



White Paper

**Alternative Fuel Vehicles at
Small Urban and Rural
Public Transportation Systems
in Texas**

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PURPOSE OF WHITE PAPER

This white paper examines alternative fuel vehicle (AFV) usage at rural and small urban public transportation systems in Texas. Transit providers identify AFV fleet requirements, procurement, maintenance, and operation as a barrier to coordination, and operation efficiency.

INTRODUCTION AND BACKGROUND

Alternative fuel vehicle requirements for transit vehicles in Texas were initially part of a larger national effort to reduce vehicle emissions and promote energy independence. These AFV requirements originated from two separate Congressional Acts: the 1990 Clean Air Act (CAA) and the 1992 Energy Policy Act (EPAct). Since the original enactment of CAA and EPAct, AFV requirements affecting transit vehicles have changed, and in some cases, have been eliminated. AFV usage requirements for transit vehicles are now primarily aimed at improving air quality by reducing vehicle emissions in non-attainment areas. AFV usage in transit buses to promote alternative energy sources is a secondary goal.

The Public Transportation Advisory Committee (PTAC) examined the AFV issue in 2005. PTAC recommended consistency with the Texas Transportation Code that states:

(c) The department may require that all or a percentage of the vehicles used to provide public transportation services comply with specified emissions standards. The standards may vary among geographic areas based on the need of each area to reduce levels of air pollution. This subsection does not apply to an authority created under Chapter 451, 452, 453, or 460.¹

PTAC subsequently recommended allowing individual systems to retire vehicles early that are more costly to maintain and allow purchase of less costly vehicles with other types of fuel. The goal is to reduce emissions and vehicle costs. PTAC suggested using an AFV exception process to accomplish this. This exception process for buying small urban and rural AFV transit vehicles was already in-place with the Texas Department of Transportation (TxDOT) at the time of PTAC's recommendation.²

What is an Alternative Fuel?

Alternative fuels, as defined by EPAct include [ethanol](#), [natural gas](#), [propane](#), [hydrogen](#), [biodiesel](#), [electricity](#), [methanol](#), and [p-series](#) fuels.³ In Texas, the most common alternative fuels in use are [natural gas](#) and [propane](#). Although classified as an alternative fuel, some fuels may not lead to emission reductions for specific pollutants. For example, some biodiesel blends may not lead to desired NOx reductions.

¹ Article 13. Statewide Coordination of Public Transportation. Texas Transportation Code, Chapter 461. Sec. 461.005.

² PTAC Meeting Minutes November 3, 2005.

³ U.S. Department of Energy, Alternative Fuels Data Center. <http://www.eere.energy.gov/afdc/altfuel/altfuels.html>

In addition to these EPAAct defined alternative fuels, TxDOT allows ultra low sulfur diesel fuel (ULSD) to be an alternative fuel for transit vehicles under its AFV exception process.

AFV Requirements for Rural/Small Urban Transit Vehicles

Currently, there are no federal legislative requirements to purchase alternatively fueled small urban and rural transit vehicles. EPAAct federal legislation that required purchase of alternative fuel vehicles ended in 2004 for local governments and communities (which included small urban and rural transit operators) after the Environmental Protection Agency determined it did not have the authority to impose fuel requirements on local governments. However, vehicle emission reductions may be required to meet State Implementation Plan (SIP) emission budgets in CAA non-attainment and management areas; and using an alternative fuel is one method of achieving the desired emission reduction. TxDOT may also require vehicles to meet specific emission standards as directed by the Texas Transportation Commission.

