ALTERNATIVE FUEL VEHICLE READINESS GUIDE FOR MEDIUM- AND HEAVY-DUTY FLEETS

Iowa Clean Cities Coalition is a program of

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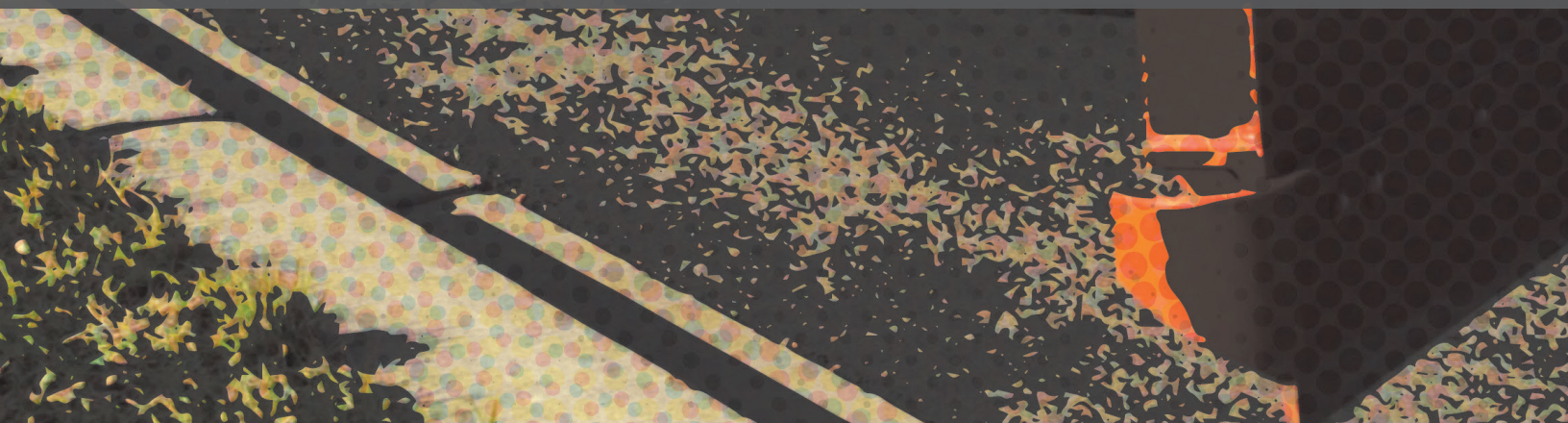

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INTRODUCTION

As alternative fuels and alternative fuel vehicles are becoming more popular throughout the United States, many fleets have decided to switch to alternative fuel vehicles to reduce emissions and/or save money. This document focuses on applications for medium- and heavy-duty fleets, yet many of the topics are also applicable to light-duty vehicles.

Throughout this document, "fleets" will be referred to as organizations that manage a group of vehicles.

This Alternative Fuel Readiness Guide was designed with fleets in mind to help make the transition to alternative fuels manageable and safe while avoiding mistakes that can occur in the absence of guidance. The guide will cover topics to consider and checklists to review when taking on alternative fuel projects.

When determining whether to switch to an alternative fuel vehicle, fleets should keep in mind fueling infrastructure that may be needed. Fleets can approach this in one of three ways:

1. Install on-site fueling infrastructure.
2. Utilize third-party, on-site fueling delivery services.
3. Use public stations. Locations of many public stations can be found at: www.afdc.energy.gov/locator/stations or through use of this locator's mobile app.

Planning considerations on stations for each applicable fuel type for medium and heavy-duty vehicles are discussed in detail in this guide, with special attention given to on-site fueling infrastructure.

This guide does not detail background information about each alternative fuel in terms of merit, production, adoption, etc. It is intended to help fleets who are mostly certain that they want to pursue alternative fuels and apply for funding yet want some guidance to help them prepare for the transition. There are a variety of organizations and other informational resources that can provide additional information as this guide is not all-encompassing. Many of these resources are provided in this guide. For example, the initiative Fleets for the Future provides more granular detail on topics like procurement and vehicle prioritization. Information on this initiative is available here: www.fleetsforthefuture.org/f4f-best-practices.

Preparing for Funding Opportunities

This publication is intended to help organizations interested in utilizing alternative fuel vehicles as they prepare to apply for funding available through the State of Iowa from the Volkswagen Settlement Environmental Mitigation Trust (EMT) and Diesel Emission Reduction Act (DERA) funding from the US Environmental Protection Agency, both administered, in Iowa by the Iowa Department of Transportation. Eligible fuels for this funding include diesel, compressed natural gas, propane, and plug in electric vehicles.

Due to the eligibility parameters of these funding sources, this document focuses on medium and heavy-duty vehicles, which may be eligible for these programs. There are similarities between the two programs; however, a few of the differences relating to projects described in this guide include:

- Alternative fuel vehicle conversions are only eligible under DERA. Conversions of existing vehicles are one option described in this guide that fleets can pursue.
- Both funding programs are primarily funding the vehicles themselves and not the fueling station equipment needed for them. The one exception is that the Environmental Mitigation Trust will fund a portion of the charging infrastructure for medium and heavy-duty electric vehicles. Therefore, being "ready" for alternative fuel vehicles necessitates having some plan and expectations of how they will be refueled.

- VW Settlement EMT funding covers Class 4-8 vehicles, whereas DERA covers Class 5-8, in addition to other types of idle reduction and off-road projects not discussed in this guide.

More information on the VW Settlement funding and the DERA program is provided in Appendix B: Funding Opportunities through State of Iowa.

VEHICLE OPTIONS

Fleets wanting to utilize alternative fuel vehicles can consider these options: replace a vehicle with a new vehicle specifically designed to operate on an alternative fuel, to convert a vehicle or repower a vehicle.

Choosing New Vehicles from OEMs

The U.S. Department of Energy's Alternative Fuels Data Center provides a search tool for finding and comparing new alternative fuel vehicles, engines and hybrid systems from Original Equipment Manufacturers (OEMs), as well as some conversion systems. This tool can be found at: www.afdc.energy.gov/vehicles/search.

