

NGV FLEET MANAGER



Photo by: Aaron A. Semer

SUPPLEMENT TO *MSW MANAGEMENT*

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Management
The Journal for Municipal Solid Waste Professionals



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Fueling with Natural Gas By David Engle

Like racers leaping forth at the green flag, fleets of natural-gas-powered trash trucks are suddenly taking to the streets around the country.

Once regarded as a fuel appropriate for firing boilers and power plants, natural gas has moved quickly to the fore as the fuel of choice for a newly arriving engine technology that delivers high-torque, heavy-duty performance.

Ray Burke, who was a manager of waste truck fleets for over 20 years, saw, firsthand, a decade-long metamorphosis of fueling opportunities that made it happen. It all began on a day in the mid-1990s, when the city of Palm Desert, CA, asked if his smoky, oily trucks of that era—which were daily plying their

routes through pristine desert air—could possibly switch to something cleaner. Burke, then with Waste Management Inc., embraced the challenge—and thus became manager of the first trucks in the nation to try natural gas as a workhorse fuel for trash hauling.

Alas, things went rather badly. The first-generation engines and bodies arrived; Burke then promptly found himself the first of a number of case histories around the country, at that time, falling victim to wobbly prototype technology he remembers now as “undependable, underpowered” and lacking durability.

The earliest engine-makers scurried off in defeat—except for one, Cummins-Westport Inc. Cummins stayed, and continued struggling. Eventually, as Burke recalls, the Vancouver, B.C.–based firm was forced to rework its CNG-powered design through several generations.

Around 2003, he says, performance improved noticeably.

Then, in 2007 came the breakthrough “ISL G” model—a power plant “that *really worked*,” he says with real admiration. Today, after three full years of proving itself in many locales, “all the tech issues with the engine have been ironed out, and it’s been performing extremely well ever since,” he says.

Burke departed Waste Management to join Clean Energy Fuels (Seal Beach, CA), a firm that was positioning itself to service the phenomenal “next big thing” for the industry—CNG fueling of heavy-duty trucks—on a big scale.

This year, he forecasts, out of a total of 8,000 new trash trucks of all kinds that will likely be purchased, more than a quarter—2,500 or so—will be fueled with natural gas instead of diesel; he bases this on his own count of several large announced purchases. Before 2007, total annual sales for the natural-gas category “were maybe 300.”

As of late 2009, Clean Energy Fuels had signed its first trash fleet contract in Florida; this was subsequent to recent deals in New York, New Jersey, Washington, Colorado, and Idaho. Burke recounts: “In the last two years this thing has gone from, ‘Well, we don’t quite trust it, and body manufacturers don’t understand installing tanks,’ to the point that everybody is jumping back in.”

Clearly, something happened in 2007 to rocket the sales, in a few scant years, to a nearly tenfold surge.

That “something” was, single-handedly, the ISL G, he says. It’s now found inside no fewer than five trash truck makers’ product lines of refuse truck bodies. “Almost every company is looking at natural gas, for all the obvious reasons,” he notes. “It’s clean and domestic... Many regions are now starting to mandate it. Cities and lots of companies are making the transition—even small companies. If you talk to people who are actually using the trucks, they love them. They think they’re fabulous.”

Jeff Campbell, Cummins-Westport director of product marketing, is certainly enjoying the success and adulation. Since the new engine model came out, company sales have increase 50% each year, he says. Perhaps half of all the natural gas engines



Fort Lauderdale's Choice Environmental operates 11 E-Z pack NGVs.

E-Z Pack

he’s producing are being put into refuse trucks. Already, about 10,000 of the nation’s total fleet of 170,000 trash trucks are fueled by natural gas, and—indicative of the epoch-making ISL G’s impact in itself—about 40% of these 10,000 are equipped with his new system.

Powerwise, at 9 liters, it produces 320-horsepower and 1,000 foot-pounds of torque, yielding, he says, “very diesel-like performance characteristics.” The previous model, at 8.3 liter, got 280 horsepower—“not quite big enough for many trucks,” he acknowledges, but the latest incremental boost has made all the difference.

On top of this, the ISL G’s use of a three-way catalyst, introduced three years ago, makes it the first EPA-certified 2010-compliant engine.

Now combine these developments with a serendipitous confluence of fuel price trends. In mid-2008, diesel prices shot up to new heights; shortly thereafter came the global downturn, and gas dropped to very appealing new lows.

And—as if this weren’t enough—federal legislation now contributes a magnanimous \$32,000 incentive credit to every purchaser of engines powered with this “alternative” fuel.

Campbell loves the fruits of company persistence: “We’re pretty excited,” he says.

For its part, one of the biggest and most successful NGV trash truck body makers, McNeilus, assembles a typical line of front, rear, and side loaders, all with the new engine. Lately, McNeilus’ Jeff Swertfeger, director of marketing and communications, reports selling hundreds of them. Most notably, trash fleets for downtown Chicago are transitioning to CNG, he reports.

Mack Trucks Inc. last year introduced its TerraPro low-entry model refuse truck, also powered with the ISL G. Mack senior vice president of product portfolio management Tom Kelly anticipates that expenses will come out “comparable to diesel in terms of cost over the life of the vehicle.” Mack is also working

with Volvo to develop a landfill-gas-fueled product that offers fuel production technology optimized for the landfill use, the company reports.

