Final Report
Rochester Vehicle Fleet
Alternative Fuels Systems Study

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Executive Summary

Project Background

The City of Rochester, as the central city in the Rochester Metropolitan Statistical Area (MSA), is currently within a Subpart 1 Basic non-attainment area for ground-level ozone since being so designated by the U.S. EPA in 2006 in accordance with the provisions of the Clean Air Act and the violation classifications of the National Ambient Air Quality Act. Although this is the least severe type of violation classification, it is a violation that requires mitigation efforts to reduce emissions in the non-attainment area. In an effort to facilitate this for the city fleet and to create a plan for implementation and funding, the City of Rochester issued a Request for Proposals (RFP) for a study entitled " Rochester Vehicle Fleet Alternative Fuels Systems Study".

Fleet Counselor Services Inc. was selected and analyzed the City of Rochester's Fleet for applications of alternative, clean fuel technologies, and integration of clean fuels into existing operations. Clean, alternative fuels were considered those defined by the United States Department of Energy and the Energy Policy Act of 1992. The respective fuels were evaluated based on City operational characteristics, existing fueling infrastructure, fuel availability, vehicle technology trends including production by original equipment manufacturers, and pricing aspects of fuel and vehicles, as well as the pros and cons of the different fuels and technologies.

Project Advisory Committee (PAC):

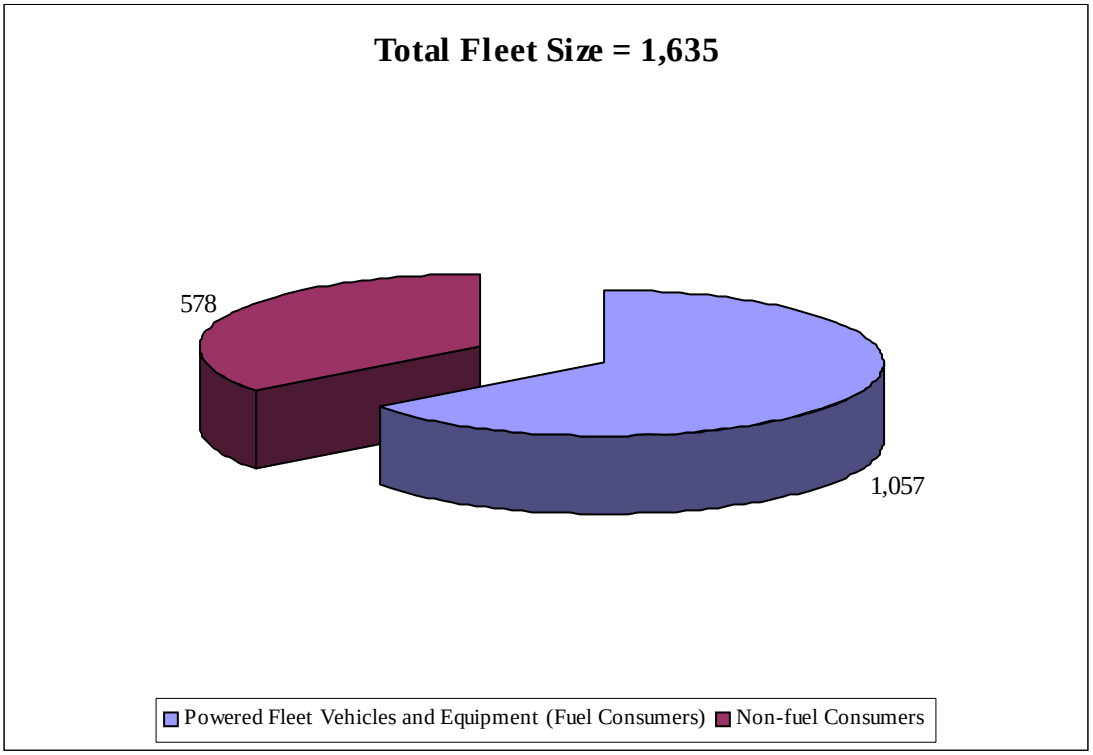
A Project Advisory Committee, made up of City, Monroe County, New York State Department of Transportation (NYSDOT), Genesee- Finger Lakes Regional Planning Council (GFLRPC) and Genesee Transportation Council (GTC) staff was formed. The purpose and role of the PAC was to provide suggestions and feedback about the project from a countywide and regional perspective as well as an interdisciplinary one.

The PAC convened for five meetings and these meetings consisted of discussion of the study process and steps; presentations regarding project progress and imperatives, as well a summary of data collected; discussion of the Peer Reviews; presentations from two guest speakers from fleets that had implemented successful alternative fuel programs and a thorough discussion of the study findings and recommendations.

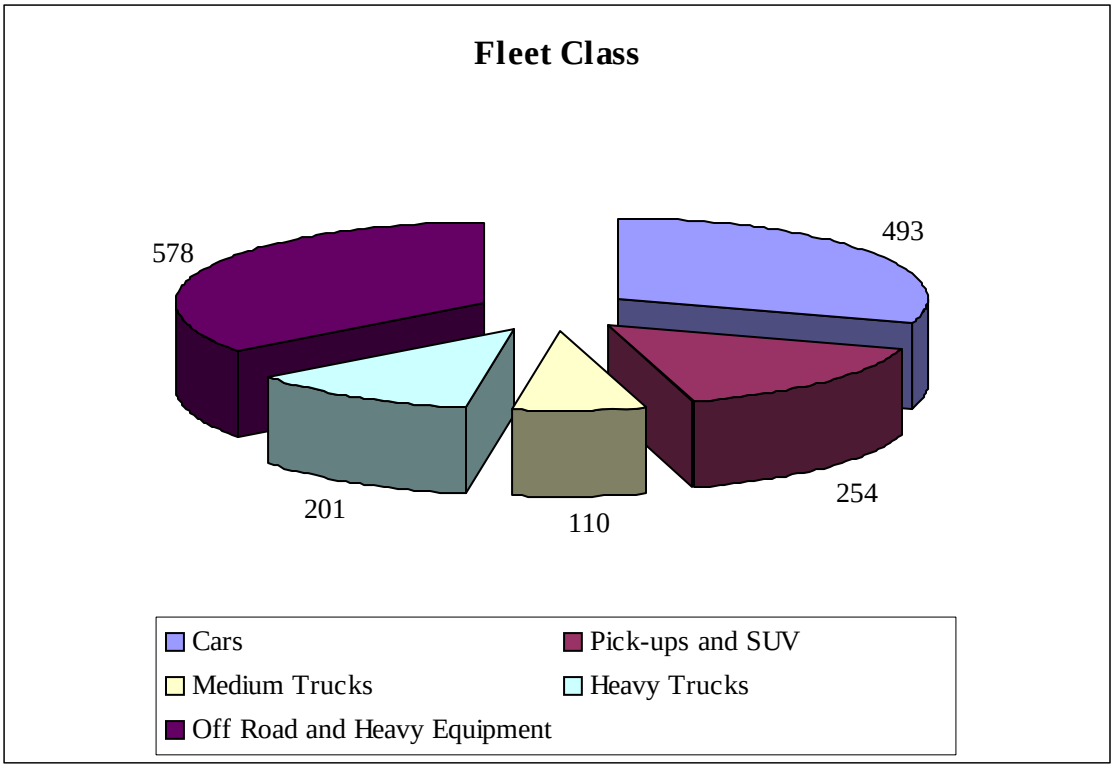
The PAC was able to work well together with a high level of efficiency, providing excellent communication on such projects as the development of the Green Station effort, application for federal funding through the Congestion Mitigation and Air Quality program, as well as the overall Fleet Study project. The Green Station was a project concept generated prior to the commencement of the Fleet Study, which entailed an inter-municipal effort to create three alternative fueling stations.

Current City Fleet Summary

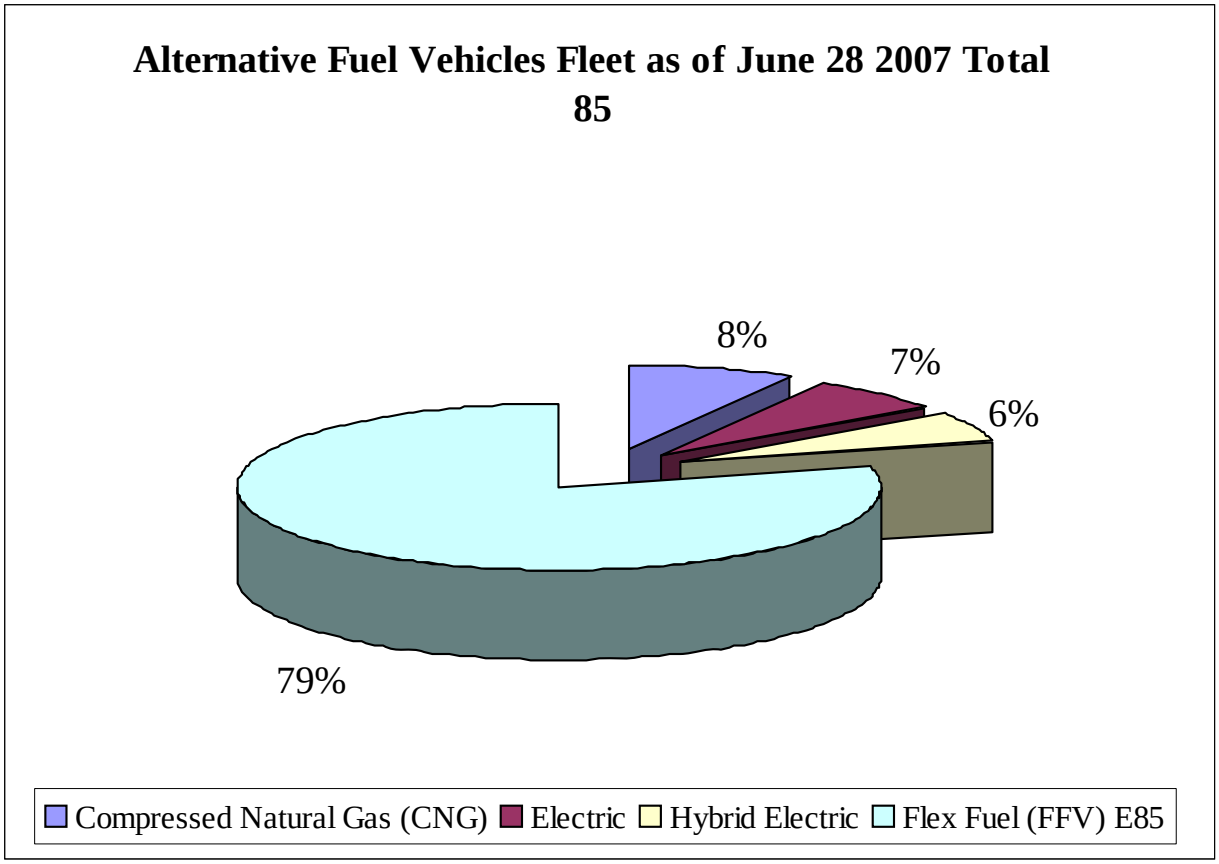
Total City Fleet Size



Overall City of Rochester Fleet by Class



Current Alternative Fuel Vehicle Fleet (6/28/07)



Study Process Overview:

Peer Review Process

A peer review process was undertaken to determine how other fleets had integrated these fuels, which looked at positive and negative outcomes, in order to learn from other fleets' experiences. The selected peer review fleets were:

- New York State Department of Transportation (NYSDOT)
- Pennsylvania Turnpike Commission (PTC)
- Brookhaven National Laboratory
- City of Lakewood Colorado.

These fleets were chosen as having salient characteristics, which would be useful for comparison with the City. The most useful findings of the peer review process involved learning how other fleets had made their alternative fuel choices, how particular fuels were chosen for integration into the fleets, the manner in which the fuels and necessary infrastructure were utilized, and the overall assessment of the willingness of each fleet to "be an innovator" in alternative fuels. It was determined that certain fleets had a higher level of

tolerance to risk associated with alternative fuels usage than was appropriate and acceptable to the City fleet, whose primary organizational imperative is complete dependability. The NYSDOT had made a large financial and organizational commitment to compressed natural gas, as had Brookhaven National Laboratory; the lack of light duty vehicle production by the major auto manufacturers has affected Brookhaven in particular. PTC and City of Lakewood had successful integration of E85 and biodiesel respectively into their fleets, and these experiences were directly applicable to the City of Rochester's fleet configuration and usage patterns; the City appears able to do a phase in of biofuels as did those organizations.

Executive Briefings from Fleet Experts

Two fleet experts who had utilized alternative fuels in their fleets were brought in to provide executive briefings to the Project Advisory Committee, in order for fleet staff and PAC members to gain a more hands-on perspective. Steven Russell, Fleet Services Superintendent of the City of Keene, New Hampshire, was brought in as a cold weather biodiesel expert. Michael McClurkin, recently retired Supervisor of Fleet Operations of the Pennsylvania Turnpike Commission, was brought in as an E85 fleet integration expert with extensive experience with other alternative fuels.

Research and Data Collection

In addition, the Fleet Counselor Team engaged in research, analysis, information gathering and data collection on a variety of topics as part to the work on the study. This included analysis of the characteristics of the City fleet, a review of the current state of the alternative fuels and alternative fuels environment, a review of availability and costs of vehicles and equipment and funding alternatives. The results of this work are contained in the final report document and are reflected in the following section on Recommendations.

Study Recommendations

- It is recommended that biodiesel be integrated into the fleet, first on a pilot test basis via a temporary tank at Mt. Read, to be used on no less than seven units of a vehicle class. The best biodiesel blend can be determined, and then utilized on a fleet wide scale in the second year.
- Flexible fuel vehicles, which can run on E85 ethanol/gasoline mix, or gasoline, should be acquired. Next, the city needs to create a fueling station for those vehicles in the second year. New infrastructure will be required for this station based on tankage limitations at Mt. Read. Regional production trends of biofuels will likely have a significant impact on fuel availability and pricing.
- The FuelMaker compressed natural gas fueling appliance at Mt. Read should be expanded in order to utilize more natural gas vehicles, which are currently limited to the Honda Civic GSX in the original equipment manufacture category. These vehicles can be accumulated at a rate of three-five per year over the first 1-2 years, and New York State Research and Development Authority funds sought via the Clean Cities Challenge to help meet both the incremental cost of the vehicles, and the station expansion costs.
- The small electric neighborhood vehicle fleet should be expanded by five-ten units over the first two years, for niche applications.

- An examination of the vehicle size in various departments should be conducted, with an effort to downsize to smaller, more fuel efficient vehicles, especially in the case of transitioning from a 3/4 ton pickup to a smaller model which is available in a flexible fuel model. Light duty hybrids are available on the New York State Office of General Services Procurement Contract, but present a price premium, as well as uncertain battery performance and maintenance/repair considerations, though have better gas mileage and cleaner emissions than standard vehicles.
- The City can consider making an investment in a high technology pilot hybrid or plug in hybrid medium or heavy-duty vehicle in the 2-3 year range, if outside funds are gained to do so. Contact should be maintained with the General Motors Fuel Cell Activity Center at Honeoye Falls in the event that a pilot hydrogen vehicle project arises with which the City could assist; funds for such an effort should come from outside the City budget.
- Some version of the Project Advisory Council should continue over the next three years, and a permanent liaison be designated at the City to maintain communications on alternative fuels programs with the County of Monroe. The short-term continuation of the PAC can be as a "Green Station Steering Committee" which will ensure proper coordination of the various entities planning and using the stations, and can be expanded to include other key staff of nearby municipalities interested in using the stations, as well as the School District. A lead entity should be designated now to ensure the PAC continues, and to assist in setting meetings, engaging other municipalities to use the Green Stations, and to set agendas for the next 2-3 meetings. This lead entity could potentially be the Genesee Transportation Council since it has the broadest purview geographically.
- The City should continue active engagement with the Genesee Region Clean Communities because of its role in promoting alternative fuel in the Rochester MSA.

Cumulative Potential Impact of Key Recommendation on Conversion of City Fleet to Alternative Fuels over a Five-Year Period

Base AFV Fleet / AFV Action Steps	# Vehicles	% of Fleet
Current # AFVs (incl. ordered vehicles)	138	13 %
Phase-in of Biodiesel (B5-B20) entire diesel fleet	588	55.6 %
Acquisition of 50 FFVs in 2008	638	60.0 %
Acquisition of 50 FFVs in 2009	688	65.0 %
Acquisition of 50 FFVs in 2010	738	70.0 %
Acquisition of 50 FFVs in 2011	788	74.5 %
Acquisition of 50 FFVs in 2012	838	79.0 %
Miscellaneous Net Acquisition of Hybrids, CNG and Electric Vehicles (5 per year 2008-2012 for a total of 20)	858	81.0 %

Therefore, one can conclude that significant strides can be achieved over a five-year period if the biodiesel and E85 strategies are adopted and the continued acquisition of FFV vehicles occurs at the typical rate of 50 per year.

Project Background

The City of Rochester is currently within a non-attainment area for ground level ozone. The Rochester Metropolitan Statistical Area is classified as a Clean Air Act "Subpart 1 Basic" for the 8-hour ground level ozone standard; this is the least severe type of violation classification of the National Ambient Air Quality Standard, though nonetheless a violation.[1] As such, mitigation efforts are required to assist in lessening emissions within the non-attainment area. During 2007, there may be some modification of this non-attainment status.[2] Vehicular emissions are a substantive source of the precursors of ozone. Diesel vehicles are also targets for national air quality improvement efforts. The price of diesel and gasoline has been on an upward trend for some years, with a high probability of continuance. The City determined that an examination of its fleet for integration of alternative fuels, also known as "clean" and/or renewable fuels, was an appropriate effort to undertake to determine whether any portion of its fleet was appropriate for conversion to these fuels. The City wished to conduct an analysis of its alternatives, and formed a Project Advisory Council made up of members of staff from various city agencies (Department of Environmental Services- Equipment Services, Bureau of Architecture & Engineering), the Genesee Transportation Council, the New York State Department of Transportation, and contract staff from the New York State Energy Research and Development Authority via the Finger Lakes Energy Smart Communities program. The City of Rochester Fire Department also assisted in the project.

The City engaged the Fleet Counselor Team to conduct the study; the team brought a strong background in fleet evaluation, usability studies, operational studies, and alternative fuels applications to the effort, entitled ***Rochester Vehicle Fleet Alternative Fuels Systems Study***. The study was performed from 4th quarter 2006 to June 2007. Fleet database records were reviewed, interviews conducted with staff, fueling facilities inspected, and numerous meetings and site visits held over the study period. The Fleet Counselor team reported to the PAC on a regular basis. The following report is the result of this process.

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[1] Genesee Transportation Council, "Transportation Conformity Statement for the Long Range Transportation Plan for the Genesee-Finger Lakes Region: 2007-2027 Update and 2007-2012 Transportation Improvement Plan", June 2007, p. 1.

[2] Per the April 4, 2007 edition of the *Environmental Notice Bulletin*, New York State plans to submit a clean data petition to EPA on behalf of the Rochester MSA. If accepted by EPA, the Rochester Metropolitan Area would be reclassified from Subpart 1 Basic non-attainment to maintenance in late-2007 or early-2008.

Section A: Project Advisory Council and Summary of Proceedings

Formation of Project Advisory Council (PAC)-

The PAC was established by the City prior to project start-up and was designed to be an integral part of the study process throughout the various project phases. The purpose of the PAC was to provide advice and feedback to the City on the study results and to help guide the direction and focus of the project, and assist the City and the Consultant Team with a broad perspective that would include not only a City government issues and concerns but a countywide and regional orientation as well.

The composition of the PAC and the selection of its members were intended to reflect a range of organizations, disciplines and interests. The PAC membership is listed below.

PAC Member	**Organization**
Alan Blood	City of Rochester/Genesee Region Clean Communities
Dave Butters	County of Monroe- Fleet Services
Mark Denecke	Finger Lakes Energy $mart Comm.
Lou Guilmette	City of Rochester- Equipment Services
Michael Quattrone	City of Rochester- Equipment Services
Robert Hamilton	County of Monroe
Charles McGarry	New York State DOT
Richard Perrin	Genesee Transportation Council
Bob Scholl	New York State DOT
Anne Spaulding	City of Rochester- Environmental Quality
John Thomas	City of Rochester-Bureau of Engineering

One of the project deliverables for the Consultant was to attend and lead the PAC meetings and to prepare minutes summarizing the proceedings. A total of four meetings were held.

