REPORT ON

State of Alaska Vehicle Fleet CNG Pilot Program Recommendations/Cost

FOR

State of Alaska

January 2011

MERCURY ASSOCIATES, INC.

MERCURY

January 28, 2011

Ms. Diana Rotkis
Fleet Manager
State of Alaska DOT&PF SEF
2200 East 42nd Avenue (RM #316)
Anchorage, AK 99508

Dear Ms. Rotkis:

Mercury Associates, Inc. is pleased to submit this final report on our feasibility study for the use of compressed natural gas (CNG) by the State of Alaska. We have included both phases of the project in this combined report.

We would like to express our appreciation to you, Senator Fred Dyson and his staff, as well as the many individuals including, in particular, Dan Sullivan, Mayor of Anchorage, who took the time to speak with us.

I can be reached at 562-596-5920 (office), 562-397-7262 (mobile) or jchristensen@mercury-assoc.com.

We appreciate being given the opportunity to assist the State of Alaska in this endeavor and look forward to working with you and others to implement some of the key action items we have recommended.

Very truly yours,

Janis Christensen

Janis Christensen, CAFM
Senior Manager

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EXECUTIVE SUMMARY

Study Scope and Methodology

The Alaska Sustainable Energy Act, Senate Bill 220, an energy policy bill passed in 2010, mandated Department of Transportation & Public Facilities (DOT&PF) Division of Statewide Equipment Fleet (SEF) to prepare a report on the feasibility of using compressed natural gas (CNG) to power vehicles in the State, including vehicles owned or operated by the State, and incorporating in that study, if warranted, a pilot program proposal for powering some vehicles owned or operated by the State with CNG. The legislation described fleet conversion as a possible short-term solution for rising energy costs in Alaska, and paired it with a policy for the State to consider long-term energy costs when buying vehicles and equipment. DOT&PF must prepare a report on the feasibility of using CNG to power vehicles in the State by January 31, 2011.

A summary of the methodologies and techniques we employed to accomplish the scope of work for this project is provided below:

1. Develop and submit an information and data request to SEF;
2. Review SEF vehicle replacement practices;
3. Evaluate SEF fuel usage;
4. Review SEF fleet inventory, vehicle functions, and usage;
5. Analyze data to calculate SEF greenhouse gas (GHG) emissions for the Anchorage region;
6. Conduct interviews with state government officials to understand the State's objectives for this endeavor;
7. Conduct interviews with potential stakeholders in Anchorage;
8. Conduct an analysis of internal strengths and weaknesses and external opportunities and threats relative to the objective goal (SWOT);
9. Present recommendations for Phase I feasibility study;
10. Incorporate feedback from Phase I presentation into development of a CNG Program (Phase II);
11. Review existing CNG fueling infrastructure in Anchorage area to determine lower cost opportunities for implementation of the CNG Program;
12. Determine station upgrade pricing estimates;
13. Determine vehicle conversion pricing estimates;
14. Develop a strategy regarding Clean Cities participation to bring Anchorage area fleets into synchronization regarding alternative fuel activities; and

Document study methodology, findings, conclusions, and recommendations in a formal report and *WebEx* online presentation.

Phase I – Feasibility Study

Phase I of the study includes a review of existing innovative government programs and incentives in place in Utah and other North American jurisdictions that promote the use of compressed natural gas (CNG); a summary of relevant studies and investigations on existing public policy incentives for the same purpose; an evaluation of the environmental benefits and technical merits of using CNG; an outline of the economic, environmental, and technical advantages and disadvantages of using and promoting the use of CNG in the State of Alaska.

Key Findings

We conducted research of historical events of government programs and incentives (fleet and general public) in the States of Utah, California, Oklahoma, New York, Texas, and Washington. Overall, we found eight significant prevailing programs, factors, and incentives offered to fleet organizations and the general public in the six states. These characteristics are listed below, not in any particular order of rank:

Similarities of Characteristics Between States

1. Tax credits for public
2. Reduced fuel tax rate for public
3. Grants
4. Loans
5. Honda natural gas vehicle retail dealers in UT, CA, NY, and OK
6. Relatively large infrastructure centered near interstate highways
7. Fleets moderately regulated
8. At least one Clean Cities organization in each state

Successful natural gas vehicle (NGV) programs must include a commitment to three elements: 1) the appropriate **vehicles**, preferably from an original equipment manufacturer (OEM) rather than retrofitted by a third party; 2) a fueling and maintenance **infrastructure** to support the vehicles; and 3) **incentives** to kick-start the program and overcome barriers to acceptance. All three of these elements must converge for a successful market transition to the alternative fuel.

Below is a list of the most current CNG incentives and infrastructure provided in Utah, which has an estimated public and private 10,000 NGVs. A summary of the incentives and laws for all states is provided in the Appendix, distinguished by the type of incentives, type of user, and by technology or fuel class. Moreover, the separate *Excel* workbook provides detailed information and data collected from the six states included in this study.[1]

Utah CNG Incentives

- Income tax credit of 35 percent of the new vehicle purchase price or $2,500, whichever is less
- Credit of 50 percent of the cost of converting a NGV, up to a maximum of $2,500 per vehicle
- Grants and loans to businesses and government entities for the cost of conversions and incremental cost of purchasing OEM vehicles
- Maximum annual awards are $500,000 and maximum grant/loan is $100,000 per project (minimum is $5,000) up to 100 vehicles acquired
- Tax of $0.085 per gasoline gallon equivalent to be modified proportionally with any changes to the traditional motor fuel rate
- Authorization to travel in high-occupancy vehicle (HOV) lanes regardless of the number of occupants
- PUC may find a gas corporation's request for a NGV rate less than full cost of service may be just and reasonable in the interest of the public; if approved, remaining costs must be spread to other customers of the gas corporation
- Public access to State-owned CNG fuel stations
- Loans and grants for NGVs and infrastructure
- Clean Cities grants
- Free parking in downtown Salt Lake City

Utah Infrastructure

- Established I-15 corridor CNG fueling infrastructure
- Developed by Questar Gas[2] for its NGV fleet
- Regulated by the State and cost spread amongst consumers
- One of few states where an individual can drive throughout the major population corridors of the state without limited access to CNG stations
- Public access to state CNG stations
- ~35 CNG public and private stations

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[1] Mercury Associates, Inc. Government CNG Programs and Incentives. December 2010.

[2] Questar Gas provides retail natural gas-distribution service to almost 900,000 customers in Utah, southwestern Wyoming and a small portion of southeastern Idaho. The Public Service Commission of Utah and the Wyoming Public Service Commission regulates Questar. Questargas.com.

Clean Cities

Since a majority of 2009 awards originated from Clean Cities, including NGVs and CNG fueling infrastructure, we believe the establishment of a Clean Cities coalition in Alaska will be a vital factor towards achieving goals relating to the expanded use of CNG in the region. The State of Utah, for example, received about $15 million in FY-09 Clean Cities grants. The mission of Clean Cities is to advance the energy, economic, and environmental security of the U.S. by supporting local initiatives to adopt practices that reduce the use of petroleum in the transportation sector. Established in 1992, Clean Cities carries out this mission through a network of more than 90 volunteer coalitions, which develop public/private partnerships to promote alternative fuels and advanced vehicles, fuel blends, fuel economy, hybrid vehicles, and idle reduction. The Anchorage Metropolitan Planning Organization (MPO) served as a coordinating organization similar to Clean Cities during the area's push for CNG use in the 1990s and could provide valuable assistance in establishing a Clean Cities in Anchorage.

Emission Reduction

CNG reduces GHG emissions versus conventional fuels primarily due to the molecular structure of methane, the primary component of natural gas. Methane, CH_4, has the highest ratio of hydrogen to carbon (4:1) of any hydrocarbon fuel. While unburned methane itself is a serious greenhouse contributor, the net effect is still a significant benefit for the environment. NGVs can produce significantly lower amounts of harmful emissions such as oxides of nitrogen (NO_X), particulate matter $PM_{2.5}$, and toxic and carcinogenic pollutants as well as carbon dioxide (CO_2) compared with vehicles fueled by diesel and gasoline. A report by Argonne National Laboratory (ANL) combined emission data from 14 primary studies to determine the effects of natural gas fuels on light duty vehicle (LDV) tailpipe emissions. The weighted results are illustrated in the table below.

Table 1
Pollutants Found to Be Significantly Reduced in CNG Use When Compared to Reformulated Gasoline in LDVs[3]

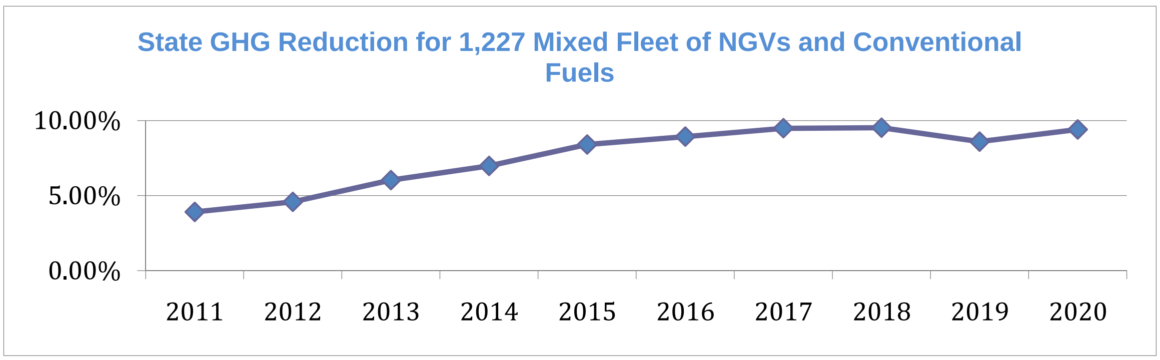
Pollutant	Percent Reduced
Volatile Organic Compounds (VOC)	10%
Carbon Monoxide (CO)	20% to 40%
Oxides of Nitrogen (NO_X)	0%
Particulate Matter (PM)	80%
Methane	-400% (increase)

[3] Argonne National Laboratory Transportation Technology R&D Center. A Full Fuel-Cycle Analysis of Energy and Emissions Impacts of Transportation Fuels Produced from Natural Gas. December 1999.

Overall, GHG emissions from natural gas are 23 percent lower than diesel and 30 percent lower than gasoline fuels.[4] CNG reduces petroleum consumption almost 100 percent from the level of gasoline, whereas LNG reductions are slightly less, because LNG requires more energy to process.

Mercury Associates' *Eco Fuel-Tool* model forecasts that 47 percent of the 1,227 SEF fleet (571 vehicles) located in the Cook Inlet region could eventually be converted to CNG, providing a 40 percent fuel substitution. The model projects an overall 7.7 percent net decrease in GHG emissions over the decade for the entire regional fleet of 1,227 units (i.e., 571 units converted to NGVs and 656 units continuing to operate on diesel or gasoline fuels), including a 9.8 percent net decrease in the last year of the model.

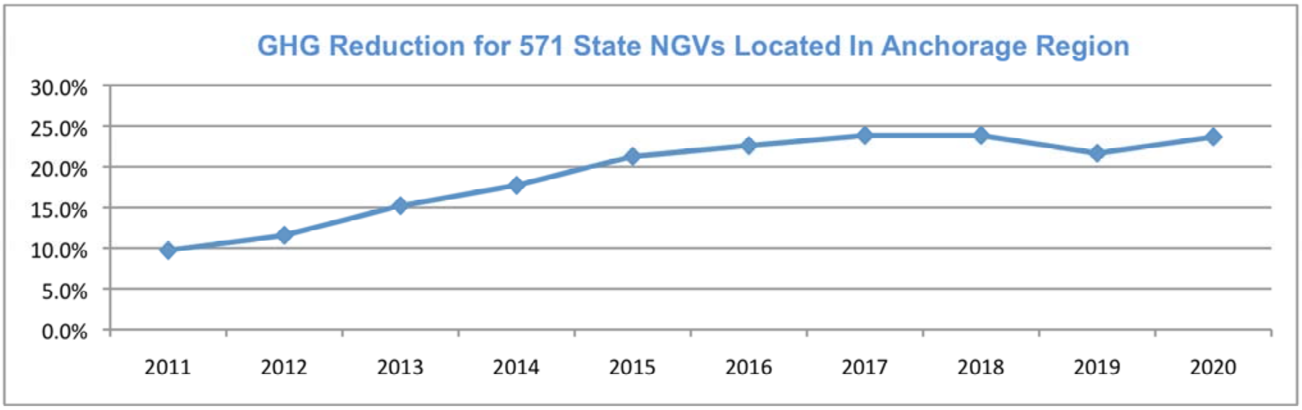
Exhibit 1
State GHG Reduction Forecast All Anchorage Vehicles



When comparing only the 571 units as NGVs versus conventional fuels, the GHG reduction ranges from 9.7 percent to 23.7 percent and averages 19.1 percent over the 10-year period. This percentage (19.1) is consistent with the ANL research presented in Table 2, *Petroleum Use and GHG Emission Reductions*, which show reductions between 21 and 26 percent.

[4] California Energy Commission. 2007. Alternative Fuels Data Center. Natural Gas Emissions. http://www.afdc.energy.gov/afdc/vehicles/emissions_natural_gas.html.

Exhibit 2
State NGV GHG Reduction Forecast vs. Conventional Vehicles



As indicated in the Methodology section of this report, we note that the management of fuel for the State of Alaska fleet is a decentralized activity and data is not collected through an automated fuel management system. SEF has requested, but not received approval, for funding of a $3 million statewide-automated fuel management system and has offered to take responsibility for centralized management of the State's estimated $29 million fuel ($25 million for bulk fuel and $4 million through retail outlets) purchases.

Centralization of fuel management and automating key processes in fuel management is an industry standard and considered a fleet management best practice. We believe such an endeavor would allow the State to reduce the cost of its fuel operations. With today's high cost of fuel, issues with fuel "shrinkage" and white-collar crime, and concerns regarding stability of supply in the event of a national emergency, weather issues, or other disruptions, fleet organizations must rely on automated systems in order to maintain consistent operations to ensure their fleet stays on the road. To this end, we have recommended SEF pursue the acquisition of a fuel management system.

Advantage and Disadvantages of CNG

Despite several advantages compared to liquid fuels, NGVs have not gained a significant share of the transportation market, other than a growing number of centrally fueled fleets such as transit; school buses; refuse; airport shuttles, taxis, and support vehicles; and regional delivery trucking. While operational characteristics of NGVs are no longer a significant problem or barrier to adoption, the vehicle choices as of late 2010 are still limited, as domestic automakers reduce spending on alternative fuel R&D investments in order to deal with endeavors related to financial restructuring. Having said this, the emission and fuel cost benefits of CNG continue to appeal to fleet operators, particularly since 95 percent of the natural gas consumed in the U.S. is domestically produced.

Natural gas supplies in Alaska are stretched by residential and commercial use, electric generation, and liquefied natural gas exports; however, the large and stable demand offered by State vehicles could help justify the need for natural gas exploration, storage facilities, and other solutions for replacing the diminishing natural gas reserves in Cook Inlet.

High costs to build a fueling network and comparatively high initial costs of the vehicles themselves are significant barriers. For several decades, the alternative fuels industry as a whole has suffered from a "chicken and egg" situation where fueling stations are financially risky without a significant demand, and vehicle adoption is seen as risky without the assurance of fuel availability. Incremental conversion of fleets or individual users does not sufficiently create enough demand to make fueling investment work financially. A coordinated, large-scale commitment is needed. Government funds have generally been the mechanism to fund or at least incent fueling infrastructure.

NGV operators are subject to the frustrations of a limited fueling network and "fueling fatigue," both a result of the fact the natural gas is stored on board as a gas instead of a liquid, despite the high pressures involved. NGVs generally have to be fueled every day. Unless there is a fixed fueling site with multiple hoses (i.e., time fill, overnight fill) where vehicles can be fueled while parked over night, drivers resent the lack of convenience with the common fast fill public fueling sites if they have to visit every day. Overnight fueling, however, can be a convenience advantage over liquid fuels, because there is no longer a need to visit a fuel pump, and productivity is enhanced.

OEMs are expanding the availability of NGVs, although they are taking different approaches to how involved the buyer becomes in the conversion process. Only a limited number of NGVs are 100 percent manufactured by the OEM. Instead, most vehicles are shipped as conventional vehicles with engines that must be converted by a certified engine upfitter. General Motors, Ford Motor Company, Fiat, Freightliner Trucks, International Truck, Kenworth Truck Company/Peterbilt, and Mack Trucks offer NGVs in the U.S market. Only Honda, GM, and Freightliner/Cummins vehicles are entirely assembled at the OEM factory, shipped directly to delivering dealers, and carry identical warranties to the conventional models. While Ford's partnership with BAF is an improvement over past "conversions" due to utilization of the "ship through" process, fleet operators must still deal with two different warranty providers. The latter can result in "finger pointing" relating to which is responsible for what failure.

Certification of aftermarket conversion systems continues to be cumbersome and expensive. This hinders the development and use of NGVs. Proposed legislation in the U.S. House of Representatives and U.S. Senate would streamline, and, thereby reduce the cost of certification. Until this issue is resolved, the difficulty and high cost of retrofitting vehicles to operate on CNG will continue to be a hindrance to wider acceptance.

Analysis of Strengths, Weaknesses, Opportunities, and Threats

We conducted a SWOT analysis as a strategic planning method to evaluate the strengths, weaknesses, opportunities, and threats involved in assessing the feasibility of CNG as a viable alternative fuel for the Alaskan market.

Table 2
SWOT Objective: Feasibility of CNG for State Fleet

	Strengths	Weaknesses
Internal Origin (Attributes of the organization)	School, Railroad, SEF are supportive	Transit, Waste, Airport tepid towards CNG
	Positive experience with NGV operational performance	Previous technical glitches still remembered
	Desire for sustainability	Limited natural gas supply in many areas
	Existing, albeit limited, infrastructure	Issues with refueling nozzles during winter
	Willingness to appropriate additional funds	Perception of garage modification requirements
	Opportunities	**Threats**
External Origin (Attributes of the environment)	Various natural gas pipeline and storage facility proposals	Timeframe to build
	Alaska has 15% of U.S. natural gas reserves	Peak demand supply shortages in Cook Inlet area during January and February
	Jobs	Abundance of natural gas in Lower 48; shale expansion
	Reduce dependence on imported oil, as prices rise	Lack of Clean Cities program
	Political support for sustainability initiatives	Limited sources of conversion kits and M&R technicians
	Renewed interest in NGVs by OEMs	Hybrid electric and electric vehicle competition

The SWOT analysis indicates that CNG is a feasible fuel for certain Alaskan fleets and that an expansion of the CNG program would be beneficial towards Alaska's sustainability efforts. A variety of stakeholders have expressed an interest in expanding their use of CNG, providing the cost barriers are surmountable and the users can reasonably expect an ample supply of the fuel. Consequently, we recommended proceeding to Phase II of the feasibility study.

Phase II – Pilot Program Proposal

The purpose of Phase II was to prepare a detailed proposal for a pilot CNG program for the State of Alaska.

Key Findings

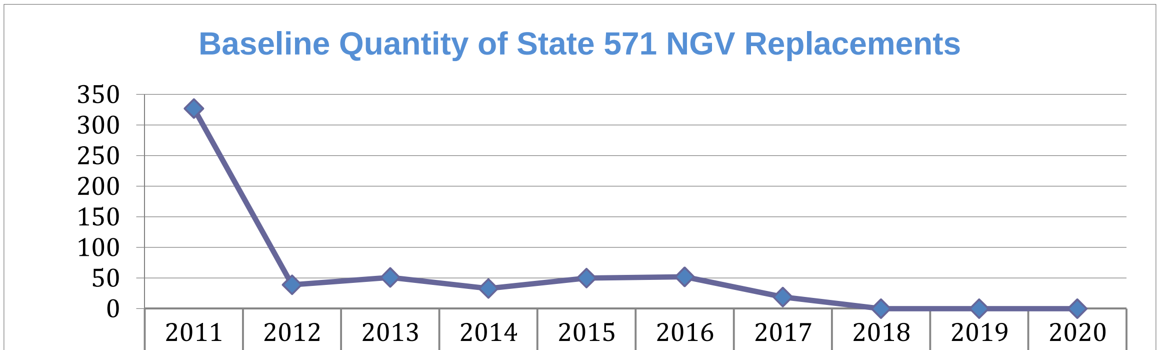
Fleets with high fuel consumption are critical to the support of a financially sound fueling CNG infrastructure, and the long-term participation of such fleets will be necessary for a sustainable program. Centrally fueled and maintained fleets are ideal candidates for conversion until such time as a broad network of fueling stations and maintenance support facilities are available.

Program Participants

Nationally, the three largest users of natural gas for transportation have been 1) transit and school buses; 2) waste collection trucks; and 3) airport support transportation vehicles. While Senate Bill 220 refers to the use of vehicles owned or operated by the State for the CNG Program (presuming the use of CNG was first found to be feasible), we believe other fleet organizations should be invited to participate due to either 1) their interest and willingness to contribute towards the mission and goals of the Program; or 2) their fleet includes the types of vehicles best suited to operate on CNG (i.e., transit, waste, airport support, high fuel consumption vehicles).

As discussed during the first Phase of this report, we have identified a total of 571 potential State vehicles, which are due for replacement over the next 10 years that would be suitable for operational use as NGVs. A complete list of the vehicles is provided in a separate *Excel* workbook, which contains the *Eco Fuel-Tool* database as well as NGV incremental replacement costs, fuel costs, and GHG emission reductions by each of pollutant category. In the following Exhibit, we have provided the number of potential vehicles by calendar year. Again, only vehicles located in the Anchorage region have been considered for the Program.

