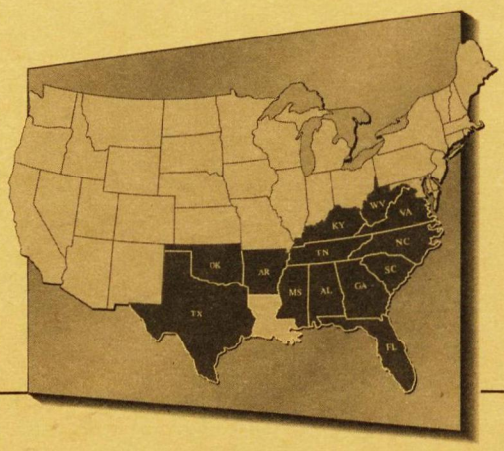
Alternative Fuel Vehicles:
A Guidebook for Local Governments



Produced for the
Conference of Southern County Associations

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CONVERTING FLEETS TO ALTERNATIVE FUELS A GUIDEBOOK FOR LOCAL GOVERNMENTS

INTRODUCTION

Many local governments in the nation are investigating fleet vehicles that operate on alternative fuels. Local governments are motivated to consider the use of alternative fuels for many reasons including legislative and regulatory requirements, cost savings, improved environmental conditions, or the desire to use a domestic (and sometimes even local) fuel source. As the United States strives to increase the use of alternative fuels, fleet vehicles are an ideal place to start. Fleet vehicles are typically centrally purchased and centrally refueled and have higher annual mileage and more frequent replacement schedules than personal vehicles.

Local governments face a multitude of questions as they consider alternatively fueled fleet vehicles. What type of fuel and technology should they use? Where can they purchase vehicles and fuel? How much will conversion cost? What are the operational requirements of these vehicles? Most local governments that use alternative fuel vehicles have begun to do so recently and do not have much documented operating experience to be drawn on to answer these questions. This Guidebook attempts to compile some of the operating experience and answer the questions faced by local government decision-makers as they consider using alternatively fueled vehicles for their fleets.

Section 1 of the Guidebook identifies the current and potential future legislative and regulatory requirements faced by local governments. Section 2 describes the non-regulatory reasons that a local government might consider converting its fleet to alternative fuels. Section 3 of the Guidebook describes alternative fuel options, including vehicle and fueling station technology, costs and benefits, operations and maintenance requirements, and commercial availability. Section 4 of the Guidebook discusses the implementation issues associated with fleet conversion and is designed to help each local government reach its own conclusions about how to proceed, providing the information and resources to accomplish this.

Appendix A of the report provides case studies of local governments in the South that use alternatively fueled vehicles. The case studies have been selected with the objective of representing various sized communities and kinds of programs. At the end of each case study is a summary of "Lessons Learned", which highlights what involved local government officials have indicated are important to a successful program. Appendix B of the Guidebook contains directions for a worksheet and three of the calculations of the payback period for alternative fuel vehicles. Appendix C contains a list of resources for more specific information about technologies, funding programs, etc., and Appendix D contains a glossary of acronyms and terms related to alternative fuels.

SECTION 1

THE REGULATORY DRIVERS

There are a number of reasons that local governments may consider converting their fleets to clean or alternative fuels. The most pressing reason for some local governments is regulatory – they may be required by the Clean Air Act Amendments of 1990 (CAAA) to purchase vehicles that emit less pollutants. In addition, the Energy Policy Act of 1992 (EPACT) may eventually require all local governments that meet certain size thresholds to purchase vehicles that use fuels other than those derived from imported oil.

What do the Clean Air Act Amendments say?

The Clean Air Act, initially passed in 1967, provided the legal foundation for a national program to control air pollution. The federal strategy to accomplish this goal was centered around a set of National Ambient Air Quality Standards (NAAQS) based on scientific determinations of the threshold levels of air pollution. In areas where ambient air quality is below threshold levels, the Act's objective is to prevent the future deterioration of air quality. In areas where air pollution exceeds the standards (i.e. "non-attainment"), the purpose of the Act is to authorize efforts to reduce air emissions to improve air quality and achieve compliance with NAAQS.

The Clean Air Act Amendments of 1990 (CAAA) establish tighter pollution standards for vehicle emissions.

The Clean Air Act Amendments of 1990 (CAAA) establish tighter pollution standards for vehicle emissions. EPA regulations promulgated pursuant to the CAAA address vehicle inspection and maintenance program requirements, vehicle fueling operations, vehicle fuel and fuel additives, maintenance of vehicle emission control systems, and clean fuel requirements for vehicle fleet operators.

One provision of the CAAA is specifically targeted at local government fleet vehicles. The CAAA require that all local governments that fall within the three highest levels of non-attainment for ozone or carbon monoxide convert their fleets to fuels that result in reduced emissions. Starting in model-year 1998, a percentage of all new fleet purchases in these non-attainment areas must be certified as a low-emission vehicle (LEV), ultra low-emission vehicle (ULEV), or a zero-emission vehicle (ZEV).

What are clean fuels?

The CAAA consider as clean fuel "[any] power source used in a clean fueled vehicle that complies with the standards and requirements applicable to such vehicle when using such fuel or power source." The CAAA specifically mention the following fuels:

- methanol;
- ethanol;
- other alcohols;
- reformulated gasoline;
- reformulated diesel (for trucks only);
- natural gas;
- liquefied petroleum gas (propane);
- hydrogen;
- electricity; and
- any other fuel that "complies with the standards and requirements applicable to such vehicle when using such fuel or power source."

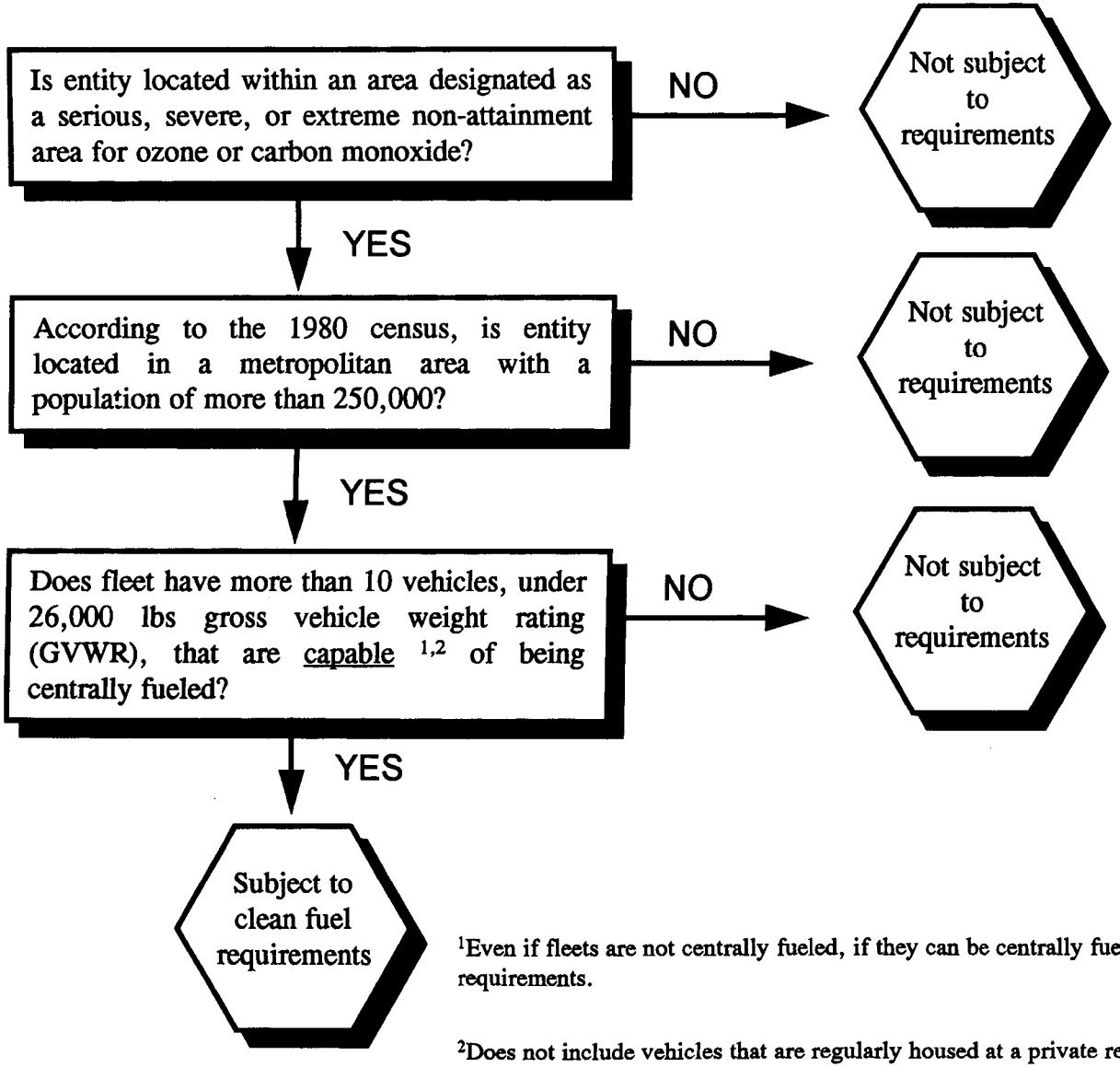
However, just because a vehicle operates on one of these fuels does not mean it meets the requirements of the CAAA. To qualify as a clean fuel fleet vehicle (CFFV), the particular model and engine must be certified by the U.S. Environmental Protection Agency (EPA). Currently, few OEMs and no converted vehicles are certified. Manufacturers, conversion firms, and local governments operating CFFVs that are not certified attribute the lack of certified vehicles to the cost and administrative requirements of the certification process.

Which local governments are subject to CAAA clean fuel fleet requirements?

The CAAA and subsequent regulations require that clean fuel fleet programs be instituted in serious, severe, and extreme non-attainment areas for ozone or carbon monoxide if the metropolitan area has a 1980 population of 250,000 or more. In these geographic areas, all public and private fleets with 10 or more vehicles that are fueled or capable of being fueled at a central location (not including vehicles that are regularly housed at a private residence) must begin to purchase Clean Fuel Fleet Vehicles (CFFVs). Figure 1.1 shows a process to determine whether a particular local government is subject to the CFFV purchase requirements of the CAAA.

As of December 1995, the Conference of Southern County Associations (CSCA) counties that are in areas designated as serious, severe, or extreme non-attainment areas for ozone are shown in Table 1.1 and Figure 1.2. No counties in the CSCA areas were categorized as serious, severe, or extreme non-attainment areas for carbon monoxide. Some communities that fall under a lower category of nonattainment have converted their fleets to demonstrate a commitment to improve air quality. It is important to note that the designation as a particular category of attainment can change over time depending on changing air pollutant levels. Any local governments in newly designated serious, severe, or extreme non-attainment areas are subject to clean fuel fleet requirements.

Figure 1.1
CAAA Criteria for Local Government Clean Fuel Fleet Requirements

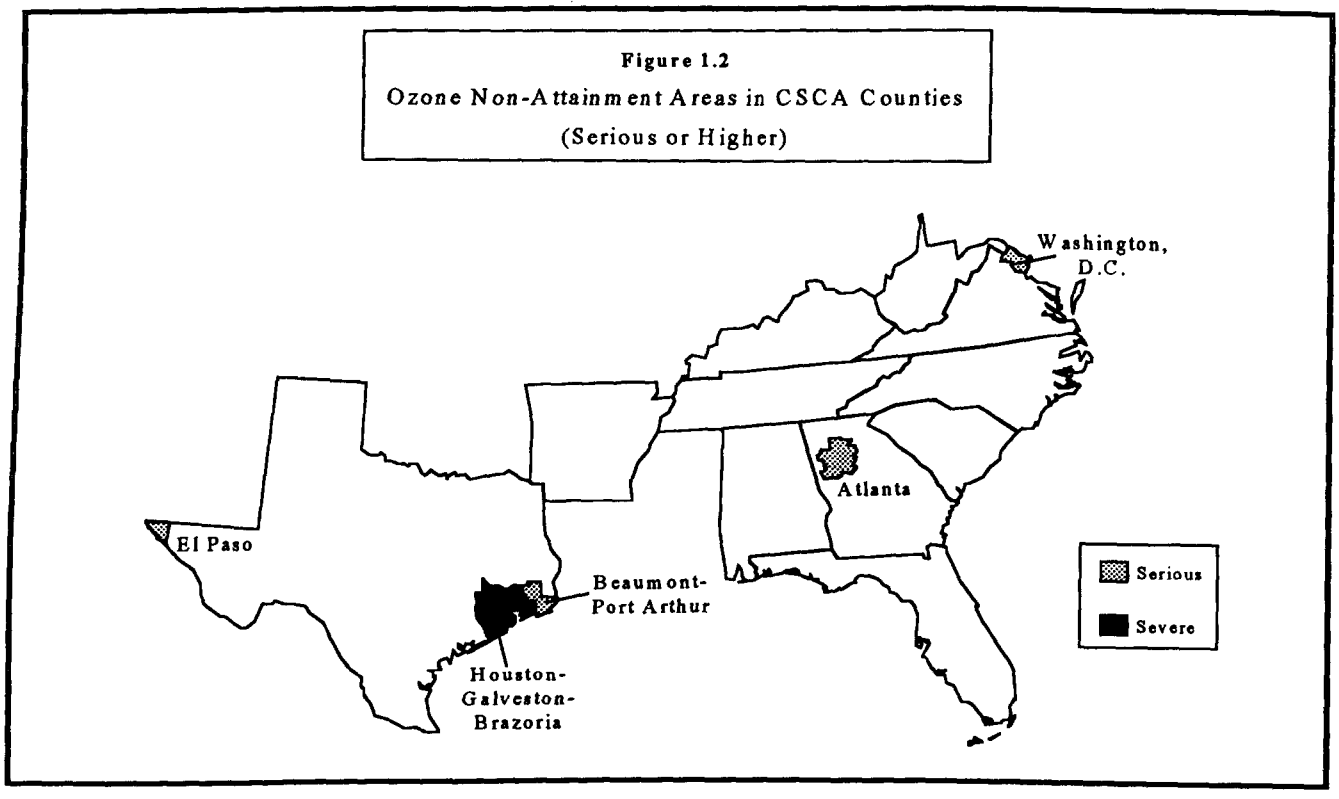


[1]Even if fleets are not centrally fueled, if they can be centrally fueled, they are subject to requirements.

[2]Does not include vehicles that are regularly housed at a private residence.

Table 1.1 CSCA Counties In Non-Attainment Areas

Metropolitan Area	Counties Affected	Designation
Atlanta, Georgia	Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Paulding, Rockdale	Serious
Beaumont-Port-Arthur, Texas	Hardin, Jefferson, Orange	Serious
El Paso, Texas	El Paso	Serious
Houston-Galveston-Brazoria, Texas	Brazoria, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller, Chambers	Severe
Washington, D.C. (Virginia Counties)	Arlington, Fairfax, Loudon, Prince William, Stafford	Serious



Which vehicles are subject to these requirements?

Starting in model year 1998, passenger cars and most categories of trucks and vans are subject to CFFV purchase requirements. Heavy duty vehicles up to 26,000 pounds gross vehicle weight rating (GVWR), including buses, also are subject to requirements. The following types of vehicles are excluded:

- motor vehicles held for lease or rental to the general public;
- dealer demonstration vehicles that are used solely for the purpose of promoting motor vehicle sales, either on the sales lot or through other marketing or sales promotions, or for permitting potential purchasers to drive the vehicle for pre-purchase or pre-lease evaluation;
- emergency vehicles (defined as vehicles authorized to exceed the speed limit);
- law enforcement vehicles;
- nonroad vehicles (farm and construction vehicles);
- vehicles that are garaged at a personal residence and are not being centrally fueled;
- vehicles used for motor vehicles manufacturer product evaluations and tests;
- any vehicle with a GVWR greater than 26,000 lbs; and
- vehicles in fleets with less than 10 vehicles.

Although these types of vehicles are exempt from the purchase requirements, many local governments still buy CFFVs for some of these purposes, especially for emergency and law enforcement vehicles, to help them maximize the benefits realized.

When does a local government have to begin to purchase CFFVs?

A specified percentage of new vehicle purchases must be CFFVs.

If a local government answers "yes" to all the questions in Figure 1.1, it must begin to purchase vehicles certified as CFFVs in model-year 1998. A specified percentage of new vehicle purchases must be CFFVs. The required percentage for vehicles under 8,500 pounds GVWR starts at 30 percent and increases through the year 2000 to 70 percent of all new purchases. For vehicles between 8,500 and 26,000 pounds GVWR, the percentage remains at 50 percent starting in 1998. Table 1.2 shows the schedule for local governments to convert their fleets to clean fuels.

Table 1.2 Purchase Requirements of the CAAA

Model Year	Percent of New Vehicle Purchases Which Must be CFFVs	
	GVWR Less Than 8,500 lbs	GVWR Between 8,500 and 26,000 lbs
1998	30	50
1999	50	50
2000 and beyond	70	50

What options does a local government have to meet regulations?

Regulations can be met through new vehicle purchases, conversion of existing vehicles to use clean fuels, or through the purchase of conversion credits (see below). However, either new or converted vehicles must be certified by EPA to count toward the purchase requirement in the CAAA. Because of the limited availability of new clean fleet fuel vehicles, many local governments are converting new or existing conventionally fueled vehicles. Local governments either perform these conversions themselves or through a contract with a private entity.

