California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

San Bernardino Associated Governments Alternative Fuel Truck Projects

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PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program, formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to $20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about $100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued PON-08-010 to provide funding from the U.S. Department of Energy (U.S. DOE). In response to PON-08-010, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards March 18, 2010 and the agreement was executed as ARV-09-001 on August 4, 2010.

ABSTRACT

San Bernardino Associated Governments is the Council of Governments and Transportation Planning Agency for San Bernardino County located in Southern California. They partnered with the California Energy Commission, United States Department of Energy/Clean Cities, and Ryder System, Inc., to deploy 202 state-of-the-art compressed natural gas and liquefied natural gas heavy-duty tractor-trailer trucks in leased service. The objectives of the project were to 1) demonstrate the feasibility of using cleaner-burning, lower-carbon content natural gas in commercial trucking operations; 2) provide a low-carbon supply chain transportation solution to Ryder System, Inc. customers seeking to displace petroleum diesel fuel with domestically produced natural gas; and 3) achieve substantial, quantifiable reductions in ozone precursor and greenhouse gas air pollutant emissions. In addition to the deployment of 202 heavy- duty natural gas tractors, the project also constructed two publicly accessible natural gas refueling stations.

The project successfully deployed 182 heavy-duty Freightliner M2112 natural gas trucks equipped with the Cummins Westport ISL engine and 20 heavy-duty Peterbilt 386 trucks equipped with the Westport high-pressure, direct-injection liquefied natural gas 14.9 liter engine. During the 20-month demonstration period, the natural gas trucks accrued greater than 8.67 million revenue miles and displaced more than 1.4 million gallons of diesel fuel, exceeding project goals. This corresponds to a reduction in ozone precursor oxides of nitrogen (NOx) emissions exceeding 3 US tons, and carbon dioxide-equivalent (CO2E) GHG reductions exceeding 2,900 US tons.

Keywords: San Bernardino Associated Governments, liquefied natural gas, ozone precursor oxides of nitrogen, Cummins Inc., Ryder System, Inc.

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EXECUTIVE SUMMARY

In August 2009, the United States Department of Energy announced that San Bernardino Associated Governments was successful in receiving grant funding from the Clean Cities' fiscal year 2009 *Petroleum Reduction Technologies Projects for the Transportation Sector* program. Subsequently, the California Energy Commission announced that San Bernardino Associated Governments was a recipient of an Assembly Bill 118 grant award to match the Department of Energy Clean Cities grant. The two grants, totaling $19.2 million, were used to co-fund the deployment of 202 heavy-duty, natural gas-fueled tractor-trailers used in leased trucking operations. The California Energy Commission funds were allocated towards the purchase of 159 trucks, and 43 trucks co-funded by the United States Department of Energy. The grant funding also co-funded construction of two natural gas fueling stations, including site improvements, facility maintenance, and operator training.

Ryder System, Inc. was a project partner, who contributed $17.1 million for a total project value of $36.3 million.

The overall goal of the Alternative Fuel Truck Project was to provide significant reductions in the use of petroleum-based diesel fuel by maximizing the use of domestically produced, low-carbon, Compressed Natural gas and Liquefied Natural Gas vehicle fuel. Additionally, the project had the following additional objectives:

- Deploy approximately 182 heavy-duty Freightliner M2112 Natural Gas trucks powered by the Cummins Westport ISL engine, or an equivalent configuration;
- Deploy approximately 20 heavy-duty Peterbilt 386 Natural Gas trucks powered by Cummins Westport ISL engine or an equivalent configuration:
- Accelerate the replacement of heavy-duty diesel trucks with clean-burning low-emission alternative fuel trucks to stimulate a more aggressive "green" automotive industry in the United States;
- Demonstrate how alternative fuel transportation technologies can achieve significant petroleum and emission reductions in fuel intensive commercial freight handling applications including regional distribution and intermodal rail yard operations;
- Demonstrate how alternative fuel transportation technologies can achieve significant petroleum and emission reductions in fuel intensive commercial freight handling applications including regional distribution and intermodal rail yard operations;
- Serve as a model for other commercial heavy-duty trucking companies on how to successfully implement advanced technology alternative fuel programs in large commercial fleet operations;
- Reduce more than 7 million pounds (4407 metric tons of Greenhouse gas emissions per year;
- Eliminate approximately 2.3 tons of diesel particulate emissions from a large fleet of trucks that operate in low-income and minority communities that suffer from disproportionate impacts from diesel emissions.

As of March 31, 2013, Ryder customers have driven more than 8.5 million revenue miles, with an estimated 1.4 million gallons of natural gas displacing more than 1.6 million gallons of diesel fuel. The City of Orange natural gas fueling station site is 100 percent operational and was opened to the public at the end of June 2013.

Findings, Conclusions, and Recommendations - The deployment of 202 heavy-duty compressed natural gas and liquefied natural gas fueled vehicles through the San Bernardino Associated Governments Ryder Alternative Fuel Truck Project was very successful in terms of environmental benefits and petroleum displacement, as it displaced 1.4 million gallons of diesel fuel with lower-carbon content methane (natural gas). This corresponds to a reduction in greenhouse gas pollutants of nearly 3,000 tons, and over three tons of ozone precursor emissions over the project's demonstration period. Through this project the total reduction of NOx was over 3 US tons and a reduction of nearly 3,000 US tons of CO2E emissions.

Key findings of the Alternative Fuel Truck Project include the following:

Fleet operator and driver acceptance of natural gas-fueled heavy-duty trucks was high. In general, Ryder project managers reported that the vast majority of truck lessees were happy with the performance of the Freightliner Cummins Westport ISL G equipped trucks;

Compressed natural gas trucks were significantly easier to deploy into leasing arrangements as compared to the liquefied natural gas trucks. This is primarily due to the limited availability of convenient liquefied natural gas refueling facilities;

Additional engineering development is necessary to optimize natural gas engine and fuel systems into existing heavy-duty truck platforms. This was most notable for the Freightliner Model M2 112 chassis equipped with the Cummins Westport ISL G 8.9 liter engine, which experienced multiple exhaust manifold and piston failures traceable to inadequate engine cooling and potentially incompatible truck axle ratios;

Fuel penalties associated with natural gas were higher than anticipated. The Peterbilt Model 386 trucks, equipped with the Westport 14.9 liter high pressure direct injection liquefied natural gas engine, demonstrated an approximately 8.5 percent fuel penalty when compared to a comparable truck equipped with the 14.9 liter Cummins ISX diesel engine; the spark ignited 8.9 liter Cummins Westport ISL G equipped trucks demonstrated an approximately 15 percent fuel penalty when compared to a comparable diesel truck;

Economically, the compressed natural gas 8.9 liter ISL G equipped trucks were able to demonstrate operating costs at or below those of a comparable diesel truck in most of the participating fleets. The Peterbilt GX-equipped trucks, however, have an operating cost breakeven point at approximately 80,000 annually.

Of the project's 202 deployed trucks, 182 were the Freightliner M2112 heavy-duty vehicles equipped with the Cummins Westport ISL G spark-ignited natural gas engine. Of these, 167 of the ISL G equipped trucks were configured to operate on compressed natural gas, and 15 configured to operate on liquefied natural gas. Overall, the ISL G-equipped Freightliner M2 112 trucks performed very well in revenue service in addition to providing adequate torque and power for the participating fleet operators.

Average demonstrated fuel economy was recorded for each vehicle configuration as follows:

- Cummins Westport ISL G (compressed natural gas): 6.33 MPG
- Cummins Westport ISL G (liquefied natural gas): 6.28 MPG

According to Ryder, this truck configuration proved more difficult to place into a lease arrangement as compared to the smaller ISL G Freightliner truck. The reasons cited by Ryder that influenced customer acceptance of the 14.9-liter-equipped truck include the following:

- Longer wheelbase– the physical size of the vehicle hampered efforts to lease the vehicle to trucking firms that operated in local delivery service applications. The vehicle was less maneuverable in urban settings and more suited for over-the-road trucking applications;
- Increased tare weight– Ryder estimated that the GX-equipped liquefied natural gas Peterbilt truck had an un-laden weight on the order of 1,500 pounds greater than a diesel-fueled truck that could accomplish the same trucking duty-cycle. This was due to the higher weight of the large displacement engine, and the added weight of the liquefied natural gas tanks:
- Incremental cost of liquefied natural gas compared to compressed natural gas– while both states of natural gas retailed at an equivalent gallon cost less than diesel, trucking firms were sensitive to the appearance that liquefied natural gas carried a price premium as compared to compressed natural gas;
- Perceived Lack of Convenient liquefied natural gas refueling infrastructure- Although several commercial liquefied natural gas refueling stations have been constructed in the greater Southern California area, fleets expressed concerns related to reduced vehicle routing flexibility; i.e., that the utility of their fleet could be reduced due to the need to remain in general proximity to an liquefied natural gas refueling station.

Air Quality & Petroleum Displacement Benefits - The Alternative Fuel Truck Project established a goal of displacing 1.4 million gallons of petroleum-derived fuel during the project's period of performance. As of March 1, 2013, the project displaced in excess of 1.4 million gallons of petroleum diesel, exceeding the established project goal:

- Compressed Natural Gas: 1.2 million Diesel Gallon Equivalent
- Liquefied Natural Gas: 180,000 Diesel Gallon Equivalent

Additionally, San Bernardino Associated Governments conducted an air quality analysis to quantify the emission reduction benefits of using cleaner-burning natural gas. Two classes of vehicle exhaust air pollutants were assessed:

- Criteria Air Pollutants regulated by the California Air Resources Board in accordance with the Clean Air Act/National Ambient Air Quality Standards;
- Greenhouse Gas Emissions proposed for regulation under the California Global Warming Solutions Act (AB 32).

The geographic region under the regulatory authority of the South Coast Air Quality Management District is designed by the United States Environmental Protection Agency as "extreme nonattainment" for ozone. Ozone, the primary component of air pollution commonly known as "smog", is formed by a photochemical reaction of hydrocarbons, oxides of nitrogen (NO, N2O, NO2), and sunlight. Oxides of Nitrogen are the primary ozone precursor emissions, and approximately 70 percent of all NOx emissions are emitted by mobile sources – automobiles, trucks, buses, etc. The combustion of diesel fuel is a significant source of NOx emissions in the South Coast Air Quality Management District; reducing the use of diesel fuel is thus a primary air quality improvement strategy and is strongly promoted by the Air quality Management District.

The following table summarizes the results of the Alternative Fuel Truck Project evaluation as it relates to reductions in criteria air pollutant emissions (NOx) and greenhouse gas emissions. Greenhouse gas emissions are shown in terms of carbon dioxide equivalent, or CO2E. Greenhouse gases emitted from internal combustion engines are typically comprised of carbon dioxide (CO2), methane (CH4), and nitrous oxide (N20), plus traces of fluorocarbon gases emitted from vehicle air conditioning systems.

Table ES-1: Air Quality Benefits of Alt-Fuel Truck Program

Criteria Pollutant (NOx)	Diesel Fuel NOx Emissions (US Tons)	Natural Gas NOx Emissions (US Tons)	Net Reduction in NOx Emissions (US Tons)
Peterbilt GX 14.9 Liter (20 Trucks)	0.33	0.17	0.16
Freightliner ISL G 8.9 Liter (181 Trucks)[1]	6.34	3.43	2.90
Greenhouse Gases (CO2E)	Diesel Fuel CO2E Emissions (US Tons)	Natural Gas CO2E Emissions (US Tons)	Net Reduction in CO2E Emissions (US Tons)
Peterbilt 14.9 Liter (20 Trucks)	761.77	644.12	117.64
Freightliner 8.9 Liter (181 Trucks)1	18,519.05	15,397.14	2,811.96
Total Reduction in NOx Emissions (US Tons)		Total Reduction in CO2E Emissions (US Tons)	
3.06		2,929.63	

Source: San Bernardino Associated Governments (SANBAG).

Conclusions - From a technical standpoint the following can be concluded:

The use of natural gas as a motor vehicle fuel for heavy-duty trucks is an effective strategy to reduce both criteria air pollutants and greenhouse gases. During the demonstration period, this project resulted in the displacement of over 1.4 million gallons of petroleum derived diesel

1 One Freightliner ISL G-equipped truck, unit #503977, did not accrue any miles during the demonstration period of performance but remains available for future lease.

fuel, reduced greenhouse gas emissions by over 2,600 US tons, and reduced ozone precursor emissions by over three tons;

Fleet operator and driver acceptance of the natural gas trucks was very high. According to Ryder, the majority of customers who operate the Freightliner ISL G equipped truck were "very happy" with the vehicle's performance and operability. While overall customer satisfaction was lower for the Peterbilt GX liquefied natural gas truck, specific "niche" fleets are currently operating the Peterbilt 386 liquefied natural gas truck with much success;

That commercial operators of truck fleets are willing to try an alternative fuel, in this case natural gas, as an alternative to conventional diesel fuel. The findings of this project indicate that while the natural gas technology did offer slightly less efficiency and performance, natural gas engines offer sufficient performance and drivability compared to diesel. Thus, natural gas technology has reached a state of maturity that it can compete directly against diesel in the marketplace;

Liquefied natural gas trucks were significantly more difficult to place into a lease arrangement as compared to compressed natural gas trucks. This is due in part to the perception that insufficient liquefied natural gas refueling infrastructure exists to ensure fuel availability when needed. The higher incremental cost of liquefied natural gas as compared to compressed natural gas was also a factor in the fuel selection decision;

The Peterbilt 386 proved too large and too expensive for most participating fleets and was difficult to place into a lease agreement. The size, specifically wheelbase, and weight of the truck was not conducive to local delivery operations. These factors also influenced the economics of placing this vehicle into revenue service;

Additional refinement of engine/chassis integration appears warranted. Although limited in the number of occurrences, failures of exhaust manifolds and pistons suggest possible thermal issues associated with the engine's integration into an existing chassis configuration. As noted, Ryder believes the Freightliner axle ratio is not optimized for the Cummins Westport ISL G engine – the axle ratio is too high, which results in higher than typical engine revolutions per minute and higher than expected engine operating temperatures.

Programmatically, the following conclusions can be reached based upon the findings of this demonstration project:

In the current economic environment, compressed natural gas competes well against conventional diesel fuel for commercial applications where operating cost heavily influence vehicle selection. This is due largely to the current low cost of compressed natural gas as compared to diesel.

The acquisition cost of a heavy-duty truck equipped with a natural gas vehicle carries a price premium as compared to conventional diesel engine-equipped truck. This is due to the cost of the compressed natural gas and liquefied natural gas specialty components, such as fuel storage pressure vessels compressed natural gas tanks and cryogenic Dewars, as well as the costs associated with third party original equipment manufacturers that design, integrate, and install the natural gas refueling systems. Due to the relative low production rates of advanced technology natural gas heavy-duty vehicles, the economies of scale associated with conventional diesel technologies are not present. As a result, subsidies to partially buy-down the capital cost of a heavy-duty compressed natural gas truck may still needed in specific trucking industries and applications to make natural gas economically viable.

The Westport GX–equipped trucks currently require purchase subsidies to allow the vehicle to compete with a comparable diesel-fueled truck due to the relatively high cost of the Westport GX liquefied natural gas engine. In this project, it was calculated that the economic breakeven point for the Peterbilt GX-equipped truck was approximately 80,000 miles, which exceeds the annual mileage accrued by most commercial trucking fleets. Despite not meeting the 80,000 annual mileage threshold, fleets who selected the GX-equipped truck reported a positive experience

To further advance the use of low-emission fuels such as natural gas in commercial trucking industries, the following is recommended:

- Continue to fund technology advancement projects that offer the potential to increase alternative fuel engine efficiency and durability. The advanced high-pressure direct injection fuel delivery system used in the Westport GX was shown to be effective in reducing the fuel penalty typically associated with gaseous fuels such as methane. Further refinement and advancement of alternative fuel engine technologies will help alternative fuels achieve performance parity with conventional fuels, further improving industry acceptance;
- Continue to offer funding incentives to partially buy-down the higher capital cost of heavy-duty alternative fuel trucks, especially in trucking industries where the use of alternative fuels has not been widely demonstrated;
- Encourage and support the construction of publicly accessible alternative fuel infrastructure, including compressed natural gas and LNG refueling stations in locations that are convenient and accessible to commercial truck operators. A robust network of compressed natural gas and liquefied natural gas refueling stations will eliminate actual or perceived barriers to the use of natural gas as a heavy-duty motor vehicle fuel.

Grant Recipient Future Intent - San Bernardino Associated Governments and Ryder will continue to monitor all 202 trucks. The project partners will also continue to monitor the use and progress of the natural gas refueling stations that were constructed as an element of this project.

CHAPTER 1: Compressed Natural Gas / Liquefied Natural Gas Alternative Fuel Truck Project Overview

Background and History

In late August 2009, the United States Department of Energy (U.S. DOE) announced that San Bernardino Associated Governments (SANBAG), was successful in receiving funding from the Clean Cities' Fiscal Year (FY) 09 Petroleum Reduction Technologies Projects for the Transportation Sector. The following week, the California Energy Commission (CEC) announced that SANBAG was a recipient of an Assembly Bill 118 grant award to match the U.S. DOE Clean Cities grant. The two grants totaled $19.2 million and would be used towards the transition of over 200 tractor/trailer vehicles to natural gas, as well as the construction of two natural gas fueling stations, improvements to maintenance facilities and training.

At the January 6, 2010 Board meeting, SANBAG approved the execution of an agreement with the U.S. DOE for its share of funding for the Project. On February 2, 2010, SANBAG received documentation from its initial fleet partner, J.B. Hunt, stating they were withdrawing from the Project. Fortunately, the U.S. DOE and CEC allowed SANBAG time to find a replacement fleet for the Project. On April 7, 2010, the SANBAG Board approved the selection of Ryder System, Inc. (Ryder), as its new Project partner. The CEC approved the funding Agreement with SANBAG at its June 30, 2010 Commission meeting. On July 7, 2010, SANBAG approved the Southern California Association of Governments (SCAG) Agreement for Clean Cities' outreach.

The overall project cost totaled $36.3 million; which consists of combined CEC/U.S. DOE funding of $19.2 million, with Ryder matching these funds with $17 million. The entire CEC allocation went towards the Natural Gas (NG) vehicles; whereas the U.S. DOE funding contributed towards vehicle purchases, two natural gas fueling stations, modifications to three Ryder maintenance facilities, training, administrative expenses, technical assistance, as well as outreach and marketing.

Goals and Objectives

The goal of this Agreement is to provide significant reductions in the use of petroleum-based diesel fuel by maximizing the use of domestically produced, low-carbon, Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG) vehicle fuel. A fleet of 202 NG trucks was the key in achieving these goals. SANBAG, under contract with U.S.DOE also constructed two publicly- accessible CNG and LNG fueling stations that support not only Ryder's own CNG and LNG fuel needs, but outside fleets' CNG and LNG fueling and petroleum reduction strategies as well; thus further expanding the petroleum reduction and use of alternative fuels beyond the significant project baseline numbers.

The objectives of this Agreement are to:

- Deploy approximately 182 heavy-duty Freightliner M2112 Natural Gas trucks powered by Cummins Westport ISL engine, or an equivalent configuration

- Deploy approximately 20 heavy-duty Peterbilt 386 Natural Gas trucks powered by Cummins Westport ISL engine or an equivalent configuration;
- Replace more than 1.4 million gallons of annual diesel use with 100 percent domestically produced low-carbon Natural Gas Fuel;
- Accelerate the replacement of heavy-duty diesel trucks with clean-burning low-emission alternative fuel trucks to stimulate a more aggressive “green” automotive industry in the United States;
- Demonstrate how alternative fuel transportation technologies can achieve significant petroleum and emission reductions in fuel intensive commercial freight handling applications including regional distribution and intermodal rail yard operations;
- Provide low-carbon supply chain transportation services to Ryder’s customers such as: Apria Healthcare, Carrier Corp., Chiquita, Las Vegas Review, Master Halco, Mazda, Toyota and Xerox;
- Serve as a model for other commercial heavy-duty trucking companies on how to successfully implement advanced technology alternative fuel programs in large commercial fleet operations;
- Reduce more than 7.9 million pounds (4400 US tons of Greenhouse gas (GHG)) emissions per year;
- Eliminate approximately 2.3 tons of diesel particulate emissions from a large fleet of trucks which operate in low-income and minority communities that suffer from disproportionate impacts from diesel emissions.

Approach and Methodology, Accomplishments

In early 2011 and under a grant agreement with the CEC and U.S. DOE, SANBAG signed a contract with Ryder that incorporated all grant requirements and started working together to comply and achieve the goals and objectives of the grant. SANBAG, as the prime recipient, and Ryder as the sub-recipient purchased 202 CNG/LNG fuel trucks (Figure 1) that meet the specifications of the grant. The cost for the conversion of 159 trucks was paid for by the CEC and the remaining balance of the 43 trucks were paid by the U.S. DOE.

Once the trucks were purchased and registered with the Department of Motor Vehicles, Ryder started securing leases in mid-2011 with their customers and started deploying the majority the trucks. Lease agreements of the CNG/LNG trucks have increased from 69 trucks in June of 2011 to 185 in early 2013. SANBAG and Ryder have been working together throughout the deployment to track a number of elements on a monthly basis, which included items such as; miles run, fuel usage, conditions of the trucks, new customers and estimated emissions reduced by the 202 natural gas trucks. Ryder customers have driven more than 8.5 million miles with an estimated 1.4 million gallons of natural gas that replaced more than 1.6 million gallons of annual diesel fuel according to the data collected by Ryder. This reduced millions of pounds of toxic emissions and eliminated tons of diesel particulate.

For the construction phase of the grant, Ryder entered into construction agreements with contractors, subcontractors and vendors to construct the infrastructure of two publically-accessible CNG/LNG fuel stations in the City of Orange and the City of Fontana. The two natural gas fueling stations will not only fuel Ryder trucks, but other fleets outside of Ryder as well. In addition, each of the stations has a public access component which provides CNG fueling dispensers to the public. The combination of services offered at both sites decreases toxic emissions and serves as a model to outside commercial heavy-duty trucking companies. In addition, as part of the project, Ryder improved their Rancho Dominquez maintenance facility to better serve their LNG trucks.

As of August 10, 2013, the Project Team has completed the construction at the City of Orange natural gas fueling station site, and Ryder is actively using the station to fuel their natural gas trucks. The City of Orange natural gas fueling station site will became 100 percent operational and open to the public at the end of June 2013. The construction of the CNG/LNG fueling station in the City of Fontana (Figure 2) is now complete and become open to the public in late June 2013. A ribbon cutting ceremony took place on July 10, 2013.

The two publically-accessible CNG/LNG fueling stations in the City of Orange and the City of Fontana are conveniently located in assisting with the fueling of Ryder CNG/LNG trucks and accessible to other major heavy-duty natural gas commercial fleets as well. SANBAG and Ryder will continue to work with its various partners, governmental and private, throughout the region to market and publicize this alternative fuel project, the natural gas fueling stations, and raising the overall awareness to the benefits and success of this project.

Figure 1: Ryder CNG truck

Source: SANBAG

Figure 2: CNG Tank at the Fontana Fuel Station

Source: SANBAG

CHAPTER 2: Findings, Conclusions, and Recommendations

The deployment of 202 heavy-duty CNG and LNG-fueled vehicles through the SANBAG Alternative Fuel Truck Project was very successful from both an environmental benefit and technology advancement perspective. This project validated the use of natural gas as a cost-effective fuel option in the commercial trucking industry, and the experience gained from this project will most certainly expand the use of alternative fuels within the trucking industry.

In terms of environmental benefits and petroleum displacement, this project displaced in excess of 1.4 million gallons of diesel fuel, replacing it with cleaner burning, lower-carbon content methane (natural gas). This corresponds to a reduction in GHG pollutants of nearly 3,000 US tons, and more than three US tons of ozone precursor emissions over the project's demonstration period.

The use of natural gas in heavy-duty trucking operations was shown to be technically feasible in terms of vehicle performance, operability, and reliability. Programmatically, the lower cost of natural gas as compared to diesel fuel helped offset anticipated fuel economy penalties, resulting in natural gas achieving economic parity with conventional fuel for the majority of participating fleets.

Any large-scale deployment of advanced technology vehicles will encounter some degree of technical challenges, especially during the initial deployment phase. Issues were encountered that presented technical and programmatic challenges, requiring the attention of and resolution by the project stakeholders. Thus, an additional beneficial outcome of this project is a wealth of practical "lessons learned" that will benefit alternative fuel engine and chassis manufacturers, fleet operators, and infrastructure providers as natural gas gains greater acceptance in the trucking industry.

The following sections will discuss in detail the findings, conclusions, and recommendations resulting from the demonstration of CNG and LNG fuels in commercial trucking applications. Quantitative data will be cited to the extent available; in cases where quantitative data is not available, e.g., driver acceptance, a qualitative discussion will be presented. This section also includes a quantification of the project benefits in terms of petroleum displacement, reduction in criteria air pollutants, and reductions in GHG resulting from the use of cleaner burning, lower-carbon natural gas fuel.

Findings

Overall, the deployment of 202 heavy-duty natural gas-fueled trucks in truck leasing operations was very successful both from a technical perspective as well as a commercial business model. This fact is borne out from the results of the project – more than 8.7 million revenue miles accrued and 1.4 million gallons of diesel fuel displaced by compressed and liquefied natural gas fuels.

As this project had as its focus the demonstration of both state-of-the-art and advanced technology alternative fuel engines, it was deemed important by the project stakeholders to document any and all technical issues encountered during the demonstration period. Thus, this section will also discuss technical issues encountered, their causes to the extent known, as well as the issue resolution.

