WHITE PAPER

Five U.S. Alternative Fuel and Advanced Vehicle Trends to Watch

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Executive Summary

Major federal tax credits and direct funding streams supporting the alternative fuel and advanced vehicle industry have expired during the past two years. As a result, stakeholders and analysts have expressed apprehension about the future prospects of the industry.

In many ways, alternative fuels have depended on these funding streams to gain market traction and compete with traditional petroleum fuels. However, a review of recent trends suggests that contrary to many expectations, optimism exists. Through our work with a diverse set of clients in the alternative transportation fuel industry, ICF Incorporated is in a unique position to evaluate the market.

In this paper, ICF reviews five trends of note:

- Increased demand in the medium- and heavy-duty sectors for gaseous fuels;
- Strong growth in plug-in electric vehicles (PEVs) supported by state and utility incentives;
- Innovations and growth in biofuels resulting from compliance markets;
- Increased awareness and adoption of third-party leasing and ownership models for alternative fueling infrastructure; and
- New approaches for fleet management.

At a time of waning federal financial support, we find that states and the private sector have moved to fill the incentive gap. When combined with steadily improving technology costs and options, alternative fuel vehicles (AFVs) and advanced vehicles, including PEVs, are exhibiting solid to robust market performance. They are poised to continue to do so in the next 5 to 10 years, with some exceptions.

Clearly, challenges remain for each technology and for the sector as a whole. For example, declining oil prices are eroding the fuel price advantage for natural gas vehicles. Biofuels and advanced vehicles remain reliant on government regulation to keep their foothold in the marketplace despite a decline in incentives. Additionally, both industries have been slowed somewhat by various limitations in key technological advancements.

Nonetheless, the overall trends are positive and should lead to opportunities within this sector in the near term. ICF is closely tracking these developments and advising clients on the relative prospects for different technologies within market niches as well as innovative program designs that are helping to support growth.

Introduction: An Industry in Transition

Following years of slow to moderate growth in the AFV industry, the American Recovery and Reinvestment Act (ARRA) of 2009 provided a jolt of rapid investment and expansion. Almost $300 million in direct funding came through the U.S. Department of Energy's (DOE's) Clean Cities program alone. As much as $6 billion in total direct ARRA funds may have gone to support the broader alternative fuel and advanced vehicle sector.[1]

1. U.S. DOE Alternative Fuels Data Center, February 2009, "American Recovery and Reinvestment Act of 2009," http://www.afdc.energy.gov/laws/arra.html. Accessed December 31, 2014. The ARRA funding discussed does not including further ancillary support through basic energy research or the total amount of claimed tax credits.

Comprehensive industry statistics remain somewhat limited. The scale-up in deployment of AFVs and advanced vehicles in recent years is evident, especially accounting for the dampening effects of the recession. Earlier in 2014, the industry was adapting well to the expiration of significant federal tax credits and reduction of direct federal funding due in part to federal budget challenges. In the latter half of 2014 with the decline in oil prices (hovering around $60 per barrel [bbl] at the time of publication), that picture unfortunately is not quite so clear. Now, certain segments of the AFV industry—particularly natural gas—may struggle to maintain market share.

The biggest issue for the industry will be losing recent momentum. With oil prices coming down, less incentive exists to switch fuels as a cost-saving measure, which ICF predicts will slow down AFV penetration.

The AFV and advanced vehicle industry must determine creatively about how to maintain market share, find ways to remain competitive with low oil prices, and continue to leverage state and private sector incentives in the absence of federal support. In a review of the five most notable trends in the industry, the signs generally point to growth and maturation in some market segments but potential regression in others. The five trends are discussed below.