Operationally, these engines, with their eerily muted and smokeless characteristics—so out of character for trucks—are proving extremely popular with drivers and crews as well. Swertfeger observes that “Engines are so much quieter, it’s incomprehensible. You can’t believe it. Guys are starting to fight for the NGV units, because the work atmosphere is so clean and quiet. They love not getting pummeled with high-decibel engine roar and soot. It really is the slick nickel.”

Scott Edelbach, general manager for Vocational Energy, a truck fleet services provider in Tampa, FL, points out that natural gas is suddenly more desirable, vis-à-vis diesel, for another reason: As of 2010, the latter are burdened with carrying SCR pollution controls. These entail doing considerably more maintenance and carrying around an extra 30 gallons of diesel exhaust fluid, which freezes at 15°F—another issue with which to contend.

Gauging Tank Options

With such a radically different fuel on board, tank size, positioning, construction and numbers will each become critical factors to weigh. Selecting and implementing tank parameters will probably constitute the most dramatic change, at least in truck body considerations, Swertfeger suggests.

Tanks and the attached routing pipes and hardware are typically either integrated right on the truck assembly line (as at McNeilus) or, quite often, are sent out to a third-party upfitter, he says. Either way, placement and attachment deserve atten-

tion. As “pressure vessels,” he says, they’re usually positioned, in a rear-loader truck, directly behind the cab “or up on the front of the body”; on front loaders, they’re almost always on top. Spacewise, “you don’t really lose anything” this way. But owners should take note of the added height and potential restrictions on usability.

On rear-loaders, tanks are usually mounted in front of and above the cab, “so it kind of gives the truck somewhat of a canopy look.”

Tank sizing, too, is a consideration. Comparatively, natural-gas systems suffer a 10% to 15% disadvantage on power output compared with diesel. So, additional volume—whether CNG or LNG—must be carried to achieve the same range. The usual conversion strategy seeks “diesel gallon equivalency,” or DGE. “We normally shoot for between 60 and 75 DGE,” Swertfeger says, meaning that sufficient tankage must be positioned somewhere onboard to get this.

Of course, installing tanks and pipes requires proper engineering, design, training, and quality control, adds David Myers, who is sales manager for Alt Fuel Products in Riverside, CA. His firm is the world’s largest manufacturer of carbon composite cylinders, marketed as the Luxfer brand. With improper workmanship, CNG, being gaseous, could be vulnerable to leakage, especially given the stresses of hauling over unpaved surfaces. For strength and lighter weight than steel, AFP’s Luxfer uses a seamless aluminum liner wrapped with carbon fiber and epoxy resin. The most popular size is 200 liters, which equates to 15 DGE; hence, “strapping four of them together on top of a cab gives you 60 DGE,” he says.

Some fleets need longer range, and with an extra tank get



Allied Waste at Boise, ID, is replacing its older diesels with NGVs.

75 DGE. Another option is the use of LNG with its increased energy-density.

AFP's inventory includes 30 or so sizes, lengths, and diameters, to accommodate numerous designs, as efficient use of space is the prime consideration.

Regardless of the body manufacturer, all tanks are mounted either with straps that go around them, or by resting in aluminum blocks that hold them by the cylinder neck.

Total truck weight is also always a key number; GVW limits apply, and exceeding them can incur a citation and fine. Steel tanks and tubes are of heavier gauge; hence, the fleet owner may decide there's an advantage in paying for lighter, composite materials.

Industry-standard pipes and fittings for gas should be made of stainless steel, rather than conventional steel, adds Mark Hurt, of SSP Fittings in Twinsburg, OH. "Natural gas has natural chemicals that erode carbon steel, and you get rust and things that cause problems," he says. When shops do makeshift conversions from one fuel to the other, failure to use stainless steel is a common mistake, he finds.



SSWR

Specialty Solid Waste & Recycling is operating NGVs in Sunnyvale, CA.

LNG, CNG, and Engine Conversions

"The engine doesn't care" which state the fuel is in, when stored," notes Richard Kolodziej, president of NGVAmerica, www.ngvamerica.org, the vehicle trade association. "By the time it gets to the firing cylinder, it's vapor anyway. Some waste haulers prefer LNG for reasons of local availability or the greatly reduced stored volumes, increased payloads, and lower front-end costs.

Mark Hurt, whose company does CNG engine conversions for smaller vehicles, notes that LNG seems to be the storage-state of choice for trucks outputting 400 hp and above; below 250 horsepower, CNG is preferred; in between, it's a tossup.

Skip Baker, president of Baker Equipment in Richmond, VA, also converts utility vehicles' gasoline engines to run on CNG; he utilizes BAF Technologies' Calcomp engine systems and Baytech Corp.'s CNG fuel injection systems, both of which are certified to meet current EPA and California standards.

Baker and Hurt each do engine conversions, which are quite commonplace with pickups and vans. Both men would like start doing trash trucks too—but the heavy-duty engines and emissions controls present a challenge.

Meanwhile, another conversion shop—Fyda Energy Solution Inc., of Pittsburgh—anticipates being the first to offer a retrofit conversion for popular Mack engines, a makeover enabling dual fueling, sometime this year.

FES president Paul Naman explains that, "Without hurting the engine, we will turn it into dual fuel to run on natural gas and/or diesel," at a cost of about \$50,000 maximum, depending on catalyzers and fuel tank configurations. The conversion it-

self consists of engine modifications, an injection system, electronic control nodules, and fuel tanks; it's based on a system imported from Europe and used there for eight years now, he says. Conversions should qualify for a \$25,000 federal alternative fuel grant program, and, thanks to fuel price advantages, total cost-recovery should arrive in 12 to 18 months.