TxDOT Goals and Requirements

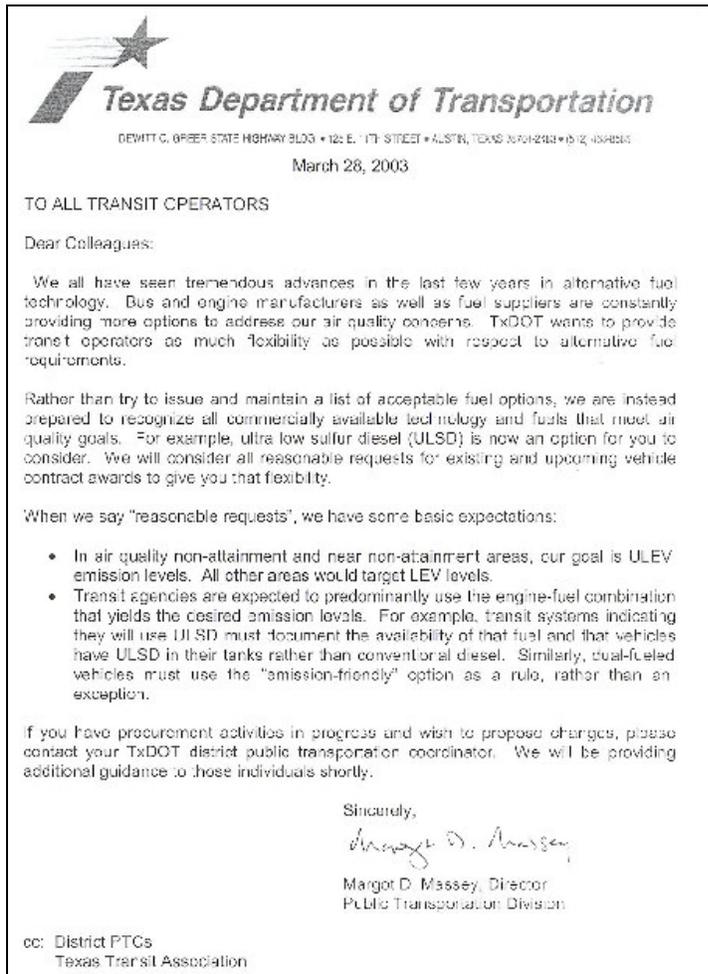
TxDOT is committed to using alternative fuels to reduce vehicle emissions to provide cleaner air, to decrease dependence on foreign oil, and to comply with state and federal environmental laws. (EPAAct requirements still apply to federal and state government fleets.) In fact, TxDOT has one of the largest AFV (propane) fleets in the country.

Texas is not the only state with commitments to AFVs. California has a long history at the forefront of emission-control requirements, and encouraging alternative fuels. The New York Department of Transportation (NYDOT) recently introduced a clean buses grant program. Approximately \$50 million in statewide transit capital grants will be available to help purchase clean-fueled hybrid-electric and compressed natural gas (CNG) buses through 2009.

The transit vehicle alternative fuel usage goals are consistent with Texas Transportation Commission directives. These goals are stated in a 2003 TxDOT letter: “In air quality non-attainment and near non-attainment, our goal is ULEV⁴ emission levels. All other areas would target LEV levels.”

⁴ ULEV (Ultra-low emission vehicle) is a vehicle certified by the California Air Resources Board to have emissions from zero to 50,000 miles no higher than 0.040 grams/mile (g/mi) of non-methane organic gases, 1.7 g/mi of carbon monoxide, and 0.2 g/mi of nitrogen oxides. Emissions from 50,000 to 100,000 miles may be slightly higher.

Figure 1. March 2003 Letter to Transit Operators



"In air quality non-attainment and near non-attainment, our goal ULEV emission levels. All other areas would target LEV levels."

TxDOT Exception to AFVs

The current TxDOT goals for transit vehicles can be interpreted as "fuel neutral". This means that non-alternative fuels be used as long as the vehicle meets emission requirements of ULEV in non-attainment areas and LEV in attainment areas. However, TxDOT grant recipients should request an exception to the AFV requirement. The exception form states that: *"All vehicles purchased by grant recipients and/or toll credit recipients under programs administered by the Texas Department of Transportation are required to be alternatively fueled. The Texas Transportation Commission may consider limited exceptions individually submitted by the grantee(s) for each occurrence and/or under each program."*



Request to Purchase Non-Alternative Fueled Vehicle(s)
All vehicles purchased by grant recipients and/or toll credit recipients under programs administered by the Texas Department of Transportation are required to be alternatively fueled. The Texas Transportation Commission may consider limited exceptions individually submitted by the grantee(s) for each occurrence and/or under each program.