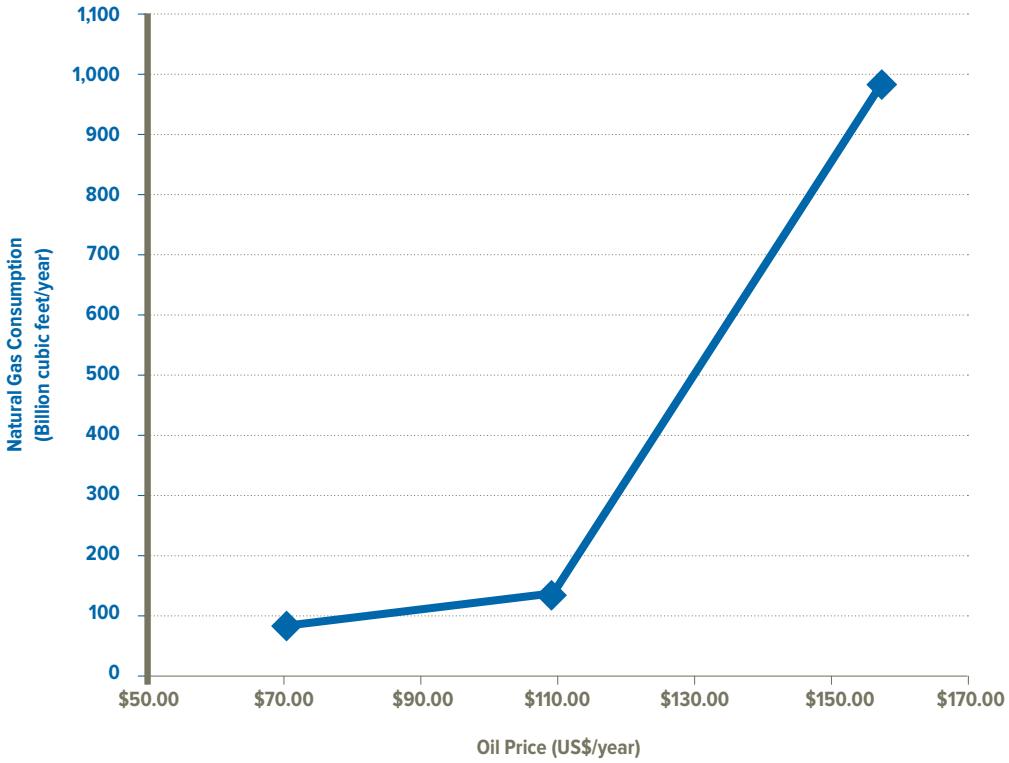
Natural Gas and Propane Use in the Medium- and Heavy-Duty Vehicle Sectors

Through mid-2014, the use of natural gas vehicles (NGVs) and propane vehicles was increasing at a robust rate. This use was driven by the growing availability of fueling infrastructure, increased vehicle options, state incentive programs (including the creative use of federal dollars), private industry incentives, and the price spread advantages of natural gas and propane relative to diesel. Natural gas was 35 to 40 percent less than the price of gasoline earlier in 2014,[2] but at the date of publication the spread was significantly smaller. Unlike the natural gas market, which is largely independent of oil prices, the propane market tends to track diesel prices. The current price advantage for propane is about 20 percent.[3] ICF expects this advantage to remain in that competitive range through the coming decade.

ICF anticipates that NGV growth will be adversely impacted by reduced oil prices in the short term. The payback period will be longer for new investments, causing fleets to be reluctant to make the switch. Worldwide at least 15 million NGVs are in use. With only 112,000 in the United States,[4] opportunities for growth exist. Earlier 2014 sales estimates for heavy-duty natural gas trucks projected upwards of 11,000 units,[5] with the market on pace to see NGVs comprising 10 percent of heavy-duty truck sales in 2020. However, as shown in Figure 1 on the next page, if prices remain between $70 to $110 per bbl the current medium- and heavy-duty market will likely remain the same—around 100 billion cubic feet per year with minimal growth, according to the Energy Information Administration (EIA) Annual Energy Outlook (AEO) 2025 reference case.[6] Only when prices exceed $110 per bbl will we see more pronounced growth in other fleets such as long-haul trucking and taxi fleets. NGVs likely will continue to perform well in certain niche applications, including refuse trucks and transit buses, in the short to medium term. For example, NGVs accounted for almost 55 percent of 2013 refuse truck sales, with 2014 projections expected to rise to 60 to 65 percent, along with 25 to 30 percent of public transit buses.[7]

2. Based on a gasoline gallon equivalent.
3. U.S. DOE Alternative Fuels Data Center, July 2014, "Fuel Prices," http://www.afdc.energy.gov/fuels/prices.html. Accessed December 31, 2014.
4. U.S. DOE Alternative Fuels Data Center, December 2014, "Natural Gas Vehicles," http://www.afdc.energy.gov/vehicles/natural_gas.html. Accessed December 31, 2014.
5. NGV Today, October 8, 2014, "Sales projections for heavy-duty NGVs being revised," http://ngvtoday.org/wp-content/uploads/2014/10/NGV-Today-October-8.pdf. Accessed December 31, 2014.
6. U.S. Energy Information Administration, "Annual Energy Outlook 2012," http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf. Accessed December 31, 2014.
7. NGVAmerica, August 2014, "NGVAmerica Responds to Wall Street Journal's "Slow Going for Natural-Gas-Powered Trucks," http://www.ngvamerica.org/pdfs/press/14-10%20-%20NGVAmerica%20Responds%20to%20Wall%20Street%20Journal%20Article.pdf. Accessed December 31, 2014.

