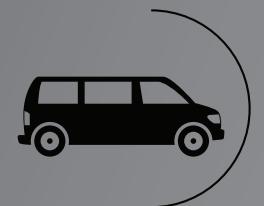
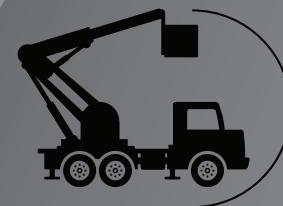
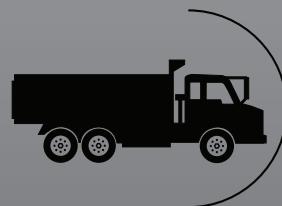
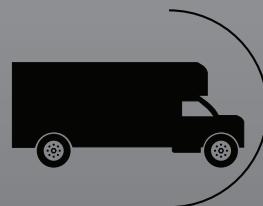


Demand Assessment of First-Mover Hybrid and Electric Truck Fleets

2012 – 2016

HTUF

High-Efficiency Truck Users Forum





Foreword

Please note: the data presented in this document was collected primarily in mid to late 2011. Subsequent changes in the industry may affect the projections herein described.

Preface

For questions or comments on the content presented here, please contact Richard Parish, Senior Program Manager (rparish@calstart.org) or Whitney Pitkanen, Project Manager (wpitkanen@calstart.org). Funding support provided for this research by the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) and the National Automotive Center (NAC) via the High-Efficiency Truck Users Forum (HTUF) program. For questions regarding CALSTART's role in accelerating the transition toward cleaner, more efficient truck technologies, please contact the report authors or visit our website at www.calstart.org.

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CALSTART is a non-profit organization that works with the public and private sectors to develop advanced transportation technologies and foster companies that will help clean the air, lessen our dependence on foreign oil, reduce global warming, and create jobs.

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1. Executive Summary

This report highlights the key findings of CALSTART's Demand Assessment of First-Mover Hybrid and Electric Truck Fleets. In contrast to previous studies and reports in this sector, this analysis directly measures and assesses fleet purchase intent for hybrid and electric trucks based on the stated plans of early-adopter fleet operators through 2016. The fleets represented in this demand assessment account for nearly nine out of every ten hybrid or electric trucks currently on the road. As a result, the findings, while likely conservative, are directly linked with real market demand expectations derived from the early market-maker fleets, as opposed to statistical models that attempt to forecast demand for the overall market. The benefit of this approach is that it provides a high level of correlation with real behavior among the early-adopter fleets. One drawback, however, is that it does not capture additional demand that may exist among fleets who have not yet begun purchasing these advanced technologies.

CALSTART's demand assessment indicates that near-term market growth will be improved over recent market demand conditions. These improvements reflect the current fleets' general satisfaction with hybrid and E-truck product offerings and their expectation that reduced cost and improved performance will become available in the very near future. Since this increased demand is being signaled by today's early adopter fleets, we believe the results represent a high degree of confidence. Additional demand from second-tier fleets was not included in this analysis and may represent additional sales growth opportunities if the industry can find a way to quickly build confidence among this larger population of fleets.

CALSTART used survey data collected directly from fleet managers and procurement directors about their future purchase decisions through 2016. While well over one thousand fleets were contacted for the report, the total number of fleets contributing specific purchase plan data totaled 82, representing more than half a million total trucks in service today. More importantly, however, these 82 fleets also represent roughly 88 percent of all the hybrid and electric trucks that have been purchased to date in North America. These early adopter fleets therefore represent the strongest first segment of the market. While CALSTART believes it highly likely that future demand will be greater than the amounts measured in this report, it also believes that these numbers provide a grounded and realistic view of future growth.

As of the release of this report, CALSTART had measured roughly 4,500 hybrid trucks produced and sold in North America, while the number of electric trucks produced and sold amounts to just under 500. Fleets measured in this report account for more than 4,300 of these vehicles. These same fleets plan to purchase an additional 18,155 hybrid and electric trucks over





the next five years, totaling more than 22,500 hybrid and electric trucks in service by the end of 2016. Factoring in the percentage of today's total market that these fleets represent, plus the expected number of trucks to be purchased as a result of incentive programs in California and New York, this leads to an adjusted, *cumulative* projection of 26,404 hybrid and electric trucks in use in 2016. CALSTART believes this number has extremely high probability as it is based directly on fleet purchase intent, but also understates the total market since it does not factor in the additional fleet adopters who are expected to join and expand the marketplace in this time frame, particularly if conventional fuel prices remain high and vehicle incremental costs go down.

The survey data also highlights the fleet applications that represent the highest current use of hybrid and electric technology and the expected growth in those segments (see table below). For instance, while many municipal fleets contributed to the survey own some hybrid or electric trucks, they represent only about 4 percent of these vehicles actually on the road in 2011, meaning they purchase just a few vehicles per fleet. On the other hand, while representing fewer total fleets in the survey, the product delivery segment (food, beverage, parcel) represents 43 percent of the current hybrid and electric trucks on the road. Interestingly, looking forward, while the product delivery segment continues to grow, it becomes a smaller percentage of the total hybrid and electric truck fleet by 2016, dropping to 19 percent of total vehicles. Meanwhile, the telecommunications industry segment is indicating strong growth, from 23 percent today to 39 percent in 2016. Due to the relatively small sample size of the product delivery and telecom fleets surveyed for this analysis, future work will focus on strengthening the statistical significance of those segments to ensure that the importance (product delivery) and dramatic growth (telecom) in their hybrid and E-truck purchases is validated and better understood (e.g., what portion of their purchases are most likely to be EV, PHEV, HEV and/or work-site electrification?).

