U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Case Study – Natural Gas Regional Transport Trucks

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Clean Cities
U. S. Department of Energy

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Case Study: Natural-Gas-Fueled Regional Transport Trucks

Background

This case study explores the use of leased heavy-duty regional transport tractors fueled by compressed natural gas (CNG) and liquefied natural gas (LNG). Natural gas shows promise for this application because fleets can save money on fuel while gaining other benefits, such as quieter operation and lower greenhouse gas emissions. Leasing offers the ability for fleets to minimize their financial risk in exploring new fuel options, gaining experience with the fuel on a short-term basis with minimal capital outlay.

MAJOR FINDINGS

- Cost Savings – The natural gas vehicles in the case study achieved a fuel cost savings of 12–16 cents per mile.
- Payback Period – The incremental cost of the Freightliner tractors can be recouped from fuel savings in 10–14 years, excluding incentives, under the operational conditions in the case study. Payback for the Peterbilt tractors was around 23 years.
- Typical Usage – The Freightliner trucks in the case study traveled about 36,000 miles per year on average and achieved fuel economy of 6 miles per diesel gallon equivalent (DGE). The Peterbilt tractors traveled about 39,000 miles per year and achieved fuel economy of 7 miles per DGE.
- Energy & Environmental Impact – The total petroleum displacement was 1 million DGE per year for the 204 tractors in the case study, while greenhouse gas reductions were approximately 1,100 tons per year.

Natural gas was used by *Ryder System, Inc.* (*Ryder*) in a fleet of leased trucks and tractors operated for regional freight transport in Southern California. The project was led by the San Bernardino Associated Governments (SANBAG), and was partially funded by Clean Cities through the American Recovery and Reinvestment Act (Recovery Act) of 2009. Project partners also received Assembly Bill 118 funding from the California Energy Commission.[i]

The project is one of 25 that Clean Cities funded with $300 million under the Recovery Act, which itself is only a small percentage of what the U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy received. The Clean Cities projects focus on reducing petroleum consumption and emissions by supporting the adoption of alternative fuel and advanced technology vehicles across the United States. Partners in these competitively selected projects contributed more than $500 million in cost share. Through Clean Cities, fleets purchased thousands of vehicles using a variety of fuels and technologies and hundreds of new and updated alternative fuel stations.

This account of *Ryder*'s project reports on the California deployment of around 200 CNG and LNG trucks, the construction and operation of two liquefied to compressed natural gas (LCNG) fueling facilities, and the upgrading of a maintenance facility to service natural gas vehicles.[ii]

Founded in 1933, *Ryder* is a $6 billion-per-year Fortune 500 organization that provides fleet management and supply chain services to 50,000 customers. The company has a fleet of around 128,000 trucks in full-service leases and 43,000 trucks in commercial rental service. *Ryder* is a member of the DOE Clean Cities National Clean Fleets Partnership and the EPA SmartWay Transport Partnership.

Among its fleet vehicle services, *Ryder* provides access to alternative fuel technologies for its leasing customers. *Ryder* offers natural gas and hybrid trucks in a variety of truck classes, and continues to evaluate other alternative fuel technologies. In early 2015, *Ryder*'s natural gas truck fleet had exceeded 30 million miles of service.

Ryder has been recognized for its work with the Clean Cities project. The company received an NGVAmerica Achievement Award for its innovative "Flex-to-Green" leasing approach, which allows a fleet to start with a conventional vehicle and switch to an alternative fuel vehicle after the first year of a three-year lease. *Ryder* has also been recognized by several publications, including *Newsweek* and *Inbound Logistics*, for its alternative fuel and sustainability initiatives.

Motivation for Adopting Natural Gas

Ryder's fleet customers are interested in natural gas to help them address the challenge of volatile fuel pricing, because it is more stable and sold at a lower price than diesel. *Ryder's* motivation is to demonstrate the feasibility of using natural gas fuels in commercial trucking applications, provide a domestic and low-carbon fuel source to its customers, and reduce criteria pollutants and greenhouse gas emissions in Southern California. Placing these trucks in a rental and leasing fleet can allow fleet customers, with minimal outlay, to gain confidence in how natural-gas-fueled vehicles will perform for their applications.

Financial Benefits

One main benefit of natural gas for commercial trucking fleets is its low and stable price relative to conventional transportation fuels. At the two LCNG stations constructed and operated by *Ryder*, fuel prices during the project period in 2012 and 2013 were at $2.57 per diesel gallon equivalent (DGE) for CNG, and $2.79 per DGE for LNG. Diesel fuel prices in California were around $4.18 per gallon, providing a cost advantage of about $1.50 per DGE for both fuels.

Environmental and Energy Benefits

The use of natural gas in vehicle applications reduces dependence on petroleum and can reduce greenhouse gas emissions. The Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool developed by Argonne National Laboratory for the Clean Cities program estimates that a natural gas vehicle can reduce lifecycle greenhouse gas emissions by 20% if it has the same fuel economy as a diesel vehicle (less if the fuel economy for natural gas is lower), and can reduce lifecycle petroleum use by 99%.

Project-Specific Activities

Vehicle Deployment

As part of this project, *Ryder* deployed a total of 168 Freightliner M2 112 CNG trucks, 16 Freightliner M2 112 LNG trucks, and 20 Peterbilt 386 LNG trucks. The Freightliner M2 112 trucks are Class 7-8 single- and tandem-axle tractors, and the Peterbilt 386 tractors are Class 8 tandem-axle tractors. Figure 1 shows examples of all three natural gas trucks.

