Tomorrow’s Vehicles
An Overview of Vehicle Sales and Fuel Consumption Through 2025

A forecast of the North American Transportation Market through 2025.
Tomorrow’s Vehicles
An Overview of Vehicle Sales and Fuel Consumption Through 2025

A forecast of the North American Transportation Market through 2025.

Executive Summary

Market Overview
Scope
Methodology

Findings
Gasoline and Ethanol
Diesel and Biodeisel
Electricity
Hydrogen
Natural Gas
Propane Autogas

Conclusion and Recommendations

About the Author

About the Fuels Institute

©2017 Fuels Institute

Disclaimer: The opinions and views expressed herein do not necessarily state or reflect those of the individuals on the Fuels Institute Board of Directors and the Fuels Institute Board of Advisors, or any contributing organization to the Fuels Institute. The Fuels Institute makes no warranty, express or implied, nor does it assume any legal liability or responsibility for the use of the report or any product, or process described in these materials.
Executive Summary

Low oil prices resulting from a sustained global oversupply are likely to rise, as production must eventually subside to balance demand. The balancing process will likely play out for some time as new vehicle fuel efficiency improvements and alternative fuel vehicles (AFVs) make advancements to road transportation, oil’s largest market, limiting price gains from production constraints.

Though low oil prices place downward pressure on alternative fuels and fuel-efficient vehicles, growth of particular technologies in various vehicle segments will not likely abate. Both governments and consumers in major light duty and commercial vehicle markets have shown particular interest in electricity and natural gas, and automakers are responding accordingly.

As a result, the energy supply chain for road transportation in North America is quickly changing. Increasing vehicle fuel efficiency is limiting gains in gasoline and diesel fuel sales that might have been made through increasing vehicle registrations, while AFVs are creating opportunities for new fuel retail business models and services. Navigant Research projects that alternative fuel light duty and commercial vehicles in use will grow from 8.4% of the North American market in 2016 to around 11.4% by 2025 under the Base scenario conditions outlined in this report.

This report seeks to provide a comprehensive analysis on the North American light duty and commercial vehicle markets by projecting the diffusion of new fuel-efficient vehicles and AFVs within the North American vehicle fleets. Projections on vehicle sales, registrations, fuel efficiency, and fuel consumption through 2025 are provided by vehicle class, powertrain technology, and supporting fuel.
Figure 1  Alternative Fuel Vehicle Share of Overall Vehicle Registrations by Powertrain, Base Scenario, North America: 2016-2025

(Source: Navigant Research)
Market Overview

The energy supply chain for road transportation in North America is changing quickly due to increasing vehicle efficiency and new vehicle technologies that use alternatives to gasoline and diesel. Spurred both by geopolitical and environmental concerns, governments globally are seeking to reduce oil consumption through a number of policies targeting oil consumption in the transportation sector.

In North America, road transportation energy policy is largely influenced by the U.S. federal government corporate average fuel economy (CAFE) and greenhouse gas (GHG) emissions standards and the second renewable fuel standard (RFS2). CAFE and GHG standards mandate that automakers increase fuel efficiency and reduce GHG emissions characteristics of new vehicles, while RFS2 mandates blend levels of biofuels within the transportation fuel pool. Additional mandates for zero emissions vehicles (ZEVs) are also found in 10 U.S. states.

The U.S. federal government also subsidizes the purchase of most alternative fuel vehicles (AFV), and a number of U.S. state and local governments provide additional subsidies and incentives for AFV owners. The Canadian national government has aligned GHG emissions standards with U.S. CAFE and GHG standards; however, biofuel mandates and AFV purchase subsidies vary by province.

Despite strong government interest in AFVs, gasoline- and diesel-powered vehicles still lead U.S. and Canadian fleets. This is a function of a number of challenges AFVs must overcome to achieve market acceptance, with the biggest obstacle being consumer awareness and understanding of these new technologies. Other issues that also must be addressed include technology costs, operating costs, accessible infrastructure, vehicle capability, and automaker support. The severity of these challenges by technology depends on the vehicle type, class, and use case.
The vehicle technologies evaluated in this report are listed in Figure 3 below alongside the fuels capable of powering them. Technology and fuel pairing vary by vehicle class; for instance, liquefied natural gas (LNG) is not consumed in light duty vehicle (LDV) or medium duty vehicle (MDV) conventional markets, and diesel is not consumed within the light duty hybrid or plug-in hybrid markets.

**Figure 3 Vehicle Technologies and Fuels**

<table>
<thead>
<tr>
<th>Vehicle Technology</th>
<th>Fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>Gasoline or Diesel</td>
</tr>
<tr>
<td>Flex Fuel Vehicle*</td>
<td>Gasoline and all ethanol blends up to E85*</td>
</tr>
<tr>
<td>Hybrid</td>
<td>Gasoline or Diesel**</td>
</tr>
<tr>
<td>Plug-in Hybrid</td>
<td>Gasoline, Diesel, and Electricity</td>
</tr>
<tr>
<td>Battery Electric</td>
<td>Electricity</td>
</tr>
<tr>
<td>Fuel Cell Electric</td>
<td>Hydrogen</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>CNG or LNG**</td>
</tr>
<tr>
<td>Propane Autogas</td>
<td>LPG</td>
</tr>
</tbody>
</table>

* Light duty market only
** Commercial Market only

(Source: Navigant Research)
Methodology

Navigant Research maintains a series of models to produce global sales projections of major AFV technologies. Core elements from each of these models have been combined in two higher-level models that forecast the penetration of all AFV technologies. One model produces sales projections for the global LDV market, and the other for the commercial vehicle market.

