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# Case Study – Propane Bakery Delivery Step Vans

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# Case Study – Propane Bakery Delivery Step Vans

## Background

Propane is a promising alternative fuel for a number of transportation applications because it is widely available, even in rural areas, and it can cost less than diesel or gasoline. Propane is generically known as liquefied petroleum gas (LPG), and is sometimes marketed as propane "autogas" when used for vehicle applications. The bakery industry has begun to look at propane as a lower-cost alternative fuel, particularly as manufacturers have developed new propane vehicle products. This case study compiles information from one of the first bakeries to adopt propane technology, and broadly discusses the company's experiences, lessons learned, and considerations for deployment in other fleets.

**MAJOR FINDINGS**

- Cost Savings – The propane vehicles in this case study typically achieved a fuel cost savings of around 7 cents per mile. Unseasonably cold winter conditions caused propane prices to spike for a brief period. Long-term fuel contracts can protect against volatility.
- Payback Period – The incremental cost of the propane step vans and infrastructure can be recouped in approximately 4 to 7 years.
- Typical Usage – The propane step vans in this case study traveled around 22,800 miles per year on average and achieved fuel economy of 8.6 miles per diesel gallon equivalent (DGE).
- Energy & Environmental Impact – The total petroleum displacement was 38,000 DGE per year for these 22 step vans, while greenhouse gas (GHG) reductions were approximately 80 tons per year.

The Alpha Baking Company was formed in 1979 by a group of investors who took over one of Chicago's largest institutional bakeries, the Mary Ann Baking Company. The company has expanded its reach through the acquisition of several other bakery companies, and now has 1,400 employees involved in making and distributing baked goods throughout the upper Midwest. The company operates a total of 300 trucks, making it the third largest bakery fleet in the United States. The Alpha Baking Company is headquartered in Chicago, Illinois, and operates four baking plants, two in Chicago, one in Manitowoc, Wisconsin, and one in LaPorte, Indiana. The products from these plants are distributed to restaurants, grocery-store chains, and other customers through a series of 16 depots throughout the Midwest, including locations in Illinois, Indiana, Wisconsin, and Michigan. The depots are positioned to ensure that no customers are more than 100 miles away from one.

In 2013, Alpha Baking deployed a total of 22 propane step vans in its fleet: these trucks use the Ford E-450 chassis equipped with a 6.8-liter V-10 spark-ignition engine and a dedicated propane system built by Roush CleanTech. Alpha used these trucks to replace an existing fleet of Freightliner MT35/MT45 diesel trucks that used 5.9-liter Cummins diesel engines. The propane trucks Alpha purchased were among the first to be deployed in regular fleet service as Alpha worked with Roush to help develop this system. The current fleet of propane trucks is deployed at a single depot in the greater Chicago area.

## Motivation for Adopting Propane

Alpha Baking has been interested in alternative fuels for its delivery fleet for about a decade, and has explored a number of options to address considerations like reliable fuel supply, vehicle maintenance support, and original equipment manufacturer (OEM) warranties. Over the past decade, Alpha has examined many alternative fuel choices, including biodiesel, propane, and natural gas. It experimented with a vapor propane injection system[i] for a Class 8 diesel tractor, deployed CNG for its Class 8 tractor fleet, and tested vegetable

oil to fuel diesel engines (the latter was not sustainable because there was no OEM support for this, nor was there any fuel infrastructure). Because of its tests and experience over this 10-year period, Alpha is aware of what questions to ask when a new technology or application is made available. Robert McGuire, Alpha's Vice President of Logistics, provided the general questions the company asks when considering new technology, which include:


Figure 1. Alpha Baking Propane Fleet (Roush CleanTech)

- What level of experience does the manufacturer have with these technologies?
- How does the manufacturer support these technologies?
- Does the technology have an impact on the vehicle's base warranty?
- Is the system recognized and accepted by the vehicle service network?
- Can the technology be maintained and serviced without the need for additional tools, diagnostic software, etc.?
- What actions does the technology manufacturer take to continuously improve its products and processes, both at a specific technology level and more broadly in their daily operations?
- What testing and validation has occurred to ensure a safe and superior product over the life of the asset?

For Alpha, propane offers a number of benefits, both from an individual company perspective and from a broader national perspective. "The technology is here, and it's the right thing to do. It is better for the environment, it is good for the economy, and it reduces our dependency on foreign oil," states Robert McGuire.