Key findings of the SANBAG CNG/LNG Alternative Fuel Truck Project include the following:

- Fleet operator and driver acceptance of natural gas-fueled heavy-duty trucks was high. In general, Ryder project managers reported that the vast majority of truck lessees were happy with the performance of the Freightliner Cummins Westport ISL G equipped trucks;
- While fleet operator and driver acceptance was generally high, the use of natural gas as an alternative to diesel in heavy-duty trucking applications tends to be confined to “niches” within the trucking industry, as opposed to broad-based acceptance. This was especially true for the Westport 14.9 liter GX LNG engine-equipped trucks;
- CNG trucks were significantly easier to deploy into leasing arrangements as compared to the LNG trucks. This is primarily due to the limited availability of convenient LNG refueling facilities;
- Additional engineering development is necessary to optimize natural gas engine and fuel systems into existing heavy-duty truck platforms. This was most notable for the Freightliner Model M2 112 chassis equipped with the Cummins Westport ISL G 8.9 liter engine, which experienced multiple exhaust manifold and piston failures traceable to inadequate engine cooling and potentially incompatible truck axle ratios;
- Fuel penalties associated with natural gas were higher than anticipated. The Peterbilt Model 386 trucks, equipped with the Westport 14.9 liter high pressure direct injection LNG engine, demonstrated an approximately 8.5 percent fuel penalty when compared to a comparable truck equipped with the 14.9 liter Cummins ISX diesel engine; the spark ignited 8.9 liter Cummins Westport ISL G equipped trucks demonstrated an approximately 15 percent fuel penalty when compared to a comparable diesel truck;
- Economically, the CNG 8.9 liter ISL G equipped trucks were able to demonstrate operating costs at or below those of a comparable diesel truck in most of the participating fleets. The Peterbilt GX-equipped trucks, however, have an operating cost breakeven point at approximately 80,000 annually.

Vehicle Performance

As an element of Task 3, Truck Data Reporting, the SANBAG project team collected quantitative and qualitative data relative to the performance of the CNG and LNG heavy-duty trucks in revenue service. Quantitative data is reported in Chapter 4 of this Final Report entitled “Truck Data Report”.

Data collected included, but was not limited to, miles accrued, fuel consumed, operator perceptions of vehicle performance and operability, and information pertaining to vehicle reliability, durability, and maintainability. Performance findings for the Freightliner M2112, equipped with the Cummins ISL G 8.9 liter natural gas engine, and Peterbilt 386, equipped with the Westport GX 14.9 liter high-pressure direct injection engine are discussed in the following sections.

Freightliner M2 112

Of the project's 202 deployed trucks, 182 were the Freightliner M2112 heavy-duty vehicles equipped with the Cummins Westport ISL G spark-ignited natural gas engine. Of these, 167 of the ISL G equipped trucks were configured to operate on CNG, and 15 configured to operate on liquefied natural gas.

Ryder assisted SANBAG in data collection and reporting. The following information is specific to the ISL G equipped Freightliner trucks.

General Performance and Fuel Economy

Overall, the ISL G-equipped Freightliner M2 112 trucks performed very well in revenue service. According to Ryder, the CNG configuration was easier to place in a lease agreement as compared to the LNG configuration. Ryder cited fleet concerns regarding the availability of convenient LNG refueling stations, as well as the cost premium associated with LNG as compared to CNG.

In most cases, the Cummins Westport ISL G offered adequate torque and power for the participating fleet operators. Average demonstrated fuel economy was recorded for each vehicle configuration as follows:

- Cummins Westport ISL G (CNG): 6.33 MPG
- Cummins Westport ISL G (LNG): 6.28 MPG

The majority of participating fleet operators deemed the ISL G's fuel economy acceptable; however, it was noted by Ryder that overall fuel economy was lower than expected. At the start of the project, it was anticipated that the overall reduction in fuel economy for the spark-ignited ISL G as compared to a comparable diesel truck would be on the order of nine percent. The consensus of the participating fleet operators was that fuel economy of the ISL G was at least 15 percent lower compared to their diesel fleet vehicles, with some fleets reporting a fuel penalty of 20 percent.

From a scientific perspective, the fuel penalty data cannot be independently validated given that reporting is based primarily on the fleet operator's perception as opposed to rigorous testing using a comparable diesel control vehicle. Nonetheless, the perception of the participating fleets is important as it relates to the future commercial viability and expansion of natural gas as a fuel for the heavy-duty trucking industry.

Freightliner M2 112 Reliability, Durability, and Maintainability

The majority of ISL G equipped Freightliner trucks operated required only scheduled maintenance and performed nominally in revenue service. However, specific failures within a subset of Freightliner trucks that suggest a design re-evaluation may be warranted. These component failures included the following:

- Fuel line failures – the fuel system that supplies natural gas is manufactured by an aftermarket original equipment manufacturer. Ryder experienced failures in the natural gas fuel delivery system that necessitated removal and replacement of a fuel line. This was handled under the vehicle's existing warranty, and the work was performed by either Ryder maintenance technicians or in some cases by the fuel delivery system manufacturer;

- Engine exhaust manifold cracking – multiple occurrences of exhaust manifold cracking were experienced on the Freightliner Cummins ISL G-equipped trucks;
- Piston cracks – multiple occurrences of cracked engine pistons were recorded during the demonstration period.

In all cases, Ryder technicians or Cummins-certified subcontractors repaired the failed engine or fuel system components. A failure modes and effects analysis (FMEA) is outside the scope of this demonstration project; however, Ryder suggested that the chassis manufacturer assess the axle ratio used in the Freightliner chassis. According to Ryder, the current axle ratio may be too high, as Ryder stated that the Freightliner trucks demonstrated in this project tended to operate at a higher than expected revolutions per minute (RPM) and higher coolant temperature. Thus, while not scientifically proven, there is anecdotal evidence that higher engine RPM and temperatures may lead to premature component failure. It should be noted that these failures were not representative of the majority of Freightliner vehicles deployed in this project.

With respect to vehicle maintenance, Ryder instituted a comprehensive natural gas vehicle inspection and maintenance program.

Peterbilt 386

Twenty (20) Peterbilt 386 model trucks were deployed and equipped with the Westport GX 14.9 liter high pressure direct inject (HPDI) engine. All Peterbilt trucks used LNG fuel.

Overall, this engine performed well engine in revenue service. However, according to Ryder, this truck configuration proved more difficult to place into a lease arrangement as compared to the smaller ISL G Freightliner truck. The reasons cited by Ryder that influenced customer acceptance of the 14.9-liter-equipped truck include the following:

- Longer wheelbase – the physical size of the vehicle hampered efforts to lease the vehicle to trucking firms that operated in local delivery service applications. The vehicle was less maneuverable in urban settings and more suited for over-the-road trucking applications.
- Increased tare weight – Ryder estimated that the GX-equipped LNG Peterbilt truck had an un-laden weight on the order of 1,500 pounds greater than a diesel-fueled truck that could accomplish the same trucking duty-cycle. This was due to the higher weight of the large displacement engine, and the added weight of the LNG Dewar tanks (double-walled vacuum-jacketed liquid cryogenic tanks). This vehicle weight penalty impacted the payload carrying capacity of the truck, which in turn impacted the operating costs. More than one fleet that initially leased the Peterbilt truck decided to modify their lease agreement and return the vehicle early, opting instead for the smaller Freightliner/Cummins Westport ISL G 8.9 liter configuration.
- Incremental cost of LNG compared to CNG – while both states of natural gas retailed at an equivalent gallon cost less than diesel, trucking firms were sensitive to the appearance that LNG carried a price premium as compared to CNG.

- An important factor that hampered LNG truck leasing was the perceived scarcity of accessible LNG refueling infrastructure. Although several commercial LNG refueling stations have been constructed in the greater Southern California area, fleets expressed concerns related to reduced vehicle routing flexibility; i.e., that the utility of their fleet could be reduced due to the need to remain in general proximity to an LNG refueling station. In addition, fleets expressed anxiety over the possibility of having vehicles stranded in the event a critical LNG station location became inoperative on a temporary or permanent basis. CNG fuel is more widely available within Southern California, resulting in a higher "comfort level" with trucking fleets.

As a result, due to the weight of the Peterbilts and the LNG containers; the trucks cannot put in their full payload amount, as it would make the truck too heavy for California weight standards. This has decreased the popularity of the Peterbilts thus why they are not being leased in Southern California. Ryder would like to transfer the remaining un-leased Peterbilts (11 trucks) to another state that does not have the same restrictive weight limits as in California.

Ryder is a supporter of this program, and has already purchased a number of additional CNG trucks that operate in California as a result of this project and the response from their customers.

Because once the trucks leave the California border, they will no longer be considered part of this program, Ryder would like to purchase additional trucks to "replace" the incremental costs of these Peterbilt trucks. These newly purchased trucks will be added to the U.S. DOE/CEC inventory and be tracked per the grant agreements.

General Performance and Fuel Economy

The LNG-fueled Peterbilt trucks that were placed into a lease arrangement performed well in revenue service, accruing in excess of 413,000 miles during the project period of performance. Average fuel economy for the HPDI-equipped trucks was recorded as follows:

- Peterbilt 386 equipped with Westport GX HPDI (LNG) 7.57 MPG

Due to the business area focus of the trucking companies that leased the Peterbilt 386, the above fuel economy figure corresponds to a truck duty cycle that is primarily "over-the-road" operation. By comparison, the Freightliner/ISL G trucks operated in various duty cycles, from local delivery routes to longer haul trucking operations.

That said, the efficiency of the HPDI GX engine was demonstrated to be measurably higher as compared to the spark-ignited ISL G natural gas engine. The fuel economy penalty assigned to the GX was estimated to be approximately 8.5 percent, whereas fleets reported average fuel economy penalties associated with the natural gas ISL G of approximately 15 percent. Again, these values cannot be compared directly in a precise manner, as the duty cycle was not identical in all cases and a diesel control vehicle was not utilized in all participating fleets.

Freightliner M2 112 Reliability, Durability, and Maintainability

As stated above, the GX-equipped Peterbilt trucks performed well in revenue service. However, one technical issue was reported on multiple occasions, prompting Ryder technicians to investigate the issue. The failure mode experienced is related to the trucks electrical system, specifically an uncharacteristically high drain on the vehicle's primary battery. In some cases, trucks that were not used for a relatively short period, on the order of a few days, would experience excessive battery drain. The battery's state of charge would be too low to engage the starter, necessitating an external battery jump to start the vehicle.

As of this Final Report, Ryder has not yet conclusively determined the cause of the excessive battery drain. However, preliminary results of an investigation by Ryder technicians point to the vehicle's onboard methane detection system (MDS), which remains operating at all times in an LNG-fueled vehicle. It is possible that the onboard MDS is subjecting the vehicle's electrical system to too high a load, resulting in excessive battery power consumption.

Fleet Operator and Driver Acceptance of Alternative Fuels

An important finding of this project was the generally high acceptance of alternative fuels by the fleet owners and drivers who participated in the demonstration program. According to Ryder, the vast majority of Freightliner ISL G operators were very satisfied with the performance, operability, and drivability of the vehicle as compared to a comparable diesel fuel truck. As stated previously, CNG-fueled trucks overall had greater acceptance compared to the LNG vehicles due to concerns regarding accessible LNG refueling infrastructure.

AS discussed in this Final Report, the Peterbilt 386 class 8 trucks equipped with the Westport GX LNG engine was more difficult to place into a lease arrangement. Once leased, retention of the GX-equipped truck was considerably lower as compared to the smaller CNG-fueled Freightliner M2 112.

Economic Considerations

The future viability of alternative fuels such as natural gas will be determined in large part by the actual and perceived cost implications of transitioning fleet operations away from conventional diesel fuel. The following sections discuss the findings of this project as they pertain to vehicle operations costs.

Operations Costs – Freightliner M2 112 with Cummins Westport ISL G

For the majority of participating fleets, the ISL G equipped Freightliner trucks offered operating costs that were equal to, or more favorable than, a comparable diesel-fuel vehicle. This is primarily due to: 1) the higher vehicle capital cost being offset by the funding subsidy; and 2) the lower retail cost of natural gas as compared to diesel fuel.

The fuel cost savings benefit was partially offset by the lower efficiency of the spark-ignited natural gas engine as compared to a conventional compression ignition heavy-duty diesel engine. As previously stated, fleets reported an average fuel penalty for the ISL G of approximately 15 percent as compared to a comparable diesel fuel truck. The substantially lower cost of natural gas, however, more than mitigated the effect of the fuel penalty/lower efficiency, yielding a net operations cost benefit for natural gas as compared to diesel.

The net operations cost benefit was greater for CNG as compared to LNG, as the retail cost of a diesel gallon equivalent (DGE) of LNG is higher as compared to a DGE of CNG.

It is important to note, however, that operations costs in the longer term will be a function of vehicle maintenance costs and overall life expectancy in addition to fuel costs. In most cases, maintenance of the natural gas trucks (both CNG and LNG) tended to be higher as compared to conventional diesel trucks due to the more complex fuel delivery systems associated with natural gas.

Also, component failures that did occur on the demonstration vehicles were covered under manufacture warranties and did not directly impact the operations costs, with the exception that the vehicles was temporarily removed from revenue service.

Assuming the natural gas truck can perform with nominal scheduled maintenance, it is probable that a fleet could structure a business case utilizing alternative fuel trucks that did not receive an acquisition cost subsidy. This assumes that the higher incremental cost of the natural gas truck can be amortized over the expected useful life of the vehicle, and that the cost of natural gas remains low relative to diesel fuel.

While not an element of this project, life cycle cost considerations will also affect the future viability of alternative fuels in heavy-duty commercial trucking operations. Factor that will impact the overall life cycle cost of the vehicle include the durability and life expectancy of the natural gas engine and fuel system. Thus, Ryder's continuing commitment to offer alternative fuel vehicles as an option to fleet customers will afford the opportunity to gather data on the long-term durability of natural gas vehicles in heavy-duty trucking applications.

Operations Costs – Peterbilt 386 equipped with Westport GX

Within the context of current conditions, the Peterbilt 386 trucks equipped with the Westport GX engine are not expected to demonstrate a positive operating cost benefit under normal lease terms. This is attributed to the following factors:

- High incremental cost of the Westport GX equipped vehicle relative to the conventional diesel truck.
- Payload capacity penalty of the LNG Peterbilt 386 relative to a conventional diesel tractor capable of performing the same duty cycle, estimated at approximately 1,500 pounds;
- Fuel penalty for the natural gas GX engine as compared to diesel, estimated to be approximately 8.5 percent – this tends to erode the benefit of the lower-cost LNG fuel as compared to diesel.

Ryder calculated the GX-equipped Peterbilt 386 operations cost "breakeven point" at approximately 80,000 miles – fleets that operate greater than 80,000 miles per truck per year would realize a net operations cost benefit, whereas fleets that accrue less than 80,000 miles per year would expect higher operations costs.

As a result of this assessment, Ryder does not believe the GX equipped Peterbilt 386 will be attractive to fleet operators in the near term unless subsidies are in place to offset a portion of the higher vehicle acquisition cost. In the longer term, the cost equation may change as LNG technology matures and economies of scale are realized that lower the incremental cost compared to conventional diesel technology. Thus, a recommendation of this project is to continue to implement research and development programs that have the potential to drive down costs associated with alternative fuel technologies, specifically heavy-duty alternative fuel engines.

Air Quality & Petroleum Displacement Benefits 2.1.5.1 Petroleum Displacement

The SANBAG Alternative Fuel Truck Project established a goal of displacing 1.4 million gallons of petroleum-derived fuel during the project's period of performance. As of March 1, 2013, the project displaced in excess of 1.4 million gallons of petroleum diesel, exceeding the established project goal. The replacement fuel was cleaner-burning natural gas, in the following quantities:

- Compressed Natural Gas: 1,177,200 DGE
- Liquefied Natural Gas: 182,360 DGE

Air Quality Benefits Assessment

This Section documents the results of an air quality assessment pertaining to the operation of 201 heavy-duty natural gas trucks leased by Ryder.

The report assesses the net air quality impact for two classes of vehicle exhaust air pollutants:

- Criteria Air Pollutants regulated by the California Air Resources Board in accordance with the Clean Air Act/National Ambient Air Quality Standards;
- GHG emissions proposed for regulation under the California Global Warming Solutions Act (AB 32).

Vehicle Description

The 201 heavy-duty trucks1 assessed fall into two vehicle categories:

- Class 8 truck tractors manufactured by Peterbilt Motors Company. These vehicles are equipped with model year 2011 14.9 liter Cummins engines equipped with the Westport Fuel Systems bi-fuel high pressure-direct injection CNG/diesel fuel system. This engine is designated engine model code GX and is certified by the California Air Resources Board (CARB) in accordance with CARB emission standards Executive Order A-343-0007. A total of 20 vehicles offered by Ryder Truck Leasing are equipped with the model GX engine;
- Class 8 truck tractors manufactured by Freightliner Trucks. These vehicles are equipped with model year 2011 8.9-liter Cummins ISL G dedicated natural gas engines. This engine is certified by CARB emission standards in accordance with Executive Order A-021-0537. A total of 182 vehicles offered by Ryder Truck Leasing are equipped with the ISL G engine. As noted, 181 of the Freightliner trucks accrued revenue miles during the project period of performance.

Emissions Reduction Quantification - Technical Approach

The assessment of net vehicle exhaust emissions impacts resulting from the deployment of natural gas engine trucks in lieu of conventional diesel-fueled trucks was conducted in two separate analyses – one for the quantification of exhaust emissions impacts for criteria air pollutants, and the second for the impact on GHG emissions. This approach is required because different emissions models and methodologies are used when quantifying criteria air pollutants versus GHG emissions.

The overall technical approach approved by CARB and the United States Environmental Protection Agency (U.S. EPA) for the quantification of criteria and GHG emissions compares the exhaust pollutants of a baseline, diesel-fueled class 8 heavy-duty vehicle against emissions produced by the natural gas-fueled vehicle.

To ensure an accurate comparison, the approved methodologies require that the baseline and natural gas vehicles undergoing evaluation:

- Be of the same vehicle weight rating (i.e., Class 8);
- Utilize a similar displacement engine of the same year of manufacture;
- To the extent feasible, use the same engine model, wherein the only difference is fuel type;
- To the extent feasible, utilize exhaust emission factors derived from CARB or U.S. EPA source documents.

In conducting the emissions analyses documented in this Report, the exact comparable baseline engine was used as the basis of comparison, i.e. the model year 2011 dedicated natural gas Cummins ISL G engine was compared directly to the 2011 Cummins ISL G diesel engine. The same approach applies to the 14.9-liter engines – the Westport GX was compared against its direct engine counterpart, the Cummins diesel ISX engine.

Emissions Reduction Quantification - Models and Methodologies

As the State regulatory authority for mobile source emissions, CARB develops, publishes, and maintains models and methodologies for quantifying criteria air pollutant emissions from motor vehicles. Several models are available to conduct emissions assessments; two models are recommended by CARB for the quantification of emissions from heavy-duty vehicles; these are described briefly below:

- Methods to Find the Cost-Effectiveness of Air Quality Projects – this modeling tool was developed by CARB and the California Department of Transportation (Caltrans) and is the recommended model for quantifying criteria pollutant emissions for projects that use motor vehicle registration fees or are funded under the Federal Congestion Mitigation/Air Quality (CMAQ) Program[2].

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2 The Cost-Effectiveness Analysis Tool can be downloaded from the CARB website. (http://www.arb.ca.gov/planning/tsaq/eval/eval.htm)

- Carl Moyer Air Quality Standards Attainment Program – this modeling guideline is specific to heavy-duty vehicles and is required for use when evaluating projects funded under the State's Carl Moyer Program as well as other state incentive programs[3].

It is important to note that for the SANBAG Alternative Fuel Truck evaluation, both methodologies cited above yield the same quantified results. This is because each model uses the same input factors, algorithms, and scalar values. In each case, the criteria pollutant emission factors are derived from the CARB Executive Orders.

The quantification of mobile source GHG Emissions utilizes methodologies recommended by the U.S. EPA. Specifically, U.S. EPA's Motor Vehicle Emissions Simulator and related models provide emission factors for mobile source evaluation[4]. A second source is the Greenhouse Gases, Regulated Emissions, and Energy use it Transportation (GREET) model developed by U.S. DOE Argonne National Laboratory and used extensively by state and federal regulatory agencies, most notably the US Department of Transportation.

Again, for the purpose of the SANBAG Alternative Fuel Truck assessment, the GHG emission factors derived from each of the above sources are comparable, as they are based primarily on the carbon content of each fuel.

Criteria Air Pollutants of Importance in the South Coast Air Quality Management District

The geographic region under the regulatory authority of the South Coast Air Quality Management District (SCAQMD) is designed by the U.S. EPA as "extreme nonattainment" for ozone. Ozone (O3), the primary component of air pollution commonly known as "smog", is formed by a photochemical reaction of hydrocarbons, oxides of nitrogen (NO, N2O, NO2), and sunlight. Oxides of Nitrogen (NOx) are the primary ozone precursor emissions, and approximately 70 percent of all NOx emissions are emitted by mobile sources – automobiles, trucks, buses, etc. The combustion of diesel fuel is a significant source of NOx emissions in the SCAQMD; reducing the use of diesel fuel is thus a primary air quality improvement strategy and is strongly promoted by the AQMD.

In lieu of diesel fuel, the SCAQMD promotes the use of natural gas as a fuel substitute, especially for on-road heavy-duty vehicle applications. Natural gas, which is comprised of methane (CH4), typically yields lower NOx combustion emissions as compared to diesel fuel. Other criteria pollutants, including hydrocarbon, carbon monoxide, and particulate matter, are in most cases equivalent between natural gas and diesel fuels. Diesel particulate matter is classified by CARB as a toxic air contaminant; however, model year 2010 and newer on-road diesel engine incorporate exhaust treatment devices that significantly reduce the amount of particulate matter emitted in the vehicles exhaust stream. Thus, when comparing exhaust

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3 The Carl Moyer guidelines and emissions modeling methodologies can be obtained from the CARB website. (http://www.arb.ca.gov/msprog/moyer/guidelines/current.htm)

4 U.S. EPA's Motor Vehicle Emissions Simulator and related models can be obtained online. (http://www.epa.gov/otaq/models.htm)

emissions between natural gas and diesel-fueled engines, the pollutant that differs most significantly, and is of greatest significance to the SCAQMD, is NOx emissions.

Because of this emphasis on reducing NOx emissions, this report will focus the criteria pollutant evaluation on the relative NOx emissions of the Ryder natural gas truck fleet as compared to a comparable, diesel-fueled Ryder class 8 heavy-duty trucks.

Emission Reduction Assessments – Criteria Air Pollutants

Peterbilt Class 8 Tractor Equipped with Westport Fuel Systems GX 14.9L Natural Gas Engine.

Twenty (20) Peterbilt class 8 trucks are equipped with the Westport Fuel Systems GX 14.9L Natural Gas Engine. This engine is certified by CARB emission standards under Executive Order A-343-0007 at a NOx emissions level of 0.13 grams per brake-horsepower-hour.

The comparable diesel-fueled engine is the Cummins™ ISX 14.9L engine, certified by CARB emission standards under Executive Order A-021-0542; the diesel version of the 14.9L engine has a NOx certification level of 0.25 grams per brake-horsepower-hour.

For the purpose of quantifying NOx emissions using the CARB model, the following additional input data was provided by Ryder:

- **Total mileage accrued during demonstration period: 413,190 miles**

The CARB model calculates NOx emissions as a function of the emission factor and annual vehicle miles traveled. The CARB emissions model converts “grams per brake-horsepower-hour” to “grams per mile” using a conversion factor whose units are brake-horsepower-hour/mile. This conversion factor is calculated using the following data inputs:

- Brake-specific fuel consumption;
- Fuel density;
- Average Fuel economy.

The conversion factor used in the CARB emissions model for an on-road class 8 truck with a gross vehicle weight (GVW) greater than 33,000 lbs. is 2.9 brake-horsepower-hour/mile.

The algorithm used in the CARB model is as follows:

{(number of vehicles) x [(diesel NOx emission factor) – (natural gas NOx emission factor)] x (conversion factor) x (annual miles accrued)} / 907,200 grams/ton.

For the twenty 14.9 liter trucks, the total NOx reduction attributable to the use of natural gas as opposed to diesel fuel is 0.16 ton during the project period of performance.

Freightliner Class 8 Tractor Equipped with Cummins ISL G 8.9L Natural Gas Engine

181 Freightliner trucks are equipped with the Cummins ISL G 8.9L Natural Gas Engine. This engine is certified by CARB emission standards under Executive Order A-021-0537 at a NOx emissions level of 0.13 grams per brake-horsepower-hour (grams per brake-horsepower-hour).

The comparable diesel-fueled engine is the Cummins ISL diesel engine, certified by CARB emission standards under Executive Order A-021-0554. The diesel version of the ISL engine has a NOx certification level of 0.24 grams per brake-horsepower-hour.

For the purpose of quantifying NOx emissions using the CARB model, the following additional input data was provided by Ryder:

- **Total mileage accrued during demonstration period: 8,258,620 miles**

The conversion factor used in the CARB emissions model for an on-road class 8 truck with a gross vehicle weight rating (GVWR) greater than 33,000 lbs. is 2.9 brake-horsepower-hour/mile.

For the 181 8.9 liter trucks, the annual NOx reduction attributable to the use of natural gas as opposed to diesel fuel is 2.90 tons during the demonstration period of performance.

Emission Reduction Assessments – Greenhouse Gases

Peterbilt Class 8 Tractor Equipped with Westport Fuel Systems GX 14.9L Natural Gas Engine

GHG emissions are calculated using a ‘fuel based” analysis where GHG emissions are expressed in units of equivalent carbon dioxide emissions (CO2E). GHG emissions include carbon dioxide (CO2), methane (CH4), and nitrous oxide (N20), plus traces of fluorocarbon gases emitted from vehicle air conditioning systems.

Based upon data received from Ryder, the Peterbilt trucks consumed 54,600 diesel equivalent gallons of fuel during the demonstration period. The CO2E emission factor for diesel fuel is approximately 28 pounds per gallon. This equates to approximately 760 tons of CO2E emissions.