Form PTN 115 (1/2009)
 (GSD-EP)
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Background		
Name of Transit Agency:		
Exception requested under which transit program: Please specify:		
How many non-alternatively fueled vehicles does the transit agency request to purchase under this exception?		
Into what type of service will the proposed vehicle(s) be placed?		
Fixed-Route/Deviated-Route <input type="checkbox"/> Fixed-Route/Paratransit <input type="checkbox"/> Demand-Response <input type="checkbox"/>		
Air Quality Status		
Current air quality status within transit agency's service area:	Does any part of your service area include an area that is currently under an air quality improvement mandate issued by a local, state, or federal agency?	
Source of information:		
Current Fleet Vehicle Composition		
Fixed-Route/Deviated-Route	Fixed-Route/Paratransit	Demand-Response
# of Alternatively Fueled Vehicles:	# of Alternatively Fueled Vehicles:	# of Alternatively Fueled Vehicles:
# of Non-Alternatively Fueled Vehicles:	# of Non-Alternatively Fueled Vehicles:	# of Non-Alternatively Fueled Vehicles:
Total: 0	Total: 0	Total: 0
Number of Vehicles by Fuel Type		
Clean Diesel: Diesel: Compressed Natural Gas: Liquefied Natural Gas: Liquefied Petroleum Gas: Methanol: Ethanol: Electric Propulsion: Gasoline:	Battery Power: Dual Mode (specify modes): Mode One: Mode Two: Fuel Cell: Hybrid Electric: Biodiesel: Other (specify): Fuel Type:	
Other Characteristics of Fleet or Service Pertinent to this Request		

AFV usage in transit vehicles is now primarily a matter of vehicle emissions. The same emission limits apply to all engines regardless of the fuel they use. That is, vehicles fueled by gasoline, diesel, or alternative fuels all must meet the same standards.

Figure 2. TxDOT Form PTN 115: Request Non-Alternative Fuel Vehicle

Fuel Neutral – It's about emissions!

AFV usage in small urban and rural transit vehicles is now primarily a matter of vehicle emissions. The same emission limits apply to all engines regardless of the fuel they use. That is, vehicles fueled by gasoline, diesel, or alternative fuels all must meet the same standards.

Rapid advances in fuel and engine technology make using prescriptive AFV guidelines difficult to justify from an emissions reduction perspective. Manufacturers continue striving to meet new vehicle emission requirements through evolving engine and exhaust after-treatment technologies. For example, until very recently alternatively fueled minivans were not available. Now, both ethanol-fueled minivans and gasoline-fueled minivans that meet lower emission requirements are available.

It is impractical to separate fuels from vehicle type and engine configurations because they go “hand-in-glove.” This is especially true for cut-away bus engine/fuel choices. Each bus manufacturer has a range of choices in combining different fuels with different engines and different body configurations. It can get very complicated pairing the engines and body configurations. The vehicle’s body affects gross vehicle weight which in turn affects the engine emissions ratings. The vehicles used in rural and small urban service span these different

combinations of engines and body configurations. Adding to the complexity is that engine emission data changes annually with each model year.

Table 1 lists various engine and fuel combinations along with their respective emissions. For example, when comparing the 6.0 L diesel and the 6.8 L gasoline engines, both engines meet the OEM standards; but neither engine has an overall "clean" rating because they each fail to meet or address the PM standard. How would one choose between these two identically-classified vehicles based upon a need to limit CO emissions? In this instance, the diesel is a better choice based on the actual pollutant count of 1 gram per brake horsepower-hour for the diesel engine versus 3.9 grams per brake horsepower-hour for the gasoline. However, if one were to add a particulate trap or catalytic oxidation after treatment to the engine, then the diesel engine would meet PM standards. This type of after treatment may not be available for a gasoline engine.