Sector	Survey Respondents	2011: All Trucks	2011: Hybrid and Electric Trucks	2016: Hybrid and Electric Trucks
Municipal	42%	4%	1%	0.6%
Utilities	33%	8%	6%	7%
Product Delivery	12%	27%	43%	19%
Telecommunications	9%	13%	23%	39%

This data should assist OEM's to understand the needs of first-mover fleets over the next 5 years, especially as they relate to quantities of vehicles desired. Quantifying this demand should also assist OEM's in setting in-house priorities and investment decisions





regarding continued development of these technologies.

Among those fleets that have already purchased hybrid and electric trucks as of 2011, hybrid and electric vehicles remained at or near the top of their preference list for new truck technology, indicating a strong long term view and some comfort with the introductions to date. It should come as welcome news to manufacturers and suppliers that these fleets are planning for robust continuing purchases. There are still constraints in the market, but this is a strong signal.

While this report intentionally does not forecast any new users, we plan to do so in future reports. Given state incentive programs in California and New York designed to ease the cost barrier, plus the expected entry of new competitors into the market from 2012-2015, hybrid and electric trucks may see a boost in sales during this time period, though the market is likely to remain relatively small.

2. Introduction

Medium and heavy-duty commercial trucks account for only 4% of the vehicles on the road in the United States, but they consume over 20% of the gasoline and diesel used by all U.S. vehicles. As such, they are a crucial focus of U.S. efforts to clean the air and secure the nation's transportation energy future. Recognizing this need, the major commercial trucking OEM's (Original Equipment Manufacturers) in the U.S. have partnered with suppliers to bring to market small but increasing quantities of hybrid trucks over the past eight years, and more recently, smaller quantities of plug-in and battery-electric trucks or "E-trucks."

In this report, the term "hybrid trucks" will include the following drivetrains:

- Hybrid electric: Hybrid electric vehicles (HEVs) generate all their power on board, and deliver that power to the wheels, either in parallel with an internal combustion engine (ICE) or in serial with no connection between the ICE and the wheels.
- Plug-in hybrid electric (PHEV): These systems get some of their power, either parallel or serial, from an off-vehicle source.
- Hydraulic hybrid: These systems use pressurized fluid, instead of electric power, as an additional or alternative power source to the engine.

The term "E-trucks" will refer only to battery electric vehicles, as described below:





- Battery electric vehicle (BEV): These systems get all of their power from off-vehicle sources, and they store the power on the vehicle. Therefore, these vehicles require large batteries and recharging time, but they have zero emissions.

While today's E-truck offerings are primarily focused on medium-duty commercial trucks where the fuel use is much lower than long-haul Class 8 trucks, many of the foundational technology components (motors, inverters, batteries, etc.) are expected to eventually find various applications to reducing fuel use in long-haul Class 8 trucks as well.

Several market research firms agree that the hybrid and electric truck sector will gain market share from traditional trucks in upcoming years. However, those market forecasts are scattered across a wide range. To build an authentic estimate from the 'ground up,' the goal of this report was to obtain information directly from fleet managers about their future purchase intent over the next five years.

2.1. Research Methodology and Process

In the development of this report, the CALSTART team performed extensive primary and secondary research designed to increase our understanding of industry dynamics and future market development. The results of this research and analysis have been incorporated into the research results, analysis, and conclusions in this report.

2.1.1. Primary and Secondary Research Approach

The study process began with a thorough set of market-specific information derived from the following primary research:

- Online survey responses from more than 65 North American truck fleets regarding their purchase intent through 2016.
- Phone interviews with 17 industry representatives, fleet managers, and other stakeholders that could represent potential sources of demand for hybrid and electric trucks.
- Research and analysis of medium and heavy-duty truck market conditions and forecasts from CALSTART and industry sources.

In an effort to obtain feedback from the end users of commercial trucks, the online survey was emailed to 1,219 commercial trucking fleets across North America in late Spring 2011,





and data collection efforts continued through the end of the year. Responses were received from 65 fleets (though not every fleet who responded answered every question). Phone interviews were then conducted with an additional 17 fleet managers to complete the data set and fill in missing information from the survey responses where possible. Both the online survey and the phone interviews provided the team with a wide variety of information including estimates on each fleet's overall size in 2011, and the fleet owners' anticipated rates of adoption of hybrid and electric trucks through 2016.

To cross-check the findings from our primary research, the team analyzed a number of reports, articles, and websites from a variety of industry sources. Secondary research sources included Frost & Sullivan, Pike Research, Stanford School of Business, IBIS World, UCLA Anderson Strategic Management Research Program, and the UCLA Luskin Center for Innovation.

2.1.2. Primary Analysis Sections

This report consists of the following two primary analysis sections:

- Industry Trends, Current Fleet Numbers, and Market Forecasts: This section offers insight into recent trends in the industry that may impact hybrid and electric trucks sales through 2016, and presents a brief summary of the results of two recent market forecasts as a basis for survey comparison.
- Market Demand Analysis: This section provides the results of a detailed survey analysis of current and future hybrid and electric truck fleet users, which helps characterize market potential for these vehicles. It also identifies the primary market uncertainties and external factors that can affect demand of hybrid and electric trucks both positively and negatively.

3. Industry Trends, Current Fleet Numbers, and Market Forecasts

The U.S. has seen a slowdown in the overall truck market in the last couple years largely due to the economic recession and increased regulations on diesel engine emissions. These factors combined with unpredictable oil prices have brought down total revenue for the commercial trucking industry in 2010 to \$18.9 billion from a peak of \$31.9 billion in 2006¹. Total North American commercial truck sales are expected to be above 600,000 in 2012².