The resulting sales forecasts by technology are then fed into an additional model that projects vehicle fleet sizes and fuel consumption. An overview of the core model elements that produce the Navigant Research projections for this report are provided in the influence diagram below.

This Executive Summary and Overview provides a general assessment of the vehicle market through 2025 by powertrain for North America and presents fuel consumption implications for each. Specific and more detailed analysis of the LDV and commercial vehicle markets and resulting fuel demand scenarios, for both the United States and Canadian markets, is presented in the companion publications, Part 1-Tomorrow’s Vehicles: A Projection of the Light Duty Vehicle Fleet Through 2025 and Part 2: Tomorrow’s Vehicles: A Projection of the Medium and Heavy Duty Vehicle Fleet Through 2025.

Figure 4  Alternative Fuel Vehicle Penetration Model Influence Diagram

(Source: Navigant Research)
Scenarios
For the purposes of this report, Navigant Research created two scenarios, Base and Aggressive, by modifying the following core model inputs: oil prices and lithium ion (Li-ion) battery prices (an element within technology costs).

In the Base scenario, Navigant Research predicts oil prices will remain low in 2016 and rise slightly in 2017 as oil producers gradually trim production levels—from 2017 through 2025, the price of oil is expected to rise gradually but is not expected to surpass $80/barrel. In the Aggressive scenario, prices are forecast to rise more sharply in 2017 to almost $80/barrel and then continue to rise modestly to nearly $110/barrel in 2025. Price increases in oil positively affect all AFV technologies, which are assumed to have relatively stable but rising costs throughout the forecast period. Oil price increases also have a marginally negative effect on average LDV travel and the penetration of light duty trucks within the light duty market.

Figure 5 Oil Prices by Scenario, World Markets: 2016-2025

(Source: Navigant Research)
Li-ion battery packs make up a significant portion of plug-in electric vehicle (PEV) costs. Li-ion cell prices have witnessed sharp declines over the last decade due in large part to the growth of mobile electronic devices. Prices are expected to fall further over the next decade as battery suppliers scale production to meet anticipated demand from global transportation markets and stationary energy storage.

Automotive battery packaging costs are also anticipated to fall as a function of scale and innovation within battery management system designs. Navigant Research’s Base scenario assumes battery pack prices will fall 36% over the next 10 years, while the Aggressive scenario assumes prices will fall by over 50%. Battery pack cost declines positively affect PEV and marginally affect hybrid electric vehicle (HEV) technologies. A marginal negative effect from pack cost decline occurs on all other AFVs and conventional vehicles in the Aggressive scenario.

Figure 6 Li-Ion Battery Pack Price Decline by Scenario, World Markets: 2016-2025

(Source: Navigant Research)
Measuring Vehicle Sales

Navigant Research constructs overall market sales forecasts for the light duty and commercial vehicle markets using high-level macroeconomic factors of gross domestic product (GDP) and population in addition to vehicle density and historic sales data sets.

In North America, the light duty truck segment of the LDV market has grown increasingly popular over the last decade. However, growth of this segment has fluctuated marginally with the rise and fall of retail fuel prices relative to personal income. Therefore, the light duty truck share of the overall LDV market is stronger in the Base scenario where oil prices are low and weaker in the Aggressive scenario where oil prices are high.

Sales for each vehicle technology segment analyzed in this study are determined by estimating the market share of the technology against the overall market as a function of a number of variables that feed into consumer choice. At a high level, these variables are as follows:

**Technology Costs:** The purchase price of the technology relative to conventional vehicles. This variable is affected by fuel efficiency regulations, purchase subsidies, and economies of scale.

**Energy Costs:** The per-mile costs of powering the technology. This variable is affected by fuel efficiency regulations and the price of various alternative fuels.

**Vehicle Capability:** The ability of the technology to satisfy all consumer requirements; this is most tangibly conveyed through driving range, power, and hauling capacity.

**Accessible Infrastructure:** The availability of refueling/recharging infrastructure relative to conventional vehicles.

**Geopolitical Concerns:** The capacity of the technology to reduce oil consumption.

**Environmental Concerns:** The capacity of the technology to reduce carbon emissions and/or other regulated criteria air pollutants.

**Maintenance:** The estimated required costs of vehicle upkeep relative to conventional vehicles.

**Automaker Support:** The vehicle production roadmap of automakers and anticipated capacities for production by year relative to the conventional vehicle.

Due to market variability, each factor is weighed differently based on how a market is likely to value each variable relative to all others. For instance, commercial vehicle markets are assumed to be more concerned with vehicle costs, capabilities, and maintenance than LDV markets, which are assumed more likely to value infrastructure accessibility and geopolitical and environmental concerns.

Using the above variables, a score relative to the others is created for each technology. These scores are evaluated against past market performance and then used to calculate how changes to any or all of the above variables going forward will affect market share per technology.

