, state, and local level to reduce urban traffic-related problems and promote hybrid vehicle sales.

5.1 Federal and State Tax Legislation

OVERVIEW

Tax legislation has been employed at both the state and federal level. Tax incentives are given to those purchasing a hybrid vehicle as a way to encourage more people to buy hybrid vehicles and compensate for the higher prices of the vehicles.

LEGISLATIVE SUMMARY

Federal tax legislation to encourage the purchasing of hybrid vehicles started in May 2002 when the IRS declared gasoline-electric hybrids eligible for tax deductions as "clean fuel" vehicles under the Energy Policy Act of 1992 (PL 103-486).[182] The deduction ceiling began at $2,000, with the tax deduction set to end in 2006. Unless changed or renewed, the deduction amount will decrease by $500 each year as it is phased out. Under the current legislation, vehicle purchased after 2006 will receive no tax deduction. [183] Since the tax break is a deduction, the value varies depending on a person's tax bracket. If a person is in the 33 percent tax bracket, a $2,000 deduction will reduce the tax bill by as much as $600. However, if a person is in the 15 percent tax bracket, it could be worth only $300. [184] In addition, to qualify for the tax deduction the following criteria must be met: 1) the vehicle must be purchased new and for private use, 2) it must be driven mostly in the United States, 3) the vehicle must meet all state and federal emissions requirements and 4) Government agencies, tax-exempt organizations and foreign entities are not eligible.[185]

State legislation varies widely across the U.S. Currently, there are 14 states that allow for some type of incentive above the federal incentive for the purchasing of a hybrid vehicle.[186] Tax

[182] Fueleconomy.gov. "Advanced Technology: Hybrid Vehicles - Tax Incentives." *U.S. Department of Energy*. 2004. Retrieved on January 20, 2005 from http://www.fueleconomy.gov/feg/tax_hybrid.shtml

[183] Fueleconomy.gov. "Advanced Technology: Hybrid Vehicles - Tax Incentives." *U.S. Department of Energy*. 2004. Retrieved on January 20, 2005 from http://www.fueleconomy.gov/feg/tax_hybrid.shtml

[184] Fueleconomy.gov. "Advanced Technology: Hybrid Vehicles - Tax Incentives." *U.S. Department of Energy*. 2004. Retrieved on January 20, 2005 from http://www.fueleconomy.gov/feg/tax_hybrid.shtml

[185] Fueleconomy.gov. "Advanced Technology: Hybrid Vehicles - Tax Incentives." *U.S. Department of Energy*. 2004. Retrieved on January 20, 2005 from http://www.fueleconomy.gov/feg/tax_hybrid.shtml

[186] HybridCars.com. **"**Local and Regional Hybrid Car Incentives." Retrieved Feb. 2, 2005 from www.hybridcards.com/incentives.html

legislation is specific to each state. Some examples include: in Connecticut when a person is exempt from sales tax when they purchase a hybrid vehicle with a fuel economy rating of at least 40 miles per gallon or a car with a dedicated natural gas, liquid propane gas, hydrogen, or electric system. In Maryland, the Maryland Clean Energy Incentive Act provides tax credits up to $2,000 for electric vehicles and up to $1,000 for qualifying hybrid vehicles. Other states such as Illinois, Maine, Utah and Oregon also provide tax credits for purchasing a hybrid or electric vehicle. States are free to pass additional legislations for tax credits or deductions in their own legislatures above and beyond that of the federal government.[187]

BROADER IMPLICATIONS

Federal tax legislation has the ability to reach across all state boundaries. Tax credits and incentives allow for the reduced price of hybrid vehicles. In addition, federal legislation can set the tone for the entire country in relation to the importance of purchasing clean fuel vehicles. The greater the federal legislation, the more support can be achieved for hybrid vehicles. Conversely, if federal tax legislation for hybrid vehicles is cut, it can send the message that the government does not feel that hybrid vehicles are important for the pollution levels in the U.S. Additionally, state tax legislation can either act as a supplement to federal legislation or as a fore-runner for tax legislation. The importance that a state places on its own hybrid legislation can show the state's commitment to clean fuel vehicles.

5.2 Cross-County, Multi-Party Legislation

OVERVIEW

The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort by Northeastern and Mid-Atlantic states to reduce carbon dioxide emissions. States participating will develop a regional strategy for controlling emissions, which do not adhere to state borders. A multi-state cap-and-trade program and a market-based emissions trading system are the core to the RGGI. Design of the program is planned to be finished by April 2005.[188]

LEGISLATIVE SUMMARY

In April 2003, New York Governor George E. Pataki sent letters to 11 state governors inviting them to participate in discussions to develop a regional cap and trade program within two years. In July 2003 governors from Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, Rhode Island, and Vermont agreed to have representatives participate in the discussions. In order to accomplish this goal, state representatives have formed sub-groups with specific tasks led by specific states. The first development phase, which is to be completed by April 2005, focuses on the design of the core cap-and-trade program covering the power sector while the second phase, which will start in April 2005, will focus on reliable offset mechanisms

[187] HybridCars.com. **"**Local and Regional Hybrid Car Incentives." Retrieved Feb. 2, 2005 from www.hybridcards.com/incentives.html

[188] This is the link to the Northeast's new initiative, which involves trading carbon emissions between states. This site includes the guiding principles used in the program, the stakeholders involved, and contact information. Additionally, it includes all documents released by the organization and data collected on trading emissions. This initiative is accepted and upheld by New York Governor George Pataki.
Regional Greenhouse Gas Initiative. 2005. Retrieved Jan. 22, 2005 from http://www.rggi.org/.

that will give credit for verifiable and surplus emissions reductions outside the electricity sector.[189]

Four guiding principles were adopted for the operation of the program. First, the program will emphasize uniformity in the trading of greenhouse gases. Second, the program will be flexible to allow other states to join if they choose. Third, the program will not interfere with other national, state or regional emission trading programs. Last, the program will develop over time and in phases to reduce complications and compliance costs.[190] West Coast states are also working to develop a cap-and-trade program for carbon dioxide emissions. The program includes governors from the states of Washington, Oregon and California. This program combines state and regional goals to reduce global warming.

BROADER IMPLICATIONS

Joint efforts across state lines are important for issues such as air pollution, which is not subject to state boundaries. Additionally, the implications are greater because the U.S. did not commit to the Kyoto Protocol. With areas of the U.S. banding together to create their own cap-and-trade systems for carbon dioxide emissions it sends the message that this is an important issue to many states. If this system works in the Northeast, it could lead to further programs being instituted in other areas of the U.S. This program is being followed by many organizations and governments, and will be closely watched for failure or success. If the program fails it can be used as an example of why cap-and-trade may not work, however if it succeeds it could be used as further leverage to an overall U.S. program. Additionally, having patchwork regulations on automobile emissions between states in the U.S. could also lead the automobile industry to push for uniform national standards.

5.3 High Occupancy Vehicle Lane Legislation

OVERVIEW

High Occupancy Vehicle (HOV) lanes have been employed in many state highway systems. HOV lanes have provided a way for vehicles carrying two or more people to travel faster than on the normal highway routes. Exact HOV lane restrictions may vary from state to state, with the largest accumulation of HOV lanes occurring around large metropolitan areas. As an incentive for buying a hybrid car, states such as California and Virginia have allowed these vehicles in the HOV lanes, regardless of the number of passengers.[191] Recently, this action has been called into question as congestion on the state highway systems continues to increase.

LEGISLATIVE SUMMARY

Northern Virginia has one of the largest HOV lane systems in the U.S. "The HOV lanes move more people in carpools, vanpools, buses, motorcycles, clean fuel vehicles and trucks from Virginia to the core areas of Arlington and D.C. than the regular highway lanes, Metrorail or

[189] Regional Greenhouse Gas Initiative. 2005. Retrieved Jan. 22, 2005 from http://www.rggi.org/.
[190] Regional Greenhouse Gas Initiative. 2005. Retrieved Jan. 22, 2005 from http://www.rggi.org/.
[191] "HOV Enforcement Task Force Makes Recommendations to Safeguard HOV lanes." Press Release NOVA-NR05-02. *VDOT News Page*. 2005. Virginia Department of Transportation. Retrieved Jan. 30, 2005 from http://www.virginiadot.org/infoservice/news/newsrelease.asp?ID=NOVA-NR05-02.

Virginia Railway Express," according to Dennis Morrison, District Administrator for Northern Virginia, Virginia Department of Transportation. On a typical weekday morning in 2002, more than 52,000 people in Virginia used the HOV lanes to travel to the Washington D.C. district and Arlington.[192] Due to larger volumes of traffic, including the exempt hybrid vehicles, there has been a need for increased enforcement in the HOV lanes of Virginia. The extra vehicles clog the HOV lanes and slow down overall travel time for all travelers.

Since 2000, hybrid vehicles have qualified for special exemption license plates that allow them access to the HOV lanes. In April 2003, approximately 2,500 hybrid vehicles were registered with clean special fuel plates. By the end of 2004, there were approximately 6,800 hybrid vehicles registered with clean special fuel plates. These vehicles now account for 18 percent of HOV traffic. This rapid growth in hybrid vehicle use has helped contribute to pushing the HOV lanes beyond their operating capacity. To better assess the situation, Virginia's Department of Transportation formed the HOV Enforcement Task Force. The Task Force examined the situation and compiled its recommendations in the Second Report of the HOV Enforcement Task Force. The Task Force recommended that only the cleanest hybrid vehicles be allowed to use the HOV lanes and that the current hybrid exemption from HOV restrictions expire in 2006.[193]

This situation is not unique to the Virginia highway system; California is also experiencing congestion in its HOV lanes, and hybrid vehicle exemptions have been questioned as one of the contributing factors. Although AB 2628, which allows hybrid vehicles in the HOV lanes, was passed in California, the Department of Transportation has begun examining other options to increase hybrid use and protect the HOV lanes.

BROADER IMPLICATIONS

The state of Virginia, one of the largest HOV areas that allows hybrid vehicle exemptions, is rethinking their policy. If they decide to remove these exemptions, other regions may follow as they see their HOV lanes become more congested. The report by the Task Force also has implications for the California system, which is currently looking for ways to protect their own HOV lanes. If Virginia follows the recommendations in the report and removes their exemptions for hybrid vehicles, this sets a precedent for other states to change their legislation to remove hybrid vehicle use in the HOV lanes.

5.4 California Legislation and Controversy

OVERVIEW

The State of California has often led the way in the development of environmental legislation and plans to continue on the issue of vehicle emissions control and global climate change. While California has recently passed several state and local level laws aimed at reducing vehicle emissions, including HOV lane expansion, increased vehicle registration fees and a smog check

[192] D.C. Morrison and M. Counts. "Second Report of the High-Occupancy Vehicle Enforcement Task Force." Virginia Department of Transportation. Jan 4, 2005.

[193] D.C. Morrison and M. Counts. "Second Report of the High-Occupancy Vehicle Enforcement Task Force." Virginia Department of Transportation. Jan 4, 2005.

exemption freeze, the most far-reaching and controversial piece of legislation has been Assembly Bill 1493 (Pavley).

LEGISLATIVE SUMMARY

Assembly Bill 1493 was signed by the Governor in August 2002 and called for the California Air Resources Board (CARB) "to adopt regulations that achieve the maximum feasible and cost effective reduction of greenhouse gas emissions from motor vehicles."[194] Regulations requiring automakers to reduce greenhouse gas emissions in new cars by 2009 were developed and published in September 2004. In setting these greenhouse gas emission standards, the CARB evaluated technologies and fuels available to reduce vehicular greenhouse gas emissions, the reductions that could be achieved and their cost to automakers, consumers, and the state. From this analysis, a comprehensive and incremental reduction program was developed that when fully phased-in (in 2016) would provide a 30 percent reduction in emissions.[195] The CARB has also identified technologies that it feels will prove useful in "providing significant reductions in emissions at favorable costs." These include but are not restricted to variable valve sizing, turbo-charging, and engine downsizing technologies. [196] By using these and other technologies the CARB analysis team has projected that consumers should expect to pay approximately $1,000 more for a new vehicle once reductions are phased-in. However, the team also calculated that with fuel prices at $1.74 per gallon, the savings on fuel costs will offset the increased vehicle purchase price and yield a net savings of approximately $3.50 to $7.00 per month.[197] Therefore, the CARB Assembly Bill 1493 will result in a reduction in greenhouse gas emissions and the related decrease in contribution to climate change while providing cost savings to the individual consumer in California.