What incentives does the CAAA provide?

The CAAA of 1990 allow affected entities to earn credits for purchasing certified CFFVs before model-year 1998, purchasing more certified vehicles than required in any year, or purchasing vehicles certified to have stricter emission standards than required. Credits can be applied to future years or sold or traded against fleet vehicle purchasing requirements within the same non-attainment area. The fleet owner or operator only accrues credits if purchases exceed the required amount or type of vehicle for basic compliance.

Table 1.3 illustrates one way credits can be used. In this case, purchasing two CFFVs per year for two years prior to the effective date of the requirements allows a local government to ease into the transition to CFFVs and reduces required purchases in future years. Rather than purchase fewer than the number of CFFVs required in the year 2000, the fleet manager could have sold or traded the credits with another fleet manager in the non-attainment area.

Table 1.3 Example of CFFV Credit Use[1]

Model Year	Vehicles in Fleet	CFFVs in Fleet	Annual Purchases	Required CFFV Purchase	Actual CFFV Purchase	Credit Accrued
1996	100	-	10	-	2	+2
1997	100	2	10	-	2	+4
1998	100	4	10	3	5	+6
1999	100	9	10	5	5	+6
2000	100	14	10	7	5	+4

[1] The number of credits per vehicle may be greater or less than one depending on the size of the vehicle and the emission standard met (LEV, ULEV, or ZEV).

What does the Energy Policy Act of 1992 say?

The Energy Policy Act of 1992 (EPACT) is intended to reduce the United States' dependence on imported crude oil by encouraging the use of

The Act requires the use of AFVs by federal and state governments and alternative fuel providers. Other private and local government fleets may be required to purchase AFVs in the future, if alternative fuel targets are not met.

domestic fuels. The goal is to replace at least 10 percent of motor fuels by the year 2000 and 30 percent by the year 2010 (on an energy equivalent basis). This Act mandates the use of alternative fuel vehicles (AFVs) and provides incentives to help with compliance. The Act requires the use of AFVs by federal and state governments and alternative fuel providers. Other private and local government fleets may be required to purchase AFVs in the future, if alternative fuel targets are not met.

What fuels qualify as alternative fuels?

Alternative fuels are fuels that reduce dependence on imported crude oil. With a few exceptions (see Table 3.1), alternative fuels are the same as clean fuels. Specifically, EPACT considers the following alternative fuels:

- methanol;
- ethanol;
- higher alcohols;
- blends of alcohol with gasoline or other fuels as long as at least 85 percent by volume is alcohol;
- compressed natural gas;
- liquefied petroleum gas (propane);
- hydrogen;
- fuels derived from biomass;
- liquid fuels derived from coal; and
- electricity.

Dual and flexible fuel vehicles qualify and there is no requirement that the vehicle operate on the alternative fuel.

Are local governments subject to the alternative fuel vehicle requirements?

Ultimately, EPACT requirements may impact more local governments in the South than the CAAA.

Ultimately, EPACT requirements may impact more local governments than the CAAA. Initially, local governments are not required to purchase alternative fuel vehicles (AFVs) according to EPACT. However, if local governments are included in the mandate, all local governments that meet the population and fleet size thresholds will be covered.

The decision about whether or not local governments will be subject to these requirements will depend on how well current fleet conversion requirements are implemented. The federal government was scheduled to begin purchases of AFVs in 1993, with 7,500 AFVs purchased, and increase to 75 percent of all new purchases by 1999 and beyond. State governments are supposed to purchase AFVs, starting with 10 percent of all new purchases in 1996 and increasing to 75 percent in the year 2000.

EPACT provides two opportunities for the U.S. Department of Energy (DOE) to implement rules requiring local governments to purchase AFVs. The first date for rulemaking is December 15, 1996, if DOE determines that such a mandate is necessary to meet the alternative fuel goals of EPACT. If the DOE does not issue a rule by this first deadline, it may finalize a later rulemaking for local governments to purchase AFVs by January 1, 2000. DOE anticipates having a proposed rule issued for comment in July 1996. However, it is unlikely that the final rule will be issued before December 15, 1996. Thus, local governments will probably not be subject to AFV requirements prior to 2002.

If rulemaking is implemented for local governments, the requirements will apply to all fleets with at least 20 vehicles that can be centrally fueled, are operated in a metropolitan area with a population of at least 250,000 (1980 census), and are controlled by an entity that controls at least 50 such vehicles in the United States. Figure 1.3 illustrates a process to determine whether a local government is subject to the requirements to purchase AFVs under potential EPACT requirements.

Which vehicles are subject to the requirements?

Light duty vehicles with a GVWR of 8,500 pounds or less, including passenger cars, pick-up trucks, and vans, are subject to alternative fuel purchase requirements. Exempted vehicles are those held for lease, dealer vehicles held for resale, law enforcement vehicles, emergency vehicles, defense vehicles, non-road vehicles (farm and construction), and those normally garaged at personal residences at night. If the goals are not met, modified fleet requirements may subject law enforcement vehicles and urban buses to the alternate fuels requirements.

If subject to the requirements, when would local governments have to purchase AFVs?

If the rules are issued by December 15, 1996 (which is unlikely as described above), then local governments would be required to begin purchasing AFVs in model-year 1999. Twenty percent of new vehicle purchases in 1999 would be AFVs, increasing to 70 percent in model-year 2006 and beyond. Table 1.4 shows the AFV purchase requirements for each sector according to EPACT. If DOE takes the second opportunity to implement rules (by January 1, 2000), the percentages for local governments would be 20 percent of all new purchases in model-year 2002, escalating to 70 percent in model year 2005 and beyond.

Figure 1.3
Energy Policy Act Criteria for Local Government AFV Fleet Requirements

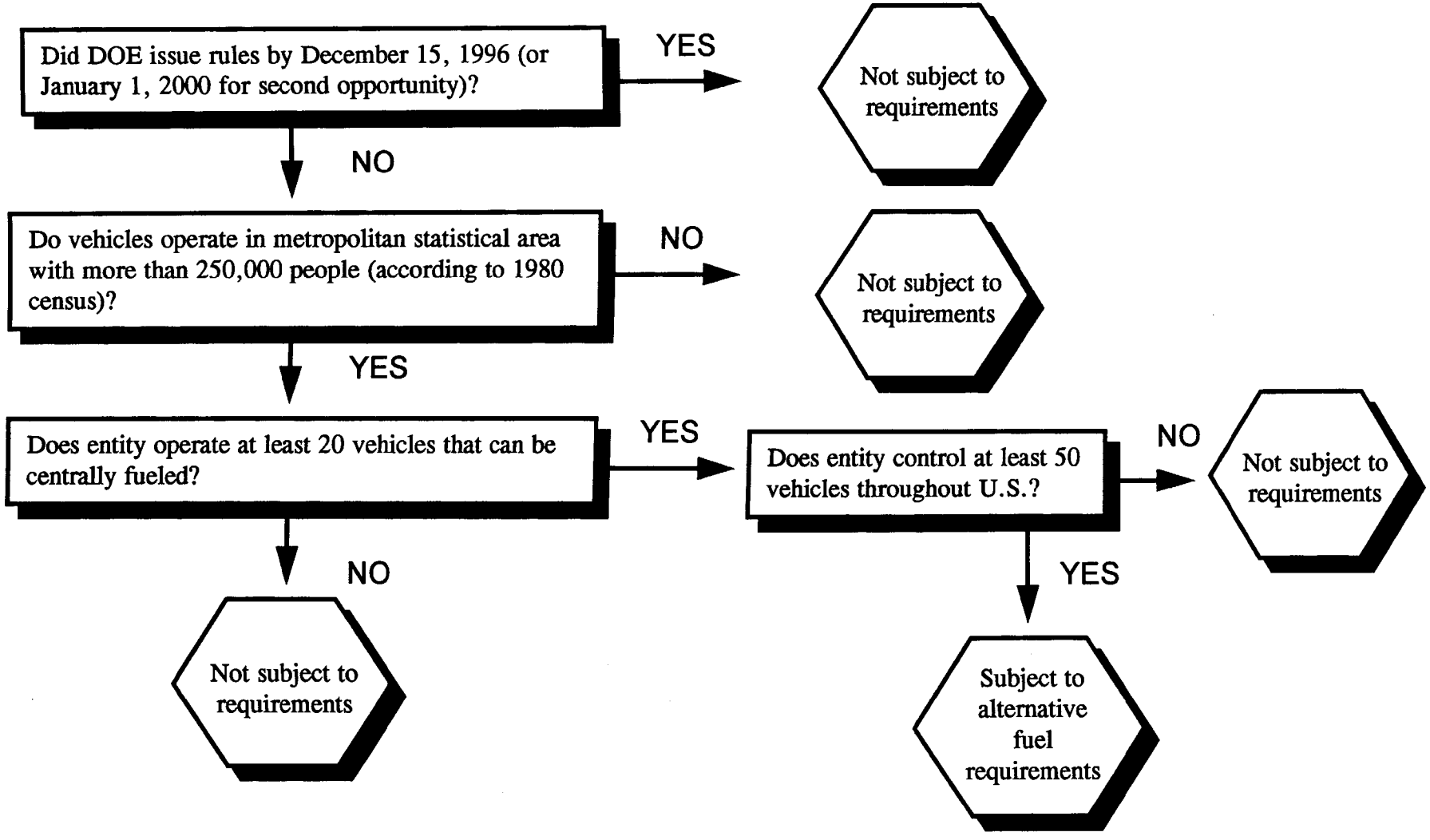


Table 1.4 Purchase Requirements of EPACT

Percent of New Vehicle Purchases[1]				
Year	Federal	State	Alternative Fuel Provider	Local/Private[2]
1993	7,500 vehicles			
1994	11,250 vehicles			
1995	15,000 vehicles			
1996	25	10	30	
1997	33	15	50	
1998	50	25	70	
1999	75	50	90	20
2000	75	75	90	20
2001	75	75	90	20
2002	75	75	90	30
2003	75	75	90	40
2004	75	75	90	50
2005	75	75	90	60
2005 and beyond	75	75	90	70

[1] Except 1993-1995 is number of vehicles.
[2] If DOE issues rules by December 15, 1996.

What incentives are provided by EPACT?

Like the CAAA, EPACT provides for credits for fleets operators that purchase qualified vehicles earlier or in greater quantities than required by the Act. For example if a county purchases ten AFVs prior to 1999, the County could apply the credits received for those vehicles to offset future purchases or sell the credits to another fleet. Unlike the CAAA, which limits the exchange of credits within the non-attainment area, EPACT permits credits to be transferred nationwide. EPACT credits and CAAA credits are not transferable since EPACT does not set an emission related standard.

EPACT authorizes DOE to establish guidelines for states to implement alternative fuel vehicle incentive programs. Ten million dollars per year has been authorized (for five years from the date of enactment) for this program. As of early 1996, the guidelines for fundable programs were being finalized. If funds are appropriated, they can be passed through states to local governments.

EPACT offers income tax deductions for the cost of AFVs depending on the weight and type of vehicle. The tax deductions range from $2,000 for passenger cars weighing less than 10,000 pounds GVWR to $50,000 for heavy trucks, vans, and buses. EPACT also provides for low interest loans for the incremental costs of purchasing AFVs or for

converting vehicles to alternative fuels. Providers of alternative fuel refueling facilities, including facilities dedicated to recharging electric vehicles, are eligible for a tax deduction of up to $100,000 for the year the facilities are placed into service. There are additional tax credits, deductions, and subsidies for electric vehicle projects.

What additional federal incentives are available?

The Congestion, Mitigation, and Air Quality Improvement Program, administered by the U.S. Department of Transportation, reimburses state or local governments for up to 80 percent of the cost of public alternative fuel vehicles and fueling infrastructure. This $6 billion program, established in the Intermodal Transportation Efficiency Act, is primarily intended to improve air quality by improving traffic flow. Funded programs must be in a non-attainment area, identified as a strategy in the State Implementation Plan, and demonstrate air quality benefits or reduce traffic congestion. CMAQ funding extends for two years beyond attainment to allow local governments a transition period. Houston, Texas tapped into these funds for their alternative fuel vehicle programs (see case study in Appendix A).

The Congestion, Mitigation, and Air Quality Improvement Program, administered by the U.S. Department of Transportation, reimburses state or local governments for up to 80 percent of the cost of public alternative fuel vehicles and fueling infrastructure.

What is the role of state governments?

State governments are required to prepare State Implementation Plans defining a strategy for improving air quality and demonstrating compliance with National Ambient Air Quality Standards. The CAAA require states with serious, severe, or extreme non-attainment areas to revise their State Implementation Plans to include clean-fuel fleet programs. These programs must comply with the Federal Clean Fuel Fleet requirements. States implement and enforce the programs defined in their State Implementation Plans. States are also responsible for administering CAAA credit programs.

Many states have deregulated the sale of alternative fuels and/or exempted these fuels from all or a portion of the motor fuels tax. Some states offer tax credits or deductions for capital expenses related to alternative fuel development or vehicle conversion. Several states require that state agencies, local governments or private companies purchase a certain percentage of alternative fuel vehicles.

The most common role of states is to offer grants or loans to local governments and others that purchase alternative fuel vehicles or develop fueling infrastructure. The City of Houston used grant funds from the State to purchase vehicles and develop infrastructure (see Appendix A). The money for many of these programs comes from oil overcharge funds from the U. S. Department of Energy or the Congestion, Mitigation, and Air Quality

Improvement Program. However, several states have appropriated funds from their own budget for alternative fuels programs.

Because each state has different Clean Fuel Fleet Program requirements and incentives, it is important for local government fleet operators to work with their State regulatory officials. Table 1.5 summarizes alternative fuel programs and contacts in the CSCA states.

Who else offers incentives?

Some private entities (mostly utilities) offer incentives for conversion. For example, Atlanta Gas Light Company, Western Kentucky Gas, Mississippi Valley Gas, and several North Carolina utilities offer a cash rebate for a portion of conversion costs or incremental purchase costs of natural gas vehicles. Virginia Power offers a special rate for recharging electric vehicles.

Table 1.5 State Clean Fleet and Alternative Fuel Programs and Contacts

State	Programs	State Energy Office
Alabama	Alternative Fuels Program provides grants up to $25,000 per project with 50% match for converting fleets to alternative fuels or purchasing original equipment manufacturers (OEMs).	Alabama Dept. of Economic and Community Affairs (334) 242-5294 Contact: Russell Moore
Arkansas	Alternative Fuels Commission established to promote alternative fuel use and assist the State to implement a state energy strategy. In 1994, the responsibilities of the Commission were transferred to the Arkansas Energy Office. $250,000 fund rebates up to 50% of the cost of converting vehicles to CNG, LPG, alcohol.	Arkansas Energy Office (501) 682-7377 Contact: Morris Jenkens
Florida	Clean fuels pilot program encourages State to convert their fleet to alternative fuels with goal that all vehicles must operate on the most efficient, least polluting alternative fuels by the year 2000. Created the Florida Gold Coast Clean Cities Coalition which must submit a plan for converting or replacing 30,000 conventionally fueled vehicles with alternatively fueled vehicles in Broward, Dade, and Palm Beach Counties by December 31, 1996. $2.5 million to support low interest loans for AFVs/CFFVs in the Gold Coast Clean Cities Coalition (maximum loan: $5,000 to $30,000 depending on vehicle size and type). $1.1 million available for local government grants. Certain suppliers of CNG are exempt from regulation as a motor fuel. $2 million for state agencies to convert vehicles to AFVs or to pay the incremental cost of AFVs. State and local governments exempt from the AFV annual decal fee. All electric vehicles purchased between July 1, 1995 and June 30, 2000 are exempt from sales tax. AFVs exempt from emissions inspection requirements. Electric vehicles exempt from insurance surcharges.	Florida Energy Office, Dept. of Community Affairs (904) 922-6086 Contact: Jane Rickey

Table 1.5 State Clean Fleet and Alternative Fuel Programs and Contacts (Continued)

State	Programs	State Energy Office
Georgia	Removed authority from the Public Service Commission to regulate the sale of CNG to the public for use as a motor fuel. Require additional fee for a permit to dispense CNG for vehicular fuel. The City of Atlanta established a Clean Cities organization, working towards conversion of vehicles to alternative fuels. Issued guidelines to ensure compliance with the CAAA and EPACT with ultimate fleet conversion of 70% of new vehicles purchased by the year 2000 in the Atlanta nonattainment area for state, local, and private fleets. Zero interest revolving loan program available to public entities to fund conversions and incremental cost of purchases. A companion grant program provides $400,000 (in 1993, $300,000 anticipated in 1994) to public entities for vehicle conversion and infrastructure improvements - limited to $25,000 per applicant.	Georgia Environmental Facilities Authority, Division of Energy Resources (404) 656-5176 Contact: Elizabeth S. Robertson
Kentucky	Requires the sale of reformulated gasoline in nonattainment areas beginning in 1995. Removed authority of Public Service Commission to regulate the rates, terms, and conditions for the sale of CNG as a transportation fuel to an end user.	Kentucky Division of Energy (502) 564-7192 Contact: John Stapleton
Mississippi	Deregulated natural gas for use as a motor vehicle fuel. Program to use cotton waste to make ethanol.	Mississippi Dept. of Economic and Community Development (601) 359-6600 Contact: Carl Burnham
North Carolina	Requires state agencies to study the use of alternative fuels in state-owned vehicles and establish a CNG demonstration project. Implements the reformulated gasoline requirements of the CAAA. Requires that all CO nonattainment areas must comply with the 2.7 weight percent oxygen content for oxygenated gasoline from November through February. Motor fuels tax exemption for non-anhydrous ethanol.	North Carolina Energy Division (919) 733-2230 Contact: Al Ebron