On a contrasting note, though, speaking from his long-standing experience in New England, Michael Manning, director of marketing and business development for AVSG LP in Boston, considers engine conversions somewhat "iffy." Having been involved with natural gas fleets since 1993, and

as the former manager for Boston's utility program for gas-fueled fleets, he says of conversions: "Possible—yes. But not so practical, operationally... The concept certainly will work. But most trash vehicles are pretty beat up," and hence are not really worth the retrofit investment. He adds: "In my 17 years, I've seen the good, the bad, and the ugly in CNG fueling. If a fleet manager came to me and said, 'We'd like to repower our vehicles,' I would tell them, 'Wait until it is time to do retirement of vehicles—and then do the transition.'" At which time: "Order new trucks, direct from the factory."

All in all, he adds, "A transition to CNG or LNG is a quantum leap for most fleets. It's an incredible change for management of company for operations," and to a lesser extent for customers.

How About Maintenance?

Besides the foregoing fueling/tankage issues, another novelty with gas is going to be spark plugs. Maintenance-wise, they add a dimension that diesels lack.

However, notes Cummins-Westport's Campbell, comparative maintenance comes out pretty close anyway, both on cost and labor. "Service intervals are the same," he says, "and both get the same warranty."

Looking at the recent past, Scott Edelbach observes that, "Anecdotally, fleet managers are seeing a maintenance savings cost-per-hour on NGVs versus the 2007 [emission compliant] diesel engine," already for the past several years.

At the 15,000-hour interval, a diesel "will show much more



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This natural-gas-powered vehicle is ready for action.

deposits and particles,” i.e., causing wear and added work., although natural gas, “is 90% cleaner and wouldn’t leave much buildup and deposits,” he says. Hence, a costly engine overhaul could well be bypassed altogether. One fleet manager for a national trash-hauling firm reported to Edelbach that, out of 140 CNG trucks owned since 2000, only two needed major overhauls after a decade.

All in all, the more significant maintenance wild card these days is SCR, urea, and diesel particulate filters; none of these is needed on a natural-gas engine, but all are, as of 2010, on a diesel.

What About Cost?

As for comparative pricing, Manning suggests that a standard diesel vehicle priced \$150,000 to \$175,000, if outfitted with CNG options, will cost another \$35,000 to \$55,000. To justify the premium, some big advantage is necessary. Privately owned fleets can reap the above-noted \$32,000 federal tax credit—a magnanimous sum he rightly calls “incredible.” However, city fleets don’t need tax breaks. Hence, three-way deals will likely be arranged between OEMs, vendors, and municipalities, to enable swapping of this credit.

Operationally, the cost of both fuels works out historically pretty close. But looking forward, the prospects for much cheaper natural gas are rosier than ever, thanks to the Marcellus shale deposits, located underground in much of the Northeast.

Manning observes: “In my 17 years in the natural-gas industry, I have never seen the supply of natural gas in the US so positive. A phenomenal amount of gas will be coming to market—as much as a 75-100-year supply,” he says.

And it’s likely to stay below \$6 per million Btus for some time, compared to much higher prices throughout the past

decade.

Even better, multiple tax breaks are coming due for passage in 2010; they’ll likely push net natural gas cost lower, through 2027. (See H.R. 1835.)

Increased Options

Royal Disposal and Recycling, headquartered in Fulshear, TX, just outside of Houston, purchased four CNG-powered rear loaders from McNeilus in recognition of a recent situation affecting operations. Co-owner Charles Gregory remembered the difficulty in finding diesel fuel during Hurricane Ike and vowed the refineries would never again hold him captive.

“When the hurricane hit, the refineries shut down, and it made it very difficult to maintain operation. We were pretty much on our own and we made the decision then and there that we would reduce our dependence on both our refineries and foreign oil,” says Gregory. Longer intervals between oil changes, the dramatic reduction in noise, and the huge savings in fuel cost were additional factors that played into the decision, Gregory says.

In sum: Now, more than ever, natural gas looks like the truck fuel for America’s future.

Making the Transition

Two years ago Chris Martin was president of a one-truck operation called CleanScapes of Seattle; a year later he was launching 75 clean, new, aesthetically eye-catching CNG vehicles across the city, after winning the trash contract of a lifetime. The deal didn’t hinge on buying CNG-fueled trucks, but that certainly helped, he says. In any case, Martin and Seattle have now accomplished “the largest CNG transition in the country” to date, he’s been told.

In selecting what to buy, Martin looked over potential

“Drivers like them because they’re quieter, and supervisors like them because they fuel overnight.”

OEM components available *à la carte*, from which one can, in effect, design and build a composite on a platform, not unlike picking toppings for a pizza: “First the chassis and engine, then the body gets put on, then fuel tanks.” But after further review he thought better. “Okay, now there’s *three* people to point fingers at each other, instead of one party.” That’s not so good.

Conversely, buying a preintegrated package from one vendor meant “everything was engineered to work together... right out of the factory.” He liked that much better, so opted for what turns out to be virtually the only mated chassis and fueling system in this particular niche, anywhere. It’s from Crane Carrier in Tulsa, OK, on which is mounted a body from waste-truck industry-leader McNeilus.