### *Financial Benefits*

Although Alpha's interest in alternative fuels was mostly driven by its owners' and senior managers' desire to be good environmental stewards, financial considerations were still a factor in Alpha's decision to adopt propane. Alpha managers saw presentations from T. Boone Pickens about the benefits of natural gas, and were thus beginning to work with Ford on development of a CNG step van. As this work developed, Alpha realized that the CNG technology would not be financially viable for its fleet. To achieve the payback necessary to cover the incremental vehicle, maintenance, and infrastructure costs, the step vans had to be driven more miles than in their current operation.

At this point, a Ford representative working with Alpha recommended that it consider propane as an alternative fuel for its fleet. Propane was interesting to Alpha because truck and infrastructure costs were lower than for natural gas, and the public and private fueling infrastructure was readily available in the Midwest. It was also possible to convert the trucks back to gasoline[ii] in the future, should it be necessary for resale or other purposes. In 2012, Alpha spoke with Roush representatives and discovered that the propane step vans that Alpha wanted did not yet exist. Alpha met with the Roush engineer leading the development of the step van product to discuss Alpha's needs, and worked with Ford and the vehicle body manufacturer, Morgan Olsen, to develop initial prototype vans for a bakery application. In total, Alpha spent about 15 months researching the use of propane in its fleet.

While propane can offer ongoing fuel cost savings, the incremental cost of the propane option for the E-450 chassis (approximately $7,900[iii] per truck versus diesel) can be an initial barrier for a fleet considering the technology. Because these trucks are not being built in large quantities, the costs may come down due to economies of scale if larger volumes are ordered in the future. Currently, incentives can be used to offset some of these early incremental costs. Alpha received financial assistance from the State of Illinois in the amount of $4,000 per truck through the Illinois Green Fleet Program.[iv]

### *Environmental and Energy Benefits*

The use of propane in vehicle applications can reduce GHG emissions while also reducing dependence on petroleum. The Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool developed by Argonne National Laboratory for the Clean Cities program estimates that a propane vehicle can reduce lifecycle GHG emissions by 15% if it has the same fuel economy as a diesel vehicle (less if the fuel economy for propane is lower). Propane use in vehicles can reduce lifecycle petroleum use by 99% when that propane is derived from natural gas processing. Currently, 70% of propane is produced from natural gas, while the remaining 30% is produced through petroleum refining. Relative to model year 2010 and newer diesel trucks, new propane trucks do not offer significant air quality benefits, but replacement of older diesel trucks with these propane trucks can reduce air pollutant emissions considerably. Mr. McGuire noted that reducing emissions by replacing older diesel trucks with propane trucks in the city areas where these vehicles typically operate is important to the baking industry.

### *Recognition*

Alpha has received public recognition for its deployment of propane trucks. In late 2013, the Illinois Environmental Protection Agency designated Alpha as one of the members of the Illinois Green Fleets Program, which recognizes businesses and local governments for implementing alternative fuel vehicles in its fleet operations. The Propane Education and Research Council (PERC) recently honored Alpha with the 2014 Propane Autogas Fleet Award for its work in deploying its propane fleet. At the award ceremony, PERC chief business development officer observed, "Alpha Baking has proven to be an alternative fuel leader in both its community and nationwide."

## Project-Specific Activities

### *Vehicles Deployed*

In 2013, Alpha deployed an initial fleet of 22 propane delivery trucks at its North Aurora depot. These trucks are Class 4 Ford E-450 step vans that use a 6.8-liter V-10 spark ignition engine with a Roush dedicated liquid propane injection system. The propane trucks replaced model year 2002–2007 diesel Freightliner MT35/MT45 step vans with a Cummins 5.9-liter ISB diesel engine. Alpha selected Penske Truck Leasing to serve as the maintenance service provider for the propane vehicles, because Penske had already worked on Alpha's diesel trucks.


Figure 2. Dedicated Propane Ford E-450 Step Van Deployed in 2013 by Alpha Baking (Roush CleanTech)

### *Infrastructure Deployed*

Alpha decided to build a station onsite at its North Aurora depot to increase convenience for drivers, lower labor costs for refueling, and maintain closer control over fuel dispensing. Ferrellgas, the fuel supplier, provided the infrastructure, two aboveground 1,000-gallon propane tanks and a dispenser, to Alpha at a cost of approximately $37,000. Ferrellgas also worked with the local fire marshal in North Aurora to obtain the appropriate approvals for the station. Alpha invested an additional $23,000 in electrical and concrete contractors to meet the requirements set forth by the fire marshal.