Exhibit 3
Recommended Quantity of State NGVs for CNG Program



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
COUNT	327	39	51	33	50	52	19	0	0	0

The spike of 327 vehicles due for replacement in 2011 indicates a large backlog of vehicles in the State fleet that have not been replaced within the normal SEF parameters provided to us for each vehicle class. For the most part, these vehicles are in their "secondary" life as State agency vehicles after completing their useful life within the SEF organization. This portion of the fleet represents amongst the highest polluters within the State fleet due to the age of the vehicles. The agencies cannot afford to replace the assets, a problem which would remain with NGVs since they could not afford to pay the incremental costs. This is not an unusual situation for government fleets and is even more commonplace as a result of the poor economic conditions over the past several years. Needless to say, even if the State had sufficient funds to replace all of the 327 vehicles in one year, we would not recommend doing so, since future spikes in replacement due date would occur in the future. Instead, we recommend "smoothing" the plan so that mission critical, obsolete, poorly functioning, and other undesirable vehicles are replaced first while the remaining vehicles are scheduled for replacement in future years.

Steps After A Successful Program

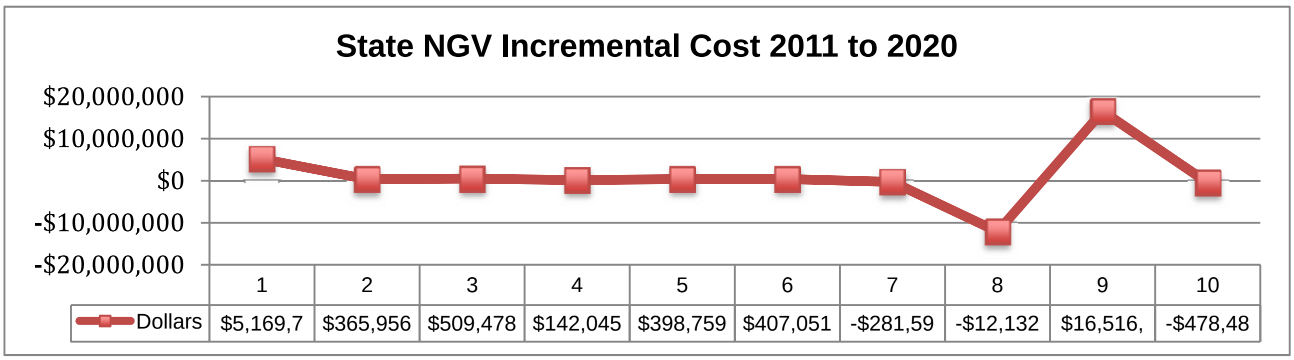
In the event the Program is successful, it will most likely be expanded in order to increase the number of NGVs in the State by reaching out to additional fleet organizations as well as to private citizens. A successful program is expected to result in several fleet organizations *wishing* to initiate use of NGVs due to the benefits experienced, including fuel cost reduction, operational success, and environmental gains. The Program will result in a working coalition of interested participants, who can join together in agreements for fueling infrastructure design, driver and mechanic training, grant applications, problem resolution, and mutual ongoing support.

Estimated Costs

We estimate overall incremental State fleet costs will increase 7.6 percent over the next nine years (2011 to 2020), presuming the most appropriate candidate vehicles for conversions are replaced with NGVs when due for replacement. The *Eco Fuel-Tool* model projects an increase in capital costs while fuel costs will decrease; the overall increase of seven percent does not include costs to build, operate or maintain a fueling infrastructure, which will be examined later in this report.

The incremental costs for the State fleet are provided in the following Exhibit; however, the large backlog of overdue vehicle replacements must be smoothed so that a large spike of vehicles are not replaced in one given year. The *Eco Fuel-Tool* model projects total existing conventionally fueled vehicle replacements to cost $140.5 million over the next 10 years whereas the costs of replacing 571 of the vehicles with NGVs costing $151.1 million. This results in an overall incremental cost of $10.6 million or 7.6 percent. Since the plan has not yet been smoothed, negative costs occur in the outlying years 2017, 2018, and 2020. Negative costs are a result of the longer lifecycle forecast for NGVs, fuel savings, and vehicle replacement costs being “top heavy” in 2011 while greatly diminishing in the outlying years.

Exhibit 4
State NGV Incremental Funding Costs



The cost of maintaining the NGVs by all estimations should be very similar to that of maintaining the equivalent liquid fuel vehicle, especially during the vehicle’s warranty period. In fact, while there is an expectation that some vehicle mechanics will need NGV training, the CNG systems themselves will come with a warranty that will either allow the vehicle to be repaired for free or that will provide reimbursement for mechanic labor costs in addition to free parts. There is a potential savings opportunity for NGV maintenance cost through extended service intervals.

Estimating the extent and cost of modifications needed to safely convert older diesel garages to CNG is made uncertain by the absence of definitive codes applicable to CNG. Certain National Fire Protection Agency (NPA) and the National Electric Code may be broadly applied to CNG garages. In the National Renewable Energy Labs (NREL) study for municipal school, refuse, and transit fleets, facility upgrade costs associated with upgrading a fleet from diesel to CNG were considered zero. NREL based this conclusion on the fact that the incremental cost of making a new garage and maintenance facility compatible with CNG is minimal (Marathon 2006). At any rate, the most common improvements cited were for use of sloped roofs, ventilation and heating system alternations, gas detection systems, various different electrical upgrades, standby generators to maintain ventilation, and fall-arrest systems to enhance safety of works on the roof of the bus during cylinder inspections.[5]

Most existing CNG stations in the Anchorage area are underutilized and require updating, especially with fuel dispensing equipment. These stations were built 10 to 25 years ago in support of prior CNG efforts, and still support a few remaining NGVs. There are several advantages to continuing use of the existing infrastructure. These sites are already established as CNG fueling centers, each supporting a small group of NGVs, and use of the existing sites will allow the widest network of stations with the smallest capital investment funded via this pilot.

The proposed fuel facility upgrades of $380,000 will decrease time required for fueling and allow fuel cards to be issued to track usage (a recommended best practice). An engineering analysis of the individual stations will need to be performed to determine what equipment in addition to the dispensers will require upgrading, rebuilding or replacement. There are several enterprises in the U.S. and Canada who will be interested in bidding on this project. It should be noted that the Railroad recently rebuilt their station, converting it from a fast fill to a time fill, and are capable to share expertise relating to this endeavor.

Fuel costs will be lower during the first phase of the Program since CNG costs less per mile than gasoline or diesel. Program participants will need to work using the base natural gas system fuel cost from Enstar to develop a reasonable markup per gallon to provide funds for the station owner, depending on how the station usage contracts are written. State fuel cost projections are provided in the *Eco Fuel Tool Excel* file.

If 35 additional NGVs are included in the Program (25 light-duty and 10 medium-duty), CNG consumption should approach 4,030 GGE (gasoline gallon equivalent) per month. Assuming a CNG cost advantage of a minimum of $1.25 per GGE (estimated $2.25/CNG GGE vs. $3.50/gallon for the liquid fuels), a savings of approximately $5,000 per month will result for the participants. Note if gasoline engines are used to power the CNG compressors, their fuel consumption must be either backed out of the total or separately metered. Not accounting for this could increase the apparent vehicle fuel consumption. In the NREL survey of transit fleets, the consumption amounted to approximately five to 10 percent of total fuel consumption.

Finally, when considering the number of "moving pieces" in the Program as envisioned and detailed herein, we recommend the State designate one individual or a consultant to manage the Program. This Program Coordinator, which should work in an inter-

[5] National Renewable Energy Laboratory (NREL). Compressed Natural Gas (CNG) Transit Bus Experience Survey. R. Adams, Marathon Technical Services and D.B. Horne, Clean Vehicle Education Foundation. April 2009 – April 2010. NREL/SR-7A2-48814. September 2010.

government capacity, would be responsible for the details such as working with participating agencies on vehicle selection, site evaluations, getting multiple competitive bids and time estimates from suppliers, problem solving and intervention, monitoring progress, and ultimately communicating results. Without a dedicated individual, the diverse aspects of the pilot would be left to those who have other responsibilities, resulting in a Program, which at a minimum is less timely and coordinated, and the chance for success would be diminished. We estimate the fully burdened cost of this individual to be $150,000 for a one-year period.

Table 3
Estimated Program Cost

Type Expense	Total Cost
25 State NGVs	$400,000
4 NGV School Buses	$240,000
4 NGV Trash Compactor Trucks	$240,000
2 Transit Buses	$160,000
2-Time Fill CNG Stations for DOT&PF	$800,000
Upgrading Existing CNG Fuel Infrastructure	$380,000
Estimated Fuel Cost Savings	-$60,000
Other Costs (staff, consultants, etc.)	$150,000
SUBTOTAL	**$2,310,000**
100% NGV Cost "Secondary Use Vehicles"	To be Determined
Fuel Management System Data Collection for Bulk Diesel and Gasoline Fuels	$3,000,000
TOTAL COSTS	**To be Determined**

Summary of Recommendations

CNG Program Phase I

The following timeline provides an overview of the activities and tasks that should be accomplished over the first 24 months of the Program.

Table 4
Program Timeline

Months	Activities
1	Contract with or designate a Program Coordinator
2	Determine/Design CNG Fueling Station Upgrades Designate and Order NGVs
3	Apply for Clean Cities Status Determine Contractor for CNG Fueling Site Upgrades Build Data Accumulation Database Determine/Arrange Technical Training for support personnel
4	Apply for Federal Grant/External Financial Support Coordinate CNG Fueling Site Upgrades First Progress Report

Months	Activities
5	Begin Receiving/Deploying NGVs Arrange CNG Driver Training
6	Continue Receiving/Deploying NGVs Ongoing Program Administration
7	Continue Receiving/Deploying NGVs Second Progress Report
8-12	Ongoing Program Administration and Problem Solving Develop Concepts for Pilot Expansion Ongoing Reporting
13-24	Conclude Receiving/Deploying transit and school bus NGVs (currently ~210 days from order through delivery dates)

1. Implement Program timeline as provided in Table 4.
2. Assign full-time responsibilities to a CNG Program Coordinator. We believe the State would be best served if this individual works for the State in the capacity of an inter-government coordinator who could assist local government entities as well as the State. We recommend the individual report to SEF, since they manage the largest number of government vehicles in the State.
3. Assign grant-writing responsibilities either to the CNG Program Coordinator or utilize private sector grant writing services.
4. Determine funding amount in order to develop budget for State fleet incremental costs (i.e., number of NGVs that may be ordered in year-one). We recommend SEF identify the “secondary” portion of the State fleet and the extent of its growth over recent years in order to possibly pursue additional State funding to replace these vehicles with NGVs (i.e., provide 100 percent of the cost to replace the vehicles rather than incremental costs).
5. Determine incremental funding for additional participants:
    - Municipality of Anchorage
        - Transit
        - Solid Waste
        - School District
        - Public Works
    - Vehicle Types
        - Street sweepers
        - Dump trucks
        - Bucket trucks
        - Shuttles/paratransit

- Construction equipment
- Other high-idling vehicles and/or equipment

6. Conduct meetings with the Alaska Railroad and Alaska Waste to bring both organizations into the Program.
7. Determine and contract for required upgrade to existing CNG stations.
8. Initiate planning for a minimum of two time fill CNG stations for SEF (ideally three-stations); contract with provider.
9. Develop a memorandum of understanding (MOU) between the various agencies that will participate in the Program so each may use available CNG stations while the infrastructure is further developed and capacity increases.
10. Initiate establishment of a Clean Cities coalition in Anchorage.
11. Initiate meetings with Enstar and other NGV business partners.
12. Arrange field site visits for Anchorage Transit staff visit the Los Angeles MTA to understand their rationale for acquiring 1,800 CNG buses since 2009, as well as to tour their garage facilities, and become acquainted with the steps taken for implementing one of the largest CNG transit bus operations in the nation.
13. Engage with Clean Energy (or similar providers) to encourage participation in the Program as well as funding partnership relationship for development of a public fuel infrastructure.
14. Consider a similar field trip by the Anchorage airport fleet manager in order to understand modifications to garages at other airports.
15. Modify current practice of decentralized bulk and fuel card management so as all State-purchased fuel is centralized under SEF who should continue to pursue acquisition of a centralized fuel management system. While the fuel system is not required for implementation of the CNG Program, it is necessary to accurately calculate the amount of liquid fuels used by the State and to calculate the amount of GHG emission reduction based on actual fuel consumption (versus the MPG methodology used for this study).

CNG Program Phase II

16. Identify and contact potential fleet operators in both the public and private sector that may have an interest in using CNG after successful implementation of the Program. We recommend consideration of the following organizations:
    - Airport on-site work vehicles
    - Airport private shuttles and taxis
    - Airport Federal Express and United Parcel Service
    - Port of Anchorage

- City of Fairbanks
- U.S. Postal Service
- Comcast Cable
- Time Warner Cable
- AT&T
- Verizon
- Carlile Transportation Systems
- Lynden Logistics
- Totem Ocean Trailer Express

17. Enact incentives to encourage use of CNG and NGVs.
18. Consider a State-sponsored, Governor-led, single-messaging communication program that would collaborate, support, and complement efforts and raise public awareness and understanding about the importance and cost-effectiveness of CNG efficiency, and thereby accelerate the deployment of NGVs.
19. Consider K-12 funding for NGV educational programs.
20. With the Governor's leadership, educate industry and the commercial sector that NGVs are also a risk-management opportunity when considering the volatile price of conventional fuels.
21. Encourage utilities and their regulators to expand NGV programs.
22. Consider job-creation tax incentives for hiring NGV resource efficiency/energy managers at private businesses.
23. Consider tax incentives to draw NGV-related businesses to Alaska.

INTRODUCTION

The Alaska Sustainable Energy Act, Senate Bill 220, an energy policy bill passed in 2010, mandated Department of Transportation & Public Facilities (DOT&PF) Division of Statewide Equipment Fleet (SEF) to prepare a report on the feasibility of using compressed natural gas (CNG) to power vehicles in the State, including vehicles owned or operated by the State, and incorporating in that study, if warranted, a pilot program proposal for powering some vehicles owned or operated by the State with CNG. The legislation described fleet conversion as a possible short-term solution for rising energy costs in Alaska, and paired it with a policy for the State to consider long-term energy costs when buying vehicles and equipment. DOT&PF must prepare a report on the feasibility of using CNG to power vehicles in the State by January 31, 2011.

In August 2010, DOT&PF solicited proposals for a qualified consultant to conduct a study of the State of Alaska vehicle fleet and make specific written recommendations regarding the feasibility of using CNG-powered vehicles (NGVs) in the SEF fleet. Mercury Associates, Inc. was selected in September 2010 to conduct the study, including the following tasks:

1. A review of existing government programs and incentives offered in Utah and other North American jurisdictions that promote the use of CNG to power vehicles;
2. A review and summary of relevant studies and investigations on existing public policy incentives that encourage the use of CNG to power vehicles;
3. An evaluation of the environmental benefits and technical merits of using compressed natural gas to power vehicles; and
4. Outlines the economic, environmental, and technological advantages and disadvantages of using and promoting the use of CNG to power vehicles in the state.
5. If the study shows that the use of CNG is feasible by DOT&PF, the project is expanded to include a proposal for a pilot program in the state to test the use of CNG to power vehicles owned, operated, or paid for in whole or in part by the State.
6. A recommendation for the most cost-effective and appropriate departments and geographic locations for a pilot program;
7. Detail how the pilot program, if successful, could be expanded to provide for increased use of CNG to power vehicles owned or operated by the State, as well as privately owned or operated vehicles;

8. An estimate of the costs to the State of a pilot program in which the State would purchase vehicles powered by CNG or convert existing vehicles to be powered by CNG, including:
    a. The costs of maintaining vehicles powered by CNG and training maintenance personnel;
    b. The costs of adapting, or encouraging the adapting of, state vehicle fueling locations to provide CNG;
    c. The costs of using CNG instead of diesel fuel or gasoline;
    d. The costs of expanding the pilot program or developing additional pilot programs; and
    e. Other costs or savings that can be reasonably expected to accompany the pilot program.

BACKGROUND INFORMATION

CNG has many advantages over mainstream liquid conventional fuels (i.e., gasoline and diesel), but, as with all liquid fuel alternatives, fights an uphill battle to gain market acceptance in the U.S, particularly when gasoline and diesel fuel prices are low. Conventional liquid fuels won over the market in the early 20th century, defeating challengers like the electric battery, steam power, and alcohols, due to its fuel energy density and ease of handling. Gasoline and diesel retain their popularity today, and the overall per-gallon cost in the U.S. remains among the lowest in the world, primarily due to relatively low levels of taxation.

With a 100-year head start, mainstream liquid fuels have the huge advantages of public acceptance and a comprehensive fuel delivery system, which culminates in a fueling “convenience store” at practically every major road intersection in the nation. The disadvantages to these fuels have become well known: contributions to greenhouse gas emissions; negative impact on U.S. balance of trade; and direct environmental costs as graphically seen in the Gulf of Mexico in 2010. To date, CNG has not taken advantage of a remarkable distribution system of its own: natural gas is delivered to millions of houses through a network lying beneath a large percentage of the roadways in the country. However, use of natural gas in vehicles generally requires the gas to be compressed for storage on the vehicle, and compression stations are neither widespread nor inexpensive (typically $250,000 to $500,000).

The Alaska statewide fleet of 7,500 vehicles is managed by SEF, which is centrally managed and headquartered in Anchorage with additional office locations in Fairbanks and Juneau. As a part of DOT&PF, SEF operates 60 maintenance and repair shops to service vehicles assigned to 252 locations around the State and on the ferry system. SEF employs 165 people and is responsible for annual operating and capital budgets of approximately $26 million and $15 million respectively. SEF does not manage the State’s acquisition of fuel, which is decentralized to various departments, agencies, and divisions. As explained in the Methodology section of this report, the lack of a centralized and automated fuel program presents a challenge to quantify and manage the overall environmental impact of conventional fuels. According to SEF, the State spends $25 million per year for the purchase of bulk fuel and an additional $4 million for fuel purchased through the use of fuel cards at retail merchants.

The use of CNG in Anchorage dates back to at least 1974. Early programs featured “bi-fuel” aftermarket conversions on gasoline vehicles, which after conversion allowed the vehicle operator to switch between gasoline and CNG operation. Compressors were primitive, unreliable, and vehicles were not sufficiently powerful. To this end, drivers most often did not elect natural gas operation and vehicles were usually run on gasoline power. Subsequent conversion efforts in the following decades of the 1980s and 1990s resulted in similar lackluster results: lack of critical mass of vehicles, infrastructure, vehicle reliability, and fuel cost differential. Today, several business organizations in Anchorage (many which made financial investments with poor returns) continue to have valuable expertise with NGVs, but are not eager to repeat past mistakes. Having said this, several trained vehicle conversion technicians, maintenance mechanics, and CNG station maintenance technicians continue to support the remaining NGVs and CNG fuel facilities in the Anchorage area.

Centralized vehicles (i.e., vehicles that return to a common location at the end of the work day) can be fueled overnight, through a network of hoses, similar to a line of block heaters. This spreads the demand/load of the fueling facility and is convenient for the drivers. In fact, overnight fueling makes CNG *more* convenient than gasoline or diesel. In contrast, repetitive CNG fueling at a fast-fill public station is less convenient than liquid fuels because, being a gaseous fuel, CNG has to be refueled two- to three-times as often.

The State of Alaska fleet can be used to support an effort to move a significant portion of the fleet vehicles in greater Anchorage to CNG fuel. As shown in the Salt Lake City area, the general public will participate in alternative fuel endeavors, given the existence of a network of fueling stations and a lower-priced fuel alternative. While natural gas is routed underground through many cities and neighborhoods, and is already in many private houses, public CNG fueling stations to support vehicle transportation is not common. It is costly to compress natural gas in the amounts needed for public fueling, typically up to $500,000 (or greater) per station. Therefore, fleets are needed to establish a demand for CNG sufficient to encourage investment in a CNG fueling network. We located seven CNG stations in the Anchorage area, with only one being open to the public:

1. Downtown (Health & Human Services)
2. Public Works
3. Tudor Garage
4. School District
5. Alaska Railroad
6. Elmendorf Air Force Base
7. Ditch Witch (public)

In recent developments, The Regulatory Commission of Alaska approved a certificate of public convenience and necessity for the natural gas storage facility that Cook Inlet Natural Gas Storage Alaska (CINGSA) wants to build on the Kenai Peninsula. The $180 million storage facility would hold excess natural gas production from warmer months so that Southcentral Alaska utilities could use the gas during the higher-demand cold months. Production from the Cook Inlet gas fields continues to decline, and Enstar Natural Gas Company has reported that gas storage is needed for it to meet all of its customers' needs during peak cold conditions in the winter of 2012-13. Both Enstar and CINGSA are subsidiaries of gas company Semco Energy, however, Semco has established CINGSA as a joint venture with MidAmerican Energy Holdings Company. The additional storage facility and new exploration in the Cook Inlet are expected to provide a secure and predictable natural gas fuel supply for the region by 2013-2014. Until that time, shortages of natural gas may occur during peak periods during the months of January and February when the demand rate is five to six times the summer rate.