GHG emissions resulting from natural gas are typically lower due to the lower carbon content of methane as compared to diesel fuel. For the purpose of estimating GHG emissions from natural gas, the annual amount of natural gas used in a Ryder truck is first converted to “diesel equivalent gallons” on an energy content basis. On an energy equivalency basis, the CO2E content of natural gas is approximately 24 pounds per diesel equivalent gallon. 54,600 equivalent gallons of natural gas equates to approximately 640 tons of CO2E emissions per year for the natural gas class 8 tractor. The difference in CO2E emissions for the natural gas truck as compared to the diesel truck is 761.77 – 644.13 = ~118 tons.

Freightliner Class 8 Tractor Equipped with Cummins Westport ISL G 8.9L Natural Gas Engine

The quantification of GHG emissions for the Freightliner ISL-equipped trucks is similar to the calculations described above. According to Ryder, the Freightliner trucks displaced 1,305,000 gallons of diesel fuel. Applying the methodology described above, the CO2E reduction attributable to the use of natural gas as opposed to diesel fuel in the 181 Freightliner trucks is approximately 2,800 tons.

The following Table summarizes the results of the SANBAG Alternative Fuel Truck Project evaluation as it relates to reductions in criteria air pollutant emissions (NOx) and GHG emissions. For the purpose of this report, GHG emissions are shown in terms of carbon dioxide equivalent, or CO2E. GHG emitted from internal combustion engines are typically comprised of carbon dioxide (CO2), methane (CH4), and nitrous oxide (N20), plus traces of fluorocarbon gases emitted from vehicle air conditioning systems. As shown in Table 2.1, the SANBAG project resulted in significant reductions in both ozone precursor emissions as well as GHG emissions.

Table 2.1-1: Emission Reductions Attributable to the SANBAG Alternative Fuel Truck Project

Criteria Pollutant (NOx)	Diesel Fuel NOx Emissions (US Tons)	Natural Gas NOx Emissions (US Tons)	Net Reduction in NOx Emissions (US Tons)
Peterbilt GX 14.9 Liter (20 Trucks)	0.3	0.2	0.2
Freightliner ISL G 8.9 Liter (181 Trucks)	6.3	3.4	2.9
Greenhouse Gases (CO2E)	Diesel Fuel CO2E Emissions (US Tons)	Natural Gas CO2E Emissions (US Tons)	Net Reduction in CO2E Emissions (US Tons)
Peterbilt 14.9 Liter (20 Trucks)	762.8	644.1	117.6
Freightliner 8.9 Liter (181 Trucks)	18,209.1	15,397.1	2,812.0

Source: SANBAG

Table 2.1-2: Total Emission Reductions Achieved During Project Period of Performance

Total reduction in NOx Emissions (US Tons)	Total Reduction in CO2E Emissions (US Tons)
3.1	2,929.6

Source: SANBAG

Conclusions

This project demonstrated the technical feasibility of using natural gas, both in a compressed and liquefied state, as an alternative to diesel in commercial truck operations. From a technical standpoint the following can be concluded:

- The use of natural gas as a motor vehicle fuel for heavy-duty trucks is an effective strategy to reduce both criteria air pollutants and GHG. During the demonstration period, this project resulted in the displacement of over 1.4 million gallons of petroleum derived diesel fuel, reduced GHG emissions by over 2,600 metric tons, and reduced ozone precursor emissions by over three tons.
- Fleet operator and driver acceptance of the natural gas trucks was very high. According to Ryder, the majority of customers who operate the Freightliner ISL G equipped truck were “very happy” with the vehicle’s performance and operability. While overall customer satisfaction was lower for the Peterbilt GX LNG truck, specific “niche” fleets are currently operating the Peterbilt 386 LNG truck with much success.

- That commercial operators of truck fleets are willing to try an alternative fuel, in this case natural gas, as an alternative to conventional diesel fuel. The findings of this project indicate that while the natural gas technology did offer slightly less efficiency and performance, natural gas engines offer sufficient performance and drivability compared to diesel. Thus, natural gas technology has reached a state of maturity that it can compete directly against diesel in the marketplace.
- LNG trucks were significantly more difficult to place into a lease arrangement as compared to CNG trucks. This is due in part to the perception that insufficient LNG refueling infrastructure exists to ensure fuel availability when needed. The higher incremental cost of LNG as compared to CNG was also a factor in the fuel selection decision.
- The Peterbilt 386 proved too large and too expensive for most participating fleets and was difficult to place into a lease agreement. The size, specifically wheelbase, and weight of the truck was not conducive to local delivery operations. These factors also influenced the economics of placing this vehicle into revenue service.
- Additional refinement of engine/chassis integration appears warranted. Although limited in the number of occurrences, failures of exhaust manifolds and pistons suggest possible thermal issues associated with the engine's integration into an existing chassis configuration. As noted, Ryder believes the Freightliner axle ratio is not optimized for the Cummins Westport ISL G engine – the axle ratio is too high, which results in higher than typical engine RPM and higher than expected engine operating temperatures.

Programmatically, the following conclusions can be reached based upon the findings of this demonstration project:

- In the current economic environment, CNG competes well against conventional diesel fuel for commercial applications where operating cost heavily influence vehicle selection. This is due largely to the current low cost of CNG as compared to diesel.
- The acquisition cost of a heavy-duty truck equipped with a natural gas vehicle carries a price premium as compared to conventional diesel engine-equipped truck. This is due to the cost of the CNG and LNG specialty components, such as fuel storage pressure vessels (CNG tanks and cryogenic Dewars), as well as the costs associated with third party original equipment manufacturers (OEMs) that design, integrate, and install the natural gas refueling systems. Due to the relative low production rates of advanced technology natural gas heavy-duty vehicles, the economies of scale associated with conventional diesel technologies are not present. As a result, subsidies to partially buy-down the capital cost of a heavy-duty CNG truck may still needed in specific trucking industries and applications to make natural gas economically viable.
- The Westport GX–equipped trucks currently require purchase subsidies to allow the vehicle to compete with a comparable diesel-fueled truck. This is due to the relatively high cost of the Westport GX LNG engine. In this project, it was calculated that the economic breakeven point for the Peterbilt GX-equipped truck was approximately 80,000 miles, which exceeds the annual mileage accrued by most commercial trucking fleets that lease vehicles. That said, participating fleets that selected the GX-equipped truck continue to report a positive experience, despite not meeting the 80,000 annual mileage threshold.

Recommendations

It is the opinion of SANBAG that this project was highly successful in demonstrating the technical and programmatic feasibility of CNG and LNG in the commercial truck leasing industry. The diversity in participating fleet composition, including trucking firm size, industry application, duty cycle requirements, etc., yielded a wealth of real-world data that can be used to advance the penetration of alternative fuels into heavy-duty truck applications.

To further advance the use of low-emission fuels such as natural gas in commercial trucking industries, SANBAG recommends the following:

- Continue to fund technology advancement projects that offer the potential to increase alternative fuel engine efficiency and durability. The advanced high-pressure direct injection fuel delivery system used in the Westport GX was shown to be effective in reducing the fuel penalty typically associated with gaseous fuels such as methane. Further refinement and advancement of alternative fuel engine technologies will help alternative fuels achieve performance parity with conventional fuels, further improving industry acceptance.
- Encourage truck chassis OEMs to continue alternative fuel engine and fuel system design and development, leading to more optimized integration of alternative fuel systems into a truck platform.
- Continue to offer funding incentives to partially buy-down the higher capital cost of heavy-duty alternative fuel trucks, especially in trucking industries where the use of alternative fuels has not been widely demonstrated.
- Due to the weight of the Peterbilts and the LNG containers; the trucks cannot put in their full payload amount, as it would make the truck too heavy for California weight standards. This has decreased the popularity of the Peterbilts thus why they are not being leased in Southern California. Ryder would like to transfer the remaining un-leased Peterbilts (11 trucks) to another state that does not have the same restrictive weight limits as in California. Ryder shall purchase the equal amount of trucks to the incremental costs put in by the CEC and U.S. DOE.
- Encourage and support the construction of publicly accessible alternative fuel infrastructure, including CNG and LNG refueling stations in locations that are convenient and accessible to commercial truck operators. A robust network of CNG and LNG refueling stations will eliminate actual or perceived barriers to the use of natural gas as a heavy-duty motor vehicle fuel.

CHAPTER 3: Grant Recipient Future Intent

Maintaining of the Project

SANBAG and Ryder shall continue to monitor all 202 trucks. Ryder has a maintenance plan for each of the truck. All natural gas trucks shall be continued to be leased and monitored for performance and tracking of emissions. The project partners will also continue to monitor the use and progress of the two natural gas fueling stations located in the City of Orange and the City of Fontana, as well as the Rancho Dominquez maintenance facility created as a result of the Project.

Further development of the Project

SANBAG shall continue to search for other funding opportunities to convert heavy duty vehicles into natural gas vehicles. In the meantime, SANBAG has been successful in the start of several energy efficient programs and projects such as:

- Pursuing a natural gas demonstration project for the Freeway Service Patrol Program in San Bernardino County, with the goal to eventually replace the current diesel fleet. The Freeway Service Patrol program consists of a fleet of tow trucks that travel on selected San Bernardino County freeways during peak commute hours to assist motorists with car trouble. Freeway Service Patrol programs are extremely beneficial to the motoring public by reducing the amount of time a motorist is in an unsafe condition, reducing traffic congestion, as well as decreasing fuel consumption, vehicular emissions, and secondary incidents.
- Completion of a regional Electric Vehicle (EV) implementation strategy.
- Develop model ordinances and other policies and procedures for use by local agencies to streamline EV implementation.
- Identify CNG/LNG funding opportunities and continue to work in improving the air quality not only in the Urban Valley region of the county, but throughout the County of San Bernardino as well.
- Adopt Energy Leader Partnership Agreement with Southern California Edison and related energy conservation work plan.

Ryder intends to continue to be a leader in the safe and efficient deployment and maintenance of Natural Gas Vehicles (NGVs) through the use of the latest engine, tank and fuel delivery technologies and the continued shop expansion into new markets across the country. In addition to Ryder's existing facilities retrofitted to maintain NGVs in California, Arizona and Michigan, their latest expansions into the West Sacramento, California; Shreveport; Louisiana; and Dallas/Ft. Worth, Texas markets add additional nodes along planned cross country paths in order to expand the NGV niche by providing a maintenance network for longer haul customers. Ryder continues to see great opportunities and efficiencies that can be brought to the market through engine, tank and fuel delivery technologies development, which is one reason why Ryder works closely with companies on field tests and trial programs. Ryder also sees the potential in the current non-OEM supported dual fuel technologies. Ryder looks forward to further development and additional certifications for new vehicle installations in order for there to be Natural Gas Vehicle offerings for those customers with, what the industry has coined “range anxiety.” Ryder continues to see great value in the federal, state and local partnerships they have engaged in, including those efforts to ease the end user adoption of Natural Gas Vehicles and looks forward to continued and new relations in existing and new markets.

Advancement in Science and Technology

The SANBAG Alternative Fuel Truck Project directly supported advancement in the science and technology. Specifically, the project accomplished the following technology advancement objectives:

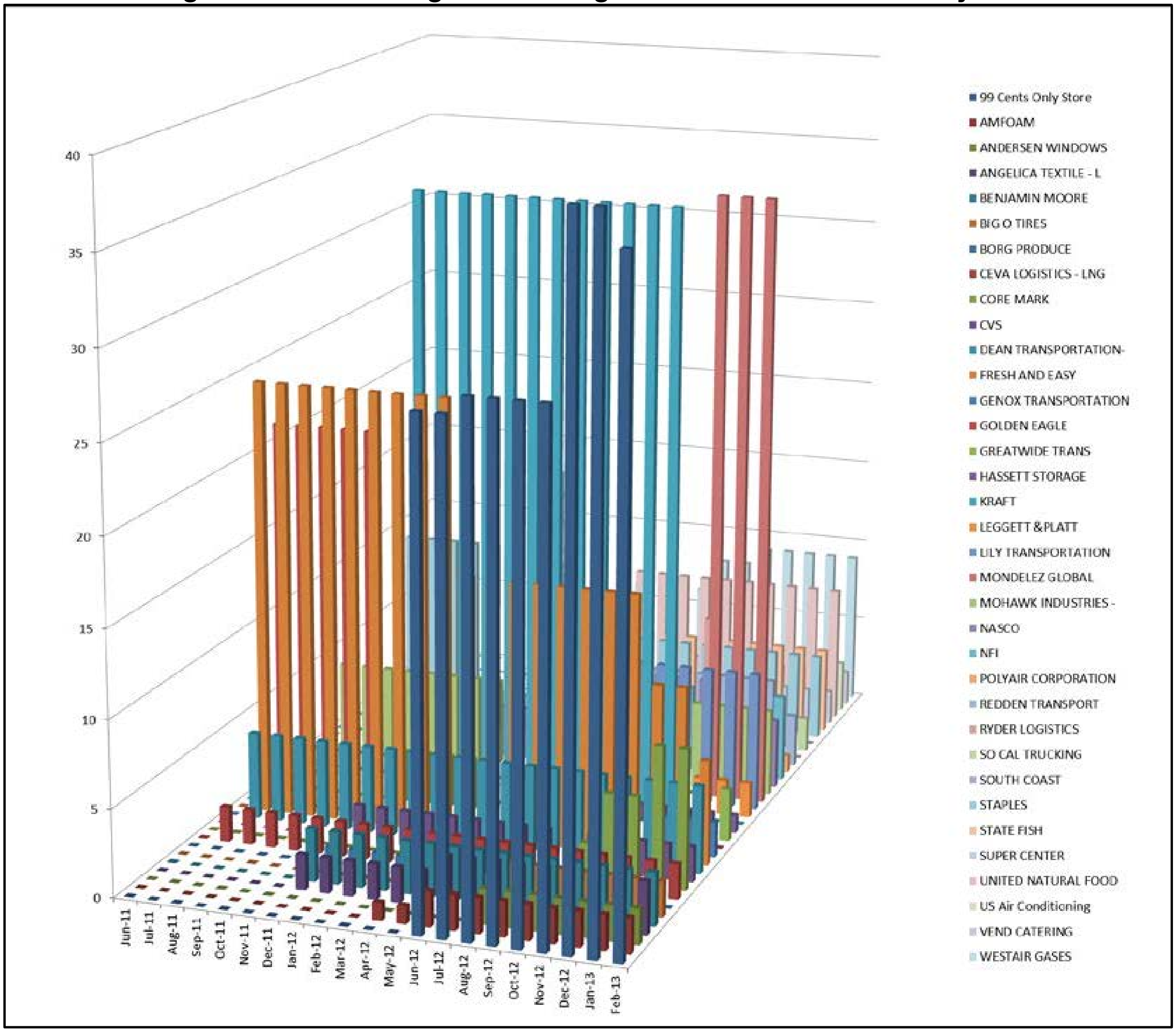
- Demonstrated in real-world commercial trucking operations the Westport high-pressure direct injection LNH engine technology. The Westport™ HPDI technology uses natural gas as the primary fuel along with a small amount of diesel as a pilot ignition source, or "liquid spark plug". Under the pressures found in the combustion chamber of a normal diesel engine, natural gas requires a higher ignition temperature than diesel. To assist with ignition, a small amount of diesel fuel is injected into the engine cylinder followed by the main natural gas fuel injection. The diesel acts as a pilot, rapidly igniting the hot combustion products, and thus the natural gas. HPDI replaces approximately 95 percent of the diesel fuel (by energy) with natural gas. The retention of the diesel compression- ignition thermodynamic cycle allows the Westport GX to achieve higher thermodynamic efficiencies as compared to an Otto cycle, or spark-ignited, natural gas engine. The HPDI engines accrued over 450,000 revenue service miles under the SANBAG demonstration project.
- Demonstrated the Cummins Westport ISL G natural gas engine in over 8.25 million revenue miles in a wide range of commercial trucking applications. This project subjected the state-of-the-art Cummins Westport ISL G to rigorous, real-world commercial trucking conditions that had previously been dominated by diesel-fueled trucks. The diversity of the participating trucking fleets allowed the natural gas technology to be demonstrated in a diverse range of operational duty cycles, ranging from short-haul, local delivery, to over-the-road driving profiles. The majority of the vehicles required only nominal scheduled maintenance. In those cases where component failures occurred, resolution of the failures afforded the opportunity to gain knowledge into engine and fuel system durability and reliability. This experience will be extremely valuable to chassis, engine, and fuel system manufacturers as they develop the next generation of alternative fuel drive systems.

CHAPTER 4:
Truck Data Report

Truck Summary Report

Figure 3 charts lease progress throughout the term of the project while Figures 4 through 23 and Tables 3 through 22 detail leases by month and year.

Figure 3: Lease Progress Throughout the Term of the Project.



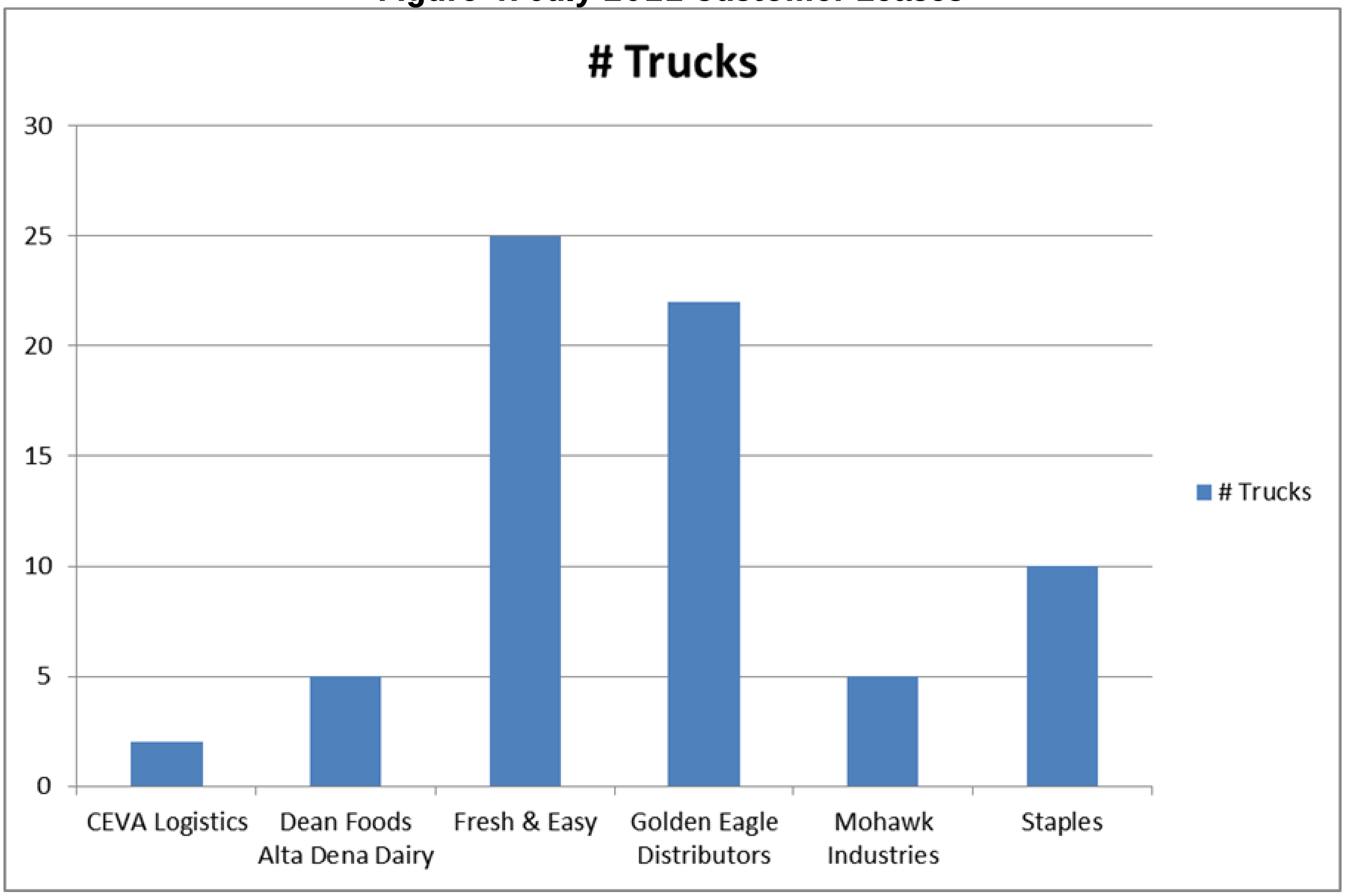
Source: SANBAG

Table 3: July 2011 Customer Leases

Company	# Trucks
CEVA Logistics	2
Dean Foods Alta Dena Dairy	5
Fresh & Easy	25
Golden Eagle Distributors	22
Mohawk Industries	5
Staples	10

Source: SANBAG

Figure 4: July 2011 Customer Leases



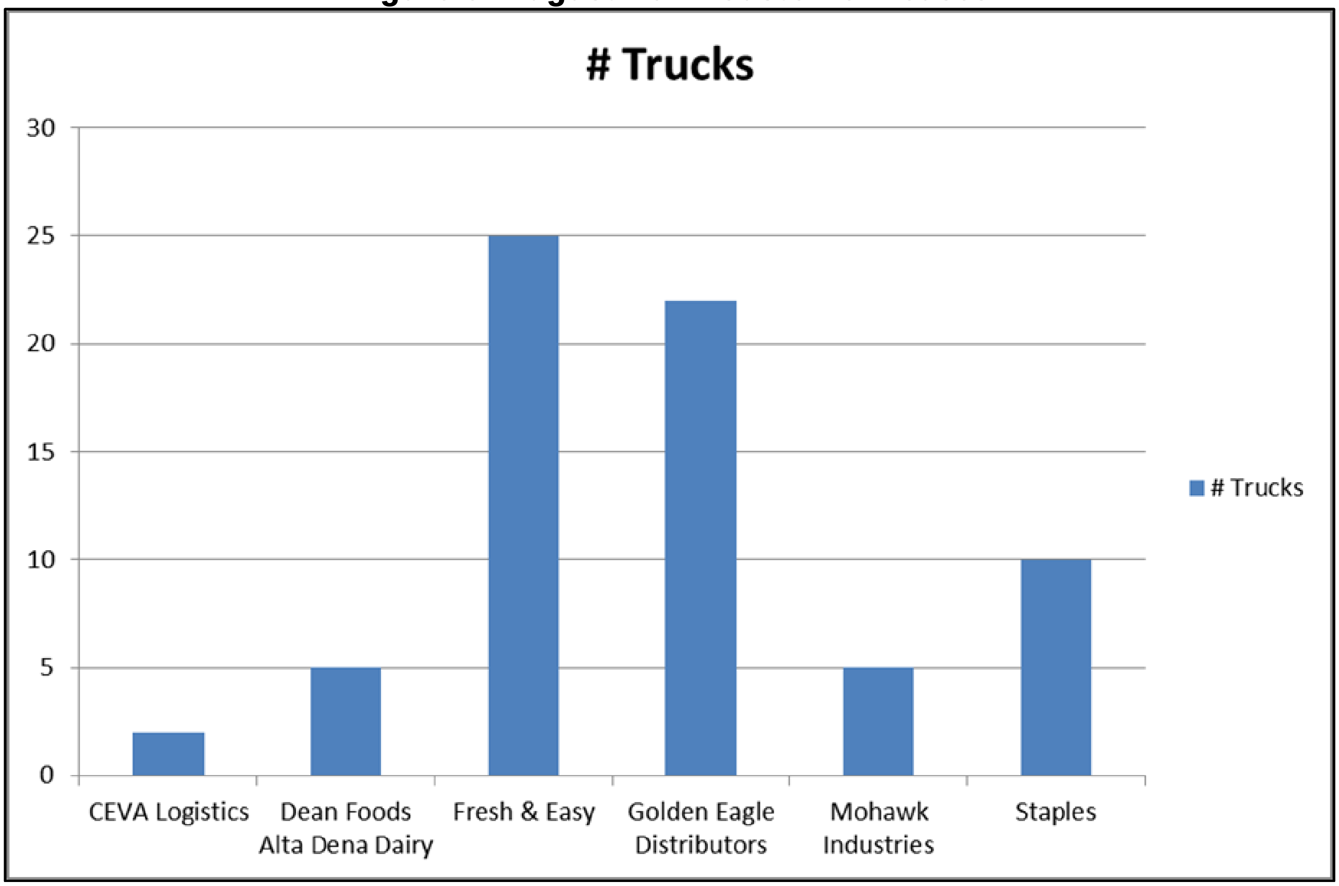
Source: SANBAG

Table 4: August 2011 Customer Leases

Company	# Trucks
CEVA Logistics	2
Dean Foods Alta Dena Dairy	5
Fresh & Easy	25
Golden Eagle Distributors	22
Mohawk Industries	5
Staples	10