BROADER IMPLICATIONS

Assembly Bill 1493 has several broad implications for addressing global climate change as a significant environmental issue and the role that personal transportation plays in this issue. Indeed, it specifically lays out the impacts of global climate change on California and states that these are directly correlated with vehicular greenhouse gas emissions. Those listed in the legislation include: (1) Potential reductions in the state's water supply due to changes in the snowpack levels in the Sierra Nevada Mountains and the timing of spring runoff; (2) Adverse health impacts from increases in air pollution that would be caused by higher temperatures; (3) Adverse impacts upon agriculture and food production caused by projected changes in the amount and consistency of water supplies and significant increases in pestilence outbreaks; (4) Projected doubling of catastrophic wildfires due to faster and more intense burning associated with drying vegetation; (5) Potential damage to the state's extensive coastline and ocean ecosystems due to the increase in storms and significant rise in sea level; and (6) Significant impacts to consumers, businesses, and the economy of the state due to increased costs of food

[194] California Environmental Protection Agency. "Fact Sheet: Climate Change Emissions Control Regulation." A.R. Board, Editor. Dec. 10, 2004.
[195] California Environmental Protection Agency. "Fact Sheet: Climate Change Emissions Control Regulation." A.R. Board, Editor. Dec. 10, 2004.
[196] California Environmental Protection Agency. "Fact Sheet: Climate Change Emissions Control Regulation." A.R. Board, Editor. Dec. 10, 2004.
[197] California Environmental Protection Agency. "Report to the Legislature and the Governor on Regulations to Control Greenhouse Gas Emissions from Motor Vehicles". A.R. Board, Editor. 2004.

and water, energy, insurance, and additional environmental losses and demands upon the public health infrastructure. [198]

California is the only state in the United States that has regulated motor vehicles for their contribution to global climate change. However, as the CARB analysis team showed the regulation not only has positive impacts on the air quality and environment in California (and to a small extent the world), but it does have positive economic impacts on California consumers. More importantly, "California is not acting in isolation." [199] There are at least seven other states (New York, Massachusetts, New Jersey, Vermont, Connecticut, Rhode Island and Maine), along with the nation of Canada, considering adopting the regulations.[200] If all of these states and Canada pass legislation to adopt regulations similar to California, the number of cars required to meet the new standards will triple.

Despite the confidence of the California Air Resources Board in the potential of Assembly Bill 1493, there are several sources of opposition to the legislation and resulting regulations. The primary source of opposition has been the automobile industry. The Alliance of Automobile Manufacturers along with several major automobile dealerships in California have filed suit against the State of California claiming the emissions regulations resulting from Assembly Bill 1493 are actually fuel economy standards which the State does not have the authority to set.[201] The Alliance also claims that the California regulations are prohibitively expensive and would force dramatic changes in vehicle technology.[202] This suit was filed on December 8, 2004 and is ongoing. There have been no court rulings as of yet, but any such rulings could have strong implications for greenhouse gas emissions regulations, the development of such regulations at the state level, and the technological direction that the automobile industry will take over the next decade.

5.5 New York City and New York State Legislation

OVERVIEW

Legislation regarding conditions of transportation in New York State is made at both the state and city level. While New York City is bound to state initiatives, the state is not necessarily bound to city ones. Even though air quality and energy policy are primarily state and federal issues, the city can play a lead role by adopting new policies. Currently, there are five Introductions that are being supported by organizations such as the NRDC, to change New York policy.

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[198] California Environmental Protection Agency. "Report to the Legislature and the Governor on Regulations to Control Greenhouse Gas Emissions from Motor Vehicles". A.R. Board, Editor. 2004.

[199] California Environmental Protection Agency. "Fact Sheet: Climate Change Emissions Control Regulation." A.R. Board, Editor. Dec. 10, 2004.

[200] California Environmental Protection Agency. "News Release: ARB Approves Greenhouse Gas Rule". A.R. Board, Editor. 2004.

[201] Plungis, J. "Auto industry sues over California air plan." *Detroit-News.com*. Dec. 8, 2004. Retrieved Jan. 30, 2005 from http://www.detnews.com/2004/autosinsider/0412/13/A01-27192.htm.

[202] G. Schneider. "Carmakers Fight Calif. CO_2 Limits." *The Washington Post.* Dec 8, 2004. Final Ed: E01.

5.5.a Introduction No. 414

The first current Introduction seeks to amend the administrative code of the city of New York in relation to the city's purchase of cleaner vehicles. The Introduction was proposed by the Speaker Council Member Miller and Council Members Gennaro, Yassky, Quinn and McMahon. The purchasing of cleaner vehicles for the city has been one of the main issues examined to reduce the amount of air pollution in the city. This Introduction, No. 0414-2000, first defines the various clean fuel vehicles and applies a rating system to rank each in the order of pollution emission levels. A ranking of one is given to zero emission vehicles while low emission vehicles are given a ranking of six. These rankings will be used for the city to determine the number of alternative fuel vehicles that the city has currently and purchases in each department. The Introduction also calls for the city to complete an inventory and analysis of its fleet of light-duty vehicles and medium-duty vehicles to determine a baseline of total carbon dioxide emitted from such vehicles by October 1, 2005. This is important for the monitoring of potential reductions in emission levels. The guidelines for percent reduction are also set and increase to a 10 percent reduction by 2010. The Introduction covers reductions in emissions from the state bus systems and calls for the mayor to submit reports on the purchasing of city alternative fuel buses each year. The Introduction also amends New York City code in relation to alternative fuel sanitation vehicles. It calls for 50 percent of the city's new sanitation vehicle purchases to be alternative fuel vehicles by the beginning of July 2005.[203]

5.5.b Introduction No. 415

A second Introduction in New York City is Introduction No. 0415-2004, an amendment to the administrative code of the city of New York that requires the use of ultra low sulfur diesel fuel and the best available technology for reducing pollution in diesel-powered motor vehicles. It was proposed by the Speaker Council Member Miller and Council Members Gennaro, Yassky, Quinn and McMahon. The Introduction calls for each diesel-powered motor vehicle owned or operated by a city agency to be powered by ultra low sulfur diesel fuel. The first step occurs in January 2006 when it is called for that each agency will use the best available fuel technology for diesel vehicles. The commissioner shall determine and publish a list of the best available technologies for each type of diesel vehicle. These technologies will be selected from those that have been verified by the U.S. Environmental Protection Agency or the California Air Resources Board. The commissioner will report every year on the state of the vehicles.[204]

5.5.c Introduction No. 416

The third New York City Introduction to address pollution in vehicles is Introduction No. 0416-2004. This Introduction amends the administrative code of New York City, to reduce the emission of pollutants from vehicles that handle, transport or dispose of solid waste and recyclable materials. The Introduction was proposed by the Speaker Council Member Miller and Council Members McMahon, Gennaro, Yassky and Quinn. The Introduction calls for any solid waste or recyclable materials contract to specify that diesel vehicles used shall be

[203] Administrative code of the city of New York. Sec. 24-163.1 and 24-163.2. Introduction No. 0414-2004. Aug 9, 2004.

[204] Administrative code of the city of New York. Sec. 24-163.4. Introduction No. 0415-2004. Aug 9, 2004.

powered by ultra low sulfur diesel fuel and the best available technology for reducing pollution emissions. The commissioner shall publish a list of the best available technology for each type of diesel vehicle. Any contractor that violates this shall be liable to a civil penalty of thirty-thousand dollars.[205]

5.5.d Introduction No. 417

The fourth Introduction dealing with vehicle emissions in New York City is Introduction No. 0417-2004. This Introduction amends the administrative code to reduce the level of pollution from sight-seeing buses. The Introduction calls for the commissioner not to issue or renew any licenses of a sight-seeing bus that: does not operate on ultra low sulfur diesel fuel or has not installed best available fuel technology. The commissioner shall make determinations for the best available technology, and publish this list. The technology shall be based on reducing particulate matter and then on the reduction of the emissions of nitrous oxides.[206]

5.5.e Introduction No. 428

The last Introduction dealing with vehicle emissions in New York City is Introduction No. 0428-2004. This Introduction amends the administrative code to reduce the level of emissions of pollutants from vehicles that transport children to and from school. It was proposed by the Speaker Council Member Miller and Council Members Addabbo, Boyland, Brewer, Clarke, Comrie, Fidler, Gennaro, Gentile, Gerson, James, Jennings, Koppell, Liu, Lopez, Martinez, Monserrate, Moskowitz, Nelson, Palma, Reed, Rivera, Seabrook, Serrano, Vallone, Weprin and Yassky. The Introduction calls for the use of ultra low sulfur diesel fuel and best available technology by September 2005 to reduce emissions. Every year the chancellor of the Department of Education shall report on the current state of the school fleet in relation to ultra low sulfur diesel fuel and best available technology use. Any person, corporation or association that violates new standards or falsifies results shall be subject to civil penalties.[207]

BROADER IMPLICATIONS

New York City is emerging as a leader of clean fuel legislation. These Introductions show the commitment of the city to new sources of clean fuel vehicles used in city projects and programs. If New York City passes the proposed Introductions then a majority of the fleet vehicles will have to follow best technology practices in relation to the amount of pollution emissions. If these are passed in New York City, then other cities may follow suit and pass their own laws on vehicles used for city purposes. The passage of these Introductions may also help the progression of clean fuel technologies and increase their adoption in other areas.

5.6 New York City Taxi Legislation

OVERVIEW

Both New York City and the Taxi and Limousine Commission (TLC) have a responsibility for legislating the taxi industry. Over the last decade, the New York City Council has passed, and

[205] Administrative code of the city of New York. Sec. 24-163.4. Introduction No. 0416-2004. Aug 9, 2004.
[206] Administrative code of the city of New York. Sec. 20-372. Introduction No. 0417-2004. Aug 9, 2004.
[207] Administrative code of the City of New York. Sec. 24-163.4. Introduction No. 0428-2004. Aug 11, 2004.

attempted to pass, legislation regarding taxi operations in the city. This legislation ranges from former alternative fuel legislation to legislation that regulates the handicapped taxis in the fleet. It is important to understand past legislation and why it passed or failed in order to draft new legislation to include alternative fuel taxis in the fleet.

LEGISLATIVE SUMMARY

5.6.a New York Assembly Bill No. 1403 (Introduced)

This Act was introduced on January 19, 2005 and will amend the administrative code of the City of New York to provide for a demonstration program for the fitting of taxicabs to accommodate the disabled. This will be accomplished by adding a new section 19-529.7 to the city code. The section will mandate that the TLC shall establish a program for the adaptation of 1,000 taxicabs to accommodate the disabled. This can apply to new taxicabs or retrofitted taxis already in service. In addition, the taxicabs shall be environmentally friendly and run on compressed natural gas or hybrid engines. The TLC will report the effects and findings of this program to the Mayor and City Council one year after the taxis have been placed in service. In addition, the program shall cease six months after this report is submitted.[208]

The passing of this Bill will not only help provide for the disabled of New York City, but it will help to guarantee that 1,000 alternative fuel taxis will be on New York City streets for at least one year.

5.6.b New York City Taxi Specific Legislation

On October 9, 2002, New York City Council Introduction No. 287 called for 100 percent of new taxis put into operation after December 31, 2003 to be alternative fuel vehicles. Included in the definition of alternative fuel vehicle are hybrid vehicles. This was called the "Clean Air Taxicab Act of 2002."[209] Introduction 0287 is a Local Law to amend the administrative code to require "all taxicabs placed into operation after December 31, 2003 to use alternative fuel."[210] Introduction 0287 was sent to the Committee on Transportation. Stated simply, the Act called for every taxi that was placed into operation after December 2003 to either be an alternative fuel vehicle, as defined in the section, or a hybrid-electric vehicle. The Administrative Code definition of alternate fuel is found in paragraph 2 of subdivision (a) of section 24-163.1 of the Administrative Code of the City of New York. The definition states that an alternative fuel is:

> "(i) alcohol; (ii) electricity; (iii) natural gas; or (iv) any other fuel other than gasoline or diesel fuel that the commissioner of environmental protection by rule determines to be acceptable for use as an alternative fuel for the purposes set forth in this section and/or section 24-163.2 of this code."[211]

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[208] Administrative code of the City of New York. New York Assembly Bill No. 1403**.** Sec. 19- 529.7. January 19, 2005.

[209] New York City Council. "Search Legislation". Retrieved March 22, 2005 from http://www.nyccouncil.info

[210] Administrative code of the city of New York. Introduction No. 0287-2002. Sec. 19-531. 10 September 2002.

[211] NYC Taxi & Limousine Commission. "Frequently Asked Questions: Alternative Fuel/Accessible Medallions." *TLC Medallion Sale Information*. Retrieved on March 22, 2005 from http://www.nyc.gov/html/tlc/medallion/html/faq/altfuel_accessible.shtml#4

At the time of the Act there were five sedans available as alternative fuel vehicles, the Taxi and Limousine Commission approved only the Ford Crown Victoria for use as a taxi cab. However, the Act was laid over by the Committee on November 20, 2003 and on the day it was to go into action, December 31, it was pronounced Sine Die, or laid over indefinitely at the end of the session.[212]

In 2003 and 2004, two Introductions (625 and 158, respectively) were put forth to give alternative fuel taxis priority in passenger queues at New York City airports.[213] These introductions were not put into law. However, one piece of related legislation that was successfully passed was Local Law No. 51 of 2003. This specified that at least nine percent of new medallions sold were to be used for the option of either compressed natural gas vehicles or hybrid vehicles, as long as the bid price for the medallions was 90 percent of the average price of a standard medallion. In the Taxi and Limousine Commission's April 2004 medallion sale, these alternative fuel medallions failed to reach the required price as mandated by the legislation. In reaction to this, the process was subsequently modified by conducting a stand-alone auction at significantly reduced rates. At the medallion sale of October 15, 2004, there were bids for 19 alternative fuel medallions. The average alternative fuel bid was $222,742.59, with a high of $225,111.20. Currently, the sales of these medallions have not been consummated due to the lack of availability of appropriate alternative fuel vehicles.[214]

Introduction 84 was presented to the City Council on February 04, 2004 and was referred to the Committee on Transportation. Introduction 84 is a Local Law to amend the code to mandate that newly issued "taxicab licenses be used only with taxicabs that are wheelchair accessible and that *all* taxicabs service be wheelchair accessible."[215] However, Introduction 84 included a line requirement that a percentage of the new licenses also be clean-fuel vehicles. Currently, the Introduction is still in committee and no further action to date has been taken on it.[216] One section of the Introduction is important for clean fuel taxis in the city. It specifically states, "at least nine percent [of new taxi licenses] shall be issued subject to the requirement that the vehicles operated by or under agreement with the owners of such licenses either be powered by compressed natural gas or be a hybrid electric vehicle."[217] The inception of the Introduction will advance this mandate as well.