¹ IBISWorld. (2010). *Truck and Bus Manufacturing in 2010*.

² IHS Global Insight data for Classes 3–8





Some truck manufacturers have expanded their offerings of alternative drivetrains to help reduce fuel usage by trucks in response to the volatility of the oil market and other important drivers such as increased urbanization, more traffic congestion, government incentives, and looming regulatory and tax changes that could further raise the domestic cost of transportation fuels. In some applications, natural gas (CNG and LNG) trucks are being offered due to their ability to lower fuel “cost”, even though these engines do not reduce energy consumption on a BTU basis. Since natural gas is generally a much more abundant domestic fuel compared with petroleum-based diesel fuel, these offerings also represent an opportunity to reduce dependence on foreign oil imports. Nevertheless, hybrid, electric, and natural gas trucks still represent a very small percentage of all commercial trucks on the road in the U.S. (even when the fleet penetration is restricted to medium-duty applications where hybrid and E-trucks are most relevant). This may be due to various restraints on the market such as the price differential of these trucks, when compared to conventional vehicles; the lack of national incentives to off-set these early incremental costs; the relatively limited amount of in-use performance data (particularly for E-trucks); and lack of technology standardization. However, some industry leaders have acknowledged that hybrid trucks have moved forward at a rapid pace when compared to the conventional truck market.

Hybrid trucks began small-scale commercial deployments beginning around 2004 with large fleet operators such as FedEx Express,³ and in very recent years, several commercial truck OEM's in the US have partnered with suppliers to bring to market small quantities of E-trucks. Together, hybrid and E-trucks can represent a viable alternative for many commercial vehicle applications since they can meet a wide variety of duty cycle requirements while using less petroleum than conventional vehicles or, in the case of E-trucks, none at all.

The U.S. Energy Information Administration reported that by 2008 that there were 1,025 medium and full-size hybrid trucks in operation.⁴ In 2012, several industry experts interviewed for this report have estimated that the total number of hybrid trucks on the road in the U.S. could be anywhere from 3,500 to 4,000 units. Manufacturers have tallied approximately 4,500 hybrid trucks sold to date.

The total number of E-trucks on the road in 2012 is harder to estimate as these vehicles are newer entrants to the market. Industry experts have estimated that there are less than 500 E-trucks in operation in North America in 2012, with the first-mover fleets including Pepsico/Frito-Lay, Coca-Cola, FedEx, Staples, and UPS. The adoption of electric trucks has

³ Hoyt, D. (2006). *FedEx and Environmental Defense: Building A Hybrid Delivery Fleet*. Stanford Graduate School of Business.

⁴ US Energy Information Administration. (2010). *Annual Survey of Alternative Fueled Vehicles*.





occurred first in states such as California and New York that have enacted policies and programs to encourage these vehicles (see Section 4.3.5 for further discussion).

It should be noted that only a small handful of these hybrid and e-trucks are in long-haul Class 8 segments, so the large majority of these trucks are in medium-duty and vocational applications

As tabulated in Chart 1 below, several large research companies have published studies forecasting that the market for hybrid and E-trucks will experience very rapid growth through 2015. For example, Frost & Sullivan predicts that approximately 39,000 hybrid Class 6-8 trucks will be manufactured in North America in 2015, expanding from about 6,934 in 2009, which will represent roughly 8% of the total truck production that year⁵. In a 2011 study entitled "Strategic Analysis of North and South American Medium-Heavy Duty Hybrid and Electric Truck/Bus Markets," Frost & Sullivan also projects that 307,000 hybrid and electric buses/trucks will be manufactured worldwide in 2020, with North America home to nearly 50% of the global production and sales. Many industry experts consider these forecasts to be very optimistic.

Forecast	Report Date	Market	Forecast Year	Truck Type	# of Units
Frost & Sullivan	2009	North America	2015	Class 6-8 Hybrids, manufactured	39,000
Frost & Sullivan	2011	Global	2020	MD/HD hybrids & electric trucks and buses, manufactured	307,000
Pike Research	2011	Global	2017	Hybrids, plug-ins, electric trucks, annual sales	100,746
		Asia Pacific	2017	Hybrids, plug-ins, electric trucks, annual sales	41,657
		North America	2017	Hybrids, plug-ins, electric trucks, annual sales	25,952
		United States	2017	Hybrids, plug-ins, electric trucks, annual sales	12,743

Chart 1: Recent Forecasts for Hybrid and Electric Trucks

⁵ Frost & Sullivan. (2009). *North American Class 6-8 Truck Hybrid Powertrain Systems Market*.





In its 2011 research report⁶, Pike Research projects that the *global* market for hybrids, plug-ins, and battery-electric trucks will grow at an annual rate of 47.2% between 2011 and 2017 to reach 100,746 trucks. The Asia Pacific market will be the largest market with 41,657 trucks sold in 2017, followed by North America with 25,952 vehicles. The U.S. market for hybrid trucks is projected to reach 12,743 vehicles in 2017. The Pike report emphasizes that sales will get their biggest push in 2015 when the new truck fuel economy rules from the EPA and NHTSA come to fruition. However, most industry experts now conclude that the EPA/NHTSA fuel economy rules are capable of being achieved without the need to implement hybrid or electric truck technologies.