Table 1.5 State Clean Fleet and Alternative Fuel Programs and Contacts (Continued)

State	Programs	State Energy Office
Oklahoma	Deregulated sale of CNG, LNG, and LPG for use as a motor vehicle fuel. Alternative fuels exempted from excise taxes. Instead, alternative fuel vehicles are assessed a $100 per vehicle fee annually. No sales tax is imposed on CNG. Income tax credit for the purchase (10 percent of cost up to $1,500) or conversion (50 percent of cost) of fleet vehicles to alternative fuels. $1.5 million revolving loan fund with zero interest to reimburse state, county, and municipal governments and school districts for alternative fuel vehicles and for the installation of fueling facilities. Repayment with fuel savings achieved by fleet. If price of alternative fuel does not remain below price of conventional fuel replaced, repayment is suspended.	Oklahoma Dept. Of Commerce (405) 841-9365 Contact: Gordon Gore
South Carolina	CNG sold by retailers for transportation can be sold at unregulated prices.	Budget and Control Board State Energy Office (803) 737-8030 Contact: Howard Coogler Tom Hodkins
Tennessee	Resolution to urge development of "environmentally sensitive domestic alternative fuels."	Tennessee Energy Division Dept. of Economic and Community Development (615) 741-2994 Contact: Terry Ellis

Table 1.5 State Clean Fleet and Alternative Fuel Programs and Contacts (Continued)

State	Programs	State Energy Office
Texas	Requires state agencies with more than 15 vehicles to purchase alternative fuel vehicles if fuel is available and does not cost more, reaching 90 percent of total fleet by 1998. In nonattainment areas, metro transit authorities and local governments with fleets of 15 or more (excluding emergency vehicles) and private fleets of more than 25 vehicles must meet low emission vehicle (LEV) exhaust standards. By 1998, 30% of new purchases or 10% of total fleet must meet LEV standards; by 2000, 50% of new purchases and 20% of total fleet must meet LEV standards; by 2002, 90% of new purchases 45% of total fleet must meet the LEV standards. Transit authorities in nonattainment areas must have 50% LEVS by 1996 and 90% by 1998. $50 million in revenue bonds, issued by the Texas Public Finance Authority, for alternative fuel projects. Funds available to school districts, state agencies, and mass transit authorities to cover capital costs on installing refueling systems, modifying engines or purchasing new vehicles that run on alternative fuels. Natural gas and propane exempt from sales tax when sold as motor vehicle fuel. Mobile Emissions Reductions Credit Program applies to purchases of low emissions vehicles. The credits may be sold, traded or banked within the same nonattainment area. The distribution of program credits began on September 1, 1994. Rebates from City of Austin/Southern Union Gas, Entex, Atmos for purchase of CNG AFVs. City of Austin rebates for any AFV.	General Services Commission State Energy Conservation Office (512) 463-1931 Contact: Craig Davis
Virginia	No-charge licensing for AFVs. Exemption from HOV-lane use restriction. Revolving fund provides loans for publicly owned alternative fuel vehicles. Fund renewed in 1994 with appropriation of $750,000. Vehicles manufactured to run on CNG, LPG, hydrogen, or electricity are exempt from 1.5 percent of the sales tax. Provides tax credits of 10% of federal clean fuel tax deduction allowed for clean fuel vehicles and refueling property to corporations, individuals and public service companies.	Mines, Minerals and Energy Energy Division (804) 692-3226 Contact: Susie Thomas

Table 1.5 State Clean Fleet and Alternative Fuel Programs and Contacts (Continued)

State	Programs	State Energy Office
West Virginia	Grant program (up to $10,000) for conversion by local governments, school boards, and transit authorities. Requires 50 percent matching. Require state and local governments with 15 or more vehicles to acquire alternative fuel vehicles. In FY 1995, 20 percent of vehicle acquisition must be AFVs/CFFVs, increasing to 50 percent in 1997 (75 percent in 1998 if cost effective). Sale of CNG as motor vehicle fuel deregulated by State.	WV Dept. Of Administration (304) 558-2614 Contact: Ken Miller

SECTION 2

ECONOMIC AND ENVIRONMENTAL DRIVERS

As of the end of 1995, only 30 counties in the states covered by the Conference of Southern County Associations (CSCA) were required by the CAAA to purchase CFFVs. However, other local governments in these states, including Jefferson County, Kentucky and Thomson, Georgia (see case studies in Appendix A) had purchased or converted to alternative fuel vehicles (CFFVs/AFVs) and even more were planning to do so. These local governments are motivated for reasons other than legislation or regulations. These other reasons include economics, environmental improvement, or the desire to use a domestic or local fuel source.

What are the economic reasons for converting to alternative fuels?

Although the up-front costs to purchase alternative fuel vehicles and construct any necessary infrastructure is likely to be higher than continuing to purchase conventionally fueled vehicles, many local governments that use CFFVs/AFVs have realized long-term savings primarily due to reduced fuel and maintenance costs. This is more likely to be the case if the vehicles are driven enough that the lower operating costs make up for the higher capital costs. Generally, a local government must consider the following costs:

- the relative costs of the conventional and alternatively fueled vehicles;
- the cost of providing a refueling station if none are sufficiently available;
- the cost of alternative versus traditional fuel;
- operation and maintenance costs between alternative and conventional vehicles;
- administrative costs, including training staff and monitoring the program; and
- any tax credits/incentives to use CFFVs/AFVs.

Section 4 provides local governments decision-makers with guidance on performing an economic analysis of converting fleets to alternative fuels.

In what situations are the economics for conversion favorable?

The capital costs of CFFVs/AFVs are usually higher than gasoline or diesel vehicles. Since some clean or alternative fuels cost less than gasoline or diesel, each mile results in savings. Thus, the more miles that a CFFV/AFV is driven, the more operational savings can offset the higher capital costs.

How can capital costs be reduced?

One of the most costly components of operating some CFFVs/AFVs is construction of a refueling station. For compressed natural gas, for example, there must be a pipeline to access the fuel source, at least one compressor at each site, and a dispensing mechanism. This can cost several hundred thousand dollars for a single site. In a large geographic area or for many vehicles, more than one refueling station may be needed, although a single refueling station may be adequate if all CFFVs/AFVs are centrally fueled.

The economics of using CFFVs/AFVs are greatly improved if refueling stations are already readily accessible to the fleet. Private companies may already have refueling locations (for example, for propane) or be willing to develop them with a commitment that local governments will be purchasing CFFVs/AFVs. For example, in the City of Houston (see case study in Appendix A), the private sector was willing to finance and construct a fueling station, knowing that the City would be purchasing CFFVs/AFVs as required by the Clean Air Act Amendments (CAAA).

The economics of using CFFVs/AFVs are greatly improved if refueling stations are already readily accessible to the fleet.

Even if the fuel is available but has never been used for vehicles, all that may be needed is the dispensing mechanism, thus greatly reducing the cost of providing a refueling station. The compressor in the natural gas delivery system is by far, the most expensive component of the natural gas refueling system. If the compressor is already in place and only the pumps must be added, the cost of the refueling station is greatly reduced.

If a local government owns a utility that can provide vehicle fuel, most commonly the case with natural gas, using alternative fuels may be more attractive. The fuel supply and cost may be more predictable. The cost may be lower due to the purchase of large amounts for many other energy uses. In addition, using fuel provided by a local utility contributes to the local economy. Finally, another condition that makes alternative fuels more economical is a grant or low-interest loan program that contributes to the cost of new vehicles and/or refueling stations.

What are the environmental reasons for converting to alternative fuels?

More than 80 percent of urban air pollution is attributed to automobile emissions. Tailpipe and evaporative emissions from cars and trucks consist of hydrocarbons, carbon monoxide, and nitrogen oxides. CFFVs/AFVs generally emit less pollutants than conventionally fueled vehicles. This is the reason that Clean Fuel Fleet Vehicles (CFFVs) are required in the regions of the country with the worst air pollution problems. Emissions from electricity, natural gas, or alcohol-powered vehicles can be up to 90 percent lower in toxins and ozone forming hydrocarbons than emissions from conventionally fueled vehicles.

Converting local government fleets may only make a minor difference in air quality in an area. Jefferson County, Kentucky (see case study in Appendix A) estimates that the conversion of 500 vehicles will result in a 200 pounds per day reduction in air emissions. However, the use of CFFVs/AFVs by government can promote the use of alternative fuels in other sectors by demonstrating the costs and benefits of alternative fuels and by promoting the development of refueling locations. If other sectors are convinced to convert their fleets based on the experience of the local government, the net effect could be a noticeable improvement in air quality.

The conversion of fleet vehicles by government can promote the use of alternative fuels in other sectors by demonstrating the costs and benefits of alternative fuels and by promoting the development of refueling locations.

What other reasons may a local government have for converting their fleet?

Alternative fuel fleets can be a very visible step for a local government to take to demonstrate a commitment to improved environmental quality.

Several private and quasi-private entities, like utility companies and the United States Postal Service, have converted their fleets, in part to satisfy their customers. Local governments have customers too – the constituents. Generally, as long as it doesn't cost too much, citizens report that they support measures to improve the environment. Alternative fuel fleets can be a very visible step for a local government to take to demonstrate a commitment to improved environmental quality. For example, the transit authority in Jefferson County, Kentucky (see case study in Appendix A) reports that customer complaints about noise and smoke provided the impetus for switching to alternative fuel buses. To maximize the public relations benefit, local governments should publicize their use of CFFVs/AFVs. At a minimum, all public CFFVs/AFVs should be clearly marked.

The motivation for including requirements for alternatively fueled fleets in EPACT is to reduce dependence on oil imports. In recent years, the United States has imported more than half of the oil we use. Thus, some fleets may be converted to use a domestic rather than an imported fuel source.

SECTION 3

THE TECHNOLOGY

There are a dozen different types of fuel that qualify as clean fuels or alternative fuels, only several of which are in wide commercial use. Each of these fuels has distinct advantages and disadvantages which a fleet manager must consider when evaluating conversion.

What are Clean Fuels and Alternative Fuels?

Both the Clean Air Act Amendments of 1990 (CAAA) and the Energy Policy Act of 1992 (EPACT) list fuels that meet their requirements (although any fuel that results in the vehicle meeting emissions requirements qualifies under the CAAA as long as the vehicle using the fuel is certified). For the most part, the listed fuels are the same. One exception is that reformulated gasoline and diesel qualify under the CAAA but not under EPACT because they do not reduce dependence on imported oil. Another exception is that fuels derived from biomass and coal qualify under EPACT but not the CAAA because they are not necessarily cleaner fuels. Table 3.1 identifies the types of fuels that qualify according to the two laws.

Table 3.1 Clean Fuels and Alternative Fuels

Fuel	Clean Fuel per CAAA?	Alternative Fuel per EPACT?
Electricity	✓	✓
Ethanol	✓	✓
Methanol	✓	✓
Higher Alcohols	✓	✓
Natural Gas	✓	✓
Propane	✓	✓
Reformulated Gasoline	✓	
Reformulated Diesel	✓	
Liquefied Petroleum Gas	✓	✓
Hydrogen	✓	✓
Fuels Derived from Biomass		✓
Fuels Derived from Coal		✓

What are the characteristics of each of the clean and alternative fuels?

The five most commonly used alternative fuels in vehicles are **electricity, ethanol, methanol, compressed natural gas, and propane.**

Electrically powered vehicles have rechargeable batteries onboard which power an electric motor. The batteries are recharged from electrical outlets which are supplied by local power generation sources, for example, coal, natural gas, nuclear, hydropower, or renewable resources.

Ethanol is produced from grain or other agricultural product. The available fuel types include E85 (85 percent denatured ethanol and 15 percent gasoline) for light duty applications and E95 (blend of 95 percent denatured ethanol and 5 percent gasoline) for heavy duty applications.

Methanol is an odorless clear liquid produced from gas, coal, or biomass. The available fuel types are M85 (a blend of 85 percent methanol and 15 percent gasoline) used in light-duty applications and M100 (pure methanol) which currently is used only for heavy-duty applications.

Compressed Natural Gas is extracted from underground reserves and composed primarily of methane gas.

Propane is liquefied petroleum gas, a byproduct of natural gas processing or petroleum refining. The fuel is usually a mix of at least 90 percent propane, 2.5 percent butane and higher hydrocarbons, and 7.5 percent ethane and propylene.

What is the difference between vehicles that operate on both alternative and conventional fuels and single fuel vehicles?

There are two kinds of vehicles that can operate on conventional and alternative fuels: bi-fuel and dual fuel vehicles. Bi-fuel vehicles are able to operate on either the alternative or the conventional fuel. In these vehicles, the driver can switch fuel types if the vehicle is running low on alternative fuel and is far from a refueling location. Dual fuel vehicles run on a mix of alternative and conventional fuel. These vehicles are usually heavy-duty diesel vehicles.

Dedicated vehicles run only on alternative fuels. These vehicles tend to have better performance and improved emissions since they are designed and tuned specifically to run on the alternative fuel instead of having to accommodate two fuels. To date, only dedicated vehicles have been certified to comply with the CAAA.

How available is the technology for each of these fuels?

For an alternative fuel to be an option for a fleet, both the vehicles and the fuel must be readily available. Local governments cite the lack of a consistent, available supply of fuel or vehicles as one of

For an alternative fuel to be an option for a fleet, both the vehicles and the fuel must be readily available. Local governments cite the lack of a consistent, available supply of fuel or vehicles as one of the main reasons they are hesitant to convert.

the main reasons they are hesitant to use CFFVs/AFVs. Although several of the major automobile manufacturers are producing CFFVs/AFVs, several local governments report difficulty in getting the vehicles delivered when needed. In addition to assured availability, most local governments want to see historic operating experience before investing in a particular technology. Table 3.2 describes the current availability of and experience with the technology for each of the major fuel types.

Will the technology become more readily available?

As more government and private entities commit to purchase clean or alternative fuel vehicles, it is likely that the private sector will manufacture more vehicles and invest in refueling infrastructure. In addition, the CAAA has set manufacturing requirements for CFFVs/AFVs in California, which may serve as an example for the rest of the country. By model year 1996, automobile manufacturers must produce at least 150,000 clean-fueled cars; for model year 1999 and beyond, manufacturers must produce at least 300,000 clean-fuel vehicles.

If the technology is not readily available, local governments are likely to get a break. The CAAA states that purchase requirements may be delayed if vehicles meeting emission standards are not available.

What are the operational issues associated with each fuel?

In addition to the availability of vehicles and fuel, a fleet manager must consider the performance, reliability, and maintenance requirements of the vehicles. Although experience with some of these technologies is limited, there is a distinct difference in the issues associated with each fuel. Table 3.3 lists the major operational issues with each fuel.

How safe are the alternative fuels?

The National Highway Traffic Safety Administration (NHTSA) within the U.S. Department of Transportation is authorized to assure safe performance of alternative fuel vehicles. NHTSA issued rules, effective September 1, 1995, containing safety standards for manufactured natural gas and propane vehicles. Rules effective March 27, 1995 cover standards for compressed natural gas containers. Some states and industries have issued standards for compressed natural gas and propane conversion kits, as well.

The National Fire Protection Association (NFPA) also has standards regarding the installation of conversion kits that some states have adopted as law. NFPA 52 emphasizes general compressed natural gas equipment qualifications; engine fuel systems compressed natural gas compression, storage, and dispensing; and residential fueling facilities. NFPA 58 has similar contents for propane.

Table 3.2 Availability of Alternative Fuel Technology

Fuel	Vehicle Availability	Vehicle Experience	Fuel Availability
Electricity	Chrysler and Ford began offering minivans in 1994. Solectria offers pickup and sedan. Conversions available in larger metro areas. Chevrolet taking orders for electric pick-up trucks available early 1997.	An estimated 2,300 vehicles were operating in U.S. in 1995.	Sources of power can be obtained from electrical outlets, or special connections to electric outlets in homes or businesses.
Ethanol	Ford began offering E85 flexible-fuel sedans in 1994. M85 vehicles can be converted by adjusting fuel metering system. Heavy-duty compression-ignition engines can be converted to E95.	An estimated 900 vehicles were operating in U.S. in 1995.	Fueling locations are currently sparse: 36 stations in U.S. and none in CSCA states. E95 only available through bulk suppliers.
Methanol	Ford and Chrysler began offering M85 flexible-fuel sedans in 1994. Detroit Diesel offers a heavy duty compression-ignition engine.	An estimated 25,000 vehicles were operating in U.S. in 1995.	Fueling stations are currently sparse: 88 stations in U.S. and 7 in CSCA states. M100 can be obtained through bulk suppliers in most major cities.
Compressed Natural Gas	Bi-fuel and dedicated vans, minivans, and light trucks are available from Ford and Chrysler. Larger sedans are available as of 1995. 15 other manufacturers produce compressed natural gas specialty buses and service vehicles. Conversion technology readily available throughout urban areas of country.	An estimated 66,000 vehicles were operating in U.S. in 1995.	Fueling stations for compressed natural gas can be found in most major cities and in many rural areas. Over 1,000 refueling stations nationally and 314 in CSCA states in 1995.
Propane	Ford offers factory installed conversion packages for medium-duty trucks. Conversion technology readily available throughout urban areas of country.	An estimated 272,000 vehicles were operating in U.S. in 1995.	Fueling locations in most areas: 3,385 nationally and 1,059 in CSCA states.