Conversions and Repowers

Besides those offered by the OEM, conversions and repower options provide fleets with alternative fuel and advanced vehicle technology options.

With proper education, fleets can make informed decisions regarding the type of technology to implement, utilize the best technology for the given situation, and ensure compliance with applicable safety, emissions and installation standards.

When deciding whether to convert or repower vehicles, preliminary steps should be considered.

1. Take inventory of the existing vehicle to fully understand its attributes, engine, specific configurations and add on equipment.
2. Ensure the technology in consideration will not negatively impact the operation or job performance of the vehicle.
3. Ensure any new equipment added to a vehicle is placed in a location that will not inhibit the vehicle's normal carrying capacity or performance.

Conversion: A process that involves modifying an existing engine using a conversion kit to run on a fuel (such as an alternative fuel) or power source (such as electricity) that is different from the one it was originally designed to operate on.

If **converting** from an existing engine to one that runs on a different fuel or power source, the following checklist should be followed to ensure a successful conversion.

1. Select an alternative power source
   a. ***Dedicated:*** operates on solely one alternative fuel
   b. ***Bi-fuel:*** Runs on two separate fuel systems, one conventional fuel and one alternative fuel
   c. ***Dual-fuel:*** Two different fuels are used in combination. (For example, the vehicle uses diesel to start, then runs on a combination of natural gas and reduced diesel)
2. Ensure the conversion is done by a trained technician associated with a qualified system retrofitter (QSR) or a qualified vehicle modifier (QVM), also known as an up-fitter or installer, who is authorized to install a conversion kit.

3. Ensure the conversion meets standards instituted by the Environmental Protection Agency (EPA), National Highway Traffic Safety Administration (NHTSA) and state agencies. Additional information can be found at: www.afdc.energy.gov/vehicles/conversions_regulations.html

If done incorrectly, changing the configuration of a vehicle engine could violate section 203(a)(3) of the Clean Air Act. To ensure a conversion doesn't violate, the EPA established protocols manufacturers offering conversion kits can use to certify their products. This ensures they meet emission standards and are exempt from the tampering prohibition for that system. The EPA maintains a list of certified alternative fuel conversion systems. This can be found at:
www.epa.gov/vehicle-and-engine-certification/lists-epa-compliant-alternative-fuel-conversion-systems

Warranty Implications of Conversions

Industry documentation and regulations cite the following regarding the effects of an approved aftermarket technology on OEM warranties;

The Federal Trade Commission (FTC) issued a Consumer Alert in January 2011 confirming it is illegal to void warranties or deny coverage for the use of an aftermarket part.

Specifically, the EPA Alternate Fuel Conversion Final Rule published on April 8, 2011, states:

"the clean alternative fuel conversion manufacturer would normally be held accountable for fixing problems that occur as the result of conversion" but "the OEM would generally retain responsibility for the performance of any parts or systems that retain their original function following conversion and are unaffected by the conversion."

Fleets are encouraged to investigate warranty implications before modifications are made.

Liability for the warranty following conversion of the vehicle may transfer from the OEM to the conversion manufacturer. The warranty for unaffected vehicle or engine parts will most likely still fall on the OEM. If roles are not decided upon before the conversion, warranty disputes could occur.

Repower: A process that involves removing a vehicle's original engine and replacing it with a new engine or power source (such as an electric drive system). Because new engine components and older vehicle engine compartments aren't designed for one another, repowering a vehicle requires an engineered solution by a trained technician.

If **repowering** an engine by replacing it with a newer engine or power source, the following "to-do" list should be followed to ensure a successful conversion.

1. Ensure the new engine and after treatment components are certified to meet the regulations and standards of the EPA's Clean Air Act.
2. Ensure a trained technician replaces the engine as it will take additional work to engineer a solution to make the new engine work with the old vehicle.

The following link provides more information regarding what fleets need to know about alternative fuel vehicle conversions and repowers. It also covers retrofits, which entail making modifications to a diesel emissions system but does not incorporate alternative fuels.
www.afdc.energy.gov/uploads/publication/afv_conversions_retrofits_repowers.pdf

Calculating Return on Investment and Emissions

Argonne National Laboratory (ANL) developed a tool to help calculate the environmental and economic costs and benefits of alternative fuel and advanced vehicles. The AFLEET (Alternative Fuel Life-Cycle Environmental and Economic Transportation) tool is an Excel-based tool designed to analyze the differences between a new conventionally fueled vehicle and a new alternative fuel vehicle. The tool can be found at: greet.es.anl.gov/afleet.

ANL developed a web-based tool, based on AFLEET calculations, and focused on emissions called the Heavy-Duty Vehicle Emissions Calculator. This also compares the cost for emissions reductions based on the funding requested. afleet-web.es.anl.gov/hdv-emissions-calculator.

The Iowa DOT will utilize its own methodology for emissions calculations for the funding opportunities it administers. ANL tools can help a fleet analyze which of its vehicles to prioritize for funding.

VEHICLE MAINTENANCE

There are two main conditions to consider regarding maintenance when deploying new fuel into a fleet. The first is access to qualified and alternative fuel certified technicians that can service the vehicles, and the second is modifying existing maintenance facilities to meet minor and major alternative fuel maintenance guidelines. The extent of on-site maintenance to be performed will dictate the level of training and garage modifications necessary. Depending on the vehicle options and procurement outcomes, fleets can delegate major repair work to the compliant OEM dealers, engine service networks or authorized aftermarket system installers.

Further Resources

Technician Training
www.afdc.energy.gov/vehicles/technician_training.html

BIODIESEL

Biodiesel is a domestically produced, renewable fuel that can be manufactured from vegetable oils, animal fats, or recycled restaurant grease for use in diesel vehicles or any equipment that operates on diesel fuel. Biodiesel is available in a variety of blends; these blends are named with the percentages of biodiesel obvious in the name. For example, B5 means the fuel is made up of a 5 percent biodiesel and 95 percent diesel blend. Due to the incentives available in Iowa, many public stations with a biodiesel option now offer a B11 blend. Biodiesel can be used in diesel vehicles, with some considerations around fuel quality and manufacturer support.

