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THE UNIVERSITY of TENNESSEE
MUNICIPAL TECHNICAL ADVISORY SERVICE

In cooperation with the Tennessee Municipal League

TECHNICAL bulletin

August 30, 2011

COMPRESSED NATURAL GAS FOR TENNESSEE MUNICIPAL FLEETS: A PRIMER FOR MUNICIPAL OFFICIALS

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INTRODUCTION

This technical bulletin examines the basics of compressed natural gas as a viable alternative transportation fuel for local government fleets in Tennessee. The University of Tennessee Municipal Technical Advisory Service (MTAS), Clean Cities Coalition of Tennessee, Tennessee Renewable Energy and Economic Development Council (TREEDC) and the Tennessee Gas Association (TGA) are important resources available to interested fleets across the state. Natural gas is certainly abundant and much cheaper than petroleum. Natural gas can be used for city garbage trucks, police vehicles, and service vehicles. This guide presents the economic and environmental benefits of compressed natural gas along with case studies and siting tips for compressed natural gas stations.

BASIC INFORMATION

Compressed natural gas, also known as CNG, is a fossil fuel substitute for gasoline (petrol), diesel or propane/LPG. More familiarly, it is the type of gas used in stoves. This gas remains clear, odorless and non-corrosive. Although its combustion does produce greenhouse gases, it is a more environmentally clean alternative to those fuels and is much safer than other fuels in the event of a spill. This is true because natural gas is lighter than air and disperses quickly when released

Most natural gas is formed from three different types of wells; natural gas-and-condensate wells, oil wells and coal bed methane wells. However, more than 90 percent of the natural gas used in the United States comes from domestic or other North American sources. Increasing demand for natural gas in power plants will require new supplies from non-North American countries, increasing our dependence on foreign sources of energy. Delivering CNG is not as difficult as it may seem. With local vehicle fueling stations owned and operated by private companies and local governments, transportation can be easy and effective. CNG can also be imported via pipeline. The natural gas must be stored in thick-walled steel, aluminum or composite tanks built to last more than 20 years.

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ENVIRONMENTAL BENEFITS

Natural gas is the cleanest of all the fossil fuels. Composed primarily of methane, the main products of the combustion of natural gas are carbon dioxide and water vapor, the same compounds we exhale when we breathe. Coal and oil are composed of much more complex molecules, with a higher carbon ratio and higher nitrogen and sulfur contents. This means that when combusted, coal and oil release higher levels of harmful emissions, including a higher ratio of carbon emissions, nitrogen oxides and sulfur dioxide. Coal and fuel oil also release ash particles into the environment, substances that do not burn but instead are carried into the atmosphere and contribute to pollution. The combustion of natural gas, on the other hand, releases very small amounts of sulfur dioxide and nitrogen oxides, virtually no ash and lower levels of carbon dioxide, carbon monoxide and other reactive hydrocarbons. The chart below is based on the Environmental Protection Agency's data and shows fossil fuel emission levels for 2010.

POUNDS PER BILLION BTUs OF ENERGY INPUT

Pollutant	Natural Gas	Oil	Coal
Carbon Dioxide	117,000	164,000	208,000
Carbon Monoxide	40	33	208
Nitrogen Oxides	92	448	457
Sulfur Dioxide	1	1,122	2,591
Particulates	7	84	2,744
Mercury	0.000	0.007	0.016

Pollutants emitted in the United States, particularly from the combustion of fossil fuels, have led to the development of many pressing environmental problems. Natural gas, emitting fewer harmful chemicals into the atmosphere than other fossil fuels, can help to mitigate some of these environmental issues. These issues include greenhouse gas emissions, smog, air quality and acid rain, industrial and electric generation emissions and pollution from natural gas vehicles.

ECONOMICAL BENEFITS

The use of CNG not only helps the environment, but it is also economically wiser as well. One of the biggest advantages CNG provides is an affordable price. As the world continues to experience ongoing hikes in the cost of gasoline, the low price of CNG offers a glimmer of hope. CNG is typically at least 30 percent cheaper than gasoline. Natural gas vehicles have been introduced in a wide variety of commercial applications, from light-duty trucks and sedans such as taxicabs, package delivery vans, postal vehicles, transit buses, street sweepers and even school buses. In California, transit agency buses are some of the most visible CNG vehicles. Below is a chart from the U.S. Department of Energy showing the difference in prices between gasoline, diesel and CNG.