Figure 1. Ryder Natural Gas Trucks: Freightliner CNG (left), Peterbilt LNG (center), Freightliner LNG (right)

The Freightliner M2 tractors employed the Cummins Westport ISL G 8.9-liter spark-ignited natural gas engine rated at 320 hp and 1,000 lb-ft torque and an Allison 3000-series automatic transmission. Fuel capacity was 75 DGE for the CNG trucks and 86 DGE for the LNG trucks. *Ryder* estimated a range for these trucks of 275 to 325 miles per fill.

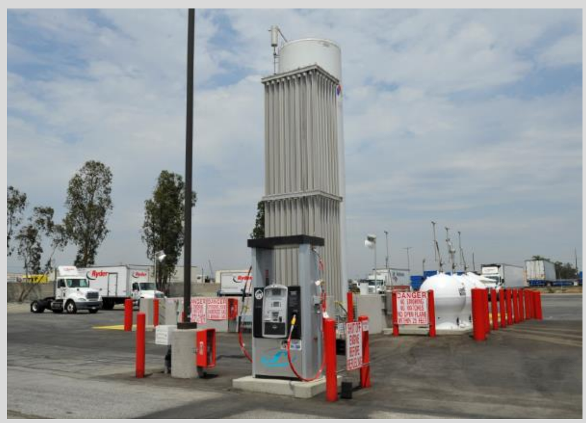


Figure 2. Ryder LCNG Station at the Fontana Maintenance Facility

The Peterbilt 386 tractors were equipped with the Westport GX 14.9-liter compression-ignited high-pressure direct-injection (HPDI) engine with diesel pilot ignition, rated at 475 hp and 1,750 lb-ft torque and equipped with Fuller 10-speed manual transmissions. Fuel capacity was 240 gallons of LNG (approximately 120 DGE), giving an estimated range of 550 to 650 miles per fill.

Ryder placed these trucks with 38 lease partners across Southern California. The companies included large organizations as well as smaller, regional fleets. The trucks were available to customers through short-term rentals, long-term leases, and *Ryder's* dedicated logistics services.

Infrastructure Deployment

Ryder constructed two natural gas fueling stations in support of this vehicle deployment. The LCNG stations were located at *Ryder* maintenance facilities in Fontana (Figure 2, completed in July 2013) and Orange, California (completed in March 2013). Each station cost approximately $2.5 million.

LCNG stations receive and then store LNG in a large tank. The LNG is either dispensed directly as LNG or it is warmed, vaporized, and compressed for dispensing as CNG. *Ryder* stated that the LCNG station design has the advantage of a more complete fill for CNG vehicles, because the fuel is produced at a temperature lower than the ambient air.

Each station offers contractual access for *Ryder* customers to one LNG dispenser and two CNG dispensers configured for larger commercial vehicles in a secured area. Two additional CNG dispensers are also available in a publicly accessible location for use by cars and light-duty trucks.

In addition to the fueling facilities, *Ryder* also invested in a natural gas vehicle maintenance facility in Rancho Dominguez, California. Ryder completed this facility in May 2011 with upgrades to the electrical, lighting, air handling, and ventilation systems. Completion of this facility corresponded with the delivery of the first of the natural gas trucks for this project. "The completion of Rancho Dominguez as a natural gas-compliant maintenance facility is a critical milestone demonstrating Ryder's commitment to alternative fuel vehicle use," said Robert Sanchez, *Ryder* president of Global Fleet Management Solutions. *Ryder* performed similar garage upgrades at the Fontana and Orange facilities, as well.

Training for Drivers and Technicians

Ryder worked with Cummins Pacific to develop a complete training program for internal *Ryder* employees as well as any customers seeking to lease the natural gas trucks. A six-part online training curriculum was developed, with modules ranging in length from 5 to 30 minutes. The list of the training classes is provided below, with a short description of each class.

- *CNG Driver Orientation:* Customers seeking to lease natural gas trucks were required to take this training course, which covered the major differences between the natural gas trucks and conventional gasoline and diesel trucks. The course also highlighted the key safety features of the natural gas vehicles.
- *Alternative Fuel Safety: Ryder* provides this course for internal employees to address the maintenance requirements of natural gas vehicles. Covered subjects include how to contain the fuel systems before starting work, which permits are required before starting work, and what to do in the event something goes wrong during the maintenance process.
- *Basics of Natural Gas Vehicle Safety:* This internal *Ryder* course explains the differences between CNG and LNG and provides safety guidelines for each fuel.
- *CNG Fuel Filter Maintenance:* This internal course focuses on servicing and replacing the high-pressure CNG fuel filters that must be replaced every 1,000 hours or 30,000 miles. The course explains how to shut off the high-pressure fuel system and relieve the pressure before the filter is replaced.
- *Fueling Alternative Fuel Vehicles: Ryder* provides this course for its employees on how to fuel natural gas vehicles (procedures, safety considerations, and draining of low-pressure fuel filters if required).
- *Mitigation of Natural Gas Hazards:* This course for internal *Ryder* employees describes how to deal with potential natural gas incidents that might impact employees and the public. Topics include controlling accidental releases of natural gas, addressing concentration and accumulation of natural gas, identifying and locating potential ignition sources, and responding to hazardous situations.