Measuring Vehicle Fleets

The vehicle fleet is a composition of past vehicle sales and the number of vehicles that are likely still in use from when they were purchased. For each vehicle technology analyzed in this report, Navigant Research constructed a distribution of the vehicle population by age using estimates on the 2015 vehicle fleet size, historic vehicle sales, and average vehicle lifespans. The forecasts assume vehicles in light and medium duty markets have average lifespans of 16 years, while vehicles in heavy duty markets have average lifespans of 25 years. Throughout the forecast period, Navigant Research does not assume average vehicle lifespan by technology in any market will increase or decrease.
Measuring Vehicle Utilization

Average vehicle travel will vary based on the age of the vehicle and the technology. Vehicles less than 8 years old tend to drive more miles than the average fleet vehicle. Some initial market data suggests battery electric vehicles (BEVs) are driven less than conventional vehicles, likely the result of range limitations and infrastructure availability. Navigant Research assumes that as BEV ranges increase and recharging infrastructure expands, average BEV travel will near conventional vehicle averages.

Plug-in hybrid electric vehicles (PHEVs) use both grid-sourced electricity and gasoline and thus avoid the range concerns of BEVs. Navigant Research’s analysis of PHEV energy consumption in the United States suggests that PHEV cars drive around half of their miles on electricity and the other half on gasoline, while PHEV trucks are likely to drive more miles on gasoline than electricity initially. PHEV truck electricity utilization is anticipated to increase to levels near those of the PHEV passenger car segment on behalf of new vehicle introductions in economy and volume segments with larger battery capacities.

Overall average vehicle miles traveled will vary based on the cost of retail fuels relative to personal income. Higher fuel costs relative to personal income have a marginally negative effect on LDV travel; therefore, LDV travel is higher in the Base scenario than in the Aggressive. Of note, Navigant Research assumes commercial vehicle travel reactions to oil prices are negligible compared to the LDV market and therefore commercial vehicle travel assumptions remain static in each scenario.

Measuring Fuel Consumption

Fuel consumption within this study is a function of the number of vehicles in use, average annual travel by vehicle, and fuel efficiency. The equation below demonstrates the high-level consumption calculation wherein vehicles in use and fuel efficiency are indexed by the vehicle sales year or the year when the vehicle joined the fleet.

Fuel efficiency is increasing among conventional technologies in both light duty and commercial vehicle classes largely on behalf of fuel efficiency standards in the United States and Canada (measured in miles driven per fuel unit consumed).

\[
\text{Fuel consumed in year } (y) = \frac{\text{vehicles in use in year } (y) \text{ by vehicle sales year } (x) \times \text{average vehicle travel in year } (y)}{\text{vehicle fuel efficiency by vehicle sales year } (x)}
\]

(Source: Navigant Research)
Findings

The following sections discuss the various technologies and markets analyzed by this study. Each section is organized by primary fuel consumed by the various vehicle technologies. Specific and more detailed analysis of the LDV and commercial vehicle markets and resulting fuel demand scenarios, for both the United States and Canadian markets, is presented in the companion publications, Part 1 - Tomorrow’s Vehicles: A Projection of the Light Duty Vehicle Fleet Through 2025 and Part 2 - Tomorrow’s Vehicles: A Projection of the Medium and Heavy Duty Vehicle Fleet Through 2025.

Gasoline and Ethanol

In the United States and Canada, gasoline is consumed in varying blends with ethanol. The U.S. fuel pool, as incentivized by RFS2, is effectively stagnant at a blend of 10% ethanol/90% gasoline (E10). A higher-level blend, E15, is available in certain regional markets, but consumption of this blend is negligible compared to E10. The highest-level blend, E85, is more ubiquitous than E15, but can only be consumed by flex fuel vehicles (FFVs).

In Canada, ethanol is blended within gasoline at varying levels depending on the province; however, the national average blend floats at just over 6%. While a number of vehicles in Canada are FFVs, very few stations in the country provide E85, effectively limiting ethanol consumption to provincial blend mandates.

Gasoline/ethanol blends are consumed by vehicles in all classes by the following technology segmentations: conventional, hybrids (HEVs), PHEVs, FFVs, and a small number of light-duty dual-fuel capable propane autogas vehicles (PAGVs) and natural gas vehicles (NGVs).1

Projections

Consumption of gasoline and ethanol is projected to experience a compound annual growth rate (CAGR) of -0.2% in the Base scenario and -0.3% in the Aggressive. Losses are expected to come mainly from LDV markets, which account for around 90% of both fuels’ consumption. Fuel efficiency improvements to conventional vehicles alongside growing AFV adoption in light duty classes is expected to drive down consumption despite overall road vehicle market growth. Consumption from commercial vehicles is expected to increase marginally, primarily from the heavy duty segment.

1 Dual-fuel vehicle sales and populations are not segmented within this analysis and gasoline consumption on behalf of these vehicles is not projected.
Figure 7: Gasoline and Ethanol Consumption by Market, North America: 2016–2025

(Source: Navigant Research)

**Diesel and Biodiesel**

Like gasoline and ethanol, diesel is sometimes consumed as a blend of the petroleum product and a biofuel: diesel and biodiesel. Biodiesel can be consumed within diesel-powered vehicles in varying amounts; common blends are 2% (B2) and 20% (B20). However, some diesel-powered vehicles can also run on 100% biodiesel (B100). Biodiesel tends to gel in winter temperatures and therefore blend levels past B20 are uncommon to minimize potential cold weather fuel performance issues.