U.S. DEPARTMENT OF ENERGY ALTERNATIVE FUEL COMPARISON

	Nationwide Avg. Price for Fuel Jan.-March 2011	Nationwide Avg. Price for Fuel 4th Quarter 2010
Gasoline (regular)	$3.69	$3.08
Diesel	$4.04	$3.45
CNG	$2.06	$1.93

As you can see, the margin between the price of gasoline and CNG is significant and is clearly more efficient.

CITY EXAMPLES

Cities now are jumping on the bandwagon and changing things so they can be classified as a "clean city." Several cities have gone to great measures to help them become more economically friendly. For example, Kansas City, Mo., is well on its way to a green future with the guidance of Kelly Gilbert, the Kansas City Clean Cities Coalition director. Although she has only had this job for a few months, she is off to an exceptional start. She has spearheaded an ambitious proposal that led to a $15 million American Recovery and Reinvestment Act award. This grant provides the funding for the installation of 27 alternative fueling stations as well as the development of about 350 alternative fuel and advanced technology vehicles. Along with 17 partners, she created the Midwest Region Alternative Fuels Project.

Another city showing great success is Grand Ledge, Mich. The GLACC (Greater Lansing Area Clean Cities) is reducing local petroleum consumption by engaging local school district bus fleets. Since 2007, they have been promoting their Clean the Air for School Kids program, which informs local school districts about school bus emission and encourages them to reduce school bus idle time, use cleaner fuels and install emission solutions. They have also worked with the statewide school bus company to replace older buses with cleaner, more efficient buses and to install emission solutions on nearly 300 buses that carry 10,000 special education students and 5,000 general education students daily. This accomplishment earned GLACC more than $1 million in American Recovery and Reinvestment Act funding to expand the program given by the Environmental Protection Agency National Clean Diesel Funding Assistance Program. For the 2010-2011 school year, this program advanced further by replacing even more buses.

A less intense way in which cities are trying to help go toward a green future is by campaigning. In San Francisco, the American Lung Association and San Francisco Clean Cities partnered together to conduct a three-month idle reduction campaign at six area elementary schools. Idling contributes to outdoor air pollution, is linked to increases in indoor air pollution, stunts children's lung developments and also wastes fuel. The goals of this campaign, called "Turn Off Your Engines: Idling Wastes Money and Hurts Children," were to inform drivers about the costs of idling in school zones and to persuade them to change their behavior. With permission, representatives observed driver behavior at each site for 36 hours over a two-week period. They timed how long drivers idled their vehicles and compiled vehicle make and type data. One out of every four drivers idled for more than 30 seconds, while some idled for as long as 10 minutes. The next week, they created flyers and passed them out with facts about idling, such as idling for 10 minutes a day wastes about $200 worth of fuel a year. This project might not be as big as the one in Kansas City but informing the public of certain dangers of everyday things can help lead a city to becoming "clean."

TENNESSEE CITIES

Knoxville was recently ranked by the Asthma and Allergy Foundation of America as the fourth worst

city in the Unites States for asthmatics. Events to help the community raise awareness about air quality issues are critical to this region due to the statistics. For the past seven years, the East Tennessee Clean Fuels Coalition has hosted the Run for Clean Air in Knoxville. The participants enjoy a live band, food, prizes and the opportunity to drive and ride in hybrid vehicles.

In the city of Bristol, officials accepted the green challenge and began efforts to reduce the city's carbon footprint and overall environmental impact in order to create a more livable and responsible community. Bristol understands that "Going Green" is a continual process. Each year, Bristol commits to being more environmentally responsible and pledges to help make the process easy for the public to embrace as well. Bristol has developed a "Going Green" website, which contains a collection of resources and information from the world's leading environmental experts to help others start their own green lifestyle. The Bristol organizers emphasize that the program helps ensure a safe and beautiful community for generations to come.

In Gatlinburg, the Chamber of Commerce initiated a voluntary program for businesses working to reduce their environmental impact to preserve the natural beauty of this tourism center. Businesses receive information on products and actions to help them achieve green goals. In addition, the city uses biodiesel for its trolleys and LED lights for its holiday display.