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[212] New York City Council Site. "Introduction 0287". Retrieved March 20, 2005 from http://www.nyccouncil.info/issues/bill_details.cfm?ID=Int%200287-2002&TYPE=all&YEAR=2002&SPONSORS=YES&REPORTS=YES&HISTORY=YES

[213] New York City Council. "Search Legislation". Retrieved March 22, 2005 from http://www.nyccouncil.info

[214] New York City Taxi & Limousine Commission. *2004 Annual Report to the New York City Council.* New York: NYC TLC. 2004. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/2004_annual_report.pdf

[215] Administrative code of the city of New York. Introduction No. 0084-2004. Sec. 19-532. 02 April 2004.

[216] New York City Council Site. "Introduction 0084". Retrieved 20 March 2005 from http://www.nyccouncil.info/issues/bill_details.cfm?ID=Int%200084-2004&TYPE=all&YEAR=2004&SPONSORS=YES&REPORTS=YES&HISTORY=YES

[217] New York City Council Site. "Introduction 0084". Retrieved 20 March 2005 from http://www.nyccouncil.info/issues/bill_details.cfm?ID=Int%200084-2004&TYPE=all&YEAR=2004&SPONSORS=YES&REPORTS=YES&HISTORY=YES

The pieces of legislation described above are important bases for new alternative fuel taxi cab legislation. As stated in a Committee on Transportation report released on November 20, 2003, it is "sound public policy to encourage large numbers of vehicles to become exclusively alternate fuel vehicles. A natural place to begin such a conversion process is the taxicab industry whose vehicles often spend most of every 24 hour period on New York City's streets."[218]

5.6.c New York City Taxi Legislation for Disability Issues

Local Law No. 51 of 2003 requires that nine percent of new medallions sold be used for wheelchair accessible cabs. Again, this legislation specified that the bid price for these restricted medallions needed to be at least 90 percent of the average price of a standard medallion. Similar to the alternative fuel medallions, none of the handicapped medallions reached the required price in the medallion sale of April 2004. This process was also subsequently modified by conducting a stand-alone auction at significantly reduced rates. In October 2004, the Taxi and Limousine Commission opened 89 bids for wheelchair-accessible taxicab medallions. In this auction, twenty-seven wheelchair-accessible medallions were sold. The average selling price was $275,262.28. The highest bid was $347,000.01.[219]

Under the terms of a Request for Proposal issued on September 2, 2003, New York State Energy Research and Development Authority has agreed to provide a total of $600,000 for multiple contracts to pay for engineering tests and other evaluations toward the development of handicap/accessible alternative fuel-efficient vehicles. The Taxi and Limousine Commission will serve as a technical advisor in this program.

Alternative Fuels Technologies Corporation has been working with General Motors and several other firms to develop the "MetroKing" taxi, which will be based on General Motors' new Colorado/Canyon pickup truck chassis. This vehicle will incorporate a wheelchair ramp that is compliant with the American Disabilities Act, wide-entry doors, and wheelchair safety restraints. The initial model has been designed to store its ramp in the trunk. Without a wheelchair, the MetroKing can accommodate seating for four behind its partition. Safety and crash testing (including taxi-relevant tests such as partition strength, jump-seat seatbelt anchors, etc.) are now being performed on components added by Alternative Fuels Technology Corporation, such as the rear frame, passenger module and modified fuel system.

GSM Vehicles, Inc., is developing a "Manhattan" taxi, with unique all-composite unibody construction and General Motors mechanical components such as engine, transmission, suspension, brakes, etc. The Manhattan taxi will incorporate a wheelchair ramp stored in the door pocket, wide-entry doors, and wheelchair safety restraints. Without a wheelchair, the vehicle can also accommodate four passengers behind the partition. The greatest difference in design between the Manhattan and MetroKing is that the Manhattan taxi has a lower floor

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[218] The Council of the City of New York. "Briefing Paper of the Infrastructure Division." *Committee on Transportation*. 20 November 2003.

[219] New York City Taxi & Limousine Commission. *2004 Annual Report to the New York City Council.* New York: NYC TLC. 2004. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/2004_annual_report.pdf

and shorter overall length. It is currently in final design stages, after which crash testing will begin.[220]

Currently the Toyota Sienna is being used as a handicap accessible taxicab, under the existing pilot program to test the feasibility of the Sienna. The Toyota Sienna offers the possibility of meeting the objectives of both the handicap and alternative fuel vehicle medallion requirements when it is released as a hybrid model, which is anticipated to occur in model year 2007.

BROADER IMPLICATIONS

According to the Taxi and Limousine Commission, there are no hybrid vehicles that have been manufactured and presented for approval that meet the size specifications set forth in the regulations, or that have been adequately tested for safety and crashworthiness for the American market. For a sedan to be approved for use by the Taxi and Limousine Commission as a medallion taxicab, the vehicle must contain at least 107 interior cubic feet, and must have undergone safety testing by the manufacturer pursuant to criteria established by Federal Motor Vehicle Safety Standards.

By requiring the Taxi and Limousine Commission to implement alternative fuel vehicles in the fleet it either requires the re-writing of the specifications or allowing special exemptions for alternative fuel taxis. However, if New York City passes legislation mandating the use of alternative fuel taxis it might help to forge the way for other cities that have taxi fleets to do the same.

The anticipated release of the hybrid Toyota Sienna provides an opportunity for the Taxi and Limousine Commission to meet the dual requirements to increase the percentage of alternative fuel and wheelchair accessible vehicles. In this way, these initiatives are not mutually exclusive and may serve to support one another in promoting a cleaner taxi fleet that better serves New York City residents.

[220] New York City Taxi & Limousine Commission. *2004 Annual Report to the New York City Council.* New York: NYC TLC. 2004. Retrieved Feb. 2, 2005 from http://www.nyc.gov/html/tlc/downloads/pdf/2004_annual_report.pdf.

6. NORTH AMERICAN CASE STUDIES

Many North American cities have spent time and money trying to alleviate their own traffic issues, leading to a multitude of policies aimed at congestion relief, improving public transportation, or decreasing air pollution. These case studies can provide baseline information on projects that have had high success rates and elucidate the reasons behind the success. Understanding the processes and policies used to address similar problems, may increase the potential success rate of a New York City initiative.

6.1 Canada

Toronto

PROBLEM

Toronto faces a congestion problem within its central business district as well as on major highways that serve as popular commuting routes around the city.

LEGISLATION AND RESULTING POLICY

To alleviate traffic on highways surrounding Toronto, a new highway called the 407 Express Toll Route (ETR) has been constructed. The 407 ETR is an unusual and groundbreaking road, which runs east-west just north of Toronto for approximately 108 kilometers and connects with six other Toronto highways. It is the world's first all electronic and open access toll highway.[221] The 407 ETR uses advanced technology to collect tolls. Vehicle identification is accomplished either by an electronic transponder installed in the vehicle (similar to New York City's E-ZPass), or by license plate recognition scanners. Drivers are charged a toll based on: 1) the time of day traveled, 2) vehicle class, and 3) distance traveled. Customers without a transponder pay an additional fee of CD$3.45 per trip.[222] Drivers are billed at the end of each month for their usage of the 407 ETR. Due to the vehicle identification technology in place, there are no toll booths on the 407 ETR, eliminating traffic lineups and time lost while drivers search for correct change. [223]

The 407 ETR uses some advanced environmental management practices in its operations. These practices include: 1) storm water run-off ponds to minimize the quantity and improve the quality of storm water runoff, 2) fenced in corridors to protect animals and prevent pedestrians from accessing the highway, and 3) unique salt spreading machines that use salt brine rather than the traditional rock salt. The brine uses 30 percent less salt and provides better road coverage.[224]

While Toronto has not yet implemented any long-term practices to reduce increasing congestion within its central business district, in recent years, they have conducted an annual

[221] 407 ETR. *407 ETR Story*. Retrieved Feb 16, 2005 from http://www.407etr.com/about/about_highway_story.asp.
[222] 407 ETR. *The World's Smartest Highway*. Retrieved Feb 16, 2005 from http://www.407etr.com/tolls/tolls.asp.
[223] 407 ETR. *407 ETR Story*. Retrieved Feb 16, 2005 from http://www.407etr.com/about/about_highway_story.asp.
[224] 407 ETR. *The Highway Environment.* Retrieved Feb 16, 2005 from http://www.407etr.com/about/about_highway_environment.asp.

"car free" day. During this day, portions of the city are blocked off to cars, allowing only pedestrians and cyclists.[225]

IMPACTS

The 407 ETR has been a successful endeavor. As of June 2004, over 9.6 billion total vehicle kilometers had been traveled on the 407 ETR since its opening in October 1997.[226] The 407 ETR has been successful in relieving congestion on other highways in Toronto.[227] Unfortunately, traffic in downtown Toronto is significant and there is some interest in implementing congestion pricing in the central business district.[228]

6.2 Mexico

Mexico City

PROBLEM

Mexico City has a dense urban population. Studies have shown 84 percent of airborne contaminants originate from the city's 3.5 million vehicles, of which more than 2 million are taxis and microbuses. The number of vehicles in Mexico City is predicted to rise to 4.5 million by 2006 and to 5.4 million by 2010,[229] which may create substantial human health risks given the current air quality problems.

LEGISLATION AND RESULTING POLICY

Mexico is currently making several efforts to increase the use of alternative fuel transportation, however not at the same scale or pace as cities and states in the United States. In June of 2004, the World Resources Institute's Center for Transport and the Environment, the U.S. Environmental Protection Agency, the Mexico City government, the Mexican Ministry for Environment and Natural Resources, and the Center for Sustainable Transport in Mexico City publicly released plans to retrofit diesel buses in Mexico City. Aimed at reducing fleet vehicles' particulate matter emissions by 90 percent using ultra-low sulfur diesel and natural gas, the one-year pilot project relies on a grant of $511,000 and utilizes expertise from both Mexican and American government, public, non-profit, and private bodies.[230]

In addition to the diesel and natural gas initiative, the Environment Secretariat for Mexico City has implemented a one-year pilot study to test and evaluate ten Toyota Prius vehicles.

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[225] Car Free Day. *Welcome to Car Free Day in Canada.* Retrieved Feb 16, 2005 from http://www.carfreeday.ca/.
[226] Car Free Day. *Welcome to Car Free Day in Canada.* Retrieved Feb 16, 2005 from http://www.carfreeday.ca/.
[227] Transportation Alternatives. *Congestion Pricing*. Retrieved Feb 16, 2005 from http://www.transalt.org/campaigns/sensible/congestion.html.
[228] Donner, Arthur. "Tolls for Toronto?" *The Toronto Star.* Retrieved Feb 16, 2005 from http://best.enigmati.ca/trans-action/200403/3532.html.
[229] Lloyd, A.W. *Mexican Economic Report; September, 2002.* Retrieved Feb. 17, 2005 from http://www.mexconnect.com/MEX/lloyds/llydeco0902.html
[230] EMBARQ. "WRI, EPA, and Mexican Partners Launch Project to Cut Emissions from Diesel Buses." *World Resources Institute.* Jun. 2004. Retrieved Feb. 17, 2005 from http://www.embarq.wri.org/en/Article.aspx?id=7

Mexico City's Metropolitan Environmental Commission has instituted a 10-Year Clean Air Plan aimed at eliminating heavy-pollution trucks, inducing cargo restrictions, implementing natural gas buses, and providing incentives for taxi fleets to incorporate low emission and hybrid vehicles.[231]

IMPACTS

Initiatives aimed at decreasing traditionally-fueled vehicle use and emissions within Mexico City are relatively recent. At present no data was located that addresses the outcomes of these activities.

