

Greening your waste collection fleet through natural gas

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Two current significant trends in solid waste management are the transition by waste haulers and municipalities of their collection fleets from diesel to compressed natural gas (CNG) or liquefied natural gas (LNG) fuels and expanding investment in natural gas fueling stations. Waste collection manufacturers report that within the last three years, more than half of their new vehicle sales include those designed to burn natural gas.

The reasons for the conversion from conventional fossil fuels to natural gas include a variety of economic, environmental, and political considerations. Foremost among these is that natural gas produced in the United States appears to be the lowest cost alternative fuel source. Traditionally, the price of a barrel of oil has been about six times that of a thousand cubic feet of natural gas. With the widespread use of fracking technology to recover significant quantities of natural gas, this ratio has jumped to as high as 12:1. Depending on geographic location and proximity to gas lines, the average price of natural gas today can cost \$1.50 to \$2.00 less per diesel gallon equivalent (DGE). Projections from government, corporate, and nonprofit prognosticators suggest that natural gas will continue to be plentiful and relatively cheap compared to diesel fuel.

Typical refuse truck fuel use averages between 8,500 to 10,000 gallons per year at an average fuel efficiency of 2.5 to 3 gallons per mile. Thus, the

growing differential between natural gas and diesel fuel, municipal or hauler operated trucks can shave as much as 30 to 50 percent on fuel costs. What was once prompted by environmentalism due to the promulgation by United States Environmental Protection Agency (USEPA) of new restrictive federal heavy-vehicle emission regulations has now been largely driven by the promise of significant long-term fuel savings.

With an estimated industry-wide fleet of more than 175,000 vehicles, including traditional packer trucks, front-end loaders, automated side loaders, recycling trucks, and roll-off trucks, the long-term replacement of the waste collection fleet is now underway. Several of the major waste hauling firms in the United States such as Waste Management, Inc., Republic Services, Inc., and Progressive Waste Solutions have already made capital replacement plans to replace their existing diesel-fuel refuse collection vehicles with natural gas vehicles as they are scheduled for replacement. A few municipalities as well are entering the arena as “early adopters” on this wave to natural gas.

This article will highlight some of the top seven issues public works directors need to know about this emerging trend in solid waste collection.

1. What is Compressed Natural Gas (CNG)?

Natural gas is primarily methane. Briefly, it is a rather simple molecule

consisting of one carbon atom and four hydrogen atoms, making it an energy-dense fuel and clean burning. CNG is natural gas under pressure which remains clear, odorless, and non-corrosive. Although vehicles can use LNG or CNG, most collection vehicles use the gaseous form compressed to pressures above 3,100 pounds per square inch (psi). LNG is used more frequently with long-haul transfer fleets. The gas used to produce CNG or LNG is the same natural gas that is delivered to most homes to use for cooking, heating water, and forced air heat.

2. How is it dispensed?

CNG is dispensed either through a time-fill, quick-fill station, or combination time-fill and quick-fill. A time-fill station slowly fills the vehicle fleet over an extended period (8 to 12 hours). A quick-fill station performs similar to a normal diesel or gasoline pump. The number of vehicles, the filling frequency, and the total quantity of fuel to be dispensed during the filling period is used to size the facility compression and storage components.

Time-fill (also known as slow-fill) fueling is usually recommended for solid waste fleets that utilize onsite fueling with vehicles that return to a central location for a period of six to eight hours, during which they can be refueled. Many solid waste operators use time-fill fueling because the fueling station equipment required is often the least expensive.

The major components of a typical



Fast-fill CNG station designed to accommodate two types of vehicles, Tampa, Florida

time-fill natural gas fueling station include:

- Compressor
- Time-Fill Dispensers

Using time-fill, vehicles refuel more slowly and therefore receive gas directly from the compressor through special time-fill dispensers. This eliminates the need for a high-pressure storage system. Time-fill fueling stations are available in a variety of sizes to meet all kinds of customer needs, including the vehicle refueling appliance that can fuel vehicles at home or at a business.

Quick-fill (also known as fast-fill) is usually used when vehicles must be refueled in a time period similar to that of other conventional fuels, approximately 3 to 7 minutes for automobiles and light-duty trucks. All public natural gas fueling stations are quick-fill.

The major components of a typical quick-fill natural gas fueling station include:

- Compressor

- High-Pressure Storage
- Gas Reservoirs
- Gas Dryer
- Expansion Tank
- Quick-Fill Dispenser(s)
- Credit Card Reader (optional)

At a quick-fill fueling station, natural gas is compressed by the compressor and stored in the high-pressure storage system. The compressor of a fuel station receives natural gas from a connection pipe. After drying (removing any condensate and impurities), gas is pressurized in several compression stages to 30 Mpa (4,350 psi). Compressed natural gas is stored in high-pressure reservoirs.

To facilitate the transfer of gas to vehicles, reservoirs are usually divided into three parts: a high-, mid-, and low-pressure section. Natural gas is filled through a gas pump. The filling connector of the pump hose is attached with a fastener to the filling valve on the vehicle, and compressed natural gas is transferred to the vehicle's pressurized gas tanks. Modern gas pumps are equipped with devices that measure the weight,

temperature, and pressure and an electronic system that ensures that gas tanks are filled up to the set operating pressure of 20–22 Mpa (2,900–3,200 psi).

When vehicles are being fueled and the pressure of the fuel supply in the storage system begins to drop, the compressor is automatically activated, causing it to replenish the supply of natural gas in the storage system. If desired by the fueling station operator, a credit card allows access to the dispenser, which meters and dispenses natural gas into the fuel storage cylinder(s) onboard the vehicle.