Today's biodiesel is guided by stringent fuel specifications, developed through years of testing. This ensures a quality, consistent product that will meet standards required by engine manufacturers. The American Society for Testing and Materials (ASTM) sets the standard for biodiesel. These standards outline the minimum required properties of the fuel to provide adequate customer satisfaction and protection. For biodiesel, this standard is called ASTM D 6751.

All major OEMs producing diesel vehicles in the U.S. market support at least B5 and lower blends. Of the Gross Vehicle Weight (GVW) Class 5-8 vehicles that account for 92 percent of on-road diesel fuel use, nearly 90 percent of the medium and heavy-duty truck OEMs support B20. The biodiesel component must meet ASTM D 6751, the approved standard for pure biodiesel (B100), and the B20 blends must meet ASTM D 7467 specifications, the approved standard for blends ranging between

B6-B20. Many OEMs also recommend the use of a BQ-9000 supplier. BQ-9000 is a voluntary quality assurance program created by the National Biodiesel Board. This program certifies biodiesel producers, marketer's and testing labs. The program starts with the ASTM B 6751 for biodiesel and adds a quality systems program to make sure biodiesel is sampled, tested, stored, blended, shipped and distributed in a way that maintains high quality.

For a complete detailed listing of OEM position statements on biodiesel, visit: biodiesel.org/using-biodiesel/oem-information.

If a fleet wants to integrate biodiesel into its fuel mix, ensure the vehicle's warranty allows up to B20 in the engine when buying new diesel vehicles.

Refueling Infrastructure

Biodiesel blends are widely available at public stations. There are requirements for selling blends above B5 at existing and new stations. Blends B5 or below are exempt from these requirements because national standards and federal code view it the same as petroleum diesel. The U.S. Department of Energy's Alternative Fuel Station Locator only indicates stations that consistently sell B20 or above for certain parts of the year. The Iowa Renewable Fuels Association provides a list of biodiesel refueling sites and associated blend ranges at iowarfa.org/biodiesel-center/biodiesel-refueling-sites.

Existing equipment may be compatible, and costs will vary by station. Installing equipment compatible with the B6 to B20 is like installing conventional diesel equipment; the same permits apply. No garage modifications are necessary as biodiesel is used in diesel vehicles.

Further Resources

Biodiesel Infrastructure Development
www.afdc.energy.gov/fuels/biodiesel_infrastructure.html

Biodiesel Handling and Use Guide
www.afdc.energy.gov/uploads/publication/biodiesel_handling_use_guide.pdf

ELECTRICITY

The primary electric vehicle designs are plug-in hybrid electric and all electric.

Plug-In Hybrid Electric (PHEV)

Plug-in hybrid electric vehicles run entirely off electricity stored in an on-board battery and can also operate solely on liquid fuel. These vehicles can be plugged into an electric power source to charge the battery.

All-Electric Vehicle or Battery Electric Vehicles (BEV)

Battery Electric Vehicles use a battery to store the electric energy that exclusively powers the motor. EV batteries are charged by plugging the vehicle in to an electric power source.

Medium and Heavy-Duty Vehicle Range

Electric drive range for a medium to heavy-duty electric vehicle depend on the type of vehicle. Common ranges include:

- Class 8 tractor: 200-500 miles*
- Straight truck: 100-230 miles*
- Transit buses: 140-160 miles
- Step van: 90-150 miles
- Cab chassis: 100-155 miles
- Terminal truck: 30-60 miles
- Refuse truck: 50-85 miles
- Bucket truck: 40 miles

*Anticipated to be commercially available by 2020

Further Resources

Electric vehicle procurement best practices
static1.squarespace.com/static/57a0a284d2b857f883096ab0/t/58594c0b20099e7458106015/1482247181025/Electric+Vehicle+Procurement+Best+Practices+Guide.pdf

Refueling Infrastructure

Fleets should communicate with local utilities to discuss electrical upgrades needed at the refueling site and electricity costs prior to beginning infrastructure installment. Iowa Clean Cities recommends engaging the local utility as soon as possible in the project planning process to avoid running into costly oversites.

Medium- and heavy-duty electric vehicles are still in the earlier stages of commercialization, and there is a wide range of vehicle types. Charging infrastructure needs for medium- and heavy-duty electric vehicles vary depending on the manufacturer of the vehicle and the application for which the vehicle is being used. Individual vehicle manufacturers should have the most accurate, up-to-date information. Charging equipment may be available with vehicle purchase. The dealer or manufacturer should indicate the connector type and charging power recommended. Many fleets install Electric Vehicle Supply Equipment (EVSE) at the fleet depot or parking area for the vehicles to charge either overnight or after completing the route.

In comparison to light-duty electric vehicles, heavier vehicles with longer electric ranges will have larger battery capacities and require a higher power output if the vehicle is to be charged in a reasonable period.