6.3 United States of America

OVERVIEW

Certain aspects of transportation in U.S. cities are influenced from the federal level. The Energy Policy Act of 1992 was the first federal legislation for clean fuel vehicles. This Act was passed by Congress on October 24, 1992 to reduce the nation's dependence on imported petroleum by requiring certain fleets to acquire alternative fuel vehicles. The U.S. Department of Energy administers the Act on four separate levels: the Federal Fleet Requirements, the State and Alternative Fuel Provider Rule, the Private and Local Government Fleet Rule and the Alternative Fuel Designation Authority. Each division focuses on specific regulatory activities in relation to alternative vehicle use. The Department of Energy's overall mission in regard to the Energy Policy Act is to replace 10 percent of petroleum-based motor fuels by the year 2000 and 30 percent by the year 2010.[232]

Additional federal support for alternative fuel vehicles was introduced in 2004 with the introduction of an IRS tax deduction for the purchase of hybrid vehicles. The deduction is a one-time federal deduction of up to $2,000 for the purchasing of a hybrid vehicle. However, the deduction is decreased $500 each year until it expires in 2006.[233]

Even though alternative vehicle use is increasing in the U.S., it is unlikely that there will be a large shift in fuel economy unless the Corporate Average Fuel Economy (CAFE) is significantly increased. Corporate Average Fuel Economy, defined in the Energy Policy Conservation Act of 1975, is the sales weighted average fuel economy for light trucks and passenger cars. The Secretary of Transportation has the delegated authority to establish the Corporate Average Fuel Economy standards; however, the U.S. Environmental Protection Agency is responsible for calculating and certifying the average fuel economy for each automobile manufacturer. This certification can be achieved in two ways: 1) The manufacturer can provide its own fuel

[231] "Testing Hybrid Vehicles." *Reuters News Service*. Sept. 2001. Retrieved Feb. 16, 2005 from http://www.yournextcar.org/NewsBriefs_0901.html

[232] U.S Department of Energy, Office of Transportation Technologies. *EPAct Fleet Information and Regulations Fact Sheet*. Apr. 2001. DOE/GO 102001-1306.

[233] Fueleconomy.gov. "Advanced Technology: Hybrid Vehicles - Tax Incentives." *U.S. Department of Energy*. 2004. Retrieved on January 20, 2005 from http://www.fueleconomy.gov/feg/tax_hybrid.shtml.

economy test data, or 2) the U.S. Environmental Protection Agency will obtain a vehicle and test it in the Office of Transportation and Air Quality facility.[234]

Corporate Average Fuel Economy is specified by Congress to set the "maximum feasible level" for miles per gallon minimums based on: 1) Technological feasibility, 2) Economic practicability, 3) the effect of other standards on fuel economy and 4) the need of the nation to conserve energy. Currently, the standard for passenger vehicles is 27.5 mpg, which was set in market year 1990. There are penalties for automobile manufactures that do not meet the Corporate Average Fuel Economy standards, a penalty of $5.50 is charged per tenth of a mile per gallon for each tenth under the target value times the total volume of those vehicles manufactured for a given model year. Since 1983, manufacturers have paid more than $590 million in Corporate Average Fuel Economy (CAFE) civil penalties. Some manufactures still continue to pay the penalty or rely on accumulated fuel credits. [235]

Given the influence of the federal government on the vehicle market and its implications for hybrid sales, it seems that federal policies may be an ultimate goal. Several U.S. cities have taken the initiative to develop innovative programs to convert their own fleets to alternative fuels, to encourage alternative fuel vehicles among their populations, and to promote alternate methods of transportation. Some of these cases are explored below.

6.3.a. Boston, Massachusetts

PROBLEM

The rise in automobile use in Boston is outpacing the increase in population. While the population increased by approximately 3 percent between 1990 and 2002, the number of automobile registrations increased by 36 percent. In the same time period the number of residential parking permits issued by Boston increased by 47 percent.[236] This increased car usage causes congestion, safety hazards for pedestrians, and public health risks.

LEGISLATION AND RESULTING POLICY

In 1996, Massachusetts Governor Weld signed Executive Order 388, which required that the Department of Procurement and General Service phase-in the use of the "cleanest alternative fuel vehicles available and practical."[237] The process of phasing-in these vehicles began in 1997, and extended to 2001, at which point the Executive Order requires that 75 percent of fleet vehicles purchased by the Department meet the alternative fuel requirement, 10 percent of which were to be zero-emission vehicles. [238]

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[234] National Highway Traffic Safety Administration. *CAFE Overview*. Retrieved February 11, 2005 from http://www.nhtsa.dot.gov/cars/rules/cafe/overview.htm.

[235] National Highway Traffic Safety Administration. *CAFE Overview*. Retrieved February 11, 2005 from http://www.nhtsa.dot.gov/cars/rules/cafe/overview.htm.

[236] Boston Transportation Department. "Update: Access Boston 2000-2010, Boston's Citywide Transportation Plan." Boston, Summer 2002. Retrieved Feb. 17, 2005 from http://www.cityofboston.gov/accessBoston/pdfs/newsletter.pdf

[237] The Commonwealth of Massachusetts, Executive Department. *Executive Order 388: Clean Alternative Fuel for the Massachusetts Fleet*. Boston: State House, 1996. Retrieved Feb. 17, 2005 from http://www.lawlib.state.ma.us/ExecOrders/eo388.pdf

[238] The Commonwealth of Massachusetts, Executive Department. *Executive Order 388: Clean Alternative Fuel for the Massachusetts Fleet*. Boston: State House, 1996. Retrieved Feb. 17, 2005 from http://www.lawlib.state.ma.us/ExecOrders/eo388.pdf

The Massachusetts Port Authority (Massport) is a leader in alternative vehicle conversion. Through an initiative that began in 1995, they have converted their entire shuttle bus fleet to compressed natural gas. Over 100 of Massport's Logan-based fleet vehicles operate on compressed natural gas or electricity, and in 2001, Massport replaced its last diesel bus. In addition to these internal successes, Massport is trying to influence the behavior of people who work at and travel to Logan Airport. These incentives include a "25% discount on Logan ground access fees for qualified alternative fuel vehicles" and the addition of numerous parking spaces with electrical car chargers.[239]

To address transportation in the Boston metropolitan area, the Boston Department of Transportation has developed Access Boston 2000-2010: Boston's Citywide Transportation Plan. This plan is conceived to allow for concurrent planning and development. The primary objectives of the plan are to improve parking systems to reduce congestion, to encourage bicycling through bicycle path improvement, to improve current public transportation and prioritize potential future capital investment projects, and to institute policies to protect pedestrian safety in residential neighborhoods.[240]

Finally, one lesson may be learned from Boston's attempt to involve the community in their studies. Boston conducted a traffic study in which they asked merchants to monitor the turn-over of parking in front of their businesses. This type of program engages the citizens and helps to educate people about how the traffic around them functions.[241]

IMPACTS

Massport's program to increase alternative vehicle usage has succeed dramatically in transforming its fleet, and has been recognized at the New England's, First Annual ALT Wheels Festival, and at the Opening Plenary Session of the Annual Clean Cities Symposium in Philadelphia. [242]

6.3.b Washington D.C.

PROBLEM

Washington D.C. faces congestion in its central business district and an increasing amount of commuters clogging highways that feed into the city.

LEGISLATION AND RESULTING POLICY

In May of 2004, Washington D.C.'s mayor, Anthony Williams, established a Congestion Task Force to tackle D.C.'s congestion issues. Its first activities have included surveys and public meetings to gauge public opinion about congestion and possible solutions. Although

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[239] Massport. *Logan Airport: Airport Programs: Environmental*. Retrieved Feb. 17, 2005 from http://www.massport.com/logan/airpo_gtu_afv.html

[240] Boston Transportation Department. "Update: Access Boston 2000-2010, Boston's Citywide Transportation Plan." Boston, Summer 2002. Retrieved Feb. 17, 2005 from http://www.cityofboston.gov/accessBoston/pdfs/newsletter.pdf

[241] de Cerreno, Allison L. C. *The Dynamics of On-Street Parking in Large Central Cities*. New York: NYU Wagner Rudin Center for Transportation Policy & Management, December 2002

[242] Massport. *Logan Airport: Airport Programs: Environmental*. Retrieved Feb. 17, 2005 from http://www.massport.com/logan/airpo_gtu_afv.html

this task force is relatively new, it is investigating multiple strategies including congestion pricing, additions to the public transportation infrastructure, initiatives to increase bike use, and new parking regimes.[243]

Washington D.C.'s commuters are also impacted by Virginia's high occupancy vehicle (HOV) lane policy.[244] Starting in 2000, hybrid vehicles have qualified for special exemption plates that allow them access to the high occupancy vehicle lanes. In April 2003, approximately 2,500 hybrid vehicles were registered with clean fuel plates. By the end of 2004, there were approximately 6,800 registered hybrid vehicles.[245] These vehicles now account for 18 percent of HOV traffic. This rapid growth in hybrid vehicle use has helped contribute to pushing the high occupancy vehicle lanes beyond their operating capacity. To assess the situation, Virginia's Department of transportation formed the HOV Enforcement Task Force. The Task Force has recommended that only the cleanest hybrid vehicles should be allowed to use the high occupancy vehicle lanes and that the current hybrid exemption from the high occupancy restrictions should expire in 2006.[246]

IMPACTS

It appears that in Washington D.C. the high occupancy vehicle lane incentive was so effective that it ended up over-burdening the lanes. This result shows the power of incentives aimed at reducing pollution and congestion, but also foreshadows potential problems. Additionally, while Washington D.C. is attempting to address its downtown congestion, the Congestion Task Force is less than one year old, and is still researching its potential options.

6.3.c Atlanta, Georgia

PROBLEM

Atlanta faces a rapidly growing metropolitan area, with increased sprawl creating congestion and potential air quality problems.

LEGISLATION AND RESULTING POLICY

The state of Georgia is home to and participant of the Atlanta[247] and Middle Georgia Clean Cities Coalitions.[248] The Alternative Fuel Vehicle Incremental Cost Incentive Program is sponsored via Congestion Mitigation and Air Quality funding, which offers grants to local governments, businesses and authorities within the 13 counties that constitute the Atlanta metropolitan area in order "to assist the introduction and expansion of alternative fuels into

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[243] District Department of Planning: Downtown Congestion Task Force. Retrieved February 17, 2005, from: http://ddot.dc.gov/ddot/cwp/view,a,1249,q,610165.asp

[244] High occupancy vehicle (HOV) lanes are used to encourage carpooling by providing a separate lane for vehicles with multiple passengers. They are generally less congested and therefore decrease travel time, which is especially important for commuters.

[245] **"**HOV Enforcement Task Force Makes Recommendations to Safeguard HOV lanes." Press Release NOVA-NR05-02. *VDOT News Page*. 2005. Virginia Department of Transportation. Jan 30, 2005. http://www.virginiadot.org/infoservice/news/newsrelease.asp?ID=NOVA-NR05-02.

[246] Morrison,, D.C. and M. Counts. "Second Report of the High-Occupancy Vehicle Enforcement Task Force." Virginia Department of Transportation. Jan 4, 2005.

[247] Clean Cities: Atlanta "Partnership for Clean Transportation". Retrieved Feb 17, 2005 from www.cte.tv/cca/cleancitiesatl.html

[248] Clean Cities: Middle Georgia "What is Clean Cities?" Retrieved Feb 17, 2005 www.mga-cleancities.com

fleet operations".[249] The program offers a reimbursement incentive for fleet-vehicle purchases to compensate for cost differences between alternative fuel vehicles and comparable conventional gasoline- or diesel-powered vehicles.

Georgia also offers seven relevant tax credits concerning zero emissions vehicles, light electric vehicles, and alternative fuel vehicles. The first tax credit is offered to individuals who either purchase or lease a zero emissions vehicle. The second tax credit is offered to individuals who lease or purchase an alternative fuel vehicle that meets or surpasses the U.S. Environmental Protection Agency's emission standards for light electric vehicles. The third tax credit is offered to individuals who convert a conventional vehicle to an alternative fuel vehicle. The fourth tax credit is offered to businesses that purchase or lease an electrical vehicle charger. The fifth is an income tax credit for the purchase or lease of a zero emissions vehicle in the amount of $5,000 or 20 percent of the vehicle cost, whichever is less. These vehicles include battery-only electric or hydrogen vehicles (refer to Georgia Code Sec. 48-7-40.16). A sixth and similar tax credit is offered to individuals who purchase, lease, or convert into a light electric vehicle. The credit is $2,500 or 10 percent of the vehicle conversion cost, whichever is less (refer to Georgia Code Sec. 48-7-40.16). A seventh tax credit is available to business enterprises (under the same terms as the light electric vehicle tax credit) for electric vehicle chargers in Georgia (refer to Georgia Code Sec. 48-7-40.16). Together these credits provide for a comprehensive commitment to cleaner vehicle use in Georgia.

In addition to the benefits from tax incentives, properly identified alternative fuel vehicles may be used in high occupancy vehicle lanes regardless of passenger load (refer to Georgia Code Sec. 32-9-4 and 40-2-76). Motor fuels that are not defined as alternative may incur an excise tax of $0.075 per gallon on distributors who sell or use such non-alternative motor fuels in Georgia (refer to Georgia Code Sec. 48-9-3).