4. Market Demand Analysis

4.1. Survey Methodology and Background Data

CALSTART approached this report with the overarching goal of helping drive successful commercialization of hybrid and electric trucks, while understanding that commercialization may be hindered by a lack of data pertaining to potential market size, particularly *as reported by the purchasing fleets themselves*. Thus, our objective was to obtain information directly from fleet managers about their future purchase decisions over the next five years via telephone interviews and an online survey.

Detailed responses to the interviews and survey were received from a total of 82 fleets (80 from the U.S. and 2 from Canada) which provided the CALSTART team with a wide variety of information including estimates on each fleet's overall size in 2011, current numbers of hybrid and electric trucks in the 2011 fleet, and fleet projections of cumulative purchase intent for hybrids and electrics through 2016. Chart 2 below identifies the survey respondents by sector. These industry sectors are key to the hybrid and electric truck market.⁷ For instance, both hybrids and electric trucks are well-suited to the stop and go drive cycle of the product delivery industry, while the utility truck market takes advantage of idle reduction systems to reduce emissions and fuel consumption at worksites.

⁶ Pike Research. (2011). *Hybrid Medium and Heavy Duty Trucks: Hybrid, Plug-in Hybrid, and Battery Electric Medium and Heavy Trucks: Market Analysis and Forecasts*.

⁷ It should be noted that the survey data is influenced by the types of fleets that responded. The individual fleets that chose to take the survey are not representative of the entire fleet universe. However, they are likely more interested in hybrid/e-trucks in the first place and therefore are highly representative of the needs of first-movers/purchasers who are the key influencers in the early market.





Percentage of Survey Respondents by Sector

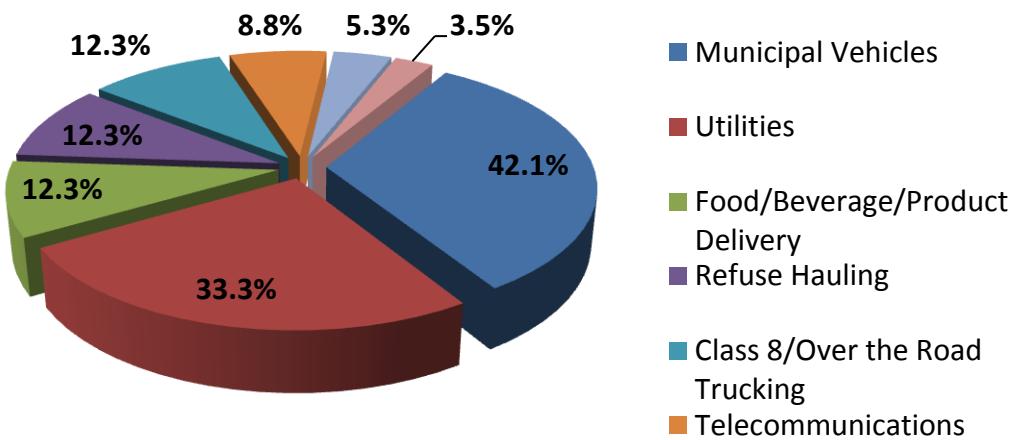


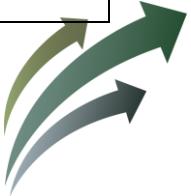
Chart 2: Percentage of Survey Respondents by Sector

Chart 3 below segments the survey data to show those fleet applications that represent the highest current use of hybrid and electric technology and the expected growth in those segments. For instance, while many municipal fleets contributed to the survey and own some hybrid or electric trucks, they represent only about 4 percent of these vehicles actually on the road in 2011, meaning they purchase just a few vehicles per fleet. On the other hand, while representing fewer total fleets in the survey, the product delivery segment (food, beverage, parcel) represents 43 percent of the current hybrid and electric trucks on the road. Interestingly, looking forward, while this segment continues to grow, it becomes a smaller percentage of the total hybrid and electric truck fleet by 2016, dropping to 19 percent of total vehicles.

Meanwhile, the telecommunications industry segment is indicating strong growth, from 23 percent today to 39 percent in 2016.

Sector	Survey Respondents	2011: All Trucks	2011: Hybrid and Electric Trucks	2016: Hybrid and Electric Trucks
Municipal	42%	4%	1%	0.6%
Utilities	33%	8%	6%	7%
Product Delivery	12%	27%	43%	19%
Telecommunications	9%	13%	23%	39%

Chart 3: Percentage of Trucks by Sector as Reported in Survey





4.2. Estimation of Market Demand

The 82 fleet owners responding to our online survey and phone calls represent 563,408 total trucks (Class 2a through 8, all technologies), with a grand total of 4,381 hybrid and electric trucks at the end of 2011, or 0.78% of all trucks in surveyed fleets.⁸ In analyzing the numbers more deeply, our research indicates that there are approximately 413 electric trucks included in that total, leaving 3,968 as the total for hybrid trucks reported in service at the end of 2011.

The total number of fleets reporting at least one or more hybrid and/or electric truck in their holdings in 2011 is 66, which represents 80% of the total survey sample. This fact reaffirms that our survey effectively tapped into an early adopter population. Sixty six (66) fleets in 2011 escalates to 78 fleets reporting hybrid and electric purchases in 2016; but none of the 12 fleets acquiring hybrid or electric trucks for the first time after 2011 planned to add more than 25 vehicles. This finding suggests that many fleets plan to “prove” the value proposition of hybrid and E-trucks within the context of their own fleets, rather than relying on the pioneering work of early adopter fleets. If this finding proves accurate, then the time horizon to achieve high levels of fleet adoption may be longer than desired, unless the industry can find meaningful ways to raise the confidence of new fleets in a shorter period of time.