Figure 3. Alpha Baking Onsite Refueling Station for North Aurora (Roush CleanTech)

Although the station is currently private, Alpha may consider opening the station to local governments in the future. Among the services provided by Ferrellgas is automatic replenishment of the fuel in the station; the fuel provider remotely monitors the level of fuel in the storage tanks, and returns to the site to refill the tanks when the fuel level drops to 30% of capacity.

### *Training for Drivers and Technicians*

To ensure success, the drivers and technicians received training specifically on propane vehicles and the propane fueling infrastructure. Roush trained the Penske technicians on vehicle repair and maintenance, including propane component identification, troubleshooting codes, and repair practices. The Penske technicians also received online instruction from Roush's web-based training program, including training on specific repair procedures. Alpha required its drivers to attend a Roush presentation on how to drive the propane vehicles most efficiently. Ferrellgas provided video training and in-person training with a Ferrellgas associate to explain propane safety and vehicle fueling. Attendees were tested to verify the training was effective.

## Data Analysis Results

For the purposes of this case study, Alpha Baking provided information on vehicle miles traveled, fuel used, and fuel costs per vehicle per month. The company provided data for the 22 propane trucks for the period of April 2013 through November 2014, representing operation through all four seasons. For comparison, the company also provided data for the period of January 2011 through April 2013 for the group of 24 diesel trucks that the propane vehicles replaced. The propane step vans were used in similar ways to the conventional counterparts they replaced. The propane vehicles achieved somewhat lower fuel economy performance (on an energy

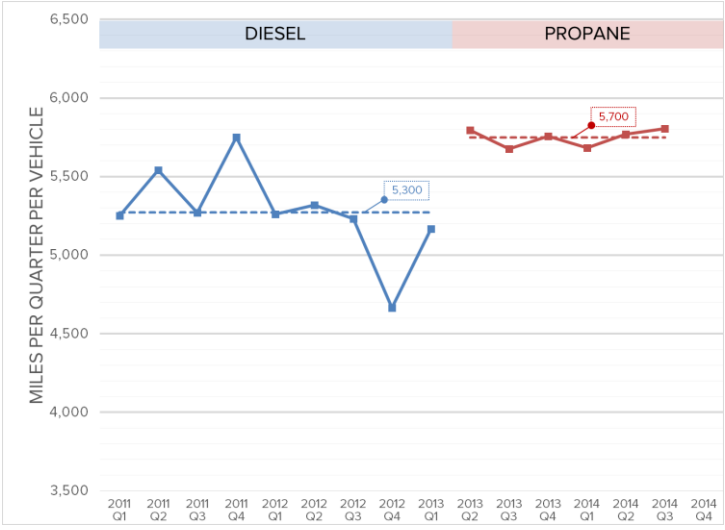


Figure 4. Vehicle Miles Traveled per Quarter per Vehicle

equivalent basis) than the diesel trucks, but provided notable petroleum displacement and GHG emission reductions. Most importantly, the fuel cost savings available to this fleet produced reasonable payback of the upfront capital costs for the propane vehicles. Although an individual fleet's payback will depend on the price differential between propane and diesel, Alpha's cost savings appear to be fairly representative of what a similar bakery fleet may experience.

### *Summary of Vehicle Operational Data*

Figure 4 shows the propane and diesel vehicles accumulated similar per-vehicle quarterly mileage; the propane trucks were replacements for the diesel trucks and were used on similar routes. The average annual mileage was 21,200 for the diesel trucks and 22,800 for the propane trucks.

Figure 5 presents quarterly fuel use per vehicle, in diesel gallon equivalents, for the diesel and propane trucks. These data translate to an average annual fuel use of 2,120 diesel gallon equivalents per diesel truck and 2,680 diesel gallon equivalents per propane truck.