The blending of biodiesel within the diesel fuel pool is incentivized by both U.S. and Canadian governments, and biodiesel makes up around 2% of the overall diesel fuel pool in both countries. Biodiesel is consumed in varying blends depending on the type of vehicle, its use case, and location. Commercial vehicles are likely to consume higher blend levels of biodiesel, usually B20, as vehicles in this market are more likely to have dedicated B20 fueling facilities than LDVs.

In North America, the diesel fuel pool powers a large variety of products besides transportation. However, road transportation, specifically commercial vehicle transportation, constitutes around 55%-60% of U.S. and Canadian diesel consumption. Within the commercial vehicle market, diesel is consumed by conventional, HEV, and PHEV technology segments.

In the LDV market, diesel consumption is limited to conventional technology segments of both passenger car and light duty truck classes. Consumption of diesel from LDVs is limited in North America as diesel-powered vehicles have failed to gain significant traction in the market. In the last decade, diesel began to make headway in passenger car segments on behalf of clean diesel-branded technology.

The primary supplier of clean diesel vehicles, Volkswagen, was investigated in mid-2015 for installing software in vehicle computers that made the vehicles comply with emissions standards under test conditions but did not meet compliance in many other conditions. Navigant Research anticipates diesel passenger car sales will drop off significantly from 2014 levels.
over the next three years and slowly recover over the rest of the forecast period. However, the drop off in light duty diesel vehicle sales is expected to have only marginal impacts on diesel fuel consumption in North America.

**Projections**

Consumption of diesel and biodiesel is expected to rise through the forecast period on behalf of gains made from heavy-duty class consumption, which is forecast to more than offset losses coming from LDVs. By 2025, consumption is expected to be around 14% and 12% higher than 2016 levels in the Base and Aggressive scenarios, respectively. However, annual growth in both scenarios is slowing throughout the forecast period, the result of impacts from fuel efficiency improvements and alternative fuel adoption in commercial vehicle classes.

**Figure 8  Diesel and Biodiesel Consumption by Market, North America: 2016-2025**

(Source: Navigant Research)
Electricity

Grid-sourced electricity is consumed by PEVs, which encompasses PHEVs and BEVs. Mass-market LDVs using this technology were first introduced to North American markets in late 2010 and early 2011. Sales have since grown to over 120,000 in 2015, or about 0.7% of the North American LDV market.

PEV sales are expected to increase to over 5% and over 8% of the LDV market in the Base and Aggressive scenarios, respectively. PHEV sales are expected to grow faster in the light-duty truck class than in the passenger car class, while BEV sales are expected to grow faster in the passenger car segment than light trucks. The introduction of a number of BEV passenger cars with ranges in excess of 200 miles at purchase prices below $35,000 is expected to begin in late 2016 and 2017. These vehicles are expected to drive strong market growth from 2017 to 2018 as automakers ramp production capacity.

Penetration of PEV technologies in the commercial vehicle market has lagged the LDV market. Commercial vehicle use cases for PEVs are limited to various market segments with low volume sales, specifically medium and heavy-duty buses and medium-duty delivery and utility trucks and vans. Expected 2016 sales are estimated to be below 0.3% of the market. Navigant Research projects sales will increase to nearly 1.5% in the Base scenario and over 1.8% in the Aggressive.

Projections

Consumption of electricity is expected to rise at a CAGR of 32.2% in the Base scenario and over 37.3% in the Aggressive. Passenger cars are expected to account for a majority of electricity consumption throughout the forecast period, while commercial vehicles are expected to only amount to around 2%–4% of road transportation market electricity consumption.

Figure 9 Electricity Consumption by Market, North America: 2016–2025

(Source: Navigant Research)
Hydrogen

Fuel cell vehicles (FCVs) in light-duty and commercial vehicle classes have been placed in a number of test pilots over the last decade in the North American, European and Asia Pacific markets. The technology has multiple challenges to overcome, including technology costs, fuel costs, and accessible infrastructure. Scale promises to drop technology and fuel costs as well as grow infrastructure; however, this scale is heavily dependent on the automotive and government support that the technology currently enjoys.

The introduction of FCVs into the North American LDV markets began in 2015, and sales volumes are anticipated to be low initially with vehicle availability limited to markets near hydrogen stations. Navigant Research assumes government supported infrastructure development will expand LDV markets leading to increased sales later in the forecast period.

FCVs in commercial classes have slowly penetrated the bus market. Navigant Research expects continued growth in this segment; however, market share over the next decade is expected to be low—Navigant Research projects FCV market share will not exceed 0.04% of the commercial vehicle market before 2025.

Projections

Consumption of hydrogen is expected to grow slowly as the vehicle market finds a foundation. Anticipated technology and energy cost reductions (as well as infrastructure developments) are expected to make FCVs competitive with conventional and PEV technologies early in the next decade. Growth in consumption is expected to follow.