Another natural gas fueling configuration for onsite fleet applications is the combination station, which includes both time-fill and quick-fill capabilities. This type of fueling may be used when some vehicles return to a central location for refueling, usually at night, and when other vehicles need to be refueled in a fairly short period of time and cannot wait for time-fill.

The major components of a typical combination natural gas fueling system include:



Card reader system, Tampa International Airport CNG Facility, Tampa, Florida



Enclosure designed to buffer compressor noise, Tampa, Florida

- Compressor
- High-Pressure Storage
- Gas Reservoirs
- Gas Dryer
- Expansion Tank
- Quick-Fill Dispenser(s)
- Time-Fill Dispensers
- Credit Card Reader (optional)
- Whether time-fill, fast-fill or both capabilities are needed.
- The level of remote station monitoring and diagnostics capability desired.
- The type and sophistication of data collection/payment processing system at the dispenser.
- The land area required.
- The availability, quality and pressure of gas service.
- The amount of backup fueling or required system redundancy.
- Site-specific factors such as permitting, site improvements and/or other requirements.

3. What impacts fuel station costs?

A CNG fueling station is more expensive to build than the average diesel pumping station. A CNG time-fill station that can fill at many as 15 vehicles can cost upwards of a half-million dollars. Depending on many factors, a fast-fill CNG station can range in cost from \$1 to \$2.5 million.

The cost of a CNG fuel depends on the following factors:

- The number of vehicles to be fueled, total daily fuel requirements and maximum hourly flow rate.
- The basic cost components of the CNG fueling station are:
 - Natural gas—either purchased on the open market through a broker or via the local distribution company (LDC) bundled rate.
 - The LDC's delivery charge and related meter and account fees.
 - Compression.
 - Station equipment (or the cost of capital to buy it).
 - Service and maintenance.
 - Local, state and federal taxes (if applicable).

4. What do CNG vehicles cost?

Typical natural gas refuse collection trucks typically range in costs between \$210,000 to \$250,000, some 15 to 25% more expensive than comparable diesel-fuel vehicles. The American Trucking Association reports that natural gas trucks sell at a large premium (\$45,000–\$75,000) compared to diesel-powered heavy-duty Class 8 trucks. The primary reason for the increased cost is their more expensive engine and complex fuel system.

5. What are CNG vehicle maintenance experiences?

Many operators report that maintenance costs for CNG vehicles are about the same as that for diesel vehicles. However, maintenance costs for natural gas refuse trucks can also be higher when a fleet is largely composed of diesel trucks, because of additional training requirements for technicians and duplication of maintenance equipment.

If a fleet has both diesel and CNG vehicles and equipment, separate maintenance facilities or areas are required for CNG and diesel vehicles because of different maintenance protocols and building code requirements for the two fuel types. When an entire fleet is replaced with CNG, more efficiency of equipment and personnel can be realized. Several features that must be incorporated into a CNG maintenance area are summarized below:

- Installation of a high-powered ventilation system that quickly removes gas from the area in case of gas line leaks or ruptures.
- The ventilation system must work in concert with an advanced combustible gas detection system that engages when fumes reach a certain level.
- All emergency HVAC, electrical, and mechanical systems must be

designed to be “explosion proof.”

- The design of the building must also incorporate the conversion of existing maintenance bays to support CNG vehicles, erecting a firewall to separate that area from the diesel bays.

6. Are grants or tax incentives available?

Over the last several years there have been several grant and tax incentive programs available to private and municipal entities considering converting or purchasing alternative fuel vehicles such as CNG. Tax incentives or grant funds can significantly reduce the purchase price premium for natural gas trucks so the remaining premium is quickly paid back in operating savings, generating savings over the rest of the life of the vehicle. These are offered by the federal government, state agencies, and local planning and air quality control districts. Like any grant or tax incentive program, it is important to utilize grant specialists who are knowledgeable about the regulations, have the ability to fill out the required packages or forms correctly, and understand time constraints in light of rapidly changing regulations. Many of the federal grant and incentive programs established under the Energy Policy Act (income tax credit for alternative fuel infrastructure and vehicles) and the Safe, Accountable, Flexible, Efficient Transportation Equity Act (excise tax credit to seller of CNG or LNG) were extended through December 31, 2013. However, further extension of these programs will need to be considered by the 113th Congress.

7. How do you assess the feasibility for your municipality?

There are both qualitative and quantitative factors in assessing whether or not CNG makes sense for a municipality’s solid waste collection fleet. Exhibit 1 lists some of the major qualitative advantages and disadvantages of CNG. To better quantify the CNG alternative, a pro forma life-cycle cost model should be used to compare the cost-effectiveness of deploying a CNG vehicle fleet to a conventional diesel fleet. The pro forma model should include the life-cycle costs associated with using CNG versus diesel, including capital costs for fueling infrastructure (time-fill or quick-fill or combination thereof) and vehicle costs, operational and maintenance costs, fuel efficiency, and fuel costs. The payback and life-cycle savings will vary based on local fuel costs, tax incentives, credits, and available federal, state, and regional grants.

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Exhibit 1. Advantages and Disadvantages

Advantages	Disadvantages
Lower fuel costs compared to diesel on an equivalent energy basis	Increased capital costs for fueling station and maintenance facilities and CNG fleet vehicles.
Reduced reliance on imported fossil fuels.	Potential decreased fleet availability (Time Fill).
Emissions compared to diesel fuel vehicles.	Increased O&M costs for fill station operation.
Reduced environmental controls and monitoring requirements	Reduced thermal efficiency
Lower engine noise	Reduced fuel economy
Ease of installation	Increased vehicle weight
Ease of fueling operation	Uncertain secondary resale market
Fully automated operation	
Safety	
Independence	
Engine durability	

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