going the DISTANCE

Renewable natural gas produced from biogas is fueling fleets in many locations across the country.

>> BY KIM MURDOCK-TIMMERMAN

OPERATIONS SPOTLIGHT

As the cost of diesel fuel rises, fleets are making the switch to compressed natural gas (CNG). Turning garbage and other waste into a renewable vehicle fuel is no longer science fiction. While producing electricity and heat from biogas has been commonplace for many years, landfills, municipal wastewater treatment plants and commercial anaerobic digesters can now use biogas to produce vehicle fuel, renewable natural gas (RNG), which is equivalent to CNG.

The development of the technology to produce a RNG vehicle fuel on a small scale was prototyped at the Rodefeld Landfill in Dane County, Wis., in 2011. The prototype was proven successful, upgraded to a 50 standard cubic feet per minute (scfm) production model and now produces up to 250 gasoline gallons equivalent (GGE) per day. The RNG fuel is used in the public works cars and light duty trucks. The site also uses biogas to produce electricity with four Caterpillar IC engines. Rodefeld was named the U.S. Environmental Protection Agency's (EPA's) Vehicle Fueling Project of the Year in 2011.

Another EPA award-winning landfill using this technology is in Washington, La. The St. Landry Solid Waste Facility processes 50 scfm of raw biogas to produce fuel for its sheriff's fleet in addition to the public works vehicles. At the Riverview Land Preserve in Michigan, the landfill has installed a system to process 100 scfm to fuel waste haulers. The biogas conditioning system at this site has a complete enclosure to protect it from the elements. For both of these sites, the landfill gas is used exclusively for RNG vehicle fuel production.

Wastewater treatment plants and commercial anaerobic digesters also are using this new technology. The Janesville Wastewater Treatment Facility in Janesville, Wis., is one site that has optimized its biogas production for RNG along with a combined heat and power system (CHP). During on-peak electrical demand periods, biogas is used to operate turbines for electricity production which is sold to the local utility. Turbine exhaust heat is recovered to supplement the plant boilers. During off-peak demand periods, it reduces its CHP system capacity and uses excess biogas to produce RNG vehicle fuel for use in four facility vehicles and a lawn mower.

In Sacramento, Calif., CleanWorld and Atlas Disposal operate a commercial anaerobic digester and produce RNG. The waste hauling trucks that bring food waste to the digester are fueled by the RNG produced at the site. This facility produces 450 GGE per day and will be expanding its production capacity in 2014 to produce up to 1,550 GGE per day. In November 2013, CleanWorld, in conjunction with its partners on the Sacramento project, were awarded the 2013 Energy Vision Green Leadership Award in New York City. Energy Vision is a national nonprofit organization that promotes clean, renewable, petroleum-free transportation fuels. The award recognized the Sacramento BioDigester project as "making a true waste-to-fuel revolution in this country a reality." This project also was selected the International Bioenergy Project of the Year for 2013.

BECOMING FUEL

For all sites with biogas, the process of utilizing it for RNG includes two separate systems: the biogas conditioning system and the vehicle fueling system. In the biogas conditioning system, hydrogen sulfide is first removed from the raw biogas. The gas then goes through a first stage of compression, after which the moisture is removed. Finally the gas is pushed through the system to remove siloxanes, volatile organic compounds, and carbon dioxide. The treated biogas then moves to the vehicle fueling system for secondary drying and final compression.

Storage and dispensing options for the final renewable fuel include fast-fill and/or time-fill installations. Fast-fill systems operate like a standard gasoline or diesel fueling station. The RNG fuel is stored in either spheres or cylindrical style storage vessels at a pressure of 4,500 pounds per square inch gage (psig). The fuel capacity in these vessels is controlled by a priority panel. The RNG fuel is then dispensed through a dispenser. This type of fueling system provides flexibility for vehicles that do not have a specific filling schedule. It is popular for sites that utilize their biogas for applications such as electricity production and heat recovery. The storage vessels for the renewable fuel allow the biogas conditioning system to operate based on the site's schedule rather than the vehicle's schedule.