Figure 10 Hydrogen Consumption by Market, North America: 2016–2025

(Source: Navigant Research)
Natural Gas

Natural gas supply increased greatly over the last decade as production in North America grew considerably with the use of hydraulic fracturing techniques for oil and gas well stimulation. Natural gas does not travel as easily as oil between regions; therefore, prices between countries tend to vary considerably. The increase of natural gas supply in North America led to a price crash late in the last decade that was initially limited to the North American market and has slowly permeated to other global markets. Natural gas prices in North America had remained low relative to retail transportation fuel prices until the global oil price crash that began in mid-2014; fuel prices are now relatively equivalent to gasoline and diesel retail fuels in North America on a cost-per-mile basis.

Natural gas has been viewed positively as an alternative fuel in both light-duty and commercial vehicle markets. This is because consumption of the fuel has avoided (in varying degrees) the environmental and geopolitical concerns tied to oil consumption while providing similar performance characteristics to gasoline and diesel that other fuels cannot yet achieve. Natural gas prices are also low and stable, whereas oil prices are often high and volatile.

Though natural gas has many advantages, a particular disadvantage is limited range caused by the relatively low-pressure storage of compressed natural gas (CNG) at 3,600 psi. This pressure requires large tanks to meet competitive conventional vehicle ranges; however, the larger the tank, the greater the packaging issue. Due to this disadvantage, penetration of NGVs is effectively limited to fleet and commercial vehicles, including light-duty trucks and medium- and heavy-duty trucks and buses that can afford space losses for fuel storage.

Some government support has spurred development of regional publically accessible refueling infrastructure networks in the United States. A few automakers have produced natural gas passenger cars, but in limited volumes. Interest within the passenger car segment has waned of late, as evidenced by Honda’s cancellation of its natural gas-powered variant of the Civic in 2015. Fleets with dedicated refueling infrastructure offer the best opportunities for NGV penetrations within the light truck segment.

Interest in natural gas is higher in commercial markets where other alternative fuels cannot compete economically or physically with gasoline and diesel. A specific opportunity lies in long-haul trucking where diesel dominates. LNG is more energy dense than CNG and can therefore be stored in higher volumes within vehicles, allowing longer ranges between refuels that satisfy long-haul trucking needs. LNG infrastructure is being developed along major U.S. corridors to fuel a growing fleet of high mileage heavy duty NGVs. Navigant Research forecasts that NGVs will grow from representing less than 1.5% of the 2016 in-use fleet of heavy-duty trucks and buses to nearly 2.6% in the Base scenario and 2.9% in the Aggressive.
Projections
Consumption of natural gas is expected to rise at a CAGR of 9.5% in the Base scenario and 10.5% in the Aggressive scenario from 2016 to 2025. Heavy-duty vehicle consumption is estimated to account for nearly 87% of total natural gas consumption in 2016. Heavy-duty consumption as a proportion of the total road sector consumption is expected to grow continuously through the forecast period as competing AFVs in other vehicle markets put downward pressure on natural gas growth elsewhere.

Figure 11 Natural Gas Consumption by Market, North America: 2016–2025

(Source: Navigant Research)
Propane Autogas

Also known as liquefied propane gas (LPG), propane autogas historically has been a popular alternative fuel in specific national markets of Europe, Asia Pacific and South America. Despite its popularity elsewhere, vehicles powered by the fuel have witnessed limited adoption among LDV markets in North America, as availability is limited to aftermarket conversions. Some applications in various commercial vehicle markets do however show promise, specifically shuttle and school bus markets as well as Class 3-7 inner city utility and refuse trucks.

Navigant Research projects that light PAGV markets will gradually decline as other AFVs push the technology out of the market, specifically PEVs and NGVs in passenger car and light-duty truck markets. PAGVs are expected to fare better in commercial vehicle markets, but volumes are expected to be limited relative to NGVs. Navigant Research forecasts that medium-duty and heavy-duty PAGVs account for just over 0.6% of the commercial vehicle market in 2016 and are expected to grow to over 1.1% in the Base scenario and nearly 1.2% in the Aggressive by 2025.

Projections

Consumption of propane autogas is expected to rise at a CAGR of nearly 4.6% in the Base scenario and 5.0% in the Aggressive scenario from 2016 to 2025. Heavy-duty buses and refuse trucks are expected to account for a majority of autogas consumption early in the next decade as consumption from light-duty trucks and passenger cars fades.

Figure 12 Propane Autogas Consumption by Market, North America: 2016–2025

(Source: Navigant Research)
Conclusion and Recommendations

The low price of oil on behalf of the global glut is unlikely to remain at such perpetually low levels. Production of oil must eventually subside to be more in line with consumption; however, this balancing process will likely play out over some time. Sluggish demand growth and alternative fuel advances to oil’s largest market, road transportation, may blunt any significant price increases gained by production constraints.

The low price of oil itself places downward pressure on competing alternative fuels. However, growth of particular technologies in various vehicle segments is not likely to abate in the near term. Automaker support for PEV technologies in LDV markets is well incentivized by government policies globally, and consumers have shown interest. Though the technology still accounts for a limited fraction of the LDV market, continued decline in technology costs alongside increased range are expected to continue the strong market growth the technology has witnessed in North America. Similarly, automaker compliance with global fuel efficiency and GHG standards are expected to push major suppliers to adapt PHEV technologies to multiple existing model lines. This process is well underway, with many automakers competing in the luxury LDV market where PEV technologies are highly competitive.