Size-wise, Martin picked smaller, more nimble trucks, suitable for tight Seattle neighborhood streets. Travel distances to the city’s outlying transfer stations is a mere 15 minutes, so bodies don’t need to haul so much tonnage. Staying compact also saved onboard weight, allowing room for welding on the largest integrated CNG tank option offered.

Why do this?

“Just to ensure that we had two days’ worth of fuel on the trucks,” Martin replies. This precaution seemed wise to him, in the eventuality that fuel supplies might ever be interrupted, as could happen for any number of reasons. With huge storage capacity on board, he’d have a second full day’s worth of gas as backup.

As for the fueling station, which was built by Clean Energy: it has suffered virtually zero downtime to date and works continuously, 24/7.

One final and major factor to weigh carefully, Martin advises, is the need to retrofit maintenance bays: by converting to CNG from diesel, “You introduce a whole new building code requirement,” necessitating things like “gas detection alarms, explosion-proof lighting and fans, and automatic venting systems that kick on to vent that gas.” These, he adds, are not necessarily cheap. However, purchase of each truck was nicely offset by \$40,000 worth of tax credits.

A contrasting approach was taken by the city of Lake Jackson, TX, a fairly early CNG adopter, notes director of public works Craig Nisbett.

The change-over began a decade ago, with 20 light-duty pickups converted; in 2002 the department added garbage trucks; as of 2010 the last diesel has been retired, and now Nisbett’s fleet of 15 is all-gaseous.

Mechanical problems did come up at first, but were traceable to an odd batch of solenoid valves. After replacement, things went fine, and every original truck is still running daily service for the city, says Nisbett.

His latest, bought in 2010, is a Heil packer body, mounted on an Autocar frame with the department’s now-standard Cummins-Westport engine for power.

Nisbett says he’s been extremely pleased with Heil’s 25-cubic-yard rear-load packers, mainly for crunching at a higher compaction-rate than the previous type he had (a now defunct brand). Daily routes weren’t being finished, he says, “so in the middle of the day we would have to go to the landfill and dump and come back and finish the route—which basically is an hour turnaround time every time.” Running back-and-forth so much, “you’re killing your vehicle time, and you also have a driver to pay,” he says.

But with the Heil’s bigger muscle, “generally speaking, we make it all the way through the day’s route and just dump at the end of the day.”

In switching to Heils (which are, he concedes, pricier) compaction wasn’t the only consideration, but when it came time to cost-justify them to the budgeters, “I think that’s what put us over the hump,” along with the brand’s reputation for being sturdy, well built, “and able to last a while. We had always wanted the Heils,” he says, but frugality ruled. “Now though, I think we’re a little more long-sighted on purchasing.” Since purchasing his first, he’s acquired six more, including a shiny new one in 2010.

Other purchases over the years include multiple Crane Carrier chassis with some John Deere and some Cummins engines, and some Macks. The latter run heavier commercial trash routes, and the Autocar Crane Carriers power the residential runs.

This motley parade of mixed chassis and bodies didn’t come about so much by conscious game plan, he says, but as a reflection of the industry’s consolidations and morphing of brands.

As for tankage decisions, here, he says, you should first calculate carefully “how many gallons of fuel do you need, and work with your supplier on where are you going to stick it on the chassis.”

He’s not saying his department erred, but he suspects that “people tend to overestimate the amount of fuel they should carry—and there’s a cost for doing that. So, don’t spec more fuel on board than you need.”

All in all, the ownership experience has been entirely positive, and nothing negative. “Drivers like them because they’re quieter, and supervisors like them because they fuel overnight and you don’t have to queue up at diesel pumps,” i.e., wasting the time of people who are on the clock.

Costwise, Nisbett’s experience was rather different from Martin’s in Seattle: Being a public agency, a write-off for him is useless—but he’d love to learn how it’s done by others. “Despite what anybody says,” he concludes, “our experience is you’re going to pay \$50,000 extra for a CNG garbage truck.”

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Writer David Engle specializes in topics related to solid waste.

Perspective on NGVs

By T. Boone Pickens

Refuse and Recycling Fleets Are Leading the Way

There was a time, and not so long ago, when if a municipality was in the market for a new or replacement refuse or recycling truck the issue of fuel was... irrelevant. It was going to run on diesel, and that was that.

Until recently, diesel was the only realistic option because natural-gas supplies were considered to be too limited or challenging to be used as a transportation fuel. Natural gas was necessary for the chemical and pharmaceutical industries, for heating and cooking, and to generate about 20% of our nation's electricity needs.

When new drilling techniques came on-stream, the natural gas we've always known to be contained in the enormous shale deposits under Texas, Louisiana, Arkansas, and Appalachia suddenly became available for commercial recovery.

Study after study concluded that, rather than being a limited natural resource, the natural gas reserves in the continental United States now are among the largest in the world and will last for over 100 years.

So a new issue *has* been introduced into the refuse and recycling truck purchasing equation: diesel or natural gas?

More and more municipalities are opting for natural-gas vehicles (NGVs) for a variety of reasons. First, the life cycle costs of an NGV are less than a diesel-powered truck because of the fuel costs and the lower maintenance costs. Those fuel-cost differences are significant. While oil is no longer selling for \$147 per barrel as it was in July of 2008, neither is it selling for \$35 per barrel as it was earlier this year.