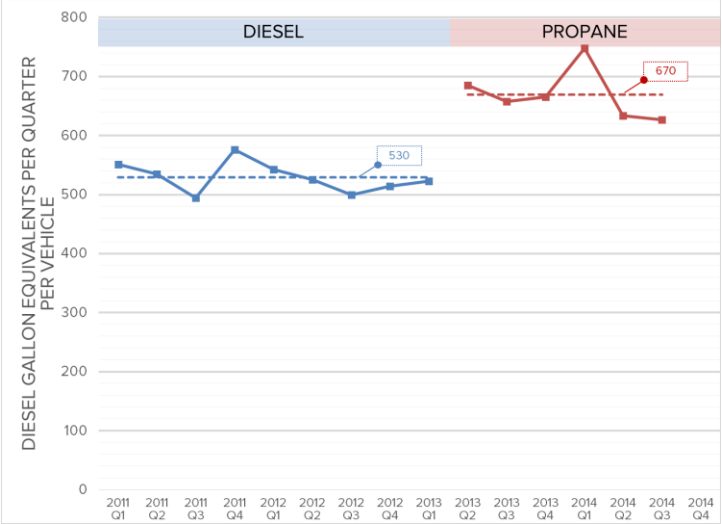


Figure 5. Fuel Use (in diesel gallon equivalents, DGE) per Quarter per Vehicle

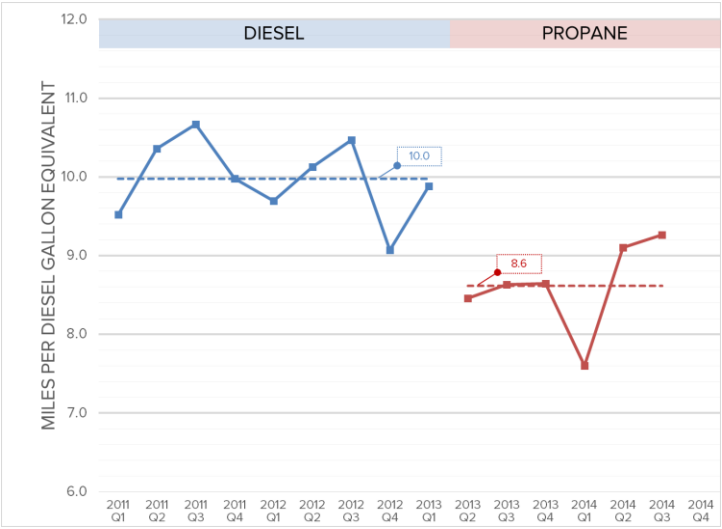


Figure 6. Fuel Economy (in miles per diesel gallon equivalent, MPDGE) per Quarter

As illustrated in Figure 6, fuel economy was 10.0 miles per diesel gallon equivalent (MPDGE) for the diesel trucks and 8.6 MPDGE for the propane trucks. This represents a 14% reduction in MPDGE for the new propane vehicles. This reduction in fuel economy (on an energy equivalent basis) is due in large part to the diesel trucks using smaller (5.9 liter) and more efficient compression ignition engines than the propane trucks, which use more powerful 6.8-liter spark-ignited engines. These propane engines did, as noted later, offer somewhat more power than the conventional diesel counterparts, which improved driver satisfaction with the vehicles. It is reasonable to assume the reduction would be smaller if the engines had the same displacement.

There appears to be a seasonal trend: fuel economy drops for both diesel and propane during the colder months in the first quarter (January–March) of the year, and increases in the warmer months. According to Robert McGuire at Alpha, one reason the performance of the propane trucks may have dropped so significantly was that vehicles were running lean during the unseasonably cold winter. Roush later identified this problem and fixed it. Mr. McGuire suggested that increased warm-up idling times and slightly higher fuel consumption at idle may have also contributed to the seasonal fuel economy fluctuations.

### *Environmental and Energy Impact Data*

Petroleum displacement and GHG reductions are important benefits of propane vehicles. Alpha Baking's operational data were used in the AFLEET Tool to estimate the reductions in petroleum use and GHG emissions for Alpha's fleet of 22 propane vehicles relative to the comparable diesel fleet being replaced. Figure 7 summarizes the total petroleum displacement and GHG reductions of the propane vehicles. The total petroleum displacement was 38,000 DGE per year, and GHG reductions were approximately 80 tons per year.