In terms of projections, surveyed fleets expect to purchase a total of 18,155 hybrid and electric in the next five years. This amounts to a total stated figure of 22,536 cumulative hybrid and E-trucks in 2016, including vehicles purchased in 2011 and earlier. Three large fleets dominate this number, each with planned truck purchases in the four digits. Eight fleets predicted purchases in the 3 digits and the remainder were well below one hundred truck purchases each. The survey did not ask the fleets to differentiate between hybrid and electric purchases. Future reports will further segregate the data

Given that manufacturers have tallied approximately 4,500 hybrid trucks sold to date, our survey likely tapped into approximately 88% of current market, which leads to a *full market projection for first-mover fleets* of at least 25,609 cumulative hybrid and electric trucks for 2016. As Section 4.4 will explain in more detail below, this number will increase to a final demand assessment of 26,404 trucks when vehicles that are purchased over the next five years via the California and New York voucher programs are included in the grand total.

4.3. The Effect of Select External Factors on Demand

⁸ The 4,381 truck total includes 593 trucks from two Canadian fleets.





There are several external factors beyond a fleet's control that could markedly reduce or potentially enhance its stated purchase projections, such as the performance of sectors that rely on trucks for their business like utilities, mining, and transit authorities. Other external factors include the following:

4.3.1. Cost of Fuel

Given highly unstable fuel prices, fleets have exhibited a tremendous openness to exploring technologies that reduce and/or offset their fuel use. Fuel, after labor, is generally the highest operational cost to a commercial fleet. Fleets are exceptionally sensitive to fuel price hikes and fuel price variability, which can leave them open to substantial financial uncertainty with regard to their operating budget each year. In recent years, fleets have realized that they can no longer count on low or stable prices for their fuel. Hybrid and electric technology, by increasing efficiency and reducing fuel consumption, and by powering the vehicle from another fuel source, can have a direct business case benefit for fleets.

Several respondents in the CALSTART survey indicated that a price of \$5.00 to \$6.00 per gallon diesel will begin to narrow the price points between hybrid/electric trucks versus gasoline or diesel-only powered vehicles, based on gains in fuel efficiency in the advanced trucks.

Reductions in incremental costs of hybrid/electric trucks will also narrow this gap. Thus, the renewal of incentives is critical to hybrid deployment because, even with now-expired federal tax credit, realistic payback projections require fuel prices to be at least in the mid-\$4/gallon range for the entire life of the asset. The voucher incentives in California and New York can make a business case today in several applications.

As of late March 2012, the national average diesel fuel price climbed to \$4.14 per gallon, 24 cents per gallon higher than last year at this time, but still not likely high enough to spur on its own widespread adoption today.

4.3.2. Cost and Performance of Batteries

Many survey respondents within this study noted that battery technology, pricing, and features need to be substantially improved to make the business case for these vehicles more persuasive. Although batteries are not the only reason for high incremental costs, they are a large component of those costs, particularly in electric trucks. The hybrid and electric truck market has been dependent on foreign suppliers for some key sub-systems and components, particularly in the case of batteries. One possible mitigating factor could be the creation of a North American battery manufacturing infrastructure to ensure long-term sustainable market growth and development.





Over the last five years, the U.S. truck industry and federal and state governments have begun to place a special emphasis on establishing domestic capacity in battery manufacturing despite the lead that Asian manufacturers have in the current generation of batteries. These investments have helped support or launch several domestic manufacturers of advanced batteries; however, the battery manufacturers will require higher purchase volumes to make use of this new capacity, and recently some companies have struggled.

4.3.3. New Fuel Economy Rules in 2014-2016

In May 2010, President Obama signed a memorandum requesting new fuel economy rules for medium and heavy duty trucks. As a result, in October 2010, the EPA and the National Highway Traffic Safety Administration (NHTSA) released a draft of the new rules set to begin the first phase in 2014, finishing by 2017. These regulations were signed into law in August 2011. The new rules limit greenhouse gas (GHG) emissions as well as set fuel economy standards for three different types of trucks: combination tractors, MD/HD pickups and vans, and vocational trucks.

It is worth noting, however, that it appears unlikely the rules themselves will contribute much to hybrid or electric truck demand. The early years of the federal rules do not require large fuel economy increases, and most of the fuel economy focus is on Class 8 over-the-road trucks, which are not good early market fits for hybrid or electric technology. Where hybrid and electric technology has its greatest current benefit is in vocational trucks, which is not targeted for significant fuel savings in the current rules.

Where the rule may provide some assistance during this slow ramp-up period could be in the use of advanced technology credits by the OEMs. The federal rules allow manufacturers to obtain additional compliance credits for the production of hybrid or electric trucks, and these credits can be “banked”, or saved for later use. Several recent forecasts, including this demand analysis, have indicated that hybrid and electric truck sales will probably see their largest increase in 2015, coinciding with the beginning years of the new federal fuel economy rules. While the first phase of the federal rules is not sufficiently rigorous to impact hybrid or electric sales directly, there may be some additional benefits via credits for OEMs which do offer them.