Oil has stabilized for the moment at a trading range of between \$75 and \$80 per barrel, which makes natural gas approximately one dollar per gallon equivalent cheaper than diesel.

Second, natural gas is significantly cleaner than diesel. Refuse and recycling trucks are among the most inefficient vehicles because they spend a huge proportion of their working days idling or driving in first or second gear.

In fact, with respect to urban pollution, replacing one existing diesel trash truck with a new natural-gas one is like taking 300 new cars off the road. As more and more cities and states adopt clean air standards, NGVs are gaining favor.

Last, and in some ways most important, natural gas is an American fuel. We import nearly 70% of the oil we need, most of which is used as a transportation fuel: gasoline for cars and light trucks; diesel for heavy trucks.

In 2009 we imported over 4 billion barrels of oil at a cost of nearly a third of a *trillion* dollars. All of that money leaves the American economy; a great deal of it goes into the economies of countries which are unstable, unfriendly, or both.

The infrastructure issues that are claimed for a massive increase in passenger vehicles



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and light trucks running on natural gas, simply do not apply to heavy trucks—or any fleet vehicle that goes home to the barn every night.

Natural gas is, after water, the most widely distributed natural resource in the nation. Natural-gas lines run up and down just about every street in America. Installing and operating a central fueling facility for natural gas is a very manageable investment. In fact, leading refuse operators in Florida, New Jersey, Idaho, and California have opened new natural-gas fuel stations to support deployment of their growing fleets of CNG refuse collection trucks.

There is legislation in Congress that will greatly accelerate the development of NGV fleets. The NAT GAS Act—H.R. 1835 and S. 1408—builds upon and augments existing tax incentives to help get even more NGVs on America's roads.

In the meantime, it should come as no surprise to anyone that the refuse and recycling truck industry is leading the way in converting from dirty, expensive, foreign diesel to clean, cheaper, domestic natural gas.

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American financier T. Boone Pickens chairs the BP Capital Management hedge fund.

Support for Your NGV Project

By Paul Hull

Consider these aspects of the infrastructure you will need for success.

The indisputable evidence is that vehicles powered by natural gas (NGVs) will bring benefits to every community that can arrange its infrastructure to support them. For most communities (and for private organizations, too) the arranging of that infrastructure is probably the greatest challenge. Finding the money is usually the most obvious problem, but it is not something that anybody should write off as impossible and then ignore. In recent history we saw that same kind of fear and ignorance in relationship to computers. How could we ever afford them? And, today, who can manage well without them?

The concern here is for the infrastructure required to derive the benefits of NGV projects, especially for refuse trucks and everything associated with solid waste management. It is the infrastructure that is the most expensive initial investment, because we cannot have an efficient NGV system without an efficient and affordable infrastructure to support and maintain it. Is there infrastructure for our traditional systems of gas- and diesel-powered truck fleets? Of course, there is. They are called gas stations and are so familiar to us that a city street seems almost deserted if there aren't one or two in view. Many city and county public departments have their own pumps.

Initials can be a curse in this century, can't they? CNG is compressed natural gas and LNG is liquid natural gas. On a refuse truck, LNG can be fitted quite readily if the rest of the truck's design has worked to that end. Perhaps a greater challenge between

LNG and CNG is its local availability. In some places, LNG is stored too far away to be practical, but if your facility is, say, near Houston, it is readily available. Compressed natural gas is available in most communities. Is the pressure important? "The pressure at which the local distribution company provides gas is critical when designing compression equipment for CNG stations," advises Bill Zobel, senior vice president of business development at Trillium, a Salt Lake City-based provider of CNG fueling services, delivering more than 35 million gallons of CNG per year. "As a general rule, the higher the delivery pressure, the better. High-pressure delivery (150 psi or more) can save money in both compression and utility expense (the electricity or natural gas used to drive the compressor motor). Conversely, delivery pressures below 30 psi can require substantial upgrades to compression packages and drive up costs for both equipment and utilities."

The leading North American provider of natural gas, both compressed and liquid, is Clean Energy. Its customer base includes more than 172,000 vehicles at 184 strategic locations across the US and Canada. As a service to its clients, Clean Energy has an in-house grants department that provides assistance with identifying, applying for, and securing grant funding. The efforts of the grants department have helped secure more than \$149 million in grant funding for Clean Energy and its customers. At the end of August, 2009, the US Department of Energy (DOE) announced the award of \$34 million (11% of total funding from the DOE) to customers and government agency partners of Clean Energy



Linde North America

Linde North America converts LFG to LNG at Waste Management of California's Altamont Landfill at Livermore, CA.

Fuels Corp. to offset the incremental cost of more than 800 new clean-burning natural-gas-powered vehicles, including refuse trucks, heavy-duty buses and shuttle buses. So don't see the financial challenges of building the infrastructure, shrug your shoulders, and tell your colleagues to forget it!

Is there anywhere to go to find good, beginning advice? "Start with basic equipment for your infrastructure," advises Clint Beauchamp, marketing director at ZeitEnergy in Dallas, TX. "You could try partnering with others to start or reduce the amount of equipment needed. Many public authorities do not buy whole new fleets of refuse trucks each year. They tend to stagger their purchases, so beginning a new system can be expensive when use is not high." ZeitEnergy has started a Web site, www.cngconnect.org. It could be most helpful because its aim is to help municipalities and private fleet owners gather information and make decisions about natural-gas-powered vehicles that are right for their organizations. The Web site addresses issues for all sizes of municipal and private fleet owners with customized solutions that are not biased towards specific vendors. ZeitEnergy has a powerful combination of technical and financial expertise in CNG fueling, including capital budgeting and cost-benefit analysis.