The CNG driver orientation class for customers has been taken more than 2,000 times to date, and the natural gas courses for *Ryder* employees have been viewed between 400 and 1,300 times (depending on the class).

In addition, *Ryder* has engaged in education and training beyond these partner-developed courses. The company conducted orientation meetings with new customers, worked with local fire departments on gas leak drills and emergency planning, and helped develop training for the California Highway Patrol.

Project Outreach

Both SANBAG and *Ryder* conducted outreach as an important part of this project, which included a marketing strategy to build both local and national awareness of the project activities. Outreach work included e-mail campaigns to encourage *Ryder* customers to consider the natural gas option; displays of the natural gas trucks at events such as the ACT Expo; speaking engagements by *Ryder* staff to describe the project and its successes; and general outreach to print and broadcast media. *Ryder's* public relations team engaged in around 70 media interviews about the project, developed 40 press releases related to the work, and published information about the project in its *Corporate Sustainability Report*.

Data Analysis Results

As required for Clean Cities projects, *Ryder* provided data on vehicle miles traveled and fuel used by its natural gas trucks for a 24-month period between 2012 and 2014.[iii] The data were analyzed to provide insight into the overall performance (fuel economy, fuel cost, and greenhouse gas emissions) of the vehicles during this time period.

Vehicle Operational Data

Figures 3 through 6 summarize the operational data of the natural gas trucks during the 24-month data collection period. Figure 3 shows the average annual miles per truck traveled by vehicle type. In general, the VMT are relatively low for a regional haul application, but vary widely within each vehicle type.[iv]

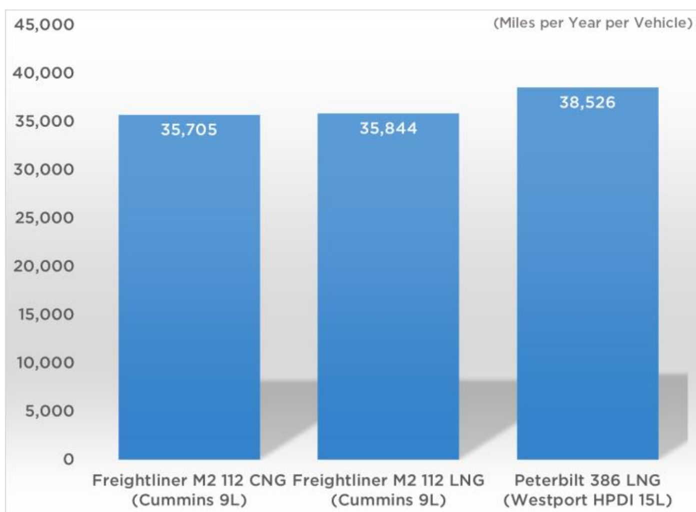


Figure 3. Average Annual Vehicle Miles Traveled By Truck Type

Annual Vehicle Miles Traveled

The annual VMT of the Freightliner CNG trucks ranged from about 3,000 miles per year to 76,000 miles per year, with about three-quarters of the trucks being in the 20,000 to 40,000 mile per year range. The Freightliner LNG trucks show a similar spread of annual VMT (around 5,000 to about 74,000), and about three-quarters of these trucks are in the 20,000 to 40,000 mile range for annual VMT.

The Peterbilt LNG truck annual VMT ranges from 9,000 to 103,000 miles per year; about half of the trucks are in the 20,000 to 40,000 annual mile range. In all three cases, 10% to 25% of trucks travel more than 40,000 miles per year, which can produce more favorable incremental cost payback than trucks with lower annual VMT (as will be discussed later).

The very similar annual VMT for the Freightliner M2 tractors in Figure 3 demonstrates that the tractors were used in very similar ways by the fleets that leased them, as would be expected given the only difference was the choice of CNG or LNG fuel (truck capabilities were similar in all other respects). The Peterbilt LNG tractors were not driven significantly farther each year than the smaller Freightliners: one possible explanation (described in more detail in the Lessons Learned section) is that these trucks were configured with a very long wheelbase that made them less maneuverable and, due to California regulations, unable to be legally operated on some of the fleets' routes.

Annual Fuel Use

Figure 4 illustrates the corresponding average annual fuel use for the CNG and LNG trucks. The Freightliner trucks show similar annual fuel use, as would be expected given that the trucks use the same engines and travel similar distances each year. About 5% of total fuel use for the HPDI trucks is diesel (shown in orange in Figure 4), used for pilot ignition to begin fuel combustion.

Fuel Economy

Figure 5 shows the average fuel economies of these trucks, expressed in miles per diesel gallon equivalent (MPDGE). Again, the Freightliner CNG and LNG trucks achieve essentially the same fuel economy, which is appropriate given the very similar specifications and operations of these trucks. The Peterbilt HPDI LNG trucks achieve higher fuel economy than the spark-ignited Freightliner trucks, which is expected of the compression-ignited HPDI system.