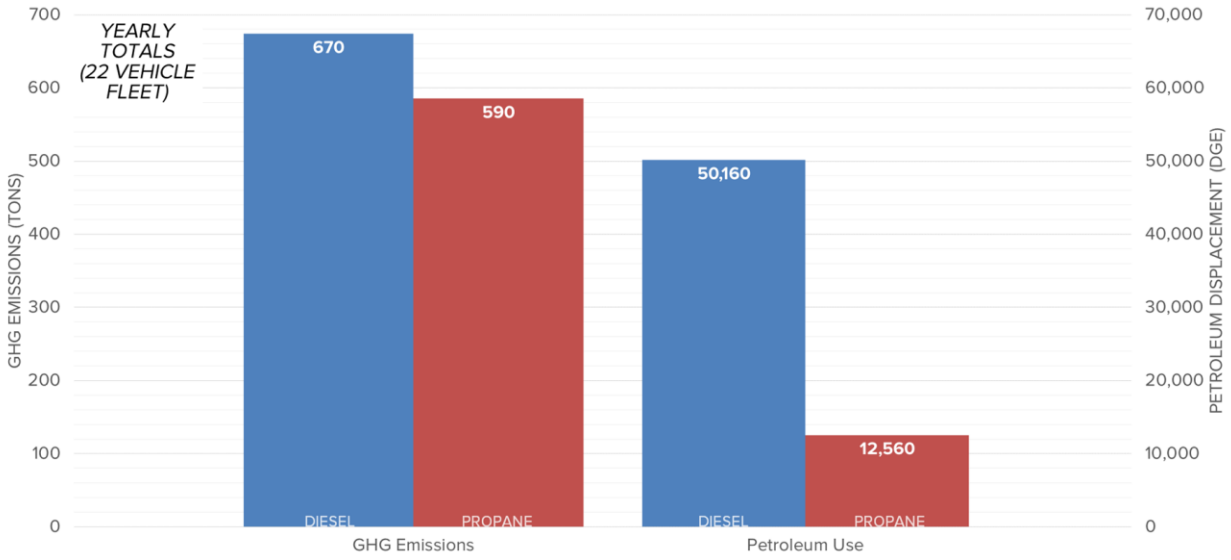


Figure 7. Greenhouse Gas Emissions and Petroleum Displacement Comparisons

### *Business Case Data*

Fleet vehicles are purchased to do a job; therefore, investments in new technologies, such as propane, must pay for themselves over time to be a viable choice for the fleet owner. Lower fuel prices and lower maintenance costs for propane relative to diesel can provide this payback opportunity and save the fleets considerable amounts of money after the capital costs for the vehicles and fueling stations are recouped. In some cases, fuel suppliers may install propane fueling stations at no cost to the fleet if fuel purchase commitments are made, which can potentially hasten cost savings. The fleet in this case study provided information that allows some assessment of potential fuel cost savings for step vans.

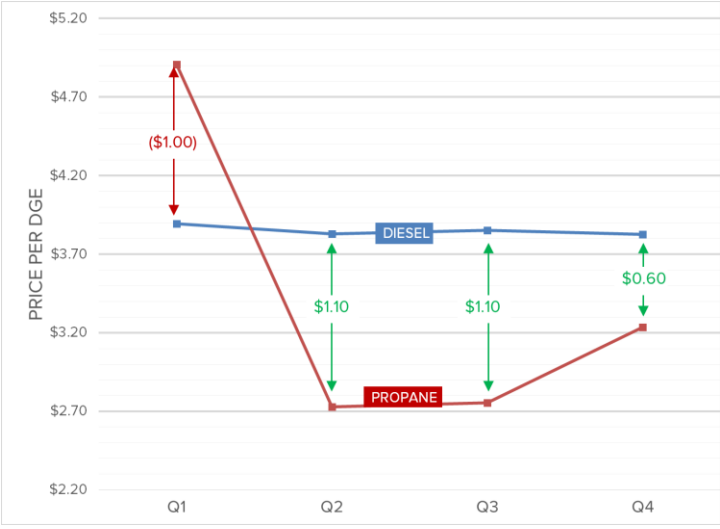


Figure 8. Fuel Costs per Diesel Gallon Equivalent by Quarter

Figure 8 presents the average diesel and propane costs per DGE for this fleet over the time period studied. During most

seasons, propane provided a considerable cost advantage of between 60 cents and $1 per DGE because of the advantageous private fleet pricing Alpha received. However, due to unseasonably cold weather that raised propane demand for other uses (such as agriculture), Alpha did encounter some difficulties with propane price increases during the winter months. This will be discussed in more detail in the Lessons Learned section.

Figure 9 compares the fuel cost per mile for the propane and diesel step van fleets, corresponding to the fuel prices in Figure 8 and the fuel efficiencies shown in Figure 6. Propane is typically less expensive on an energy equivalent basis, but the fuel efficiency of the propane vehicle is also lower, which offsets some of the fuel cost benefit. As with Figure 8, the spike in fuel prices during the first quarter of 2014 is clearly visible: also noticeable is the subsequent return to more normal propane autogas prices by the second quarter of 2014. Outside of the first quarter of 2014, the propane trucks achieved a fuel cost advantage relative to their diesel counterparts of around 7 cents per mile, without having applied the 50 cent federal excise tax credit on alternative fuel. If the federal tax credit of 50 cents per gallon were applied to the propane prices that Alpha paid, the payback period can be reduced even further, to as little as one year if maintenance cost savings are considered.[v]