METHODOLOGY USED FOR THE PROJECT

A summary of the methodologies and techniques we employed to accomplish the scope of work for this project is provided below, followed by individual details relating to specific processes.

1. Develop and submit an information and data request to SEF;
2. Review SEF vehicle replacement practices;
3. Evaluate SEF fuel usage;
4. Review SEF fleet inventory, vehicle functions, and usage;
5. Analyze data to calculate SEF greenhouse gas (GHG) emissions for the Anchorage region;
6. Conduct interviews with state government officials to understand the State's objectives for this endeavor;
7. Conduct interviews with potential stakeholders in Anchorage;
8. Conduct an analysis of internal strengths and weaknesses and external opportunities and threats relative to the objective goal (SWOT);
9. Present recommendations for Phase I feasibility study;
10. Incorporate feedback from Phase I presentation into development of a CNG Program (Phase II);
11. Review existing CNG fueling infrastructure in Anchorage area to determine lower cost opportunities for implementation of the CNG Program;
12. Determine station upgrade pricing estimates;
13. Determine vehicle conversion pricing estimates;
14. Develop a strategy regarding Clean Cities participation to bring Anchorage area fleets into synchronization regarding alternative fuel activities; and
15. Document study methodology, findings, conclusions, and recommendations in a formal report and *WebEx* online presentation.

Review of Government Programs and Incentives

Utilizing resources identified in the Appendix and in the separate *Excel* workbook,[6] we have prepared a summary table of six North American jurisdictions that promote the use of CNG. We researched comparisons of CNG infrastructure, tax rates, licensing and reporting requirements, special fuel tax credits, vehicle and vehicle conversion tax credits, grants and loan programs, home refueling, etc. As appropriate for each jurisdiction, we have compiled a high level summary of the major legislation that was

[6] Mercury Associates, Inc. Government CNG Programs and Incentives. December 2010.

essential to establishing use of CNG in each jurisdiction. We have also included major communication methods to promote use of CNG to both fleet organizations and the general public (e.g., local meetings, the number of CNG fueling locations for fleets and private citizens, and the involvement of Clean Cities for each jurisdiction included in the study.

We reviewed reports, newsletters, plans, fact sheets, demonstration programs, brochures, and business cases from a wide variety of sources in order to assemble information on approaches for development of successful public policies.

Greenhouse Gas Emission Calculations

Mercury Associates has developed the *Eco-Fuel Tool*™ to capture fuel data such as the average fuel cost per year by individual vehicle, total fuel dollars spent per year, average miles-per-gallon (MPG) per unit, energy score (barrels of fossil fuels) per unit, and total carbon dioxide (CO_2) footprint from the current fleet inventory. The tool has the capability to analyze the same factors for the new replacement vehicle and calculate the improvements in fuel economy, savings in fuel costs, difference in energy score, and total CO_2 reduction.

Fuel consumption data is used to generate a GHG baseline as a starting point from which to measure future reductions in fuel consumption and emissions, because each gallon of gasoline burned releases approximately 19.5 pounds of CO_2. CO_2 is the dominant GHG (95 percent) from vehicles. The U.S. Environmental Protection Agency (EPA) has developed a specific CO_2 coefficient factor, which is used as follows in order to measure CO_2 emissions from a given fleet:

Gallons of gasoline x CO_2 coefficient for gasoline 8.81 kg[7] *= total carbon dioxide*

For diesel, CO^2 coefficient = 10.15 kg

The remaining ~five percent of emissions include: methane (CH_4 = 0.12%), nitrous oxide (N_2O = 1.88%), and refrigerant leakage (HFC = 3.71%). For the measurements of these emissions, EPA produces a grams-per-mile emissions factor for CH_4 and N_2O.[8]

Utilizing the inventory of vehicles provided to us by SEF, we conducted a two-fold calculation to determine the current baseline of GHG emissions and, subsequently, the potential for improvement through the use of CNG. Through the tracking of GHG, we assessed the current environmental impact of the fleet and potential to lower the impact through use of CNG vehicles. It should be noted that the management of fuel for the State of Alaska fleet is a decentralized activity and data is not collected through an automated fuel management system. SEF, therefore, did not have access to the fuel

[7] U.S. EPA. Climate Leaders. Mobile Source Guidance. May 2008.
[8] U.S. EPA. Climate Leaders. Direct Emissions from Mobile Combustion Sources. Table 2. May 2008.

data (e.g., gallons purchased by vehicle) as requested by Mercury.[9] To that end, we resorted to calculating fuel consumption based on the vehicle mileage provided to us by SEF and using EPA vehicle make/model MPG estimates based on an average of city and highway driving. This methodology tends to underestimate emissions, because of vehicle idling and other driving behaviors that impact real-world fuel usage, but are not considered when using EPA MPG-based data. Moreover, since we were required to manually match the SEF vehicles to EPA MPG estimates, we were only able to analyze the portion of the SEF fleet designated as domiciled in the greater Anchorage area; a total of 1,227 vehicles or about 16 percent of the entire State fleet. While viable local "pockets" of SEF vehicles most likely are domiciled in Fairbanks, Juneau or elsewhere, the conversion of vehicle fuel data was beyond the scope of this project.

Of 1,227 SEF vehicles domiciled in the greater Anchorage area, 571 units—47 percent of the vehicles reviewed—are projected to be acceptable CNG candidates. The following parameters were used in order to establish a set of realistic limitations and assumptions for the selection of viable vehicles:

1. Vehicle selections were limited to only those vehicle classes (24 of 113 classes in total) where certified conversions and/or original equipment manufacturer (OEM) products are available, primarily light duty vehicles and shuttle buses.
2. All existing SEF fleet vehicles will be operated until the end of their projected useful life, at which time the replacement vehicle will be a NGV.
3. CNG capital costs were projected to be between $16,000 and $24,000 higher per vehicle, depending on vehicle class.
4. NGVs were projected to have an extended vehicle life, by one year, based on engine life, oil life, and a desire to recover the higher initial investment.[10]
5. Baseline fuel costs equal $3.33 per gallon for gasoline, $3.60 per gallon for diesel, and $0.75 per gallon equivalent for CNG.

It is important to note that a limitation, which could not be quantified, is the proper designation of a domicile location for SEF vehicles since vehicles designated as being domiciled in Anchorage, may actually leave the area for periods as long as one year. Such vehicles would not be viable candidates as NGVs, meaning a slightly lower number of vehicles (than 571) would eventually be replaced as NGVs.

Interviews

We conducted interviews with State government officials in order to understand the State's objectives for this endeavor (e.g., clean air, displacement of foreign oil, creation of jobs, technology development, lower cost transportation fuel) as well as with a

[9] SEF requested, but has not received funding of $3 million for an automated statewide fuel management system, as of the date of this report.

[10] Extended NGV lifecycles are reflected as negative costs in the model.

number of stakeholders and potential stakeholders. Interview summaries are provided in the Appendix, whereas pertinent details regarding findings and recommendations are provided within the various sections of this report.

Municipality of Anchorage

- Mayor Dan Sullivan
- Public Works: Mark Warfield, Principal Administrative Officer
- Schools: Steven Kalmes, Director Transportation/Vehicle Maintenance
- Transit: Gary Taylor
- Solid Waste: Mark Madden

Anchorage Airport:

- Mark Luiken, Deputy Commissioner of Aviation

Alaska Railroad:

- Dave Thompson, Fleet Manager and Paul Farnsworth, Director of Facilities

Enstar:

- Mark Slaughter, Inna Johansen, Nick Szymoniak

Others:

- Charles Bussell, Ditch Witch Compressor Dealer
- Arnie Swanson, Truckwell

Strengths, Weaknesses, Opportunities, and Threats Analysis

We conducted a SWOT analysis as a strategic planning method to evaluate the strengths, weaknesses, opportunities, and threats involved in assessing the feasibility of CNG as a viable alternative fuel for the Alaskan market. Identification of SWOTs is essential, because subsequent steps in the process of planning for achievement of the objective may be derived from the SWOTs. The aim of any SWOT analysis is to identify the key internal and external factors that are important to achieving the objective. The SWOT analysis groups key pieces of information into two main categories:

1. **Internal factors:** The strengths and weaknesses internal to the organization (i.e., government organizations in the State of Alaska)
2. **External factors:** The opportunities and threats presented by the external environment to the organization (e.g., macroeconomic matters, technological changes, legislation, and socio-cultural changes, as well as changes in the marketplace or competitive position)

During the SWOT process, decision makers determine whether the objective is attainable, given the SWOTs. If the objective is NOT attainable, a different objective must be selected and the process repeated.

Phase II

Using the information gained doing research for Phase I, knowledge of the current state of the CNG industry in the Anchorage area gathered during interviews and site visits, and feedback from the Phase I presentations with stakeholders, a Phase II recommendation for a pilot program (Program) was developed. The most logical Program would utilize existing infrastructure in Anchorage and involve parties who have past experience.

The site visits and interviews conducted during the fall of 2010 revealed that the CNG fuel dispensers had not been upgraded since their initial installation, resulting in paper recordkeeping and sub-optimal fuel delivery times. The upgrading of several CNG dispensers would result in increased driver satisfaction at these sites, as well as complete documentation of fuel usage during any potential pilot program.

The cost of the potential fueling site upgrades was estimated by obtaining an approximate installed cost for a combination card reader/CNG fueling dispenser from Clean Energy Fuels Corp.[11], who has been the fueling station equipment leader in the lower-48 states. The estimated approximate cost was used for Program cost development only: a precise estimate will need to be determined after site selection and evaluation, and will depend of factors such as electrical and phone infrastructure, traffic patterns, routing, etc. Additional funding for site upgrades has been included as a separate line item in the Program cost section. Any grants or tax credits, which might be obtained to cover these station costs were not included in the estimates, and if obtained, could be used to either reduce Program costs or extend the number of participating fueling sites. The same can be said if the installed costs are lower than expected.

Program participant costs were estimated through several studies, including the NREL report on CNG Municipal Fleets,[12] and other on-line references cited later in this report. An average of these prices suffice for the needs of this study until such time as specific fleets and vehicles are determined during the early part of the Program, and the various options for CNG suppliers can be determined. The number of OEM vehicle suppliers is increasing and multiple bids may be available for any given vehicle application, a welcome problem to have. We note that only incremental costs of CNG vehicles were

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[11] Clean Energy Fuels Corp. Seal Beach, CA. Northstar, BAF Technologies, and IMW Industries are wholly owned subsidiaries of Clean Energy, which was founded by T. Boone Pickens in 1997 as Pickens Fuel Corp. Mr. Pickens serves on the Clean Energy Board of Directors. cleanenergyfuels.com.

[12] National Renewable Energy Laboratory (NREL). Business Case for Compressed Natural Gas in Municipal Fleets. Caley Johnson. NREL/TP-7A2-47919. June 2010.

included: it is presumed that each participating agency or business would be replacing vehicles during normal business in 2011 and these vehicles would be selected and deployed in the Program. Again, any grants or tax credits designed to encourage vehicle conversion costs were not included, and if obtained could be used to either reduce Program costs or increase the number of participating vehicles.

PHASE I

Review of Existing Government Programs and Incentives

As stipulated in the Request for Proposal (RFP), we conducted research of historical events of government programs and incentives (fleet and general public) in the State of Utah, which contributed to the success of NGVs in the State. We also conducted similar research of five other states where a foothold has been established for the use of CNG as is evident based on the number of CNG stations located in each jurisdiction. These states are: California, Oklahoma, New York, Texas, and Washington.

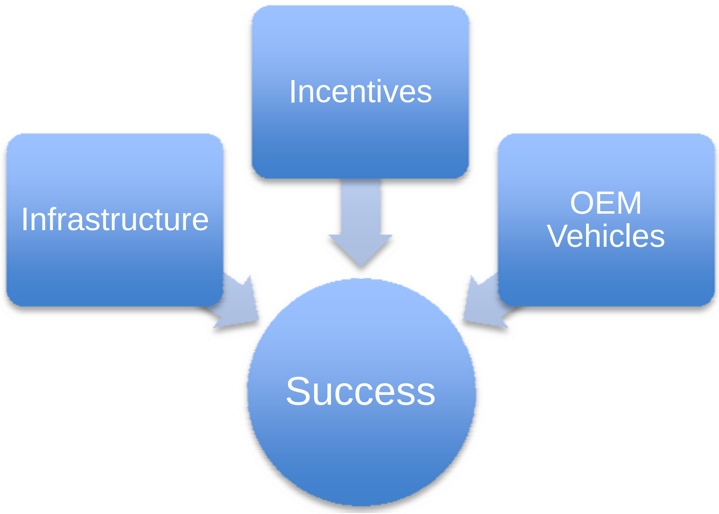
Overall, we found eight significant prevailing programs, factors, and incentives offered to fleet organizations and the general public in the six states. These characteristics are listed below, not in any particular order of rank:

Similarities of Characteristics Between States

1. Tax credits for public
2. Reduced fuel tax rate for public
3. Grants
4. Loans
5. Honda NGV retail dealers in UT, CA, NY, and OK
6. Relatively large infrastructure centered near interstate highways
7. Fleets moderately regulated
8. At least one Clean Cities organization in each state

An overview of the advantages and disadvantages of the various incentives is provided later in this section, as is the importance, in our view, of Clean Cities. We note that, excluding perhaps California, each of the states only moderately regulated fleet use of alternative fuels and, yet, was able to increase use of NGVs. Moreover, a contributing factor towards success with the general public's acceptance of NGVs, is the availability of a Honda retail NGV dealer in four of the six states (excludes Washington and Texas). Although the general public can acquire the Honda NGV through other sources, the presence of the OEM within the State of Alaska would indicate its support for the use of NGVs in the area.

Successful NGV programs <u>must</u> include a commitment to three elements: 1) the appropriate **vehicles**, preferably from an OEM rather than retrofitted; 2) a fueling and maintenance **infrastructure** to support the vehicles; and 3) **incentives** to kick-start the program and overcome barriers to acceptance.



All three of these elements must converge for a successful market transition to the alternative fuel. To that end, we have structured our research of existing government programs and incentives based on each of these key elements.

Use of Natural Gas in Utah

According to Utah Energy Initiative[13], future energy projections place significant demands on natural gas production in Utah and may require the importation of additional natural gas supplies from neighboring states. Natural gas demand has historically come from the residential home heating, commercial, and industrial sectors. In 2008, those sectors consumed approximately 137 billion cubic feet (bcf) of natural gas.[14] NGVs consumed only approximately 240 million cubic feet. Even a doubling of transportation fuel use would have little impact on consumption. However, natural gas consumption for electricity generation has increased steadily since the late 1990s, totaling more than 55 bcf in 2008, while generating approximately 16 percent of Utah electricity production.

Utah Incentives

Utah currently does not distinguish incentives between light-duty vehicles (LDVs) and heavy-duty vehicles (HDVs), however, the most current draft of the State's 10-year strategic energy plan (draft dated November 3, 2010) recommends that incentives be prorated on a sliding scale, with higher amounts for larger vehicles. We find this to be logical since HDVs achieve a much greater reduction in GHG emissions than LDVs. Utah's draft plan also calls for changing the current Utah Clean Fuel Tax provision from being applicable to only CNG-powered NGVs to include liquid natural gas (LNG) and

[13] Utah Energy Initiative Governor Herbert's 10-Year Strategic Energy Plan draft dated November 3, 1010.

[14] Utah Geological Survey Energy Statistics. Geology.utah.gov/emp/energydata/renewenergydata.htm. Cited in Utah Energy Initiative Governor Herbert's 10-Year Strategic Energy Plan draft dated November 3, 1010.

other clean fuels (presumably non-petroleum liquids). In addition, due to current economic conditions, Utah does not intend to increase gasoline taxes.

Below is a list of the most current incentives provided in Utah:

- Income tax credit of 35 percent of the new vehicle purchase price or $2,500, whichever is less
- Credit of 50 percent of the cost of converting a NGV, up to a maximum of $2,500 per vehicle
- Grants and loans to businesses and government entities for the cost of conversions and incremental cost of purchasing OEM vehicles
- Maximum annual awards are $500,000 and maximum grant/loan is $100,000 per project (minimum is $5,000) up to 100 vehicles acquired
- Tax of $0.085 per gasoline gallon equivalent to be modified proportionally with any changes to the traditional motor fuel rate
- Authorization to travel in high-occupancy vehicle (HOV) lanes regardless of the number of occupants
- PUC may find a gas corporation's request for a NGV rate less than full cost of service may be just and reasonable in the interest of the public; if approved, remaining costs must be spread to other customers of the gas corporation
- Public access to State-owned CNG fuel stations
- Loans and grants for NGVs and infrastructure
- Clean Cities grants
- Free parking in downtown Salt Lake City

Utah Infrastructure

- Established I-15 corridor CNG fueling infrastructure
- Developed by Questar Gas[15] for its NGV fleet
- Regulated by the State and cost spread amongst consumers
- One of few states where an individual can drive throughout the major population corridors of the state without limited access to CNG stations
- Public access to state CNG stations
- ~35 CNG public and private stations

15 Questar Gas provides retail natural gas-distribution service to almost 900,000 customers in Utah, southwestern Wyoming and a small portion of southeastern Idaho. The Public Service Commission of Utah and the Wyoming Public Service Commission regulates Questar. Questargas.com.

Utah Vehicles

- More than 10,000 CNG vehicles in Utah[16]

The next section provides a high-level overview of various alternative fuel incentives in all states along with the advantages and disadvantages of each. A summary of the incentives and laws for all states is provided in the Appendix, distinguished by the type of incentives, type of user, and by technology or fuel class. Moreover, the separate *Excel* workbook provides detailed information and data collected from the six states included in this study.[17]

Overview of Alternative Fuel Incentives[18]

Grants

- 33 states offer grants for alternative fuels
- Commonly used incentive to provide funding for use of alternative fuels
- Highly desirable since funds reduce cost of goods or services
- Unlike loans, are not repaid by the recipient
- Most grants are available to both public and private entities
- Consumers typically receive grant funds at the time goods are purchased

Tax Incentives

- 39 states offer tax incentives for alternative fuels
- Less popular than grants
- Most tax incentives do not help municipalities, state governments, and municipal utilities[19]
- Less useful to small business fleets with low net income
- Fuel price discounts encourage fuel use rather than vehicle purchases
- Fuel tax deductions have a long payback period
- Fuel tax deductions do not result in enough of a price discount to attract a new market

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[16] Source: Questar Gas.

[17] Mercury Associates, Inc. Government CNG Programs and Incentives. December 2010.

[18] U.S. Department of Energy Alternative Fuels Data Center. All Incentives and Laws Sorted by Type. http://www.afdc.energy.gov/afdc/laws/matrix/incentive. Includes District of Columbia.

[19] Alternative Fuel Excise Tax Credit is an exception. Tax-exempt entities such as state and local governments that dispense qualified fuel from an on-site fueling station for use in vehicles qualify for the incentive.

Loans and Leases

- 19 states offer loans
- Powerful, but can be less effective than tax deductions, credits or grant funding
- Useful for fleets to offset high price differentials between alternative and conventional fuels

Rebates

- 18 states offer rebates
- Typically for the purchase of a vehicle or fuel purchases

Exemptions

- 39 states offer exemptions from restrictions and requirements
- Many states include HOV lane access and some allow access with less than the required occupants
- Other examples include roadway weight limitations, parking fees or preferential parking, and vehicle inspections
- Non-financial incentives can be particularly attractive to private fleets, but often require additional vehicle identification, such as decals or special license plates

Clean Cities

The mission of Clean Cities is to advance the energy, economic, and environmental security of the U.S. by supporting local initiatives to adopt practices that reduce the use of petroleum in the transportation sector. Established in 1992, Clean Cities carries out this mission through a network of more than 90 volunteer coalitions, which develop public/private partnerships to promote alternative fuels and advanced vehicles, fuel blends, fuel economy, hybrid vehicles, and idle reduction. At the national level, the organization provides OEMs, trade associations, and federal agencies with coordinated strategies and resources they can leverage to obtain maximum petroleum reduction. Clean Cities also provides coalitions with access to information and incentives from U.S. Department of Energy (DOE), other federal agencies, and industry partners that can help fund significant, high-impact projects. The organization is part of the Office of Energy Efficiency and Renewable Energy's Vehicle Technologies Program.[20]

[20] U.S. Department of Energy Vehicle Technologies Program. What is Clean Cities? http://www1.eere.energy.gov/cleancities/pdfs/48384.pdf.

Geographical Coverage of Clean Cities Coalitions

For the most current list of Clean Cities coordinators, visit *www.afdc.energy.gov/cleancities/progs/coordinators.php.*

Since a majority of 2009 awards originated from Clean Cities, including NGVs and CNG fueling infrastructure, we believe the establishment of a Clean Cities coalition in Alaska will be a vital factor towards achieving goals relating to the expanded use of CNG in the region. The State of Utah, for example, received about $15 million in FY-09 Clean Cities grants. The West Coast received $52 million, East Coast $99 million, and Midwest $134 million. Heavy-duty vehicles are generally the largest fuel users and thus, tend to be the most cost-effective project vehicles for grant funding programs (e.g., Clean Cities 2011).

The Anchorage Metropolitan Planning Organization (MPO) served as a coordinating organization similar to Clean Cities during the area's push for CNG use in the 1990s and could provide valuable assistance in establishing a Clean Cities in Anchorage. Likewise, the Fairbanks MPO should be included in coalition efforts, since the city is a non-attainment area for $PM_{2.5}$[21] and is the next most likely city in Alaska where potential NGVs would be feasible (after Anchorage).