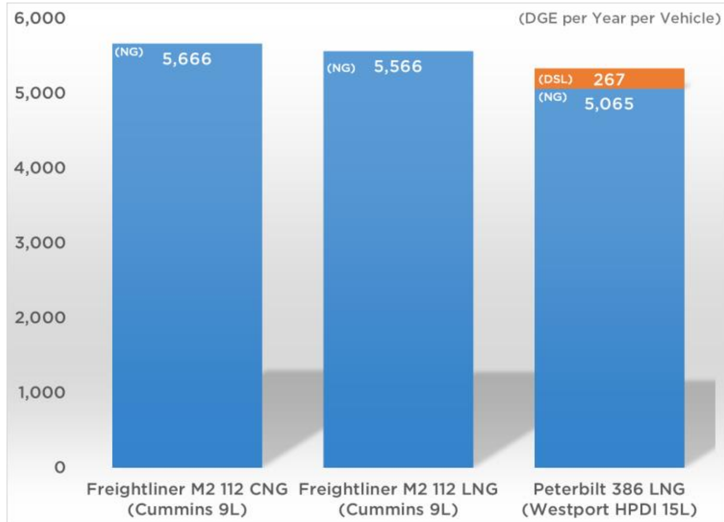


Figure 4. Average Annual Fuel Use by Truck Type

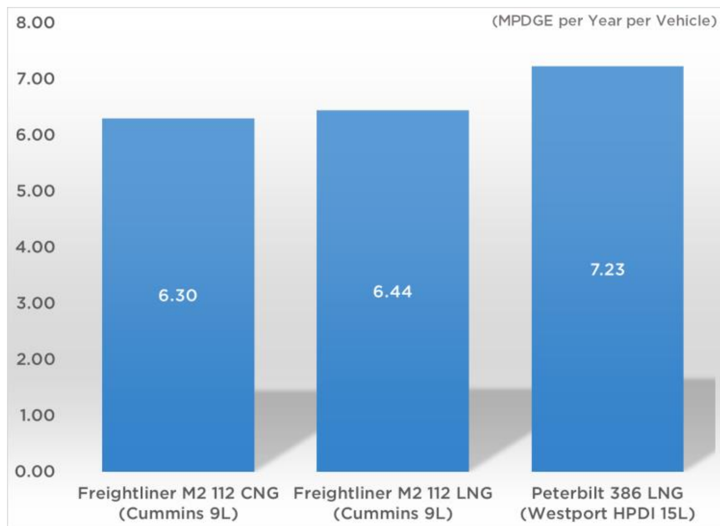


Figure 5. Fuel Economy by Truck Type

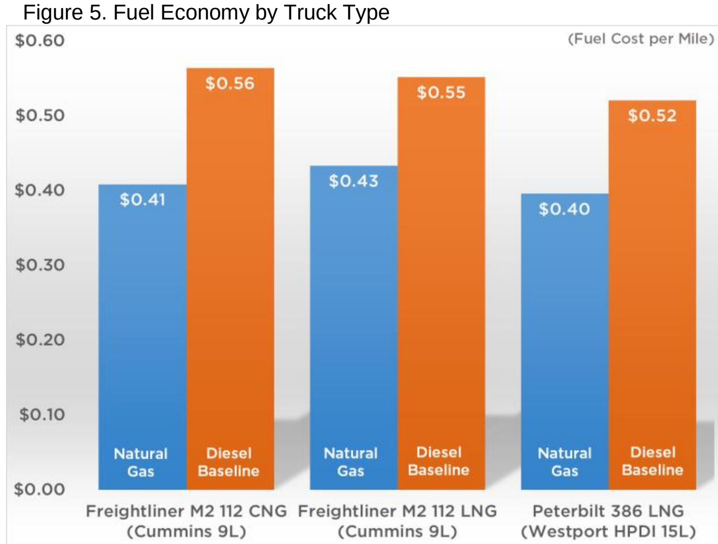


Figure 6. Average Fuel Cost per Mile by Truck Type

Fuel Cost per Mile

Ryder constructed CNG and LNG stations for use by its natural gas truck customers. As noted previously, *Ryder* reported that the average fuel cost during this time period was $2.57 per DGE for CNG, and $2.79 per DGE for LNG. Applying these prices to the VMT in Figure 3 and the fuel use in Figure 4 yields the average fuel cost per mile for these vehicles, as shown in Figure 6. The Freightliner CNG and Peterbilt LNG have similar fuel costs per mile because the higher fuel economy of the Peterbilt truck is offset by the higher cost for LNG and the additional cost of the 5% diesel fuel used by the HPDI engine. The Freightliner LNG trucks have slightly higher fuel cost per mile than the CNG trucks, as the cost of LNG fuel is higher.

Ryder did not directly provide operational data on diesel baseline trucks in the fleet that would be comparable to the natural gas vehicles involved in this project. However, *Ryder* did provide information on how the fuel economy of the Cummins Westport ISL G[v] and Westport HPDI[vi] engines compares with conventional diesel vehicles in its fleet. This information was used to estimate the fuel economy of equivalent diesel vehicles. Average annual VMT for the diesels was assumed the same as for the natural gas vehicles.[vii] Figure 6 shows the diesel baseline fuel costs per mile, derived by applying *Ryder's* reported average diesel price in California during this time period of $4.18 per gallon to the calculated annual fuel use.