Summary of Meeting Proceedings

Meeting #1 November 2, 2006

This meeting was the kick-off meeting for the project. The following were the meeting highlights:

- Introduction and discussion of project purpose, scope, schedule, milestones and deliverables
- Introduction of PAC members and Consultant Team
- Review of Key Findings of Fleet Utilization Analysis
- Overview of Commonly Used Alternative Fuel Choices and how they are used
- Discussion and recommendations by PAC for peer review sites based on a proposal from Consultant Team
- Comments and feedback from PAC regarding project direction, scope and schedule
- Briefing and discussion of CMAQ funding requests led by John Thomas

Meeting #2 December 7, 2006

The following were the meeting highlights:

- Consultant Team presented the Peer Review Questionnaire that the team designed to use in the Peer Review Process. The Peer Review Process was a key part of the project and was designed to examine what fleets in other places were doing with various alternative fuel applications. The selection was guided by the PAC based on the Consultant's recommendations
- The Consultant Team presented the findings for three of the peer reviews. These were as follows:
    - **City of Lakewood CO.-** This city in the Metro Denver area has had a very successful biodiesel/B20 program since 2003.
    - **New York State Department of Transportation (NYSDOT)-** This large state agency has made a substantial investment in the development of a statewide CNG fleet, which consists of 716 light-duty vehicles and 35 heavy-duty CNG conversion vehicles. There are 53 CNG fueling stations in the NYSDOT system.

      In addition, NYSDOT has a small hybrid fleet consisting of 10 vehicles. However, the fleet philosophy is to engage in "across-the-board" implementation rather than "niche" applications.
    - **Brookhaven National Lab (Brookhaven NY (LI)-** This organization is a private contractor with the U.S. Department of Energy and as a result must follow certain requirements of the Energy Policy Act (EPACT) and must purchase a certain percentage of vehicles that are AFVs, as defined by EPACT.

They have chosen to develop a sizable CNG fleet, which is comprised of 77 vehicles out of a total of 292 (26.4%). In addition, they have a number of electric vehicles that operate primarily in a campus environment.

- The Consultant Team made a proposal regarding the biodiesel site visit deliverable that would fulfill the site visit requirement by arranging for a presentation by a fleet manager with significant biodiesel experience to the PAC. The reason for this was that after significant research, no biodiesel fleets could be identified that were within reasonable travel distance from the City of Rochester vicinity. The fleet manager identified for this presentation was Mr. Stephen Russell, Fleet Services Superintendent for the City of Keene NH. The PAC accepted this proposal.
- There was a an informal proposal by the Consultant Team to conduct an educational event that would provide for executive briefings to the PAC, and possibly other groups like the City Green Team, on topics related to biofuel alternatives such as E85 and biodiesel. The PAC consensus was that this would be more effective after some of the recommendations had been presented and discussed.
- Brief discussion about preliminary findings, which included the merits of niche versus across-the-board applications and also the value of continued City and County cooperation and communication regarding alternative fuels and vehicles
- CMAQ funding updates were provided by Rich Perrin (GTC)

Meeting #3 February 8, 2007

The following were the meeting highlights:

- Stephen Russell, Superintendent of Fleet Services for the City of Keene, New Hampshire gave an excellent presentation about the biodiesel program he implemented in the City of Keene in 2001. He described how he launched the program, discussed the characteristics and benefits of biodiesel and provided a rationale for why biodiesel was the “right thing to do”. He uses B20 in all his diesel vehicles on a year-round basis and has had no significant problems due to his use of a trusted supplier and the proper additives. It provided several excellent insights for the City.

  Members of the City of Rochester Green Team also attended this portion of the meeting, which is an interdepartmental team established to facilitate the city’s environmental agenda.

- A draft of the Table of Contents for the Final Report was presented. The PAC approved the overall draft but made a couple of recommended changes, including expanding the E85 Section to Ethanol and adding a section focusing on Hydrogen and examining the transitional role of current technologies to development of hydrogen fueling capacity.

- The Consultant Team presented the findings for the fourth and final peer review

    - Pennsylvania Turnpike Commission- This fleet is innovative and seeks to be on the cutting edge of new technologies. The fleet has been involved with AFVs since 1995. The fleet uses several types of alternative fuel:
    - Biodiesel – They use this system-wide (since 2006) in a total of 550 heavy-duty vehicles and 25 light-duty vehicles. They use B20 in warm weather and switch to B5 in the winter.
    - E85- They have 210 flexible fuel vehicles and they seek to acquire new ones when the application is suitable. They had some problems initially getting fair pricing for E85 but solved this problem after improving lines of communications with potential bidding suppliers, and rebidding the contract several times
    - Propane- The fleet has 43 propane vehicles that are conversions. They had good success with this program until they were forced to use another vehicle upfitter due to the exit of OEM's from that market and the new vehicles have been less than satisfactory. There was a high level of success with the OEM vehicles originally used. They are seeking a new vendor to solve this problem, provide better upfitted vehicles, and improved service.
    - Rich Perrin provided a CMAQ update
    - The Consultant Team provided the PAC with an informational memo with responses to several questions related to discussion at the previous meeting
    - The Consultant Team presented a sample of a report section to the PAC to seek comments on format and type of content. No substantive changes were recommended and the section was accepted.

Meeting # 4 April 12, 2007

The following were the meeting highlights:

- In addition to the PAC, the meeting included guests from the City's Green Fueling Station Project
- **A** key portion of the meeting featured a presentation from Michael McClurkin, the recently- retired Fleet/ Equipment Manager of the Pennsylvania Turnpike Commission (PTC). He was instrumental in implementing several different AFV components in the PTC fleet during his tenure. The details of the program were covered in the peer review segment that was described in proceedings for the PAC meeting held on 2/8/07, so the focus of this segment will be to highlight some of the key points of his talk.
    - This included an overview of some of the reasons why the PTC began the development of an AFV program, which included the Clean Air Act

Amendments of 1990 and the Energy Policy Act of 1992 (EPAct), with the latter placing mandates on state fleets to acquire a certain percentage of AFVs when making new purchases.

- He described some of the characteristics, advantages and disadvantages of biodiesel and E85.
- Mr. McClurkin discussed the E85 program he implemented at PTC and discussed some of the issues related to implementation, including pricing issues. He also talked about the strategy he employed with the acquisition of flexible fuel vehicles when feasible. His fleet was a pioneer in the usage of E85 in the Northeast.
- There was also a description of the PTC Biodiesel program, which was expanded to the entire PTC fleet in 2006 (total of 575 vehicles). He provided practical tips on biodiesel tank conversion that should be especially useful to the City if a biodiesel initiative is implemented.

  In addition, there was some very interesting information about some EPA testing that was done as part of the biodiesel project. The tests showed that the biodiesel vehicles, especially the newer models, showed NOX emissions that were equal to or better than the control group of regular diesel vehicles.[3]
- Overall, Mr. McClurkin's obvious zeal and commitment to making a difference by using AFVs was a very valuable part of his talk. He was able to provide a real-life example of how leadership can truly make a difference with these programs

- The Consultant Team led a discussion of several of the preliminary recommendations:
  - Biodiesel Strategy and Options
  - E85 Strategy
  - Communication, Partnerships and Development of Alternative Fuel Networks
  - Laying the Ground for Hydrogen Fueling and Vehicles
- The Consultant Team distributed the following reports and handouts;
  - **Part C. Evaluation of Alternative Fuel Technology Options for the City Fleet.**
- Report on :**On-site Presentation/Demonstration for Biodiesel**
- **Summary of Peer Review Results**

The full record of PAC meeting minutes is contained in **Appendix A- PAC Meeting Minutes**.

[3] Biodiesel has in the past been considered to raise NOX slightly, especially in the B100 form when older data showed up to 10% increase. Thus, more practical, in-shop testing is indicating that the NOX penalty may not be correct. City of Keene testing found a similar result. See NOx Issue section herein.

Additional Comments on PAC Meetings and Process

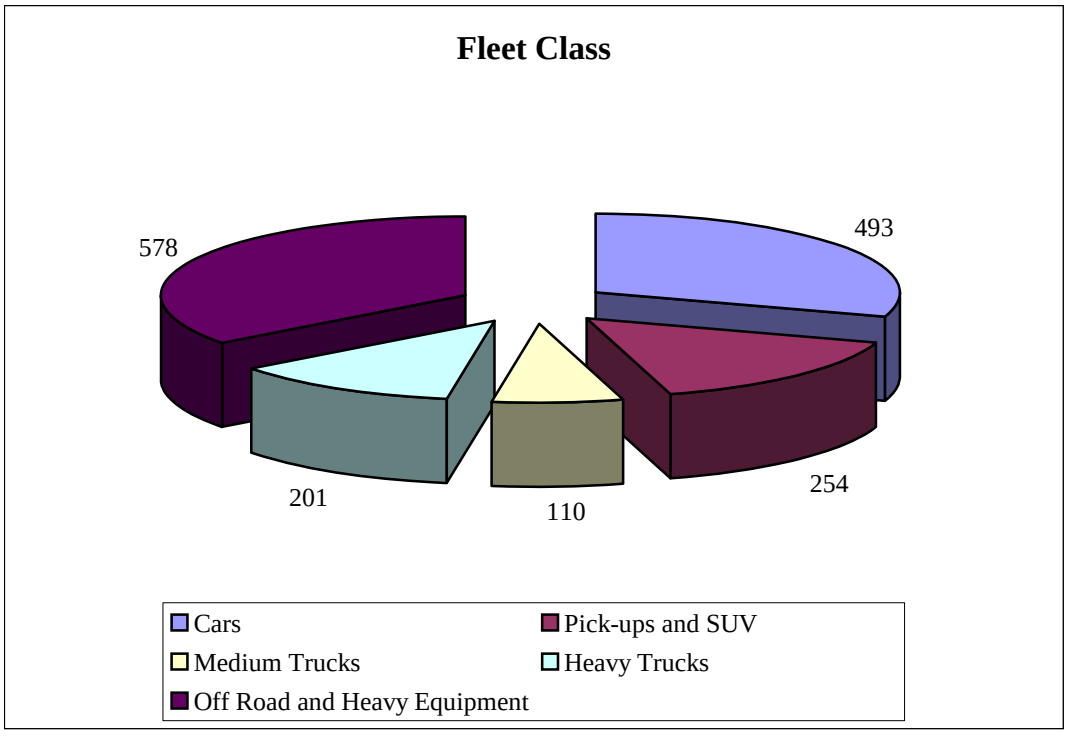
It should be noted that the PAC and the process evolved over the course of the project.The level of understanding of the alternative fuel environment varied greatly among the PAC members at the outset. However, as the PAC and the Consultant Team went through the process, the aggregate level of knowledge, understanding and awareness increased. This created the foundation for the Executive Briefing format with guest speakers and was very effective in helping the PAC in applying these concepts. The result was recommendations that were pragmatic and meaningful. Thus, an integral recommendation of this report, as discussed later in Section E, will be a continuance of some form of the PAC, in its current focused form, which has proved highly successful and effective. One alternative is to continue as a separate entity and the other is to function as a subgroup of the City Green Team.

Section B: City of Rochester Fleet Usage Characteristics

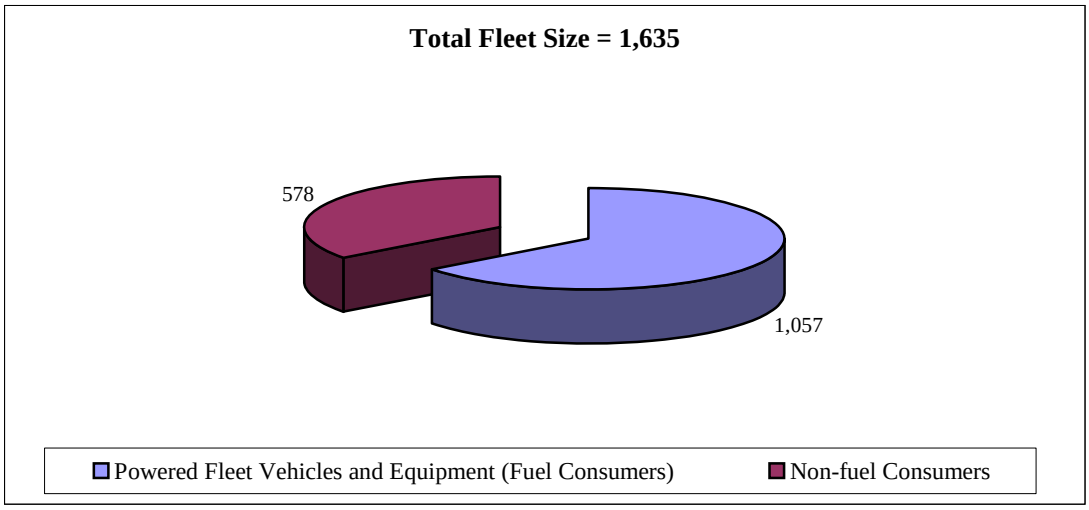
Introduction

A fleet utilization analysis was performed in order to identify vehicles and equipment that may or may not be considered candidates for the alternative fuel program. By sorting the fleet into categories for consideration, we also specifically identify vehicles that may or may not be considered for any type of alternate fuel.

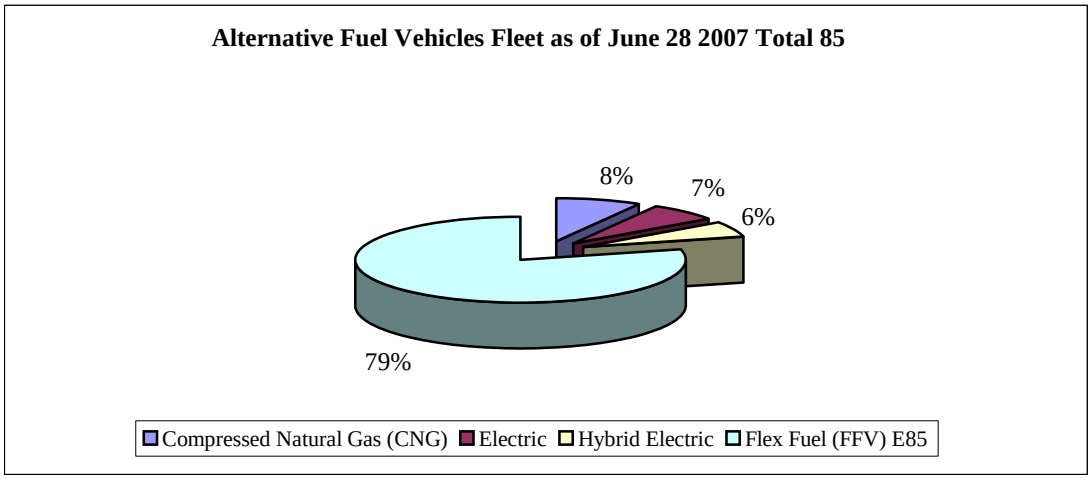
The following depicts the City fleet by vehicle class:



The following depicts the City fleet by Fuel Consumption vs. Non-Fuel Consumption



Existing Alternative Fueled Vehicles



The results of the utilization analysis are outlined below with a brief description for each category.

Aged Equipment

Approximately 245 vehicles and pieces of equipment are seven years old or older. The primary concern with these vehicles is the cost for modifications in order to allow them to use biodiesel. Out of the 245 mentioned above, 58 are potential biodiesel consumers, not including off road equipment. The older vehicles that use gasoline are recommended to use E-85 when available if these vehicles are flex fuel. There are some older vehicles, such as the Ford Taurus in certain model years that flex fuel.

High Mileage

High mileage vehicles and equipment are defined as metered vehicles that have in excess of 50,000 miles. A total of 318 vehicles are in this category. We feel that some vehicles are not potential candidates for conversion kits. However, a significant number of these vehicles (287) are recommended to use E-85.

Non-powered or Non-priority Alternate Fuel Vehicles

This category includes off road equipment, specialized equipment, and fleet assets that do not use fuel. 512 vehicles and pieces of equipment are in this category.

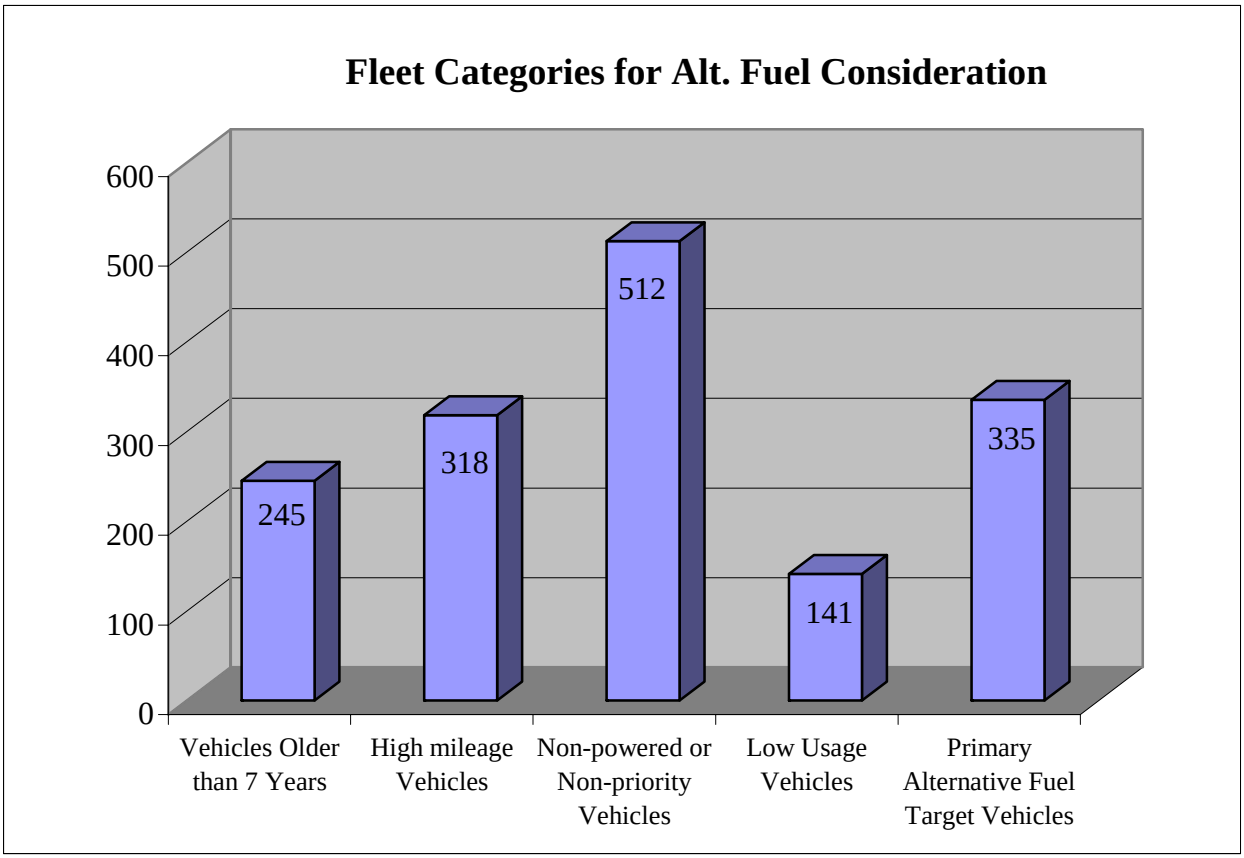
Low Usage

There are a considerable number of low usage vehicles in both the diesel and gasoline classes of equipment, with approximately 141 low usage vehicles in the fleet that travel less than 300 miles per month or 3,600 miles per year. These low usage vehicles represent approximately 13% of the entire powered fleet and do not include off-road equipment. There are 100 gasoline-powered vehicles in this group that will be placed on the list as *potential* alternate fuel (E-85) users, depending on the year and fuel system configuration.

However, the same cannot be said for the diesel fuel low usage equipment. Of these low usage vehicles, 41 are diesel-powered trucks. The primary reason is that in order to use biodiesel, a vehicle or piece of equipment must use sufficient fuel so the tank will not be susceptible to algae growth. Algae growth can potentially occur in biodiesel fuel tanks when the fuel has been exposed to high temperatures, such as summer heat, usually for an extended period of time but sometimes after only a few months. Algae remains a primary concern for the diesel fuel vehicles in this category and thus the reason that a biofuel option is not recommended for this subgroup of vehicles.

Primary Target Alternate Fuel Vehicles

This category consists primarily of the vehicles and equipment that have good usage patterns, are not older than seven years in age, and do not have a high meter reading. There are approximately 335 vehicles in this category representing 64 diesel-powered vehicles and 271 gasoline powered vehicles.