National Clean Diesel Campaign

EPA's National Clean Diesel Campaign is distributing funding for the National Clean Diesel Funding Assistance Program through EPA's Fiscal Year (FY) 2011 Appropriations. The National Clean Diesel Funding Assistance Program provides funding to reduce emissions from existing diesel engines through a variety of strategies, including but not limited to: add-on emission control retrofit technologies; idle reduction technologies; cleaner fuel use; engine repowers; engine upgrades; and/or vehicle or

[21] Particle matter that is 2.5 microns or less in diameter ($PM_{2.5}$) is a subset of the larger PM_{10}. $PM_{2.5}$ can be emitted directly from both human activities and natural sources. "Secondary" $PM_{2.5}$ can form from gases, such as oxides of nitrogen (NO_X) or sulfur dioxide (SO_2), reacting in the atmosphere. The U.S. EPA set the first $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS) in 1997.

equipment replacement; and the creation of innovative finance programs to fund diesel emissions reduction projects. Under this grant program, funding is restricted to the use of U.S. EPA and California Air Resources Board (CARB) verified and certified diesel emission reduction technologies.[22] Eligible participants include:

- U.S. regional, state, local or tribal agencies/consortia or port authorities with jurisdiction over transportation or air quality
- Nonprofit organizations or institutions that:
  - Represent or provide pollution reduction or educational services to people or organizations that own or operate diesel fleets; or
  - Have, as their principal purpose, the promotion of transportation or air quality
- School districts, municipalities, MPOs, cities, and counties are all eligible entities under this assistance agreement program to the extent that they fall within the definition above
- Buses, medium, and heavy duty trucks qualify for funding

School Bus USA

We understand that the following programs are currently available to assist with funding school bus fleets towards cleaner burning vehicles. The U.S. EPA has compiled a list of state and federal grants and funding that applies especially to school buses, including the Congestion Mitigation and Air Quality Program (CMAQ).[23]

- A new program from the National Association for Pupil Transportation (NAPT) will help school districts convert older buses to run on CNG. The grant for the program was provided through the U.S. EPA from American Recovery and Reinvestment Act funds.
- The National School Bus Equity Investment Lease Program aims to help qualified districts take diesel school buses that are scheduled for retirement and cost-effectively extend their life by converting them to CNG. Program officials claim that it can save districts as much as 50 percent on the interest rate to finance the cost of repowering a school bus with a new CNG engine. The program manages the sourcing for conversion to CNG, the utilization of U.S. EPA funds and the lease program. It also works with participating districts to monitor monthly fuel consumption.[24]

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[22] Clean Diesel Program. http://epa.gov/cleandiesel/prgnational.htm.

[23] School Bus Program. http://epa.gov/cleanschoolbus/funding.htm.

[24] National School Bus Equity Investment Lease Program. http://schoolbusmoney.org/. http://operationupcycle.org/.

Federal Transit Administration Grants

The Federal Transit Administration (FTA) offered grants for transit buses in urban areas through its Urbanized Area Formula Program and Clean Fuels Grant Program. Funding for these programs has expired, but is expected to resume through upcoming legislation. The grants are expected to pay for 83 percent of the cost of a CNG bus to eligible recipients. This funding scenario resulted in the CNG buses actually being $2,700 less than diesel buses in the NREL business case model for municipal transit fleets. In the NREL model, FTA funding reduced the payback period for transit buses by approximately 1.6 years for all fleet sizes over 10 vehicles.

Fleets' Experience with CNG

This section of our report recaps the results of our review of government fleets' experience using CNG-fueled vehicles. The review involved interviews of fleet management officials in selected government jurisdictions and institutions, including the states of Utah and Washington, Oklahoma State University, and the City of Seattle. We also reviewed the findings of a recently published study of transit bus fleets' experience with CNG.

General Conclusions

Of all of the types of government fleets operating NGVs, the public transit industry has gone the farthest in embracing the use of such vehicles. NGVs account for an estimated 20 to 25 percent of all U.S. transit bus purchases over the last 10 to 15 years.[25] This degree of adoption of NGVs by an industry that operates very expensive vehicles to provide transportation services for which there is little tolerance for unreliability and a high degree of public visibility, scrutiny, and accountability suggests that CNG is a very viable fuel for certain types of fleets. Overall, the transit industry (as well as school bus transportation) has found the performance and costs of NGVs and the infrastructure required to fuel them to be acceptable.

Not all government fleets have the same operating characteristics as do transit fleets, however, and the adoption of NGVs thus has not been uniformly extensive or enthusiastic. General-purpose government fleets that have embraced NGVs generally have done so where third parties, principally local gas utility companies, have fronted much of the cost of building the necessary vehicle fueling infrastructure. This has been one of the keys to adoption of NGVs in Utah and Oklahoma. Conversely, the lack of conveniently located fueling facilities has been the principal impediment to fleet users' embrace of NGVs in jurisdictions such as the State of Washington and the City of Seattle.

Although there were concerns years ago about the reliability and performance of NGVs and CNG fueling infrastructure, these concerns have largely been addressed through

[25] Adams, R. and Horne, D.B. Compressed Natural Gas (CNG) Transit Bus Experience Survey. Golden: National Renewable Energy Laboratory. September 2010. afdc.energy.gov/afdc/pdfs/48814.pdf.

advances in their respective technologies. The incremental costs of using NGVs have not been a major obstacle to their adoption by the organizations with which we spoke, partly because these costs have been subsidized with grant funds and federal fuel subsidies (some of which recently have expired or have been reduced) and/or have been borne by third party fuel providers who amortize and recover the costs over long periods of time. Neither operational performance nor costs were cited as the number one reason that those entities such as Utah and Oklahoma that are expanding their NGV fleets are doing so. Rather, the concerns of elected officials about reducing U.S. dependence on imported oil and reducing the environmental impacts of using gasoline and diesel fuel reportedly are the primary factors behind such expansions.

Operational Considerations

As just noted, the operational performance (e.g., reliability, safety, horsepower and torque) of NGVs does not appear to be a major concern to those organizations that have deployed such vehicles in significant quantities, most notably the transit industry. While there are operational and maintenance issues with any type of automotive technology, such problems are not reported to be significantly more prevalent with most of today's CNG technology, although fleet operators such as the State of Utah report more technical glitches with NGVs that have been converted to run on CNG than with OEM NGVs, such as the Honda Civic.

The principal technical issues with NGVs reported by transit bus operators related to the failure rates of ignition systems and sensors. In comparison to older diesel buses, the miles driven between failures are higher for NGVs largely due to such problems. However, the introduction of clean diesel buses, which use sophisticated aftertreatment systems, is anticipated to narrow, if not eliminate, this reliability gap. On the flip side, some fleet operators report being able to reduce the frequency with which they have to perform certain types of preventive maintenance on NGVs. Oklahoma State University, for instance, has increased the intervals for some chief preventive maintenance services on its CNG buses from 5,000 to 10,000 miles.

Perhaps the biggest vehicle-related technical concern of fleet operators with significant numbers of NGV vehicles stems from the limited availability of OEM vehicles, components, and parts. Bus transit operators surveyed in the recently completed U.S. DOE study expressed concern that there was, until recently, only one mainstream supplier of engines (Cummins) and that its monopolistic position seemed to adversely affect its responsiveness to customer concerns and complaints. While a second engine manufacturer (Doosan) has recently entered this market, there now is some concern that such competition might dampen Cummins' enthusiasm for staying in NGV engine production.

In the small vehicle market, there seems to be less concern about the responsiveness of Honda (the sole OEM producer of NGVs prior to GM shipping its new CNG-fueled Chevy Express and GMC Savana cargo vans late in 2010) to vehicle performance issues, but more concern about the high cost of replacement parts for NGVs resulting from its quasi-monopolistic position. On the other hand, the use of conversion kits clearly results in more technical glitches and associated concerns about not voiding OEM warranties and finding qualified service providers. According to the State of Utah, which has access to the second largest network of CNG fueling stations in any state (after California), initial technical problems with converted NGVs have been a source of fleet user resistance to increasing their use of such vehicles.

On the fleet fueling side, the number one operational impediment to greater use of NGVs is access to fuel. This is much less of an issue for transit fleets than for many types of vehicles in government fleets, because transit buses are centrally garaged or stored at night and can be refueled overnight using relatively inexpensive time fill stations. Many types of fleet vehicles require access to fast fill stations where they can refuel during the course of normal daily operations, because they are not usually parked overnight in the same fashion as transit or school buses and in sufficiently large quantities to warrant the construction of fueling stations. In addition, the use of such vehicles is usually much less predictable than that of buses operated on fixed routes and schedules. Unfortunately, fast fill stations are very expensive to build (as much as $500,000 or more) and maintain. Consequently, fleet operators cannot provide its vehicle operators as many points of access to fuel with CNG as it can for gasoline and diesel fuel. The lack of ready access to fueling stations is the primary reason cited by jurisdictions such as the State of Washington and the City of Seattle for not having more NGVs in their fleets.

The performance and reliability of fueling stations (once they are available) is not reported to be a significant concern by fleet operators with sizable numbers of NGVs. However, transit operators point out that a fleet comprised predominantly if not entirely of such vehicles is highly susceptible to major service disruptions if their fueling infrastructure fails, so building redundancy into such systems is of critical importance. The aforementioned U.S. DOE-funded study addresses a number of industry best practices related to CNG station design, ranging from modular design features that readily accommodate expanding capacity, to the use of gas filtration systems that minimize downstream oil contamination that can void engine manufacturers' warranties, to the merits of natural gas versus electric-powered compressors.

A final set of operational considerations associated with using CNG as a fleet fuel relates to operator, mechanic, and public acceptance. After 15 years, such acceptance is widespread and commonplace.

Cost Considerations

It is universally acknowledged by the organizations with whom we spoke that NGVs do not "make sense" from a direct vehicle total cost of ownership standpoint. NGVs cost more to procure than do comparable conventionally fueled vehicles. For instance, the State of Utah told us that the cost of EPA-certified conversion kits for light-duty vehicles is around $14,000.[26] The incremental cost of the CNG package for the aforementioned Chevy Express and GMC Savana cargo vans is more than $15,000; and Oklahoma State University pays a price premium of about $9,000 for a CNG-fueled Honda Civic, and about $13,000 for an aftermarket Chevy Impala conversion.

Based on the gasoline gallon equivalent fuel consumption rates and typical annual usage rates for light-duty vehicles, Utah has calculated that gasoline needs to cost in excess of $3 per gallon in order to justify paying the higher capital costs of NGVs. In our experience, however, such break-even calculations typically do not take into account the relatively lower (or unknown) residual values of NGVs or the relatively higher costs of building, maintaining, and accessing CNG fueling stations. Moreover, without the federal fuel tax credit of $0.50 per gasoline gallon equivalent, the break-even point for recouping the incremental capital costs of NGVs is even higher. The federal fuel tax credit, which expired in 2010, has been extended for 2011.

While such capital cost recovery considerations are not unimportant, the principal economic impediment to wider use of NGVs in government fleets is the substantial up-front costs of building fast fill fueling stations. As mentioned earlier, the State of Utah fleet enjoys access to the second largest network of CNG fueling stations of any state. However, only six of the 33 stations in this network are owned by the State; the local gas utility company, Questar, owns the other stations. The State of Oklahoma is expected to invest an estimated $20 million in the construction of new CNG stations over the next five years. All of this investment will be paid for by Clean Energy Fuels Corp. and recouped through a combination of grants and surcharges on the price of CNG furnished for State vehicles under long-term contracts. Similarly, CNG fueling stations in Seattle were built not by the City, but by third-party providers such as Clean Energy Corp. and WorldCNG[27].

The implications of these practices are that government fleets are unlikely to make significant investments in the construction of additional CNG fueling infrastructure without either sizable amounts of grant funds from federal, state, and/or local sources or public-private partnerships with third-party fuel providers that can, in essence, finance up-front facility costs through long-term fuel supply agreements.

Other Considerations

Given the relatively weak economic arguments for using NGVs—until such time as gasoline and diesel fuel prices increase as they did in 2008—and/or the number of such

[26] Although the Utah State legislature passed and the governor signed HB 70 earlier this year, which authorizes the manufacture, distribution, and certification (by the State of Utah) of aftermarket CNG conversion kits at a cost of about $6,000 apiece, the U.S. EPA has communicated its reservations about Utah trying to bypass federal law requiring EPA certification of such kits, and Utah told us that it has not purchased such locally certified kits for any of its own vehicles—and has no plans to do so at the present time.

[27] WorldCNG. Located in Seattle, WA, produces and installs U.S. EPA-certified natural gas fueling systems. Worldcng.com.

vehicles on the road increases substantially so as to more easily recoup the costs of building and maintaining more infrastructure, one may well wonder why government jurisdictions such as the State of Alaska should seriously contemplate facilitating the increased use of NGVs. The *principal* reasons that the representatives of the states of Utah and Oklahoma with whom we spoke cited for continuing to do so have nothing to do with the *direct* economic costs of vehicles, fuel stations, or fuel. In Oklahoma, a primary motivator for the legislature is reducing dependence on imported oil. In Utah, it is reducing the harmful environmental impacts of using carbon-based fuels to power motor vehicles. While the benefits to the citizens of these two states of achieving these particular goals are difficult to express in quantitative terms, the elected officials in both states (which, it might be noted, are relatively conservative politically and not known for having large populations of "tree huggers"), apparently feel that paying a little—or even a lot—more to fuel state-owned vehicles with CNG is worth it.

Review of Existing Public Policy Incentives

A number of the incentives already identified in the previous section of this report include public policy incentives, which influence the use of CNG by private citizens; however, common incentives that exist in the six states include the following:

- Grants
- Loans
- Tax credits
- Use of government CNG stations
- Use of HOV lanes regardless of the number of occupants
- Insurance discounts

Evaluation of Environmental Benefits and Technical Merits

CNG reduces GHG emissions versus conventional fuels primarily due to the molecular structure of methane, the primary component of natural gas. Methane, CH_4, has the highest ratio of hydrogen to carbon (4:1) of any hydrocarbon fuel. While unburned methane itself is a serious greenhouse contributor, the net effect is still a significant benefit for the environment. NGVs can produce significantly lower amounts of harmful emissions such as NO_X, particulate matter $PM_{2.5}$, and toxic and carcinogenic pollutants as well as CO_2 compared with vehicles fueled by diesel and gasoline.

Light-Duty Vehicles

A report by Argonne National Laboratory (ANL) combined emission data from 14 primary studies to determine the effects of natural gas fuels on LDV tailpipe emissions. The weighted results are illustrated in the table below.

Table 5
Pollutants Found to Be Significantly Reduced in CNG Use When Compared to Reformulated Gasoline in LDVs[28]

Pollutant	Percent Reduced
Volatile Organic Compounds (VOC)	10%
Carbon Monoxide (CO)	20% to 40%
Oxides of Nitrogen (NO_X)	0%
Particulate Matter (PM)	80%
Methane	-400% (increase)

Overall, GHG emissions from natural gas are 23 percent lower than diesel and 30 percent lower than gasoline fuels.[29] CNG reduces petroleum consumption almost 100 percent from the level of gasoline, whereas LNG reductions are slightly less, because LNG requires more energy to process.

Table 6
Petroleum Use and GHG Emission Reductions[30]

Fuel	Percent Reduction in Petroleum Use	Reduction in GHG Emissions
CNG	~100%	21-26%
LNG	~98%	21-25%

According to the AFDC website, a NREL fleet study of 13 vans in the Denver Super Shuttle fleet found that dedicated CNG vans have significantly lower emissions of nonmethane hydrocarbons (NMHC), CO_2, and NO_X than gasoline or bi-fuel vans operated on CNG or gasoline. Another NREL study of 20 taxicabs also found that CNG reduced NMHC and CO_2, but did not find any reduction in NO_X.

Heavy-Duty Vehicles

NREL and the University of West Virginia (UWV) conducted studies of numerous fleets as part of its Alternative Fuel Truck Evaluation Project. The following table lists the natural gas vehicle emissions as a percentage below the emissions of comparable diesel HDV.

[28] Argonne National Laboratory Transportation Technology R&D Center. A Full Fuel-Cycle Analysis of Energy and Emissions Impacts of Transportation Fuels Produced from Natural Gas. December 1999.

[29] California Energy Commission. 2007. Alternative Fuels Data Center. Natural Gas Emissions. http://www.afdc.energy.gov/afdc/vehicles/emissions_natural_gas.html.

[30] Argonne National Laboratory Transportation Technology R&D Center. A Full Fuel-Cycle Analysis of Energy and Emissions Impacts of Transportation Fuels Produced from Natural Gas. December 1999. Results are relative to baseline light-duty vehicle fueled with reformulated gasoline.

Table 7
NREL and UWV Field Test of NGV Emissions

Vehicle Type	CNG Mail Delivery Trucks	LNG Buses*	LNG Semi Trucks	LNG Refuse Trucks	LNG Dual-Fuel Refuse Trucks
Fleet	United Parcel Service (UPS)	Dallas Rapid Transit (DART)	Raleys	Waste Management (WM)	Los Angeles Bureau of Sanitation
Number of NGVs	7	15	8	6**	10
Number of Diesel Vehicles	3	5	3	2	3
Drive Cycle	City Suburban HDV Route	Central Business District	Five-Mile Route	WM Refuse Truck Cycle	AQMD Refuse Truck Cycle
PM Reduction	95%	NSS***	96%	86%	NSSS***
NO_X Reduction	49%	17%	80%	32%	23%
NMHC Reduction	4%	96%	59% less than diesel THC	64% less than diesel THC	NSS***
CO_2 Reduction	75%	95%	-263%	-80%	NSS***

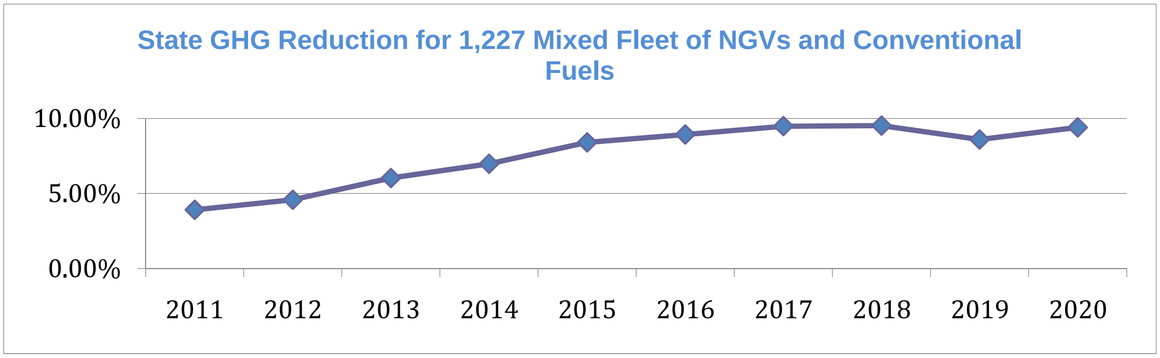
*Diesel buses in DART study used oxidation catalysts.
**WM's NOx tests omitted three trucks due to malfunctioning turbochargers; a problem that skewed results and has been since fixed.
***NSS: Not statistically significant because emissions were too low for the testing equipment for the LNG buses or both LNG and diesel (due to the use of catalyzed particulate filters) refuse trucks. Emissions given in percentage reduced from diesel emissions, based on grams emitted per mile driven. Negative reduction values indicate an increase in pollutants.

This table shows that PM is heavily reduced by natural gas—reduced to undetectable levels in two tests and by at least 85 percent in the other three. NOx is reduced by 17 percent to 80 percent from diesel. The reduction of NMHCs varies widely, but all tests show a reduction. Two of the tests compare NMHCs from natural gas to the total hydrocarbons (including methane) from diesel, and both show the NMHCs to be 60 percent lower. The CO_2 reduction varies widely from a near 100 percent reduction to a 260 percent increase, but the reports do not offer insight to this wide variance.

State Fleet Anchorage Region GHG Reduction Findings

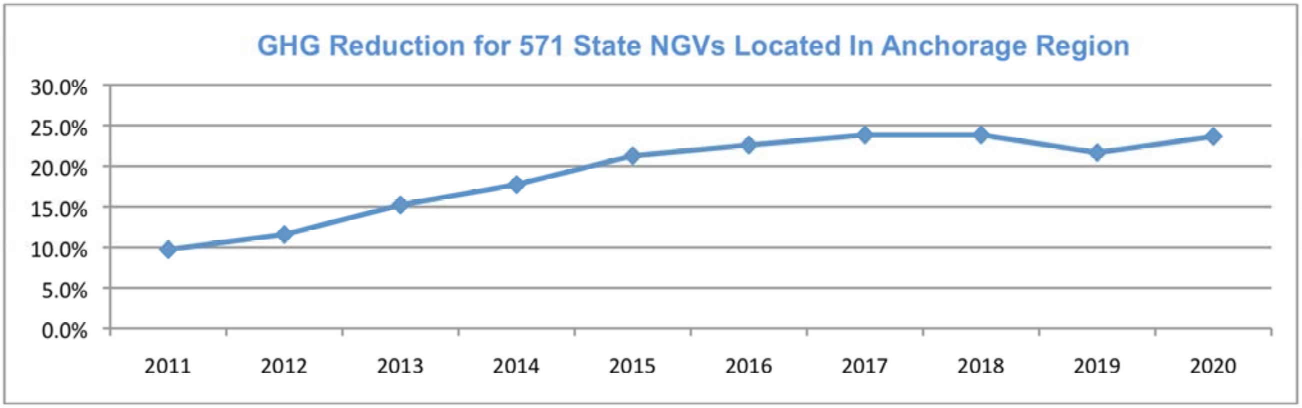
The Mercury Associates *Eco Fuel-Tool* model forecasts that 47 percent of the 1,227 SEF fleet (571 vehicles) located in the Cook Inlet region would eventually be converted to CNG, providing a 40 percent fuel substitution. The model projects an overall 7.7 percent net decrease in GHG emissions over the decade for the entire regional fleet of 1,227 units (i.e., 571 units converted to NGVs and 656 units continuing to operate on diesel or gasoline fuels), including a 9.8 percent net decrease in the last year of the model.