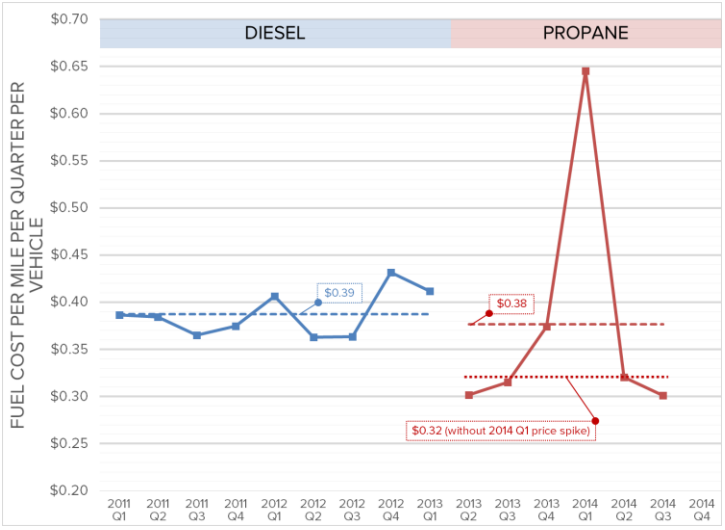

Figure 9. Fuel Costs per Mile

The major capital costs for implementing a propane truck program such as the one Alpha has developed involve the incremental cost of the propane vehicles themselves, plus the cost of any fueling infrastructure that may be necessary to support the fleet.

At a minimum, a favorable business case for a propane fleet deployment requires yearly fuel and maintenance cost savings that are sufficient to repay the initial capital costs of the vehicles and stations in a timeframe acceptable to the fleet without outside funding. Given that the propane trucks in this fleet traveled around 22,800 miles per year, and assuming the non-winter propane cost savings of 7 cents per mile, payback of the initial incremental cost of the vehicle ($7,900)[vi] can be achieved in about 5 years. This is about half of the useful life of the step van; Alpha estimates that the van bodies have a 10-year lifetime. Case 1 in Table 1 summarizes this business case situation.

Table 1. Example Business Case Analysis – Four Scenarios (dollars in thousands)

| Parameter | Case 1 | Case 2 | Case 3 | Case 4 |
|---|---|---|---|---|
| Propane fleet size | 22 | 22 | 22 | 22 |
| Number of fueling stations | 0 | 0 | 1 | 1 |
| Cost per station | N/A | N/A | $60 | $60 |
| Total vehicle incremental cost | $174 | $174 | $174 | $174 |
| Total fueling station cost | N/A | N/A | $60 | $60 |
| Total capital cost | $174 | $174 | $234 | $234 |
| Total fuel and maintenance cost savings from fleet | $33 | $63 | $33 | $63 |
| **Simple payback (years)** | **5.3** | **2.8** | **7.1** | **3.7** |

Alpha is still in the process of analyzing the data on maintenance costs, but projects that there will be

maintenance savings relative to its diesel vehicles, particularly those with post-2010 emission systems (diesel particulate filters and selective catalytic reduction systems). Data from previous propane case studies[vii] show a maintenance cost savings for propane relative to diesel of around 6 cents per mile. For the same number of annual miles traveled and the same cost savings per mile as Case 1, including this maintenance cost savings in the calculations for the propane trucks in this fleet lowers the simple payback of the initial incremental cost of the vehicle from about 5 years to 3 years. Case 2 in Table 1 summarizes this business case situation.

As noted above, Alpha invested approximately $60,000 to construct the propane fueling facility for its vehicle fleet. Including this capital cost with the total incremental cost of the 22 vehicles, and using only the fuel cost savings described above, the total simple payback of the vehicles and fueling facility is about 7 years (without maintenance cost savings). Case 3 in Table 1 summarizes this business case situation. If the estimated maintenance cost savings are included in the calculation (as shown in Case 4 in Table 1), the payback of the vehicles and fueling facility is around 4 years. If the Illinois Green Fleet incentive that Alpha received, $4,000 per truck, is applied to the incremental costs relative to diesel, the simple paybacks in Table 1 for cases 1 through 4 will be reduced to 2.6 years, 1.4 years, 4.5 years, and 2.3 years, respectively.

## Lessons Learned and Future Plans

Alpha gained valuable experience from its initial deployments, including vehicle specifications, vehicle financing, driver satisfaction, partnerships, and propane pricing. The company's experience was largely favorable, which has encouraged Alpha to consider additional propane vehicle deployments in several locations and applications across its network.