Further Resources

Transportation Research Board's publication Battery Electric Buses – State of the Practice
www.trb.org/Publications/Blurbs/177400.aspx

Costs associated with non-residential electric vehicle supply equipment
www.afdc.energy.gov/uploads/publication/evse_cost_report_2015.pdf

Field Evaluation of Medium-Duty Plug-In Electric Delivery Trucks
www.afdc.energy.gov/uploads/publication/field_evaluation_md_elec_delivery_trucks.pdf

Electric Truck and Bus Grid Integration
www.calstart.org/Libraries/Publications/Electric_Truck_Bus_Grid_Integration_Opportunities_Challenges_Recommendations.sflb.ashx

Maintenance and Safety of Hybrid and Plug-In Electric Vehicles
www.afdc.energy.gov/vehicles/electric_maintenance.html

NATURAL GAS

Natural gas is a clean burning, domestically produced fuel. Most of the natural gas in the U.S. is considered a fossil fuel as it's made from sources formed over millions of years through the action of heat and pressure on organic materials. Renewable natural gas, also referred to as biomethane, is produced from organic materials such as livestock and food waste through anaerobic digestion. There are two types of natural gas vehicles can run on, compressed natural gas (CNG) and liquefied natural gas (LNG). For the purposes of this Guide, information is most focused on Compressed Natural Gas Vehicles as CNG is eligible for VW funding and LNG is not. CNG vehicles have a similar fuel economy as conventional gasoline fueled vehicles on a gallon of gas equivalency (GGE) basis. A GGE is roughly 5.66 pounds of CNG. CNG is appropriate for light, medium and heavy-duty vehicles. Depending on the number of CNG tanks installed on the tractor the mileage of CNG vehicles typically ranges from 300 miles to over 1,000 miles.

There are three types of CNG vehicles:

- ***Dedicated Natural Gas Vehicles:*** A dedicated natural gas vehicle is designed to run only on natural gas.
- ***Bi-Fuel Natural Gas Vehicles:*** Bi-fuel vehicles are designed with two separate fueling tanks, this enables the vehicle to run on either natural gas or gasoline at one time.
- ***Dual fuel Natural Gas Vehicles:*** Dual fuel vehicles are typically only used with heavy duty vehicles. Dual fuel vehicles have independent fueling systems that run on either fully diesel, or a combination of natural gas and reduced diesel usage.

Further Resources

Gaseous Fuel Vehicle Procurement Best Practices
static1.squarespace.com/static/57a0a284d2b857f883096ab0/t/58594bd9c534a5dba5fe012a/1482247132192/Gaseous+Fuel+Vehicle+Procurement+Best+Practices+Guide.pdf

Compressed Natural Gas Vehicle Maintenance Facility Modification Handbook
www.afdc.energy.gov/uploads/publication/cng_maintenance_facility_mod.pdf

Natural Gas Vehicle Maintenance and Safety
www.afdc.energy.gov/vehicles/natural_gas_maintenance_safety.html

Maintenance Facility Modifications

Depending on the vehicle options and procurement outcomes, fleets can delegate major repair work to alternative fuel compliant OEM dealers, engine service networks or authorized aftermarket system installers. If major repair work on CNG vehicles will be done on site, fleets need to evaluate maintenance facilities for potential modifications to accommodate this work.

Examples of the topics that need evaluated:

- Ventilation must provide sufficient air flow to reduce the concentration of the released gas and, at the same time, evacuate the gas from the structure. Major repairs require changes to ventilation systems and capacities, as well as the potential installation of methane detection systems. Methane detection and control systems and alarms must provide defense against dangerous concentrations of natural gas by altering personnel and disabling potential electrical ignition sources.
- Space heating must be designed in accordance with guidelines so open flames or hot surfaces do not provide an ignition source.
- Electrical wiring and equipment must be installed to avoid providing sources of ignition due to sparking, the equipment itself can be designed to be “explosion proof.”
- Companies must establish specific protocols and training to ensure safety.

Further Resources

CNG Vehicle Maintenance Facility Modification Handbook:
www.afdc.energy.gov/uploads/publication/cng_maintenance_facility_mod.pdf

Associated Codes are listed in Appendix A of this Guide.

Refueling Infrastructure

Fleets looking to deploy CNG have three basic options for fueling:

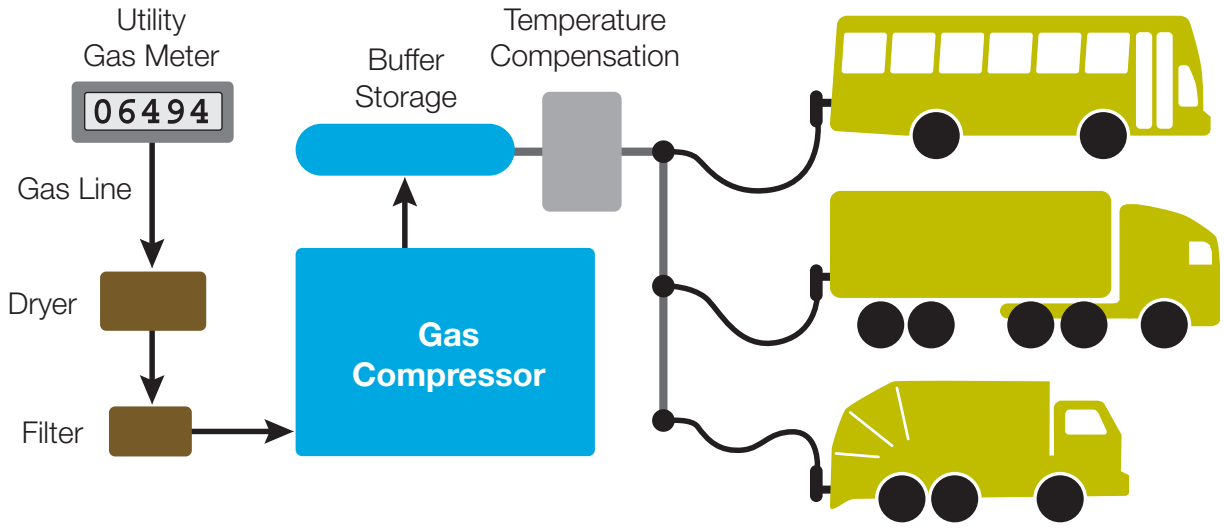
1. Use existing fueling infrastructure if it’s sufficient in size, capacity, flow rate and is close enough that time spent traveling to the station does not negate savings.
2. Consider mobile fuel delivery if the nearest public station is too far away and/or if fuel use is insufficient to justify a station investment.
3. Build fueling infrastructure at or near a fleet yard if it will be used by fleets frequently and the cost of infrastructure will be paid back through fuel savings.