Another city heavily involved in becoming greener is Nashville. Nashville created the Green Ribbon Committee, with its goal to become the greenest city in the Southeast. Award-winning Metro Parks Nature Centers work to increase environmental education and outdoor recreation areas. As you can see, going green is contagious in Tennessee! Pervasive programs are cropping up to take Tennessee into a greener future, including Adopt-a-Highway, TVA's environmental partnerships, Tennessee's Biofuels Initiative and land acquisition for further development of Tennessee parks.

CNG STATION SITING TIPS

After reading the preceeding information and learning about the environmental and economic benefits of natural gas, the next step is to examine the factors in locating CNG stations. There is clearly a need to develop the infrastructure for CNG fueling stations in Tennessee. Selecting the right configuration is critical to success. According to Energy International, a global energy consulting firm, the main considerations in choosing a station are the number and type of vehicles fueled and their fueling pattern. Secondary considerations include location, potential future growth, and permitting restrictions. The CNG Station Guide is available online. (See "Natural Gas Resources.")

STATION TYPES

Energy International outlines four major CNG station types.

TIME-FILL STATIONS fill vehicles over a six- to eight-hour period. Compressors compress natural gas from pipeline pressure (5–100 psi) to the required vehicle pressure (2,400–3,600 psi) and dispense it into multiple vehicles simultaneously. These stations

are best for vehicles such as school buses and utility trucks that return to a central location and can fuel while parked for an extended period. Among all options, they are least expensive to build and staff and require no full-time attendant. Extended fueling time is needed, however, because time-fill stations have relatively small compressors and no CNG storage.

CASCADE FAST-FILL STATIONS provide fast and convenient fueling similar to that provided by conventional liquid fuel stations. CNG storage vessels arranged in cascades, or banks, are used to quickly fill vehicles during peak fueling times, when the compressors alone cannot meet demand. During off-peak times, the compressors refill the CNG storage cascades. These stations are suitable for fueling light-duty vehicles at public access stations where use patterns are random. They also are suitable for fueling fleets of light-duty vehicles, such as taxis and police cars, which require a fast-fill and have peak fueling periods. Cascade fast-fill stations are not appropriate for continuous, high-volume fueling because the compressors are not large enough to provide a fast fill once the CNG storage has been depleted. Most of the several hundred public access CNG stations in North America use a cascade fast-fill system.

BUFFERED FAST-FILL STATIONS provide fast, continuous, high-volume fueling. Relatively large compressors run continuously during fueling, filling vehicles and, in the interval between vehicles, a CNG storage buffer. The storage buffer provides CNG to vehicles at the beginning of the fueling cycle and allows the compressor to run for long periods. Unlike CNG storage in cascade fast-fill systems, buffer storage is not separated into separate banks. Buffered fast-fill stations are suitable for quickly fueling large numbers of heavy-duty, high-fuel-capacity vehicles, such as transit buses.

VEHICLE REFUELING APPLIANCES (VRAs) are like small time-fill stations, containing a small compressor and other equipment within a single unit. VRAs use natural gas from low-pressure pipelines found in many homes and businesses and require 220-volt, single-phase electricity. They are suitable for fueling individual vehicles over an extended period. Grouping multiple VRAs together and adding a cascade storage system provides small- to medium-sized light-duty fleets with fast-fill fueling. VRAs will soon be available for residential installation.

INFRASTRUCTURE RESOURCES

AFDC Infrastructure Section – New addition to the Alternative Fuels Data Center provides info on equipment and installation, codes and standards, fuel providers, safety, training, success stories and contacts. Link to industry groups such as DOE's Natural Gas Vehicle Technology Forum.
www.afdc.doe.gov/altfuel/infrastructure.html

Clean Cities Tiger Teams – Created to help coalitions overcome AFV and infrastructure challenges, with experts from various technical disciplines. Part of the Clean Cities Technical Assistance Program. www.ccities.doe.gov/tiger.html

CNG Station Guide – Free online guide helps prospective and existing station owners build and operate efficient and cost-effective facilities. Created by Energy International, sponsored by DOE and the Gas Technology Institute.
www.energyint.com/cng_station/index.htm

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