Finally, under provisions of the Transportation Equity Act for the 21st Century, the Georgia Regional Transportation Authority entered into a partnership agreement with Suburban Propane, U-Haul and several other private and non-profit agencies in order to stimulate and expand alternative fuel use in the Atlanta metropolitan area. The partnership draws upon Congestion Mitigation and Air Quality program funding to support refueling stations owned by for-profit firms. "In a dramatic departure from standard practice under Title 23 of the U.S. Code, [Transportation Equity Act for the 21st Century] authorized the use of [Congestion Mitigation and Air Quality] funds for these purposes provided that the public benefit of cleaner air is realized."[250]

[249] Cummins Westport. "Products / Incentives". Retrieved Feb 17, 2005 from http://www.cumminswestport.com/products/incentives.php

[250] Public Roads. "Georgia Regional Transportation Authority Signs Public-Private Contract on Alternative Fuels." March 2002. Retrieved Feb 17 2005 from http://web1.infotrac.galegroup.com/itw/infomark/251/745/57668244w1/purl=rc1_ITOF_0_A87425724&dyn=12!xrn_3_0_A87425724?sw_aep=22516

IMPACTS

On January 20th 2004, four environmental groups were able to halt federal funding for transportation projects in Atlanta when they sued a number of transportation agencies on the grounds that 61 proposed road construction projects would worsen public health via vehicle emissions. The intentions of the group were not to halt urban sprawl and road building, but were to persuade implicated parties to re-examine traffic issues, economic suffering, and emission increases to promote better air quality planning for construction endeavors. The prosecuting parties involved were the Georgians for Transportation Alternatives, the Georgia Conservancy, and the Sierra Club. They raised allegations against the Georgia Department of Transportation, the 10-county member Atlanta Regional Commission and the U.S. Department of Transportation. In addition to successfully stopping 44 proposed projects, the prosecuting bodies secured reassurance that the defendants would consider low income and minority repercussions, scientific review, and transportation data before approving future construction plans. The court decision prohibits construction that violates the Clean Air Act and federally-established emission standard levels. "Metro Atlanta is the fastest sprawling metro area in the country…and ranks among the worst cities for air pollution. We hope our efforts here can serve as a model for other urban areas to avoid the crisis we are dealing with here."[251] The lawsuit, pitted against threats to Atlanta's quality of life, was the first to test federal-level provisions of clean air and transportation legislation.

Information regarding the efficacy of Atlanta's numerous tax policies was not found in the course of this research.

6.3.d Dallas/Fort Worth and Houston, Texas

PROBLEM

Texas is the home to the Alamo Area,[252] Central Texas, Dallas/Fort Worth,[253] Greater Houston Regional, and South East Texas Clean Cities Coalitions.[254] Houston and Dallas/Fort Worth are areas of non-attainment under the Clean Air Act, meaning that they exceed the U.S. Environmental Protection Agency's emission standards for industrial and motor vehicle pollution. Additionally, in January of 2004, Dallas and Houston were both facing a loss of federal construction funding for roadway projects that violated, or would contribute to the violation of, U.S. Environmental Protection Agency emission standards.[255]

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[251] Southern Environmental Law Center. "Atlanta Clean Air Lawsuit Settled". June 21, 1999 Retrieved Feb 16, 2005 from http://www.selcga.org/Newsroom/res_news_1999-06-21.shtml

[252] Clean Cities. "Alamo Area Named in Top Ten of Best Performing Clean Cities". Retrieved Feb 17, 2005 from www.aacog.dst.tx.us/naturalresources/cleancities/cleancities.htm,

[253] *DFW Clean Cities*. North Central Texas Council of Governments Transportation Department. 17 February 2005 http://www.cleancities.nctcog.org/

[254] *Clean Cities / Clean Vehicles: Approximately $40 million Available*. Houston-Galveston Area Council. 17 February 2005 www.houston-cleancities.org

[255] Preston, D. "Trends in the Region: EPA Rules Could Cloud Road Funding for Texas Cities." The Bond Buyer. January, 2000. Retrieved Feb 17, 2005 from http://web1.infotrac.galegroup.com/itw/infomark/251/745/57668244w1/purl=rc1_ITOF_0_A58453413&dyn=34!xrn_12_0_A58453413?sw_aep=22516

LEGISLATION AND RESULTING POLICY

The Texas Emissions Reduction Plan is a conglomeration of incentive programs with the intent of improving air quality in Texas through grant incentives put forth by the Texas Commission on Environmental Quality. The grants apply to alternative fuel vehicles and conversion vehicles. General research and demonstration projects are funded in conjunction with the New Technology Research and Development Program. The School Bus Rebate Program is another state-level program providing incentives to encourage organizations to operate liquid propane gas buses within their fleets.

Similarly, the Adopt-A-School Bus Program is a fundraising endeavor to bring non-profit aid to local school districts that replace their older, diesel school buses with newer alternative-fuel buses. This program relies on area partnerships formed between the U.S. Environmental Protection Agency, various state agencies, local elected officials, and corporate sponsors. These programs are operational in the Austin/Central Texas,[256] Dallas/Fort Worth,[257] Houston,[258] and San Antonio/Alamo areas.[259] Additionally, a school bus replacement rebate program is administered by the Alternative Fuels Research and Education Division, which offers 80 percent rebates to school bus fleets incorporating low-emission vehicles.[260]

Additional grant programs for alternative fuel procurement and usage are offered by multiple organizations and agencies such as the Texas Economic Development and Tourism Office (refer to Texas Statutes, Agriculture Code, Chapter 16). Several other agencies and organizations provide grants to research partnerships in the public and private arenas, especially federal and state fleet conversions. They include the Texas State Energy Conservation Office and the Texas Alternative Fuels Council.[261]

Texas has pursued the conversion of government fleets under the Texas Clean Fuel Fleet Program. As of September 1, 2002, government fleets with more than 15 vehicles and private fleets with more than 25 vehicles were required to possess 70 percent light-duty low emissions vehicles and 50 percent heavy-duty low emissions vehicles that meet U.S. Environmental Protection Agency standards. Within the same program, public transportation authorities are required to convert 50 percent of operational vehicles weighing less than 26,000 pounds to run on alternative fuels (refer to Texas Statutes §382.131 to §382.142).

Finally, fuel incentives attempt to influence individual behavior. Biodiesel or ethanol blended with conventional diesel is exempt from diesel fuel tax in Texas (refer to Texas Statutes, Tax Code, §162.001 and §162.204). Fuel quality is also regulated; as of April 1,

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[256] Clean Air Force. Retrieved Feb 17, 2005 from www.cleanairforce.org

[257] Adopt-a-School-Bus.0rg. Retrieved Feb 17, 2005 from www.adopt-a-schoolbus.org

[258] Education Foundation of Harris County "Adopt a School Bus". Retrieved Feb 17, 2005 from www.educationfoundation.info/adopt.htm

[259] Adopt-a-School Bus. "Clean it up. Turn it off. Keep it Green". Retrieved Feb 17, 2005 from www.aacog.dst.tx.us/schoolbus

[260] Railroad Commission of Texas. "Alternative Fuels Research and Education Division". Retrieved Feb 17, 2005 from www.propane.tx.gov/rebate_program

[261] SECO - Texas Office of the Comptroller. *State Energy Conservation Office*. Retrieved Feb 17, 2005 www.seco.cpa.state.tx.us

2005, all diesel fuel sold in 110 eastern Texas counties must contain less than 500ppm of sulfur, which will be mandated to no more than 15ppm of sulfur by June 1, 2006.

IMPACT

Most of the state and local initiatives in Texas have focused on converting fleets to alternative fuel vehicles. No data was encountered that directly relates these fleet improvements to changes in non-attainment and other high-emissions areas in Texas. These vehicle enhancements specifically target pollution and do not address the problems of congestion and sprawl.

6.3.e Chicago, Illinois

PROBLEM

Chicago is the third largest city in the country and faces problems with both congestion and air quality.

LEGISLATION AND RESULTING POLICY

The Chicago Area Clean Cities (CACC) coalition is part of the U.S. Department of Energy's Clean Cities Program. The Chicago Area Clean Cities aims to promote the use of clean vehicles in Chicago. The city works in coordination with this coalition to encourage municipal fleets to convert to alterative fuel vehicles, including compressed natural gas, E85 (a fuel blend of 85 percent ethanol, 15 percent gasoline), propane, and biodiesel.[262] Specifically, two grants from the Federal Congestion Mitigation and Air Quality (CMAQ) Improvement Program, have supplied Chicago and the Chicago Area Clean Cities program with funds to develop adequate infrastructure for new alternative fuel municipal fleets. This development includes 25 fueling stations. One of these stations boasts not only a pump for compressed natural gas, but also solar panels that contribute to 13 percent of the station's electrical needs.[263]

In addition to its progress in converting municipal fleets, Chicago is outfitting a large portion of its public school buses with oxidation catalysts, which are designed to reduce particulate matter by as much as 30 percent, hydrocarbons up to 50 percent, and carbon monoxide up to 40 percent.[264] Funding for this endeavor was provided in part through grants from the U.S. Environmental Protection Agency and the Illinois Environmental Protection Agency. [265]

Chicago, along with Seattle, San Francisco, and Los Angeles, offers another incentive called a Location Efficient Mortgage. This is a reduced mortgage rate that reflects savings that are inherent to certain efficient locations. "Location efficient communities are neighborhoods where residents can walk from their homes to stores, schools, recreation, and public

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[262] Chicago, Department of Environment. *Alternative Fueling Program*. Chicago, 2005. Retrieved Feb 2, 2005 from http://egov.cityofchicago.org:80/city/webportal/home.do

[263] Chicago, Department of Environment. *Alternative Fueling Program*. Chicago, 2005. Retrieved Feb 2, 2005 from http://egov.cityofchicago.org:80/city/webportal/home.do

[264] Illinois, Environmental Protection Agency. "Illinois Clean Bus Program." 2005. Retrieved Feb. 2, 2005 from http://www.epa.state.il.us/air/cleanbus/.

[265] Illinois, Environmental Protection Agency. "Illinois Clean Bus Program." 2005. Retrieved Feb. 2, 2005 from http://www.epa.state.il.us/air/cleanbus/.

transportation. Residents of location efficient neighborhoods have less need to drive than people living in less convenient locations, so they save money on transportation costs."[266]

IMPACTS

No data were encountered addressing the success that converting municipal fleets to alternative fuel vehicles has had on Chicago's air quality.

6.3.f Seattle, Washington

PROBLEM

Like many other cities, Seattle has focused its efforts on addressing diesel-fueled fleet vehicles to reduce risks to public health and the environment.

LEGISLATION AND RESULTING POLICY

The City of Seattle made international headlines in 2002 by committing to purchase 235 diesel hybrid-electric buses, a total of 16 percent of its fleet. The new hybrid-diesel buses operate on both ultra-low sulfur diesel and electricity stored in rooftop batteries. Despite the $200,000 increase in cost from the standard diesel buses, the city expects annual fuel and maintenance savings of $3.5 million.[267]

The Seattle City Council introduced a "Clean Green Fleet Action Plan" in 2003, which established policies and recommendations for decreasing harmful emissions from heavy-duty vehicles. Plan recommendations include rules mandating that a minimum of 50 percent of all compact cars purchased by the city use cleaner-burning alternative fuels such as compressed natural gas or have a minimum fuel efficiency of 45 miles per gallon.[268] As of 2004, the City of Seattle's vehicle fleet contains 200 bi-fuel natural gas vehicles out of a total 3,000 vehicles. [269]

Public transit buses within the King County Metro Transit system, representing the full Seattle metropolitan region, began to employ B20 fuel (a blend of 20 percent biodiesel and 80 percent standard petroleum diesel) in 10 buses without requiring modification. Transit authorities estimate that using this B20 fuel in the entire fleet could reduce fossil fuel use by as much as 1.7 million gallons per year. [270]

IMPACTS

After a full year and a half in service, many believe Seattle's diesel hybrid buses are not living up to their expectations. Although overall emissions are better than the older full-diesel buses, the trade-off has been fuel efficiency. Transit authorities believe that the

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[266] Institute for Location-Efficiency. "Location Efficiency." 2004. Retrieved Feb. 2, 2005 from http://www.locationefficiency.com/faq.

[267] King County Transit Metro Online. Metro Transit Rolls out the First Hybrid Buses. May 31, 2004. Retrieved Feb. 16, 2005 from http://transit.metrokc.gov/am/vehicles/hy-dieselrollout.html

[268] City of Seattle, Office of Sustainability and Environment, Fleet and Facilities Department. *A Clean and Green Fleet: An Action Plan for the City of Seattle.* Apr. 2004.

[269] City of Seattle, Office of Sustainability and Environment, Fleet and Facilities Department. *A Clean and Green Fleet: An Action Plan for the City of Seattle.* Apr. 2004.

[270] King County Transit Metro Online. Metro Transit Rolls out the First Hybrid Buses. May 31, 2004. Retrieved Feb. 16, 2005 from http://transit.metrokc.gov/am/vehicles/hy-dieselrollout.html

expected fuel efficiency is not being met because the hybrids are used on suburban express routes with more highway mileage, where there is less of a fuel-efficiency advantage.[271]

6.3.g Portland, Oregon

PROBLEM

Beginning in the early 1990s Portland, Oregon has actively addressed urban development, and for the last 10 to 15 years they have instituted initiatives both to reduce sprawl and to reduce greenhouse gas emissions.