At these costs, fleet operators using natural gas can save between 12 and 15 cents per mile on fuel costs. Maintenance costs were not included in the *Ryder* data, but previous analyses indicate that the incremental maintenance costs are around 1.7 cents per mile more for the Cummins Westport spark-ignited engines.[vii]

Environmental and Energy Impact Data

Petroleum displacement and greenhouse gas reductions are important benefits of CNG and LNG vehicles, and in part drove *Ryder's* interest in this project. The fuel use reported for the CNG and LNG vehicles and the estimated fuel use for equivalent diesel vehicles were applied to the AFLEET[viii] tool to estimate the total reductions in petroleum use and greenhouse gas. Figure 7 shows petroleum displacement for the CNG and LNG vehicles. The natural gas fleet displaced just over 1 million diesel gallons per year, with the average truck displacing about 5,000

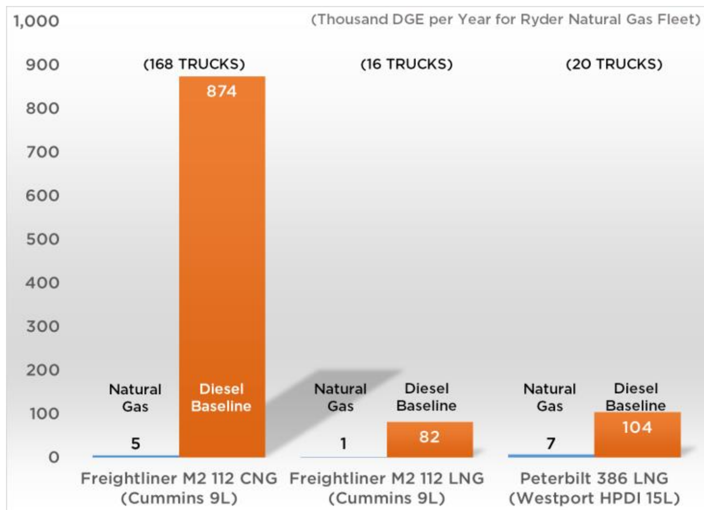


Figure 7. Total Petroleum Use by Truck Type

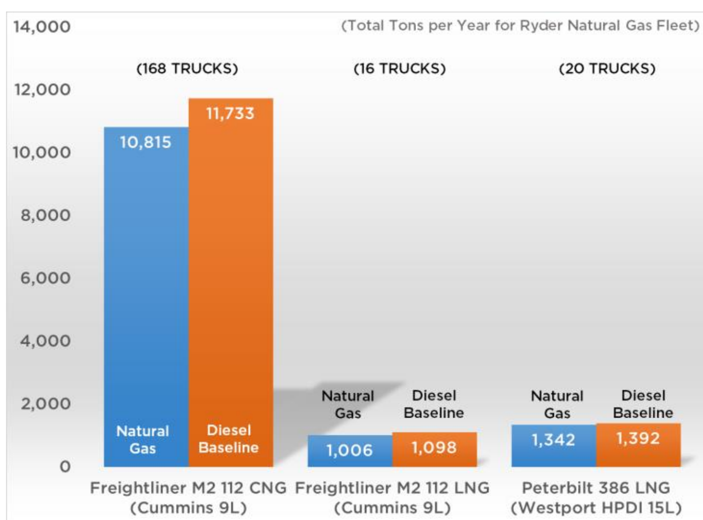


Figure 8. Total Greenhouse Gas Emissions by Truck Type

diesel gallons per year. Greenhouse gas emissions are presented in Figure 8. The total reduction in greenhouse gas emissions for the test fleet is around 1,100 tons per year, an average of 5 tons annually per truck.

Business Case Data

Fleet vehicles are purchased to do a job profitably; therefore, investments in new technologies must pay for themselves over time to be a viable choice. This is particularly critical for an organization such as *Ryder*, whose business is dependent on providing cost-effective trucks to fleet customers. Fuel cost savings can be significant for natural gas vehicles, but incremental costs for the vehicles and costs for the fueling stations must be paid back through these fuel cost savings.

The incremental costs of the trucks at the time of their purchase in 2010 (funded through Clean Cities by DOE and the California Energy Commission) were:

- $53,700 per Freightliner 8.9-liter CNG truck
- $59,200 per Freightliner 8.9-liter LNG truck
- $109,200 per Peterbilt 14.9-liter LNG truck

The higher incremental cost for the Freightliner LNG trucks over the CNG trucks can be attributed to the somewhat costlier storage tanks required for LNG. The incremental cost of the Peterbilt LNG trucks was significantly higher than for the Freightliner trucks because of the HPDI system and the larger storage tank (to allow for more range).

For *Ryder* customers, the lease payment for a truck includes the cost for the truck itself (as with a conventional lease payment for a vehicle) plus maintenance costs. The customer makes arrangements for fuel separately. *Ryder* noted that maintenance costs for the natural gas trucks in its fleet are higher than for comparable diesel vehicles, but these additional costs are not reflected in the lease payment. Over time, *Ryder* expects to move along a learning curve to reduce maintenance costs for the natural gas vehicles to a point in the future where they are lower than for diesel vehicles.

At a minimum, net fuel cost savings for the fleet user will need to enable repayment of truck incremental costs within a reasonable time frame. If these trucks were purchased by a fleet at the incremental costs listed above, with the operational conditions and fuel costs reported by *Ryder*, the simple payback of the incremental cost for the Freightliner CNG truck would be 10 years; for the Freightliner LNG truck, 14 years; and for the Peterbilt LNG truck, 23 years. These simple paybacks are somewhat longer than the 1–3 years that typical heavy-duty fleet operators expect for capital expenditures.