4.3.4. Second Generation Designs and Increased Competition

In the coming years, improved system engineering (second and third generation designs), more robust supply chains, and increased competition in the hybrid and electric truck sector will likely be additional factors which bring down overall prices in the industry. Eaton Corporation is currently the dominant system supplier for medium- and heavy-duty hybrid trucks and is in the midst of on-going system improvements, including a new, larger battery that increases





fuel economy performance. Among the major commercial trucking OEMs, Paccar/Kenworth, Daimler/Freightliner and Navistar all use Eaton drivetrains. Recently, several very large companies have entered the hybrid truck market and will be competing with Eaton as system suppliers. Some of the notable new entrants include:

- **BAE Systems:** BAE is one of two dominant hybrid drivetrain system providers to the municipal bus segment. The company plans to begin offering a new parallel version of its hybrid drivetrains designed specifically for Class 6-8 commercial vehicles beginning in 2013, focusing primarily on the refuse and construction segments.⁹
- **Hino Trucks:** Hino Trucks is targeting an expanded U.S. market share and has developed a 2013 model-year Class= 5 cab-over-engine (COE) diesel- electric hybrid truck that builds on its parent company's (Toyota) supply-chain for batteries and some system components. As a result, this truck, while in a limited segment, promises to be extremely price competitive. Indeed, with incentive vouchers in some markets, they may be cheaper than their diesel counterpart. These trucks have specifications particular to the U.S. market and will be rolled out first in California, Dallas, Houston, Philadelphia, Chicago, Atlanta, Washington D.C., and the greater New York City metro area.¹⁰
- **Allison Transmission:** Allison, also a major hybrid provider to the bus segment, plans to begin offering hybrid truck drivetrains in 2013. With the aid of a \$63M development grant from the US Department of Energy, it plans to open a new plant capable of producing 20,000 hybrid systems per year when it reaches full capacity.
- **Parker Hannifin:** In March 2012, Parker Hannifin's test fleet of hydraulic hybrid refuse trucks finished its first year of service in Florida with generally impressive fuel economy benefits. Parker plans to use the results of the test fleet to market hydraulic hybrid service trucks to other cities.¹¹ Parker is also field-testing a pre-production version of a series-hydraulic parcel delivery van with the major North American delivery companies.

In the electric truck market over the last year, several manufacturers in the U.S. have stepped in to expand the market niche, including Navistar, Smith Electric Vehicles, Electric Vehicles International (EVI), VIA Motors, Quantum Technologies and Boulder EV, with Freightliner

⁹ BAE. (April, 11 2011). *BAE Systems Forms Strategic Alliance with Dennis Eagle on New Hybrid Refuse Trucks*. From Business Wire:
<http://www.bloomberg.com/apps/news?pid=conewsstory&tkr=DCA:LN&sid=a5toN07X7CS8>.

¹⁰ <http://www.worktruckonline.com/Channel/GPS-Telematics/Article/Story/2011/07/Hino-Targets-Expanded-Market-Share-with-New-Class-4-5-COEs.aspx>

¹¹ <http://www.cleveland.com/business/index.ssf?/base/business/1332700000000000&coll=1>





Custom Chassis in testing. Notably, Navistar is producing the eStar which is an up to 100-mile-per-charge, 2-ton payload electric van, and Smith is producing their Newton electric medium duty box trucks which also have a range of about 100 miles, depending on battery pack configuration, and a payload of more than 16,000 pounds. By summer 2012, Frito-Lay Foods Ltd. was the nation's biggest operator of electric trucks, with other early leaders including AT&T Inc., Staples Inc., Coca-Cola Refreshments, Pacific Gas & Electric Co., and Kansas City Power & Light Co., also purchasing Smith vehicles. Smith has recently announced it will expand its U.S. operations in 2012 by adding a manufacturing facility in New York. The new facility, Smith's second U.S. manufacturing, sales and service center, will join existing operations in Kansas City, Mo. The first Newton vehicles are planned for production in New York in the second half of 2012. New player EVI received much attention when it secured a 100 truck order from UPS, while FedEx has been quietly evaluating several possible e-truck platforms for its use.

It is also important to note that hybrid and electric technology is being introduced into a dynamic and changing marketplace. Many fleets are increasingly assessing multiple fuels, technologies and strategies as they source new vehicles. On the fuels side, natural gas is currently an especially attractive option for several applications, because increased production has caused a major near-term reduction in price compared to diesel. Long term pricing is less certain, but likely relatively stable. Propane and even gasoline are also being considered in some platforms. Added to this, fleets are also looking at "right-sizing" vehicles for applications, such as procuring smaller, lighter chassis that can greatly increase energy efficiency on some routes. Hybrid and electric technologies are now one of several options to reduce fuel use that fleets are comparing and assessing. As demand for greater energy efficiency and reduced emissions increase, however, and fleets also demand insulation from fuel price variability, hybrid and electric trucks are well positioned to compete particularly as system costs come down.

4.3.5. State Incentive Programs

The top two barriers restricting fleet purchases of hybrid and electric trucks are economic in nature. High incremental cost was identified by the survey respondents as the biggest barrier for fleet purchase in the early market years, with the second most important barrier being the current economic recession (see Chart 7 below). Consequently, the surveyed fleets indicated that incentive funding is needed to cover the incremental cost until economies of scale can be reached and costs decline.





How important are the following factors in DISCOURAGING you from investing in hybrid or electric technology for your fleet?