Exhibit 5
State GHG Reduction Forecast All Anchorage Vehicles



When comparing only the 571 units as NGVs versus conventional fuels, the GHG reduction ranges from 9.7 percent to 23.7 percent and averages 19.1 percent over the 10-year period. This percentage (19.1) is consistent with the ANL research presented in Table 6, *Petroleum Use and GHG Emission Reductions*, which show reductions between 21 and 26 percent.

Exhibit 6
State NGV GHG Reduction Forecast vs. Conventional Vehicles



Findings for the four specific areas of study: 1) GHG reduction; 2) replacement costs; 3) fuel costs; and 4) overall net cost are presented in further detail within both sections of this report: Phase I and Phase II. The environmental benefits are presented in this section as well as in the subsequent section, *Advantages and Disadvantages of CNG for Alaska*. We have presented the advantages and disadvantages by three different characteristics, including technological. Vehicle incremental replacement cost, fuel cost, and overall costs are presented in the Phase II section of the report. Finally, a complete *Excel* workbook of the *Eco Fuel-Tool* model is provided as an attachment to this report.

As indicated in the Methodology section of this report, we note that the management of fuel for the State of Alaska fleet is a decentralized activity and data is not collected through an automated fuel management system. SEF has requested, but not received approval, for funding of a $3 million statewide-automated fuel management system and has offered to take responsibility for centralized management of the State's estimated $29 million fuel ($25 million for bulk fuel and $4 million through retail outlets) purchases.

Centralization of fuel management and automating key processes in fuel management is an industry standard and considered a fleet management best practice. Such an endeavor would allow the State to reduce the cost of its fuel operations through:

- Mitigating the risk of theft and pilferage of fuel by State employees and contractors
- Determining the true cost of a gallon of fuel
- Ability to compare State fuel operations to industry standard pricing and performance
- Determine an effective supply strategy by balancing security of supply with desired cost and margins
- Optimize inventories, daily pricing decisions and delivery schedules
- Streamline operations and accounting through centralization of tasks
- Reconcile bill-of-ladings with fuel delivery data
- Reconcile fuel price, volume, and freight costs
- Reduce manual data entry

Since SEF did not have access to the fuel data (e.g., gallons purchased by vehicle) as requested by Mercury, we resorted to calculating fuel consumption based on the vehicle mileage provided to us by SEF and using EPA vehicle make/model MPG estimates based on an average of city and highway driving. This methodology tends to underestimate emissions, because of vehicle idling and other driving behaviors that impact real-world fuel usage, but are not considered when using EPA MPG-based data. Moreover, since we were required to manually match the SEF vehicles to EPA MPG estimates, we were only able to analyze the portion of the SEF fleet designated as domiciled in the greater Anchorage area; a total of 1,227 vehicles or about 16 percent of the entire State fleet. While viable local "pockets" of SEF vehicles most likely are domiciled in Fairbanks, Juneau or elsewhere, the conversion of vehicle fuel data was beyond the scope of this project.

With today's high cost of fuel, issues with fuel "shrinkage" and white-collar crime, and concerns regarding stability of supply in the event of a national emergency, weather issues, or other disruptions, fleet organizations must rely on automated systems in order to maintain consistent operations to ensure their fleet stays on the road. To this end, we have recommended SEF pursue the acquisition of a fuel management system.

Advantages and Disadvantages of CNG for Alaska

Despite several advantages compared to liquid fuels, NGVs have not gained a significant share of the transportation market, other than a growing number of centrally fueled fleets such as transit; school buses; refuse; airport shuttles, taxis, and support vehicles; and regional delivery trucking. While operational characteristics of NGVs are no longer a significant problem or barrier to adoption, the vehicle choices as of late 2010 are still limited, as domestic automakers reduce spending on alternative fuel R&D investments in order to deal with endeavors related to financial restructuring. Having said this, the emission and fuel cost benefits of CNG continue to appeal to fleet operators, particularly since 95 percent of the natural gas consumed in the U.S. is domestically produced.

We have separated the advantages and disadvantages of CNG and NGVs by three different characteristics: 1) economic; 2) environmental; and 3) technological; these results are each displayed in a separate table. As appropriate, each advantage and disadvantage is displayed in a "point—counter-point" quick-scan format reflecting the fuel's merits compared to conventional fuels. Although presented from a fleet organization perspective, most points would apply to the general public as well.

Table 8
Economic Advantages and Disadvantages of CNG and NGVs

Economic Advantages	Economic Disadvantages
Fuel cost per mile is lower	Vehicle cost premium (OEM & retrofit)
Ability to fuel onsite overnight with unattended filling, enhancing productivity	Fueling station cost premium
CNG price stability versus diesel and gasoline	Limited number of public fueling stations
Alternative fuel excise tax credit of $0.50 per gallon extended through 2011 (including credits for tax exempt fleets)	Additional gas storage required in Cook Inlet to meet peak winter natural gas demand
Alternative fuel infrastructure tax credit extended for 2011, but less $$ than prior years	Secondary resale market for NGVs is lacking
Alternative fuel home refueling tax credit extended for 2011 but less $$ than prior years	Vehicle choices limited (OEM and certified conversion kits)
CNG has regained some "momentum" in the vehicle market	Federal alternative fuel vehicle purchase tax incentive expired 12/31/10
Potential for increased engine life/vehicle life	Upgrade costs for accommodation of NGVs in garages

Fuel Infrastructure

Natural gas supplies in Alaska are stretched by residential and commercial use, electric generation, and liquefied natural gas exports; however, the large and stable demand offered by State vehicles could help justify the need for natural gas exploration, storage facilities, and other solutions for replacing the diminishing natural gas reserves in Cook Inlet.

On the positive side, since Alaska has only a limited number of highways and limited number of conventional fuel filling stations, there is a potential to service a large group of State and municipal vehicles with somewhat limited resources as compared to other states (i.e., 80 percent of vehicles are most likely located in 20 percent of the geographic area).

High costs to build a fueling network and comparatively high initial costs of the vehicles themselves are significant barriers. For several decades, the alternative fuels industry as a whole has suffered from a "chicken and egg" situation where fueling stations are financially risky without a significant demand, and vehicle adoption is seen as risky without the assurance of fuel availability. Incremental conversion of fleets or individual users does not sufficiently create enough demand to make fueling investment work financially. A coordinated, large-scale commitment is needed. Government funds have generally been the mechanism to fund or at least incent fueling infrastructure.

NGV operators are subject to the frustrations of a limited fueling network and "fueling fatigue," both a result of the fact the natural gas is stored on board as a gas instead of a liquid, despite the high pressures involved. NGVs generally have to be fueled every day. Unless there is a fixed fueling site with multiple hoses (i.e., time fill, overnight fill) where vehicles can be fueled while parked over night, drivers resent the lack of convenience with the common fast fill public fueling sites if they have to visit every day. Overnight fueling, however, can be a convenience advantage over liquid fuels, because there is no longer a need to visit a fuel pump, and productivity is enhanced.

Availability of NGVs

Commercial truck manufacturers are expanding the availability of NGVs, although they are taking different approaches to how involved the buyer becomes in the conversion process. Only a limited number of NGVs are 100 percent manufactured by the OEM. For many years, the Honda Civic GX has been the lone OEM NGV in low volume production. Instead, most vehicles are shipped as conventional vehicles with engines that must be converted by a certified engine upfitter.

General Motors

General Motors recently launched a CNG option for its Chevrolet Express and GMC Savana vans in partnership with Productive Concepts Inc. (PCI), Union City, IN. Vans will be shipped to PCI for the conversion and then shipped to GM dealers for customer delivery. They carry the same warranty as GM's conventional engines: three-year/36,000-mile vehicle warranty and five-year/100,000-mile powertrain warranty.

The protocol established by GM and Freightliner/Cummins is most favored by fleet operators since, like conventional models, vehicles are entirely assembled at the OEM factory, shipped directly to delivering dealers, and carry identical warranties. While Ford's partnership with BAF is an improvement over past "conversions" due to utilization of the "ship through" process, fleet operators must still deal with two different warranty providers. The latter can result in "finger pointing" relating to which is responsible for what failure.

Ford Motor Company

Ford Motor Company has been offering a CNG prep kit on its E-Series vans since November 2009 and recently added the Super Duty and Transit Connect models for the 2011 model year. Buyers can elect to send the vehicle to BAF Technologies in Dallas, currently Ford's only approved CNG conversion partner. BAF is setting up a "ship-through" facility near a Ford truck assembly plant that will enable the upfitter to complete conversions as soon as vehicles leave the production line. These vehicles then re-enter the distribution network and are distributed normally through participating dealerships. Buyers may also choose their own upfitter or complete the conversion at their own shop. Notwithstanding, all upfitters must completely follow a Ford-issued service bulletin on conversions to receive warranty coverage. However, Ford's warranty coverage does not extend to the injectors and fuel system; coverage for those parts falls to the upfitter.

Fiat

Fiat is planning to bring its CNG vehicles to the U.S. branded as Chrysler models. While GM and Toyota are focusing on hybrid electric vehicles as their alternative to conventional gasoline engines, Fiat's chief executive officer Sergio Marchionnethe, argues the hybrids present "too many obstacles," such as the recharge time for batteries. His five-year plan for Chrysler includes bringing CNG large and small commercial vans to the U.S. in 2012 under the Ram brand based on Fiat's trucks platforms. Fiat is the market leader in Europe in natural-gas engines, with an 80 percent share of methane-powered cars and 55 percent of light commercial vehicles, with sales of 127,000 methane-powered cars last year, including versions of the Panda compact and Ducato van. The OEM will re-enter the U.S. next year, and targets sales of 50,000 of its compact NGV in the market. [31]

Freightliner Trucks

Freightliner Trucks offers a medium-duty factory-installed CNG system, including tanks, powered by the Cummins Westport ISL G-series near-zero emission engine with 320

[31] NGV Journal. Fiat's CEO bets on CNG technology. June 12, 2010. http://www.ngvjournal.com/en/markets/item/3518.

horsepower for its M2 112 truck. This truck is available in several Class 7 and 8 GVW configurations for CNG and LNG. All components are factory-installed and warranted.

International Truck

International Truck is developing a natural gas variant of one of its big-bore engines and is currently offering dealer retrofits for its MaxxForce DT medium-duty engine. A conversion kit for Navistar's DuraStar medium-duty truck that was developed by Emissions Solutions Inc. (ESI), McKinney, TX, is sold through Navistar's Truck Specialty Center in Garland, TX. The kit, which has been available through aftermarket channels for some time, can support both CNG and LNG. ESI provides the engine warranty.

Kenworth Truck Company /Peterbilt

Kenworth Truck Company is targeting local and regional-haul and vocational customers with the natural gas-powered version of its T440 model. Available now, the truck features power from the Cummins Westport ISL G engine, which can run on either CNG or LNG. Peterbilt Motors[32] offers the same engine in its model 384, 365 and 320 trucks. While the 384 and 365 models can serve numerous vocational markets, the 320 is built specifically for refuse applications.

Mack Trucks

Mack Trucks also serves the refuse market with natural gas version of its TerraPro low-entry, which is available now. Equipped with the Cummins ISL G engine, rated at 320 horsepower, the engine is installed on the production line at the manufacturer's Macungie, Pa., assembly plant. Mack provides a full factory warranty on the trucks. Mack's sister company Volvo Trucks, does not offer a natural gas option.

High Cost of Certified Retrofit Conversions

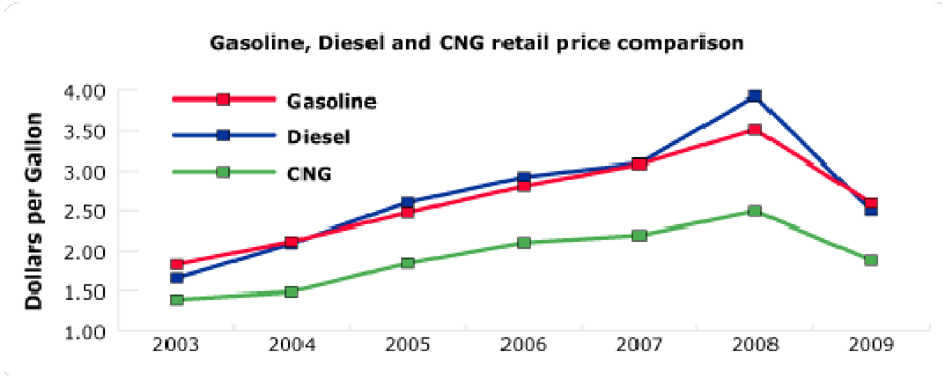
As discussed earlier in this report, the certification of aftermarket conversion systems is currently cumbersome and expensive. This hinders the development and use of NGVs. Proposed legislation in the U.S. House of Representatives and U.S. Senate would streamline, and, thereby reduce the cost of certification. Until this issue is resolved, the difficulty and high cost of retrofitting vehicles to operate on CNG will continue to be a hindrance to wider acceptance.

Economics of CNG

While the fuel costs vary across different regions of the country, a good rule of thumb, is that a gallon equivalent of natural gas costs about two-thirds the price of a gallon of fuel. Historical prices for CNG versus gasoline and diesel fuels in the State of California are provided in the exhibit below.

[32] Both Kenworth and Peterbilt are owned by PACCAR, Inc.

Exhibit 7
Comparison of California Fuel Prices[33]



Unless there is dissatisfaction with the cost of the mainstream conventional fuels (as there was most recently in 2008), fleet operators and the general public have taken a limited interest in any alternative fuels, including CNG. To that end, other than niche markets and regions of the country, it appears CNG will remain a fleet-only fuel unless an extensive, nationwide network of fueling stations is established. On the other hand, fleets will continue to use the lowest-cost fuel, which meets their entire operational requirement.

Table 9
Environmental Advantages and Disadvantages of CNG and NGVs

Environmental Advantages	Environmental Disadvantages
Longer oil life results in less used oil disposal	Fleet operators typically do not take advantage of longer oil life due to a desire to perform periodic safety inspections
Less greenhouse gas emissions per mile	
Demonstrates environmental stewardship that gives users brand a positive sustainability image	
Potential for natural gas supply to add “recycled,” renewable landfill gas	
Improved indoor air quality and cleanliness in garages as result of upgrades for use of CNG versus diesel fuel	

[33] Sources: Gasoline prices acquired from annual average of U.S. Governmental Energy Information Administration’s Weekly California Regular Reformulated Retail gasoline prices. Diesel prices acquired from annual average of U.S. Government Energy Information Administration’s Monthly California No. 2 Diesel Retail Sales. CNG prices acquired from annual average of Southern California Gas monthly public CNG station prices.

The emission and fuel cost benefits appeal to fleet operators, and the fact that 95 percent of the natural gas used in the U.S. is domestically produced is an advantage over conventional fuels.

Table 10
Technological Advantages and Disadvantages of CNG and NGVs

Technological Advantages	Technological Disadvantages
Safety benefit due to tank ruggedness	Potential payload penalty due to tank size and weight
Safety benefit due to fuel dispersion and narrow flammability range	Power decreased slightly unless engine is designed for CNG
Potential for fueling at home for general public	Garage facilities generally not designed for CNG (overhead open-flame heaters are not inherently safe without methane detection)
130 octane rating allows use of efficient, higher-compression engines[34]	Reduced driving range (gaseous fuel storage)
As a gaseous fuel, CNG does not tend to contaminate engine oil	Limited number of trained service mechanics and service facilities

CNG has technological advantages over gasoline and diesel, which can be significant to both fleet operators and the general public. In some cases, these advantages were not available to early adopters of the fuel, due to the necessity that NGV engines were originally designed to run on gasoline or diesel, and were merely "converted" to run on CNG.

For example, CNG is a high-octane fuel, which allows spark-ignition engines to operate at very high compression ratios, increasing efficiency (power and fuel economy). However, this advantage is only available if the engine has been designed from the outset to run with high octane. A NGV driving range depends on the size and number of natural gas storage cylinders and on driving conditions. In a passenger car, two cylinders of natural gas can provide the equivalent of about eight-and-one-half gallons of gasoline. Trucks and other larger vehicles can be equipped with more cylinders as required.[35]

NGVs are also safer than gasoline and diesel due to the ruggedness of the storage tanks, which gives them a high resistance to puncture or crush events. Moreover, when a leak occurs during an accident, natural gas disperses in the atmosphere rather than "puddling" as is the case with conventional fuels.

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[34] Southern California Gas Company. Comparing natural gas vs. other fuels. http://www.socalgas.com/ngv/residential/fuelcomparison.html.
[35] Washington Gas. Frequently Asked Questions. http://www.washgas.com/pages/NaturalGasVehicles.

Generally, due to engineering costs, a significant market share of NGVs will need to be gained before vehicles can be fully designed to take advantage the beneficial aspects of the fuel, involving use of structural tanks, high-compression engines, etc.

Proposal for Pilot Program

As indicated in the Methodology section of this report, we conducted a SWOT analysis as a strategic planning method to evaluate the strengths, weaknesses, opportunities, and threats involved in assessing the feasibility of CNG as a viable alternative fuel for the Alaskan market. Listed below are five leading barriers and opportunities for the State to achieve its objectives towards implementing a successful CNG Program. We will revisit these factors as well as output from the SWOT in the Phase II section of this report.

Barriers and Opportunities for State of Alaska CNG Program

- Some key fleets are skeptical—Refuse, Transit, and Airport
- No local air quality issues In Anchorage to drive change
- Many existing NGV capabilities from past efforts
- Hunger for a clean, domestic fuel
- Strong political interest and support

Table 11
SWOT Objective: Feasibility of CNG for State Fleet

Origin	Strengths	Weaknesses
Internal Origin (Attributes of the organization)	School, Railroad, SEF are supportive	Transit, Waste, Airport tepid towards CNG
	Positive experience with NGV operational performance	Previous technical glitches still remembered
	Desire for sustainability	Limited natural gas supply in many areas
	Existing, albeit limited, infrastructure	Issues with refueling nozzles during winter
	Willingness to appropriate additional funds	Perception of garage modification requirements
	Opportunities	**Threats**
External Origin (Attributes of the environment)	Various natural gas pipeline and storage facility proposals	Timeframe to build
	Alaska has 15% of U.S. natural gas reserves	Peak demand supply shortages in Cook Inlet area during January and February
	Jobs	Abundance of natural gas in Lower 48; shale expansion
	Reduce dependence on imported oil, as prices rise	Lack of Clean Cities program
	Political support for sustainability initiatives	Limited sources of conversion kits and M&R technicians
	Renewed interest in NGVs by OEMs	Hybrid electric and electric vehicle competition

The SWOT analysis indicates that CNG is a feasible fuel for certain Alaskan fleets and that an expansion of the CNG program would be beneficial towards Alaska's sustainability efforts. A variety of stakeholders have expressed an interest in expanding their use of CNG, providing the cost barriers are surmountable and the users can reasonably expect an ample supply of the fuel. Consequently, we recommended proceeding to Phase II of the feasibility study.

Due to the sizable cost of expanding the current fueling infrastructure in Alaska and funding incremental NGV costs, we recommend refraining from calling the project a “pilot,” but, rather, the “CNG Expansion Program” (Program). DOT&PF has experience with NGVs, having conducted a “pilot” in the 1990s. And, other fleet organizations in the region, such as Alaska Railroad and the Anchorage School District, already operate NGVs and CNG stations. It is possible that “pilot” groups—those with no experience whatsoever with NGVs (e.g., Anchorage Transit, Anchorage Solid Waste, Alaska Waste, Anchorage Airport)—may want to participate in the Program with a very small number of test NGVs. We will discuss these groups further in the Phase II section of this report.

PHASE II

Recommendation for Pilot Program Participants

In this section we will provide a recommendation for the most cost-effective and appropriate State vehicle classes and geographic locations for the Program. The most likely location is the Anchorage area, since that region already has a small CNG station infrastructure.

Fleet Organizations

Fleets with high fuel consumption are critical to the support of a financially sound fueling CNG infrastructure, and the long-term participation of such fleets will be necessary for a sustainable program. Centrally fueled and maintained fleets are ideal candidates for conversion until such time as a broad network of fueling stations and maintenance support facilities are available. Nationally, the three largest users of natural gas for transportation have been 1) transit and school buses; 2) waste collection trucks; and 3) airport support transportation vehicles. While Senate Bill 220 refers to the use of vehicles owned or operated by the State for the CNG Program (presuming the use of CNG was first found to be feasible), we believe other fleet organizations should be invited to participate due to either 1) their interest and willingness to contribute towards the mission and goals of the Program; or 2) their fleet includes the types of vehicles best suited to operate on CNG (i.e., transit, waste, airport support, high fuel consumption vehicles).