Source: SANBAG

Figure 5: August 2011 Customer Leases



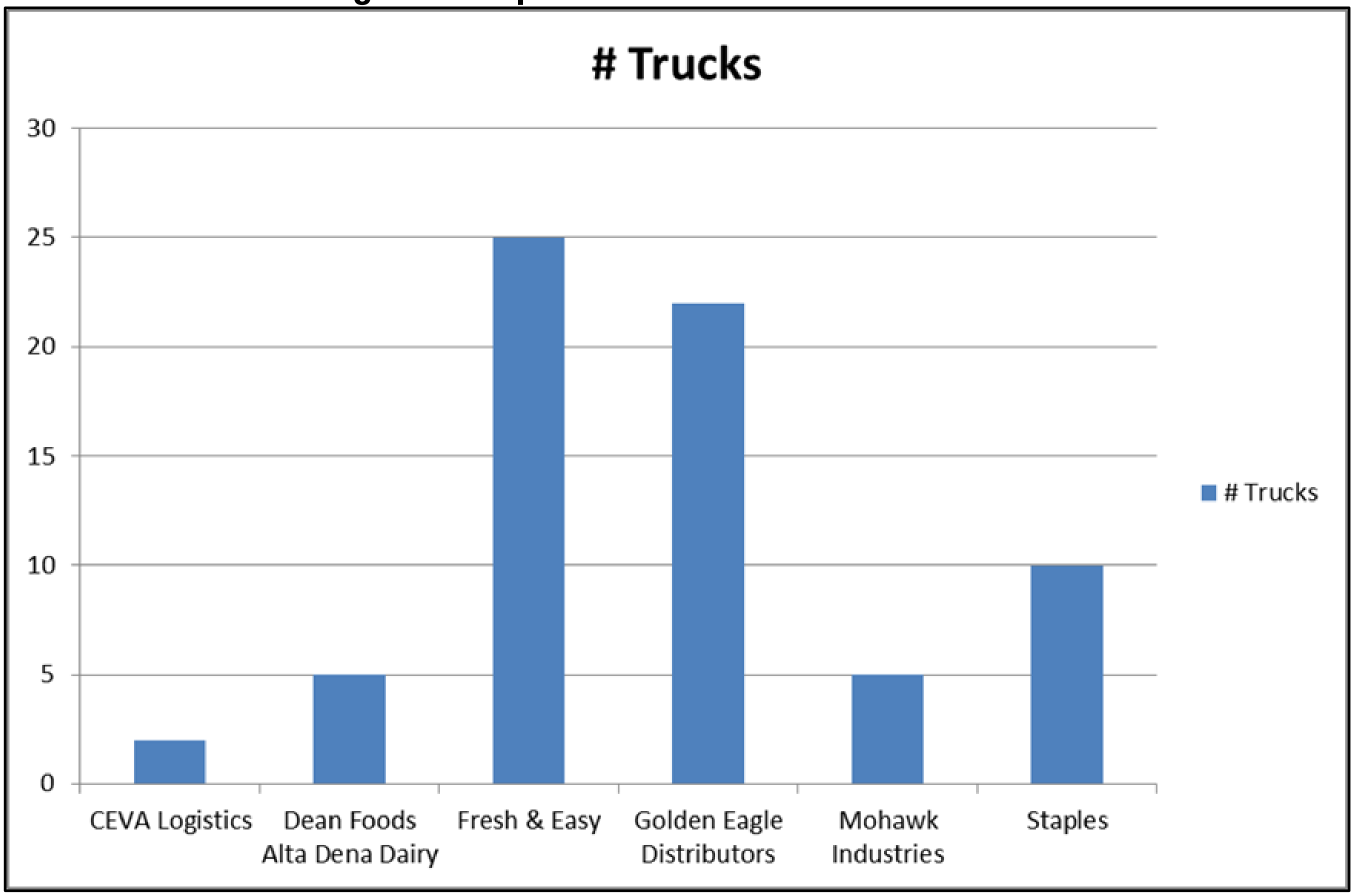
Source: SANBAG

Table 5: September 2011 Customer Leases

Company	# Trucks
CEVA Logistics	2
Dean Foods Alta Dena Dairy	5
Fresh & Easy	25
Golden Eagle Distributors	22
Mohawk Industries	5
Staples	10

Source: SANBAG

Figure 6: September 2011 Customer Leases



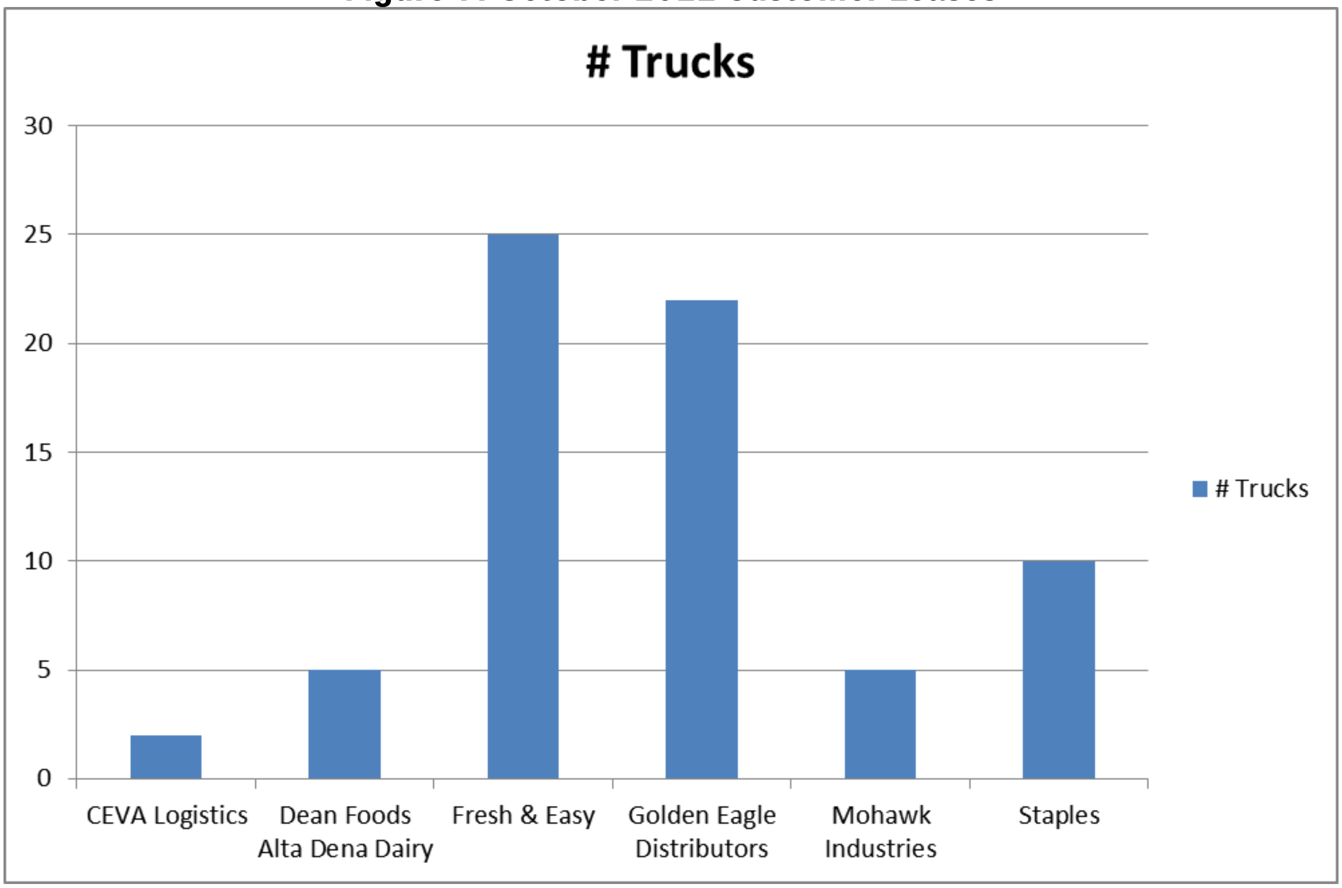
Source: SANBAG

Table 6: October 2011 Customer Leases

Company	# Trucks
CEVA Logistics	2
Dean Foods Alta Dena Dairy	5
Fresh & Easy	25
Golden Eagle Distributors	22
Mohawk Industries	5
Staples	10

Source: SANBAG

Figure 7: October 2011 Customer Leases



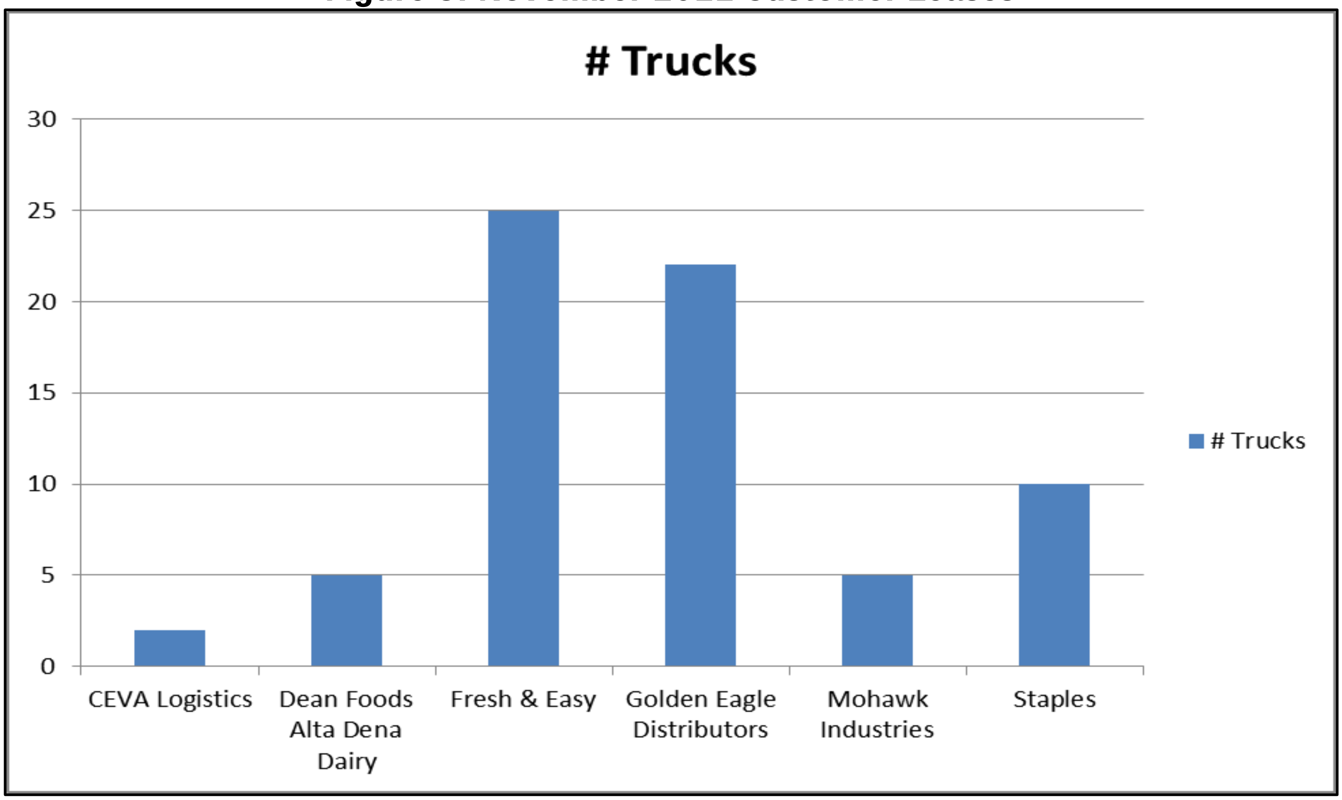
Source: SANBAG

Table 7: November 2011 Customer Leases

Company	# Trucks
CEVA Logistics	2
Dean Foods Alta Dena Dairy	5
Fresh & Easy	25
Golden Eagle Distributors	22
Mohawk Industries	5
Staples	10

Source: SANBAG

Figure 8: November 2011 Customer Leases



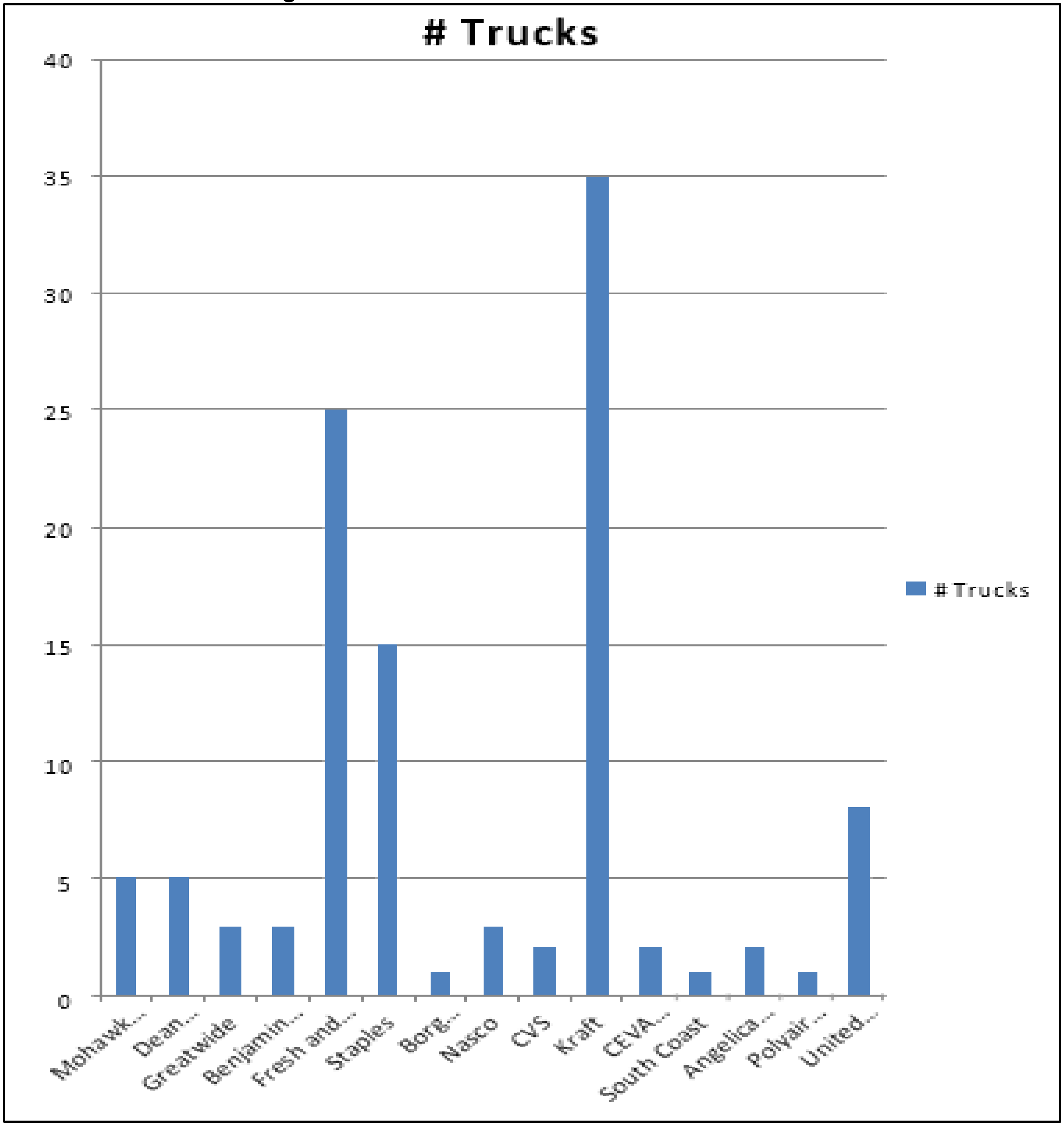
Source: SANBAG

Table 8: December 2011 Customer Leases

Company	# Trucks
Mohawk Industries	5
Dean Transportation	5
Greatwide	3
Benjamin Moore	3
Fresh and Easy	25
Staples	15
Borg Produce Sales	1
Nasco	3
CVS	2
Kraft	35
CEVA Logistics - LNG	2
South Coast	1
Angelica Textile	2
Polyair Corporation	1
United Natural Food	8

Source: SANBAG

Figure 9: December 2011 Customer Leases



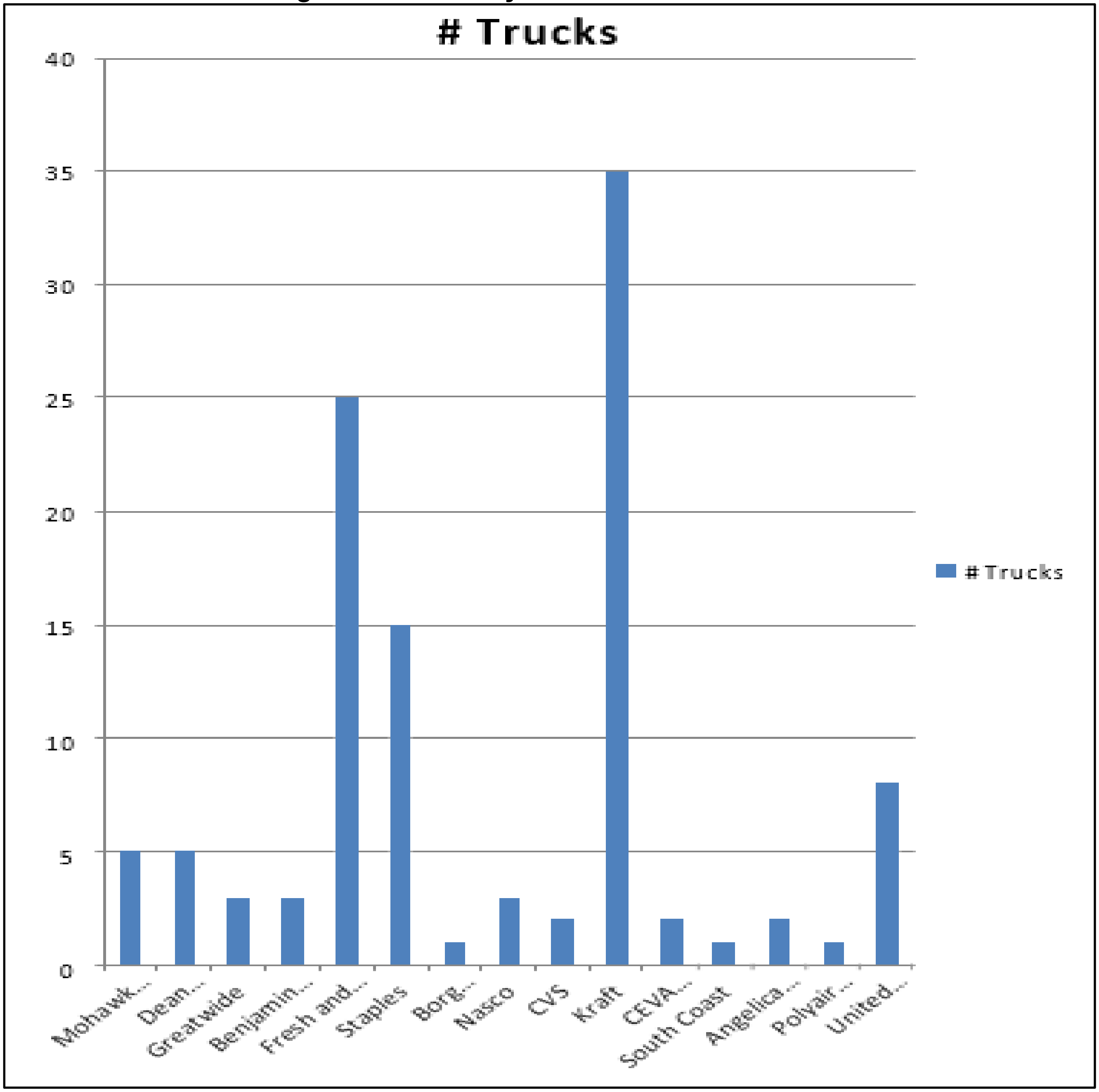
Source: SANBAG

Table 9: January 2012 Customer Leases

Company	# Trucks
Mohawk Industries	5
Dean Transportation	5
Greatwide	3
Benjamin Moore	3
Fresh and Easy	25
Staples	15
Borg Produce Sales	1
Nasco	3
CVS	2
Kraft	35
CEVA Logistics - LNG	2
South Coast	1
Angelica Textile	2
Polyair Corporation	1
United Natural Food	8

Source: SANBAG

Figure 10: January 2012 Customer Leases



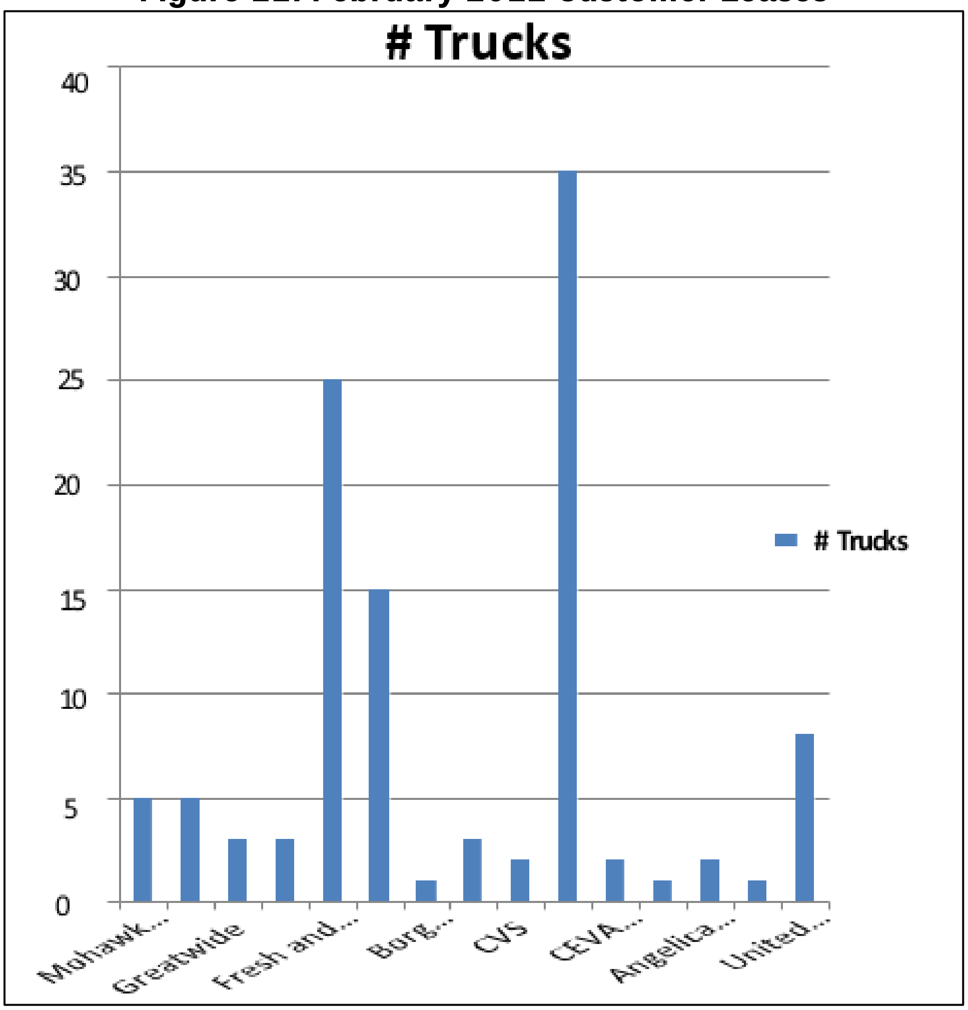
Source: SANBAG

Table 10: February 2012 Customer Leases

Company	# Trucks
Mohawk Industries	5
Dean Transportation	5
Greatwide	3
Benjamin Moore	3
Fresh and Easy	25
Staples	15
Borg Produce Sales	1
Nasco	3
CVS	2
Kraft	35
CEVA Logistics - LNG	2
South Coast	1
Angelica Textile	2
Polyair Corporation	1
United Natural Food	8

Source: SANBAG

Figure 11: February 2012 Customer Leases



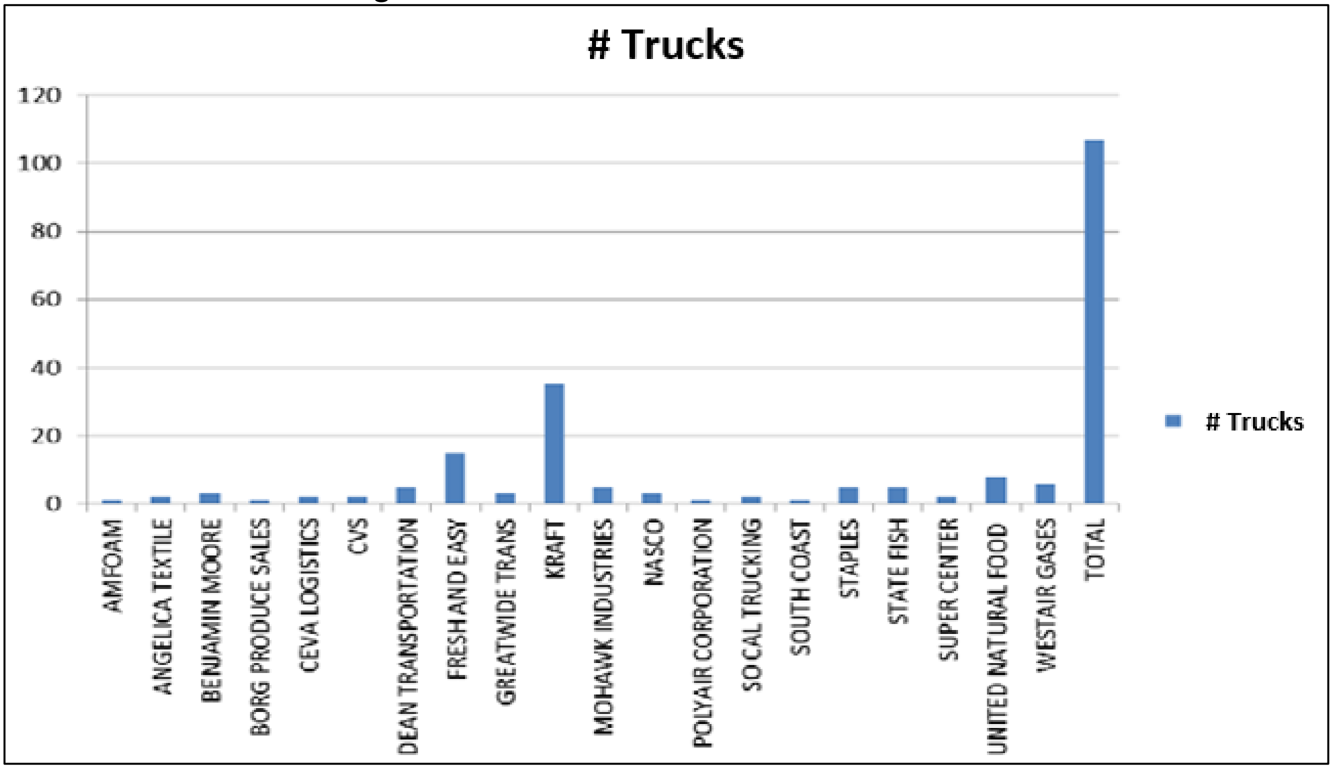
Source: SANBAG

Table 11: March 2012 Customer Leases

Company	# Trucks
AMFOAM	1
Angelica Textile	2
Benjamin Moore	3
BORG Produce Sales	1
CEVA Logistics	2
CVS	2
DEAN Transportation	5
Fresh & Easy	15
Greatwide Trans	3
Kraft	35
Mohawk Industries	5
NASCO	3
Polyair Corporation	1
SO CAL Trucking	2
South Coast	1
Staples	5
State Fish	5
Super Center	2
United Natural Food	8
Westair Gases	6