Table 3.3 Performance and Maintenance Requirements of Alternative Fuel Vehicles

	Range and Performance	Maintenance	Fueling requirements
Electricity	Cars have reported range up to 90 miles; trucks have reported range up to 60 miles. Battery weight limits payload.	Battery packs replaced every 30,000 miles or 3 years. Less downtime and maintenance than gasoline vehicles. No tune ups or oil changes. Tires may need more frequent replacement due to vehicle weight. Battery water requires frequent checking.	Hours for battery to recharge.
Ethanol	Range lower than comparable gasoline vehicle. Power, acceleration, payload, and cruise speed comparable to gasoline.	Requires slightly more expensive special lubricants available by direct order from supplier. Replacement parts must be compatible. Local dealers provide maintenance assistance.	Same as gasoline or diesel.
Methanol	Range about half of comparable gasoline vehicle. Power, acceleration, and payload all comparable to gasoline.	Requires slightly more expensive special lubricants available by direct order from supplier. Replacement parts must be compatible. Local dealers provide maintenance assistance.	Same as gasoline or diesel.
Compressed Natural Gas	Range at least one-half of comparable gasoline vehicles. Power, acceleration, payload, and cruise speed are comparable to gasoline.	Longer use life than gasoline vehicles. Fewer tune-ups and oil changes.	"Slow" fill takes up to 8 hours; "quick" fill takes 3-5 minutes for compressed natural gas.
Propane	Range almost equal to gasoline. Power, acceleration, payload, and cruise speed are comparable to gasoline.	Slightly longer use life than comparable gasoline vehicle. Generally lower maintenance costs.	Refueling comparable to gasoline. Tanks are filled to 80 percent to allow for expansion.

What are the capital costs of converting fleets to each alternative fuel?

The two main capital costs of converting to alternative fuels are 1) the cost to purchase new vehicles or to purchase and install conversion kits and 2) the cost for a refueling station. Assuming that the alternative fuel vehicles will replace existing vehicles, rather than be new additions to the fleet, the net cost of vehicles is the cost between the alternative and the conventionally fueled vehicle. All types of alternative fuel vehicles, whether purchased new or converted, currently are more expensive than comparable gasoline or diesel powered vehicles. For ethanol or methanol, the increase in cost is $500 to $2,000 for the special fittings that are required to use these fuels in a conventionally fueled vehicle. For compressed natural gas or propane, conversion kits cost several thousand dollars. Because the most expensive part of these converted vehicles is the tank, the increase in cost depends on the size and number of tanks. Average electric vehicle conversions cost an estimated $7,000, while new electric vehicles are estimated to cost several times more than equivalent gasoline models.

All types of alternative fuel vehicles, whether purchased new or converted, currently are more expensive than comparable gasoline powered vehicles.

Some fuels require a costly refueling station or other infrastructure. A new refueling station for compressed natural gas can cost several hundred thousand dollars although small fleets may be able to use a small compressing unit for a fraction of the cost.

The total cost of refueling stations depends on how many are needed which, in turn, depends on the number and range of the vehicles. The cost may be reduced, or eliminated, depending on the existing infrastructure. For example, the City of Thomson only needed one refueling station (see case study in Appendix A) to serve its 36 vehicles. Because the City already operated a natural gas system, it only needed to add a compressor and dispenser at its maintenance facility. Still, the cost to add this totaled $35,000 in 1979.

Tables 3.4 and 3.5 contain more information on capital costs associated with each fuel.

What are the operating costs of each alternative fuel?

The cost of ethanol and methanol is generally higher than for gasoline. Compressed natural gas, propane, and electricity are generally less expensive than gasoline or diesel (on a fuel equivalent basis).

The main operating costs of alternative fuel vehicles are fuel costs, maintenance costs, and costs resulting from other changes in operations. The fuel cost of ethanol and methanol is generally higher than for gasoline. Compressed natural gas, propane, and electricity are generally less expensive than gasoline or diesel (on a fuel equivalent basis). However, relative fuel costs vary tremendously based on location and over time. Fleet prices for some fuels may be different than prices paid by individuals since local governments may have contracts with local utilities or companies.

Table 3.4 Relative Costs of Alternative Fuels

Fuel	Fuel Cost	Vehicle Cost	Other Costs
Electricity	Depends on local utility rates, usually less than gasoline.	Estimates for conversion as high as $25,000, average $7,000. New cars and pick-up trucks low $30,000s.	Minimal cost for charging facility. New battery costs $3,000 to $4,000. Service and diagnostic equipment if no access to commercial maintenance facility.
Ethanol	About twice the cost of gasoline.	Conversions from $500 to $2,000. Up to $250 more than gasoline vehicles, due to special fittings.	Approximately $250 per hose more for nickel plate at refueling station.
Methanol	About 50 percent more than gasoline.	Flexible fuel vehicle cost an estimated 7 percent more than equivalent gasoline vehicle. Up to $250 more than gasoline vehicles, due to special fittings.	Approximately $250 per hose more for nickel plate at refueling station.
Compressed Natural Gas	About three-fourths of gasoline, depending on local utility rates. Seasonal variations in price.	Conversion cost averages $2,700 to $5,000 per vehicle. Cost for new vehicle averages $3,500 to $7,500 more than comparable gasoline vehicle.	Completely new refueling facility costs up to $350,000. Service and diagnostic equipment if no access to commercial maintenance facility.
Propane	Bulk purchase can offer fuel savings over gasoline. Seasonal variations in price.	Averages $1,000 to $2,500.	Comparable to gasoline refueling station. Service and diagnostic equipment if no access to commercial maintenance facility.
Source: Burmeister, George and Katherine Mahoney, Alternative Transportation Fuels: Options for State Legislatures, State Legislative Report Vol. 17, No. 9, May 1992.			

Table 3.5 Capital Costs of Four Conversions [1]

	Jefferson Co., KY	Thomson, GA	Houston, TX	Broward Co., FL
Vehicles	$4,000 - $5,000 [2,3]	$1,200 [4]	$5,000 [5]	$4,000 [6]
Refueling Station	existing station used	$35,000 [7]	private	private

[1] See case studies in Appendix A.

[2] Including installation by contractor.

[3] $5,000 - $10,000 for trucks.

[4] Installed by city; labor cost (estimated to be one person for one day) not included.

[5] Difference in purchase price between gasoline and natural gas vehicle.

[6] $1,800 per vehicle for propane.

[7] In 1979.

Maintenance costs for electric, compressed natural gas, and propane vehicles tend to be less than for gasoline powered vehicles. With fewer carbon deposits, alternate-fueled vehicles need fewer oil changes and tune-ups (none for electric vehicles). With ethanol and methanol, maintenance costs are likely to be slightly higher since special lubricants are required which cost a little more than for gasoline powered vehicles.

A fleet manager must also consider changes in operations that may lead to changes in costs. Because many alternative fuel vehicles must be refueled more frequently and refueling stations are likely to be less accessible, drivers may spend more time refueling. This loss in productivity may cost some local governments more money. In addition, training of technicians and drivers is a cost.

Table 3.4 describes the operating costs for each of the fuels.

What is the net economic result of these capital and operating costs?

Every local government documents different net costs and savings resulting from the use of alternative fuels. The City of Thomson, Georgia, who has operated alternative fuel vehicles for 15 years, reports a net savings primarily attributed to reduced fuel costs and reduced maintenance costs. Broward County, Florida reports similar reductions in costs. On the other hand, the City of Houston, Texas, claims that it does not see a significant cost savings resulting from the use of alternative fuels. Section 4 includes some guidance on performing a cost analysis, and Appendix B has an example of cost analysis to convert a fleet to natural gas.

SECTION 4

CREATING AND OPERATING AN ALTERNATIVE FUEL FLEET

Each local government will need to consider different factors when considering alternative fuels. For some local governments, long-term savings may drive decisions. For others, availability of equipment may determine when and how they shift to alternative fuel. This section assists local government decision makers in answering questions that may arise when considering fleet conversion.

How do we choose a fuel type?

Section 3 describes the availability, performance, maintenance, availability, and costs associated with the five most commonly used alternative fuels. This information should be used as a guide for each local government to evaluate which fuel type best meets its needs. Table 4.1 provides further guidance on fuel choices based on the criteria of most importance to a local government. Some of the most important factors, such as the accessibility of a fuel source or maintenance capabilities, will vary from area to area. In most cases, the answer will not be straightforward because most local government decision makers have more than one criterion to meet.

Table 4.1 Choosing a Fuel

If you want to	Then choose ...
Reduce air emissions	Electricity (which, depending on the fuel source, has the potential for zero emissions).
Reduce conversion costs	Ethanol or methanol
Reduce life cycle costs	Compressed natural gas or propane (if vehicles are driven enough miles to break even)
Provide readily accessible refueling locations	The fuel that a private entity or the local government has committed to provide.
Use a domestic fuel source	Electricity, ethanol, or compressed natural gas.
Avoid reducing vehicle range	Propane
Use a fuel with the most fleet experience	Compressed natural gas or propane

What are the legal requirements for conversion?

Section 88.306-94 of the Code of Federal Regulations states the requirements for a converted vehicle to qualify as a clean fuel fleet vehicle (CFFV). Vehicles meeting these requirements are certified through an EPA testing program which is similar to the current test procedures for new

gasoline powered vehicles. This procedure ensures that the converted vehicles do indeed result in cleaner emissions.

How do we determine how much switching to alternative fuel vehicles will cost or save?

For local governments that are not required to purchase alternative fuel vehicles (CFFVs/AFVs), the decision may be based, at least in part, on the cost to convert to clean or alternative fuels. Although initially it will cost more to convert fleets to alternative fuels, in the long run, the costs may be more than offset by savings. Therefore, it is important to consider short- and long-term costs and savings resulting from switching to CFFVs/AFVs.

Although initially it will cost more to convert fleets to alternative fuels, in the long run, the costs may be more than offset by savings. Therefore, it is important to consider short- and long-term costs and savings resulting from the conversion.

Figure 4.1 shows one way to perform a life cycle cost analysis of switching to alternative fuel.[1] At a minimum, this analysis should be performed for typical fleet replacement with conventionally fueled vehicles and compared to the alternative fuel vehicles of choice. A life cycle cost analysis could be done for each fuel being considered to aid in decision-making. A local government may use this analysis to make decisions about fuel types or to inform decision-makers about the fiscal impact of conversion.

A simpler method to assess the costs of conversion is to calculate how many miles a vehicle must travel before the typically lower fuel costs make up for the typically higher capital costs. Figure 4.2, from the United States Department of Energy's *Guide to Alternative Fuel Vehicle Incentives and Laws*, shows how this is calculated. Appendix C contains directions on how to use this worksheet and three calculations of the payback period for alternative fuel vehicles. These worksheets account for any incentives received from government or a private entity but do not consider reduced maintenance costs.

Who should convert existing vehicles?

Alternative fuel vehicles can be purchased directly from the manufacturer. The City of Houston (see case study in Appendix A) reports that only the vehicles that were originally manufactured with the alternative fuel equipment (and not those converted from conventionally-fueled vehicles), showed improved emissions over the conventionally-fueled vehicles. However, because of limited availability, local governments more commonly add conversion kits for natural gas and propane after the original conventionally-fueled vehicle has been purchased.

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[1] Economic Analysis of Alternative Fuels and Vehicles, from an Unidentifiable Source.

Figure 4.1
Life Cycle Cost Analysis

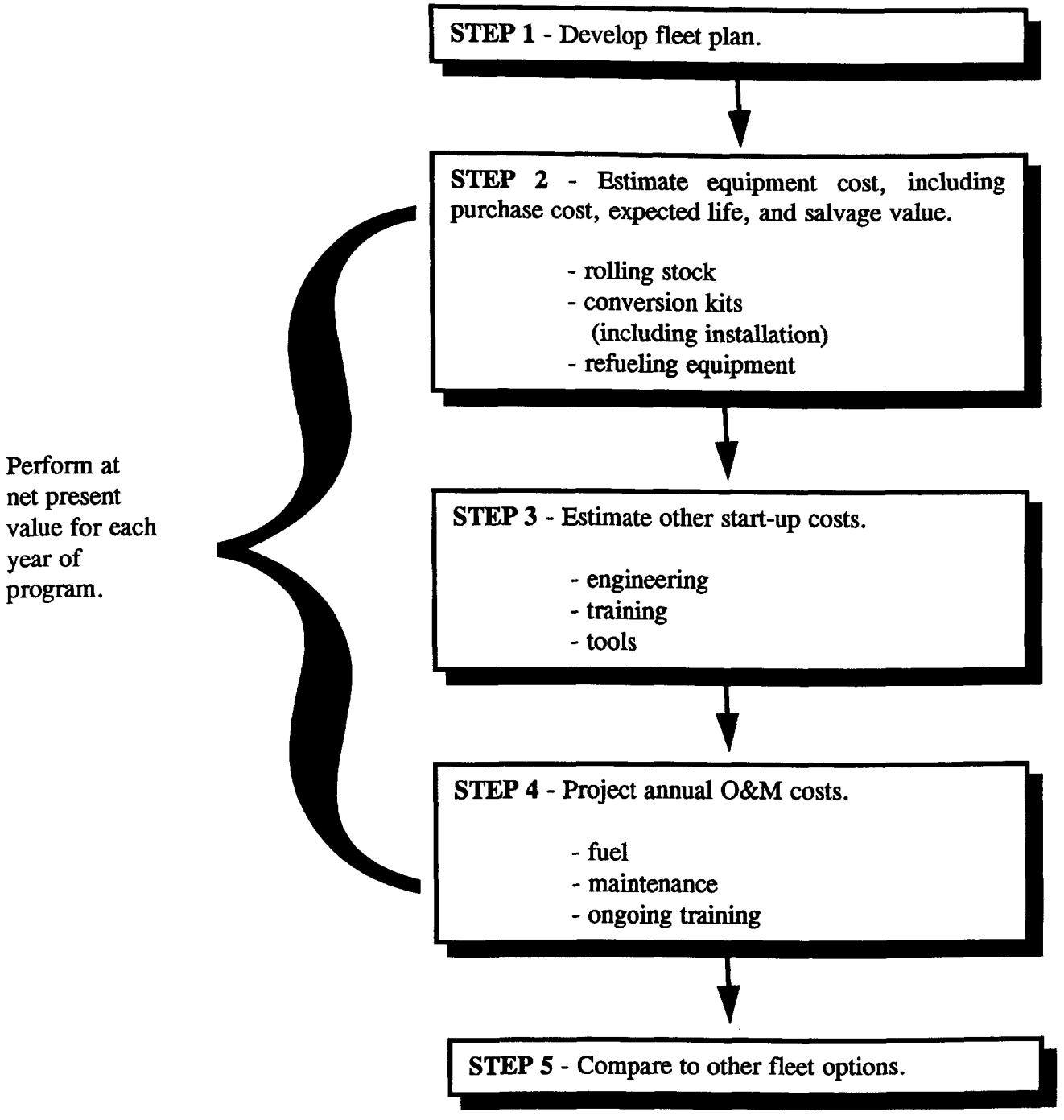

FIGURE 4.2

ALTERNATIVE FUEL VEHICLE INCENTIVES AND LAWS

AFV FUNDING WORKSHEET -- State of _____

PART 1 - Sources of Funding	Amount You Expect to Receive
I. State Incentives	
_____	$
_____	
_____	
II. Utilities/Private Incentives	
_____	+ $
_____	
_____	
III. State Laws & Regulations	
_____	+ $
_____	
_____	
IV. Federal Tax Incentives	
_____	+ $
_____	
_____	
Total Funding	= $

PART 2 - Payback Period

1) To calculate an AFV's payback period, you first need to know the Incremental Cost of that vehicle compared to a comparable gasoline vehicle:

$ _____ (Initial Cost of AFV) − $ _____ (Cost of Comparable Gasoline Vehicle) = $ _____ (Incremental Cost *) 1a

* NOTE: If you are converting existing fleet vehicles, then substitute the conversion cost for the Incremental Cost.

2) Subtract from the Incremental Cost, box 1a, the Total Funding from the box at bottom of Part 1 to get the Net Incremental Cost.

$ _____ (Incremental Cost (from box 1a)) − $ _____ (Total Funding (from part 1)) = $ _____ (Net Incremental Cost) 2a

3) To find the $ per mile fuel cost, divide your fuel cost per gasoline gallon equivalent (gge) by your vehicle's miles per gallon (mpg). Do this calculation for both gasoline and the alternative fuel.

a) gasoline: $ _____ ($ per gallon) / _____ mpg (vehicle mpg) = $ _____ ($ per mile fuel cost) 3a

b) alternative fuel: $ _____ ($ per gge) / _____ mpg (vehicle mpg) = $ _____ ($ per mile fuel cost) 3b

c) electric: $ _____ ($ per kWh) / _____ mi/kWh (vehicle miles per kWh) = $ _____ ($ per mile fuel cost) 3c

4) Then subtract the $ per mile fuel cost of your alternative fuel from the $ per mile fuel cost of gasoline to find your $ savings per mile.