Table 1. Fuel and Emission Comparison⁵

Fuel System Applications & Emissions Comparison for a Cutaway Bus (>14,000 GVWR)				
Engine & Fuel	Pollutant	Emissions* & Standard Cited	Comment	Emissions Summary
Powerstroke 6.0 L Diesel (#2 Diesel)	NOx + NMHC	2.2 (LEV / ULEV)	Meets standard	Meets OEM standards
	CO	1 (LEV / ULEV)	Meets standard	
	PM	.1	Does not meet clean vehicle standards	
Powerstroke 6.0 L Diesel w/ Particulate Trap or Oxidation Catalyst (ULSD)	NOx + NMHC	1.78 (LEV / ULEV)	Emissions based on use of this fuel & fuel system are estimated**	ULEV – consistent (not certified)
	CO	.1 (LEV / ULEV)		
	PM	.02 (LEV / ULEV)		
Ford 6.8 L (Gasoline)	NOx + NMHC	1.1 (LEV / ULEV)	Meets standard	Meets OEM standards
	CO	3.9 (LEV / ULEV)	Meets standard	
	PM	Data not available	Does not meet clean vehicle standards	
Ford 6.8 L w/ GFI Teleflex (Propane)	NOx + NMHC	.5 (LEV / ULEV)	Meets standard	ULEV certified
	CO	1.6 (LEV / ULEV)	Meets standard	
	PM	0 (LEV / ULEV)	Meets standard	
Notes:				
<ul style="list-style-type: none"> Sources include: 2004 data from engine certification information center: http://www.epa.gov/otaq/certdata.htm , EPA certificates of conformity, California Air Resources Board executive orders, and EPA regulations (40 CFR 9, 85, 86, and 88). Units* are grams per brake-horsepower-hour. Estimates ** derived from report at http://www.cleanairfleets.org 				
Acronyms:				
CO – carbon monoxide		NOx – nitrogen oxide	PM – particulate matter	
GVWR – gross vehicle weight rating		NMHC – non-methane hydrocarbon	ULEV – ultra low emission vehicle	
LEV – low emission vehicle		OEM – original equipment manufacturer	ULSD – ultra low sulfur diesel	

⁵ Table courtesy of TxDOT PTN Division.

What About Diesel Fuel?

New clean fuel requirements from the Environmental Protection Agency (EPA) and Texas Commission on Environmental Quality (TCEQ) are being implemented in Texas and across the country. It is the combination of the Model Year 2007 diesel engines and the lower sulfur diesel fuel that the EPA (and states) expects to result in reduced emissions to the atmosphere. There are two clean diesel fuels that should be noted:

- Texas Low Emission Diesel (TxLED) is a low sulfur diesel fuel available in 110 counties of East Texas (East of IH-35) that include most of the air quality non-attainment areas in Texas.
- Ultra low sulfur diesel (ULSD) is a low sulfur (less than 15 parts per million) diesel fuel that became available nationally in the fall of 2006.

For the purposes of AFVs in transit applications, ULSD and TxLED can be considered equivalent. Although ULSD and TxLED are not classified as alternative fuels under EPCRA, they are allowed by TxDOT as an exception, provided the engines meet the clean vehicle emission requirement. This permits a fuel neutral approach to reducing emissions.

ULSD and TxLED are not without drawbacks. Operators have cited problems with using ULSD related to cost, fuel availability, lubricity, and cold flow properties. These drawbacks are being addressed by engine manufacturers, fuel standards organizations, after-market fuel additives, and fuel refiners/suppliers. Taken together, these issues contribute to the changing nature of the industry.

Although ULSD and TxLED are not classified as alternative fuels under EPCRA, they are allowed by PTN as an exception, provided the engines meet the clean vehicle emission requirement.

Engine manufacturers certify their engines, or fuel conversion systems, in accordance with EPA regulations for both LEV and ULEV status. While ULSD and TxLED fueled vehicles are cleaner than traditional diesel and gasoline fuels, they still may need additional exhaust treatments such as catalytic oxidizers and/or particulate matter (PM) traps to meet lower emission requirements. After-treatments may also be needed for bio-diesel configurations.

Issues Affecting AFV Usage

The experience for small urban and rural transit providers using AFVs is varied. Some operators have seen success using AFVs, while others claim increased cost and operational difficulties.⁶ This varied experience is not limited to Texas. Transit providers using AFVs in other states experience both success and difficulties.⁷

Liquefied petroleum gas (LPG), also commonly referred to as propane, is currently the only alternative fuel used by small urban and rural providers in Texas. It is also the most widely used

⁶ U.S. Department of Energy. Alternative Fuels Data Center List success stories for various fuels. http://www.eere.energy.gov/afdc/infrastructure/prop_resources.html

⁷ Reviews of experiences at the Department of Energy (DOE) Alternative Fuel Data Center <http://www.eere.energy.gov/afdc/> and in Transit Cooperative Research Program Reports (e.g. TCRP Report 38 and 61).

alternative fuel in Texas and the nation.⁸ Propane is widely used to fuel small transit and school buses. (Compressed natural gas is a commonly used fuel in large transit vehicles.)