In subsequent sections discussing biodiesel, information is presented concerning costs to transition some or all of the diesel vehicles to biodiesel. The remainder of the gasoline-powered vehicles are recommended to use E85 as it becomes available.

Section C: Evaluation of Alternative Fuel Technology Options for City Fleet

Background

The Fleet Counselor team examined aspects of the City of Rochester fleet, and in preparation for the first PAC meeting held in November 2006, prepared an informative background document for the PAC members entitled *Alt Fuels Primer: What are the commonly used clean, alternative fuel choices and how are they used?* This document was intended to provide an introduction to the basics of alternative fuels for an audience that had some knowledge of the topic, and which could explain what the fuels were, and the vehicle applications pertinent to the respective alternative fuel. This primer is included herein under **Appendix B- Alt Fuels Primer** and proved useful for the PAC as a resource guide during the project.

Task Approach

Alternative fuels evaluated for the project are based upon the clean fuels outlined by the U.S. Department of Energy, originating from the Energy Policy Act of 1992 (EPAct), and in 1999 adding "P-series", and are defined as follows: biodiesel, electricity, ethanol, hydrogen, methanol, natural gas, propane, and p-series. For the purposes of the Fleet Study, electricity was expanded to include a wider range of options based on battery capability such as light duty hybrids, medium and heavy-duty hybrids and plug-in hybrids.

Internal City of Rochester Fleet Dynamics, Concerns and Objectives

The City Fleet's primary concern is **dependability**. Due to operational imperatives, severe cold weather periods, and heavy snow conditions, the fleet faces constant challenges in keeping vehicles in good order and running properly. It was determined during the peer review process that fleets which have undertaken alternative fuel programs regionally have varying degrees of tolerance of risk related to the implementation of AFV's. Some fleets may be more willing to tolerate higher risk based upon an organizational desire to be an "alternative fuel leader". This is not the case with the City of Rochester Fleet, which has an interest in implementing AFV's and to improve air quality emissions, and do something good for the environment, while at the same time maintaining the highest level of fleet dependability. Therefore, certain applications of AFV's such as pilot type program vehicles may not have the best fit. Niche applications of known technology are likely the most acceptable to fleet management.

Overview of Findings

The fuels were evaluated by a number of factors, including current implementation in New York State or Northeast region, comparison with current City alternative fuel activities (i.e. existing natural gas vehicles, the propane asphalt recycling truck, and the Global Electric Motor (GEM) cars), feasibility of implementation by the City, availability of fuel, cost of fuel, technical feasibility in short to mid term time frame, availability of vehicles for specific fuels, original equipment manufacturers (OEM's) versus up fitters for vehicles, relative clean air benefits, ease of integration into existing fleet, necessity of infrastructure additions[4]. The following options were discussed based upon *initial* review of the City fleet, and were presented to the PAC group for consideration and discussion of synergy with City fleet operational objectives. The options generated were as follows:

- Increase compression capacity of existing FuelMaker CNG unit, and augment fleet with light duty Civic GX's. Benefits- "cleanest car on the planet", only CNG light duty vehicle available at reasonable incremental cost, useful for "niche" applications for certain departments; reasonable fuel costs of natural gas and also the use of a "local" fuel, since NYS is a natural gas exporter. Barriers-could be perceived by staff as "not made in America", though the vehicle is actually produced by American Honda in the United States; existing FuelMaker unit at Mt. Read facility has severe operational limits, and can only fuel a couple of vehicles within a reasonable period (one- two vehicles over 1-3 hours), and needs time to recharge the storage pressure; only useful for some applications due to size limitations; concerns over repair logistics- sending out to dealership for repair, can not be done in-house; concerns over general dependability of NGV's in general, though they appear to work well for the State DOT fleet; range concerns of fueling and general logistics of fueling.
- Large-scale commitment to compressed natural gas via application to heavy duty work trucks and refuse fleet. Benefit- substantial clean air emissions savings, barriers- high cost of entry; lack of interest by bidders in 2003 effort for recycling vehicle, may be too much of a fast-track transition- substantial organizational change involved, O&M differences, etc.
- Introduction of various types of hybrids (light duty, medium/heavy duty). Benefits- clean emissions, general level of understanding of hybrids among users (i.e. not "too different"). Barriers- limited offerings of light duty hybrids, Prius perceived as "not made in America"; still uses gasoline; higher incremental costs; concern about battery life and long-term dependability. Ford Escape could be an option since it is made in America, used for limited niche areas in fleet, but fleet utilizes mostly GM and is a GM certified repair shop. GM has limited choices with the hybrids, limited to Silverado, which is a "mild hybrid" and a quite different vehicle than the Prius or Escape, with limited benefits. Heavy duty and or plug in hybrids could be introduced in *very* limited numbers. Benefits- very clean, high tech, leadership opportunity. Barriers- goes against operational outlook of fleet decision makers, very

[4] The respective costs of new infrastructure additions will be examined in Section F: Recommendations for City Fleet Fuel Conversions and Section G: Implementation Plan,Cost Issues and Funding Options.

experimental, pilot type applications, unknown dependability and usability characteristics; very high incremental costs.

Discussion of Specific Fuels

Biodiesel

Biodiesel presents as one of the best options for alternative fuel usage for the City. This renewable fuel is produced from various feed stocks, generally virgin soy oil, and to a lesser degree, recycled grease. Other feed stocks include rapeseed oil (canola), palm oil, cottonseed oil, and other plants found internationally. An effort is underway in Philadelphia to use trap grease to produce biodiesel (via the company Fryodiesel), which enjoys the support of the Pennsylvania Department of Environmental Protection. Biodiesel is produced via the process of "transesterification", which results in both glycerin, and methyl esters (biodiesel). Biodiesel is entirely appropriate for diesel engine applications; Rudolph Diesel designed his original engine to run on peanut oil. The OEM's such as DaimlerChrysler, John Deere, Cummins, and others have extensively tested their products using the fuel, and allow usage up to 20% biodiesel in their engines. DaimlerChrysler delivers its diesel Liberty with 5% biodiesel. However, many advocates utilize higher blends with no anecdotal reports of ill effects.

According to the National Biodiesel Board (NBB.org):

> Biodiesel is defined as mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, which conform to ASTM D6751 specifications for use in diesel engines. Biodiesel refers to the pure fuel before blending with diesel fuel. Biodiesel blends are denoted as, "BXX" with "XX" representing the percentage of biodiesel contained in the blend (i.e.: B20 is 20% biodiesel, 80% petroleum diesel).

Biodiesel enjoys an enthusiastic following, has a folksy image[5], and production trends are increasing exponentially. With extensive production capacity planned for the Rochester area and Western New York region, the fuel should be available from regional producers in the immediate vicinity within the next 18-24 months[6]. The fuel is also on the New York State OGS Contract. The advantages of the fuel are its domestic, renewable nature, and good emissions characteristics. It requires no new infrastructure, can be dispensed from standard diesel fueling facilities, and requires no modifications to existing vehicles as long as they are of relatively new vintage and use Viton seals and hoses. Older vehicles (pre-1990 or earlier) may have rubber hoses and seals which can leak or pit when exposed to the biodiesel. It can be blended into the standard diesel at any percentage, though for the City a blend of up to 20% would be most effective; the blend can be decreased in the winter to 2%, or

[5] Note the popularity and press coverage devoted to Bio Willie [Nelson].
[6] Rochester Democrat Chronicle, "Biofuel in the Rochester region", Sunday, January 28, 2007.

straight diesel used to avoid cold weather concerns altogether. A B2 blend is considered to add needed lubricity to the new low sulfur diesel now required for use. The most important concern for the City during the initial phase in of the fuel is to ensure a quality supplier with a consistently good product, which meets the ASTM. It has been observed that the rare occurrence of a "bad load" of the fuel can create operational problems via clogged filters, gelling, etc. New and inexperienced producers and or suppliers can increase the risk related to product quality. Another major concern with the fuel is ensuring proper cold weather performance. The fuel can gel under cold conditions, both in the tank, and in vehicle systems via clogging the fuel filter. This concern has been addressed on a national basis by research on utilization of fuel additives which prevent cold weather gelling. It has been determined that the feedstock of the biodiesel affects the performance properties of the biodiesel/diesel blends, and that in most cases:

> "B20 users are generally pushing all these issues onto the fuel distributor and blender's shoulders with contractual language. Users may simply specify that they need a fuel to remain crystal free at temperatures down to –14 degrees F for December, January, and February. Then the blender will work with the biodiesel and diesel suppliers and the additive firms to address these issues…"[7]

Thus both supplier controls regarding additives, blending tests on diesel/biodiesel mixtures, and cold weather testing, along with City controls of decreased usage of bioblends during cold season, and protective contractual language can be used to address this issue.

Electricity

For the purposes of this study, electricity will cover purely electrical vehicles, and those with electrical battery assist to the drive train and or/motor, which are referred to as hybrids. Hybrids are further categorized as light duty, medium/heavy duty and plug-in hybrids as applied to the latter category. Light duty hybrids currently include the Toyota Prius, a vehicle enjoying a high level of prominence and national popularity, and the Ford Escape, a small SUV. The City currently has four (4) Priuses, which are assigned to the Water Bureau. The Prius is not made in America, and costs more than a traditional equivalent light duty, high fuel efficiency vehicle in the same vehicle class. The life cycle and dependability of the battery pack of the Prius are currently unknown. In the past, this vehicle was not on the State Office of General Services (OGS) procurement contract, so purchasing these required the generation of a bid package, thus entailing a greater amount of administrative staff time to acquire these vehicles. It is feasible to acquire more Priuses, which are extremely fuel efficient at approximately 49 miles per gallon. However, it is now listed on the 2007 OGS Procurement Contract. Also on the Contract as a gasoline hybrid electric compact sedan is the Honda Civic. The Ford Escape is on the State Contract and is appropriate as a small SUV. The larger SUV gasoline hybrid is the

[7] Biodiesel Handling and Use Guidelines, U.S. Department of Energy, 2006, p. 38- B20 Cold Weather Blends.

Toyota Highlander. All the models noted herein, excepting the Ford, have the perceived problem of not being manufactured in the US, though the Civic may be made domestically. Toyota also has extensive manufacturing capacity in the U.S.

The 2007 State Contract for Alternative Fueled Vehicles, 40401, which came into effect in November 2006 for model year 2007 may be accessed via http://www.ogs.state.ny.us/purchase/spg/pdfdocs/4040120555a.pdf. It covers CNG, E85 and gasoline hybrid light duty sedans and SUV's. A copy is included herein under **Attachment 1**.

A separate contract section "Electric Vehicles" exists for purely electric vehicles, which at this time includes only the small neighborhood vehicle GEM, found in four configurations on the State Contract (2 passenger, 4 passenger, Short Box, and Long Box). The City currently has three (3) GEM vehicles. Previous OEM electric vehicles such as the Toyota RAV SUV and the Ford F150 pickup were discontinued some years ago. The contract section for electric vehicles is currently pending at the Comptroller's office, but is expected to be released in 2nd quarter 2007 (Source: OGS Alt Fuel Program, phone conversation[8]). Such a vehicle is appropriate for limited City usage for such tasks as Parking Control, usage at Park Department compounds, and other limited range, low speed, contained areas. Neighborhood electric vehicles are limited to roadways having a 35-mile per hour speed limit, and while handy, environmentally friendly, and attention getting, can present a hazard if motorists are unfamiliar with their presence. They are also difficult to use in extremely cold weather due to their small interior heating capacity.

Other types of medium and heavy-duty hybrids, which can be configured with gasoline, diesel, or as pure electric hybrids are available on a pilot level program basis, and could be considered by the City for acquisition on a very limited basis. These vehicles can have high incremental costs ($150K and up), but have the advantage of being extremely clean, highly innovative, and quiet. NYSERDA funding can be acquired to assist in meeting the incremental cost. Used vehicles such as a refuse truck can also be retrofitted to extend its lifespan (example, Greater Long Island Clean Cities project for Town of Hempstead utilized an old New York City Department of Sanitation (DOS) vehicle, installed an electric hybrid drive train, and the vehicle is now successfully operated by the Town of Hempstead Sanitation Department). Such applications, when utilized with recycling type activities, bring a high level of community interest and generate positive environmental synergies. Such applications are appropriate for limited use by the City, in limited numbers (likely in orders of 1-2 units per year).

Ethanol

Ethanol is an alcohol fuel, which is renewable and presents air quality emissions benefits through reduction in many of the priority pollutants including particulates, carbon monoxide, ozone, and toxics including toluene, xylene and benzene. The

[8] The 2006 Electric Vehicle Contract was Award 19970, Group 40511; the new contract for Model Year 2007 was issued April 16, 2007.

carbon dioxide performance is considered neutral, since though the emissions of CO2 from an FFV are very similar to a standard gasoline model, the CO2 is incorporated into the growth cycle of the crops used to produce the ethanol. The majority of ethanol produced in the U.S. is corn-based, and the production of ethanol is currently enjoying an enormous boom due to the phase-out of MTBE in the national gasoline supply, where ethanol is used as a clean air oxygenate, and the Renewable Fuels Standard (RFS) of the Energy Security Act of 2005, which mandates minimum incorporation of biofuels into the nation's gasoline up to and including 2012. The intent of the RFS is to "ensure the use of renewable fuels such as ethanol in gasoline" (Source: Clean Fuels Development Coalition, Renewable Fuels Standard 2006). Thus, many standard gasoline stations now offer a ten (10) percent blend of ethanol in their products.

A significant opportunity exists for the City to make use of a higher level ethanol blend termed E85, which is an eighty-five (85) percent ethanol/fifteen (15) percent gasoline product. OEM's produce vehicles directly from the factory ready to utilize such a blend; these vehicles are termed "***flexible fuel vehicles***" or FFV's for short. They are produced by General Motors, Ford, Daimler Chrysler[9], and in limited models by Nissan and in the future, Toyota. FFV's are designed to run on varying blends of ethanol and they may be used with regular gasoline or E85. A number of FFV's are currently in the City fleet (67are owned at present and 50 more are on order) , which can immediately run on E85. The fleet is currently acquiring more FFV's, especially the new police vehicles, the Police Package Impalas, which are all FFV's. Many FFV's in all categories (vans, pickups, sedans) are available on the state contract and have no incremental cost.

This opportunity is an extremely easy way for the fleet to utilize a proven alternative fuel on a fast-track basis, and effect a significant petroleum reduction. With a basic upgrade, existing fuels storage and dispensing facilities can be made E85 compatible via change out of hoses and nozzles to "hard metal" components (stainless steel or nickel plated). Although there is currently an Underwriters Laboratory effort to formalize certification procedures for E85 dispensers, UL did certify a full line of OPW component parts in 2005, and no failures of E85 pumps have been observed. Though it rescinded this certification as part of a greater effort to perform an overall evaluation of its testing standard, these OPW parts are appropriate for use with E85, and would likely be approved for use by the State of New York Department of State Division of Code Enforcement and Administration (Source: NYS Biofuels Working Group meeting March 27, 2007). The Department of Energy's Clean Cities website offers an excellent resource in its "E85 Toolkit" which provides technical information on all aspects of the fuel. The National Ethanol Vehicle Coalition is a non-profit organization, which also provides technical support for questions related to the fuel (www.E85fuel.com).

[9] As of the 2007 model year, there are no Chrysler/Dodge models certified for the air quality requirements in New York State, though their vehicles can be used in states with less stringent emissions requirements. This differentiation leads to some confusion about which FFV's are available in New York State.

In 2007, the New York State Energy Research and Development Authority is expected to make a major push for biofuels (E85 and biodiesel) usage in New York state, and the NYS government has approximately six (6) stations for its own use; a private retail gas station E85 pump opened recently in Albany (May 2007), and another was opened in Warrensburg. However, in the Rochester region, Monroe County is the only entity with a biodiesel station at this time but this is not open to the public. There are plans construct several Green Stations, which should include biofuels, and the first one is planned near the City of Rochester Operations Center. Regionally, a large number of ethanol plants are planned for the Upstate region, many in the direct vicinity of Rochester (Greece, Medina, Caledonia, Shelby). The plant in Greece, the Mascoma cellulosic ethanol pilot plant, has the support of both NYSERDA and the USDA. Cellulosic ethanol, or that produced from plant materials such as vegetative grasses, corn stover, municipal waste, and other materials, is the "holy grail" of ethanol production. Though it can be made using current technology, the energy needed to break down the cellulose (the part of the plant that gives rigidity) requires an energy input, generally in the form of heat to break down the mash. The high technology efforts focus on developing more effective "cold temperature" enzymatic processes that eliminate the need for heating the mix, and break down the material with the enzymes. A large amount of federal support is being directed towards such efforts to produce cellulosic ethanol. The emissions benefits of cellulosic ethanol are considerable, since a waste product may be used as the feedstock, eliminating fossil fuel inputs associated with corn-based ethanol, and eliminating off-gassing from the decomposition process of the waste feedstock.

Thus, the choice of FFV's (whenever appropriate and available) for the fleet application is recommended when ordering all new vehicles. The FFV's can be accumulated, and a phase-in of E85 undertaken at the appropriate time for the City, when infrastructure and supply have been effected. This has been the procedure for other Northeastern fleets which have implemented E85 such as the Pennsylvania Turnpike Commission, New York City Department of Sanitation, and Nassau County, Long Island, New York.

Hydrogen

Hydrogen or H2 is a highly combustible gas, which can be utilized in internal combustion engines with little or no tailpipe emissions. Fuel cell technologies utilizing hydrogen are also under development by the major OEM's, including Delphi and GM facilities in Rochester. Though hydrogen is the most common element in nature, it readily combines with other elements, and H2 for the purposes of use as a transportation fuel is not naturally occurring, but must be produced from other sources. It can be reformed from natural gas (CH4 et. al), which presents carbon dioxide/greenhouse gas concerns, or can be electrolyzed on a smaller scale from water.

There has been much talk about hydrogen as the fuel, which will free America from both the grip of foreign oil, and prevent further global warming. The use of hydrogen

as a motor fuel is at the most early stages of evaluation, with no concrete date of when the fuel could be practically used. OEM's have prototype vehicles, and the State of New York has a very small number of Honda FCX's that are being evaluated for cold weather performance, and which require special fueling procedures. In the Rochester region, Monroe County is seeking to participate in the GM Project Driveway Hydrogen ICE Car Project by requesting one vehicle and RIT and NYSERDA will work together on a joint venture that will feature 3 hydrogen ICE cars. One of these will be deployed to the Wegman's supermarket chain.

As a gaseous fuel requiring 5,000 or 10,000 pounds per square inch of compression storage, there is no existing infrastructure for the fuel within the current transportation fueling system[10], few standards for emergency response in the event of fire, an inordinate cost of a vehicle (of nearly $1 million), and presents many unknowns. However, the availability of government funding for a hydrogen fueling facility presents interesting opportunities for a pilot facility for the City. Likewise, the nearby General Motors research facility for advanced propulsion systems located in Honeoye Falls presents as a clear opportunity for partnering on a special project, such as the Project Driveway test vehicle.

Methanol

Methanol does not appear as a feasible alternative fuel choice at the current time. No methanol-powered vehicles are readily available for use by the city, and the major auto manufacturers have discontinued their production. Nor is any fueling infrastructure available for the fuel. Methanol, an alcohol based, clean burning fuel, enjoyed a more prominent level of use during the mid-90's, when attempts to create a methanol infrastructure were undertaken. Though some limited numbers of methanol vehicles remain in fleets in California, their use is being phased out. Methanol fueling infrastructure has been found to be a useful conversion option for the use of E85, since the requirements for material fueling components is more stringent than those for ethanol, methanol having a greater corrosive potential than ethanol, and a number of former methanol tanks have been converted to E85. (Source: National Ethanol Vehicle Coalition, California E85 Site Evaluation, December 2005, and NYS Thruway Authority site conversions, 2006)

There are currently efforts to determine whether methanol could act as a feasible fuel source for hydrogen, as an application for fuel cell vehicles. (Source: US Dept. of Energy Alternative Fuels Data Center, with web based information link for methanol, to the Methanol Institute http://www.eere.energy.gov/afdc/progs/related2alt.cgi?31) It is also used in the production of biodiesel.

[10] With the exception of special project sites around the country, including one in Buffalo, Syracuse, White Plains and Albany. However, one may be built at RIT with possible connection to Green Station (see p.59)

Natural Gas

Natural gas is a colorless, odorless hydrocarbon mixture, primarily constituting methane (CH4). The fuel is readily available in the Northeast. Commonly used for power generation, and heating applications, it can also be used for transportation. Natural gas is produced in American, including western New York State. In transportation applications the natural gas in compressed to 3,600 pounds per square inch and used in vehicles equipped with a CNG internal combustion engine. Older model natural gas vehicles (NGV's) were filled to 3,000 psi. CNG as a transportation fuel is widely used around New York State, and presents a feasible option for application to the City fleet.