Figure 1: Annual Energy Outlook 2025 Reference Case for Natural Gas Vehicles



Source: Adapted from 2014 EIA AEO reference and sensitivity cases.

Historically, fueling infrastructure has been the Achilles heel to significant NGV penetration Approximately 1,700 public and private compressed natural gas (CNG) stations and 200 liquefied natural gas (LNG) stations are operating and planned in the country.[8] Infrastructure limitations have inhibited the ability of individuals, and certain types of fleets, to reliably refuel.

Although the infrastructure may be lacking for some applications such as long-haul trucking, it is working well for applications like refuse, transit, and other fleets. This status is due in large part to the high fuel consumption potential, set routes, and return-to-base operations. However, new investments in NGV infrastructure may decrease, and existing infrastructure may be shuttered or temporarily closed as the market adjusts to a decline in oil prices.

Conversely, ICF considers propane vehicles to be on a positive growth track. Twenty-three million propane vehicles are in use worldwide. While only 143,000 of these vehicles were on U.S. roads as of 2010, these numbers are increasing. More than a dozen propane-compatible engines are certified for on-road use. They provide a variety of options for fleets, including school buses, shuttles, service vehicles, and delivery trucks.

ICF projects that propane's price advantage—combined with new emissions-certified engines for propane vehicles, growing availability of fueling infrastructure, and increasing acceptance by commercial vehicle fleet operators—will mean that by 2020, more than 220,000 propane vehicles will

8. U.S. DOE Alternative Fuels Data Center, Alternative Fueling Station Locator.

be on the road, consuming some 400 million gallons of propane annually.[9] For example, in 2014, UPS announced plans to invest $70 million to purchase 1,000 propane delivery trucks and install 50 fueling stations. This fleet will be one of the most extensive private propane fleets in the country.

The growth in propane-fueled vehicles will translate into demand for additional fueling infrastructure. At the date of publication, nearly 3,000 public and private propane fueling stations were operating and planned in the country.[10] To accommodate increased demand, ICF projects a fourfold increase in total propane fueled vehicles to a total of 12,000 stations nationwide by 2020.[11]

Overall, much of the NGV and propane vehicle industry likely will experience negative impacts to vehicle and infrastructure sales until oil prices stabilize or increase. ICF is closely monitoring this trend. We will update projections through our industry-leading modeling tools to determine potential impacts within the market under a range of price scenarios.

Robust Growth in PEVs

Although the federal Qualified Plug-In Electric Drive Motor Vehicle tax credit is still an important driver for early PEV adoption, ICF anticipates PEV credits will begin to phase out around 2018 for some manufacturers as they approach 200,000 PEV sales.[12] Similar to the 2010 phase-out of the alternative fuel motor vehicle tax credit that supported the growth of the hybrid electric vehicle (HEV) industry, consumers are expected to continue to purchase PEVs if a clear cost-benefit exists.

Although PEVs remain a relatively small part of the U.S. automobile market, their share is growing rapidly. U.S. PEV sales topped 100,000 in 2013—nearly double the sales in 2012. The total for PEVs deployed in 2014 is on pace to exceed 2013 sales. As of September 2014, the national total was more than 250,000 PEVs.[13] These adoption rates for PEVs have outpaced analogous rates for HEVs: By the third year of availability in the retail market, PEV sales were 50 percent higher than HEV sales at the same point. The market expansion has gone hand in hand with increasingly accessible charging infrastructure. More than 8,500 public charging locations and more than 21,000 charging outlets are available nationwide.[14]

This growth has been bolstered by state commitments to promote zero emission vehicles (ZEVs), including PEVs. In October 2013, eight governors signed a memorandum of understanding to deploy 3.3 million ZEVs and adequate infrastructure by 2025. Many of these states, including California, Maryland, and Massachusetts, have implemented vehicle and infrastructure incentives to encourage rapid deployment.