The use of propane in transit vehicles has seen success at the Capital Area Rural Transportation System (CARTS). Other transit operations such as Island Transit in Galveston, Port Arthur Transit, and several school districts in Texas have AFV buses in use. TxDOT operates a fleet of more than 5000 propane vehicles (mostly cars and light-duty trucks).

Based on a review of LPG usage in Texas and throughout the country, positive experiences with LPG as a fleet fuel generally occur at medium to large centrally fueled fleets with shorter trip distances. In contrast, problems are reported more frequently with small fleets in rural regions that have longer trip distances, where propane vehicle range becomes an issue, smaller fleets have limited access to fueling infrastructure, and access to technical and mechanical expertise is limited.

...positive experiences with LPG as a fleet fuel generally occur at larger centrally fueled fleets that make shorter trip distances.

Texas Provider AFV Survey

As part of PTAC's 2005 examination of AFVs, PTN conducted a survey of rural and urban transit districts in Texas. The survey covered operational data from December 2004 through May 2005. In general, the survey comments cited:⁹

- Low fuel efficiency of propane vehicles
- Limited range of propane vehicles (making long-distance trips difficult)
- Scarcity of LPG fueling infrastructure (Texas has the most LPG fueling sites).
- Scheduling difficulties in re-fueling at existing LPG fueling facilities
- Significant mechanical downtime for LPG vehicles
- Lack of technical/mechanical expertise for LPG repairs (especially in rural areas)
- Scarcity of repair locations for LPG vehicle repairs.

A common issue among transit operators is that propane vehicles are more expensive to operate than traditionally fueled vehicles. Fuel station availability, fuel economy, and vehicle range (trip length) are concerns for regions with remote and sparsely populated passengers.

The Alternative Fuels Data Center (AFDC) acknowledges AF buses are more expensive than diesel buses for several reasons, including:¹⁰

- Produced in smaller volume (which almost always translates into higher cost)
- Costlier on-board fuel storage: Diesel<LPG<Natural Gas
- Specialized components (e.g., fire suppression, spark plugs, and coils)
- Incremental costs vary with bus specifications and order size (13 to 18 percent higher than diesel)

⁸ The Propane Education and Research Council. 2005. <http://www.propanecouncil.org/trade/fleet/index.cfm>

¹⁰ U. S. Department of Energy. Alternative Fuels Data Center, Fleet Applications and Niche Markets. http://www.eere.energy.gov/afdc/apps/toolkit/transit_bus_toolkit.html. The Government Accounting Office 1999 Report: "Mass Transit: Use of Alternative Fuels in Transit Buses GAO/RCED -00-18 also reported increased cost to operate AF buses.

Propane AFV Advantages

Among the various alternative fuels, vehicles fueled with propane have advantages over other alternative fuels according to the AFDC, including:¹¹

- Transit agencies such as VIA in San Antonio are making LPG work very effectively, and at life-cycle costs within 10 percent of diesel.
- LPG fueling stations cost more than diesel, but significantly less than CNG and LNG stations.
- Operational issues associated with using LPG in transit (e.g., range and fuel efficiency) are generally less challenging than CNG or LNG.
- Life-cycle costs for LPG buses appear to be decreasing, while life-cycle costs for diesel buses are likely to increase.

Service Impacts

Small urban and rural providers generally use three types of vehicles: the less than 30-ft transit bus, the cutaway bus, and the transit van. In Texas, most rural and small urban providers use cutaway buses.

When small urban and rural providers' vehicles require maintenance and are taken out of service it affects their ability to provide and coordinate service. The impact on service that breakdowns cause is relative to the size of the transit provider's fleet. For example, when a transit provider has 10 vehicles servicing a region and loses one vehicle to repair, the service level typically falls accordingly. When a provider with a fleet of two vehicles loses one vehicle to a breakdown, the service impact can be severe. By comparison, for larger fleets with 100 buses, losing several buses would have less impact on service, and would also likely go unnoticed by the provider's customer base. Unlike larger transit agencies that are more equipped to compensate for bus breakdowns, small providers and their customers suffer greatly when vehicles are not available for service.