$ _____ ($ per mile fuel cost gasoline (from box 3a)) − $ _____ ($ per mile fuel cost alternative fuel (from box 3b or 3c)) = $ _____ ($ savings per mile) 4a

5) Then divide the Net Incremental Cost, box 2a, by the $ savings per mile, box 4a, to get the payback period for your AFV in terms of miles.

$ _____ (Net Incremental Cost (from box 2a)) / $ _____ ($ savings per mile (from box 4a)) = _____ miles (Payback in miles)

Local governments can either install conversion equipment themselves or contract with someone else. Conversion kits used by fleet operators must be certified by EPA or the California Air Resources Board (CARB) in order to avoid tampering violations. Thomson, Georgia (see case study in Appendix A) fleet mechanics have been installing their own conversion kits for over a decade. The conversion kits cost $1,200 and it takes one person one day to install them (barring any unforeseen problems). Jefferson County, Kentucky contracts with several private firms to install the equipment, at a cost of $4,000 - $5,000 for the kit and installation. Jefferson County strictly monitors the performance of the installer by performing a safety and workmanship inspection on every vehicle, in addition to emissions tests before and after installation. Broward County, Florida initially installed the kits themselves and then decided to contract for the installation.

The decision on who converts vehicles depends on the number of vehicles to be converted, the capabilities of the local government and local contractors, and the relative costs of each approach. If a contractor is used, the local government will need to closely monitor every installation. Conversion companies have to register with EPA and be certified as a qualified converter. Local government should require that EPA Memo 1A, that lays out requirements for conversion, are followed. Local governments can get this memo through EPA's Office of Mobile Sources (313-668-4310). Finally, the local government should ask the contractor to provide the results of emissions tests before and after conversion, any warranties regarding the conversion, and any changes to the vehicle warranty resulting from conversion.

Who should own and operate the refueling station?

If the local government owns a utility that provides the fuel that will be used (for example, natural gas), it may make sense for it to provide the refueling stations.

If the local government owns a utility that provides the fuel that will be used (for example, natural gas), it may make sense for it to provide the refueling stations. Thomson, Georgia, which owns a gas utility, operates its own single refueling station at its maintenance garage. On the other hand, private companies may already have refueling stations (for example, for propane) or be willing to provide them. For example, in the City of Houston, the private sector offered to construct a sufficient number of refueling stations for the City's compressed natural gas fleet. If a private company provides the refueling stations, the initial capital cost to local government to use CFFVs/AFVs may be significantly reduced because often, a refueling station, is one of the largest expenses. A local government should negotiate with the private fuel provider on a price for fuel (based on gallons per gas equivalent), the length of time the price will be in effect, the location of refueling sites, and hours of operation.

Traveling long distances for refueling could greatly reduce the productivity of the vehicle and its driver.

No matter who provides the refueling stations, they must be accessible. One of the most common drawbacks to using alternative fuels, is the difficulty with access to refueling stations. Some alternative fuel vehicles have shorter ranges than conventionally fueled vehicles. Traveling long distances for refueling could greatly reduce the productivity of the vehicle and its driver. Depending on the use of vehicles to

be converted, the fuel source must be available at odd hours of the day. For example, if police cars operate on alternative fuels, the refueling station probably needs to be available 24 hours each day. If the local government decides to use the private sector to provide fuel, the provider will need to agree to site a sufficient number of refueling stations in convenient locations that are accessible at the hours needed.

Who should be involved in implementing an alternative fuel program?

A fleet manager is likely to depend on the private sector to implement parts of the program. A private firm will manufacture the original vehicle. In addition, the private sector may be involved in converting vehicles and providing refueling stations.

For the program to be successful, a fleet manager also will need to work closely with the departments operating the vehicles. The departments will need to support the use of CFFVs/AFVs. They should be involved in selecting the vehicles. Drivers should be trained in operating the vehicles, including refueling. The concerns and complaints of vehicle operators, from performance issues to accessibility of refueling locations, should be heard and, whenever possible, addressed.

The local government converting its fleet can open its program to others. In Jefferson County, Kentucky, the federal funds for conversion are offered to all 95 municipalities in the County as well as quasi-public agencies like the transit and water authorities. Each agency must apply to the County for funds and the County monitors performance. One primary benefit of this approach is the cumulative air quality improvements of converting multiple fleets.

What training will be needed?

Training needs to focus on two groups: mechanics and drivers. Depending on the level of involvement of local government fleet mechanics in installing conversion kits or repairing alternative fuel vehicles, they need training on the technology, safety issues, and repair of vehicles and refueling stations. Usually the equipment manufacturer can provide this training. Some states have a specific training course that is required for mechanics installing, diagnosing, or repairing certain types of alternative fuel vehicles.

Drivers need to be educated about the operations and safety issues associated with their vehicle, including refueling. The City of Thomson, Georgia (see case study in Appendix A) cites errors in refueling by new and inexperienced drivers, as one of main challenges of its alternative fuel program. The local government mechanics working on the alternative fuel vehicles may be the best person to provide the training to drivers.

How should the program be monitored?

The results of using alternative fuels can be monitored in terms of improved air quality, vehicle performance, costs or many other factors. The choice of what to monitor depends on the reason that the program was implemented and the documentation requirements associated with any regulatory or funding programs. Some of the most commonly monitored items include:

The results of using alternative fuels can be monitored in terms of improved air quality, vehicle performance, costs or many other factors. The choice of what to monitor depends on the reason that the program was implemented and the documentation requirements associated with any regulatory or funding programs.

- emissions before and after conversion (and periodically after that) to estimate improvement in air quality;
- mileage and fuel usage records to document performance and costs and to demonstrate that bi-fuel vehicles are indeed operating on alternative fuel (this is a requirement of some regulations and funding programs); and
- maintenance work orders on every vehicle to monitor performance and costs.

APPENDIX A

CASE STUDIES

BROWARD COUNTY, FLORIDA

I. Program Summary

Program Objective	Comply with State law. Decrease dependence on imported oil. Demonstrate commitment to improve air quality.
Selected Technology	Compressed natural gas, liquefied petroleum gas, electricity, hydrogen (future).
Fleet Characteristics	1,000 vehicles total: 33 compressed natural gas, 10 liquefied petroleum gas By end of 1998: 312 compressed natural gas, 23 liquefied petroleum gas, 15 electric vehicles
Funding Approach	State grant.
Implementation Approach	Conversion by contractor. County performs maintenance. County monitors work orders, fuel use and cost, emissions.
Costs	$4,000 for compressed natural gas conversion. $1,700 for liquefied petroleum gas conversion.
Benefits	Reduced fuel costs. Reduced maintenance costs. Lower vehicle emissions.
Challenges	Finding suppliers of electric vehicles. Reduced vehicle range.
Lessons	Be patient. Be versatile. Heed advice of peers.
Contact	Don Stiegerwald (305) 357-6499

II. Background

Broward County, Florida, is a member of the Gold Coast Clean Cities Coalition which also includes Dade and Palm Beach Counties. State law requires these three counties to develop a plan to replace 30,000 conventional-fueled vehicles with alternative fueled vehicles.

Broward County, Florida, began its alternative fuel program in 1989 in order to decrease its dependence on petroleum fuels and to demonstrate a commitment to a reduction in mobile emissions to improve air quality. The County's current program uses compressed natural gas and liquefied propane gas fuels. In addition, the County is also in the process of purchasing electric powered vehicles to include in its fleet and is pursuing the use of hydrogen powered vehicles which will be added in the fall of 1997.

IV. Costs and Benefits

Conversion costs usually run approximately $4,000 per vehicle for COMPRESSED NATURAL GAS conversions (including labor and parts) and $1,700 per vehicle for liquefied petroleum gas conversions. According to quotes received by the County, the cost for an electrically-powered vehicles is approximately $30,000 - $38,000 per vehicle, depending on the equipment options provided.

Broward County's fuel usage records document reduced fuel costs as a result of the AFVs. The maintenance log and purchase order records for maintenance parts show lower maintenance costs than for the gasoline-powered vehicles.

In addition to the economic benefits, the County notes lower vehicle emissions. The County periodically performs emissions tests of its vehicle fleet to determine if the AFVs are meeting the low emission vehicle standards. Because the County has only converted vehicles previously used as gasoline burning vehicles in its fleet, comparisons can be made between the emissions test results taken before and after the conversion. The County has recorded improved emissions which meet the low emission vehicle standards on its AFV vehicles.

Impediments experienced by the County include the following:

1. Difficulty getting vehicle purchases approved because of unfamiliarity with the new technology.

2. Difficult with electrically-powered vehicles manufacturers ability to produce and deliver vehicles.

3. The range of the AFVs has been less than that of gasoline vehicles, resulting in additional costs and inconvenience. However, the improving technology of AFV vehicles is resulting in longer ranges. Currently, the County's AFV vehicles average about 50-70 miles between refueling stops.

V. Lessons for Other Local Governments

1. Be patient. When initiating an alternative fuel program, it is important to remember that successful programs do not occur immediately. Local officials must understand that in the long-run, these programs do yield benefits.

2. Be versatile. It is also important to experiment with different types of fuels to determine which are best for a particular situation. Ultimately, Broward County will incorporate three types of fuels in its program. Different types of alternative fuel vehicles work better with certain uses or activities. For example, the County has found that electrically-powered vehicles will be better for making short trips around the immediate area rather than longer trips.

3. Heed the advice of peers who have initiated alternative fuel conversion programs. There are many options that local governments can choose to pursue when attempting to start an alternative fuel program. Those local governments with experience in alternative fuel conversion programs can be a valuable source of information when making critical decision about a program.

VI. Contact

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JEFFERSON COUNTY, KENTUCKY

I. Program Summary

Program Objective	Improve air quality.
Selected Technology	Compressed natural gas
Fleet Characteristics	Currently, 80 vehicles converted. Project 500 vehicles will be converted.
Funding Approach	$1.5 million from Congestion, Mitigation, and Air Quality Improvement Program.
Implementation Approach	County opened program to other governments. Private contractors install conversion kits. Extensive testing of emissions, workmanship inspection.
Costs	$400,000 to date to convert. $4,000 - $5,000 per car, $5,000 - $10,000 per truck.
Benefits	Reduced emissions. Stimulation of local economy.
Challenges	Limited refueling locations. Congestion, Mitigation, and Air Quality Improvement Program funding reimbursement procedure. Extensive documentation required.
Lessons	Involve fleet managers early. Create a database. Test vehicles. Be specific in bid solicitation for installer.
Contact	Gary Wilson (502) 458-0944

II. Background

In 1993, Jefferson County, Kentucky (pop. 650,000) was awarded a $1.5 million grant from the Federal Highway Administration's Congestion, Mitigation, and Air Quality Improvement Program (CMAQ). This program reimburses state or local governments for 80 percent of the cost of streamlining signals and improving traffic flow. In addition, a minor provision allows state and local governments to use the funds for alternative vehicle technology. Jefferson County proposed to use the funds to retrofit existing vehicles and to purchase new alternative fuel vehicles. One reason the County applied for the funds was to take steps to improve air quality. The County, which includes the City of Louisville and 95 other municipalities, was identified as a moderate non-attainment area for ozone with a projected attainment date of 1996.

Jefferson County administers the program but shares the grant funds with other governmental or quasi-governmental agencies in the County. The Jefferson County Air Pollution Control District (the District), a unit of the County's Planning and Environmental Management Department, oversees the

program. The District reviews applications, distributes funds, provides technical assistance, and ensures program compliance.

III. Alternative Fuel Fleet Conversion Program

A projected 500 AFVs will be used in the Jefferson County program. Any vehicle with official plates that travels on surface roads is eligible to participate. Some of the current participants include the County, the City of Louisville, the Louisville Water Company, the Metropolitan Sewer District, and the Airport Authority. Each participant proposes the number and type of vehicles they intend to purchase or convert and the fuel and technology they intend to use.

To date, approximately 80 AFVs are operating, all compressed natural gas. These vehicles are dual fuel with the capability to run on gasoline as well as compressed natural gas, although the Louisville police department is in the process of purchasing dedicated natural gas vehicles. As a requirement of the program, the dual fuel vehicles must run on alternative fuel at least 80 percent of the time. Compliance is verified by a review of fuel use and mileage records.

The AFVs range from small sedans to five ton trucks. Some are new vehicles that come with a natural gas system; some are new gasoline-powered vehicles that the County retrofitted with a natural gas conversion kit; and some are existing gasoline vehicles that the County "upfitted" to use natural gas. The District estimates that 60 percent of the AFVs are existing vehicles that were converted while 40 percent are new alternative fuel vehicles. Some of the AFVs include the following.

- Jefferson County has converted approximately 25 vehicles to compressed natural gas and is in the process of purchasing four or five heavy duty dual fuel (diesel/natural gas) trucks.

- The local transit authority is converting eight buses that operate on a downtown loop to diesel and compressed natural gas in response to customer complaints about noise and smoke.

- Anchorage, one of the smaller municipalities, has one compressed natural gas police car but hesitates to invest in additional AFVs because of the inconvenience of refueling at a single fueling location.

The County has contracts with private companies to install the natural gas kits (and propane kits, if selected by the fleet manager) on gasoline and diesel vehicles. Agencies participating in the program have the option of using the County's contractors or conducting their own solicitation of a contract using acceptable bid procedures. The District monitors the performance of the contractors through an extensive testing program, measuring the emissions of every vehicle on both fuels both before and after the conversion is performed. In addition, a safety and workmanship inspection is performed after installation of each conversion kit. If the conversion kit is installed incorrectly, the vehicle is sent back to the contractor. At the beginning of the program, the equipment occasionally was installed improperly. However, as the program has matured, the installation errors have occurred less frequently.

A major drawback to the program is the unavailability of fueling locations. Currently, there is only one fueling location in the County, operated by Louisville Gas and Electric. Several private companies are

considering opening additional fueling locations. The District hopes that by purchasing or converting 500 vehicles, it will encourage companies to open fueling stations, which in turn will encourage more companies to invest in alternative fuel vehicles.

Another impediment to broader participation is the CMAQ's funding procedure. The Federal Highway Administration reimburses governments for expenses rather than providing money up front. Sometimes, it is difficult for elected officials, especially in the smaller communities, to approve the relatively large outlay of capital to purchase the vehicles or conversion kits.

A final reason that some eligible agencies may be hesitant to participate is the documentation requirements of the program. A participant must first apply for the grant and then document expenses with a receipt and a canceled check to be reimbursed. In addition, fuel, mileage, and maintenance records must be maintained for each vehicle. Finally, every vehicle must be brought to the District for testing, both before and after conversion. Although these requirements may seem burdensome to a manager concerned about productivity, these testing and record-keeping requirements justify the expenditure of grant funds and provide valuable information about alternative fuel vehicles.

IV. Costs and Benefits of the Program

The District estimates that to date, it has spent a total of $400,000 to purchase or convert vehicles to use alternative fuels. Eighty percent of this cost is reimbursed through the CMAQ.

The average cost for converting an automobile in Jefferson County's program is $4,000 to $5,000. The average cost for converting a truck is $5,000 to $10,000. The majority of the cost is for the fuel tanks. Since Louisville Gas and Electric already operated the fueling station, there was no cost to the County to install or operate one. Louisville Gas and Electric provides access to the existing station free of charge.

The two major benefits of the program as cited by the District are improvement in air quality and a boost to the local economy. The District measures the improvement in tailpipe emissions by comparing the emissions of gasoline as compared to natural gas. The District predicts that pollution will be reduced by 200 pounds per day once all 500 alternative fuel vehicles are operating. Perhaps more importantly, the District hopes that its program will demonstrate the costs and benefits of alternative fuels to local companies who will convert their fleets and further improve air quality.

The economic development benefits result from the influx of federal dollars into the local economy. This money, which is funneled through the State Cabinet of Transportation, is provided to the District and then to the contractor to install the alternative fuel equipment. The local contractor pays his employees who are likely to spend their pay in Jefferson County. This transfer of money stimulates the local economy.

V. Lessons for Other Local Governments

1. Involve fleet managers as soon as possible. Especially if multiple fleets are participating, it is critical to involve fleet managers and other decision makers as soon as possible. Jefferson County held introductory meetings, inviting all eligible fleets to participate. These workshops

were effective but only reached those people who attended. A District official recommends visiting each potential participant in his or her own office to determine their eligibility (by determining the number and types of vehicles) and to garner support and participation.

2. Dedicate resources to create a database. A database could help monitor and evaluate the program. In the case of Jefferson County, it could be used to demonstrate efforts to comply with the Clean Air Act Amendments. A database could document the number and type of vehicles purchased or converted; the type and date of purchase or conversion; fueling and maintenance needs; and the results of emission tests.

3. Test vehicles. Emission tests should be done before and after the conversion, on both fuels, to determine the impact of conversion. In addition, a workmanship and safety inspection is critical to make sure the conversion kits are installed correctly. A District official emphasized that if the results of the tests and inspections are not satisfactory, the vehicle should be sent back for repair. Allowing any leeway for vehicle performance could taint the reputation of the technology. Also, the testing should be performed by someone with vehicle testing experience. If a local government does not have this experience, a private contractor with experience should be considered.

4. Be specific in the bid specifications for an installer. Jefferson County chose to use a private contractor to install the kits because the cost was lower due to the volume of vehicles converted by the contractor. The contractor was selected based on his response to bid specifications. The specifications should be explicit, detailed and consistent with National Fire Protection standards (52 and 54). The procuring local government should hold a bidders conference to address questions and comments in order to receive the best, most accurate bids.