The push for timely payback highlights the need for matching the right truck to the right duty cycle, though in all cases, payback for the natural gas vehicle will improve if the annual VMT increases. *Ryder* also stated that fleet size and the ability to leverage resources are crucial to the business case for natural gas vehicles, especially in fueling and maintenance. An operator can significantly reduce its fuel costs by having a greater number of vehicles using the fueling and maintenance facilities, spreading those costs over a larger vehicle population. Because small fleet operators would have an uphill challenge to enter the natural gas market by themselves, a leasing arrangement such as *Ryder's* can help small fleets begin their natural gas activities.

Because *Ryder* is providing these trucks for lease to customers rather than retaining them for its own fleet use, the business case calculations are more complex than a simple payback calculation. *Ryder* must take into account both the initial purchase price of the vehicle and the potential residual value of the truck at the end of the customer's lease term in order to set appropriate lease payments. *Ryder* has found that the natural gas trucks depreciate at a faster rate than comparable diesel vehicles. As a result, the lease payment for a natural gas truck will typically be higher than for a diesel truck, a monthly incremental cost that the lease customer will try to pay back through fuel cost savings.

One of the main factors establishing the residual value of the truck when *Ryder* sells it into the secondary market is the willingness of that secondary buyer to pay for the natural gas option. *Ryder* stated that, in its experience, the typical truck buyer in the secondary market is looking to operate that truck for a total of 3 years, and wants a payback of any additional costs (such as those for a natural gas option) in 1 year.

Because *Ryder* is installing its own fueling stations, this infrastructure cost will need to be amortized as well. Each LCNG station costs $2.5 million, which will need to be recouped by station operators as a charge included in the fuel price customers are charged. More station throughput and a higher cost per unit of fuel will pay the station costs back more quickly, but the cost charged per unit of fuel cannot be so high that the cost advantage for the fleet customer is erased. *Ryder* estimates that the capital recovery and profit margin together represent around 40% of the cost of the fuel.[ix]

Lessons Learned

Natural Gas Vehicles

Ryder's participation in the Clean Cities project yielded useful insights about developing the specifications for natural gas trucks. The fleets who leased the trucks from *Ryder* used these vehicles in a variety of duty cycles, ranging from local delivery to over-the-road. This allowed the project to demonstrate the performance of these trucks in a wide range of commercial truck applications typically dominated by diesel engines. Economic viability will depend on the particular fleet duty cycle characteristics, and better business cases can be built with higher annual miles traveled than what was seen in this case study. By providing a visible example of the capabilities of natural gas vehicles, *Ryder* believes it has helped kick off the widespread acceptance of gas alternative fuel vehicles in the trucking market.

Ryder reported that, in general, fleet operators were very satisfied with the performance and drivability of the Freightliner trucks using the Cummins Westport 8.9-liter engine. At the time *Ryder* purchased the trucks, these engines were approved for use in Class 8 tractors at gross vehicle weights up to 80,000 pounds. *Ryder* found that the 8.9-liter engine does not have sufficient power in applications that require truck gross vehicle weights above 66,000 pounds, but is more suited to applications requiring single-axle tractors instead of tandem-axle tractors.[x] *Ryder* noted that the 8.9-liter engine performed well in beverage delivery, where gross vehicle weights are in the 30,000-pound range—an important lesson learned for the industry as a whole. Cummins Westport has since lowered the gross vehicle weight limit for the 8.9-liter engine to 66,000 pounds.

The Peterbilt LNG trucks provided additional lessons learned for *Ryder*. The Westport HPDI trucks, with their longer wheelbases, were more difficult to place with customers than the Freightliner tractors, but performed well in the higher-VMT regional haul applications where the truck is best suited to operate. The Westport HPDI wheelbase is about 2 feet longer because of the need to package LNG tanks for adequate range, plus diesel tanks and diesel exhaust fluid tanks for the emission control systems. The extra length hindered maneuverability in the urban environments of Southern California, particularly for local delivery service. It also meant that the trucks could not legally be operated on city streets and state highways where overall length restrictions are in place.[xi]

Ryder's customers preferred the shorter Freightliner trucks in both local- and regional-haul applications where maneuverability is important and restrictive length laws are in effect. *Ryder* concluded that the Peterbilt truck is more suited to a long-haul highway application. In addition, *Ryder* found that the HPDI engines experienced some reliability issues with both the engines themselves and the HPDI fuel systems, which also contributed to the lower level of customer satisfaction.

Ryder learned some lessons about truck specification. To expedite purchases with the Recovery Act funding, the trucks purchased as part of this project were all based on a single standard specification.[xii] *Ryder* found that this standard specification made the natural gas trucks more difficult to deploy than standard-specification diesel trucks, because of the impact of payload and range requirements for individual fleets. *Ryder* determined that the natural gas trucks should be tailored to the specific needs of the fleet customers to ensure they can be successfully deployed.

Lead times for procuring natural gas trucks were also an area of concern. *Ryder* learned that all of the participating organizations in a natural gas truck project must be aware of the longer lead time for building and delivering natural gas trucks compared with diesel trucks.

Finally, *Ryder* noted that customer support is extremely important in the success of an alternative fuel initiative. *Ryder's* dedicated sales resources created positive experiences with customers and assisted with ensuring consistency for the customer experience with natural gas trucks across the country.