The City currently has a small FuelMaker unit (Model FMQ-8-36, 8.8 max scfm, with Model FF350D dispenser) at the Mt. Read Boulevard facility, and has seven (7) light duty OEM vehicles (3 trucks and 4 passenger vehicles). The original FuelMaker unit was constructed such that it could easily be expanded to fuel more vehicles. Thus, adding compression capacity to the current unit, and augmenting the fleet with additional Honda Civics, the only remaining OEM vehicle, can expand the light duty fleet most easily. The Honda GX is listed on the New York State Office of General Services State Contract, at $22,246 plus delivery.[11] The fuel economy of this unit is rated at 28-mpg city/39 mpg highway, and the annual fuel cost used by the USEPA for 15,000 miles of driving is $1,204.[12] Thus the GX has a less than one percent fuel economy penalty versus the standard gasoline model. Other vehicles can be upfitted to utilize CNG, such as the Crown Victoria, and various Ford and GM model trucks. This upfitting can be costly, in the range of $15,000 per vehicle, though applications for grant funding can be made to the NYSERDA for financial assistance with a portion of the extra, or "incremental" cost. Therefore, the simplest way to gain clean air benefits resultant from NGV's would be to acquire more Honda GX units, which could be filled at the Mt. Read station, as well as at the proposed "green stations" of the City.

CNG can also be utilized by the City on a wider scale, by incorporating its use into their larger vehicles such as work trucks and the refuse fleet. Such an incorporation is a material shift in operational conduct for the Fleet Services, and brings with it substantial incremental vehicle costs, likely $69,000 per refuse truck (source- Greater Long Island Clean Cities CMAQ Round 7.1 Demonstration CNG Refuse Truck Project, 2006). Likewise, significantly greater CNG infrastructure would be required to fuel a large refuse or heavy duty fleet, at a probable cost of $650,000 per station or greater. There is a potential that a "turnkey" CNG design/build/supply firm could be recruited to construct a CNG station at its own cost, and then sell the fuel back to the City (Source- New York State Hauppauge/Clean Energy Public Private Partnership/Town of Smithtown Refuse Fleet, 2006). This option will be further discussed under the implementation section of this report. The benefit to converting

[11] Retail list price of the Honda Civic GX is $24,590.
[12] Standard gasoline powered Civic is rated at 30 mpg city/40 mpg highway.

to CNG on such a large and expensive scale is the great clean air benefits, which result from use of these extremely clean-burning engines.

Propane

Propane is widely used in various applications (heating, cooking, etc.), and is available in the northeast. Also known as liquefied petroleum gas (LPG), it is a byproduct of oil refining and natural gas processing. It is a hydrocarbon mixture, often 90% propane, 2.5% butane, with ethane and propylene. In certain regions of the US, specifically Texas, the fuel is commonly used for transportation. Limited applications for alternative fuels have been done on a project-by-project basis elsewhere. Shuttle buses are run on propane at national parks such as Acadia and Yellowstone. Schwans, a prepared food distributor, runs a fleet of propane delivery trucks. Currently, the most common manner of converting a medium or heavy-duty vehicle to propane would be via an "after-market" conversion, or "upfit". Such conversion packages must be certified by the USEPA.
"according to Mobile Source Enforcement Memorandum 1A (Memo 1A), as well as the Addendum to Memo 1A, and the Revision to the Addendum to Memo 1A, which were issued by EPA."[13] This certification requires either an EPA Certificate of Conformity, or a California Air Resources Board retrofit system certification. Having this certification ensures that the converted vehicle meets emission standards and operates according to its required parameters. **Attachment 2: Conversions 101 for Alternative Fueled Vehicles** explains the intent and procedures involved in the certification process, and is taken from the USDOE Alternative Fuels Data Center web-based information compendium for alternative fuels, and is included for reference.

The City owns one (1) propane vehicle, an asphalt recycler/mobile patch truck. The performance of this vehicle has been less than ideal, and has not met the City fleet need for dependability. The peer review conducted with the Pennsylvania Turnpike Commission revealed that the problem with propane vehicles included changes in availability of vehicles, changes in aftermarket conversion companies (with dependable firms getting out of the market), geographic interferences with remaining conversion companies (the majority being located in Arizona) which resulted in lengthened vehicle downtime, and performance issues of the remaining conversion products. However, with new entrants into the market in 2006, including the Roush LPI, the new propane vehicle system problems may be ameliorated.

The benefits of propane are primarily its domestic nature since 85% of propane consumed domestically is produced in the US, which reduces use of foreign fuel sources, and its significant clean air benefits:

> "Propane vehicles can produce fewer ozone-forming emissions than vehicles powered by reformulated gasoline. In addition, tests on light-duty, bi-fuel vehicles have demonstrated a 98% reduction in the emissions of toxics, including benzene, 1,3

[13] USEPA web-based Alternative Fuels Data Center, Propane link.

butadiene, formaldehyde, and acetaldehyde, when the vehicles were running on propane rather than gasoline."[14]

The cost of a basic propane fueling station consisting of a 1,000-gallon storage tank, dispenser, and permitting is $20-30,000 exclusive of card reader (an additional $10-15,000). If fire suppression is required, this adds another $7,500.

P-Series

Added to the EPAct listing of alternative fuels in 1999, P-series or pentanes plus, is a mixture of "natural gas liquids (pentanes plus), ethanol, and the biomass-derived co-solvent methyltetrahydrofuran (MeTHF). P-Series fuels are clear, colorless, 89-93 octane, liquid blends that are formulated to be used in flexible fuel vehicles (FFV's). P-Series are designed to be used alone or freely mixed with gasoline in any proportion inside the FFV's gas tank."[15] Though considered one of the alternative fuels, they are not widely produced or used, and the Fleet Counselor team does not know of any application of P-Series.

[14] Ibid, #4.
[15] USDOE web-based Alternative Fuels Date Center, P-series link.

Section D: Summary of Peer Review Results

Background

The AFFS (Alternative Fuels Systems Study) required a series of "peer reviews" to be conducted with applicable fleets, including the New York State Department of Transportation. The fleets chosen for assessment were those that brought a high level of alternative fuel experience over a multi-year time frame, had similar weather challenges to the City of Rochester, and to which the Fleet Counselor team could be expected to gain good access via past relationships. The NYSDOT program evaluation was a study requirement, based upon its statewide implementation, geographic/cultural synergy, national leadership, and strong track record.

At the PAC meetings #1 and #2, various fleets were presented to the group as options for the peer review. The group considered the feasibility and applicability of the proposed fleets' experience, the variety of AFV applications in each fleet, and whether subject fleets had leaned towards a particular application (i.e. CNG, biodiesel, E85, etc.) It was concluded that fleets with a good mix of AFV solutions were appropriate, as well as those that had utilized biodiesel and could address issues with that fuel. The team wished to ensure that the overall peer review process provided significant experience with the respective fuels under consideration, and that all the fuels were represented in the final evaluation. The peer fleets were selected such that extensive experience with each fuel was represented by at least one of the fleets, though most fleets had multiple fuels in use.

Task Approach

A Peer Review Questionnaire was compiled and presented to the PAC at the #2 meeting in December. The intent of the form was to generate a history of the fleet's AFV usage, determine how well the program had worked, what type of vehicles were utilized, and what the greatest problems as well as benefits had been. Maintenance information was requested for vehicle downtime and repair issues. Questions included information on training programs, OEM support, and user response to AFV introduction.

The questionnaire was distributed to the fleet managers for review, and a subsequent telephone interview was conducted. Results were transcribed onto the forms. Copies of the final forms are found in **Appendix- C Peer Review Questionnaires**. The results of the peer review were distributed at the PAC meetings, fleet characteristics and significant findings outlined, and discussion of findings opened to the group to generate feedback and commentary.

Peer Review Fleets

The fleets selected for the peer review process were as follows:
New York State Department of Transportation, fleet contact Joe Darling, Director-Fleet Administration and Support
Pennsylvania Turnpike Commission, fleet contact Michael McClurkin, Fleet Equipment Operations Manager
Brookhaven National Laboratory, fleet contact Henry Hauptman, Fleet Manager
City of Lakewood, Colorado, fleet contact Nina Hoffert, Fleet Services Coordinator

Overview of Findings

The fleets chosen for the peer review are all national leaders in the AFV and clean fuel movement. The fleets had all been involved in AFV usage since the mid to late 1990's, and their programs had developed over time, and in some cases the focus of their programs evolved substantially.

The most significant anecdotal indicator was observed to be the level of the fleets' willingness to be an innovator/and or leader in utilizing AFV technology. An initial question on the survey was "How would you rate your fleet's willingness to try new or innovative vehicle technologies?" followed by a scale from 1- Very willing, seek to be on the cutting edge, 2-Somewhat willing, prefer to see how technologies have worked in other fleets, 3- Not very willing, seek established and proven technologies, to 4- Not willing at all. Surprisingly, New York State, which is considered to have one of the most advanced programs in the country, did not view itself at the far end of the innovation scale, instead stating that they were a 2 on the scale. Brookhaven concurred, judging it a 2. Pennsylvania Turnpike Commission stated it was very willing to innovate, rating itself a 1, while City of Lakewood stated it was somewhere between a 1 and 2.

This self-evaluation is interesting to compare against the Rochester experience. Though some inroads have been made with AFV's, currently the fleet appears to be closer to a three. This is due to their strong and commendable dedication to having the most completely reliable fleet possible, and a wish to avoid anything that might interfere with dependability. Alternative fuels, by their nature, are relatively new, and thereby can create a perception of interfering with "standard operations". Therefore, it appears that the best route for the City fleet to take is an incremental approach towards incorporating alternative fuels. They would best learn from the experiences of others, and take what is perceived to be the best parts from other programs.

Applicability to City of Rochester Fleet

The most useful aspects of the peer review relate to biofuels usage, and the ease of integration of the biofuels into an existing fueling infrastructure for use with an existing fleet. Biodiesel was observed to have been successfully introduced into peer fleets, with little or no downside. In certain instances the fuel involved a premium pricing over diesel, but with the onset of large scale biodiesel production slated for

the Rochester area, and the increased cost of diesel based upon the new emissions requirements associated with low sulfur diesel, this pricing concern should ameliorate over time. The biodiesel can be utilized at a low blend in the existing diesel fleet and should not have any outward changes for fleet vehicle users. The biodiesel should be procured from a well-established producer whose product meets the required ASTM standard, and should be properly treated for cold weather conditions starting no later than October 1 of the respective year. Biodiesel is currently available on the regional OGS fuel contract. Based upon the City of Keene experience (biodiesel fleet visit), an additive such as Artic Express (or equal) should be kept on hand for emergency purposes. The City should start with a basic pilot program for biodiesel usage (see following section on Implementation Strategies), determine usage optimization, and then expand the fuel's usage over time. This was the approach taken by the peer fleets (NYSDOT, PATC, and City of Lakewood). The City can discontinue usage of the biodiesel in the winter months if it so chooses, or decrease the blend, as does the PATC, though other fleets utilize up to B20 year-round. The fuel can be used in existing fleet vehicles, and the City of Lakewood recommends consistent fuel filter changes (which it does at every PM).

Likewise, E85 can be introduced to the City fleet and used in existing vehicles. The City can accumulate FFV's, as did the PATC, and then begin use of the E85 once fleet infrastructure fueling is in place. Meanwhile, the vehicles can operate on gasoline. Similar to the biodiesel, expanded regional production of ethanol should cause a downward trend in overall E85 pricing, and likely E85 will be on the region's OGS Fuel Contract going forward.

The Brookhaven National Laboratory peer review reflects the potential hazard of leaning too much towards only one alternative fuel, which in their case was natural gas. The BNL fleet effort suffered when the OEM's Ford, Daimler Chrysler and GM left the NGV market, leaving only the Honda Civic light duty vehicle NGV. BNL requires pick-up trucks and work vans, and though there are dependable upfitters for such vehicle types, there is a significant incremental cost for the CNG upfit, though application can be made to NYSERDA to assist in meeting a portion of the incremental cost. Brookhaven also shows the applicability of small neighborhood electric vehicles for use in contained areas (i.e. a campus or park type setting).

Finally, a good training implementation program should be conducted for fleet users at the start of any expanded alternative fuel program. It was determined by the peer fleets that an awareness and acceptance of the goals of an alternative fuel program is useful to impart to staff. As with any organizational effort to modify standard operating procedures, there can be some resistance to change. If users understand what and why policies are adjusted, and what benefits are expected (use of regional biofuels, energy independence, clean air benefits to the community), this strengthens the program (see City of Lakewood). Also, good outreach and communication with first responders and fire officials is extremely helpful in gaining acceptance for new fueling facilities. An awareness training session can be conducted, such as was sponsored by the Brookhaven National Lab and Town of Brookhaven, for local fire

marshals, and proved very successful. This training event entailed classroom work, a tour of the fueling facilities, and viewing of the alt fuel vehicles; certificates of completion were provided to participants. Such training also assists in expanding greater community awareness of the benefits of clean fuel programs, as the fire officials tell peers, friends, and family members.[16]

Respective Peer Review Fleet Characteristics

New York State Department of Transportation-
This program began in 1996, and has received a high level of support. The fleet manager stated that they "cannot be a research and design center; will do a technology that makes sense that has been proven elsewhere". The fleet takes the position that any fuel it utilizes must be able to be used "across the board", without using "niche" technology applications.

This fleet is heavily geared towards CNG for light duty applications, as well as heavy-duty usage. Currently it has 716 light duty CNG vehicles consisting of Honda GSX Civics, and other vans, sedans and trucks, presumably Ford and GM vehicles dating from when those OEM's produced light duty CNG models. In the last two years, it has also incorporated thirty five (35) dual fuel CNG/diesel heavy-duty Class 6 small dump and Class 8 large dump trucks upfitted by BAF of Dallas, Texas. The small dumps are used for pothole repair, cleanup work, and maintenance activities. The large dumps are used for traffic control during roadwork, and for snowplowing. The use of these vehicles was an innovative application at the time, but the initial order worked well and more were ordered.

In 2000, the State sought to create a CNG fueling infrastructure, and constructed thirty (30) stations in the first year and a half. Now there are fifty-nine (59) stations across New York State, augmented by stations built by utility companies, municipalities, and some privately owned retail locations.

The most beneficial aspects of the CNG effort has been the price benefit for the fuel ($1.40/gge CNG versus $1.90/gal for gasoline, and $2.25/gal for diesel), thereby saving taxpayer dollars, the notable clean air benefits from these very clean engines, and the lower maintenance costs. The fleet plans on continuing acquisition of NGV's, for both light and heavy-duty vehicles.

There were some electric vehicles in use in the past, the Toyota RAV models, which were phased out by the OEM when their leases expired. The fleet manager foresees augmenting his light duty fleet with hybrids, since the other OEM's except Honda have bowed out of the CNG market.

[16] Many fire officials may also possess an FFV- the First Responder Tahoe package is E85 compliant.

The fleet has gotten into biodiesel incrementally, having conducted a pilot program at nine (9) sites, which currently use a B20 blend. In 2007 it plans on going system-wide with B5. The fuel is purchased via the state Office of General Services fuel contract, and it has been observed that no bidders wish to bid on the biodiesel for the extremely cold portions of the state, where temperatures can fall to minus 40-50 degrees Fahrenheit.

Overall, there have been no significant problems with the AFV program, or any maintenance issues of note. The main problem was the OEM's getting out of the CNG light duty market.

Pennsylvania Turnpike Commission-
This fleet has been involved in alternative fuels since 1995. The PATC started out with CNG vehicles, which fueled at utility operated sites near Philadelphia and Pittsburgh. Based on the approximately 360 mile (east to west), 61.5 mile western expansions, and 110-mile (north to south) scope of the Turnpike, the range of 530.5 miles that vehicles had to cover was extensive. The cost of CNG infrastructure was deemed prohibitive to cover such a large area, there were concerns about vehicle range capability, and the CNG vehicles were phased out. The fleet is primarily staged out of the New Cumberland (near Harrisburg) headquarters, but some tasks require traveling long distances.

The alternative fuels utilized by the PATC are E85, biodiesel, and propane.

The light duty work trucks require enough space to carry tools and materials, which made use of hybrids prohibitive. The light duty fleet has now moved towards E85, and all vehicles models which can be ordered as FFV's are purchased. They currently have 210 FFV's, and one station in New Cumberland, which was converted from gasoline use. The fleet manager accumulated the FFV's in the fleet prior to having an E85 station. They believe the Pennsylvania E85 corridor project will help them use E85 in other areas of the state, by providing public fueling stations at various retail locations.

The medium duty fleet is geared towards propane, and the PATC has nineteen (19) propane stations, out of twenty-three (23) total fueling locations. The fuel has worked well, and performs well. A problem arose when the GM upfitter Quantum got out of the market in 2005. The newer vehicles, upfitted in Arizona, have had performance problems. Fixing them is time consuming because the upfitter is in Arizona, and getting parts from there takes a few days. It is hoped that a new, fully certified propane upfit system from Clean Fuel USA will be more dependable, and a good resource going forward. This is a liquid propane injection system suitable for various applications. They currently have nine (9) light duty and thirty-four (34) medium duty trucks on propane.

The fleet has used biodiesel since a pilot program in 1997-8. In 2005 the program expanded to five (5) locations, and in 2006 went system-wide. In warm weather

months, a B20 blend is used, and in October is changed over to B5. In the mountainous areas of the region, winter temperatures can dip to minus 10 degrees Fahrenheit, and around New Cumberland, temperatures average 25 degrees, but can go down to minus 5. They have not experienced weather related problems, but did have a bad delivery of fuel which caused injector damage to an engine, as the fuel filter gelled up and clogged, and starved the injectors of fuel. This cost approximately $1,500 to repair and resulted in downtime for the vehicle.

They use biodiesel in 25 light duty vehicles, 280 dump trucks (6 and 10 wheel), and in the graders, backhoes, pay loaders, and generators, totaling to 550 units (27K to 33K GVW). They are moving all their light duty vehicles towards E85.

They have their own Turnpike contract for fuel, and they did experience fuel price spikes over the last two years, as did the national market. It was deemed important to have good communication with potential bidders on the alt fuel contract, to ensure the distributors received bid packages, and to have a price escalation clause in the contract to cover risk related costs of fuel prices and accessibility.

Brookhaven National Laboratory (Brookhaven NY-Long Island)

This fleet began its alternative fuel vehicle program in 1994, with the acquisition of CNG vehicles. However, these vehicles were purchased without the necessary CNG fueling structure in place, so they could not be utilized at that time and therefore there was no actual operation of these vehicles. The organization acquired bi-fuel CNG vehicles in 1999 but they were operated initially on gasoline because there was no CNG fueling facility at that time. A CNG station was installed in 2002 and this provided the foundation for a substantial CNG fleet for Brookhaven labs.

It is important to note that Brookhaven Labs is a contractor to the US Department of Energy (USDOE) and is required to purchase and operate a certain number of alternative fuel vehicles that meet that definition according to the regulations promulgated in accordance with the Energy Policy Act of 1992(EPAct 1992). As a result, the decisions regarding the acquisition of AFVs are driven by these constraints and as a result, certain AFV vehicle choices would not be considered. In our peer review survey, the fleet manager rated the fleet's willingness to try new or innovative vehicle technologies as: *somewhat willing but would prefer to see how technologies have worked in other fleets*.

The primary alternative fuel used by Brookhaven Labs is CNG.

Brookhaven Labs has 77 CNG vehicles in a fleet comprised of 292 vehicles, which is 26%. These are all light equipment vehicles that include a mix of sedans, vans and pickups. Most of the vehicles are dedicated CNG vehicles but there are some bi-fuel vehicles in the fleet also. The average annual driving distance is 5,000 miles and much of the driving occurs in a campus environment at Brookhaven Labs.

There is on-site fueling capacity and they have a reciprocal CNG fueling agreement with the Town of Brookhaven, which also has its own CNG station and vehicles and they also provide CNG fuel to Dowling College, a nearby educational institution. This provides for backup for each organization in the event that there are maintenance or service issues with their respective stations and it generates good will in the community.