VI. Contact

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CITY OF THOMSON, GEORGIA

I. Program Summary

Program Objective	To use domestic fuel source during oil embargo.
Selected Technology	Compressed natural gas
Fleet Characteristics	104 total vehicles. 36 on compressed natural gas.
Implementation Approach	City installs conversion kit.
Costs	$1,200 for conversion kit plus installation. $35,000 for refueling system in 1979
Benefits	Reduced maintenance requirements. Net savings.
Challenges	More frequent refueling. Driver operation of refueling equipment.
Lessons	Access to fuel supply reduces costs and ensures supply. Use one responsible supplier. Invest in training. Consider dual fuel vehicles.
Contact	Emory Newsome (706) 595-3751

II. Background

The City of Thomson, Georgia, began its conversion to a compressed natural gas fleet in 1979 and 1980, in response to the oil shortage. Concerned about the rising cost and uncertain supply of gasoline, the Mayor and City Council decided to convert their fleet to compressed natural gas. was the alternative fuel chosen because the City had its own natural gas system. The City continued the program after the oil embargo ended both because the program was successful and because Thomson already had made the capital investment in fueling equipment and vehicles.

III. Alternative Fuel Fleet Conversion Program

The City of Thomson operates 36 natural gas vehicles including police cars, pick-up trucks, and dump trucks. The City's total fleet contains 104 vehicles (including equipment like lawn mowers, welding machines, and street cleaners). The Mayor and City Council have directed that any vehicle that uses gasoline and operates on the road be converted to operate on compressed natural gas.

The City brought a natural gas pipeline into the vehicle maintenance facility and installed a compressor and other necessary equipment to fuel the vehicles. The natural gas, which is normally at 40 psi, is compressed to 3,600 psi and stored in cylinders for vehicle fueling.

All of the City's alternative fuel vehicles are dual fuel vehicles, that is, they can operate on both compressed natural gas and gasoline. A driver can change fuel types using a toggle switch in the vehicle. Gasoline is used if an alternative fuel vehicle runs out of compressed natural gas while it is away from the vehicle maintenance facility until it can return to refuel.

The City purchases regular, gasoline powered vehicles and installs a compressed natural gas conversion kit. Now that the City is replacing compressed natural gas vehicles, mechanics can transfer the conversion system from the vehicle that is being replaced to the new vehicle. Transferring a conversion system to a new vehicle requires a new mixer and electronic upgrade since most of the new vehicles have fuel-injected, rather than carbureted engines. Still, transferring a conversion system is one-third the cost of purchasing a new kit.

Initially, the City used natural gas conversion kits from five different companies. However, when the systems needed repair, it was sometimes difficult to get parts. Occasionally, the City would have to replace the entire system rather than repair it. Now, the City uses one company who provides all the equipment and parts. With this centralized accountability, the City is able to repair rather than replace natural gas systems and the parts are available within a few days (shipping is required since the supplier is located in Missouri).

The head mechanic with the City of Thomson reports reduced maintenance requirements with the alternative fuel vehicles. Because the natural gas burns cleaner than gasoline, there are less carbon deposits and thus the vehicle requires fewer oil changes and less frequent replacement of new rings and valves.

The vehicles do need to be refueled more frequently when using natural gas. Rather than operating for two days before requiring refueling, the natural gas tanks (two per vehicle, each seven cubic feet) must be refueled after four hours of operation. The drivers generally refuel when they return to the vehicle maintenance facility at lunch time.

The primary operational difficulty reported by the head mechanic is getting drivers and operators to use the equipment properly, especially when refueling. New employees spend their first few days training with an experienced driver, learning how to operate and fuel vehicles as well as the safety factors of alternative fuel vehicles. Still, because employee turnover is high and most new employees have no experience with alternative fuel vehicles, some operators use equipment improperly. Although the vehicles themselves are relatively foolproof, refueling requires that the driver turn on a compressor, use the appropriate valves, and hook up the fueling system correctly.

The City has not widely promoted its alternative fuel program. Each vehicle is labeled with a sticker that identifies it as a natural fuel vehicle. There has been some television coverage and just this year, the City received a Clean Air Award from the United States Department of Energy.

IV. Costs and Benefits of the Program

Although the City has not performed an in-depth analysis of the costs and savings associated with the alternative fuels program, City officials report that the program has a net savings. The fluctuating costs of natural gas and gasoline have the greatest impact on the degree of savings. The City does not maintain records of how much it spends on natural gas for its fleet. The cost of natural gas to the City of Thomson may be lower than in some communities because the City has its own gas system.

The capital costs of using natural gas vehicles include converting the vehicles and providing a fueling system. The cost to put a new conversion kit on a vehicle is approximately $1,200. However, if an existing conversion kit is used, which is only possible if existing AFVs are being replaced, the cost is approximately $400 for a new mixer and electronic upgrade.

City officials report that in 1979-1980, the cost to install the refueling system was approximately $35,000. The City is spending that much in 1996 to purchase an additional compressor. The City also budgeted $8,000 in 1996 for spare and replacement parts. Other costs of the alternative fuels program include the labor to convert vehicles to alternative fuels, which barring any problems can be accomplished by one person in one day; any additional labor or loss in productivity due to increased frequency refueling the vehicles; and the cost of training drivers and operators.

Reported savings, in addition to the lower fuel cost, include reduced maintenance cost. The other major benefit cited by the City, although difficult to quantify, is reduced air emissions.

V. Lessons for Other Local Governments

1. Access to an alternative fuel system reduces cost and ensures supply. Because the City of Thomson has its own gas system, it can better predict the cost of compressed natural gas. Costs are likely to be lower because the City purchases compressed natural gas in large quantities for many purposes. Developing fueling infrastructure only required piping in the gas to the vehicle maintenance facility and compression. In other communities that do not have a gas system, it may be necessary to negotiate agreements with local utilities.

2. Use one responsible equipment supplier. The City of Thomson found that a single supplier for all conversion systems was more reliable than multiple suppliers. Once it began to use the same exact equipment for all vehicles, the City was able to repair inoperable equipment rather than having to replace entire conversion systems.

3. Invest in training new equipment operators. In Thomson, new vehicle drivers and operators occasionally misuse equipment. An extensive training (and retraining) program may be needed to make sure that new drivers and operators correctly use the equipment to minimize maintenance costs. Also, minimizing turnover may reduce errors in operating equipment. Alternatively, it may be worthwhile to invest in the most foolproof equipment available. Thomson officials report less error with vehicles than with refueling equipment because if the vehicles are not operated properly, they just don't start.

4. Consider dual fuel vehicles. If the alternative fuel source is not readily accessible, for example, if vehicles must refuel at a single location, the vehicles must be able to operate on a more accessible fuel source. This is especially important if the vehicles travel far from the fuel source.

V. Contact

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Thomson, GA 30824 (706) 595-2161 FAX

CITY OF HOUSTON, TEXAS

I. Program Summary

Program Objective	Comply with Clean Air Act Amendments of 1990 and state requirements.
Selected Technology	Compressed natural gas (reformulated gasoline preferred but unavailable).
Fleet Characteristics	12,000 total; 5,400 affected by requirements. 100 compressed natural gas.
Funding Approach	Federal and state grants, including funds from Congestion, Mitigation, and Air Quality Improvement Program.
Implementation Approach	Uses original equipment from manufacturer. Private sector provides refueling locations.
Cost	Originally, $1,500 more per vehicle than conventionally-fueled vehicles, now $5,000 differential.
Benefits	Reduced emissions.
Challenges	Limited range of vehicles. Changing regulatory requirements. Original vehicles recalled.
Lessons	Seek independent sources of information. Analyze situation before making decisions. Talk to peers.
Contact	Dewayne Huckaby (713) 658-4517

II. Background

The City of Houston, Texas (population: 1.75 million) began its alternative fuel program in 1989 in response to the ozone attainment problems experienced by its metropolitan area and the regulatory mandates issued by federal and state governments. The City is located within a serious ozone nonattainment area as identified under the Clean Air Act Amendments of 1990 (CAAA). Therefore, the City must meet the requirements of the CAAA. Under the CAAA, each state is required to enforce the regulations as set-out by the EPA. The State of Texas has issued its regulations which parallel the federal CAAA regulations and require the City to comply with the following:

- By the year 1998 - 30 percent of the City's new fleet purchases must meet the low emission vehicle standards or 10 percent of the total applicable fleet (about 5400 of its vehicles) must meet the low emission vehicle standards set by the regulations.

- By the year 2000 - 50 percent of the City's new vehicle purchases must meet the low emission vehicle standards and 20 percent of its total applicable vehicle fleet must meet the low emission vehicle standards set by the regulations.

- By the year 2002 - 90 percent of the City's new vehicle purchases must meet the low emission vehicle standards and 50 percent of its total applicable vehicle fleet must meet the low emission vehicle standards set by the regulations.

The City determined that the best strategy for cost effectively meeting these regulations is to buy vehicles which use reformulated gasoline, except when alternative fuel vehicles are required according to federal or state law since reformulated gasoline does not qualify as an alternative fuel according to the Energy Policy Act of 1992. However, since the City found no available reformulated gasoline vehicles on the market, it is purchasing compressed natural gas vehicles to meet the CAAA standards.

III. Alternative Fuel Fleet Conversion Program

The City of Houston currently maintains a fleet of approximately 100 compressed natural gas vehicles which include passenger and light duty vehicles. Of the 100 compressed natural gas vehicles, 25 are compressed natural gas dedicated and 75 are bi-fueled vehicles. The City maintains a total fleet of approximately 12,000 vehicles including heavy rolling stock, of which 8,000 are trucks and passenger vehicles. Approximately 5,400 of these vehicles fall under the affected categories of the federal and state regulations.

The City decided on compressed natural gas as its alternative fuel because of its own analysis of different alternative fuels available on the market. The conclusion of the analysis resulted in the City choosing compressed natural gas for the following reasons:

- Compressed natural gas was the only fuel that was significantly cheaper than gasoline

- Compressed natural gas was a cleaner burning fuel than gasoline or other alternative fuels

- Private sector compressed natural gas fuel providers were the only providers that would support the program through the contribution of test vehicles to the City, at no cost, for the analysis. Also they were willing to finance and construct fueling stations throughout the area. The City purposely wanted to seek private sector fuel providers to encourage other entities to use alternative fuels. With available compressed natural gas fueling stations, other companies could avoid the potential start-up cost associated with providing refueling stations for its vehicles.

- The City wanted to select one alternative fuel to use in its fleet and compressed natural gas was the only fuel that met the qualifications listed above.

In addition to its decision to use compressed natural gas, the City also conducted testing of air emissions on vehicles with compressed natural gas conversion kits versus the purchase of Original Equipment Manufactured (OEM) vehicles. The conclusion resulted in a decision to purchase OEM vehicles because vehicles converted using the conversion kits produced inadequate results for air emissions. In most cases, the emissions from conversion kits tested no better than the gasoline powered engines. OEM vehicles tended to burn cleaner and met the low emission vehicle standards set-out by the regulations. The City began by purchasing 110 GM compressed natural gas vehicles at a cost differential of $1,500 per vehicle over the gasoline burning equivalent. The City received a federal grant which paid for 50 percent of these vehicles. The City was later notified by GM that due to a fuel tank problem, all of the vehicles would have to be recalled and that GM would no longer produce the compressed natural gas vehicles. This prompted the City to convert all of its 110 compressed natural gas vehicles to gasoline burning engines. The City was given a rebate from GM to assist in paying for these conversions. In order to continue its program, the City was then forced to find other manufacturers of compressed natural gas vehicles.

One detriment to using the compressed natural gas vehicles in Houston is their limited range. Gasoline powered engines have an estimated range of 250 - 350 miles per tank. Compressed natural gas vehicles have a range of 80 to 100 miles with the fuel tanks that the manufacturer places on the vehicle. With an additional tank installed, the range increases to 150 to 180 miles; however, there is an additional cost associated with the installation of the tank. The limited range also creates an inconvenience and additional cost associated with man hours required for refueling. To address this, manufacturers are designing compressed natural gas vehicles with larger fuel tanks.

Changing regulatory requirements since 1989 have also had a heavy influence on the City's program since these changes require the City to adjust its program accordingly. The State originally required alternative fuel vehicles in S.B. 740 and 769 which did not include reformulated gasoline. Then in 1995, the State enacted S.B. 200 rolling back the alternative fuel vehicle mandates and requiring only that applicable fleets meet the low emission vehicle exhaust standards. Therefore, the City shifted its strategy toward using reformulated gasoline and low sulfur diesel fuels which previously did not meet requirements.

A final impediment to using compressed natural gas vehicles in Houston is the perceived lack of reliability of the vehicles. The GM recall of compressed natural gas vehicles resulted in a loss of confidence by City workers in the structural soundness of the vehicle.

IV. Cost and Benefits of the Program

According to its own cost monitoring measures, the City has not realized any significant cost savings associated with its alternative fuel program. During recent years, gasoline prices have continued to drop resulting in a reduction in the cost differential between compressed natural gas

and gasoline. In addition, the current cost differential between compressed natural gas and gasoline powered vehicles has risen to approximately $5,000 per vehicle.

The City continues to receive support in the form of federal and state grants which contribute significantly towards the cost of additional compressed natural gas vehicles. The City plans to purchase approximately 63 OEM (Original Equipment Manufacture) compressed natural gas dedicated vehicles this year and will receive matching funds from the state's Alternative Fuels Counsel Program totaling about 80 percent of the cost of the vehicles. Additional assistance will also be received from the federal Congestion, Mitigation, and Air Quality Improvement program. The federal and state assistance received from these programs has been instrumental in funding the City's program.

V. Lessons for Other Local Governments

1. Seek independent sources of information when evaluating what type of program to implement. It is very important to obtain information from certified independent sources in order to limit the reliance on representations from parties that have an interest in the outcome of the program.

2. Analyze the existing situation. Local governments should assess the conditions of the area in order to determine the needs that the program should address. For example, consider the air quality of the area according to the EPA standards. Analyze why the program should be established (i.e. to comply with regulations, to meet air quality standards, to decrease reliance on petroleum fuels). Analyze the types of alternative fuels and alternative fuel vehicles that are accessible, feasible, and meet all regulatory requirements. The problem or need to be addressed will help determine the type of program to be implemented.

3. Talk to peers in other local governments that have initiated programs. These entities are often the best sources of information and can be very valuable during the decision making process.

VI. Contact

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APPENDIX B

ALTERNATIVE FUEL VEHICLE INCENTIVES WORKSHEET[1]

[1] From U.S. Dept. of Energy, *Guide to Alternative Fuel Vehicle Incentives & Laws*, November 1995.

Alternative Fuel Vehicle Incentives Worksheet

Clean Cities realizes that most of you do not have the time to search for funding opportunities. Therefore, this guide identifies available funding opportunities and presents the information clearly and concisely. We have made every effort to replace wordy descriptions with $ signs and numbers, because this funding guide is all about saving you money. To take this idea of $ signs and numbers one step further, we have created an easy-to-use worksheet so that you can calculate a cumulative AFV funding potential. Examples of completed worksheets are included in this guide as well as a blank worksheet for you to calculate your potential savings. An additional perforated blank worksheet can be found at the end of the book.

The worksheet is composed of two parts. The first part includes a section for tabulating various potential sources of funding. The second part of the funding worksheet allows you to calculate the individual payback periods for your AFV purchases.

Completing Part 1 of the Worksheet

To complete the first part of the worksheet on sources of funding, please turn to your state's section of this book. To help identify incentives with dollar values, we have highlighted in green those incentives that can be plugged into the worksheet. Look at the AFV funding opportunities in your state and insert into the worksheet those incentives for which you are eligible. In addition, read through your state's section to see if there are any other possible sources of funding. You may need to make some phone calls to get the details on some programs.

Part 1 of the worksheet, Sources of Funding, is divided into four headings: I. State Incentives, II. Utilities/Private Incentives, III. State Laws & Regulations, and IV. Federal Tax Incentives. Headings I - III correspond to headings under each state section. Heading IV corresponds to the Federal section of the book, starting on page 128.

I. **State Incentives** - If any state incentives apply to you, fill in the name of the programs on the lines, and enter the total dollar amount in the corresponding box under the "Amount You Expect to Receive" column.

II. **Utilities/Private Incentives** - If your local utility has an incentive program listed, you can insert that into the worksheet here. You may want to call the contact person listed to get the details on the program. In addition to what is listed, many local utility companies will work with customers on a case-by-case basis to provide custom incentives for AFVs. Call the local utility in your area for details. Some alternative fuel providers that are not utilities offer incentives for AFVs. In addition, when purchasing a new vehicle, check with the manufacturer for any rebates.

III. **State Laws & Regulations** - Some state laws and regulations can provide savings for AFVs. For instance, several states offer sales tax exemptions for AFV purchases. If your state offers this exemption, you could figure out how much tax you would have had to pay and enter that amount in the worksheet. If the fuel tax in your state is lower on your alternative fuel of choice than on gasoline, you could calculate your fuel tax savings by multiplying the difference between the gasoline fuel tax and the alternative fuel tax by the vehicle's miles per gallon (mpg) to find the dollars per mile fuel tax savings. Then multiply the dollars per mile fuel tax savings by the annual driving distance you expect for your vehicle to find the fuel tax savings for the first year. Again, enter the total amount in the corresponding box.