Natural Gas Fueling Stations

Both *Ryder* and SANBAG gained expertise in planning, designing, and constructing natural gas fueling stations. One key insight was the need to engage local government organizations early in the planning process. the *Ryder*/SANBAG team reached out to the city's Planning Department when planning the first station in Orange, but the Planning Department did not initially see the need to have such a meeting. During the later phases of the project, it became apparent to *Ryder* that the Planning Department's unfamiliarity with natural gas stations and the Clean Cities initiative caused permit delays that set the project back nearly 12 months. When the project team commenced planning for the Fontana station, *Ryder* and SANBAG took a proactive approach in educating the local officials instead of waiting for those officials to seek answers to questions. This led to fewer roadblocks in planning and permitting the second station.

Ryder noted that its ability to make alternative fuel options available to its customers hinges on its ability to make a business case: sufficient revenue needs to be generated by having a critical mass of customers to pay back the infrastructure investments for fueling stations and maintenance facility upgrades. Getting this many customers requires having the right trucks for their applications. Financial assistance from Clean Cities was critical to making the short-term business case for the initial truck and infrastructure deployments.

Future Plans

Ryder continues to pursue natural gas trucks as a viable alternative to offer customers who are interested in reducing fuel costs and addressing broader energy security and emissions reduction goals. While the incremental costs of natural gas trucks in this project were relatively high, the increasing popularity of natural gas trucks has begun to lower costs, which will assist *Ryder* in making a business case for offering the natural gas option.

The experience gained from this project encouraged *Ryder* to offer natural gas options in more locations for its truck leasing program. *Ryder* has also expanded its natural gas leasing project to other truck classes. The company is now offering a natural gas straight truck (i.e., a truck that does not pull a semitrailer) in the 16,000-pound gross vehicle weight class, and has begun offering tractors with the larger, 11.9-liter Cummins Westport spark-ignited natural gas engine. The *Ryder* fleet now includes more than 500 natural gas vehicles, which are deployed in Arizona, California, Georgia, Louisiana, Michigan, New York, Texas, and Utah. *Ryder* has a total of 14 maintenance facilities that can service alternative fuel vehicles, and plans to add this capability to several more in the near future.

In 2011, *Ryder* launched the Flex-to-Green program that offers customers the flexibility of beginning a 3-year truck lease with a conventional truck and switching to a natural gas vehicle in the future. *Ryder* stated that this program has become increasingly popular with customers who are seeking to convert their fleet to natural gas but are not yet quite ready to make this move. As an incentive for fleets to exercise a “green” option, *Ryder* offers 1 year of its fleet location and tracking software service for free.

In 2015, *Ryder* launched an online natural gas vehicle training program for all of its North American maintenance personnel (6,000 people across 800 facilities). The training will provide the technicians with information that supplements the existing customized natural gas training described in this case study.

Also in 2015, *Ryder* announced an agreement with Clean Energy Fuels Corp. to shift the fuel supply for the two natural gas stations built under this project (Fontana and Orange) to renewable natural gas, which will significantly reduce greenhouse gas emissions. Clean Energy will also provide the fuel station maintenance under this agreement.

Conclusion

With the aid of funding from Clean Cities and several additional sources, *Ryder* deployed more than 200 natural gas trucks in local and regional delivery fleets throughout Southern California. These vehicles displace 1.2 million gallons of diesel and 2,200 tons of greenhouse gas emissions annually. *Ryder’s* lessons learned has encouraged them to expand green fleet offerings across the country, with the associated infrastructure investments necessary to make this a success. Specifically, *Ryder* has expanded its natural gas truck leasing efforts with additional truck configurations and more locations across the country where customers can obtain natural gas vehicles.

Endnotes

i. This funding is part of the Low Carbon Transportation Investments and Air Quality Improvement Program (AQIP)—see http://www.arb.ca.gov/msprog/aqip/aqip.htm for additional information.

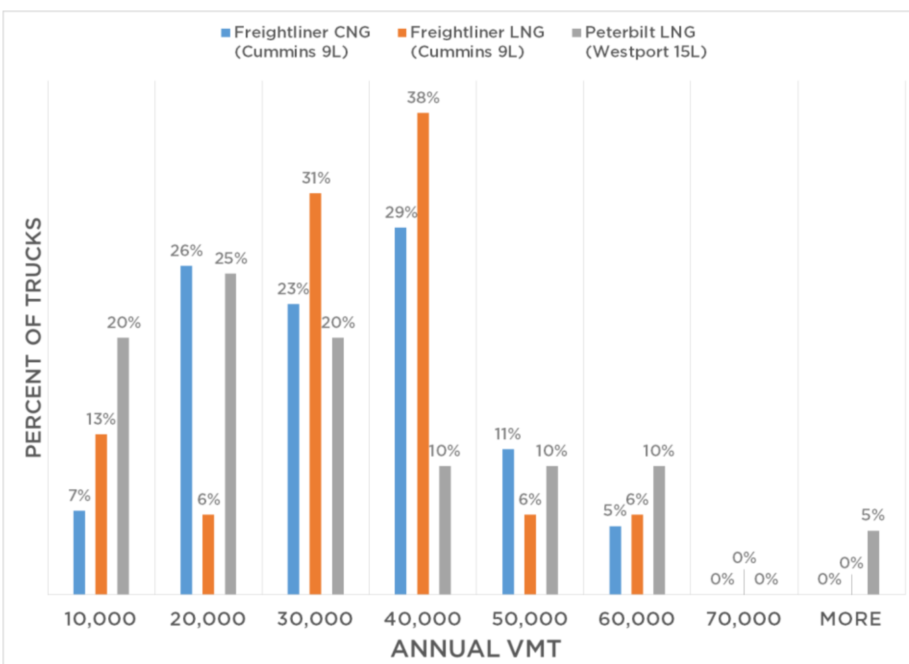
ii. The information in this case study was obtained from several sources, including quarterly American Recovery and Reinvestment Act data submissions to DOE, public announcements about the project by *Ryder* and other project partners, and the SANBAG final report to DOE on the project (*Ryder*/*SANBAG*: *Alternative Fuel Truck Project Final Report, March 2014*)

iii. *Ryder* employed two methodologies for collecting data from the project trucks:

1) From the start of the project through the second quarter of 2012, *Ryder* tracked vehicle mileage by recording odometer readings when the vehicle was serviced or refueled. If an odometer reading was not taken, *Ryder* used an assumed monthly VMT based on that customer's typical annual VMT. Fuel economy was assumed to be 5.5 mpg for the Freightliner trucks and 6.5 mpg for the Peterbilt trucks.

2) After the second quarter of 2012, *Ryder* used a telematics system (RydeSmart) to collect information on mileage and fuel use directly from the trucks.

iv. Because the vehicles were leased to third-party customers, the average annual miles per vehicle varied fairly widely. To describe this variation more thoroughly, the graph below provides a histogram of vehicle miles traveled in several categories, ranging from 10,000 miles per year or less, to more than 70,000 miles per year. As this graph shows, the Freightliner CNG vehicles were used mainly in applications from 20,000 miles per year to 40,000 miles per year. The annual miles traveled for the Freightliner LNG trucks are in the 30,000 to 40,000 mile range, somewhat higher than the CNG trucks. The Peterbilt LNG trucks were mainly in the 10,000 to 30,000 mile range, with a small percentage in the 60,000 and higher category.



v. *Ryder* stated that the fuel economy for vehicles using the Cummins Westport ISL G 8.9-liter spark-ignited natural gas engine was about 15–20% lower than comparable diesel vehicles available at the time the project vehicles were purchased. For comparison, Argonne National Laboratory estimated that the energy equivalent fuel economy penalty of a spark-ignited heavy-duty natural gas vehicle in regional haul application was 10% relative to a comparable diesel vehicle (*The GREET Model Expansion for Well-to-Wheels Analysis of Heavy-Duty Vehicles*, May 2015, https://greet.es.anl.gov/publication-heavy-duty). A 15% fuel economy penalty for natural gas was used for the *Ryder* trucks using the ISL G 8.9-liter engine to derive the equivalent diesel fuel economy.

vi. *Ryder* stated that the fuel economy of vehicles using the Westport HPDI 14.9-liter compression-ignited LNG engine was about 10% lower than comparable diesel vehicles available at the time the project vehicles were purchased. For comparison, Argonne completed a similar analysis for dual fuel natural gas engines such as the Westport HPDI engines in this study (see reference in endnote v); the fuel economy penalty for those vehicles was estimated to be 5%. *Ryder*'s fuel economy differential was used in this analysis. In both the spark-ignition and HPDI cases, *Ryder* stated that improvements in diesel fuel efficiency since the project vehicles were purchased likely account for the difference between their reported fuel efficiencies for natural gas and diesel vehicles and the more recent Argonne results.

vii. *Ryder* stated that the natural gas trucks accumulated mileage at a lower annual rate than comparable diesel trucks in its fleet, but did not provide specifics on the actual level of diesel VMT. As a result, this case study assumes equivalent VMT levels for natural gas and diesel trucks for the purposes of the comparison calculations.

viii. The AFLEET tool may be found at https://greet.es.anl.gov/afleet.

ix. In a presentation by *Ryder* to the Harbor Trucking Association, the fuel price for natural gas listed was $2.15 per gallon, implying a capital recovery and margin cost contribution of $0.86 per gallon, http://www.harbortruckers.com/downloads/RES092513%20RyderPresentation.pdf.

x. *Ryder* observed that the newer 11.9-liter Cummins Westport natural gas engine is a superior product for its regional haul customers and are receiving very positive feedback.

xi. California restricts the length of tractor-trailers to a maximum of 65 feet on certain state routes and local streets, http://www.dot.ca.gov/hq/traffops/trucks/truck-length-routes.htm. These are referred to as "California-legal" trucks, as opposed to STAA (Surface Transportation Assistance Act) trucks that are legal for the national interstate highway network. STAA trucks have length restrictions only for the trailer, along with restrictions on the distance between the kingpin (where the trailer attaches to the tractor) and the axles on the trailer. The 65-foot overall length restriction is in place because the longer STAA trucks have a larger turning radius than many local roads can accommodate, http://www.sacdot.com/Pages/TruckRoutes-STAA.aspx. For the Peterbilt HPDI tractors, their additional wheelbase meant that the tractor could not be used with a 53-foot trailer and stay within the overall 65-foot length required by California (a shorter trailer would have to be used with these tractors).

xii. *Ryder* agreed to participate in the project after the original fleet partner withdrew (and after award of the project to the prime contractor, SANBAG). As a result, *Ryder* came onboard to the project with little advance notice and time was limited to execute the vehicle purchases.

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