Source: SANBAG

Figure 12: March 2012 Customer Leases



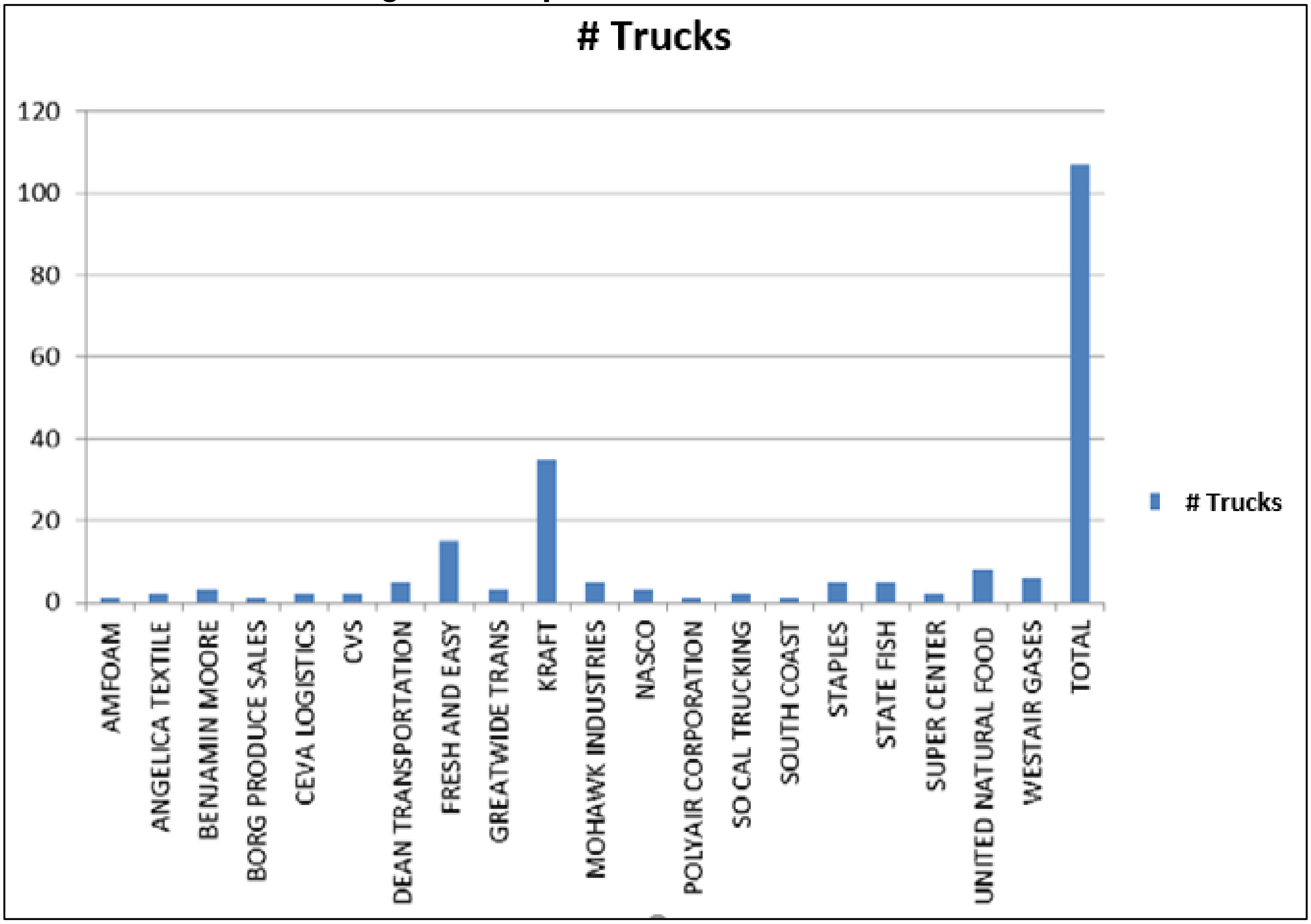
Source: SANBAG

Table 12: April 2012 Customer Leases

Company	# Trucks
AMFOAM	1
Angelica Textile	2
Benjamin Moore	3
BORG Produce Sales	1
CEVA Logistics	2
CVS	2
DEAN Transportation	5
Fresh & Easy	15
Greatwide Trans	3
Kraft	35
Mohawk Industries	5
NASCO	3
Polyair Corporation	1
SO CAL Trucking	2
South Coast	1
Staples	5
State Fish	5
Super Center	2
United Natural Food	8
Westair Gases	6

Source: SANBAG

Figure 13: April 2012 Customer Leases



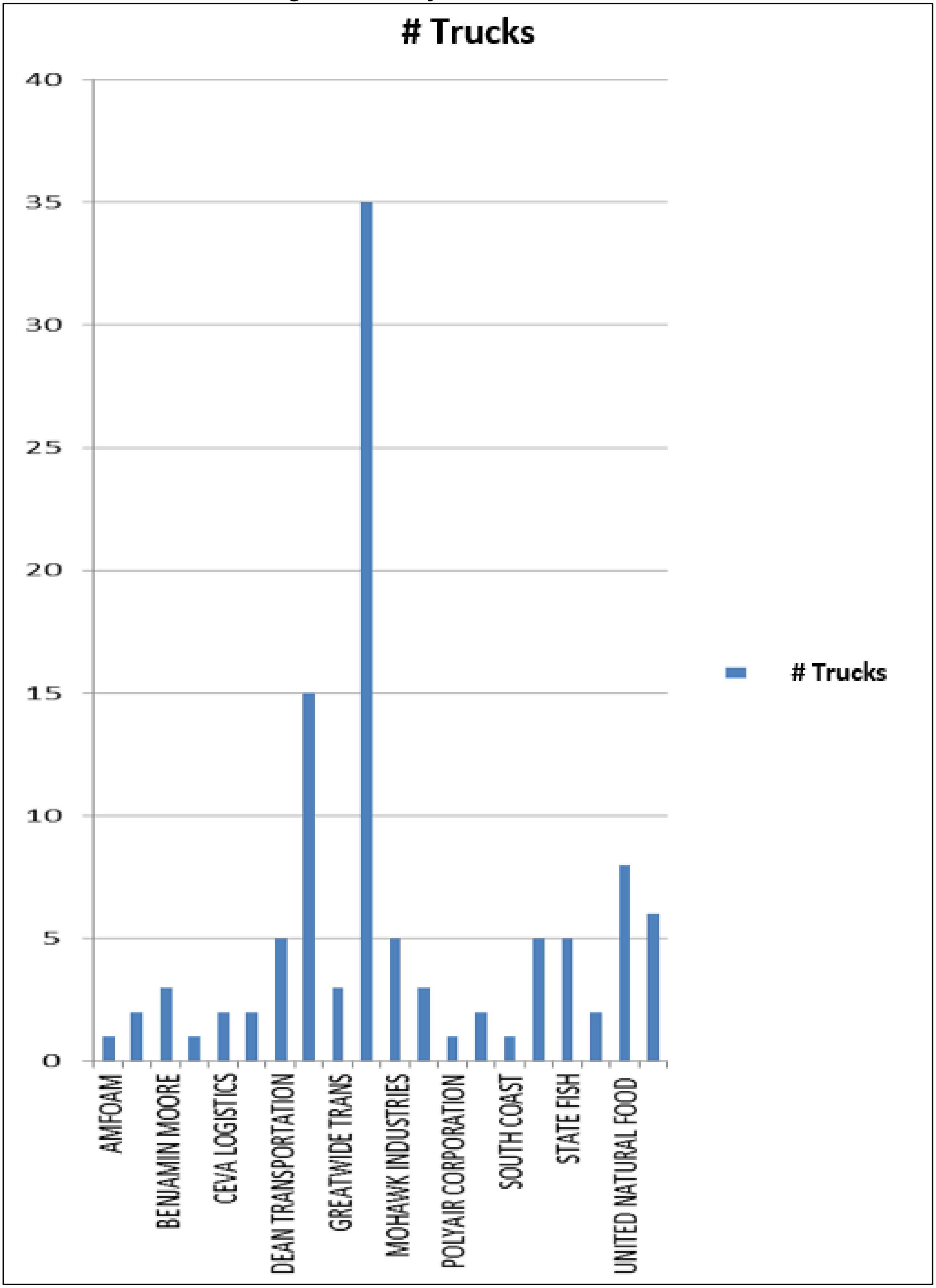
Source: SANBAG

Table 13: May 2012 Customer Leases

Company	# Trucks
AMFOAM	1
Angelica Textile	2
Benjamin Moore	3
BORG Produce Sales	1
CEVA Logistics	2
CVS	2
DEAN Transportation	5
Fresh & Easy	15
Greatwide Trans	3
Kraft	35
Mohawk Industries	5
NASCO	3
Polyair Corporation	1
SO CALTrucking	2
South Coast	1
Staples	5
State Fish	5
Super Center	2
United Natural Food	8
Westair Gases	6

Source: SANBAG

Figure 14: May 2012 Customer Leases



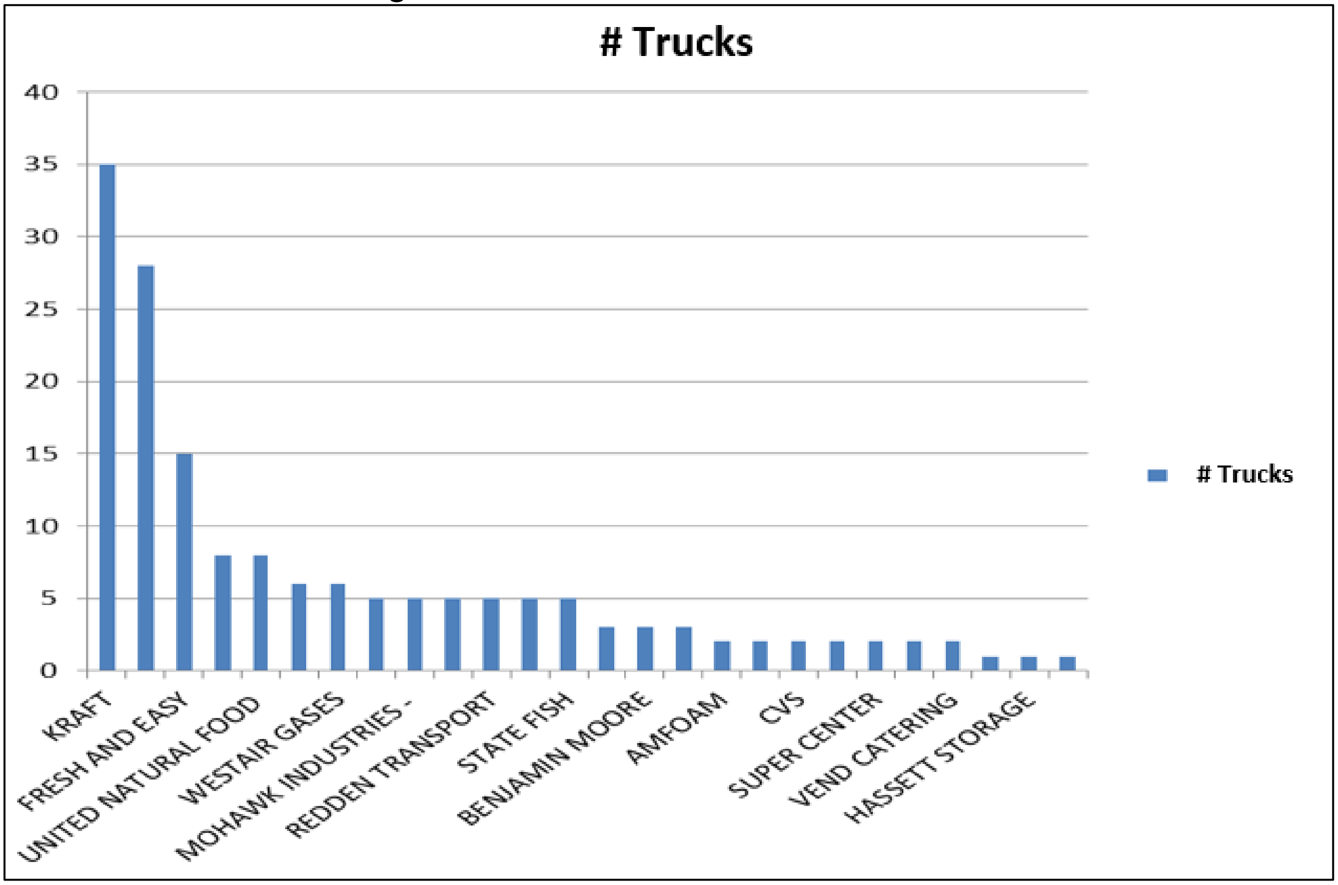
Source: SANBAG

Table 14: June 2012 Customer Leases

Company	# Trucks
Kraft	35
99 Cents Only Stores	28
Fresh & Easy	15
Lily Transportation	8
United Natural Food	8
NASCO	6
Westair Gases	6
DEAN Transportation	5
Mohawk Industries	5
NFI	5
Redden Transport	5
Staples	5
State Fish	5
Angelica Textile	3
Benjamin Moore	3
Greatwide Trans	3
AMFOAM	2
CEVA Logistics	2
CVS	2
SO CAL Trucking	2
Super Center	2
US Air Conditioning	2
Vend Catering	2
BORG Produce Sales	1
Hassett Storage	1
Polyair Corporation	1

Source: SANBAG

Figure 15: June 2012 Customer Leases



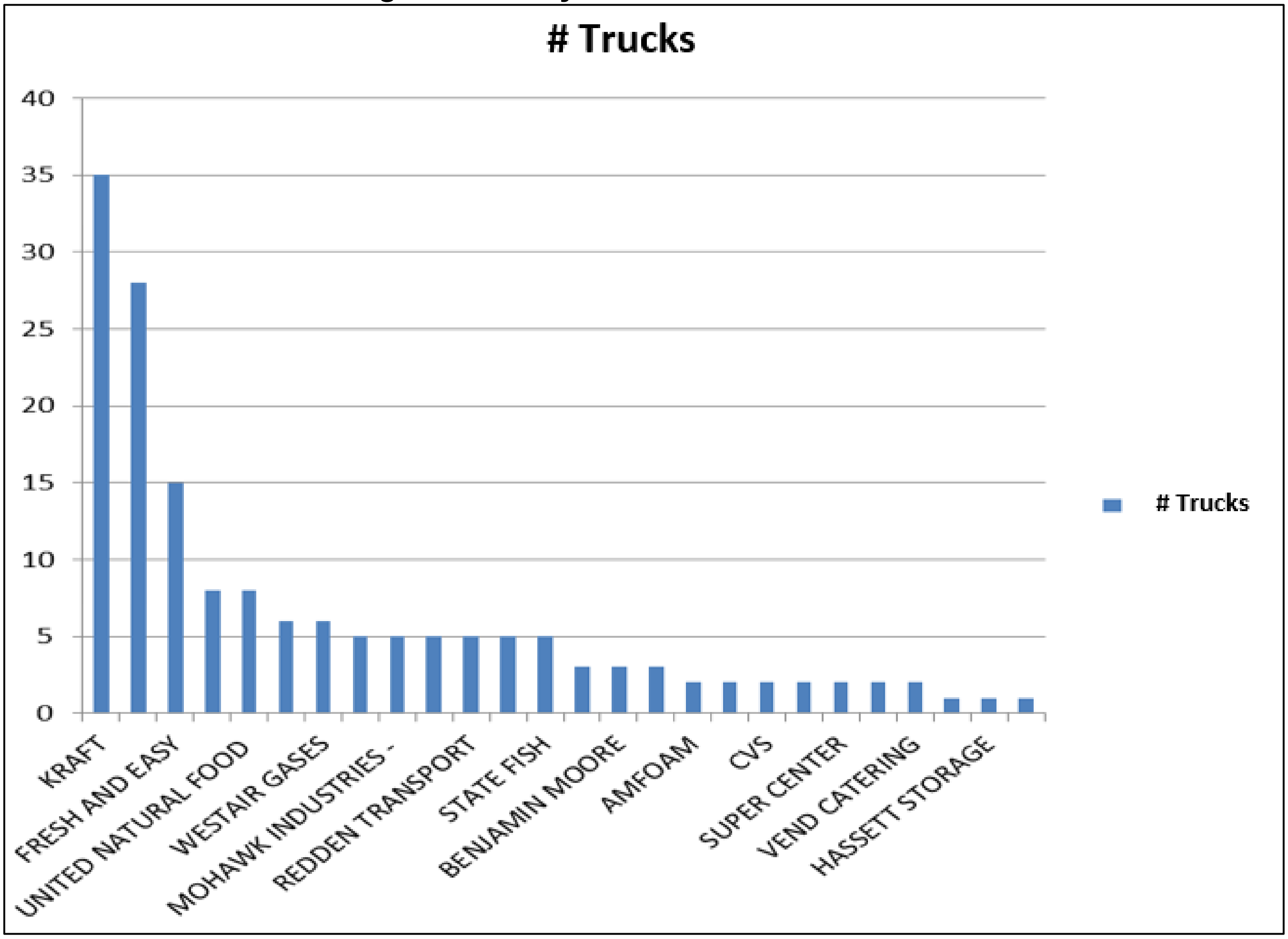
Source: SANBAG

Table 15: July 2012 Customer Leases

Company	# Trucks
Kraft	35
99 Cents Only Stores	28
Fresh & Easy	15
Lily Transportation	8
United Natural Food	8
NASCO	6
Westair Gases	6
DEAN Transportation	5
Mohawk Industries	5
NFI	5
Redden Transport	5
Staples	5
State Fish	5
Angelica Textile	3
Benjamin Moore	3
Greatwide Trans	3
AMFOAM	2
CEVA Logistics	2
CVS	2
SO CAL Trucking	2
Super Center	2
US Air Conditioning	2
Vend Catering	2
BORG Produce Sales	1
Hassett Storage	1
Polyair Corporation	1

Source: SANBAG

Figure 16: July 2012 Customer Leases



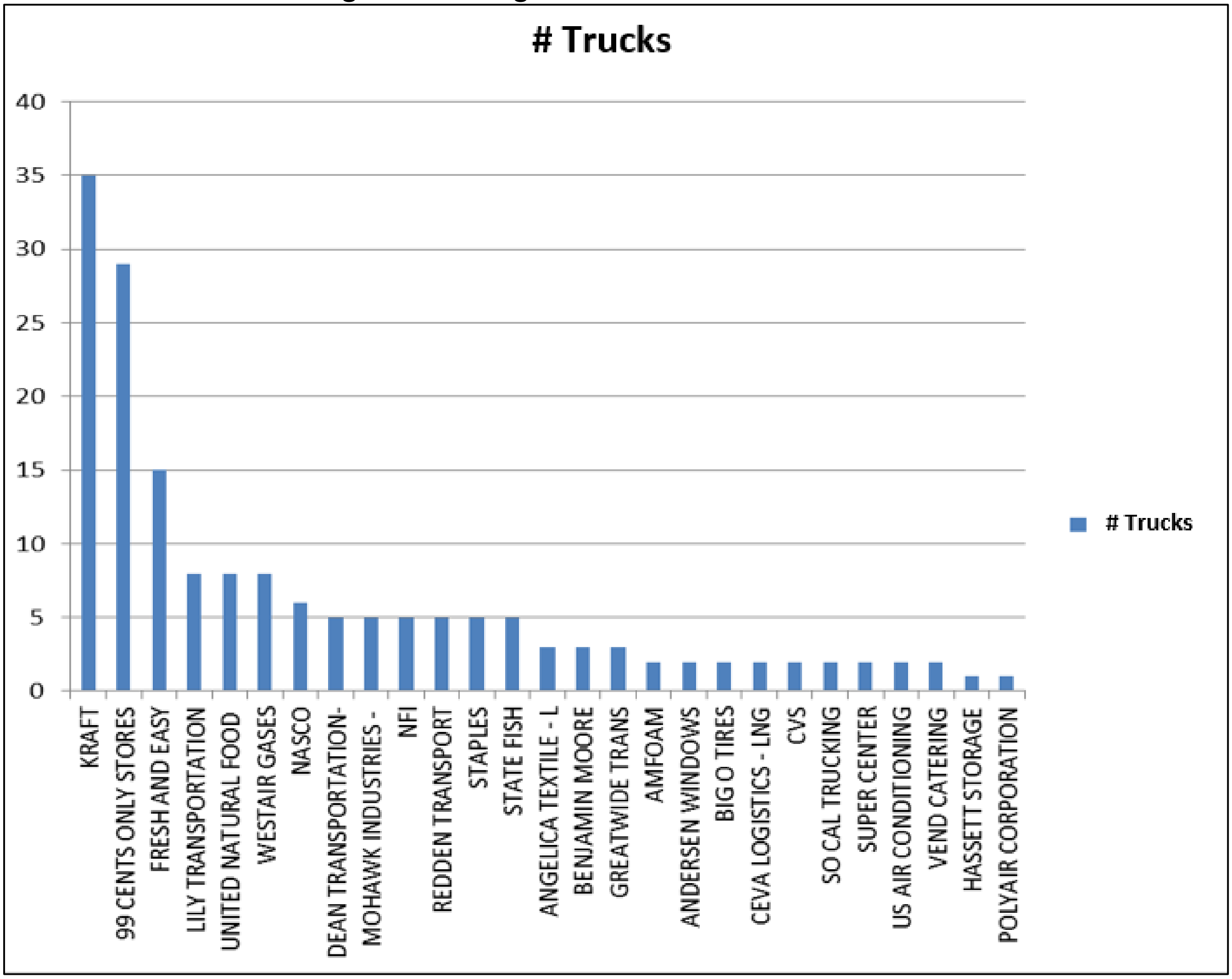
Source: SANBAG

Table 16: August 2012 Customer Leases

Company	# Trucks
Kraft	35
99 Cents Only Stores	29
Fresh & Easy	15
Lily Transportation	8
United Natural Food	8
Westair Gases	8
NASCO	6
DEAN Transportation	5
Mohawk Industries	5
NFI	5
Redden Transport	5
Staples	5
State Fish	5
Angelica Textile	3
Benjamin Moore	3
Greatwide Trans	3
AMFOAM	2
Andersen Windows	2
Big O Tires	2
CEVA Logistics	2
CVS	2
SO CAL Trucking	2
Super Center	2
US Air Conditioning	2
Vend Catering	2
Hassett Storage	1
Polyair Corporation	1

Source: SANBAG

Figure 17: August 2012 Customer Leases



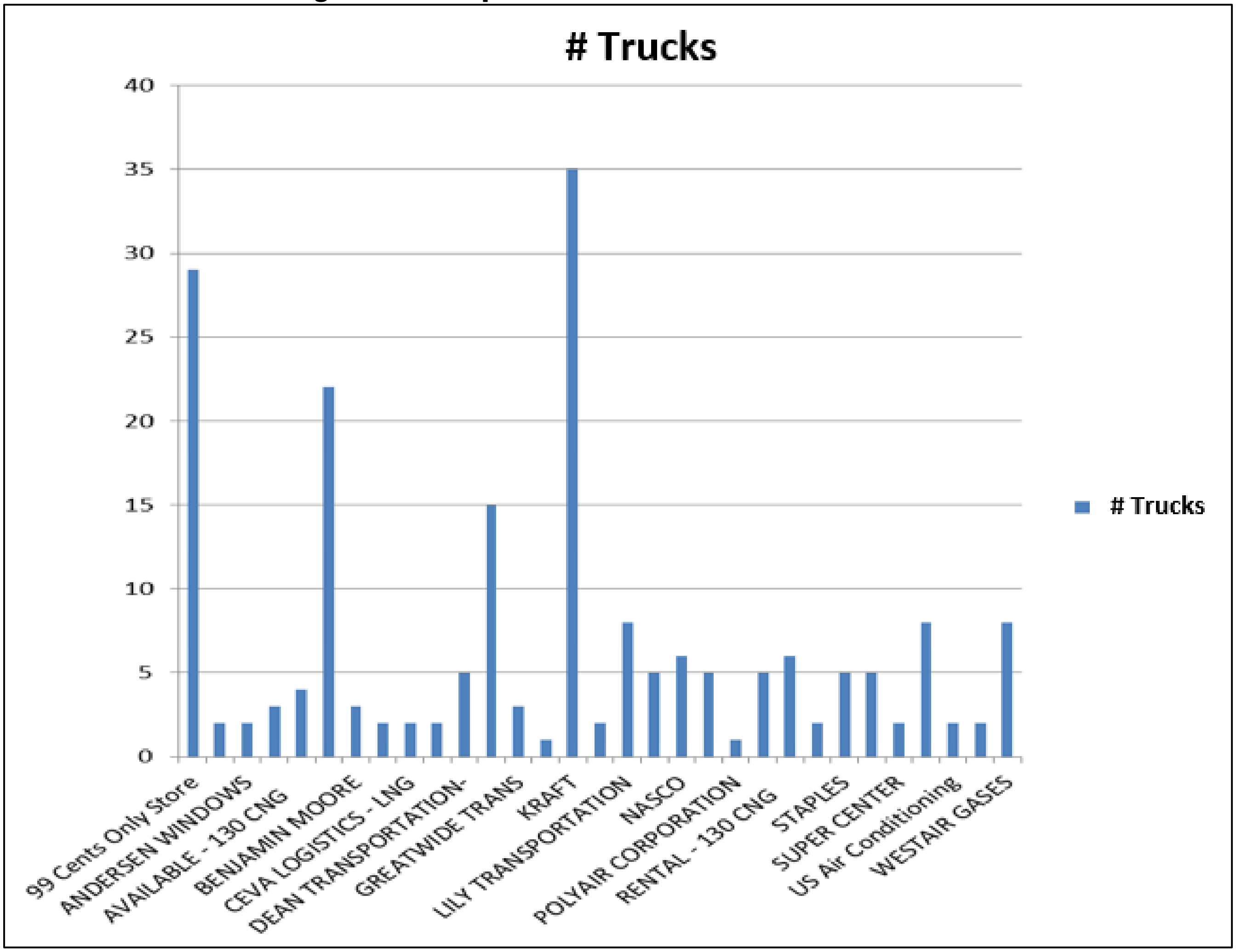
Source: SANBAG

Table 17: September 2012 Customer Leases

Company	# Trucks
99 Cents Only Store	29
AMFOAM	2
Andersen Windows	2
Angelica Textile	3
Benjamin Moore	3
Big O Tires	2
CEVA Logistics	2
CVS	2
DEAN Transportation	5
Fresh & Easy	15
Greatwide Trans	3
Hassett Storage	1
Kraft	35
Leggett & Platt	2
Lily Transportation	8
Mohawk Industries	5
NASCO	6
NFI	5
Polyair Corporation	1
Redden Transport	5
SO CAL Trucking	2
Staples	5
State Fish	5
Super Center	2
United Natural Food	8
US Air Conditioning	2
Vend Catering	2
Westair Gases	8