There are many factors that affect CNG station costs for building the fueling infrastructure. The following should be taken into consideration before deciding to open a station and can be conducted with the assistance of qualified professionals.

There are two designs of CNG stations, Time-Fill and Fast-Fill.

Time-Fill: Fueling takes a longer period and can be completed overnight. Fleets should consider whether the tank size and range are sufficient for daily needs.

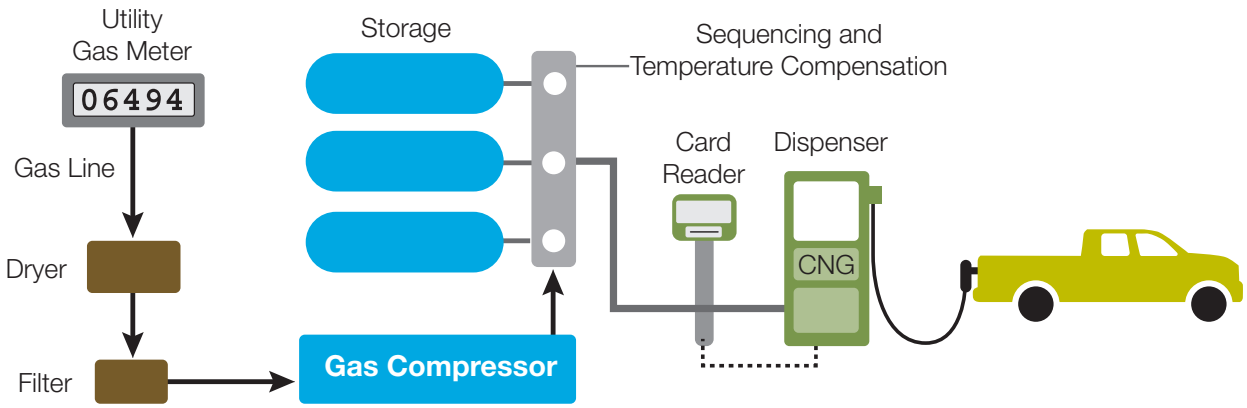
Time-Fill Station



Graphic adapted from Alternative Fuels Data Center image.

Fast-Fill: Fueling takes a shorter period, less than five minutes. However, the cost for a fast-fill station is significantly higher and fleets needing this option should consider a public station or sharing with other users.

Fast-Fill Station



Graphic adapted from Alternative Fuels Data Center image.

To choose which station design meets needs of the fleet best, assess needs for the vehicles using the station.

- Determine how many vehicles will be using the station, how much fuel is needed, and at what times/ how long the vehicles will be at the station.
- Determine which type of access the station will have - public, private, or a combination of private and public access.
  - **Public access** usually requires liability insurance and makes it open to the public.
  - **Private access** means it's only accessible by the private fleet.
  - There can also be a combination of public-private, yet the station may need separate fueling aisles or areas.

Identify factors that impact CNG station development and costs:

- Installation and site parameters
  - Check to see if the inlet gas pressure is the available gas pressure in the supply natural gas line. If a site has low gas pressure, additional compression may be needed, which increases capital and operating costs.
  - The site will need to be assessed for the potential station layout, available power supply, space constraints and proximity to the natural gas pipeline. A geotechnical survey of the site may be needed to ensure the soil conditions can support the weight of the equipment.
- Station Design
  - Depending on the size and complexity of the station, engineering drawings may be needed for design by a qualified professional. If the station is expected to increase in the future, thoughtful input into where additional equipment could be placed should be put forth. Station components that may be in the design, yet impact costs, include:
    - Compressor redundancy, which means installing additional compressors to allow the station to continue operating at full capacity even if one compressor stops functioning.
    - Compressor enclosures, which are used to protect compressors from the weather and prevent premature wear.
    - The metering system, which can be provided at each dispenser or only once to cover the entire fuel flow at the station.
  - A backup power generator to power the station in the event of a power outage.
- Regulatory and Permitting
  - It is necessary to obtain permits for the project, and there are a variety of state and local fire codes that impact CNG station implementation.
  - Permitting is subject to the Authorities Having Jurisdiction (AHJ), such as the local fire marshal or building department. Requirements may vary from location to location. Working with the AHJ, often at the city level depending on the location, from the beginning of the project will make processes simpler. See Appendix A for more information on codes and regulations.
- Project Management
  - Construction of the station can result in cost variances including supplier reliability, timing of equipment delivery and regional labor costs. After equipment is installed, a commissioning process is needed to ensure it all functions properly.

Further Resources

- Types of CNG fueling stations
  www.afdc.energy.gov/fuels/natural_gas_cng_stations.html
- Costs associated with CNG vehicle fueling infrastructure
  www.afdc.energy.gov/uploads/publication/cng_infrastructure_costs.pdf
- CNG implementation
  nccleantech.ncsu.edu/wp-content/uploads/CNG-Chapter.pdf

PROPANE

Propane is produced as a by-product of natural gas processing and crude oil refining. Developments are currently underway to produce renewable propane. Propane production, storage and distribution already exists across most of the U.S. A GGE is roughly 1.35 gallons of propane. Based on the gallon capacity of the fuel tank option chosen by the customer, propane vehicles have a range of 400 miles.

There are two types of propane vehicles:

- **Dedicated Propane Vehicles:** A dedicated vehicle designed to run only on propane.
- **Bi-Fuel Propane Vehicles:** Bi-fuel vehicles are designed with two separate fueling tanks enabling the vehicle to run on either propane or gasoline. These vehicles run on propane until the tank is depleted, then automatically converts to gasoline.

Maintenance Facility Modifications

Few, if any, facility modifications are required when transitioning to propane because it behaves much like gasoline or diesel. Fleets are encouraged to review facilities compliance with existing codes for liquid fuels such as gasoline or diesel, as the facility may have been built under older editions of the codes. Any modifications done on new propane vehicles may also require bringing the facility up to code for traditional fuels. Always consult with the Authorities Having Jurisdiction (AHJ) for the facilities location to ensure facilities and infrastructure are compliant with all federal, state, and local codes and standards.