Again, PEVs continue to be supported by a significant federal tax credit. Nonfederal incentives may be playing an increasingly meaningful role in inducing consumers to consider advanced vehicles. The Alternative Fuels Data Center lists more than 350 incentives, laws, and regulations related to PEVs, including fleet acquisition requirements, electric vehicle supply equipment (EVSE) access requirements, free or preferential parking, and building code modifications for EVSE. High-occupancy vehicle (HOV) lane access also has been a motivator in certain metropolitan areas in states such as California, Georgia, and New York. An October 2014 study from University of California-Davis found that, depending on the

9. ICF International, 2013 Propane Market Outlook Update, http://www.icfi.com/insights/reports/2013/propane-market-outlook-2013. Accessed December 31, 2014.
10. U.S. DOE Alternative Fuels Data Center, Alternative Fueling Station Locator.
11. ICF International, 2013 Outlook for Vales and Regulators in Consumer Propane and LNG Vehicle Markets.
12. Based on vehicle purchase data; for more information about the Plug-In Electric Drive Motor Vehicle Tax Credit, see http://www.afdc.energy.gov/laws/409. Accessed December 31, 2014.
13. InsideEVs, December 2014, "Monthly Plug-In Sales Scorecard," http://insideevs.com/monthly-plug-in-sales-scorecard/. Accessed December 31, 2014.
14. U.S. DOE Alternative Fuels Data Center, Alternative Fueling Station Locator.

type of vehicle purchased, 34 to 57 percent of PEV owners in California were primarily motivated by solo access to HOV lanes.[15] In fact, the California program has been so popular that the California Air Resources Board expanded the HOV access limit to 70,000 qualified vehicles.

A significant emerging trend is the role of utilities and the deployment of PEVs and charging infrastructure. In certain markets, utilities are beginning to understand the value proposition for PEVs—not just through increased electricity sales but also improved ancillary services for ratepayers and battery storage opportunities through vehicle-to-grid technologies. Consumers also may benefit through reduced time-of-use pricing for electricity, infrastructure rebates, and incentives to obtain vehicle batteries at the end of the serviceable life.

All in all, the news for PEVs has been mostly positive. Unfortunately, PEVs are not likely to be cost competitive in the near- to midterm until innovations in battery technologies result in significantly lower manufacturing costs. Until then, state incentives, utility programs, and nonfinancial incentives will be key to the sustained growth and adoption of these vehicles in the interim, which adds a degree of uncertainty to the future. For strong growth to continue, careful design of these incentive programs will be important. So will be the continued advancement of vehicle technology to improve cost profile and performance.

Growth and Innovations in Biofuels Resulting from Compliance Markets

Environmental regulations such as the U.S. Renewable Fuels Standard (RFS), administered by the U.S. Environmental Protection Agency (EPA), and the California Low Carbon Fuel Standard (LCFS), administered by ARB, have markedly increased the amount of alternative fuel consumed in transportation with little to no direct federal investment. Despite initial compliance challenges with these regulations, the market has responded by developing innovations in everything from feedstock use to production efficiencies.

RFS requires obligated parties (e.g., refiners) to meet progressively higher annual volumetric targets for biofuels, including renewable fuels, biomass-based diesels, and cellulosic fuels totaling 36 billion gallons in 2022. The industry has experienced some challenges reaching the 2013 and 2014 blending targets due to the limitations of blending ethanol in gasoline (also known as the blend wall). However, many innovations have resulted to overcome these limitations. For example, renewable natural gas, which was approved in 2014 as an eligible D3 cellulosic biofuel, may be used in NGVs. As of November 2014, nearly 18 million D3 cellulosic biofuel renewable identification numbers (RINs) were generated, with the majority just within the latter half of the year.

In late November, EPA announced a delay in the final volumetric requirements until 2015, in part due to the agency's need to evaluate "whether and on what basis the statutory volumes should be waived."[16] This delay has led to a number of ramifications in the industry, including uncertainty surrounding future investments, particularly for cellulosic biofuels, and blending requirements for obligated parties.

The RFS impacts national fuel markets. State mandates have significantly impacted regional markets. The California LCFS, for example, requires a 10 percent reduction in the carbon intensity of transportation fuels sold in the state by 2020. This LCFS uses a market-based system of credits and deficits: Transportation fuels that have a greater carbon intensity lead to deficits, and fuels that have a lower carbon intensity generate credits.