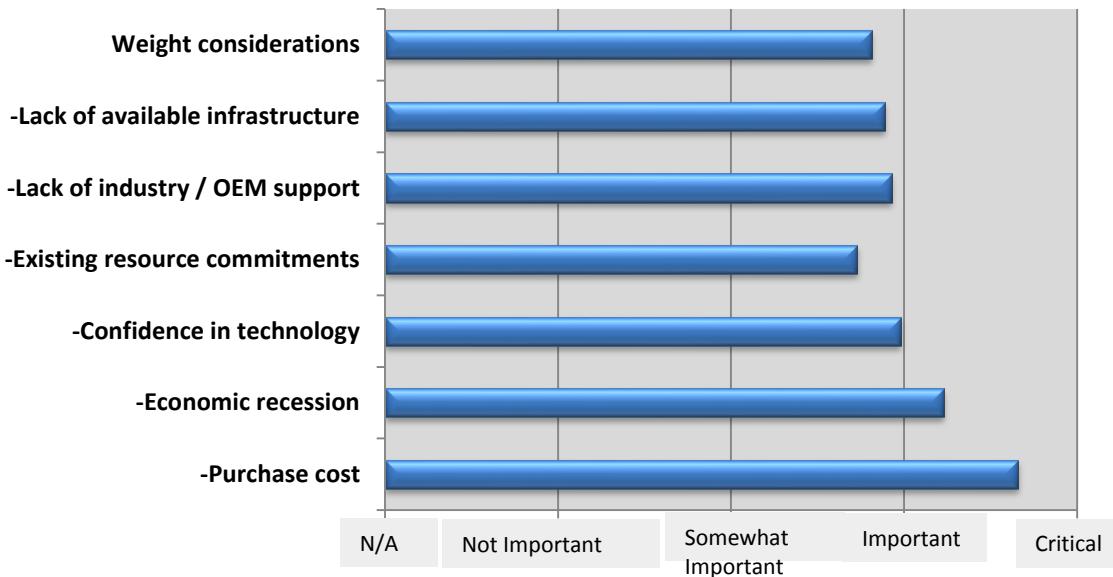


Chart 7: Survey Ranking of Barriers to Hybrid/Electric Truck Adoption

Most hybrid trucks sold today cost approximately \$40,000 more than equivalent diesel trucks, and cost differentials for electric trucks are even larger (see Chart 8 below). In response to this challenge, four states have or will implemented voucher programs to offset a portion of that incremental cost: California, Maryland, New York and Oregon. CALSTART is managing two of those programs, in California and New York.

Electric Truck	Price guidelines
Class 4 Driving	\$140,000
Class 5-6 Driving	\$155,000
Class 4 Work Site	\$170,000
Class 5-6 Work Site	\$200,000
Conventional Diesel	Price guidelines
Class 4 Driving	\$65,000
Class 5-6 Driving	\$97,000
Class 4 Work Site	\$90,000
Class 5-6 Work Site	\$130,000

Chart 8: Cost Differentials between Electric and Conventional Diesel Trucks





The California Air Resources Board has implemented the California Hybrid Truck and Bus Voucher Incentive Project (HVIP) (www.californiahvip.org). This program, now in its second year, provides as much as \$35,000 toward the cost of purchasing a hybrid truck and as much as \$50,000 toward the cost of an electric truck that operates within the state. This program has been used by a variety of large corporate fleet operators in their early adoption efforts. Since 2010, \$36.5 million in vouchers has been distributed through the program for an average of \$28,680 per vehicle.

New York Governor Andrew Cuomo in 2012 announced the development of a state-directed, federally funded, multiyear truck voucher incentive program (truck-vip.ny.gov) for commercial vehicles that has many facets. The state-wide program is an electric vehicle buyer incentive program to accelerate adoption and allow for fleet conversion throughout New York. The New York State Department of Transportation has committed \$10 million in federal Congestion Mitigation and Air Quality funding for the first year, which will be offered in the form of vouchers of up to \$20,000 per vehicle. A New York City only program, adding funds managed by the New York City Department of transportation, will provide incentive vouchers of up to \$40,000 per vehicle for qualifying electric, hybrid and natural gas trucks. This program starts with \$6 million in initial funding. The programs are operated by the New York State Energy Research and Development Authority.

4.4. Final Demand Assessment Through 2016

CALSTART's cumulative demand assessment figure starts with the 18,155 hybrid and E-trucks that surveyed fleets expect to purchase over the next five years. This figure is added to the trucks already purchased by fleets by 2011, to equal 22,536 hybrid and E-trucks. Assuming our survey respondents represent 88% of the first-mover fleet market, the figure is then expanded to 25,609 trucks to represent 100% of that market. It is next anticipated that all funds in the California and New York voucher incentive programs will be exhausted to purchase trucks over the next five years, which equals approximately 1,500 trucks (according to CALSTART estimates) and which will likely create a small spike of purchase activity between 2013 and 2014.

However, it is also expected that some percentage of those 1,500 trucks is already included in the stated demand figure reported by the surveyed fleets. In order to determine how many additional trucks should be added above the fleets' assumptions as a result of the voucher programs, we further analyzed the survey data to determine which fleets indicated that subsidies were "very important" to "critical" when making future decisions regarding investment in hybrid/electric technology. This analysis indicated that 47% of the surveyed fleets would likely utilize vouchers to purchase hybrid and E-trucks over the next five years. If we then assume that 47% of 1500 (which is the estimated number of trucks to be bought with NY and CA vouchers) is already included in the stated demand, then the remainder (795





trucks) must be additive to the fleets' assumptions. ***This results in a final cumulative demand assessment of 26,404 trucks in 2016.*** This figure remains relatively conservative because it does not forecast any new users, or count any future or additional voucher programs (except as they may be built into the surveyed fleets' own assumptions). It also assumes that there will be a nominal amount of hybrid or E-truck retirements (if any) prior to 2016 given that most vehicles have an estimated 10-year operational life and the majority of hybrids did not enter the market until around 2006.