Source: SANBAG

Figure 18: September 2012 Customer Leases



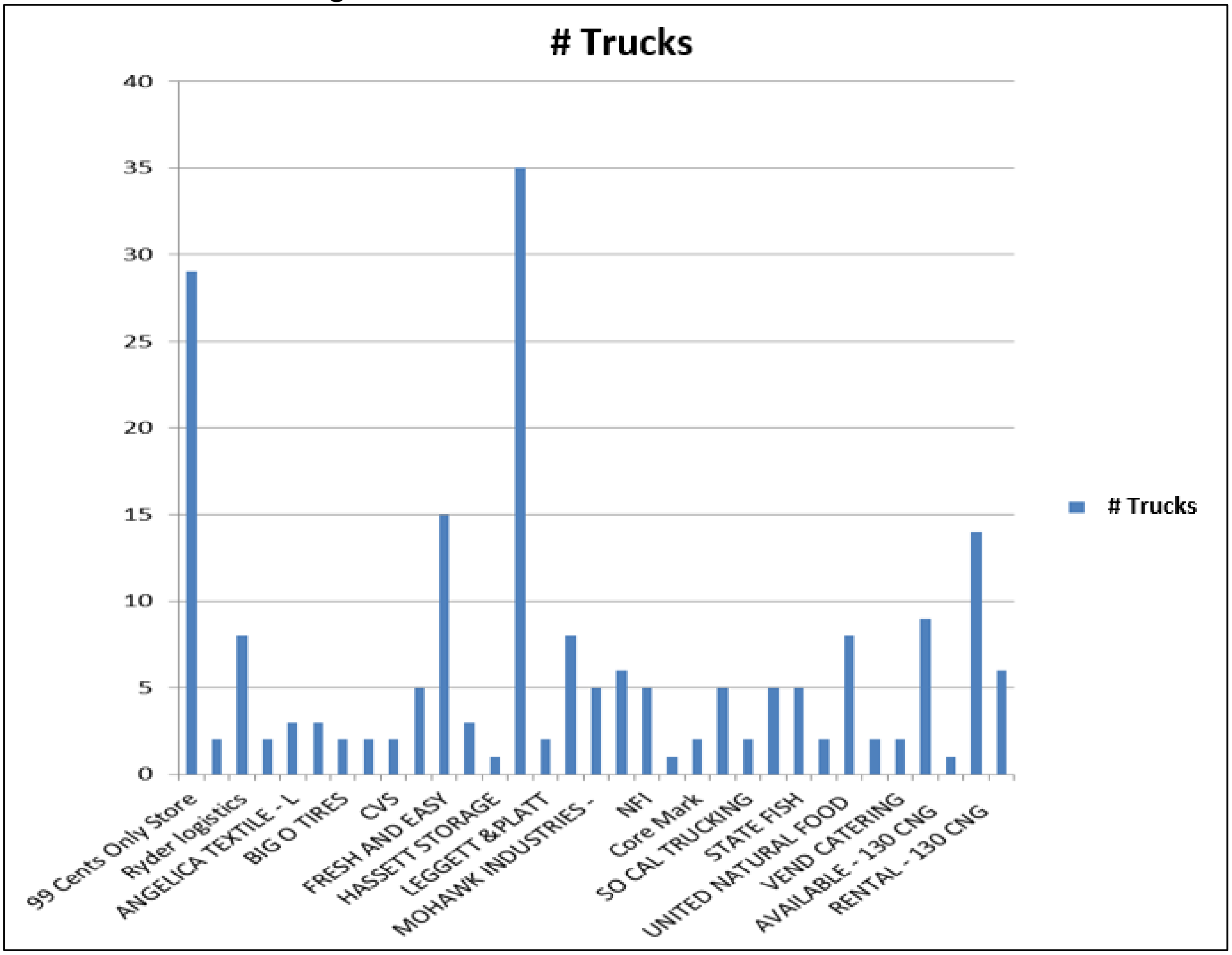
Source: SANBAG

Table 18: October 2012 Customer Leases

Company	# Trucks
99 Cents Only Store	29
AMFOAM	2
Ryder logistics	8
Andersen Windows	2
Angelica Textile	3
Benjamin Moore	3
Big O Tires	2
CEVA Logistics	2
CVS	2
DEAN Transportation	5
Fresh & Easy	15
Greatwide Trans	3
Hassett Storage	1
Kraft	35
Leggett & Platt	2
Lily Transportation	8
Mohawk Industries	5
NASCO	6
NFI	5
Polyair Corporation	1
Core Mark	2
Redden Transport	5
SO CAL Trucking	2
Staples	5
State Fish	5
Super Center	2
United Natural Food	8
US Air Conditioning	2
Vend Catering	2
Westair Gases	9

Source: SANBAG

Figure 19: October 2012 Customer Leases



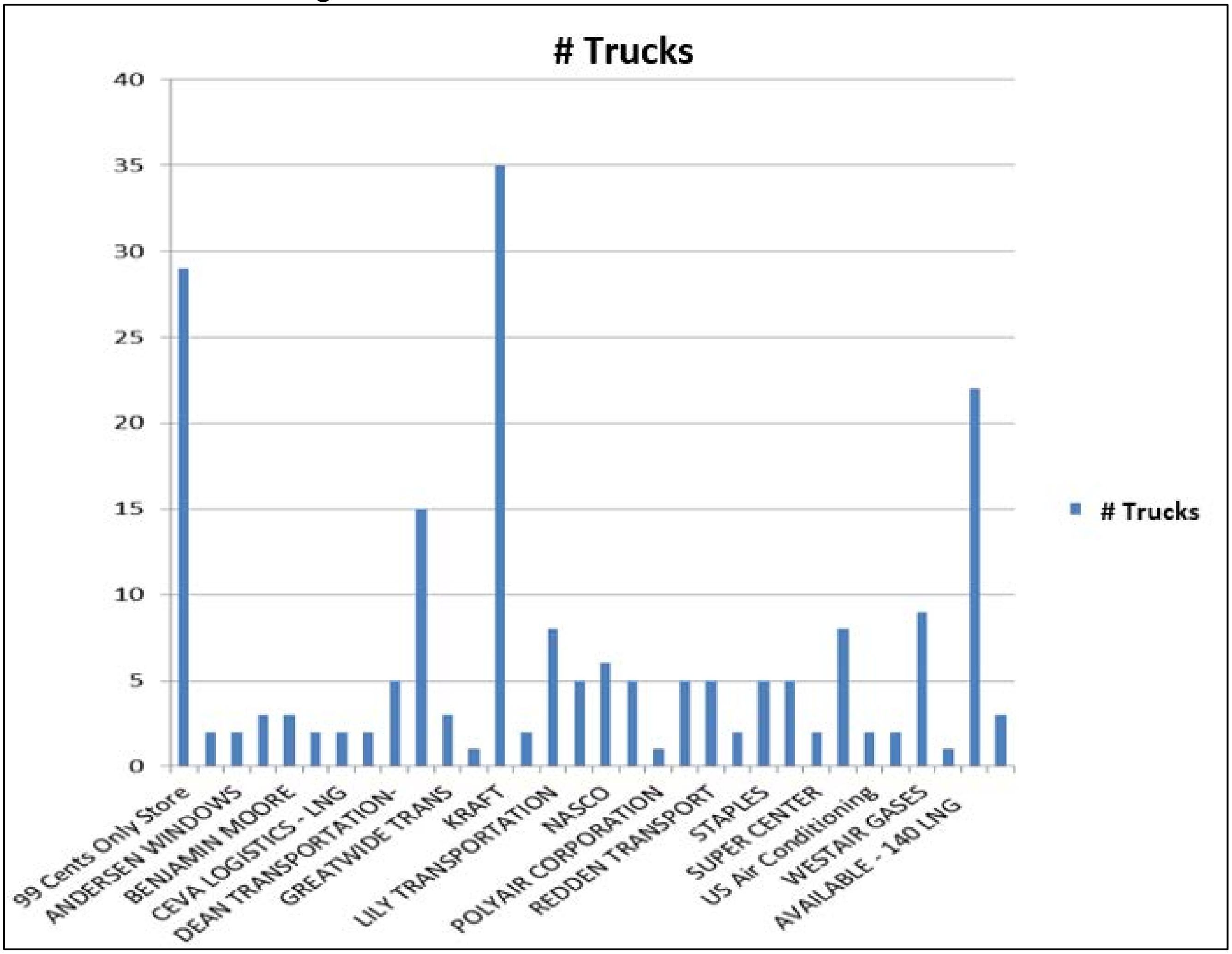
Source: SANBAG

Table 19: November 2012 Customer Leases

Company	# Trucks
99 Cents Only Store	29
AMFOAM	2
Andersen Windows	2
Angelica Textile	3
Benjamin Moore	3
Big O Tires	2
CEVA Logistics	2
CVS	2
DEAN Transportation	5
Fresh & Easy	15
Greatwide Trans	3
Hassett Storage	1
Kraft	35
Leggett & Platt	2
Lily Transportation	8
Mohawk Industries	5
NASCO	6
NFI	5
Polyair Corporation	1
Core Mark	5
Redden Transport	5
SO CAL Trucking	2
Staples	5
State Fish	5
Super Center	2
United Natural Food	8
US Air Conditioning	2
VEND Catering	2
Westair Gases	9

Source: SANBAG

Figure 20: November 2012 Customer Leases



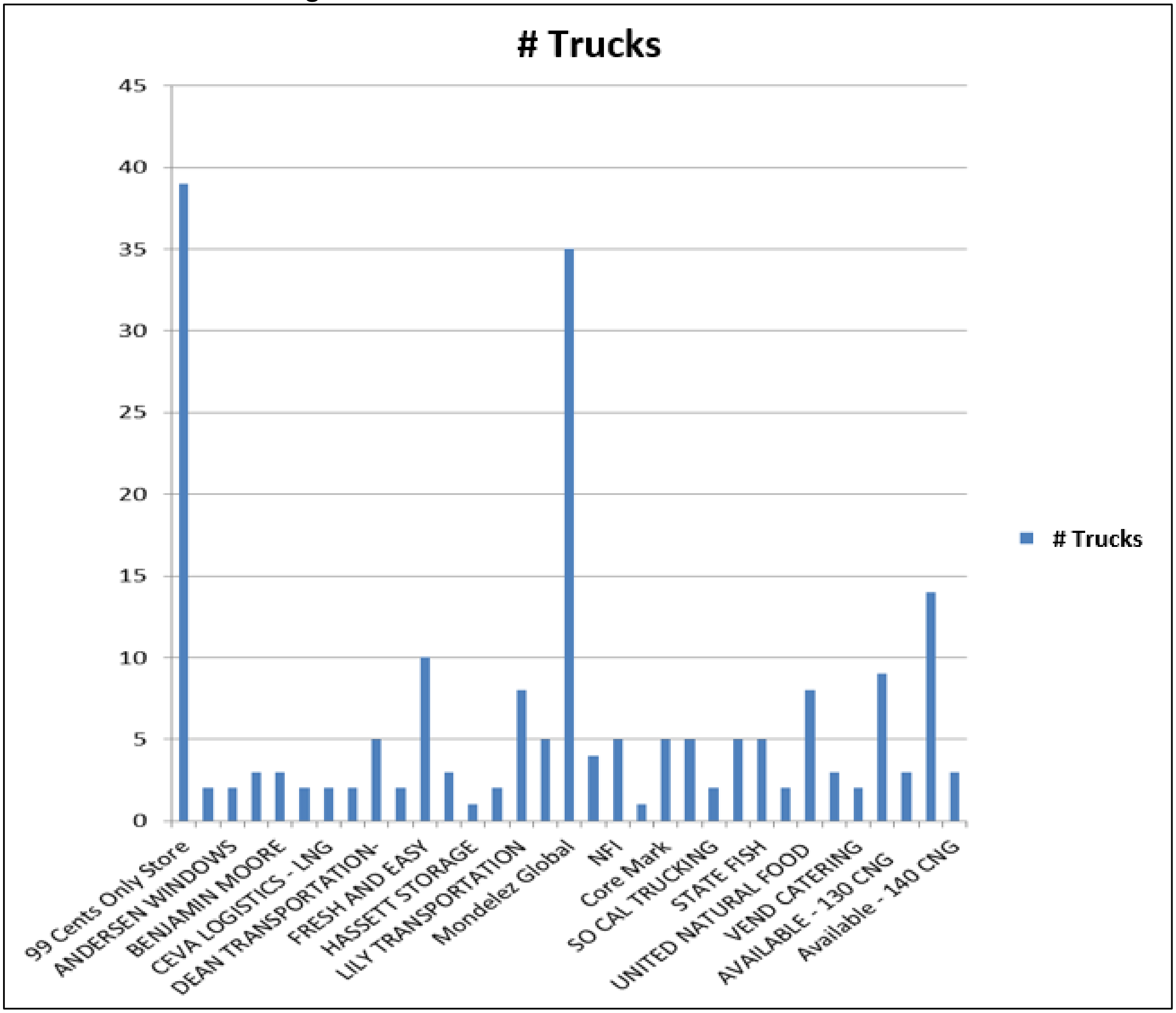
Source: SANBAG

Table 20: December 2012 Customer Leases

Company	# Trucks
99 Cents Only Store	39
AMFOAM	2
Andersen Windows	2
Angelica Textile	3
Benjamin Moore	3
Big O Tires	2
CEVA Logistics	2
CVS	2
DEAN Transportation	5
Genox Transp	2
Fresh & Easy	10
Greatwide Trans	3
Hassett Storage	1
Leggett & Platt	2
Lily Transportation	8
Mohawk Industries	5
Mondelez Global	35
NASCO	4
NFI	5
Polyair Corporation	1
Core Mark	5
Redden Transport	5
SO CAL Trucking	2
Staples	5
State Fish	5
Super Center	2
United Natural Food	8
US Air Conditioning	3
VEND Catering	2
Westair Gases	9

Source: SANBAG

Figure 21: December 2012 Customer Leases



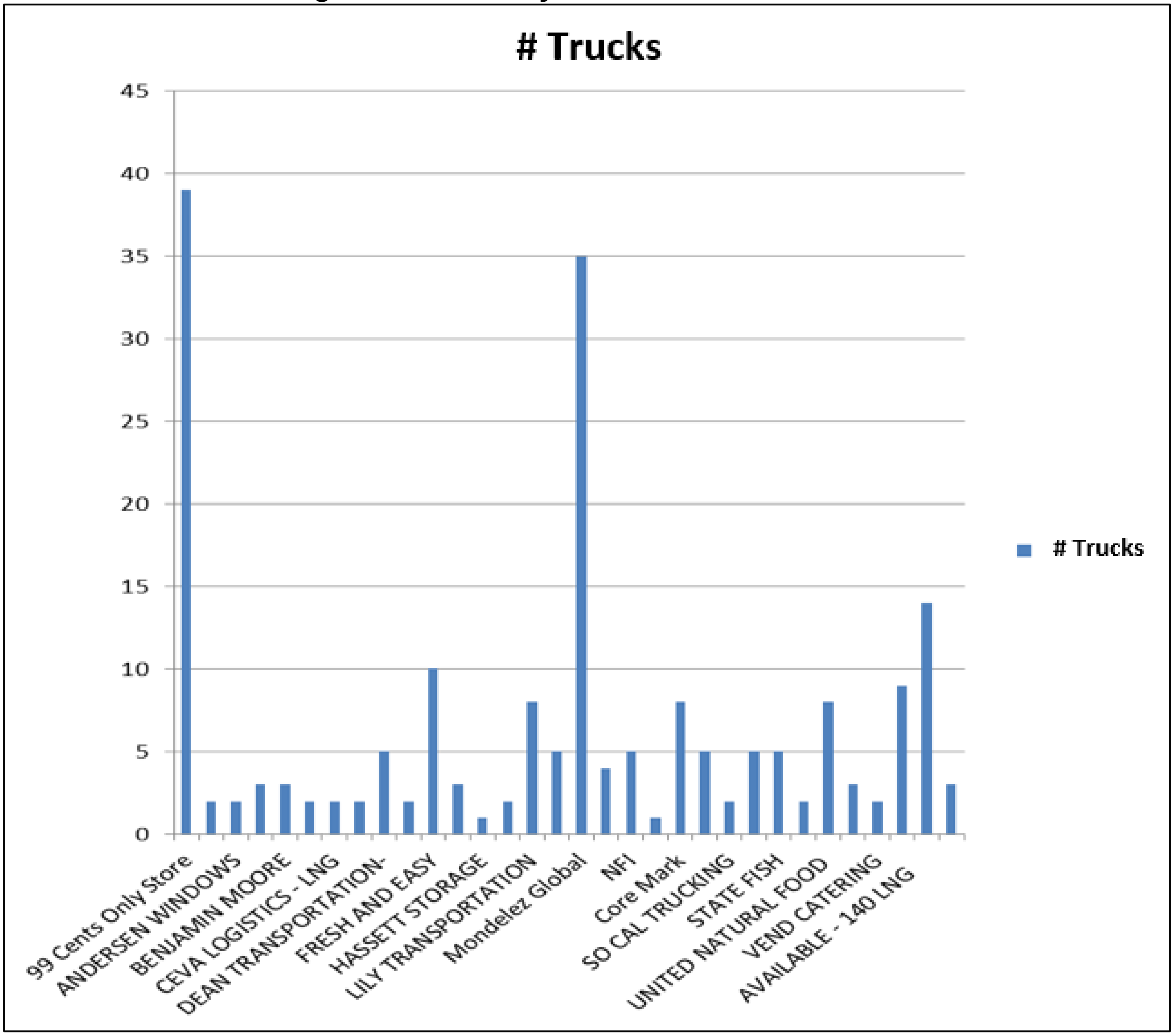
Source: SANBAG

Table 21: January 2013 Customer Leases

Company	# Trucks
99 Cents Only Store	39
AMFOAM	2
Andersen Windows	2
Angelica Textile	3
Benjamin Moore	3
Big O Tires	2
CEVA Logistics	2
CVS	2
DEAN Transportation	5
Genox Transp	2
Fresh & Easy	10
Greatwide Trans	3
Hassett Storage	1
Leggett & Platt	2
Lily Transportation	8
Mohawk Industries	5
Mondelez Global	35
NASCO	4
NFI	5
Polyair Corporation	1
Core Mark	8
Redden Transportation	5
SO CALTrucking	2
Staples	5
State Fish	5
Super Center	2
United Natural Food	8
US Air Conditioning	3
VEND Catering	2
Westair Gases	9

Source: SANBAG

Figure 22: January 2013 Customer Leases



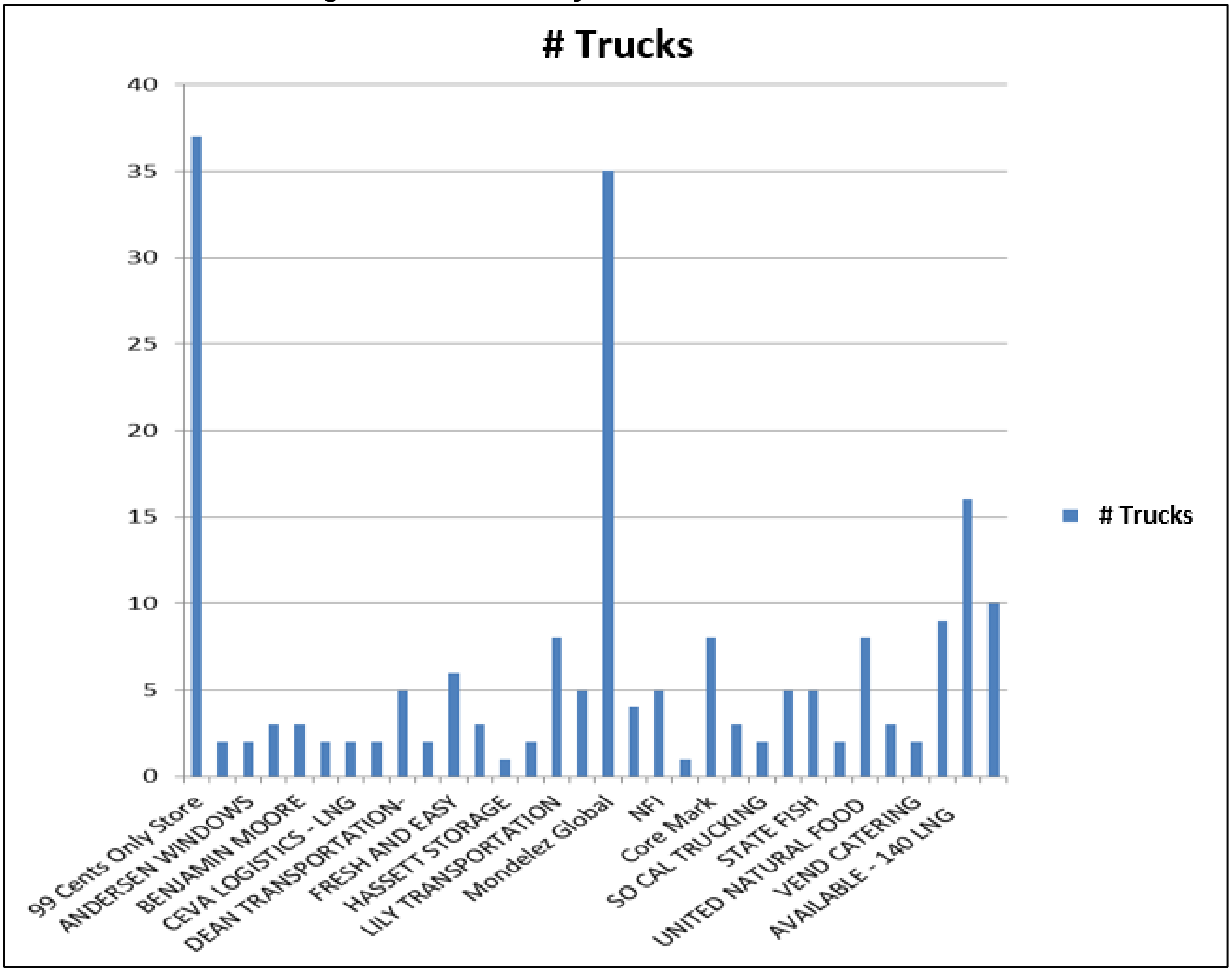
Source: SANBAG

Table 22: February 2013 Customer Leases

Company	# Trucks
99 Cents Only Store	37
AMFOAM	2
Andersen Windows	2
Angelica Textile	3
Benjamin Moore	3
Big O Tires	2
CEVA Logistics	2
CVS	2
DEAN Transportation	5
Genox Transp	2
Fresh & Easy	6
Greatwide Trans	3
Hassett Storage	1
Leggett & Platt	2
Lily Transportation	8
Mohawk Industries	5
Mondelez Global	35
NASCO	4
NFI	5
Polyair Corporation	1
Core Mark	8
Redden Transport	3
SO CAL Trucking	2
Staples	5
State Fish	5
Super Center	2
United Natural Food	8
US Air Conditioning	3
VEND Catering	2
Westair Gases	9

Source: SANBAG

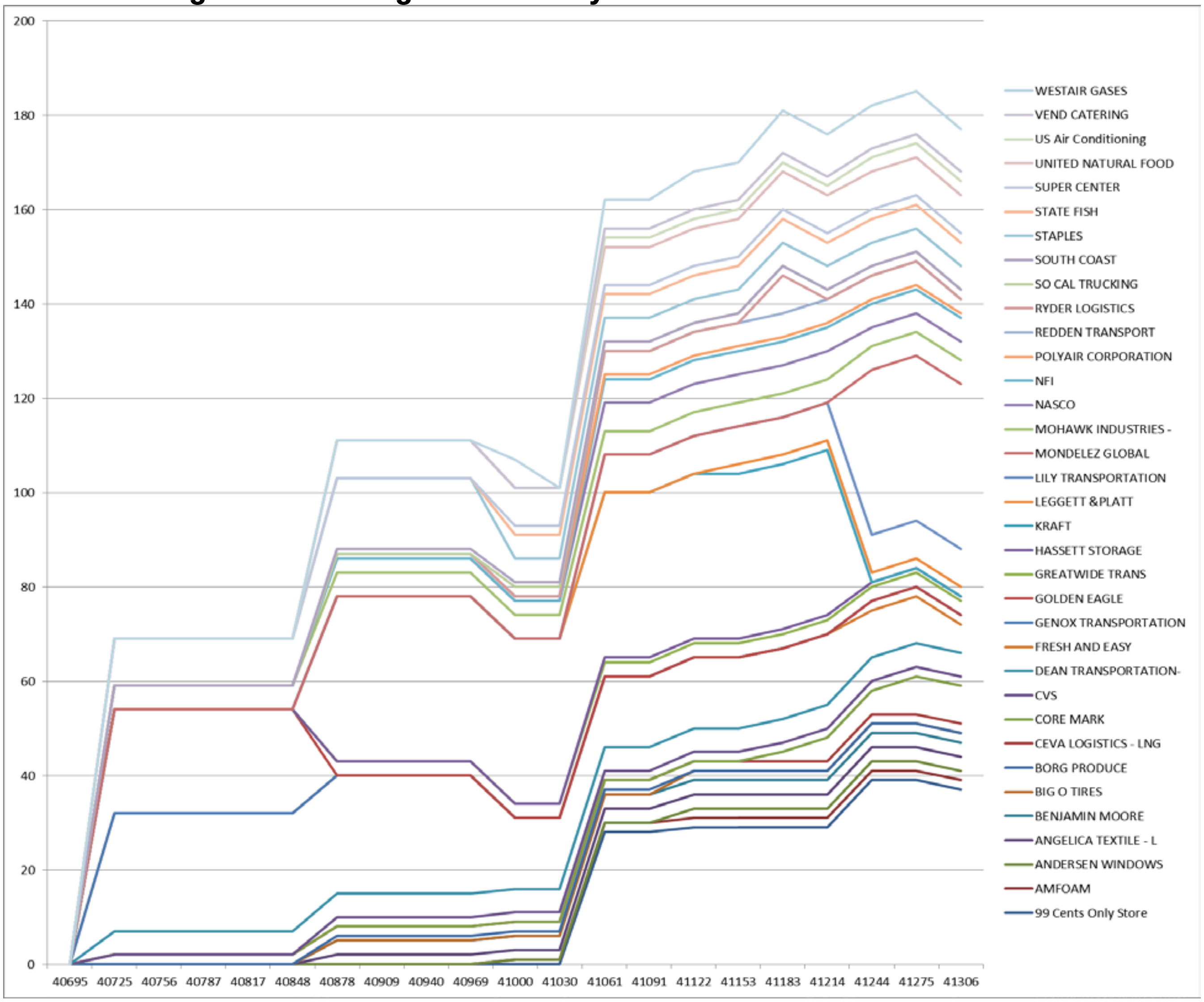
Figure 23: February 2013 Customer Leases



Source: SANBAG

Figure 24 shows mileage traveled by each leased CNG or LNG truck by which company leased them.