### *Lessons Learned*

Clean Cities was a critical link in making this project happen. Carl Lisek, the South Shore Clean Cities Coordinator, met with Alpha early in its process of examining alternative fuels and informed them of Roush and other suppliers that might meet its needs. Mr. Lisek helped facilitate partnerships, which are of key importance to successful deployments. Mr. McGuire noted that, "the team must include partners who are solid and major league players, and will be in business for the long haul, especially fuel suppliers." Alpha's experience with the vegetable oil project taught it that partners should be OEMs wherever possible, in order to avoid concerns with warranty coverage and to ensure Environmental Protection Agency compliance.

Teamwork is important when deploying new technologies that may still have technical issues to resolve. The step vans deployed in 2013 were early production models, developed in collaboration with Alpha and project partners Roush, Ford, and Morgan Olsen. One difficulty Alpha encountered was engine stalling at low ambient temperatures, because the trucks were running lean and not receiving enough fuel, particularly at idle.

Roush sent an engineer out to the depot to troubleshoot the problems, and he spoke with the truck operators directly to learn about the problem, running routes with the drivers to see the issues firsthand. This was critical for solving the problem. Roush determined that the issue had to do with the fuel lines freezing, which was solved by applying additional insulation on these prototype step vans.

Financing the trucks was problematic for Alpha, because the residual values for the propane trucks were largely unknown and it was difficult to determine amortization schedules. The step van bodies themselves are designed for a 10-year life, but questions remained about the rest of the vehicle. Alpha worked with their financing company, GE Capital, to develop appropriate residual values for the vehicles.

Finding the right location for deploying the propane trucks required the Alpha fleet manager to consider many factors, such as the average miles per route for each location, availability of nearby maintenance and fueling infrastructure, and space onsite for building and operating fueling infrastructure. Alpha found that only a few of its depots have enough space for onsite fueling infrastructure, so expansion to other areas will likely require that Alpha secure offsite fueling.

Drivers and customers had positive feedback about these trucks. They are quieter than the diesel vehicles they replaced, which is particularly important because bakery truck deliveries occur in the early morning hours. Mr. McGuire said that although drivers usually have difficulty accepting the benefits of new technologies, Alpha's drivers immediately embraced the propane trucks. The propane trucks had 6.8-liter V-10 engines that were more powerful than the 5.9-liter engines in the diesel trucks they replaced, which contributed to driver satisfaction. Mr. McGuire did note that Roush recalibrated the engines to reduce horsepower because Alpha felt the power increase compared to the diesel trucks was too large.

Alpha found that propane pricing could surge upward during unseasonably cold winter months. In the winter of 2013–2014, Alpha saw propane prices increase from $2 to $7 per propane gallon over two weeks as a result of frigid temperatures compounded by propane usage by farmers for drying crops. The price spike was relatively short, lasting about 3–4 weeks before leveling off at around $3 per propane gallon. Alpha learned from this experience that propane is a commodity, and the company must be concerned with how to hedge against surging prices by using longer-term contracts to lock in pricing during the year. They are getting advice from industry experts on how to do this because prices above $2 per propane gallon substantially damage the business case.

Figure 10. Display Truck for International Baking Industry Exposition (Alpha Baking)

Outreach and education were also important considerations for the project's success. Alpha displayed one of its propane trucks at the 2013 International Baking Industry Exposition, produced every 3 years by the American Bakers Association and the Bakery Equipment Manufacturers and Allieds. This display helped garner increased interest in the propane trucks among attendees; the truck displayed at this event is shown in Figure 10. Alpha has wrapped its vehicles with a design that incorporates phrases that describe propane's benefits. This has encouraged customers to stop the drivers and ask about the trucks and propane, and to get more information on the fuel and Alpha's initiatives. Additional exposure for the project has come from videos by MotorWeek[viii] and the Propane Education and Research Council.[ix]

### *Future Plans*

Based on its success with the initial deployment in the North Aurora depot, Alpha is now looking to expand the use of propane trucks to several other depots in its system; the Northwest Indiana depot may be considered as the next site. Alpha would ultimately like to move its entire step van fleet to propane, and is considering using propane for some larger delivery trucks at the Northwest Indiana site to accommodate growth, add payload, and increase efficiency. Alpha is interested in deploying trucks that are heavier than the current E-450 chassis, which have a gross vehicle weight rating of 14,500 pounds. Alpha also would like to deploy CNG for its Class 8 tractor fleet, which moves ingredients and finished goods among its production plants (Illinois, Indiana, and Wisconsin) and depots. These trucks travel between 90,000 and 125,000 miles

per year, and have relatively low loaded weights, so the additional weight of CNG equipment is not projected to be a concern in this application.