Overall, the CNG program implementation has been successful. They had training support from the gas supplier (KeySpan Energy Delivery) initially and they have continued to provide training in-house for employees and they also provided orientation and safety training to the local fire marshals. They have achieved an estimated displacement of petroleum of 25-33% overall. The initial safety concerns of employees have been reduced significantly through orientation and safety training. The OEM dealers are not conveniently located so they generally purchase the parts and repair the CNG vehicles in-house.

The disadvantages to the program include the lack of available CNG fueling sites when they venture out of the Brookhaven Labs campus and the Town of Brookhaven. In addition, the repair costs and downtime are higher for the CNG vehicles, particularly the bi-fuel ones. Repairs to the CNG station are also costly when they are required.

As the availability of OEM product offerings for CNG vehicles diminishes, the options available for the Brookhaven fleet will be reduced to either engaging in costly conversions to CNG or finding another AFV option for the fleet. This may be instructive to any fleet planning on new light equipment AFVs in the future. In addition, Brookhaven Lab has 31 specialized electric vehicles (GEM etc) that are used only on the campus.

City of Lakewood, Colorado

The City of Lakewood Colorado began an AFV program in the 1970s with some early-generation electric vehicles but these were of limited value and were phased out. The City currently has a small fleet of three hybrid Prius sedans but the City's primary involvement with alternative fuels is with biodiesel. In the peer review survey, the fleet services coordinator rated the fleet as being at the midpoint between: *seek to be on the cutting edge of new technologies* and *prefer to see how technologies have worked in other fleets.* It is interesting to note that one of the Lakewood City Council values is to support innovation.

The primary alternative fuel for Lakewood Colorado is Biodiesel

The use of biodiesel began in 2003 and the catalyst for this was that there was an internal champion within the organization who pushed for implementation. The goals

of the program were twofold: reduced dependence on foreign oil and reduced air pollution.

For the first three years of the program, the fleet used B20 on a year-round basis. They had no performance problems in the winter months but they switched to B10 for the 2006-2007-winter season due to uncertainties about the affects of the newly required Ultra Low Sulfur Diesel (ULSD). Since the peer review was conducted in the early portion of the winter, the performance results are unknown at this time.

The Lakewood fleet is comprised of 100 vehicles that are a combination of medium and heavy-duty classes. In addition to providing biodiesel for their own fleet they have inter-municipal fueling agreements with several other governmental units in the region and they fuel an additional 200 vehicles through these contracts. The total amount of B20 biodiesel dispensed is 350,000 gallons annually. They use one 12,000-gallon tank that serves a total of four different fleets. These fleets include the Lakewood municipal fleet, one school district, one fire department and one water and sanitation district. Since the program began in 2003, the program has displaced 70,000 gallons of petroleum annually or almost 260,000 gallons since program inception.

The weather conditions in Lakewood (near Denver) are slightly less harsh than in Rochester with significantly less snowfall (most years) and higher average winter temperatures of highs in the 30s-40s and lows in the 20s. They do occasionally get lows below zero degrees Fahrenheit but this is atypical. This is somewhat comparable to Rochester. Lakewood does comprise a fairly large geographic area, and the driving distances may be greater than in a typical city in the Northeast. There were no differences noted for performance or downtime in the Lakewood fleet experience.

The Lakewood fleet contact described several key attributes of a successful biodiesel program. These points are instructive if a decision is made to implement a biodiesel program. The key points are:

- **Frequent fuel filter changes-** they do it at *every PM*
- **Communication and attitude-** it is important that the employees at the operational level understand the reasons for the implementation for the program and the facts behind it. This will help create buy-in and support .
- **Use a trusted fuel supplier-** In Lakewood, the biodiesel supplier is always available to support the fleet when issues or concerns arise. They frequently test the fuel and tanks and provide excellent customer service. It is essential that the fuel supplier maintains the fuel according to ASTM specifications and also ensures that the proper additives are available to the fleet during the winter months.

In conclusion, there is a fair amount of commonality between the types of equipment used, volume for diesel fuel and weather conditions that would be useful if the City chose explore a biodiesel program.

Section E: On Site Presentation/Demonstration for Biodiesel

Background

The AFFS (Alternative Fuels Systems Study) required an "on-site" biodiesel tour and demonstration. The Fleet Counselor team examined biodiesel usage patterns in the Rochester/Western New York State area. It soon became clear that no suitable fleet using biodiesel in the vicinity of Rochester could be identified for an on-site tour. Moreover, no biodiesel production facility was yet on-line in the area, eliminating that alternative. An alternate plan was considered whereby a biodiesel fleet user could be brought in to brief the PAC on his/her fleet's experience with biodiesel. The evaluation scope was expanded to potential fleets from the available user cohort in the Northeastern and Mid-Atlantic states. Utilizing experience and contacts gained from past attendance at the National Biodiesel Board and Clean Cities Congress meetings,a short list of possible fleets for examination was determined.

At the PAC meeting #2 held in December, the group was asked to consider the feasibility of bringing a biodiesel fleet expert to Rochester, and after discussion, the group agreed that this was an appropriate avenue to pursue.

Task Approach

The short list of biodiesel experts was compiled based upon experience and length of time using biodiesel, system-wide use of the fuel throughout the fleet, and most specifically, a strong level of cold weather experience with the fuel. The team wished to minimize any travel costs, which ruled out experts from Western fleets such as Yellowstone National Park, and the City of Lakewood, Colorado. The best choices were determined to be a biodiesel expert from the United States Department of Agriculture's Experimental Farm in Beltsville, Maryland, or a fleet manager from Keene, New Hampshire. The Fleet Counselor team determined that the cold weather experience from Keene, New Hampshire was more representative of the type of weather experienced in Rochester, with more deep freezes, below zero temperatures, and heavy snow conditions. This option was presented to the PAC via e-mail notice, and the go-ahead was given to bring in the New Hampshire expert.

Overview of Findings

On February 8, 2007, Mr. Steven Russell, Fleet Services Superintendent, Public Works Department, for the City of Keene, New Hampshire, was brought in to address the PAC. Mr. Russell is a pioneer in the use of biodiesel in the Northeast, and has used the fuel since 2001. His fleet, comprising 68 vehicles and pieces of equipment, uses B20 (20% biodiesel/80% diesel) year-round. The fleet covers numerous city agencies including the Highway Department, Parks and Recreation, and significantly, Emergency Services (Fire and Police). It is utilized in the various work trucks,

construction equipment, snow plowing equipment, and the Fire Department's ladder and engine trucks.

Mr. Russell provided a complete overview of his program, including fuel characteristics, usage patterns, supply and price issues, and cold weather properties and concerns. The main conclusions resultant from his presentation were as follows.

Biodiesel can be used in any percentage combined with diesel fuel, but is most easily integrated via 5 to 20% blends; some fleets use a B20 blend in the summer and warm weather months, and switch to a B5 blend during cold weather. Mr. Russell uses B20 year round, and ensures that his supplier apply a cold weather additive, starting October 1, to prevent gelling. This date is suggested to protect against early cold snaps. His additive of choice is Power Service "Artic Express" biodiesel antigel. It is essential to have a dependable supplier who can certify that their product complies with the American Society of Testing Measures (ASTM) 6751. Mr. Russell deals with World Energy Alternatives, an early production leader who has supplied the US military and other large state and federal contracts, located in Chelsea, Massachusetts. The City of Keene uses the biodiesel system-wide, in all of its diesel vehicles and equipment.

They have experienced no mileage penalty (i.e. decrease in miles per diesel gallon), nor have they experienced any loss in power or performance. Keene actually observed a 1-2 mpg ***increase*** in fuel economy. As fleet manager, he has observed an improvement in the working conditions for his mechanics and staff, with cleaner air and less soot in the shop area. Also, at the recycling facility, with equipment moving all day within the building, the air quality has improved very much. The mechanics prefer working with the B20 fueled fleet, and experience less skin and odor exposure to the diesel fuel. He has also assisted a professor at Keene State University who is performing a USEPA study grant on biodiesel emissions; the results of air testing and worker dosimeter testing to date indicate considerable decreases in exposure to PM 2.5.

So far, the city has displaced over 200,000 gallons of petroleum. Mr. Russell sees the use of domestic biodiesel as a replacement for foreign fuel as one of the best aspects of his program, and reports that the City Council has had a very positive response to this program. The most important factors for a successful program are to ensure the biodiesel comes from a reliable producer; is ASTM certified; and is properly winterized via a proven and dependable brand of additive. He also keeps extra additive on hand in the event of emergency. He has experienced no problems related to the biodiesel, which resulted in maintenance outlays.

He noted other fleets using biodiesel include: Harvard University, the Port Authority of New York and New Jersey, the City Express Bus Service in Keene, and a fleet in Bangor Maine. Keene State University uses B100 in their fleet during warm weather.

Section F: Recommendations for City Fleet Fuel Conversions

Background

The City has made some inroads in application of clean fuel fleet technologies (basic CNG application, GEM vehicles, propane asphalt truck), but seeks to increase its clean fuel component based upon air quality and emission reduction improvement goals. Designation as a non-attainment area for ozone and particulate matter is a driver for region-wide emissions reductions and use of clean fuels, along with a regional and national impetus to utilize more domestic fuels for transportation.

Task Approach

Recommendations herein are based upon an overall evaluative approach examining fleet characteristics, organizational goals, rolling stock of vehicles, usage patterns, and existing fueling facilities. A review was made of vehicles available from OEM's or present on the New York State Office of General Services procurement contract, both for conventional and alternative fuel vehicles. These factors were examined in relation to the results of the peer review analyses, as well as current alternative fuel technology application and vehicle production trends. Fuel availability and cost were considered, as well as regional developments related to biofuels production, which affect both availability and price. The respective discussion for each fuel is presented as a strategy; the numbering system is arbitrary and does not reflect a prioritization of recommended fuel usage. Likewise, the sources for various estimated costs were developed based upon industry information sources, specialized technology firms in the clean fuels field, and available contacts; the notation of any company name in no way implies a recommendation of that firm, but rather the ability of the consultant team to gain information from those entities.

Overview of Findings

The fuels were evaluated by a number of factors, including current implementation in New York State or Northeast region, feasibility of implementation by the City, availability of fuel, cost of fuel, technical feasibility in short to mid term time frame, availability of vehicles for specific fuels, original equipment manufacturers (OEM's) versus upfitters for vehicles, relative clean air benefits, ease of integration into existing fleet, and necessity of infrastructure additions. The basic findings are as follows:

- Biodiesel presents as the best avenue to integrate an alternative fuel into the existing fleet, and can be accomplished quickly. Based upon the blend, existing infrastructure can be utilized if the City wished to do a low level (5% or less) blend. New infrastructure may be needed if a higher blend is desired, in the event that fleet managers did not want to use the higher blend fleet-wide. A pilot-testing program is recommended to be performed first.

- E85 presents an excellent opportunity to make use of the large number of flexible fuel vehicles currently in the fleet. No modification to the FFV's is required, and they can switch between E85 and gasoline with no problem. New infrastructure would be required for this option, due to the limited existing gasoline fueling capacity. Strong interest exists both in the local county government, as well as private industry, to produce ethanol in the immediate Rochester area. E85 does contain less BTU's than gasoline, so a mileage penalty can be expected of potentially 11-17 percent.[17] FFV's are listed for various light duty units on the OGS procurement contract.
- CNG, though extremely clean burning, and less expensive than petroleum based fuels, would require considerable infrastructure investment if used on a large scale, as well as a large vehicle investment if used on the medium and heavy duty work trucks. Such a fleet transition is not appropriate at this time, but the existing FuelMaker unit could easily and affordably be doubled in size, and more Honda Civics brought into use. This would afford emissions benefits, including NOX reduction, and also reduce petroleum use. An application could be made for NYSERDA Clean Cities Challenge funds, which could assist in meeting these costs (approximately $70K for the station[18], and $4,636 incremental cost per vehicle[19]). Five additional Hondas could easily be added to the fleet the first year. Care should be taken in ordering new vehicles that the total fleet of NGV's does not exceed the filling capacity of the station.
- More GEM cars can be acquired and utilized for low speed, controlled applications. Utilization of similar electric models configured as small sedans such as the Zero Emission No Noise (ZENN) or Miles Automotive should be considered for very limited applications for less than ten units over the first two year period in order to capitalize on their very low emissions, and engage the public via interaction of view of these types of units.
- An examination of the fleet should be conducted to determine appropriate vehicle sizes for certain vehicle classes of pickup trucks and sedans. Consideration should be given to utilizing ½ ton pickup trucks instead of ¾ ton units, which will allow use of a flexible fuel model, and gain mileage efficiency and emissions reductions.
- Significant clean air benefits could be gained from a limited application of retrofitted older diesel units converted into electric hybrid or plug in hybrid models. A pilot test of such a unit could be considered for the mid to long term. Though the upfitting cost could be high (up to $70-100K per unit), NYSERDA funds could likely be gained for such an endeavor. Refuse trucks are an excellent application for such a retrofit, which would use the existing truck body and engine, but remove the existing transmission for installation of

[17] Based upon standard General Motors estimates, and as presented by Brad Beauchamp, Regional Chevrolet Truck Manager for the Northeast, and alternative fuel liason for the area.
[18] Based upon cost quotation provided by FuelMaker, including contingency allowance.
[19] Based on State Contract price and information provided by American Honda. The retail cost of a Civic GX is $24,590, with an incremental cost over a standard gasoline powered Civic of $6,980. The State Contract GX is listed at $22,246. Thus, the discounted State incremental cost is $4,636.

the hybrid power train, and installation of the electronic control components. This approach provides the benefit of taking an old, dirty diesel and creating a "recycled" clean fuel vehicle. Similarly, a new unit can be upfitted at the factory, whether for a work truck or a refuse/recycling type vehicle, and hybridized.

Discussion of Specific Fuels

Strategy 1- Biodiesel

The AFV Study has explored the use of biodiesel in two municipal fleet applications. The first fleet example was examined as part of the Peer Review with the City of Lakewood, Colorado. This fleet has been using B20 since 2003 and has rated its program as very successful.

In addition, a second fleet case was presented to the PAC through the biodiesel site visit component of the study. This involved a visit from a fleet manager from the City of Keene NH who has been using B20 for approximately six years. The biodiesel experience for this fleet was also very successful. In both cases, the fleet administrators were very committed to their respective fuel programs and gave the performance of biodiesel, and B20 in particular, high marks.

These two fleet examples are both instructive for the City of Rochester fleet in the event a decision is made to pursue a biodiesel strategy for the following reasons:

- Weather Conditions- The winter temperatures in Keene NH and in Lakewood CO are similar enough to those found in Rochester to indicate comparability of conditions. This would include variations in temperature and in the potential for comparable low temperatures.
- Volume of fuel usage- Due to the fueling agreements in Lakewood, the total volume of fuel used is quite comparable to the Rochester fleet (Lakewood dispenses 350,000 gallons of diesel fuel annually (all types of diesel) and the City uses between approximately 450,000 gallons per year
- Range of Diesel Vehicle Types- Both of the fleets in the study had a wide range of medium and heavy -duty vehicles that were fueled with biodiesel. There was generally a great deal of comparability with the diesel vehicles in the Rochester fleet. This includes dump trucks, pay loaders, tractors, panel trucks and a variety of other types. The one notable exception was the refuse collection vehicles that the Rochester fleet contains. The other jurisdictions did not have these in the fleet.

Environmental Benefits

In the presentation for Keene NH, there was a significant reduction in the concentration of the smaller, and more harmful amount of PM 2.5 particulate matter.

In air quality testing inside the Keene NH Recycling Facility, they achieved a reduction of 50% when using B20 instead of regular diesel. The employees reported that the headaches they had experienced, while working in this confined area with diesel fumes, had gone away once the B20 was used. In addition, the Keene biodiesel program, with 68 vehicles running on B20, has eliminated approximately 417 tons of CO2 annually since program inception.

The PA Turnpike Commission, with the assistance of the U.S. EPA, conducted emissions testing on a group of its vehicles that had been running on B20. The results of these tests indicated that NOx emissions in the biodiesel(B20) test group had NOx emissions that were equal to, or in some cases lower than the test vehicles that were using conventional diesel fuel. The lower emissions seemed to correlate with newer vehicles, which would support the conclusion that the changes in engine technology had a positive effect on these results. Despite these test results in this fleet, the general concern about increased NOx emissions with biodiesel blends is one of the few notable disadvantages attributed to biodiesel fuel.

NOX Issue

The generally held notion regarding biodiesel and NOx is that B100 raises NOx approximately 10%, and that biodiesel blends raise NOx in proportionately based on that factor (i.e. B20 2%, etc.). Since Rochester is currently in non-attainment for NOx, this property of biodiesel is of the greatest interest, though this non-attainment status may be modified during 2007.[20] The National Biodiesel Board's Fuel Fact Sheet makes reference to this emissions characteristic, and references the USEPA's study "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions".[21] However, based upon information raised during the subject area executive briefings as noted above, the Fleet Counselor Team pursued information related to further testing on biodiesel exhaust characteristics, and found very interesting feedback from the U.S. Department of Energy's National Renewable Energy Laboratory, which performed a further analysis of the EPA study, and further conducted dynamometer chassis emissions testing.

Their findings have been published as the "Effects of Biodiesel Blends on Vehicle Emissions", (Fiscal Year 2006 Annual Operating Plan Milestone 10.4), by McCormick, Williams, Ireland, et. al. of the National Renewable Energy Laboratory. To summarize, the EPA data set was heavily skewed by testing of a particular engine model, and the new NREL study intended to address that via a reexamination of previous studies, combined with further vehicle testing. The findings were that there was variation between biodiesel emissions of NOx from both engine types, as well as vehicle type, and duty cycle. Certain engines did show an increase, while others showed a slight decrease, while others evidenced no net change. Though the vehicles tested were not generally of the type present in the City Fleet (transit buses, motor

[20] Op. cit #2.

[21] http://www.nbb.org/pdf_files/fuelfactsheets/emissions.pdf

coaches, and Class 8 trucks), there were some similarities with the Class 8 platform, and the findings are of interest.

> The NOx impact of B20 varied with engine/vehicle technology and test cycle ranging from minus 5.8% to +6.2%. A preliminary examination of real-time NOx emission data did not reveal any consistent reason for the wide range. On average NOx emissions did not change (0.6 plus/minus 1.8%)…
>
> Individual engines may show NOx increasing or decreasing, but on average there appears to be no net effect, or at most a very small effect on the order or plus/minus 0.5%. The small apparent increase in NOx reported for engine testing results in EPA's 2002 review occurred because the dataset was not adequately representative of on-highway engines… However considering all of the data available, we conclude that B20 has no net impact on NOx.[22]

Warranty Concerns

Fleet Managers are typically very concerned about the affect that operational decisions, including fuel choices, may have on the vehicle warranties from manufacturers of vehicles, engines and other components. This was the case with biodiesel for quite some time as well. It is encouraging to note that most engine manufacturers are making changes to their warranty policies and will honor warranties for vehicles using blends up to B20. The Cummins engine company made major changes in their policies regarding biodiesel in early 2007. It should be noted that the manufacturers typically require that certain standards be followed with respect to biodiesel fuel quality. Typically, the standard used is known as ASTM D-6751 and provides for a common and uniform point of reference for fleet operators, manufacturers and fuel producers/distributors.

Advantages of Biodiesel for the City of Rochester

The City of Rochester has a large and diverse fleet of diesel vehicles. There are approximately 450 diesel vehicles, which comprise about 40% of the total fleet size. There are several advantages to pursuing a biodiesel strategy:

- Integrates with existing fueling structure
- Biodiesel can be used in range of mixtures from B2 –B100, although most fleets do not exceed B20
- Biodiesel (B20 and lower) may be used in existing, unmodified diesel engines
- Increases lubricity
- Provides the environmental benefits noted previously in this section
- Low risk and low cost for a pilot approach to implementation or full implementation
- Monroe County fleet has had positive experience with biodiesel in warm weather conditions

[22] McCormick, Williams, Ireland, Brimhall, and Hayes, "Effects of Biodiesel Blends on Vehicle Emissions", National Renewable Energy Laboratory, p. iii-Executive Summary.

- The effect of switching the entire diesel fleet to B20 would displace 90,000 gallons of petroleum diesel annually. Using B5 in the fleet would displace 22,500 gallons annually
- Performance is not affected

Biodiesel is currently on the OGS contract in a B20 blend for Monroe County, though other counties (Nassau, et. al) have a B5 option as well. On the contract Group 05602- Diesel Engine Fuel, Ultra Low Sulfur and Biodiesel, Award Number 20331, Griffith Oil is listed as the supplier for Monroe County. The fuel is priced above standard diesel, though the differential may be less than the noted $.20 due to increased costs of diesel fuel.[23] A selected section of the contract showing the costs for Monroe County is found in **Attachment 3- NYS OGS Fuel Contract 20331- Selected Sections**.