Figure 24: Mileage Traveled by Each Leased CNG/LNG Trucks



Source: SANBAG

Table 23 gives miles run by the truck VIN number for CNG trucks.

Table 23: CNG Miles Run

VIN #	Type of Fuel (CNG)	Miles Run
1FUBC4DX1CHBF3188	CNG	41,343
1FUBC4DX3CHBF3189	CNG	43,129
1FUBC4DXXCHBF3190	CNG	37,294
1FUBC4DX1CHBF3191	CNG	42,906
1FUBC4DX3CHBF3192	CNG	33,212
1FUBC4DX5CHBF3193	CNG	67,984
1FUBC4DX7CHBF3194	CNG	71,912
1FUBC4DX9CHBF3195	CNG	57,090
1FUBC4DX0CHBF3196	CNG	14,191
1FUBC4DX2CHBF3197	CNG	5,409
1FUBC4DX4CHBF3198	CNG	16,774
1FUBC4DX6CHBF3199	CNG	9,666
1FUBC4DX9CHBF3200	CNG	53,883
1FUBC4DX0CHBF3201	CNG	80,378
1FUBC4DX2CHBF3202	CNG	78,911
1FUJC5DX2CHBF3203	CNG	75,916
1FUJC5DX4CHBF3204	CNG	90,267
1FUJC5DX6CHBF3205	CNG	88,422
1FUJC5DX8CHBF3206	CNG	87,543
1FUJC5DXXCHBF3207	CNG	46,150
1FUJC5DX1CHBF3208	CNG	122,381
1FUJC5DX3CHBF3209	CNG	114,297
1FUJC5DXXCHBF3210	CNG	7,634
1FUJC5DX1CHBF3211	CNG	56,992
1FUJC5DX3CHBF3212	CNG	106,236
1FUJC5DX5CHBF3213	CNG	60,871
1FUJC5DX7CHBF3214	CNG	92,321
1FUJC5DX9CHBF3215	CNG	32,858
1FUJC5DX0CHBF3216	CNG	47,703
1FUJC5DX2CHBF3217	CNG	112,997
1FUJC5DX4CHBF3218	CNG	86,747
1FUJC5DX6CHBF3219	CNG	23,350
1FUJC5DX2CHBF3220	CNG	94,005
1FUJC5DX4CHBF3221	CNG	43,517
1FUJC5DX6CHBF3222	CNG	95,673
1FUJC5DX8CHBF3223	CNG	58,840
1FUJC5DXXCHBF3224	CNG	58,528
1FUJC5DX1CHBF3225	CNG	62,656
1FUJC5DX3CHBF3226	CNG	39,750
1FUJC5DX5CHBF3227	CNG	34,929
1FUJC5DX7CHBF3228	CNG	58,798
1FUJC5DX9CHBF3229	CNG	59,572
1FUJC5DX5CHBF3230	CNG	30,561
1FUJC5DX7CHBF3231	CNG	55,381

VIN #	Type of Fuel (CNG)	Miles Run
1FUJC5DX9CHBF3232	CNG	38,595
1FUJC5DX0CHBF3233	CNG	28,403
1FUJC5DX2CHBF3234	CNG	8,578
1FUJC5DX4CHBF3235	CNG	21,694
1FUJC5DX6CHBF3236	CNG	33,303
1FUJC5DX8CHBF3237	CNG	81,603
1FUJC5DXXCHBF3238	CNG	82,229
1FUJC5DX1CHBF3239	CNG	58,959
1FUJC5DX8CHBF3240	CNG	84,701
1FUJC5DXXCHBF3241	CNG	44,524
1FUJC5DX1CHBF3242	CNG	46,767
1FUJC5DX3CHBF3243	CNG	65,710
1FUJC5DX5CHBF3244	CNG	24,953
1FUJC5DX7CHBF3245	CNG	56,360
1FUJC5DX9CHBF3246	CNG	68,805
1FUJC5DX0CHBF3247	CNG	109,054
1FUJC5DX2CHBF3248	CNG	56,008
1FUJC5DX4CHBF3249	CNG	105,046
1FUJC5DX0CHBF3250	CNG	27,650
1FUJC5DX2CHBF3251	CNG	39,234
1FUJC5DX4CHBF3252	CNG	22,730
1FUBC4DX1CHBF3787	CNG	3,980
1FUBC4DX3CHBF3788	CNG	24,422
1FUBC4DX5CHBF3789	CNG	6,420
1FUBC4DX1CHBF3790	CNG	13,696
1FUBC4DX3CHBF3791	CNG	22,840
1FUBC4DX5CHBF3792	CNG	6,506
1FUBC4DX7CHBF3793	CNG	18,256
1FUBC4DX9CHBF3794	CNG	7,886
1FUBC4DX0CHBF3795	CNG	7,147
1FUBC4DX2CHBF3796	CNG	12,711
1FUBC4DX8CHBF3835	CNG	12,227
1FUBC4DXXCHBF3836	CNG	36,256
1FUBC4DX1CHBF3837	CNG	22,989
1FUBC4DX3CHBF3838	CNG	27,092
1FUBC4DX5CHBF3839	CNG	29,827
1FUBC4DX1CHBF3840	CNG	15,269
1FUBC4DX3CHBF3841	CNG	21,456
1FUBC4DX5CHBF3842	CNG	20,344
1FUBC4DX7CHBF3843	CNG	40,070
1FUBC4DX9CHBF3844	CNG	60,197
1FUBC4DX0CHBF3845	CNG	51,919
1FUBC4DX2CHBF3846	CNG	13,933
1FUBC4DX4CHBF3847	CNG	14,574
1FUBC4DX6CHBF3848	CNG	8,612
1FUBC4DX8CHBF3849	CNG	24,999
1FUJC5DX2CHBF4089	CNG	58,297

VIN #	Type of Fuel (CNG)	Miles Run
1FUJC5DX9CHBF4090	CNG	66,886
1FUJC5DX0CHBF4091	CNG	38,364
1FUJC5DX2CHBF4092	CNG	51,007
1FUJC5DX4CHBF4093	CNG	54,131
1FUJC5DX6CHBF4094	CNG	8,342
1FUJC5DX8CHBF4095	CNG	6,746
1FUJC5DXXCHBF4096	CNG	72,166
1FUJC5DX1CHBF4097	CNG	80,002
1FUJC5DX3CHBF4098	CNG	13,129
1FUJC5DX5CHBF4099	CNG	62,404
1FUJC5DX8CHBF4100	CNG	48,514
1FUJC5DXXCHBF4101	CNG	29,568
1FUJC5DX1CHBF4102	CNG	20,416
1FUJC5DX3CHBF4103	CNG	55,113
1FUJC5DX5CHBF4104	CNG	55,272
1FUJC5DX7CHBF4105	CNG	54,880
1FUJC5DX9CHBF4106	CNG	25,079
1FUJC5DX2CHBF4108	CNG	30,612
1FUJC5DX4CHBF4109	CNG	54,154
1FUJC5DX0CHBF4110	CNG	34,708
1FUJC5DX2CHBF4111	CNG	47,890
1FUJC5DX4CHBF4112	CNG	37,226
1FUJC5DX6CHBF4113	CNG	67,243
1FUJC5DX8CHBF4114	CNG	39,137
1FUJC5DXXCHBF4115	CNG	54,324
1FUJC5DX1CHBF4116	CNG	30,587
1FUJC5DX3CHBF4117	CNG	48,437
1FUJC5DX5CHBF4118	CNG	47,565
1FUJC5DX7CHBF4119	CNG	48,218
1FUJC5DX3CHBF4120	CNG	47,136
1FUJC5DX5CHBF4121	CNG	54,222
1FUJC5DX7CHBF4122	CNG	31,688
1FUJC5DX9CHBF4123	CNG	47,192
1FUJC5DX0CHBF4124	CNG	53,353
1FUJC5DX2CHBF4125	CNG	24,018
1FUJC5DX8CHBF3867	CNG	25,089
1FUJC5DXXCHBF3868	CNG	81,034
1FUJC5DX1CHBF3869	CNG	43,040
1FUJC5DX8CHBF3870	CNG	63,169
1FUJC5DXXCHBF3871	CNG	20,563
1FUJC5DX1CHBF3872	CNG	31,081
1FUJC5DX3CHBF3873	CNG	43,315
1FUJC5DX5CHBF3874	CNG	29,310
1FUJC5DX7CHBF3875	CNG	28,744
1FUJC5DX9CHBF3876	CNG	28,207
1FUJC5DX0CHBF3877	CNG	25,610
1FUJC5DX2CHBF3878	CNG	25,214

VIN #	Type of Fuel (CNG)	Miles Run
1FUJC5DX4CHBF3879	CNG	28,680
1FUJC5DX0CHBF3880	CNG	26,859
1FUJC5DX2CHBF3881	CNG	25,405
1FUJC5DX4CHBF3882	CNG	33,348
1FUJC5DX6CHBF3883	CNG	26,093
1FUJC5DX8CHBF3884	CNG	41,823
1FUJC5DXXCHBF3885	CNG	26,063
1FUJC5DX1CHBF3886	CNG	37,837
1FUJC5DX3CHBF3887	CNG	25,929
1FUJC5DX5CHBF3888	CNG	31,656
1FUJC5DX7CHBF3889	CNG	45,093
1FUJC5DX3CHBF3890	CNG	61,601
1FUJC5DX5CHBF3891	CNG	30,921
1FUJC5DX7CHBF3892	CNG	61,251
1FUJC5DX9CHBF3893	CNG	52,651
1FUJC5DX0CHBF3894	CNG	32,448
1FUJC5DX2CHBF3895	CNG	21,261
1FUJC5DX4CHBF3896	CNG	34,265
1FUJC5DX6CHBF3897	CNG	24,864
1FUJC5DX8CHBF3898	CNG	39,984
1FUJC5DXXCHBF3899	CNG	50,260
1FUJC5DX2CHBF3900	CNG	58,726
1FUJC5DX4CHBF3901	CNG	55,179
1FUJC5DX6CHBF3902	CNG	59,990
1FUJC5DX8CHBF3903	CNG	51,880
1FUJC5DXXCHBF3904	CNG	45,037
1FUJC5DX1CHBF3905	CNG	66,946
1FUJC5DX3CHBF3906	CNG	65,353
1FUJC5DX8DHFD8590	CNG	0

Source: SANBAG

Table 24 gives miles run by the truck VIN number for LNG trucks.

Table 24: LNG Miles Run

VIN #	Type of Fuel (LNG)	Miles Run
1FUJC5DX0CHBF3183	LNG	71,665
1FUJC5DX2CHBF3184	LNG	88,584
1FUJC5DX4CHBF3185	LNG	64,013
1FUJC5DX6CHBF3186	LNG	62,874
1FUJC5DX8CHBF3187	LNG	72,816
1FUJC5DX2CHBF3766	LNG	14,144
1FUJC5DX4CHBF3767	LNG	50,464
1FUJC5DX6CHBF3768	LNG	32,951
1FUJC5DX8CHBF3769	LNG	7,778
1FUJC5DX4CHBF3770	LNG	42,471

VIN #	Type of Fuel (LNG)	Miles Run
1FUJC5DX6CHBF3771	LNG	62,967
1FUJC5DX8CHBF3772	LNG	19,066
1FUJC5DXXCHBF3773	LNG	57,372
1FUJC5DX1CHBF3774	LNG	82,480
1FUJC5DX3CHBF3775	LNG	72,759
1XPHDW9X5CD140194	LNG	8,147
1XPHDW9X7CD140195	LNG	2,283
1XPHDW9X9CD140196	LNG	37,021
1XPHDW9X6CD140205	LNG	6,050
1XPHDW9X1CD140208	LNG	18,566
1XPHDW9X3CD140209	LNG	28,085
1XPHDW9X1CD140211	LNG	5,819
1XPHDW9X3CD140212	LNG	47
1XPHDW9X0CD140197	LNG	14,900
1XPHDW9X9CD140201	LNG	75,836
1XPHDW9X8CD140206	LNG	20,900
1XPHDW9X5CD140213	LNG	16,815
1XPHDW9X4CD140199	LNG	41,787
1XPHDW9X4CD140204	LNG	1,742
1XPHDW9X0CD140202	LNG	9,453
1XPHDW9X7CD140200	LNG	10,965
1XPHDW9XXCD140207	LNG	21,780
1XPHDW9XXCD140210	LNG	39,525
1XPHDW9X2CD140198	LNG	24,458
1XPHDW9X2CD140203	LNG	29,007

Source: SANBAG

Figure 25 is an example CNG truck at a Ryder facility.

Figure 25: CNG Truck Parked at a Ryder Facility in Fontana, CA.

Source: SANBAG

Table 25 gives fuel consumption by the truck VIN number for CNG trucks.

Table 25: CNG Fuel Consumption

VIN #	Type of Fuel (CNG)	Fuel Usage (DGE)
1FUBC4DX1CHBF3188	CNG	6,912
1FUBC4DX3CHBF3189	CNG	7,103
1FUBC4DXXCHBF3190	CNG	6,119
1FUBC4DX1CHBF3191	CNG	7,030
1FUBC4DX3CHBF3192	CNG	5,498
1FUBC4DX5CHBF3193	CNG	10,828
1FUBC4DX7CHBF3194	CNG	11,748
1FUBC4DX9CHBF3195	CNG	9,927
1FUBC4DX0CHBF3196	CNG	2,387
1FUBC4DX2CHBF3197	CNG	929
1FUBC4DX4CHBF3198	CNG	1,685
1FUBC4DX6CHBF3199	CNG	1,022
1FUBC4DX9CHBF3200	CNG	8,670
1FUBC4DX0CHBF3201	CNG	13,085
1FUBC4DX2CHBF3202	CNG	12,948
1FUJC5DX2CHBF3203	CNG	12,720
1FUJC5DX4CHBF3204	CNG	14,576
1FUJC5DX6CHBF3205	CNG	14,906
1FUJC5DX8CHBF3206	CNG	14,480
1FUJC5DXXCHBF3207	CNG	6,996
1FUJC5DX1CHBF3208	CNG	20,065
1FUJC5DX3CHBF3209	CNG	18,646
1FUJC5DXXCHBF3210	CNG	1,388
1FUJC5DX1CHBF3211	CNG	10,096
1FUJC5DX3CHBF3212	CNG	17,371
1FUJC5DX5CHBF3213	CNG	8,993
1FUJC5DX7CHBF3214	CNG	15,498
1FUJC5DX9CHBF3215	CNG	4,865
1FUJC5DX0CHBF3216	CNG	7,078
1FUJC5DX2CHBF3217	CNG	18,388
1FUJC5DX4CHBF3218	CNG	13,700
1FUJC5DX6CHBF3219	CNG	2,936
1FUJC5DX2CHBF3220	CNG	15,465
1FUJC5DX4CHBF3221	CNG	6,522
1FUJC5DX6CHBF3222	CNG	15,276
1FUJC5DX8CHBF3223	CNG	10,283
1FUJC5DXXCHBF3224	CNG	9,531
1FUJC5DX1CHBF3225	CNG	10,891
1FUJC5DX3CHBF3226	CNG	6,746
1FUJC5DX5CHBF3227	CNG	5,483
1FUJC5DX7CHBF3228	CNG	9,418
1FUJC5DX9CHBF3229	CNG	10,034
1FUJC5DX5CHBF3230	CNG	4,724
1FUJC5DX7CHBF3231	CNG	9,011
1FUJC5DX9CHBF3232	CNG	5,367
1FUJC5DX0CHBF3233	CNG	5,054
1FUJC5DX2CHBF3234	CNG	1,233

VIN #	Type of Fuel (CNG)	Fuel Usage (DGE)
1FUJC5DX4CHBF3235	CNG	3,799
1FUJC5DX6CHBF3236	CNG	4,888
1FUJC5DX8CHBF3237	CNG	14,548
1FUJC5DXXCHBF3238	CNG	14,197
1FUJC5DX1CHBF3239	CNG	9,893
1FUJC5DX8CHBF3240	CNG	14,299
1FUJC5DXXCHBF3241	CNG	6,581
1FUJC5DX1CHBF3242	CNG	7,094
1FUJC5DX3CHBF3243	CNG	11,422
1FUJC5DX5CHBF3244	CNG	3,480
1FUJC5DX7CHBF3245	CNG	8,480
1FUJC5DX9CHBF3246	CNG	11,721
1FUJC5DX0CHBF3247	CNG	18,371
1FUJC5DX2CHBF3248	CNG	9,321
1FUJC5DX4CHBF3249	CNG	18,478
1FUJC5DX0CHBF3250	CNG	4,062
1FUJC5DX2CHBF3251	CNG	6,142
1FUJC5DX4CHBF3252	CNG	3,181
1FUBC4DX1CHBF3787	CNG	604
1FUBC4DX3CHBF3788	CNG	3,009
1FUBC4DX5CHBF3789	CNG	1,015
1FUBC4DX1CHBF3790	CNG	2,182
1FUBC4DX3CHBF3791	CNG	3,989
1FUBC4DX5CHBF3792	CNG	634
1FUBC4DX7CHBF3793	CNG	3,072
1FUBC4DX9CHBF3794	CNG	1,060
1FUBC4DX0CHBF3795	CNG	677
1FUBC4DX2CHBF3796	CNG	1,867
1FUBC4DX8CHBF3835	CNG	1,107
1FUBC4DXXCHBF3836	CNG	5,260
1FUBC4DX1CHBF3837	CNG	2,748
1FUBC4DX3CHBF3838	CNG	4,307
1FUBC4DX5CHBF3839	CNG	3,665
1FUBC4DX1CHBF3840	CNG	2,016
1FUBC4DX3CHBF3841	CNG	2,898
1FUBC4DX5CHBF3842	CNG	2,827
1FUBC4DX7CHBF3843	CNG	6,752
1FUBC4DX9CHBF3844	CNG	9,187
1FUBC4DX0CHBF3845	CNG	8,207
1FUBC4DX2CHBF3846	CNG	1,780
1FUBC4DX4CHBF3847	CNG	2,092
1FUBC4DX6CHBF3848	CNG	961
1FUBC4DX8CHBF3849	CNG	4,070
1FUJC5DX2CHBF4089	CNG	7,902
1FUJC5DX9CHBF4090	CNG	9,110
1FUJC5DX0CHBF4091	CNG	3,886
1FUJC5DX2CHBF4092	CNG	7,151
1FUJC5DX4CHBF4093	CNG	6,942
1FUJC5DX6CHBF4094	CNG	1,517
1FUJC5DX8CHBF4095	CNG	1,227

VIN #	Type of Fuel (CNG)	Fuel Usage (DGE)
1FUJC5DXXCHBF4096	CNG	11,695
1FUJC5DX1CHBF4097	CNG	12,861
1FUJC5DX3CHBF4098	CNG	1,856
1FUJC5DX5CHBF4099	CNG	8,989
1FUJC5DX8CHBF4100	CNG	8,568
1FUJC5DXXCHBF4101	CNG	4,503
1FUJC5DX1CHBF4102	CNG	3,478
1FUJC5DX3CHBF4103	CNG	8,859
1FUJC5DX5CHBF4104	CNG	8,455
1FUJC5DX7CHBF4105	CNG	8,001
1FUJC5DX9CHBF4106	CNG	3,388
1FUJC5DX0CHBF4107	CNG	3,558
1FUJC5DX2CHBF4108	CNG	5,013
1FUJC5DX4CHBF4109	CNG	8,011
1FUJC5DX0CHBF4110	CNG	5,251
1FUJC5DX2CHBF4111	CNG	7,461
1FUJC5DX4CHBF4112	CNG	5,371
1FUJC5DX6CHBF4113	CNG	12,130
1FUJC5DX8CHBF4114	CNG	6,255
1FUJC5DXXCHBF4115	CNG	8,384
1FUJC5DX1CHBF4116	CNG	5,561
1FUJC5DX3CHBF4117	CNG	7,081
1FUJC5DX5CHBF4118	CNG	7,472
1FUJC5DX7CHBF4119	CNG	7,407
1FUJC5DX3CHBF4120	CNG	7,515
1FUJC5DX5CHBF4121	CNG	8,768
1FUJC5DX7CHBF4122	CNG	4,555
1FUJC5DX9CHBF4123	CNG	6,927
1FUJC5DX0CHBF4124	CNG	8,176
1FUJC5DX2CHBF4125	CNG	3,365
1FUJC5DX8CHBF3867	CNG	3,928
1FUJC5DXXCHBF3868	CNG	12,606
1FUJC5DX1CHBF3869	CNG	6,582
1FUJC5DX8CHBF3870	CNG	10,011
1FUJC5DXXCHBF3871	CNG	3,335
1FUJC5DX1CHBF3872	CNG	4,459
1FUJC5DX3CHBF3873	CNG	6,127
1FUJC5DX5CHBF3874	CNG	3,426
1FUJC5DX7CHBF3875	CNG	3,630
1FUJC5DX9CHBF3876	CNG	4,469
1FUJC5DX0CHBF3877	CNG	4,018
1FUJC5DX2CHBF3878	CNG	3,915
1FUJC5DX4CHBF3879	CNG	4,565
1FUJC5DX0CHBF3880	CNG	4,117
1FUJC5DX2CHBF3881	CNG	3,937
1FUJC5DX4CHBF3882	CNG	5,407
1FUJC5DX6CHBF3883	CNG	4,293
1FUJC5DX8CHBF3884	CNG	6,753
1FUJC5DXXCHBF3885	CNG	3,918
1FUJC5DX1CHBF3886	CNG	6,124

VIN #	Type of Fuel (CNG)	Fuel Usage (DGE)
1FUJC5DX3CHBF3887	CNG	3,965
1FUJC5DX5CHBF3888	CNG	3,886
1FUJC5DX7CHBF3889	CNG	7,318
1FUJC5DX3CHBF3890	CNG	9,678
1FUJC5DX5CHBF3891	CNG	5,259
1FUJC5DX7CHBF3892	CNG	10,509
1FUJC5DX9CHBF3893	CNG	7,755
1FUJC5DX0CHBF3894	CNG	5,002
1FUJC5DX2CHBF3895	CNG	3,204
1FUJC5DX4CHBF3896	CNG	5,354
1FUJC5DX6CHBF3897	CNG	3,946
1FUJC5DX8CHBF3898	CNG	5,978
1FUJC5DXXCHBF3899	CNG	8,644
1FUJC5DX2CHBF3900	CNG	9,203
1FUJC5DX4CHBF3901	CNG	9,682
1FUJC5DX6CHBF3902	CNG	9,520
1FUJC5DX8CHBF3903	CNG	8,496
1FUJC5DXXCHBF3904	CNG	6,703
1FUJC5DX1CHBF3905	CNG	10,800
1FUJC5DX3CHBF3906	CNG	10,444
1FUJC5DX8DHFD8590	CNG	0

Source: SANBAG

Table 26 gives fuel consumption by the truck VIN number for LNG trucks.