15. Tal, G. and Nicholas, M. Exploring the Impact of High Occupancy Vehicle (HOV) Lane Access on Plug-in Vehicle Sales and Usage in California. October 2014. Available online: http://www.its.ucdavis.edu/research/publications/publication-detail/?pub_id=2355. Accessed December 31, 2014. See also Hybridcars.com, "HOV Access Is Key for California Plug-in Car Purchases."
16. Federal Register, December 2014, "Delay in issuing 2014 Standards for the RenewableFuel Standard Program," https://www.federalregister.gov/articles/2014/12/09/2014-28163/delay-in-issuing-2014-standards-for-the-renewable-fuel-standard-program. Accessed January 9, 2015.

In a recent ICF report, approximately 50 percent of all fuels used for LCFS compliance in 2020 are projected to be biofuels, including many advanced biofuels.[17] Ethanol producers are responding to the need for lower carbon fuels by investing in technologies such as cogeneration and feedstock switching (e.g., moving from corn to sorghum or milo). Furthermore, most corn ethanol facilities today are outfitted with equipment to extract distiller's corn oil. A nonedible vegetable oil well suited for biodiesel production, it has a lower carbon footprint than traditional soy-based biodiesel. Today, much of the corn oil-based biodiesel is consumed in California.

The LCFS will lead to significant investments in infrastructure (including EVSE and natural gas stations) and AFVs and is already driving increased volumes of alternative fuels into California.[18] Other states such as Washington and Oregon are evaluating whether similar standards may work in their areas, potentially leading to more alternative fuel demand.

Some discussion remains about whether, and how greatly, fuel mandates might affect consumer prices, creating a degree of regulatory uncertainty in the future. Clearly, both the RFS and LCFS have dramatically reshaped the alternative fuels market and can be expected to continue to drive growth in the short and medium term. However, for the time being, the biofuel industry needs realistic solutions to overcome the blend wall and remain cost competitive, particularly as gasoline and diesel prices decline. Alternative fuel initiatives based on carbon reductions such as the LCFS may possibly inform national policies and could provide the market with greater flexibility for compliance. Understanding how alternative compliance solutions could benefit the biofuels industry will be important for producers, regulators, and vehicle manufacturers.

Private Sector Financing of AFV Fueling Infrastructure

The recently expired federal Alternative Fuel Infrastructure Tax Credit provided a significant financial incentive to support investments in AFV fueling infrastructure, allowing developers to claim credits worth 30 percent of the cost, up to $30,000. However, in the wake of the expiration of the incentive in 2013,[19] the private sector moved to fill the gap by developing a variety of approaches on fueling services, easing fleet and individual use of AFVs. Companies such as Clean Energy Fuels, Trillium, Ferrellgas, AmeriGas, ChargePoint, NRG eVgo, and AeroVironment provide a broad range of infrastructure financing and payment schemes.

Some, such as eVgo, offer infrastructure and services under a third-party ownership model: Commercial building owners, for example, can contract with the company to install EVSE on an a la carte basis depending on tenant demand. The chargers are removed when tenants leave. ChargePoint, on the other hand, sells its equipment directly on a no-money down, 3- to 7-year financing plan. Some businesses also provide the fueling infrastructure at low or no cost with a volume commitment. Although the natural gas and propane industry have been offering similar financing options for many years, awareness and adoption of these infrastructure services is greater than ever before. For example, Trillium CNG develops public access stations by securing a fuel purchase agreement with a customer for each station location. The business model is designed to meet a wide range of customer needs for both public access and private CNG fueling locations. In May 2014, Trillium announced plans to build 101 public access Class 8 truck-accessible CNG stations along major interstate highways by the end of 2016.[20] However, some risk is

17. ICF, 2013 California's Low Carbon Fuel Standard: Compliance Outlook for 2020, prepared for the California Electric Transportation Coalition.
18. California's Low Carbon Fuel Standard: Compliance Outlook for 2020, June 2013.
19. HR 5771, the Tax Increase Prevention Act of 2014, extended the Alternative Fuel Infrastructure Tax Credit through 2014 which had originally expired in 2013.
20. Integrys, May 2014, "Trillium CNG on Target to Build 101 Class 8 Accessible Public CNG Stations by 2016," http://www.integrysgroup.com/news/view_article.aspx?reckey=02556&companyID=ITF. Accessed December 31, 2014.

evident for these stations to be suitably used, and sufficient demand is required. As one way to address this chicken compared with the egg scenario, some fuel providers such as Clean Energy Fuels will buy down the cost of the vehicles in addition to providing fueling infrastructure. These and other vehicle options are addressed in the next trend for innovative fleet management options.