Further Resources:

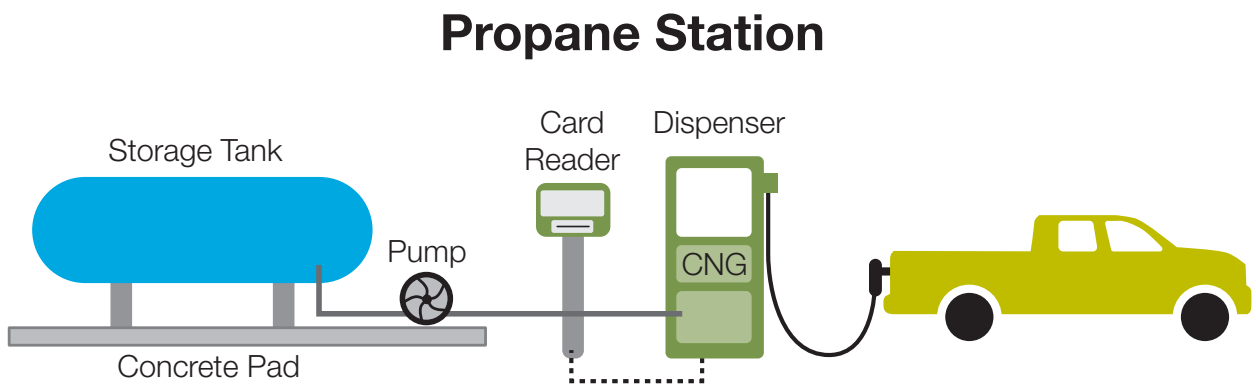
Propane Education and Research Council (PERC) Guide to Repair and Maintenance Facility Requirements
www.propane.com/uploadedFiles/Propane/On_Road_Fleets/Safety/autogas%20repair%20and%20maintenance1.pdf

PERC Fleet Garaging Requirements
www.propane.com/on-road-fleets/safety-and-training/garaging-video-series

Refueling Infrastructure

Propane refueling infrastructure is very similar to gasoline and diesel fueling stations and can be placed alongside gas and diesel dispensers. Propane is stored as a liquid in the fuel storage tank and is dispensed into vehicles in a liquid state. The dispenser cabinet is similar in appearance to that of gasoline or diesel fueling cabinets. Propane fueling stations include a storage tank, pump, card reader and fuel dispenser.

Fleets have a few options for refueling stations. Permanent options include building a new station or upgrading current infrastructure to meet the fleets' needs. Less permanent, mobile options include mobile refueling through a propane retailer and a temporary set up that includes a dispenser and fuel tank mounted on a trailer. The temporary set up equipment would be owned by the propane retailer.



Graphic adapted from Alternative Fuels Data Center image.

Building a new station can be accomplished through either the signing of a contract with a supplier or establishing private infrastructure. Many suppliers offer an inexpensive lease of the tank, pump and dispensing equipment— making the upfront cost affordable. In the lease arrangement, the only cost the station owner is responsible for is for the infrastructure that cannot be removed from the site when the contract expires (such as the concrete pad, electricity lines, etc.). The same infrastructure is needed to build a private station; however, the cost then lies entirely on the station owner or fleet manager.

There are two basic private station models, standard private station and advanced private station.

- **Standard private stations:** These are stations with approximately 1,000-3,000-gallon storage. Standard private stations are best suited for fleets with 50 vehicles or less.
- **Advanced private stations:** These stations include larger and possibly more storage containers than a standard station, as well as a canopy and multiple dispensers. Advanced stations are best suited for fleets with more than 50 vehicles.

There are many factors that affect propane station costs for building the fueling infrastructure. Many things should be taken into consideration before deciding to open a propane fueling station and can be addressed with the assistance of qualified professionals.

Assess needs for the vehicles using the station including:

- Fleet size, anticipated fuel use and fueling window of operation
  Determine how many vehicles will use the station, how much fuel will be needed, and at what times and for how long the vehicles will be at the station.
- Access to the station
  - Public access usually requires liability insurance and makes the facilities available to the public.
  - Private access means the facilities are only accessible by the private fleet.
  - Or, a combination of public-private access that may lead to separate fueling aisles or areas.

  There are two designations for public propane stations; primary and secondary.

  - Primary stations offer vehicle specific fueling capabilities and competitively priced fuel for vehicles. Primary stations must be staffed during regular business hours, must not require drivers to call ahead to fuel, must accept credit cards or fleet cards as payment and must have a dedicated fuel dispenser for vehicle fueling.
  - Secondary stations are stations with limited vehicle fueling capabilities. Fuel tends to be priced higher at these locations than at primary stations.

Identify factors that impact propane station development and costs:

- Installation and site parameters
  - In accordance with NFPA 30A and NFPA 58, above ground propane storage tanks must be separated by at least 20 feet from devices that dispense liquid or gaseous motor vehicle fuels. If the facility also has compressed natural gas or liquid natural gas tanks, the propane tank must be separated by at least 20 feet from the natural gas storage tanks.
- Station Design
  - Depending on the size and complexity of the station, engineering drawings may be needed for design by a qualified professional. If the size of the station is expected to increase in the future, thoughtful consideration should be put into where additional equipment will be placed when the time comes.

The station design and build process can incur the following costs:

- Regulatory and Permitting
  - Regulatory compliance matters will depend on the size of propane storage, generally less than 4,000 gallons or more than 4,000 gallons and can be determined with the assistance of qualified professionals.
  - Permitting is subject to the AHJ, such as the local fire marshal or building department. Requirements vary from location to location. Working with the AHJ, often at the city level, from the beginning of the project will make the processes simpler. See Appendix A for more information on codes and regulations.
- Project Management
  - Construction of the station can result in cost variances including supplier reliability, timing of equipment delivery and regional labor costs. After equipment is installed, a commissioning process, including operation training, is needed to ensure the system functions properly.