LEGISLATION AND RESULTING POLICY

In 1993, Portland became the first local government in the United States to adopt a plan to reduce greenhouse gas emissions. The Portland Climate Change Initiative was established to reduce greenhouse gas emissions to 10 percent below 1990 levels by 2010.[272] Transportation use in the Portland region has transformed dramatically over the last 10 to 12 years, due to a mix of transit behavior shifts and public transit investments. The number of bicycle commuters has more than doubled in the last 10 years, due in large part to the addition of 150 miles of bicycle paths and lanes.[273] The city opened a new streetcar service in 2001, the first new service in the U.S. in the last 50 years. As a result, public transportation use has increased 65 percent since 1990.[274] Portland's transit service, called TriMet, is now testing ten hybrid diesel buses similar to those currently employed by the City of Seattle. The city is also testing a program called TravelSmart, which provides customized assistance and incentives to individuals with the express goal of making it easier to take public transit, walk, bike, or carpool. The TravelSmart program, which was commissioned by Portland in 2002, is a tool for changing individual travel behavior based on surveys, marketing, and incentives that has been highly successful across Europe.[275]

In 1989, the Oregon state legislature authorized regional authorities to establish urban growth boundaries, with the sole purpose to encourage dense urban growth and stop urban sprawl. Portland's per-capita gasoline use has fallen almost 10 percent since 1990, resulting in over $40 million annually kept within the local economy. On a per-capita basis, more hybrid vehicles are sold in Portland than anywhere else in the United States.[276] However, these trends are offset by the accelerated growth of Portland's suburbs. Areas outside the central city grew by one-quarter during the 1990s, the fifth-fastest rate of suburban growth in the country.[277]

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[271] Hadley, J. "Hybrid buses' fuel economy promises don't materialize: Older models have gotten better mpg." *Seattle Post-Intelligencer*. Dec. 13, 2004.

[272] City of Portland, Office of Sustainable Development Energy Division. *Portland Climate Change Efforts*. Apr. 2003.

[273] City of Portland, Office of Sustainable Development Energy Division. *Portland Climate Change Efforts*. Apr. 2003.

[274] City of Portland, Office of Sustainable Development Energy Division. *Portland Climate Change Efforts*. Apr. 2003.

[275] Socialdata America, Ltd. "TravelSmart Pilot Project Final Report, 2004." *Individualized Marketing Pilot Project Final Report*.

[276] City of Portland, Office of Sustainable Development Energy Division. *Portland Climate Change Efforts*. Apr. 2003.

[277] The Brookings Institution. "Portland in Focus: A Profile from Census 2000." Sept. 2001. Retrieved Feb. 16, 2005 from http://www.brookings.edu/es/urban/livingcities/portland.htm.

IMPACTS

As outlined above, most of Portland's programs have been successful in encouraging alternative methods of transportation and reducing greenhouse gas emissions.

6.3.h Los Angeles, California

PROBLEM

Primarily due to mild weather, Los Angeles air in 2004 was the cleanest on record. Unfortunately, it is still the worst in the country.[278] Although California has set high standards in environmental protection within the U.S, particularly on air quality and vehicle emission issues, several areas within the state have the unique distinction of having the unhealthiest air in the country. More than four million Californians suffer from lung disease, with ozone alone causing more than 10 percent of hospital visits for respiratory ailments.[279] In a 2001 report by the American Lung Association, 33 counties in California received "F" grades, and of the 25 metropolitan areas across the country with the worst ozone air pollution, nine were in California.[280]

LEGISLATION AND RESULTING POLICY

State-Wide

In 2004, California regulators adopted the world's first rule limiting vehicle emissions that contribute to global warming. Fiercely opposed by auto manufacturers, the rule will apply to all cars, trucks, and SUVs sold in the state starting in 2009, with a goal of reducing motor vehicle greenhouse gas emissions by 30 percent by 2012.[281] The outcome of the auto industry's lawsuit and future implementation of the rule could have major impacts on the future of automobile production, with several other states including New York and New Jersey indicating a plan to follow California's lead. Although California only represents 11 percent of the U.S. auto market, a coalition of six states adopting the rule represents a full 30 percent of the market.[282]

In addition to paving the way to greenhouse gas reductions, California is leading efforts to build a hydrogen vehicle market. In early 2004, Governor Schwarzenegger announced the California Hydrogen Highway Network initiative to energize a rapid transition to a hydrogen transport economy within the state. The Governor's "Vision 2010" includes plans to create a network of 150 to 200 hydrogen fueling stations throughout the state by 2010 at an estimated cost to taxpayers of $75 to $200 million.[283]

The California Air Resources Board established the zero emission vehicle program to help the state reach the U.S. Environmental Protection Agency's health-based air quality goals.

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[278] "Los Angeles air quality best on record, but remains nation's worst" *Associated Press.* Nov. 5, 2004.

[279] American Lung Association of California. "Driving Californian's Towards Good Health in Electric Vehicles." *In The Sportlight: Cleaner Vehicles.*

[280] "American Lung Association's Air Pollution Report Highlights Need for Zero Emission Vehicles." *Air Quality News, Breathe Easy Magazine.* Fall 2000/Winter 2001.

[281] Sanchez, Jesus "California Limits Greenhouse Emissions." *The LA Times*. September 24, 2004.

[282] Sanchez, Jesus "California Limits Greenhouse Emissions." *The LA Times*. September 24, 2004.

[283] "Hydrogen Means Business in California, 2004." *California Hydrogen Highway Network Action Plan*. Retrieved Feb. 16, 2005 from http://hydrogenhighway.ca.gov/.

Since 1990, several northeastern states have adopted California's Zero Emission Vehicle program in place of federal emissions standards.[284] Automakers sued the state of California in 2002 and were granted an injunction barring implementation. The state, however, decided to revise the program's guidelines to fully sidestep the legal challenge with the aim of restarting the program in 2005.[285]

Municipal

The City of Los Angeles has launched a very successful alternative-fuel campaign within the Metro Transit Authority's bus fleet. Of the 2,600 buses currently in use by Metro Transit Authority, 1,400 are powered by compressed natural gas.[286] With more than half of their fleet powered by natural gas, the Los Angeles Metro Transit Authority has the largest alternative-fuel fleet in the United States.[287]

The City of Los Angeles has also stepped up efforts to phase-in alternative fuel vehicles in other government fleets. The City now owns and maintains 1,237 alternative fuel vehicles, which are characterized as vehicles that are powered by a source other than gasoline or diesel fuel (e.g. electric, natural gas, fuel cells). The city is also committed to increasing its fleet of alternative fuel vehicles by 15 percent per year.[288] The City's Department of Water and Power recently launched the most aggressive electric vehicle infrastructure campaign in the country to support the growing use of electric vehicles. In partnership with 29 other agencies and private companies, the Department of Water and Power has completed the installation of 200 electric vehicle charging stations across the greater metropolitan region.[289] By the end of 2004, the Los Angeles Bureau of Sanitation employed a fleet of over 250 dual-fuel liquefied natural gas refuse trucks.[290]

In 1995, the 91X project in Orange County represented the first instance of value pricing in the United States. In this scheme, additional lanes of traffic were added and tolled. Commuters willing to pay the toll faced less traffic within the pay lanes. This type of pricing scheme is an incentive for users because the person paying benefits directly. Additionally, the system serves to reduce congestion.[291]

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[284] Union Of Concerned Scientists – Clean Vehicles Campaign. *California's Zero Emissions Vehicle (ZEV) Campaign*.

[285] Union Of Concerned Scientists – Clean Vehicles Campaign. *California's Zero Emissions Vehicle (ZEV) Campaign*.

[286] "Los Angeles air quality best on record, but remains nation's worst" *Associated Press.* Nov. 5, 2004.

[287] Union Of Concerned Scientists – Clean Vehicles Campaign. *California's Zero Emissions Vehicle (ZEV) Campaign*.

[288] City of Los Angeles, Environmental Affairs Department. *Alternative Fuel Vehicles (AFV).* Retrieved Feb. 17, 2005 from http://www.lacity.org/ead/EADWeb-AQD/afvehicles.htm

[289] City of Los Angeles, Environmental Affairs Department. *Alternative Fuel Vehicles (AFV).* Retrieved Feb. 17, 2005 from http://www.lacity.org/ead/EADWeb-AQD/afvehicles.htm

[290] National Renewable Energy Laboratory. "Advanced Technology Vehicles in Service: City of Los Angeles Bureau of Sanitation - LNG Heavy Duty Trucks." *U.S. Department of Energy.* February 2004. Retrieved on Feb. 16, 2005 from http://www.nrel.gov/docs/fy04osti/35115.pdf.

[291] de Cerreno, A.L.C. Evaluation Study of the PANYNJ's Value Pricing Initiative: Task 5- Monitoring of Media and Decision Maker's Reactions. New York: NYU Wagner Rudin Center for Transportation Policy & Management, Jan. 8, 2004.

IMPACTS

Los Angeles' initiatives have successfully converted a substantial number of fleet vehicles into alternative fuel vehicles. The potential state law regulating vehicle emissions may alter individual commuter vehicles in the state; if other states follow suit, the U.S. automobile market could see a substantial impact.

6.3.i Bay Area (San Francisco, Oakland, San Jose), California

PROBLEM

The Bay Area has several innovative transit policies to encourage alternative fuel use and to reduce air pollution, thereby improving human health and the environment.

LEGISLATION AND RESULTING POLICY

Public transportation systems in the San Francisco Bay region, including Oakland, San Jose, and San Francisco, tend to be in the early stages of testing or implementing clean vehicles. San Francisco's Municipal Transportation Agency approved a request in 2004 to acquire 56 diesel-electric hybrid buses for the Municipal Railway (Muni). Oakland's AC Transit entered an agreement with ThunderVolt, a fuel-cell and electric hybrid system company, for the delivery of four fuel-cell buses in December 2004. The new buses will be evaluated on service through hilly areas (grades as steep as 17 percent), freeway service to San Francisco, and heavy-duty lines carrying as many as 20,000 people per day.[292] One example of a private sector initiative is Environmental Vehicle Rental Cars, which is the only U.S. company to exclusively rent clean vehicles. Introduced at San Francisco International Airport, the fleet includes natural gas and hybrid vehicle rentals.[293]

The City of San Jose took a major step toward increasing clean vehicle use in the metropolitan region by allowing owners of clean air vehicles, including hybrids, to park for free at all of the city-owned parking lots and garages, as well as metered spaces on streets. Owners of clean air vehicles are issued a "Clean Air Vehicle" decal by the State of California Department of Motor Vehicles, which is periodically verified by Traffic Enforcement.[294] The City of San Jose has recently followed suit, as the Santa Clara Valley Transportation Authority purchased 3 hydrogen fuel-cell buses to debut in March 2005, testing the viability of emerging clean fuel technologies.

In response to the San Francisco City Council's "Cleaner Fleets" ordinance, the San Francisco Transportation Authority has purchased more than 500 clean fueled cars and vans – including electric, natural gas and hybrid. In February 2005, San Francisco welcomed the arrival of 15 hybrid taxis.[295] Additionally, the Authority's Municipal system will purchase 30 electric buses in 2005, which are currently being used successfully in Santa Barbara.[284]

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[292] "AC Transit, SunLine Adding Fuel Cell Buses to Fleets." *Passenger Transport.* June 17, 2002

[293] EV Rental Cars. 2005. Retrieved on April 22, 2005 from http://www.evrental.com/index.html

[294] City of San Jose, California, Department of Transportation. "Clean Fuel Vehicle Purchase Incentive Program." Retrieved Feb. 17, 2005 from http://www.sanjoseca.gov/transportation/whatsnew/hybrid/index.htm

[295] The details of the San Francisco case and its impact on implementing a similar program in New York City are discussed in the policy recommendation document accompanying this research report.

Augustine, P. et al. *Transporting New York York City to a Sustainable Future: Clean Air Taxi Bill of 2005.* Columbia Univeristy: New York. April 2005.

IMPACTS

Most of the state and local initiatives have focused on converting fleets to alternative fuel vehicles. The incentive programs appear to have effectively supported the transition of fleet vehicles to cleaner alternatives. However, the impact of the Bay Area programs on air quality is unknown due to the recency of several initiatives.

7. INTERNATIONAL CASE STUDIES

Examining international case studies is particularly important for comparisons to New York City given its unique structure. Unlike other cities in the United States, New York City is extremely densely populated, having a similar profile to urban areas abroad, such as London and Singapore. Although the political context of dealing with urban transportation issues may vary quite drastically, there are some important lessons to be learned by analyzing the successes and failure of international initiatives.

7.1 France

Paris

PROBLEM

Much like Atlanta, Paris has a problem with urban sprawl and increased private vehicle transportation. Of the 11 million residents, only 2 million live in the city center and it is becoming more common for families to have two to three cars.[296] Additionally, noise pollution seems to be a significant complaint as reducing noise is one of the objectives in pursuing electric vehicle alternatives. The Mayor of Paris, who was elected on a platform of transit reform, noted that "private motorists, who make up a quarter of road users, use up 94 per cent of Paris's road surfaces".[297] Although Paris is a useful case study, its differences in spatial distribution and related transit issues make it not closely applicable to New York City issues.