Disadvantages

Other than the cold weather issues previously described, another prominent disadvantage is the possible cost differential. Given the fluctuating nature of fuel markets, analysis of this issue is challenging. However, these are some considerations /observations concerning cost:

- Higher petroleum costs reduce the differential between biodiesel and petroleum diesel
- As biodiesel production and usage increases, the forces of supply and demand should have a favorable impact on biodiesel pricing
- Select a supplier who will equitably share the legal tax credits with the end user
- Be proactive in ensuring that the procurement process is providing the best price possible.

The other potential disadvantage is fuel quality and ensuring a good product is obtained at all times. With the rise of numerous new biodiesel production ventures, there is a high possibility that users could receive bad loads, based upon both lack of production experience and track record, as well as divergent feedstocks. Biodiesel is produced to ASTM D6751, and national biodiesel advocates are seeking a higher level of accountability and quality control through the BQ 9000 program. This program seeks to create accredited producers who track not only the production, but also the storage, handling, distribution, and testing of the product. It utilizes an accreditation commission which then designates accredited producers. The National Biodiesel Board states:

[23] The cost of Griffith's standard diesel fuel was most recently modified as of a purchasing memo dated March 1, 2007.

About the National Biodiesel Accreditation Commission:

- Commissioners represent wide scale of interested parties
- Nominated by the NBB President, and approved by the NBB Board of Directors
- Although committee of NBB, NBAC has full authority for design and implementation of BQ-9000
- Developed BQ-9000 as it stands today
- Responsible for on-going improvements to BQ-9000

TWO CATEGORIES OF CONFIDENCE...

BQ-9000 helps companies improve their fuel testing and greatly reduce any chance of producing or distributing inadequate fuel. To receive accreditation, companies must pass a rigorous review and inspection of their quality control processes by an independent auditor. This ensures that quality control is fully implemented. [24]

Though this is a nascent process, with only 19 certified companies as of this writing, producers of the City's biodiesel should, if not presently accredited, be undertaking the process of accreditation, and the potential supplier provide written assurances of such efforts. It should be noted that one of the keys to the success of the Keene New Hampshire program was the provision of fuel by a leading firm, World Energy Alternatives, which is a BQ9000 accredited producer.

In conclusion, it is the opinion of the Consultant team that the biodiesel has great potential as an alternative fuel strategy for the City of Rochester fleet. The implementation plan that follows outlines several options for the City to begin this process.

[24] NBB.org- National Biodiesel Board Web-site, Fuel Quality pull down menu option.

Strategy 2- Natural Gas

Advantages of Compressed Natural Gas for the City of Rochester

Natural gas is extremely clean burning, domestically produced, including production in upstate New York. Its main advantage when used as a transportation fuel in an internal combustion engine is the resultant emissions benefits. Though it has considerable reductions in particulate matter, carbon monoxide, and in many cases hydrocarbons, its most prominent emissions benefit is its very low nitrous oxide emissions.[25] For example, in the John Deere 8.1 L vs. EPA diesel standard the NOx reduction is 70%[26], though in comparison with the low sulfur diesel now required by the EPA, that delta has narrowed. The project peer review process investigated the New York State Fleet, which has made a significant and substantial commitment to CNG, having constructed fifty-three CNG stations around the state, and accumulated a fleet of 716 light duty vehicles and 35 heavy duty small and large dump work trucks. The state has contracted out the management of eleven other CNG stations to a company called Clean Energy. The State has succeeded through the approach that they wish to completely integrate this fuel into their operations, and were willing to utilize new technologies on a large scale. The state now special orders the medium/heavy duty vehicles, and makes use of Honda Civics for light duty applications.

Natural gas is also less expensive than petroleum based fuels, providing in the example of the State Department of Transportation fleet a benefit of nearly a dollar per gallon[27]. Likewise, the Volumetric Excise Tax Credit, which recently came into effect, provides even non-taxable entities with a $0.50 cent per gallon equivalent rebate directly from the Internal Revenue Service (IRS). Gaining this credit involves the filing of a number of forms with the IRS, and the Consultant team as of this writing has witnessed no actual checks yet; however, checks from large users of CNG are expecting considerable rebates imminently[28].

The City currently has a small FuelMaker unit (Model FMQ-8-36, 8.8 max scfm, with Model FF350D dispenser) at the Mt. Read Boulevard facility, and has seven (7) light duty OEM vehicles (3 trucks and 4 passenger vehicles). These FuelMaker units are considered appliances, and are inexpensive to operate, but fill slowly. Thus, not

[25] In traditional petroleum powered internal combustion engines, a design dilemma occurs when hydrocarbons and particulate matter are reduced to very low values, that a resultant increase in NOX can occur, and vice versa, when NOX is reduced, the PM and HC can increase. Thus the requirement for particulate filters and afterburner components in the new low NOX diesel engines. Natural gas does not create this problem.

[26] The Cleaner Choice: Natural Gas as a Substitute for Diesel, GRI, December 1999.

[27] An exact value is not provided herein due to the constantly changing fuel prices, as witnessed by the recent run-up in petroleum based fuels during Q2 2007.

[28] Interview by Rhea Courtney Bozic with Lower Merion School District Transportation Administrator Michael Andre, May 31, 2007. Lower Merion operates approximately 76 CNG school buses, and runs two filling stations.

many vehicles can fuel, and large vehicles such as work trucks could be harder to fill in an expeditious manner. This unit has been constructed with the possibility of expansion incorporated into its design, and thus can easily be double in size at an affordable cost. An equipment cost quote was obtained from FuelMaker, which was approximately $49K. The installation was estimated at approximately $8-10K, equating to roughly $60K. Even using a $10K contingency to cover material increases, engineering, and extra electrical upgrades, at $70K, the consultant team considers this option a preferable one. Expanding the existing FuelMaker would:

- Leverage the original project expenditures and reinforce the NYSERDA Clean Cities Challenge objective of decreasing use of foreign fuel
- Provide the ability to increase the use of the "cleanest car on the planet[29]", the Honda Civic GX
- Decrease NOX and other priority pollutant emissions on the light duty side
- Facilitate use of small, high mpg units at the main operational facility
- Provide a low cost, low impact method for incorporating CNG into the fleet
- Allow the City to avail itself of further Clean Cities Challenge funds towards the station expansion and the incremental ($4,636) cost of the Civics
- Provide increased fueling should the City choose to incorporate a larger vehicle pilot test for a recycling, boom, bucket or other type of work truck[30]

The FuelMaker quote is found in **Attachment 4- FuelMaker CNG Station Expansion Quote**.

The City should consider adding approximately three to five Honda Civic GSX units to the fleet over the first two years, augmenting the current fleet. Any increase in the fleet thereafter should replace existing Honda units, and care taken that the capacity of the station to conveniently fill the vehicles is not exceeded.

[29] The American Council for An Energy Efficient Economy, a not for profit organization dedicated to promoting energy efficiency, in its GreenerCars.com "Greenest Vehicles of 2007" gave the Honda Civic GX the highest green rating, a green score of 57. The Toyota Prius was second at a score of 55. http://www.greenercars.com/12green.html. Additionally, the California Air Resources Board classifies this vehicle as an AT-PZEV (Advanced Technology Partial Zero Emissions Vehicle) indicating its extremely low emissions: http://www.arb.ca.gov/msprog/zevprog/factsheets/calemissions.pdf and http://automobiles.honda.com/models/model_overview.asp?ModelName=Civic+GX.

[30] Such vehicles have been observed in other jurisdictions to afford public benefits via use of a "clean and green" recycling unit, or are well used for a vehicle that idles considerable such as a bucket or boom truck.

Disadvantages

Capital Costs of Vehicles and Fueling Infrastructure

Due to its gaseous nature, utilizing CNG would require a complete infrastructure upgrade if the City were to utilize the fuel on a large scale. Unfortunately, the cost of entry into a significant CNG program requires capital inputs for both the fueling infrastructure, and the vehicles: at least $500-750K for a large capacity station; approximately $35-50K for upfit costs for retrofitting a medium or heavy duty work truck; and approximately $4K incremental cost for a Honda Civic GX.

It was the determination of the consultant team that in order to gain an advantage via CNG, the City should either utilize the fuel on a very large, significant scale, via transitioning of a large portion of some segment of its fleet, likely the refuse trucks. Using a similar project in Long Island's Town of Smithtown, which mandated all its approximately thirty-nine contract refuse vehicle be CNG at the start of 2007, the incremental cost of a CNG refuse truck was $69K for one of the truck suppliers.[31] Thus, if the City had ordered CNG refuse trucks as part of the 2007 replacement cycle fleet (28 trucks), this would have resulted in a $1.9 million premium, plus the costs of a large station. The high costs, as well as the extreme technical transition such a program would involve, were deemed too great for the City to justify, though the clean air benefits would be significant. Likewise, the logistics for the City to make such a transition by the 2007 ordering period were too difficult to accomplish, including "super" fast track design and construction of the necessary large capacity CNG station.

The potential exists that the City, should it decide to embark on a very large scale CNG venture, could engage a "turnkey" CNG supplier/design build station operator, who might cover some costs of the construction of the station. In this case, the City might have to turn over the majority of some fleet sector exclusively to CNG in order to attain the minimum throughput that such a contractor would require. This approach also causes an increase in the price of the fuel, which is sold to the City through the operating entity. Since the City has recently turned over a majority of its refuse fleet to new diesel vehicles to be purchased imminently, achieving the minimum throughput would be difficult.

Exit of Original Equipment Manufacturers from Natural Gas Vehicle Market

The second significant disadvantage is the on-going departure of the OEM's from all levels of the CNG market. On the light duty side, encompassing cars and pickup trucks, Ford, GM, and Daimler Chrysler have all left the market, leaving the Honda Civic GX as the only available model. Though an excellent and reliable clean air vehicle, the City has other vehicle needs for larger sedans, pickups and vans. Upfit firms such as Baytech and BAF have California Air Resource Board (CARB) and EPA certified options for some vehicles including the Crown Victoria and Ford 350

[31] Demonstration CNG refuse truck project, Greater Long Island Clean Cites Coalition 2006.

series, and a number of GM models, but these upfits can nearly equal the vehicle cost (approximately $15K).[32]

Moreover, on the heavy-duty side, John Deere will cease production of its CNG engine in 2007, and has no plans to re-enter the market. Remaining CNG choices include the Cummins CNG engine, and an upfit engine the ESI retrofit for the International DT 466.

Peer Review Findings

The peer review process also revealed that the large CNG commitment made by the Brookhaven National Laboratory, involving the accumulation of a fleet of vehicles and a large capacity station construction, suffered when the OEM's exited the light duty market. The many vehicle types required by the Lab, including vans and pickup trucks, now come at a higher incremental cost, which is difficult for the Lab to justify.

Likewise, the PA Turnpike Commission initially investigated CNG and did have vehicles, which made use of utility owned stations, but moved away from the CNG option early in its program.

[32] The Alternative Fuel Data Center lists upfitters on its website http://www.eere.energy.gov/afdc/progs/res_guide.cgi?CONVCO for convenience.

Strategy 3- Ethanol

Ethanol is an alcohol-based fuel made from a starch-bearing feedstock; currently feed corn is the feedstock of choice nationally due to the favorable supply and cost of corn (i.e. corn is the easiest commodity from which to make ethanol). It is a renewable and clean burning fuel, which supports the domestic farm economy. Other feedstocks include expired beverages, cheese whey, sugar cane (widely used in Brazil), brewery waste, and waste wheat. Cellulosic ethanol is that produced from the non-starch portion of the plant, biomass, or potentially from other material such as domestic municipal waste. Though frequently discussed, the production of cellulosic ethanol is at an early development stage, and the cost estimated at $4.30-5.50 per gallon in capital cost, and $2.35-3.50 per gallon production cost, versus corn-based ethanol ($1.25-1.50, and 1.25-1.55, respectively) by the USDA.[33] A NYSERDA cellulosic pilot 500K-gallon/year plant is slated for the Rochester area by Mascoma, to be located in adjacent community of Greece.

Ethanol is currently enjoying a national boom in production. The total volume of ethanol produced in the United States will likely double over approximately the previous eighteen months.[34] This boom has been driven by a number of factors. Ethanol is used as a clean air oxygenate, and with the phase-out of methyl tertiary-butyl ether (MTBE) in 2006, a significant spike in demand transpired. Ethanol has also received advantageous legislative treatment from the United States Congress, which has enacted a number of laws which have spurred production, and which are sometimes referred to as "subsidies". Ethanol receives a $0.51 per gallon tax credit against the federal excise tax from the 2004 Jobs Act provision for a Volumetric Ethanol Excise Tax Credit (VEETC). This is awarded to an entity, which has filed as a "blender of record" with the IRS, and is applicable to any blend configuration of ethanol and gasoline. Using the $0.184 federal excise tax, the $0.51 is discounted off of that, resulting in a $0.326 advantage.

Ethanol is blended into gasoline in different ratios based upon geographic location, air quality, and gasoline supplier blend. In New York's downstate non-attainment area, below Newburgh, a ten percent blend known as E-10 is required. Likewise, E-10 is used by some petroleum retailers in Rochester, though not in all other areas of the state. The reformulated gasoline provision of the 1991 Clean Air Act was replaced with the 2005 Renewable Fuel Standard included within the 2006 Energy Policy Act, which mandates an increasing incorporation of renewable fuel into the national transportation fuel supply, from 4 billion gallons in 2006 to 7.5 billion

[33] Dr. Kevin Hicks, USDA Eastern Regional Research Center, Wyndmoor, PA e-mail to consultant team member R.C. Bozic referencing data from the US Chief Economist 10/06 and Andrew McAloon USDA 12/06.
[34] Renewable Fuels Association, Industry Overview and Statistics, http://www.ethanolrfa.org/industry/statistics/#EIO

gallons in 2012.[35] An overview of the provisions of the RFS are included in **Attachment 5- Renewable Fuel Standard Summary**, for informational purposes, and the reader can review aspects relating to petroleum refining credit trading and cellulosic ethanol.

When blended in an 85 percent ethanol/15 percent gasoline configuration, known as E85, the fuel is a USDOE alternative fuel, which can be used in OEM model flexible fuel vehicles (FFV's). An FFV can use E85, switch back to gasoline, and so on, with no performance issues or vehicle modifications needed. The FFV's are manufactured to run on any blend of ethanol, and have slight modifications to their fueling systems and fuel sensors to allow this. The fuel is appropriate for the light duty sector only, and cannot be used in diesel engines.

E85 not only lessens use of foreign petroleum, but also has air quality advantages. Carbon monoxide, particulate matter, and hydrocarbons are all reduced when using E85. The US Department of Energy considers E85 to have a 25% reduction in overall ozone forming pollutants versus reformulated gasoline.[36] Though producing about the same amount of carbon dioxide as gasoline when burned in an automobile engine, the fuel is considered carbon neutral since the growing plant feedstock uses carbon dioxide in its growth cycle.

Advantages of E85 for the City of Rochester

The City of Rochester currently possesses a large number of flexible fuel vehicles, especially in its Police Department Impala fleet. A number of standard vehicles available on the State OGS Procurement Contract are flexible fuel, and present no incremental cost for acquisition. These vehicles can be accumulated into the fleet and use either gasoline or E85, with no operational change for the user whatsoever. Maintenance is the same, and the vehicles manufactured by the major auto manufacturers based upon Corporate Average Fuel Economy (CAFÉ) standard provisions. Thus, a simple strategy for the City is to accumulate FFV's, ordering an FFV model when available for the fleet application. The resulting units can then be turned over to E85 when a fueling station becomes available. This approach was observed to work well for the Pennsylvania Turnpike Commission, which was able to convert 85 percent of its light duty fleet (210 vehicles made up of sedans, vans, and pickups) immediately to E85 when its station conversion was completed in 2005. The peer review process revealed that the Brookhaven National Lab is also reviewing the applicability of E85 for its light duty fleet.

The City can construct its own fueling facility at Mt. Read through the Green Station project, as well as filling at potential County of Monroe and Rochester City School District stations proposed as part of the same effort. Likewise, NYSERDA is currently conducting a large push to engage private station retailers to place E85 at their stations via their Proposal Opportunity Notice 1093- Biofuel Station Initiative,

[35] This includes both ethanol and biodiesel.
[36] http://www.eere.energy.gov/afdc/progs/fuel_compare.cgi

which places $9.5 million towards that effort, and will likely result in a number of gas stations in the area offering the fuel.

To summarize a number of advantages of making E85 a part of fleet fueling:

- Numerous vehicles already present in fleet, especially in Police Department
- No incremental cost of purchase
- The major automotive manufacturers produce units, and certain models are all FFV's (example Tahoes, Yukons, etc.)
- FFV's are available on the State Contract
- Provides support to local economy when production facilities are constructed, and to domestic farm economy
- Clean air emissions benefits including 25% reduction of ozone forming emissions
- Boosts performance via higher octane rating of 105
- No change to maintenance or repair garage standard operating procedures
- City is already a GM certified repair facility, and may become a Ford certified repair shop
- Provides "green" option for larger, low mpg units such as SUV's (Tahoes, etc.), and pickups (Silverados)
- High level of support from state and local government for ethanol and E85
- High level of support from General Motors via "Live Green, Go Yellow" West to East campaign, which could provide public outreach assistance and events

Disadvantages

The primary disadvantage is ethanol's lower energy content, which in BTU value is approximately ¾ that of gasoline. Thus, the fuel efficiency of FFV's operated on E85 decreases by anywhere from eleven to twenty percent. This decrease is generally addressed in the following manner:

1. Obtain good pricing for the E85, which should be feasible since numerous ethanol plants are proposed for the Rochester environs. This should provide a benefit in lowering the transport and delivery charges.
2. Institute good user driving practices via training, whereby drivers endeavor to decrease poor driving habits such as jackrabbit starting, and large variations in accelerator pressure. Slower, but even, increases in speed can improve mpg regardless of fuel.
3. Maintain good tire inflation recommended pressure.

These factors can provide mpg benefits to help offset the mileage penalty.

The fuel cannot be used in diesel engines, and thus does not address the needs of a large section of the fleet. There is also a risk of a non-FFV being filled with E85, which could result in stalling or hard starting. E85 has been known to cause some hard starting problems in certain FFV models, such as the Ford Taurus, but Ford has issued a service bulletin addressing this issue.

A new fueling facility will be required at Mt. Read or elsewhere to fuel the FFV's, since the limited existing gasoline dispensing facility will need to remain in service for dispensing gasoline. This facility could require the expenditure of $150K to $200K , not including design costs and a canopy for the station.[37] Funds for this expenditure can be sought from the Green Station project, and NYSERDA.

Moreover, a high level of uncertainty exists regarding the Underwriters Laboratory certification of E85 dispensers. Though no failures of E85 dispensers have been observed in the United States or Brazil, where E85 is widely used[38], UL has decided to completely review its E85 testing and certification procedures for fueling systems. In making this decision, UL rescinded the parts certification it had provided to the Ohio based firm OPW, though no failures or problems were observed. Currently the major dispenser manufacturers Wayne Dresser and Gilbarco have E85 dispensing units, which await certification. NYSERDA has chosen to go ahead with its program while the UL issue proceeds.

This uncertainty can be addressed in the following manner:

1. Work with NYSERDA and the New York State Department of State Bureau of Administration and Code Enforcement if a waiver is needed to install an E85 dispenser.
2. Work with the Fire Department officials to provide them with information from the above-mentioned Bureau, as well as the many state fire marshals nationally that have issued interim guidance on this issue.[39]

Local distributors are not currently carrying E85, and there is a measure of perceived uncertainty with any change in operations for such firms. However, ethanol is present at numerous locations, and the E85 fuel can be obtained by blending the gasoline and ethanol, just at a higher blend from the more typical E10. Certain distributors, such as NOCO in Tonawanda, received funds from NYSERDA to bring E85 to their fueling rack, so the distribution of the fuel will become more common going forward.

The net energy balance of ethanol has been discussed in the press to a large extent, and concerns the amount of energy needed to make ethanol versus the amount of energy produced when the ethanol is used. The most recent study examining the previous energy balance studies of ethanol found the energy balance to be positive.[40]

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[37] Canopies, though ubiquitous, have large concrete footings to ensure stability and wind resistance, and are expensive.

[38] See various Underwriters Laboratory recent reports on the issue found on their website.