Investment in a System

There are, in the United States, about 150,000 refuse trucks that burn an estimated 1.2 billion gallons of diesel fuel each year. They release into the air billions of pounds of smog-forming compounds, toxic air contaminants, and greenhouse gases. Diesel-fueled trash trucks could be considered one of the most concentrated sources of health-threatening air pollution in virtually all our cities. Isn't that a good reason to consider change? Natural-gas trucks save operators money, and that's another good reason for the investment. If you own your own refueling station and are using natural gas in your vehicle fleet, you are entitled to a rebate on every gallon of fuel you consume. Insist that your provider is either providing, or enabling you to receive, the credit directly, or is working completely transparently with you about how the federal credit (currently \$0.50/gasoline gallon equivalent) is factored into your cost of service. The infrastructure required to make the profitable change is the equipment which will allow natural gas, typically delivered by the local utility at the meter at pressures ranging from 20 to 125 psi, to be delivered at the pressure level required (3,600 psi) for storage and use in the trucks.

"We've done this because it was the right thing to do," notes Dave Fisher, general manager of Allied Waste in Idaho. It is a company of Republic Services, a leader in the provision of solid waste collection, transfer, recycling, and disposal services. Allied Waste has opened a compressed-natural-gas station that will fuel the company's own CNG refuse truck fleet and is also serving as the first public fueling station in Idaho. Republic has a contract with the City of Boise to provide all solid waste and recycling services for both residential and commercial customers in the Greater Boise area. "We believe that natural gas, because it is a domestic fuel source, is a positive move for the country," adds Kory Coleman, area president of the Mountain Region for Republic Services. "It will help us achieve energy independence. The use of clean-burning NGVs as replacements for our older diesel models aligns with the city of Boise's strategic plan to achieve consistent compliance with the increasingly stringent standards set by the USEPA." The mayor of Boise, David Bieter, observes that the project is a perfect example of how, through partnerships such as the Clean Cities Coalition, we can make real progress in

lowering our carbon footprint and improving the quality of our air. Clean Energy provided the fueling infrastructure and was praised for the good workmanship and efficiency demonstrated in Idaho.

"CNG infrastructure investments by fleet operators are coupled with vehicle procurements, purchase of both the cart and horse together," advises Bill Zobel. "We tend to find operators making these investments based on any one, or a combination of, three reasons. First, the economics of the CNG investment make good business sense. Second, the state or local regulating body is forcing them to convert their fleet to CNG. Third, the company views CNG as providing a 'green' edge over the competition or as a means of garnering goodwill by abating public/agency concern over air pollution. The first of these reasons is typically an easy business decision driven purely by the numbers, but it is further reinforced by the reasons given in the last of the three points. The second and third reasons need not make economic sense (but it helps!) as there are other factors at play compelling the operator to make the investment. That said, economics are the clear driver. Volume is critically important. Higher volumes allow operators to spread fixed costs (infrastructure investments) over more units of fuel, significantly improving project economics."

There are plenty of details to study and understand before the infrastructure is decided and built. There are many sources of information for those planning to convert their refuse trucks to natural-gas power. For an infrastructure project to change current trucks to natural gas, it is essential that your advisers know what they are talking about. In my research I have come across a couple of incidents where bids were mixed up or misdirected because the engineers or companies advising public authorities had little or no expertise in either the infrastructure equipment needed or, in one instance, no acceptable license to authorize bids. There's too much at stake to tolerate incompetence at the early stages of development.

There are many government incentives for private and public entities to pursue for helping with the cost on designing and developing the infrastructure you need. "A vehicle and landfill gas cleaning system can pay for itself in three to five years," says Tony Wong of FirmGreen, based in Newport Beach, CA. He gives us some basic arithmetic, without getting too deeply into the economics. "You produce a gasoline [diesel] gallon equivalent for \$0.90 per gallon all-in. Most of a vehicle's conversion cost can be paid by government incentives. The cleanup system for a small landfill (say, 500 scfm) installed will be \$3 million. CNG dispenser-tanks-compressor will run \$2 million. A 500 scfm system will produce approximately 1,800 DGEs per day. Do the math! That's about a five-year payback using \$2.50 per diesel gallon."

Before, During, and After the Infrastructure Construction

The equipment for enabling the infrastructure is of supreme importance. "CNG fueling stations comprise high-use, high-wear, energy-intensive, precision rotating equipment," says Zobel. "These units require frequent periodic inspections, preventative maintenance, and routine replacement of lubrication oils and critical components to ensure ongoing, smooth operations and to avoid catastrophic and costly equipment failure, and downtime. High-use, high-volume applications should favor equipment with high reliability and a proven track record of operating under difficult or extreme conditions. Oil-field-tested equipment is typically the best, and not all CNG developers offers these packages." These considerations are important

details in your RFP. They are good reasons why those advising you should be truly qualified (in knowledge and legally) to advise. You must evaluate responses to RFPs carefully to be sure you are getting the reliability you need for your specific application.