Outside of the LDV market, multiple alternative fuel technology vendors are seeking to gain traction in various commercial vehicle use cases. The medium- and heavy-duty bus market has attracted attention from all technologies; however, annual sales volumes in this market are historically low relative to the rest of the commercial vehicle market. Alternative fuel performance in medium- and heavy-duty truck markets has been limited due to technological limitations. Natural gas, however, may be able to carve out growing portions of the market in long-haul Class 8 use cases, which account for a vast majority of commercial vehicle fuels consumption.

FCVs still need to prove viability in light-duty and commercial vehicle markets. Despite strong automaker and government support, the technology may still run into the same problems NGVs and PAGVs have had in accessing light-vehicle markets. If FCVs are to succeed, technology and energy costs will need to come down quickly before BEV range and costs are competitive with conventional technologies without subsidies. If a foundation for FCVs in the LDV market can be achieved before 2025, the technology may eventually be a realistic alternative to conventional vehicles and competing alternatives.

Fuel suppliers seeking to capture alternative fuel market growth should focus on electricity and natural gas opportunities. Hydrogen may eventually be an opportunity; however, automakers must show sales successes with initial model lines being introduced in the next five years. Propane autogas opportunities are limited to fuel suppliers of commercial vehicle fleets that are likely to operate fleet-owned refueling facilities.
About the Author

Navigant Research has provided the information in this publication for informational purposes only. The information has been obtained from sources believed to be reliable; however, Navigant does not make any express or implied warranty or representation concerning such information. Any market forecasts or predictions contained in the publication reflect Navigant’s current expectations based on market data and trend analysis. Market predictions and expectations are inherently uncertain and actual results may differ materially from those contained in the publication. Navigant and its subsidiaries and affiliates hereby disclaim liability for any loss or damage caused by errors or omissions in this publication.

Any reference to a specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply an endorsement, recommendation, or favoring by Navigant.

This publication is intended for the sole and exclusive use of the original purchaser. No part of this publication may be reproduced, stored in a retrieval system, distributed or transmitted in any form or by any means, electronic or otherwise, including use in any public or private offering, without the prior written permission of Navigant Consulting, Inc., Chicago, Illinois, USA.

Government data and other data obtained from public sources found in this report are not protected by copyright or intellectual property claims.
About the Fuels Institute

The Fuels Institute, founded by NACS in 2013, is a 501(c)(4) non-profit research-oriented think tank dedicated to evaluating the market issues related to vehicles and the fuels that power them. By bringing together diverse stakeholders of the transportation and fuels markets, the Institute helps to identify opportunities and challenges associated with new technologies and to facilitate industry coordination to help ensure that consumers derive the greatest benefit.

The Fuels Institute commissions and publishes comprehensive, fact-based research projects that address the interests of the affected stakeholders. Such publications will help to inform both business owners considering long-term investment decisions and policymakers considering legislation and regulations affecting the market. Our research is independent and unbiased, designed to answer questions, not advocate a specific outcome. Participants in the Fuels Institute are dedicated to promoting facts and providing decision makers with the most credible information possible, so that the market can deliver the best in vehicle and fueling options to the consumer. For more about the Fuels Institute, visit www.fuelsinstitute.org.

Board of Advisors  (*Denotes individual who also serves on Board of Directors)

- **Jay Ricker (Chairman)***
  Ricker’s
- **Robert Wimmer (Treasurer)***
  Toyota Motor North America, Inc.
- **Jeremy Bezdek**
  Flint Hills Resources
- **Wendy Chronister**
  Chronister Oil Company
- **Mark DeVries***
  POET Ethanol Products
- **Karl Fails**
  Sunoco
- **Matthew Forman*’**
  FCA
- **Deborah Grimes**
  Casey’s General Stores
- **Doug Haugh*’**
  Mansfield Oil Company
- **Norman Herrera**
  Sparq Natural Gas, LLC
- **Tom Kloza**
  OPIS
- **JeSean Hopkins**
  Nissan North America
- **Steve Loehr*’**
  Kwik Trip, Inc.
- **Mike Lorenz**
  Sheetz, Inc.
- **Brian Mandell*’**
  Phillips 66 Company
- **Rebecca Monroe**
  General Motors
- **Jeff Morris*’**
  Alon USA
- **Jim Pirolli**
  Kum&Go
- **Derek Regal**
  Tesoro Refining and Marketing Company, LLC
- **Rob Sabia*’**
  Gulf Oil, L.P.
- **Jon Scharingson**
  Renewable Energy Group
- **Danny Seals**
  Gilbarco Veeder-Root
- **Robert Stein**
  Kalibrate
- **Norman Turiano*’**
  Turiano Strategic Consulting
- **Michael Whatley*’**
  Consumer Energy Alliance
- **Dave Whikehart**
  Marathon Petroleum Corporation
- **Craig Willis**
  Archer Daniels Midland Company
Participants