Upgrading existing retail sites, such as co-ops or truck stops that sell propane for non-vehicle uses, will involve installing retail-style dispensing equipment to accommodate an increased demand due to vehicle refueling. Most propane vehicles can refuel at existing retail sites that sell propane in small volumes; however, it could be more expensive than refueling at specified propane refueling station.

Further Resources:

Propane fueling infrastructure development
www.afdc.energy.gov/fuels/propane_infrastructure.html

Costs associated with propane vehicle fueling infrastructure
www.afdc.energy.gov/uploads/publication/propane_costs.pdf

TRAINING

Before operating an alternative fuel vehicle fleet, take the appropriate training courses necessary to learn how to correctly and safely operate the station. Any employees or drivers who will use the refueling station should also be up-to-date on any relevant training. There are currently multiple organizations providing alternative fuel training:

1. **Natural Gas Vehicle Institute (NGVi)**
   NGVi focuses solely on natural gas vehicles and fueling, providing training for fleet managers, drivers, maintenance technicians and others on how to "safely operate and fuel natural gas vehicles, how to size, design, operate, and maintain CNG fueling stations, how to manage LNG fleets and fueling" amongst other subjects. For more information on the specific NGVi training courses, visit: www.ngvi.com.
2. **Gas Technology Institute (GTI)**
   GTI provides training on natural gas, including topics such as natural gas distribution and liquefied natural gas. For more information, visit:
   www.gastechnology.org/Training/Pages/Training-Topics.aspx.
3. **National Alternative Fuels Training Consortium (NAFTC)**
   NAFTC provides training on all types of alternative fuels through different courses and workshops covering topics from heavy-duty natural gas vehicles and electric drive vehicle infrastructure training to biodiesel and propane feet applications. For the comprehensive list of training provided, visit: naftc.wvu.edu.
4. **National Fire Protection Association (NFPA)**
   NFPA provides training for emergency responders to safely handle emergencies involving alternative fuel vehicles. For more information, visit:
   www.nfpa.org/training-and-events/by-topic/alternative-fuel-vehicle-safety-training.

APPENDIX A: CODES AND REGULATIONS

Biodiesel

Biodiesel blends are subject to the same codes and regulations as diesel fuels. Blends up to B5 are approved for use in existing diesel infrastructure, but blends above B5 are subject to additional requirements. All portions of an Underground Storage Tank (UST) system must be compatible with the fuel stored. Some requirements are:

- Owners of USTs switching to store blends containing greater than B20 must notify their implementing agency (usually a state office) 30 days prior to switching fuels to store B20+ blend.
- Owners of USTs storing blends greater than B20 must demonstrate compatibility through either:
  - Certification/listing of equipment for use with the fuel stored by a nationally recognized, independent testing laboratory
  - Equipment or component manufacturer approval for use with the fuel stored. This statement must be in writing affirming compatibility and must list the specific ranges of biofuel blend the equipment or component is compatible with
  - Use of another option determined by the implementing agency to be no less protective of human health and the environment
- Owners of USTs storing blends greater than B20 must maintain records demonstrating compatibility, as long as the fuel is stored.

For more information on biodiesel codes, standards and safety, visit:
www.afdc.energy.gov/fuels/biodiesel_codes.html
www.afdc.energy.gov/pdfs/48603.pdf

Electricity

Codes and regulations for electric vehicle infrastructure include:

- Energy Transfer System for EV (SAE J-2293)
- Utility Factor Definitions for Plug-In Hybrid Electric Vehicles (SAE J-2841)
- National Fire Protection Association National Electrical Code
  - Electric Vehicle Charging System Equipment
  - Electrified Truck Parking Spaces

For more information on electric vehicle infrastructure codes and standards, visit:
www.afdc.energy/gov/pdfs/48605.pdf

Natural Gas

There are a number of codes and ordinances dealing with the design and use of a CNG vehicle maintenance facility, including:

- NFPA 30A- Code for Motor Fuel Dispensing Facilities and Repair Garages
- International Building Code
- International Electrical Code
- International Mechanical code
- NFPA 52- Vehicular Gaseous Fuel Systems Code
- NFPA 88A- Standard for Parking Structures
- National Electrical Code
- National Fire Code
- National Mechanical Code
- International Code Council (ICC) Fire Code and NFPA 30A- Code for Motor Fuel Dispensing Facilities and Repair Garages
- Minor maintenance procedures may be performed without any changes to the facility (assuming it meets basic code for automotive repair facilities)

For more information, see the Natural Gas Vehicle and Infrastructure Codes and Standards Citations document: www.afdc.energy.gov/pdfs/48611.pdf

Propane

Codes and regulations for propane vehicle and fueling infrastructure include:

- Propane Vehicle and Infrastructure Codes and Standards Citations www.afdc.energy.gov/pdfs/48612.pdf
- CSA Natural Gas and Propane Installation Code B149.5-15 shop.csa.ca/en/canada/natural-gas-and-propane-installation-codes/b1495-15/invt/27006672015
- National Fire Protection Association (NFPA) NFPA 58 Vehicular Liquefied Petroleum Gas Code www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards
- NFPA 30 A-Code for Dispensing Facilities and Repair Garages www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=30A

APPENDIX B: VW SETTLEMENT AND DERA

Volkswagen Settlement

In 2016, the EPA filed a complaint alleging Volkswagen violated the Clean Air Act by the sale of approximately 580,000 motor vehicles containing 2.0 or 3.0 turbocharged direct injection (TDI) liter diesel engines equipped with "defeat devices" between model years 2009 and 2016. The subject vehicles are equipped with devices in the form of computer software designed to perform differently during normal vehicle operation than during emissions tests. It is alleged that during normal use, the subject vehicles emit level of nitrogen oxides (NOx) in excess of the EPA compliant levels and are a serious health concern.

As a result of two related Volkswagen settlements, the State of Iowa is expected to receive approximately $21 million in environmental mitigation trust funds to be spent over the next ten years for projects that reduce emissions of NOx.