Table 26: LNG Fuel Consumption

VIN #	Type of Fuel (LNG)	Fuel Usage (DGE)
1FUJC5DX0CHBF3183	LNG	13,030
1FUJC5DX2CHBF3184	LNG	14,615
1FUJC5DX4CHBF3185	LNG	10,186
1FUJC5DX6CHBF3186	LNG	10,946
1FUJC5DX8CHBF3187	LNG	12,081
1FUJC5DX2CHBF3766	LNG	1,631
1FUJC5DX4CHBF3767	LNG	6,665
1FUJC5DX6CHBF3768	LNG	4,131
1FUJC5DX8CHBF3769	LNG	1,327
1FUJC5DX4CHBF3770	LNG	5,783
1FUJC5DX6CHBF3771	LNG	8,930
1FUJC5DX8CHBF3772	LNG	2,746
1FUJC5DXXCHBF3773	LNG	10,143
1FUJC5DX1CHBF3774	LNG	13,664
1FUJC5DX3CHBF3775	LNG	11,886
1XPHDW9X5CD140194	LNG	1,357
1XPHDW9X7CD140195	LNG	376
1XPHDW9X9CD140196	LNG	6,170
1XPHDW9X6CD140205	LNG	863

VIN #	Type of Fuel (LNG)	Fuel Usage (DGE)
1XPHDW9X1CD140208	LNG	1,168
1XPHDW9X3CD140209	LNG	3,754
1XPHDW9X1CD140211	LNG	970
1XPHDW9X3CD140212	LNG	8
1XPHDW9X0CD140197	LNG	2,483
1XPHDW9X9CD140201	LNG	9,682
1XPHDW9X8CD140206	LNG	3,105
1XPHDW9X5CD140213	LNG	2,372
1XPHDW9X4CD140199	LNG	6,721
1XPHDW9X4CD140204	LNG	37
1XPHDW9X0CD140202	LNG	869
1XPHDW9X7CD140200	LNG	719
1XPHDW9XXCD140207	LNG	1,498
1XPHDW9XXCD140210	LNG	5,180
1XPHDW9X2CD140198	LNG	3,623
1XPHDW9X2CD140203	LNG	3,637

Source: SANBAG

Table 27 provides alternative fuel truck cost data such as total cost of trucks, cost of conversion, U.S. DOE share, CEC share and who each truck was funded by.

Table 27: Alternative Fuel Truck Cost Data

VIN Number	Total Cost of Trucks	Cost of Conversion	U.S. DOE Share	CEC Share	Funded By (Conversion Cost)
1FUBC4DX0CHBF3196	$139,660.00	$49,305.57	$0.00	$49,305.57	Tractor - Grant funding provided by CEC.
1FUBC4DX0CHBF3201	$139,660.00	$49,305.57	$0.00	$49,305.57	Tractor - Grant funding provided by CEC
1FUBC4DX0CHBF3795	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX0CHBF3845	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX1CHBF3188	$139,660.00	$49,305.57	$49,305.57		Tractor, Funded by DOE
1FUBC4DX1CHBF3191	$139,660.00	$49,305.57	$49,305.57		Tractor, Funded by DOE
1FUBC4DX1CHBF3787	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX1CHBF3790	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX1CHBF3837	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX1CHBF3840	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX2CHBF3197	$139,660.00	$49,305.57	$0.00	$49,305.57	Tractor - Grant funding provided by CEC
1FUBC4DX2CHBF3202	$139,660.00	$49,305.57	$0.00	$49,305.57	Tractor - Grant funding provided by CEC
1FUBC4DX2CHBF3796	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX2CHBF3846	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX3CHBF3189	$139,660.00	$49,305.57	$49,305.57		Tractor, Funded by DOE
1FUBC4DX3CHBF3192	$139,660.00	$49,305.57	$49,305.57		Tractor, Funded by DOE
1FUBC4DX3CHBF3788	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX3CHBF3791	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX3CHBF3838	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX3CHBF3841	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX4CHBF3198	$139,660.00	$49,305.57	$0.00	$49,305.57	Tractor - Grant funding provided by CEC
1FUBC4DX4CHBF3847	$139,325.00	$48,970.55	$48,970.55		Tractor, Funded by DOE
1FUBC4DX5CHBF3193	$139,660.00	$49,305.57	$49,305.57		Tractor, Funded by DOE
1FUBC4DX5CHBF3789	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX5CHBF3792	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX5CHBF3839	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX5CHBF3842	$139,325.00	$48,323.85	$0.00	$48,323.85	Tractor - Grant funding provided by CEC.
1FUBC4DX6CHBF3199	$139,660.00	$49,305.57	$0.00	$49,305.57	Tractor - Grant funding provided by CEC
1FUBC4DX6CHBF3848	$139,325.00	$45,730.00	$45,730.00		Tractor - Funded by DOE
1FUBC4DX7CHBF3194	$139,660.00	$49,305.57	$49,305.57		Tractor, Funded by DOE
1FUBC4DX7CHBF3793	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX7CHBF3843	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX8CHBF3835	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX8CHBF3849	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX9CHBF3195	$139,660.00	$49,305.57	$49,305.57		Tractor, Funded by DOE
1FUBC4DX9CHBF3200	$139,660.00	$49,305.57	$0.00	$49,305.57	Tractor - Grant funding provided by CEC
1FUBC4DX9CHBF3794	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DX9CHBF3844	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUBC4DXXCHBF3190	$139,660.00	$49,305.57	$49,305.57		Tractor, Funded by DOE
1FUBC4DXXCHBF3836	$139,325.00	$48,970.55	$0.00	$48,970.55	Tractor - Grant funding provided by CEC.
1FUJC5DX0CHBF3183	$153,731.00	$61,841.58	$0.00	$61,841.58	Tractor - Grant funding provided by CEC.
1FUJC5DX0CHBF3216	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX0CHBF3233	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX0CHBF3247	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX0CHBF3250	$146,519.00	$54,629.58	$0.00	$54,629.58	Tractor - Grant funding provided by CEC.
1FUJC5DX0CHBF3877	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX0CHBF3880	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.

1FUJC5DX0CHBF3894	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX0CHBF4091	$146,127.00	$53,579.88	$0.00	$53,579.88	Tractor - Grant funding provided by CEC.
1FUJC5DX0CHBF4107	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX0CHBF4110	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX0CHBF4124	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX1CHBF3208	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX1CHBF3211	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX1CHBF3225	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX1CHBF3239	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX1CHBF3242	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX1CHBF3774	$150,491.00	$58,601.58	$0.00	$58,601.58	Tractor - Grant funding provided by CEC.
1FUJC5DX1CHBF3869	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX1CHBF3872	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX1CHBF3886	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX1CHBF3905	$147,814.00	$55,924.58	$0.00	$55,924.58	Tractor - Grant funding provided by CEC.
1FUJC5DX1CHBF4097	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX1CHBF4102	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX1CHBF4116	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC. *
1FUJC5DX2CHBF3184	$153,731.00	$61,841.58	$61,841.58		Tractor, Funded by DOE
1FUJC5DX2CHBF3203	$146,548.00	$54,658.58	$0.00	$54,658.58	Tractor - Grant funding provided by CEC
1FUJC5DX2CHBF3217	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX2CHBF3220	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX2CHBF3234	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX2CHBF3248	$146,519.00	$54,629.58	$0.00	$54,629.58	Tractor - Grant funding provided by CEC.
1FUJC5DX2CHBF3251	$146,519.00	$54,629.58	$54,629.58		Tractor, Funded by DOE
1FUJC5DX2CHBF3766	$151,753.00	$59,863.58	$0.00	$59,863.58	Tractor - Grant funding provided by CEC.
1FUJC5DX2CHBF3878	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX2CHBF3881	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX2CHBF3895	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX2CHBF3900	$147,814.00	$55,924.58	$0.00	$55,924.58	Tractor - Grant funding provided by CEC.
1FUJC5DX2CHBF4089	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX2CHBF4092	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX2CHBF4108	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX2CHBF4111	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX2CHBF4125	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX3CHBF3209	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX3CHBF3212	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX3CHBF3226	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX3CHBF3243	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX3CHBF3775	$150,491.00	$58,601.58	$58,601.58		Tractor, Funded by DOE
1FUJC5DX3CHBF3873	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX3CHBF3887	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX3CHBF3890	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX3CHBF3906	$147,814.00	$55,924.58	$0.00	$55,924.58	Tractor - Grant funding provided by CEC.
1FUJC5DX3CHBF4098	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX3CHBF4103	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX3CHBF4117	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX3CHBF4120	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX4CHBF3185	$153,731.00	$61,841.58	$0.00	$61,841.58	Tractor - Grant funding provided by CEC.
1FUJC5DX4CHBF3204	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX4CHBF3218	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX4CHBF3221	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX4CHBF3235	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX4CHBF3249	$146,519.00	$54,629.58	$0.00	$54,629.58	Tractor - Grant funding provided by CEC.
1FUJC5DX4CHBF3252	$146,519.00	$54,629.58	$54,629.58		Tractor, Funded by DOE
1FUJC5DX4CHBF3767	$150,491.00	$58,601.58	$0.00	$58,601.58	Tractor - Grant funding provided by CEC.
1FUJC5DX4CHBF3770	$150,491.00	$58,601.58	$0.00	$58,601.58	Tractor - Grant funding provided by CEC.
1FUJC5DX4CHBF3879	$146,127.00	$53,579.88	$0.00	$53,579.88	Tractor - Grant funding provided by CEC.
1FUJC5DX4CHBF3882	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX4CHBF3896	$146,127.00	$53,579.88	$0.00	$53,579.88	Tractor - Grant funding provided by CEC.
1FUJC5DX4CHBF3901	$147,814.00	$55,924.58	$0.00	$55,924.58	Tractor - Grant funding provided by CEC.

1FUJC5DX4CHBF4093	$146,127.00	$53,579.88	$0.00	$53,579.88	Tractor - Grant funding provided by CEC.
1FUJC5DX4CHBF4109	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX4CHBF4112	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX5CHBF3213	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX5CHBF3227	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX5CHBF3230	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX5CHBF3244	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX5CHBF3874	$146,127.00	$53,579.88	$0.00	$53,579.88	Tractor - Grant funding provided by CEC.
1FUJC5DX5CHBF3888	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX5CHBF3891	$146,127.00	$53,579.88	$0.00	$53,579.88	Tractor - Grant funding provided by CEC.
1FUJC5DX5CHBF4099	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX5CHBF4104	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX5CHBF4118	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX5CHBF4121	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX6CHBF3186	$153,731.00	$61,841.58	$0.00	$61,841.58	Tractor - Grant funding provided by CEC.
1FUJC5DX6CHBF3205	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX6CHBF3219	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX6CHBF3222	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX6CHBF3236	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX6CHBF3768	$150,491.00	$58,601.58	$0.00	$58,601.58	Tractor - Grant funding provided by CEC.
1FUJC5DX6CHBF3771	$150,491.00	$58,601.58	$0.00	$58,601.58	Tractor - Grant funding provided by CEC.
1FUJC5DX6CHBF3883	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX6CHBF3897	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX6CHBF3902	$147,814.00	$55,924.58	$0.00	$55,924.58	Tractor - Grant funding provided by CEC.
1FUJC5DX6CHBF4094	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX6CHBF4113	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX7CHBF3214	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX7CHBF3228	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX7CHBF3231	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX7CHBF3245	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX7CHBF3875	$146,127.00	$53,579.88	$0.00	$53,579.88	Tractor - Grant funding provided by CEC.
1FUJC5DX7CHBF3889	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX7CHBF3892	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX7CHBF4105	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX7CHBF4119	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX7CHBF4122	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX8CHBF3187	$153,731.00	$61,841.58	$0.00	$61,841.58	Tractor - Grant funding provided by CEC.
1FUJC5DX8CHBF3206	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX8CHBF3223	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DX8CHBF3237	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX8CHBF3240	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX8CHBF3769	$150,491.00	$58,601.58	$0.00	$58,601.58	Tractor - Grant funding provided by CEC.
1FUJC5DX8CHBF3772	$150,491.00	$58,601.58	$0.00	$58,601.58	Tractor - Grant funding provided by CEC.
1FUJC5DX8CHBF3867	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX8CHBF3870	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX8CHBF3884	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX8CHBF3898	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX8CHBF3903	$147,814.00	$55,924.58	$0.00	$55,924.58	Tractor - Grant funding provided by CEC.
1FUJC5DX8CHBF4095	$146,127.00	$50,658.00	$50,658.00		Tractor - Funded by DOE
1FUJC5DX8CHBF4100	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX8CHBF4114	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX9CHBF3215	$146,548.00	$53,984.01	$0.00	$53,984.01	Tractor - Grant funding provided by CEC
1FUJC5DX9CHBF3229	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX9CHBF3232	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX9CHBF3246	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DX9CHBF3876	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX9CHBF3893	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX9CHBF4090	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DX9CHBF4106	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DX9CHBF4123	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DXXCHBF3207	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DXXCHBF3210	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE

1FUJC5DXXCHBF3224	$146,547.69	$53,893.70	$53,893.70		Tractor, Funded by DOE
1FUJC5DXXCHBF3238	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DXXCHBF3241	$146,547.69	$53,893.70	$0.00	$53,893.70	Tractor - Grant funding provided by CEC.
1FUJC5DXXCHBF3773	$150,491.00	$58,601.58	$0.00	$58,601.58	Tractor - Grant funding provided by CEC.
1FUJC5DXXCHBF3868	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DXXCHBF3871	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1FUJC5DXXCHBF3885	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DXXCHBF3899	$147,814.00	$55,924.58	$0.00	$55,924.58	Tractor - Grant funding provided by CEC.
1FUJC5DXXCHBF3904	$147,814.00	$55,924.58	$0.00	$55,924.58	Tractor - Grant funding provided by CEC.
1FUJC5DXXCHBF4096	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DXXCHBF4101	$146,167.00	$54,277.58	$0.00	$54,277.58	Tractor - Grant funding provided by CEC.
1FUJC5DXXCHBF4115	$146,127.00	$54,237.58	$0.00	$54,237.58	Tractor - Grant funding provided by CEC.
1XPHDW9X0CD140197	$226,447.00	$109,012.41	$0.00	$109,012.41	Tractor - Grant funding provided by CEC.
1XPHDW9X0CD140202	$226,447.00	$109,012.41	$109,012.41		Tractor, Funded by DOE
1XPHDW9X1CD140208	$226,447.00	$109,012.41	$0.00	$109,012.41	Tractor - Grant funding provided by CEC.
1XPHDW9X1CD140211	$226,447.00	$109,012.41	$0.00	$109,012.41	Tractor - Grant funding provided by CEC.
1XPHDW9X2CD140198	$226,447.00	$109,012.41	$109,012.41		Tractor, Funded by DOE
1XPHDW9X2CD140203	$226,447.00	$109,012.41	$109,012.41		Tractor, Funded by DOE
1XPHDW9X3CD140209	$226,447.00	$109,012.41	$0.00	$109,012.41	Tractor - Grant funding provided by CEC.
1XPHDW9X3CD140212	$226,447.00	$109,012.41	$0.00	$109,012.41	Tractor - Grant funding provided by CEC.
1XPHDW9X4CD140199	$226,447.00	$109,012.41	$109,012.41		Tractor, Funded by DOE
1XPHDW9X4CD140204	$226,447.00	$109,012.41	$0.00	$109,012.41	Tractor - Grant funding provided by CEC.
1XPHDW9X5CD140194	$226,511.00	$109,076.41	$109,076.41		Tractor - Funded by DOE
1XPHDW9X5CD140213	$226,447.00	$109,012.41	$0.00	$109,012.41	Tractor - Grant funding provided by CEC.
1XPHDW9X6CD140205	$226,447.00	$109,012.41	$0.00	$109,012.41	Tractor - Grant funding provided by CEC.
1XPHDW9X7CD140195	$226,447.00	$108,171.85	$108,171.85		Tractor, Funded by DOE
1XPHDW9X7CD140200	$226,447.00	$109,012.41	$0.00	$109,012.41	Tractor - Grant funding provided by CEC.
1XPHDW9X8CD140206	$226,447.00	$109,012.41	$0.00	$109,012.41	Tractor - Grant funding provided by CEC.
1XPHDW9X9CD140196	$226,447.00	$108,171.85	$0.00	$108,171.85	Tractor - Grant funding provided by CEC.
1XPHDW9X9CD140201	$226,447.00	$109,012.41	$0.00	$109,012.41	Tractor - Grant funding provided by CEC.
1XPHDW9XXCD140207	$226,447.00	$109,012.41	$0.00	$109,012.41	Tractor - Grant funding provided by CEC.
1XPHDW9XXCD140210	$226,447.00	$109,012.41	$0.00	$109,012.41	Tractor - Grant funding provided by CEC.
	$30,975,492.67	**$11,917,022.60**	**$2,608,464.73**	**$9,308,557.87**	

Total trucks 202

43 trucks funded by DOE(conversion)
159 trucks funded by CEC (conversion)

202 trucks funded by Ryder (original cost)

COST SHARE (CEC)	COST SHARE (DOE)	COST SHARE (Ryder)	TOTAL COST
$9,308,557.87	$2,608,464.73	$19,058,471	$30,975,492.67

Source: SANBAG

Data Collection and Analysis

In early 2011, and after the initial delivery and deployment of 69 of the natural gas fuel trucks, the Project Team started collecting the following "Truck/Vehicle" data:

- The number of trucks deployed on a monthly basis;
- Fuel usage and truck miles traveled;
- Estimated volume of diesel fuel displaced and LNG fuel used, as well as GHG, NOx, and PM emissions/reductions;
- Number of trucks deployed.

Information was gathered and noted in the Ryder Truck Data Report that was sent on the 10th of each month to the CEC Project Manager, along with a monthly progress report as stipulated in the grant agreement.

For the Project, Ryder assigned a staff member, Senior Manager of Alternative Fuels & Finance, to collect a variety of truck related data which includes; existing and new lease agreements with customers; monthly miles run and fuel usage; condition of the deployed trucks; accidents and other special conditions. This information was then provided to the SANBAG Project Team to include in monthly reports.

The summary of the Truck Data Reports are included in this Chapter. In addition, a great deal of the analysis of the data, findings and recommendations regarding the trucks are located in Chapter 2 and 3 of this report.

Observations Regarding the Truck Data

LNG Trucks

- One (1) truck was driven more than 80,000 miles
- Eleven (11) trucks were driven more than 40,000 miles
- Ten (10) trucks were driven more than 20,000 miles
- Thirteen (13) trucks were driven more than 10,000 miles

CNG Trucks

- Two (2) trucks were driven more than 120,000 miles
- Four (4) trucks were driven more than100,000 miles
- Seventeen (17) trucks were driven more than 50,000 miles
- Sixty-three (63) trucks were driven more than25,000 miles
- Sixty-three (63) trucks were driven more 10,000 miles
- Twenty (20) trucks were driven less than 5,000 miles

CUSTOMER SATISFACTION ANALYSIS

- One hundred and sixty-two of 167 CNG trucks that were deployed are currently leased to Ryder customers. In addition, 18 of the 35 LNG trucks are deployed and leased by Ryder customers.
- Ryder customers have demonstrated a great deal of interest in leasing CNG trucks.
- Almost 90 percent of the monthly leases continue to be with the same customers as in the past 12 months.
- At least four of Ryder's major customers such as Kraft, Fresh & Easy, 99 Cents Store and Mondelez Global have been leasing approximately 85 of the natural gas fuel trucks each.

CHAPTER 5:
List of Contractors, Subcontractors, and Vendors

Truck purchases

Peterbilt Motors Company

1700 Woodbrook Street

Denton, TX 76205

Freightliner Trucks

4435 N. Channel Ave.

Portland, OR 97217

CNG/LNG Truck Modifications

Agility Fuel Systems

10007 Elm Ave,

Fontana, CA 92335

Truck leases

99 Cents Only Stores

AM Foam

Andersen Windows

Angelica Textile

Benjamin Moore Big

O Tires

BORG Produce

CEVA Logistics

Core Mark

CVS

Dean Transportation

Fresh and Easy

Genox Transportation

Golden Eagle

Greatwide Trans

Hassett Storage

Kraft Foods, Inc.

Legget & Platt

Lily Transportation

Mondelez Global

Mohawk Industries

NASCO

NFI

Polyair Corporation

Redden Transport

Ryder Logistics

So Cal Trucking

South Coast

Staples

State Fish

Super Center

United Natural Food

US Air Conditioning

VEND Catering

Westair Gases

CHAPTER 6:
Additional Information/ Special Conditions

In July of 2012 one of the trucks was totaled in an accident in Victorville, CA. The truck VIN number was 1FUJCSDX1CHBF4116. Throughout the course of the project, SANBAG noted on the progress reports that this truck had been totaled and would be replaced by the Ryder.

SANBAG is pleased to report that truck has been replaced. Ryder has replaced vehicle 636924 as it was declared a loss after the collision. It has been replaced with Tandem Axle CNG vehicle 503997, VIN number 1FUJC5DX8DHFD8590, which is the exact same spec and fuel storage configuration (75 DGE back of cab) as vehicle 636924.

This vehicle has yet to be assigned to a customer but has been delivered to California.

GLOSSARY

CALIFORNIA AIR RESOURCES BOARD (CARB or ARB) - The "clean air agency" in the government of California, whose main goals include attaining and maintaining healthy air quality; protecting the public from exposure to toxic air contaminants; and providing innovative approaches for complying with air pollution rules and regulations.

CALIFORNIA ENERGY COMMISSION (Energy Commission or CEC) - The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The Energy Commission's five major areas of responsibilities are:

- Forecasting future statewide energy needs
- Licensing power plants sufficient to meet those needs
- Promoting energy conservation and efficiency measures
- Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels
- Planning for and directing state response to energy emergencies.

CARBON DIOXIDE EQUIVALENT (CO2e) - A metric used to compare emissions of various greenhouse gases. It is the mass of carbon dioxide that would produce the same estimated radiative forcing as a given mass of another greenhouse gas. Carbon dioxide equivalents are computed by multiplying the mass of the gas emitted by its global warming potential.

COMPRESSED NATURAL GAS (CNG) - natural gas that has been compressed under high pressure, typically between 2,000 and 3,600 pounds per square inch, held in a container. The gas expands when released for use as a fuel.

(U.S.) DEPARTMENT OF ENERGY (U.S. DOE) -- The federal department established by the Department of Energy Organization Act to consolidate the major federal energy functions into one cabinet-level department that would formulate a comprehensive, balanced national energy policy. U.S. DOE's main headquarters are in Washington, D.C.

ELECTRIC VEHICLES (EV) – A broad category that includes all vehicles that are fully powered by electricity or an electric motor.

GREENHOUSE GASES (GHG) – Any gas that absorbs infra-red radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), halogenated fluorocarbons (HCFCs), ozone (O3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

GREENHOUSE GASES, REGULATED EMISSIONS, AND ENERGY USE IN TRANSPORTATION (GREET®) - is a full life-cycle model sponsored by the Argonne National Laboratory (U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy). It fully evaluates energy and emission impacts of advanced and new transportation fuels, the fuel cycle from well to wheel and the vehicle cycle through material recovery and vehicle disposal need to be considered. It allows researchers and analysts to evaluate various vehicle and fuel combinations on a full fuel-cycle/vehicle-cycle basis.

GROSS VEHICLE WEIGHT (GVW) – The maximum operating weight/mass of a vehicle as specified by the manufacturer including the vehicle's chassis, body, engine, engine fluids, fuel, accessories, driver, passengers and cargo but excluding that of any trailers.

HIGH PRESSURE DIRECT INJECTION (HPDI) - technology involves the injection of both diesel and gas at high pressure directly into the combustion chamber at the end of the compression stroke.

KILOGRAM (kg) -- The base unit of mass in the International System of Units that is equal to the mass of a prototype agreed upon by international convention and that is nearly equal to the mass of 1000 cubic centimeters of water at the temperature of its maximum density.

LIQUIFIED NATURAL GAS (LNG) – Natural gas that has been condensed to a liquid, typically by cryogenically cooling the gas to minus 260 degrees Fahrenheit (below zero).

METHANE (CH_4) - A light hydrocarbon that is the main component of natural gas and marsh gas. It is the product of the anaerobic decomposition of organic matter, enteric fermentation in animals and is one of the greenhouse gases. Chemical formula is CH4.

MILES PER GALLON GASOLINE EQUIVALENT (MPGe) - a measure of the average distance traveled per unit of energy consumed. MPGe is used by the United States Environmental Protection Agency (U.S. EPA) to compare energy consumption of alternative fuel vehicles, plug-in electric vehicles and other advanced technology vehicles with the energy consumption of conventional internal combustion vehicles rated in miles per US gallon.

NATURAL GAS (NG) - A gaseous mixture of hydrocarbon compounds, the primary one being methane.

NATURAL GAS VEHICLE (NGV) - is an alternative fuel vehicle that uses compressed natural gas (CNG) or liquefied natural gas (LNG).

NOx - Oxides of nitrogen that are a chief component of air pollution that can be produced by the burning of fossil fuels. Also called nitrogen oxides.

ORIGINAL EQUIPMENT MANUFACTURER (OEM) - makes equipment or components that are then marketed by its client, another manufacturer or a reseller, usually under that reseller's own name.

SAN BERNARDINO ASSOCIATED GOVERNMENTS (SANBAG) - is the council of governments and transportation planning agency for San Bernardino County. SANBAG is responsible for cooperative regional planning and furthering an efficient multi-modal transportation system countywide. SANBAG serves the 1.9 million residents of San Bernardino County.

SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS CLEAN CITIES COALITION (SCAG Clean Cities Coalition) – SCAG Clean Cities Coalition works with vehicle fleets, fuel providers, community leaders, and other stakeholders to save energy and promote the use of domestic fuels and advanced vehicle technologies in transportation.**Error! Bookmark not defined.**

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD) - the air pollution control agency for all of Orange County and the urban portions of Los Angeles, Riverside and San Bernardino counties. This area of 10,740 square miles is home to over 17 million people–about half the population of the whole state of California. It is the second most populated urban area in the United States and one of the smoggiest. Its mission is to clean the air and protect the health of all residents in the South Coast Air District through practical and innovative strategies.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (U.S. EPA) - A federal agency created in 1970 to permit coordinated governmental action for protection of the environment by systematic abatement and control of pollution through integration or research, monitoring, standards setting and enforcement activities.