CORPORATE PARTNERS
Doug Dorfman
CHS, Inc. (CENEX)
Jeff Murphy
Copec
Jeff Cole
Costco Wholesale
Peter Davis
GreenPrint, LLC
Steve Vander Griend
ICM, Inc.
Kevin McWilliams
Lucas Oil Products
Ashlee Kidd
Metroplex Energy, Inc.
Ron Oligney
Midwest Methanol, LLC
John Dimartini
The Andersons, Inc.
Deanna Murlin
The Lubrizol Corporation

Tracy Williams-Prince
U.S. Venture, Inc.
Scott Negley
Wayne Fueling Systems
Robert Nix
WEX, Inc.
Tom Tietjen
Xerxes Corporation

ASSOCIATION PARTNERS
Valerie Ughetta
Alliance of Automobile Manufacturers
Ron Lamberty
American Coalition for Ethanol (ACE)
Tricia Anderson
Canadian Independent Petroleum Marketers Association

Joe Gagliano
CA Fuel Cell Partnership
Ezra Finkin
Diesel Technology Forum
Robin Vercura
Fuel Freedom Foundation
Chris Billey
Growth Energy
Gregory Dolan
Methanol Institute
Jessica Bennett
National Corn Growers Association
Paige Anderson
NACS
David Fialkov
NATSO
Jeff Clarke
NGV America
Kris Kiser
Outdoor Power Equipment Institute

Rick Long
Petroleum Equipment Institute
Rob Underwood
Petroleum Marketers Association of America
Dawn Carlson
PMCI/RINAlliance, Inc.
Robert White
Renewable Fuels Association
Ryan McNutt
SIGMA
Wayne Geyer
STI/SPFA
Scott Fisher
Texas Food & Fuel Association

Financial Support

Founder Level
NACS

Platinum Contributor
SIGMA

Gold Contributors
Archer Daniels Midland Company
Casey's General Stores
Chronister Oil Company
Consumer Energy Alliance
FCA
Flint Hills Resources
General Motors
Gilbarco Veeder-Root
Kalibrate
Kum & Go
Kwik Trip

Marathon Petroleum Corporation
Nissan North America
OPIS
Phillips 66 Company
POET Ethanol Products
Renewable Energy Group
Sheetz, Inc.
Sunoco
Tesoro Refining and Marketing Company, LLC
Toyota Motor
North America, Inc.

Lucas Oil Products
Metroplex Energy, Inc.
Midwest Methanol, LLC
U.S. Oil
The Andersons
The Lubrizol Corporation
Wayne Fueling Systems
Xerxes Corporation

Association Partners
Alliance of Automobile Manufacturers
American Coalition for Ethanol
CA Fuel Cell Partnership
Canadian Independent Petroleum Marketers Association
Diesel Technology Forum

Fuel Freedom Foundation
Growth Energy
Methanol Institute
National Corn Growers Association
NATSO
NGV America
Outdoor Power Equipment Institute
Petroleum Equipment Institute
Petroleum Marketers Association of America
PMCI | RINAlliance, Inc.
Renewable Fuels Association
STI/SPFA
Texas Food & Fuel Association

Bronze Contributors
CHS, Inc. (CENEX)
Copec
Costco Wholesale
GreenPrint, LLC
ICM, Inc.

Fuels Institute Staff

John Eichberger
Executive Director
ejichberger@fuelsinstitute.org

Amanda Appelbaum
Director, Research
aappelbaum@fuelsinstitute.org

Donovan Woods
Director, Operations
dwoods@fuelsinstitute.org

Participants

CORPORATE PARTNERS
Doug Dorfman
CHS, Inc. (CENEX)
Jeff Murphy
Copec
Jeff Cole
Costco Wholesale
Peter Davis
GreenPrint, LLC
Steve Vander Griend
ICM, Inc.
Kevin McWilliams
Lucas Oil Products
Ashlee Kidd
Metroplex Energy, Inc.
Ron Oligney
Midwest Methanol, LLC
John Dimartini
The Andersons, Inc.
Deanna Murlin
The Lubrizol Corporation

Tracy Williams-Prince
U.S. Venture, Inc.
Scott Negley
Wayne Fueling Systems
Robert Nix
WEX, Inc.
Tom Tietjen
Xerxes Corporation

ASSOCIATION PARTNERS
Valerie Ughetta
Alliance of Automobile Manufacturers
Ron Lamberty
American Coalition for Ethanol (ACE)
Tricia Anderson
Canadian Independent Petroleum Marketers Association

Joe Gagliano
CA Fuel Cell Partnership
Ezra Finkin
Diesel Technology Forum
Robin Vercura
Fuel Freedom Foundation
Chris Billey
Growth Energy
Gregory Dolan
Methanol Institute
Jessica Bennett
National Corn Growers Association
Paige Anderson
NACS
David Fialkov
NATSO
Jeff Clarke
NGV America
Kris Kiser
Outdoor Power Equipment Institute

Rick Long
Petroleum Equipment Institute
Rob Underwood
Petroleum Marketers Association of America
Dawn Carlson
PMCI/RINAlliance, Inc.
Robert White
Renewable Fuels Association
Ryan McNutt
SIGMA
Wayne Geyer
STI/SPFA
Scott Fisher
Texas Food & Fuel Association

Financial Support

Founder Level
NACS

Platinum Contributor
SIGMA

Gold Contributors
Archer Daniels Midland Company
Casey's General Stores
Chronister Oil Company
Consumer Energy Alliance
FCA
Flint Hills Resources
General Motors
Gilbarco Veeder-Root
Kalibrate
Kum & Go
Kwik Trip

Marathon Petroleum Corporation
Nissan North America
OPIS
Phillips 66 Company
POET Ethanol Products
Renewable Energy Group
Sheetz, Inc.
Sunoco
Tesoro Refining and Marketing Company, LLC
Toyota Motor
North America, Inc.