[39] States issuing interim guidance on installing or using E85 stations include Minnesota, Illinois, Iowa, West Virginia, Oregon, and others. Information on this is available from the National Ethanol Vehicle Coalition, 877-485-8595 or e85fuel.com.

[40] Farrell, A.E., Plevin, R.J., Turner, B.T., Jones, A.D., O'Hare, M., Kammen, D.M., 2006. Ethanol Can Contribute to Energy and Environmental Goals, Science Volume 311: 506-508. http://rael.berkeley.edu/EBAMM/

Those studies that did not find a positive energy balance were generally considered to have utilized outdated and inefficient production and energy input values. Additionally, a short summary of Argonne National Laboratory's Ethanol study is included herein under **Attachment 6-Argonne National Laboratory Ethanol Study Key Points**, and which indicates a 0.74 million BTU's of fossil energy consumed in the production of ethanol, for each 1 million BTU's of ethanol delivered.

Industrial farming, and the run up of corn prices are other criticisms of ethanol. Farmers are sometimes presented in press articles as planting more corn instead of other crops. However, certainly the production of ethanol is helping farmers, who are able to earn more from their acreage. It is expected that further acreage in New York State will go into production of corn, which should help economically challenged rural areas.

A recent study by Mark Z. Jacobson of Stanford University in April 2007 indicated negative public health impacts of 85% ethanol/gasoline blends (E85). The report, *Effects of Ethanol (E85) versus Gasoline Vehicles on Cancer and Mortality in the United States*, indicated higher levels of acetaldehydes from E85, and that E85 could increase ozone-related human mortality (by 185 actual deaths) in the Los Angeles region in the year 2020. Criticisms of this study relate to the projections used in the study regarding the project E85 fleet size (all vehicles), and the extrapolation of current vehicle emission standards to 2020 with no accounting for improvements.

To summarize the disadvantages:

- Lower fuel efficiency
- Cannot be used in diesel engines, so does not address the medium and heavy duty fleet component
- Requires new fueling facility at Mt. Read which could be $150-200K
- Uncertainty regarding Underwriters Laboratory certification of E85 dispensers
- Newness of fuel to local distributors who may not carry the fuel
- Risk of non-FFV being filled with E85
- Possible hard starting in certain Ford Taurus models
- Press and public perception and confusion regarding energy balance of ethanol production, industrial farming, and a rise in corn prices

Strategy 4- Electricity (Hybrids, Plug-In Hybrids, Neighborhood Electric Vehicles)

Hybrids

There is tremendous potential for hybrid cars and trucks to provide both significant reductions in petroleum usage and reduced emissions and improved air quality. In general terms, there are two classes of hybrids: Light Duty Hybrids and Medium and Heavy Duty Hybrids. This section will address each group separately.

Light Duty Hybrids

Typically light-duty hybrids, encompassing cars, pickup trucks, and SUV's, operate with a gasoline engine that is supplemented at certain times by an electric motor. Although there are different hybrid configurations that will determine when this occurs, it is generally upon starting the vehicle, while idling or when operating at lower speeds.

Hybrid vehicles offer the advantage to the City of Rochester of providing the maximum benefit in an urban environment where driving speeds tend to be lower, at 30-40mph, due to the operation of the electric engine at these times. The hybrid vehicle creates the inverse relationship of city to highway miles that is typical with conventional gasoline vehicles and the fuel savings are best at the lower speeds found in city driving.

At the beginning of this project, a fleet analysis identified four light duty hybrid vehicles, Toyota Priuses that were used primarily for staff vehicles. Given the available models, there are a number of choices in the sedan and SUV categories. The following light equipment hybrids are currently available through the NYS OGS procurement system:

Compact Sedan	OGS Price
Honda Civic Hybrid	$ 19,681
Mid-Size Sedan	
Honda Accord Hybrid	$ 27,998
Toyota Prius	$ 20,122
SUV	

Ford Escape Hybrid (4X2)	$23,376
Ford Escape Hybrid (4X4)	$24,804
Toyota Highlander Hybrid (4X2) 7 pass.	$27,605
Toyota Highlander Hybrid (4X4) 7 pass.	$28,801

Disadvantages to Hybrids

Two key disadvantages to hybrids have been identified. The first one is the cost differential between light equipment hybrids and regular gasoline vehicles. Government pricing for a gasoline Ford Escape is $17,536 but pricing, per the NYS OGS, for a comparable Ford Escape Hybrid is $24,804. This is a difference of $7,268.

Pricing for a mid-size gasoline sedan is $12,027 for a Chevrolet Malibu and $14,687 for a Dodge Charger but is $20,122 for a mid-size Toyota Prius hybrid vehicle. The price differential range is $ 8,095 and $5,435, respectively.

There will be variable payback of this cost difference, which will be determined by the price of unleaded fuel and the miles driven. It is our recommendation that the selection of the hybrid vehicles be limited to those that have an application suited to available hybrid models and that will be used in situations where anticipated mileage is well above the average for the City fleet.

The second disadvantage is related to an uncertainty factor regarding the long-term repair costs for hybrid vehicles. They represent new technology and are all relatively new models. To date, there is no evidence that there are problems but there are questions to be considered. What will happen as these vehicles age? What will the repair experience be? How much will replacement parts, such as batteries, cost? Will the fleet technicians assigned to operating fleets have the expertise? At this time, these cannot be quantified but is a reason to perhaps consider how and where hybrids are added to the fleet.

Medium and Heavy-Duty Hybrids

This category of hybrid vehicles are also known as hybrid electric vehicles (HEV's) and are emerging as an attractive potential alternative for fleets but are not yet commercially available in the same way that the light equipment hybrids are, which is typical of the industry in that innovation often occurs first in the light equipment environment and then is adopted to medium and heavy-duty equipment (e.g. –ABS and electronic engines). Thus, no hybrids in this category are found on the OGS State Procurement Contract, and would have to be specially ordered and custom

configured. The hybrid drive train can be combined with diesel, natural gas, gasoline, etc., dependent upon the manufacturer.[41]

The Hybrid Truck Users Forum (HTUF) is an organization that is leading the development of this niche and has made significant progress in the past several years. HTUF is a consortium comprised of more than sixty fleets with a mission of commercialization of medium and heavy duty vehicles in a variety of applications, including parcel delivery, utilities, buses, refuse collection and military operations. The partnership of fleet operators and manufacturers is unique and successful.

We cannot recommend any applications for the City in the short term but this is something to consider in the medium and long-term range time horizons as products become commercially available, have a known track record for performance and maintenance, and are more cost-effective. Numerous municipal entities are ordering such vehicles, and trade and newspaper articles daily refer to new hybrid vehicle projects. NYSERDA in the past has supported the technological development of hybrid applications, and companies located in New York State produce such vehicles on a pilot basis.

An advantage is that with a pilot vehicle, it can be specially tailored to meet all user needs regarding configuration. The disadvantage is the newness of the technology, and unfamiliarity of maintenance staff with the units.

Plug-In Hybrids-

Plug-in hybrids work similarly to an HEV in that a special hybrid electric drive train is required to power the vehicle, and a complex electronic auxiliary power control unit (APU) acts as the interface and control "brain". Though relatively new, such units utilize "off the shelf" technologies (batteries, vehicle platforms), and are now gaining a much higher prominence and acceptance. The aforementioned HTUF has assisted in this mainstreaming process. A plug-in hybrid charges off the electrical grid, and like the medium and heavy-duty hybrid electric units, can be hybridized with any fuel (diesel, gasoline, CNG, propane, hydrogen, etc.). The most common plug in hybrids are found as medium and heavy-duty work trucks, bucket trucks, and recycling units. Though light duty plug-ins can be configured, at this point in time, such an alteration would void the OEM warranty.

The greatest avenue of promise for plug-in hybrids is the development of more sophisticated battery technologies, which will allow for longer charges and vehicle range.

[41] While certain hybrid system manufacturers concentrate on one platform, such as diesel, others are "fuel agnostic", meaning that their systems can be combined with any fuel type.

Electric-

Electric vehicles operate only on electric power and are powered by an electric motor that is supplied its electricity from large battery packs. These batteries require recharging by being plugged into the electrical grid.

Several years ago, electric vehicles were offered in several models of sedans and light trucks (GM EV1 and Ford Electric Ranger). Unfortunately, these programs were discontinued by Original Equipment Manufacturers (OEMs). The reasons varied but were related to a material change in the California air quality regulations which drove their original production, as well as the program development costs, vehicle cost, battery replacement cost and range issues.

At the present time, the commercially available neighborhood electric vehicles could be considered for niche applications where range and speed limits were limited to 35mph or less. Some examples of available electric vehicles on the NYS OGS contract include:

- GEM passenger and utility vehicles
- Zero Emission No Noise (ZENN) passenger vehicles
- Miles Automotive passenger vehicle

The price range for these varies from $6995 for the GEM 2 passenger GEM e2 to the Miles ZX40s 4 passenger vehicle at $15450.

It is recommended that the City consider supplementing its small electric fleet of 3 GEM vehicles for applications such as internal campus transport at the Operations Center, use in the Main St. Improvement District, parks operations, and perhaps downtown parking enforcement. Such vehicles have an eye-catching effect on the public, and their small and quirky design symbolizes innovation and green design to the viewer. The use of such vehicles (5-10 in the first two years) will afford air quality benefits, as well as indicating to the public that the City is committed to a clean fuel transportation effort.

Strategy 5- Transitional Phase-Rightsizing of Current Fleet

The focus of this study is on alternative fuel vehicles and on alternative fuels and some of the alternatives will take some time to implement due to market or cost factors. However, there are some actions that can be taken in the transitional phase with conventional vehicles. Although this is somewhat outside the scope of the study, the Consultant believes there are opportunities available to facilitate cost-savings, reductions in fuel usage and environmental benefits. We have labeled this *Rightsizing the Current Fleet* and there are two approaches to this.

1. **Reduce the Overall Fleet Size-** In the initial analysis by the Consultant, and presented in the Key Findings in our first PAC meeting, there were a number (141), of vehicles and equipment with very low usage based on miles driven or hours. One of the industry best practices is to manage the size of the fleet based on usage standards. It is our understanding that a City initiative is currently under way. To support this initiative the consulting team recommends that vehicle and equipment usage standards are implemented fleet wide. These standards should use our recommended standards as a starting point and through internal analysis make the standards specially designed for the city. Our recommended starting standard is 300 miles per month, average for the past 12 months, for any vehicle that reports miles and 20 meter hours for all equipment that records hours as the primary meter reading.

As stated in the Key Findings report we wish to recommend vehicles and equipment that do, in fact, consume quantities of fuel that when replaced by an alternate fuel source the net effect will be a measurable amount of reduced pollution and reliance on foreign oil dependency. Many of the older vehicles and equipment that were identified as being far too old to convert to an alternate fuel are also the same vehicles and equipment that are low usage. One alternative is to consider limited use of rental vehicles and equipment , replacing low/intermittent use vehicles, thus eliminating high pollution vehicles. The real key to success is to move these older high polluting vehicles and equipment out of the area or require them to be sold as scrap.

2. **Optimal Vehicle Application** (Find the right size vehicle)- From the observations of the Consultant team and the personal knowledge of the fleet of one of the team members, it obvious that there are significant number of SUVs and other four-wheel drive vehicles in the fleet. This correlates with a trend of vehicle acquisition for some other fleets and for the American driving public. This impacts fleet acquisition costs, fuel consumption, repair costs and environmental factors. Recently, some government agencies have started to eliminate these types of vehicles due to voter outcry. In order to assist the city

with managing these vehicles types we are recommending that the city adopt vehicle standards that directly address what a vehicle operator needs to fulfill their job tasks. These standards should be documented and administered by the Fleet Management Department. Any variation from the established standard should require mayoral approval. Furthermore, the consulting team recommends that a utilization review committee be assembled to assist the fleet manager with this endeavor. The committee should be made up of non-vehicle and equipment users. Our team recommends that a member from the following office of the city be asked to participate on the committee;

a. Purchasing department
b. Finance department
c. Auditors office

The Fleet Manager that is the final member of the committee will support this make up. This committee would also evaluate annual replacement vehicles and equipment for alternate fuel consideration.

3. **Evaluation of Light and Medium Duty Pick-up Trucks for Transition to E85 Models**

In addition to the aforementioned general downsizing of the fleet, an examination should be made of the ¾ ton medium duty category pickup truck component of the fleet (Ford F250 type), in order to determine if any portion of this vehicle category can perform the substantial body of duty via a ½ ton model (Ford 150/GM Silverado type). This approach, transitioning from a ¾ ton to a ½ to model accomplishes three things:

- Ability to utilize E85 in ½ ton models instead of gasoline
- Provides better fuel economy
- Decreases emissions

The ½ ton models listed on the NYS OGS Procurement Contract are available in 4/4 and extended cab configurations, providing significant size and power in those units.

Strategy 6- Propane

Propane vehicles at this time would present a "niche" type application for the City, and could be applied to a limited number of medium or heavy duty vehicles; a light duty Ford F150 is expected to be available imminently. Such vehicles would require an "after-market" conversion of the fuel tank, engine, and other components. For the medium duty truck the costs of an upfit are estimated at $10-$12K; for the Ford F150 $7.5K. Incorporating more propane vehicles would also require the installation of a station, thereby incurring more cost to the City. The estimated cost of a very basic station installation of a 1,000-gallon storage tank and dispenser is estimated at $20-30,000, excluding card reader ($10-15,000) and fire suppression ($7,500) if required. Dependent upon fuel throughput, the possibility exists to recruit a "turnkey" design/build/supply contractor who could construct a larger facility, subsume the costs of construction, and then charge a monthly usage fee to the City. Exact costs of this option would have to be worked out with such a contractor, but minimum volumes for this type of facility start at 30K gallons per year. The fuel costs decrease as the volume approaches 75-100K gallons per year[42].

Based upon its generally conservative approach to the incorporation of new fuels into its fleet, and the strong commitment to dependability of vehicles, propane may not be the best fit for the City fleet, based upon the results of the peer review, the relative "newness" of propane transportation applications in the area, and the need for a completely new infrastructure. The fuel is however considered a good fit for cold weather applications in areas not serviced by natural gas. (Source: Maine Clean Cities Coalition, coordinator, Steve Linnell)

[42] Source for propane vehicle and station estimated costs: Clean Fuels USA for Western US regional manager John Von Bogart via e-mail request; CFUSA does not have an eastern regional manager at this time

Strategy 7- Hydrogen

Hydrogen, based upon its extremely high tech requirements for storage and vehicle design, does not present as a feasible alternative at this time. However, as has been stated in other report sections, due to the near proximity of General Motors' Advanced Propulsion facility in Honeoye Falls, contact should be maintained with the highest levels of administration there, in the event some interesting project opportunity for the City transpires. One example is to jointly participate in the testing and publicizing of a GM ICE vehicle in conjunction with Monroe County, which currently has plans to lease a hydrogen vehicle and fueling station through a GM partnership.

Another example is to collaborate in the construction of a hydrogen fueling station to service the three hydrogen vehicles being purchased by RIT with NYSERDA funds. This station could also provide fuel for the County's Hydrogen vehicle obtained through the Driveway Program.

The primary advantage of participation in these hydrogen vehicle projects is publicity and support for Rochester as an alternative fuels center.

Funds for such projects should not be borne by the City, but rather by the project sponsors, equipment or fueling provider, or by some federal or state grant such as the Green Station CMAQ funds.

Strategy 8- Methanol

Methanol does not appear as a feasible alternative fuel choice at the current time. No methanol-powered vehicles are readily available for use by the city, and the major auto manufacturers have discontinued their production. Nor is any fueling infrastructure available for the fuel. In the long-term, methanol produced from indigenous waste sources (wood wastes, etc.) may be examined for "pilot" type research and design applications. Methanol is also being considered as a precursor fuel source for hydrogen; this option also presents as a long-term, R&D application.

Strategy 9- P-Series

P-Series fuel applications do not appear as a feasible fleet alternative at this time, due to their general lack of production and use. In the future, a possibility exists that some fuel source may become available, specifically from the neighboring Commonwealth of Pennsylvania, which is undertaking efforts to produce fuels from coal wastes, and other indigenous hydrocarbon sources.

Section G: Implementation Plan, Cost Issues and Funding Options

The alternative fuels and City options have been discussed at length in both Sections C and E of this report. This section will focus on implementation of the options discussed, and breaks the phase-in of clean fuel applications into categories as follows:

I. Short Range – Immediate to 12 months forward
II. Medium Range- 2nd to 3rd year
III. Long Range- 3rd to 5th year

There may be some overlap of phase-in timing between these designations, due to faster technology implementation or City imperatives and/or goals.

Background: Green Station Effort

- **Green Fuel Station Project-** The most significant recommendation emerging from the fleet study process is the ***Green Fuel Station concept***. This idea, along with several other options, was actually suggested by the Consultant Team during the early stages of the project, in conjunction with transportation staff from the Bureau of Architecture and Engineering, after a preliminary meeting with city staff that involved discussion and brainstorming about project options for the City of Rochester's submission for Congestion Mitigation and Air Quality (CMAQ) funds.

  The City's CMAQ project application was due in early October 2006 and this required that the discussion of project options occur prior to this date and before the study phase, analysis and final recommendations could be completed.

The Green Fuel Station project is designed as an intergovernmental collaboration between three local government agencies: City of Rochester, Monroe County and the Rochester City School District. The project will provide for the construction of at least three (3) multi-fuel "green" stations at facilities owned by each of these governmental entities. The alternative fuels that have been considered for use at these stations include biodiesel, E85, CNG and also to provide for the possible accommodation of hydrogen in the future. The total project budget is $5 million ($4 million in federal CMAQ funds and a $1million local share). The actual selection of fuels will be made a part of the preliminary design process.

As the project progressed and the PAC gained more insight into the alternative fuels subject matter and content, a decision was made by those responsible for planning and programming of CMAQ funds to fast-track the funding for the Green Fuel Station Project and to approve it in advance of the normal approval date in the latter part of June 2007. As a result, planning and preliminary design steps began in late winter/early spring 2007 for a station, and the reciprocal use of one another's fueling facilities to reduce dead-heading for refueling, which will be constructed on a City of Rochester site near the Mt. Read Blvd. Operations Center. Another concept being explored is the possible public access to the Green Fuel Stations.

- Other City CMAQ Projects- In addition to the Green Station Project, the City has also been successful in obtaining funds for several other initiatives that will promote alternative energy or reduce fuel consumption. These projects are:
    - Plug-In Hybrid Electric Vehicles (PHEV)- a reference to this project was made earlier in the report and this will fund charging stations, new PHEVs and retrofit of existing hybrids (Funding $200,000 federal funding)
    - Green Card Parking Incentive-fund a demonstration program for discounted parking for AFVs in City parking garages ($100,000 federal funding)
    - Automated Vehicle Locator (AVL)/Weather Sensor Project-fund installation of weather sensors and AVL equipment in City vehicles ($750.000 federal funding)

I. Short Range – Immediate 12 months forward

The Consultant team understands the operational concerns of the City Fleet, and its strong organizational dedication to performing its duties in a seamless manner. Thus the short-term recommendations are tailored to ease the fleet into the use of the recommended alternative fuel technologies, taking guidance from the PAC meetings, and the insights gained from the peer review process.

Policies for Intergovernmental relationships and shared services

One of the most useful observations of the fleet study process has been the good working relationship developed by the Project Advisory Committee. It was observed that the group was able to make fast track decisions, within a focused, face-to-face setting, that enabled optimal group decisions to be generated. Thus, **it is recommended that some version of the PAC continue**, likely via an integrated agency (City, County, State, MPO) Green Station Advisory Council. However**, it is recommended that the on-going PAC entity be relatively small and focused**, bringing in targeted new members as needed. The PAC success appeared to be related to its focused nature and composition. This recommendation should be

continued into the early mid-term, with an evaluation and feedback from members on its continuance at that juncture.

The advantages of the PAC have been described and there was some discussion among PAC members about expanding the collaboration on alternative fuels and vehicles to a larger network at the county or regional level. Such an effort can be expanded over time to **create a separate, larger working group to include other municipalities and stakeholders within the Metropolitan Statistical area**, and outreach conducted to professional organizations which may have interested members (American Public Works Association, New York Pupil Transport Association, etc.). An effort should be made now to engage the interest other towns, school districts, RATSA, the Monroe County Supervisors' Association, the Monroe County Highway Superintendents' Association, the Council of Governments, Genesee Region Clean Communities, and the Mayor's Green Team in a collaborative, on-going clean fuels effort, which could be shepherded by the Genesee Region Clean Communities or another organization. Given the City's jurisdictional constraints, it may not be ideally placed to lead such an effort. It is recommended that the City encourage this type of expansion and participate in any collaborative efforts when appropriate.