Several Anchorage-area public sector fleet organizations have already expressed interest in participating in the program, including the Anchorage School District and the Alaska Railroad Corporation. The Anchorage School District currently has two CNG buses and has indicated interest in adding to this fleet. Likewise, the Railroad has two CNG bi-fuel vans and plans to increase the number of NGVs in its fleet.

From the private sector, Enstar Natural Gas Company (Enstar) is the most viable and logical participant, since they share a common interest in increasing the supply of natural gas to the Cook Inlet region.

Alaska Waste would also be a potential participant since they have internal maintenance facilities and would be excellent candidate to evaluate new CNG trash compactor trucks, which have seen success, especially in California. Although we did not interview Alaska Waste, we did interview the Municipality's Solid Waste agency and they provided us with information about the Alaska Waste fleet, which has 75 refuse trucks and recently opened a commercial biodiesel plant in Anchorage, without use of government funding.[36] With an interest in sustainability, Alaska Waste could be a potential private-public sector partner for the CNG Program. Even if the refuse company

[36] Alaska Waste. http://www.alaskawaste.net/news.htm.

does not elect to test NGVs, it could assist in other ways, such as supporting efforts to start a Clean Cities organization in Anchorage.

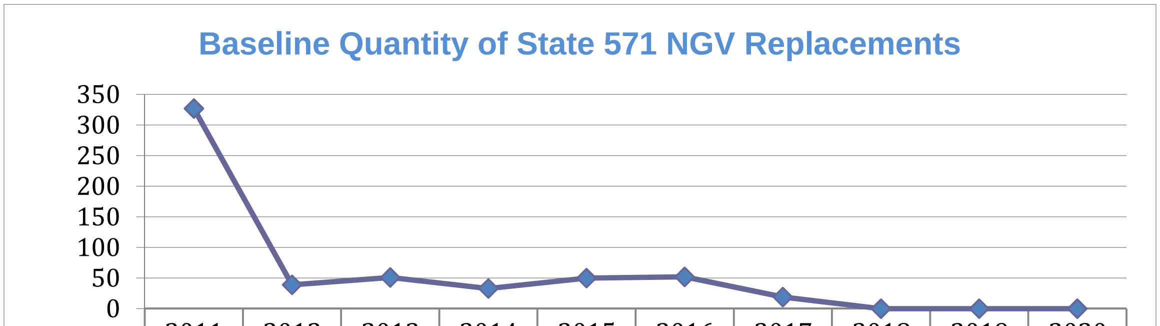
We have identified a total of 24 vehicle classes within the State fleet, which would be suitable candidates for NGV applications. A list of the vehicle classes is provided in the table below along with the replacement and incremental costs (today's dollars) for the NGV, the weight class, GHG type, planned replacement cycle, meter type, and current fuel type.

Table 12
State Vehicle Class Codes for NGV Program

Class	Description	ATA GVWR Class	GHG Type	Replacement Cost	CNG Cost	Replacement Cycle	Meter Type	Fuel Type
164	PU 1T 4X2 DRW	Medium Duty	Medium and Heavy Duty	$28,958	$24,000	84	Odometer	Gasoline
204	BUS PASS	Medium Duty	Medium and Heavy Duty	$93,446	$24,000	84	Odometer	Diesel
104	SEDAN SCOM	Light Duty	Passenger Car	$16,639	$16,000	84	Odometer	Gasoline
108	SEDAN MID	Light Duty	Passenger Car	$18,567	$16,000	84	Odometer	Gasoline
109	SEDAN STD	Light Duty	Passenger Car	$22,582	$16,000	84	Odometer	Gasoline
121	PU MID RCAB 4X2 1/2T	Light Duty	Light Duty	$18,597	$16,000	84	Odometer	Gasoline
122	PU RCAB 4X2 1/2T	Light Duty	Light Duty	$18,922	$16,000	84	Odometer	Gasoline
123	PU XCAB 4X2 1/2T	Light Duty	Light Duty	$24,180	$16,000	84	Odometer	Gasoline
131	PU RCAB 4X2 3/4T	Light Duty	Light Duty	$22,186	$16,000	84	Odometer	Gasoline
132	PU XCAB 4X2 3/4T	Light Duty	Light Duty	$22,238	$16,000	84	Odometer	Gasoline
137	VAN, FULLSIZE 4X2	Light Duty	Light Duty	$27,239	$16,000	84	Odometer	Gasoline
143	TRK FLATBED 4X2 1T	Light Duty	Light Duty	$28,454	$16,000	84	Odometer	Gasoline
144	PU CCAB 4X4 1/2T	Light Duty	Light Duty	$26,990	$16,000	84	Odometer	Gasoline
146	PU XCAB 4X4 1T SRW	Light Duty	Light Duty	$29,975	$16,000	84	Odometer	Gasoline
147	PU CCAB 4X4 1T SRW	Light Duty	Light Duty	$34,688	$16,000	84	Odometer	Gasoline
149	PU XCAB 4X4 1/2T	Light Duty	Light Duty	$26,183	$16,000	84	Odometer	Gasoline
151	PU RCAB 4X4 1/2T	Light Duty	Light Duty	$21,507	$16,000	84	Odometer	Gasoline
154	PU RCAB 4X4 3/4T	Light Duty	Light Duty	$27,823	$16,000	84	Odometer	Gasoline
155	PU XCAB 4X4 3/4T	Light Duty	Light Duty	$29,399	$16,000	84	Odometer	Gasoline
156	PU CCAB 4X4 3/4T	Light Duty	Light Duty	$29,128	$16,000	84	Odometer	Gasoline
158	FULLSIZE SUV4X4 3/4T	Light Duty	Light Duty	$39,912	$16,000	84	Odometer	Gasoline
159	VAN, FULLSIZE 4X4	Light Duty	Light Duty	$33,552	$16,000	84	Odometer	Gasoline
162	PU RCAB 4X4 1T SRW	Light Duty	Light Duty	$32,819	$16,000	84	Odometer	Gasoline
163	PU 1T 4X4 DRW	Light Duty	Light Duty	$44,315	$16,000	84	Odometer	Gasoline

As discussed during the first Phase of this report, we have identified a total of 571 potential State vehicles, which are due for replacement over the next 10 years that would be suitable for operational use as NGVs. A complete list of the vehicles is provided in a separate *Excel* workbook, which contains the *Eco Fuel-Tool* database as well as NGV incremental replacement costs, fuel costs, and GHG emission reductions by each of pollutant category. In the following Exhibit, we have provided the number of potential vehicles by calendar year. Again, only vehicles located in the Anchorage region have been considered for the Program.

Exhibit 8
Recommended Quantity of State NGVs for CNG Program



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
COUNT	327	39	51	33	50	52	19	0	0	0

The spike of 327 vehicles due for replacement in 2011 indicates a large backlog of vehicles in the State fleet that have not been replaced within the normal SEF parameters provided to us for each vehicle class. For the most part, these vehicles are in their "secondary" life as State agency vehicles after completing their useful life within the SEF organization. This portion of the fleet represents amongst the highest polluters within the State fleet due to the age of the vehicles. The agencies cannot afford to replace the assets, a problem which would remain with NGVs since they could not afford to pay the incremental costs. This is not an unusual situation for government fleets and is even more commonplace as a result of the poor economic conditions over the past several years. Needless to say, even if the State had sufficient funds to replace all of the 327 vehicles in one year, we would not recommend doing so, since future spikes in replacement due date would occur in the future. Instead, we recommend "smoothing" the plan so that mission critical, obsolete, poorly functioning, and other undesirable vehicles are replaced first while the remaining vehicles are scheduled for replacement in future years. Mercury Associates has a number of analytical tools, which can assist the State with this process if, in fact, the CNG Program is adopted.

A summary of other fleet organizations and types of vehicles, which we recommend for participation in the Program are provided below.

- Municipality of Anchorage
  - Transit
  - Solid Waste
  - School District
  - Public Works
- Vehicle Types
  - Street sweepers

- Dump trucks
- Bucket trucks
- Shuttles/paratransit
- Construction equipment
- Vanpools
- Other high-idling vehicles and/or equipment

- Alaska Railroad
- Alaska Waste
- Enstar Natural Gas Company

We recommend the Transit staff visit the Los Angeles MTA to learn why they decided to acquire 1,800 CNG buses since 2009, tour their garage facilities, and become acquainted with the steps taken for implementing one of the largest CNG transit bus operations in the nation.

We recommend development of a memorandum of understanding (MOU) between the various agencies that will participate in the Program so each may use available CNG stations while the infrastructure is further developed and capacity increases.

We recommend SEF identify the "secondary" portion of the State fleet and the extent of its growth over recent years in order to possibly pursue additional State funding to replace these vehicles with NGVs (i.e., provide 100 percent of the cost to replace the vehicles rather than incremental costs).

Next Steps After A Successful Pilot Program

In the event the Program is successful, it will most likely be expanded in order to increase the number of NGVs in the State by reaching out to additional fleet organizations as well as to private citizens. A successful program is expected to result in several fleet organizations *wishing* to initiate use of NGVs due to the benefits experienced, including fuel cost reduction, operational success, and environmental gains. The Program will result in a working coalition of interested participants, who can join together in agreements for fueling infrastructure design, driver and mechanic training, grant applications, problem resolution, and mutual ongoing support.

The Program will create a nascent fueling infrastructure in the Anchorage area that will need to be expanded significantly in order to accommodate a number of vehicles with high daily fuel consumption. Existing fueling facilities, upgraded as part of the Program, will eventually need to increase their capacity by adding or replacing natural gas compressors and high-pressure storage at each location. Costs for this will range from $100,000 (for LDVs) to $500,000 (for HDVs) per station.

The promise of a large and stable natural gas demand for fleet NGVs could help justify and support various solutions to the State's problems in providing a sufficient natural gas supply in the Cook Inlet area during the peak usage months of January and February when the demand rate is five to six times that in the summer months.

Ultimately, the "macro" advantages of NGVs, including GHG reduction, fuel security, and stable pricing, will continue to garner public and legislative support; however, interest in NGVs among fleet managers is naturally accelerated by high costs of the conventional fuels being replaced: unleaded gasoline and diesel. Alternative fuel vehicle products initially funded and engineered during the high fuel cost interval in 2008 are reaching the market today, and promise unprecedented operator acceptance. Still, fleet managers and other NGV supporters have a "wait and see" attitude due to past fits and starts with CNG, and their skepticism will need to be turned around during the Program.

Recommended Fleet Organizations After Initial Program Success

- Airport on-site work vehicles
- Airport private shuttles and taxis
- Airport Federal Express and United Parcel Service
- Port of Anchorage
- City of Fairbanks
- U.S. Postal Service
- Comcast Cable
- Time Warner Cable
- AT&T
- Verizon
- Carlile Transportation Systems
- Lynden Logistics
- Totem Ocean Trailer Express

Recent CNG-Related Activities with the Recommended Fleets

The following recent developments involve a number of the organizations we have recommended and provide an indication as to the likelihood of their interest in converting their Alaska fleets to CNG.

- AT&T and Verizon announced in 2010 that they were buying or converting a sizable number of existing vehicles to run on CNG.
- UPS, which has more than 1,100 CNG vehicles, has been using the fuel for 20 years. The company's West Coast alternative fuel fleet also includes 11 LNG tractors, which travel daily from California to Nevada

- In December 2010, car and equipment rental company Hertz Global Holdings Inc.'s subsidiary, Hertz Corp., announced a partnership with Clean Energy Fuels Corp. to build, operate, and supply CNG fueling stations at Hertz's Los Angeles Airport (LAX) facility. The Hertz/Clean Energy compressed natural gas fueling station will be built adjacent to LAX and will include public access fueling islands for local fleets of CNG taxis and shared-ride vans, plus hotel, parking, and rental car buses. Station construction is expected to begin in March and be completed by the third quarter of 2011. By 2015, Hertz expects to have transitioned its entire LAX transit bus fleet to CNG power. The table below lists 10 major airports that utilize NGVs either on or off-site.

Table 13
Major Airports Operating CNG Vehicles On- and/or Off-site

Airports		
Chicago O'Hare	Dallas Fort Worth	Denver
Houston	Las Vegas	Los Angeles
Oakland	Phoenix	San Francisco
San Jose		

- In August 2010, the City of Nashua, NH and UPS entered into an innovative sharing partnership to build a permanent CNG fueling station. The Nashua Department of Public Works is replacing seven diesel-fueled refuse trucks with CNG models. More businesses with large fleets may get involved, according to The Nashua Telegraph.
- Since Fairbanks is a non-attainment area for air quality under the Clean Air Act Amendments, it is a logical choice for further expansion of the State's CNG efforts. While, the city is no longer in non-attainment for carbon monoxide (CO_2) it has been designated as a non-attainment area for $PM_{2.5}$ since December 2009 and must develop an air quality control plan by 2012. Attainment is required y 2014.[37] As noted in Table 3, *NREL and UWV Field Test of NGV Emissions*, heavy-duty NGVs have significant reductions in the amount of PM, UPS delivery trucks experienced a 95 percent reduction.

Program Timeline

The following timeline provides an overview of the activities and tasks that should be accomplished over the first 24 months of the Program.

[37] Fairbanks Metropolitan Area Transportation System (FMATS). Donna Gardino, MPO Coordinator. http://www.fmats.alaska.gov/files/fmats101.pdf.

Table 14
Program Timeline

Months	Activities
1	Contract with or designate a Program Coordinator
2	Determine/Design CNG Fueling Station Upgrades Designate and Order NGVs
3	Apply for Clean Cities Status Determine Contractor for CNG Fueling Site Upgrades Build Data Accumulation Database Determine/Arrange Technical Training for support personnel
4	Apply for Federal Grant/External Financial Support Coordinate CNG Fueling Site Upgrades First Progress Report
5	Begin Receiving/Deploying NGVs Arrange CNG Driver Training
6	Continue Receiving/Deploying NGVs Ongoing Program Administration
7	Continue Receiving/Deploying NGVs Second Progress Report
8-12	Ongoing Program Administration and Problem Solving Develop Concepts for Pilot Expansion Ongoing Reporting
13-24	Conclude Receiving/Deploying transit and school bus NGVs (currently ~210 days from order through delivery dates)

Recommendations and Action Items

CNG Program Phase I

1. Implement Program timeline as provided in Table 10.
2. Assign full-time responsibilities to a CNG Program Coordinator. We believe the State would be best served if this individual works for the State in the capacity of an inter-government coordinator who could assist local government entities as well as the State. We recommend the individual report to SEF, since they manage the largest number of government vehicles in the State.
3. Assign grant-writing responsibilities either to the CNG Program Coordinator or utilize private sector grant writing services.
4. Determine funding amount in order to develop budget for State fleet incremental costs (i.e., number of NGVs that may be ordered in year-one). We recommend SEF identify the "secondary" portion of the State fleet and the extent of its growth over recent years in order to possibly pursue additional State funding to replace these vehicles with NGVs (i.e., provide 100 percent of the cost to replace the vehicles rather than incremental costs).
5. Determine incremental funding for additional participants:
    - Municipality of Anchorage

  - Transit
  - Solid Waste
  - School District
  - Public Works
- Vehicle Types
  - Street sweepers
  - Dump trucks
  - Bucket trucks
  - Shuttles/paratransit
  - Construction equipment
  - Other high-idling vehicles and/or equipment

6. Conduct meetings with the Alaska Railroad and Alaska Waste to bring both organizations into the Program.
7. Determine and contract for required upgrade to existing CNG stations.
8. Initiate planning for a minimum of two time fill CNG stations for SEF (ideally three-stations); contract with provider.
9. Develop a memorandum of understanding (MOU) between the various agencies that will participate in the Program so each may use available CNG stations while the infrastructure is further developed and capacity increases.
10. Initiate establishment of a Clean Cities coalition in Anchorage.
11. Initiate meetings with Enstar and other NGV business partners.
12. Arrange field site visits for Anchorage Transit staff visit the Los Angeles MTA to understand their rationale for acquiring 1,800 CNG buses since 2009, as well as to tour their garage facilities, and become acquainted with the steps taken for implementing one of the largest CNG transit bus operations in the nation.
13. Engage with Clean Energy (or similar providers) to encourage participation in the Program as well as funding partnership relationship for development of a public fuel infrastructure.
14. Consider a similar field trip by the Anchorage airport fleet manager in order to understand modifications to garages at other airports.
15. Modify current practice of decentralized bulk and fuel card management so as all State-purchased fuel is centralized under SEF who should continue to pursue acquisition of a centralized fuel management system. While the fuel system is not required for implementation of the CNG Program, it is necessary to accurately calculate the amount of liquid fuels used by the State and to calculate the amount

of GHG emission reduction based on actual fuel consumption (versus the MPG methodology used for this study).

CNG Program Phase II

16. Identify and contact potential fleet operators in both the public and private sector that may have an interest in using CNG after successful implementation of the Program.

17. Enact incentives to encourage use of CNG and NGVs.
18. Consider a State-sponsored, Governor-led, single-messaging communication program that would collaborate, support, and complement efforts and raise public awareness and understanding about the importance and cost-effectiveness of CNG efficiency, and thereby accelerate the deployment of NGVs.
19. Consider K-12 funding for NGV educational programs.
20. With the Governor's leadership, educate industry and the commercial sector that NGVs are also a risk-management opportunity when considering the volatile price of conventional fuels.
21. Encourage utilities and their regulators to expand NGV programs.
22. Consider job-creation tax incentives for hiring NGV resource efficiency/energy managers at private businesses.
23. Consider tax incentives to draw NGV-related businesses to Alaska.

Estimate of Costs

We estimate overall incremental State fleet costs will increase 7.6 percent over the next nine years (2011 to 2020), presuming the most appropriate candidate vehicles for conversions are replaced with NGVs when due for replacement. The *Eco Fuel-Tool* model projects an increase in capital costs while fuel costs will decrease; the overall increase of seven percent does not include costs to build, operate or maintain a fueling infrastructure, which will be examined later in this report.

NGV Incremental Acquisition Costs

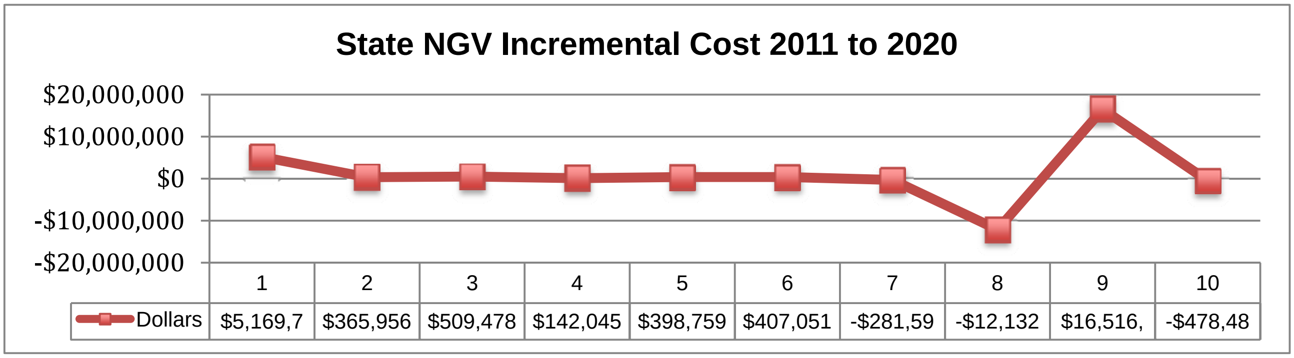
The incremental costs for the State fleet are provided in the following Exhibit; however, as previously stated, the large backlog of overdue vehicle replacements must be smoothed so that a large spike of vehicles are not replaced in one given year. The *Eco Fuel-Tool* model projects total existing conventionally fueled vehicle replacements to cost $140.5 million over the next 10 years whereas the costs of replacing 571 of the vehicles with NGVs costing $151.1 million. This results in an overall incremental cost of $10.6 million or 7.6 percent.

Since the plan has not yet been smoothed, negative costs occur in the outlying years 2017, 2018, and 2020. Negative costs are a result of the longer lifecycle forecast for NGVs, fuel savings, and vehicle replacement costs being "top heavy" in 2011 while greatly diminishing in the outlying years. A complete summary of all costs is provided on the following two pages.