Small agencies generally do not have maintenance staff employed to fix the problems associated with AFV repairs. Transit agencies with cutaway buses frequently rely on outside sources for maintenance. If a vehicle is under warranty, the provider is required to take the vehicle to a specific location (sometimes outside the region) to fix the problem. This can result in long wait times for buses taken out to service. Conflicts can also arise from determining which manufacturer warranty is responsible for fixing a problem due to the use of multiple vendors in the cutaway manufacturing process. Cutaway buses are usually made for the lowest cost possible because they are designed to be sold in a low-bid market. As a result, quality suffers as cost considerations override concerns about the overall effectiveness of the vehicle.

Small agencies generally do not have maintenance staff employed to fix the problems associated with AFV repairs.

Many small providers believe that the purchase price and maintenance cost difference between an AFV and diesel bus could account for a significant amount of a small agency's annual operating costs. This was confirmed by Advanced Transportation Technology Institute (ATTI),

¹¹ Ibid.

which has performed some research into the rural transportation industry including surveys and interviews of transit agencies.

Clean Air Act Framework for Emission Standards

CAA establishes tailpipe emission standards for five pollutants, including: hydrocarbons (HC), nitrogen oxides (NOx), carbon monoxide (CO), particulate matter (PM, for diesel vehicles only), and formaldehyde (HCHO). As a rule of thumb for the federal standards, the lower the bin number, the cleaner the vehicle. For a simple example, a 2004 Toyota Prius is a very clean Bin 3, while a Hummer H2 is a dirty Bin 11. The federal standards use the following “bins”:

- Tier 2 bin 1: The cleanest Federal Tier 2 standard. A zero-emission vehicle (ZEV)
- Tier 2 bins 4 – 2: Cleaner than the average standard (approximately ULEV)
- Tier 2 bin 5: “Average” of new Tier 2 standards, roughly equivalent to a LEVII vehicle
- Tier 2 bins 9-6: Not as clean as the average requirement for a Tier 2 vehicle
- Tier 2 bin 10: Least-clean Tier 2 bin applicable to cars
- Tier 1: The former Federal standard; carried over to model year 2004 for those vehicles not yet subject to the phase-in.

Tier 2 Standards

Two sets of standards were defined for light-duty vehicles in the CAA Amendments. Adopted in 1999, Tier 2 standards are in effect now. Under the Tier 2 regulation, the same emission standards apply to all vehicle weight categories and include cars, minivans, and light-duty trucks. The same emission limits also apply to all engines regardless of the fuel they use. That is, vehicles fueled by gasoline, diesel, or alternative fuels all must meet the same standards.

What Does All This Mean?

The previous brief description of CAA “bins” and Tier 2 standards are presented here as the framework in which vehicles are currently classified. The terms “LEV” and “ULEV” have been replaced with “bins” in terms of EPA’s regulatory framework, but LEV and ULEV still have a meaning in terms of vehicle emissions. In a simpler form, TxDOT fleet emission goals are still expressed in terms of LEV and ULEV.¹² What is important to note for small urban and rural transit providers is that transit vehicles should meet LEV for attainment areas, and ULEV (Tier 2 bins 1-5) in non-attainment areas to meet TxDOT requirements. Figure 3 shows the rural service providers in both the non-attainment and near non-attainment areas.

What is important to note for small urban and rural transit providers is that transit vehicles should meet LEV for attainment areas, and ULEV (Tier 2, bins 1-5) in non-attainment areas to meet TxDOT requirements.

¹² ULEV (Ultra-low emission vehicle) is a vehicle certified by the California Air Resources Board to have emissions from zero to 50,000 miles no higher than 0.040 grams/mile (g/mi) of non-methane organic gases, 1.7 g/mi of carbon monoxide, and 0.2 g/mi of nitrogen oxides. Emissions from 50,000 to 100,000 miles may be slightly higher.