As required by the trust, Iowa submitted a Beneficiary Mitigation Plan, stating how the money would be used. This plan addresses the following:

- Iowa's overall goals for use of the funds
- The eligible mitigation actions selected to achieve Iowa's goals
- The estimated percentage of the funds assigned to each action
- A general description of the range of expected emission reductions
- Prioritizing air quality improvements in areas disproportionately affected by air pollution
- Outlining how Iowa will seek and consider public opinion on its plan

Iowa's Eligible Mitigation Projects

- Class 4-8 School Bus, Shuttle Bus or Transit Bus
- Freight Trucks and Port Drayage Trucks
- Non-Road Transport and Equipment
- Zero Emission Vehicle (ZEV) Supply Equipment
- Diesel Emission Reduction Act (DERA) Grant Program

Eligible fuels for Iowa's eligible mitigation projects are diesel, compressed natural gas, propane and electricity.

For more information or to read the entire beneficiary mitigation plan, visit:
www.iowadot.gov/vwsettlement

To read the Volkswagen Partial Consent Decree, visit:
www.epa.gov/sites/production/files/2016-10/documents/amended20lpartial-cd.pdf

Diesel Emission Reduction Act (DERA)

The DERA grant program provides funding for projects that reduce emissions from diesel fleets, like the EMAs, but allows for actions not eligible under the EMAs. These projects include bus replacements, exhaust control devices, idle reduction actions and truck replacements.

For more information on the DERA grant program, visit: www.iowadot.gov/dera

APPENDIX C: ADDITIONAL RESOURCES

Project planning

- Designing a Successful Transportation Project
  www.afdc.energy.gov/uploads/publication/designing_successful_transportation_project.pdf
- Fleet Transition Planning for Alternative Fuel Vehicles
  static1.squarespace.com/static/57a0a284d2b857f883096ab0/t/58594c92414fb54ef8689bba/1482247315853/Fleet+Transition+Planning+for+Alternative+Fuel+Vehicles.pdf
- What Fleets Need to Know About Alternative Fuel Vehicles Conversions, Retrofits and Repowers:
  www.afdc.energy.gov/uploads/publication/afv_conversions_retrofits_repowers.pdf

Clean Cities

Clean Cities Coalitions help connect fleets to other fleets, vendors and associations doing similar projects to build partnership and foster collaboration. Clean Cities Coalitions also serve as a conduit to technical expertise for fleets.

During the first cycle of Volkswagen funding, Iowa Clean Cities will offer an analysis of fleets VW-eligible to help fleets determine which alternative fuel best suits their needs energy wise, as well as financially.

Tiger teams

This technical assistance helps Clean Cities coordinators, stakeholders, original equipment manufacturers and fuel providers overcome obstacles to deploying alternative fuels and advanced vehicles and make informed choices to reduce their fuel consumption.

Tiger Teams will consider technical-assistance requests for the following types of projects:

- **Technical Problem Solving – Vehicle Operations:** Issues pertaining to vehicle performance, drivability, safety, maintenance, driver acceptance, training or best practices for implementation of alternative fuel vehicles at specific sites.
- **Technical Problem Solving – Infrastructure Operations:** Issues relating to fueling station design, siting, interaction with alternative fuel providers or fire safety code officials, fueling station performance, maintenance requirements, or user and operator training.
- **Evaluation of Project Potential:** Some projects (including transit systems and airports) may qualify for technical assistance if expertise is not available from local or regional resources or stakeholders. When there is demonstrated local interest, a Tiger Teams expert can evaluate local market conditions, conduct infrastructure assessments, gauge stakeholder needs and assist in defining project execution feasibility.

Procurement

- AFDC Alternative Fuel and Advanced Vehicle Search
  www.afdc.energy.gov/vehicles/search
- Guide to Financing Alternative Fuel Vehicle Procurement
  static1.squarespace.com/static/57a0a284d2b857f883096ab0/t/58594c73414fb54ef8689a5b/1482247284686/Guide+to+Financing+Alternative+Fuel+Vehicle+Procurement.pdf
- Gaseous Fuel Vehicle Procurement Best Practices Guide
  static1.squarespace.com/static/57a0a284d2b857f883096ab0/t/58594bd9c534a5dba5fe012a/1482247132192/Gaseous+Fuel+Vehicle+Procurement+Best+Practices+Guide.pdf
- Electric Vehicle Procurement Best Practices Guide
  static1.squarespace.com/static/57a0a284d2b857f883096ab0/t/58594c0b20099e7458106015/1482247181025/Electric+Vehicle+Procurement+Best+Practices+Guide.pdf

Natural Gas

- Alternative Fuels Readiness Workbook Natural Gas Vehicles and Infrastructure
  www.alabamacleanfuels.org/docs/afmi/AFMI%20Workbook%20-%20Propane_1stEdition_8_31_14r.pdf
- Compressed Natural Gas Vehicle Maintenance Facility Handbook
  www.afdc.energy.gov/uploads/publication/cng_maintenance_facility_mod.pdf

Propane

- Alternative Fuels Readiness Workbook Propane Vehicles and Infrastructure
  www.alabamacleanfuels.org/docs/afmi/AFMI%20Workbook%20-%20Propane_1stEdition_8_31_14r.pdf
- Propane Autogas Repair and Maintenance Facility Requirements
  www.propane.com/uploadedFiles/Propane/On_Road_Fleets/Safety/autogas%20repair%20and%20maintenance1.pdf
- Dispensing propane autogas training video
  www.propane.com/on-road-fleets/safety-and-training
- Fuel Tank purging and evacuation video training modules
  www.propane.com/on-road-fleets/safety-and-training/fuel-tank-evacuation
- Repair and maintenance facility design video training modules
  www.propane.com/on-road-fleets/safety-and-training/garaging-video-series

Case Studies

Case studies and success stories about alternative fuel transportation technologies and alternative fuels.

www.afdc.energy.gov/case

Iowa Clean Cities Coalition

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