The second type of fueling station is time-fill and includes a hose post assembly for multiple vehicles to fuel at the same time. Vehicles that require fueling are all connected to their individual stations. After secondary drying and compression of the treated biogas, the time-fill panel sends the fuel to all of the vehicle tanks at the same time, so no ancillary storage tanks are required. This type of fueling system is suitable for vehicles that return to a common location each night and operate on standardized schedules such as school buses and waste haulers. A combina-

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tion of fast-fill and time-fill also may be used.

To determine the feasibility of a site to operate a biogas-to-RNG system, the CNG fleet requirements need to be identified first. The number of vehicles, size of the fuel tanks, and how often the vehicles are fueled, are all criteria that need to be considered for a future system. Other considerations include where the biogas source is located in relationship to the fleet vehicles and whether CNG is currently available at the site.

For fleets such as waste haulers, the location of the RNG/CNG dispensing equipment is typically either at the landfill or the digester since the trucks are at one of the sites on a regular basis. However, for fleets such as city vehicles or school buses, there may not be a convenient location to refuel with RNG.

The next step in the process is testing the raw biogas and determining the volume of biogas available. Testing should be done to verify the major components, determine the levels of impurities such as hydrogen sulfide, and identify the speciated siloxanes and volatile organic compounds.

Major components in biogas include methane, carbon dioxide, nitrogen and oxygen. These components factor into the overall energy content of the gas. Hydrogen sulfide, siloxane and volatile organic compounds will determine the operations and maintenance costs associated with removing these impurities from the biogas.

Hydrogen sulfide (H_2S) and organic sulfur removal from biogas is necessary to prevent corrosion and decrease maintenance of downstream equipment. This may be accomplished with either a media bed or a biological system depending on the hydrogen sulfide concentration. H_2S also can inhibit the effective removal of siloxanes.

Siloxanes in biogas are becoming a concern for many sites. As manufacturers utilize siloxanes in products such as lubricants, personal care products and cleaning products, the siloxane compounds are becoming more prevalent in waste streams. When biogas containing siloxanes is combusted in engines, deposits of solid silica dioxide (SiO_2) collect within the engines. Damage inflicted by siloxane deposits can be profound, causing more frequent maintenance.

The Janesville Wastewater Treatment Plant in Wisconsin produces RNG vehicle fuel for its vehicles and lawn mower from excess biogas.

Assuming that the raw biogas meets certain and typical raw gas criteria, the biogas conditioning system will produce RNG fuel that meets the Society of Automotive Engineers Recommended Practice for Compressed Natural Gas Vehicle Fuel (SAE J1616) standards. Since the source waste for landfills, municipal wastewater treatment plant and commercial anaerobic digesters can vary significantly, determining the production costs of RNG will be dependent on the raw biogas quality. Once the vehicle requirements, biogas quantity and biogas impurity levels are identified, the RNG system may be sized appropriately. If the site produces excess biogas, a parallel CHP system should also be considered.

ADDITIONAL REVENUE

Once the RNG system is in place, in addition to the cost savings from producing the fuel from biogas, opportunities may exist for a revenue stream in the form of RINs. A RIN is the Renewable Identification Number assigned to renewable fuel, and includes fuel generated by the conversion of organic matter from landfills and municipal wastewater treatment plant digesters.

RIN demand originates from the renewable volume obligation (RVO) percentages. RVOs are set by the EPA each year and affect the refiners and importers of gasoline or diesel fuel. For RIN's to be awarded, the supply of RNG and the vehicle demand must be demonstrated and tracked. Typically there are approximately 1.6 to 1.8 RIN/GGE, and with small systems the supply/demand chain is easy to define. Brokers for RINs combine fuel quantities from multiple sites to secure best pricing per RIN.

Landfill and anaerobic digester operators are working hard to make the most from their biogas while being good stewards of the environment. RNG fuel from biogas is another way they can lower transportation costs at their facilities while reducing their overall carbon footprint. e

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