Rural Public Transportation Service in Non-Attainment and Near Non-Attainment Areas

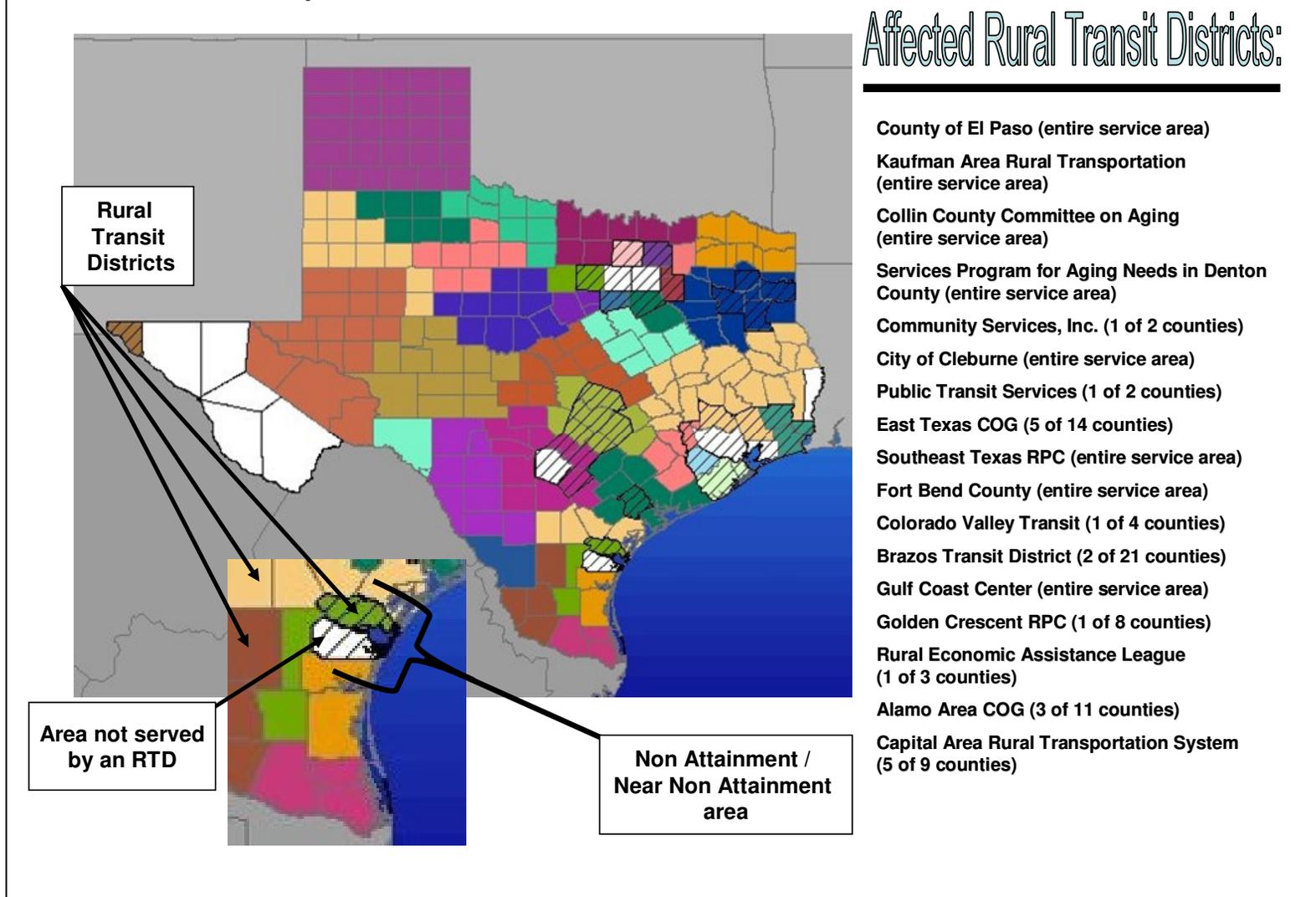


Figure 3. Rural Service Providers in Non Attainment and Near Non Attainment Areas.

Small urban and rural transit providers narrowly missed being included in the EPA Clean Fleet program when EPA acknowledged it did not have the authority over local fleets. Yet, many fleets are covered under the authority of the EPA Clean Fleets Program. Additionally, fleets that operate in non-attainment areas must comply with the State Implementation Plan for compliance with CAA. In either case, although a small urban or rural provider may not currently have a federal “clean” vehicle requirement now, it may be included in the future, or be subject to changes as a result of a region’s air quality attainment status.

To find vehicle and engine certification data, go to the EPA website at <http://www.epa.gov/otaq/cert.htm>

Helpful AFV Links

Provided below are a few helpful links to websites with specific information on AFV buses. Many of these sites also provide helpful links.