The operation and maintenance (O&M) of your infrastructure are critical, too, as they are with all other types of infrastructure, such as roads, water, wastewater, and sewer. You can do the O&M yourself or you can contract with others to have it done. Natural-gas station developers can offer an O&M services contract, usually based on so-much-per-fuel-unit, which allows the operator to unitize or spread those costs. Again, public authorities should be most careful and clear about the terms of O&M contracts; bidders should understand exactly what is required and involved. Before awarding long-term contracts for operations and maintenance, the owner of the proposed fueling station should check references of bidders (and, perhaps, check on service done but not offered in reference). You are looking for good customer service, energy efficiency and improvements in control and operation.

Moving aside just a little, but still staying relevant to the development of natural gas as the fuel for your refuse trucks, it is worth investigating if landfills can help. They are an integral part of many solid waste management systems. "Municipalities and even private landfill owners/operators should be looking at using their landfill gas asset for waste-to fuel," observes Tony Wong at FirmGreen. Waste-to-electricity is nice, but electricity is not the most efficient or best use of landfill gas. NGV fuel is. With that in mind, the key is to



Republic Services

Allied Waste's CNG refuelling stands in action at Boise, ID.

have natural-gas demand nearby, because the challenge with waste-to-fuel is on the demand side. Every landfill does not have a natural gas pipeline to transport the fuel and every landfill does not have abundant NGV fleets nearby to make use of the fuel. FirmGreen and one of its public landfill partners, SWACO (Solid Waste Authority of Central Ohio), have received innovation and project of the year awards from SWANA and LMOP.

Referring to the CNG fueling facility developed by Allied Waste in Idaho, Dave Fisher made some helpful and interesting remarks. "On the infrastructure side, when you are considering moving forward, are there any plans to make use of converted landfill gas in the operation?" asks Fisher. "If so, will the onsite production be CNG or LNG? Currently we have no plans to use the county's landfill gas to fuel trucks. The county [Ada County] has a robust program in using their landfill gas to make electricity but its use in waste management could be a topic of discussion in the future. With a good supply of CNG available we made the decision to concentrate on CNG rather than LNG. In order to supply the required gas for the

refuse truck fleet, we hired Intermountain Gas—the local utility—to run a 6-inch, 150-psi pipeline extension to our property, a distance of about a mile and a half. Once the pipeline was complete, it was connected to the equipment installed by Clean Energy. That equipment includes a filter/dryer and redundant compression equipment taking the gas up to our desired tank pressure of 3,800 psi. The 12 refuse trucks we currently operate take about four hours to refill. When we are totally built out in the fleet, our current system will be able to fuel about 60 trucks per day. Operationally, our drivers and customers are pleased with the equipment. The cleaner, quieter trucks have provided good service. One concern we had initially was the trucks' ability to operate at 2,400 feet elevation and negotiate the 800-foot climb to the Ada County landfill. For both tasks, the CNG trucks have performed as well as their diesel counterparts."

A common question from the uninformed is: "Where will all this natural gas come from?" There are a million miles of natural gas pipes in place, some the little ones that feed your house, but others are 24-inch, 36-inch, and 42-inch pipes. Nationally, supplies of natural gas are huge, enough for many, many years, at least into the next century. The infrastructure you need to get your trucks going is what is needed to bring that readily available natural gas to a place that is convenient for your fleets. Other details that your experts need to address concern the choice between a fixed price contract for the gas or using the current market price, the advisability (or necessity, if grants demand it) of a public fueling facility and the best way to set prices for that service. If you do have a truly public fueling facility, you may have to supply restrooms, a trash collection service, credit card acceptability, and so forth. Yes, deciding and acquiring the infrastructure for natural gas vehicles for your waste management work involve many important details. The first stage is to decide that, yes, you can do it, with the right help and investment. Then find good advisers for everything. They may not be in your community but they are available and you can find them with some research on the Internet or by contact with other communities and companies that have progressed to NGV for refuse trucks and seen the benefits.

The Solid Waste Authority of Central Ohio has teamed with FirmGreen to convert and clean to pipeline quality the gas from the Franklin County Landfill and then compresses it for vehicle use. This green fuel has already been put to use in SWACO's fleet, thus far consisting of CNG-powered Honda Civics, light- to medium-duty Chevy and Ford pickup trucks, and a packer truck used for recycling collections. Construction on phase two of what SWACO terms its Green Energy Center will be owned and operated by SWACO partner, FirmGreen. When completed, The Green Energy Center will utilize all of the landfill gas available and have a capacity of 5 to 10 million gasoline gallon equivalents.

Tulsa Gas Technologies is a world leader in the manufacture of dispensers for natural gas. Recently the company made a CNG station for Crane Carrier Corp. (one of the nation's leaders in the manufacture of refuse truck chassis). Both companies are headquartered in Oklahoma, one of the states that has shown excellent encouragement for the building and use of NGV trucks with its tax credits. "We used a twin Ingersoll-Rand compressor for Crane," notes Tom Sewell, president of Tulsa Gas Technologies. "That has enabled the customer to fill one new truck's tank every hour. It's a small station, but it copes easily with the realistic demand at the factory yard. The State of Oklahoma gave a 50% tax credit and there was federal credit, too, so the cost of the station was minimal." That's how tax credits can help municipal purchasers, too. The chassis builders

Altamont LFG-LNG Facility and Technology

By Duane Woods

In Northern California, a new and innovative facility has begun production of liquefied natural gas (LNG) from an unusual source: solid waste. Notably, the waste-based LNG is fueling a fleet of hundreds of natural-gas-powered waste and recycling collection vehicles throughout the state.