Lucas Oil Products
Metroplex Energy, Inc.
Midwest Methanol, LLC
U.S. Oil
The Andersons
The Lubrizol Corporation
Wayne Fueling Systems
Xerxes Corporation

Association Partners
Alliance of Automobile Manufacturers
American Coalition for Ethanol
CA Fuel Cell Partnership
Canadian Independent Petroleum Marketers Association
Diesel Technology Forum

Fuel Freedom Foundation
Growth Energy
Methanol Institute
National Corn Growers Association
NATSO
NGV America
Outdoor Power Equipment Institute
Petroleum Equipment Institute
Petroleum Marketers Association of America
PMCI | RINAlliance, Inc.
Renewable Fuels Association
STI/SPFA
Texas Food & Fuel Association

Bronze Contributors
CHS, Inc. (CENEX)
Copec
Costco Wholesale
GreenPrint, LLC
ICM, Inc.

Fuels Institute Staff

John Eichberger
Executive Director
ejichberger@fuelsinstitute.org

Amanda Appelbaum
Director, Research
aappelbaum@fuelsinstitute.org

Donovan Woods
Director, Operations
dwoods@fuelsinstitute.org

Participants

CORPORATE PARTNERS
Doug Dorfman
CHS, Inc. (CENEX)
Jeff Murphy
Copec
Jeff Cole
Costco Wholesale
Peter Davis
GreenPrint, LLC
Steve Vander Griend
ICM, Inc.
Kevin McWilliams
Lucas Oil Products
Ashlee Kidd
Metroplex Energy, Inc.
Ron Oligney
Midwest Methanol, LLC
John Dimartini
The Andersons, Inc.
Deanna Murlin
The Lubrizol Corporation

Tracy Williams-Prince
U.S. Venture, Inc.
Scott Negley
Wayne Fueling Systems
Robert Nix
WEX, Inc.
Tom Tietjen
Xerxes Corporation

ASSOCIATION PARTNERS
Valerie Ughetta
Alliance of Automobile Manufacturers
Ron Lamberty
American Coalition for Ethanol (ACE)
Tricia Anderson
Canadian Independent Petroleum Marketers Association

Joe Gagliano
CA Fuel Cell Partnership
Ezra Finkin
Diesel Technology Forum
Robin Vercura
Fuel Freedom Foundation
Chris Billey
Growth Energy
Gregory Dolan
Methanol Institute
Jessica Bennett
National Corn Growers Association
Paige Anderson
NACS
David Fialkov
NATSO
Jeff Clarke
NGV America
Kris Kiser
Outdoor Power Equipment Institute

Rick Long
Petroleum Equipment Institute
Rob Underwood
Petroleum Marketers Association of America
Dawn Carlson
PMCI/RINAlliance, Inc.
Robert White
Renewable Fuels Association
Ryan McNutt
SIGMA
Wayne Geyer
STI/SPFA
Scott Fisher
Texas Food & Fuel Association

Financial Support

Founder Level
NACS

Platinum Contributor
SIGMA

Gold Contributors
Archer Daniels Midland Company
Casey's General Stores
Chronister Oil Company
Consumer Energy Alliance
FCA
Flint Hills Resources
General Motors
Gilbarco Veeder-Root
Kalibrate
Kum & Go
Kwik Trip

Marathon Petroleum Corporation
Nissan North America
OPIS
Phillips 66 Company
POET Ethanol Products
Renewable Energy Group
Sheetz, Inc.
Sunoco
Tesoro Refining and Marketing Company, LLC
Toyota Motor
North America, Inc.

Lucas Oil Products
Metroplex Energy, Inc.
Midwest Methanol, LLC
U.S. Oil
The Andersons
The Lubrizol Corporation
Wayne Fueling Systems
Xerxes Corporation

Association Partners
Alliance of Automobile Manufacturers
American Coalition for Ethanol
CA Fuel Cell Partnership
Canadian Independent Petroleum Marketers Association
Diesel Technology Forum

Fuel Freedom Foundation
Growth Energy
Methanol Institute
National Corn Growers Association
NATSO
NGV America
Outdoor Power Equipment Institute
Petroleum Equipment Institute
Petroleum Marketers Association of America
PMCI | RINAlliance, Inc.
Renewable Fuels Association
STI/SPFA
Texas Food & Fuel Association

Bronze Contributors
CHS, Inc. (CENEX)
Copec
Costco Wholesale
GreenPrint, LLC
ICM, Inc.

Fuels Institute Staff

John Eichberger
Executive Director
ejichberger@fuelsinstitute.org

Amanda Appelbaum
Director, Research
aappelbaum@fuelsinstitute.org

Donovan Woods
Director, Operations
dwoods@fuelsinstitute.org