LEGISLATION AND RESULTING POLICY

The city of Paris partnered with CGEA-Onyx waste disposal company to develop electric trash-trucks and make them mandatory in some areas of the city. At the time of the agreement, the city set the goal of having 5 percent electric vehicle use by 1999. However, the current status is unknown.[298] As part of a larger environmental policy program, the city partnered with Electricite de France,[299] car manufacturers, equipment suppliers, and RATP (Paris Transport Company) to investigate alternative fuel sources. The initiative began as an experimental trial to test the effectiveness of electric buses, which receive fast charges during the day and are fully recharged at night. There are concerns about the range of the buses that can only be solved with technological improvement. Despite the initial costs of the technology, the requiring of installation of two fueling stations and various other concerns,

[296] Gerondeau, C. "Mass Transit: A Tale of Two Cities' Transportation." *Demographia.* Reprinted from *The Atlanta Journal* 1 November 2000.

[297] Monaghan, J. "Bertrand Delanoe, Mayor of Paris." *World Mayor.* Retrieved February 16, 2005 from http://www.worldmayor.com/finalists2004/paris.html

[298] "All About Electric and Hybrid Vehicles: Pilot Programmes." *Cereveh*. Retrieved February 16, 2005 from http://www.cereveh.org/eng/internet/pilotes.html.

[299] "Electricite de France, the driving force in the development of electric transport." *Electrcite de France.* Retrieved February 16, 2005 from http://www.edf.fr/html/en/decouvertes/voyage/voiture/role/voiture_role_d.html.

the test was generally successful. The 10 vehicle fleet of the Monmartrobus line has been replaced by electric buses.[300]

Taxi G7 company participated in an experiment to determine the feasibility of liquefied propane gas (LPG). From 1998 to 2000, 10 fleet vehicles were run on liquefied propane gas.[301] The success of this experiment is unknown.

According to a news release by the Associated Press, the mayor of Paris, Bertrand Delanoe, is pursuing a policy to reduce the number of car lanes by increasing bus lanes. The objective is to encourage public transit use as a means of reducing air pollution and congestion.[302] Eventually, the hope is to eliminate traffic from the roads that line both sides of the Seine.

IMPACTS

Besides the obvious pollution reduction by using electric buses, the city has also reduced noise pollution which is considered to be a primary problem in the city.[303] By limiting the number of car lanes in the city center, the Mayor essentially made personal vehicles an undesirable urban transit option.

7.2 Netherlands

PROBLEM

Much like other urban centers, Holland has become increasingly concerned that automobile congestion within its urban centers is having detrimental effects on those that travel, work and live in the city centers. Holland's National Environmental Policy Plan (NEPP), drafted between 1990-1994, identified road traffic as the largest source of environmental and noise pollution in urban areas. Although Dutch cities are densely packed, comparatively they do not have the same level of congestion problems as London, Singapore and North American cities.

LEGISLATION AND RESULTING POLICY

As a result of National Environmental Policy Plan identifying automobile traffic as the largest source of environmental pollution, there have been several policies enacted to encourage consumers, workers and businesses to decrease their reliance on automobile transportation.

The Second Transport Structure Plan (SVV-II) lays-out three objectives in order to lower automobile reliance. These objectives include choosing environmentally and economically sound vehicles, choosing a mode of transit that consumes the least amount of energy and

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[300] "The Monmartrobus: Electric Buses Experiment in Paris." *SchoneVoertuigen.* February 16, 2005 from http://www.schonevoertuigen.nl/asp/display_projecten.asp?tabelnaam=cases&landcode=0&id=24.

[301] "Experiments: Project Description." *Urban Transports: Options for Propulsion systems and Instruments for Analysis (UTOPIA).* Retrieved February 16, 2005 from http://www.utopia-eu.com/asp/UtoProj.asp?num=183.

[302] Associated Press. "Paris Plans to Reduce Car Lanes." *Your Next Car & the Environment.* 23 August 2001. Retrieved February 16, 2005 from http://www.yournextcar.org/NewsBriefs_0801.html.

[303] "The Monmartrobus: Electric Buses Experiment in Paris." *SchoneVoertuigen.* February 16, 2005 from http://www.schonevoertuigen.nl/asp/display_projecten.asp?tabelnaam=cases&landcode=0&id=24.

coordinating residential and work locations to minimize travel time and maximize leisure time. These three vague objectives have motivated three distinct policies centered on improving vehicle emission standards, reducing car dependency and implementing urban traffic control measures. Highlights include increased public spending on mass transportation, increased bicycle capacity and improved educational awareness of benefits of reduced car dependency. Measures have been taken to reduce parking spaces, remove tax breaks for auto commuters and increase tax breaks for public transportation commuters.[304]

Dutch cities can be seen as an example of how to promote and increase bicycle use in an urban setting. The Dutch Bicycle Master Plan (1990-1996) was based on mobility, transport chain, cyclist safety, parking/theft and communication. These focal points worked to force businesses to provide bicycle storage, shower facilities and changing stations. The government increased public spending on train and bicycle coordination to help reduce the burden on private businesses. The program relied heavily on communication, not only to encourage cycling but allow feedback and subsequent improvement.

One of the largest goals of Second Transport Structure Plan was to create a responsibility factor for all automobile commuters. To achieve this goal, Dutch officials instituted voluntary measures designed to revamp the relationship between businesses and their employees. The main goals were that by 2000, 80 percent of organizations with 500 plus employees will have mobility management plans, 50 percent of organizations with 100-500 employees will have plans and 30 percent of organizations with 50-100 employees will have plans. These voluntary measures were backed by automatic legislation if targets were not met. Additionally, financial incentives were developed to help spur voluntary compliance: rebates were given for living closer to work, bicycle costs were reimbursed and taxation of work related automobile purchase or a rental was instituted. The government tried to match private and commercial costs by improving public transit, providing better public facilities and allocating parking spaces based on "need".[305]

IMPACTS

The bicycle program has been extremely successful. As the bicycle network has become more developed and safer, participation has dramatically increased. The ability of the government to provide safe bicycle routes and storage was the biggest reason for mass acceptance. The successful leadership within the government and private industry communicated the goals and failures of the project. This open disclosure has increased the public's faith in the program and allowed them to play a vital role in continuous improvement.[306]

7.3 India

[304] Kroon, M. "Traffic and environmental policy in the Netherlands" *The Greening of Urban Transport: Planning for Walking and Cycling in Western Cities* Ed. Rodney Tolley. London, UK 1997, 161-176.

[305] Touwen, M. "Stimulating bicycle use by companies in the Netherlands." *The Greening of Urban Transport: Planning for Walking and Cycling in Western Cities* Ed. Rodney Tolley. London, UK 1997, 415-422.

[306] Welleman, T. "The Dutch Bicycle Master Plan 1990-96" *The Greening of Urban Transport: Planning for Walking and Cycling in Western Cities* Ed. Rodney Tolley. London, UK 1997, 177-190)

Delhi

PROBLEM

In relation to other "megacities," Delhi's resident and visitors rely very little on automobile and rail transportation. Delhi's main transportation routes are by foot, bicycle and bus. Although automobile use makes up a proportionally small section of urban travel, it is increasing at the greatest rate and subsequently is the "fastest increasing source of urban air pollution in most developing cities."[307] In Delhi, automobile emissions account for approximately 70 percent of air pollution.[308] Approximately 80 percent of carbon monoxide, 70 percent of nitrogen oxides, and 95 percent of hydrocarbon emissions come from mobile sources in Delhi. [309]

There are two main reasons for the growing automobile pollution within Delhi. First, automobiles in Delhi have a much longer life than similar automobiles in North America. The average car in Delhi operates for 15-20 years, compared to 6-8 years in developed countries.[310] As the vehicles age, their engines become less efficient; emitting larger amounts of particulate matter and other forms of airborne pollutants as time passes. Second, although Delhi has a low relative number of vehicles per unit road length as compared to many other cities around the world, it still remains the most congested urban road network within India.[311] By year 2020, Delhi is projected to have 13 million vehicles and 20 million people, twice the projected car to population ratio of New York City.[312]

LEGISLATION AND RESULTING POLICY

Delhi has addressed the growing automobile congestion and subsequent increasing pollution levels on two different levels. They have passed several rounds of legislation controlling and restricting both the private and commercial vehicle fleets. In addition, they have attempted to improve and incentivize mass transportation to encourage residents to restrain from further automobile use.

A series of legislation was passed targeting different aspects of the personal and commercial passenger vehicle fleets; with a compliance date of 2000. The main legislation set mandatory retirement dates for cars at 25 years, for two wheelers 15 years, for autorickshaws 10 years,

[307] Kokaz, K., N.R. Harshadeep, P. Rogers, and S. Srinivasan. "A Systems Analysis of Transportation Needs in Delhi, India: The Importance of Land Use Planning for Air Quality." Harvard University.
[308] Kokaz, K., N.R. Harshadeep, P. Rogers, and S. Srinivasan. "A Systems Analysis of Transportation Needs in Delhi, India: The Importance of Land Use Planning for Air Quality." Harvard University.
[309] Kokaz, K., N.R. Harshadeep, P. Rogers, and S. Srinivasan. "A Systems Analysis of Transportation Needs in Delhi, India: The Importance of Land Use Planning for Air Quality." Harvard University.
[310] Kokaz, K., N.R. Harshadeep, P. Rogers, and S. Srinivasan. "A Systems Analysis of Transportation Needs in Delhi, India: The Importance of Land Use Planning for Air Quality." Harvard University.
[311] Kokaz, K and P. Rogers. "Urban Transportation Planning for Air Quality Management – The Role of Social and Economic Costs in Welfare Maximization of Mobility Choice: A Case Study in Delhi, India." Harvard University.
[312] Kokaz, K and P. Rogers. "Urban Transportation Planning for Air Quality Management – The Role of Social and Economic Costs in Welfare Maximization of Mobility Choice: A Case Study in Delhi, India." Harvard University.

for taxis 10 years, for buses 8 years, and for trucks 12 years. In addition, Delhi legislation targeted at particulate matter control banned all diesel taxis by year 2000.

Delhi's attempts to encourage mass transportation use centered on clean buses and increased rail lines. In an attempt to reduce passenger vehicle reliance and prevent additional diesel emissions, Delhi initiated a clean bus program. All Delhi Transport Corporation and private buses were mandated to be run on compressed natural gas by September 30, 2001.[313] Delhi has gone as far as restricting car registration, therefore reducing the number of automobiles sold from 4000 to 1500 per month.

Finally, with the foresight of growing population and already congested roadways, Delhi has developed aggressive light rail and subway development initiatives. The first phase will include 11 kilometers of subway track and 41 kilometers of ground and elevated train track by 2005. The final project will entail over 17 kilometers of bus-only lanes, 140 kilometers commuter rail and 34 kilometers of subway; all to be completed by 2021.[314]

IMPACTS

Although many of the targets dates are in the future, the compressed natural gas mandates for all buses has not been met. The target date had been postponed several times, with the last recorded compliance date of March 2001.

7.4 Singapore

PROBLEM

Singapore is an independent city-state with an area of almost 700 square kilometers and a population of approximately 4.35 million. Congestion was a source of air pollution and enormous economic costs in Singapore. While economic incentives such as congestion fees have been proposed by economists for decades, transportation authorities have consistently failed to employ economic incentives on major roadways to internalize the costs of congestion.

LEGISLATION AND RESULTING POLICY

Singapore's Area Licensing Scheme is "the best-known example of a successful congestion pricing program."[315] In this program, which was first implemented in 1975, vehicles wishing to enter the central business district (which became a "restricted zone") during peak travel

[313] Kokaz, K and P. Rogers. "Urban Transportation Planning for Air Quality Management – The Role of Social and Economic Costs in Welfare Maximization of Mobility Choice: A Case Study in Delhi, India." Harvard University.

[314] Kokaz, K and P. Rogers. "Urban Transportation Planning for Air Quality Management – The Role of Social and Economic Costs in Welfare Maximization of Mobility Choice: A Case Study in Delhi, India." Harvard University.

[315] Harrington, W., A.J. Krupnick, and A. Alberini. "Overcoming Public Aversion to Congestion Pricing." Resources for the Future, Discussion Paper 98-27. April 1998. Retrieved April 15, 2005 from http://www.rff.org/rff/Documents/RFF-DP-98-27.pdf.

periods were forced to purchase a license. [316] Originally this program was implemented by using stickers in the window of cars, which were checked by police at various checkpoints. In 1998, Singapore began to use an electronic collection system to administer the pricing scheme.[317] The Area Licensing Scheme was accompanied by the development of an efficient public transport service.

IMPACTS

Soon after its introduction, rush-hour traffic was reduced by 45 percent, traffic speeds increased by 20 percent and accidents fell by 25 percent. The Area Licensing Scheme achieved great success in managing traffic conditions within the center city. Area Licensing Scheme led to a 25 percent reduction in total traffic entering the restricted zone of the city during the hours of restriction and private car traffic decreased by about 70 percent.[318] Overall, Singapore's well-established congestion pricing scheme has proved a remarkable success.

7.5 England

London

PROBLEM

London's Central Business District has had continual problems with congestion, mostly attributable to the volume of automobiles. This has led to a series of problems including: slower and more unpredictable journeys, increased cost to business, rat-running through environmentally sensitive areas, disrupted bus operations, and expensive taxi and private hire vehicle journeys. All of these maladies increase the amount of vehicle emissions and noise, adversely affecting travelers and residents of the Central Business District. Congestion adds to vehicle emissions and the noise, disruption and severance suffered by local communities. In essence, it makes travel and the environment unpleasant for everybody.