At the Altamont Landfill in Livermore, CA, Waste Management Inc. and Linde North America, a leading gases and engineering company, have created the world's largest facility to convert landfill gas (LFG) into clean vehicle fuel. Waste Management is now using this ultra-low-carbon fuel to power its fleet of LNG waste-collection vehicles.

Liquefied and compressed natural gas (CNG) are among the cleanest fuels currently available for use in heavy-duty trucks, and California now requires many truck fleets operating in the state to use these fuels given their air-quality and lower-carbon benefits. For over 20 years, Waste Management had already been capturing LFG at the Altamont Landfill to generate renewable electricity. With a steady supply of LFG, municipal and state support, and an internal corporatwide goal to reduce total fleet emissions by at least 15% and improve fuel efficiency by 15% by 2020, Waste Management and Linde seized the opportunity to harness the energy potential of the Altamont Landfill and develop a novel gas conversion system.

The LFG-to-LNG plant purifies and liquefies LFG that Waste Management collects from the natural decomposition of organic waste in the Altamont landfill. Conversion of LFG to LNG is a multi-step process that, roughly speaking, consists of two stages: purification to remove such compounds as sulfur, carbon dioxide, nitrogen, and alcohols from the methane, and a liquefaction stage that cools the conditioned gas to approximately -260°F.

Altamont liquefies the natural gas by passing a mixture of refrigerants through one side of a counter-current aluminum heat exchanger. The refrigerants are recycled by a compression and expansion cycle. Finally, the LNG is stored in a set of double-walled insulated tanks to keep it at liquid temperatures until it is transported by tanker trucks to Waste Management's LNG fueling stations throughout California.

The LFG-LNG conversion process produces a clean, renewable vehicle fuel with a carbon intensity that is about 85% lower than conventional diesel fuel and lowers greenhouse gas emissions by more than 30,000 tons per year. The Altamont facility alone has the ability to produce up to 13,000 gallons of LNG per day—enough to fuel 350 of WM's 485 LNG waste and recycling collection vehicles in 20 communities in California. Also, LNG engines cut vehicle NOx and particulate emissions by up to 75% when compared with a conventional diesel fueled engine system. In these ways, the use of LNG reduces the environmental impact of the waste-hauling fleets and the local communities in which they operate.

The Altamont Landfill and the technological initiative of Waste Management and Linde North America serve as an example to other municipalities in California and across the country interested in waste-to-energy technology, which can provide benefits for companies, local communities, and the global environment.

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like Crane start the basic truck, then the packer will add the kind of refuse collection details and design you require. "A federal tax credit can cut the cost of a truck in half, and then your state may add even more benefits for you."

All projects and programs that are true advances in technology and attitude bring hesitation and some doubt to their planners. When you plan for infrastructure and equipment for refuse trucks, you wonder where the hidden snags lie, where the purchasing problems will appear. "If you're considering refuse trucks with NGV capabilities, you can be sure now that all your favorite manufacturers build them at the factory," comments Stephe Yborra, director of marketing and communications for NGVAmerica, www.ngvamerica.com. "It is not difficult to order them, to stay with one favorite for this, another for that. There is a premium for buying them, but that can be turned into a profit for you sooner than you think. Let's say the premium is \$45,000. At once there is a \$32,000 tax credit. Then you calculate your actual savings with the new truck and you will find that you are making money within three years—not just saving money: making money. And that truck usually has a life cycle of eight years, so you can work out the benefits." NGVAmerica is a comprehensive source of information for those considering progress into NGV refuse trucks (or other vehicles); many individuals and companies involved in natural-gas vehicles belong to the association. Along with them I would recommend another site in which Mr. Yborra is involved. That is www.cleanvehicle.org. On the first page is a box to direct you to "The Compelling Case for NGVs" Workshops. It is a most interesting and helpful presentation.

Talking to those who have tried NGV refuse trucks is helpful, too. In Fort Lauderdale, FL, Choice Environmental has just invested in its eleventh NGV truck. It is an independent company, with Glen Miller as chief executive officer, a man who has spent a lifetime in the waste collection business and can appreciate advantages and disadvantages of anything proposed in that arena. "We are proud to be the first commercial waste company in Florida to deploy clean, quiet CNG-powered collection vehicles." "It's not only been good for us, the company," observes Ray Peraino, director of special projects for Choice Environmental. "We have appreciated the performance of the trucks, including the ease of maintenance, but our customers all over the city have welcomed their quiet operation and efficiency." At the open house at the company's own Pompano Beach CNG fueling station, John Seiler, mayor of the city of Fort Lauderdale, applauded "the tremendous environmental leadership that is going to make our community better, cleaner, and safer."

In Seattle, WA, CleanScapes has 40 NGV refuse trucks. "We were pleased with the prices we found, and the maintenance of these collection trucks has been better than that we experienced with diesel trucks," comments John Taylor, in charge of government relations at CleanScapes. "They are noticeably quieter, and that is a definite plus for our customers." CleanScapes is well known for its good efforts to help customers reduce their waste and lower the impact on their environment and wallets. The company provides customers with waste reduction and recycling recommendations and maintains full-time staff to implement diversion programs. Reduction of greenhouse gas emissions is another sign of commitment to that better environment.

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Paul Hull is a frequent guest author for Forester Media.