2016	Survey: Expected Purchases	Survey: Cumulative 2011-2016	Projection: 100% of Market	Vouchers: Expected Additional Purchases	Final Demand Assessment (cumulative)
Number of Hybrid & Electric Trucks	18,155	22,536	25,609	795	26,404

4.5. Conclusion

CALSTART's demand assessment indicates that near-term market growth will be improved over recent market demand conditions. These improvements reflect the current fleets' general satisfaction with hybrid and E-truck product offerings and their expectation that product cost and performance improvements will quickly become available. Since this increased demand is being signaled by today's early adopter fleets, we believe the results represent a high degree of confidence. Additional demand from second-tier fleets was not included in this analysis and may represent additional sales growth opportunities if the industry can find a way to quickly build confidence among this larger population of fleets.

It should be noted that, while growth in sales was indicated by this survey, that growth rate appears to be slower than recently forecast by other market research teams. CALSTART's more modest projection is informed by fleet operator interviews, purchase intent survey data, and an intimate knowledge of both the California and New York incentive programs. Yet, among those fleets that have already purchased hybrid and electric trucks as of 2011, hybrid and electric vehicles remained at or near the top of their preference list for new truck technology, indicating a strong long term view and some comfort with the introductions to date. It should come as welcome news to manufacturers and suppliers that these fleets are planning for robust continuing purchases. There are still constraints in the market, but this is a strong signal.

Our data indicates that commercial fleets nationwide have a definite interest in adopting hybrid and electric trucks over the next 5 years, providing that significant barriers, such as the





high incremental purchase cost, can continue to be overcome by government incentive programs and design cost reductions. The market continues to be positively affected by the volatility of oil prices and increasingly stringent regulations. If these barriers can be adequately addressed by OEMs and advanced vehicle proponents in the next few years, vehicle purchase numbers should increase proportionally and demand will likely rise at a much faster rate.

CALSTART plans to extend the results of this survey to include more detailed analysis of the Product Delivery and Telecom segments, which appear to represent the strongest sales growth potential among the vehicle applications surveyed. In addition, CALSTART plans to expand the survey to include second-tier fleets who have not yet begun purchasing clean tech hybrid and E-trucks. The purpose for this expansion will be to quantify the level of interest in these new technologies as well as what actions may be required for the industry to see this new portion of the fleet adopt clean technologies.

5. Appendix

5.1. Selected Survey Questions and Results

(Answers have not been provided to open-ended questions below).

2. Which market / vehicle sector does your fleet represent (i.e. what is the main use of the vehicles in your fleet)?			
	Response Percent	Response Count	
Class 8 / Over-the-road trucking	12.3%	7	
Construction	5.3%	3	
Food / Beverage / Product Delivery	12.3%	7	
Military	0.0%	0	
Municipality and/or Emergency Vehicles	42.1%	24	
Parcel Delivery	3.5%	2	
Refuse Hauling	12.3%	7	
Telecommunications	8.8%	5	
Utilities	33.3%	19	
Other (please specify)		12	





Demand Assessment of First-Mover Hybrid and Electric Truck Fleets

2012 - 2016

HTUFTM

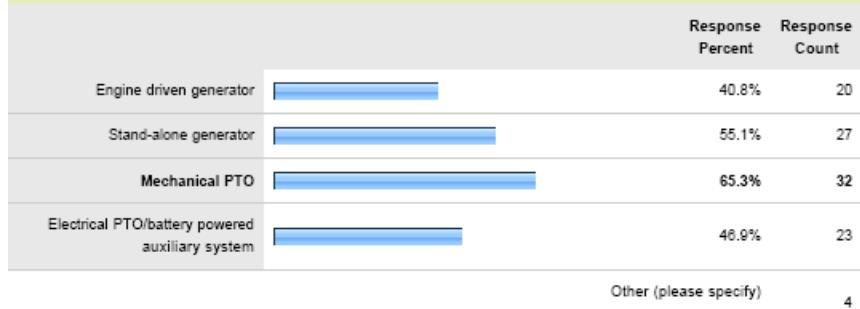
3. In seeking options to "green your fleet," please rate the following fuels and technologies according to preference:

	Highly Preferred	Somewhat Preferred	Not Preferred	N/A	Rating Average	Response Count
Biodiesel	27.6% (16)	29.3% (17)	43.1% (25)	0.0% (0)	1.84	58
Compressed Natural Gas (CNG)	28.3% (17)	28.3% (17)	41.7% (25)	1.7% (1)	1.86	60
Clean Diesel Technology	51.7% (30)	36.2% (21)	8.6% (5)	3.4% (2)	2.45	58
Electric Vehicles	52.5% (31)	25.4% (15)	22.0% (13)	0.0% (0)	2.31	59
Ethanol / Flex Fuel Vehicles	10.9% (6)	43.6% (24)	38.2% (21)	7.3% (4)	1.71	55
Hybrid Vehicles	66.1% (41)	24.2% (15)	9.7% (6)	0.0% (0)	2.56	62
Propane / LPG	14.8% (8)	24.1% (13)	55.6% (30)	5.6% (3)	1.57	54
Other (please specify)						6

4. Do you have a need to provide power for work site operations such as power tool or bucket operations?



5. What type of work site power do you use?



6. What are the numbers and types of Class 2a through Class 8 trucks in your total fleet nationwide? (If possible, please indicate numbers according to weight class).

Response Count
53





7. What number (or what percentage) of your trucks are hybrids or electric?

Response
Count

53

8. Under a "business as usual" scenario, how many hybrid or electric trucks do you anticipate adding to your fleet in the next 5 years?

Response
Count

52

9. If you have hybrid or electric trucks in your fleet, what has motivated you to purchase these vehicles?

Response
Count

37

10. If you are not purchasing hybrid or electric trucks, why not? And what types of vehicles are being purchased instead, and why?

Response
Count

28