ICF expects that the market will continue to grapple with the issue of how best to meet the needs of fleets for capital-intensive fueling investments. However, the private sector is already well under way in developing innovative approaches that help mitigate the upfront cost for infrastructure and make AFVs more attractive. Again, some fuels such as natural gas will likely see reductions in private sector infrastructure investments contingent on the reaction of fleets as they navigate lower conventional fuel prices.

Innovative Fleet Management Options for AFVs

Similarly, with the loss of federal tax incentives, the private sector is stepping in to create new approaches for purchasing and managing alternative fuel and advanced vehicles.

The Nissan LEAF lease has been an especially popular option for fleets, including the cities of Sacramento, Seattle, Olympia, Dallas, Houston, and Oklahoma City. Nissan's Municipal Lease option includes 24- to 60-month terms with advance annual payments and leases that fully amortize down to $1 at the end of the term. The company also offers other options with the same or shorter terms, along with stipulated lease-end purchase prices set at the lease inception and with either one upfront payment or varying payment terms.[21]

At the same time, fleet share services with companies such as Zipcar are making AFVs more widely available to fleets and individuals. The City of Houston created a central car share program for city employees along with training on basic vehicle operation. This program has opened HEV and PEV use to almost 20,000 people, with a focus on the 800 downtown employees without assigned vehicles. The city is hopeful that the exposure also may create rippling benefits as workers make decisions on vehicle purchases for their own use.

Some states also are offering no- or low-interest loans to government and for-profit entities for the acquisition of alternative fuel vehicles. For example, the SouthCarolinaSAVES™ Green Community Program, administered by Abundant Power, provides low-cost financing for qualified conservation measures, including natural gas and propane fleet conversions. The loan is repaid through the fuel savings from the project.[22] Many other states have implemented similar revolving loan programs in part, or whole, from ARRA funding.

This innovation is welcome news and should be helpful to cost-effectively expand the market. In the longer term, however, continued advancement in vehicle technology and cost competitiveness is necessary to make more significant and widespread inroads in both public and private fleets.

Conclusion

In an environment where states and the private sector have moved to fill the incentive gap left by waning federal financial support and certain alternative fuels and advanced vehicles beginning to gain traction, we see signs of solid performance in the market. We forecast strong continued growth in certain segments of the AFV and advanced vehicles industry.

21. Nissan, June 2014, "100% Zero Emission Nissan Leaf, EV Fleet Applications," https://www.mysolutionis.com/fleet-management/clean-cities-coalition/Documents/Presentation-CFTC2014-DamianHerdCompressed.pdf. Accessed December 31, 2014.
22. South Carolina Energy Office, "SouthCarolinaSAVES™," http://www.energy.sc.gov/files/view/SCSAVESOverview814.pdf. Accessed December 31, 2014.

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The encouraging trends have included innovative financing and fleet management options, effective compliance markets and regulatory mandates supporting alternative fuels, and signs of growing acceptance and rapid adoption of AFVs and advanced vehicles, especially in certain niche markets.

Looking ahead, fleet managers, utilities, policy makers, and consumers should nonetheless be prepared for natural growing pains as the market develops and attempts to retain momentum in a new reality of lower oil prices. The AFV and advanced vehicle industry will need to think creatively about how to maintain market share, find ways to remain competitive, and continue to leverage state and private sector incentives in the absence of federal support. The generally hopeful signs emerging in 2014 will not necessarily translate smoothly across all vehicle types. Risks remain from an unknown rate of technological advance, fluctuations in relative fuel price spreads, and the ever-present uncertainty in regulatory support.

ICF has been working with the alternative fuels industry for decades and remains heavily engaged. We continue to leverage our deep understanding of the market and experience working with a broad range of clients in the public and private sector, including the alternative fuel and advanced vehicle industry, utilities, and all levels of government. We provide policy and technology analysis, program design and implementation, and other advisory services to position our clients for the growth and change that lies ahead.

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