Continue and Nurture Collaboration- One of the indirect benefits of the Fuels System Study and formation of the PAC was that it provided a forum for discussion and information sharing between representatives of local and state governmental agencies and others. This was particularly relevant in the case of Monroe County, which has implemented several green initiatives that could have direct applicability to City plans and projects.

The City is clearly expanding its environmental leadership in a variety of ways and an excellent example of this is the Mayor's Green Team, which is an interdepartmental and cross-functional team charged with addressing a variety of environmental issues including buildings, vehicles and environmental contamination. Some members of the Green Team participated in two of the sessions involving guest presentations and this involvement clearly provided mutual benefits for all participants. **It is recommended that these internal relationships be maintained and nurtured to take advantage of the synergy that can occur.**

Most importantly, **it is recommended that the City designate a liaison to work on alternative fuel issues directly with a designated counterpart at Monroe County**. This cannot be emphasized too much, as it was discovered at the beginning of the study that the County had an extensive alternative fuel program planning process underway, from which the City could dovetail efforts, thereby saving on costs via inter-municipal cooperation. This staff person should serve to communicate on alternative fuel developments and projects and to provide for the possibility of continued collaboration and resource sharing AFVs and particularly infrastructure. The available tool of inter-municipal agreements for fueling facilities and other shared services creates an option to formally engage in these joint efforts.

Vehicular Strategies

Accumulate Flexible Fuel Vehicles (FFVs)- Regarding vehicle acquisition strategies, the City can create the foundation for an E85 fuel program quite easily by continuing to acquire FFVs as new vehicles are purchased. This will supplement the current inventory of FFVs that include the Ford Taurus, Impala and Tahoe models, among others. The City's large fleet of Impala police vehicles comprises more than one-third of the light equipment fleet and has the potential for significant benefits when an E85 fuel station is operational. The availability of FFVs is growing and there is a wide range of vehicles that will suit a variety of applications. This can be achieved through a targeted and carefully managed purchasing program. One cautionary note, as mentioned in one of the presentations, is to be sure to order the FFV option specifically as there are occasions when some manufacturers do not provide the FFV technology on all units within a model class. This approach can be implemented at no additional cost and can begin immediately.

Thus, the City should accumulate flexible fuel E85 vehicles in the light duty sectors. These vehicles are available on the OGS state contract, are already present in the fleet, and require no special modifications or incremental cost. Once E85 fueling is arranged, the FFV's can begin using E85, or switch back to gasoline when traveling to remote locations where the biofuel is not available. This strategy involves no extra cost. This strategy should be extended into the mid and long-term to maintain infrastructure investment benefits.

Biodiesel Pilot Program

Through both the peer review portion of the study and the guest presentations, the PAC and Consultant Team learned of several biodiesel programs that had achieved success in a governmental fleet environment. There are some caveats to be considered, including fuel availability and price, engine warranty considerations and cold weather dependability. However, given the large diesel fleet of over 400 vehicles, the implementation of some kind of biodiesel program could generate significant benefits. It is recommended that the City initiate a pilot diesel program to test the viability of this fuel.

The **biodiesel effort in the short term should be conducted via a pilot project evaluation of the fuel utilizing a small temporary tank and dispenser (1-2K gallons)**, and performed starting in the warm weather months, starting now, and continuing on into the cold weather 4th quarter. In this way, the effects of weather can be observed. A vehicle test group of no less than seven (7) vehicles of a particular fleet component should use the fuel, records kept for each, and comparison of performance, maintenance, mileage and emissions be kept. Ideally, at minimum, three vehicle types at least should be evaluated, for a total of no less than twenty-one vehicles. This sample size should be representative and improve accuracy of results.

At the end of the first three months, a review and examination of the units should be conducted. The data gathered should be compared against the same make, model and vintage units utilizing diesel. It is recommended that the fleet start with B5, and on the second delivery, B20. Clearly, oil filter life and required changes will be of interest. Any clogged fuel lines, stalling, and engine problems should be recorded. Check hoses and lines for pitting or undue wear. In October, utilize a B2 or B5 blend, being careful that the fuel is treated for cold weather as per the City of Keene biodiesel findings. The fuel dealer should ensure that the fuel has the proper cold weather additives. The Department of Energy also provides extensive biodiesel storage and handling guide available from the National Biodiesel Board web site[43].

A temporary tank unit is available off of the NY State OGS Tank Contract, but unfortunately, the consultant was not able to procure a copy of this contract or the line item costs. Based upon costs in other jurisdictions, the City could expect a mobilization charge, a demobilization charge (likely $2,500 each), plus a monthly rental fee of around $350. The state contract holder is Nature's Way. Other pump and tank firms can provide quotes as well for these services. Biodiesel blends are available on the state contract as well, and the contract holder is Griffith.

II. Medium Range- 2nd to 3rd year

Fuel Implementation

Once the initial pilot testing of the biodiesel is completed, **a larger fleet phase-in of biodiesel can be conducted**. Should the fleet administrators decide to utilize the fuel fleet wide, the existing diesel tank and dispenser can be used. Procedures for integrating the fuel, as outlined in the Biodiesel Storage and Handling Handbook referenced above should be followed, as the biodiesel can sometimes emulsify sludge that can deposit in the tank. Possibly a preferable approach to using the fuel at the existing Mt. Read station would be via the proposed Green Station to be located adjacent to the Mt. Read facility. In this way, the City could maintain its diesel facility, and install a new tank and dispenser for biodiesel at the new station. That way possibly a higher blend ratio of up to B20 could be used in vehicles designated by fleet administrators for the biofuels use.

The **main E85 program** can commence during this same period, via new tankage at the Green Station. **A tank size of no less than 8,000 gallons** is recommended in order to get attractive pricing on the E85. Fuel companies will charge a premium "small drop" charge for smaller quantities of fuel, as they prefer to drop an entire tanker load. By this time, E85 should be available on the state contract as well, though with all the ethanol production facilities slated for Rochester vicinity, the City may get better pricing on its own. Contacts should be made starting now for provision of ethanol for the program, in order to gain the best pricing. Some **basic driver education for staff users should be conducted**, either via a short training

[43] http://www.nrel.gov/vehiclesandfuels/npbf/pdfs/40555.pdf

event, or though a tri-fold type handout, which would cover: What is E85, why is the fleet using it (energy independence, renewable fuel, clean air concerns, etc.), fuel properties (higher octane, lower mpg), driving strategies (smooth acceleration, good tire inflation, etc.).

The FuelMaker unit can be expanded during this period (or sooner) via having a turnkey contractor do the basic design and installation. Prior to this, **an electrical review should be conducted to determine if further electrical upgrades are needed** for the new unit. The larger appliance size FMQ-VM-8 is appropriate for this application. FuelMaker staff can provide the recommendations on exactly what is needed for the upgrade, which was estimated for this project at approximately $60K; even using a $10K contingency for electrical work, the upgrade can be performed for an estimated $70K, but likely less.

Phase In of Green Station Project

It is anticipated that the first Green Station should be completed and will begin operating during this period at the City of Rochester site. Depending on the fuel selection that is made for this station, the City will be able to begin considerably expanding its use of alternative fuels in the fleet. Given the current number of FFVs, and the potential accumulation of additional FFVs as recommended, the use of E85 fuel holds promise**. It is recommended that the FFV fleet be phased into utilization of the Green Station when E85 is available at this location. .**

The results of the pilot biodiesel program, if implemented, should be available by this point and the potential availability of some mixture of biodiesel at the Green Station will enable a phase in of selected diesel vehicles at this site. **It is recommended that decisions be made about the correct biodiesel mixture by season and that decisions be made about what classes of vehicles be phased in, and a timetable for this set. This step should also include decisions about mission-critical vehicles and what is the appropriate fuel to use based on seasonal conditions. If the biodiesel experience has proven to be successful, it is further recommended that the City consider offering biodiesel in a lower blend at least one of the two diesel tanks at the Mt. Read Facility to improve fueling efficiency during peak periods.**

Vehicle Acquisition

Additional Honda Civic GX units (3-5 per year) can be ordered off the state contract. The incremental cost of this unit is approximately $4,000, but there is the potential that NYSERDA funds could be applied for these costs, and that some percentage would be covered via the Clean Cities Challenge Grant program. As of this writing, the state does make available funds for CNG projects, and this will likely continue in the near to midterm future based on current NYSERDA administration and internal policies.

Further in the mid-term, the City can consider **the application of a larger chassis platform specialized CNG vehicle**. Numerous municipalities are using such vehicles as refuse trucks, recycling trucks, and work trucks. An ideal application for the City would be for a limited application vehicle such as a recycling truck. Though such a vehicle would be materially different from the rest of the fleet, a limited application of such a vehicle, with integration of up to three such vehicles over a 2 year period, would save considerably on emissions, including NOX and PM, due to the very clean burning nature of the CNG engines. A number of existing contractors can assist the City in determining the configuration of such a vehicle, and industry contacts can be provided by the Fleet Counselor team as required.

Or, **street sweepers present a useful application for the CNG technology**, and likewise the incremental cost of such vehicles could be applied for from NYSERDA. Should a significant number (greater than three) be sought, some stationery CNG slow fill fueling infrastructure may be needed, which involves extending a line a dedicated location where the vehicles would be parked over night, and two dual slow fill posts installed. This configuration could fill four units, having one post with two fill attachments.

Another useful application over this mid-term period, on a special order basis, would be some type of **alternative fuel hybrid, or plug in hybrid vehicle**. Similar to the CNG medium or heavy-duty application, the air quality benefits are considerable, but the vehicles have two points of concern: incremental cost ($75,000-150,000) and their prototypical nature. A further iteration of this type of vehicle includes refurbishing of an existing unit, and conversion to a hybrid or plug in hybrid. The Town of Hempstead, New York recently refurbished an older model former New York City Department of Sanitation refuse truck, had a hybrid electric drive train installed, and the exterior completely restored. The result was a "recycled" and "reused" sanitation truck.[44] Again, NYSERDA funds could be applied for use towards the incremental cost of a new hybrid vehicle, and possibly other available funds such as federal DOT funds could be put towards such an effort. Due to its novel nature, further inquiries to NYSERDA can be made to determine if Clean Cities Challenge funding could be directed towards the conversion of an older model vehicle to a hybrid.

Such hybrid vehicles, either new or refurbished, can use any primary fuel- diesel, CNG, etc. and have the benefit of being specifically tailored to the City fleet's needs in both configuration and performance. The cost range is dependent upon the type of truck refurbished, and its condition (suspension, engine, etc.). A vehicle in poor shape is not a good candidate for such a transition, but rather an older vehicle in better condition.

It is recommended that the City consider supplementing its small electric fleet of 3 GEM vehicles for applications such as internal campus transport at the Operations Center, use in the Main St. Improvement District, parks operations, and perhaps

[44] Great Long Island Clean Cities Coalition project, 2006. Town of Hempstead contact is Dominick Longobardi.

downtown parking enforcement. Such augmentation should be based upon specific needs related to these bureaus, and funding may be available from NYSERDA for a portion of their cost. In addition, there is $200,000 in CMAQ funding now available in the Rochester region for Plug-In Hybrid Electric Vehicle (PHEV) initiatives.

Interaction with other organizations (County, MPO, Clean Cities, etc.)

City staff have been involved with the local Clean Cities chapter, Genesee Region Clean Communities (GRCC), since the early 1990's, with employees taking active roles as officers or board members. There has been a strong tradition of mutual support for programming and information sharing. This relationship clearly played a key role in the previous efforts to acquire various AFVs and the existing FuelMaker CNG station and enabled the City to learn of vehicle options and funding opportunities. **It is recommended that the City maintain this strong connection and active participation in GRCC governance and other activities and programs. This has mutual benefits for both organizations, particularly with the City having one of the largest fleets in the region.**

In addition, the GRCC has obtained a CMAQ grant that will be administered over five years (2007-2012) and that will assist fleets in acquiring AFVs by helping offset 75-80% of the incremental costs of eligible vehicles. **It is recommended that the City develop a strategy to help leverage some of these funds to aid in the buildup of its AFV fleet.** The continuation of the strong relationship with GRCC will certainly facilitate this funding process.

The formation, development, processes and activities of the PAC expanded and strengthened the local AFV network by bringing together a range of agencies with diverse perspectives and expertise but with mutual interests. Clearly the prominent role played by the local Metropolitan Planning Organization (MPO), the Genesee Transportation Council (GTC) helped create a robust environment for study and discussion and also perspective on the transportation and air quality issues in the Rochester Metropolitan Statistical Area (MSA). **It is recommended that the City fleet operations staff maintain a relationship with the GTC, either directly or indirectly through the Transportation Planning office in DES/ Engineering Services.**

III. Long Range

Regional Impact of Biofuels Production

Currently, numerous production plants for both biodiesel and ethanol are underway. Major ethanol plants are under construction in Fulton, New York, as well as in Medina, located between Rochester and Buffalo. The latter facility is scheduled to go

on-line in November 2007[45]. A smaller scale (500K gallon/year) cellulosic ethanol pilot plant by Mascoma is to be built in Greece, New York, with the support of NYSERDA. Biodiesel plants are planned for various locations in Fulton, Buffalo, and Ontario (target opening summer 2007 for wholesale customers). Finally, discussions have been conducted to attempt to build an ethanol plant using brewery waste from the High Falls Brewery. Therefore, there is an extremely high level of biofuels production slated for Rochester and vicinity. These conditions provide the City fleet with a number of crucial benefits. The local production has the potential to vastly increase local supplies of biodiesel and ethanol. Local production, along with local delivery, should allow attractive pricing for these fuels. With a short delivery route, from for example, the Brewery to Mt. Read, the fuel delivery and transport charges should be much less.

Therefore, **the City should maintain contact with staff from the nearby biofuels production facilities in order to be the "first in line" for superior pricing** and preferred deliveries from the plants. Contact should be maintained during the planning and construction period to ensure good contacts are well in place, and that City needs and expectations are met.

In summary, <u>regional biofuels production</u> presents the City with advantages of supply, price, and decreased delivery charges.

Impact of CNG Program

The long range impact of a continued CNG light duty, or limited medium/heavy duty program produces strong air quality benefits, though any entry into more than the scale of CNG vehicles discussed previously will present a high cost for installation of a large capacity quick fill station with dispenser, which involves design and engineering costs (potentially $35,000-50,000), high capital costs ($500,000-750,000 or more), and a steadily dwindling number of vehicle options in light duty and other engine platforms. Though CNG is very clean, and the per gallon equivalent fuel costs are more affordable than petroleum based fuel, the Fleet Counselor team has determined that either the City must make a large scale, expensive commitment to the fuel and associated new infrastructure, or maintain and modestly expand the CNG vehicle fleet as was recommended above. Anything in between is not cost effective because the large capacity station would still be required. Greater use of natural gas in place of oil for power plants, heating of industrial facilities, and other uses have also affected the supply of domestic natural gas, and the pricing trend over recent years has been upward.

[45] Fleet Counselor team member site visit to Western New York Ethanol plant construction site, June 15, 2007, as noted by company principal during site tour.

Transition to Hydrogen and or Fuel Cells

As has been stated, the City has a good opportunity to interact with GM's Fuel Cell Activity Center facility program staff at Honeoye Falls. CNG is often touted as a "bridge" to hydrogen, since both CNG and hydrogen are gaseous fuels. It is presented by CNG proponents that a CNG infrastructure on a larger scale (i.e. a large capacity station, not a small, appliance sized FuelMaker unit such as the City possesses) can one day be transformed into a hydrogen station. However, the compression ratios currently needed for CNG vehicles, 3,000 pounds per square inch (PSI) for older NGV's to 3,600 for newer NGV's, differs substantially from the 5,000 to 10,000 psi needed for the hydrogen prototype vehicles. It is difficult to extrapolate the usability of a potential large scale CNG station the City might construct now, to determine how it could be used to fill future hydrogen vehicles that do not yet exist. Design improvements for hydrogen and fuel cell vehicles can be expected to continue at a steady pace, but fuel storage and range are the two impediments at present. Likewise, to expend upwards of $500K for a large CNG station, with the expectation of using it one day as a hydrogen station is premature based on the current level of technology of the vehicles.

Continued Interaction with County of Monroe

In the Short-Range portion of this section, a recommendation was made to designate a City liaison with a designated counterpart at Monroe County to work on alternative fuel issues. As the City and County AFV programs develop and evolve, it is essential for these two governments to continue to collaborate on these issues and programs. This is particularly important in a time of scarce resources that may make the need for sharing of resources even more important**. The recommendation is that the City continues with and nurtures its collaborative relationship with the County.**

IV. Summary of Funding Sources for Alternative Fuel Vehicle and Fueling Facilities Applications

The following information is included as an easy reference for application for funding for the types of fleet additions discussed herein and is presented in succinct form.

Funding Sources

Agency	Name of Program	Frequency	Comment/s
NYSERDA	Clean Cities Challenge	Annually	Includes all the alternative fuels
NYSERDA	Advanced Transportation Technologies	Annually	Oriented towards more prototypical vehicles; City would want to partner with the vehicle developer and have them make the grant application
US Department of Energy	State Energy Program	Formerly annually, future of program uncertain, but likely to continue	Oriented towards larger scale projects; application for smaller percentage of total cost more likely to succeed; covers various alt fuels
US Department of Transportation	Congestion Mitigation and Air Quality	Semi-Annually	In conjunction with Genesee Transportation Council- Intent is to implement mitigation measures to decrease priority pollutants
United States Federal budget items	Congressional appropriation	Annually	In conjunction with Congressional representative. City staff must work with Cong. Staff to do application, and follow through process of getting item into final federal budget
New York State budget item	NYS member item	Annually	Targeted line item for inclusion in budget, sponsored by assembly or senate representative

In addition, there may be further US Department of Energy opportunities that could arise. Federal programs develop over time, and currently there is a high level of

interest congressionally in decreasing dependence on foreign fuel. Debate is on-going in committee as of this writing for new alternative fuel and renewable energy programs and funding. One such program is the proposed Energy Efficiency Promotion Act of 2007, which would provide $4 billion nationwide for an Energy Environment Block Grant Program (EEBG). The City should support such Federal Legislation that provides funds for alternative fuel projects.

Concluding Remarks

Fortunately, the City has initiated this study and is considering an enhanced AFV program at an excellent time. Due to several factors, including persistently high fuel prices with continuing upward pricing trends, concerns about global warming, and geopolitical turmoil, there is an increased interest and availability of vehicle options and fuel choices. The commercial sector understands the viability of the alternative fuel market segment and is eager to provide products and services. The general demand for these types of vehicles and fuels exists across a broad spectrum of our society and the global community as well. These factors will contribute to the availability and affordability of both alternative fuels and vehicles, with these technologies becoming more "mainstream". Increased production of biofuels should also contribute to greater availability and lower fuel prices for both ethanol and biodiesel.

One of the challenges that the City will need to address is the uncertainty about the changes in technology and how quickly this happens. While this is a fact of life in most settings, the financial impact may be greater when one has a significant investment in a large fleet. This challenge can be addressed in part by maintaining the collaborative relationships that have been described in the previous sections and by dedicated involvement in some of the local networks involving alternative fuels, as well as demonstration projects and incremental implementation of alternative fuel initiatives.

The recommendations contained in this report provide a diverse approach to achieving the goals of reducing both vehicular emissions and the consumption of petroleum-based fuels. These strategies and recommendations reflect the current state of the alternative fuel field and product and fuel availability. This environment is fluid and subject to shifts and changes in a relatively short period of time. It is essential that City staff remain vigilant in keeping up with the trends and developments in this field. This can be achieved in part by utilizing the local networks described previously but also by utilizing the resources available through national organizations such as the National Association of Fleet Administrators (NAFA), the National Ethanol Vehicle Coalition (NEVC) and the National Biodiesel Board (NBB). Another resource is the US Department of Energy, with its Freedom Car and Clean Cities programs, which maintain constantly updated websites, including "Tool Kits" for alternative fuels. The Fleet Counselor Team remains available to further assist the City with its ongoing alternative, green fleet efforts.

The Consultant Team has sought to provide the City and the PAC with a comprehensive view of the alternative fuel and alternative fuel vehicle environment and to provide an array of options tailored to the requirements of a large, urban fleet of a general governmental unit. These options should provide a framework for

decision-making based on available resources, program objectives and operational requirements.

It is the intent of the Fleet Counselor Team that this template will be a key tool in helping create the foundation for a Green Fleet for the City and its residents for many years to come.