## Conclusion

Alpha drew on its previous experience with alternative fuels to deploy propane technology successfully in its delivery fleet. The trucks have performed well in daily revenue service, and are yielding reasonable paybacks of vehicle and infrastructure costs. Alpha is moving to expand the propane truck deployments elsewhere in its fleet.

The success of this initial deployment by Alpha has increased interest in the baking industry for adopting propane. Other large companies like Bimbo Bakeries USA and H&S Bakery have begun to deploy their own propane step van fleets. Bimbo Bakeries has been operating five propane trucks in Ohio for a year and half as a pilot program to test the technology. According to Gary Meresca, Bimbo Bakeries' Senior Director Fleet Services, the company will soon convert 30 delivery trucks to propane for use in Illinois and will purchase 30 new propane trucks for use in Colorado in the next year.

H&S Bakery has purchased an initial fleet of 30 Roush propane step vans for its Baltimore, Maryland, operations and intends to operate about 10% of its 600-vehicle fleet on propane with deployments in 2015 and 2016. Like Alpha, H&S has installed a private propane refueling station, developed as part of a new facility constructed in Baltimore, to serve the fleet's fuel needs. Chuck Paterakis, Vice-President for Transportation and Logistics at H&S, stated that the propane trucks were cost-efficient while being sustainable and environmentally friendly. "This is more than just our company seeking to improve the environment," explained J.R. Paterakis, the company's Vice-President for Sales and Marketing. "It's important to us and also important to all our customers, whether they are food retailers, government agencies or foodservice organizations. They are also requesting that their vendors develop strategies that will help the way we all live."

## Supplemental Information

i. Vapor propane injection is a system by which propane is injected into the engine as a vapor. The systems in the trucks for this case study use liquid propane injection, which maintains the propane as a liquid through the fuel system to an injector mounted close to each cylinder. Liquid propane injection systems offer efficiency and reliability advantages over vapor propane systems.

ii. Alpha (Robert McGuire) noted that it is possible to convert the dedicated propane vehicles to gasoline, but gasoline components (fuel pumps, tanks, fuel injectors, etc.) would need to be procured and installed in place of the propane components. Alpha is still reviewing the potential costs of such a conversion, and is still exploring the feasibility of removing and disposing of the propane fuel system components.

iii. This is the net incremental cost quoted by Roush relative to a diesel baseline for this chassis in public documentation (http://www.roushcleantech.com/popup/CleanTechSavingsCalc.htm). Alpha contacts confirmed this price is reasonable, based on their experience.

iv. The Illinois Green Fleets Program (http://www.illinoisgreenfleets.org) provides rebates of 80% of the incremental cost of an alternative fuel vehicle, up to $4,000 per vehicle, for new vehicles purchased in Illinois by an Illinois business. The rebate program was suspended in 2014 and is not currently available, according to the Green Fleets website (http://www.illinoisgreenfleets.org/rebates).

v. Alpha's fuel prices outlined in this document do not include the federal 50 cent per gallon alternative fuel excise tax credit, which originally expired in December 31, 2013, but was retroactively extended through December 31, 2014 (http://www.afdc.energy.gov/laws/laws_expired?jurisdiction=US).

vi. For the purposes of this business case analysis, the incentives Alpha received from the Illinois Green Fleets Program were not included, to make the analysis results more widely applicable nationwide. In addition, the rebate program was suspended in 2014 and is not currently available, according to the Green Fleets website (http://www.illinoisgreenfleets.org/rebates).

vii. The information on maintenance savings was taken from the Clean Cities case study on propane school buses (*Case Study – Propane School Bus Fleets*, August 2014). In this case study, the buses used engines that were different sizes from those used in the Alpha fleet (8.1-liter propane engines and 7.6-liter diesel engines versus the 6.8-liter propane engines and 5.9-liter diesel engines in the Alpha fleet). However, the maintenance cost savings are in line with the 50% reduction in maintenance costs per mile estimated by Roush in their propane vehicle business case calculators (http://www.roushcleantech.com/popup/CleanTechSavingsCalc.htm).

viii. The MotorWeek video may be viewed at http://www.afdc.energy.gov/case/1623.

ix. The Propane Education and Research Council video may be viewed at https://www.youtube.com/watch?v=Wugoq9QUt_s.


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