IV. **Federal Tax Incentives** - The Federal tax incentives on page 128 can be plugged right into the worksheet. For electric vehicles, the tax credit of 10% of the vehicle cost, up to $4,000 can be entered directly in the corresponding box under numeral IV. For other AFVs, the value of the tax deduction will depend on your tax rate. To find the dollar value of the tax deduction, multiply the amount of the deduction by your tax rate. For example, if you were purchasing an AFV that qualified for the $2,000 tax deduction, and your income level put you in the 28% tax bracket, the value of the tax deduction would be $560. Check with your tax advisor for the details of how the Federal tax incentives would apply to your specific situation, or call the Internal Revenue contact person listed with the Federal tax incentives on page 128.

Once you have identified all the incentives that apply to you, simply add them up to see your potential savings, and enter the total in the box labeled **Total Funding**.

Completing Part 2 of the Worksheet

Part 2 of the worksheet involves determining the payback period for your AFV. To calculate the payback period, follow these step-by-step instructions.

1. Determine the **Incremental Cost** for your vehicle by subtracting the cost of a comparable gasoline vehicle from the initial cost of your AFV. For converting existing vehicles, use the conversion cost as the **Incremental Cost.**

2. Subtract the **Total Funding** that you calculated in **Part 1** from the Incremental Cost (1a). This will give you the **Net Incremental Cost** (2a) of the AFV. If the **Net Incremental Cost** is less than zero, then your incentives offset the incremental cost for the AFV. You do not need to continue to figure your payback period, because you do not have any additional costs to pay back. For most people, the incentives will not be enough to cover the additional incremental costs of the AFV. However, if it costs you less to run your vehicle on the alternative fuel than it would to run it on gasoline, then you can use steps 3 through 5 to determine how many miles you will need to drive the vehicle to save enough in fuel costs to pay back the **Net Incremental Cost** of the AFV.

3. Determine your fuel costs per mile for using both the alternative fuel and gasoline. Complete section 3a below, and then complete one of the two remaining sections, 3b or 3c, depending on the type of fuel for your AFV.

   a) For gasoline, divide the per gallon price of gasoline by the vehicle's miles per gallon (mpg). For example, if the average price in your city for a gallon of gasoline is $1.20, write $1.20 in the box labeled "$ per gallon." If your vehicle gets 20 miles per gallon, write 20 in the box labeled "vehicle mpg." Then divide $1.20 by 20 to get $0.06 per mile fuel cost.

   b) For the alternative fuel, divide the price per gasoline gallon equivalent (gge) by the vehicle's mpg when operating on the alternative fuel. If you are buying a new vehicle, the manufacturer can provide you with this number. If you are converting a vehicle, the conversion company can provide you with an estimate of the mpg. For example, if you are converting to a natural gas vehicle (NGV), and natural gas will cost you $0.75 per gge, write $0.75 in the box labeled "$ per gge." If the vehicle, once converted to natural gas will get 20 miles per gge, write 20 in the box labeled "vehicle mpg." Then divide $0.75 by 20 to get $0.0375 per mile fuel cost.

   c) For an electric vehicle, divide the price of electricity per kilowatt hour (kWh), by the miles the vehicle will get per kWh. The manufacturer or conversion company will be able to give you this figure. For example, if your electric rate is $0.041 per kWh, write $0.041 in the box labeled "$ per kWh." If the vehicle will get 4 miles per kWh, enter 4 in the box labeled "vehicle miles per kWh." Then divide $0.041 by 4 to get $0.01025 per mile fuel cost.

4. Find your **$ savings per mile** by subtracting the per mile fuel cost of the alternative fuel (box 3b or 3c) from the per mile gasoline cost (box 3a). For example, for the NGV shown above in 3b, subtract $0.0375 per mile fuel cost from $0.06 per mile gasoline cost in 3a to get a cost savings of $0.0225 per mile.

5. To find the **Payback Period,** divide the **Net Incremental Cost** (box 2a) by the **$ savings per mile** (box 4a) to get the payback period in miles. This calculates the number of miles the vehicle would need to be driven to pay back the additional incremental cost of the AFV.

AFV FUNDING WORKSHEET -- State of _____

PART 1 - Sources of Funding | **Amount You Expect to Receive**

I. State Incentives
_____ $ [ ]
_____
_____

II. Utilities/Private Incentives
_____ + $ [ ]
_____
_____

III. State Laws & Regulations
_____ + $ [ ]
_____
_____

IV. Federal Tax Incentives
_____ + $ [ ]
_____
_____

Total Funding = $ [ ]

PART 2 - Payback Period

1) To calculate an AFV's payback period, you first need to know the **Incremental Cost** of that vehicle compared to a comparable gasoline vehicle:

$ [ ] Initial Cost of AFV − $ [ ] Cost of Comparable Gasoline Vehicle = $ [ ] Incremental Cost * 1a

* NOTE: If you are converting existing fleet vehicles, then substitute the conversion cost for the **Incremental Cost.**

2) Subtract from the **Incremental Cost,** box 1a, the **Total Funding** from the box at bottom of Part 1 to get the **Net Incremental Cost.**

$ [ ] Incremental Cost (from box 1a) − $ [ ] Total Funding (from part 1) = $ [ ] Net Incremental Cost 2a

3) To find the **$ per mile fuel cost,** divide your fuel cost per gasoline gallon equivalent (gge) by your vehicle's miles per gallon (mpg). Do this calculation for both gasoline and the alternative fuel.

a) gasoline: $ [ ] $ per gallon / [ ] mpg vehicle mpg = $ [ ] $ per mile fuel cost 3a

b) alternative fuel: $ [ ] $ per gge / [ ] mpg vehicle mpg = $ [ ] $ per mile fuel cost 3b

c) electric: $ [ ] $ per kWh / [ ] mi/kWh vehicle miles per kWh = $ [ ] $ per mile fuel cost 3c

4) Then subtract the **$ per mile fuel cost** of your alternative fuel from the **$ per mile fuel cost** of gasoline to find your **$ savings per mile.**

$ [ ] $ per mile fuel cost gasoline (from box 3a) − $ [ ] $ per mile fuel cost alternative fuel (from box 3b or 3c) = $ [ ] $ savings per mile 4a

5) Then divide the **Net Incremental Cost,** box 2a, by the **$ savings per mile,** box 4a, to get the payback period for your AFV in terms of miles.

$ [ ] Net Incremental Cost (from box 2a) / $ [ ] $ savings per mile (from box 4a) = [ ] miles Payback in miles

Examples of Completed Worksheets

Example 1

Example 1 is the completed worksheet for the purchase of a new OEM CNG vehicle in Pennsylvania (see page 9). Suppose you live in Pennsylvania and are interested in purchasing a new CNG Chrysler Ram Van. In this example, the cost of the vehicle is $20,556, the cost of a comparable gasoline vehicle is $15,493, the vehicle gets 18 miles to the gallon on either gasoline or CNG, gasoline costs are $1.20 per gallon, and CNG costs are $0.75 per gasoline gallon equivalent (gge).

On page 96 you find, in the green highlights box, that the State Energy Office's Incentive Grants program will pay for 50% of the incremental costs for the natural gas option on your vehicle. Since the incremental cost for the natural gas option for the vehicle is $5,063, the Alternative Fuel Incentive Grants (AFIG) program will pay 50% or $2,531.50. The AFIG program is put under the **State Incentives** heading in **Part 1** of the worksheet, with the amount of $2,531.50 in the box in the **Amount You Expect to Receive** column. On pages 96 and 97 you see that if you live in the service area of Consolidated Natural Gas Company, you can receive a $1,000 rebate on the purchase of an OEM AFV. Assuming that Consolidated Natural Gas is your local gas utility, the rebate is put under the **Utilities/Private Incentives** heading in Part 1 of the worksheet, with the amount $1,000 in the box in the **Amount You Expect to Receive** column. The details on the programs in the highlights section for each state are printed in green with a $ next to them to make it easier for you to find the information you need. The text for each state also includes additional information on other AFV programs in the state.

For the **Federal Tax Incentives** heading, turn to page 128. The CNG van qualifies for a $2,000 tax deduction. If you are in the 28% tax bracket, the value of the tax deduction would be $560. The $2,000 Federal tax deduction is put under the **Federal Tax Incentives** heading in **Part 1** of the worksheet, with the amount of $560 in the box in the **Amount You Expect to Receive** column. Add together all of the numbers in the **Amount You Expect to Receive** column to get a **Total Funding** amount of $4,091.50.

Part 2 of the worksheet calculates the payback period. In step 1, subtract the $15,493 cost of a comparable gasoline vehicle from the $20,556 cost for the NGV to get the **Incremental Cost** of $5,063. In step 2, subtract the **Total Funding** of $4,091.50 from the **Incremental Cost** of $5,063 to get $971.50 as your **Net Incremental Cost** after applying incentives. In step 3a, divide the price of $1.20 per gallon for gasoline by the vehicle fuel efficiency of 18 mpg, to get $0.0667 per mile fuel cost. In step 3b, divide $0.75 per gge cost of CNG by the vehicle fuel efficiency of 18 mpg to get $0.0417 per mile fuel cost. In step 4, subtract the $0.0417 per mile fuel cost (box 3b) from the $0.0667 per mile gasoline cost (box 3a) to get a cost savings of $0.025 per mile. In step 5, divide the **Net Incremental Cost** of $971.50 (box 2a) by the fuel cost **$ savings per mile** of $0.025 (box 4a) to get 38,860 miles as the payback period. The vehicle would need to be driven 38,860 miles to pay back the additional incremental cost of the AFV.

Example 2

Example 2 is a completed worksheet for a CNG conversion in Kansas (see page 10). The amounts for the incentives for Kansas can be found on page 52. The worksheet uses a conversion cost of $4,000. The green highlights box on page 58 shows that Kansas offers a tax credit for 50% of the conversion cost for AFVs. With a conversion cost of $4,000, the 50% tax credit would be worth $2,000. On page 51, you see that the Kansas Corporation Commission offers a $1,500 incentive for AFVs. Add together the $2,000 tax credit and the $1,500 incentive to get a total of $3,500 for the **State Incentives** heading in **Part 1** of the worksheet, and enter the amount of $3,500 in the box in the **Amount You Expect to Receive** column. Then figure out value of the Federal tax deduction as shown in Example 1. The $2,000 Federal tax deduction is put under the **Federal Tax Incentives** heading in Part 1 of the worksheet, with the amount of $560 in the box in the **Amount You Expect to Receive** column. Add together all of the numbers in the **Amount You Expect to Receive** column to get a **Total Funding** amount of $4,060. In this case, the **Total Funding** of $4,060 completely covers the incremental cost of the conversion, so there is no need to complete **Part 2** of the worksheet.

Example 3

Example 3 is a completed worksheet for the purchase of an EV in California (see page 11). The incentives for California are on page 21. The worksheet assumes that the EV cost is $32,000, and the cost of a comparable gasoline vehicle is $20,000. A $5,000 incentive for EV purchases is available from the South Coast Air Quality District. The Federal Tax Credit for EVs is based on 10% of the vehicle cost, up to $4,000. For the vehicle in the worksheet, the credit would be 10% of $32,000 or $3,200. Add these two incentives to get a **Total Funding** amount of $8,200. **Part 2** assumes a cost for gasoline of $1.20 per gallon, and a cost of electricity of $0.041 per kWh, and an EV fuel efficiency of 4 miles per kWh. Using these figures, the payback period for the EV would be 76,381 miles.

NOTE: These examples are provided to give you an idea of how to use the worksheets. Your individual situation may be different, even if you live in the same state used in one of the examples. Be sure to call to confirm the details of incentives that apply to you.

EXAMPLE 1

AFV FUNDING WORKSHEET -- Pennsylvania - Natural Gas Vehicle Purchase

PART 1 - Sources of Funding | **Amount You Expect to Receive**

I. State Incentives
AFIG pays 50% of incremental costs on dedicated NGVs: (see page 95)
$26,500 - $20,000 = $6,500 incremental cost
$6,500 * 0.50 = $3,250
$ 2,531.50

II. Utilities/Private Incentives
$1,000 rebate from Consolidated Natural Gas
(see page 95)
+ $ 1,000

III. State Laws & Regulations
+ $ 0

IV. Federal Tax Incentives
$2,000 tax deduction (see page 128)
* $2,000 * 0.28 = $560
(28% tax bracket)
+ $ 560

Total Funding = $ 4,091.50

PART 2 - Payback Period

1) To calculate an AFV's payback period, you first need to know the **Incremental Cost** of that vehicle compared to a comparable gasoline vehicle:

$ 20,556 (Initial Cost of AFV) – $ 15,493 (Cost of Comparable Gasoline Vehicle) = $ 5,063 (Incremental Cost *) 1a

* NOTE: If you are converting existing fleet vehicles, then substitute the conversion cost for the **Incremental Cost.**

2) Subtract from the **Incremental Cost,** box 1a, the **Total Funding** from the box at the bottom of Part 1 to get the **Net Incremental Cost.**

$ 5,063 (Incremental Cost (from box 1a)) – $ 4,091.50 (Total Funding (from part 1)) = $ 971.50 (Net Incremental Cost) 2a

3) To find the **$ per mile fuel cost,** divide your fuel cost per gasoline gallon equivalent (gge) by your vehicle's miles per gallon (mpg). Do this calculation for both gasoline and the alternative fuel.

a) gasoline: $ 1.20 ($ per gallon) / 18 mpg (vehicle mpg) = $ 0.0667 ($ per mile fuel cost) 3a

b) alternative fuel: $ 0.75 ($ per gge) / 18 mpg (vehicle mpg) = $ 0.0417 ($ per mile fuel cost) 3b

c) electric: $ ($ per kWh) / mi/kWh (vehicle miles per kWh) = $ ($ per mile fuel cost) 3c

4) Then subtract the **$ per mile fuel cost** of your alternative fuel from the **$ per mile fuel cost** of gasoline to find your **$ savings per mile.**

$ .0667 ($ per mile fuel cost gasoline (from box 3a)) – $ .0417 ($ per mile fuel cost alternative fuel (from box 3b or 3c)) = $ .025 ($ savings per mile) 4a

5) Then divide the **Net Incremental Cost,** box 2a, by the **$ savings per mile,** box 4a, to get the payback period for your AFV in terms of miles.

$ 971.50 (Net Incremental Cost (from box 2a)) / $ 0.025 ($ savings per mile (from box 4a)) = 38,860 miles (Payback in miles)

* NOTE: Fuel prices were collected in July 1995. Actual amount of tax deduction figure will vary with individual's/company's tax bracket.

EXAMPLE 2

AFV FUNDING WORKSHEET -- Kansas - Compressed Natural Gas Vehicle Conversion

PART 1 - Sources of Funding | **Amount You Expect to Receive**

I. State Incentives
50% tax credit for conversion cost (see page 58)
Conversion cost = $4,000; $4,000 * 0.50 = $2,000
$1,500 from Kansas Corporation Commission (see page 58)
$2,000 + $1,500 = $3,500 — $ 3,500

II. Utilities/Private Incentives
_____ + $ _____

III. State Laws & Regulations
_____ + $ _____

IV. Federal Tax Incentives
IRS tax deduction 0.28 * $2,000 = $560 (see page 128)
(28% tax bracket) + $ 560

Total Funding = $ 4,060

PART 2 - Payback Period

1) To calculate an AFV's payback period, you first need to know the **Incremental Cost** of that vehicle compared to a comparable gasoline vehicle:

$ ____ (Initial Cost of AFV) − $ ____ (Cost of Comparable Gasoline Vehicle) = $ 4,000 (Incremental Cost *) 1a

* NOTE: If you are converting existing fleet vehicles, then substitute the conversion cost for the **Incremental Cost**.

2) Subtract from the **Incremental Cost**, box 1a, the **Total Funding** from the box at the bottom of Part 1 to get the **Net Incremental Cost**.

$ 4,000 (Incremental Cost (from box 1a)) − $ 4,060 (Total Funding (from part 1)) = $ - 60 ** (Net Incremental Cost) 2a

3) To find the **$ per mile fuel cost**, divide your fuel cost per gasoline gallon equivalent (gge) by your vehicle's miles per gallon (mpg). Do this calculation for both gasoline and the alternative fuel.

a) gasoline: $ ____ ($ per gallon) / ____ (vehicle mpg) mpg = $ ____ ($ per mile fuel cost) 3a

b) alternative fuel: $ ____ ($ per gge) / ____ (vehicle mpg) mpg = $ ____ ($ per mile fuel cost) 3b

c) electric: $ ____ ($ per kWh) / ____ (vehicle miles per kWh) mi/kWh = $ ____ ($ per mile fuel cost) 3c

4) Then subtract the **$ per mile fuel cost** of your alternative fuel from the **$ per mile fuel cost** of gasoline to find your **$ savings per mile.**

$ ____ ($ per mile fuel cost gasoline (from box 3a)) − $ ____ ($ per mile fuel cost alternative fuel (from box 3b or 3c)) = $ ____ ($ savings per mile) 4a

5) Then divide the **Net Incremental Cost**, box 2a, by the **$ savings per mile**, box 4a, to get the payback period for your AFV in terms of miles.