Table 15
Summary of State CNG Program Costs and Emission Reductions

Total Costs											
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Total**
Existing	$40,924,431	$7,353,608	$7,977,008	$7,976,581	$9,613,482	$6,670,336	$3,754,406	$25,439,874	$14,862,635	$15,953,538	$140,525,898
Converted	$46,094,219	$7,719,564	$8,486,486	$8,118,626	$10,012,241	$7,077,387	$3,472,810	$13,307,603	$31,379,344	$15,475,055	$151,143,335
Increase	$5,169,789	$365,956	$509,478	$142,045	$398,759	$407,051	-$281,596	-$12,132,271	$16,516,709	-$478,483	$10,617,437
% Increase	12.63%	4.98%	6.39%	1.78%	4.15%	6.10%	-7.50%	-47.69%	111.13%	-3.00%	7.56%
GHG Reduction											
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Total**
Existing	6,061,072	5,975,436	5,981,998	6,021,327	6,017,993	6,021,217	6,014,876	6,031,238	5,959,283	5,968,143	60,052,583
Converted	5,824,022	5,701,683	5,621,173	5,601,295	5,512,304	5,483,635	5,444,358	5,457,039	5,447,292	5,406,870	55,499,671
Reduction	237,049	273,754	360,825	420,032	505,689	537,581	570,518	574,199	511,992	561,272	4,552,912
% Reduction	3.91%	4.58%	6.03%	6.98%	8.40%	8.93%	9.49%	9.52%	8.59%	9.40%	7.58%
Replacement Costs											
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	
Existing	$38,793,169	$5,252,425	$5,873,529	$5,859,267	$7,497,341	$4,553,059	$1,639,364	$23,319,086	$12,767,136	$13,854,930	
Converted	$44,243,641	$5,939,663	$6,802,236	$6,488,983	$8,473,380	$5,575,343	$2,012,597	$11,845,743	$29,925,456	$14,025,036	
Increase	$5,450,472	$687,238	$928,707	$629,716	$976,039	$1,022,284	$373,233	-$11,473,343	$17,158,320	$170,105	
% Increase	14.05%	13.08%	15.81%	10.75%	13.02%	22.45%	22.77%	-49.20%	134.39%	1.23%	
Fuel Costs											
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	
Existing	$2,131,261	$2,101,183	$2,103,479	$2,117,314	$2,116,141	$2,117,277	$2,115,042	$2,120,787	$2,095,499	$2,098,608	
Converted	$1,850,578	$1,779,901	$1,684,250	$1,629,643	$1,538,862	$1,502,044	$1,460,212	$1,461,859	$1,453,888	$1,450,020	
Reduction	$280,683	$321,283	$419,229	$487,670	$577,280	$615,233	$654,830	$658,928	$641,611	$648,588	
% Reduction	13.17%	15.29%	19.93%	23.03%	27.28%	29.06%	30.96%	31.07%	30.62%	30.91%	

Exhibit 9
State NGV Incremental Funding Costs



Costs Associated with Other Recommended Program Participants

Transit and refuse vehicles and buses are overwhelmingly accepted as having the most success relative to economic, operational, and environmental considerations. To this end, we have recommended an extension of the Program beyond SEF vehicles to include these groups to the extent funding is available. Table 12 provides our estimated incremental costs for the NGVs. We have provided the cost with and without the federal Alternative Motor Vehicle Credit, which expired December 31, 2010. This credit was equal to 80 percent of the incremental cost of a NGV to a maximum of $32,000 per vehicle.

Table 16
Recommended Program Participants NGV Incremental Acquisition Costs

Fleet Organization	Type Vehicles	Cost Each w/ Expired Fed Disc.	Cost Each w/o Fed Disc.
School District	School Buses	$31,376[38]	$60,000
Solid Waste	Trash Compactor Trucks	$30,295[39]	$60,000
Transit	Transit Buses	$50,502[40]	$80,000

We anticipate that other recommended Program participants, the Alaska Railroad, Enstar, and Alaska Waste, will fund their own incremental costs of NGVs.

[38] Incremental cost for a CNG school bus is $31,376 (average of four sources—Linder 2009, Leonard et al. 2001, Cohen 2005, and USCS 2003—where the latter three sources have been adjusted for inflation).

[39] Incremental cost of a CNG refuse truck is $30,295 (average of three sources: Lemmons 2009, Andrews 2009), and San Antonio 2009).

[40] Incremental cost of a CNG transit bus is $50,502 is an average of the incremental costs found in Chandler et al. 2006 (adjusted for inflation) and from an interview with Bob Antila (Antila 2009).

NGV Maintenance and Repair Facility Upgrade Costs

The cost of maintaining the NGVs by all estimations should be very similar to that of maintaining the equivalent liquid fuel vehicle, especially during the vehicle's warranty period. In fact, while there is an expectation that some vehicle mechanics will need NGV training, the CNG systems themselves will come with a warranty that will either allow the vehicle to be repaired for free or that will provide reimbursement for mechanic labor costs in addition to free parts. There is a potential savings opportunity for NGV maintenance cost through extended service intervals. As a gaseous fuel, CNG is less prone to engine lubricating oil contamination, and oil change intervals can be increased significantly. It remains to be seen what the recommended interval for oil changes will be with upcoming OEM vehicle offerings; however, past recommendations and field findings were that the life of the oil and filter could be doubled on dedicated CNG vehicles, such as found with the State of Oklahoma as cited earlier in this report.

In the NREL study for municipal school, refuse, and transit fleets, facility upgrade costs associated with upgrading a fleet from diesel to CNG were considered zero. NREL based this conclusion on the fact that the incremental cost of making a new garage and maintenance facility compatible with CNG is minimal (Marathon 2006). Therefore, NREL modeling assumed the fleet already had well-ventilated facilities or that they are building new facilities that would be the same cost regardless of fuel type. It should be noted, however, that NREL will further explore the economics of garage upgrade costs in a second part of the study.[41] While the NREL study predicts no incremental costs for transit and refuse fleets, the payback time for school fleets increased from 1.8 years to 2.3 years depending on the size of the school bus fleet.

Estimating the extent and cost of modifications needed to safely convert older diesel garages to CNG is made uncertain by the absence of definitive codes applicable to CNG. Certain National Fire Protection Agency (NPA) and the National Electric Code may be broadly applied to CNG garages. A partial list of various codes commonly applied to CNG garage improvements is provided in the Appendix. In a separate study conducted by NREL for a survey of transit fleets, respondents were unable to provide building upgrade costs either because the work was managed by others and/or may not have been exclusively performed to address CNG upgrades (i.e., improvements were required anyway). At any rate, the most common improvements cited were for use of sloped roofs, ventilation and heating system alternations, gas detection systems, various different electrical upgrades, standby generators to maintain ventilation, and fall-arrest systems to enhance safety of works on the roof of the bus during cylinder inspections.[42]

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[41] National Renewable Energy Laboratory (NREL). Business Case for Compressed Natural Gas in Municipal Fleets. Caley Johnson. NREL/TP-7A2-47919. June 2010.

[42] National Renewable Energy Laboratory (NREL). Compressed Natural Gas (CNG) Transit Bus Experience Survey. R. Adams, Marathon Technical Services and D.B. Horne, Clean Vehicle Education Foundation. April 2009 – April 2010. NREL/SR-7A2-48814. September 2010.

Training Costs

While training costs will vary greatly depending on the type vehicle and wages, we have provided best practices related to CNG training as compiled by NREL in their *CNG Transit Bus Experience Survey* results released in September 2010.

Table 17
Summary of Training Requirements for Transit Fleet

Vehicle	Station[43]	Emergency Responder
Typically provided by OEM and includes:	Typically provided initially by station manufacturer:	Typically provided by the fleet organization:
o 160-200 hours per order (includes 40-60 engine related hours) o Two-days cylinder inspection o Driver training: NGV operation and emergency response	o Safe fueling for affected staff o Emergency situations: emergency shutdown procedures, fire response, gas leak response, etc.	o Orientation for local fire departments, including location of shutoffs, hydrants, etc. o Possible additional fire department orientation with different vehicle models (e.g., location of cylinders) o Police department orientation

Upgrade of Existing Anchorage CNG Fueling Infrastructure

Most existing CNG stations in the Anchorage area are underutilized and require updating, especially with fuel dispensing equipment. These stations were built 10 to 25 years ago in support of prior CNG efforts, and still support a few remaining NGVs. The Anchorage School District's time fill system should have additional fueling hoses added to support overnight fueling of the recommended four additional buses, which are discussed later in this report. There are several advantages to continuing use of the existing infrastructure. These sites are already established as CNG fueling centers, each supporting a small group of NGVs, and use of the existing sites will allow the widest network of stations with the smallest capital investment funded via this pilot.

The proposed fuel facility upgrades of $380,000 will decrease time required for fueling and allow fuel cards to be issued to track usage (a recommended best practice). An engineering analysis of the individual stations will need to be performed to determine what equipment in addition to the dispensers will require upgrading, rebuilding or replacement. There are several enterprises in the U.S. and Canada who will be interested in bidding on this project. It should be noted that the Railroad recently rebuilt

[43] The amount of CNG station training required should be linked to the degree of involvement that the fleet organization has with the maintenance of the fuel facility. The organization providing the greatest degree of maintenance work should be responsible for a greater degree of training.

their station, converting it from a fast fill to a time fill, and are capable to share expertise relating to this endeavor.

Table 18
Estimated Costs for Upgrading Existing CNG Fuel Infrastructure

Owner/Location	Type	Improvements	Total Cost
Anchorage/Downtown (Health & Human Services	Private	Upgrade dispensers	See below
Anchorage Public Works	Private	Upgrade dispensers	See below
Anchorage/Tudor Garage	Private	Upgrade dispensers	See below
Anchorage/School District	Private	Upgrade dispensers	See below
Alaska Railroad	Private	Site already upgraded	$0
Elmendorf Air Force Base	Private	Not included in Program	$0
Ditch Witch of AK	Public	Establish partnership	$0
Sub-total for Dispensers		*Upgrade 5 @ $60,000 ea.*	*$300,000*
Sub-total for Miscellaneous[44]		*Upgrade 2 @ $40,000 ea.*	*$80,000*
TOTAL COSTS			**$380,000**

New CNG Station Design

At this point in time, we do not know a number of factors related to the building of new CNG stations. For example, we do not know where the stations would be built and who the users will be and, therefore, if the requirements would be fast fill or time fill. To this end, we are refraining from providing specific cost estimates at this time.

Transit agencies responding to the NREL survey, reported the importance of providing room for expansion, but to do so carefully because compressor equipment that is too large will tend to cycle more, causing reliability problems. Planners may also elect to “rough in” an additional pad and services and sizing the dryer, piping, and electrical systems for future additional compressors as well as providing space for additional dispensers and compressors to be installed at some later date.

The following are typical steps recommended for selection of the proper CNG station. Sources for this information include Energy International, Marathon,[45] and NREL.

1. Identify Fleet Users

- Project fill time and quantity of fuel required in the present and for future growth

[44] Miscellaneous site improvements for curbs, routing of traffic, fuel card booths, etc.

[45] CNG Station Design Primer. Presented at Waste-to-Wheels: Building for Success Workshop on December 1, 2010, in Columbus, OH. http://www1.eere.energy.gov/cleancities/pdfs/ngv_wkshp_adams.pdf.

- Collect fleet data to determine highest demand fuel window to govern sizing
- Use average fuel consumption per vehicle rather than maximum since the latter will oversize the station
- Convert gasoline and diesel gallons to standard cubic feet (SCF)[46]

2. Station Type

Type	Description
Time Fill	Useful for fleets such as school buses that return to base and are parked for an extended period of time; fill entire fleet directly from the compressor over a period of six to eight hours; least expensive alternative; requires no full-time attendant.
Cascade Fast Fill	Suitable for fueling light-duty vehicles at public access stations where use patterns are random and for fleets such as police or taxis that require fast fill during peak hours. Used where fueling requirements are needed in short (one to two hour) peak periods; fill each vehicle in five to 20 minutes primarily from gas stored in vessels arranged in cascades for use during peak time; compressors refill cascades during off-peak time. Not appropriate for continuous high-volume fueling.
Buffer Fast Fill	Used where many large vehicles such as transit buses must be fast filled back to back for several hours; fill each (large) vehicle in five to 20 minutes primarily from the compressor(s); provides high-volume fueling with relatively large compressors and a CNG storage buffer.

3. Gas Supply

- Meet with Enstar to determine available gas:
    - Minimum, maximum, and typical pressure in service line with new station load imposed
    - (Medium to large scale) CNG stations can be designed to accept (higher) floating gas service pressure rather than (lower) regulated gas pressure
    - Floating service pressure can significantly reduce size, complexity, initial and operating cost of the station
    - It may be necessary to discuss this need with Enstar as they may have policies to supply only (low) regulated pressures
    - Gas composition and moisture content is required

4. Dryer

- Inlet drying recommended
- Regeneration equipment recommended

[46] Gasoline gallons x 120 = SCF. Diesel gallons x 137 = SCF (possible add 10 percent for diesel efficiency).

- Virtually all stations will require a dryer to be code compliant for gas quality and prevent condensation problems that would impact fueling and vehicle performance

5. Compressors

- Raise gas pressure from utility service pressure to 4500 psig:
    - Reciprocating compressor; usually electric motor powered
    - Electric-drive compressors are smaller, quieter, more reliable, durable, have lower capital and maintenance costs, and require no special environmental permit than natural-gas-engine-driven compressors
    - Given the trend towards electric-drive compressors, inclusion of a diesel or natural gas powered standby generator should be considered to address power outage situations that would prevent fueling
    - Redundancy through multiple compressors or portable standby compressor
    - Equip with enough compressors so that the flow can be "scaled" to the fueling demand
    - Having multiple smaller compressors versus one large compressor reduces the cycle (load and unload), which increases compressor reliability as well as electrical demand charges

6. Filtration System

- Gas-filtration system design should prevent excess oil used to lubricate compressor parts leak downstream of the compressor
- Presence of oil is commonly cited by engine manufacturers in refusing warranty claims
- Various different methodologies (e.g., drainage systems, oversize filters)

7. Storage

- Required for Cascade and Buffer Stations:
    - ASME design code
    - 5500 psig design-4500 psig operating pressure
    - Tubes or spheres

8. Dispensing System Design

- Several different dispensing-control systems are available
- Specifications should clearly require a system that ensures independent and simultaneous fueling of each vehicle and avoids batching of vehicles

9. Remote Support and Troubleshooting

- Internet access to monitor and control analog instrumentation
- Includes critical pressures and temperatures in the dryer, compressors, storage, and dispensers with a controller
- Particularly important when station maintenance is performed in-house

CNG Station Maintenance

The cost of maintaining the CNG fueling stations may increase over current levels with the expanded throughput associated with the Program. This only pertains to existing compressors and storage systems: as will be the case with the vehicles, any new fuel dispensing equipment purchased for the Program will be under warranty during the duration of the Program. CNG dispensing equipment is reliable and should not require high-cost maintenance for several years. Training for local technicians should be included as part of the contract to install the dispensing equipment.

Maintenance of CNG fueling station will vary depending on the decision to use in-house personnel or contract with an outside provider. In the NREL CNG Transit Survey, researchers found that small to medium-sized transit agencies tended to take on more maintenance in-house to reduce costs whereas larger agencies tended to outsource based on fuel-throughput. Since the transit agencies surveyed had five to 20 years of CNG station ownership experience, responders had time to develop and stabilize their maintenance approach. The following four maintenance methodologies were practiced by the 10 transit agencies interviewed by NREL:

1. Provide all or most CNG station maintenance using in-house personnel;
2. Provide light maintenance (walk-around inspections and possibly oil changes) using in-house personnel and contract specialized or more invasive maintenance and repair tasks on a fee-for-service basis;
3. Contract out most or all maintenance based on a fee-for-service or annual contract, which may include what amounts to an extended warranty on equipment; or
4. Contract out all maintenance based on a fuel-throughput charge, with minimum throughputs guaranteed by the transit agency; this contract typically includes what amounts to an extended warranty on equipment.

A NREL transit survey concluded that the comprehensive station maintenance cost unweighted average equaled $0.18/DGE, which is in line with other studies that show maintenance contracts generally in the $0.20-$0.30/DGE range. Note that the average is not adjusted for the number of buses in various fleets and thus is unweighted, meaning that a 50-bus fleet is given the same weight as a 2,000-bus fleet.

CNG versus Gasoline and Diesel Cost

Fuel costs will be lower during the first phase of the Program since CNG costs less per mile than gasoline or diesel. Program participants will need to work using the base natural gas system fuel cost from Enstar to develop a reasonable markup per gallon to provide funds for the station owner, depending on how the station usage contracts are written. State fuel cost projections are provided in the *Eco Fuel Tool Excel* file.

If 35 additional NGVs are included in the Program (25 light-duty and 10 medium-duty), CNG consumption should approach 4,030 GGE (gasoline gallon equivalent) per month. Assuming a CNG cost advantage of a minimum of $1.25 per GGE (estimated $2.25/CNG GGE vs. $3.50/gallon for the liquid fuels), a savings of approximately $5,000 per month will result for the participants.

Note if gasoline engines are used to power the CNG compressors, their fuel consumption must be either backed out of the total or separately metered. Not accounting for this could increase the apparent vehicle fuel consumption. In the NREL survey of transit fleets, the consumption amounted to approximately five to 10 percent of total fuel consumption.

Other Costs or Savings that can be Reasonably Expected to Accompany the Pilot Program

Finally, when considering the number of “moving pieces” in the Program as envisioned and detailed herein, we recommend the State designate one individual or a consultant to manage the Program. This Program Coordinator would be responsible for the details such as working with participating agencies on vehicle selection, site evaluations, getting multiple competitive bids and time estimates from suppliers, problem solving and intervention, monitoring progress, and ultimately communicating results. Without a dedicated individual, the diverse aspects of the pilot would be left to those who have other responsibilities, resulting in a Program, which at a minimum is less timely and coordinated, and the chance for success would be diminished. We estimate the fully burdened cost of this individual to be $150,000 for a one-year period.

Summary of Estimated Program Total Costs for Year-One

Table 19
Estimated Program Cost

Type Expense	Total Cost
25 State NGVs	$400,000
4 NGV School Buses	$240,000
4 NGV Trash Compactor Trucks	$240,000
2 Transit Buses	$160,000
2-Time Fill CNG Stations for DOT&PF	$800,000
Upgrading Existing CNG Fuel Infrastructure	$380,000
Estimated Fuel Cost Savings	-$60,000
Other Costs (staff, consultants, etc.)	$150,000
SUBTOTAL	**$2,310,000**
100% NGV Cost “Secondary Use Vehicles”	To be Determined
Fuel Management System Data Collection for Bulk Diesel and Gasoline Fuels	$3,000,000
TOTAL COSTS	**To be Determined**

APPENDICES

Resources and Citations

U.S. EPA

- Climate Leaders. Mobile Source Guidance. May 2008.
- Clean Diesel Program. http://epa.gov/cleandiesel/prgnational.htm
- School Bus Program. http://epa.gov/cleanschoolbus/funding.htm

U.S. Department of Energy Vehicle Technologies Program / Clean Cities

- www.cleancities.energy.gov
- What is Clean Cities? http://www1.eere.energy.gov/cleancities/pdfs/48384.pdf
- CNG Station Design Primer. Presented at Waste-to-Wheels: Building for Success Workshop on December 1, 2010, in Columbus, OH. http://www1.eere.energy.gov/cleancities/pdfs/ngv_wkshp_adams.pdf
- Federal Fleet Requirements
- http://.eere.energy.gov/femp/program/fedfleet_requirements.html
- http://eere.energy.gov/vehiclesandfuels/epact/index.html
- FuelEconomy.gov

U.S. Department of Energy Alternative Fuels Data Center (AFDC)

- http://afdc.energy.gov
- Alternative Fuel Excise Tax Credit. http://www.afdc.energy.gov/afdc/laws/laws/US/user/3264
- Alternative Fuel Infrastructure Tax Credit. http://www.afdc.energy.gov/afdc/laws/laws/US/incentive/3234
- Natural Gas Emissions. http://www.afdc.energy.gov/afdc/vehicles/emissions_natural_gas.html
- All Incentives and Laws http://www.afdc.energy.gov/afdc/laws/matrix/incentive

MIT

- The Future of Natural Gas, An Interdisciplinary MIT Study. Interim Report. June 2010. ISBN (978-0-9828008-0-5).

National Renewable Energy Laboratory (NREL)

- Business Case for Compressed Natural Gas in Municipal Fleets. Caley Johnson. NREL/TP-7A2-47919. June 2010.
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- Adams, R. and Horne, D.B. Compressed Natural Gas (CNG) Transit Bus Experience Survey. Golden: National Renewable Energy Laboratory. September 2010. afdc.energy.gov/afdc/pdfs/48814.pdf

Utah Energy Initiative

- Governor Herbert's 10-Year Strategic Energy Plan draft dated November 3, 1010.

http://utah.gov/emp/energydata/renewenergydata.htm

National School Bus Equity Investment Lease Program

- http://schoolbusmoney.org/. http://operationupcycle.org/

Argonne National Laboratory Transportation Technology R&D Center

- A Full Fuel-Cycle Analysis of Energy and Emissions Impacts of Transportation Fuels Produced from Natural Gas. December 1999.

Fairbanks Metropolitan Area Transportation System (FMATS)

- Donna Gardino, MPO Coordinator. http://www.fmats.alaska.gov/files/fmats101.pdf.

National Governors Association

- Lead by Example. Alternative Fuel and Vehicle Fleets. 2010 Update.

California Energy Commission

Clean Energy Fuels Corp.

- www.cleanenergyfuels.com
- Pickens Plan, Andrew Littlefair, Clean Energy
- NGV R&D Demonstration Deployment Recommendations, Michael Eaves, Clean Energy
- Market Development for Natural Gas, Mitchel Pratt, Clean Energy

Natural Gas Vehicles for America (NGVAmerica)

- www.ngvc.org
- Potential of Renewable Natural Gas, R. Kolodziej, NGV America

- NGV Journal. Fiat's CEO bets on CNG technology. June 12, 2010. http://www.ngvjournal.com/en/markets/item/3518
- NGV America Fact Sheet: Tax Incentives for Conversion. March 17, 2009.

North American Natural Gas Supply, American Clean Skies Foundation

- http://www.cleanskies.org/resources-supply.html

Southern California Gas Company

- Comparing natural gas vs. other fuels. http://www.socalgas.com/ngv/residential/fuelcomparison.html.