LEGISLATION AND RESULTING POLICY

London began addressing vehicle congestion by developing a congestion pricing program for its Central Business District. The area consists of 8 square miles (1.3 percent of Greater London), 174 vehicle entry points, over 1 million people daily, 315,000 cars daily and 20,000 vehicles during the four-hour morning peak period.[319]

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[316] Harrington, W., A.J. Krupnick, and A. Alberini. "Overcoming Public Aversion to Congestion Pricing." Resources for the Future, Discussion Paper 98-27. April 1998. Retrieved April 15, 2005 from http://www.rff.org/rff/Documents/RFF-DP-98-27.pdf.

[317] Sandholm, W.H. "Evolutionary Implementation and Congestion Pricing." *Review of Economic Studies* Vol. 69: 667: 2002.

[318] Khan, A.M. "Reducing Traffic Density: The Experience of Hong Kong and Singapore." *Journal of Urban Technology*. Vol. 8: April 2001 Retrieved April 15, 2005 from http://taylorandfrancis.metapress.com/media/B5CR1C2UVH6TYLAWRH5U/Contributions/L/R/U/6/LRU6V1EE014958LT.pdf.

[319] Zupan, Jeffrey M. et al. "An Exploration of Motor Vehicle Congestion Pricing in New York." *Regional Plan Association*, 2003.

London's Transport Strategy mandates a reduction of 2001 levels of weekday traffic by 15 percent by year 2011. It also sets a target of zero growth across the rest of inner London, and reducing growth in outer London by a third, with the aim of achieving zero growth in outer London town centers.

The charging hours are proposed to be the same as the existing central London scheme, currently 7 am to 6:30 pm on Monday to Friday. Consideration will be given to bringing forward the end of charging to 6 pm to assist central London's evening economy.

As with the Central Business District scheme, there would be no charge on public holidays. Additional consideration will be given to suspending charging between Christmas Day and New Years Day. This change, if implemented, would apply to both the central zone and a possible western extension.

Drivers using a vehicle in the charging zone would pay the charge, either in advance or on the day, to have the registration number of their vehicle entered into the charging authority's database. Drivers pay the charge and notify their vehicle registration numbers at certain petrol filling stations, newsagents or shops, by post, telephone, mobile phone text messaging or over the Internet. Residents living inside the charging zone could park in an on-street residents' parking place within their local parking zone without paying any congestion charge. However, if they move their vehicle within the charging hours they would be required to pay the charge (or the discounted rate if registered). The number plates of vehicles entering or moving within the charging zone would be 'inspected' by a network of fixed and mobile cameras. All emergency and medical vehicles are reimbursed 100 percent for any congestion charges they incur.

All of these congestion pricing zones, payment plans and regulations are being managed by London's Traffic Control Centre. Through real time traffic management systems, London's Traffic Control Centre is ensuring full compliance with all Central Business District and outlier area congestion pricings along with parking violations, loading restrictions and lane enforcements.

London is not only addressing congestion issues by regulating automobile traffic, but like many other cities is attempting to encourage alternative and mass transportation options. Over the next six years, London has pledged to increase bicycle commuter routes by at least 900 kilometers. These routes will fully service the majority of public schools, government buildings and major work areas. They are currently looking into the best ways to integrate walking into planning and how to make it a viable option for London workers and residents.[320]

IMPACTS

After several years of congestion pricing, there are no hard results on whether congestion pricing had a positive or negative effect on the economy. Of 504 businesses surveyed in London's Central Business District, 71 percent said it had no discernable effect on their

[320] Greater London Authority. "The Mayor's Transport Strategy Revision" City Hall, Queen's Walk: London August 2004.

profits; nine percent believed it reduced their profits and nine percent believe it increased their profits. Some of the businesses that have been hurt are parking garages and repair shops. On the other hand, delivery services, medical vehicles, police vehicles and fire vehicles have all expressed strong support for the decrease in traffic.

8. GLOSSARY

ADA – American Disabilities Act
B100 – 100 percent biodiesel fuel
B20 – a fuel blend of 20 percent biodiesel and 80 percent petrodiesel
CAFE – Corporate Average Fuel Economy; enacted in 1975, the goal of which was to reduce fuel consumption by increasing the efficiency of cars and light trucks sold in the United States
CARB – California Air Resources Board
Carbon dioxide – a byproduct of combustion; greenhouse gas that contributes to global climate change
Carbon monoxide – odorless and colorless poisonous gas that interferes with oxygen transport in the human circulatory system; vehicle emissions are the main source of carbon monoxide
Central Business District (CBD) – defined in Manhattan as the area south of 60th street
CNG – compressed natural gas
Congestion pricing – a special type of variable pricing in which prices fluctuate based on demand: a fee is charged to enter a highly congested area
E10 – a fuel blend of 10 percent ethanol and 90 percent gasoline
E85 – a fuel blend of 85 percent ethanol and 15 percent gasoline; used in flexible fuel vehicles (FFVs)
EPA – Environmental Protection Agency
EPAct – Energy Policy Act of 1992; provides definition of alternative fuel as including biodiesel, electricity, ethanol, hydrogen, natural gas, and propane.
FFV – flexible fuel vehicles
Gasohol – also known as E10, a fuel blend of 10 percent ethanol and 90 percent gasoline
Ground-level ozone – ozone, a natural component of the upper atmosphere, can form at the ground-level, becoming a pollutant and respiratory irritant; a major component of smog
HEV – hybrid electric vehicle
Hydrocarbons – vehicle emissions created during the combustion of fuel, which can react to form ground level ozone
LNG – liquefied natural gas
Long-term leasing – a central leasing agent purchases the medallion and lease the taxicab to an operator for a period of months, during which time the driver has control of the car
LPG – liquefied petroleum gas
M100 – 100 percent methanol fuel
M85 – a fuel blend of 85 percent methanol and 15 percent gasoline
MTBE - methyl tertiary-butyl ether; Initially MTBE was used during the phase out of leaded gasoline as an additive to raise the octane and reduce air pollution. It is not easily degraded in the environment and is now considered a serious threat to water quality.
Minifleet – a fleet of two cabs owned by two drivers; functionally operate like owner-drivers[321]
Nitrogen oxides – vehicle emissions that contribute to the formation of ground-level ozone and acid rain

[321] Schaller Consulting. *The New York City Taxicab Fact Book.* Brooklyn: Schaller Consulting. Jun. 2004. Retrieved Feb. 2, 2005 from http://www.schallerconsult.com/taxi/taxifb.pdf

Owner-driver – a driver who owns his or her own medallion and drives his or her own taxicab, as opposed to leasing from a fleet owner; they are required to operate the vehicle themselves for at least 210 shifts per year

Particulate matter – small, discrete solid or aerosol particles, some of which are toxic or may have toxic substances adhered to their surfaces; a primary contributor to asthma and respiratory problems in urban areas with traffic-related pollution

Short-term leasing – a central leasing agent owns the medallion and leases the taxicab to drivers on a per-shift basis

Taxi fleet – the New York City Taxi and Limousine Commission defines a fleet as greater than two (2) vehicles

TLC –Taxi and Limousine Commission (New York City)

Value pricing – a pricing system where an additional payment results in a direct benefit to the driver; e.g. drivers pay a special toll to travel in faster-moving lanes

Variable pricing – a general term referring to prices that fluctuate or vary; for example, prices may vary according to time of day, entrance or location point onto a road, or vehicle type

ZEV – zero emissions vehicle

9. APPENDIXES

Appendix A: Hybrid Vehicle Options

Note:
Full Hybrids Definition - In full hybrid systems the electric drive system will provide significant power boost in all acceleration modes including standing start and hill climbing. The vehicle may operate solely on electric power during some portion of the duty cycle. The American Lung Association of California prefers full hybrids because they offer a far greater benefit in terms of increased mileage and they offer better air quality and energy efficiency benefits.

Mild Hybrid Definition - Use the electric drive system less, provide for less improvement in fuel consumption or emission reduction and. The fuel economy may only be improved by a small amount for such systems and the air quality benefits are not as great as they are for full hybrids.

Chart 1 of 3

Hybrid Vehicle Options			
Areas of Investigation	**Toyota Prius**	**Ford Escape**	**Toyota Sienna**
Availability	Available now	Available now	Expected 2007
Vehicle Type	Midsized sedan (full hybrid)	Compact SUV (full hybrid)	Minivan
Seating (number of seats/ passenger room in cubic feet)	5/ 96.2	5/ 100	7/ 177
Max. Cargo Area (cubic feet)	16.1	27.6	43.6
MSRP (Base model)	$20,875	$27,400	$27,000
MPG (city/hwy)	60/51 tank size: 11.9 gallons	36/31 tank size: 15 gallons	~ high 20s tank size: 20 gallons
OVERALL	PROS: gas mileage in city driving CONS: questionable durability, passenger space, foreign	PROS: gas mileage in city driving, SUV (taller), short length, cargo capacity, domestic CONS: unibody construction, less passenger space than Crown Victoria	PROS: Toyota Sienna vans already used, more passenger space than Crown Victoria, large gas tank (less refueling) CONS: not yet available

References

Toyota Prius – Information is available from the Toyota web site http://www.toyota.com/prius/index.html. (Retrieved on March 18, 2005)

Ford Escape – Information is available from the Ford web site http://smartguide.fordvehicles.com/View.jsp?spaceName=cars (Retrieved on March 18, 2005)

Toyota Sienna – Information is available from the Toyota web site http://www.hybridcars.com/toyota-sienna-minivan-hybrid.html. (Retrieved on March 18, 2005)

Cargo Areas and Passenger Seating information is available online under "Research" at Cars Direct, http://www.carsdirect.com. (Retrieved on March 18, 2005)

Hybrid car availability is available online under "Cars" at http://www.hybridcars.com/cars.html . (Retrieved on March 18, 2005)

Fuel Economy information is available online at http://www.fueleconomy.gov/. (Retrieved on March 18, 2005)

Chart 2 of 3

Hybrid Vehicle Options			
Areas of Investigation	**Honda Accord**	**Honda Civic**	**Chevrolet Malibu**
Availability	Available now	Available now	Expected 2007
Vehicle Type	Midsized sedan (mild hybrid)	Compact sedan (full hybrid)	Midsized sedan (mild hybrid)
Seating (number of seats/ passenger room in cubic feet)	5/ 103	5/ 91.0	5/ 101
Max. Cargo Area (cubic feet)	11.2	10.1	15.4
MSRP (Base model)	$30,140	$19,900	low $20Ks
MPG (city/hwy)	29/37 tank size: 17.1 gallons	46/51 tank size: 11.9 gallons	
OVERALL	PROS: power, Honda minivans used in past CONS: high price, not full hybrid	PROS: gas mileage CONS: passenger space, cargo space	PROS: domestic CONS: mild hybrid, not yet available yet

References

Honda Accord & Civic – Information regarding both the Accord and the Civic is available from the Honda web site www.honda.com . (Retrieved on March 18, 2005)

Chevrolet Malibu – Information is available from the Chevrolet web site, http://www.chevrolet.com/cars/. (Retrieved on March 18, 2005)

Cargo Areas and Passenger Seating information is available online under "Research" at Cars Direct, http://www.carsdirect.com. (Retrieved on March 18, 2005)

Hybrid car availability is available online under "Cars" at http://www.hybridcars.com/cars.html . (Retrieved on March 18, 2005)

Fuel Economy information is available online at http://www.fueleconomy.gov/. (Retrieved on March 18, 2005)

Chart 3 of 3

Hybrid Vehicle Options			
Areas of Investigation	**Toyota Highlander**	**Mercury Mariner**	**Crown Victoria**
Availability	Available mid-2005	Available Fall 2005	Available now
Vehicle Type	Midsized SUV (full hybrid)	Compact SUV (full hybrid)	Large sedan (conventional gas-powered)
Seating (number of seats/ passenger room in cubic feet)	7/ 105	5/ 100	6/ 111
Max. Cargo Area (cubic feet)	39.7	29.3	20.6
MSRP (Base model)	~$28,000	~$25,000	$24,410
MPG (city/hwy)	27.5 tank size: 19.1 gallons	33/ 29 tank size: 15 gallons	18/ 25 tank size: 19 gallons
OVERALL	PROS: cargo space, 7 passenger CONS: foreign, cost	(same as Escape)	PROS: durability, passenger room, proven history, power, body-on-frame construction CONS: gas mileage

References

Toyota Highlander – Information is available at http://www.autobytel.com/content/shared/articles/templates/index.cfm/article_page_order_int/8/article_id_int/309 (Retrieved on March 18, 2005)

Mercury Mariner – Information is available from the Mercury web site, www.mercuryvehicles.com. (Retrieved on March 18, 2005)

Ford Crown Victoria – Information is available from the Ford web site http://smartguide.fordvehicles.com/View.jsp?spaceName=cars (Retrieved on March 18, 2005)

Cargo Areas and Passenger Seating information is available online under "Research" at Cars Direct, http://www.carsdirect.com. (Retrieved on March 18, 2005)

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