- TxDOT – PTN Division Transit Vehicle Procurement: http://www.dot.state.tx.us/services/public_transportation/transit_procurement.htm
- EPA Light Duty Vehicle and Engine Emission Certification <http://www.epa.gov/otaq/cert.htm>
- Transportation & Fuels, EPA: <http://www.epa.gov/air/transport.html>
- Alternative Fuels Data Center, DOE: <http://www.eere.energy.gov/afdc/>
- Clean Cities, DOE: <http://www.cities.doe.gov>
- The Altoona Bus Research and Testing Center – Bus Data Base: <http://www.vss.psu.edu/BTRC.htm>
- Advanced Transportation Technology Institute: <http://www.att-info.org/index.html>
- The Propane Education and Research Council: <http://www.propanecouncil.org/>

Table 2. Propane Powered Product Providers¹³

Provider	Location	Website
Parnell USA, Inc.	Phoenix, AZ Phone (623) 581-8335	http://www.parnellusa.com
Clean Fuel USA	Georgetown, Texas (512) 942-8300	http://www.cleanfuelusa.com/
BAF Technologies	Dallas, Texas (214) 231-1450	http://baftechnologies.com/

¹³ Propane Education and Research Council. 2006 Propane Fleet Product Listing. http://www.propanecouncil.org/industry/resLib_tradesDetail.cfv?id=313&t=Fact%20Sheets

RECOMMENDATIONS

Based on the review of AFV usage at small urban and rural systems in Texas, four broad areas should be addressed:

- Existing AFV fleets,
- New AFV purchases,
- Fleet maintenance, and
- AFV fuel infrastructure.

Table 2 presents how these areas can be addressed. The table is organized to list a specific constraint within that area, a recommended action, and the type of action to be taken (i.e., a policy action, an agreement, or action in the form of a project). A blank table is provided for readers who wish to add or suggest additional constraints that need to be addressed, how they should be addressed, and what type of action is needed.

Table 2. Recommended Actions – Overcoming Barriers and Constraints

Area to be Addressed	Issue/Barrier/Constraint/ Specifics	Recommendation	Type of Action
AFV Fuel Infrastructure	Scarcity of fueling infrastructure Limited access and operating hours for fueling locations	Regional shared fueling agreements at TxDOT LPG fueling locations.	Coordination Agreement
Existing AFV Fleets New AFV Purchases	LPG vehicle range (low fuel economy)	Allow mixed-fuel fleets to include ULSD diesel fueled vehicles for long trip distances. Shared fueling agreements to allow re-fueling for long trips.	Policy Clarification Coordination Agreements
Fleet Maintenance New AFV Purchases	Vehicle downtime affects service	Allow fleet mix to include traditional and bi-fueled vehicles. Implement a diesel retro-fit program and broad maintenance program to address aging fleets.	Policy Action
Existing AFV Fleets Fleet Maintenance	LPG fueled vehicle reliability	Identify LPG maintenance assets and promote shared / regional maintenance facilities. Prepare and deliver propane maintenance and repair workshops and training. Retro-fit vehicles to traditional fuel in attainment areas.	Statewide Coordination Project

Table 2. Recommended Actions – Overcoming Barriers and Constraints (Continued)

Area to be Addressed	Issue/Barrier/Constraint/ Specifics	Recommendation	Type of Action
Existing AFV Fleet New AFV Purchases	Maintenance and repairs to existing propane buses Distance to qualified mechanics	Conduct propane workshops involving conversion/manufacturing companies and mechanics. Shared maintenance and mechanics pool agreements. Regional maintenance centers to reduce drive/down time for remote providers. Pooled resource contracts for “traveling” mechanics with expertise in AFVs.	Statewide and Inter-regional Coordination Projects
New AFV Purchases Existing AFV Fleet AFV Fuel Infrastructure	Vehicle longevity and replacement costs Maintaining emissions budget and reducing air pollution	Institute regional performance based fleet emissions, or regional emission budgets for entire transit fleet. Allow agencies to buy/trade bus emissions. For example, if an agency wishes to retro-fit to gasoline, then they would pay a premium. If the traditional fuel is cheaper, then the savings is passed on to AFV users. This concept is based on existing commodity/emissions trading among polluters in other industries.	Policy Development