Washington Gas

- Frequently Asked Questions. http://www.washgas.com/pages/NaturalGasVehicles

Chesapeake Energy

- Natural Gas: Today's Abundant American Energy Solution

Alaska Waste

http://www.alaskawaste.net/news.htm

NGV Global News

- U.S. Congress Continues Incentives for NGVs. December 21, 2010. http://www.ngvglobal.com/us-congress-continues-incentives-for-ngvs-1221

Examiner

- President Obama signs H.R. 4853, extends several employee benefits set to expire. December 27, 2010. https://www.examiner.com/employee-benefits-in-philadelphia/president-obama-signs-h-r-4853-extends-several-employee-benefits-set-to-expire

Table 20
Summary of Interviews

Organization	Contacts	Overview of Fleet / NGV Experience
SEF	Diana Rotkis	▪ Has one Honda Civic NGV left from 1990s ▪ Time fill station would work ▪ Needs AWD models ▪ Express vans to transport elderly to doctors ▪ Dept. of Corrections vehicles ▪ Building maintenance ~15 vans
ENSTAR	Mark Slaughter, Inna Johansen, Nick Szymoniak	▪ They have no NGVs in their fleet ▪ Supportive of any project that will bring more natural gas to Cook Inlet market ▪ They have concerns about natural gas shortages during peak demand for winter 2010-2011
Anchorage School District	Steven Kalmes, Director Transportation Vehicle Maintenance	▪ 239 school buses o 1/3 are run in-house o 2/3 run by contractor, Forsythe Transportation ▪ Very happy with 2-Bluebird CNG buses ▪ Satisfied with current slow fill station ▪ No major issues ▪ Would like more NGVs if funding is available ▪ Very supportive of CNG Program
Anchorage Airport	Marc Luiken, Deputy Commission of Aviation, Dan Frisby, Mgr, Airfield Maint, Richard Swoboda, Asst Facilities Mgr, and about 7 others	▪ Fleet Manager has no interest in CNG for sweepers, plows, tugs, etc. ▪ Fleet manager has issue with garage retrofit cost ▪ Due to use of federal grants, ANC must get FTA approval to use its land for non-aviation fuel. Mr. Luiken believes a CNG station could be shared with potentially UPS and FedEx and within FTA guidelines

Organization	Contacts	Overview of Fleet / NGV Experience
Alaska RR	Dave Thompson (265-2544) Paul Farnsworth (265-2540) FarnsworthP@akrr.com	▪ The Railroad has two E350 bi-fuel vans that were converted in Utah ▪ They scrapped the 12-year-old municipal fast fill CNG facility and replaced it with a Fuelmaker time fill system ▪ Railroad is planning a transportation hub, which could be a potential fast fill public facility ▪ Mr. Farnsworth is very knowledgeable about NGVs ▪ Railroad is very supportive of the CNG Program
Municipality of Anchorage, Mayor's Office	Mayor Dan Sullivan	▪ Concerns that limited OEM NGVs are available ▪ High cost of conversion ▪ Potentially shortage of natural gas (no pipeline) ▪ They have hydro-electric project so maybe EVs might work better for Anchorage
Municipality of Anchorage, Public Works Fleet	Mark Warfield, Principal Admin Officer (343-4826) warfieldmh@muni.org	▪ They have 21 light-duty NGVs ▪ All conversions that were done before he took over ▪ Issues getting parts ▪ Doesn't know if garage was retrofitted ▪ They want OEM NGVs; no retrofits
Municipality of Anchorage, Transit	Gary Taylor (907) 343-8228 taylorga@muni.org	▪ City Transit, Ops and Maintenance Superintendent ▪ Retiring next Sept after 31 years ▪ 31 total staff: 3 leads, 6 journeymen, 4 apprentices, 3 body techs, 3 PM techs, 3 partsmen, and wash/shag and office ▪ Run 3 shifts ▪ 52 buses ▪ Likes to keep things simple, i.e. lease with Goodyear to standardize tires ▪ 540k fuel gallons projected in 2010 ▪ Can't see spending this much extra for an experiment o Basic bus $400k o CNG bus $600k o Hybrid Electric bus $800k ▪ Would entertain the idea with $ support, but they typically are not an "early adopter" for technology due to harsh environment and the need to keep the buses on the road

Organization	Contacts	Overview of Fleet / NGV Experience
Compressor Dealer, Ditch Witch	Charlie Bussell Charlie.bussell@alaska.net (907) 248-0010	■ Owner of DitchWitch of AK, also DW of HI ■ Just back from HI, spending more time there (he is in his upper 70's) ■ "Another Study?" ■ Has been involved in CNG since 1974 ■ Has invested over $260k ■ Hundreds of vehicles run, and has worked on just about every CNG station in the area ■ Extensive knowledge of stations from tiny 1.5 cfm to 25 cfm ■ Has run 5 cfm Ajax compressors extensively, to destruction, and this isn't a bad size for a small station for a small fleet ■ Built 25 cfm station for AK bus in Barrow ■ Built 2 skid-mount compressors for ARCO ■ Ran new 1981 Ford LTD over 400k miles on NG ■ The city ran some shuttle vans, about 12, back in the day ■ Thinks Enstar is ultimately concerned about opening discussion about their tariff to serve if it has to be modified for vehicles. ■ Enstar is also concerned about gas supply ■ He believes the pipeline will be built by Quanta/Price Gregory eventually ■ He led the Alaska Energy Authority and built two big Bureau of Reclamation projects, which were then turned over to the state, including the Bradley Hydro facility ■ Has some interest but these ventures always seem to go nowhere in the end
Municipality of Anchorage, Solid Waste	Mark Magden 1111 E 56th Avenue, Anchorage, AK 99518 907 343-6262	■ Landfill Operations/Solid Waste ■ They have 20% of the city and compete with AK Waste ■ Fleet is 100 vehicles, including tractors, compactors, a few support trucks ■ No alt fuel experience in their vehicles ■ On-site diesel fuel facility ■ Has 2 garages, 1 focused on garbage and 1 over-the-road ■ 8 mechanics ■ Not very interested, lots on their plate already just keeping things going with tight times and small staff

Organization	Contacts	Overview of Fleet / NGV Experience
Truckwell	Arnie Swanson (349-8845)	■ Owner of Truckwell, a vehicle upfitter ■ Ship-through upfitter for Ford and GM ■ 4-acre site, large 18k sq ft facility ■ Has been on the vehicle side of CNG since 1984 ■ Still has 4 of the 6 original techs he trained up on CNG from the peak period ■ Is still betting this could make a comeback with the right support ■ Failed in the past due to poor vehicle performance and the drivers could select gasoline. They did. ■ Lack of education with drivers, heavy tanks, gasoline was cheap ■ Involved in building the station at Tudor in the 80's ■ Built a cascade as well ■ MoGas was the old provider of the conversion kits for vehicles: poor ■ Has been talking to folks in TX about their progress ■ Has discussed a gas scrubber needed to reduce sulphur in the slope at the Kapanic field (Conoco/Phillips) ■ Has strong interest and would like to participate!

Table 21
User Incentives
Number of Clean Transportation Laws, Regulations, and Funding Opportunities
By Jurisdiction[47]

Jurisdiction	Vehicle Owner or Driver	Fleet Purchaser or Manager	Fueling or TSE Infrastructure Owner	Alternative Fuel Producer	Alternative Fuel Dealer	Alternative Fuel Purchaser	AFV Manufacturer or Retrofitter	Other
Alabama	2	5	1	3	1	2		2
Alaska	1	1			1	1		5
Arizona	11	13	3		1	1	1	5
Arkansas	4	8	1	2	3	2	1	
California	24	28	6	2		7	9	15
Colorado	7	1	6	2	3	3	1	1
Connecticut	2	11	4	2	2		3	3
Delaware	5	9	2		1	2		
Dist. of Columbia	5	5					1	1
Florida	8	11	4	9	4	3	4	7
Georgia	4	7	4	4	4	2		1
Hawaii	4	6	4	4	1	1	1	8
Idaho	1	3	1	3	3	5		
Illinois	1	19	7	6	5	5	1	5
Indiana	4	12	4	8	7	6	3	5
Iowa	4	8	8	5	7	1		4
Kansas	3	7	3	7	7	3		1
Kentucky	1	4	2	6	4	2	1	2
Louisiana	6	13	8	7	4	2	3	1
Maine	5	9	2	5	3	4	1	2
Maryland	8	8		1			1	2
Massachusetts	2	9	2	2	3	2	1	3
Michigan	2	4	3	4	5	1	3	8
Minnesota	4	9	6	4	4	2		7
Mississippi	3	6	2	2	4	3	2	
Missouri	5	9	4	2	2	2		1
Montana	3	4	2	5	4	3		3
Nebraska	4	5	1	4	3	3		1
Nevada	5	8		1	1	1		4
New Hampshire	3	6	1	2	2	2		2
New Jersey	7	8				1	1	1
New Mexico	3	1	3	4	3	3	2	4
New York	8	17	8	2	3	2	5	3
North Carolina	2	9	5	7	6	4	1	
North Dakota	2	1	5	4	8	1		3
Ohio	1	4	1	2	1		3	2
Oklahoma	7	1	9	5	2	2	2	5
Oregon	1	11	4	4	3	2	1	5
Pennsylvania	5	6	2	4	1	3	2	3
Rhode Island	3	5		1	1	1	1	
South Carolina	6	9	5	5	7	4	1	3
South Dakota		2	1	8	4	8		4
Tennessee	5	6	6	5	6	4		3
Texas	9	16	4	4	3	3		4
Utah	7	11	2		1	1	2	2
Vermont	3	7	1	1		1	2	2
Virginia	9	11	4	7	2	4	3	4
Washington	1	15	9	8	8	4	2	11
West Virginia	3	5	1	2	1	1		2
Wisconsin	4	9	3	1	6	4	1	4
Wyoming		1			1			
Totals	**26**	**461**	**172**	**189**	**167**	**128**	**74**	**171**
Count	**49**	**51**	**44**	**44**	**46**	**46**	**32**	**44**

Table 22
Technology and Fuel Incentives
Number of Clean Transportation Laws, Regulations, and Funding Opportunities
By Jurisdiction[48]

Jurisdiction	Biodiesel	Ethanol	Natural Gas	Propane (LPG)	Hydrogen Fuel Cells	EVs	HEVs or PHEVs	NEVs	Aftermarket Conversions	Fuel Economy or Efficiency	Idle Reduction	Other
Alabama	7	5	4	4	3	3	1			1	2	
Alaska	2	3	4	2	2	2		1	2	2		
Arizona	7	6	13	13	11	13	1	1			2	2
Arkansas	4	3	5	3	2	2			1	1	2	
California	13	1	25	16	22	3	23	3	5	5	4	8
Colorado	8	9	12	9	8	7	3	1	4	1	4	
Connecticut	5	4	7	5	7	6	5		3	2	3	3
Delaware	3	3	3	5	2	3	2	1		2	3	
Dist. of Columbia	1	2	4	3	3	5	3			2	1	1
Florida	12	13	3	3	7	7	3	1		1	2	1
Georgia	6	6	7	3	3	5			2	1	2	1
Hawaii	8	1	5	5	6	9	1	1		1	1	
Idaho	4	2	3	3	2		1	1		1		
Illinois	2	18	1	9	9	1	6	2	4	3	3	
Indiana	12	17	9	6	5	5	4	1	3	1	1	
Iowa	13	18	6	5	5	7		1	1	1		
Kansas	9	14	5	4	1	1		1	1	1	1	
Kentucky	8	8	6	4	1	1	1	1		1		
Louisiana	6	1	11	5	1	4	2	1	2	1		
Maine	7	7	4	4	3	4	1	1		1	2	1
Maryland	2	3	1	1		4	3	2			1	2
Massachusetts	9	9	7	5	5	6	5				1	1
Michigan	9	9	4	4	5	6	7			2	1	
Minnesota	9	11	3	2	4	5	2	2		1	2	1
Mississippi	4	4	7	5	2	2	1		1	1		
Missouri	8	6	7	6	5	4		1			1	
Montana	8	7	4	4	2	2		1	1	1		
Nebraska	5	6	4	3	2	2			1		1	
Nevada	6	5	7	7	6	6	5	1			1	
New Hampshire	7	3	3	3	3	3	2	1		1	3	
New Jersey	2	2	4	4	2	3	2	1		1	1	1
New Mexico	14	12	7	6	9	7	2	1	1	1	1	1
New York	9	1	13	8	9	9	4	1		1	3	2
North Carolina	13	11	6	6	5	6	3		1	1	3	
North Dakota	12	9	3	2	3			1				
Ohio	5	6	3	3	3	2			1		2	
Oklahoma	11	12	12	9	8	9	3	1	5		1	
Oregon	11	11	6	5	5	9	3	1	2	3	4	5
Pennsylvania	6	5	5	3	3	3	1		1	1	5	1
Rhode Island	2	1	2	1	2	2	1	1		1	1	3
South Carolina	11	9	3	4	7	2	3	1			2	
South Dakota	9	1	1	2								
Tennessee	11	1	5	4	2	4	4	1		2		
Texas	9	9	13	1	6	8	6	1	3		4	1
Utah	1	1	1	5	4	5	2		2		2	
Vermont	5	5	6	4	4	4	3	1	1	3	2	1
Virginia	14	1	12	9	1	1	3	1	3	3	2	1
Washington	18	14	9	8	6	19	6	1	4	2	3	3
West Virginia	5	5	5	5	5	5	1	1		1	2	
Wisconsin	11	8	7	7	6	5	3	2	1	1	3	
Wyoming		1	1									
Totals	**435**	**421**	**353**	**283**	**263**	**298**	**14**	**44**	**62**	**69**	**91**	**49**
Count	**50**	**51**	**51**	**50**	**48**	**47**	**39**	**36**	**26**	**37**	**40**	**20**

48 U.S. Department of Energy Alternative Fuels Data Center. All Incentives and Laws Sorted by Type. http://www.afdc.energy.gov/afdc/laws/matrix/incentive.

Table 23
Type Incentives
Number of Clean Transportation Laws, Regulations, and Funding Opportunities By Jurisdiction[49]

Jurisdiction	Grants	Tax Incentives	Loans and Leases	Rebates	Exemptions	Other
Alabama	1	1			1	1
Alaska						
Arizona	1	3			3	1
Arkansas	1		1		1	1
California	11		2	5	2	12
Colorado	3	2		1	2	2
Connecticut	5				2	2
Delaware		1		1	1	3
Dist. of Columbia					3	3
Florida	2	2	1		2	1
Georgia		5			1	3
Hawaii	1	2		1		
Idaho		2			1	1
Illinois	4			2	5	2
Indiana	4	6		2	1	1
Iowa	3	4	2			1
Kansas		6	1	2	3	
Kentucky	1	4				2
Louisiana	1	3	1			3
Maine		1			2	
Maryland		4			1	2
Massachusetts	1	1			1	1
Michigan	2	6			2	1
Minnesota	3	1	1		1	1
Mississippi	2			1		2
Missouri	3	1		1	2	2
Montana		7			1	
Nebraska		3	1	1	2	
Nevada					2	
New Hampshire	1				1	
New Jersey		2			1	1
New Mexico	1	3	1		1	2
New York	6	2		1	2	5
North Carolina	5	2	1		3	
North Dakota	2	6	1		2	
Ohio	4	1	2			
Oklahoma		6	2		2	1
Oregon		6	2		2	2
Pennsylvania	4	1	1	2	1	1
Rhode Island		2				
South Carolina	1	8		1	2	
South Dakota		3		1		
Tennessee	3			1	1	2
Texas	7	1		2		7
Utah	1	1	1		2	1
Vermont	1	1	1			2
Virginia	2	3	2		3	4
Washington	2	7	1		6	4
West Virginia				1	1	
Wisconsin	2	2		1	2	1
Wyoming						1
Totals	**113**	**139**	**29**	**27**	**76**	**85**
Count	**33**	**39**	**19**	**18**	**39**	**36**

49 U.S. Department of Energy Alternative Fuels Data Center. All Incentives and Laws Sorted by Type. http://www.afdc.energy.gov/afdc/laws/matrix/incentive.

Table 24
Codes, Standards, and Advisories Applicable to NGVs[50]

Document	Applicability	Comments
NFPA 52 – Compressed Natural Gas Vehicular Fuel Systems Code – 1998	**CNG vehicles (incl. marine) and fueling facilities**	**Probably the single best source of guidance for CNG vehicles and fueling facilities.**
NFPA 57 – Liquefied Natural Gas Vehicular Fuel System Code – 1999	LNG and L/CNG vehicles (incl. marine) and fueling facilities	Single best source of guidance for LNG vehicles and fueling facilities.
NFPA 88B – Standard for Repair Garages – 1997	All garages used for major repair and maintenance of motorized vehicles	Has some specific requirements for garages working with NGVs, such as ventilation, electrical requirements near the ceiling, temperature of exposed surfaces on heaters.
NFPA 88A – Standard for Parking Structures – 1998	Open, enclosed, basement and underground parking structures	No special requirements for NGVs other than reference to NFPA 52 and 57.
NFPA 30A – Code for Motor Fuel Dispensing Facilities and Repair Garages – 2000	Facilities dispensing **both** gaseous **and** liquid fuels at the same facility	Includes requirements of 88B.
NFPA 59A – Standard for the Production, Storage, and Handling of Liquefied Natural Gas – 1996	Site selection, design, construction, and fire protection for LNG facilities.	
SAE J1616 – Recommended Practice for Compressed Natural Gas Vehicle Fuel	CNG motor vehicle fuel	Recommendations on vehicular fuel composition.
SAE J2323 – Recommended Practices for LNG Powered Heavy Duty Trucks	LNG powered heavy duty trucks	Primarily heavy truck recommendations but some maintenance facility equipment and procedures.
SAE J2406 – Recommended Practices for CNG Powered Medium and Heavy Duty Trucks	CNG powered medium and heavy duty trucks (>14,000 GVWR)	Should be approved and published in 2002.
Design Guidelines for Bus Transit Systems Using Liquefied Natural Gas (LNG) as an Alternative Fuel (3/97)	Transit Facilities but useful reference for other fleets	FTA Report – Not only references required codes (e.g., NFPA) but also suggests additional precautions and provides general information.

[50] NexGen Fueling. List is not complete.

Document	Applicability	Comments
Design Guidelines for Bus Transit Systems Using Compressed Natural Gas as an Alternative Fuel (6/96)	Transit Facilities but useful reference for other fleets	FTA Report – Not only references required codes (e.g., NFPA) but also suggests additional precautions and provides general information.
Compressed Natural Gas Safety in Transit Operations (10/95)	Transit Facilities but useful reference for other fleets	FTA Report – Not only references required codes (e.g., NFPA) but also suggests additional precautions and provides general information.
Liquefied Natural Gas Safety in Transit Operations (3/96)	Transit Facilities but useful reference for other fleets	FTA Report – Not only references required codes (e.g., NFPA) but also suggests additional precautions and provides general information.
Uniform Fire Code – 1997	"The most widely adopted model building code in the US"	May be the fire code used in your area. Check with local fire marshal.
International Fire Code – 2000	"New" fire code	Check with local fire marshal on applicability.
CSA B108 99 Natural Gas Fuelling Stations Installation Code	Canadian Standard applicable to fleet and public stations	
CSA B108 99 Appendix B – Indoor Fuelling of Natural Gas Vehicles	Canadian Standard. Fueling facilities within a building that has primary functions other than fueling. Does not cover public stations.	Published August 2001.
CSA B109 01 – Natural Gas for Vehicles Installation Code	Canadian Standard. Applies to "installation, servicing and repair of NG fuel systems on self propelled vehicles."	
ANSI NGV1 1994 (with 1997 and 1998 addenda) – Compressed Natural Gas Vehicle Fueling Connection Devices	CNG vehicular fueling connection devices	Assures standardized nozzles and receptacles.
ANSI NGV2 2000 – Basic Requirements for Compressed Natural Gas Vehicle Fuel Containers	CNG fuel containers	Container requirements in addition to FMVSS 304.
ANSI NGV3.1 1995 – Fuel System Components for Natural Gas Powered Vehicles	Fuel system components for NGVs (excludes LNG components upstream of vaporizer)	Primarily for converted vehicles.

Document	Applicability	Comments
ANSI NGV4.1/ CSA 12.5 1999 – NGV Dispensing Systems	CNG vehicular fuel dispensing systems	
ANSI NGV4.2/CSA 12.52 1999 – Hoses for NGVs and Dispensing Systems	CNG dispenser and vehicular hose assemblies	
ANSI NGV4.4/CSA 12.54 1999 – Breakaway Devices for Natural Gas Dispensing Hoses and Systems	CNG dispenser shear valves and fueling hose emergency breakaway shutoff devices	
ANSI NGV4.6/CSA 12.56 1999 – Manually Operated Valves for Natural Gas Dispensing Systems	Manually operated CNG valves, excluding cylinder shut-off valves	
ANSI NGV4.8/CSA 12.8 2002 – Natural Gas Vehicle Fueling Station Reciprocating Compressor Guidelines	Compressor packages containing reciprocating compressors used in CNG fueling station service.	
ANSI PRD1 1998 (with 1999 addendum) – Basic Requirements for Pressure Relief Devices for Natural Gas Vehicle Fuel Containers	Pressure Relief Devices for CNG Fuel Containers	
CGA C 6.4 1998 – Methods for External Visual Inspection of Natural Gas Vehicle Fuel Containers and Their Installations	CNG vehicular fuel containers	Referenced in ANSI NGV2
49 CFR 178.56 – Specification 4AA welded steel cylinders	CNG cylinders for fueling stations.	Generally not used for new CNG fueling stations. ASME vessels now generally used.