$ ____ (Net Incremental Cost (from box 2a)) / $ ____ ($ savings per mile (from box 4a)) = ____ miles (Payback in miles)

** We did not calculate the payback period because there was no additional cost to pay back.

EXAMPLE 3
AFV FUNDING WORKSHEET -- State of California - Electric Vehicle Purchase

PART 1 - Sources of Funding | **Amount You Expect to Receive**

I. State Incentives
South Coast Air Quality Management District
$5,000/Electric Vehicle (see page 20) — $ 5,000

II. Utilities/Private Incentives — + $

III. State Laws & Regulations — + $

IV. Federal Tax Incentives
Federal tax credit for electric vehicle (see page 128)
10 percent of vehicle cost up to $4,000
Vehicle cost = $32,000 * 0.10 = $3,200 — + $ 3,200

Total Funding = $ 8,200

PART 2 - Payback Period

1) To calculate an AFV's payback period, you first need to know the **Incremental Cost** of that vehicle compared to a comparable gasoline vehicle:

$ 32,000 (Initial Cost of AFV) − $ 20,000 (Cost of Comparable Gasoline Vehicle) = $ 12,000 (Incremental Cost *) 1a

* NOTE: If you are converting existing fleet vehicles, then substitute the conversion cost for the **Incremental Cost.**

2) Subtract from the **Incremental Cost,** box 1a, the **Total Funding** from the box at the bottom of Part 1 to get the **Net Incremental Cost.**

$ 12,000 (Incremental Cost (from box 1a)) − $ 8,200 (Total Funding (from part 1)) = $ 3,800 (Net Incremental Cost) 2a

3) To find the **$ per mile fuel cost,** divide your fuel cost per gasoline gallon equivalent (gge) by your vehicle's miles per gallon (mpg). Do this calculation for both gasoline and the alternative fuel.

a) gasoline: $ 1.20 ($ per gallon) / 20 mpg (vehicle mpg) = $ 0.06 ($ per mile fuel cost) 3a

b) alternative fuel: $ ($ per gge) / (mpg vehicle mpg) = $ ($ per mile fuel cost) 3b

c) electric: $ 0.041 ($ per kWh) / 4 mi/kWh (vehicle miles per kWh) = $ 0.01025 ($ per mile fuel cost) 3c

4) Then subtract the **$ per mile fuel cost** of your alternative fuel from the **$ per mile fuel cost** of gasoline to find your **$ savings per mile.**

$ .06 ($ per mile fuel cost gasoline (from box 3a)) − $ 0.01025 ($ per mile fuel cost alternative fuel (from box 3b or 3c)) = $ 0.04975 ($ savings per mile) 4a

5) Then divide the **Net Incremental Cost,** box 2a, by the **$ savings per mile,** box 4a, to get the payback period for your AFV in terms of miles.

$ 3,800 (Net Incremental Cost (from box 2a)) / $ 0.04975 ($ savings per mile (from box 4a)) = 76,381 miles (Payback in miles)

* NOTE: Fuel prices were collected in July 1995.

APPENDIX C

RESOURCES

APPENDIX C

RESOURCES

Table C-1 lists sources that were used to prepare this Guide. The Table indicates the contents of each source so that the reader can evaluate the applicability of the document for specific purposes. The end of this Appendix contains telephone contacts for more information about particular fuels.

Source	Federal Policy	State Policy	Fuel Description	Technology	Economics	Guidance	Case Studies
U.S. Environmental Protection Agency, "The Clean Fuel Vehicle Fleet Program Information Sheet", July 1992.	✓						
U. S. Department of Energy, "EPACT Initiatives for Alternative Fuel Vehicles: An Integrated Approach for Implementing the Energy Policy Act", March 1995.	✓						
Comparative Alternative/Clean Fuels Provisions of the Clean Air Act Amendments of 1990 and the Energy Policy Act of 1992.	✓						
George Burmeister and Katherine Mahoney, "Alternative Transportation Fuels: Options for State Legislatures", State Legislative Report, Volume 17, No. 9, May 1992		✓	✓		✓		
U.S. Department of Energy, "Facts About CNN & LPG Conversion", DOE/CH100093-315.				✓			
Texas General Services Commission, "Workbook on Cost Effectiveness of Alternative Fuels Using Life Cycle Cost Benefit Analysis", September 1, 1991.					✓	✓	
U.S. General Accounting Office, "General Accounting Office Comparison of Alternative Fuels", *Air Pollution, Air Quality Implications of Alternative Fuels*, GAO/RCED-90-143, July 1990.			✓	✓	✓		
"A Fleet Manager's Guide to Natural Gas Vehicles", RP Publishing, Inc., 1995.			✓	✓		✓	
U. S. Department of Energy, "First Interim Report of the Federal Fleet Conversion Task Force", DOE/PO-0001, August 1993.	✓						
J. E. Sinor Consultants, Inc., *The Clean Fuels Report, Volume 7, No. 4,* , Sept. 1995.	✓	✓		✓			✓
Argonne National Laboratory, "Taking an Alternative Route", U.S. Department of Energy.	✓		✓			✓	
Alabama Alternative Fuels Program, "Fueling Alabama's Future".	✓		✓			✓	
U.S. Department of Energy, "State Alternative Fuel Laws & Incentives, DOE/CH100093-319		✓					
Stephanie Gott, "NGV News Guide to NGV Funding", Pasha Publications, Inc., Arlington, VA, 1993.	✓	✓					
"Economic Analyses of Alternative Fuels and Vehicles" from an Unidentifiable Source.					✓	✓	✓

GENERAL

National Association of Fleet Administrators
908-494-8100

National Alternative Fuels Hotline
1-800-423-1DOE

Clean Air Vehicle Association
770-261-0804

Clean Fuels Development Coalition
301-913-9636

National Fire Protection Association
617-984-7407

ELECTRIC

Electric Transportation Coalition
202-508-5995

The Electric Vehicle Association of the Americas
408-253-5262

Edison Electric Institute
202-508-5000

Electric Power Research Institute
415-855-2984

ETHANOL

Renewable Fuels Association
202-289-3835

Clean Fuels Development Coalition
301-913-3633

American Biofuels Association
703-522-3392

METHANOL

American Methanol Institute
202-467-5050

NATURAL GAS

Natural Gas Vehicle Coalition
703-527-3022

American Gas Association
703-841-8000

Gas Research Institute
312-399-8100

PROPANE

National Propane Gas Association
708-515-0600

Propane Vehicle Association
202-371-6262

APPENDIX D

GLOSSARY

ACRONYMS

AFV	alternative fuel vehicle
Btu	British thermal unit
CAAA	Clean Air Act Amendments of 1990
CAV	clean air vehicle
CFFV	clean fuel fleet vehicle
CNG	compressed natural gas
CO	carbon monoxide
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
EPACT	Energy Policy Act of 1992
GVW	gross vehicle weight
ILEV	inherently low emission vehicle
LEV	low emission vehicle
LNG	liquefied natural gas
LPG	liquefied petroleum gas (propane)
NAAQS	National Ambient Air Quality Standards
OEM	original equipment manufacturer
PSI	pounds per square inch
SIP	State Implementation Plan
ULEV	ultra low emission vehicle
ZEV	zero emission vehicle

DEFINITIONS

Alcohols: Organic compounds that are distinguished from hydrocarbons by the inclusion of a hydroxyl group. The two simplest alcohols are methanol and ethanol.

Alternative Fuel: As defined pursuant to the EPACT, methanol, denatured ethanol and other alcohols, separately or in mixtures of 85% by volume or more (but not less than 70% as determined by DOE rule) with gasoline or other fuels, CNG, LNG, LPG, hydrogen, "coal-derived liquid fuels," fuels "other than alcohols" derived from "biological materials," electricity or any other fuel determined to be "substantially not petroleum" and yielding "substantial energy security benefits and substantial environmental benefits."

Bi-fuel Vehicle: A vehicle with two separate fuel systems designed to run on either an alternative fuel or conventional gasoline, using only one fuel at a time. These systems are advantageous for drivers who do not always have access to an alternative fuel refueling station but sacrifice the potential for optimized combustion and very low evaporative emissions. Bi-fuel systems are usually used in passenger cars or trucks. These vehicles are referred to as "dual-fuel" in the CAAA and EPACT.

Biodiesel: A biodegradable transportation fuel for use in diesel engines that is produced through transesterification of organically derived oils or fats. Biodiesel is used as a component of diesel fuel. In the future, it may be used as a replacement for diesel.

Biomass: Renewable organic matter such as agricultural crops, crop-waste residues, wood, animal and municipal wastes, aquatic plants, fungal growth, etc., used for the production of energy.

British Thermal Unit (Btu): A standard unit for measuring heat energy. One Btu represents the amount of heat required to raise one pound of water one degree Fahrenheit (at sea level).

Clean Air Act Amendments of 1990 (CAAA): The original Clean Air Act (CAA) was signed in 1963. The law set emissions standards for stationary sources (e.g., factories, power plants). The CAA was amended several times, most recently in 1990 (P.L. 101-549). The Amendments of 1970 introduced motor vehicle emission standards (e.g., automobiles, trucks). Criteria pollutants included lead, ozone, CO, SO_2,, NO_x and PM as well as air toxics. The regulations require certain fleet operators to use clean fuel vehicles in 22 cities.

Clean Diesel: An evolving definition of diesel fuel with lower-emission specifications, which strictly limit sulfur content to 0.05 weight %; in California, aromatics content is further limited to 10 volume % (for large refiners).

Clean Fuel Vehicle (CFV): Any vehicle certified by EPA as meeting certain federal emissions standards. The five categories of federal CFV standards from least to most

stringent are LEV, ULEV, ILEV, and ZEV. CFVs are eligible for two federal programs, the California Pilot Program and the Clean-Fuel Fleet Program. CFV exhaust emissions standards for light-duty vehicles and light-duty trucks are numerically identical to those of CARB's California Low Emission Vehicle Program, which also includes a TLEV standard. (See Appendix A for a detailed listing of CARB's tailpipe emissions standards.)

Compressed Natural Gas (CNG): Natural gas that has been condensed under high pressure, typically between 2000 and 3600 psi, held in a container. The gas expands when released for use as a fuel.

Converted Vehicle: A vehicle originally designed to operate on gasoline or diesel that has been modified or altered to run on an alternative fuel.

Duel-fuel Vehicle*:

* **EPACT Definition**: Vehicle designed to operate on a combination of an alternative fuel and a conventional fuel. This includes: a) vehicles using a mixture of gasoline or diesel and an alternative fuel in one fuel tank, commonly called flexible-fueled vehicles; and b) vehicles capable of operating either on an alternative fuel, a conventional fuel or both, using two fuel systems.

* **CAAA Definition**: Vehicle with two separate fuel systems designed to run on either an alternative fuel or conventional gasoline, using only one fuel at a time.

E10 (Gasohol): Ethanol/gasoline mixture containing 10% denatured ethanol and 90% gasoline, by volume.

E85: Ethanol/gasoline mixture containing 85% denatured ethanol and 15% gasoline, by volume.

E93: Ethanol mixture containing 93% ethanol, 5% methanol, and 2% kerosene, by volume.

E95: Ethanol/gasoline mixture containing 95% denatured ethanol and 5% gasoline, by volume.

Electric Vehicle: A vehicle powered by electricity, generally provided by storage batteries but also provided by photovoltaic cells or a fuel cell.

Energy Policy Act of 1992 (EPACT): (P.L. 102-486) A broad-ranging act signed into law on October 24, 1992. Titles III, IV, V, XV, and XIX of EPACT deal with alternative transportation fuels. EPACT accelerates the purchase requirements for AFVs by the federal fleet, proposes eliminating the cap on CAFE credits that manufacturers can earn by producing dual- and flexible-fuel vehicles and requires fleets in large urban areas to purchase AFVs. Establishes tax incentives for purchasing AFVs, converting conventional gasoline vehicles to operate on alternative fuels and installing refueling or recharging facilities by the private sector.

Ethanol (also known as Ethyl Alcohol, Grain Alcohol, CH3CH2OH): Can be produced chemically from ethylene or biologically from the fermentation of various sugars from carbohydrates found in agricultural crops and cellulosic residues from crops or wood. Used in the United States as a gasoline octane enhancer and oxygenate, it increases octane 2.5 to 3.0 numbers at 10% concentration. Ethanol also can be used in higher concentration in vehicles optimized for its use.

Flexible-Fuel Vehicles: Passenger cars designed to run on blends of unleaded gasoline with either ethanol or methanol.

Hybrid Electric Vehicle (HEV): A vehicle that is powered by two or more energy sources, one of which is electricity. HEVs combine the engine and fuel tank of a conventional vehicle with the battery and electric motor of an electric vehicle in a single drivetrain.

Inherently Low Emission Vehicle (ILEV): FEDERAL ONLY. Describes vehicle meeting EPA's CFV ILEV standards. Tailpipe standards may be LEV, ULEV, or ZEV but include the requirement that evaporative emissions be 2 grams per test over the full test procedure and 5 grams per test without the use of any auxiliary emission control devices. ILEVs will be dedicated AFVs in most cases. Dual-fuel vehicles will be considered ILEVs only if both fuels meet the standard. ILEVs are exempt from certain transportation control measures, including high occupancy vehicle (HOV) lane restrictions.

Liquefied Natural Gas (LNG): Natural gas that has been condensed to a liquid typically by cryogenically cooling the gas.

Liquefied Petroleum Gas (LPG): A hydrocarbon and colorless gas found in natural gas and produced from crude oil, used principally as a home heating fuel or motor vehicle fuel. Also known as propane.

Low Emission Vehicle (LEV): Describes vehicle meeting either EPA's CFV LEV standards, or CARB's California Low Emission Vehicle Program LEV standards. LEVs produce fewer emissions than TLEVs.

M85: 85% methanol and 15% unleaded gasoline by volume, used as a motor fuel in FFVs.

M100: 100% (neat) methanol.

Methane (CH4): The simplest of the hydrocarbons and the principal constituent of natural gas. Pure methane has a heating value of 1,012 Btu per standard cubic foot.

Methanol (also known as Methyl Alcohol, Wood Alcohol CH3OH): A liquid fuel formed by catalytically combining CO with hydrogen in a 1:2 ratio under high temperature and pressure. Commercially, it is typically manufactured by steam reforming natural gas. Also formed in the destructive distillation of wood.

National Ambient Air Quality Standards (NAAQS): Ambient standards for air pollutants specifically regulated under the CAA. These pollutants include ozone, CO, NO_2, lead, particulate matter and SO_x.

Natural Gas: A mixture of gaseous hydrocarbons, primarily methane, occurring naturally in the earth and used principally as a fuel.

Nonattainment Area: A region, determined by population density in accordance with the U.S. Census Bureau, which exceeds minimum acceptable NAAQS for one or more "criteria pollutants" (see **Clean Air Act Amendments**). Such areas are required to seek modifications to their SIPs, setting forth a reasonable timetable using EPA-approved means to achieve attainment of a NAAQS for these criteria pollutants by a certain date. Under the CAA, if a nonattainment area fails to attain NAAQS, EPA may superimpose a FIP with stricter requirements or impose fines, construction bans, cutoffs in federal grant revenues, etc., until the area achieves the applicable NAAQS.

Propane: See Liquefied Petroleum Gas (LPG).

Reformulated Gasoline (RFG): Gasolines that have had their composition and/or characteristics altered to reduce vehicular emissions of pollutants, particularly pursuant to EPA regulations under the CAA.

State Implementation Plan (SIP): Plan that a state must submit to EPA under the CAA to demonstrate compliance to NAAQS.

Tax Incentives: In general, a means of employing the tax code to stimulate investment in or development of a socially desirable economic objective without direct expenditure from the budget of a given unit of government. Such incentives can take the form of tax exemptions or credits.

Transitional Low Emission Vehicle (TLEV): Describes vehicle meeting either EPA's CFV TLEV standards or CARB's California Low Emission Vehicle Program TLEV standards. TLEVs produce fewer emissions than federal Tier 1 vehicles. TLEVs are eligible for the federal California Pilot Program but <u>not</u> eligible for the Clean-Fuel Fleet Program.

Ultra-Low Emission Vehicle (ULEV): Describes vehicle meeting either EPA's CFV ULEV standards or CARB's California Low Emission Vehicle Program ULEV standards. ULEVs produce fewer emissions than LEVs. Fleets who purchase CFV ULEVs may earn credits under the Clean-Fuel Fleet Vehicle Program. Manufacturers that sell CFV ULEVs may earn credits under the federal California Pilot Program.

U.S. Department of Energy (DOE): A department of the federal government, established by the Carter Administration in 1977, to consolidate energy-oriented programs and agencies. The DOE mission includes the coordination and management of energy conservation, supply, information dissemination, regulation, research, development and

demonstration. The Department includes the Office of Transportation Technologies, the umbrella of the Office of Alternative Fuels.

U.S. Environmental Protection Agency (EPA): A government agency, established in 1970, responsible for the protection of the environment and public health. EPA seeks to reduce air, water, and land pollution and pollution from solid waste, radiation, pesticides, and toxic substances. EPA also controls emissions from motor vehicles, fuels, and fuel additives.

Zero Emission Vehicle (ZEV): Describes vehicle meeting either EPA's CFV ZEV standards or CARB's California Low Emission Vehicle Program ZEV standards. ZEV standards, usually met with electric vehicles, require zero vehicle (not power plant) source emissions. ZEVs earn more Clean-Fuel Fleet Vehicle Program credits the ULEVs. ZEVs may also meet ILEV standards if evaporative emissions are near zero.